



# International Cartographic Conference 2021 Florence (Italy)

## Pre-Conference Workshop

### Disaster Risk Reduction Progress for Cartography in the Big Data Era and Sessions on Cartography for Early Warning and Crisis Management

---

## Report

compiled by

**Christophe Lienert, Bern (Switzerland) and Horst Kremers, Berlin (Germany)**

*christophe.lienert@bafu.admin.ch*

*office@horst-kremers.de*

The 30th International Cartographic Conference (ICC) took place in Florence, Italy 14.-18. December 2021 <https://www.icc2021.net/>. The conference was organized as a hybrid event.

The ICA – International Cartographic Association – Commission on Cartography for Early Warning and Crisis Management <http://plat.casm.ac.cn/ewcm> arranged a pre-conference workshop and two sessions in the main conference.

Scientific cartography today moves within a conceptual triangle that includes 1) technology/ Information management and analysis; 2) perception/psychology; and 3) the arts/aesthetics. The goal of the conference was to provide, on all these three orientations, an international platform for the presentation of new methods and domain-specific use cases.

### **The pre-conference workshop**

The workshop aimed at combining and addressing as comprehensively as possible the current Big Data issue, cloud computing, and latest trends and technologies in cartographic visualization in the field of early warning, crisis management and Disaster Risk Reduction.

The growth of Internet-based services and cloud services is leading and has led to a comprehensive view on data characterized by the terms Volume, Variety, Velocity and Veracity. The emergence of very large, unstructured, dynamic, time-varying data sets including associated measures of quality (so-called Big Data) offers considerable challenges for cartography which - if processed and visualized correctly and appropriately for the target audience - can provide significant new insights for information, situation analysis, decision making and alternative actions. Experts from different, interdisciplinary directions discussed different concerns from the above mentioned topics.

Prof. Piero Boccoardo (University of Torino, Italy):

### **Earth Observation and Emergency Management: Current Services and Future Perspectives**

- showed the added value of Earth Observation (EO) in disaster management using the example of the International Charter of the Copernicus Emergency Management Service (CEMS).

- Explained that various (large-scale) natural hazard processes and events can be better managed with satellite imagery. At the European level, the Emergency Response Coordination Centre (ERCC) obtains various services from CEMS, but there is still a need for action on standardization of map products, especially rapid mapping products (e.g., regarding reference maps, or reconciliation of pre- and post-disaster maps)
- suggested that the future strategy of EO services should definitely include public-private partnerships, research results (e.g., from the Copernicus program) need to be even more integrated into practice, and a high-quality training program (MSc and PhD levels) needs to be pursued.

Prof. Liu Jiping (Beijing Normal University, China)

#### **Integrated and Comprehensive Disaster Reduction Technology in the Era of Big Data**

- 70% of emergencies and emergency situations have a direct spatial relationship
- Strongly advocated a comprehensive, technological approach to DRR ("Integrated DRR technologies").
- His research group is currently heavily involved in mass movement warning systems using machine learning methods.

Prof. Milan Konečný (University of Brno, Czech Republic)

#### **New Cartographic Challenges for DRR Realization**

- Showed the relation of cartography to the Sustainable Development Goals (SDGs) and the Sendai Framework, pointing out that combined disasters are underrepresented on the international agenda. Cartography should and can contribute to risk reduction in disaster situations in a timely, accessible, understandable, and level-appropriate manner.
- Presented different research projects between China and Czech Republic: 1) the Sino-EU Soil Observatory for intelligent land use management and 2) a project concerning Social Media Geographic Information SMGI.
- The SMGI is about the involvement of volunteers in the data collection process. Volunteers are increasingly important for the emergence and maintenance of openly accessible data platforms in crisis situations (e.g. Humanitarian Open Street Map Team, hotosm.org, or missingmap.org). Although data quality and data verification remain a concern, so-called crowdsourcing offers great potential to quickly fill data gaps and incorporate user perspectives and preferences. This contrasts with government agency map products and data platforms, which tend to be static and require lead time for development.

