Introduction to Spatial Data Infrastructure

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The World Bank

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* Benefits
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* Current use trends
* Challenges in SDI implementation

Background

The mission of The World Bank's Latin America and the Caribbean Region (LCR) Disaster Risk Management (DRM) team is to work with national and local governments and with communities to identify hazard risk, assess vulnerability to adverse natural events and mitigate the impact of disaster through structural and non-structural measures, including risk financing and transfer.

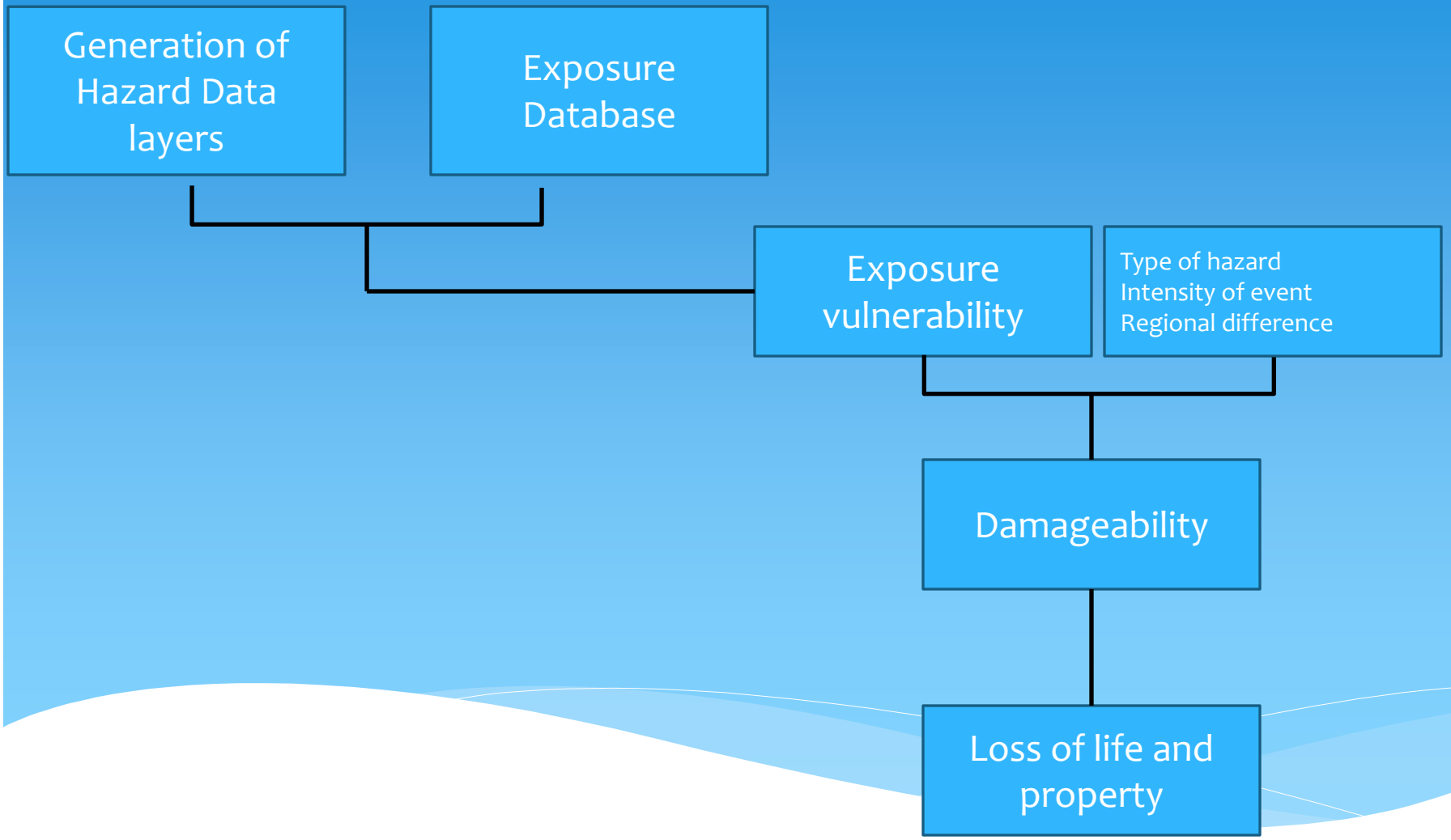
Spatial Data is the ***key*** to the analysis.


Puerto Rico
Anguilla
Antigua and Barbuda
St. Kitts and Nevis
Montserrat
Guadeloupe
Dominica
Martinique
St. Lucia
Barbados
St. Vincent and the Grenadines
Grenada
Venezuela
Trinidad and Tobago

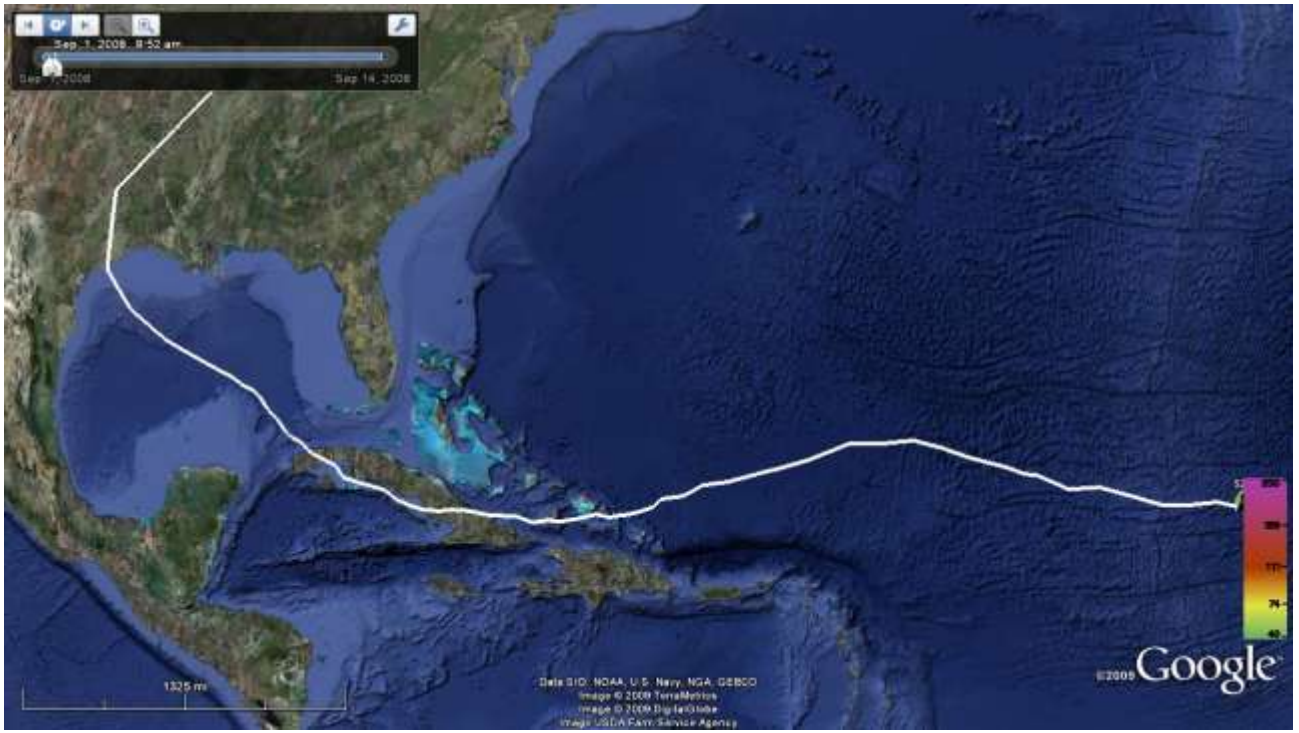
Building resilience and better decision-making

* Latin America and the Caribbean (LAC) region is one of the most vulnerable region with respect to natural disasters
* 20 countries in LAC region have half of the GDP exposed to natural disasters
* Damages due to natural hazards happen because of **HOW** and **WHERE** we build
* The key is using (geospatial) data in decision making process

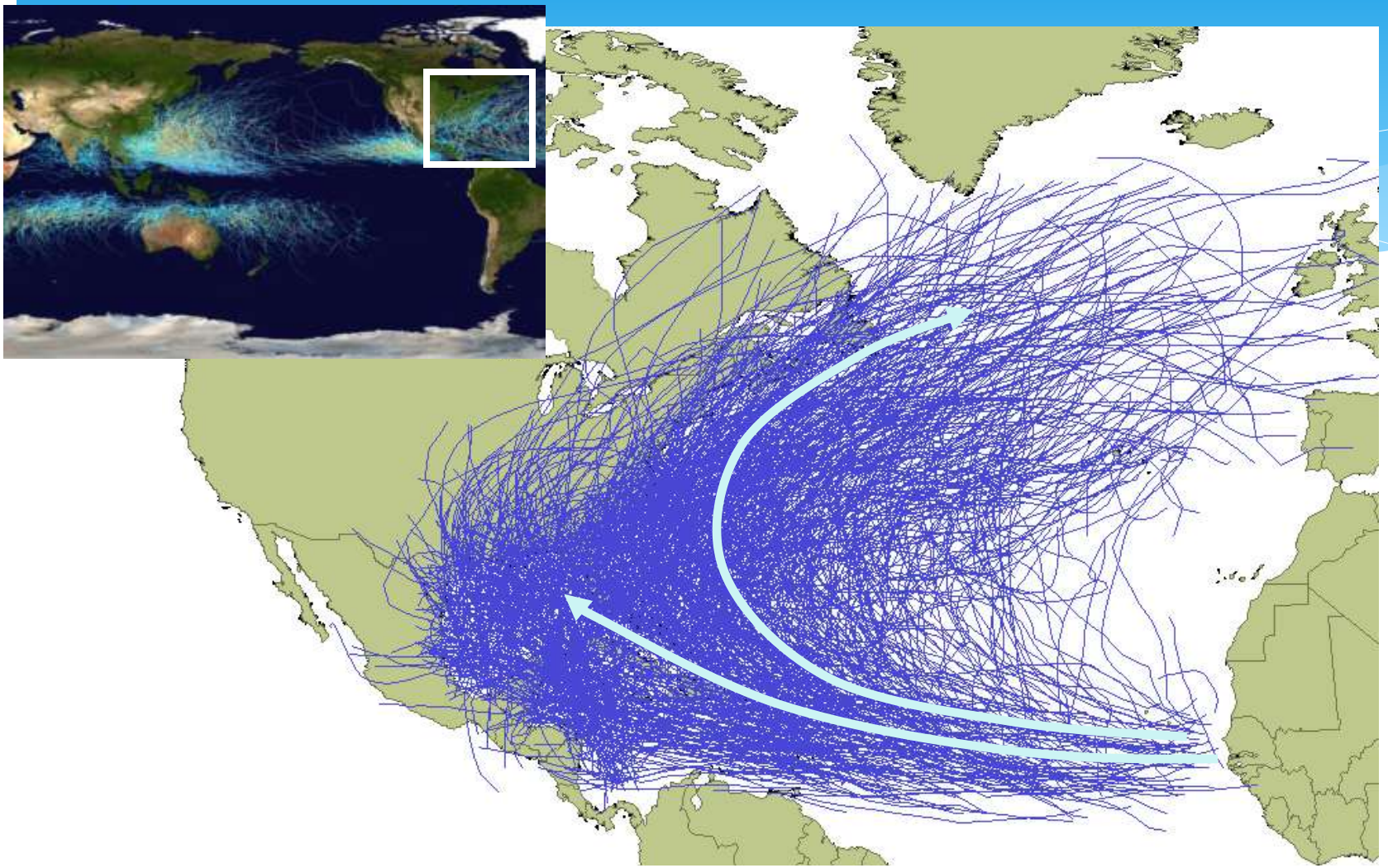
Risk Assessment Process



Simulation of Hurricane Hazard



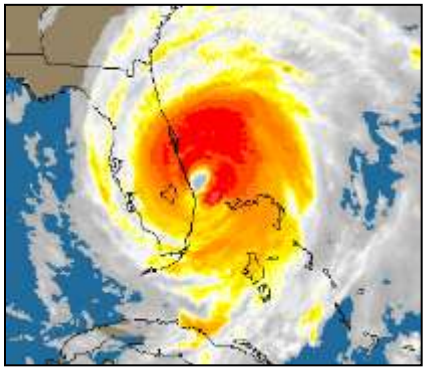
Historical Tracks since 1900



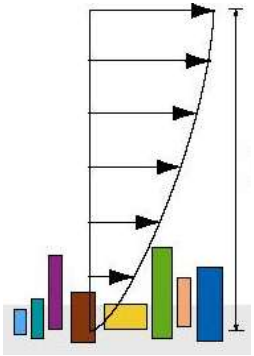
Since 1900, over 900 tropical cyclones have formed in the North Atlantic.

Calculation of damage and loss (Risk)

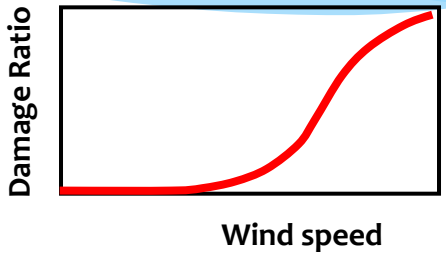
Event Footprint



Local Intensity Calculation



Damage Estimation



Loss of life, injury / Displacement
Loss in monetary values

Exposure Database

Spatial Data layers and attributes

* Location, Footprints (Buildings, Assets)
* Primary characteristics – Geometry, Orientation construction class occupancy, roof types, roof geometry, roof slope, roof built, wall, stories, age, foundation, ornamentation … etc
* Secondary characteristics - Soft story, Pounding by nearby buildings, loose debris, Trees, Large missile object, Terrain roughness, Irregular structure, Retrofit, Glass material type… etc

Exposure

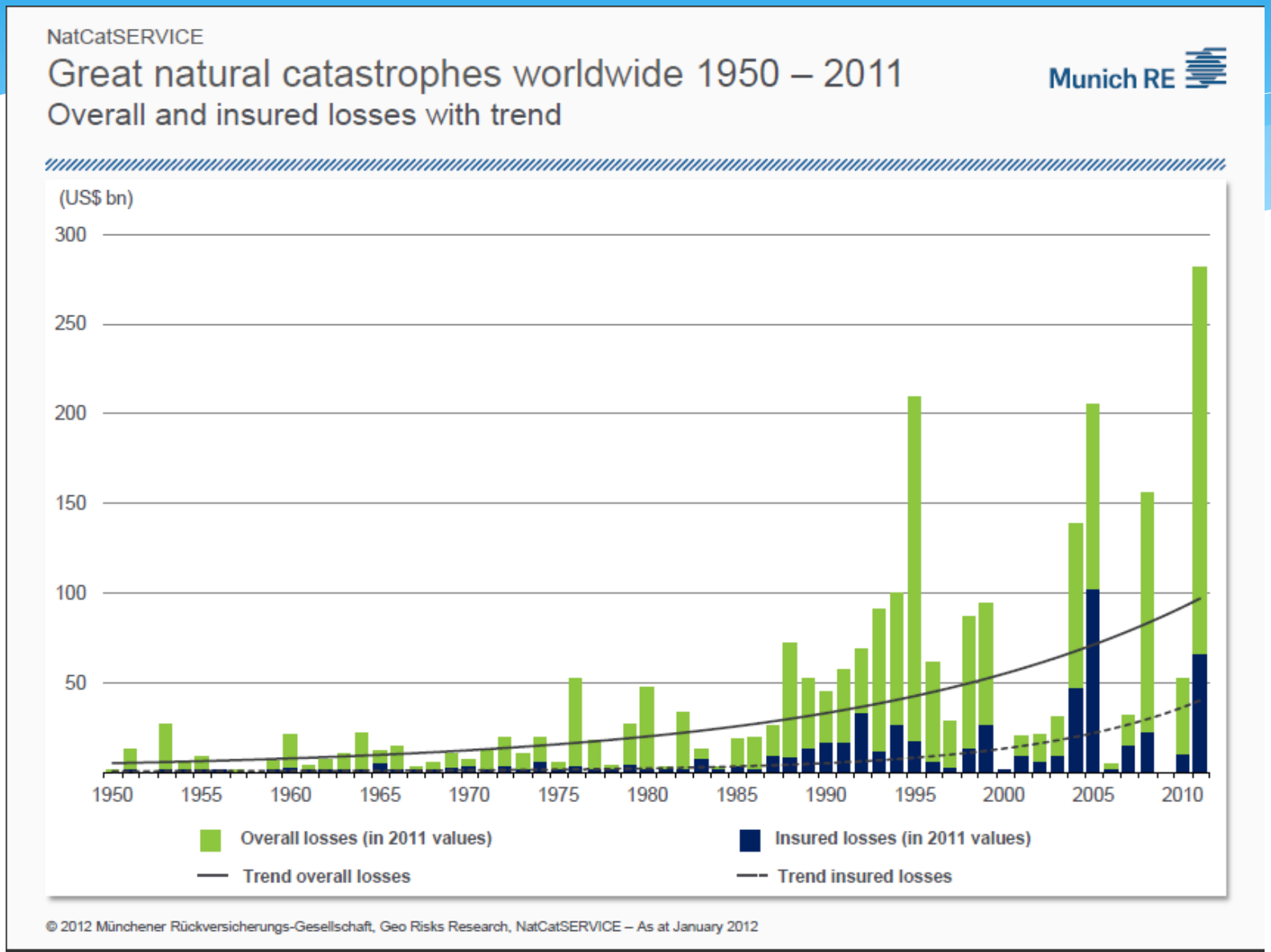
Feature Info

to_buildings.11362

2 / 2

Name	Value
age	0
attrsource	ADB-PED 2010
bldg_id	TO-TO-004356
b_frame1	LOAD BEARING WALL
c_exist	False
defect1	NONE
featsource	SOPAC 2010
followup	False
found1	SLAB
found_br1	NONE
f_area	2197
f_maxht	0.2-0.3 M
f_minht	0.2-0.3 M
g_slope	FLAT
id	4356
machine	SB1
mainuse	COMMERCIAL
nav_id	2527

Risk Assessment – Why it matters?



