Earth Observation for Urban Management, Land Administration & Spatial Data Infrastructures

International trends & developments

How to promote earth observation applications?

How to get funding?

Capacity building

0. Introduction

Mark Noort, consultant, project manager

HCP international:
consulting, marketing of earth observation

Coordinator GEONetCab:
project for promotion & capacity building of earth observation applications

Earth observation applications

- On the verge of reaching new user communities
- These new user communities need to be involved
- Weakest link / last mile aspects are important
- Marketing needed: promotion & capacity building

Life cycle of products & services

Initialization

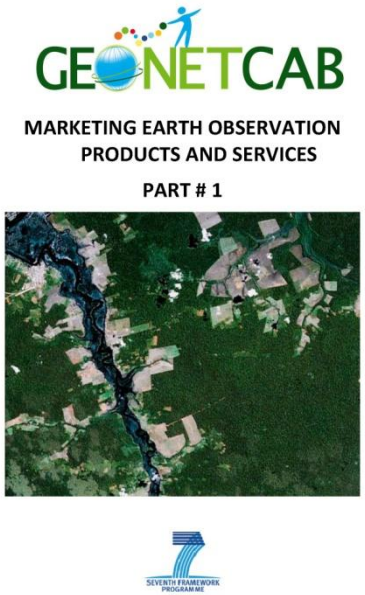
System analysis & design

Rapid prototyping

System development

Implementation

Post-implementation



Assessment of business & funding opportunities

- Categories of environmental products & services
- Life cycle phase of product or service
- Regional context, level of technological & economic development
- Optimum marketing mix

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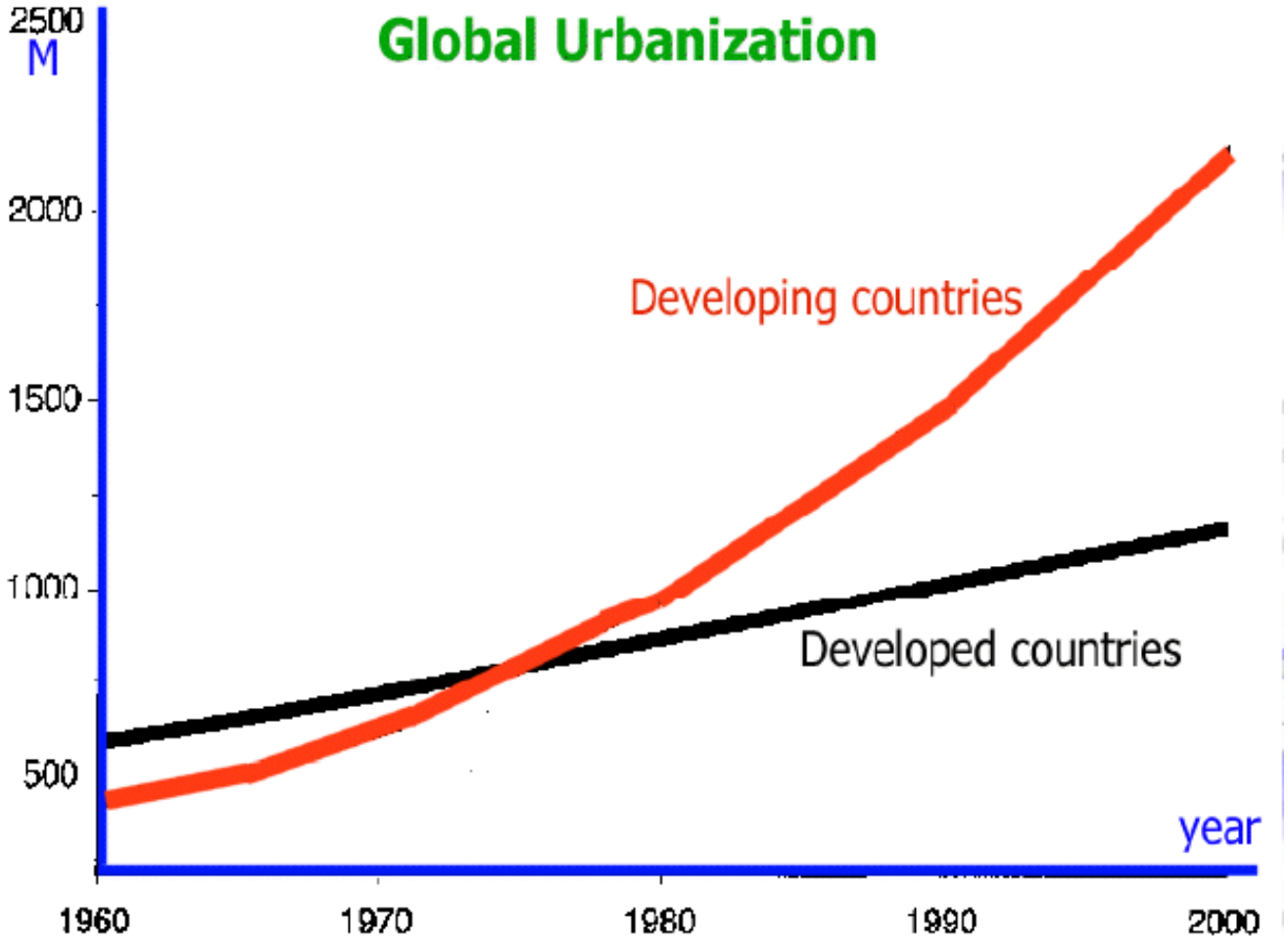
1. International trends & developments in urban management, land administration & spatial data infrastructures

Main trends:

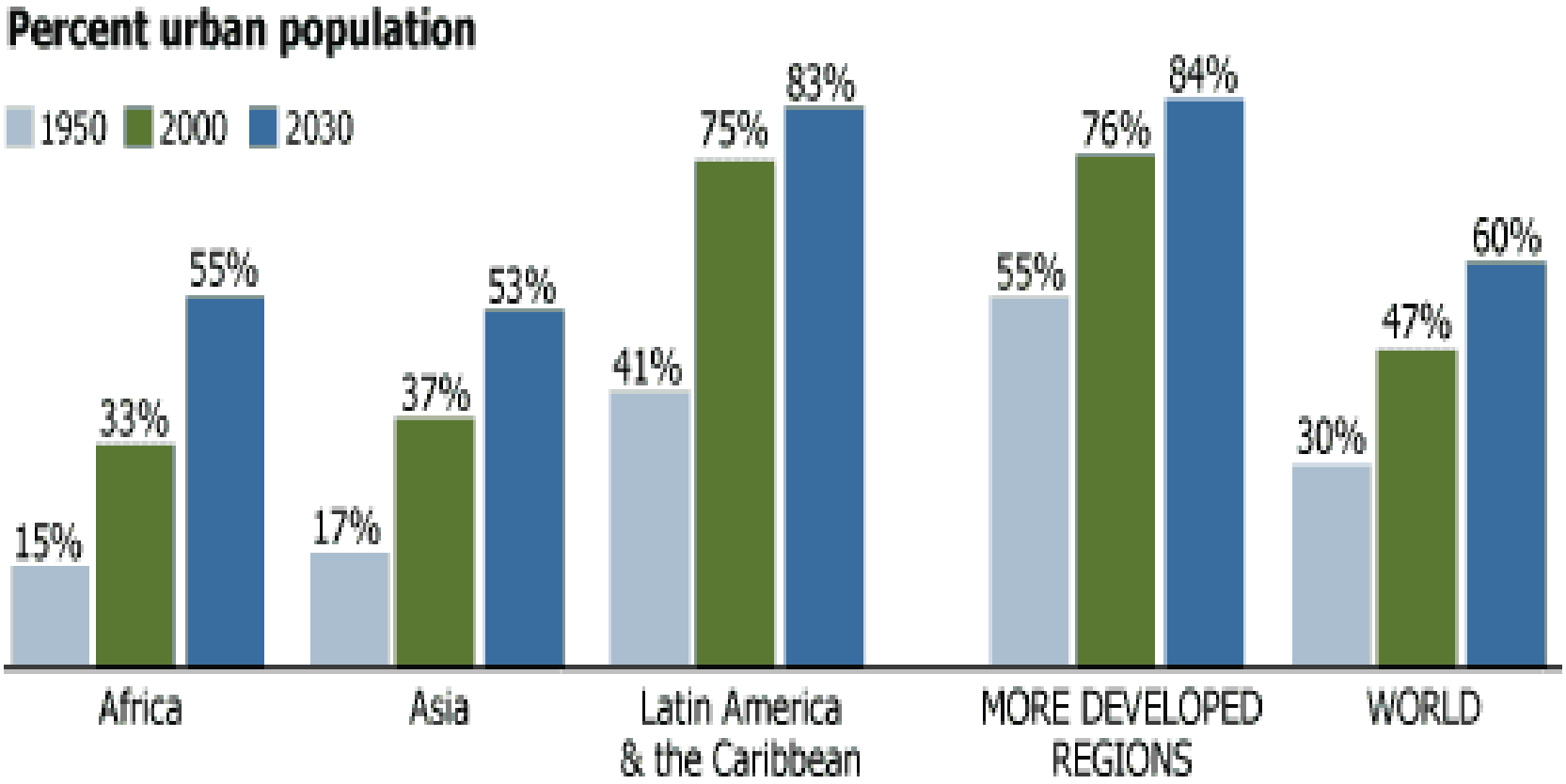
- Rapid urban growth: need for management and planning
- Improve the urban living environment: infrastructure, services, health, environment
- Improve urban safety: risk management (natural and man-made disasters), crime, anticipating and mitigating climate change
- Increase community participation: e-governance, web-based consultation