Horst Kremers (CODATA-Germany, Berlin):

#### **Cartography as a Data Science - The Case of RISK Information Management -**

- indicated on the rapidly growing demands of joint data science and cartography research and development.
- showed that there are challenges from all the various UN programs (Sendai Framework on Disaster Risk Reduction, IPBES, SDGs, others) due to complexity and the unanimous urgent demand of cross-program coherence in dealing with the issues. There is also a need for action in implementing cross-organizational infrastructures to simplify accessing and sharing data, and to make it consistently and efficiently ("we need to leave behind working in silos in favor of a more systemic approach").
- discussed that early warning and crisis management are not just sectoral, technological tasks. It needs experts who are able to think and act in an interdisciplinary way and can combine the knowledge of experts from different sectors. However, sectoral thinking is still widespread and can be an obstacle in finding solutions.
- made it clear that multi-actor and cross-organizational information management is needed in many areas. Only this allows a holistic, "cross-silo" approach to the large, growing data and information volumes of the Big Data era.

- reminds on the multi-millions of people that currently are in urgent humanitarian need and rely on cartography as well as on appropriate information management to save lives and mitigate severe risks, especially for most vulnerable stakeholder groups.

Download presentation (including selected references)

[https://horst-kremers.de/2211213\\_ICC\\_Florence\\_Workshop\\_EW\\_CM\\_\\_\\_\\_\\_KREMERS\\_\\_\\_\\_.ppsx](https://horst-kremers.de/2211213_ICC_Florence_Workshop_EW_CM_____KREMERS____.ppsx)

Christophe Lienert (Steering Committee on Intervention in Natural Hazards LAINAT, Bern, Switzerland):

### **Breaking the Silos: The Need for Cooperation for Improving Multi-Hazard Warning Services**

- showed the motivation and need for cooperation in natural hazard management, risk assessment and warning activities. We have to move from hazard-by-hazard risk assessment towards multi-hazard and multi-sectoral risk assessment. There is a need for an inclusive approach that reflects vulnerabilities of different groups and people
- explained the character and properties of the “Swiss Steering Committee on Intervention in Natural Hazards (LAINAT)”: it is a coordination body for natural hazards on the level of Swiss Federal Offices that streamlines warning products and product development. Its legal basis is in the revised Swiss civil protection act.
- introduced the partners of LAINAT include four federal offices and two federal research institutions that are responsible for the following warnings and related services: floods, droughts, wild fires, mass movements, weather, avalanches, earthquakes, rapid mapping, and operation of national alerting headquarters.
- showed the position of LAINAT in the integral risk management circle (an established circular model in the civil protection domain): the focus is continuous monitoring, forecasting and (early) warning of various natural hazard processes. LAINAT aims at enabling intervention emergency measures
- described the various aspects of cooperation of LAINAT: i) *technical*, with a focus on natural hazard processes; ii) *operational*, with a focus on established products and services, such as web-based information platforms; iii) *organizational*, with a focus on existing work teams and their relations, fields of (future) action, services, working programs and projects; and iv) *cultural*, with a focus on joints visions and missions, integrative questions and new products.
- stressed out the national role of LAINAT: a framework for collaboration and action within the Swiss government, a coordination and consulting body as to questions of natural hazards warnings. The main aim is to speak as a one single voice and to deliver whole-of-government services.
- also highlighted that international role of LAINAT: a member of the Swiss Consultative Group DRR (along with other Swiss Federal Offices, ETH, private sector and NGOs), led by the Swiss Agency for Development and Cooperation. LAINAT is engages actively in the preparation of the UNDRR’s Global Platforms and European Forums, as well as in the reporting for the Sendai Framework (Target G, Early Warning Systems).
- concluded that maps, cartographic products and visualization, data services are an integral part of LAINAT and are important instruments to disseminate and communicate natural hazard warnings. Cartographic products may particularly add value, when these products are integrative, communicative, ubiquitous, supportive and (to a certain degree) intelligent.