A&B – Natural Disasters

Disaster	Date	Damage (000 US$)
Hurricane Luis Category 4	5-Sep-1995, Direct hit	350,000
Hurricane Georges Category 3	20-Sep-1998 Direct Hit	100,000
Hurricane Hugo	17-Sep-1989	80,000
Hurricane Earl	29-Aug-2010	12,600
Hurricane Baker/Hurricane Dog	August/Sep 1950 Storm Surge of 2.4 m Wind gust 144mph	1,000

Source: EM DAT

Top 10 Natural Disasters in Antigua and Barbuda for the period 1900 to 2014
sorted by numbers of total affected people:

Disaster	Date	No Total Affected
Drought	**Nov-1983**	**75,000**
Storm	15-Oct-2008	25,800
Storm	17-Sep-1989	8,030
Storm	29-Aug-2010	5,000
Storm	5-Sep-1995	3,702
Storm	17-Nov-1999	3,423
Storm	20-Oct-1999	2,534
Storm	20-Sep-1998	2,025

Exiting Spatial Data Situation in the Caribbean

- Not enough data to carry out analysis
- Existing data not readily available
- Numerous data format
- Poor or questionable data quality
- Scale of the data not sufficient
- Metadata non-existent or scant
- Data Vintage
- Data not in digital format or not in raw machine readable format

No comprehensive Data Sharing mechanism

Treating Spatial Data as a National Asset

National Policy

Data Inventory

Quality

Relevance

Data Gap

Policy/Guidelines/Standards


Belize National Spatial Data Infrastructure (NSDI) Policy

National Spatial Data Infrastructure (NSDI) Working Committee

Belize

21st August 2012

Approved at meeting of Cabinet held 21st August, 2012

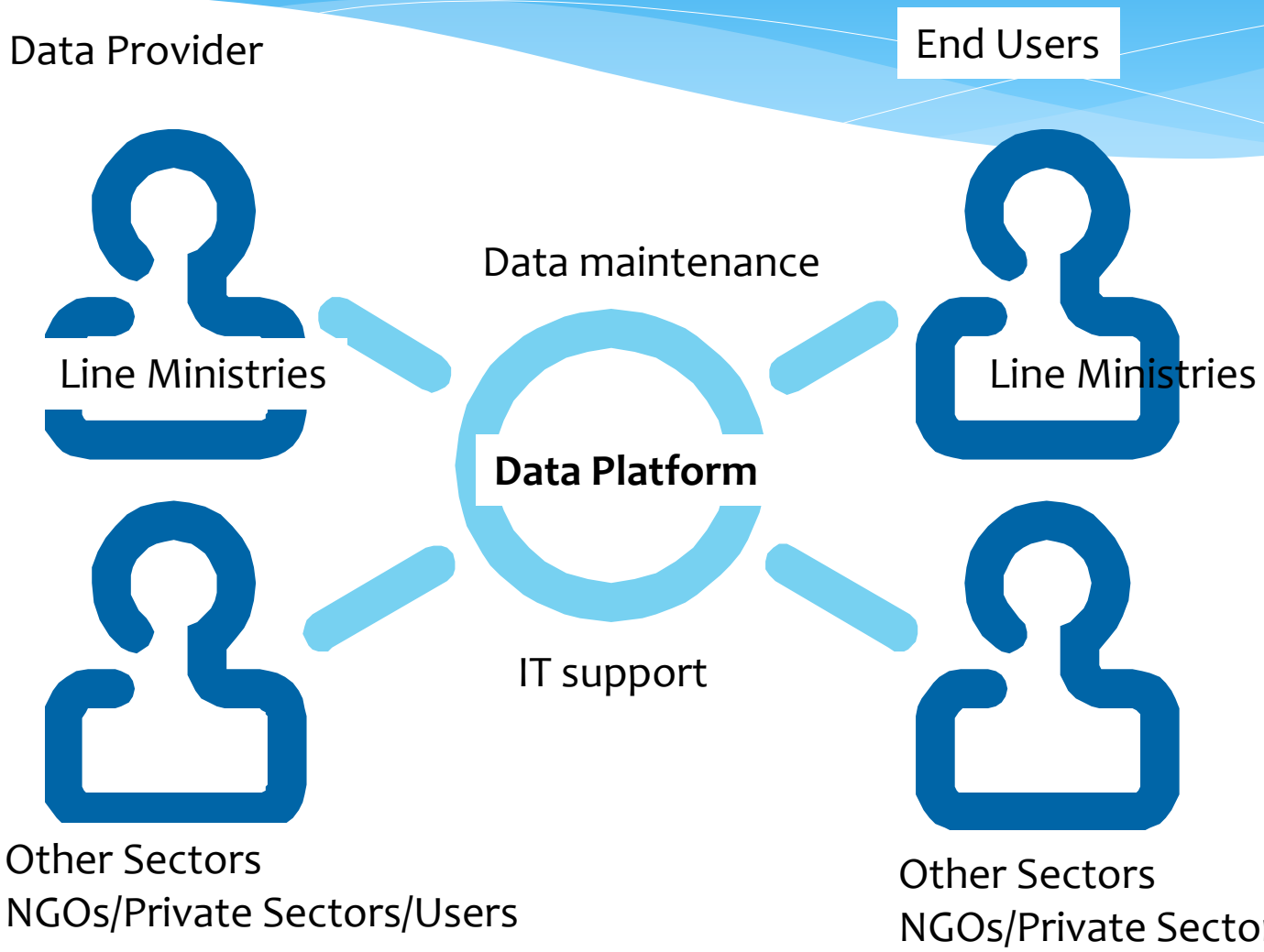
Cabinet-Confidential Memorandum No. 40 of 2012

Resource/Capacity inventory

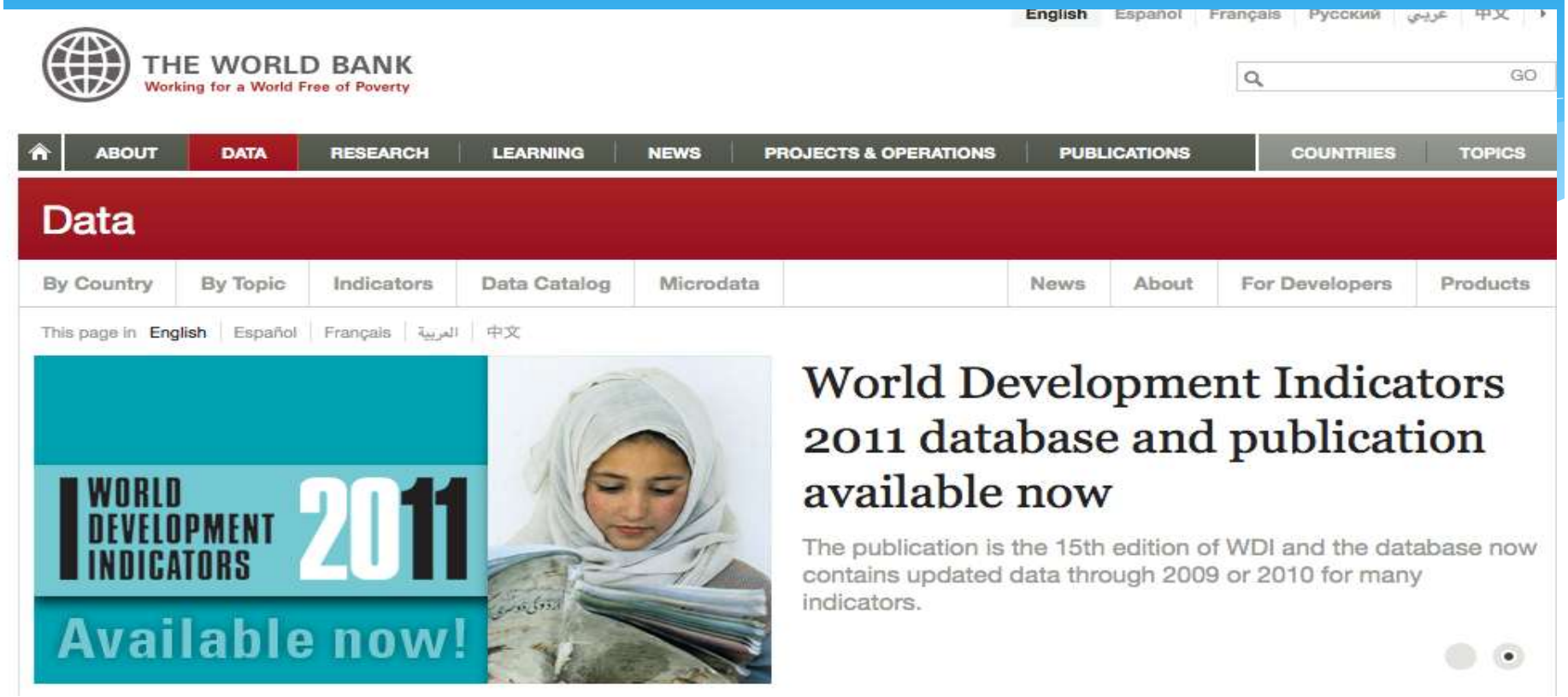
	Sewer surveys?	information given. Using Carlson Surveys with AutoCAD to transfer data to referenced shapefiles.	required to transfer AutoCAD road surveys to GIS. ArcGIS was given to them. Also, road surveys need to be referenced to the survey grid.
DOWASCO	Water and Sewer lines.	Would need training similar to what public works has in order to reference and transfer their data from AutoCAD to GIS. Would need personnel with training in GIS/AutoCAD. They rely on paper maps from Lands/Surveys. It would be more efficient for them to have geotiffs perhaps.	No effort is being made to put data into a GIS. It is not a priority. They do not have the software or the people. Older maps are on paper, only newer lines are in AutoCAD (not georeferenced).
Met Office	Rainfall, weather and climate.	They claim to have the necessary training but need the software and a system with clear procedures and requirements to upload to. It may be useful to do some geostatistical analysis on the weather data once it is entered to create continuous climate maps for Dominica.	All data is in a tabular format based on weather station locations. They are working actively with Agriculture. They will likely contribute when the geonode is operational.

Data Inventory

Collaboration Framework



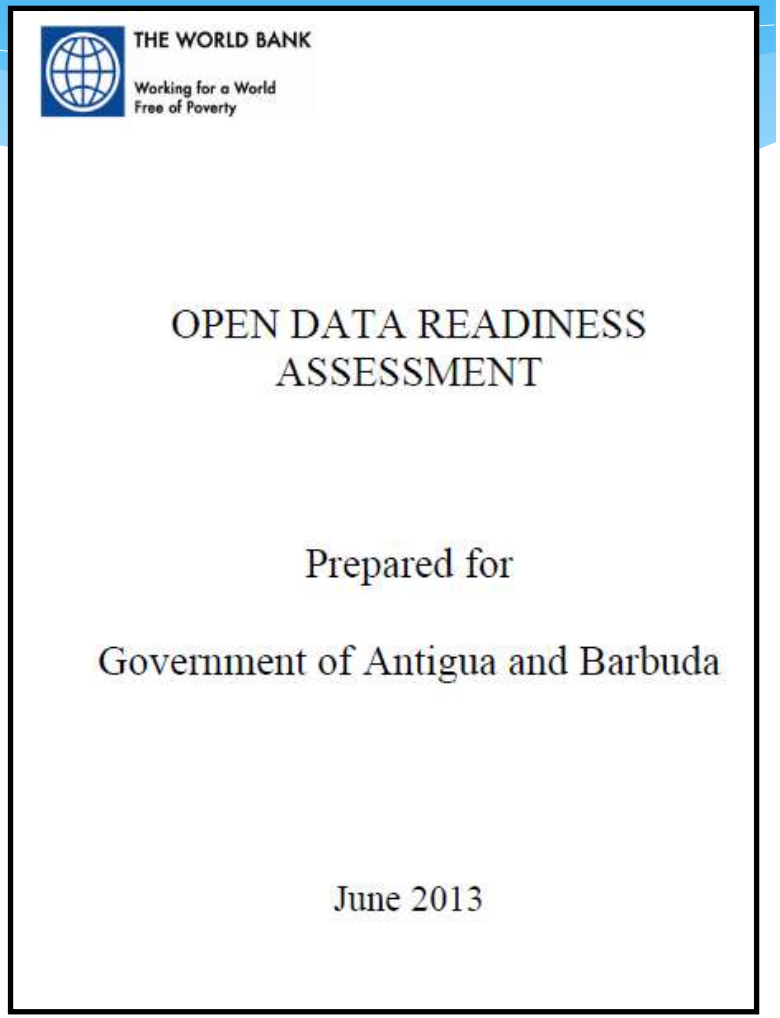
Open Data & the World Bank



The World Bank recognizes that transparency and accountability are essential to the development process and central to achieving the Bank's mission to alleviate poverty. As a knowledge institution, the World Bank's first step is to share its knowledge freely and openly.

Advances in Antigua and Barbuda

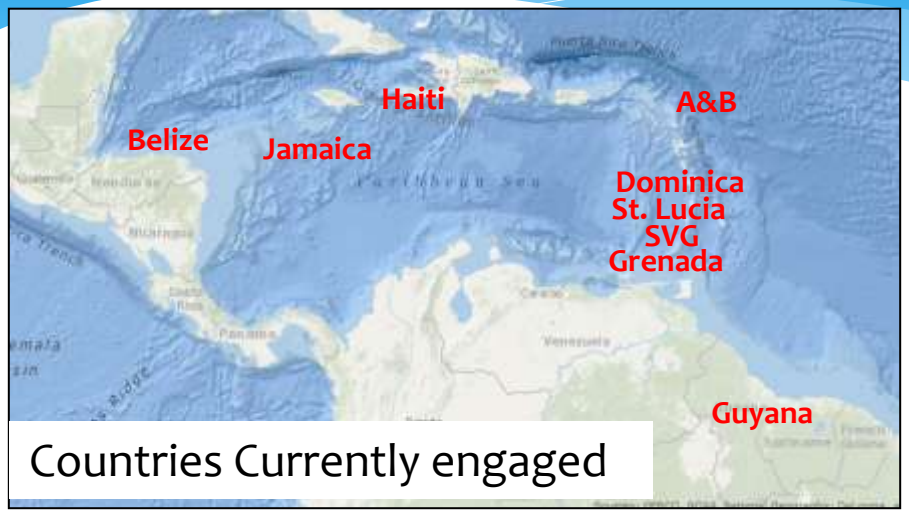
* Open Data readiness Assessment



Open Data for Resilience Initiative (OpenDRI)

The Open Data for Resilience Initiative (OpenDRI) is a global partnership that aims to encourage and facilitate the sharing and use of climate, disaster and other geospatial data to enable more effective decision-making by providing the rationale, technical assistance, and tools for data sharing.

Caribbean OpenDRI



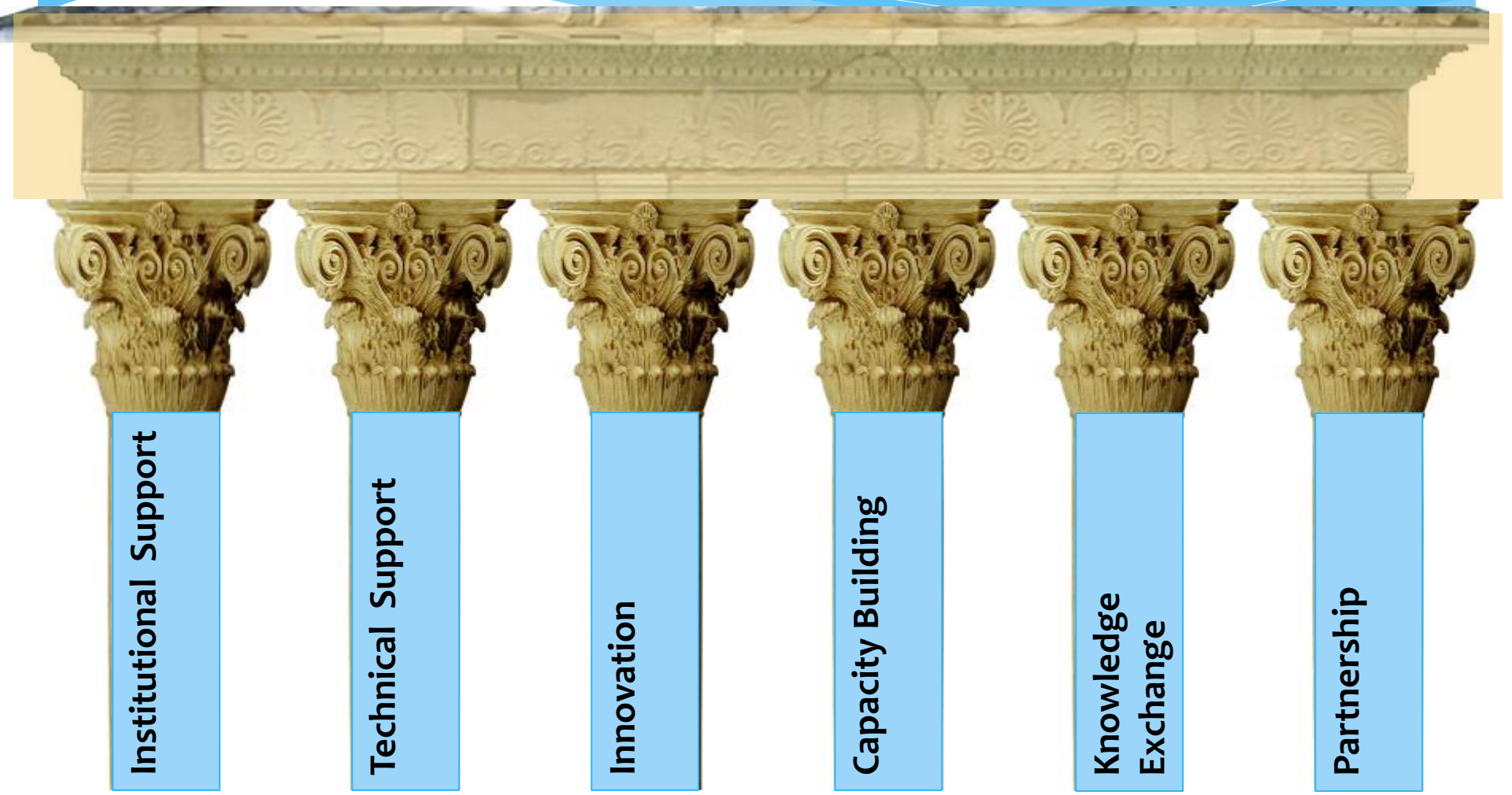
Haiti	www.haitidata.org
St. Lucia	http://sling.gosl.gov.lc/
SVG	http://geonode.gov.vc/
Dominica	www.dominode.net
Grenada	Intranet version only
Belize	http://geoserver.bnsdi.gov.bz/
Jamaica	http://cariska.mona.uwi.edu/
Guyana	http://www.geoserver.ggmc.gov.gy/
Antigua and Barbuda	http://geonode.data.gov.ag

Current Activities to promote OpenDRI

- Institutional Support
- Technical Support
- Innovation
- Capacity Building
- Knowledge Exchange
- Partnership

One of the largest community of practitioners with over 150 active community members

Six Pillars of OpenDRI



Capacity Building

Two regional workshops have been conducted on data management practices in the Caribbean.

