ISPRS Forum Track Report

A compilation of the reports from the fora held at the XXIV ISPRS Congress held in Nice, France between June 6 and 11 with recommendations for ISPRS Council.

Contents

Introduction

A forum track was included in the Congress. This took place in parallel with the scientific sessions with the objective of addressing the interactions between science, public organizations, industry and decision-makers on hot topics of the geospatial community. The forum was not a place to make research presentations but a proper place to address the impact of innovations and the role that our community could play in this changing context for “building a better future together by providing collective visions and/or roadmaps”.

Each forum organiser was asked to produce a report which sets out the state of the art of the forum theme and will act as a guide to Council on the way forward. These reports have been edited by the ISPRS International Science Advisory Committee (ISAC) and the ISPRS International Policy Advisory Committee (IPAC) and incorporated into a single document which will set out future directions for ISPRS.

The reports generated by each forum organiser have been edited into a consistent format to emphasise the main conclusions from the fora. Each forum put emphasis on different aspects of the discussion and conclusions so there are differences in presentation, but we have attempted to clearly set out any conclusions which suggest actions for ISPRS Council. Note that any reference to Working Groups is to the Groups established in the 2016 -2022 period.

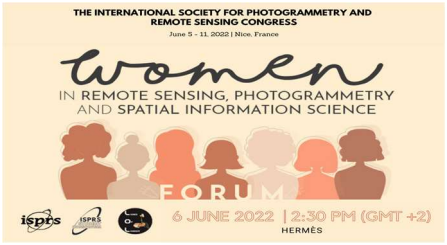
There are a number of common themes to the recommendations which are summarised here

- Formation of new working groups.
- Organisation of meetings.
- International collaboration, particularly with GEO and industry.
- Education of the public, other geoscience organisations and students.
- Standards and documentation.

Details of these proposals can be found in the individual reports.

Ian Dowman, Chair of ISAC, 2016-2022.
Gunter Schreier, Chair if IPAC, 2016-2022.
Laurent Polidori, Chair of Nice Congress Forum Track Committee.

Women in Remote Sensing, Photogrammetry and Spatial Information Science



Organisers

Sheryl Rose Reyes, ISPRS Student Consortium
Dr. Morgan Crowley, Ladies of Landsat and Natural Resources Canada
Dr. Marguerite Madden, ISPRS and University of Georgia
Charmaine Cruz, ISPRS Student Consortium
Laxmi Thapa, ISPRS Student Consortium

Scope and Objectives

Our forum was entitled "Women in Remote Sensing, Photogrammetry and Spatial Information Science" and was organised by the ISPRS Student Consortium and ISPRS in partnership with the Ladies of Landsat. The forum aimed to connect women in remote sensing, photogrammetry and spatial information science within and outside ISPRS. The forum was an avenue for women to tell their stories and exchange ideas and experiences in the profession. Our forum's ultimate goal was to raise awareness about the current status of women in the profession and promote diversity and inclusiveness within ISPRS through the exchange of ideas and recommendations to the Society.
The objectives of the forum were:

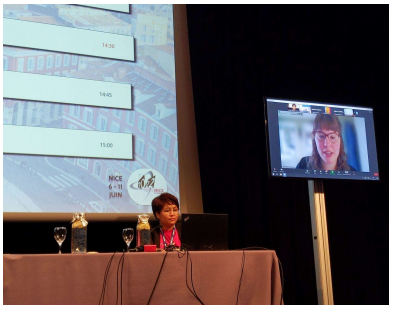
- To connect women in remote sensing, photogrammetry and spatial information science,
- To provide a platform for women to tell their stories and exchange ideas and experiences in the profession, and
- To raise awareness about the current status of women in the profession and promote diversity and inclusiveness within ISPRS.

Outline of the Forum

<u>Part I: Virtual Lightning Talks</u>
Moderators:
Dr. Morgan Crowley, Sheryl Rose Reyes

Presenters:
She Maps Australia (Dr. Karen Joyce)
IEEE GRSS IDEA (Dr. Heather McNairn)
Women+ in Geospatial (Sabrina Szeto)
African Women in GIS (Mary Salami)
Women in GIS Kenya (Yawiro Kitiyo)
Sisters of SAR (Dr. Laura Dingle-Robertson)
Geoladies PH (Leigh Lunas)
Women in Copernicus
Ladies of Landsat (Dr. Kate Fickas)
<u>Q&A</u>

Moderators: Dr. Morgan Crowley, Sheryl Rose Reyes
Panel Discussion
Moderators: Dr. Marguerite Madden, Sheryl Rose Reyes
Panelists:
Dr. Sisi Zlatanova of the University of New South Wales
Dr. Arzu Coltekin of the University of Applied Sciences and Arts Northwestern Switzerland
Miriam Gonzalez of UP42
Laxmi Thapa of ISPRS SC and the University of Oxford
Amanda Aragon of the University of Georgia
Dr. Jane Bemigisha of ESIPPS International Ltd.
Q&A
Moderators: Dr. Marguerite Madden, Dr. Morgan Crowley, Sabrina Szeto, Sheryl Rose Reyes



Sheryl Rose Reyes, President of the ISPRS SC, and Dr. Morgan Crowley of the Ladies of Landsat who was moderating the virtual lightning talks.

The panelists, together with the organizers, moderators and ISPRS SC Board of Directors, after the forum.

Summary of presentations and discussion

In our virtual lightning talk Q&A, the discussion centred around what ISPRS can do to make the field more welcoming and inclusive for women remote sensing scientists. The organisations suggested actions for ISPRS to take going forward, focusing especially on the importance of ISPRS leading a census/survey of members and forming a committee for women in remote sensing or for diversity, equity, inclusion and justice (DEIJ). Additional suggestions included having more women keynotes, women on organisational boards, microgrants for women to support travel and childcare costs, and women-led mentorship opportunities. In the panel discussion, notable ISPRS leaders and early career students discussed their experiences as women in the fields of remote sensing, photogrammetry and spatial information science, and how geospatial technologies have changed over time and across regions. Throughout the session, we used online conferencing (Zoom) and chat technologies like Slido and Padlet to allow for anonymous contributions and reflections from the audience.

Similar to many other organisations, increasing awareness of DEIJ within ISPRS can bring about changes that would open more opportunities not only to women but to other underrepresented groups. For the term 2022 - 2026, we have the first female President and Secretary General of the Society, two female Technical Commission Presidents, a female President of the Consortium and numerous prospective female chairs, co-chairs and secretaries of the different working groups. Having female role models in ISPRS leadership empowers more women and other underrepresented groups in the organisation to nurture a more diverse pool of leaders that can build a stronger and more inclusive Society. The ISPRS SC has been actively engaging with organisations such as the Ladies of Landsat, and together, we were able to publish one of the most read issues of the SpeCtrum on Women in Remote Sensing and Geospatial Information. This partnership has been further strengthened through this forum. We believe that by engaging ISPRS with other groups that tackle socially relevant issues, we initiate more partnerships and collaborations that can contribute to improving and advancing the goals of the Society. A follow-up special issue has also been published as an additional resource for this forum under the same theme.

Moreover, we also witnessed the impact of the forum on social media and on the personal experiences of the audience and guest panelists. Dr. Karen Joyce was inspired by the forum and started the Twitter account of Dames of Drones (@DamesOfDrones), with the very apt description of "celebrating women using drones to map and collect data." Dr. Shawn Kefauver, an ally of the IEEE-GRSS IDEA, also commented on the wonderful line-up of this forum. Leigh Lunas of Geoladies PH also shared her personal experience of finding the courage to join the discussions and speak her truth. Dr. Kate Fickas of the Ladies of Landsat shared her excitement about taking part in this forum that demonstrated how we are stronger together and the importance of collaboration over competition. The presence of the ISPRS SC on social media significantly helped in reaching a wider audience as well as increasing partnerships with many organisations since 2016. The ISPRS should further consider increasing its social media presence to reach more individuals and organisations in the profession.

From the panel discussion, we also learned that the experiences of women in our profession can vary and can be highly influenced by culture. For example, Dr. Sisi Zlatanova demonstrated her courage in pursuing the field of photogrammetry and believing just like her male colleagues, she can succeed. Meanwhile, Laxmi Thapa described her day-to-day situation of receiving questions on how she was able to achieve her current position in the surveying department of her country and how traditional views of hierarchy also affected the perception of her capabilities as a female leader. ISPRS as an international organisation can develop better regional strategies to bring forward more women in the profession by understanding these different situations and helping women overcome challenges in their careers and barriers to advancement.

This forum also reiterates the ISPRS SC's recommendation on considering the organisation of future ISPRS events in a hybrid format (Reyes and Cruz, 2022). The ISPRS SC, given its experience in organising virtual events, can provide recommendations to the Council on how to carefully design, implement and host these hybrid events while also opening more opportunities for early-career scientists to get involved. Hybrid events attract a bigger, more diverse and more inclusive audience, which can increase the representation of women and other underrepresented groups and also increase the reach of ISPRS across the globe.

