

# Geographical Thinking in the Digital Age

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# Idea and Motivation

**Quantitative geography:** founded during the „quantitative revolution“ in many sciences in the 1970s

**Then:** many other developments and scientific approaches like systems thinking, spatial turn, complexity science, data mining, geocomputation, GI-Science, ...

**Today:** „Digital Revolution“, „Digital Age“, „Dataism“ (Yuval Noah Harari), eScience (Jim Gray), Data Analytics, Big Data, Data Science

**Question: Influences and dependencies between (quantitative) Geography and Aspects of the Digital Age (Data Analytics of Big Data)**

# 3 Aspects

are considered to discuss these influences and dependencies between (quantitative) **Geography** and the **Digital World**:

**(1) Big Spatial Data**

**(2) Spatio-temporal aspects in a digital world**

**(3) Spatial modelling in a new Spatial Data Science**

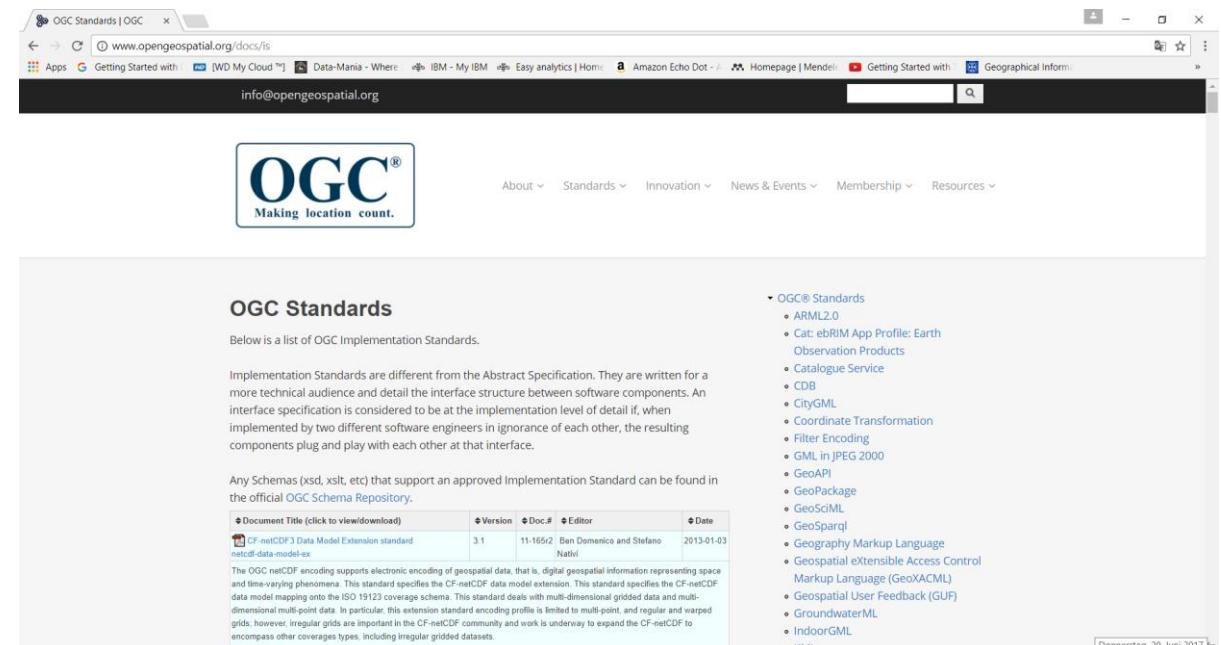
**for analysis, prediction and prescription of spatial processes**

# (1) Big Spatial Data

- **Traditional in geography:**  
structured & quantitative data mostly geo-referenced like satellite data, GIS-data, census data, interview and survey data

- **Special in geography:**

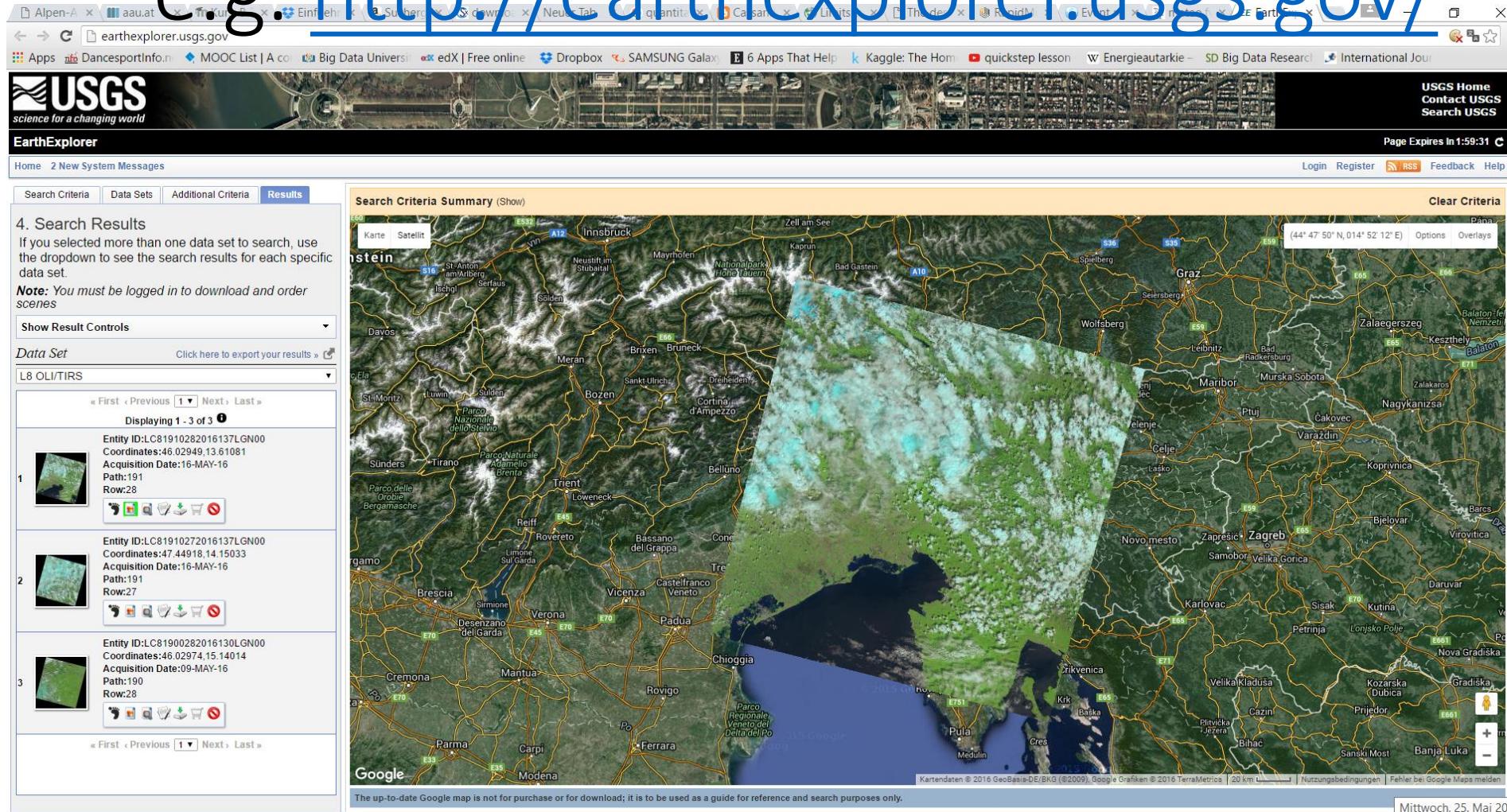
➤ Spatial data standards:  
<http://www.opengeospatial.org/>



The screenshot shows the OGC Standards page. At the top, there's a navigation bar with links for About, Standards, Innovation, News & Events, Membership, and Resources. Below the navigation is a sidebar titled 'OGC® Standards' containing a list of various standards such as ARML2.0, ebRIM App Profile: Earth Observation Products, Catalogue Service, CDB, CityGML, Coordinate Transformation, Filter Encoding, GML in JPEG 2000, GeoAPI, GeoPackage, GeoSciML, GeoSparql, Geography Markup Language, Geospatial extensible Access Control Markup Language (GeoXACML), Geospatial User Feedback (GUF), GroundwaterML, IndoorGML, and KML. The main content area features the OGC logo ('OGC® Making location count.') and a section titled 'OGC Standards' which describes implementation standards. It includes a table showing details for the 'CF-netCDF3 Data Model Extension standard' (version 3.1, editor Ben Domenico and Stefano Natoli, date 2013-01-03). A note explains that this standard specifies the CF-netCDF data model mapping onto the ISO 19123 coverage schema. The bottom right corner of the page shows the date 'Donnerstag, 29. Juni 2017'.