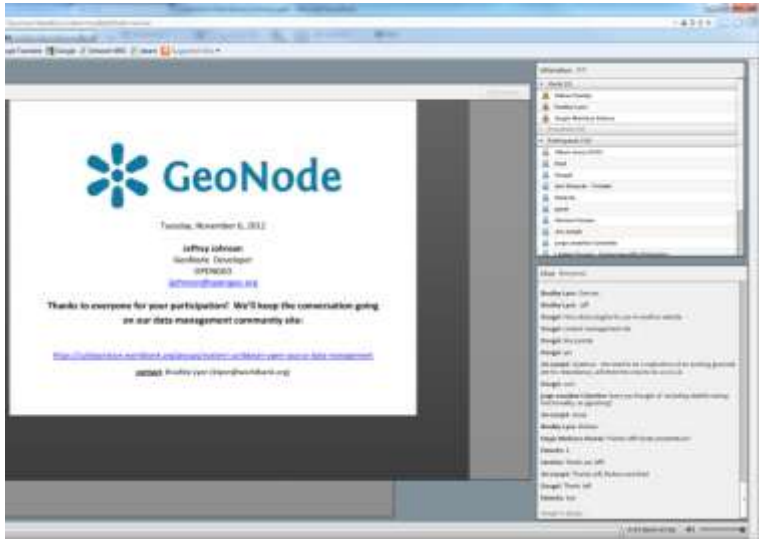
Training/Workshop	Date	Location
Spatial Data Management Training	January, 2013	Belize
Advanced Training on spatial data management	Feb. 18-23, 2013	UWI - Trinidad
DVRP Data Management Workshop	Fall 2013	SVG
Workshop on Conservancy Adaptation Project	March 2014	Guyana
Caribbean Risk Information Program – Kickoff	Spring 2014	TBD

Knowledge management and exchange

Strong community of practitioners - about 80 active participants

Monthly Webinar

Continuous engagement with community of practitioners



Partnership

* Partnership with local entities
* The Nature Conservancy
* Caribbean Community Climate Change Center
* University of West Indies
* USAID (RRACC)
* Georgia Tech CHAMP
* The World Bank – other sectors

OpenDRI Emerging Technologies

Tools

GeoNode - Collaborative data sharing

InaSAFE - Deterministic risk assessment

CAPRA - Probabilistic risk assessment

QGIS – Open Source Desktop GIS

OSM - Participatory mapping

Open Data Tool Kit – Mobile data collection

Spatial Data Infrastructure (SDI)

Adapted from GeoNode training previously conducted

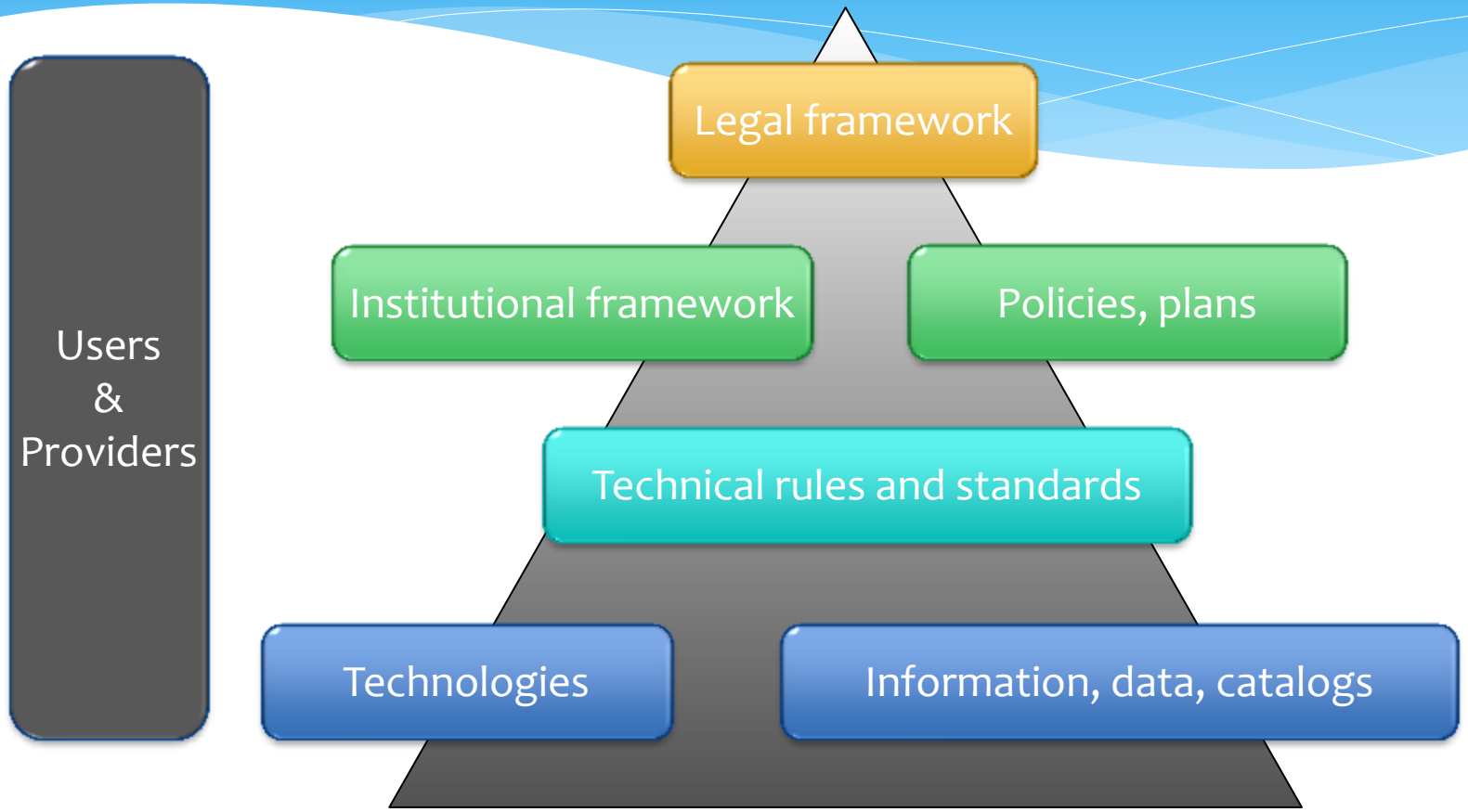
SDI goals

* Fulfill the basic rights regarding **access** to information generated by public institutions, for governmental and private entities as well as the general public
* Provide better visibility and **transparency** to the actions and projects of the public and private institutions, offering the public useful information and participation tools
* **Integrate** geographical information on a common cartographic base, complete and updated
* **Coordinate** information production, access and use, to improve efficiency and interoperability, both horizontally and vertically
* Support the coordination of **multi-disciplinary activities** like strategic planning, land planning, risk management, resource management…
* Support the economic and social **development**, reducing costs for companies and professionals to access information and therefore allow them to create added-value products and services

Brief history

* FGDC: Created in USA by National Executive Order (1994)
* Open Geospatial Consortium created from OpenGIS project (1994)
* ISO/TC211 formed (1994): WMS (2000), WFS (2002), GML Simple Features (2006) standards released
* National SDI consolidation in USA, Europe, Australia. EU INSPIRE Directive (2007)
* Thematic and national SDIs advancing in other regions

Components of a SDI



Components of a SDI

- The **legal and institutional framework** is essential to the sustainability of an SDI:
- Defining *competences and responsibilities* for information production, maintenance and distribution
- Defining *policies* regarding information access and use
- Creating reasonable *rules and standards* for interoperability, and promote their adoption
- *Planning* of coordinated needs and solutions
- Optimizing *resources* by means of joint projects

Key Elements for a National SDI

* National Policy for Geoinformation
  * Access, use, distribution
  * Allow modulation for different thematic areas
* National Cartography Plan
  * Define fundamental and thematic datasets
  * Define responsibilities for sectors/thematic areas
  * Define mechanisms for funding, shared responsibility
* SDI Implementation Plan
  * Must consider all SDI components
  * Phase 1: Base legislation, data production investments. Visible prototypes
  * Phase 2. Technological development and institutional development
    * Human resources intensive (training, metadata, publishing)
    * Investment towards technological platform and institutional capabilities
  * Phase 3. Maintenance and update
    * Coordinated procedures and funding for data maintenance
    * Metadata update, scalability of services

Funding options

- Essential shared datasets should be assumed as **a public asset** and funding provided by the State
  - E.g. The National Plan or Aerial Ortho-photography in Spain
- Under the co-responsibility policy, **each institution** must provide funding for the data assigned by the National Plan
  - Free Web access, at least for map-image view
  - Cost recovery for non-commercial downloads, physical copies
  - Data sales and exploitation agreements for commercial uses
  - Added-value products and services
- **International** cooperation funds
  - Inter-institutional R&D (to develop technological platform)
  - Generation of base datasets (orthophotos, cadaster, base cartography) to regularize land property, support infrastructure development
  - Multi-national priority areas: climate change, disaster risk management
  - Institutional and governance strengthening
- Coordination with e-Government **programs**
  - Implementation of public services (certifications, permits…)
  - Develop network connectivity and other technological components
  - Improve institutional capabilities, especially at local government level

Key benefits

- Better information management **within country**
  - Avoid information *loss*, *duplications and inconsistencies* leading to inefficiencies, mistakes and even legal problems (a 30% cost save reported after metadata/catalog creation)
  - Better internal *control* on information responsibility, access and use
  - Reduce information *acquisition and distribution costs*. Resources are released to be used to advance the organization's true mandate
  - Improvement in *planning and tracking of projects*, by using geospatial statistics and indicators

Key benefits

* Improved coordination between institutions
  * Develop common strategic and operative planning (e.g. for disaster risk mitigation)
  * Have a common framework for following up & reporting on interventions (e.g. public works impact)
  * Consultation on proposed development projects (e.g. common discussion and advance warning on public infrastructures)
  * Joint data acquisition and updates
  * License and permit processing and verification (avoid multiple requests, inconsistent permits…)

Key benefits

- Provide information **integration** mechanisms for inter-disciplinary sectors.
  - Environmental management: water, soil, air, waste, biodiversity, climate
  - Social services: health, education, culture, public transportation
  - Development: public works, tourism & transportation, commerce, industry
  - Risk management: safety, public events, disaster prevention and relief

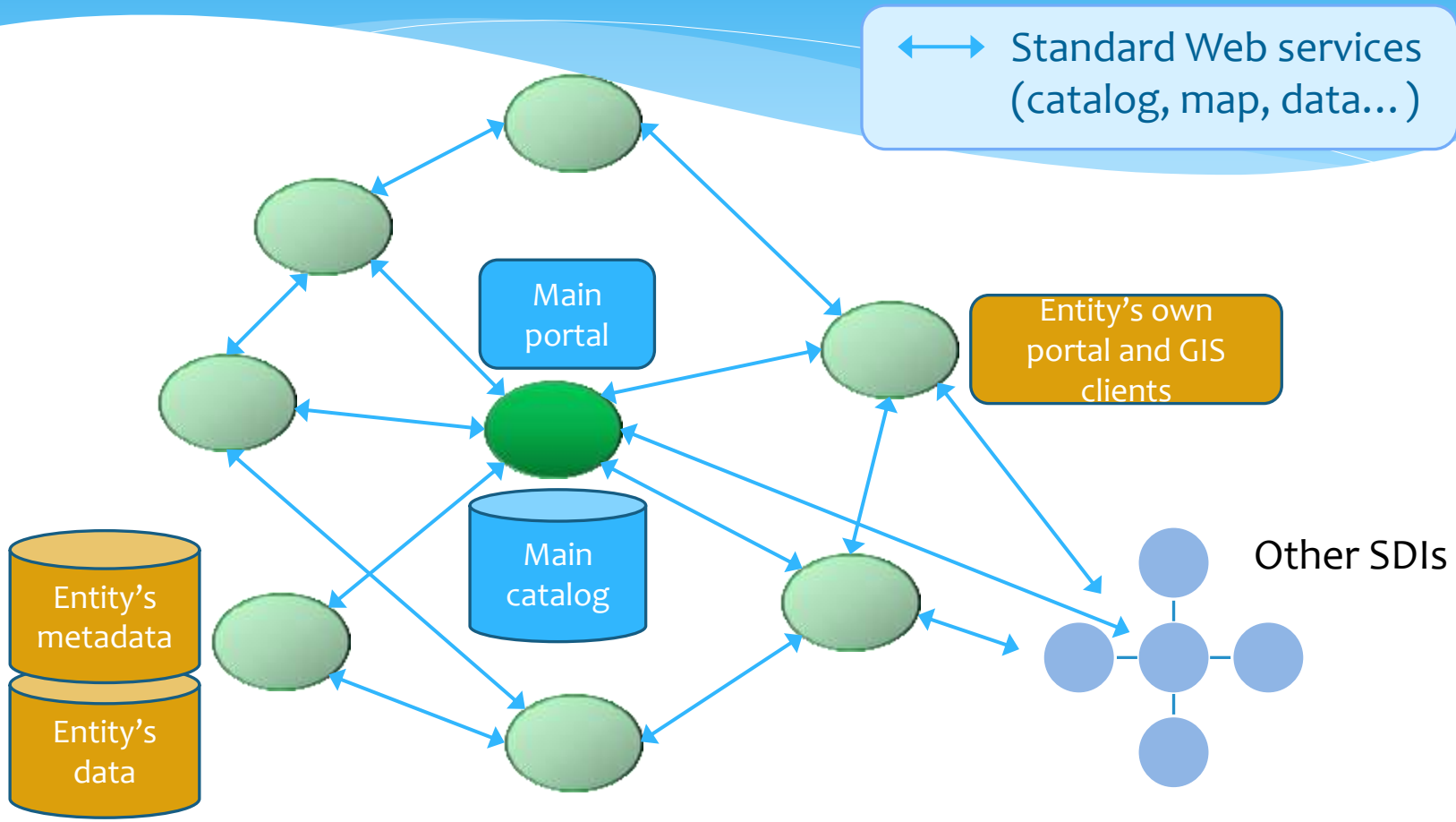
Key benefits

- Economic **development**: access of government and private sector to information is a key factor
  - *Cost reduction* for private activity, better planning and marketing (e.g. geomarketing, logistics…)
  - Creation of *added-value services and products* (e.g. smartphone apps based on location)
  - Reduced cost, better quality and reliability in *return of information to government* (e.g. web license request based on updated map information).