Absolute urban growth



Source: http://iwrmnotes.blogspot.com

And relative urban growth



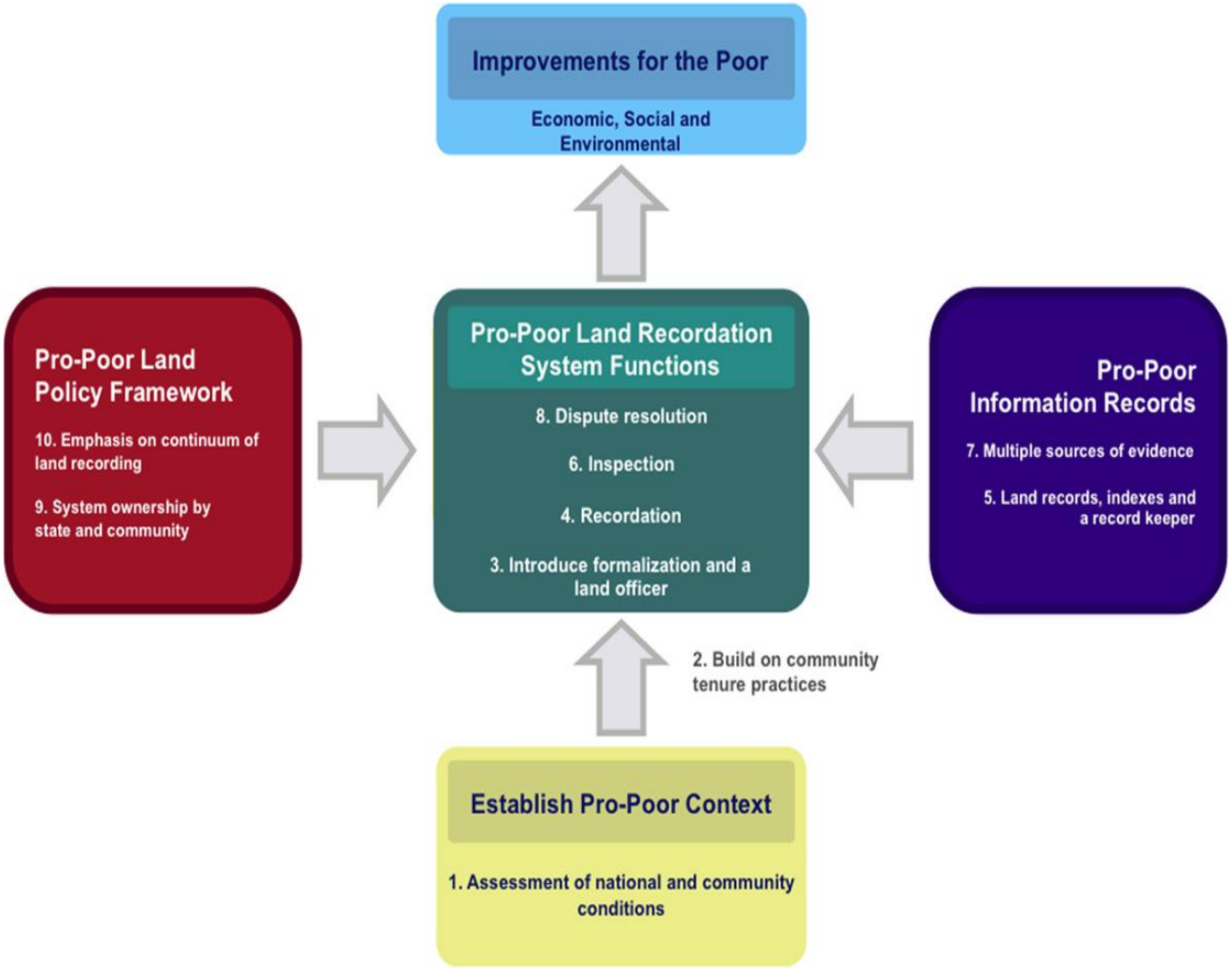
Source: www.prb.org

Example urban Africa:

- Diversity of urban sizes
- Large cities are growing at a faster rate than smaller cities
- Great heterogeneity between countries in size distribution of their cities
- Faster urban growth means faster slum growth
- More and better infrastructure and service are needed

Source: Africa's urbanization for development: understanding Africa's urban challenges and opportunities (World Bank)

Pro-poor land administration



The ten design elements of the pro-poor land recordation system (re-worked from Williamson et al., 2010: land administration for sustainable development)

Benefits of modern land administration systems:

- Improvement security of tenure
- Improved land resources management
- Land disputes reduction
- Increased revenue generation
- Credit security

Source: Crowd sourcing support of land administration systems (RICS)

Desirable characteristics of property rights to land:

- Long enough horizon to provide investment incentives
- Defined in a way that makes them easy to observe, enforce and exchange
- Administered and enforced by institutions that have both legal backing and social legitimacy and are accessible by and accountable to the holders of property rights
- Rights and duties of individuals, within a group that holds communal rights, have to be clear
- Institutions administering property rights need to be flexible enough to evolve over time in response to changing requirements

Source: Land policies for growth and poverty reduction – executive summary (World Bank)

References land administration:

Pro-poor land administration: principles for recording the land rights of the underrepresented

Description of a pro-poor approach to land administration, as developed by the global land tool network (GLTN)

Crowd sourcing support of land administration (RICS)

Description of opportunities provided by crowd sourcing for land administration, including examples of crowd sourcing with mobile phones for other applications

Land policies for growth and poverty reduction - executive summary (World Bank)

Description of the basics for good land policies, showing empirical evidence of the link between tenure security and economic development and poverty reduction + an analysis of land markets and description of the situation in different regions of the world

References land administration (2):

Social tenure domain model (STDM) – a pro-poor land tool (FIG)

Description of a land administration model, accommodating community land rights and using earth observation as an instrument for community participation

A domain model for land administration (ITC)

PhD thesis on the social tenure domain model, including a description of other land administration models

www.cadastre.org – exploring potential avenues and concerns

Article on volunteered geographic information for land administration applications (the article provides interesting perspectives, but the website doesn't exist)

Benefits of spatial data infrastructures:

- Positive cultural change in the stakeholder organizations with greater willingness to cooperate and share resources;
- More coordinated initiatives at the local level in data collection, and reduction of duplication and costs;
- Agreement on the common usage and maintenance of reference datasets;
- More evidence-based applications, particularly in land use planning and infrastructure planning and maintenance;
- Time and cost reduction in finding and accessing data held by other organizations;
- Improved shared understanding among public agencies of the problems and issues affecting the region.

Source: Advanced regional spatial data infrastructures in Europe (JRC)

Important elements spatial data infrastructures (SDIs):

- "Regional" dimension of SDIs is crucial (often neglected by professional and academic debates that tend to focus more on the national dimension, subsuming the regional in a hierarchical view of SDIs);
- SDIs facilitate building and supporting applications for citizens and local businesses related to land and property, planning, traffic, local services, as well as allowing new services from the private sector to be developed around addresses and locations

Source: Advanced regional spatial data infrastructures in Europe (JRC)

Do's and don'ts of SDIs

- All stakeholders must feel ownership
  - public sector
  - private sector
  - third sector
- Top-down leadership
  - government mandate extremely valuable
- Bottom-up implementation
  - individual organizations will determine whether it is successful
  - the more that participate the more useful the infrastructure becomes

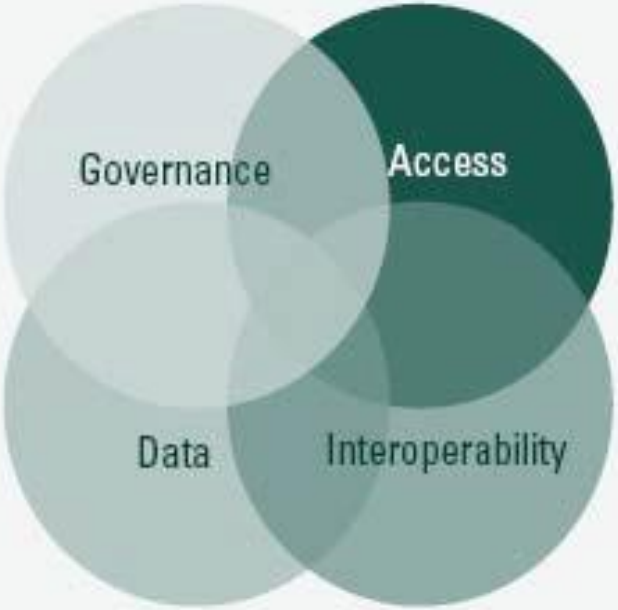
Source: Spatial data infrastructures: some lessons learned from UK and Europe (ConsultingWhere)

SDI goals

Four Strategic Goals

I.
Governance –
establish the governance structure required to optimise the benefits from government's geospatial resources.

II.
Data –
ensure the capture, preservation and maintenance of fundamental (priority) geospatial datasets, and set guidelines for non-fundamental geospatial data.



III.
Access –
ensure that government geospatial information and services can be readily discovered, appraised and accessed.

IV.
Interoperability –
ensure that geospatial datasets, services and systems owned by different government agencies can be combined and reused for multiple purposes.

Source: Spatial data infrastructures: some lessons learned from UK and Europe (ConsultingWhere)

Other references SDI:

Open geospatial consortium (OGC) www.opengeospatial.org
Information on standards and open geospatial data

United Nations geo-information working group (UNGIWG)
www.ungiwg.org
Info on standards and international cooperation efforts in cartography and geospatial information

United Nations Spatial Data Infrastructure compendium
Overview of international SDIs and description of UNSDI

Strategy for developing and implementing a United Nations Spatial Data Infrastructure in support of Humanitarian Response, Economic Development, Environmental Protection, Peace and Safety
Roadmap towards achieving the UNSDI, focusing on different application fields

Other references SDI (2):

Geospatial Science & Technology and Development (UNCTAD)
Report on the state-of-the-art of geospatial science and applications, including urban management, land administration and SDIs

External ties that bind: shaping geospatial information
Overview of SDIs and their effectiveness, viewed from a research standpoint, with lots of regional examples

The socio-economic impact of the spatial data infrastructure of Catalonia (JRC) *Study into cost-benefit of SDI in Catalonia: mainly derived from internal efficiency (time saved by government staff) and external effectiveness (time saved by the general public) + potential democracy impact*

GeoSUR: setting the foundation for a regional SDI in Latin America and the Caribbean www.geosur.info
Description of framework and first steps for setting up an SDI in the LAC-region

Other references SDI (3):

D 6.1.2 Report on user requirements, costs, derived direct benefits, and current obstacles for a European and Global Spatial Data Infrastructure (EuroGEOSS) *Report describing the user requirements, costs, derived direct benefits, and current obstacles for a European and Global Spatial Data Infrastructure, with special emphasis on GEOSS and INSPIRE, based on a survey of (potential) users*

Mapping for results (World Bank) **http://maps.worldbank.org**
Geospatial data on World Bank projects

World Bank on spatial data infrastructure
References to World Bank and country SDI reports

Using spatial data infrastructures for monitoring development outcomes: a manual for developing countries (World Bank SDI report) *Report on SDI for measuring progress in development (in wiki format)*

Other references SDI (4):

INSPIRE: a real step forward in building an interoperable and unified spatial information infrastructure for Europe? (ESPI) *Description of, and views on, a European initiative for uniform rules for an SDI*

INSPIRE: infrastructure for spatial information in the European Community http://inspire.jrc.ec.europa.eu/

eGovernment Economics Project (eGEP) - measurement framework final version www.epractice.eu

Towards a national 3D spatial data infrastructure: case of the Netherlands *Research article on a possible 3D SDI*

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2. Steps to promote earth observation for urban management, land administration & spatial data infrastructures

State-of-the-art

Earth observation is new technology.