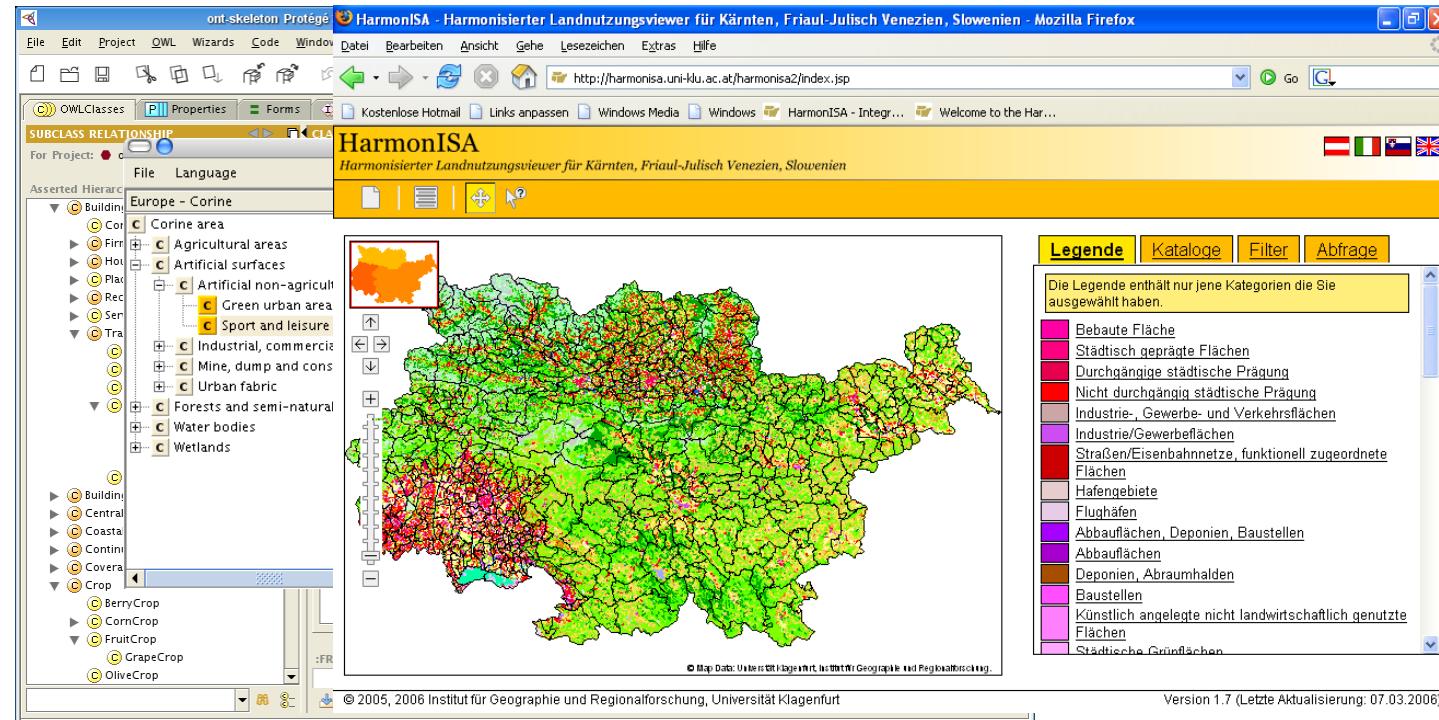
# ► Big spatio-temporal data repositories

e.g. <http://earthexplorer.usgs.gov/>



# ➤ Considering semantics: Ontologies

e.g. <http://harmonisa.aau.at/>

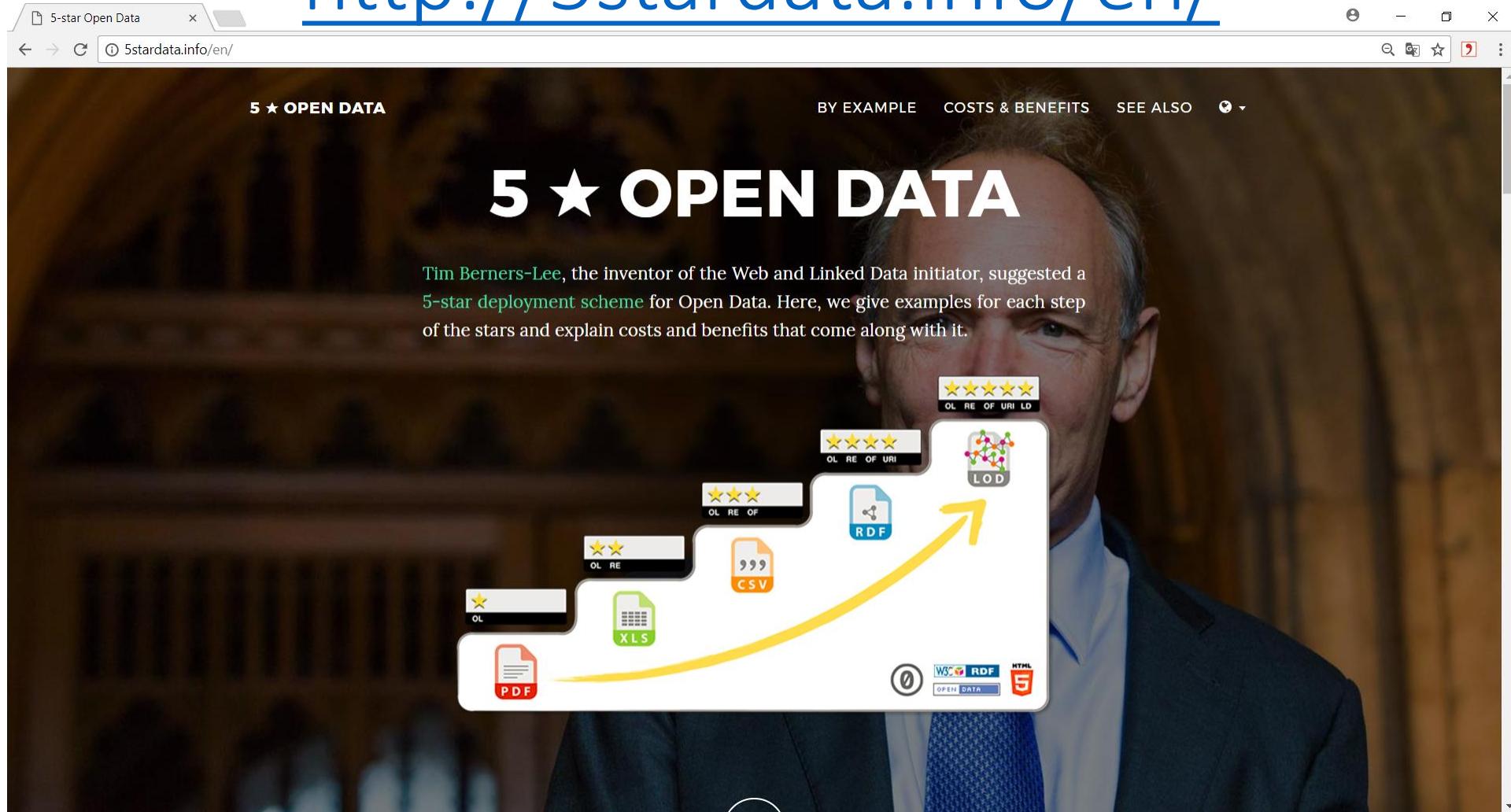


# (1) Big Spatial Data

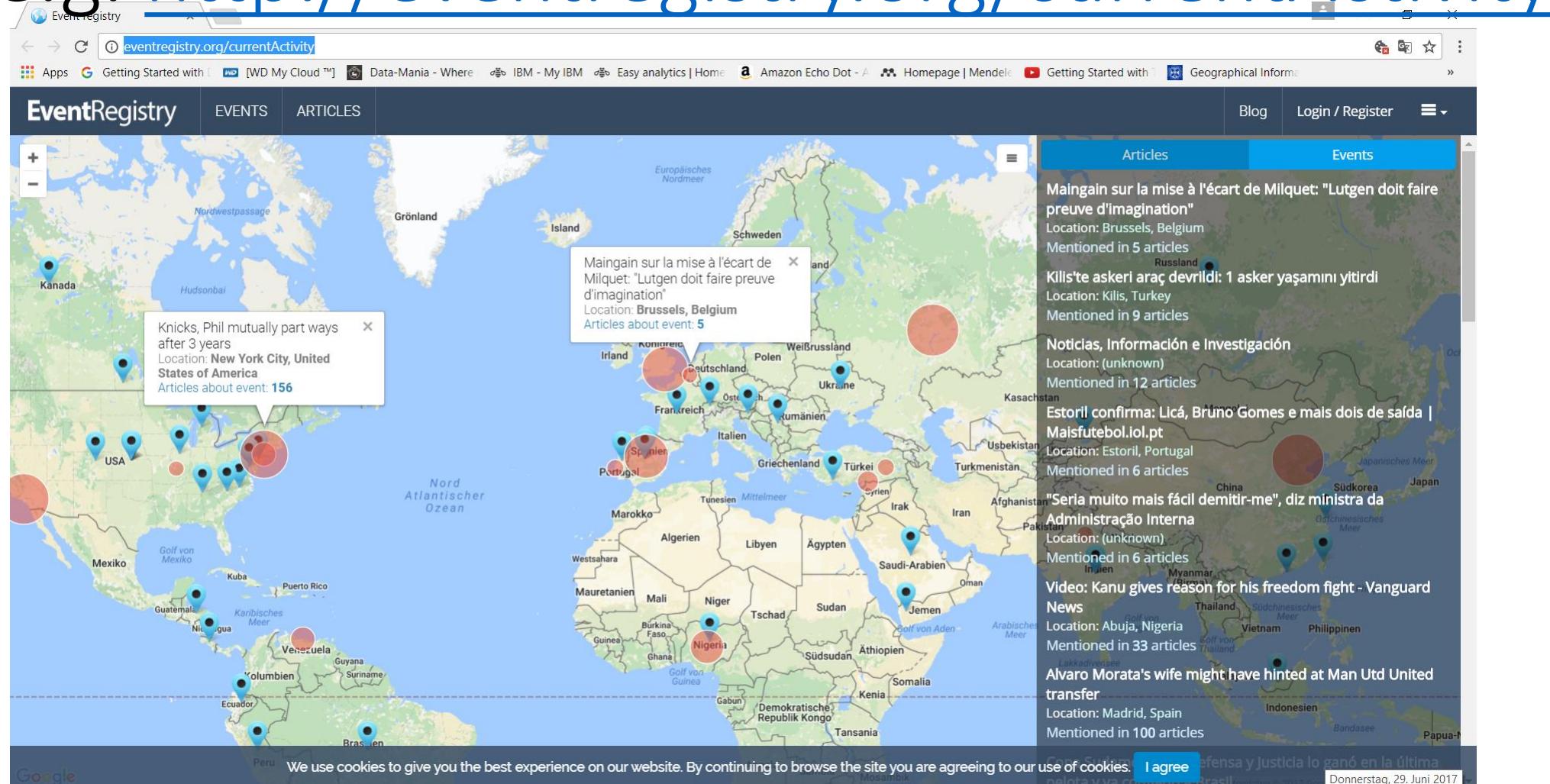
- **New in the digital age:**  
unstructured, qualitative and/or big data like  
texts, images, videos, data from many different sensors, crowd  
sourced data, open data, linked data
- **Special in Data Analytics of Big Data :**

