**XXIV CONGRESS OF ISPRS**

**RESOLUTIONS 2022**

## General Resolutions

**Resolution 1: Appreciation of the *Société Française de Photogrammétrie et de Télédétection* (French Society for Photogrammetry and Remote Sensing - SFPT), the *Institut National d'Information Géographique et Forestière* (National Institute of Geographic and Forest Information - IGN), the *Centre National d'Études Spatiales* (French National Space Agency - CNES) and the other supporting French organisations (CNRS, IRD, Université Côté d'Azur, INRIA, and Ordre des Géomètres Experts).**

The CONGRESS commends:

to congratulate the ***Société Française de Photogrammétrie et de Télédétection*** (SFPT), its president Aurélie Sand, the ISPRS Congress Director 2016-2022, Nicolas Paparoditis, the Congress Executive Committee, the Programme Chairs of all three Congress editions, all supporters of SFPT, IGN and CNES, the International Programme committee, and the ISPRS Commission Presidents, for their excellent work which has resulted in a very successful Congress organized in difficult and uncertain conditions, resulting in three Congress editions.

**Resolution 0.2:**

THE CONGRESS

Noting:

- that the links between academia, government, space agencies and industry in ISPRS have loosened over the years, and
- that the link between science and policy needs to be reinforced in order to build more sustainable public policies;

Recognizing:

- the need for tighter links between academia, government, space agencies and industry in ISPRS to address common relevant topics and societal challenges, and in particular the global monitoring of the impact of climate change and mitigation on earth resources;

Recommends:

- that a specific task force including the chairs the ISPRS committees be created to work with the Council and propose and implement a more inclusive scientific-industry-government policy and road map for ISPRS.

## Technical Resolutions

### TC I

**Resolution I.1: Sensor Systems for (Near-) Real-time Indoor and Outdoor Mapping**

THE CONGRESS

Noting:

- the continuously growing consumer market and ubiquity of low-cost 2D/3D sensors, including stereo-RGB and RGB-D cameras, IMU, and laser scanners, in particular the increasing advancement in smartphone and IoT technologies, and
- the developments in (near-)real-time monitoring and mapping capabilities in both indoor and outdoor environments;

Recognizing:

- the need for robust and highly automated methods for calibration, multi-sensor co-registration, pose estimation, and sensor level data fusion for indoor and outdoor domains;

Recommends:

- the further development, improvement and performance characterization of

automated algorithms, software tools and integrated systems to support these tasks for various sensor systems.

**Resolution I.2: Embedded Vision, Onboard Processing and Cooperative Navigation and Mapping**

THE CONGRESS

Noting:

- the increasing importance of real-time applications in 2D/3D navigation and mapping,
- the use of small multi-sensor platforms (multi-sensor UAS and UGV) or swarms, and
- the rapidly growing volumes of crowdsourced data acquired from a variety of real-life and virtual platforms;

Recognizing:

- the need for real-time capable and robust methods focused on onboard processing, and
- the increasing use of collaborative systems for data collection;

Recommends:

- the further development and investigation of real-time capable onboard-processing of photogrammetric tasks, such as sensor orientation, calibration and sensor data fusion from single and multiple platforms.

**Resolution I.3: Small Satellite System Constellations**

THE CONGRESS

Noting:

- the increasing deployment of small satellite systems for earth observation especially by the private sectors;

Recognizing:

- the availability and value of earth observation data derived from small

satellites for remote sensing applications;

Recommends:

- the further investigation of the requirements for small satellite data used in geo-spatial applications, and
- in collaboration with the private sector, the development of algorithms for geospatial information extraction from small and low-orbiting satellites.

## TC II

### Resolution II.1: Machine Learning and Photogrammetry

THE CONGRESS

Noting:

- the developments in 3D-based deep learning, and
- the strong need for rapid 3D recovery, measurements, and object reconstruction;

Recognizing:

- the efforts extended to 2D/3D semantic segmentation in the society and their use in photogrammetric pipelines, and
- the rising interest in 3D content creation for digital twins and virtual/augmented/mixed/extended reality (VR/AR/MR/XR);

Recommends:

- extending the collaboration between TC II and other TCs for the explicit use of these pipelines in their research, including the creation of benchmark datasets and the organization of related competition, and
- taking the lead to create a concept of characterizing ML-produced data for accuracy estimation and overall performance assessment.

