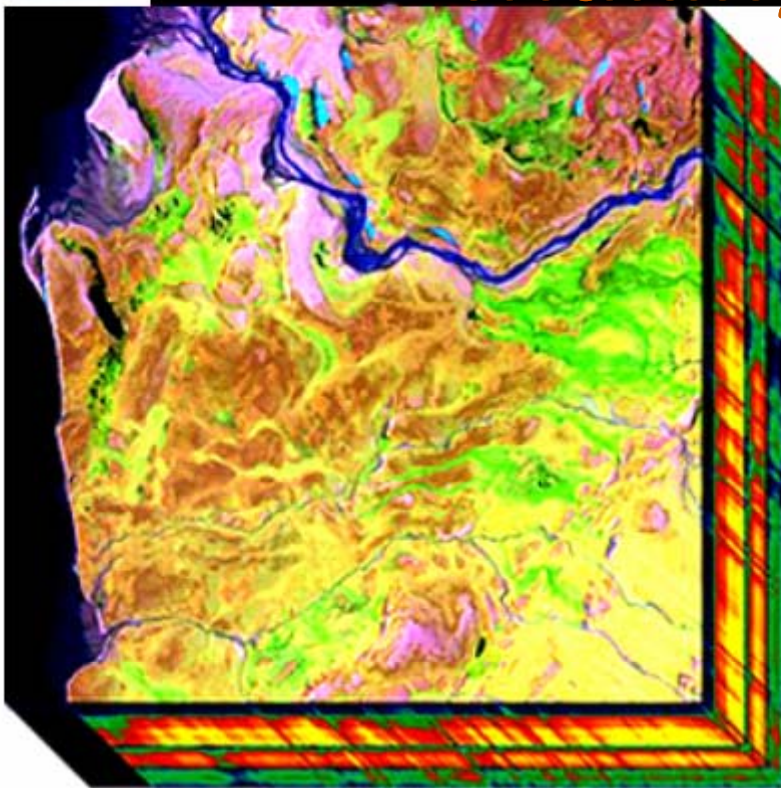
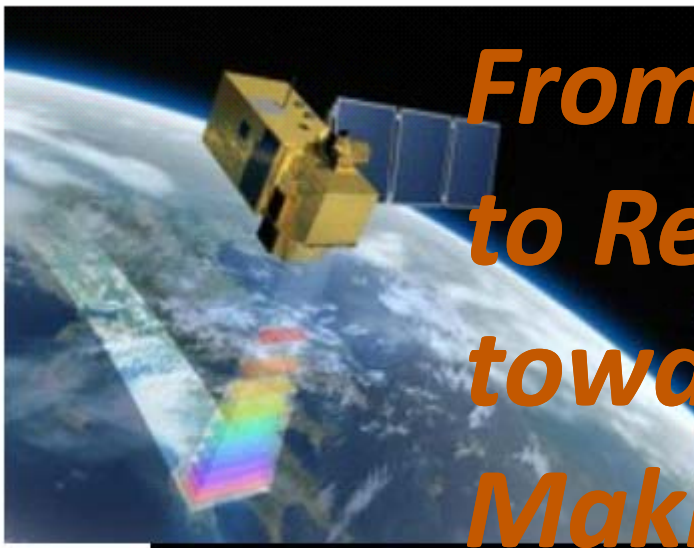


From Observation to Representation toward Decision Making process



$$\theta) dx = \int \frac{\partial}{\partial \theta} \pi(\theta)$$
$$f_{\theta, \theta}(\xi) = \frac{1}{\sigma} \left| \frac{\partial \pi(\theta)}{\partial \theta} \right|$$
$$\ln L(\xi, \theta) \quad \int \frac{\partial}{\partial \theta} \pi(\theta)$$
$$\left(\frac{\partial}{\partial \theta} \pi(\theta) \right) \pi(\theta)$$
$$\int \frac{\partial}{\partial \theta} \pi(\theta) \pi(\theta)$$
$$\frac{\partial}{\partial \theta} \ln f_{\theta, \theta}(\xi) = \frac{\partial}{\partial \theta} \left(\frac{\partial \pi(\theta)}{\partial \theta} \right)$$





JOINT ASSYST – FUTURICT MEETING
Torino, 17-18 November 2011

Visualizing Information in Complex Environments

Visualization and Decision Making in Spatial Environments

From Observation to Representation toward Decision Making process

Christiane Weber

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→ Environmental issues

- Urbanisation gradient
- Urban area limits
- Artificial areas



Impacts



Earth Observation: new paradigm

- From pixel to object
- New technologies
- Multi sensors, multisources

EO and Urban environment

- Spatial indicators
- Urban Heat Island
- Artificial areas
- Urban biodiversity

Decision making

- EO product as media for collaborative actions

The XXIe Urban Issues .. .

» Population growth (natural rate, migration)

- Increase of Urban artificial areas

» New environmental interests and obligations

- Environmental issues

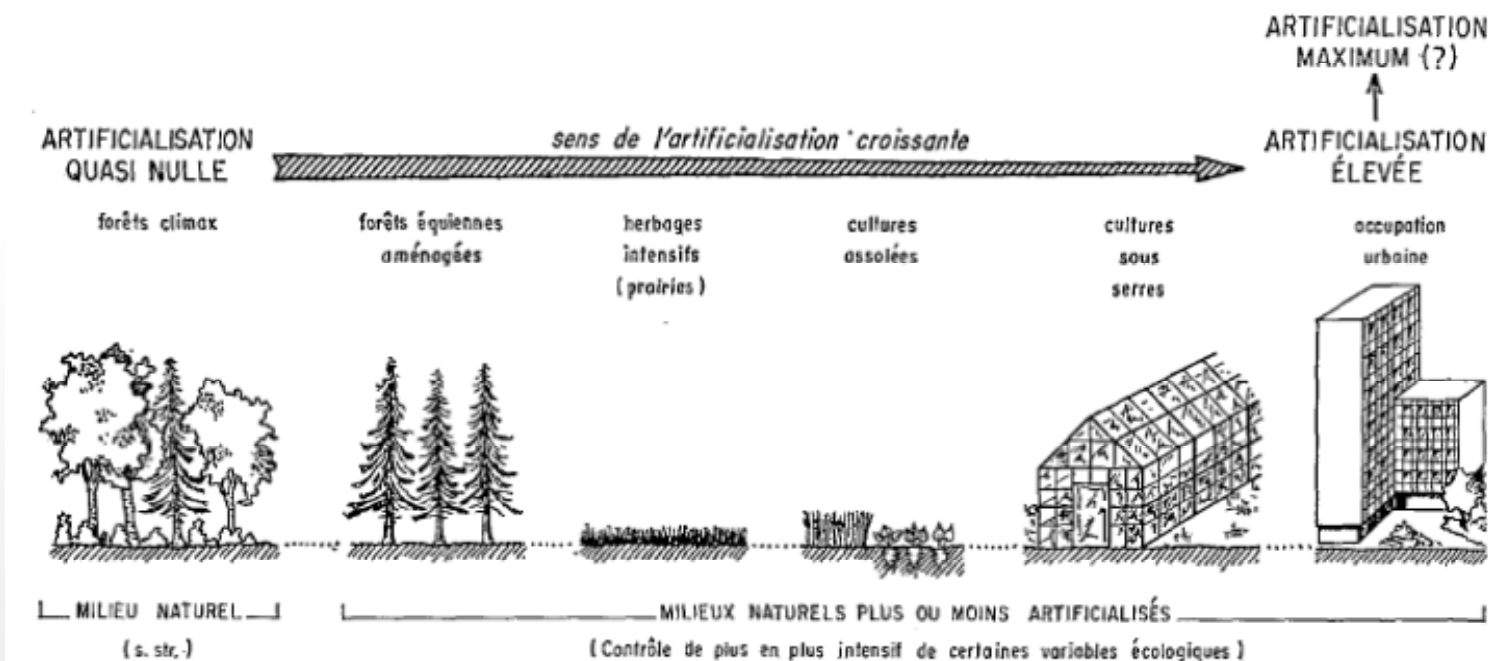
➔ Environmental vision

➔ Communities vision

➔ Sustainable challenges



Urbanisation gradient



Urban Area limits

Box 1.3 Definitions of urban areas

Urban areas can be defined according to different criteria. Apart from population thresholds these include:

Administrative area: constitutes the territorial expression of the political and technical framework of governance, forming the focus for, and critical to the understanding of, the development and implementation of policies to secure both quality of life and sustainable development.

Morphological area: constitutes, irrespective of administrative borders, the spatial dimension and form of cities and towns in physical terms, comprising urban fabric with buildings, roads and artificially surfaced area, industrial and commercial units, green urban areas within urban fabric, and in addition port areas, airports, and sport and leisure facilities if included or continuous to other urban land use.

Functional urban area: constitutes the territorial influence of the built environment. It includes both urban and rural areas and forms the basis for the development of towns and cities. The functional urban area that

Problem of territorial competences
Emergence of peri urban structures
Multifunctionalities of areas

Using different delineations: the relationships between administrative, morphological and the functional urban areas and their appropriate consideration by decision-makers is critical to the effective governance of the forces creating the social, economic and environmental challenges posed by towns and cities. Due to inertia in the re-definition of administrative areas, the functional urban area typically extends well beyond the administrative and morphological boundaries of the town or city. These considerations, which concern the relationships between the socio-economic driving forces of change and the administrative units of governance designed to manage change, highlight the need to secure both vertical and horizontal policy integration for the effective governance of towns and cities.

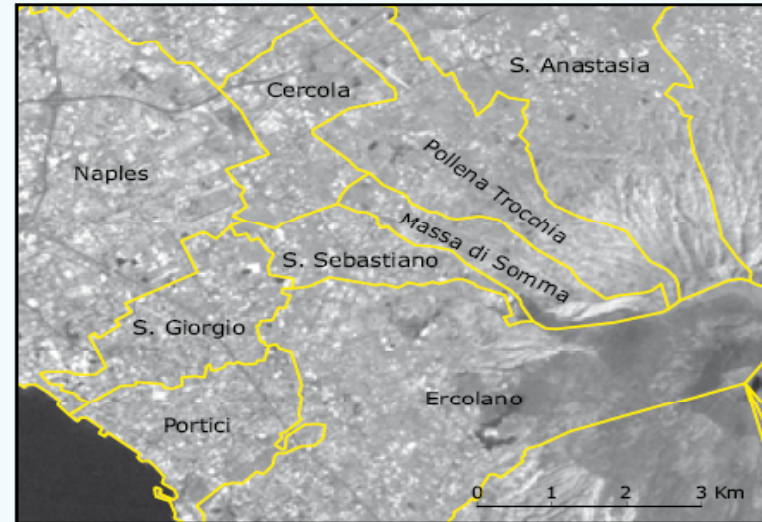
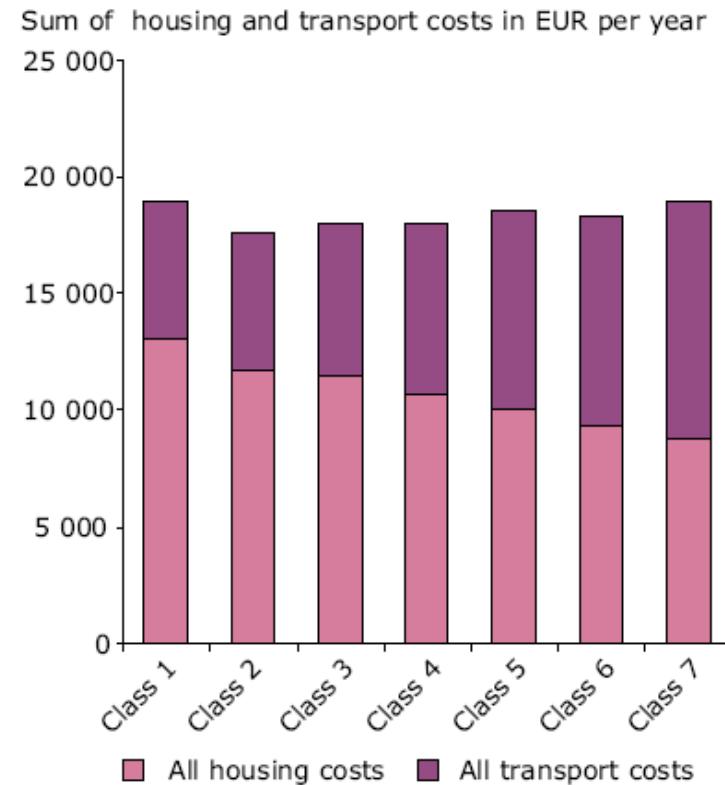
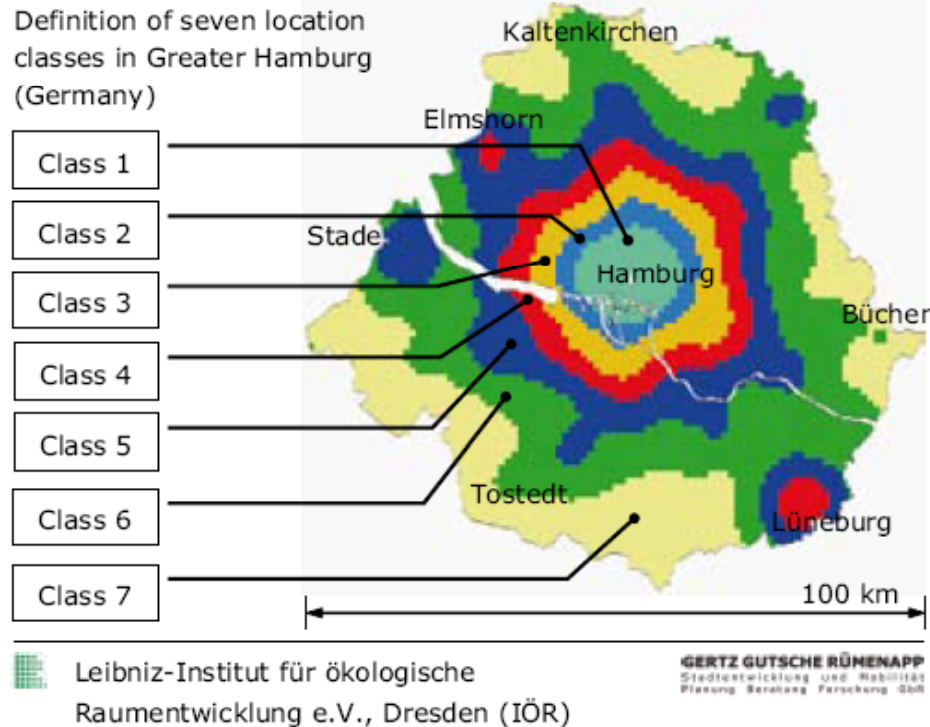


Photo: © Image 2000

essed in terms of
levant structures
n — suburb
hat mould the
trends within the

Figure 2.9 Greater Hamburg (Germany) – modelled costs for transport and housing in residential areas



Source: UBA, 2009.

→ Environmental vision

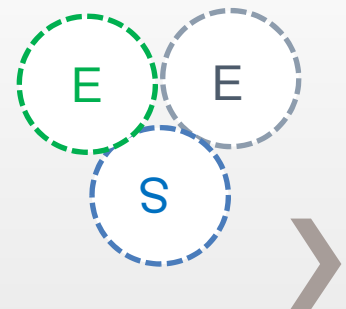
International issues and decision : Kyoto regulation, reducing carbon emission, preservation of biodiversity; global scale, Embedded issues, multiple actors

→ Communities vision

Arrhus directive, participative and collaborative actions, social networking, stewardship actions, decision scales interactions: vizualisation media, virtual reality, inequalities challenges

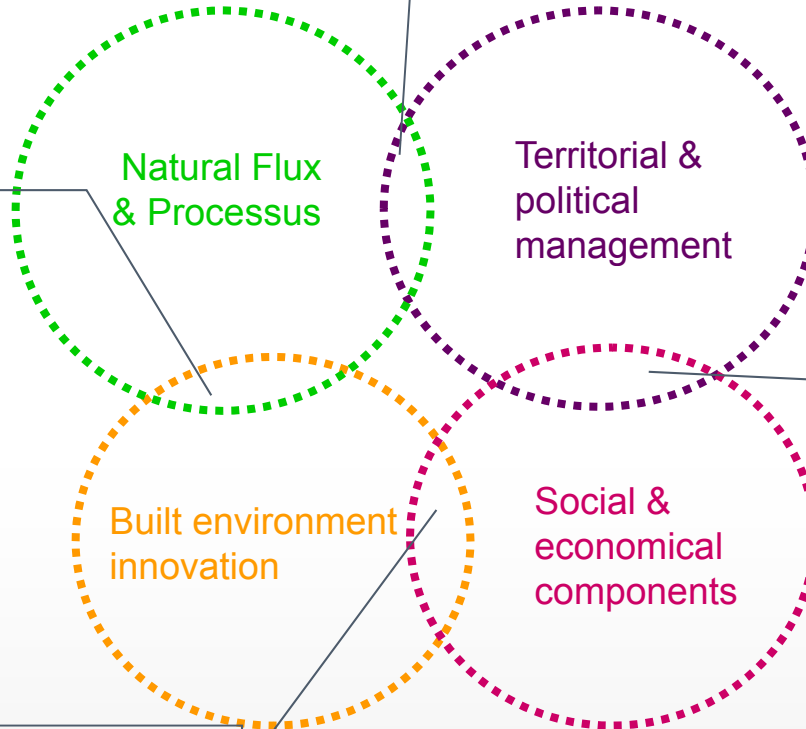
→ Ciities's sustainable challenges:

City delineation, impacts assessments, indicators definition and mapping



Urban sustainable challenges

Environmental Assessment
Resources & Exploitation
...