# ➤ Data deployment scheme for open data

<http://5stardata.info/en/>



# ➤ Automatization and AI in content recognition e.g. <http://eventregistry.org/currentActivity>



# ➤ Linked Open Data

## <http://linkeddata.org>

<http://lod-cloud.net/>

Linked Data | Linked Da +

linkeddata.org/home

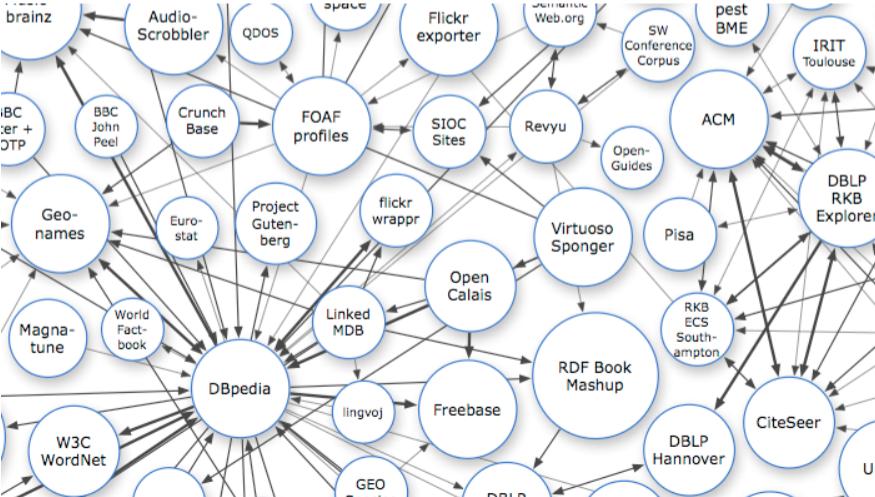
### Linked Data - Connect Distributed Data across the Web

Home  
Guides and Tutorials  
Frequently Asked Questions  
Glossary  
Images and Posters  
Presentations  
Data Sets  
Tools  
Events  
Calls for Papers  
Research  
News and Blogs  
Domains  
See Also

#### Linked Data

Linked Data is about using the Web to connect related data that wasn't previously linked, or using the Web to lower the bar linking data currently linked using other methods. More specifically, Wikipedia defines Linked Data as "a term used to describe recommended best practice for exposing, sharing, and connecting pieces of [data](#), [information](#), and [knowledge](#) on the Semantic Web using [URIs](#) and [RDF](#)."

This site exists to provide a home for, or pointers to, resources from across the Linked Data community.

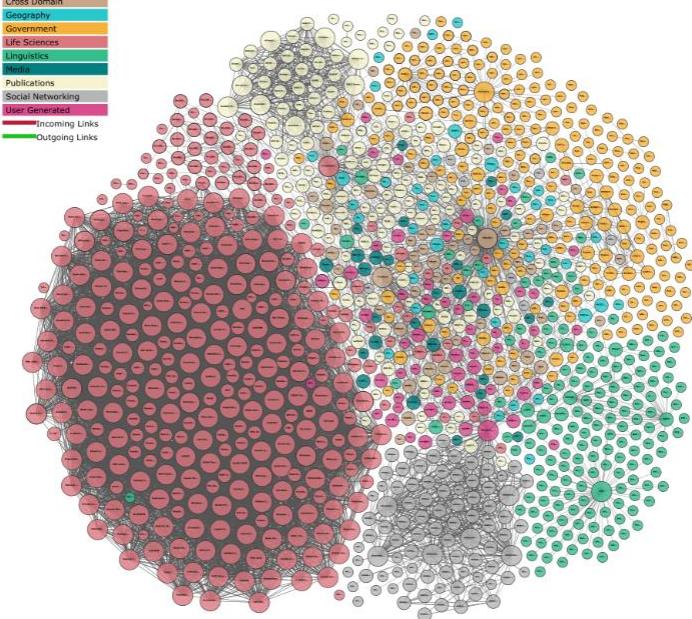


### The Linking Open Data cloud diagram

This web page is the home of the LOD cloud diagram. This image shows datasets that have been published in Linked Data format, by contributors to the Linking Open Data community project and other individuals and organisations. It is based on metadata collected and curated by contributors to the Data Hub. Clicking the image will take you to an interactive SVG version, where each dataset is a hyperlink to its entry in Datahub.

The diagram is maintained by Andrej Abele and John McCrae (Insight Centre for Data Analytics at NUI Galway). For any questions and comments, please email [andrej.abele@insight-centre.org](mailto:andrej.abele@insight-centre.org) and [John.McCrae@insight-centre.org](mailto:John.McCrae@insight-centre.org). The original version was developed by Richard Cyganiak and Anja Jentzsch.

Last updated: 2017-08-22



Can I use this diagram in my slides, paper, book? #

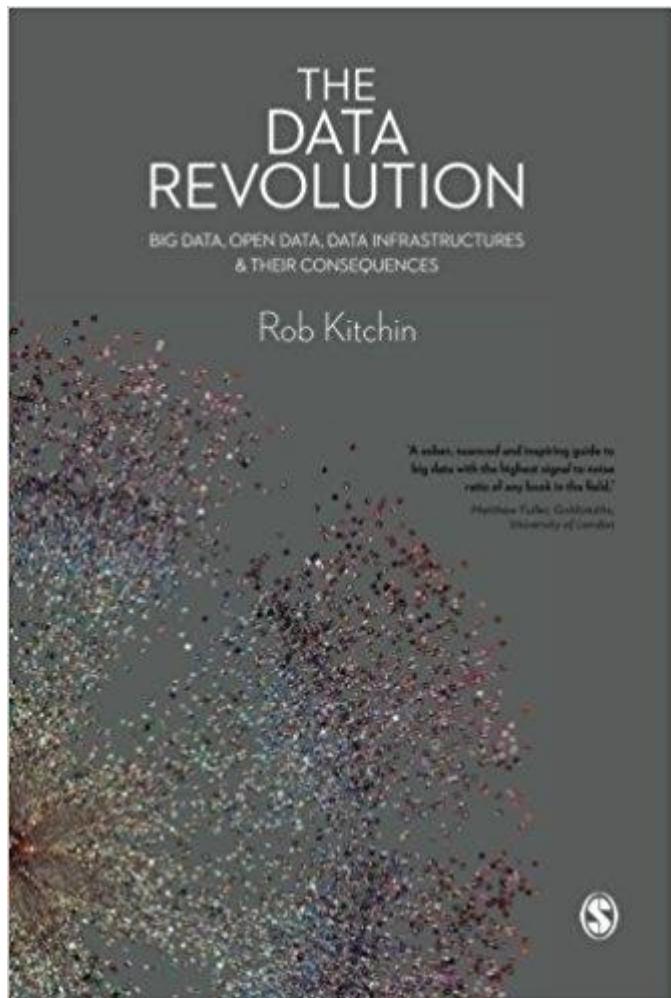
 Yes. This work is available under a CC-BY-SA license. This means you can include it in any other work under the condition that you give proper attribution. If you create

# (1) Big Spatial Data

## Influences and dependencies

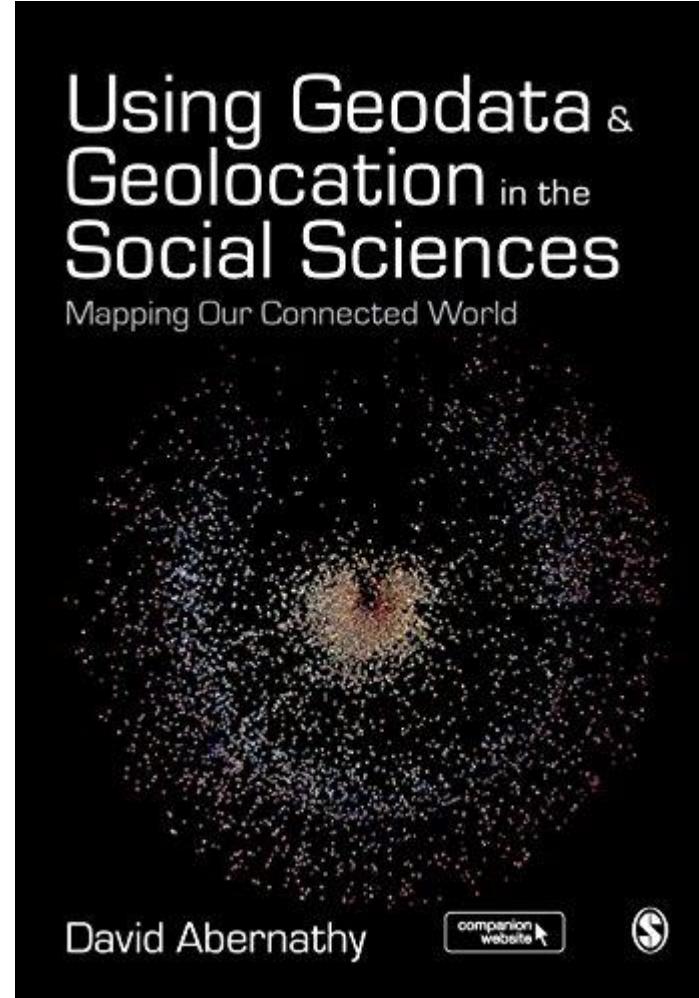
- a. **Data-Sources:** remote sensing, open data, social networks, sensors, smart sensors
- b. **Data storage:** NoSQL Data Bases, metadata
- c. **Interoperability:** standards, linking via ontologies
- d. **Privacy:** open, user generated, aggregated
- e. **Specific aspects:** georeferencing, visualisation, web-based, ubiquitous