Jie Shen (Nanjing Normal University, China):

### **The Framework of Scenario Building for Urban Disaster Management Based on the Integration of CIM and Big Data**

- indicated on the important intersection of the “Belt-and-Road” project and the “Yangtze River Economic Belt”
- in recent years, China has attached great importance to urban disaster emergency research, improved urban governance, emergency management system and disaster prevention,

- mitigation, resistance, and relief capabilities
- Urban Data Observatories support production, sharing and use of urban data and knowledge and the Observatories concept supports the deeper understanding of complex urban environments
- indicated on the need for Globalized Standards of City Data (e.g. ISO 37120, 37122, 37123)
- the development and application of CIM (City Information Model) related technologies such as big data, Internet of Things, and GIS are listed as encouraged industries.
- Urban disaster management and emergency response are common problems and important challenges faced by China and Japan in the context of rapid urbanization
- research goals include: Ontology and Knowledge Graph Construction in the Field of Urban Disaster Emergency Response, Urban disaster emergency integration and mining based on a unified spatio-temporal information model, Design and construction of disaster emergency response scenarios based on multi agent cognition, Urban disaster emergency scenario application, service, evaluation and optimization
- current Problem: Lack of knowledge graph of coupling mechanism of urban disaster and emergency response coordination and linkage
- trend: Trend Extract entities, attributes, and relationships from multi source disaster emergency data, and combine top down and bottom up methods to construct ontology and knowledge graphs

## Discussion

There were several interesting remarks in the pre-conference workshop discussion:

- There is a need for a roundtable to gather inputs and best practices
- How should women and children, minorities, disadvantaged be included in the DRR process?
- There needs to be a common terminology/vocabulary, increased collaboration including with experts / practitioners from the field and if possible including the private sector
- DRR needs to be brought more into education, into universities
- The cultural challenges, the different perceptions, which cartography and GIScience research needs to further and increasingly address, are becoming apparent

## Presentations from the main conference sessions on "Cartography for Early Warning and Crisis Management":

Kevin Patrick Helzel, Alexander Klaus, Mathias Jahnke Germany/Switzerland:

### **Mixed Reality Maps to Help Convey Disaster Information.**

Maps and real imagery together with augmented reality processed by 3D scene rendering can be helpful in crisis management as they provide an improved picture of the spatial situation and there is a high demand for dynamic data in crisis situations. Such applications can also help to quickly form incident and response scenarios. Use cases on forest fire (Portugal) and earthquake (Turkey) were shown

Research questions:

- Are the current visualization techniques (printed maps) the adequate medium and able to facilitate an effective management of disasters?
- Does it make sense to incorporate additional dimensions into the communication to support the multidimensionality of such data?
- Can the visualization of this multidimensionality help decision makers to grasp more quickly the desired information?

Silvia Grandi, Anna Bernasconi. Italy:

**Geo-Online Explanatory Data Visualization Tools as Crisis Management and Communication Instruments**

Communication during emergency and crises times is a critical aspect. When available information contains a spatial dimension, maps and interactive localization features may help conveying strong messages to audiences that are otherwise difficult to reach. The COVID-19 pandemic has prompted the design and implementation of a great number of online tools to communicate data of the disease spread and its dynamics that are helpful to support informed decisions for both people in their everyday life and decision makers. Observing this phenomenon has inspired this conceptualization of the geo-Online Explanatory Data Visualization (geo-OEDV) tools.