Finally, we also believe that through this forum, we are able to understand some of the issues that women in science encounter. For example, a conference participant shared an experience through Padlet where she saw how the registration staff asked another participant to get rid of her daughter's stroller. She challenged us by asking, "Can we encourage the norm for conferences to support child care facilities?" If we address this and other similar challenges, we encourage more parents with young children to attend ISPRS activities.

Current directions

In the virtual lightning talk portion of our forum, we heard about current innovations from affinity groups in the realm of DEIJ for women in remote sensing. For example, we learned how Dr. Karen Joyce and She Maps Australia are going into classrooms to teach young girls how to operate unoccupied aerial systems to pique interest in remote sensing at young ages. We learned about IEEE GRSS IDEA's Women mentoring women program from Dr. Heather McNairn, and about their microgrants for professionals to use granted funds as they wish related to conference travel and childcare costs. Sabrina Szeto of Women+ in Geospatial spoke about their mentorship cohorts and speaker database to prevent manels (male-only panels) and wanels (white-people-only panels). We heard from African Women in GIS about their mentorship program that matches women who work in the geospatial realm based in Africa with mentors from around the globe. Women in GIS Kenya contributed a joint presentation from their leaders that spoke about their training and outreach activities in Kenya. Dr. Laura Dingle-Robertson outlined the multi-faceted efforts of the Sisters of SAR to increase the capacity for SAR-based science and the visibility of SAR scientists through their

series on Twitter. Leigh Lunas represented Geoladies PH and their presentation highlighted their open-source mapathon events for women and active allies in the Philippines. Women in Copernicus' pre-recorded talk discussed their findings from a recent survey of women and active allies in the field of remote sensing in Europe. Lastly, the lightning talk session concluded with an overview presentation of Ladies of Landsat by the founder, Dr. Kate Fickas, who emphasised the importance of community over competition, grassroots actions, and systemic change to make the field of remote sensing more inclusive for all scientists.

In the panel discussion, we heard about the individual panelist's experiences in academic, scientific, and career journeys for how they ended up where they are today. Some panelists had more traditional journeys, while others discussed returning to the field with encouragement from key mentors. We asked the panelists whether they had ever doubted staying in the field or on their current path, and panelists discussed the challenges of having children, moving abroad for studies, biases, and finding support along the way. When we asked what kept panelists motivated to keep going, many mentioned the importance of mentors, colleagues, and communities who supported and encouraged them to stick with it. We rounded out the panel with questions about what the ISPRS can do to help contribute to inclusivity and diversity to support women and other underrepresented groups in remote sensing. The conversation was lively and free-flowing and inspired many questions and reflections from the audience members on the Slido and Padlet webpages.

Furthermore, we also share some of the questions we receive in Slido that ISPRS can use as a guide in organising future events:

- What does being a mother in research entails, that men seem not to understand yet?
- How can we better acknowledge challenges that may be more dependent on culture? For example, the experiences of Asian women may be different from European women.
- How can we improve our skills to overcome challenges?
- What would be the first thing to change in the current system to make it more inclusive?
- Despite many events to promote, What do you think that is still putting women back? Your experience or learnings to improve the situation in future?
- What are the major problems these organisations are facing specifically to get stronger and motivate more women in Remote Sensing?
- Do you think that women employers and women leaders will be better suited to increase women inclusiveness? Is it a gender or cultural issue?

Future requirements:

From this forum, we have distilled a multi-point action plan for the ISPRS and other similar organisations to undertake to make the field of remote sensing more inclusive, equitable, and diverse for women and other underrepresented scientists. We plan to submit this action plan with all participants of our forum as co-authors to help direct concrete efforts that remote sensing professional organisations can make to actually make a change in the field starting with their conferences and activities.

Proposals for future activities for ISPRS

- We believe that this session could be a recurring forum at future ISPRS events including Congresses, Geospatial Week, Symposia and other ISPRS co-organised events to engage with women in the organisation and hear about their experiences in a safe place. As discussed in our forum, the most important next step from ISPRS should be to form a gender or diversity, equity, inclusion and justice DEIJ-focused working group to act upon the items discussed in

the 2022 forum. The formation of the working group was aligned with the proposal of the elected Technical Commission V President, which can immediately be formed for the term 2022 - 2026.

- Secondly, it is vital for ISPRS-affiliated events to not host or advertise panels that are manels, wanels, or if regional in focus, do not include local voices from the study region of the discussion. There are new efforts in the field to highlight and speak out against exclusionary panels such as the ones listed, thus reducing respect for organisations that support or organise them. By taking this stance against exclusionary panels and sessions, ISPRS will be at the forefront of DEIJ actions to ensure diverse voices are heard in scientific sessions and panels. In addition, this can be a great opportunity for ISPRS to highlight more individual members through the regional coordinators, coming from various countries and make the most out of its vast database of experts in the field of remote sensing, photogrammetry and spatial information science.
- Lastly, the ISPRS Foundation may also consider including child care costs as an acceptable entry for applicants developing their budgets for Travel Grants and Summer Schools. This action is expected to increase participation by parents with young children to attend ISPRS events and thereby remove one of the barriers that prevent women from engaging in professional development. Future ISPRS events should also consider child care facilities (i.e., stroller storage, breastfeeding rooms) at their event venues.

Conclusions

The forum "Women in Remote Sensing, Photogrammetry and Spatial Information Science" was an extremely successful event on Tuesday, June 6, 2022, as part of the ISPRS Congress. The session was divided into two parts, the first highlighting virtual lightning talks from affinity organisations from around the world, and the second being an in-person panel discussion among notable women in remote sensing, photogrammetry and spatial information science from ISPRS. Our forum aimed to provide a space for discussion on experiences, challenges, barriers and pathways to success by women of different ages and backgrounds who study and work in the geospatial sciences. We hope our shared stories will inform all members of our community and encourage women to pursue geospatial research and careers. The conversations from our forum have resulted in a clear way forward to make ISPRS a diverse professional organisation, not only for scientific contributions but also for innovations in the realm of DEIJ efforts.

References

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Reyes, S.R.C. and Cruz, C.A. (2022). *Forging Ahead and Adapting to Change: A Review of the Initiatives of the ISPRS Student Consortium*. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 43, pp.37-43.

Geospatial Information-enabled SDG Monitoring

Organisers

Chen Jun, (NGCC, China), Aurélie Sand (CNES, France), Sheryl Rose Reyes (ISPRS Student Consortium, Philippines)

Scope and Obectives

In September 2015, the United Nations adopted "Transforming Our World: the 2030 Agenda for Sustainable Development" as a new ambitious global development plan to end extreme poverty, fight inequality and injustice, and combat climate change. The agenda recognized the complex and diverse challenges that the world of today faces and defined 17 Sustainable Development Goals (SDGs) with 169 associated targets. To ensure a successful implementation of this global agenda, the United Nations has been devoting to establish a systematic follow-up and review of the progress towards SDGs at national, regional, and global levels, through an indicator-based and data-driven monitoring approach. Accurate, reliable, and up-to-date geospatial data plays a fundamental role in the monitoring process. This makes the design and implementation of geospatial information-enabled SDGs monitoring mechanisms and systems a critical task for both international communities and local governments. In this context, ISPRS council has decided to set up a scientific program on "Geospatial Information-enabled SDGs Monitoring for the 2030 Agenda (GI4SDGs)", jointly with other international organizations. The overreaching goal of this scientific program is to advance and achieve geospatial-enabled SDGs monitoring and applications by mobilizing and integrating all resources that ISPRS members and other stakeholders have.

The objectives of this forum were to:

- Present the novel and innovative methods for Geospatial Information-enabled SDGs Monitoring through deep learning, big data, cloud computing, and other related technologies.
- Showcase the use of geospatial information and Earth observation as well as statistical and other data sources for monitoring SDGs.
- Examine key scientific and technological challenges of geospatial information and Earth observations in support of SDG monitoring.
- Explore international collaboration on Geospatial Information-enabled SDGs Monitoring.
- Explore, through a bottom-up approach, training requirements and awareness on GI and GIS for SDGs from different users' groups.
- Identify support for the development of needs-driven training models and materials on GI and GIS for SDGs.