Technological structure

* The ‘standard’ SDI is made of distributed nodes
  * Each participant entity
    * Publishes standard services to provide access to its information
    * Catalogs these services with metadata
    * As a user, it can access metadata and services from other nodes
  * Common resources
    * The SDI catalog collects all metadata and provides search service
    * The SDI portal offers search, query, download and visualization

Technological structure



Relationship between SDIs

* Thematic SDIs

  Participants share a common thematic interest (biodiversity, disaster management, land use and planning, geosciences…)

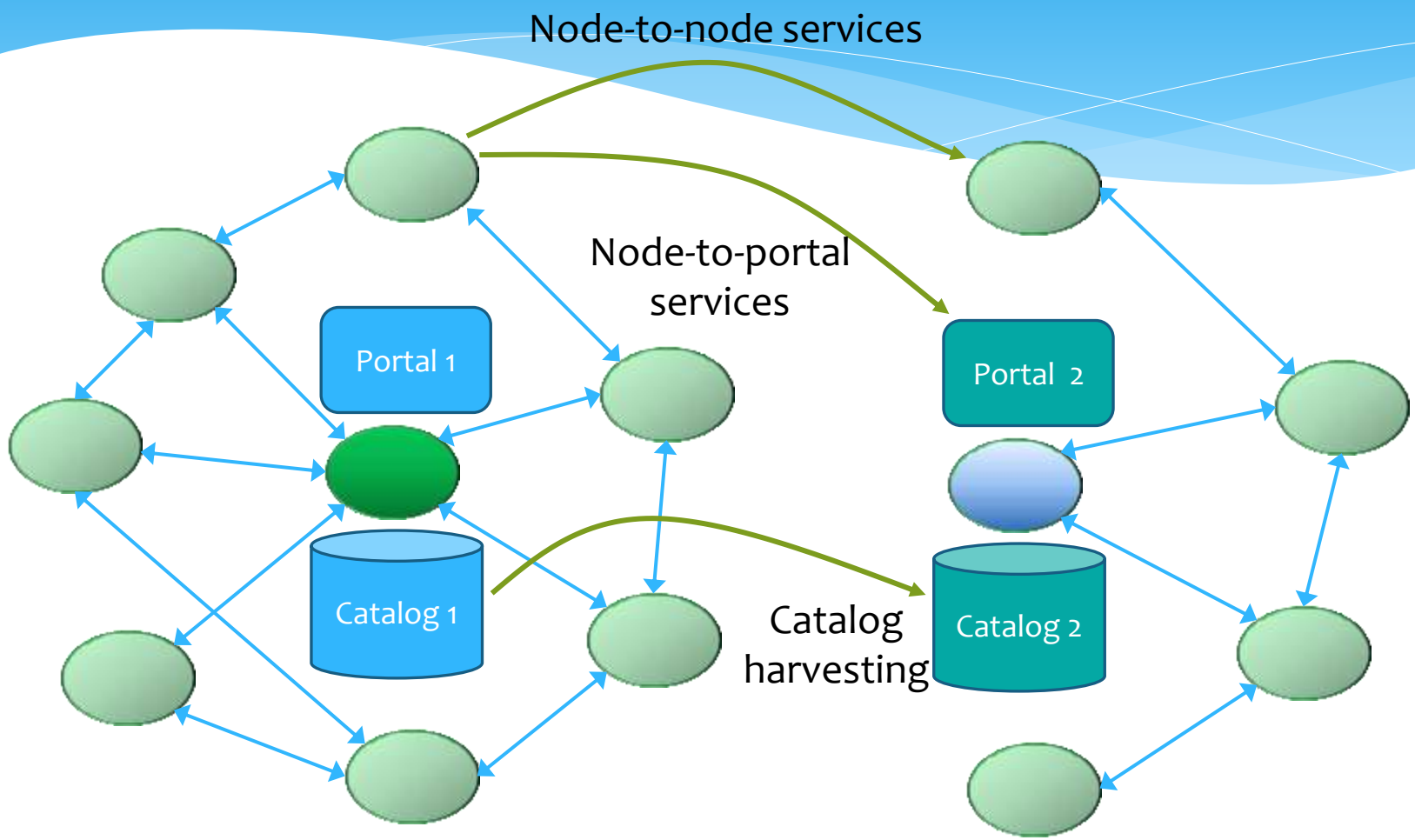
* Hierarchical SDIs

  Defined at different levels (multinational, national, regional, municipalities). Each level aggregates the lower ones

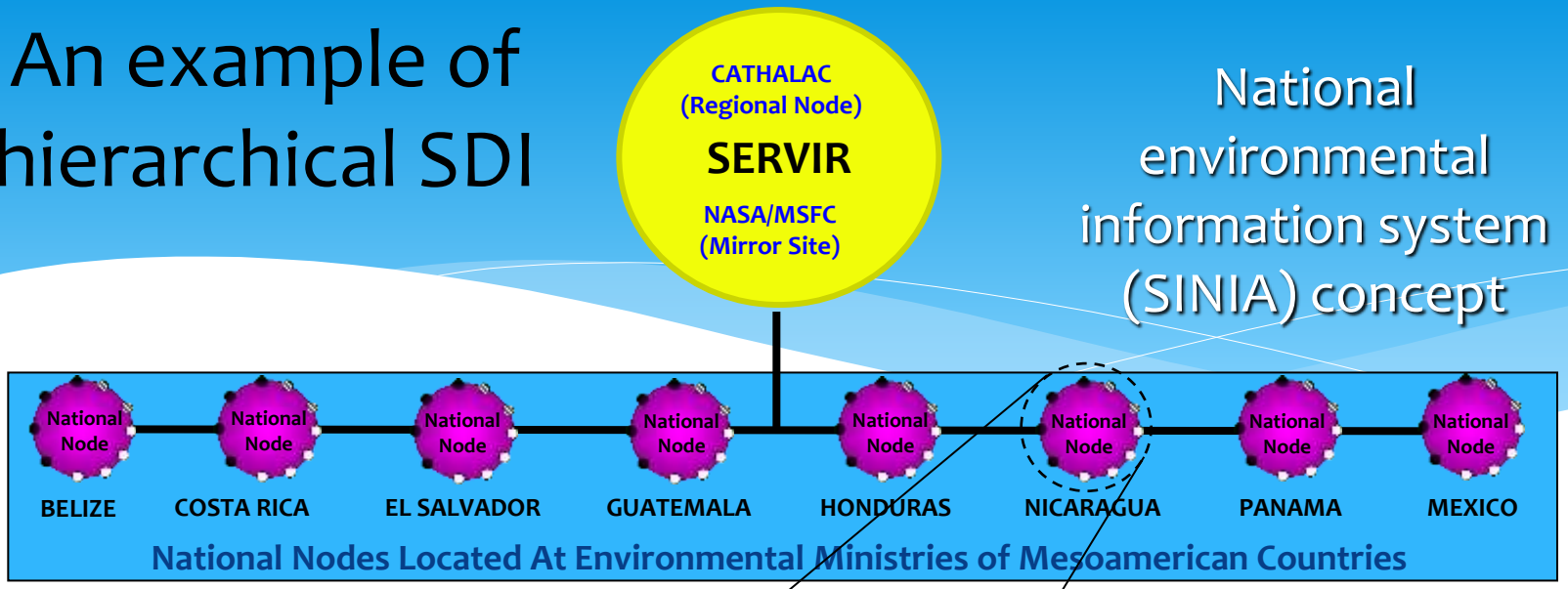
* SDI Federation

  Because of the distributed interoperability and access, SDIs can merge, reusing, composing and adding value on services and metadata. **SDIs don't have boundaries.**

Relationship between SDIs

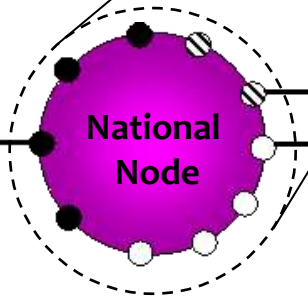


An example of hierarchical SDI



National environmental information system (SINIA) concept

National Node End-User Communities



PUBLIC INSTITUTIONS

- Geography/Mapping
- Climate/Meteorology/Hydrology
- Biodiversity (Forest, Protected Areas)
- Agriculture
- Disaster Prevention
- Other

UNIVERSITIES & NON-GOVERNMENTAL

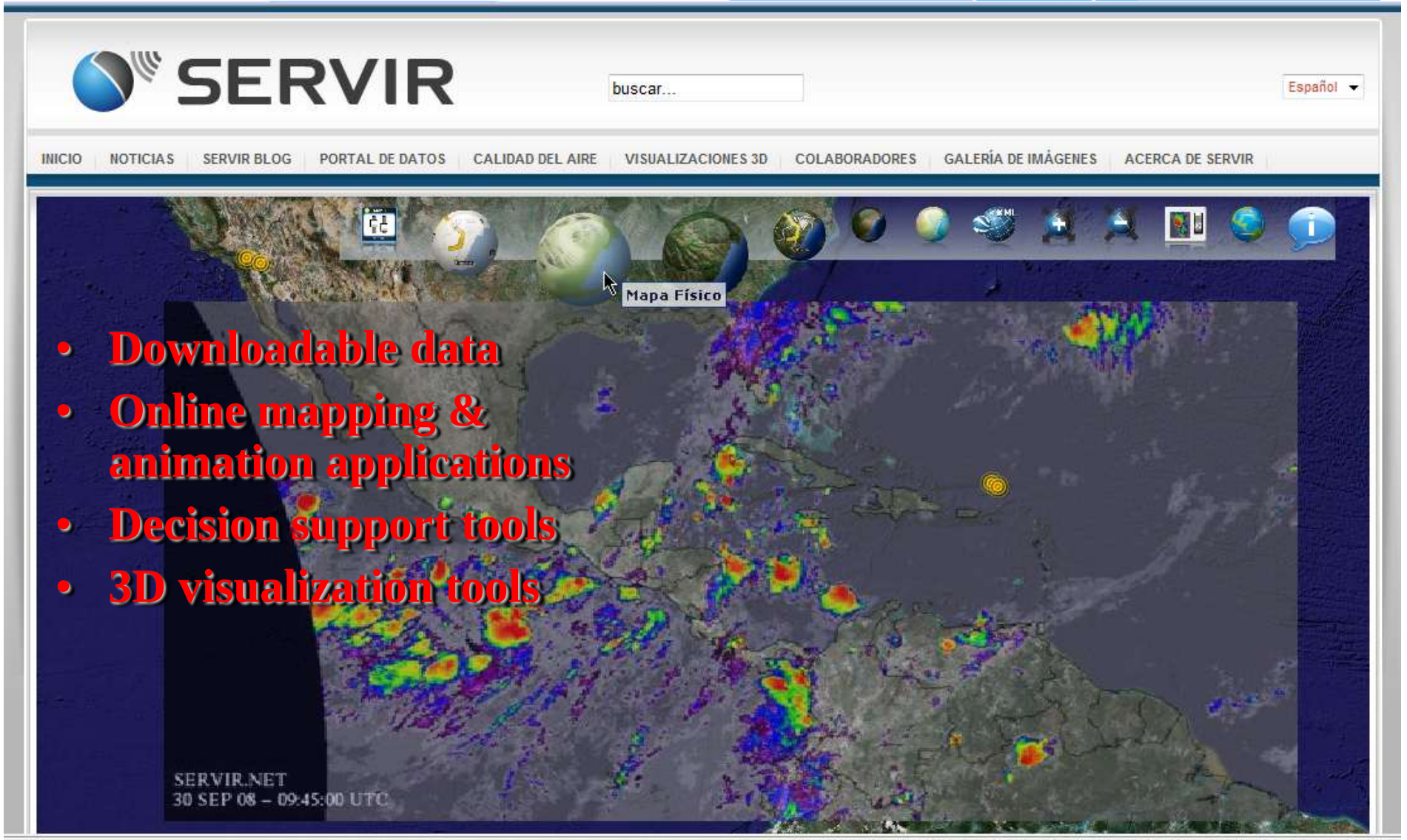
- Research/Educational
- Conservation
- Other

PRIVATE SECTOR

- Hydroelectric
- Aviation
- Other

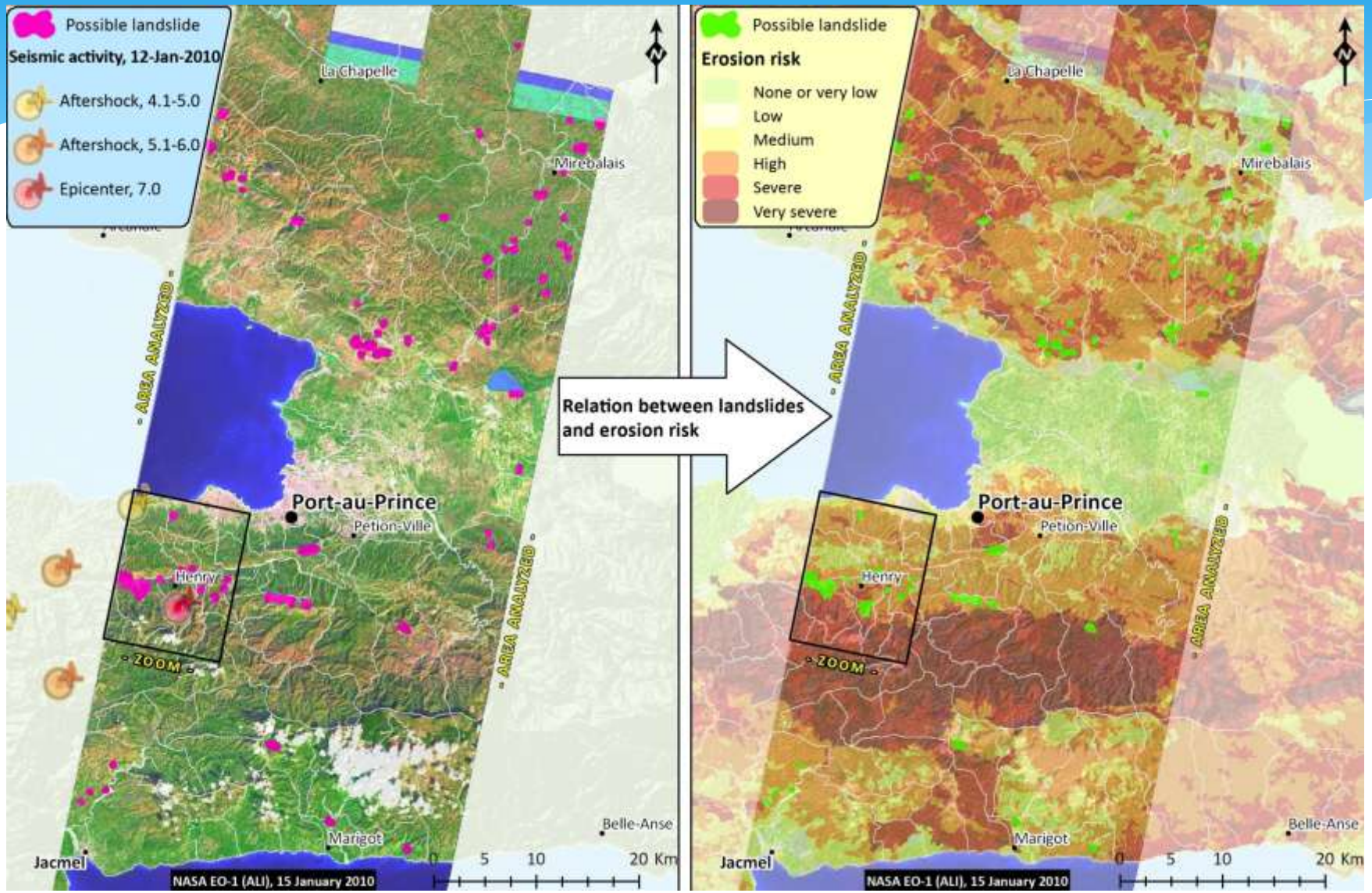
Source: D. Irwin, NASA 2005

https://www.servirglobal.net/Mesoamerica.aspx



- **Downloadable data**
- **Online mapping & animation applications**
- **Decision support tools**
- **3D visualization tools**

Locating Landslide Risks in Post-Quake Haiti



SDI and Disaster Risk Management

* The evaluation of threats and vulnerabilities requires spatial information analysis
* Risk management is multi-discipline, multi-institutional and multi-level. It does not understand of political boundaries
* The need for interoperability and integration makes it difficult to cross institutional and technical barriers
* Projects to provide access to global data (satellite imagery and other sensor data) have been advancing, but there is little progress in other systems

SDI and Disaster Risk Management Global programs

GROUP ON EARTH OBSERVATIONS

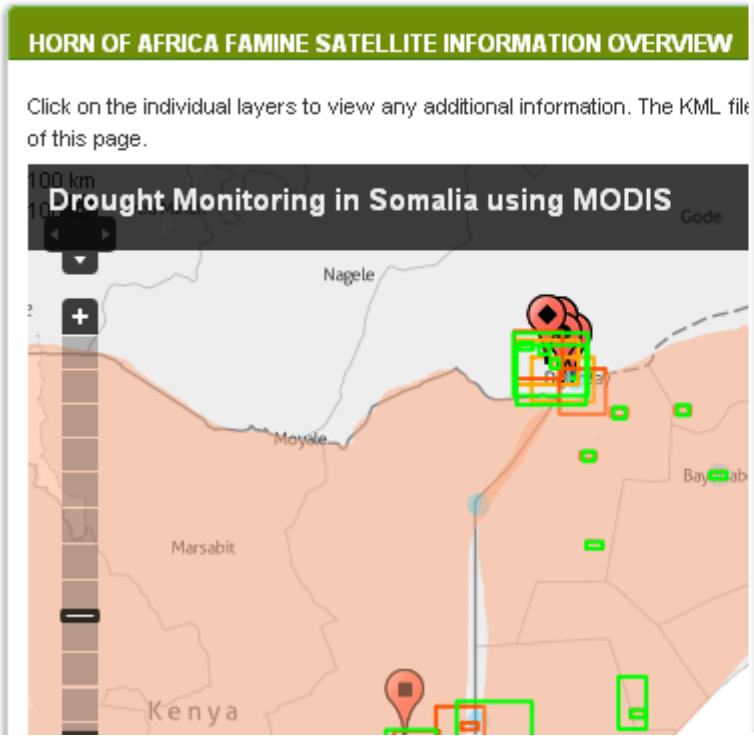
Global Earth Observation System of Systems (GEOSS)

