Space & Geospatial Value Chain – Co-creating Geospatial Knowledge Infrastructure

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ISPRS is …

- An international NGO with a focus on
  - **science and development**
    - in photogrammetry, remote sensing, spatial information
  - **cooperation** between **all relevant stakeholders**
    - academia, private industry, government, end users
  - truly **global** cooperation
    - **education**, technology transfer, capacity building
- More than 100 years old
- Approx. 180 institutional members

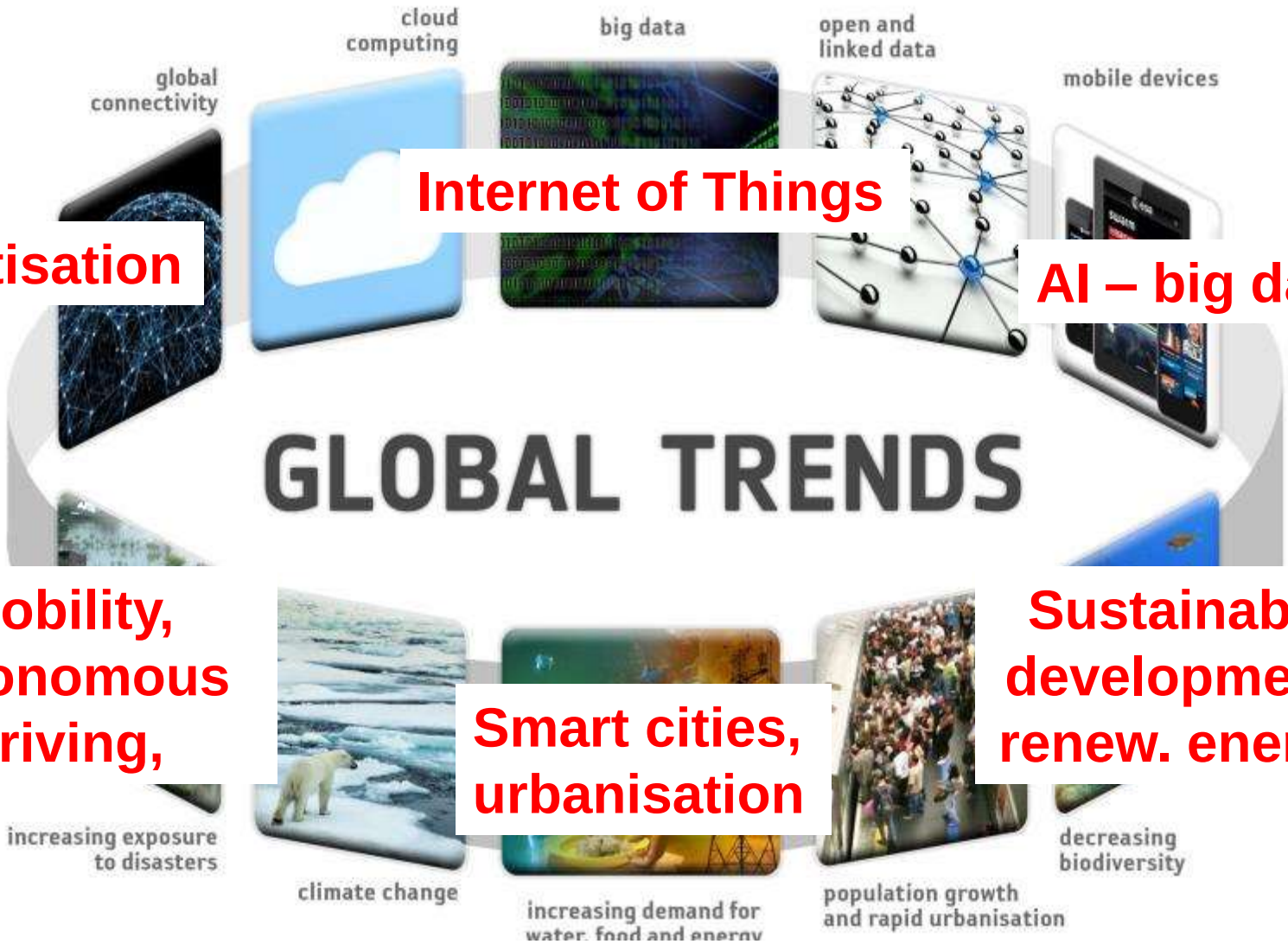
Social and political frame

- **Globally increasing population**
  - in particular in emerging countries and coastal areas
  - shrinking population in some developed areas, aging society
- **Increasing globalisation**
  - mobility of people, markets, capital, education, information, …
  - health (the virus)
- **Global companies entered the scene**
  - Google Maps/Earth Engine - esri, Trimble, Hexagon, …
  - Amazon Web Services, TianDiTu - 天地图, …
- **Global change (only ONE earth, no plan[et] B …)**
  - political backing, e.g. „Fridays for Future“
  - 2030 UN Agenda and SDGs, Sendai Framework, Paris Agreement

Social and political frame

- **Changing role of governments**
  - from GI producer to geospat. portals – open data, open access
  - not the only provider of GI information any more - **VGI**
  - eGovernment services
- **Increased need for global GI and GI management**