Ecosystemic Services

*Environmental
Enginery*

*Recycling
& reconversion*
...

a1

Landscape dynamics

*Urban sprawl &
densification*

*Sustainable
development*

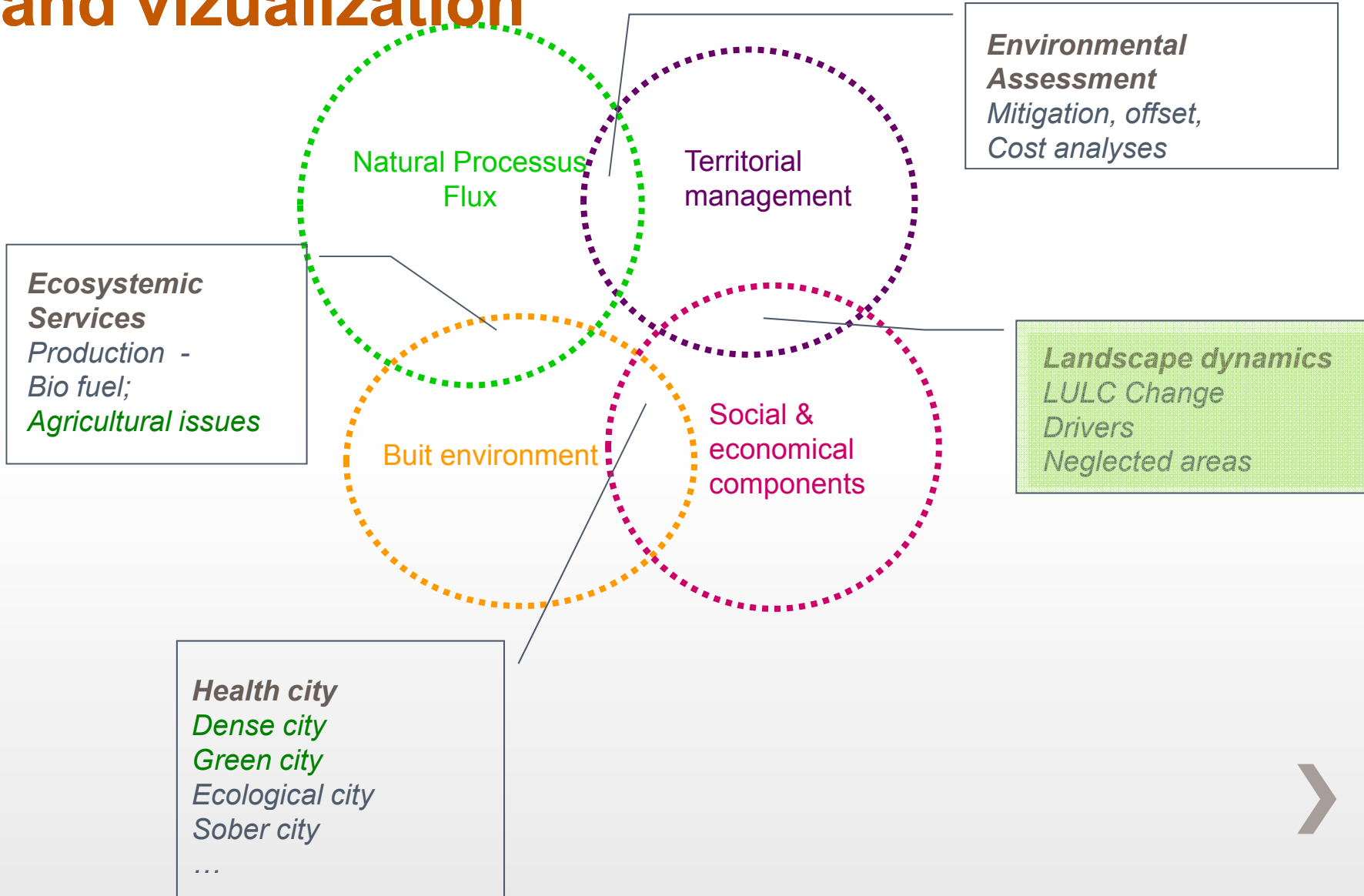
Health city

*Environmental
Justice*
....



admres; 14/11/2011

Impacts assessment measures and vizualization



Environmental issues

- Urbanisation gradient
- Urban area limits
- Artificial areas



→ Earth Observation: new paradigm

- *From pixel to object*
- New technologies
- Multi sensors, multisources

EO and Urban environment

- Spatial indicators
- Urban Heat Island
- Artificial areas
- Urban biodiversity

Decision making

- EO product as media for collaborative actions

Urban (geographic) information

- » Needs : Relevant, accurate, up to date, exhaustive
- » Heterogeneous sources:
 - Maps and Data base
 - Imagery: terrestrial and satellite data
 - Aerial photographs
 - Ancillary data



Earth Observation Satellites

1946 1ères photos de l'espace V2

1950 Launch TIROS – 1ere image satellite

Années 1960 Satellites espions – Corona

Fin années 1960 – photographies : Apollo Gemini

1972 Earth Ressources Technology Satellite ERTS – Landsat

1977 Launch METEOSAT (EU)

1986 premier satellite de télédétection : SPOT 1 (EU)

1991 1^{er} satellite radar : ERS 1 (ESA)

1999 1^{er} satellite commercial THR : IKONOS-2 (USA)

2002 Launch SPOT 5 (EU)

CARTOSAT-1 photographes stéréographiques 2.5m (1:10 000 et cartes 3D)

Formosat2 2005

2007 CARTOSAT-2 PAN 0.80 m

2007 Launch WorldView 1 – (2) (USA - 50 cm)

2009 Launch WorldView 2 – (2) (USA – 46 cm; 1.8m)

2010-2013 Pleiade constellation



RS characteristics and urban fabric

→ Heterogeneous areas
cities resilience

→ Complexe urban
structures; history
and planning
practices

→ Spatial resolution

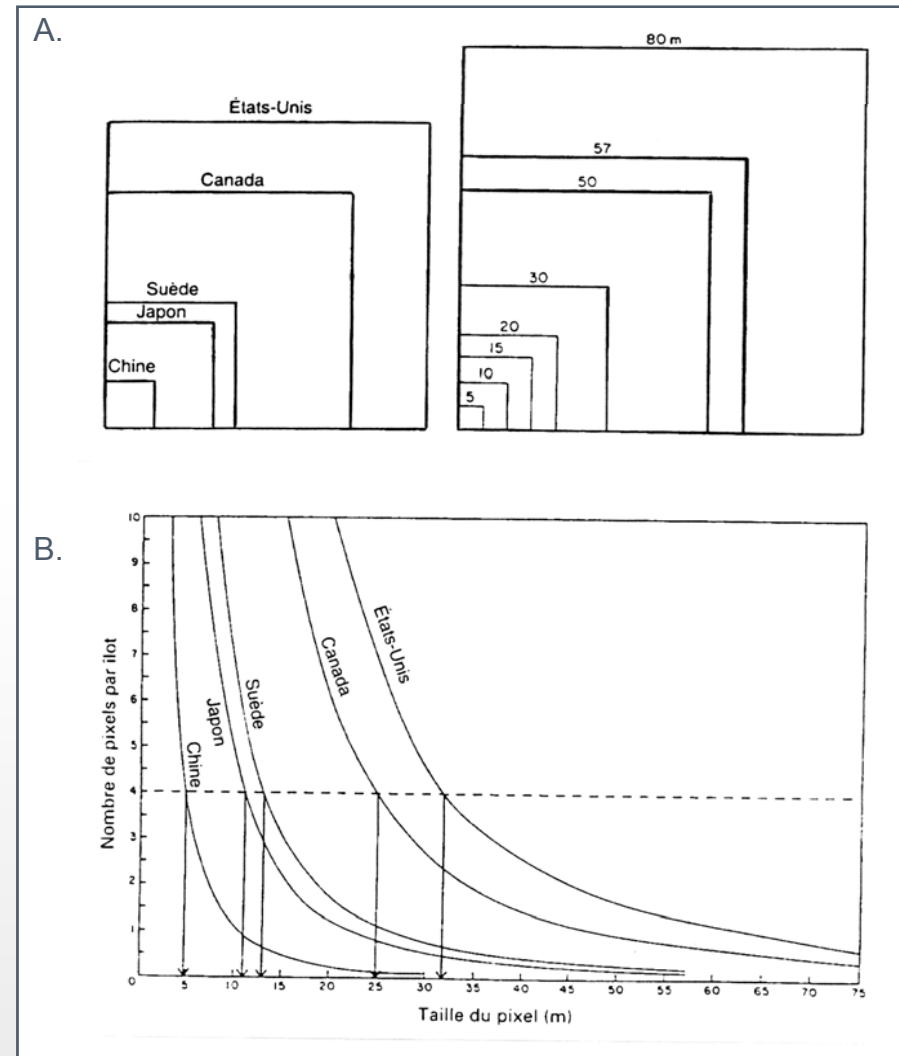


Figure A : Comparaison des tailles de parcelles urbaines de plusieurs pays avec la taille d'un pixel.

Figure B : Taille des pixels nécessaire pour discriminer un îlots urbains (d'après Welch R., 1982).

Urban complexity

Vizualisation depends on

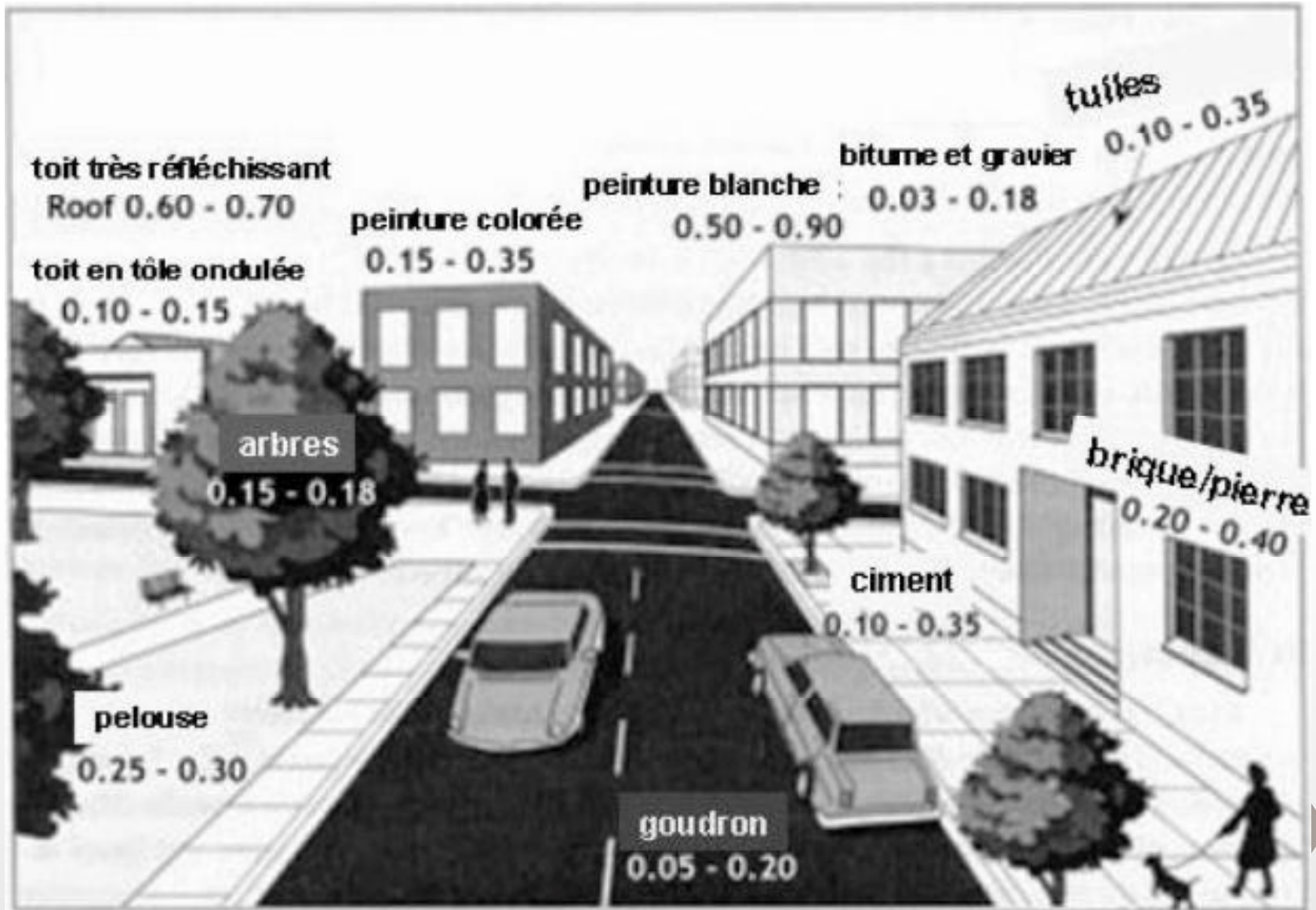
-The type of urban element → spectral resolution
Physico-chemist characteristics (material, albedo, age...).

- The size of elements → spatial resolution
The enhancement of spatial resolution (sub-metric) provides new capacities to detect and analyse urban landscape.

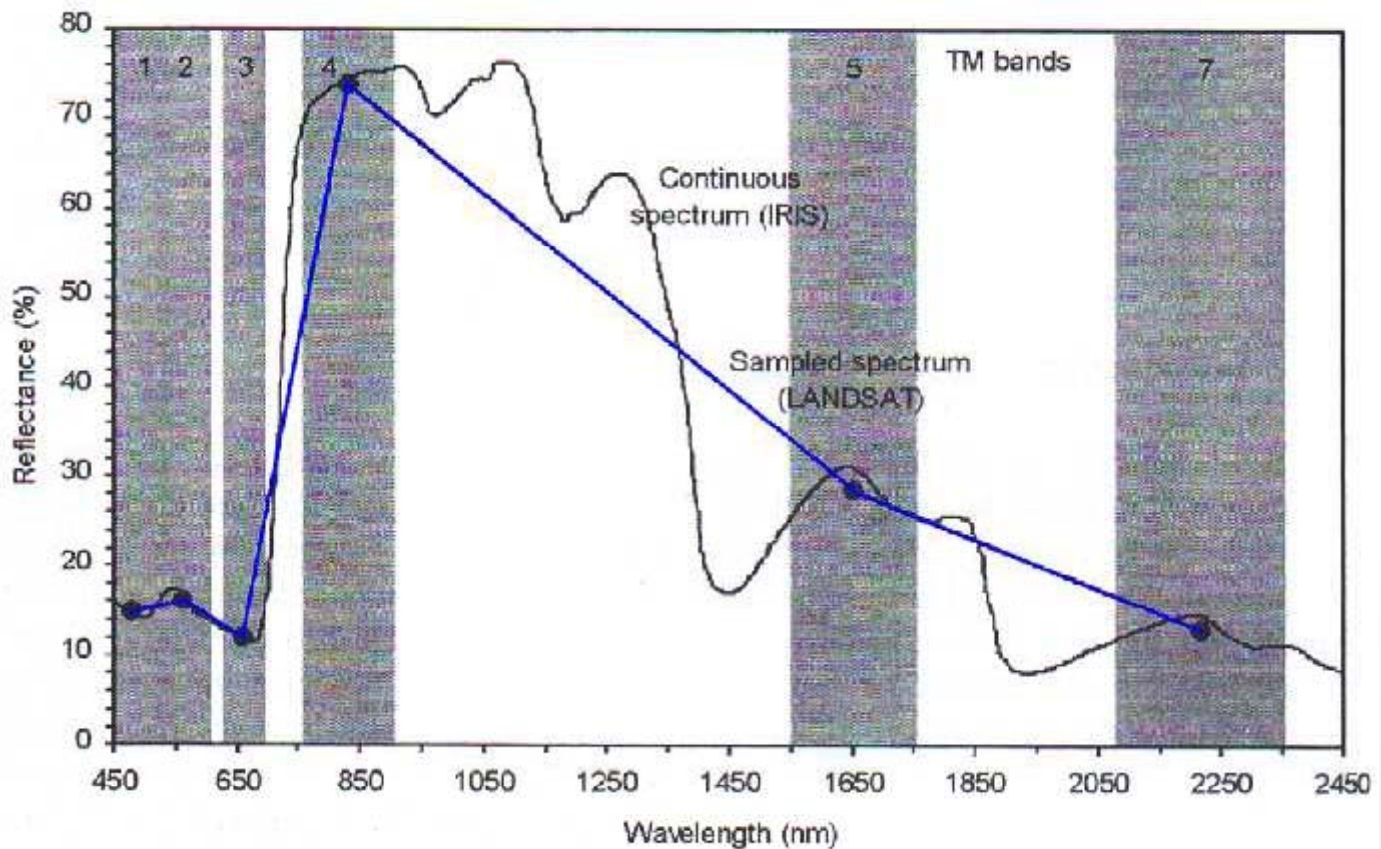
- The form of the object → structure of element and spatial relationships
Regular forms are easier to detect, isolated element is more difficult to detect.



Physical characteristics: spectral resolution



Multispectral and Hyperspectral radiometric spectre



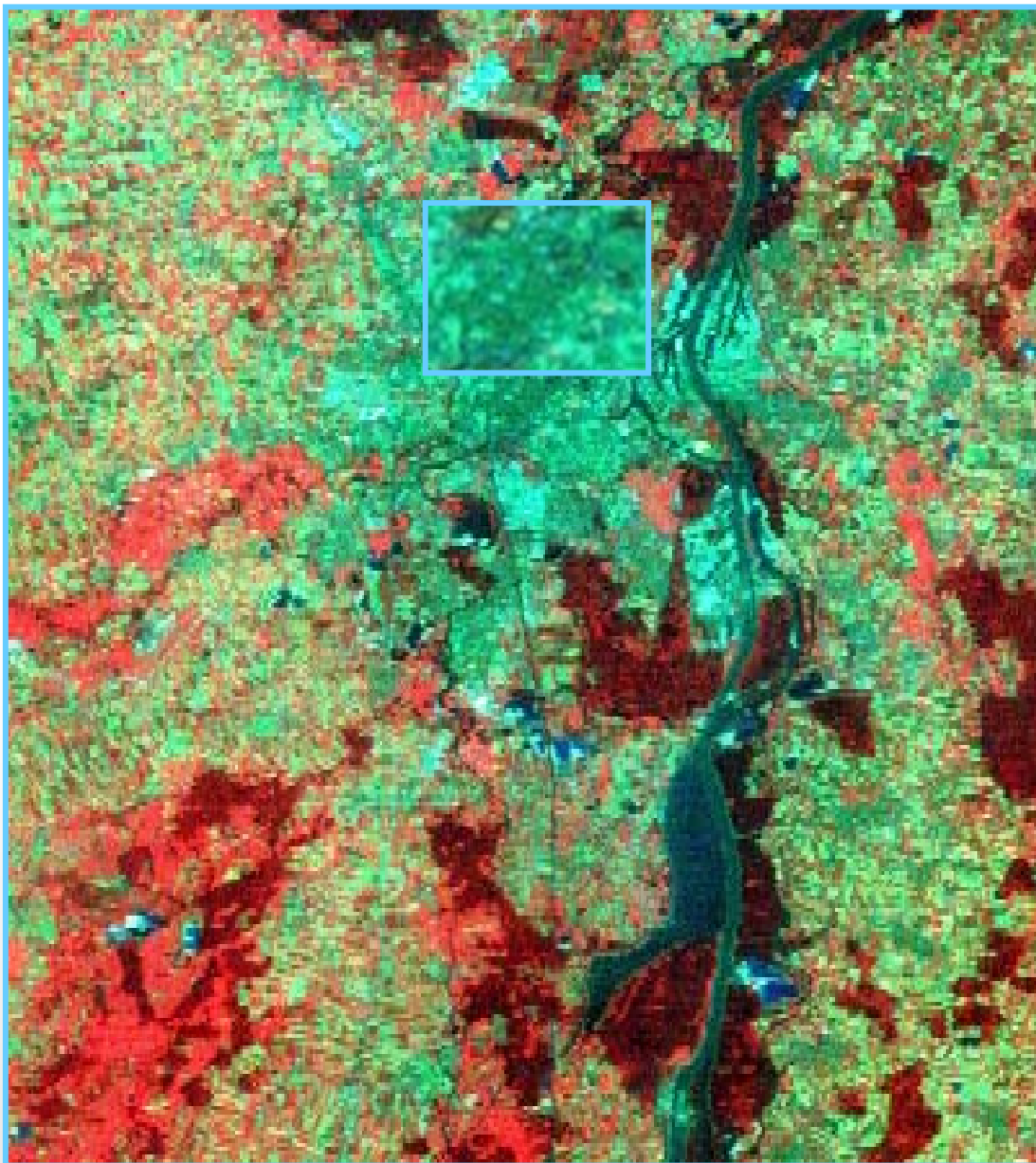
70' : Satellites of «1^{ère} generation»

Landsat 1, 2 et 3 : sensor MSS

- pixel 80 x 80 m
- 4 ↑ spectral channels (V, R, PIR, PIR)
- coverage 185 km²
- return 18 days at nadir



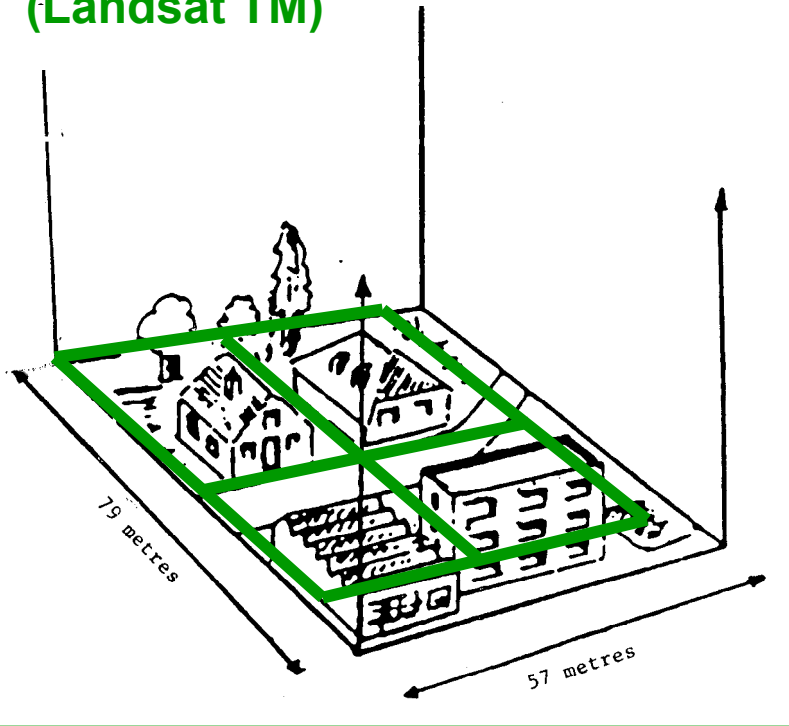
Landsat MSS 1981 (80 m)



➤ 80' :

Satellites of 2^{ème} generation : HSR

Grid 30m x 30m
(Landsat TM)