# Selected Books

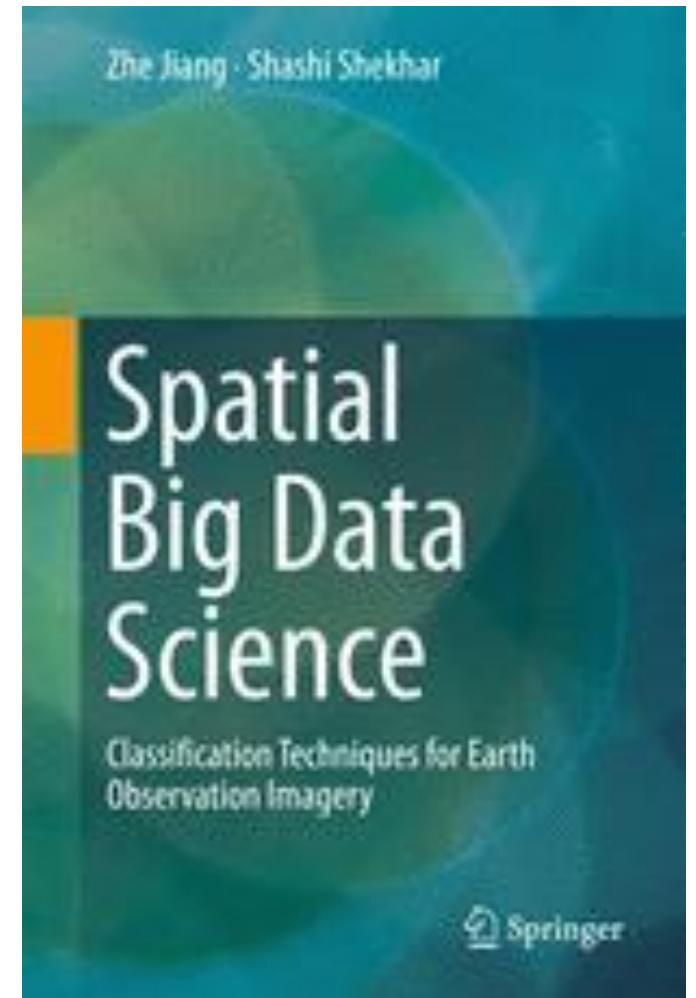


Peter Mandl, AAU

Geographical Thinking in the Digital Age



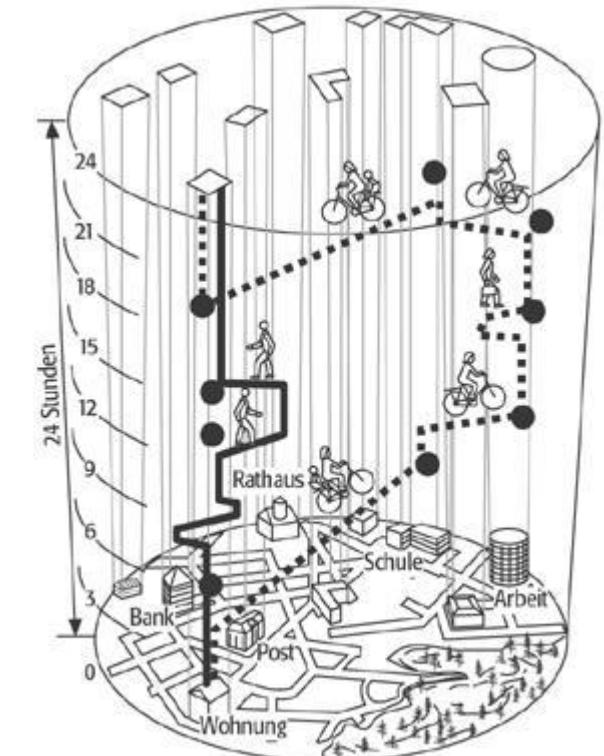
Geographical Thinking in the Digital Age



GeoIT Wherencamp 2017, Berlin

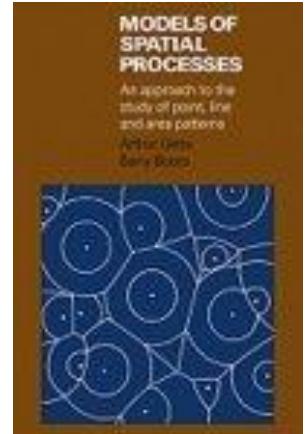
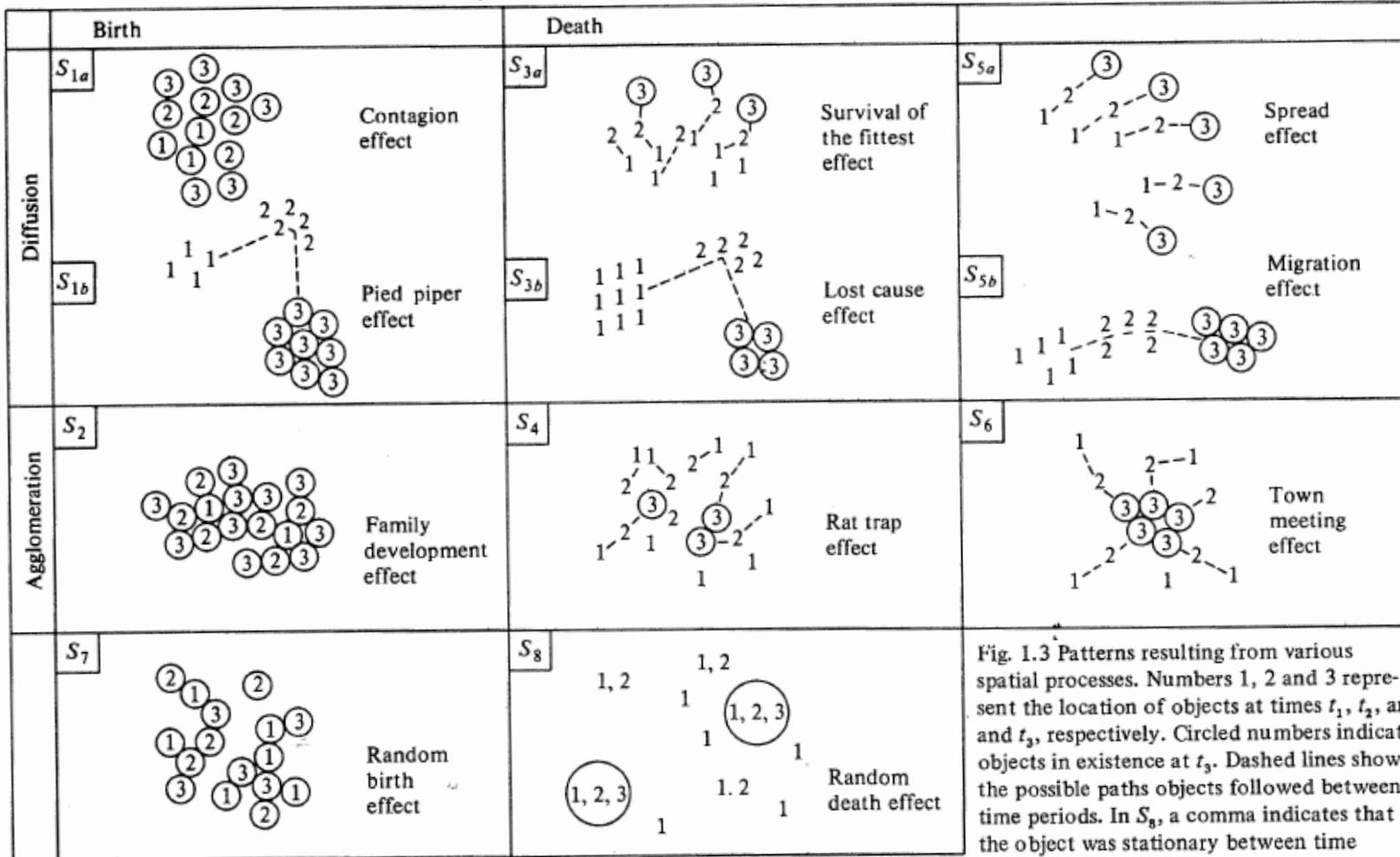
## (2) Spatio-temporal aspects in a digital world

- Most of the scientific and practical problems and data have **spatio-temporal aspects**
- Geography is the **science of spatial structures and processes**
- Traditional and modern geography has **many spatio-temporal concepts and approaches**
- They can be the **conceptual base for structuration and analysis and maybe interpretation** of spatio-temporal big data