Learn technical skills, but when back in professional practice, it has to be put to good use.

That involves ‘selling’ it.

How to do that?

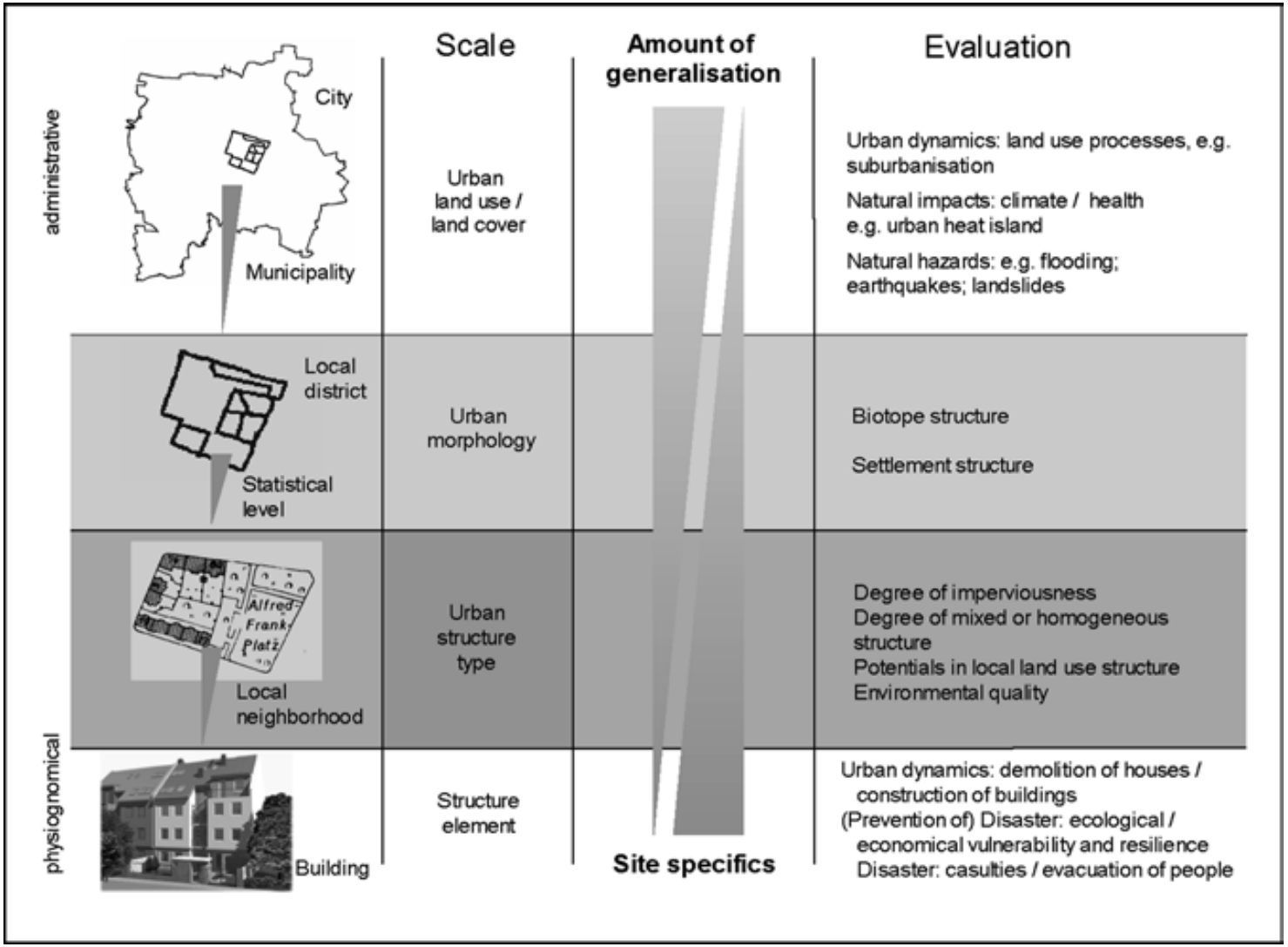
To whom? Could be your own boss, local authorities, communities, etc.

Categories of products and services

Earth observations provides an important base layer for urban management, land administration and spatial data infrastructure products and services. No special categories are therefore distinguished; a number of examples are given.

Mapping scales (resolution) are related to various forms of planning.

Scale dependent urban analysis



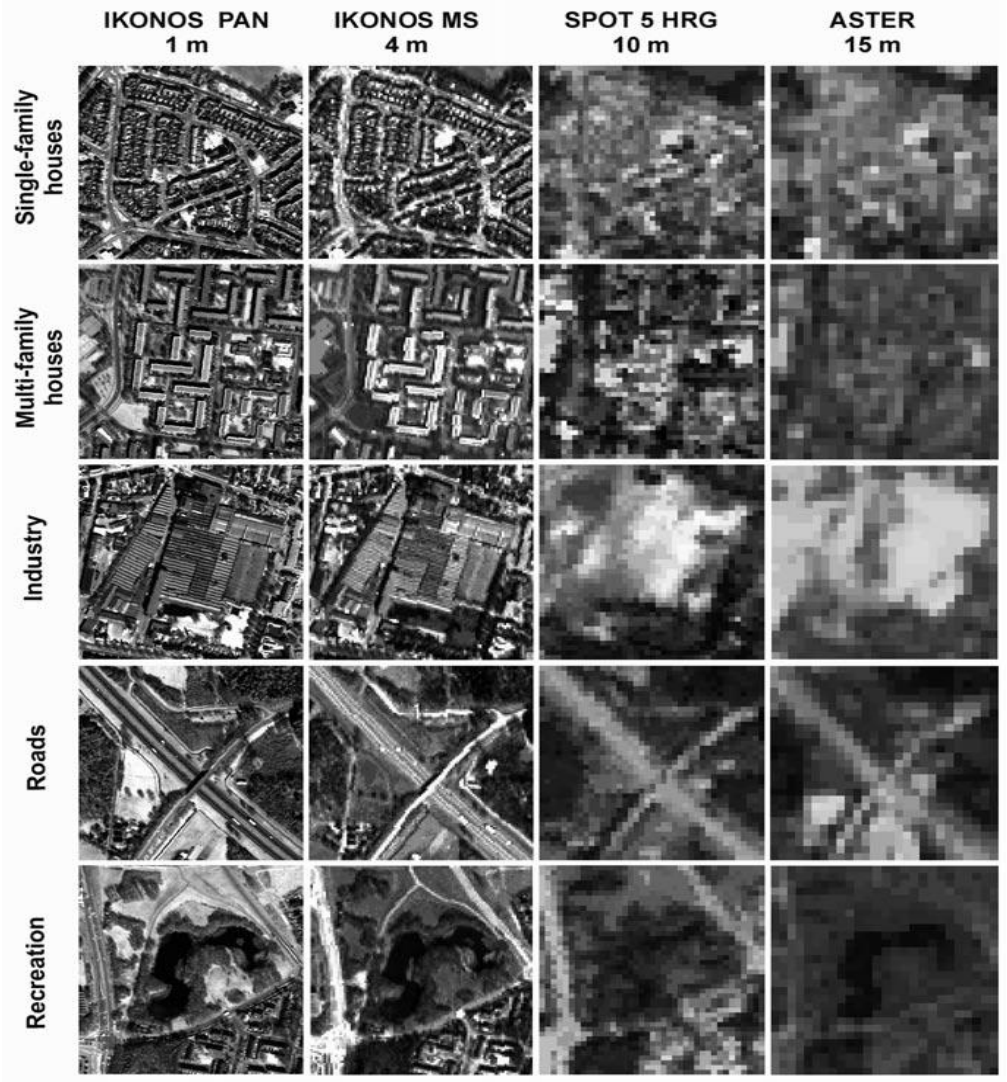
Source: Remote sensing of urban and suburban areas (from Banzhaf and Höfer 2008; modified after Wickop et al. 1998)

Benefits of urban remote sensing:

- The growth of 'Spatial Data Infrastructures', Geo-portals and private sector initiatives (e.g. Google Earth, Microsoft Virtual Earth, etc.) produced an increase of geographical data availability at any scale and worldwide;
- Remote sensing can provide a useful and direct indication of the physical form and morphology of urban land cover in cities;
- Remote sensing represents a complementary data source to traditional socioeconomic surveys;
- Remote sensing supports "smart growth" (a range of urban strategies that focuses on sustainability of development under different economic scenarios).

