

Preface: ISPRS Technical Commission IV (Spatial Information Science)

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Abstract

In the period 2022-2026, the Commission concentrated on many fundamental as well as application-oriented topics related to digital twins and the metaverse. In a rapidly changing world, digital twin models of reality are crucial for governments and businesses to address environmental and socio-economic issues and to promote sustainable development. The demand for effective decisions in evolving spaces highlights the necessity of complex, multi-dimensional spatial data. Digital twins and the metaverse have emerged as pivotal technologies, allowing testing and analyzing intricate systems, overcoming challenges like data discovery, visualization, sharing, fusion, analysis, and simulation, as well as managing big multidimensional data with GeoAI models. These topics were largely reflected by the papers presented at the XXV ISPRS Congress in Toronto, 4-11 July 2026.

1. Introduction

The Commission on Spatial Information Science was organized into 12 working groups (WGs) and two inter-commission working groups (ICWGs). A brief overview of the working groups follows.

WG 1 'Spatial Data Representation and Interoperability' focused on spatial data representation and interoperability, emphasizing international standards, good practices for data management, and collaboration with standardization organizations.

WG 2 'Artificial Intelligence and Uncertainty Modeling in Spatial Analysis' delved into artificial intelligence and uncertainty modeling in spatial analysis, covering data mining, machine learning, spatial statistics, and uncertainty visualization.

In WG 3 'Geo-computation and Geo-simulation', geo-computation and geo-simulation took center stage, exploring high-performance techniques, knowledge-based methods, and effective integration into spatial decision support systems.

WG 4 'Data Management for Spatial Scenarios' concentrated on data management for spatial scenarios, addressing interfaces, standards, and strategies for managing big and heterogeneous spatial data.

WG 5 'Extended Reality and Visual Analytics' explored human factors, geo-visualization evaluations, and novel tools for exploring phenomena.

WG 6 'Human Behaviour and Spatial Interactions' delved into understanding human behavior and spatial interactions, addressing models, uncertainties, spatial analysis technologies, and strategies for handling geo-privacy and ethical issues.

WG 7 'Intelligent Systems in Sensor Web and IoT' focused on intelligent systems in sensor web and IoT, covering data fusion from sensors and new analysis methods.

WG 8 'Digital Twins for Mobility and Navigation' focused on digital twins for mobility and navigation, with an emphasis on conceptual frameworks, algorithms, standards, and solutions for sustainable and resilient mobility.

'Spatially enabled urban and regional digital twins' were the focus of WG 9, where AI-based methods and BIM/GIS integration were also addressed.

WG 10 'Applied Spatial Science for Public Health' covered spatial technologies, citizen science, AI for hotspot detection, and multidimensional data handling for health.

In WG 11 'Cultural Heritage Visualization and Virtual Restoration' topics included cognition, data integration, deterioration monitoring, deep learning, digital storytelling, and sustainable development.

WG 12 'Grid Modelling for Full-space Integration and Calculation', which was founded after the midterm symposium, addressed aspects of integrated grid-based 3D modelling and analysis.

ICWG IV/III 'Global Mapping for SDGs' addresses challenges, spatial information use, and innovative methods for SDG monitoring.

Finally, the collaborative efforts under ICWG IV/III/II 'Openness in Geospatial Science and Remote Sensing' revolved around openness in the domain of interest of ISPRS, covering reproducibility, good practices, and communication between stakeholders.

2. ISPRS Congress publications

The papers received for the XXV ISPRS Congress reflected the above-mentioned scientific research areas. The reported research ranges from advances in new and emerging theories, through experiments and analyses, to demonstrations of technologies in

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different applications. There were 72 full papers and 107 abstracts submitted to the Congress. Additional 60 abstract were submitted for presentation only. A rigorous peer-review process was performed by the ISPRS TC IV Scientific Committee, which contributed to high-quality proceedings. Each abstract and full paper was reviewed blindly by three reviewers. The research captured through accepted full papers was published in the ISPRS Annals and ISPRS Archives collections. Sixty papers were included in the ISPRS Annals and 84 papers in the ISPRS Archives. Fifty-nine abstracts submitted as 'abstracts only' were accepted as short oral or poster presentation.

The papers were presented in oral and poster sessions. The oral presentations were organised into 15 scientific sessions, one technical session entitled 'Towards Large Cultural Heritage Foundation Models: Datasets, Semantics, Alignment and Component-level Annotations' and two special sessions 'Roundtable Digital Twins for Conservation of World Heritage Sites' and 'ISO Data Quality Measures Register and the ISPRS Community'. A Special Forum on 'Photogrammetry and Remote Sensing Enabled Geospatial Science for Equitable, Liveable Cities' was organised in collaboration with FIG.

The submitted contributions reveal several emerging trends in Spatial Information Science. A substantial number of papers focused on spatial data representation, artificial intelligence, uncertainty modelling, and Digital Twins for a wide range of applications.

Research on multi-dimensional modelling and semantic enrichment is becoming increasingly important, particularly as a foundation for the effective deployment of artificial intelligence (AI) technologies. The integration of knowledge across multiple domains is widely recognised as essential for addressing complex spatially related challenges, especially those that inherently span different sectors, such as urban planning in conjunction with heritage preservation, public health, and climate change adaptation.

Spatial analytics, statistical modelling, and uncertainty analysis remain highly active research areas. The rapid growth of large-scale spatio-temporal datasets has stimulated extensive work on data mining approaches and foundation models, a trend that has intensified considerably in recent years. There has also been a notable increase in AI-driven research involving spatial data, including GeoAI and SpaceTimeAI methods, aimed at knowledge extraction, enrichment of city-scale datasets, and the generation of new insights and value from spatial information.

The Digital Twin paradigm was prominently represented across numerous contributions, reflecting growing interest in data integration, management, visualisation, simulation, and predictive modelling. Data management approaches are evolving towards spatial schemas that support the integrated handling of multi-resolution and multi-representation datasets, as well as distributed cloud-based infrastructures enabling parallel processing, scalability, and dynamic updates. New technologies for interacting with spatial data have also been explored. A particularly strong trend is the increasing emphasis on simulation and predictive capabilities that can support evidence-based decision-making processes across multiple application domains.

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