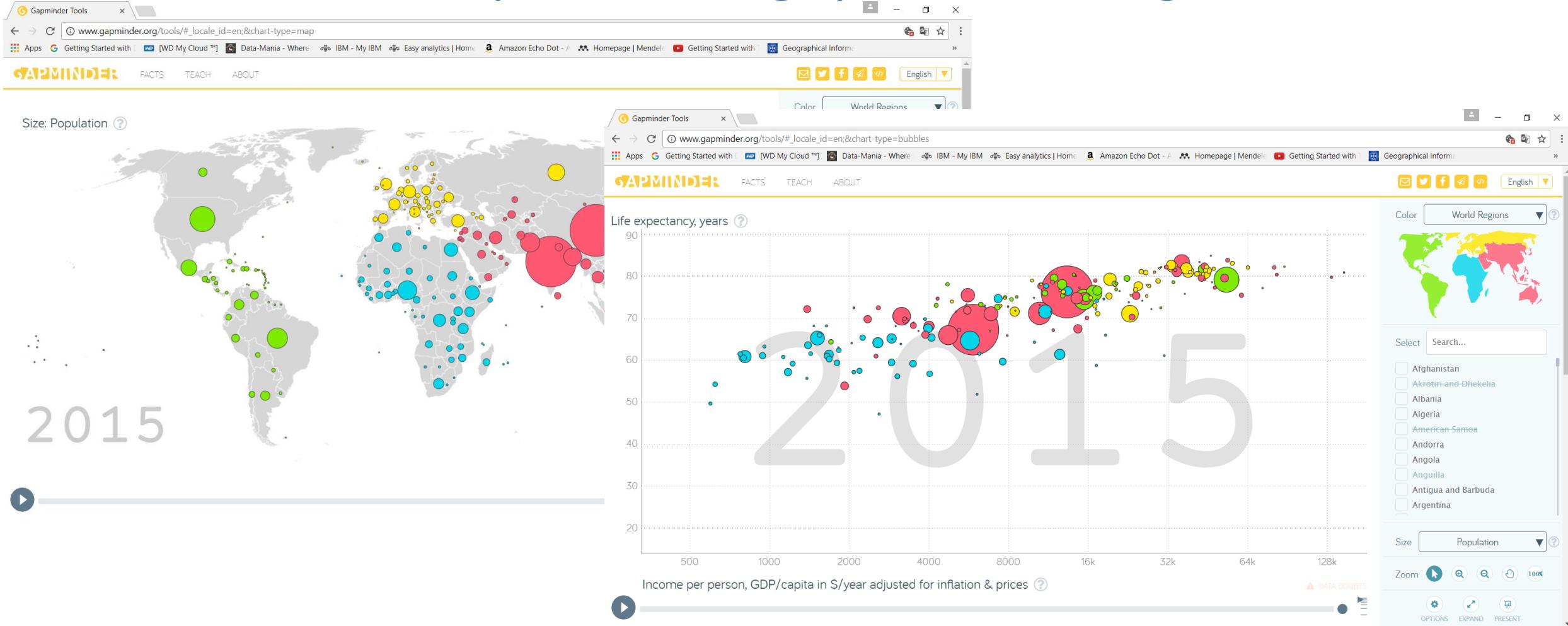
[https://www.spektrum.de/lexika/showpopup.php  
?lexikon\\_id=10&art\\_id=9196&nummer=191961](https://www.spektrum.de/lexika/showpopup.php?lexikon_id=10&art_id=9196&nummer=191961)