Source: Remote sensing of urban and suburban areas

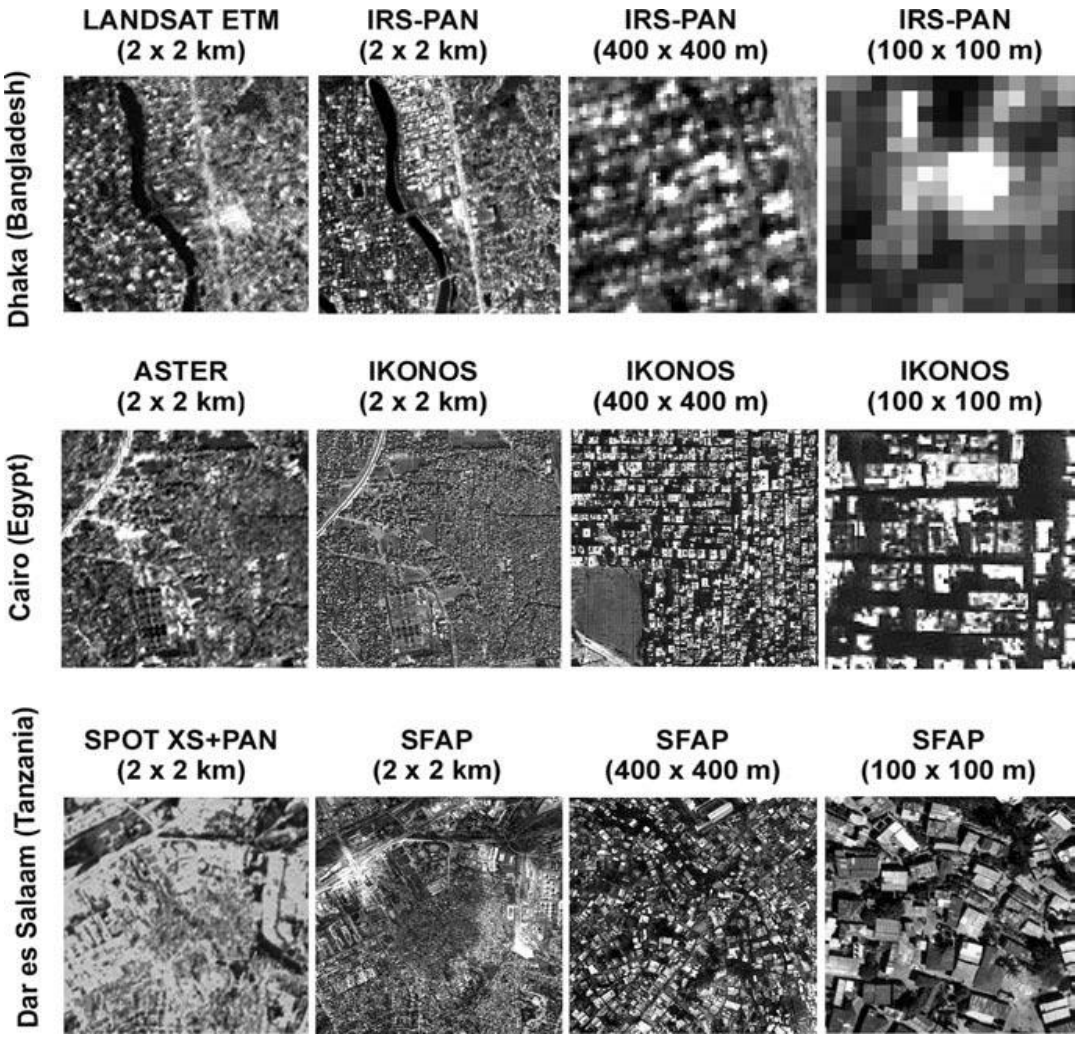
Urban remote sensing scale example



Comparison of urban objects and land uses in Enschede, The Netherlands, by sensor and spatial resolution (each window represents a 400 × 400 m area on the ground)

Source: Remote sensing of urban and suburban areas

Urban remote sensing scale example (2)



Examples of informal urban development with different sensors and spatial resolution

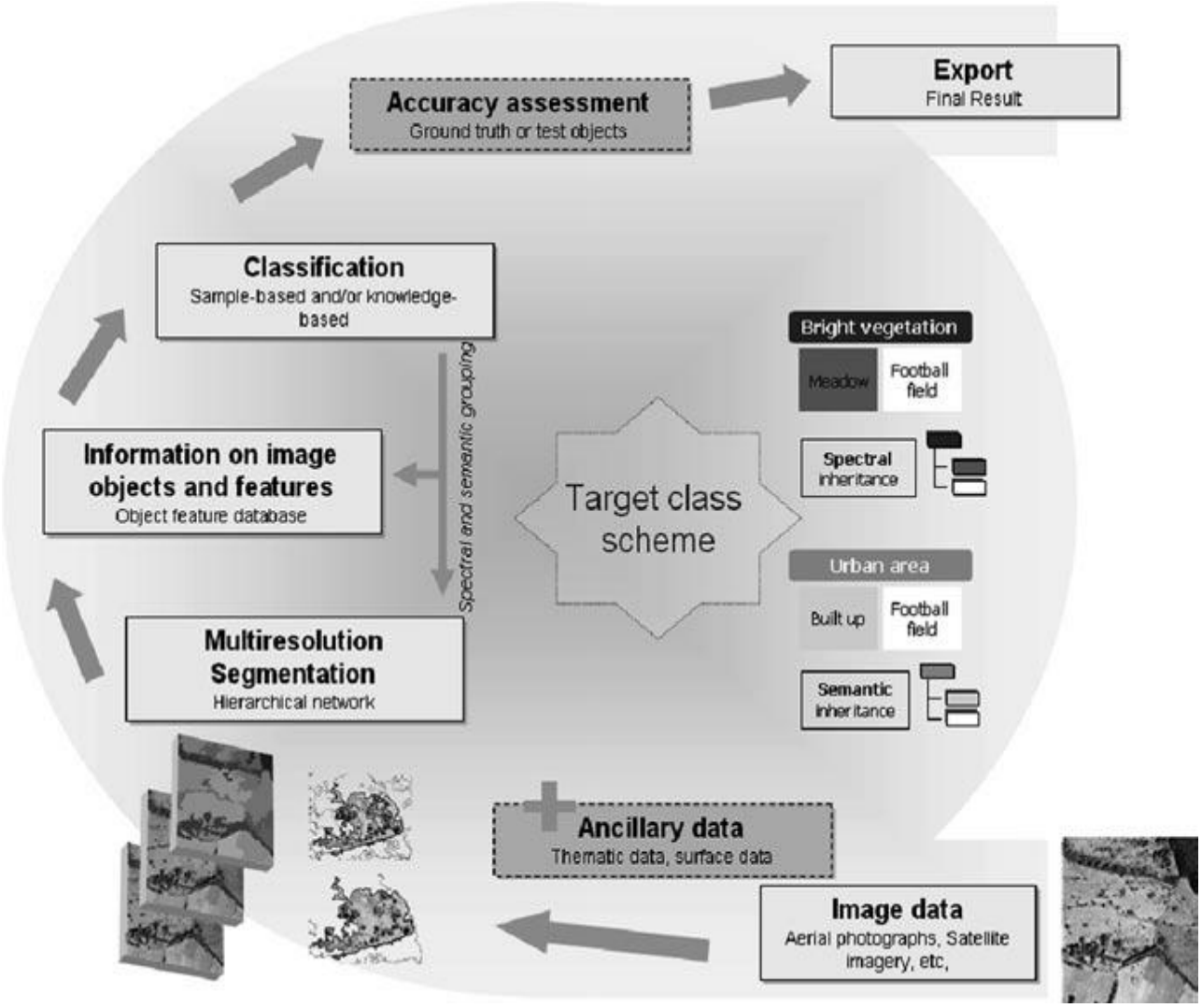
Source: Remote sensing of urban and suburban areas

Urban remote sensing applications:

- Urban population studies
- Health
- Environment
- Interpreting urban land uses from urban land cover
- Desertification
- Urban heat islands (thermal mapping)
- Urban ecosystems
- Crime mapping (combination RS & GIS)
- Characterizing urban population (nighttime satellite data)

Source: Remote sensing of urban and suburban areas

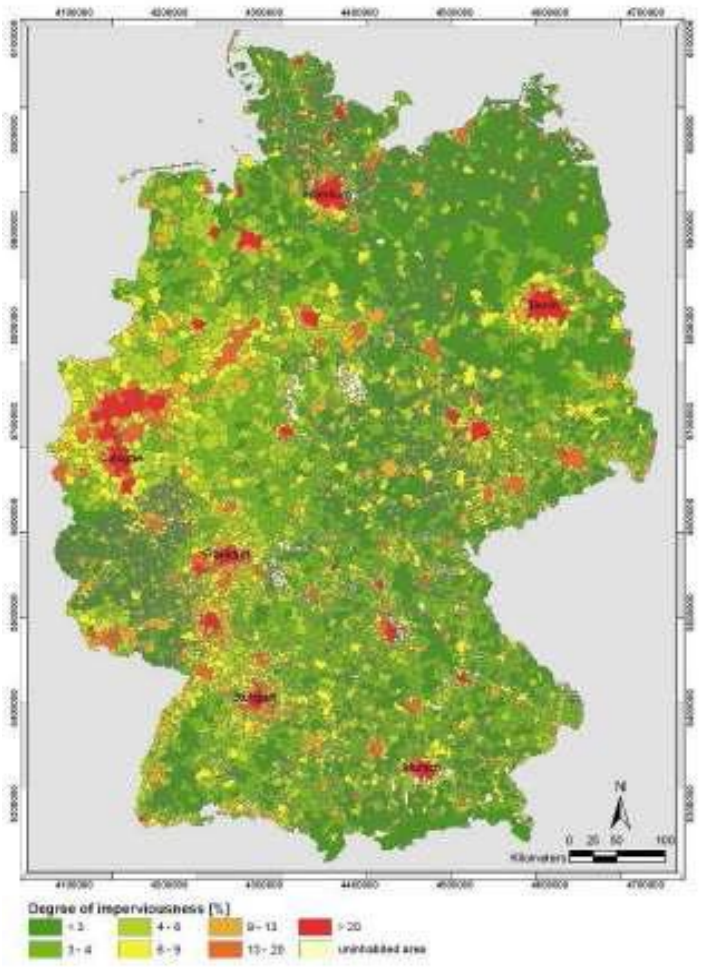
Object-based urban remote sensing

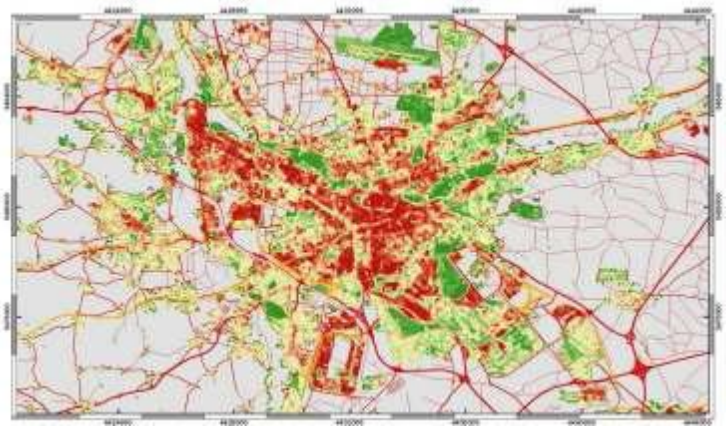


Principle workflow of object-based image analysis

(Source: Remote sensing of urban and suburban areas)

Urban example: impervious surfaces





Imperviousness (vector lines)

Expressway
Highway
District road
Farm track
Railroad

Imperviousness (raster)

100%

0%

Source: Urban remote sensing: how can earth observation support the sustainable development of urban environments?