### Resolution II.2: Algorithmic Developments to Support Autonomous Platforms

THE CONGRESS

Noting:

- the need in industry, government, and academia to improve autonomy in robotic/autonomous driving by developing fast geospatial semantic segmentation methods, and
- the development of high definition (HD) maps (as defined in the automotive context) with rich spatial, attribute, topologic information, and meta data;

Recognizing:

- efforts extended in the field regarding panoptic segmentation and geo-positioning;

Recommends:

- the further development of autonomous driving for ground, aerial and underwater platforms, and
- the further development of automatic mapping via autonomous platforms.

**Resolution II.3: Integrative and Generalizable Artificial Intelligence and Machine Learning (AI/ML)**

THE CONGRESS

Noting:

- the need to improve the photogrammetric pipeline using multiple data sources, and
- the need to address generalization issues of AI/ML models in photogrammetry;

Recognizing:

- the increasing availability of multiple sensor streams from the same platforms and systems,
- the potential of deep AI/ML models to address the specific complexity of geo-related problems of different geographical regions, and
- the relative lack of training data required for supervised AI methods;

Recommends:

- Providing datasets with multiple data sources for benchmarking and

competition activities, and

- Integrating AI/ML models into geospatial information extraction from optical and LiDAR data.

**TC III**

**Resolution III.1: New Methods and Techniques for Processing Multi-dimensional Remote Sensing Imagery**

THE CONGRESS

Noting:

- the increasing availability of multi-temporal, multi-scale, multi-platform, multi-sensor remote sensing images and the need for efficient data processing,
- the significant advancement of deep learning technologies for image interpretation, and
- the general lack of large remote sensing sample datasets;

Recognizing:

- the challenges of constructing large scale sample datasets and deep learning networks for effective interpretation of remote sensing images, and
- the challenges on quality control, evaluation and validation of information extracted from remote sensing images at global/ regional level;

Recommends:

- facilitating the thematic scene understanding through using multi-dimensional (spatial, spectral and temporal) remote sensing data,
- promoting open access of remote sensing image resources, algorithms, deep learning networks, and publications, and
- developing benchmark datasets and task-oriented networks for intelligent remote sensing image interpretation and product validation.

**Resolution III.2: Remote Sensing Applications**

THE CONGRESS

Noting:

- the need for bridging the information gaps between the capabilities of earth observation systems and analytical techniques used to process such data, and
- the increasing requirement for accurate and timely monitoring of epidemics, disasters and emergency events;

Recognizing:

- the need for dynamic monitoring and better understanding of the earth system, and
- the environment, and human activities, for smarter decision making and risk reduction;

Recommends:

- developing new methods for exploiting the synergy of the earth observation systems to improve parameter retrieval and its use in predictive modelling, and
- strengthening the emphasis on developing applications to meet the requirements of a broad spectrum of remote sensing users, such as construction and infrastructure monitoring, disaster resilience, natural resources management, observations of the environment, human health monitoring, and Antarctic and Greenland ice sheet monitoring.

**Resolution III.3: Geospatially-enabled SDGs Monitoring**

THE CONGRESS

Noting:

- that the implementation of the 2030 Agenda for Sustainable Development requires the use of a wide range of data, including earth observation and the extracted geospatial information,
- that geospatial information is expected to play a pivotal role in assessing and monitoring the progress of Sustainable Development Goals (SDGs),
- that a number of the inter-governmental organizations, in particular UN-GGIM and GEO, have already supported studies and developments, and

- that ISPRS has already launched a scientific program in support of geospatially-enabled SDG monitoring;

Recognizing:

- the need for new data aggregation and disaggregation approaches to produce trusted geospatial information, and
- the need for new methodologies to extract relevant geospatial information to support SDG indicator estimation;

Recommends:

- initiating ISPRS-led or co-sponsored activities, such as innovative research and development as well as capacity building and outreach activities on geospatially-enabled SDG monitoring, to promote inter-disciplinary studies by mobilizing and integrating all resources that ISPRS and its members have.