Anne Ruas, Quy Thy Truong, Serge Lhomme. France:

**Hurricane and Waste Collection Simulations on QGIS for Improving Post-Hurricane Waste Collection.**

This presentation discussed results gathered from investigations with a prototype allowing to simulate the collection of waste from buildings damaged during the passage of a hurricane. The focus is on building waste which include construction and demolition debris as well as household goods wastes (furniture, clothes, and wastes of electrical and electronic equipment) as they constitute the largest waste volume. The process was first designed from the data available after the passage of Irma on the island of Saint-Martin. It was then enriched and generalized to be applied to another territory and from a simulated hurricane. The purpose of this tool is to allow communities and stakeholders to test their equipment and resources for waste collection and to imagine other solutions to reduce delays and improve sorting and recycling.

Mila Atanasova-Zlatareva, Hristo Nikolov, Lyubka Pashova. Bulgaria:

**Application of INSAR Satellite Method for Mapping of Active Landslides in Bulgaria - Opportunities and Perspectives**

Mitigation of the negative effects of destructive landslides is based on the compilation of inventory maps of their distribution and registers with the main characteristics of the individual landslides. Conventional methods for making such maps are time-consuming and resource-intensive. Modern satellite, air and ground-based remote sensing technologies facilitate the production of landslide maps, reducing the time and resources required to compile and systematically update them. The authors demonstrate the applicability of Differential Sentinel-1A satellite SAR interferometry (DInSAR) to assess the movement activity and use the information for further updating the national landslide inventories and also facilitating the processes of inventory, mapping and study of landslides.

Horst Kremers (CODATA-Germany, Berlin):

**Risk Information management in Support of UN Humanitarian Missions**

This presentation indicated on methods and techniques scalability for dealing with very high complexity in the cross-program cooperation of UN agencies and operational units. There is a high need for tools that enable automated documentation of crises/disasters. These tools would also improve the coherence and comparability of data/events, which is very important especially for large organizations like the UN. It is pointed out that cartography is a key science with appropriate long-term cooperation and competence in cross-domain information systems semantic mapping and thus should be involved massively in such processes. Cartographers urgently need to be encouraged to get much more visibly involved in the shaping, wording and national/international implementation & control of UN conventions and programs.

*Download presentation (including selected references)*

[https://horst-kremers.de/2211215\\_ICC\\_Florence\\_Session\\_EW\\_CM\\_\\_Humanitarian\\_Missions\\_\\_KREMERS\\_\\_\\_\\_.ppsx](https://horst-kremers.de/2211215_ICC_Florence_Session_EW_CM__Humanitarian_Missions__KREMERS____.ppsx)

Christophe Lienert, Franziska Angly Bieri, Barbora Neversil, Daniel Meier. Switzerland:

**The Public Swiss Natural Hazard Portal for Warnings and Recommended Behavior.**

The public Swiss natural hazard portal (NHP), accessible on <https://www.natural-hazards.ch>, is a web-based cartographic, real-time information service to the Swiss public. It provides warnings and recommended behavior before, during and after natural hazard events. The NHP follows a 'one-stop shop', cartographic concept to deliver and obtain information on eleven hazard categories in five languages: German, French, Italian, Raetho-Roman, and English. The synoptic overview map on the entry page enables users to obtain real-time information about the overall natural hazard situation in Switzerland. The map may also be easily embedded into third party websites, allowing to spread natural hazard warnings widely, e.g. on news portals or on other highly frequented websites. Only a few clicks enable users to retrieve a real-time situational natural hazard analysis round the clock, detailed spatial information on every zip-code location in the country, a customizable list of current hazard bulletins, and news releases. The entire NHP is able to handle a very large number of simultaneous visitor requests, with an agreed availability of 99.5%, and has proven to be highly reliable to date

### **Reachout**

The cartographic process always was concerned about data sources, intermediate analytics, dynamics and operational decision support. In the facets of Disaster Risk Reduction and operational management the massiveness, complexity, media-/structural variety, dynamics and veracity of information along with processes of data acquisition, interoperability and task-oriented decision and action along with information management for goal-reaching control (full information management cycle) explicitly relay on best practices support from a very broad view of cartography. Big Data information complexity is not a traditional generic field of cartography but needs to be covered in appropriate curricula as well as in R&D. Strategic partnerships of the different professions involved (information management, operations research, logistics and others) is a suitable way for holistic approaches and for generating appropriate synergies.