Urban example: cost - benefit

nrsc

Description project activity	RS & GIS methods		Traditional ground methods (~ estimated values)	
	~ costs per square km (Indian rupees)	~ time required	~ costs per square km (Indian rupees)	~ time required
Thematic/urban land use / land cover mapping and GIS database creation for Delhi NRC region (34,000 $km^{2)}$ on 1: 50,000 scale	1,000	1 year	10,000	more than 2 years
Cartographic quality large scale mapping on 1: 10,000 scale using high resolution satellite data; 5,000 km^2 covering 40 towns	10,000	2 years	25,000	more than 3 years
Thematic quality urban land use / land cover mapping and GIS database created for Hyderabad, HUDA region on 1: 5,000 scale, using high resolution satellite data	5,000	6 months for 2,000 km^2	20,000	more than 2 years

Cost and time requirements for preparation of urban thematic maps in various scales
Source: Remote sensing applications, chapter 5 – urban & regional planning (NRSC)

Urban remote sensing references:

Urban remote sensing: how can earth observation support the sustainable development of urban environments?
Description of opportunities for remote sensing with examples on monitoring of urban sprawl, mapping of the percent impervious surface, mapping of urban heat islands (local heating potential), micro-climate model development and flood vulnerability and risk mapping

Remote sensing applications: chapter 5 urban and regional planning (NRSC)
Overview of the use and prospects of remote sensing for urban and regional planning applications in India

Remote sensing of urban and suburban areas
Collection of state-of-the-art chapters on urban remote sensing, aimed at capacity building (with references); a strong focus on science and techniques

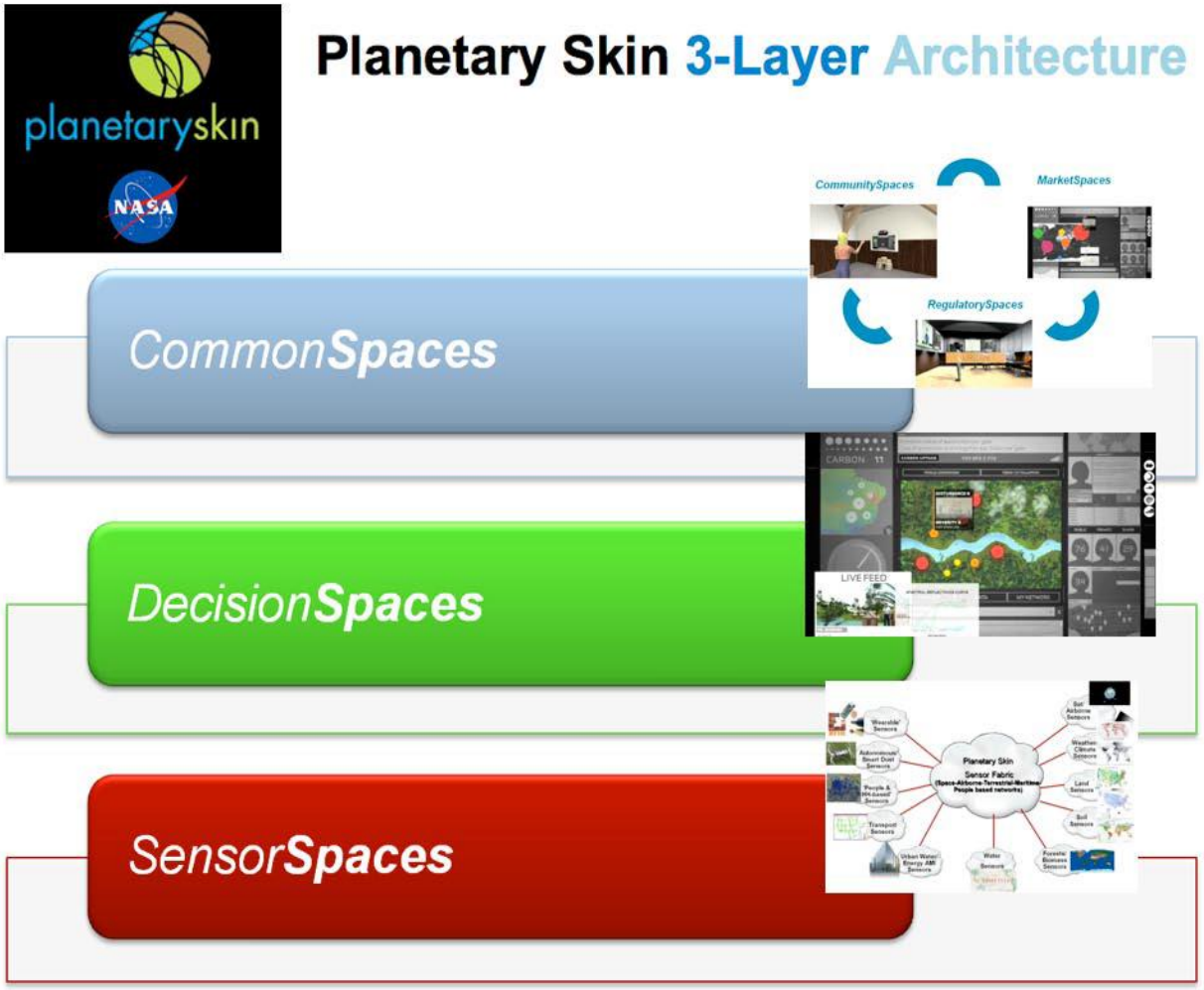
Urban remote sensing references (2):

Expanding cities – a growing concern (GMES brochure)
Description of remote sensing activities for Europe, including the development of an urban atlas and a pan-European comparable land use and land cover information database at high resolution

Workshop report on sustainable urban development (NASA)
Urban heat islands, urban vulnerability to climate change, sustainability (including transportation and renewable energy), community participation, sustainable buildings, air quality and urban health, urban risk management

Planetary skin www.planetaryskin.org
Instrument for decision making

Example: decision making



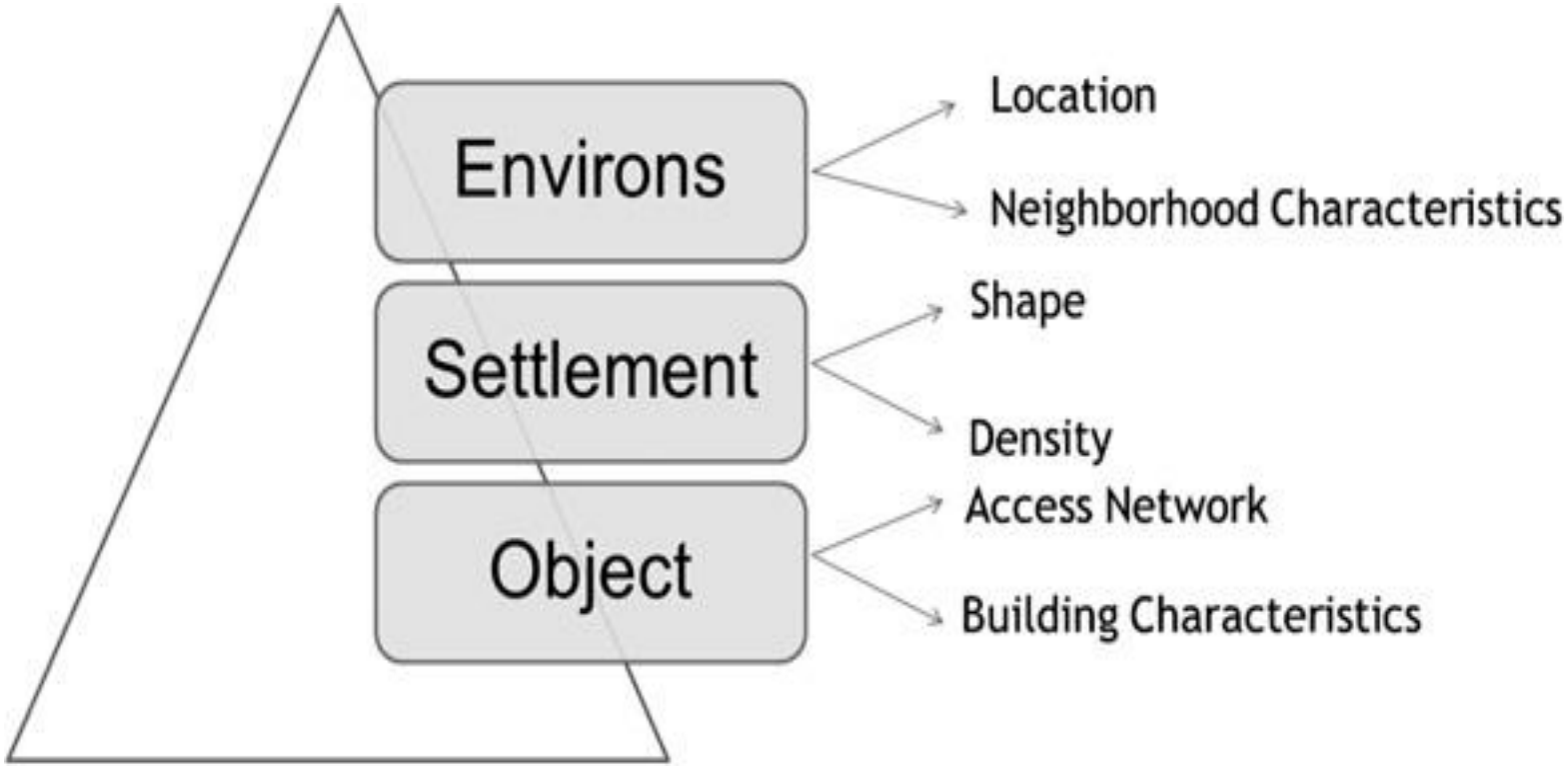
The planetary skin platform

Example slum mapping: features

- Access network
  Irregular road layout with variable road types and widths; mostly approach roads or in some cases perhaps only footpaths that may be easily distinguishable from road networks in planned areas.
- Density
  Very dense, with generally very high roof coverage and very little open spaces and vegetation.
- Shape
  Irregular shape easily distinguishable from planned areas; tend to follow the shape of features like roads, railways due to easy availability of land.
- Connectivity
  Very poor connectivity with infrastructure in neighbouring areas.
- Location
  Tend to locate near to places that offer substantial economic opportunities and/or in hazard-prone areas.