## TC IV

### Resolution IV.1: Multi-dimensional and Semantically Rich Data Models

THE CONGRESS

Noting:

- the increasing availability of huge, complex, multi-dimensional (including time), multi-resolution, and unstructured location-based and spatial data, representing social, economic, man-made and natural phenomena above, beneath and on the surface, enclosed and open, designed and as built, local and global;

Recognizing:

- the contributions of ISPRS to representations, processing algorithms of multi-scale multi-dimensional data, models and data structures, and uncertainty and quality modelling for static, mobile and dynamic data for a range of applications from indoor navigation, climate change monitoring to SDG implementation;

Recommends:

- the further development of semantically rich spatial data structures, spatial indexing schemes, and generic analytical tools for model validation,
- the further development of federated spatial data models and linked data, considering different representations, data uncertainty, and data quality, and
- the further development of multi-dimensional data models integrated with the internet of things (IoT).

**Resolution IV.2: Spatial Analysis and Advanced Visualization**

THE CONGRESS

Noting:

- the increasing availability of unprecedented amounts of big spatial data, from traditional remote sensors (satellites, aircrafts, UAVs, in-situ sensors, etc.) to the internet of things (IoT) and user-generated content (volunteered geographic information and social networks) for sustainable development, Smart Cities, Digital Twins and time-critical applications (such as disaster management);

Recognizing:

- the contributions of ISPRS to processing, analyzing, deep learning, mining, simulation, visualization, AR/VR/XR, and quality assessment (emphasizing user-centered aspects) of static and dynamic (including trajectory) data, user-generated content, image, and video data;

Recommends:

- further strengthening the research on real-time analytics, exploratory and confirmatory analysis, data interpretation, and uncertainty modeling for local and global applications,
- further intensifying the application of artificial intelligence and machine learning for data analysis and data fusion, and

- further developing web-based, VR/AR/MR environments, and multi-dimensional and multi-user visualizations, considering privacy, usability, and ethics.

**Resolution IV.3: Information Services and Applications**

THE CONGRESS

Noting:

- the rapid advancement of cloud computing, clusters and grids, high-performance computing, open source, geo-sensor networks, mobile technologies (e.g., smartphones, wearables and apps), web service technologies, and new AR/VR/XR devices and equipment, rising interest in human-centered design of technology, as well as open spatial standards;

Recognizing:

- the contributions of ISPRS to semantics and ontologies, sensor web, visual analytics, service architecture, applications for Smart Cities, Digital Twins, online interfaces, and open international spatial standards in the context of mobile/web/cloud-based geospatial services and usability concerns;

Recommends:

- the further involvement of parallel and distributed processing paradigms for management and analysis of spatial data,
- further intensifying the development of Application Programing Interfaces (API) and Software as a Service (SaaS), accounting for privacy and security issues, and
- further strengthening theory and practice in developing seamless indoor/outdoor localization/navigation applications, location-based services, Smart Cities, and Spatial Digital Twins.

**TC V**

**Resolution V.1: Restructuring Commission V Functional Activities**

THE CONGRESS

Noting:

- that Commission V, on the theme 'Education and Outreach' for addressing capacity development in geospatial science and technologies, has been part of ISPRS structure for the last eighteen years,
- strong commonalities in their activities during the last four Congresses on capacity development,
- that capacity development methods/tools deliberated have reached a high-level of maturity and are operational in most educational institutions, so that the proposed innovative solutions are becoming rather incremental,
- that, barring summer school events, there have been no strong direct interactions with other Commissions' objectives and activities, and
- that the new initiative of TC-V in its Mid-term Symposium in 2018, jointly conducting with IPAC to deliberate on "International Cooperation on Earth Observation", received great appreciation with participation from international space agencies and regional/global organizations;

Recognizing:

- the need for re-orienting Commission V's activities and for supporting innovation for other Commissions' themes,
- that Commission V should continue engaging with ISPRS Advisory Committees in jointly organizing topical meetings to discuss especially on advances in Earth Observation data access and democracy and new geospatial technologies from a knowledge sharing point of view, and
- that new application-oriented capacity development activities, such as innovative technologies in training civil engineers and architects, citizen science, and geospatial technologies, 3D-survey integrating topology, drone imaging, and laser scanning for documenting the built heritage, have attracted a good number of events/programs in the last 4 years;

Recommends:

- focusing on a) planning ISPRS sponsored/co-sponsored events using capacity development tools and methods; b) conducting summer schools, competition programs and supporting the ISPRS Student Consortium and youth promotional activities; and c) reporting the experience and research as feedback in the Commission V Mid-term Symposia,
- establishing special working groups to address innovative technologies in education, training and outreach, jointly with IPAC, with an aim to deliver topics not covered in depth in previous Commissions, such as a) methods of enhancing academia-industry-government partnerships; b) methods of achieving global partnering for promoting quality education and gender inequality issues in STEM, regionally, that address SDG Goal 4 and 5 in collaboration with UN, CEOS, and WMO to promote geospatial science and technologies in societal benefit areas, and
- continuing significant contributions from dedicated working groups in developing educational tools in BIM and civil engineering for geospatial education in architecture, engineering and construction (AEC) towards digital transformation that includes digital twins, smart cities, and VR/AR tools for decision-support system in AEC.