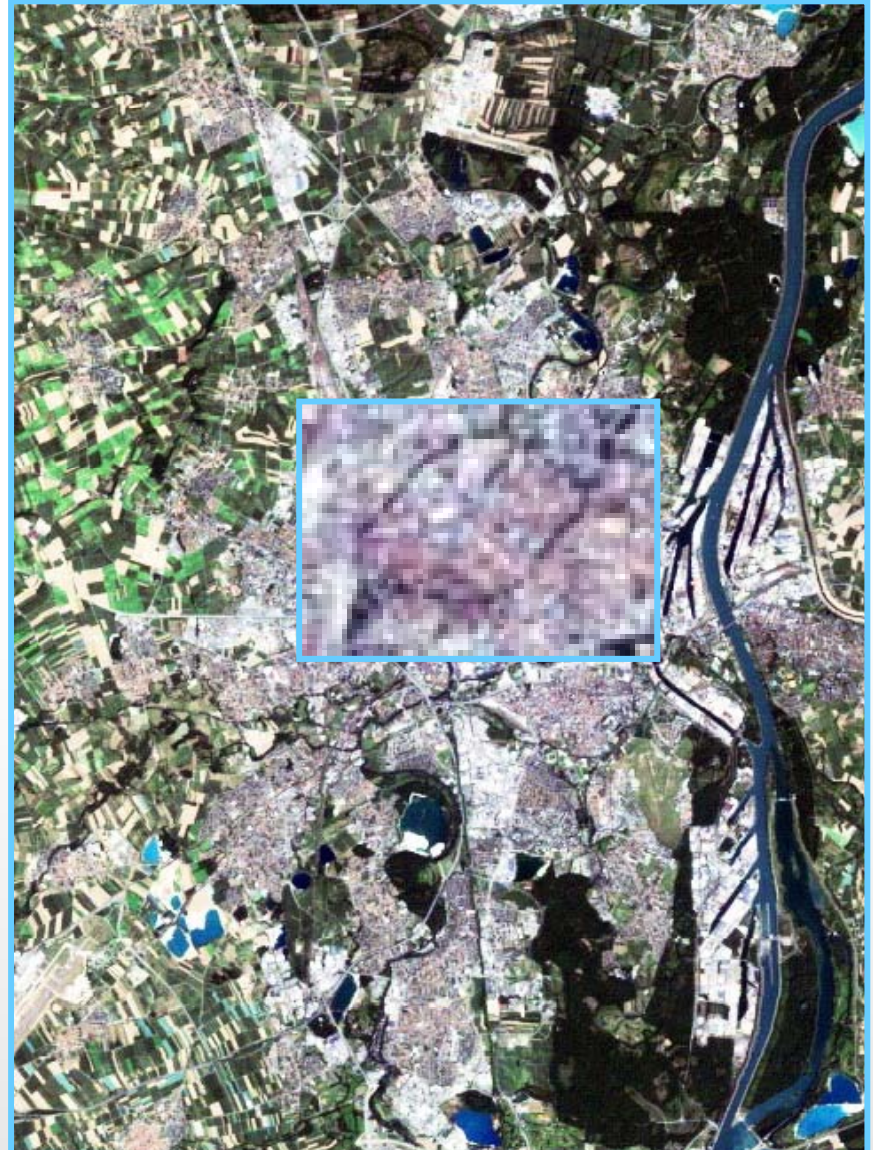
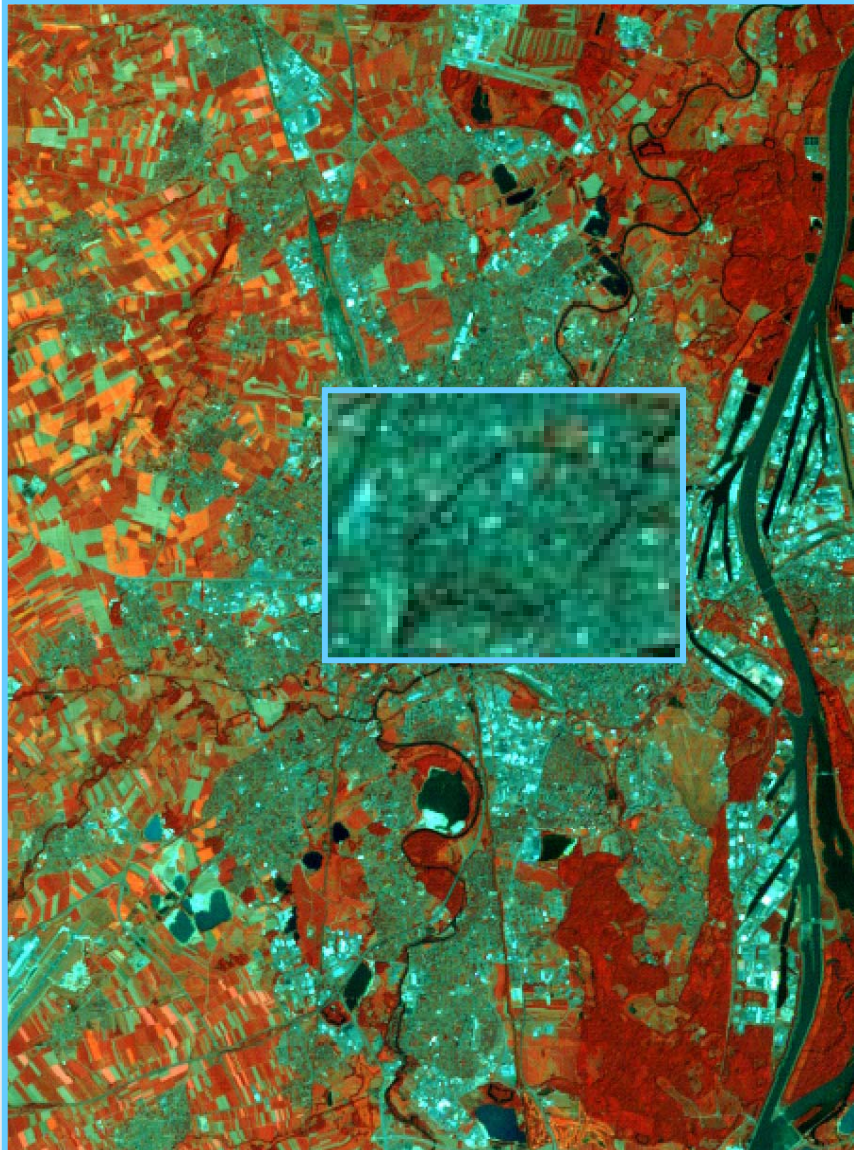


Landsat 4 et 5 : sensorTM

- pixel 30 x 30 m
- 7 spectral channels B à IRM)
(IRT 120 m)
- 185 km²
- return 16 days at nadir

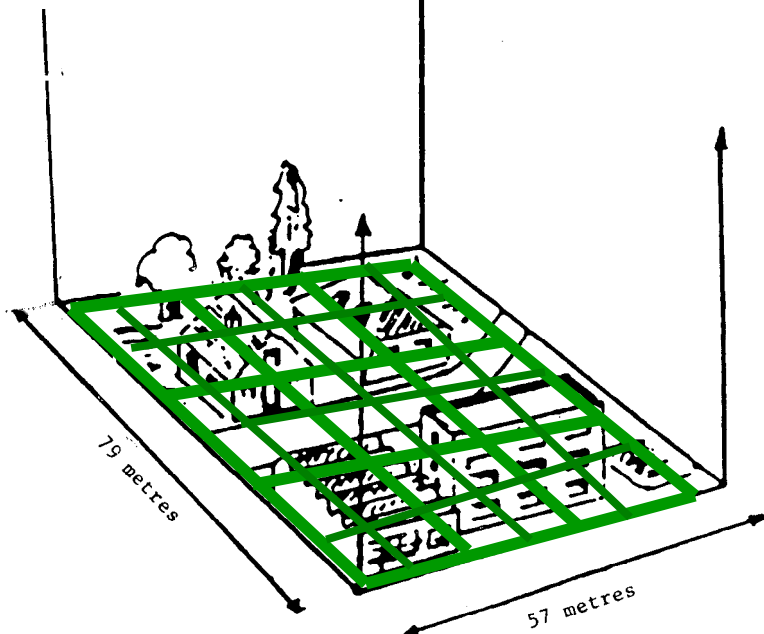
+ 1999 Landsat 7 = ETM+ ➤
(P 15 m and IRT 60 m)

Landsat TM 2002 (30 m)



Middle 80': Satellites of 2^{ème} generation HSR

Grid 20m x 20m (SPOT XS) ;
10 x 10m (SPOT P)

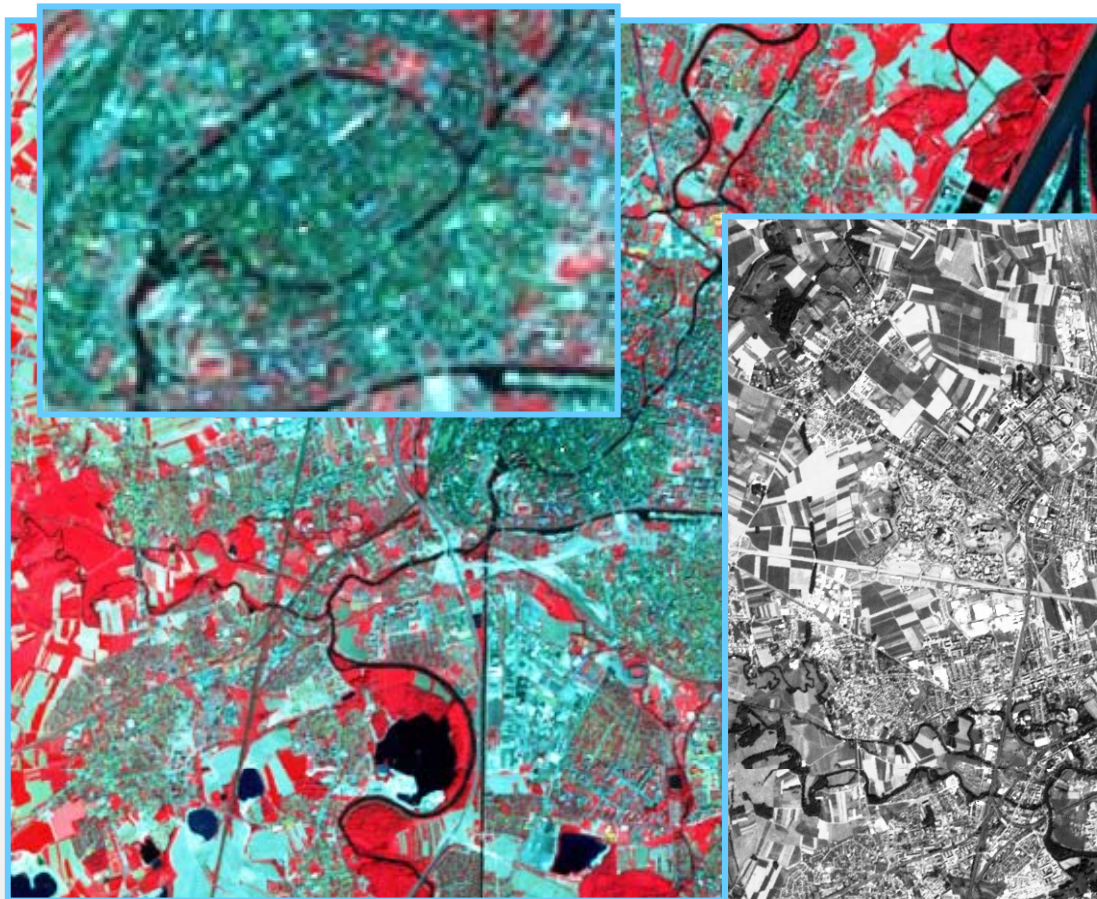


SPOT 1 à 4 : sensor VHR

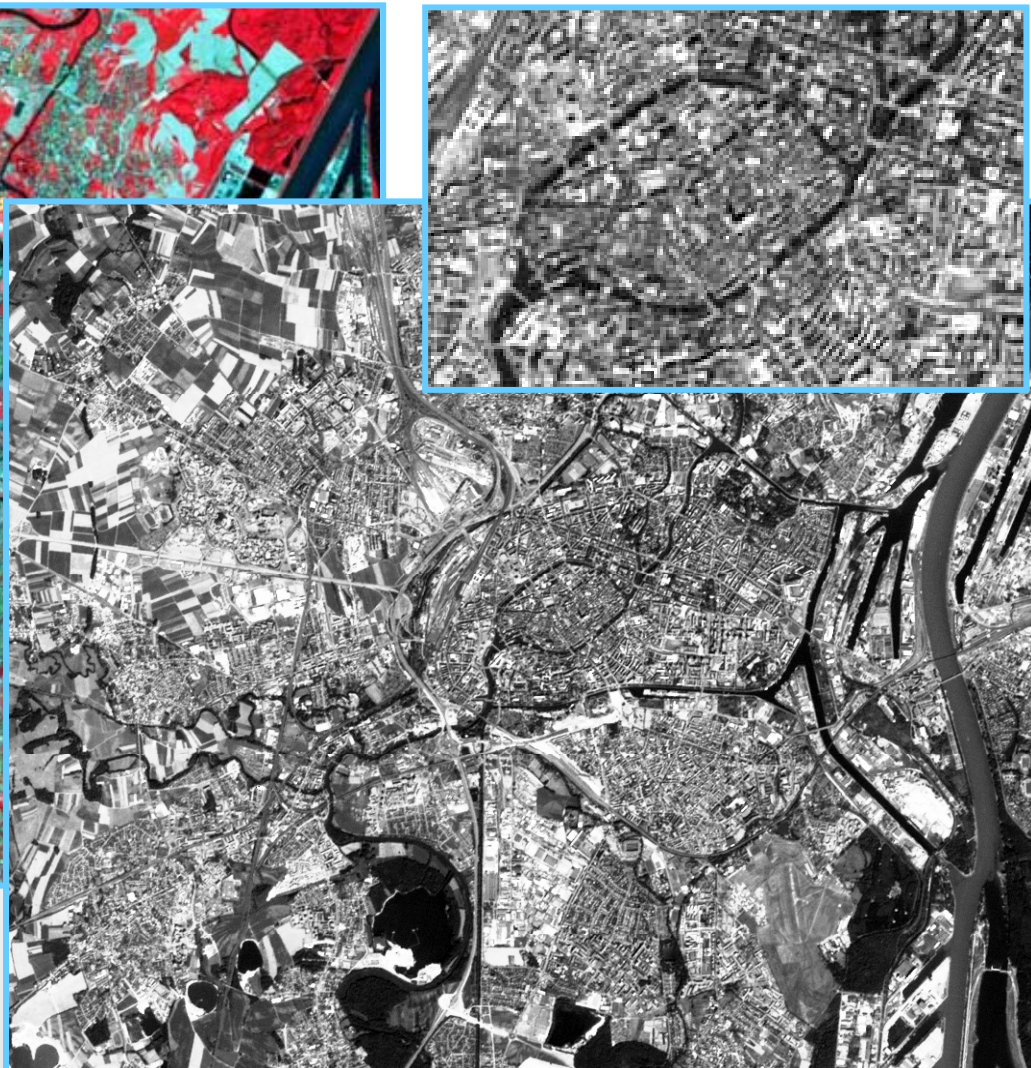
- pixel 20 x 20 m XS
- pixel 10 x 10 m Pan
- 3 spectral channels (G, R, PIR)
- 60 km²
- return 26 jours at nadir
(3 to 5 day other angles)



Spot XS 1986 (20 m)



Spot P 1986 (10 m)



Characteristics: urban needs and EO

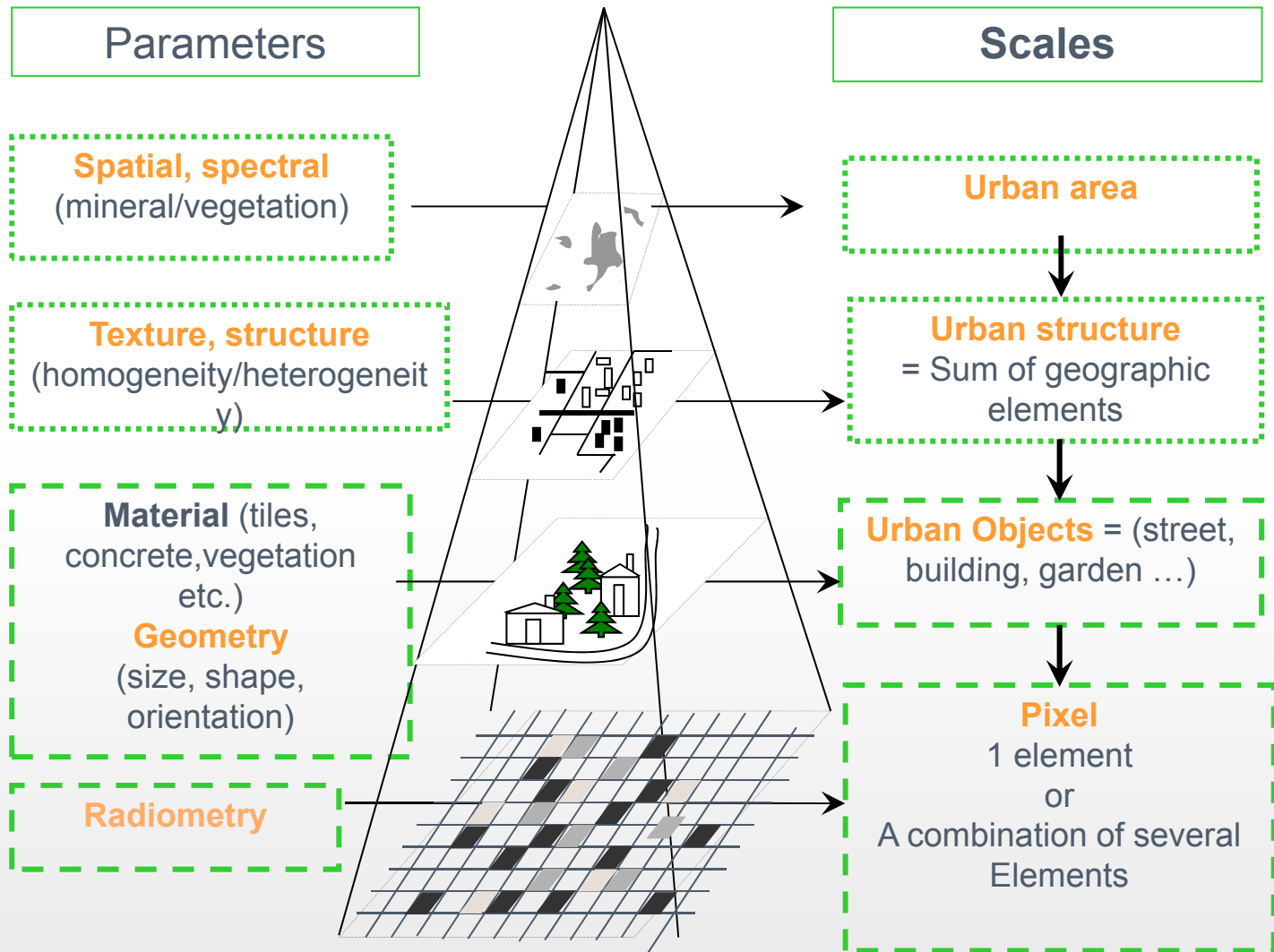
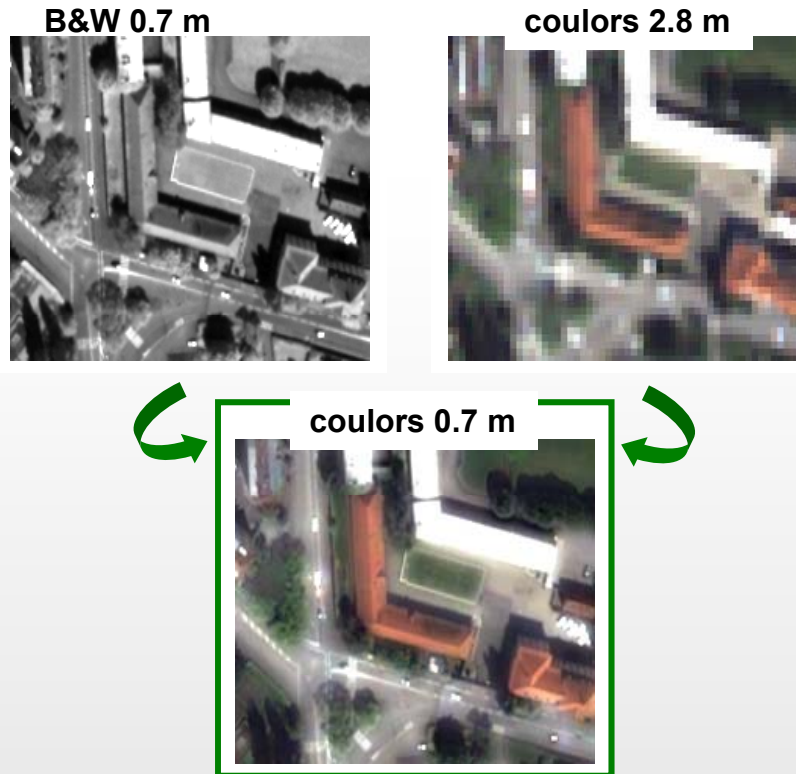