# ➤ e.g. Arthur Getis & Berry N. Boots 1978: Models of Spatial Processes



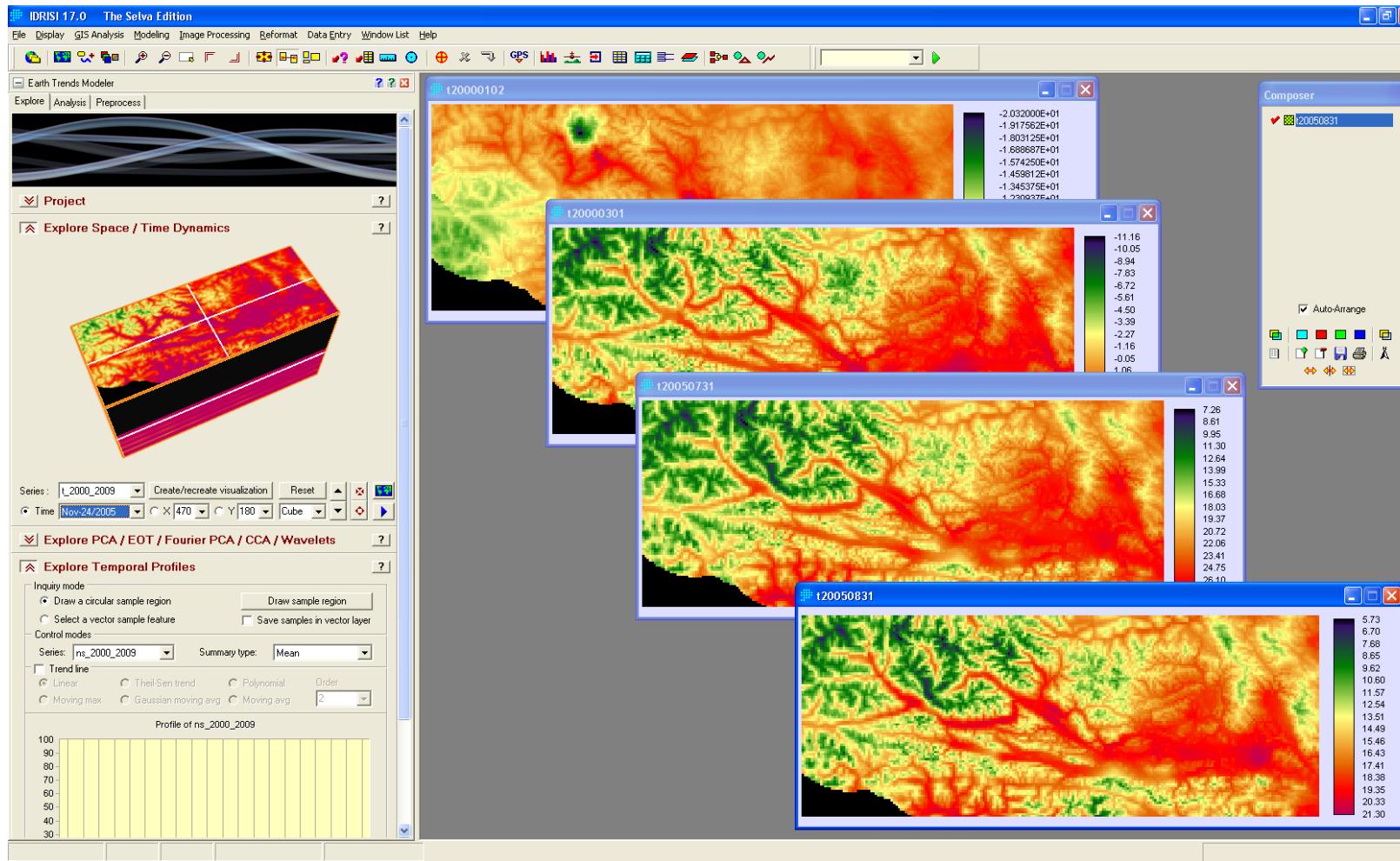
# ➤ Spatio-temporal visualisation

<http://www.gapminder.org/>

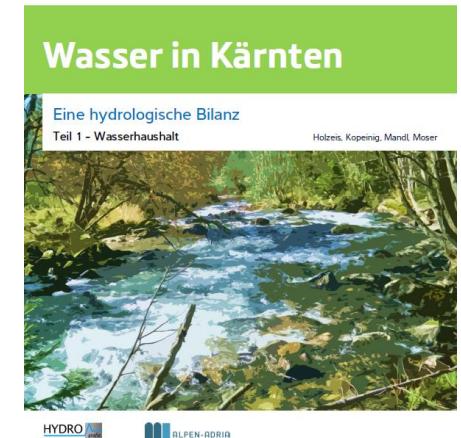


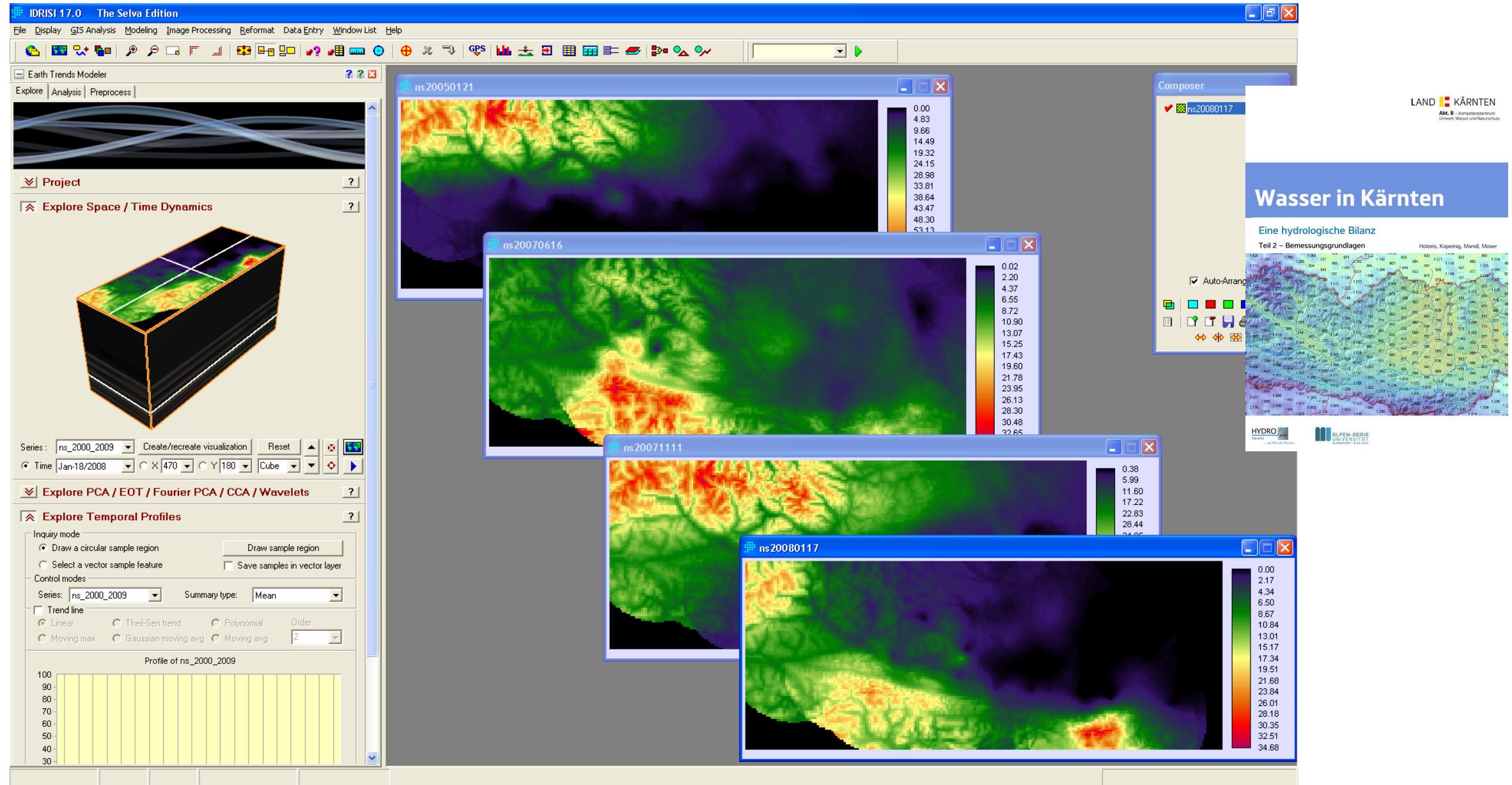
# ➤ Spatio-temporal Big Data Analysis

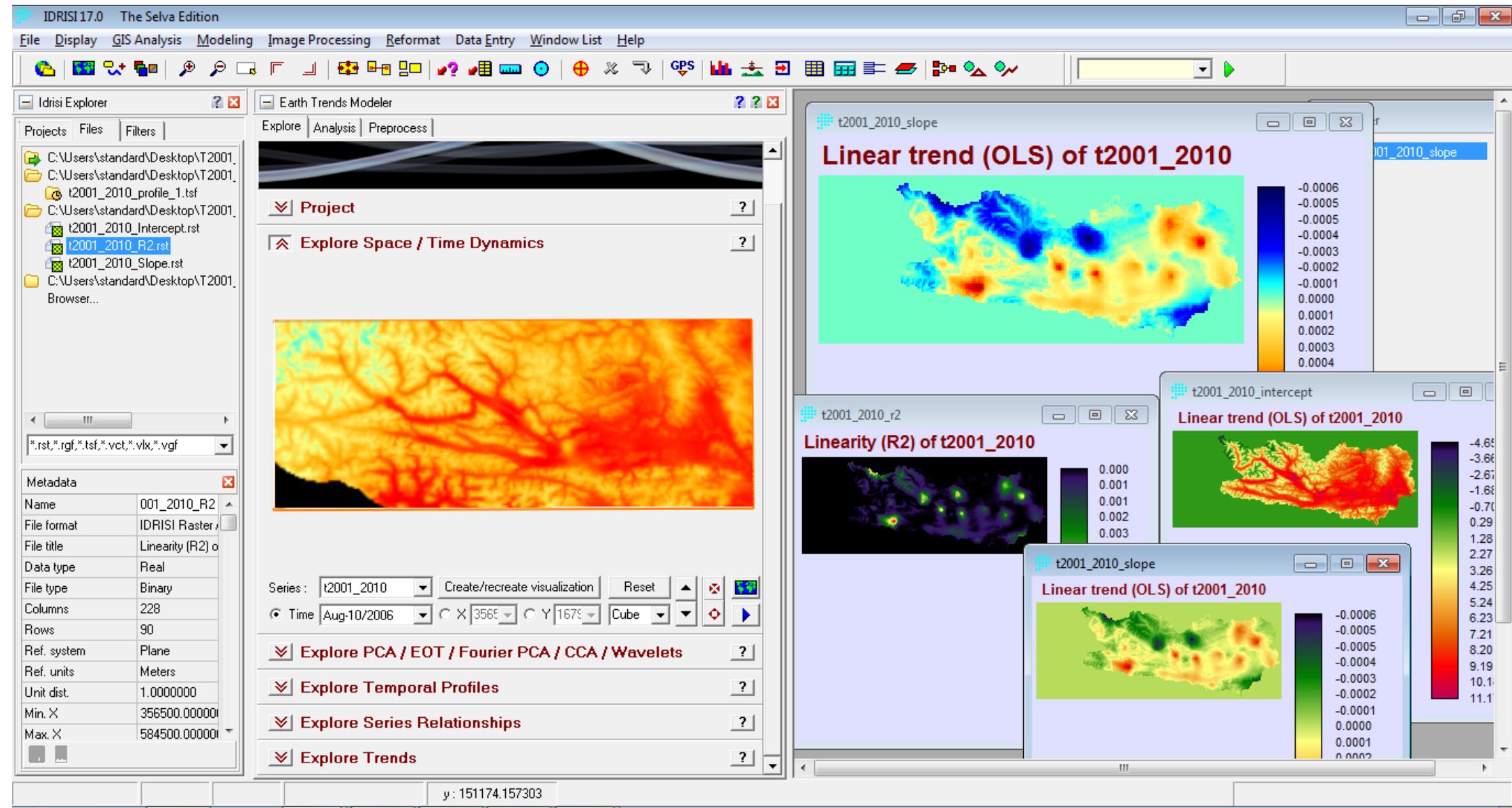
e.g. Earth Trends Modeler, TerrSet, <https://clarklabs.org/>



LAND KÄRNTEN  
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Universität, Wasser und Naturschutz







## (2) Spatio-temporal aspects in a digital world

### Influences and dependencies

- a. **Data-Dimensions:** space, time, content
- b. **Purpose:** visualisation, analysis, prediction, prescription
- c. **Integration:** spatial process
- d. **Representational formats:** film, dynamic systems, geo-simulations
- e. **Specific aspects:** autocorrelation, ecological fallacy, MAUP

# (3) Spatial modelling in a Spatial Data Science

- From data to **information** and **knowledge**
- Data **processing** and **modelling** necessary
- For that: **concepts** from „GIScience“ and „(Spatial)  
Data Science“

# ➤ Processing and modelling concepts

e.g. Cross Industry Standard Process for Data Mining (CRISP-DM)