Cartography competences for Disaster Risk Management especially can support humanitarian assistance on local, national and global level and in all phases of the disaster management cycle.

New categories of meta-cartography successfully show the role of innovative reachout that blends online communication with cartographic representation and management principles.

### **Follow-up**

Further meetings (virtual, hybrid, physical) are planned within the ICA and within the Commission Cartography in Early Warning and Crisis Management. Some of them are relevant for LAINAT regarding exchange of ideas, further development of warning platforms, cartography and platforms as communication tools, as well as regarding the composition of the ICA Commission Cartography in Early Warning and Crisis Management:

- 8th ICCGIS 2022, 20-25.6.2022, Nessebar Bulgaria, organized by the Bulgarian Society of Cartography and ICA. Meetings of various ICA Commissions are planned, including the Commission Cartography in Early Warning and Crisis Management.
- Eurocarto 2022, 19-21.9.2022 in Vienna Austria, organized by the Austrian Cartographic Commission (ÖKK), the German Cartographic Society (DGfK), the Swiss Cartographic Society (SGK) and the British Cartographic Society.
- 31st ICC 2023, 13-18 August 2023, Cape Town South Africa, organized by ICA.

## **General Assessment**

The International Cartographic Association ICA provides an international framework to discuss research basic and applied scientific results in the fields of Cartography and GIScience. Participation in the International Cartographic Conferences ICC and the Commission on Early Warning and Crisis Management activities is recommended for experts in Disaster Risk Reduction, First Aid, Building Back Better and improved Resilience and Preparedness, exchange of knowledge on visual dissemination channels and platforms aiming at visual methods to reach warning recipients in the most effective and impactful way. ICA, with its biennial ICC, adds significant value to experts in Early Warning and Disaster Risk Reduction for sharing and networking, for potential improvement of existing applications, and for knowledge generation.

# Appendix A

Authors - in sequence of presentations

Pre-Conference Workshop                      2022 Dec. 13

---

**Piero Boccardo**                                      **Earth Observation and Emergency Management: Current Services and Future Perspectives**

---

**Jiping Liu**    **Integrated and Comprehensive Disaster Reduction Technology in the Era of Big Data**

---

**Milan Konecny**                                      **New Cartographic Challenges for DRR Realization**

---

**Horst Kremers**                                      **Cartography as a Data Science - The Case of RISK Information Management -**

---

**Christophe Lienert**                                      **Breaking the Silos: The Need for Cooperation for Improving Multi-Hazard Warning Services**

---

**Jie Shen**    **The Framework of Scenario Building for Urban Disaster Management Based on the Integration of CIM and Big Data**

---



## Appendix A continued

---

Conference Session T05-1.	2022 Dec. 15 (Convenor: Christophe Lienert)
<b>Kevin Patrick Helzel, Alexander Klaus, Mathias Jahnke</b>	<b>Mixed Reality Maps to Help Convey Disaster Information</b>
<b>Silvia Grandi, Anna Bernasconi</b>	<b>Geo-Online Explanatory Data Visualization Tools as Crisis Management and Communication Instruments</b>
<b>Anne Ruas, Quy Thy Truong, Serge Lhomme</b>	<b>Hurricane and Waste Collection Simulations on QGIS for Improving Post-Hurricane Waste Collection</b>
<b>Mila Atanasova-Zlatareva, Hristo Nikolov, Lyubka Pashova</b>	<b>Application of Insar Satellite Method for Mapping of Active Landslides in Bulgaria - Opportunities and Perspectives</b>
<b>Horst Kremers</b>	<b>Risk Information Management in Support of UN Humanitarian Missions</b>
<hr/>	
Conference Session T05-2.	2022 Dec. 15 (Convenor: Milan Konečný)
<b>Christophe Lienert, Franziska Angly Bieri, Barbora Neversil, Daniel Meier</b>	<b>The Public Swiss Natural Hazard Portal for Warnings and Recommended Behaviour</b>
<b>Yanping Li</b>	<b>A Combined Flood Risk Assessment with SWMM Hydrological Modelling and AHP Based on Multi Criteria Decision Making</b>
<b>Jie Shen, Jingyi Zhou, Jijun Yang</b>	<b>Preliminary Study on Knowledge Graph Construction Based on the Coupling Mechanism of Urban Disaster and Emergency Response</b>
<b>Jiping Liu, Rongfu Lin, Shenghua Xu, Yong Wang, Xianghong Che, Jie Chen</b>	<b>Landslide Susceptibility Evaluation Based on Optimized Support Vector Machine</b>

