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Geospatial Knowledge Organisation of a National Map in AI Driven Ecosystems

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Abstract:

The latest technical developments within the cartographic domain, especially those driven by Artificial Intelligence (AI), demonstrate once again the true value of maps in the digital world: maps serve as a learning interface for exploring geospatial knowledge. The "learning interface" stands for the fast interaction between humans and self learning systems, which produce maps. This high degree of automation places new demands on trustworthy and useful human-computer interaction for expanding knowledge and the foundation for decision-making. Minten (2026) states that in the current 2026 landscape, we are moving from a system that provides "layers of data" to one that provides "answers to questions".

Leaving data accessibility beyond and placing the importance on geospatial semantics means that the value of geospatial knowledge organisation (GKO) arises. Maps inherit the organisation of geospatial knowledge, but the thinking of a map as a raster output (from printed map to a web map tile service WMTS) prevented from formalisation and appropriate modelling. Geospatial knowledge organisation (GKO) develops with a few characteristics, most of them are familiar to map makers from within the map-making process:

1. Clarity for bridging the semantic gap is the most immediate value of geospatial knowledge organisation, which establishes semantics with describing attributes or labels, e.g. "stream", "creek" or "watercourse type2". With formal ontologies the GKO establishes a "Rosetta Stone" for spatial data. Different systems and humans, including AI, are able to name the same thing and overcome ambiguities.

2. GKO enables automated reasoning (intelligence) by organizing space with topological and functional relationships. Raw data cannot "think", but semantic interoperability allows to perform complex reasoning. Instead of manually checking if a building footprint overlaps with a flood zone, the prompt "...draw a map of all residual structures located within the 100-year floodplain…" could deliver a correct result when the system understands the rules of those spatial entities.

3. GKO can empower discovery of already existing maps by using the principles of Linked Data. Basically assigning Unique Ressource Identifiers (URIs) for spatial features, like a specific bridge or mountain, makes this geographic information crawable by search engines and AI agents. This characteristic moves us from searching in a file to asking a question.

4. Enhancing efficiency by reducing "data friction" by formalised geospatial knowledge organisation, means that the time and effort that is lost by cleaning, reformatting and understanding someone else´s spatial data can be reduced. GKO standardises the metadata and the context, When knowledge is organised according to international standards (ISO, OGC, W3C) the time-to-insight gets drastically reduced. Analysts may spent less time in fixing and understanding geometries, but more time in solving spatial problems.

5. The importance of GKO has skyrocketed by the development and use cases of Large Language Models (LLM) and autonomous agents. We have experienced that AI cannot effectively navigate raw shapefiles without any context. GKO provide context with the establishment of knowledge graphs, which allow AI to understand the physical world. If an AI agent shall manage a city´s traffic, it needs a Geospatial Knowledge Organisation (GKO) to understand the laws of that environment.

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Therefore Geospatial Knowledge Organization (GKO) is the study and practice of structuring information about the physical world so that it can be processed, analysed, used in actions and visualised by both humans and machines. It moves beyond simple "data storage" into the realm of spatial semantics, understanding not just where something is, but what it is and how it relates to its surroundings. The map, if accepting these main characteristics, deals as cognitive interface between machine and human-being by using its dimensions “semantic visualisation”, “synthesis and generalisation” and “visual analytics and storytelling”. Semantic visualisation supports an automated adjustment of symbols and visual hierarchy based on the intent of the query, rather than just the data type. Synthesis and generalisation names the “filtering” and simplification of exploding data volumes and complex 3D or even 4D knowledge graphs into human interpretable visualisations (Sourd et al 2025). Visual analytics and storytelling become introduced by interactive dashboards and spatial storytelling to help decision makers understand the consequences of spatial relationships.

Concept	Primary	Function
Maps	Communication& Visualization	The final "output" or interface. Maps simplify complex spatial knowledge into a visual language (symbols, colors, projections).
GIS	Management& Analysis	The technological infrastructure. GIS provides the tools to store, manipulate, and query spatial data (the "engine").
GKO	Meaning& Structure	The theoretical blueprint. GKO defines the logic and rules that GIS uses to ensure the data on the Map is accurate and meaningful.

Table 1. Comparing the concepts Map-GIS-GKO and their functions.

In our contribution we discuss the role and importance of geospatial knowledge organisation (GKO) for a modern national map. We highlight the fundamental ideas of GKO to establish the transition from fundamental data themes to actionable geospatial knowledge, including spatial topographic foundational ontologies, topological relations and indicators of truth, semantic interoperability and hierarchical knowledge organisation by scale and resolution. The most important trend in modern GKO is the shift from geometry-centric (coordinates and shapes) to object-centric (entities and behaviors). In older systems, a river was just a blue line. In modern GKO, a river is an object with a flow rate, a biological health status, and a relationship to the towns it passes through, thus a highly data integrated product. The future role of a national map is GKO with enhanced characteristics. In our paper we will highlight the steps and up-to-date results towards a modern GKO within the national map in Austria.

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