  - coordination among **countries and internat. organisations**, e.g. GEO, GEOSS, UN-GGIM, INSPIRE, OGC, …
  - global GEOINT activities
  - global coordination for disaster management (Int. Charter)
- **Changing ICT**
  - digitisation, **smart cities** (but not for everybody on the globe …)
  - request for 24/7 availability, **real-time** response
  - IoT, increased autonomy (driving, flying, robotics, …)

ICT frame



Internet of Things

Digitisation

AI – big data

Mobility, autonomous driving,

Smart cities, urbanisation

Sustainable development, renew. energy

Disaster mgt.

adapted from Volker Liebig, ESA

Space

- Here: focus on Earth observation
  - GNSS, communication sat.'s etc. essential, but beyond the scope of this talk

- NewSpace, Space 4.0
  - constellations: swarms of small satellites (Planet, ICEYE, Capella, …)
  - many different countries involved – cooperation and competition
  - private funding, cost cut (SpaceX, Blue Origin, Virgin Galactic, …)
  - continuity: temporal, spatial and spectral data cubes
    - analysis ready data ("orthophotos") with location as reference
  - low latency space internet (SpaceX, Amazon, One Web, …)

Space and EO making headlines

The Guardian, Aug. 23, 2019

G7 leaders to hold emergency talks over Amazon wildfires crisis

Brazil's handling of fires to top agenda in Biarritz as France and Ireland threaten to block trade deal

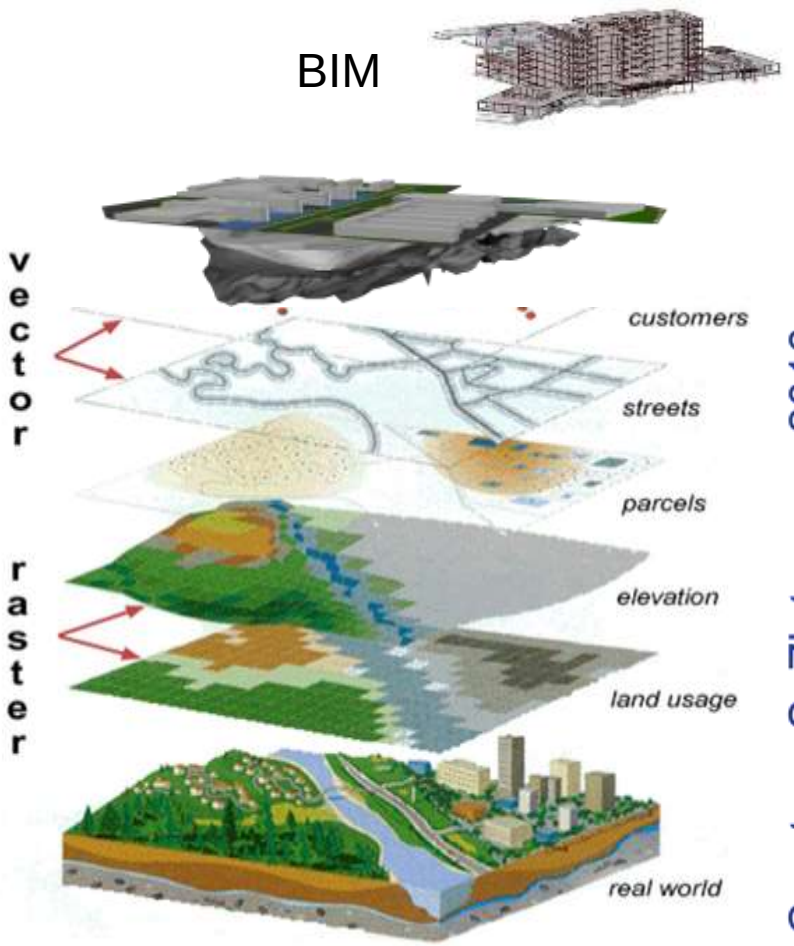
Amazon fires: what is happening and is there anything we can do?