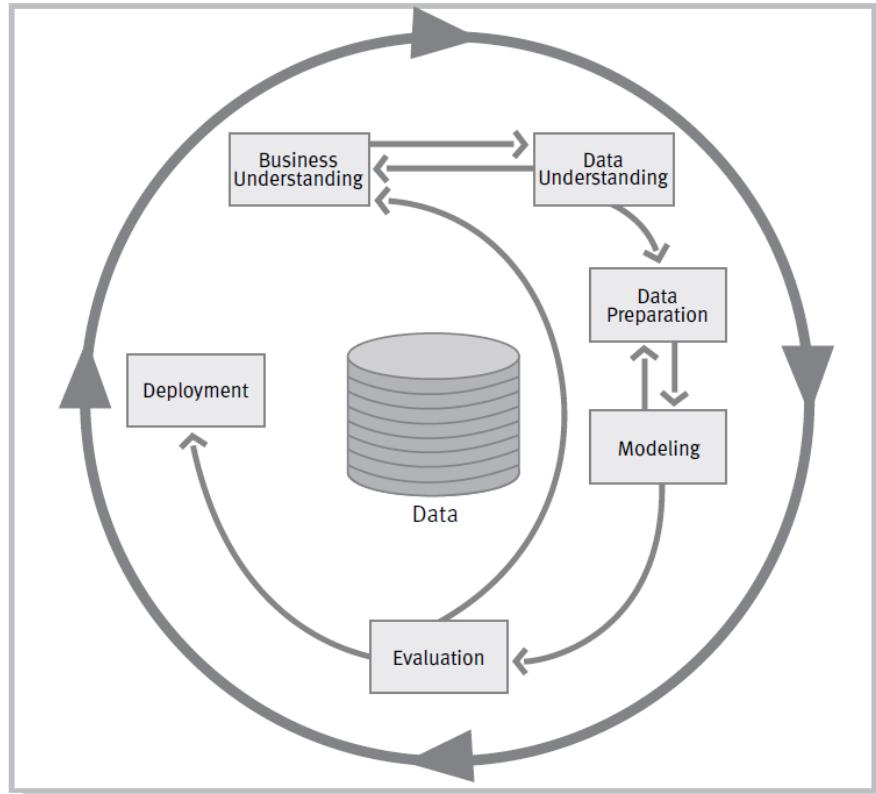
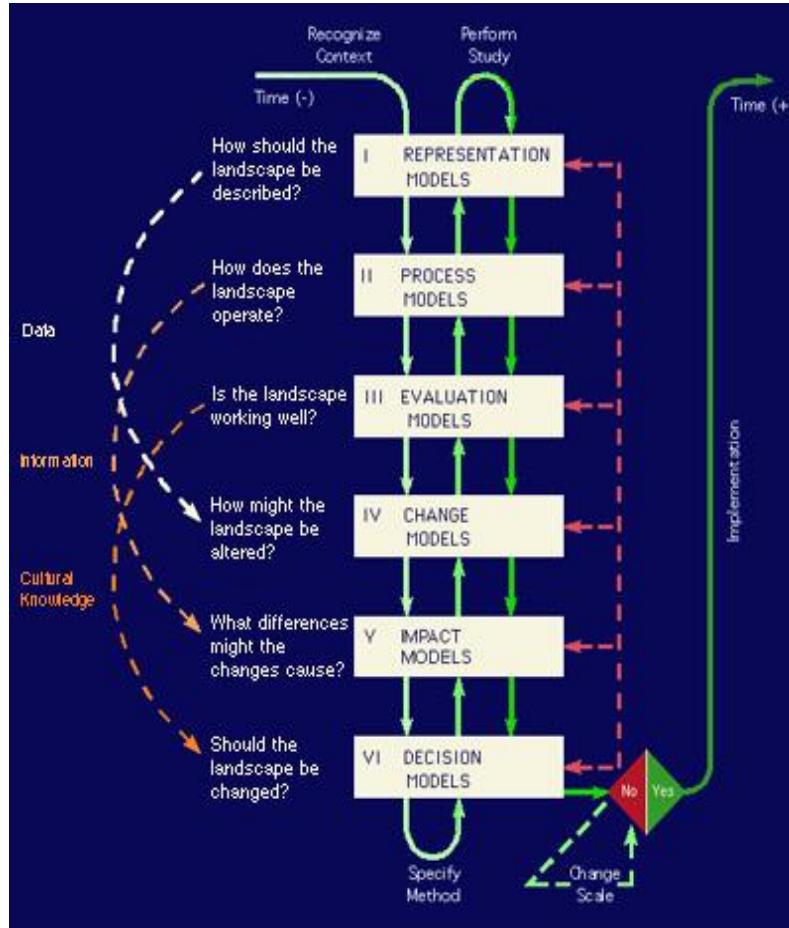


Figure 2: Phases of the CRISP-DM reference model

Pete Chapman, Julian Clinton, Randy Kerber, Thomas Khabaza, Thomas Reinartz, Colin Shearer and Rüdiger Wirth (2000): **CRISP-DM 1.0 Step-by-step data mining guide.** SPSS Inc.

# ➤ Processing and modelling concepts

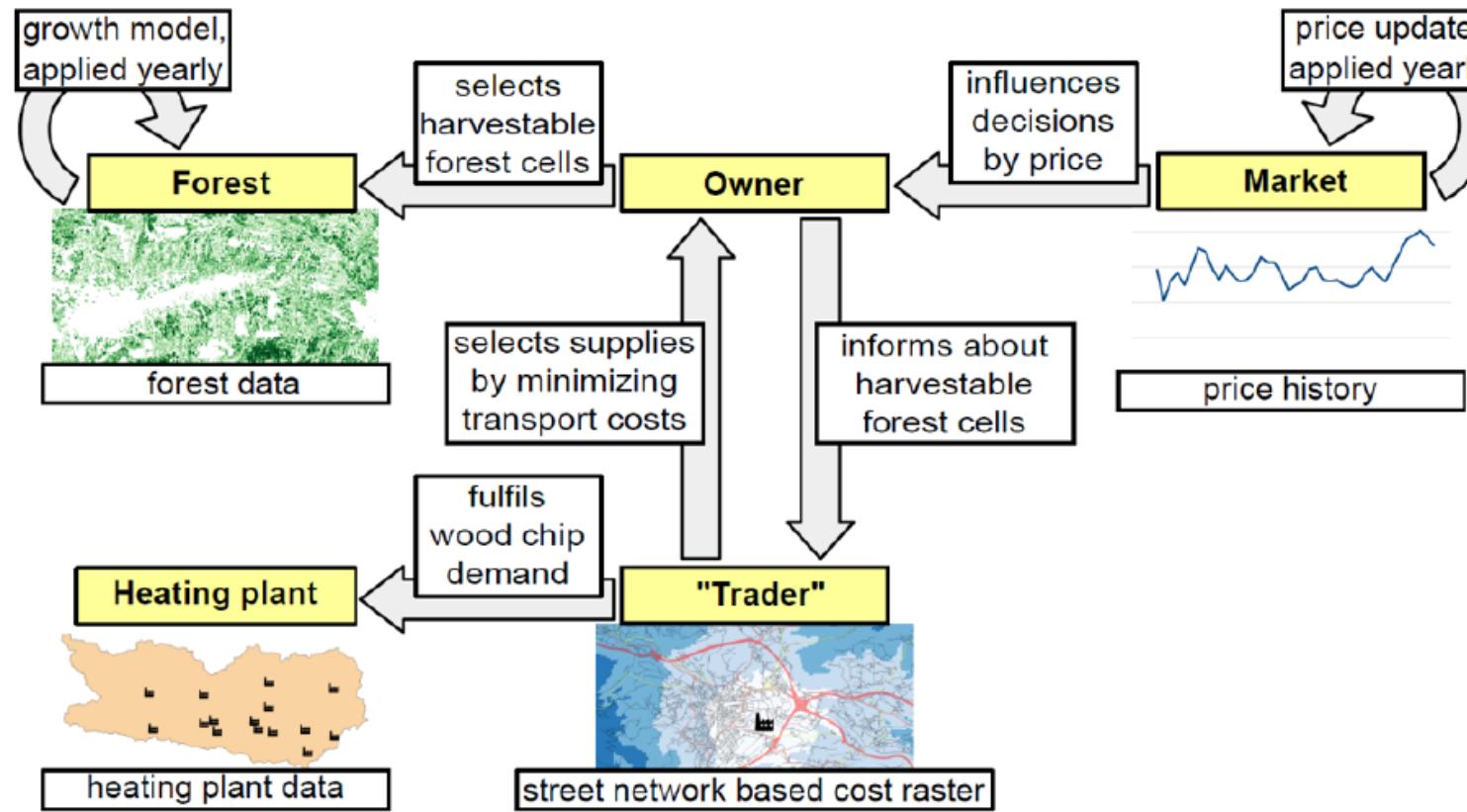
e.g. A Framework for Geodesign by Carl Steinitz