---

# Appendix B

## Selected References, links, further reading

The Internet of FAIR Data & Services.

<https://www.go-fair.org/resources/internet-fair-data-services/>

National Environmental Information Infrastructure. , Commonwealth of Australia,

<http://www.neii.gov.au/>

Information Governance Annotated Bibliography.

<http://bok.ahima.org/PdfView?oid=300425>

A World that Counts - Mobilising the Data Revolution for Sustainable Development. (2014) 32 p., UN IEAG,

<http://www.undatarevolution.org/wp-content/uploads/2014/11/A-World-That-Counts.pdf>

Accountability: AccountAbility 1000 (AA1000) – accountability standard, focused on securing the quality of social and ethical accounting, auditing and reporting. Institute of Social and Ethical Accountability (1999) 28 p. <http://www.accountability.org/images/content/0/7/076/AA1000%20Overview.pdf>

Constantinides, Panos; Barrett, Michael: Information Infrastructure Development and Governance as Collective Action. Information Systems Research

26 (2014) 1-17 DOI: 10.1287/isre.2014.0542

[https://www.researchgate.net/publication/273130860\\_Information\\_Infrastructure\\_Development\\_and\\_Governance\\_as\\_Collective\\_Action](https://www.researchgate.net/publication/273130860_Information_Infrastructure_Development_and_Governance_as_Collective_Action)

Department of Health: Information: To share or not to share? The Information Governance Review. (2013) 139 p

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/192572/2900774\\_InfoGovernance\\_accv2.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/192572/2900774_InfoGovernance_accv2.pdf)

European Court of Auditors: ‘Have your say!’: Commission’s public consultations engage citizens, but fall short of outreach activities. Special Report 14 (2019) 85 p

[https://www.eca.europa.eu/Lists/ECADocuments/SR19\\_14/SR\\_Public\\_participation\\_EN.pdf](https://www.eca.europa.eu/Lists/ECADocuments/SR19_14/SR_Public_participation_EN.pdf)

European Union: Infrastructure for Spatial Information in the European Community (INSPIRE).

<http://inspire.ec.europa.eu/>

Hedelin, Beatrice: Complexity is no excuse. Introduction of a research model for turning sustainable development from theory into practice. Sustainability Science 14 (2019) 733–749, Springer,

<https://doi.org/10.1007/s11625-018-0635-5>

Klien, E; Lutz, M; Kuhn, W.: Ontology - Based Discovery of Geographic Information Services - An Application in Disaster Management. Computers, Environment and Urban Systems 30 (2006) 102-123

Kovacic, Samuel F; Sousa-Poza, Andres: Managing and Engineering in Complex Situations. Topics in Safety, Risk, Reliability and Quality (2013), Springer, 9,7894007551e+012

Kremers, Horst: Sociology of Agents in Sustainable Development. in: "Environmental Communication in the Information Society". Proc., 16th Int. Conf. on Informatics in Environmental Protection. W. Pillmann / K. Tochtermann, eds., Vienna 2 (2002) (250)