Outline of programme

<u>Recent Progress on Geospatial Information-enabled SDGs Monitoring</u>
Chairs Aurelie Sand John Mills

Laurent Durieux (GEO): An Integrated Perspective of International Collaboration in Earth Observation in Services of the 2030 Agenda for Sustainable Development
Menno-Jan Kraak (former ICA president, University of Twente, Netherlands): Monitoring the SDG Indicators Using Maps - Some Ethical Considerations
Petros Patias (The Aristotle University, Greece): Earth Observation and SDGs: Mainstreaming Workflows from Data Sources to Policy Indicators
Yifang Ban (KTH Royal Institute of Technology, Sweden): Earth Observation Big Data and AI for Monitoring Urban SDG Indicators

GI4SDGs: Case Studies and Capacity Building.
Chairs Songnian Li (Toronto Metropolitan University, Canada) and Sheryl Rose Reyes (ISPRS Student Consortium, Philippines),

Frédéric Bretar (CNES, France): How Do Projects from the Space for Climate Observatory (SCO) Target Good Health and Well-being (SDG 3)?
Jon Mills (Newcastle University, UK): Global Water Security and Sustainable Development: A (geospatial) Systems Approach to SDG 6
Shu Peng (NGCC, China): Local SDG monitoring at Deqing County in China - a UN SDG Good Practice (Pre-Recorded)
Daniele Oxoli (Politecnico di Milano, Italy): A Brief Introduction to Capacity Building for GIS-based SDG Indicator Analysis with Global High-resolution Land Cover Datasets Project (ISPRS Educational and Capacity Building Initiative 2021, Including results of a preliminary survey of GIS&SDGs)

The sessions were held in a hybrid mode with three presentations delivered live remotely. The well-mixed presentations addressed the interface between science and society. Both sessions were attended by a good number of participants but certainly not a large number, as expected. Participants seemed to be well engaged by asking questions. However, due to the time limit, a planned panel discussion did not happen. Still, a few observations were made from the presentations and Q/A after the presentations.

Current directions and issues

Monitoring SDGs with Earth Observation Data
EO provides an efficient, reliable, and affordable way to sustainably monitor SDGs from global to local scales. Based on multiple analyses undertaken by GEO, CEOS Agencies and others, About 34 indicators can be directly or indirectly informed with EO data, spanning across 29 targets and 11 goals. This evaluation needs systematic updates as developments and achievement are growing quickly and are not always well reported to the rest of the community. Some improvements are still required like better integrate EO to complement traditional statistical data, improve capacity to analyze data, and the use of cloud computing to manage big data. Further, the combination of EO and citizen science offers a great opportunity to monitor better the SDGs.

Observing the Earth from space and combining the observations with in-situ data makes it possible to identify risk-increasing parameters and to predict the probability of the propagation of diseases, which helps assess SDGs.

Ethical use of geospatial information for supporting SDG monitoring and assessment is an important issue, which needs further consideration by researchers and practitioners. EO data while in and of itself a huge opportunity, has also created a large challenge with nations lacking the capacity to discover, access and effectively use this information to drive proactive and effective sustainable development policy. The challenge is getting intelligence in the form of actionable knowledge out of this data revolution and equipping those on the frontlines of conservation and sustainable development – namely those operating at national scales, the tools and technologies to streamline optimization of this data. There is a need for urban data and the role of EO data for producing timely and reliable data to support sustainable and resilient urban planning. With respect to using EO for SDGs, the need for increased collaboration among disciplines/domains and cooperation among users and providers and the need for establishing global resources based on standards and interoperability.

Essential Variables
Local SDG monitoring, such as in Deqing, China, emphasizes the importance of developing essential geo-information variables (EGiV), which can increase the efficiency of indicator calculations and

provide standardized system. A common approach to essential variables may provide one way to enhance integration across the work plan. Further, use of Essential Variables to support supporting adequate observing systems in the context of restricted budgets and to improve the definition and maintenance of workflows from raw data to final end users' products. Development of such workflows that specify the sequence of geospatial processes with their data inputs/parameters, also addressing several barriers including cloud services management and data interoperability and leveraging the use of existing GEOSS Platforms.

Complications in Calculating SDG Metrics (methodologies)**.**
This include Ontologies & Definitions, Data availability/usability and especially existing data gaps in regional or local levels; not fully developed methodologies; not clear what is the reporting level; lack of global consensus on data integration and dissemination.

Nature-based solutions are an opportunity to tackle multiple SDGs and EO is essential to support them. In addition, some improvements are still required like better integrate EO to complement traditional statistical data, improve capacity to analyze data, and the use of cloud computing to manage big data. SDG 6 calls for available and sustainable management of water and sanitation for all. However, the integrated and indivisible nature of the SDGs means the way we deal with issues of water security will affect (and be affected by) our ability to achieve other SDGs. As a goal concerning the lifeblood of the planet, progress towards the eight SDG 6 targets therefore has catalytic effects across the entire 2030 Agenda. Threats to water security are not in isolation to one another. Global water security and sustainability can only be achieved by building resilience across the whole water system, rather than focusing on individual parts or peoples. The UKRI GCRF Water Security and Sustainability Hub therefore aims to enable sustainable water security through developing and demonstrating a systems approach. Such a systems approach requires consideration of multidimensional, transdisciplinary issues, and collaboration of multiple stakeholders. Geospatial technologies enable such a complex systems approach, underpinning research activity across the GCRF Water Security and Sustainability Hub. Continued progress in geospatial (big) data acquisition, management, processing, analytics, modelling, visualisation and decision support are therefore key to tackling the intractable challenge of global water security and sustainability.

SDG Working and Training Programmes and Collaborations.
The 2030 agenda for sustainable development goals is one of the four engagement priorities of the Group on Earth Observations (GEO). Better relationship between ISPRS and GEO should be established, and ISPRS needs to be more active in the different activities of the GEO Work Programme as well as the GEO Working Groups and the GEO Knowledge Hub.
There is a need to enhance awareness of GI4SDGs, especially, among GIS students and practitioners due to their potential key contribution to achieving Agenda 2030 in the next few years. Master and Post-graduated students should be introduced to GI4SDGs directly in their study curricula to expect timely impacts. Advocating both open data and software in this path would maximise the access to the required knowledge for students worldwide (without any economical barrier), which is critical for tackling such global challenges.

Proposals for future activities for ISPRS

Enabling activities:

- Increased collaboration among disciplines/domains and cooperation among users and providers and the need for establishing global resources based on standards and interoperability.
- Better relationship between ISPRS and GEO should be established, and ISPRS needs to be more active in the different activities of the GEO Work Programme as well as the GEO Working Groups and the GEO Knowledge Hub.

- Enhance awareness of GI4SDGs

Technical areas where ISPRS could contribute

- Integration of EO data traditional statistical data, improve capacity to analyze data, and the use of cloud computing to manage big data. Further, the combination of EO and citizen science offers a great opportunity to monitor better the SDGs.
- Data integration

Cultural Heritage

Organisers

Andreas Georgopoulos (National Technical University of Athens, Greece)
Minna Silver (Universities of Oulu and Helsinki, Finland)

Scope and objectives

The Cultural Heritage Forum during the ISPRS Nice Congress was designed to address the interactions between science, public organisations, industry and decision-makers on the topics of Digitisation of Cultural Heritage. This is a booming field of implementation of contemporary digital technologies, especially in the sector of documentation of Cultural Heritage. This is the reason why the Forum track was co-organised by ISPRS and CIPA-Heritage documentation (www.cipaheritagedocumentation.org), a joint International Scientific Committee of ISPRS and ICOMOS, commissioned to bridge the gap between technology providers and users for the benefit of Cultural Heritage.

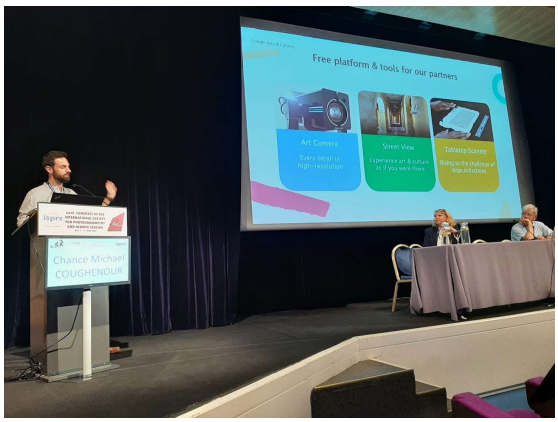
The scope of the Forum on Cultural Heritage was mainly to exchange views on the impact of contemporary technologies to Cultural Heritage documentation and assess their usefulness. In addition, the future roadmap was to be discussed to serve as a guideline for current and future research directions.

Outline of Programme

The Forum on Cultural Heritage was programmed to start with a few short (approx. 10 minutes) keynote speeches by selected CIPA Executive Committee members to introduce the key topics. These were scheduled to be followed by discussion from the audience present, who could also introduce their own questions and topics to the Forum.

Minna Silver and Andreas Georgopoulos chaired the forum which opened the floor to the experts and interesting people to discuss the role of geomatics tools in the Cultural Heritage documentation process.