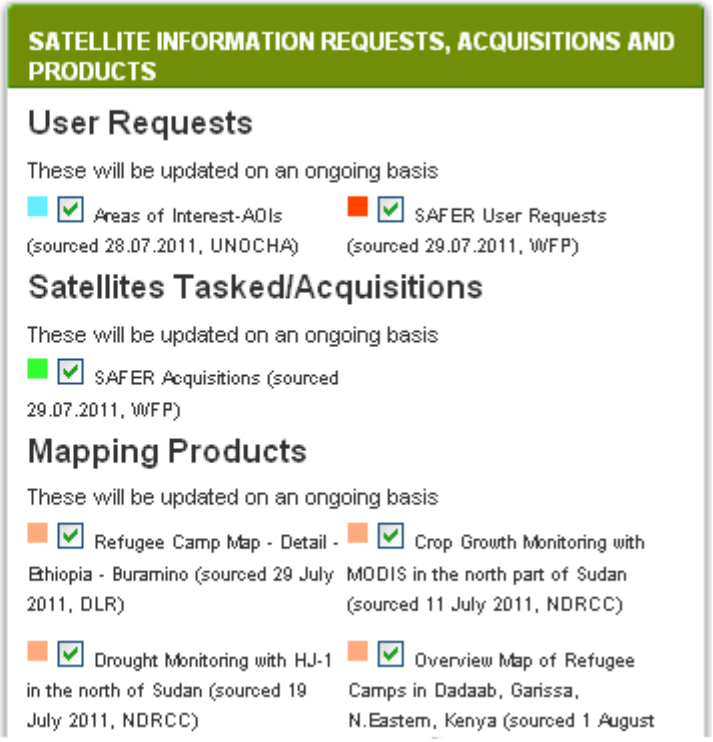
Source: L. Moodie, NOAA 2008

SDI and Disaster Risk Management Global programs

UNITED NATIONS | UNOOSA | UN-SPIDER

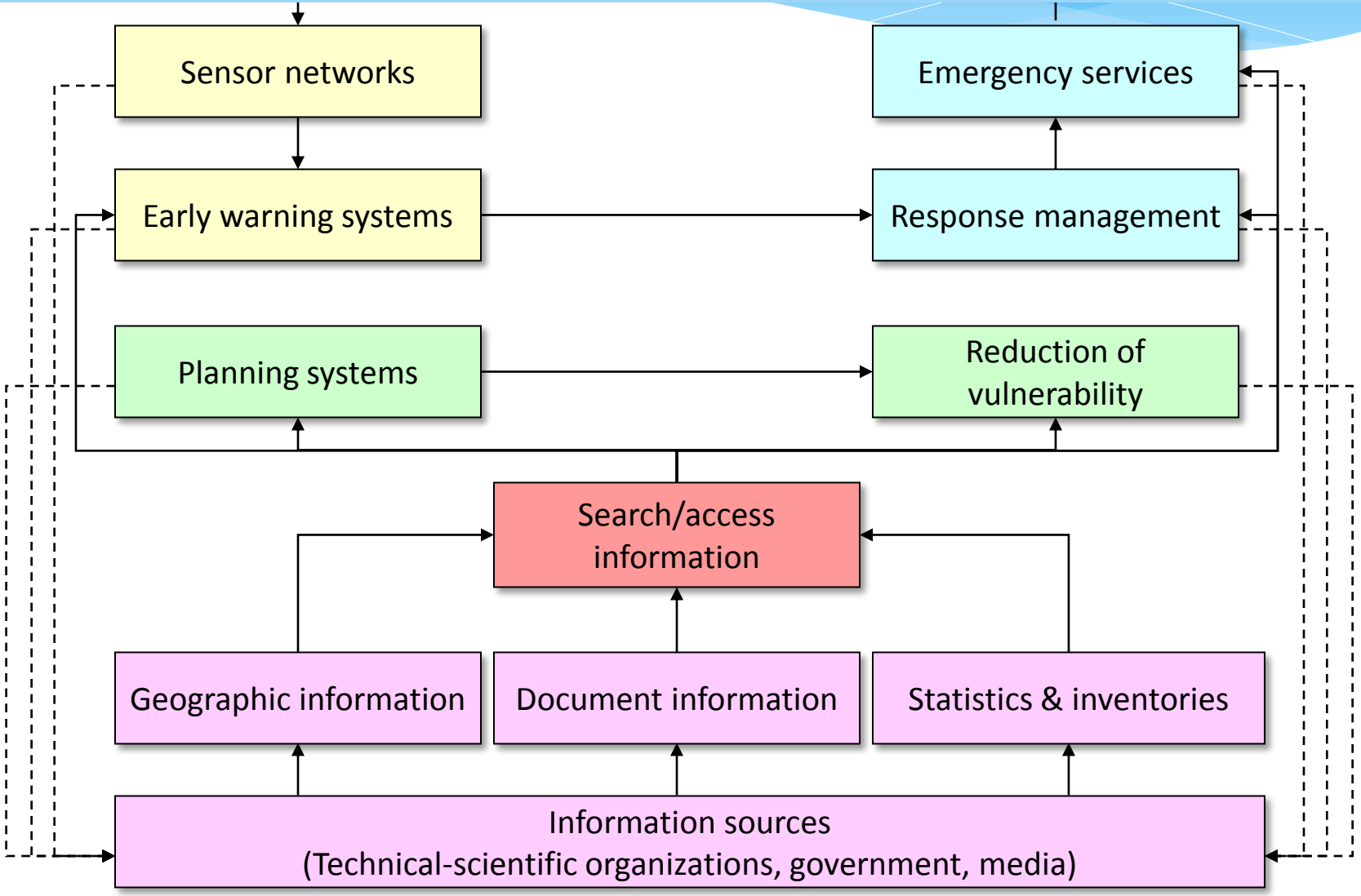
United Nations Platform for Space-based Information for Disaster Management and Emergency Response