Kremers, Horst: Global Programs and Conventions: Coherence and Mutual Synergies from Holistic Information Management. LNIS Lecture Notes in Information Sciences. Selected Papers. Geoinformation and Sustainable Development 9 (2020) 90-100, CODATA-Germany, ISBN 978-3-00-062981-5

<https://tinyurl.com/GlobalProgramsCoherence2020>

Kremers, Horst: Generalization Principles in Applied Semiotics. ISGI 2005, Proceedings, International CODATA conference of Generalization of Information (2006) 191-204

Kremers, Horst: Generalization and Semiotics: The Way to Consistent Multilevel Decisions.

Diskussionsbeitraege zur Kartosemiotik und zur Theorie der Kartographie 8 (2005) 41456

Kremers, Horst: Context Spaces and Generalization. Proc., ISGI 2007, International Symposium on Generalization of Information p. 124

- Lachhab, M; et al.: Towards an Integration of Systems Engineering and Project Management - Processes for a Decision Aiding Purpose. IFAC PapersOnLine 50 (2017) 7266–7271, Elsevier, Doi 10.1016/j.ifacol.2017.08.1379
- Li, Yanping: A Combined Flood Risk Assessment with SWMM Hydrological Modelling and AHP Based on Multi Criteria Decision Making
- Liu, Jiping; Rongfu Lin, Shenghua Xu, Yong Wang, Xianghong Che, Jie Chen. China: Landslide Susceptibility Evaluation Based on Optimized Support Vector Machine. Modeling susceptibility to mass movement using machine learning has great potential. Support Vector Machines is a purely mathematical method of pattern recognition implemented in computer programs.
- Longley, Paul: Grand Challenges, Environment and Urban Systems (Editorial). Computers, Environment and Urban Systems 30 (2006) (1) 44075
- Morris, Charles W: Foundation of the Theory of Signs. (1938 (repr. 1971)) Mouton
- OECD, 2017. Boosting Disaster Prevention through Innovative Risk Governance. Insights from Austria, France and Switzerland. OECD Reviews of Risk Management Policies, OECD Publishing, Paris, <https://doi.org/10.1787/9789264281370-en>.
- Peirce, Charles Sanders: Collected Papers (1931-1958), Harvard University Press,
- Robinson, A.C. et al. (2017) : Geospatial big data and cartography: research challenges and opportunities for making maps that matter, International Journal of Cartography, 3:sup1, 32-60, DOI: 10.1080/23729333.2016.1278151
- Scott, William T: The Possibility of Communication. Approaches to Semiotics 87 (1990) Mouton de Gruyter, Berlin/New York, SBB 1 A 50 595,
- Shen, Jie; Jingyi Zhou, Jijun Yang. China: Preliminary Study on Knowledge Graph Construction Based on the Coupling Mechanism of Urban Disaster and Emergency Response.
- Smallwood, Robert F: Information Governance: Concepts, Strategies, and Best Practices. (2014) 464, Wiley, ISBN 1118218302
- Smith, Mike: Fundamentals of Management. 2nd ed. (2011), McGraw-Hill Education, ISBN 13 9780-07-712693-3
- UNDRR: Sendai Framework for Disaster Risk Reduction 2015-2030. <http://www.unisdr.org/we/inform/publications/43291>
- Vescoukis, Vassilios; Doulamis, Nikolaos; Karagiorgou, Sofia: A Service Oriented Architecture for Decision Support Systems in Environmental Crisis Management. Future Generation Computer Systems 28 (2012) (3) 593-604, Elsevier, ISSN 0167-739X
- Wilkinson, Mark D; et al.: The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3 (2016) 160018, Springer Nature Limited, ISSN 2052-4463
- Ziemann, Jörg: Architecture of Interoperable Information Systems - An enterprise Model-based Approach for Describing and Enacting Collaborative Business Processes. (2010) 298 p., Logos Verlag, 978-3832524142