<http://www.esri.com/news/arcwatch/0412/a-conversation-with-carl-steinitz.html>

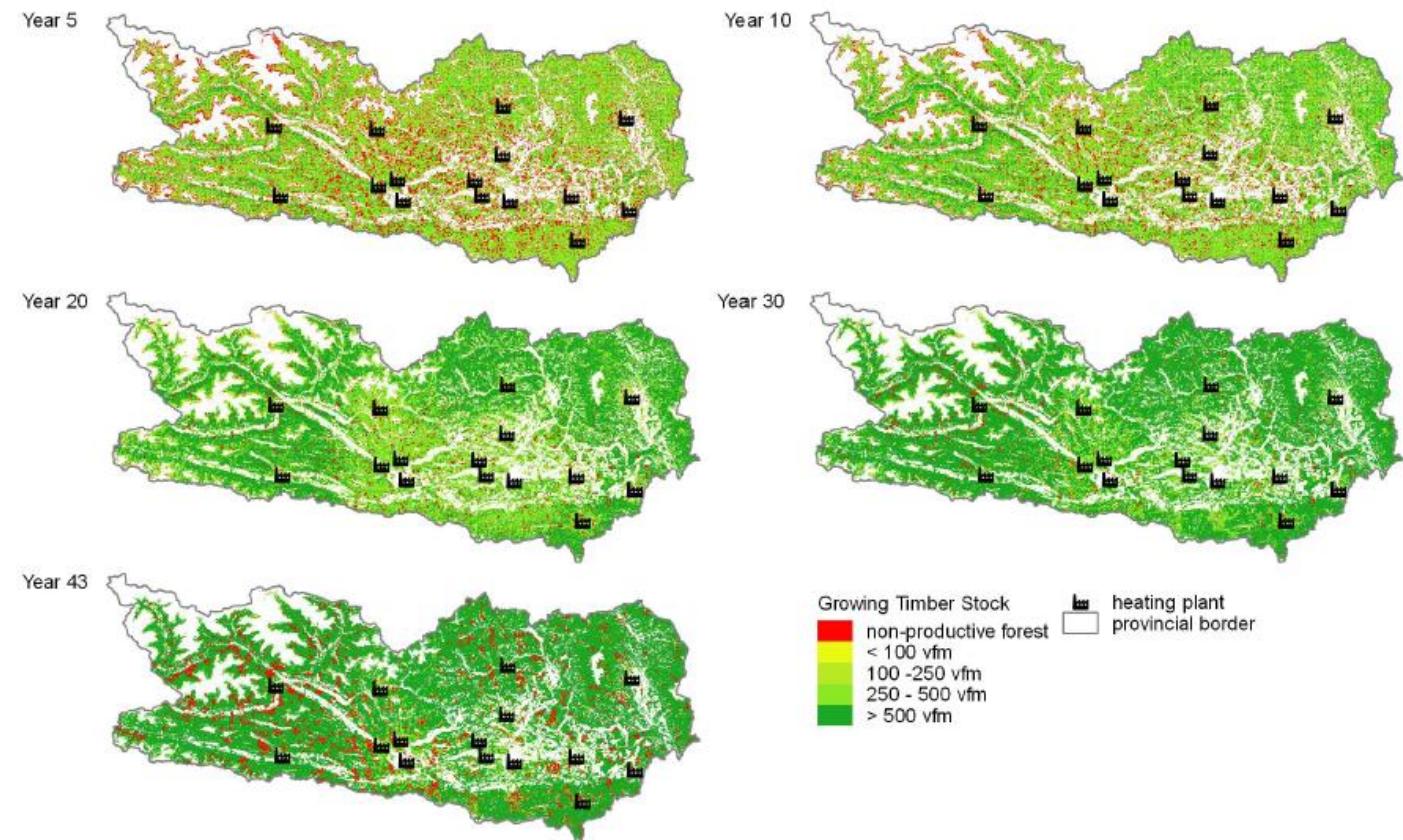
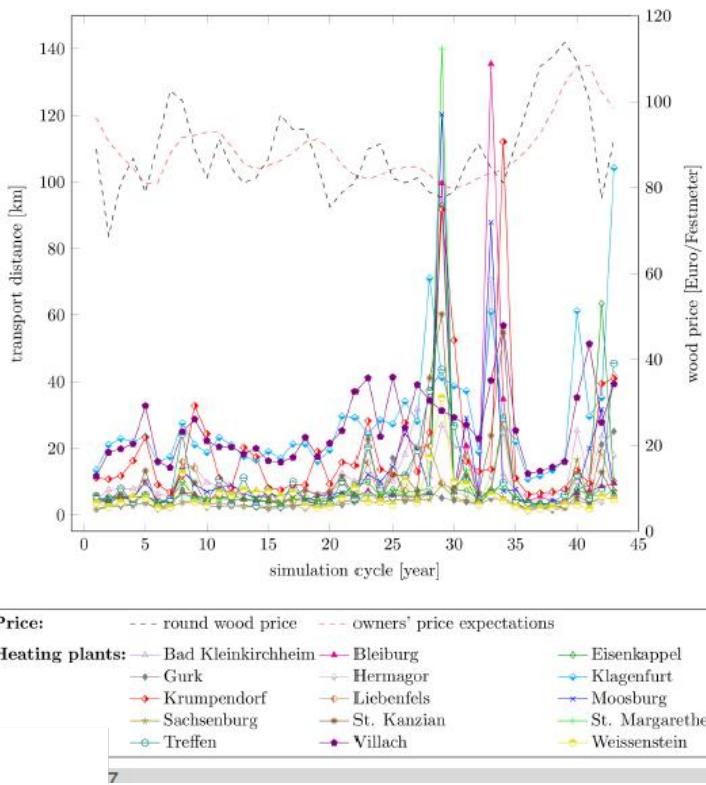
<http://www.esri.com/news/releases/12-3qtr/carl-steinitz-explains-geodesign-process-in-new-esri-press-book.html>

- Combination of spatio-temporal concept, big data and models  
e.g. Modelling a Dynamic Forest Fuel Market Focusing on Wood Chips / Analysis, prediction and prescription of a spatial process



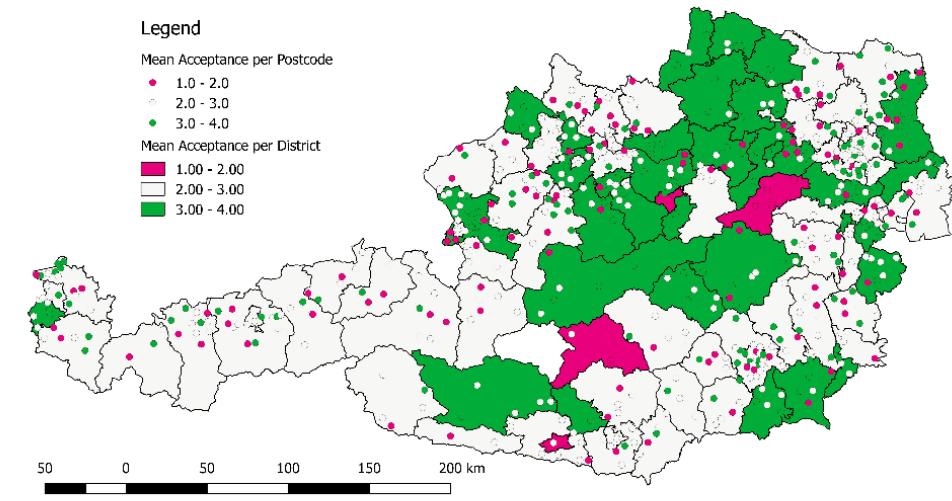
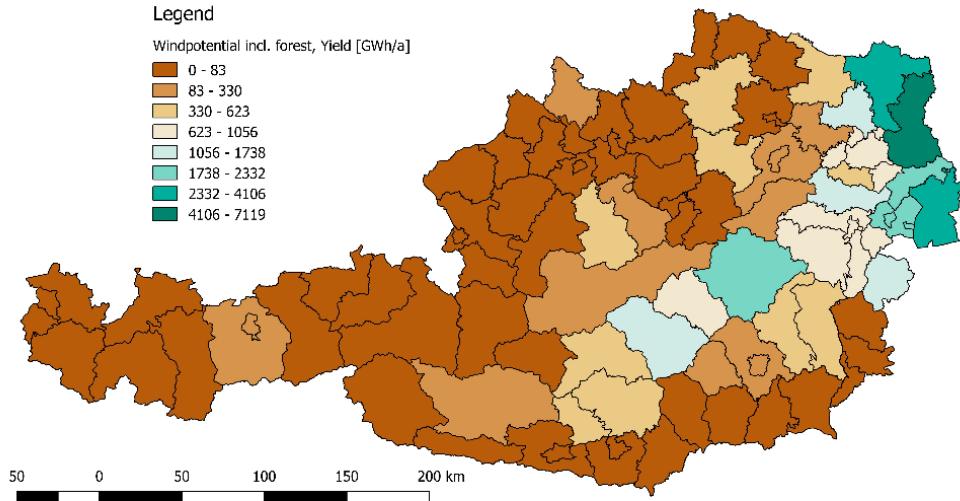
Scholz, Johannes, Florian Breitwieser & Peter Mandl (2017): Modelling a Dynamic Forest Fuel Market Focusing on Wood Chips: A Spatial Agent-based Approach to Simulate Competition among Heating Plants in the Province of Carinthia, Austria. In: GI\_Forum 2017, Volume 1.

# Spatio-temporal results

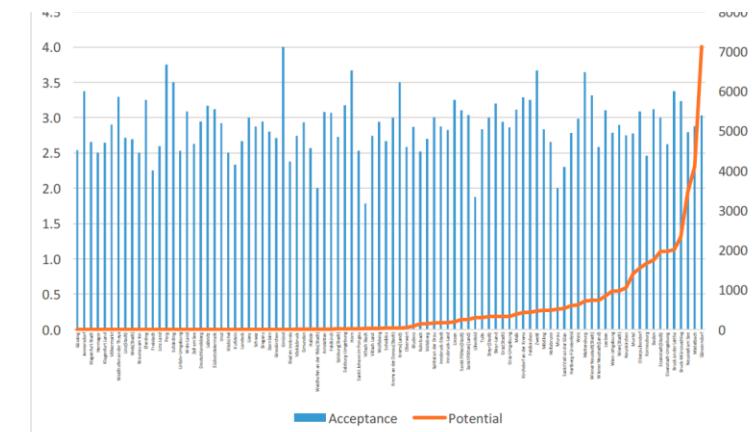


# ➤ Integration of engineering, economy and social science

e.g. Combining wind energy potential and social acceptance



Robert Gennaro Sposato, Peter Mandl, Glenda Garcia-Santos,  
Nina Hampl: Estimating potentials of renewable energy  
technologies using GIS analytics and social survey data on public  
acceptance – A working paper. 2017, Vol 10, S. 1 - 16.  
([http://eeg.tuwien.ac.at/eeg.tuwien.ac.at\\_pages/events/iewt/iewt2017/html/files/fullpapers/200\\_Sposato\\_fullpaper\\_2017-03-07\\_08-43.pdf](http://eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/events/iewt/iewt2017/html/files/fullpapers/200_Sposato_fullpaper_2017-03-07_08-43.pdf))



# (3) Spatial modelling in a Spatial Data Science Influences and dependencies

- a. **Integration:** natural, social, economic and ecological contexts
- b. **Data processing:** exploratory data analysis, data mining, agent based modelling, ...
- c. **Problems:** description, classification, location/allocation, assessment, interaction, diffusion, ...
- d. **Simulation tasks:** sensitivity analysis, what-if-simulation, inversion of model, optimisation
- e. **Specific aspects:** locational, visual, predictive, prescriptive analytics

# Resumé

- **Geographical Thinking:** Orientation
- **Spatio-temporal aspects:** Process thinking
- Nature & society, environment & human, ecology: Systems thinking
- Data – information – knowledge: spatial knowledge
- Aspects of the humanities, criticism: Reflection
- Analysis, prediction and prescription: Application
- New approaches: data-driven geography or Digital Geography
- Integration of: AI, VR , remote sensing, citizen science, augmented reality

# Thank you very much for your attention!

Questions and suggestions please to:

[peter.mandl@aau.at](mailto:peter.mandl@aau.at)

Informationen under:

<http://geo.aau.at/de/team/peter-mandl-wissenschaftliche-biografie>