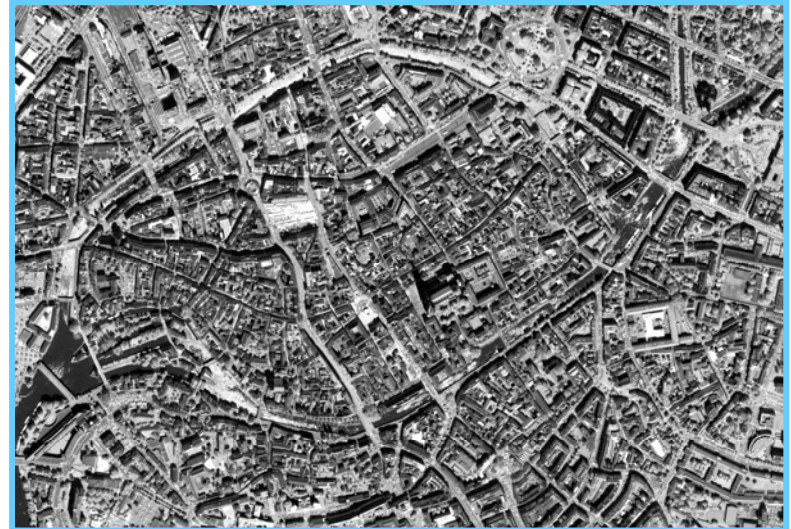
Image visualisation and user needs

Fusion

Image with higher spatial resolution and spectral gain
→ More accuracy, relevant scale



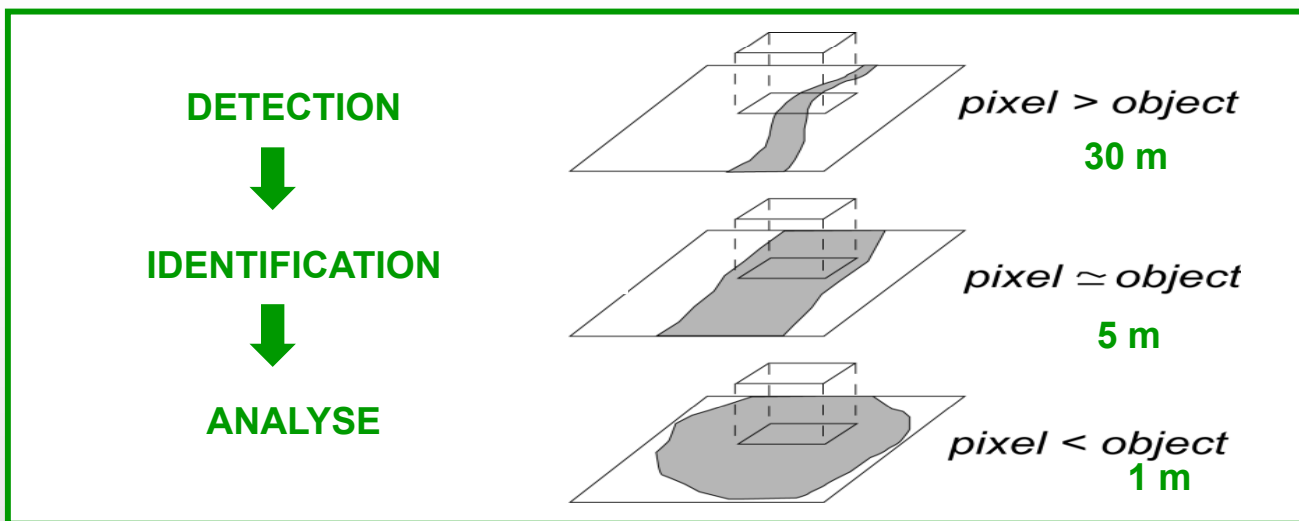
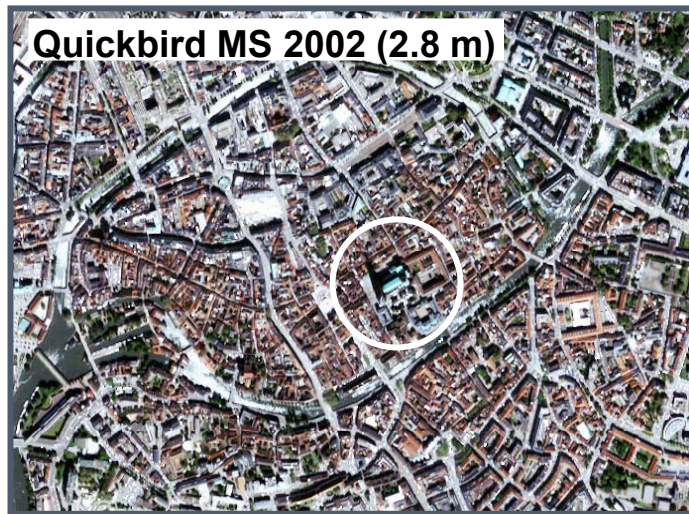
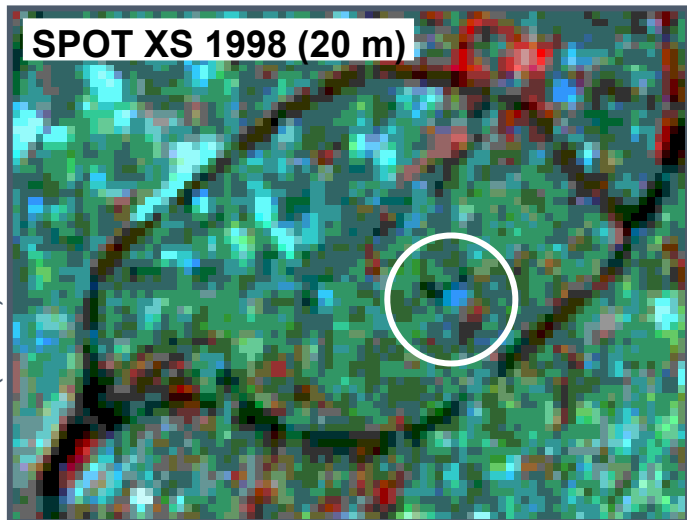
Quickbird MS + Pan 2002 (0.7m)



2.8m



From Pixel to Object: the more the spatial resolution...



Urban management

Land use land cover information at various scales

<i>Applications and used images</i>			
<i>Scales of applications in urban areas</i>		<i>Currently images data used to answer to these applications</i>	
<i>Applications</i>	<i>Scales</i>	<i>Images</i>	<i>Resolution</i>
Technical management	1:200 to 1:500	Orthophotograph	20 cm
Basic mapping	1:1000 to 1:2000	Orthophotograph	20 to 50 cm
Urban planning	1:5000 to 1:10 000	Orthophotograph	50 cm to 1 m
Prospective	1:10 000 to 1:1 000 000	Spot P et XS / Landsat	10 to 30 m

<i>Methods</i>
Manual Interpretation
Automatic extraction

Major Remote sensing capacities

- Global visualization
- Easy access
- Return and up date of information
- Numeric format and processing (correction, projection, analyses, display...)
- SIG compatibility

→ **VHR imagery sources (1 to 5 m)**

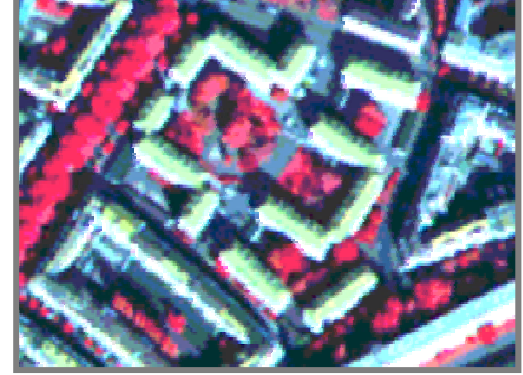
→ **New approaches (Object oriented) → new opportunities**



Object oriented

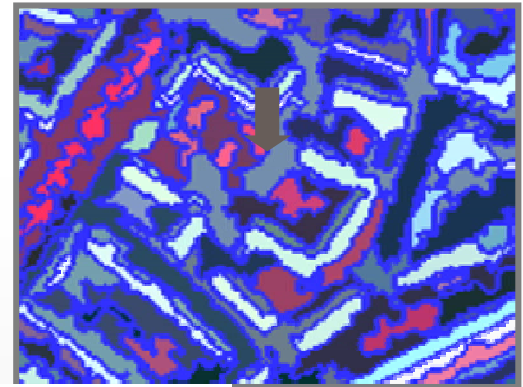
Urbain Objects

1



Segmentation « regions »

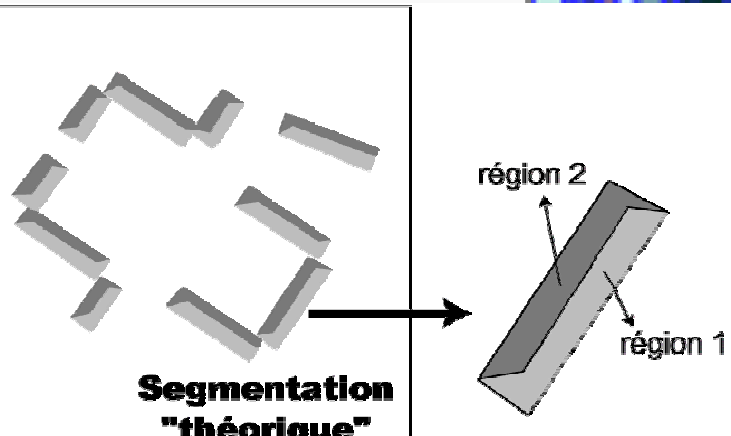
Object characteristics



- 3 elements :
- (a) Spectral value
 - (b) Dimensions and form
 - (c) adjacence, geometry

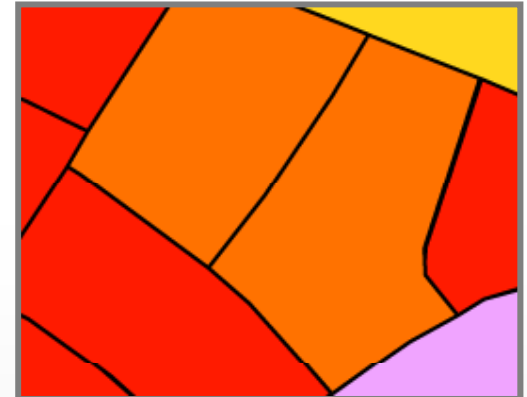
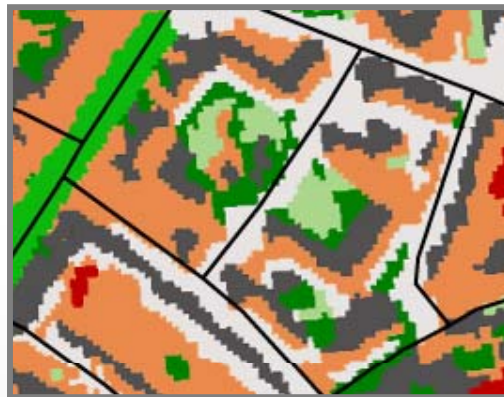
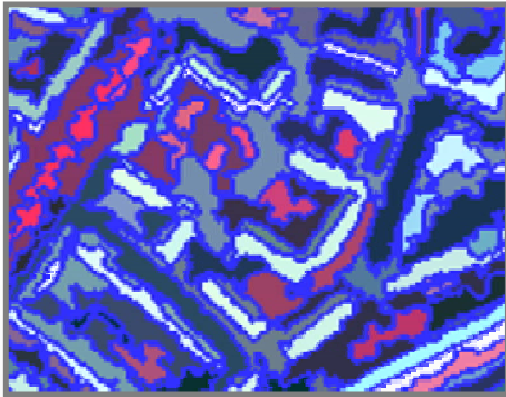


© IGN, 1998



Object oriented and GIS GEOBIA

→ Knowledge Strategy



Segments

- Ombre
- Bâtiment (toits divers)
- Bâtiment (toits uniles)
- Image classification
- Pelouse
- Arbres
- Alignement d'arbres

- Tissu urbain dense
- Tissu urbain moyennement dense
- Tissu urbain de grands ensembles
- Urbanistic classes



Environmental issues

- Urbanisation gradient
- Urban area limits
- Artificial areas



→ Earth Observation: new paradigm

- From pixel to object
- *New technologies*
- *Multi sensors, multisources*

EO and Urban environment

- Spatial indicators
- Urban Heat Island
- Artificial areas
- Urban biodiversity

Decision making

- EO product as media for collaborative actions

Various sensors and adapted resolution ...

Spatial resolution of 5 m is needed:

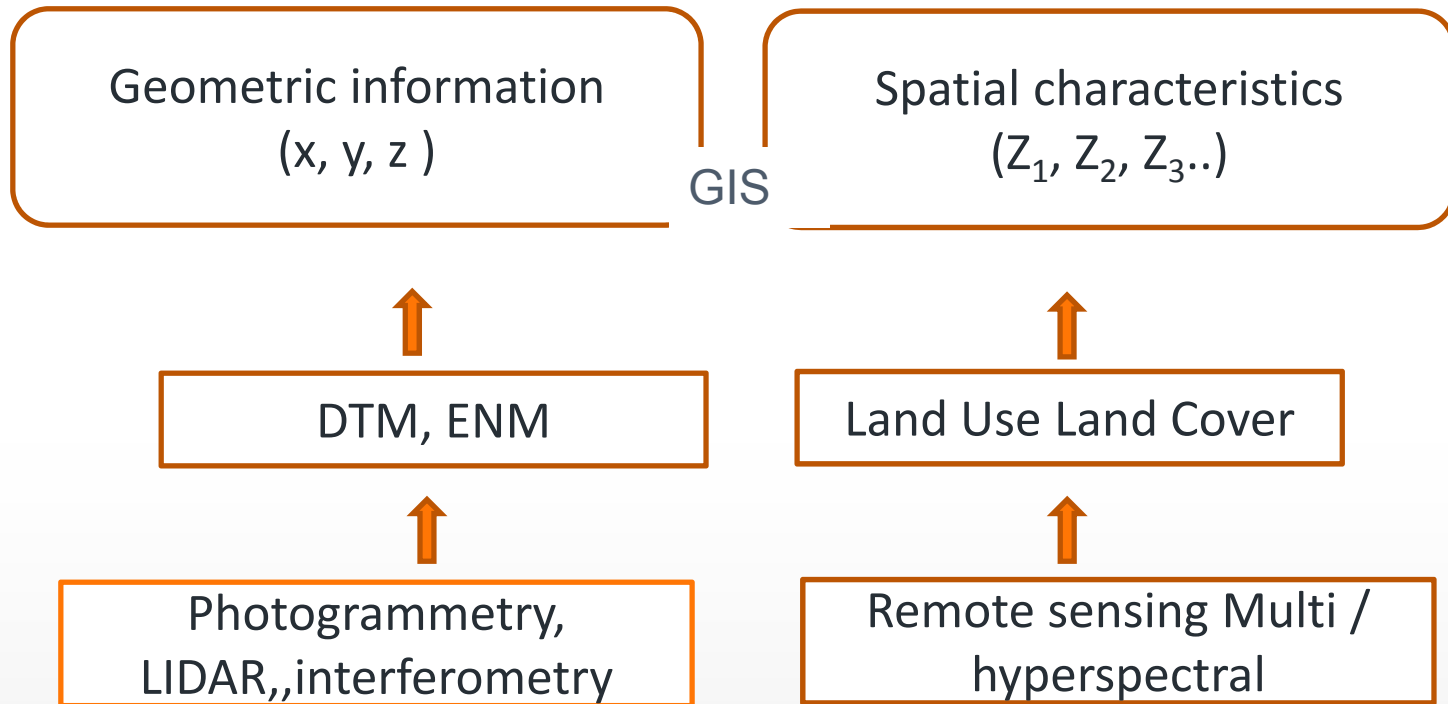
- **Representation of urban objects**: buildings, roads, vegetation or green patches [Weng, 2007]
- **Planning** [Puissant, 2003, 2004] : for urban managers (relevés, cartes, projets)
- **Information appropriation** by the population: more easy to recognize city elements

But

High **variability** of the urban elements

<i>Classes de référence</i>	30 m	10 m	5 m	2.5 m	1 m
Arbres	<i>Bouquet</i>				
Pelouses					
Espaces végétaux interstitiels					
Bâti dense					
Grands ensembles					
Route	Sauf emprise d'auto- route				
Chemin de fer			em- prise		
Espaces minéraux interstitiels					
Eau	<i>fleuve</i>				
Ombre					

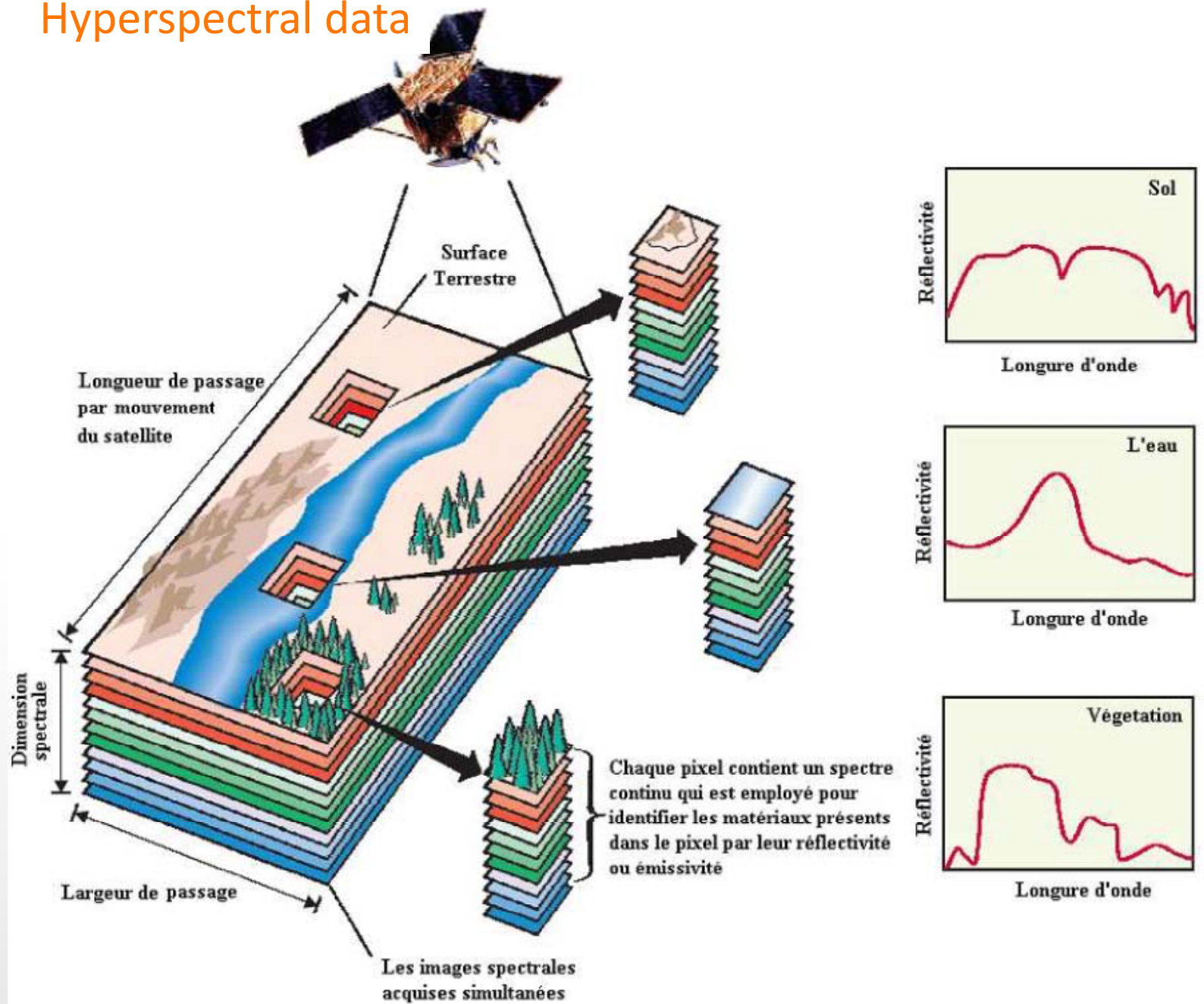
New technologies, new sources



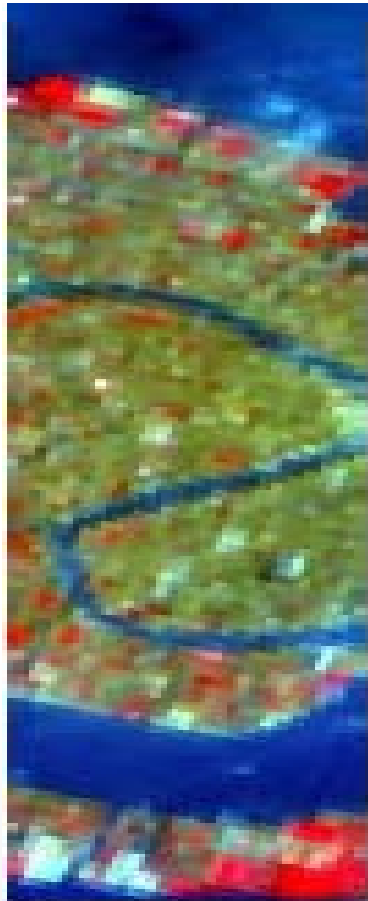
→ Complementary information for urban areas :
Description and dynamic processes