## Resolutions on Emerging Issues

**Resolution 0.1: Establishment of a new Section on "Resolutions on Emerging Issues",**

THE CONGRESS

Noting:

- the need to further increase our Society profile within society and science,
- the need to provide a broader picture of emerging scientific challenges, especially to our younger colleagues, and
- the need to record signals of changes as noted in discussions in academia,

civil society or at political spheres;

Recognizing:

- that emerging issues are those for which there is generally not yet a body of research nor good scientific understanding, and that the aim is to describe, in exploratory and even speculative terms, the identified drivers, observed trends, potential key developments, eventual implications (opportunities/risks) and what kind of challenges this may mean to the ISPRS community;

Recommends:

- the establishment of a new section on "Resolutions on Emerging Issues", with the advice to the TCs to further elaborate and adapt these to suit their specific scientific work, as well as to translate the identified challenges to meet with their technical expertise and capacities. This section is structured in the following parts:
  - emerging environmental issues
  - emerging societal issues
  - emerging technological issues.

**Resolution 0.2: Emerging Environmental Issues**

THE CONGRESS

Noting:

- ISPRS Statue I, which emphasizes the Society's "…contribution to the well-being of humanity and the sustainability of the environment."

Recognizing:

- that emerging environmental issues reflect observed changes/developments in the environment occurring as a result of new research or knowledge, a shift in geographical or temporal scales of impact, or due to heightened awareness or new response measures to issues, their impact assessed in short-medium-/and long-term;

Recommends:

- emphasizing the investigation on the following cross-disciplinary issues:
  - Biodiversity-Food-Water-Energy nexus
  - Supply chains and circularity in economies.

**Resolution 0.3: Emerging Societal Issues**

THE CONGRESS

Noting:

- ISPRS Statue I, which emphasizes the Society's "…contribution to the well-being of humanity and the sustainability of the environment."

Recognizing:

- that emerging societal issues reflect shifts and changes in societal values and habits as well as individual behaviors, such as awareness of environmental concerns, wider economic changes, production/consumption practices, community cohesion, inclusion and resilience, health, and wellbeing;

Recommends:

- emphasizing the investigation on the following cross-disciplinary issues:
  - population concentration and pressures on infrastructure and resources
  - social, spatial inequalities and disproportionality in exposure to pollution and the impacts of climate change.

**Resolution 0.4: Emerging Technological Issues**

THE CONGRESS

Noting:

- ISPRS Statue IV, where a main ISPRS activity is to "…facilitate excellence in research and development."

Recognizing:

- that emerging technological issues reflect either technological pushes or technological responses to emerging issues and, as such, normally correspond

with innovate answers to cross-cutting and complex issues requiring coordination, integration, and collaboration across different siloed disciplines;

Recommends:

- emphasizing the investigation on the following cross-disciplinary issues:
  - contribution of geospatial information to Digital Twins and their applications (e.g. 3D model of the built infrastructure, street network model, urban mobility simulation - autonomous driving, pedestrian traffic, social distancing -, wind flow simulation, qualitative/quantitative data provided by citizens, circularity in cities, reduction of energy and environmental impacts)
  - open big data and peer-to-peer knowledge sharing, especially space and navigation data to boost downstream applications (e.g. researchers to track glacial recession, maritime agencies protect vulnerable marine reserves, and agronomists better predict food supply)
  - cloud and edge computing for IoT real-time sensoring
  - image/video contextualization as a more natural communication tool and user interface, replacing the text/keyboard/mouse.

This text of these Resolutions (2022-2026) was prepared by ISPRS Technical Commission Presidents (2016-2022) and the Resolution Committee (Jun Chen (Chair), Costas Armenakis, Shailesh Nayak, Petros Patias, and John Shi.) It was further discussed by ISPRS Council (2016-2022).