The forum, which lasted 3 hours, was introduced by an invited speaker from Google Arts and Culture Group. Chance Michael Coughenour, who showed the main activities of Google Arts & Culture under the UNESCO umbrella. Exciting examples of “impossible” expositions, Machine Learning assisted restoration proposals and other exciting initiatives were presented. All the results and future initiatives can be reached at https://artsandculture.google.com/.



Chance Coughenour delivering his keynote speech

Minna Silver, then presented the book "Challenges, Strategies and High-Tech applications for Saving the Cultural Heritage of Syria", which collects the proceedings of the 10th ICAANE Workshop held in Wien in 2016. The already published book "Reviving Palmyra in Multiple Dimensions: Images, Ruins and Cultural Memory" completes the contribution of Minna Silver, Ahmet Denker, and Gabriele Fangi to the documentation of Syrian Cultural Heritage assets.

After these presentations, Andreas Georgopoulos underlined some topics to open the discussion: digital tools are essential to improve the Cultural Heritage Documentation thanks to the benefits that this technology could give to the management, distribution, and sharing of the Cultural Heritage Documentation, but many questions are still open: the data are often required in a 2D representation due to practical management problems on the field, looking for specifications on the 3D metric survey can be possible only at a very general level.

Relevance to ISPRS

As mentioned before, CIPA is a Committee of ISPRS and its mandate is to convey the technological innovations to the Cultural Heritage conservation and preservation community. Hence, it is directly relevant to ISPRS, especially Commission II and the related WG's which develop and implement such technologies.

Future Requirements for CIPA and ISPRS

- Documentation needs a correct mixture of metric and historical data, and the experts have to work as a team from the beginning.
- 3D models, today produced in different ways, must be documented in terms of quality (metric and level of detail).
- Users of 3D models for different topics must be aware of the quality they need.
- It is evident that a lot of experts and non-experts are producing 3D models of debatable quality and usefulness nowadays. It is imperative that those interested should be offered the opportunity to get trained and "educated" in the pitfalls of the automated software available.
- A significant action at the educational level must be pursued by using all the possible initiatives (e.g., summer schools, videos on basics of photogrammetric image acquisition, quality assessment strategies, etc.)
- Also, visualization tools must be considered to make free access to documentation results.

Earth Observation

Organisers
Gunter Schreier, DLR German Remote Sensing Data Center, Oberpfaffenhofen, DE, IPAC Chair
Ian Dowman, Emeritus; University College London, UK, ISAC Chair

Scope and Objectives

This forum presented current and perceived future trends in satellite based Earth observation (EO) from the point of view of the space agencies and commercial operators. New Earth observation programmes, missions and satellite constellations as well as new IT-systems and data analysis approaches were presented by agencies and companies. The forum finished with a round table discussion.

Outline of the programme

Session 1: Perspectives on International Earth Observation Missions

Simonetta Cheli, Director EO, ESA
Selma Cherchali, Head of Earth Science, CNES
Gay Jane Perez, Philippine Space Agency (PhilSA)
Laurent Durieux, SDG coordinator, GEO
Session chair: Gunter Schreier

Session 2: Perspectives on commercial opportunities in Earth Observation

Jean-François Segrestaa, Head of Marketing Intelligence & Solutions, Airbus
Irene Benito, Planet
Yusuke Nakanishi (Mr.), Director and CPO, Axelspace Corporation, Japan
Aakash Parekh, CCO, PIXXEL, India
Martin Langer, CTO Ororatech, Germany
Session chair: Ian Dowman

Session 3: Round Table all speakers above

Theme: Earth Observation: Looking ahead in science, technology and markets
Moderator: Gunter Schreier

Relevance to ISPRS

Earth Observation data is a major input to photogrammetric and remote sensing processes and in this regard is particularly important to Commissions I, II and III, and, as this report shows, is of great relevance to Commission V. ISPRS is a member of GEO, UNGGIM and UN COPUOS and needs to be informed on all aspects of Earth Observation in order to be able to take part in discussions and to be kept up to date with new developments. Scientific processes such as calibration, data fusion, data analysis, feature extraction and many others are fundamental operations which are used by users of EO who can benefit from collaborating with experienced photogrammetrists and remote sensing scientists.

Current directions

The main points to come out of the presentations were that satellites are becoming smaller and come in fleets and constellations, resulting in significantly more data. Large mission operators such as ESA, CNES and Airbus, small organisations and start-ups are directing their programmes towards environmental challenges, with the commercial operators also targeting commercial customers to gain from image intelligence and specific information extraction. Planet and other companies aim to cover the whole Earth everyday (even several times per day) thus creating enormous requirements for data analysis in a "Big Data" sphere. This comes along with a need for citizen science, open data, open science and better data processing strategies. There is also recognition of the importance of supporting technical innovation and the need to provide data for the digital transformation. The need for cooperation was stressed with integration and collaboration a key driver. Supporting the science community is important, but likewise operators and companies are scouting for innovation coming from the science community.

Of particular note is the emergence of small companies and organisations focusing on identified problems, for example Pixxel, using hyperspectral data, to solve problems not solvable from existing data, concentrating on crop disease and water pollution and Orora Technologies offering a wild fire service looking at fires and CO2 emissions using satellite and ground based data including social media. These companies need a collaborative effort to develop techniques of image registration, data fusion and calibration. It is interesting to note that both companies are spring-offs, i.e. younger students from Universities, who dare to be entrepreneurs. The Philippine Space Agency (amongst others), focuses on environmental disaster and urgently needs to develop educational resources.

As well as supporting innovation to solve environmental challenges, there is also innovation in technology. Axel Space Japan, operates small satellites, allowing versatility and scalability in satellite

manufacturing registration with visible imaging from other sources. Orora offers an innovative, easy to use, central platform. Several initiatives from organisations/programmes such as COPERNICUS, GEO were mentioned including Phi lab (ESA), e-shape programme (EC Horizon2020), GEO Knowledge Hub, GEOSS and Earthnet/Copercncius data buy programme (ESA); these are programmes in which ISPRS could participate or its members can benefit from accessing freely commercial EO data. The SWOT satellite from CNES/NASA for oceanography and hydrology is another innovative programme. It is worth noticing that nearly all larger national & international space agencies give access to their EO mission data under a free and open data regime.

Future requirements

From the presentations we can identify a number of requirements. In the area of science these include data analysis, data processing strategies, collection and use of hyperspectral data, registration and data fusion, calibration and standards. The area of policy includes structures for collaboration, education and support for innovation.

Proposals for future activities for ISPRS

In General ISPRS needs to be involved to better understand requirements and on-going developments in order to shape the structure and themes of Commissions and to offer current information for academic members. Besides, the knowledge of programmes and initiatives opens opportunities for ISPRS members which could be funded.

After an open discussion on various topics the panel formulated the following recommendations to ISPRS:

- To establish better relationship to GEO. ISPRS needs to be more active in the different activities of the GEO Work Programme as well as the GEO Working Groups and the GEO Knowledge Hub.
- Continue to pursue open data and open source in all domains, including, for example, establishing open libraries for spectral signatures/hyperspectral data analysis.
- Collaborate with industry to develop business-oriented solutions, to help its users in their daily life and solve their problems. Support definition of, and be a forum for, science needs to formulate requirements for new EO missions (public and commercial).
- Support Science wide interdisciplinary approaches, not just scientists and engineers from photogrammetry, earth science and computer science. There are also other sciences with a potential need for geospatial information (including social science and economy).
- Increase involvement of other stakeholders (e.g. from public services, governments, companies etc.) to formulate their needs for EO and EO data analytics.
- Help to define international measures and standards. Help to define “accuracy” (in various domains) as this term seems often to be used arbitrarily. Consider generation of widely accepted “measures” and “standards” (i.e. “ISPRS Standard” compared to IEEE standards?).
- Bring more young people to ISPRS. Put them also in charge for ISPRS WGs, Commissions etc. Be more attractive for young people.
- Support educational and outreach activities. Not just students, but also school children and the public; there is the example of the IAC industrial exhibit which is open one day for the public in the hosting city.
- Support the formulation of clear science statements, based on ISPRS related science results on societal and ecological challenges such as pandemics and global climate change.
- Establish more openly a forum for “lessons learned”, where also failures can be discussed and analysed.

Conclusions

The EO Forum has presented a wide range of activities which demonstrate the very varied sources and uses of EO data. It has also shown the opportunities for ISPRS to collaborate and transfer the knowledge and skills held by its members and working groups. In summary ISPRS has opportunities through its network and contacts to increase its influence and scope of activities to benefit for both, organisations which produce and use EO data and the ISPRS science community.