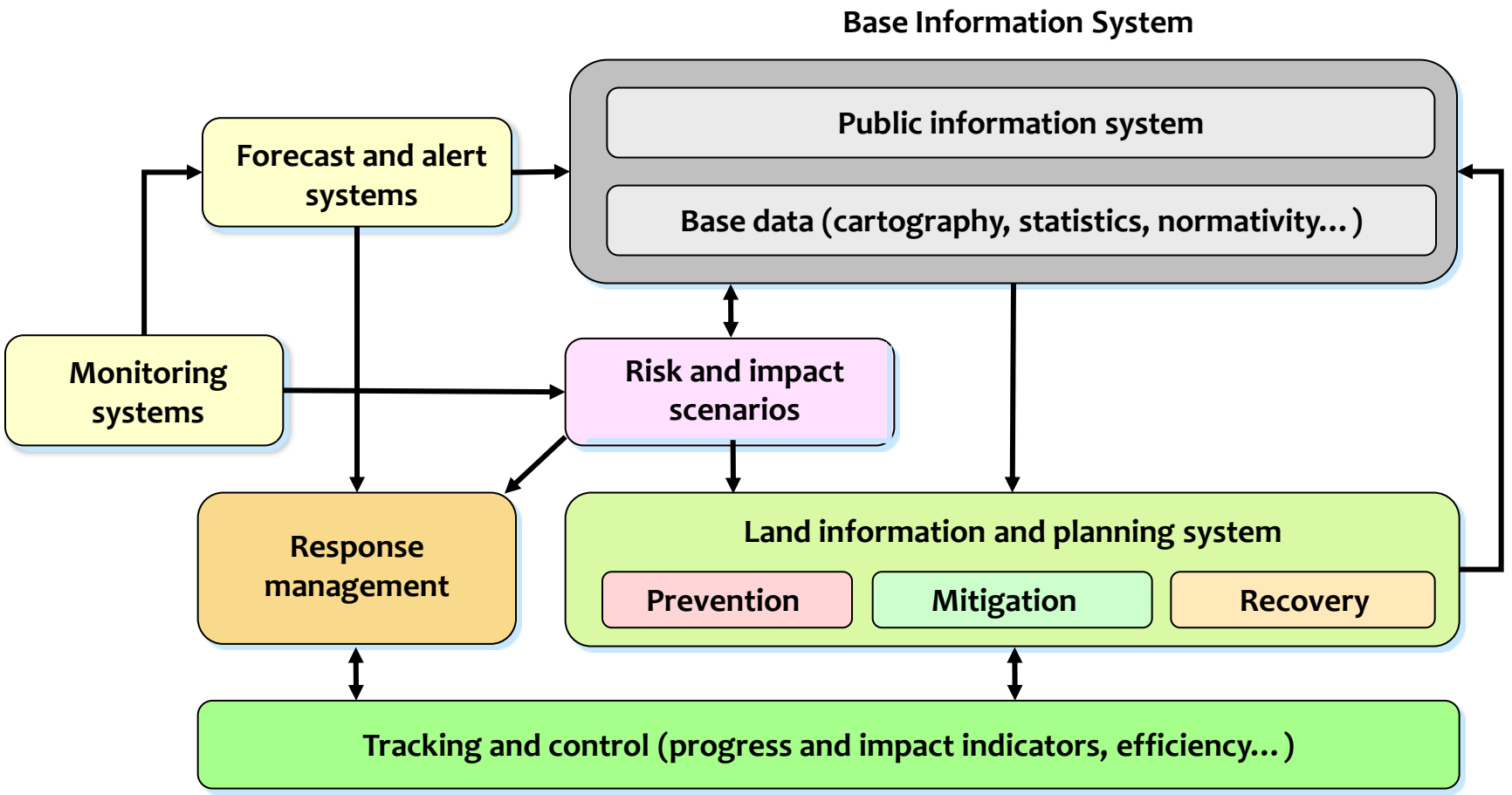


SDI and Disaster Risk Management Global programs

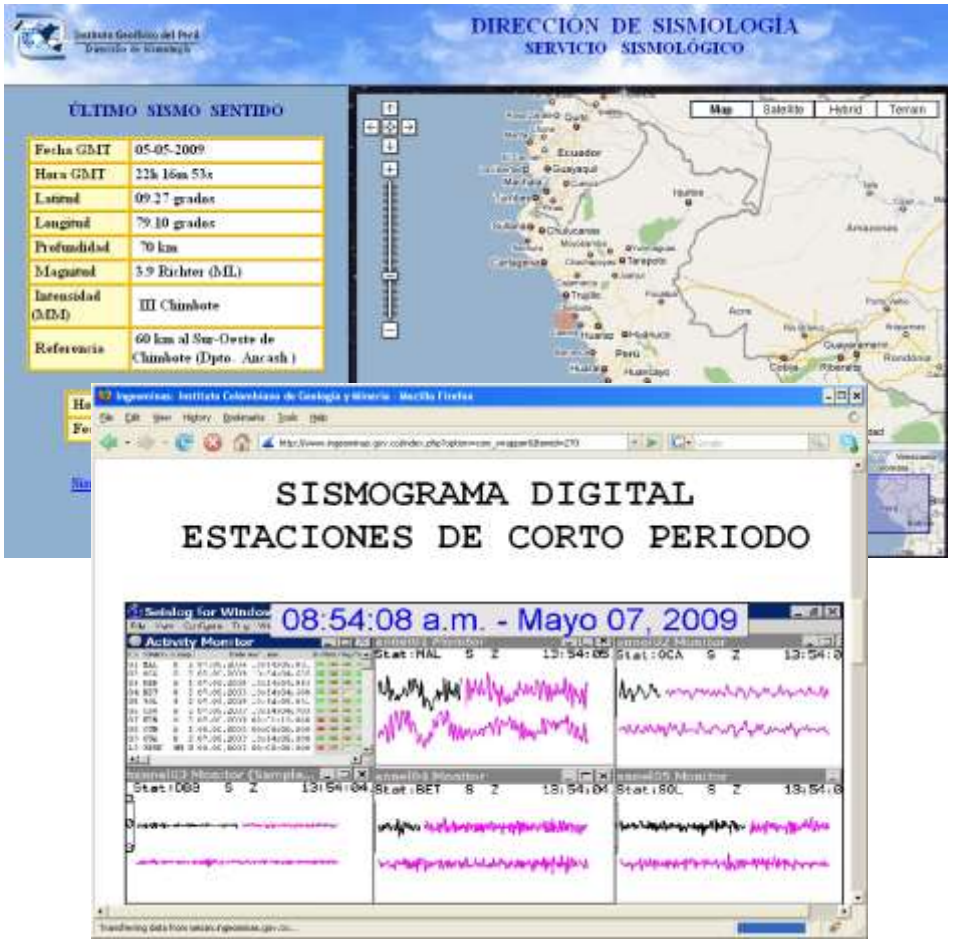
SDI and DRM
Data flow



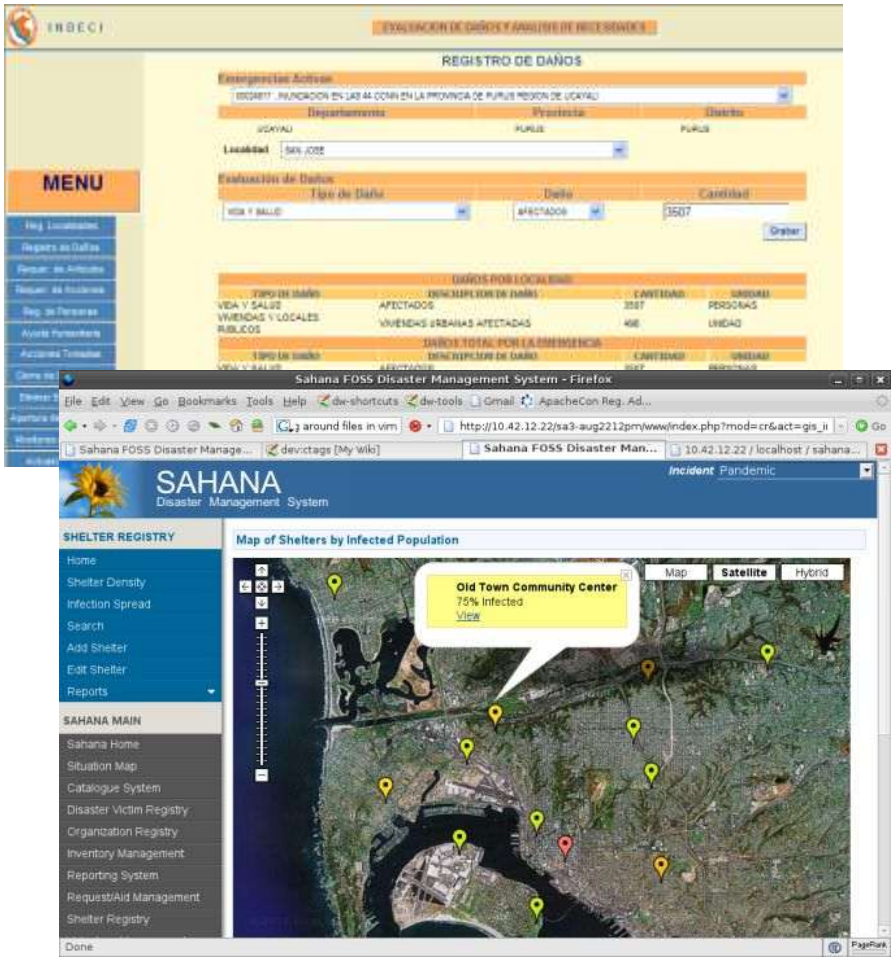
SDI and DRM
An ideal system of systems

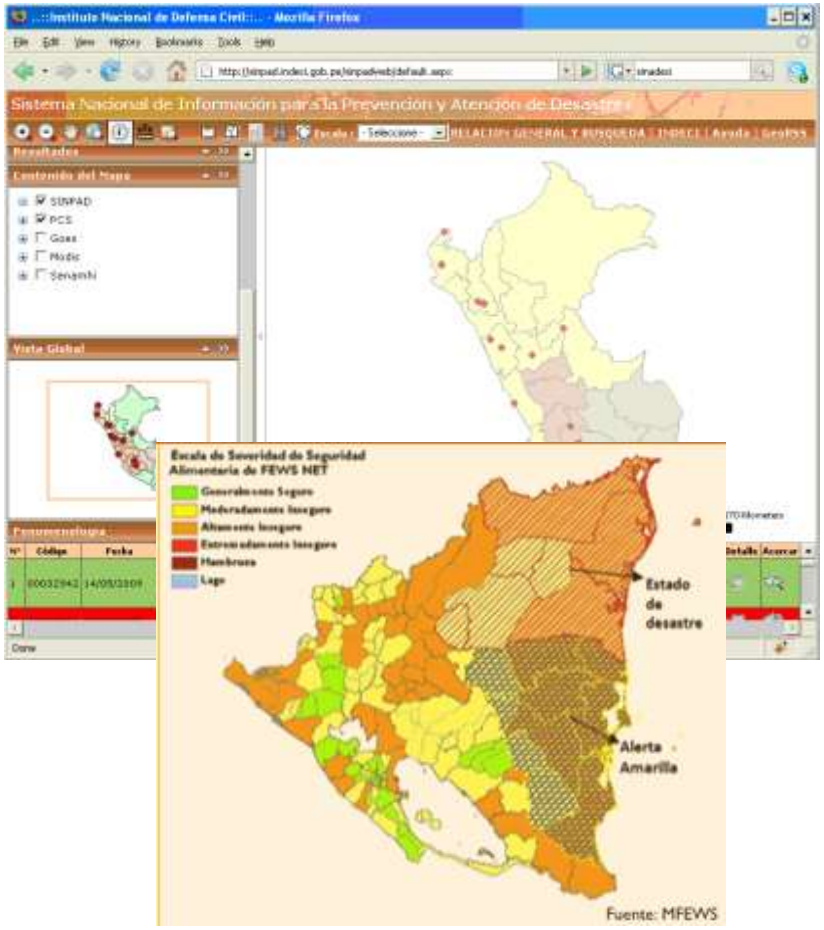


SDI and DRM
Monitoring, forecast and alert

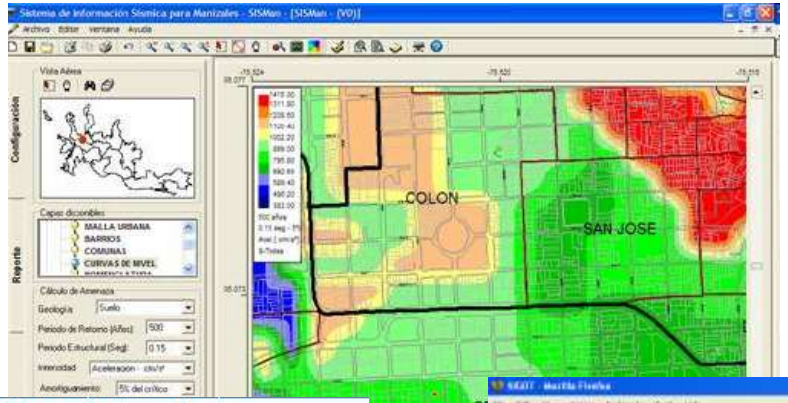


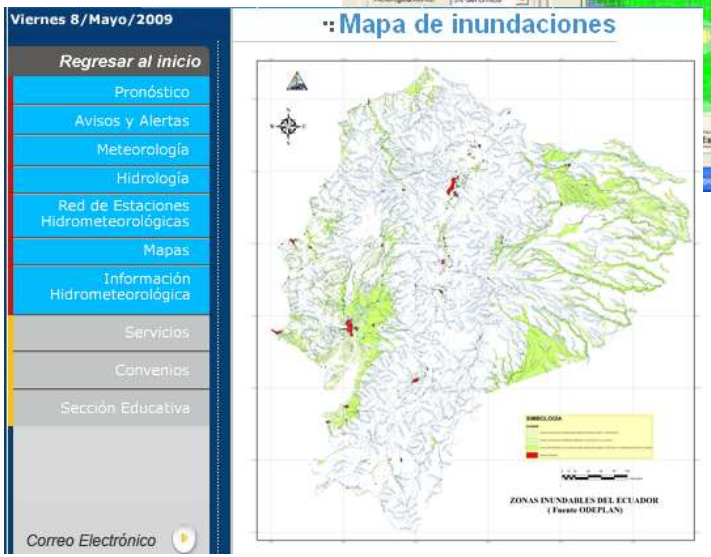
SDI and DRM
Response management

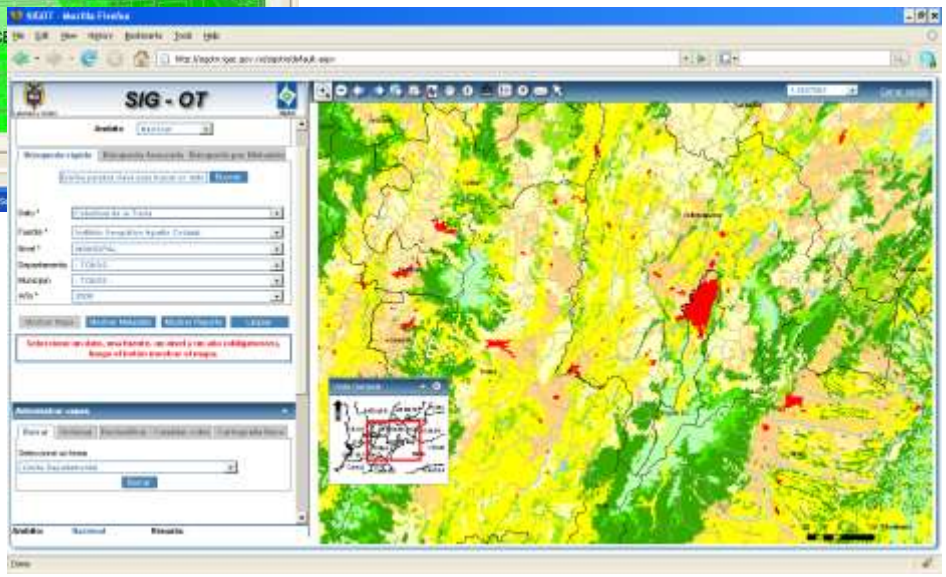




SDI and DRM
Risk assessment, land use planning



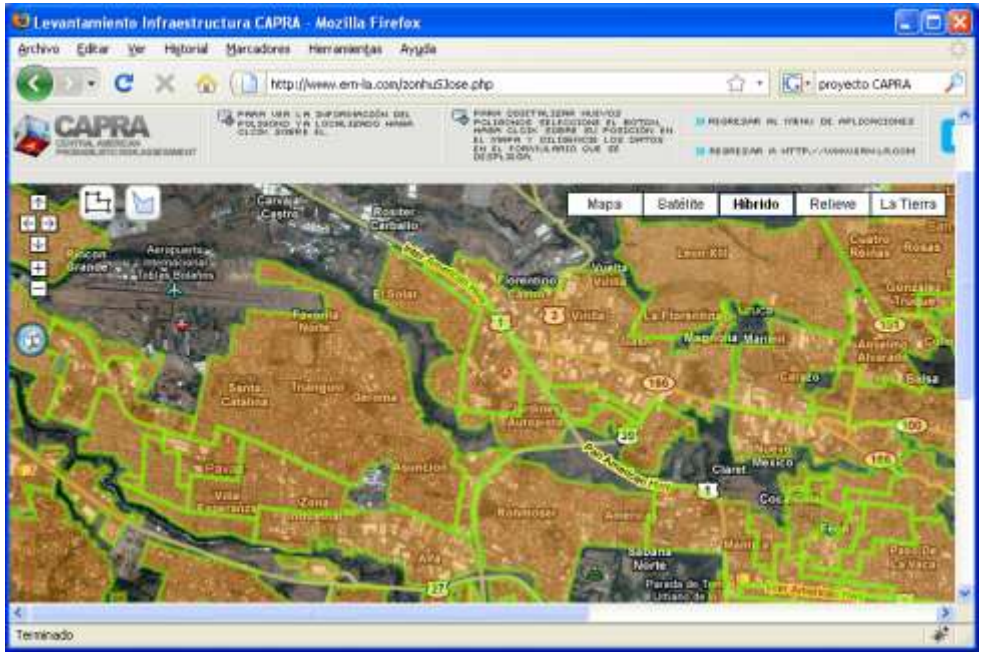




SDI and DRM
Scenario analysis systems

- These systems integrate data services from different sources to perform a risk analysis, evaluating the possible event impacts

- Remote processing Web services (WPS) allow to access distributed analysis processes, so many organizations can access not only data but also intelligent analysis



SDI and risk management
Scenario analysis systems

- **Central American Probabilistic Risk Assessment** (CAPRA). This project provides data, software and financial support for risk assessment projects www.ecapra.org
- They have started using **GeoNode**

SDI and urban land management

* SDIs are potentially a powerful land management tool:
  * Integrate different government-administrative levels
  * Integrate the many organizations involved in planning, use and manage territory and its resources
  * Municipalities are potentially the ones who have more to gain from a simple and inexpensive access to territory information
  * The cadastral-property information is the base to manage land at detailed scales (1:1000), in both urban and rural environments
* But an SDI is not enough if it is not linked to specific local management tools (urbanism, taxes, tourism, agriculture, waste, water…)

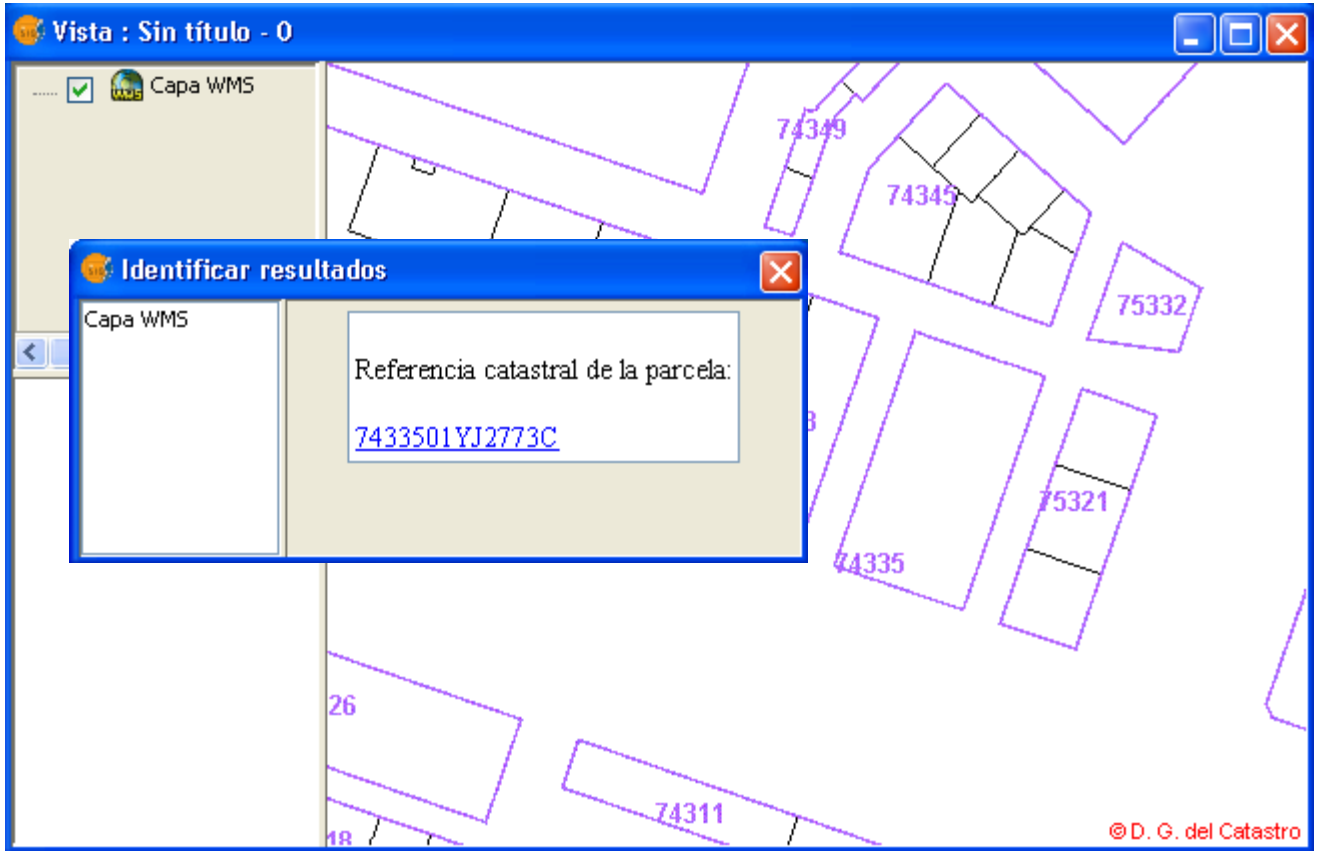
SDI and urban land management

- Generic requirements of municipalities
  - Access to base cartography (orthophotos, roads and streets, land use), complete and updated
  - Coordinated acquisition of geoinformation and statistics
  - Geocoding and georeferencing of records (e.g. a table of shop permits contains an informal address but no precise geolocation)
  - Coordination of strategic planning through administrative levels
  - Coordination in planning and execution of development plans, interventions and events