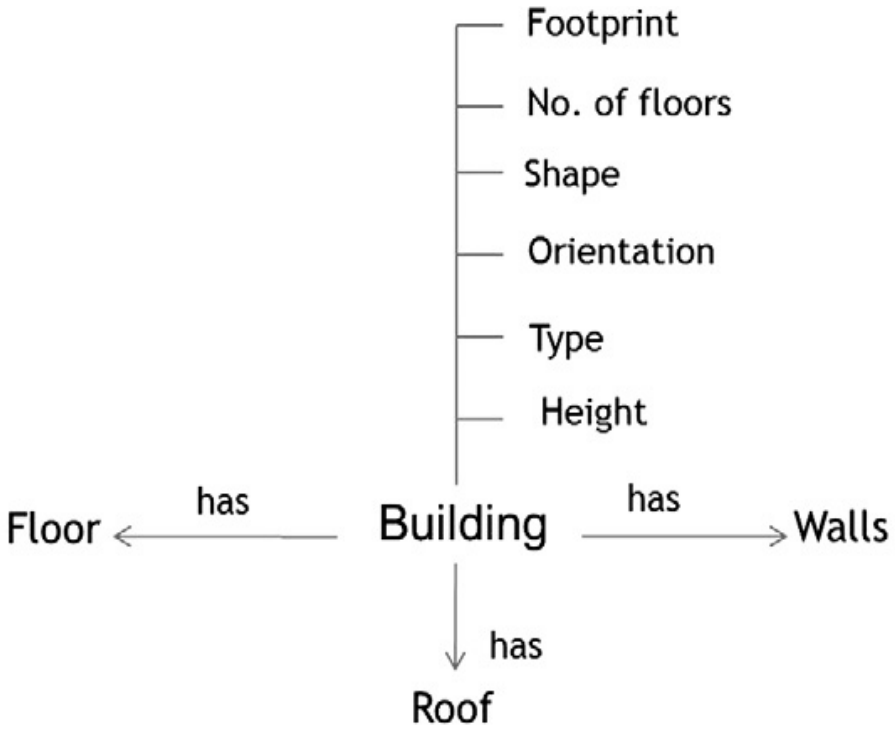
Source: An ontology of slums for image-based classification

Example slum mapping: indicators



The six general indicators categorized to form a hierarchy to represent concepts at three spatial levels
(Source: An ontology of slums for image-based classification)

Example slum mapping: building attributes

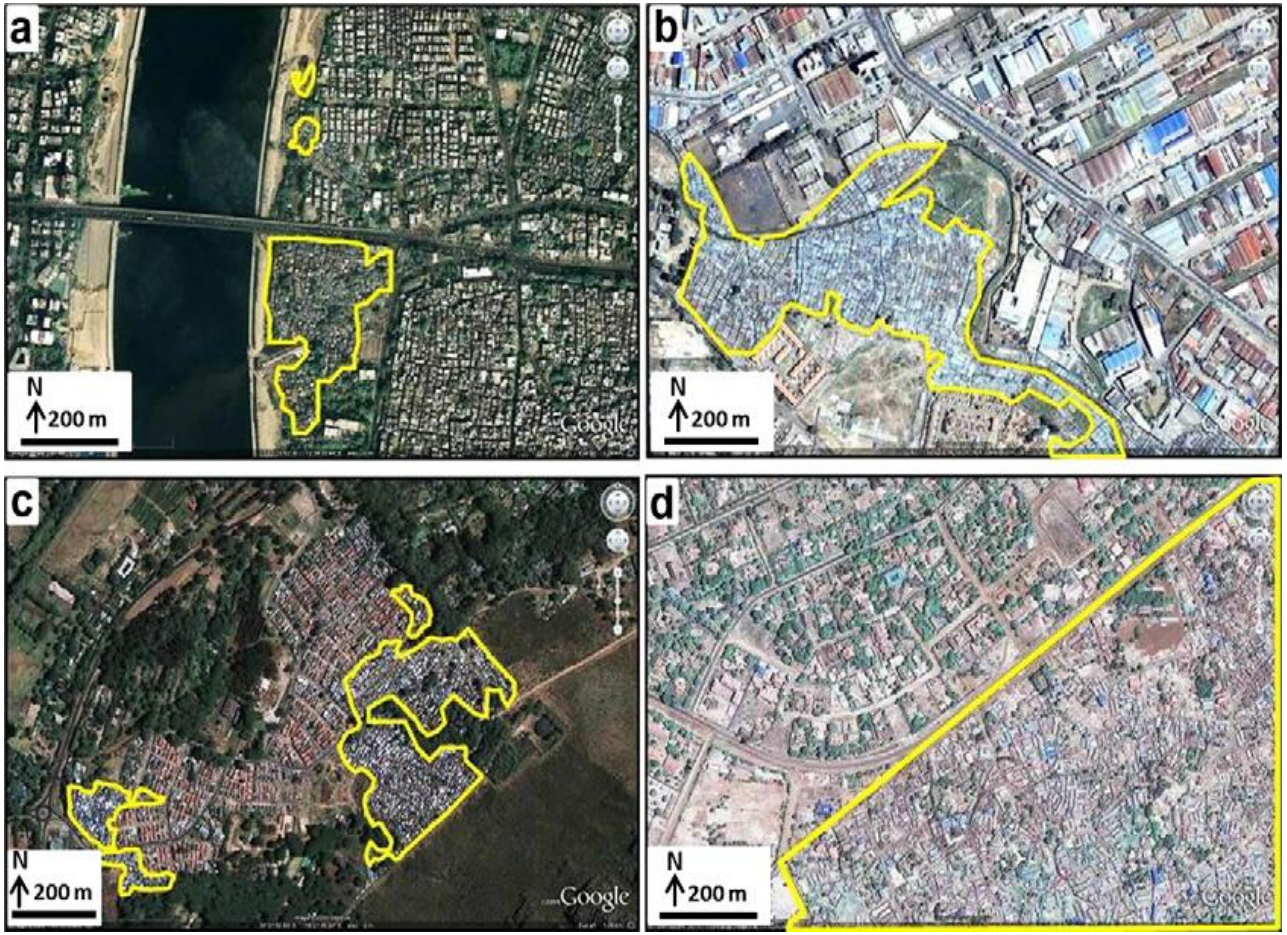


Floor, roof, walls	is of	Material (poor iron sheet, wood, mud, plastic, unburnt brick)
Shape/Orientation/Type	is	Rectangle, elongated/ Irregular, haphazard/Attached, detached
Roof	has	Color (brown, blue, grey)
Footprint, no. of floors, height	is	Specific value or range

Diagram of building attributes with the corresponding values derived from the expert survey

(Source: An ontology of slums for image-based classification)

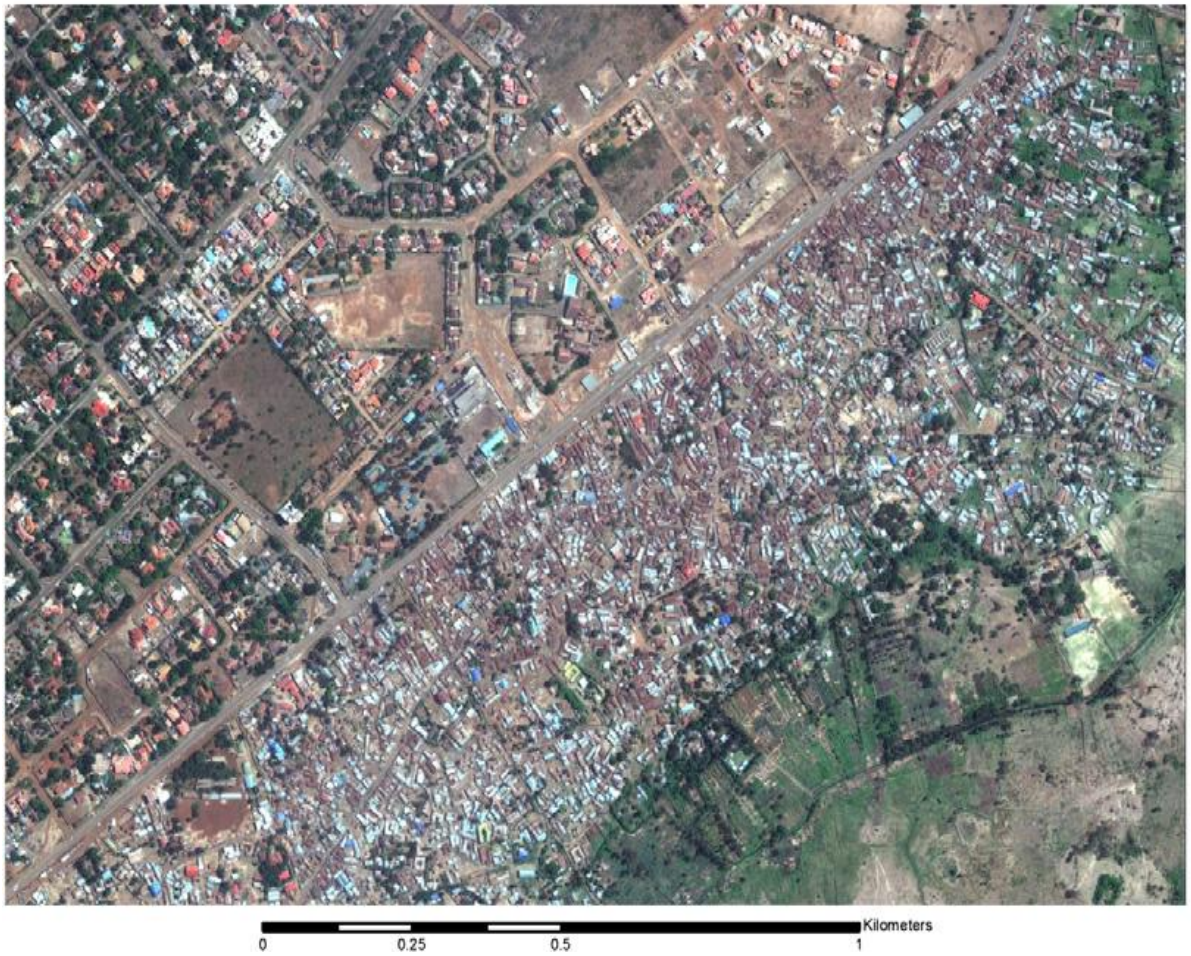
Example slum mapping: delineation



An example of slum delineation in different contexts by an Indian expert. City names: (a) Ahmedabad (India), (b) Nairobi (Kenya), (c) Cape Town (South Africa) and (d) Kisumu (Kenya). Source: Google Earth.