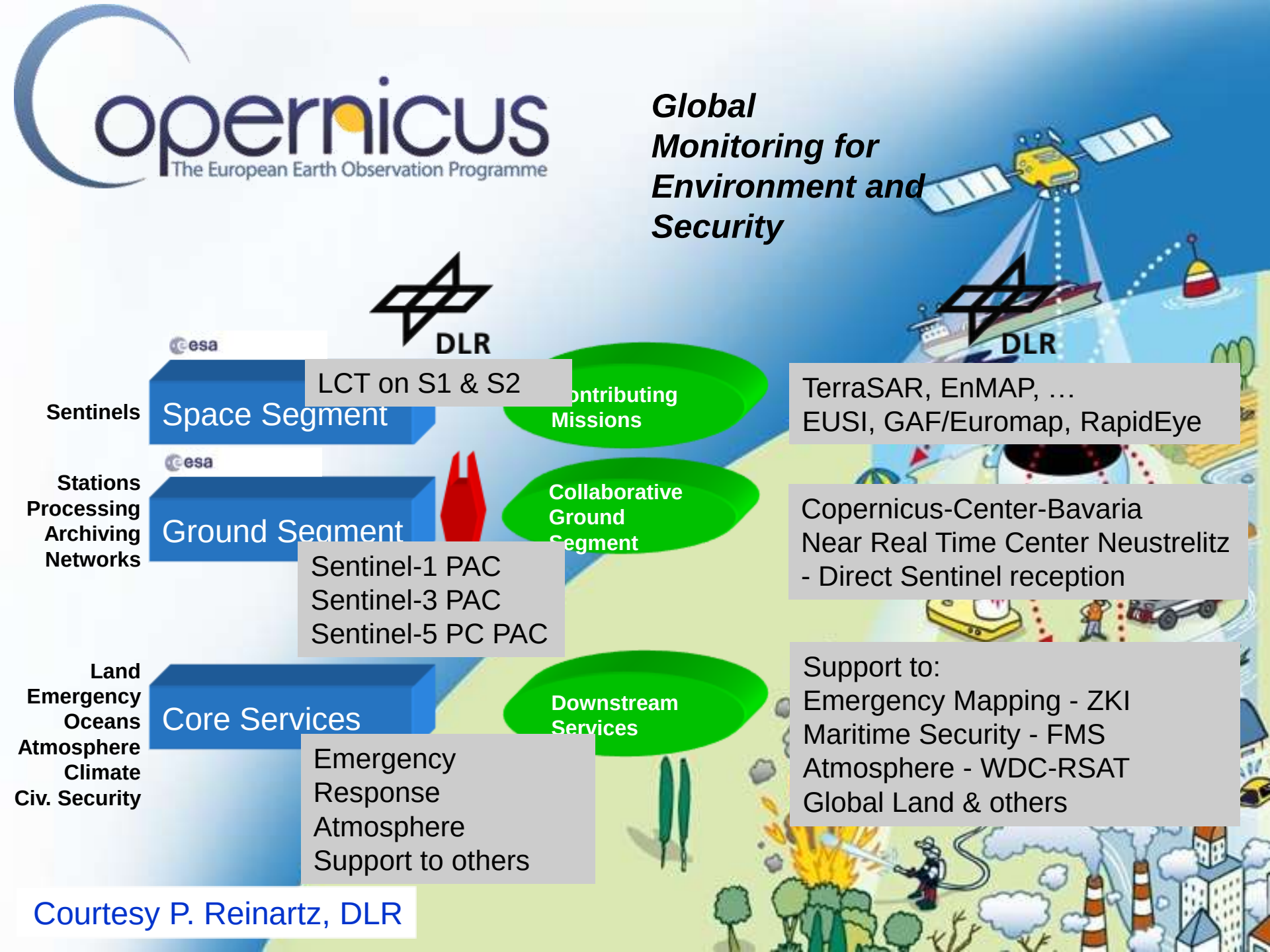
Geospatial value chain

- Integrated space services
  - space segment, various systems
  - ground segment, reception of all kinds of data
  - **integration with in-situ data** (often captured by IoT devices)
  - downstream application SERVICES
- Big data analytics
  - artificial intelligence and machine learning (many, e.g. Descartes Labs, Orbital Insight, spire), **explainability leads to (needed) trust!**
  - processing in the cloud (e.g. AWS, MS Azure)
  - data interoperability, also **across sensors**
    - location is key for integration
  - **real-time** distribution of results (**merger of positioning, EO capture and processing, GIS and communication**)

Integration – location is key

- **location uniquely ties items together** and thus unlocks value in other‘s data (N. Clifford, CEO Ordnance Survey, 2016)
- we are part of a more complex, connected world, not an isolated island