Openness and Innovation in Geomatics and Earth Observation

Organisers

Maria Antonia Brovelli (Politecnico di Milano, Italy)
Serena Coetzee (University of Pretoria, South Africa)

Scope and objective

Openness typically refers to transparency, to free and unrestricted access to information, and to inclusive consensus-based decision-making. Organizations are increasingly considering the adoption of open source software and open data. In the geospatial domain, this is no different, and the last few decades have seen significant advances in this regard. Openness has changed the way in which geospatial data is collected, processed, analyzed and visualized. This has led to innovative solutions based on open geospatial technologies. Despite the fact that global political power balances are changing and with looming trade wars some countries are 'closing up', in most parts of the world there is currently a strong sentiment towards openness linked to significant scientific activism by citizens, as well as a strong trend by governments towards publishing open data. The question is therefore whether openness will continue into the foreseeable future. How will the concept and practice of openness evolve into the future? How will it be impacted by deep learning, big data and cloud computing developments?

The objective of this forum is to

- Present the latest on openness and innovation related to Earth Observation, open source software, open data, open standards, open science and citizen science
- Share experiences of implementing open data and open source software in innovative geospatial solutions
- Encourage discussion about the pros and cons, as well as future directions, of openness and how these will impact innovation
- Inspire innovation through openness by allowing delegates to interact with experts in open technologies

Outline of the Programme

Keynote: Marco Bernasocchi, QGIS.org Chair, OSGeo.org Board member and OPENGIS.ch CEO

Panel: Open geospatial data and open standards
Chair: Maria Brovelli
All panelists introduce themselves and their experience with open data and open standards.
Marco Minghini**,** European Commission - Joint Research Centre (JRC)
Sisi Zlatanova, UNSW Built Environment, University of New South Wales, Sydney, Australia, and President: ISPRS Technical Commission IV, Spatial Information Science
Azile Mdleleni, YouthMappers Chapter, University of Pretoria, South Africa
Miriam Gonzalez, Geochicas, HOTOSM, UP42, Fire Forum
Sheryl Rose Reyes**,** ISPRS Student Consortium

Discussion
Panel: Open geospatial software and open standards
Chair: Serena Coetzee

All panelists introduce themselves and their experience with open software and open standards.

Timur Obukhov, Geospatial Information Officer, United Nations, and Secretariat: UN Open GIS

Francesca Noardo, Open Geospatial Consortium (OGC)

Bolelang Sibolla, Principal Earth Observation Researcher, Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa

Anca Anghelea, Open Science Platform Engineer, Science, Applications and Climate Department, Directorate of Earth Observation Programmes, ESRIN

Venkatesh Raghavan, Graduate School for Creative Cities, Osaka City University

Relevance to ISPRS

The topic of openness is of interest to more than one of the ISPRS Commissions, given the relevance and importance of open source software and, above all, open data, in the many fields of interest of the community today.

The forum followed the guidelines by addressing the impact of open data and software on innovation, and the role that the ISPRS community can play in building a better and more sustainable future. This forum was not the first time this topic was addressed, on the contrary, it built on related activities in the past. Since 2017, ISPRS has organized the Academic Track of the FOSS4G (Free and Open Source for Geospatial) Conferences together with OSGeo (Open Source Geospatial) Foundation, with conference proceedings being published in the ISPRS Archives:

- 28 paper from the FOSS4G Europe Conference in 2017, in Marne La Vallée, France: ISPRS Archives Volume XLII-4/W2, 2017, Editor(s): M. A. Brovelli, D. Kotzinos, N. Paparoditis, and V. Raghavan.
- 36 papers from the FOSS4G 2018 Academic Track in Dar Es Salaam, Tanzania: ISPRS Archives Volume XLII-4/W8, Editor(s): M. A. Brovelli and A. H. Namangaya.
- 39 papers from the FOSS4G 2019 Academic Track in Bucharest, Romania: ISPRS Archives Volume XLII-4/W14, Editor(s): M. A. Brovelli and A. F. Marin.
- 32 papers from the FOSS4G 2021 Academic Track in Buenos Aires, Argentina: ISPRS Archives Volume XLVI-4/W2, Editor(s): M. Gasparotto, S. Acosta y Lara, and M. A. Brovelli.

Current directions

The trend towards geospatial innovation through open source software and data is generally acknowledge and supported, see e.g. the UN GGIM Future Trends in Geospatial Information Management https://ggim.un.org/future-trends/ and the European Commission's open data policy https://digital-strategy.ec.europa.eu/en/policies/open-data and open source software strategy https://ec.europa.eu/info/departments/informatics/open-source-software-strategy_en.

Proposals for future activities for ISPRS

To date, the activities related to openness, while relevant and important, have somehow been fragmented and dispersed within the ISPRS. The creation of an (Intercommission) Working Group, aimed at promoting the development of technologies, policies, approaches and practices in support of open innovation in the domains of geospatial information science and remote sensing is therefore very timely.

The forum led itself to the expression and discussion of different viewpoints on openness, which could be repeated at future ISPRS events, either on a similar forum track or in panel discussions in a plenary session.

We recommend that the publication of the proceedings of the Academic Track of the FOSS4G conferences in the ISPRS Archives be continued. The (InterCommission) Working group could take the lead in facilitating this.

Conclusions

The forum was characterized by a remarkable diversity of panel members, allowing voices from different backgrounds and demographics to be heard: the private and public sector, research and universities, agencies like the United Nations (UN), the European Commission, the European Space Agency (ESA) and also citizens communities. This confirms that the topic of openness is generally and widely relevant. The forum was well attended and received, even by the younger generation, who were in the majority in the audience. While this was the first forum at an ISPRS event on this topic, we are encouraged by its success and the response from the audience to propose similar initiatives at future workshops and congresses.

Geospatial Education Towards Digital Transformation

Organisers

Roman Shults, (Kyiv National University of Construction and Architecture, Ukraine)
Karel Vach (EuroGV, Czech Republic)

Scope and Objectives

The last few years have shown an increased interest in applying new digital educational technologies that were not used before. The reason for that is twofold. The first is due to growing opportunities for online communications that have led to various forms of e-learning approaches globally. Humanity has opened wondrous possibilities provided by different digital educational platforms employing the internet. As a matter of fact, the role of digital technologies became dominant for training, regardless of the major or academic level. In such a way, the educational process has transformed into digital, sometimes even without our concern. The second one is about another global circumstance. The pandemic outbreak has changed the educational process throughout the world, as probably no one phenomena during the last hundreds of years. Presumably, that phenomenon has played the final role in the global transfer from traditional education to hybrid. The evidence points to the educational process will never return to the approaches and methodologies we have applied before. However, the role of digital education is still poorly understood. Especially this transformation is significant for engineering majors, and questions are more than answers. Should the digital education approach be different, e.g., for civil engineers and mathematicians? Whether the difference between traditional and digital education significant regarding quality or effectiveness? May we consider digital education more accessible around the world? Should we still commit to the current timelines for education in the case of its digital form? Is there a difference significant between web-facilitated learning, blended and hybrid learning, and e-learning/online education? The forum aimed to answer the mentioned questions in line with the mission of WG V/7 and unveiled the problems of geospatial education towards digital transformation for the training of AEC majors.

Outline of the Programme

The forum consisted of four parts.

1. Presentations of WG's members and other participants that embrace national experience according to mentioned topics and summarize the WG activities during the outgoing time (Czech Republic, Ukraine, Italy, etc.).

Roman Shults, WG V/7 Prospective activities and challenges
Manuel Garramone, Digital transformation in AECO education: the role of digital models as dissemination tools
Jaroslav Nechyba, Digital transformation needs skilled users
Cecilia Maria Bolognesi (remotely), Realizing the digital to know the real HBIM and BIM in contemporary educational processes
Roman Shults, Geospatial education and its role in multidisciplinary training

2. Open discussion of current and future issues concerning the dissemination of innovative geospatial technologies in multidisciplinary training and knowledge exchange.

Discussion participants: WG V/7 - Innovative Technologies in Training Civil Engineers and Architects (Czech Republic); WG V/2 - Promotion of International Collaborative Education Programs (Italy); WG III/5 - Information Extraction from LiDAR Intensity Data (Italy); Nigerian Institution of Surveyors

(Nigeria); Nepal Remote Sensing and Photogrammetric Society (Nepal); Czech Standardization Agency (Czech Republic); Photogrammetric Education Construction Institute (Czech Republic).

3. Suggestions and pathways for further coordination between WG V/7 and educational organizations and societies (International Association of Educational Civil Engineering Institutions, ICOMOS, - International Union of Architects, UN-GGIM Academic Network, etc.).

4. The discussion and adoption of the new plan for the WG V/7 - Innovative Technologies in Training Civil Engineers and Architects

The topics covered during the discussion:

- Innovative geospatial technologies in multidisciplinary training and knowledge exchange;
- Teaching innovative geospatial technologies to get learning skills in assessing the environmental impact of construction;
- BIM and geospatial education for building life cycle support;
- Geospatial education for civil engineering;
- Digital Twins and their geospatial educational constituent;
- Real estate management and its geospatial educational constituent;
- Smart Cities and their geospatial educational constituent;
- Geospatial technologies for facilities management.