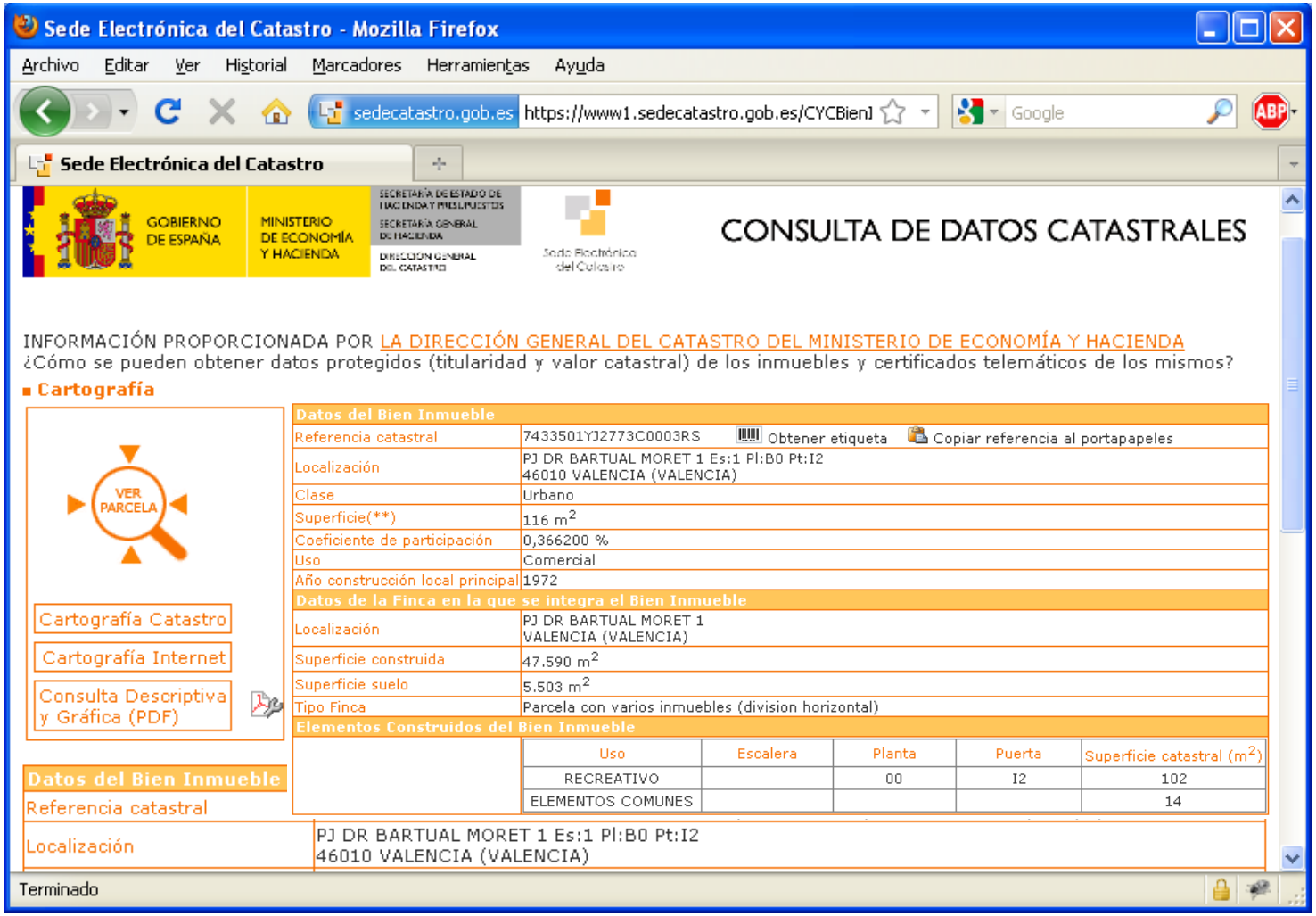
SDI and urban land management

SDI and urban land management

SDI and urban land management

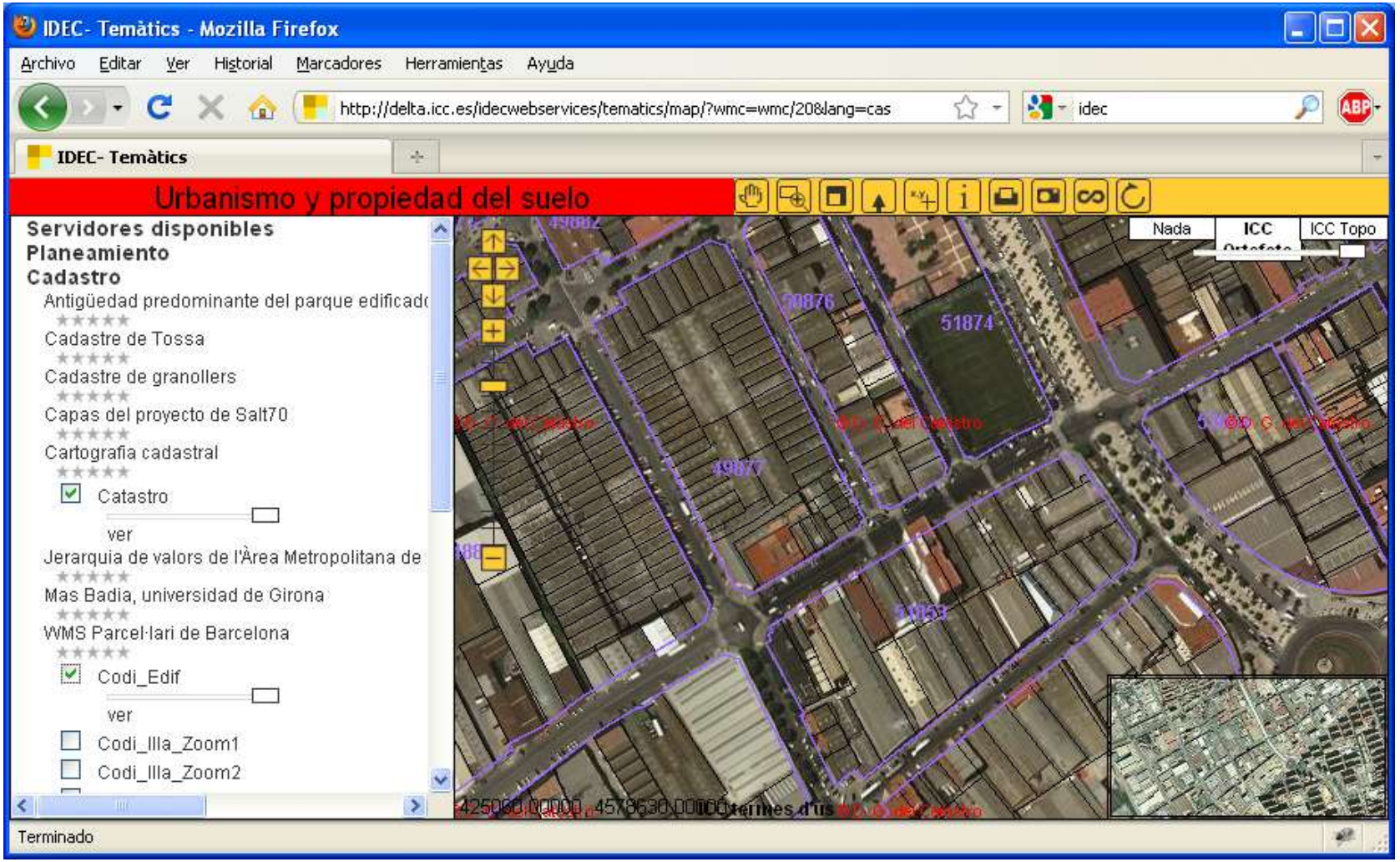


SDI and urban land management
Access to National Cadaster e-Office



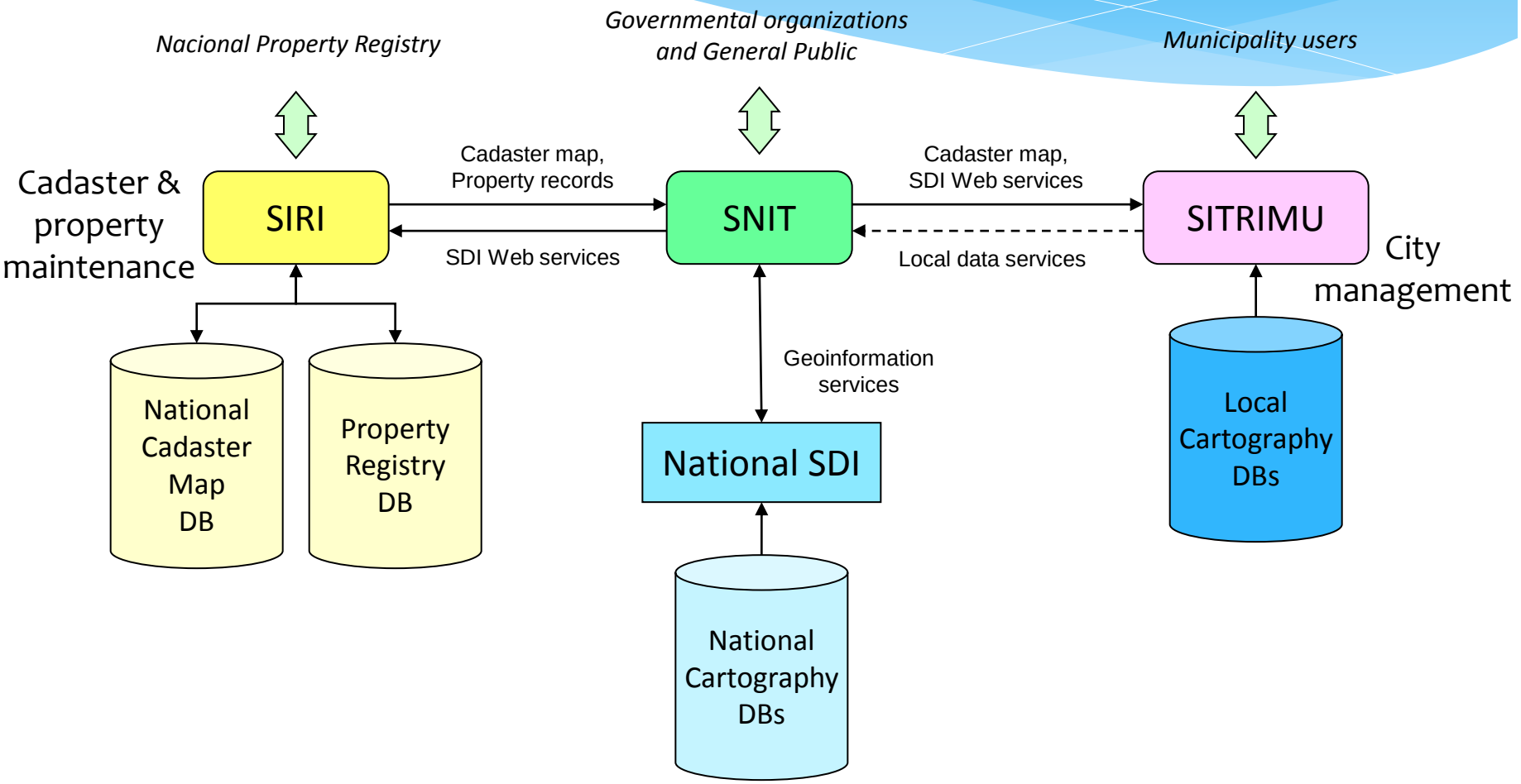
SDI and urban land management

Catalonia SDI: local services based on cadaster data



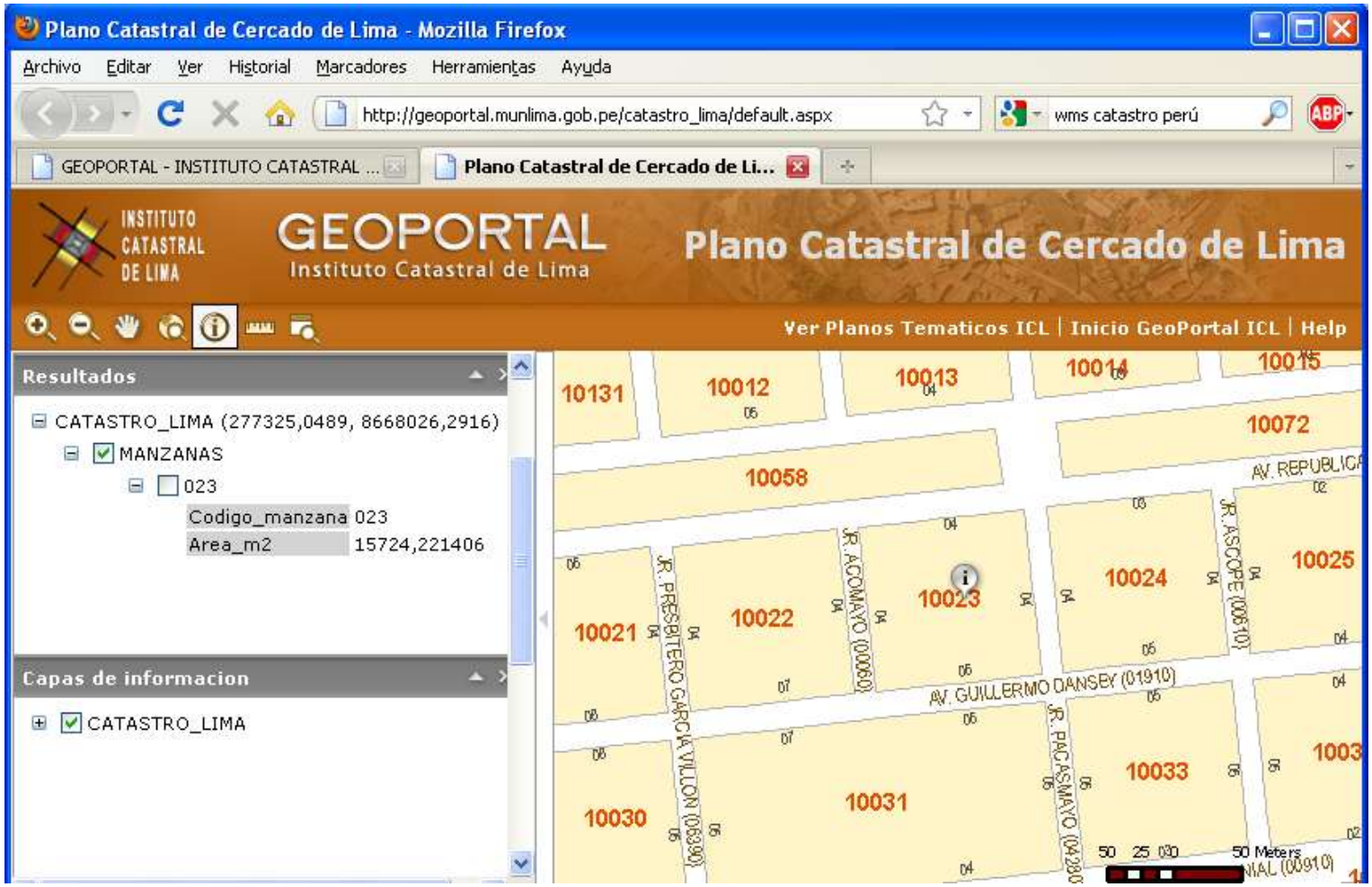
SDI and urban land management

SNIT in Costa Rica as land-management SDI



SDI and urban land management

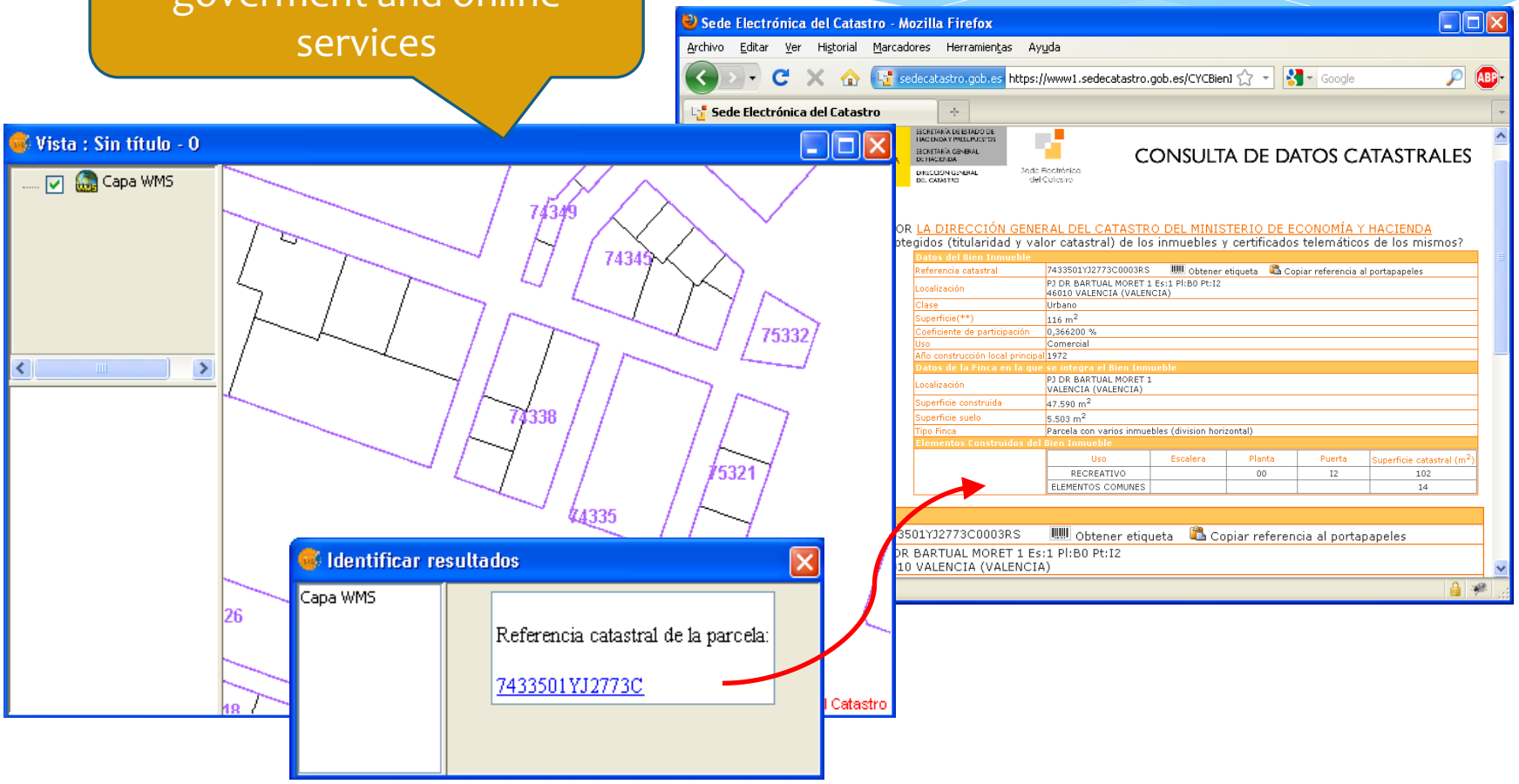
Instituto Catastral Lima



Current SDI use trends

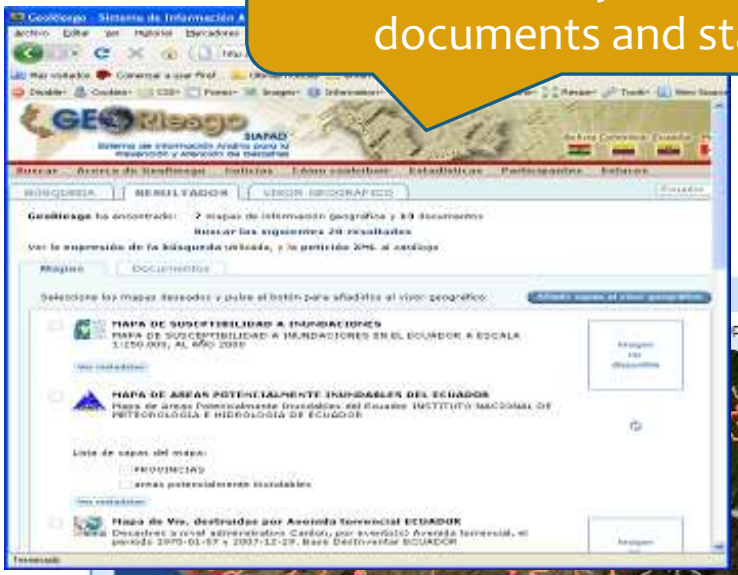
Current SDI use trends

Integration with e-goverment and online services

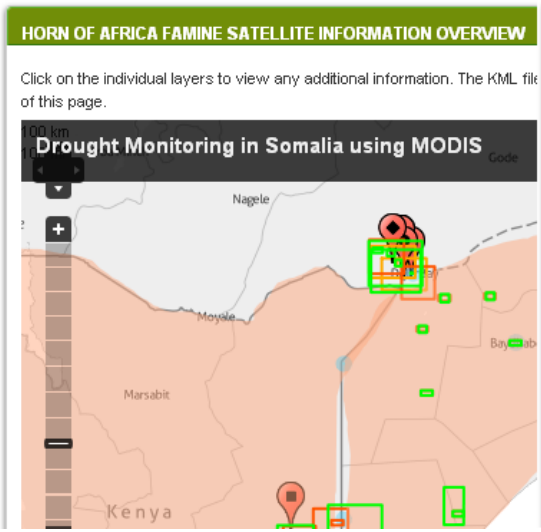


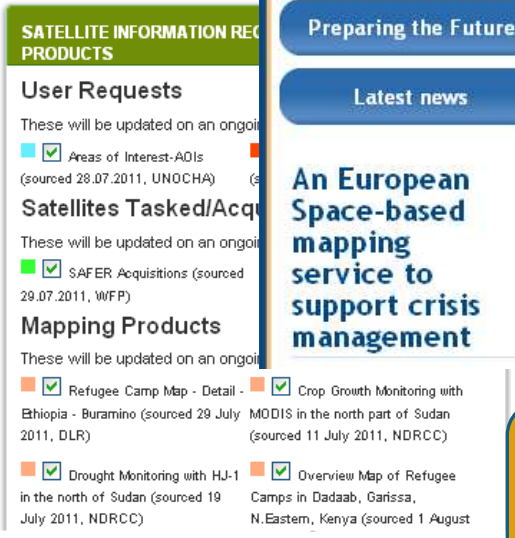
Current SDI use trends

Integration of Distributed Information Systems including documents and statistics



Current SDI use trends





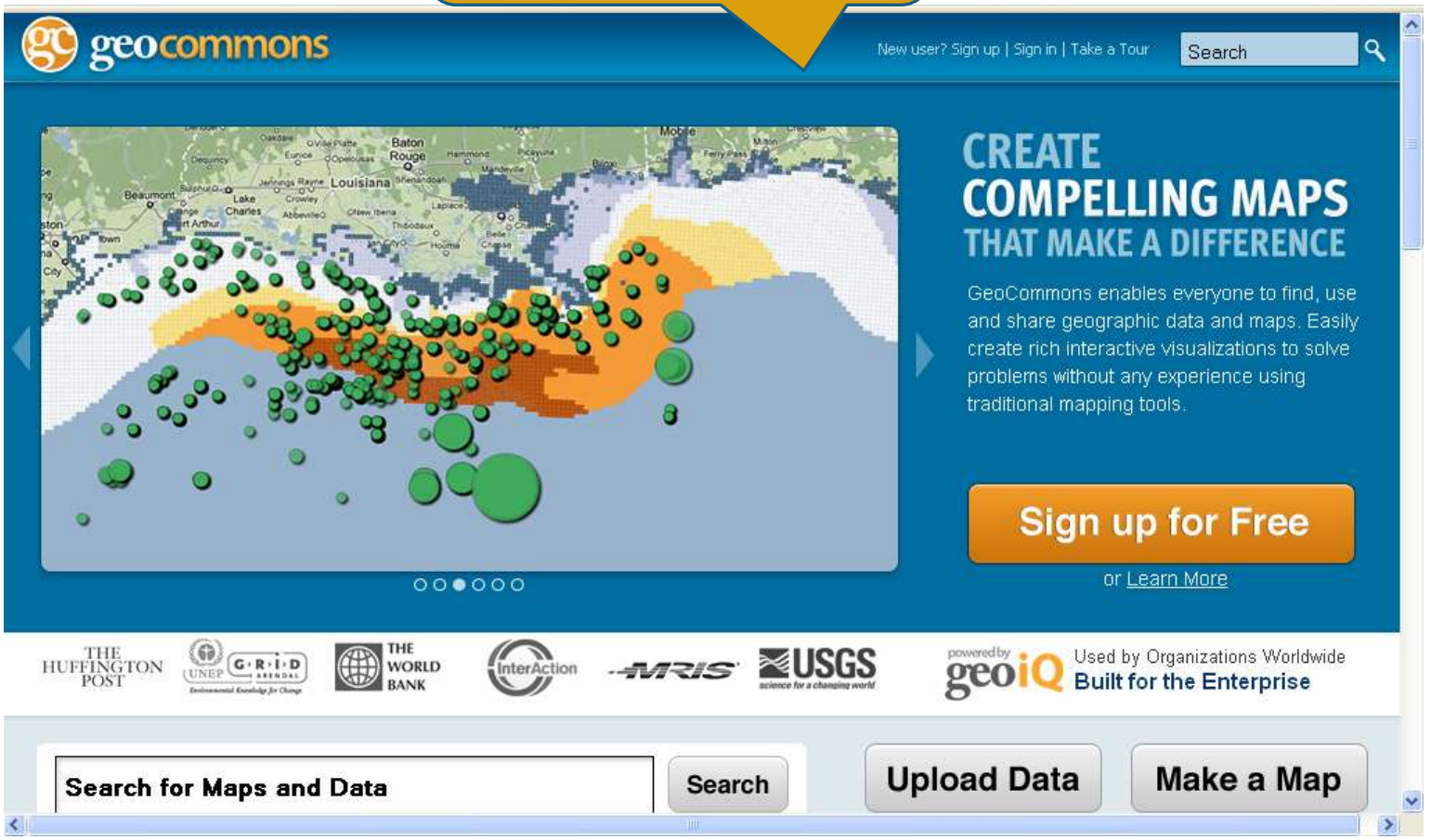
Access to sensors and alerts in quasi-real-time