Hyperspectral data



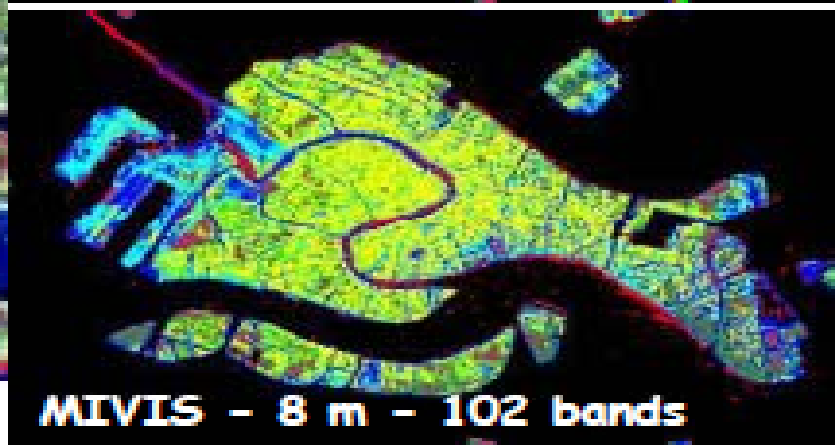
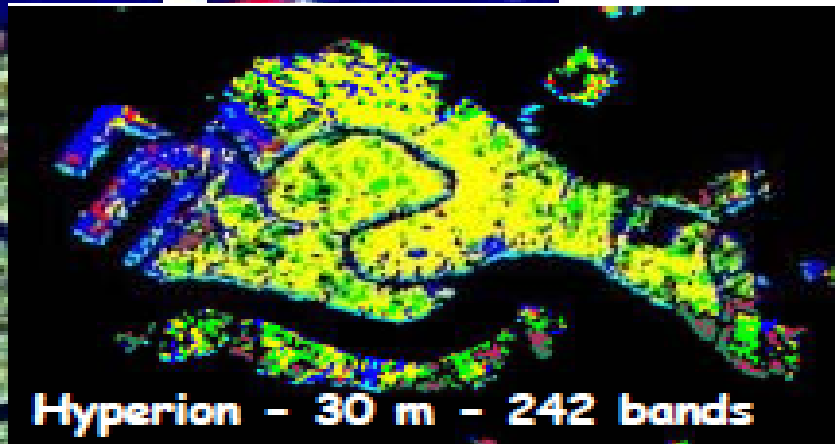
→ XS to HYPERSPECTRAL



Hyperion
30 m
242 bands



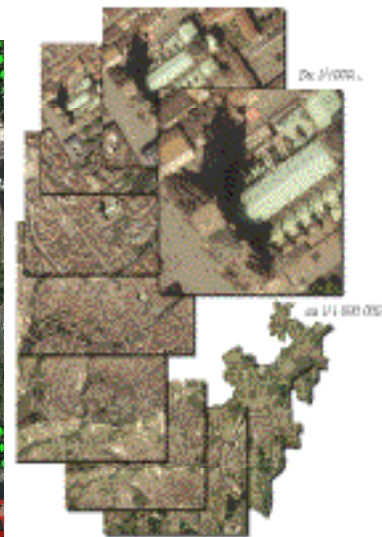
ASTER
15 m VNIR; 8 m
30 m SWIR 102 bands
9 bands



Gain due to very high
spatial resolution
Less mixed pixel

Orthophotographs

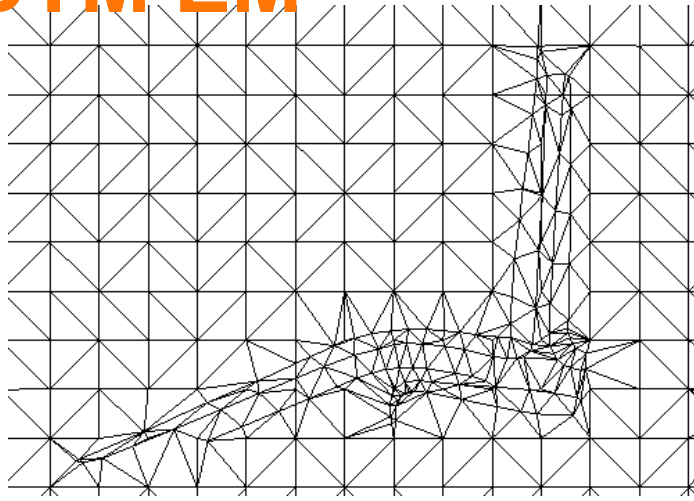
BDOrtho®



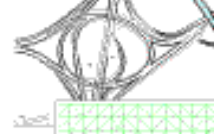
1/8000^e
Resolution 13cm
Scales: 1/1000^e to
1/1 000 000^e



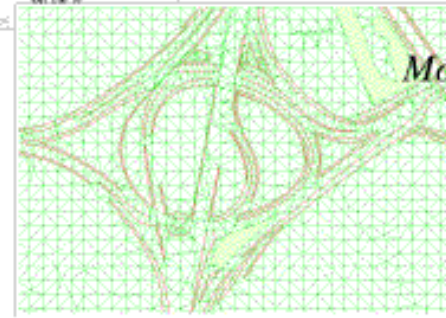
DTM EM



DTM is a area model with X, Y et Z.
DTM allows to discriminate elevation curves and altitude for each point of the mesh with high precision (X,Y & Z).



3D et VOLUMETRIE

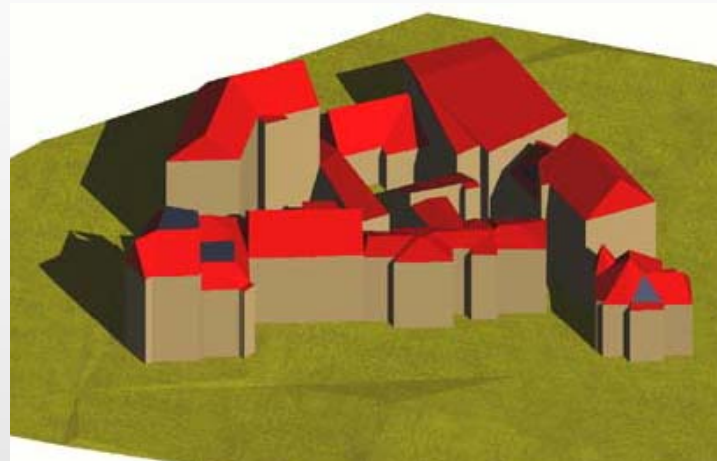


*Modèle Numérique de Terrain
sur 310 Km² + Kehl
1,8 million de points
précision 20cm en Z*

©Strasbourg



*Modèle Numérique d'Élévation
et maquette virtuelle
sur 15 Km² (test en cours)*



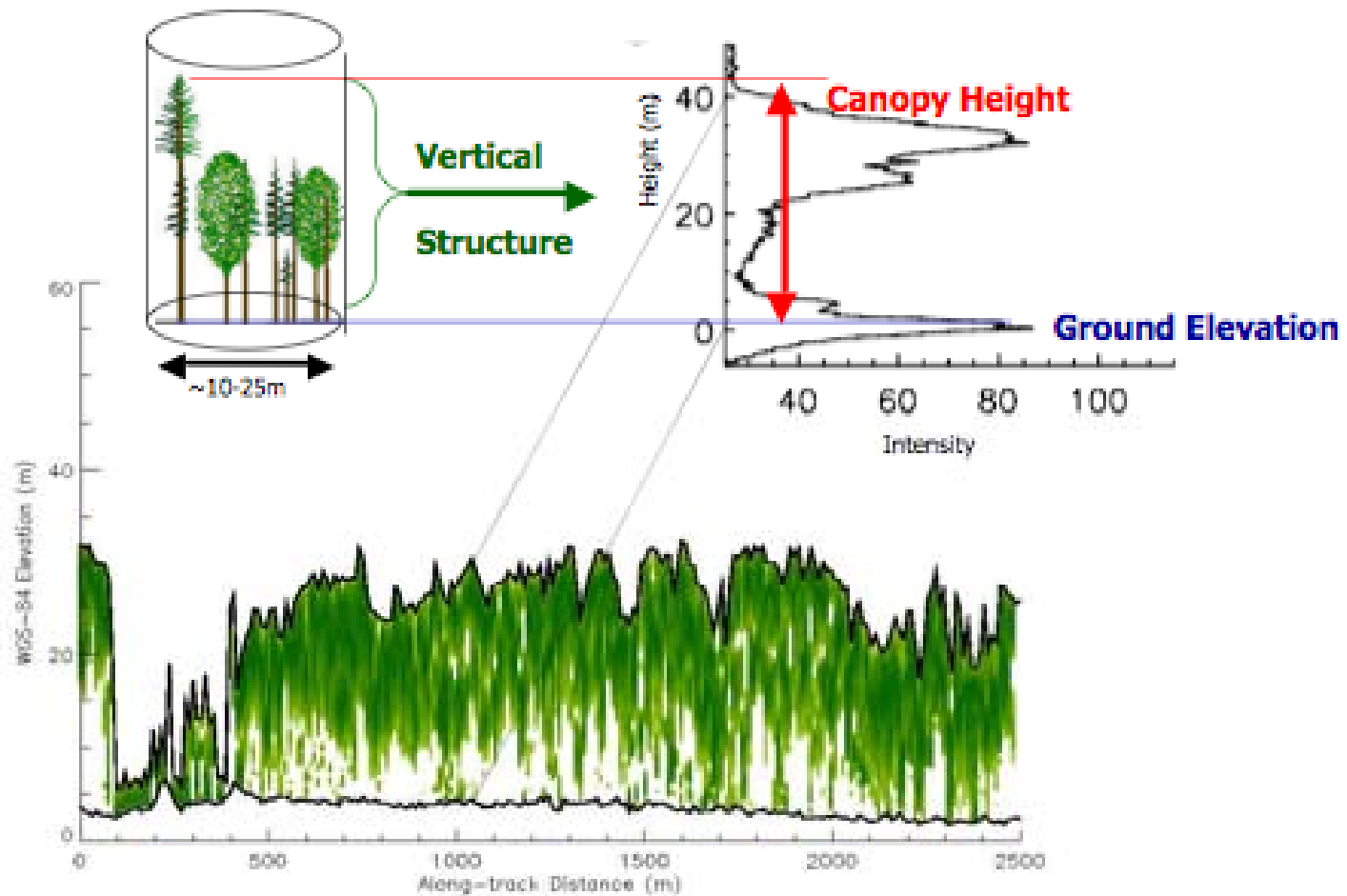
Elevation model

Is the modeling of the buildings height

➔ 3D planning



LIDAR sensors



Waveform LiDAR (from Dubayah and Drake, 2000)

LIDAR results



- Canopy height
- Size of timber
- Biomass
- Forestry characteristics

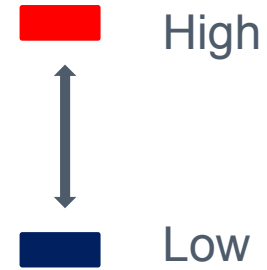
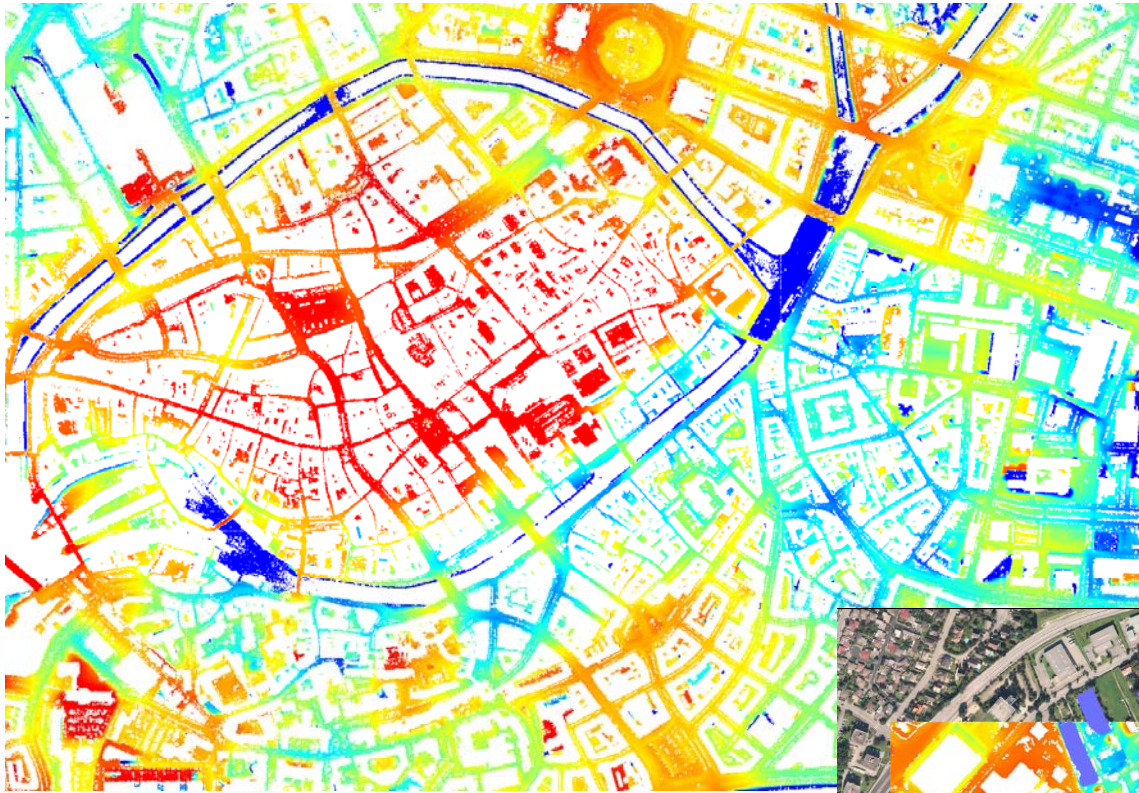
- Linear structures, isolated element

LIDAR Discrete Return

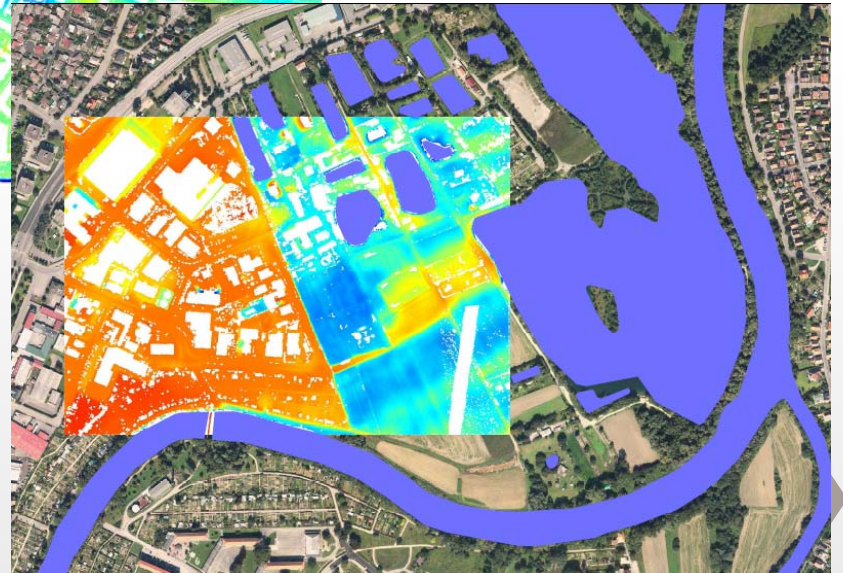
- Cambridge University
 - Optech ALTM 3033 LiDAR

- Piper Navajo Chieftain aircraft
- 33,000 obs per s
- first and last returns and intensity
- operating altitude of 1000 metres
- RMS ht. accuracy of $< \pm 15\text{cms}$
- made available to NERC ARSF

LIDAR : high and low surface

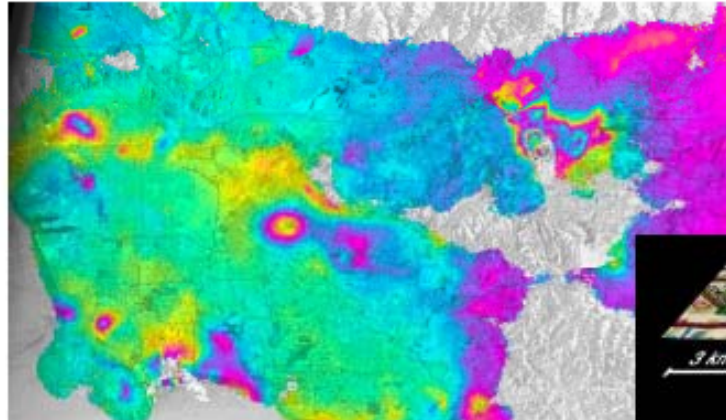


Series (pairs of) of LIDAR images

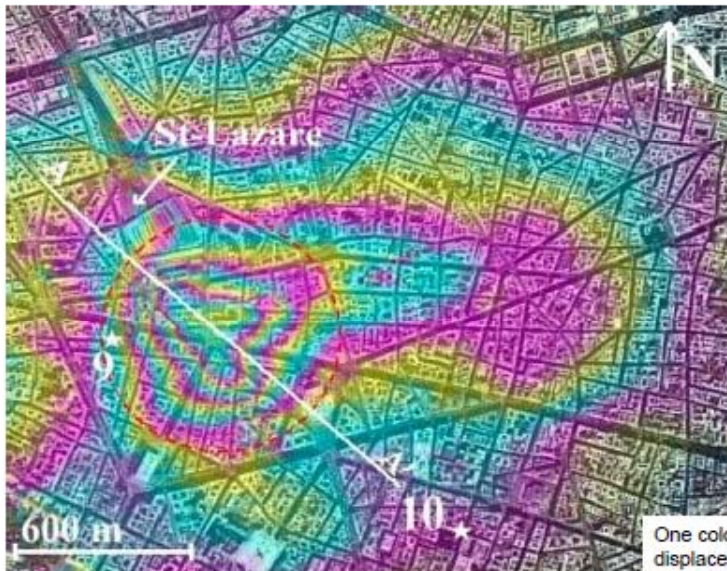


INTERFEROMETRY urban Subsidence

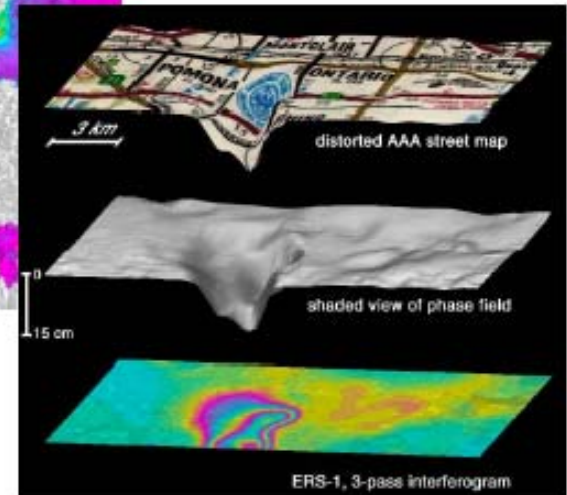
Los Angeles Subsidence



Paris Travaux Gare Saint Lazare



One color cycle = 3 mm of vertical displacement (Le Mouélic et al., GRL 2002).