The key concept of ISPRS Working Group V/7 is to promote global literacy and advance innovations in geospatial technologies, mainly in photogrammetry and remote sensing, for implementation in the educational process of applied and natural sciences through the development of multidisciplinary educational content that will facilitate knowledge exchange between various majors and scientific organizations.

We are establishing and soliciting a global collaborative network focused on the most efficient ways to integrate professionally and crowdsourced geospatial data into civil engineering, architectural, ecological, geological, and other operational workflows. To meet this challenge, WG plans to develop and promote worldwide educational content that provides training and education for geospatial literacy and skills-set development in civil engineering, environmental and architectural activities, ecological and geological studies, etc.

Special attention will be given to the low-cost photogrammetry, UAS, LiDAR, and open-sourced geospatial technologies suitable for deployment by developing countries. To this end, the group aims to collaborate with the UN University, European, and US educational programs that challenge to help developing countries. Finally, WG shares educational content, develops novel educational components of training and education in photogrammetry and remote sensing for civil engineers, architects, environmental engineers, etc., organizes joint workshops, symposium and prepares curriculums, textbooks, and recommendations.

Plan for WG V/7
ISPRS WG V/7 welcome workshop “Innovative Photogrammetry and Remote Sensing Technologies for Civil Engineers and Architects” by the Satbayev University, Almaty, Kazakhstan, in May 2023 in Almaty, Kazakhstan (with ISPRS Archives/Annals publication).
ISPRS WG V/7 workshop “Measurement, Visualisation, and Processing in BIM for Design and Construction Management MVPBIM 2024” hosted by Czech Technical University in Prague on September-October 2024, Prague, Czech Republic (with ISPRS Archives/Annals publication).

ISPRS WG V/7 workshop “BIM education and its liaison with geospatial technologies” hosted by University of Pisa on September-October 2025, Pisa, Italy (with ISPRS Archives/Annals publication).
Joint ISPRS WG V/7 workshop as a part of XII international ENVIRO-2023 “Environmental Engineering” conference hosted by the Vilnius Gedeminas Technical University on April 2026 in Vilnius, Lithuania (with ISPRS Archives/Annals publication and WoS conference publication).
Organize annual summer/winter schools with Czech Technical University in Prague during 2022-2026 on BIM, close-range photogrammetry, and UAV applications.

Edition of the online tutorial “Innovative Geospatial Technologies for Multidisciplinary Applications”, during 2024-2025.
Preparation of e-learning manual “Innovative Geospatial Technologies for Multidisciplinary Applications”, during 2023-2024.

Actions for ISPRS

Support for WG V/7 proposals for workshops.

Promote ISPRS WG V/7 activity through the system of getting grants for educational programs (from the EU) for the universities involved.

Conclusions

The forum has played a primary role in the further cooperation between different WGs and international societies. A lot of cooperation agreements were established just during the discussion process, particularly between the Nigerian Institution of Surveyors (Nigeria) and Photogrammetric Education Construction Institute (Czech Republic), Nepal Remote Sensing and Photogrammetric Society (Nepal) and Photogrammetric Education Construction Institute (Czech Republic), Czech Standardization Agency (Czech Republic) and Photogrammetric Education Construction Institute (Czech Republic). The organizers intend to implement the ideas and suggestions declared during the forum and hold similar events in the following years under the auspice of the ISPRS and WG V/7.

Intelligent Data for Smart Cities

Organisers

- Sisi Zlatanova (UNSW, Australia)
- Vincent Tourre (Centrale Nantes, France)

Scope and objective of the forum

The notion of Smart City is becoming critical to understand city dynamics, identify trends, predict further changes and provide a mechanism to make cities manageable, livable and sustainable. In this forum, five smart city experts debated on spatial data and their use in developing smart city technologies. The goal of the forum was to review past and ongoing projects and bring forward emerging and challenging topics for research. Several best practices of use of spatial data in Smart cities such as wellbeing, food, water, energy, mobility were central to the forum. Emerging technologies and best practices in the field of data collection using different sensors (in a broad sense) were also discussed. A large part of the conversation was on data models, data structures and standards such as CityGML, IFC, landinfra, as well as aspects of linking different concepts and enriching semantics. Being an important component of Smart Cities, communication with the citizens by dashboards, AR and VR interfaces, public displays, etc. were elaborated as well, including privacy concerns. The forum was organized as a mixture of short presentations, discussions and a closing Q&A session.

Outline of the programme

Short keynotes (10 min each + questions)

Volker Coors (HFT Stuttgart, Germany, Scientific Director of the Institute for Applied Research)
Irina Bastrakova (Geoscience Australia, Australia, Principal Advisor on Metadata Data and Linked Data)
Gilles Gesquière (University Lumière Lyon 2, France, Director of Intelligence of Urban Worlds Lab)
Yang Yue (Shenzhen University, China, Director of Shenzhen Key Laboratory of Spatial Smart Sensing and Services)
Valerio Signorelli (UCL, England, Lecturer in Connected Environments CASA)

Panel (10/5/5 – Ten questions to five experts on five topics)

Each topic was addressed by two keynote speakers to share and cross their view points about the next key challenges identified in the management of the urban data:

Data usage (eg wellbeing, green roofs, smart waste collection, smart traffic)
Data acquisition (sensors in a broad sense)
Data modeling/standards (eg CityGML, IFC, landinfra, linking data, semantics)
Physical phenomena/human behavior modeling (eg wind simulation, crowd behavior)
Interaction (eg Visual analytics, virtual/augmented reality, public displays)

Time was planned for the question of the audience to let the discussion append.

Relevance to ISPRS

The Smart City is an interdisciplinary concept in which several communities need to collaborate: geospatial science, remote sensing, computer science, sensors, sustainability, economics, politics, etc. Therefore ISPRS must be part of this convergence to influence the definition of the concepts, development of software and interfaces.

The forum is directly related to the topics of TC IV Spatial Information Science. More precisely, it deals with the spatial data on highly populated areas, thus addressing not only the data related to geography (eg: terrain height, land use, buildings) and physical phenomenon (eg: fluid mechanics, temperature) but also the data related to human behavior (eg: mobility, emotions).

Current directions

The current topics presented by the speakers or discussed during the panel:

- Data usage (e.g. wellbeing, food, water, energy, mobility)
    - Analysis: Socio-demographic with mobility data, Progress in the use of collected data by urban planners as they understood their need it
    - Communication of data: mobile island
    - Exploration of data: find patterns
    - Social exchange: Historic of a place
- Data acquisition (sensors in a broad sense)
    - Trusted data
    - Crowd sourcing for participative projects
    - Real time acquisition
    - Privacy: e.g. problem of anonymization in urgency
- Data modeling/standards (eg CityGML, IFC, landinfra, linking data, semantics)
    - Data exchange from different sources (ontology and open data)
    - Real-time data Modeling, in particular for the temporal dimension
    - Evolution and versioning of cities
    - Models for a multi-scalar city
- Physical phenomena/human behavior modeling (eg wind simulation, crowd behavior)
    - Multi-phenomena climatic simulation
    - Design guidelines for city planners
- Interaction (eg Visual analytics, virtual/augmented reality, public displays)
    - AR/VR data layers
    - In situ spots
    - Website and multimedia
    - Tangible interfaces

Globally, all these topics grouped together tends to claim **Urban Informatics** as a new discipline devoted to address the issues related to spatial data in highly populated areas.

Future requirements

It is acknowledged that data and specifically spatial data are rapidly collected and kept by many institutions in larger amounts than ever. Many of these data contain private of sensitive information about individuals or companies. **Privacy** was addressed in all discussed topics**.** There are two major issues: on one hand citizens and professionals want to know how their data are collected, stored and used through the whole chain from acquisition to exploitation, regardless of the data owner, private, governmental or public companies. On the other hand, having these personal data is of great importance to perform analysis to be able to understand tendencies and better account for sustainable development. How to balance between protecting privacy and making data available is a challenge that needs further attention. In this respect the role of researchers is critical. Researchers can bring their knowledge to help cities to find compromises between privacy and analysis efficiency, allowing establishing relevant urban policy. More generally, finding a balance between opposite goals (eg biodiversity vs. population density) will be a critical trend in spatial data analysis. Indeed, an alternative to deal with privacy issues is to produce synthetic datasets based on real

ones, allowing training models without revealing sensitive information about people's behavior, preferences, health, financial status, etc.