- Digital twins





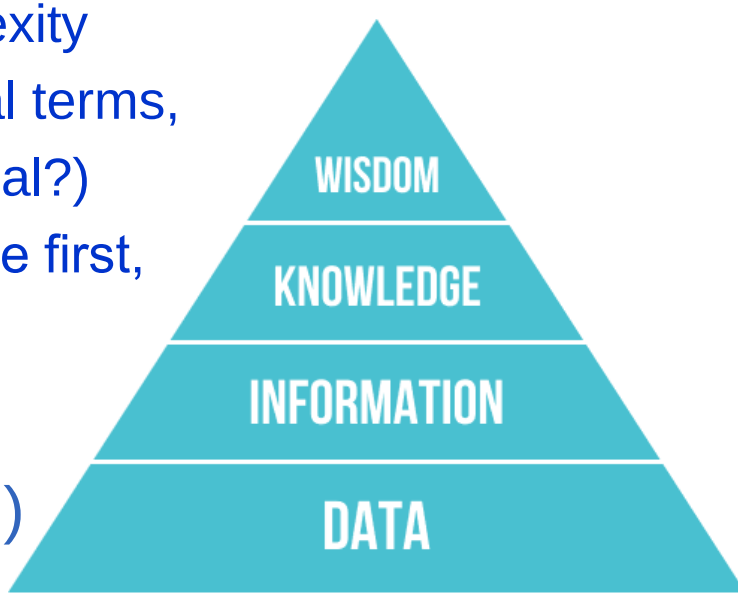
Courtesy P. Reinartz, DLR

Data, information, knowledge, wisdom …

Where is the Life we have lost in living?
Where is the **wisdom** we have lost in **knowledge**?
Where is the **knowledge** we have lost in **information**?

Nobel Laureate T. S. Elliot, *The rock*, 1934[1]

- DIKW pyramid
  - a often cited model[2] to represent different levels of data processing with increasing abstraction and complexity
  - no agreement on definition of individual terms, neither on their overlap and (hierarchical?) relationships ("what is information to the first, can well be data for the second")
- A **somewhat vague, but useful concept** (but, action is missing)



[1] www.poetrynook.com/poem/choruses-%C3%B4%C3%A7%C2%A3the-rock%C3%B4%C3%A7%C3%B8
[2] for a discussion of the origins see en.wikipedia.org/wiki/DIKW_pyramid