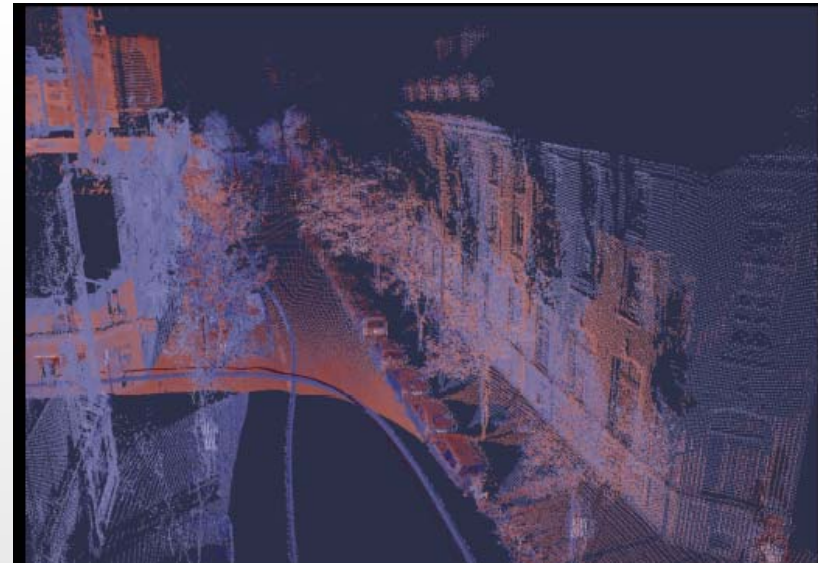
Emissivity of buidings, formd



Imagerie LASER

• RIEGL LMS-Q120i
• 10 000 pts par seconde
• 80 degrés
• 150 m pour 0.8 de reflectance

IGN



Environmental issues

- Urbanisation gradient
- Urban area limits
- Artificial areas



Earth Observation: new paradigm

- *From pixel to object*
- New technologies
- Multi sensors, multisources

→ EO and Urban environment

- Spatial indicators
- Urban Heat Island
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- Urban biodiversity

Decision making

- EO product as media for collaborative actions

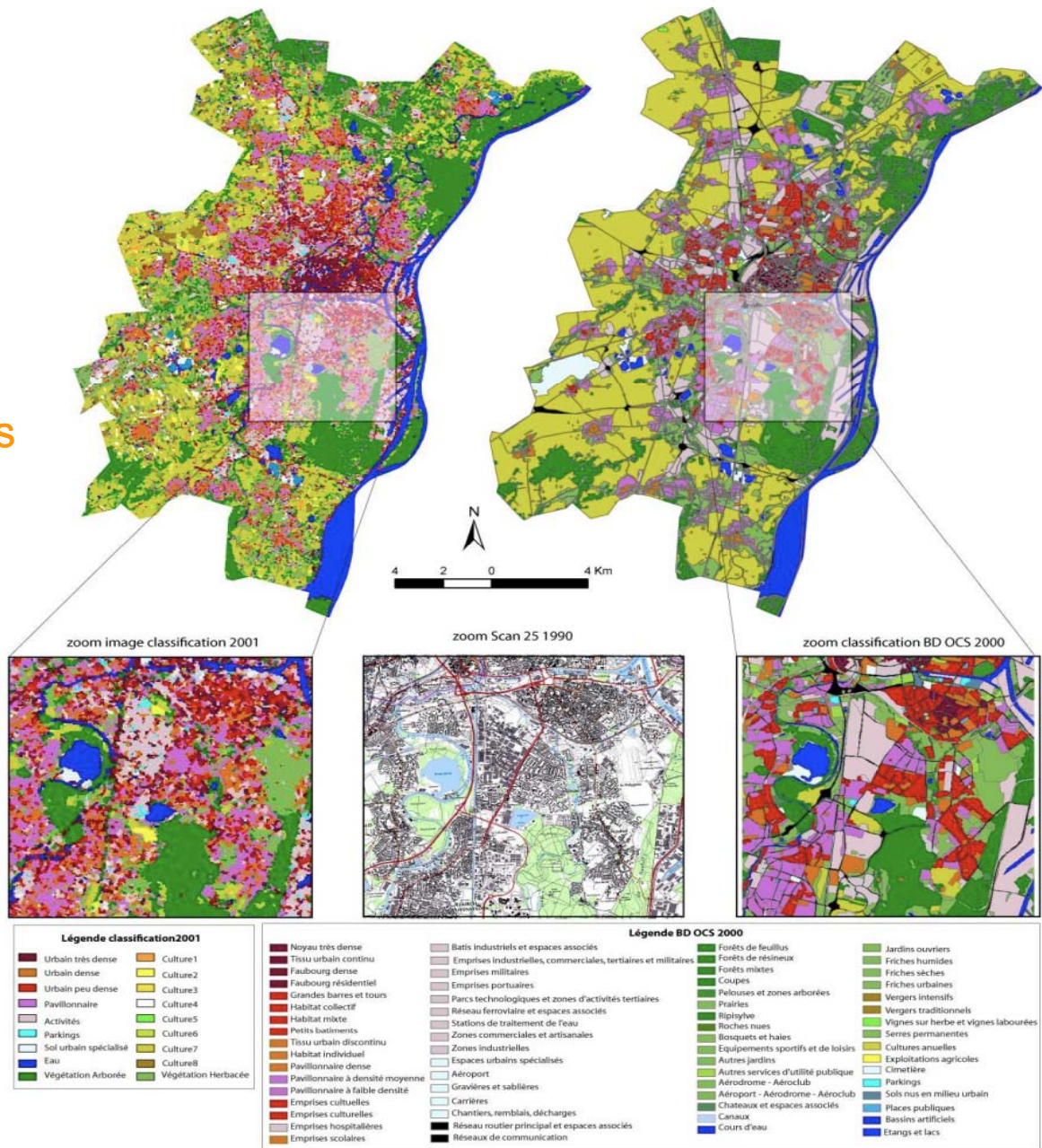
Earth observation: LULC indicators

Scales adaptation

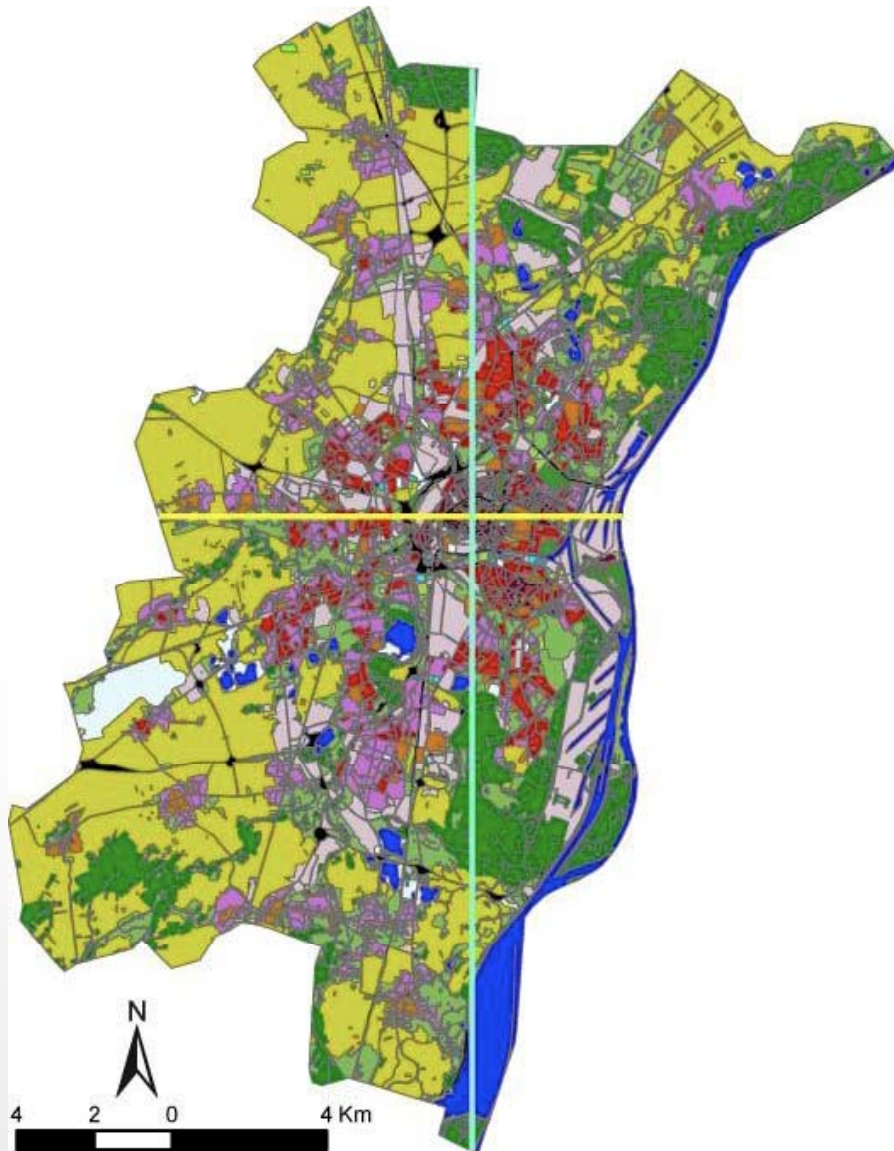
- Geometry / resolution

Adaptation of the typologies

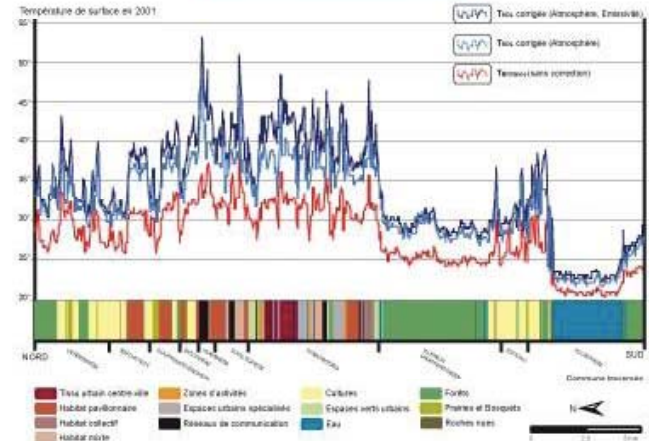
- Semantic definitions



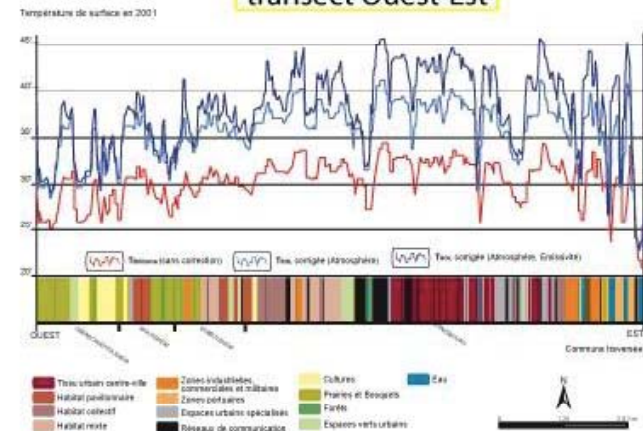
Combination of spatial indicators



transect Nord-Sud



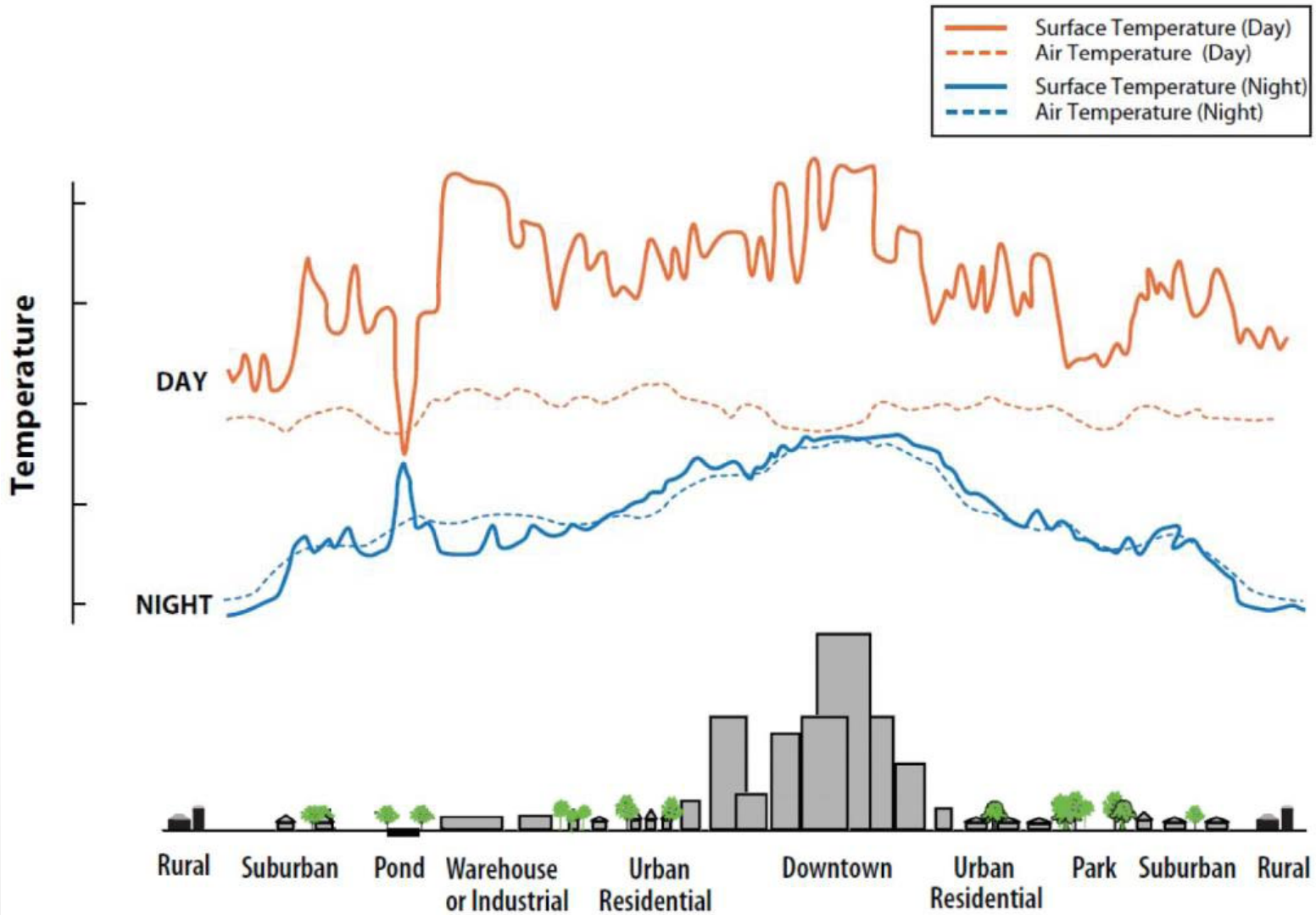
transect Ouest-Est



Transects **BD OCS 2000** de la zone d'étude : Nord-Sud, et Ouest-Est



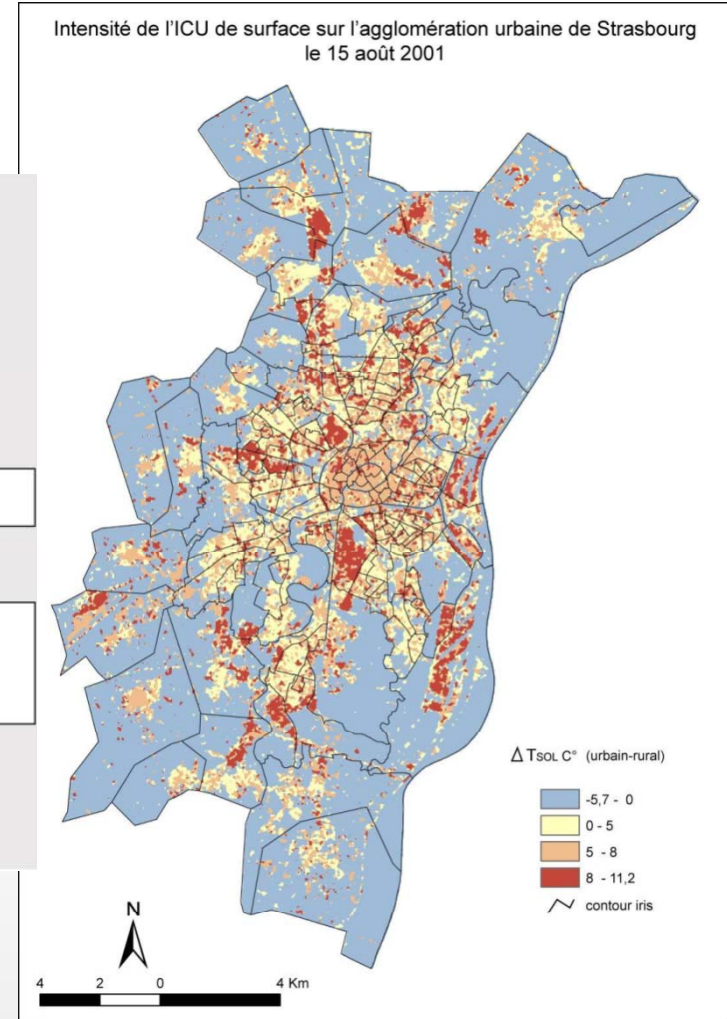
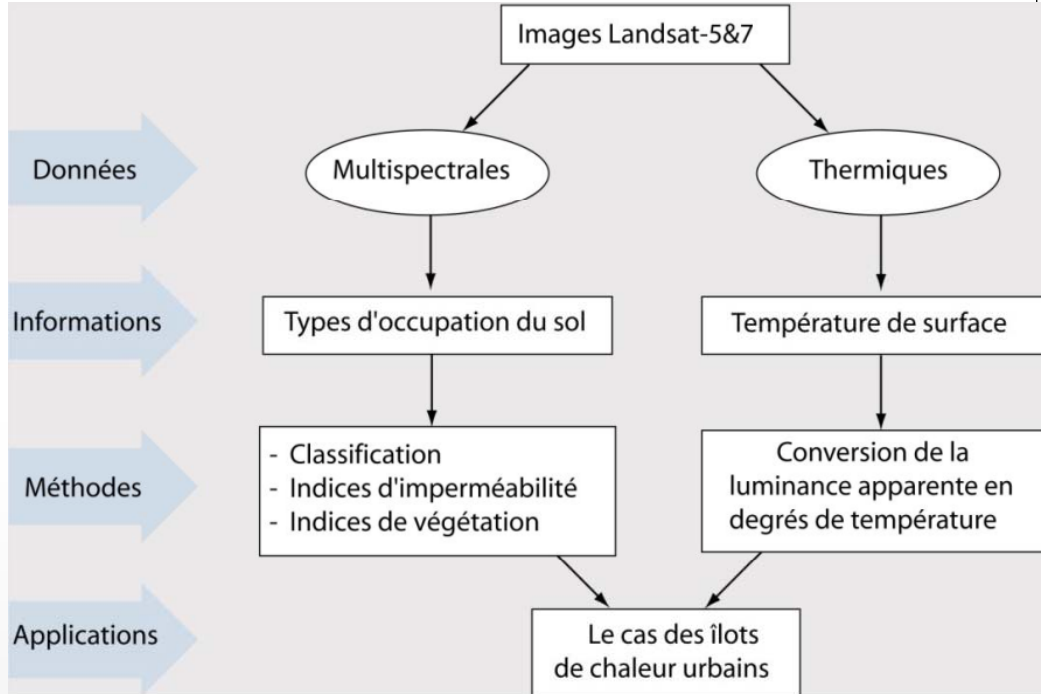
Temperature Characteristics: air and soil