The **content** of the data was another key topic of conversation. Besides the qualitative aspect of the data that remains underexplored, the need to know how people perceive and react to the urban spaces becomes more and more critical to achieve a sustainable urban design. Data about **perception, emotion and cognition** are important, but also very intimate and therefore closely linked to the privacy. Such data is very difficult to gather as it involves either wearable sensors or qualitative methods from the human sciences, which are very difficult to model because they involve reactions of users to a place, unknown, difficult to predict social behavior.
Social behavior is also closely related to social networks and communities. They become increasingly used to study and predict the evolution of cities. This tendency links closely to the trust issue, because such a collective data production obtained by a public participation could have more validity than other methods.

To support efficiently sustainable planning and development, urban planners need to have a **large scope of data**, they can operate with. A range of user-friendly tools should be developed to allow selecting, query and process data in an efficient way. The planners and decision makers should be able to have a full view of the city with a minimal set of indicators and without the burden of full raw data. In this process, spatial standards are critical to resolve heterogeneity issues and compatibility challenges. The standardized conceptual data models should provide guidance on how to encode the patterns or relations between the data.

The **understanding** of the data remains a tough problem and even becomes increasingly complex. It was discussed therefore, that it seems necessary to improve the visual literacy of involved publics, allowing proposing a more reliable transmission of information. As an example, the 3D geometry data is now largely accepted by urban planners and decision makers and it is now the moment to convince other key stakeholders such as urban management and maintenance, which definitively could also be helped by 3D models.

Finally, the question was raised about how to handle the **complexity** of the city in all the previous topics. Several viewpoints brought some insights to the discussion as follows: the scalability and the intrinsic multidisciplinary features of the data require establishing mappings between data models based on a model-driven approach and ontology networking; the understanding of the dynamics of physical or human phenomena is mandatory for analysis and for the compacity of data representation; the interaction with the data to get insights could be achieved by setting interactive visualization tools with the help of designers.

Proposals for future activities for ISPRS

Here as some possible topics for futures ISPRS events:

- Involve actively city authorities in workshops or dataset production to help them to reach their sustainable goals as a sustainable city model should be integrated into our fundamentals in our research agenda.
- Make contact with the mathematical community to advance data filtering models for most informative indicators to train models, to extrapolate
- Train new user generation by being involved into teaching and upskilling activities at international level (e.g. via ISPRS TC V).
- Setup of a community project to allow gathering data about perception in a clean (privacy) and non-invasive way (avoiding specific equipment).

- Handling the complexity of the city in all its aspects: multidisciplinary, scalability, modeling and interaction, with specific tracks and conference.

Conclusions

The forms and the discussed topics clearly revealed that:

- The role of spatial data is increasing, which puts further pressure on the geospatial researchers towards developing new more effective technologies and methods for data collection, processing, management, analysis, understanding, visualization and simulation of data. The agreements on data access, standards and regulations, management and update should be intensified.
- The topics of sustainable development are based on knowledge derived from integrating traditional spatio-temporal data with sensors measurements, social and economic data is increasing. The uprising challenges of fusing and understanding heterogeneous data can be resolved only via close collaboration between different research disciplines including citizens and social sciences.
- Applications for smart cities as well as Digital Twins have been rapidly developed, which poses challenges for professionals to follow, understand, adopt and appreciate developments, tendencies and challenges. More focused activities should be organized on disseminating and promoting research and developments, as well as educating and skilling up professionals especially from low-income countries.

Multi-source Data Collection for National/Regional-Wide Mapping

Organisers

Raphaële Héno (IGN)
Anna Cristofol (IGN)

Scope and objective of the forum

Climate change is disrupting our environment and forcing us to change our behaviour. In support of public policies, reliable and frequent observations of the territory are required. National mapping and cadastral agencies (NMCA) are facing the challenge of up-to-date cartography of a constantly changing territory. The profusion of earth observation data (spatial and aerial images, drone images, Lidar data, mobile mapping data, and collaborative data) is of course an asset, but combining them optimally remains a technical, economic and organizational challenge. This forum means to outline scenarios of technological mix, on the basis of presentations by holders of use cases, by industrial suppliers of technical solutions and by users of these solutions.

Outline of the programme

Use-case presentation

Use cases on Strasbourg; Olivier Banaszak (Ville et Eurométropole de Strasbourg - France)
Use cases on Brazil; Antonio Maria Garcia Tommaselli (Unesp, Presidente Prudente - Brazil)

Brainstorming: other interesting use cases

State of the art in the field of earth observation

Satellite imagery; Michael Tonon (Airbus Defence and Space - France)
Aerial imagery; Marcos Martinez (European Association of Aerial Surveying Industries)
Drone acquisition; Francesco Nex (ITC, University of Twente – the Netherlands)

Earth observation data: collective work session

How to address specific use cases?

Summary of presentations and discussions

Interesting points from use cases - Strasbourg:

- Example of use cases:
    - How many trees to plant to reduce urban heat island? Where?
    - What is the potential for constructing the city on the city?
- Existing data :
    - High density aerial Lidar
        - Classified and colorized 3D point cloud from two airborne Lidar acquisitions in 2015 and 2021.
        - Average density: 20 points/m² in 2015 and 30 points/m² in 2021.
        - The accuracy is 10 cm in XY and 5 cm in Z.
    - Complementary data to Lidar acquisitions

        - The 3D photomesh from systematic nadir and oblique aerial photographs, taken between 6 and 22 August 2018 at a pixel size of 5 cm/ground.
- Example of other use of 3D point clouds
    - Archaeological index / Mosquito control / Favourable sites for amphibians
    - Solar cadastre Update of the 3D GIS layers (soil, building, vegetation)…

More to see on the GIS of Strasbourg metropolis : http://sig.strasbourg.eu/ and http://www.data.strasbourg.eu/

Interesting points from use cases - Brazil:

- Example of use cases:
    - How to map Sao Paulo (250 000 km^2; most developed state)
    - Mapping Amazon region
- Existing data (Sao Paulo):
    - Aerial images (RGB and IR) + Lidar
    - North region, 60 000 km^2, GSD 25 cm, ALS 12 pt/m^2
    - Main products are :
        - Orthomosaics, DTMs, Hydrography, Municipal borders (645 municipalities)
        - Vector products being produced are mainly Hydrography
        - Land use maps for protected areas
    - For the future, the aim is to use satellite images with automatic processing to update land cover annually
- Existing data (Amazon):
    - SAR images
        - P-band – with a wavelength of 75cm – can penetrate the vegetation
-

2. Brainstorming: other interesting use cases - Results

· Yearly updated land use cover · Land use classification · Land use / land cover map at global level · Automatic land cover cartography at cadastral unit level · Land cover maps · Modular artificialisation mapping · Visibility of a monument or any relevant building in a city (example: from where can I see this church?) · Hiking trail · Potential places to produce wine in 30 years	· Offering public alternative to google map · Renewable energy production · Urban 3D data for emergency response · Urban 3D maps · Updating new building for planning · Obstacle databases · Forest clear cut detection · Maturation of forest · Relief mapping through forest · High resolution DTM in border area · Pan European DTM for flooding prevention	· Location of light sources in urban and countryside areas · Flood modelling risk · Coastal bathymetric Lidar to monitor sea level · Urban heat islands · Heat/cold loss on building · Crop type maps at national level · Vegetation mapping · Ground reference for agriculture management · Understanding utility network for maintenance · Map new urban area / change detection · Impulse geodata into video games

Two specific uses cases were chosen by the group for a further investigation:

1. Use case n°1: map new urban area / change detection
2. Use case n°2: impulse geodata into video games.

State of the art in the field of earth observation

Satellite imagery; Michael Tonon (Airbus Defence and Space - France)

- Overabundant market: only some satellites are listed (optical sensors; GSD < 5 m; commercially available)
- Advantages of satellite images: non-intrusive, permanent and global capacity, wide swath & high resolution
- Main industrial actors: Digital globes, Airbus, Planet (and many others)
- An impressive offer, growing exponentially
    - Around 400 commercial optical satellites
    - Since the beginning of the year, around 50 launches of new satellites (radar, optical, around 8 per month)
    - Around 35 others (at least) planned in 2022
    - The new frontier: GSD < 50 cm (around 30 cm)
- But very heterogeneous levels of quality:
    - Commercial availability
    - Tasking capacity and speed
    - Image radiometric quality
    - Image geometric accuracy
    - Level of services (delivery, after-sales service…)
    - Different value-added products
    - Stereo capacities

Aerial imagery; Marcos Martinez (European Association of Aerial Surveying Industries)

- Advantages of aerial images: very high-resolution measurements; HR oblique imagery; different physical inputs (RGB/IR/Lidar); data captured in a short time frame; higher frequency & larger areas; reasonable cost levels
- How is the industry reacting? more efficient sensors (cmos sensor; frame rate 4x faster; better spatial resolution à 2,5 cm); developing hybrid solutions; renewing and adapting their fleets; R&D investing

Drone acquisition; Francesco Nex (ITC, University of Twente – the Netherlands)