(From: An ontology of slums for image-based classification)

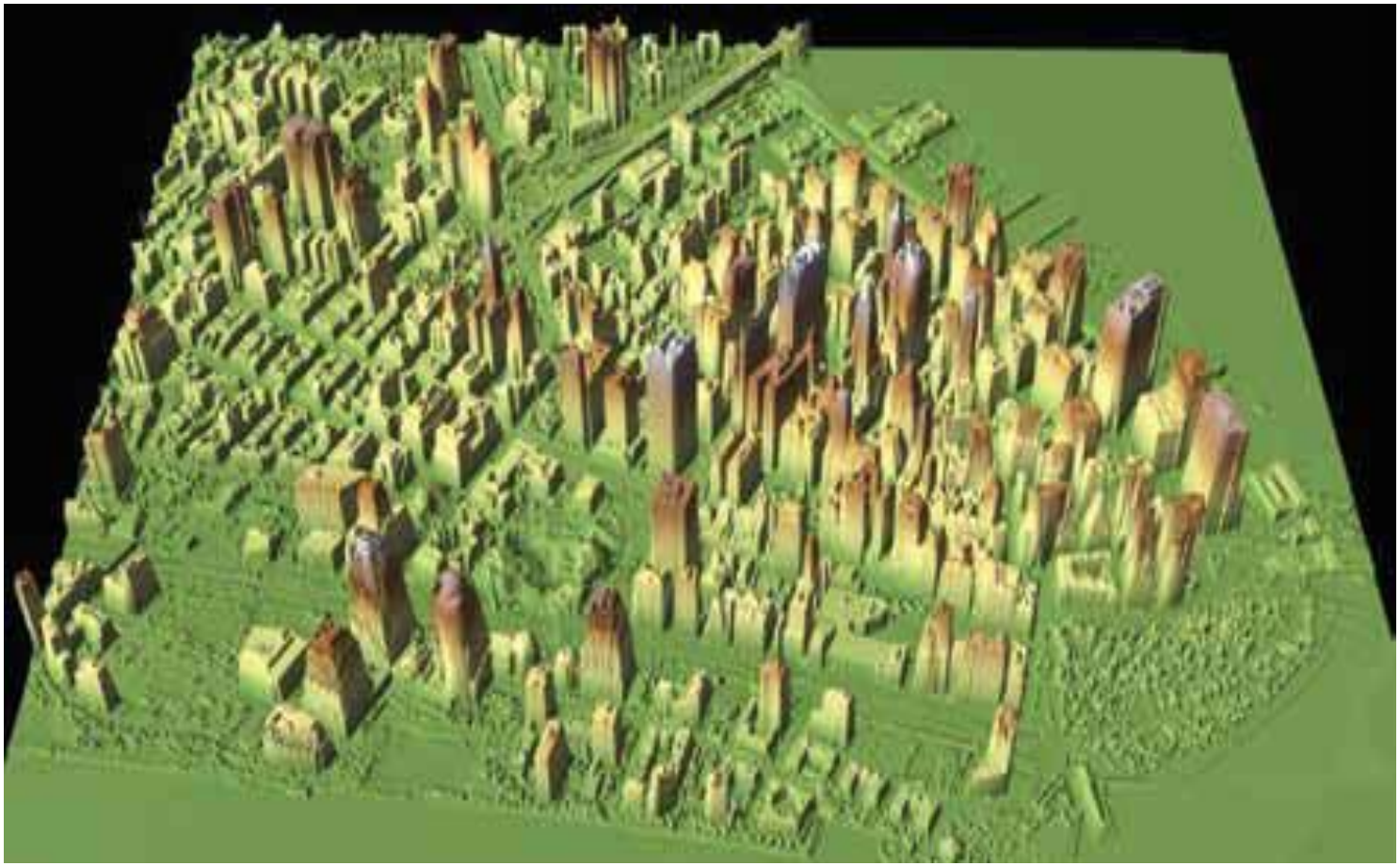
Example slum mapping: recognition



A snapshot of Kisumu, Kenya. The Nyalenda slum area is clearly visible below the major road running diagonally from bottom left to top right.

(From: An ontology of slums for image-based classification)

Completely different example: LIDAR



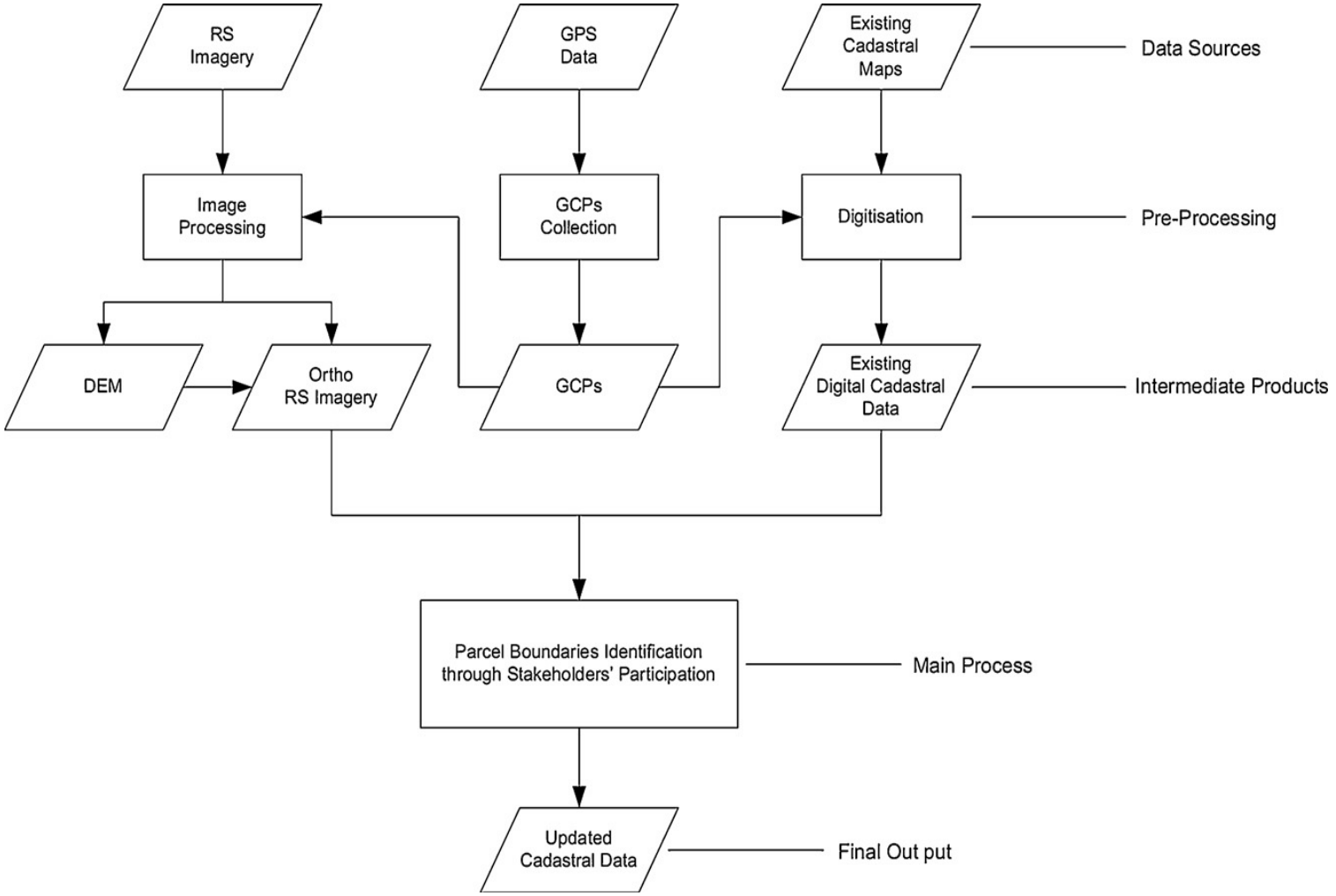
Lidar map from Manhattan, New York

Land administration & earth observation

- Rural areas
  Surveying from images HRSI (high resolution satellite imagery) and even lower resolution satellite imagery, can also provide for high-speed cadastral surveying. The use has already been trialed in Ethiopia by the World Bank. This approach is particularly worthy for rural areas: these contexts possess the wide-open spaces necessary for boundary identification.
- Urban areas
  In urban areas, where highly precise boundaries are used (known to surveyors as fixed boundaries) current HRSI resolutions are not yet considered adequate. The situation will most likely change as image resolutions increase and prices inevitably decrease.
- Benefits for cadastral applications
  The benefits of using HRSI for cadastral applications, even in urban areas, should become increasingly apparent for some contexts. However, the need for in field checks, surveys, and more importantly, agreement on where boundaries lie, will remain.