United States Environmental Protection Agency, 2008b

UHI (Surface Temperature)

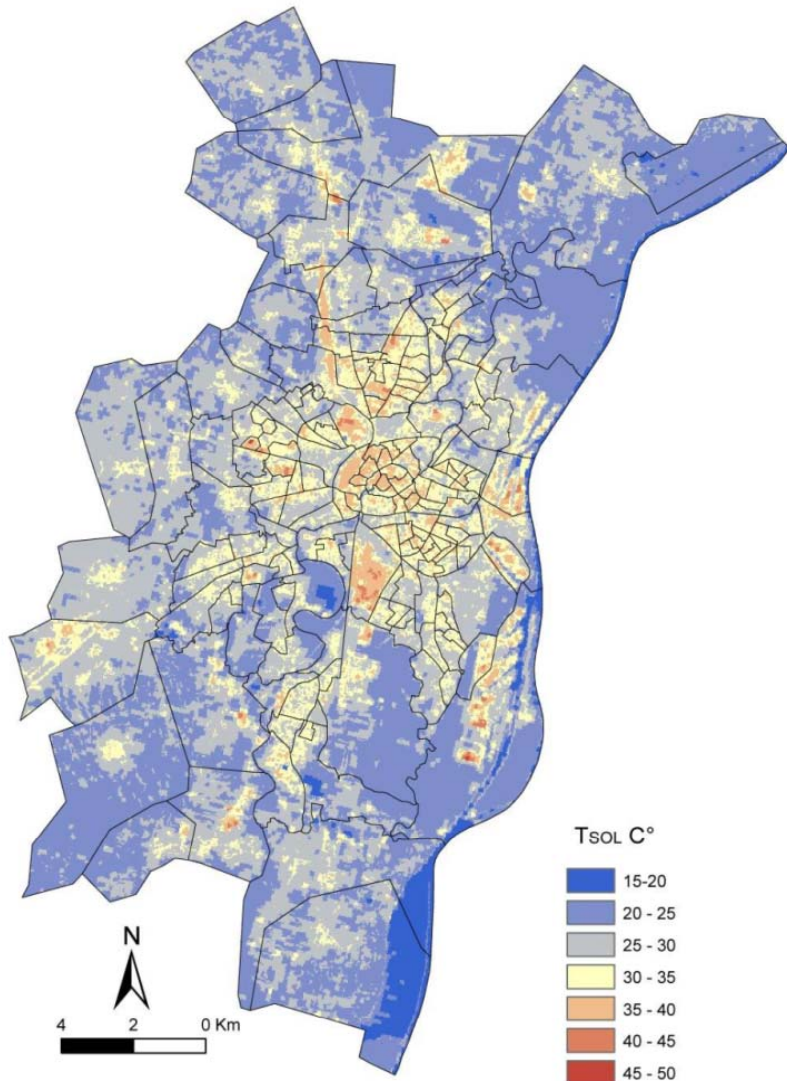
15 août 2001



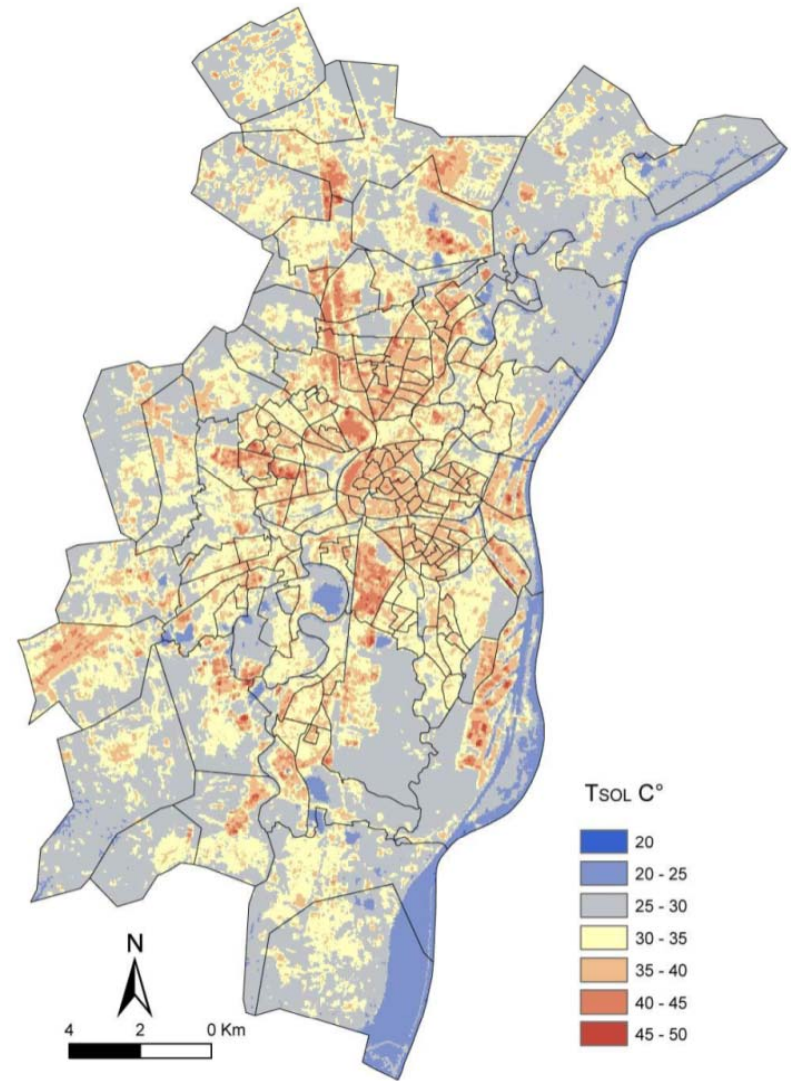
(H Kabil, 2010)

Surface temperature evolution

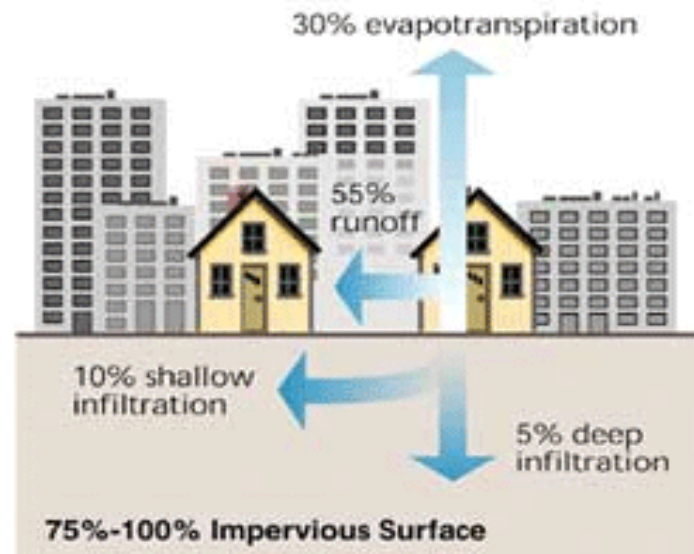
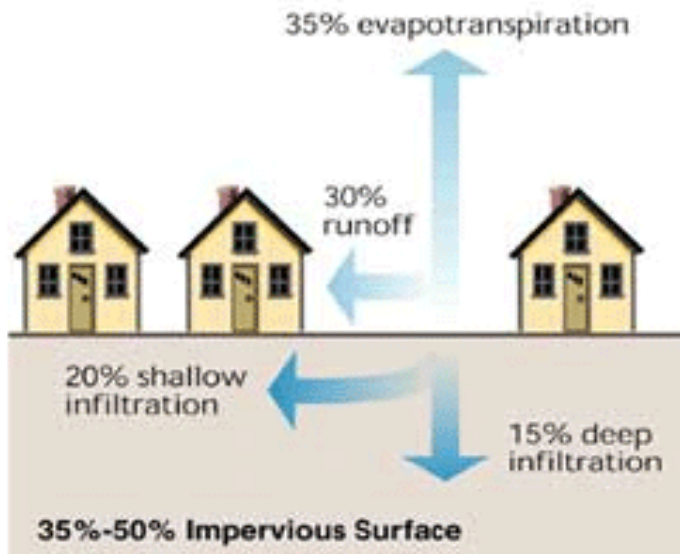
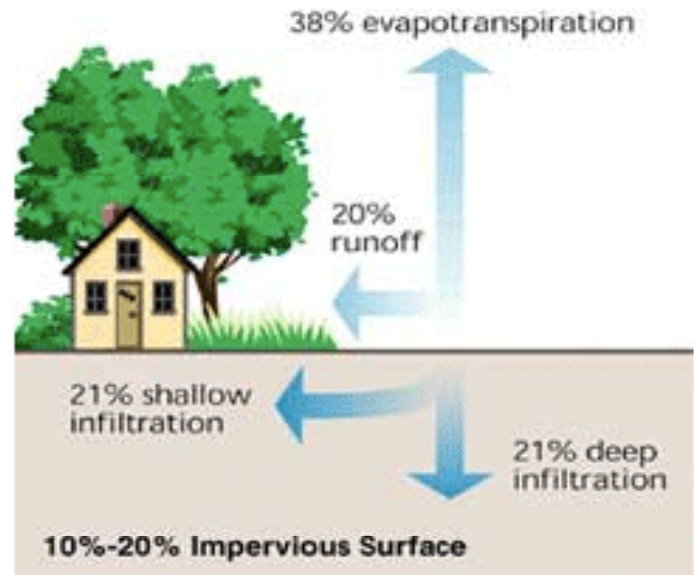
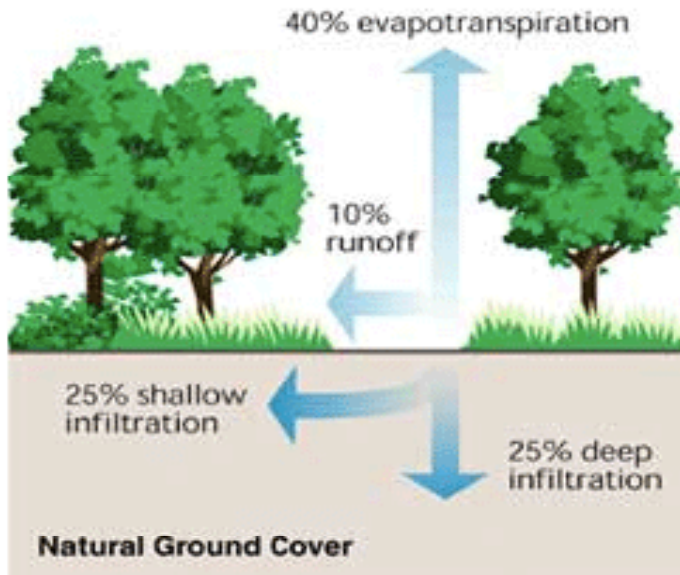
Répartition spatiale de la TsOL sur l'agglomération urbaine de Strasbourg
le 30 juillet 1984



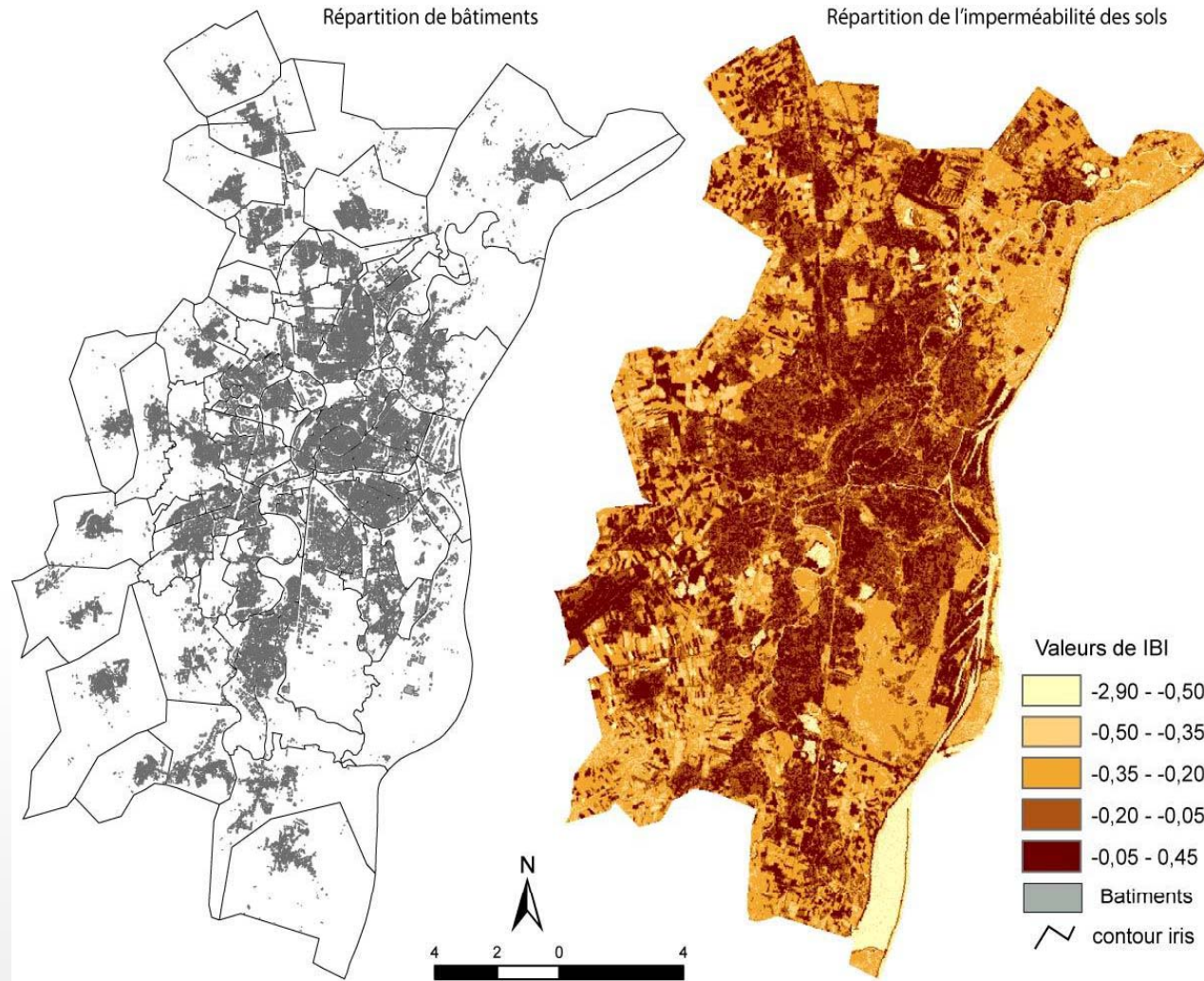
Répartition spatiale de la TsOL sur l'agglomération urbaine de Strasbourg
le 15 août 2001



Artificial soils: Characteristics



Artificial soils



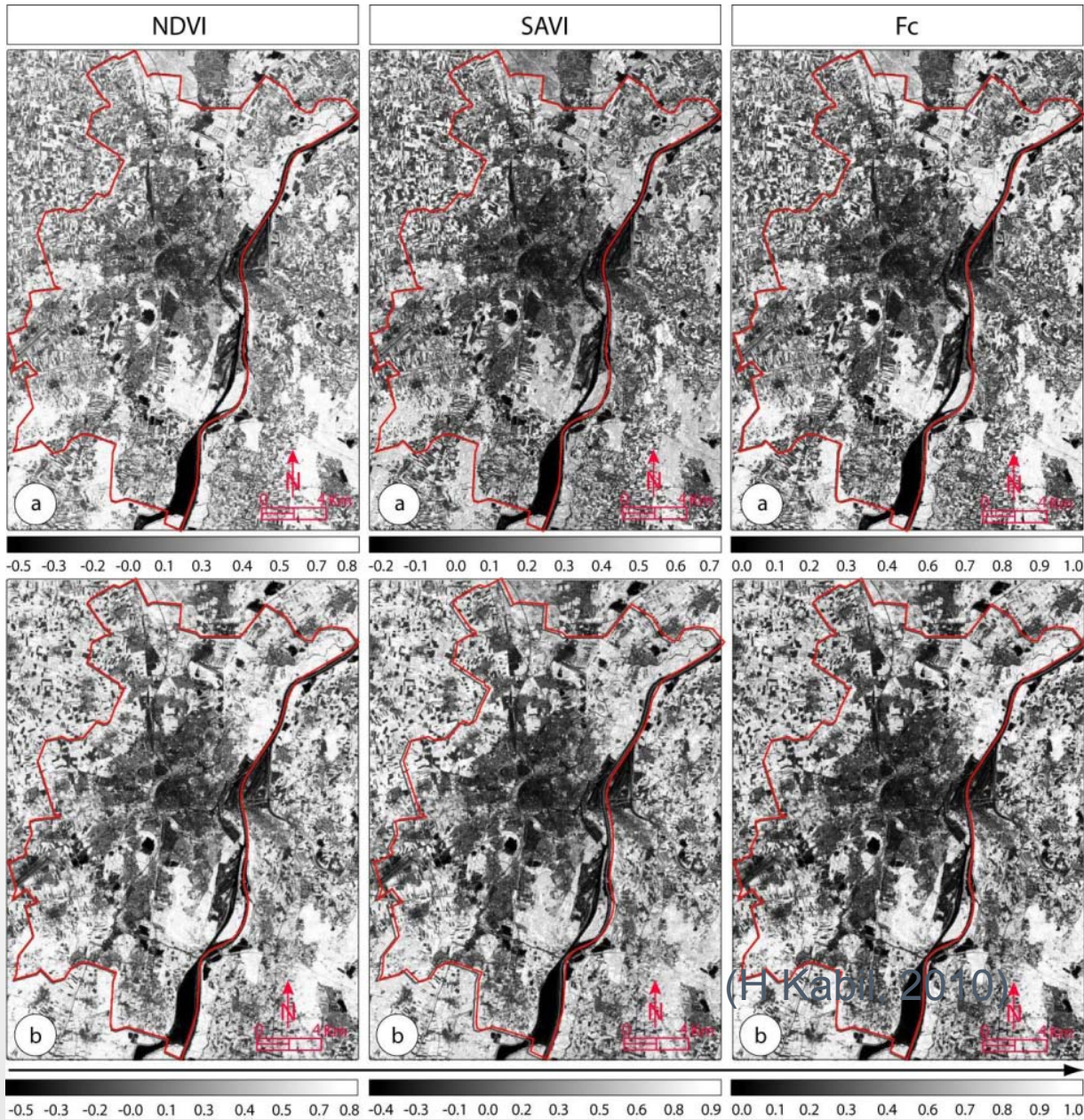
Comparison: Landsat data 2001 with Buildings **BD OCS en 2000**

(H Kabil, 2010)

Urban Biodiversity

- **Ordinary Biodiversity**: location, identification and diffusion process for species [RUILIANG PU, 2009], [Wania, 2007]
- **Trames vertes et bleues** (Agenda 21, Plan Climat, ecological corridors, protected areas & species lists ...)
- **Habitats and ecological matrice** (continuity and distance of patches, diversity and richness; landscape elements[Clergeau 2007])

Vegetation

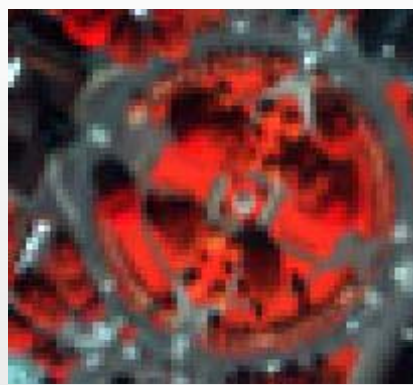


Estimation of
vegetation
indices : NDVI, SAVI
et Fc

a : 1984, *b* 2001

Urban Biodiversity

Vegetation forms location, strata and species identification, sanitary determination → ecological, esthetical, social, economic role



Various species

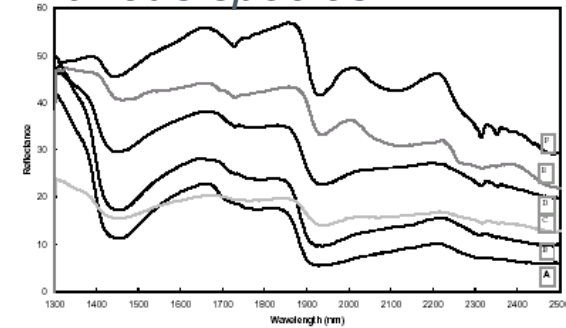
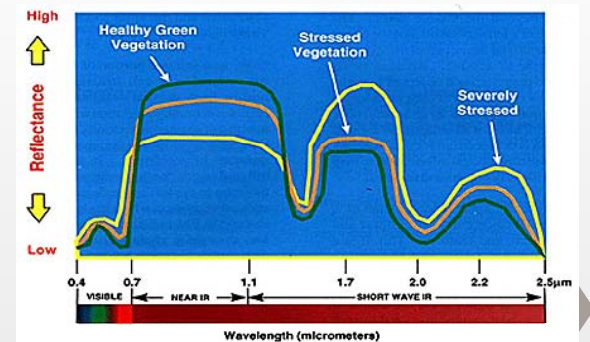
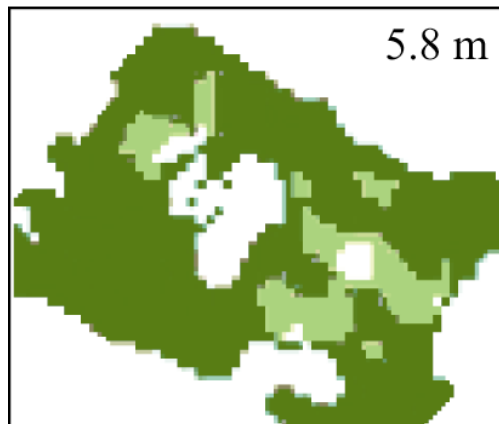


Figure 2. Examples of PIMA spectra from arid plant species: A- Eucalyptus leaves; B- bulluck bush leaves; C- black bluebush leaves; D- saltbush leaves; E- crustose lichen on soil; F- Eucalyptus bark.