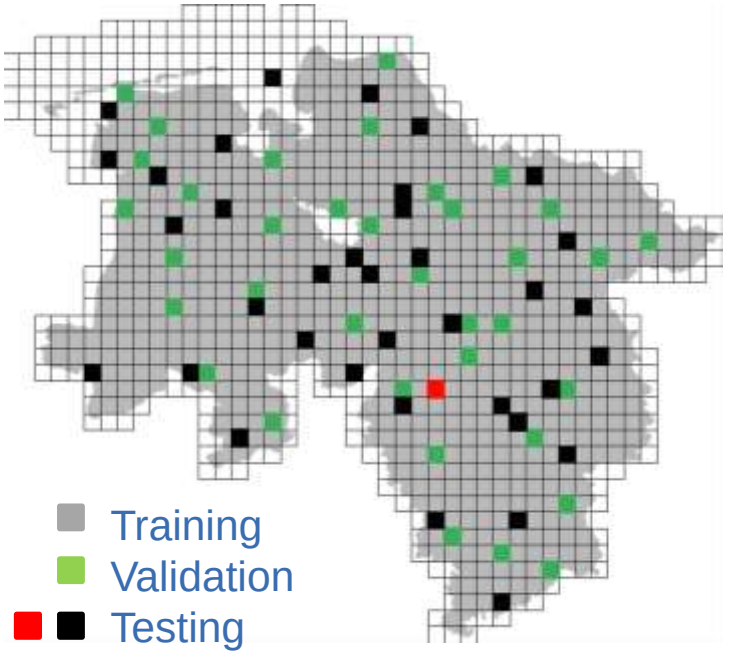
Geospatial information 4.0

- primary (digital) resource of the 21st century
- base for public, commercial and private opinion forming and decision making
- GDI/GKI - Geospatial Data/Knowledge Infrastructure
  - GKI: *a set of interoperable components, including software, information, hardware, procedures and standards, that work together to support advanced discovery and creation of geoscientific resources, including publications, data sets and web services* (Stock et al., 2012)[1]
  - digital infrastructure, comparable in importance to traffic, electricity, communication, water/wastewater, …
  - integration of data, digital twins
- interdisciplinary in nature

[1] Stock K., Stojanovic T., Reitsma F., Oue, Y., Bishr M., Ortmann J., Robertson A., 2012: To ontologise or not to ontologise: An information model for a geospatial knowledge infrastructure, Computers & Geosciences 45 (2012) 98–108

A case study: LC class. using existing map

- Land Cover classification based on **Sentinel-2** (GSD: 10 m, 10 channels)
- data covering the **entire state** of Lower Saxony (48,000 km^2) at 10 m GSD
  - 16 epochs (different seasons)
  - 6 classes (labels from the German landscape model
- Estimated level of **label noise**: 8%
- Preliminary results:
  - overall accuracy: 90%, mean F1-score 75%
  - only little impact of label noise IF all epochs are used



Voelsen M. et al. 2021: Investigations on feature similarity and the impact of training data for land cover classification. ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., V-3-2021, 181–189.

Issues, stakeholders and their roles

- public and private sector, citizens
  - authoritative data from NCMAs; data cubes from space agencies
  - private data collection, storage and processing (Google, Amazon, …)
  - participation and role of citizens, VGI crowd sourcing
  - commercially viable products and services (beyond trad. examples)
- international players, public and private
  - UN-GGIM, GEO, ISPRS, … coordination role
  - OGC, W3C, ISO standards
- updating and data currency
  - in hot spots and on demand; country-wide and periodic
- cost, licensing, open data/free use
- data privacy, data security (“big data” is “big brother”)
- **must be underpinned by research & development**

Some points for a successful cooperation

- Cooperation on a level playing field – from day 1
  - independence of research inst. +is holy grail
  - common selection of staff
  - contracts with different competitors must be possible
- Contract with clear rules (IPR, publications, NDA, ...)
  - research inst. must be allowed to publish
  - research inst. defines amount of work necessary for PhD degree
- Clear understanding of terms
  - “research” means that result is unknown, not predictable
- Research needs research environment
  - at least one day per week at university
  - participation in international scientific meetings is a must

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