Source: Land administration: a key to sustainable economic development

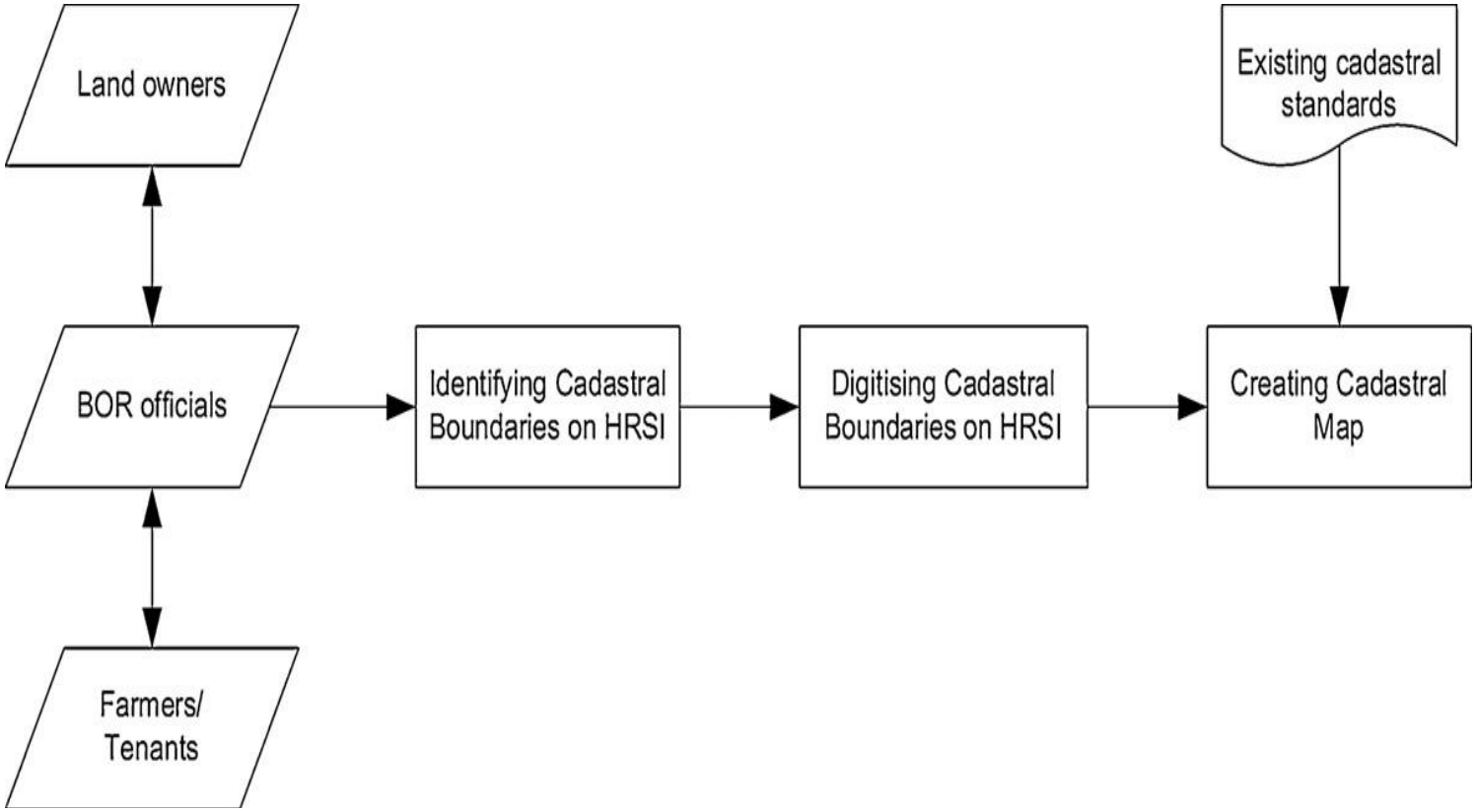
Land administration: workflow (1)



Process flow of integrated approach

(Source: An integrated approach for updating cadastral maps in Pakistan using satellite remote sensing data)

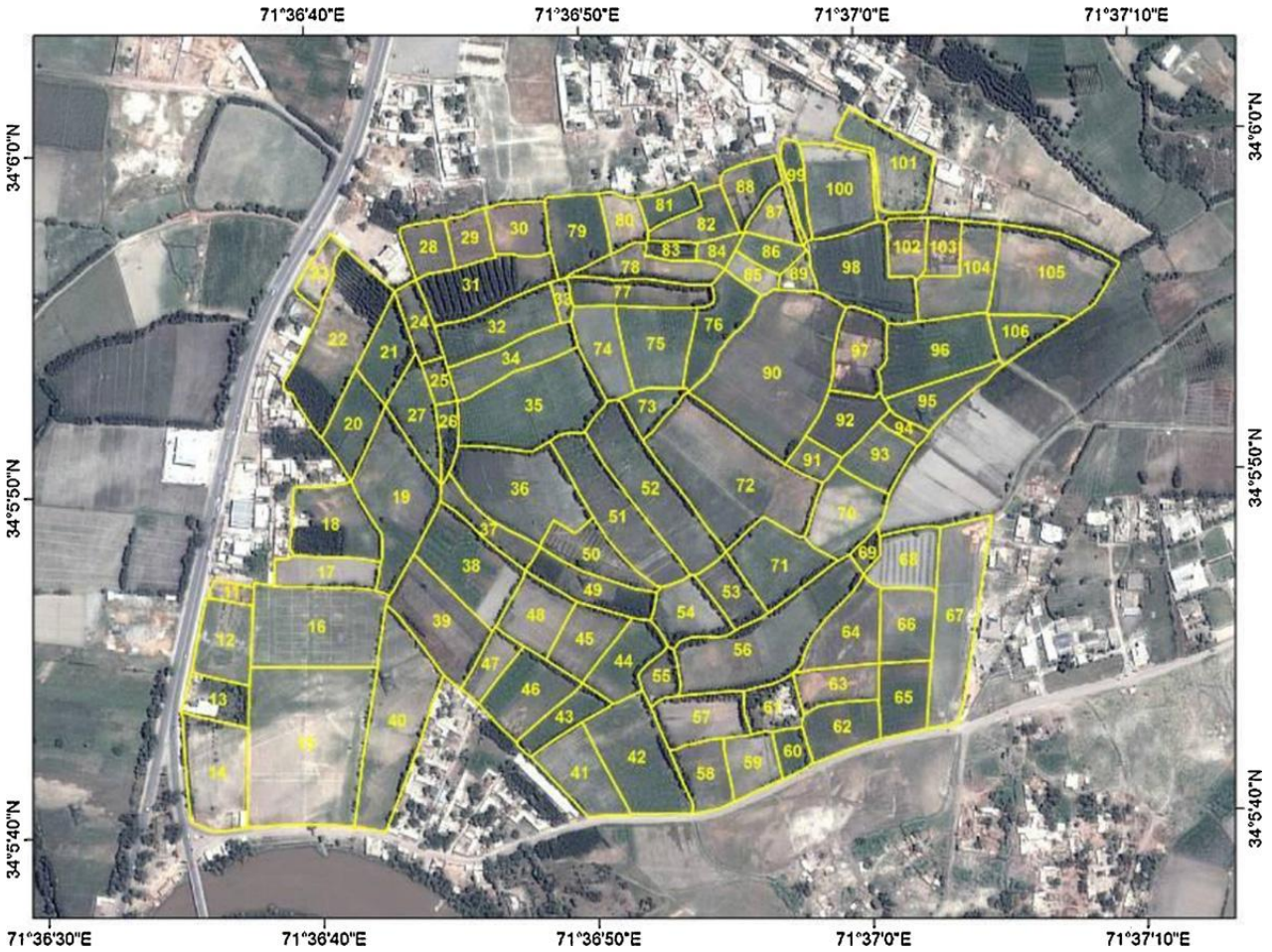
Land administration: workflow (2)



Workflow for capturing cadastral boundaries using PGIS technique

(Source: An integrated approach for updating cadastral maps in Pakistan using satellite remote sensing data)

Land administration: example



Digitised parcel boundaries on QuickBird HRSI in Zormandi area

(Source: First experiences using high-resolution imagery-based adjudication approach in Ethiopia (WB))

Marketing of earth observation

Marketing of earth observation is difficult.

New technology, few big companies, lots of small ones.

Lots of reports describing the bottlenecks, like reliability, data access, data continuity, etc.

Means that relatively a lot of effort is needed to promote EO.

Points to keep in mind:

- Look for opportunities, where can you have most success in a short time: quick-wins.
- Target the right audience to start with: who would be interested and listen to you?
- Identify the problem that they are trying to solve: is it the same as yours?
- Learn to speak the same language. Avoid abbreviations, such as PGIS or VGI, that politicians and managers do not understand and do not care about. Use terms related to profits and losses.
- Look for examples from elsewhere (success stories): solutions that work and are affordable.

Be patient:
introduction of new technology
and / or applications takes time

3. How to get funding for your activities

Approach

- Share information on your subject (a thing you are doing) and think that is interesting for your contact, then look for the link. Could this solve a problem for your partner? Are adjustments necessary? Need other parties be involved? Take it from there.
- LEADS, LEADS, LEADS

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How?

- Establish your network.
- Look for opportunities.
- Write a good proposal.
- Promise much, but not too much.

Proposal outline

(more detailed version in separate document, see also www.geonetcab.eu)

1. Introduction / relevance
2. Objective(s)
3. Activities
4. Output
5. Management & evaluation
6. Risk assessment
7. Time schedule
8. Budget

Annexes

Other references

- Civicus: writing a funding proposal
- Michigan State University: guide for writing a funding proposal
- ESRI: writing a competitive GRANT application
- REC: project proposal writing

Again:

- *SHARED PROBLEM*
- *SHARED LANGUAGE*
- *SHARED SOLUTION*

If all else fails, try to link with a more popular (and easy to understand) topic.

4. Capacity Building

General

Marketing is promotion + capacity building.

Especially for the introduction of new technologies capacity building is important at all levels.

Capacity building is the instrument to increase self-sufficiency and make solutions work.

Think of:

- Different instruments for different levels: workshops for decision makers and awareness raising, detailed technical training for professionals.
- Provide follow-up. Getting funding for good capacity building is difficult: everybody agrees that it is important, but nobody has time.
- Training is usually part of funding of big projects that are managed by big companies or ministries, as a consequence capacity building is forgotten (in the end).
- Aim at small budgets that are available without having to tender.

Examples & references

Remote sensing of urban and suburban areas
Collection of state-of-the-art chapters on urban remote sensing, aimed at capacity building (with references); a strong focus on science and techniques

An ontology of slums for image-based classification
Description of approaches for slum identification and mapping and how remote sensing can help

First experiences using high-resolution imagery-based adjudication approach in Ethiopia (WB)
Description of a pilot for using Quickbird images by communities for land adjudication

More references

A Rough Google Earth Guide

MEASURE Evaluation Global Positioning System Toolkit (USAID)

Handbook of Research on Developments and Trends in Wireless Sensor Networks: From Principle to Practice

Further details:

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www.geonetcab.eu