- State of the art: Rotor drones (autonomy = 40 mn); Fixed wing drones (autonomy = 2 h) ; Battery life is constantly improving (about 3-5%/year); Area extension is still limited by regulations more than technology
- Drones are now on the Gartner's hyper cycle productivity area.
- Research UAV & photogrammetry (multi-modal registration, flight path optimization, direct georeferencing issues)
- Research UAV & mapping (Building Damage detection, Urban classification, Object detection, Active and hyper/multi-spectral data analysis)
- What UAV can do for NMCA to tackle Climate Change? (High resolution, Low cost & Flexibility, Easy repetition of flights over the same area, Customized solutions, 24/7 services, real time data processing, Growing miniaturization, UAV & IOT)
- What is still missing? (fully autonomous and reliable systems, legal permits to fly in any environment, Capacity to fly in night conditions and in adverse weather conditions, still limited extension, although complementary to other typologies of data)
- cf. www.itc.nl/uav-centre

Earth observation data: collective work session

Opportunities		Obstacles
· Large scale mapping	**Satellite imagery**	· Price

· Repetitiveness
· Historical data archive
· Change detection potential
· Very good for change detection of large features
· Many satellites
· No legal limitation (in theory)
		· Clouds
		· Accuracy (Z)
		· Geometric accuracy
		· Geometric resolution
		· Sensor vulnerabilities
		  · Hacking
		  · Collision
		  · Hardware failure
		· Lack of ground reference
		· Off the shelf processing solutions

· Easy to produce 3D info · High resolution + large areas · Well known practices	**Aerial imagery**	· Price · Weather dependant · Flight permits · Flight regulations · Reactivity · Cost?
· Flexibility · Quick to planify and acquire data on a specific location · Very high spatial / temporal resolution + cheap	**Drone acquisition**	· Very restrictive flying rules · Spectral bands · Weather dependant · Meteorological limitations · Complex regulations · Legal limitations · Rules · Regulations not yet developed
· Quick update of urban areas · GIS data update (topometric & thematic)	**Mobile mapping data**	· Masks GDPR · GDPR · Obstacles in mapping area · High cost and huge scale
· Compound with aerial data · Accuracy · Not weather dependant · Effective on vegetation mapping	**Lidar data**	· Price · Sensor hybridization · Data access · Archive data existence · Not easy to understand
· Indoor acquisitions · Gamification · Crowd down to earth: local knowledge · Variety of point of view · “free” source of data acquisition · Close to people needs · Low cost / high frequency	**Crowd sourcing data**	· quality · Quality control · Some “false” data could appear · GDPR · Noisy · Trust & authority

<u>How to address specific use cases?</u>

Use case n°1: map new urban area / change detection

Stakeholders	Cities, authorities / NMCA / Cadastral land management agencies
Governance	Administration & decision making / Urban land use planning
Users	Companies doing service deliveries / security services (fire ; civil security) / cadastre / city authorities / citizens

Thematic fields	Protected areas / smart cities / deforestation / automatic driving / protected areas
Temporal dynamics	Crowd sourcing (almost real time) / few days-months or real time dynamic env / Update time depends on local (Europe expects greater than 3 months) / Urbanization is normally one direction change but can also be abandoned
Spatial dynamics	Need for fast production (AI, ML Methods) / urban sprawl vs reconstruction / Multi dimension & resolution / Spatial completeness (all or partial)
Constraints	People intimacy / cost of regular updating / change detection tools are not fully precise / Crowd sourcing is difficult to integrate
Economic, political societal, value	Keeping trust in city data / better decisions with good data / more upstaged reference data à better projects; better public services / new urban area increase; land values in the surrounding areas / transparency

Mixed approaches for a specific case study

Technological mix	Sensors in vehicles / phone positions (detect density in protected areas; illegal buildings) / cameras on board commercial planes (change detection) / Regular –yearly- satellite images to detect changes / Long term urbanization monitoring; open access data –eg Landsat / local acquisition –Lidar + RGB / Satellite (temporal resolution) ; Airborne (spatial resolution)
Business model	Public & private partnership / Public money – common property
stakeholders	NMCA (local acquisition for cities/region) / local authorities / market applications (web, phone) could drive the need / companies /
Threats	Data produced and owned by big companies / lack of solutions to make it happen is reality / lack of consistent solutions / if data outdated it is useless /
Opportunities	A way to develop new solutions / better decision making; monitoring /

Use case n°2: impulse geodata into video games

Stakeholders	Video game companies / data centres / geodata producers / gafams
Governance	Open source to reduce price and monopole
Users	Gamers / VR applications / guinea pigs used to monitor a community and their interactions with the game / augmented reality
Thematic fields	Heritage / ecology (ecosystems dynamics; impact studies) / History (bring some epic flavour to the game / crisis management –a SimCity like game)
Temporal dynamics	Temporal dimension visualisation
Spatial dynamics	Every scale
Constraints	Data formats / licence; open data / GDPR / Big data
Economic, political societal, value	Communication (advertising for tourism in a city) / serious gaming; training / event management

Mixed approaches for a specific case study

Technological mix	All types of resolution depending on the landscape to model (monument vs global view) All spectral bands; part of the scenarios
Business model	Crowdfunding / free with advertisement / Freemium/premium
Stakeholders	Develop GI interest into geodata / start up

Threats	Video games too fun for geodata producers (and vice versa)
Weakness	Updating / maintenance costs
Opportunities	Expertise of video game in compression / generalisation Gamers = futures users

Relevance to ISPRS

The subject of the forum is obviously relevant within the framework of ISPRS: it places photogrammetry and remote sensing at the heart of operational actors needs, whether they relate to land use planning, environmental protection, architecture, creative industry, or others. The needs-based approach highlights the technical and social issues related to multi-sensors data acquisition and to the mapping of territories at the scale of a region or a community.

Current directions

Interesting use cases in the field of climate change monitoring were mentioned:

- At the city scale:
  - How many trees to plant to reduce urban heat island? Where?
  - What is the potential for constructing the city on the city?
  - How to regularly update data in urban area?
  - How to monitor changes in urban landscapes under regulatory constraints of urban policy?
- At a country scale:
  - How to map a highly forested area constantly under the clouds?
- Whatever the scale:
  - How to better use videogames to map a country in the context of climate change?

Presentations and insights from the audience provided an update on current innovations in earth observation data that can be harnessed to monitor the impact of climate change. The most significant innovations are reminded here below:

- Satellite optical imagery:
  - GSD: new frontier < 50 cm
  - Always more satellites in the air
- Aerial imagery:
  - GSD up to 2 cm
  - Oblique imagery as a quasi-standard
  - Frame rate (thus acquisition rate) faster
- Drone imagery:
  - Battery life longer (more autonomy)
- There was no specific presentation on airborne Lidar data, mobile mapping nor on crowd sourcing but it has been mentioned:
  - [crowd sourcing]: carry cameras on airliners

Debates showed that everyone is aware of the diversity of Earth observation sources and the high potential to use them in a complementary way. However data processing ready to use bricks are still missing, especially in the field of data updating.
Challenges for mapping a fast changing environment:

- Does “fast” mean “near real time”?
- Many data is available but efficient (as automated as possible and reliable) processing methods to produce analytics or maps are still under construction.

Future requirements

The different sources of earth observation are relevant for the many use cases that were discussed during the workshop, and in general for monitoring the impacts of climate change. Proposals for change detection on spatial images supplemented by mapping these changing zones on aerial images or even drone images have been made. In this context, work still needs to be done on the evolution of legislation on the use of drones. Moreover, while the observation data are certainly numerous, fairly automatic processing methods for analysing ever more data in a complementary mode are not yet available.

Proposals for future activities for ISPRS

The subject of mapping our fast changing world has become essential to optimize the public policies that aim at limiting climate change and its many impacts.

- A specific working group could address this challenge on technical, economic and organizational aspects (while the WG1/6 “multi-sensor integration and fusion” is rather focussed on scientific and technical aspects).
- Another ISPRS group could work on taking more benefit from the video game industry, for example using Stylish 3D representation of objects, high quality rendering, Immersive reality and involving gamers, young people who can be sensitized to geoinformation through serious games.xs

Conclusions

Current climatic, environmental and social transformations are the source of challenges in a wide variety of fields: monitoring and supervision of urbanization and land take, renewable energies, monitoring of the environment and biodiversity, monitoring of deforestation, floods, agriculture, urban heat islands, sea level rise, crisis management, etc.

Multiplication of earth observation sources is a real opportunity to address these issues. It makes it possible to monitor territories more frequently, under several conditions: 1/ propose a relevant technological mix taking technical, financial, regulatory and organizational constraints into account; 2/ facilitate the implementation of this technological mix thanks to operational technical bricks.

Research in the fields of multi-sensor mapping, change detection and automatic data analysis meets crucial needs. And valorisation of research results into easily integrated operational bricks is a major challenge.