Current SDI use trends

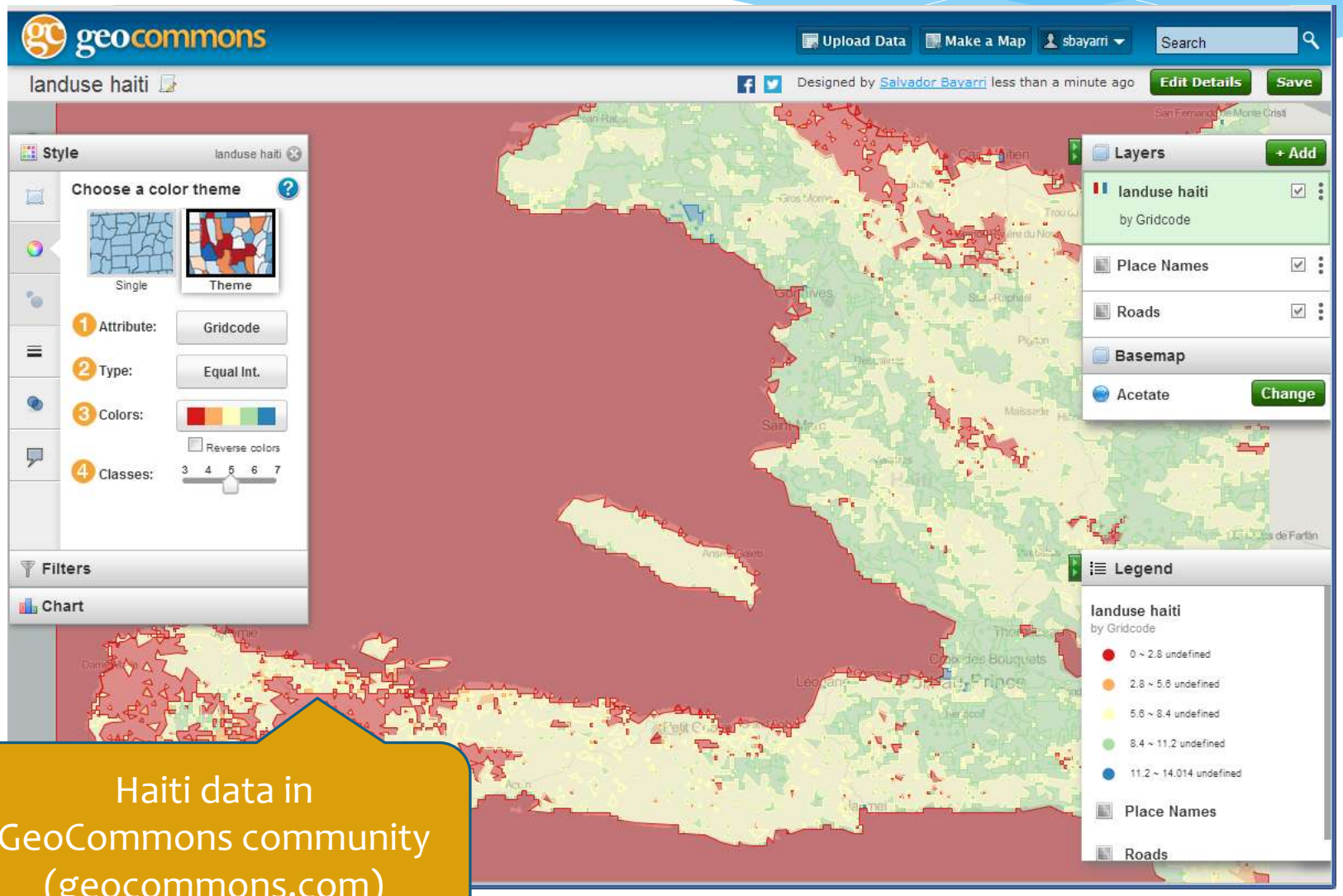
Use in mobile devices, real-time information

Current SDI use trends

Crowdsourcing and open communities

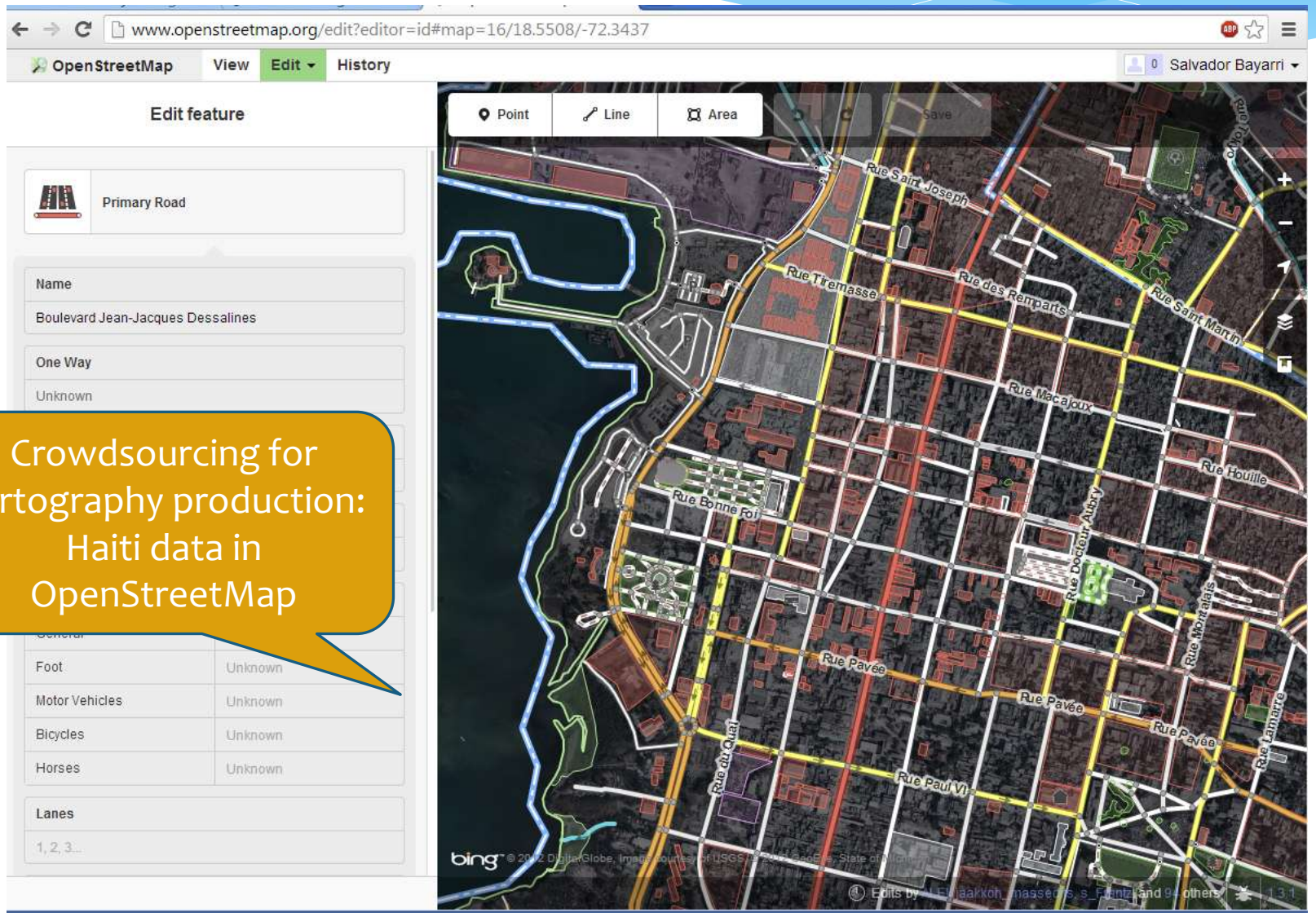


Current SDI use trends



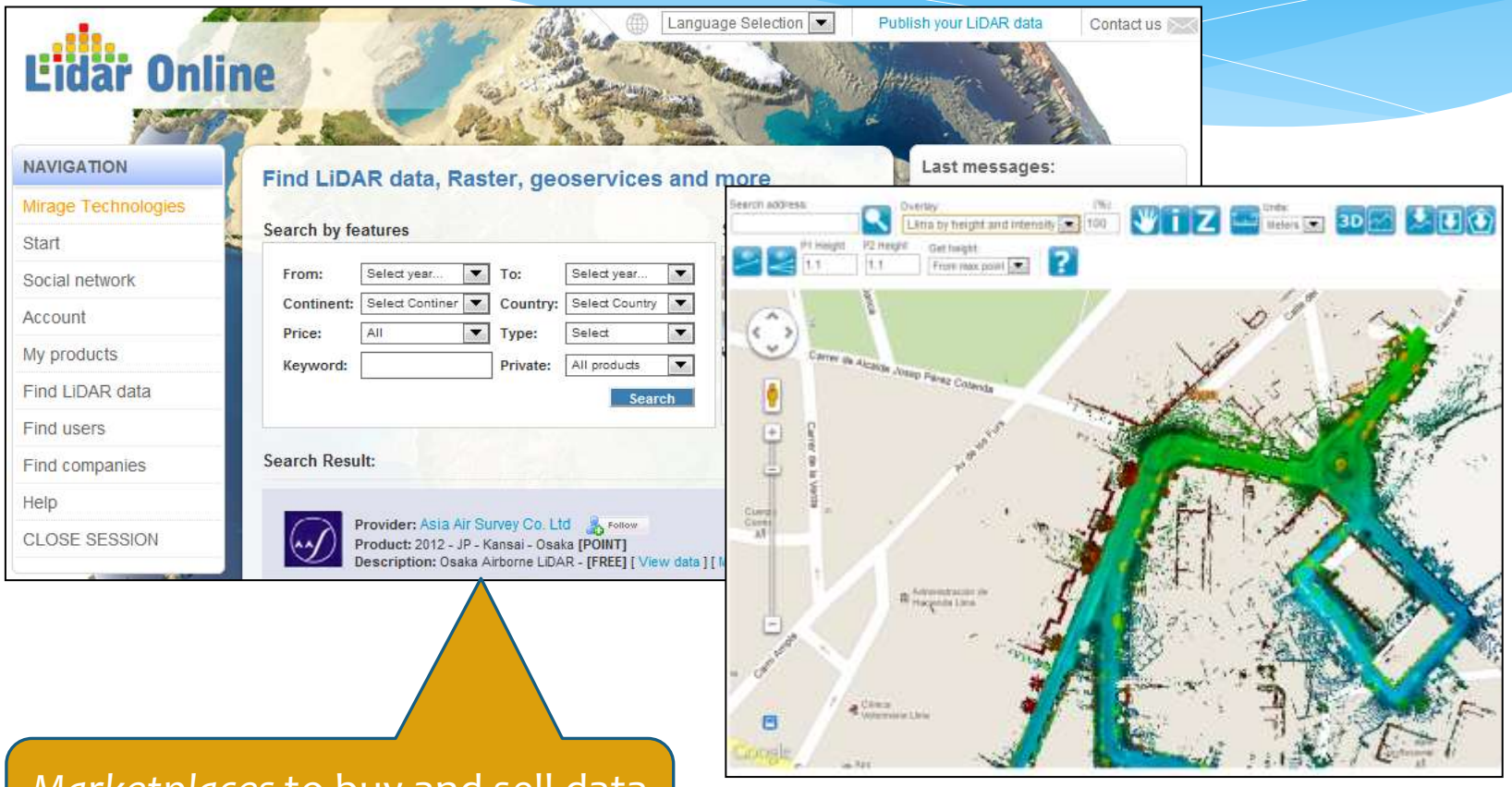
Haiti data in GeoCommons community (geocommons.com)

Current SDI use trends



Crowdsourcing for cartography production: Haiti data in OpenStreetMap

Current SDI use trends



Marketplaces to buy and sell data and services

Current SDI use trends

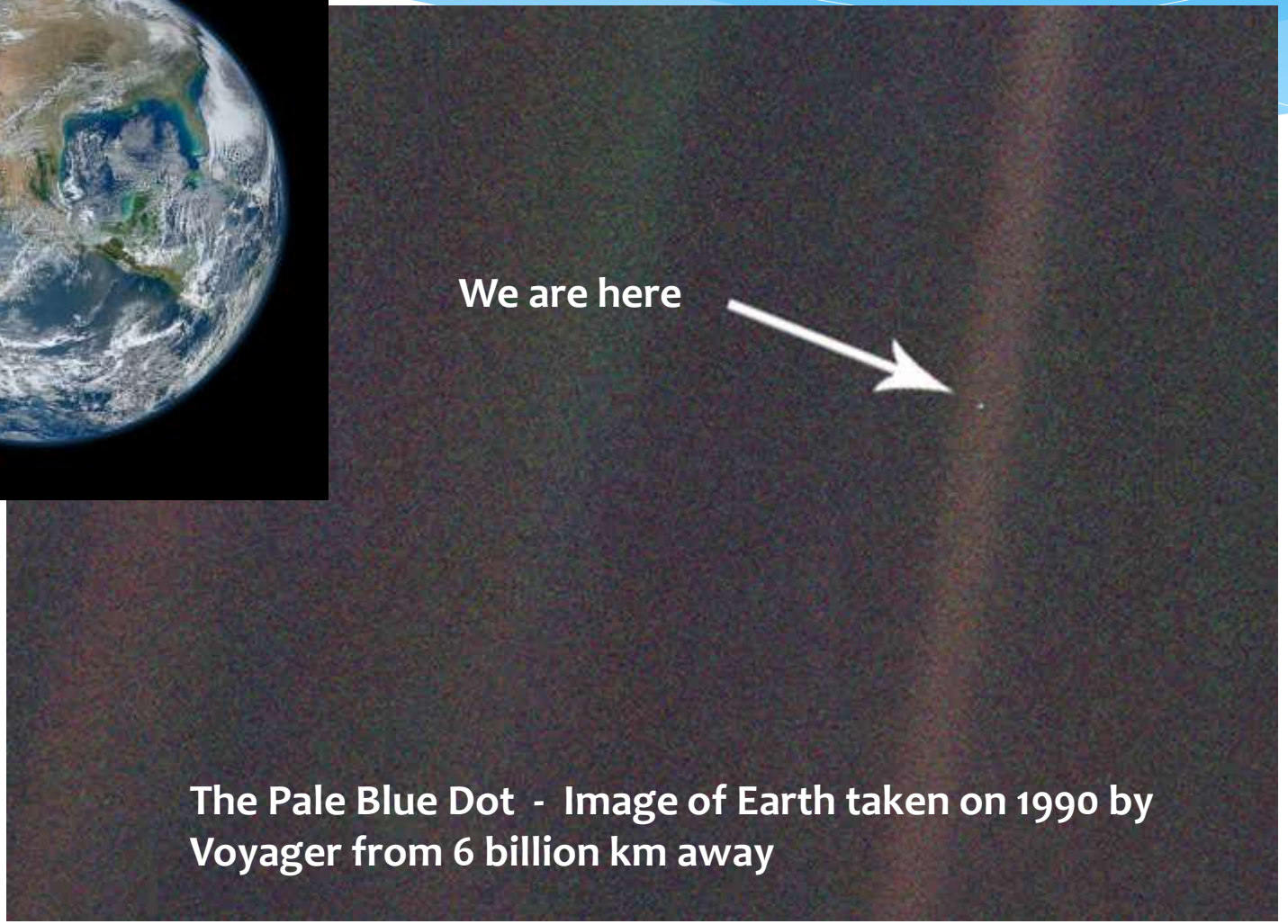
SDI and Big Data

Big data - Data Source diverse, huge and seemingly unrelated

Traditionally big data was the domain of the scientific, military or intelligence community

Increasingly local Governments are collecting or using big data to get different perspectives

Meaning of Data Depends on Context



The Pale Blue Dot - Image of Earth taken on 1990 by Voyager from 6 billion km away

Challenges in SDI implementation

* Provide *access* to information
  * No legal framework for open access
  * Organizational resistance to open data access
  * Analog information (printed maps, photos)
  * No catalog
  * Effort needed to create metadata
  * Resistance of IT departments to change

⇒ Show benefits ⇒ Early, simple prototypes

Challenges in SDI implementation

* Slow progress on *legal framework*
  * Military-oriented view of GI
  * Monopolies on creating & distributing GI
  * Compartmentalized government structure
  * Difficult to see short-term benefit within political election cycle

⇒ Start with informal SDI groups ⇒ Prepare drafts and reach consensus to gain political leverage

Challenges in SDI implementation

* Cost of resources
  * High initial investment in acquiring/updating/digitizing/cataloging information
  * Training human resources
  * Problem of human resources rotation
  * Adapt/develop appropriate tools linked to SDI
  * A critical mass is needed to make SDI really useful

⇒ Make the case of SDI as national asset ⇒ get funds from national budget and programs

⇒ Promote savings in organizations linked to SDI implementation ⇒ get funds from organization budget

Challenges in SDI implementation

* Lack of fundamental *information*
  * No resources for updating cartographic base (orthophotos, DEM, base vector cartography), specially for detailed scales
  * Institutional responsibilities are not clear for different scales, themes
  * Lack of geocoding normalization and automation
    * Linear reference systems (streets, highways)
    * Statistical units
    * Toponyms

⇒ Form a working group on fundamental information ⇒ create a national cartographic plan

⇒ Create a working group on data and service normalization ⇒ create partnerships with Post Office, banks, transportation, tourism actors

Challenges in SDI implementation

* Managing *expectations*
  * Short-term political goals, seek visible results soon
  * SDI may be seen as silver bullet
  * If the process fails, it will be more difficult to get started again

⇒ Create realistic strategic plan with phases, visible & useful intermediate results

⇒ Make implementation speed conditional to budget allocation, but don't push an all-or-nothing approach

SDI challenges in A&B: open discussion

* Suggested topics
  * National and thematic policies on information sharing
  * Status of data and infrastructures
  * NSDI progress
  * Application in disaster risk management, climate change, natural resources management…
  * Main challenges identified and possible solutions
  * Main information needs
  * How can the World Bank contribute?