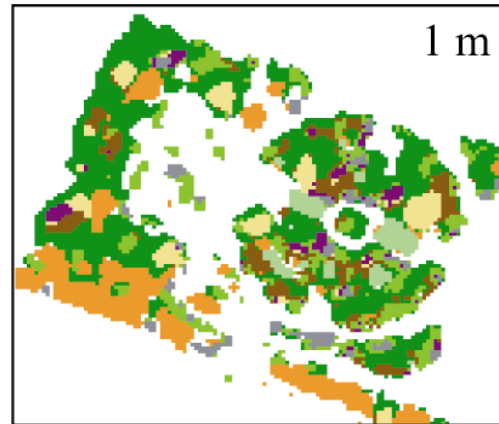
Sanitary conditions

(a)



© IRS Simulation, 2000

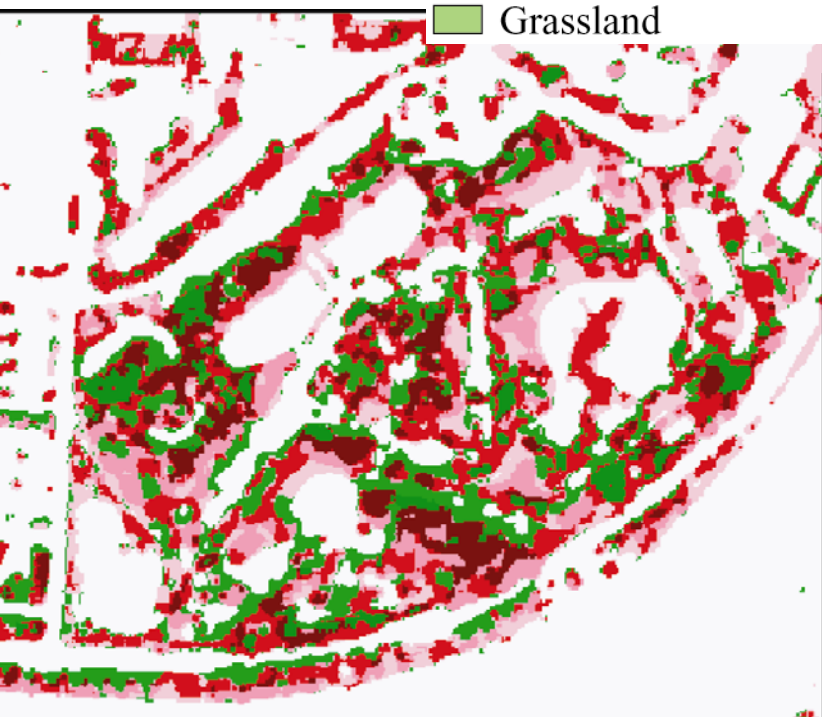
(b)



© CNES Simulation, 1997

Shrubby layer
 Grassland

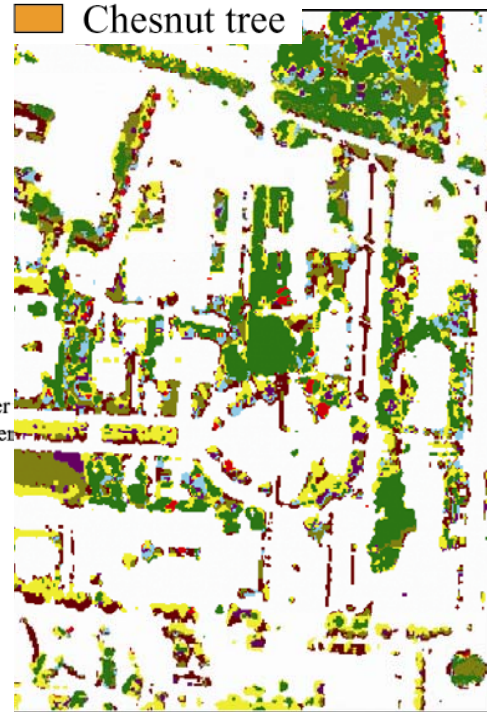
Lime
 Beech
 Plane tree
 Chesnut tree



Légende :

mixed shrubby layer
 irrigated herbaceous layer
 average shrubby layer
 high and dense shrubby layer
 not irrigated herbaceous layer
 small shrubby layer
 not plant

0 m 200



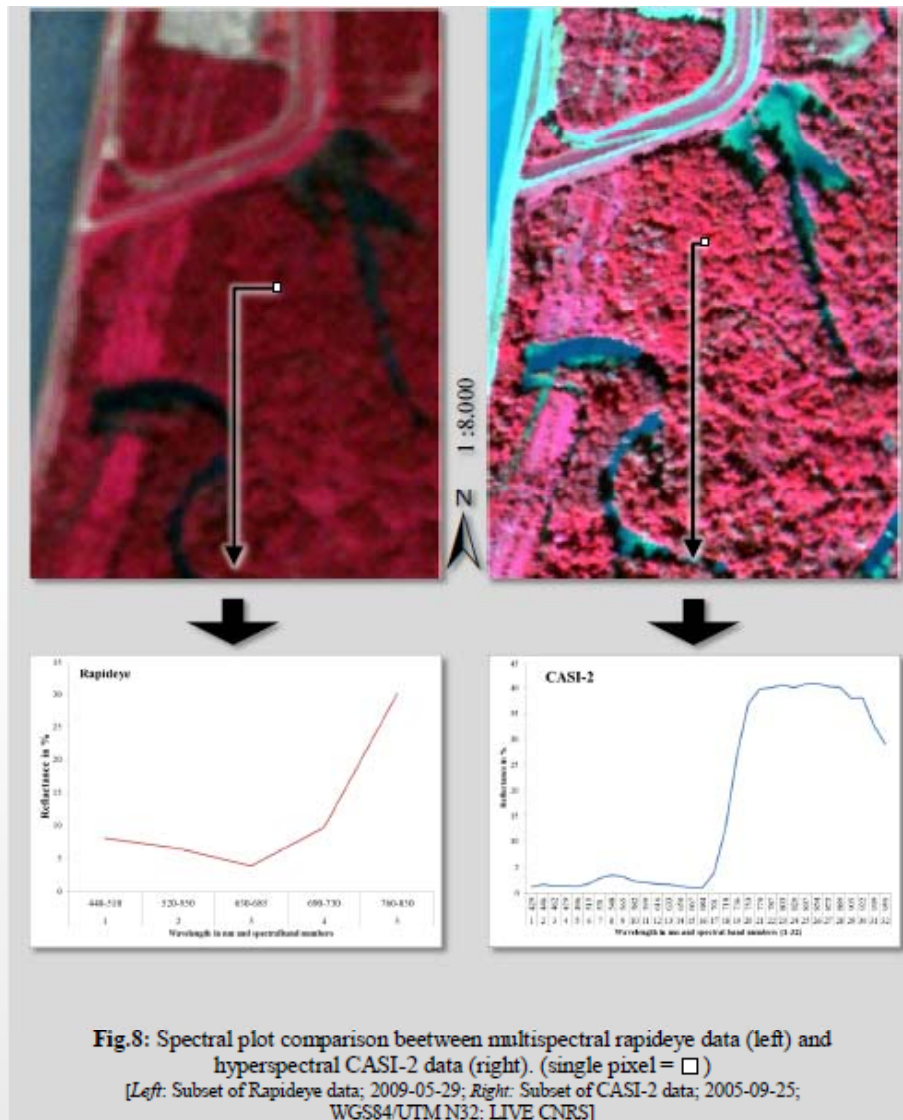
Légende :

irrigated
 lawn
 beech
 young li
 dense pl
 plane tre
 birch
 lime
 maple
 italian p
 not plant

0 m

XS to HYPERSPECTRAL

Ile du Rohrschollen



Environmental issues

- Urbanisation gradient
- Urban area limits
- Artificial areas



Earth Observation: new paradigm

- From pixel to object
- New technologies
- Multi sensors, multisources

EO and Urban environment

- Spatial indicators
- Urban Heat Island
- Artificial areas
- Urban biodiversity

→ Decision making

- EO product as media for collaborative actions

Urban management and environmental challenges

Anthropogenic pressure Indicators

→ Environmental Indicators : vegetation, soils, temperature using EO data

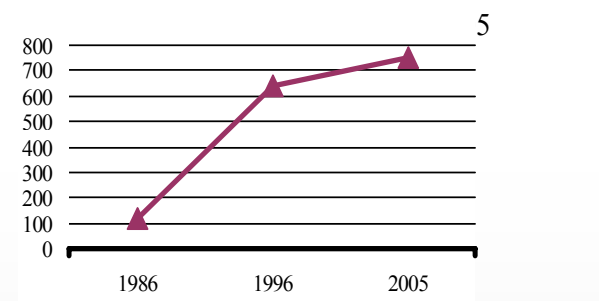
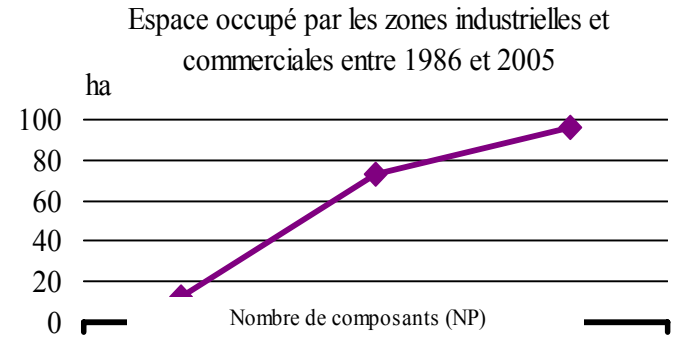
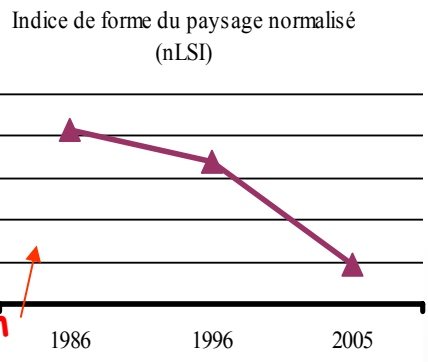
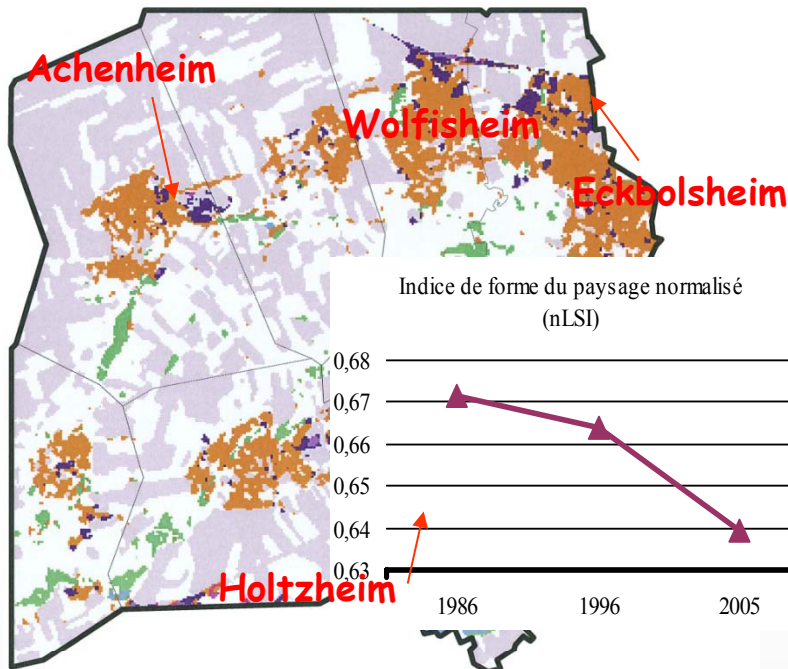
→ Vizualisation, prospective modelling, participative media,

→ Use of various mobil supports: PDA, smartphone, GPS

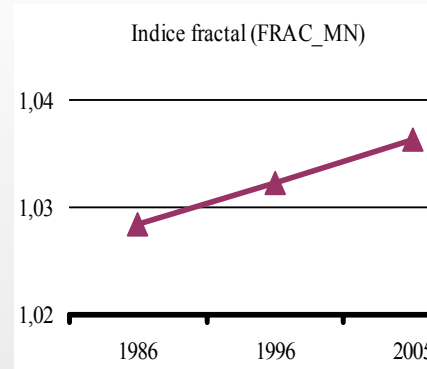
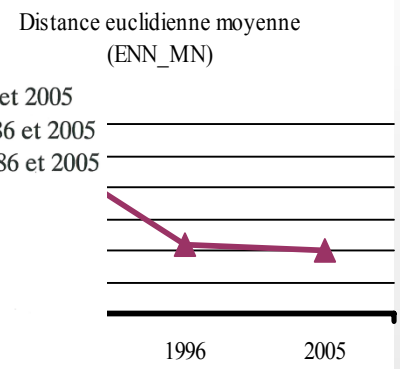
→ Use of network facilities: webmapping, webGIS, web depository,



Landscape analyses Urban growth evolution (Industrial areas)



- Tissu urbain
- Zones industrielles et commerciales existantes en 1986 et 2005
- Zones industrielles et commerciales apparues entre 1986 et 2005
- Zones industrielles et commerciales disparues entre 1986 et 2005
- Vegetation arborée
- Vegetation herbacée et cultures
- Espaces nus urbains ou ruraux
- Cours et plans d'eau
- Limite de commune
- Limite de la zone d'étude



(Fragstat)

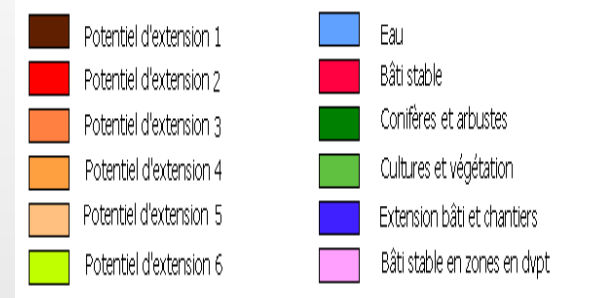
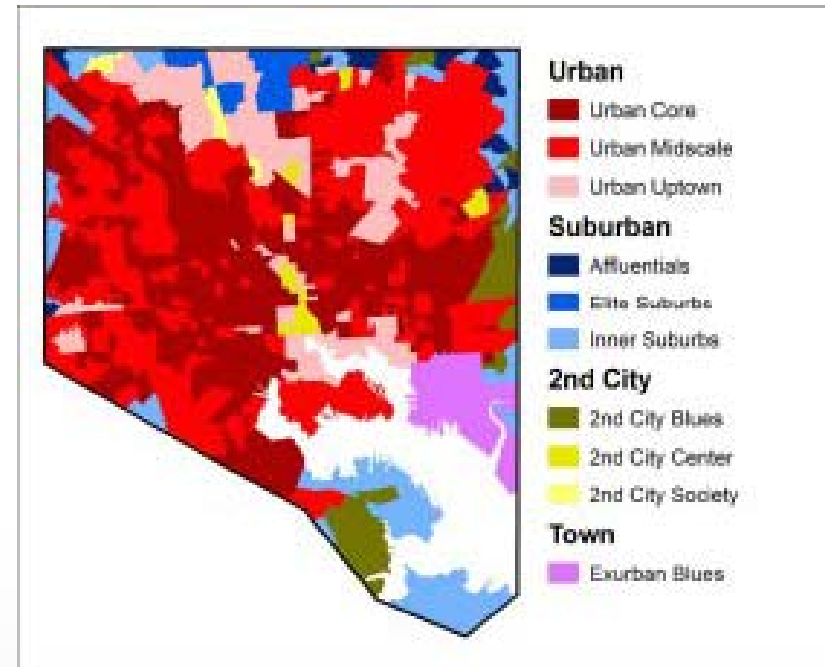
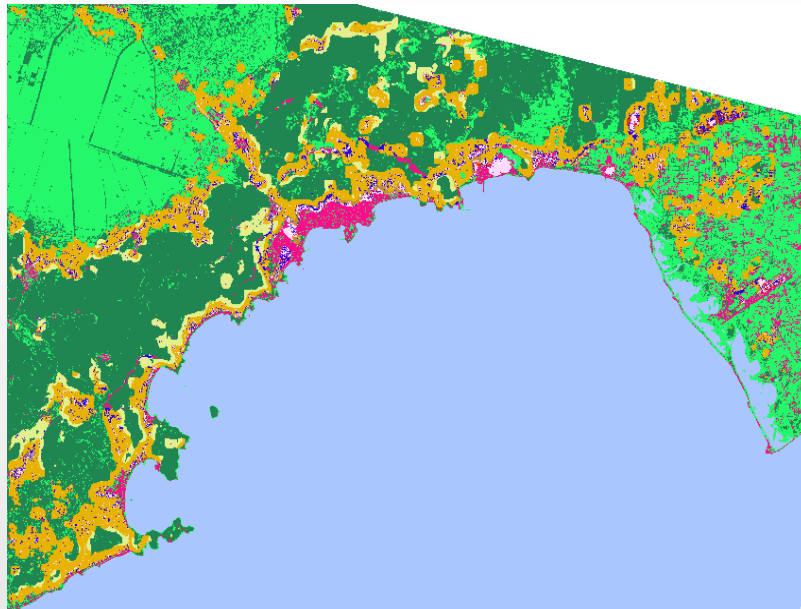
Decision making

EO product as media for collaborative actions (Baltimore LTER US)



-Prospectives and simulation KAVALA (Greece)

- Maps realisation
- Model representation



Possible and Realized total stewardship against PRIZM 15

Participative actions
Stewardship emergence
EO data as reference support



A sample streetscape in a neighborhood classified with the “Money and Brains” PRIZM Group in Baltimore (photograph by Austin Troy)



A sample streetscape in a neighborhood classified with the “Bohemian Mix” PRIZM Group in Baltimore (photograph by Jennifer Jenkins)



BALTIMORE LTER

Baltimore Stewardship Mapping & Assessment Project: Caring for the Land, Water, & People of Baltimore Our new project looks at the network of groups and organizations doing environmental stewardship work in Baltimore City.

Through a citywide survey, we seek to better understand:

- **WHO works on the environment in Baltimore? What types of stewardship activities are they working on?**
- **WHERE in the city is stewardship work being done? Which neighborhoods have more or less activity?**
- **HOW do stewardship groups and networks affect the communities and environment where they work?**

WHY IS THIS RESEARCH IMPORTANT? One organization can help build stronger communities and improve the environment, but it is only one part of a larger picture. Given the relationships and overlap among those working on the environment, it is important to understand the networks that tie them together.

HOW WILL THIS RESEARCH BE USED? The results of this work will be published on a publicly available, interactive map so that Baltimore residents, public agencies, and stewardship groups can visualize and search the types and locations of stewardship work being done in their city. This can help support organizations as they seek new projects, funding, and opportunities to grow and build capacity.

Thank you for attention

