

## VIRTUAL TOOLS ECOSYSTEM FOR PERIURBAN GREEN AREAS MONITORING AND PROMOTION: OUTCOMES AND OUTLOOKS OF THE INSUBRIPARKS PROJECT

D. Oxoli<sup>1\*</sup>, M. A. Brovelli<sup>1</sup>

<sup>1</sup> Dept. of Civil and Environmental Engineering, Politecnico di Milano, Como Campus, Via Anzani 42,  
22100 Como, Italy - (daniele.oxoli, maria.brovelli)@polimi.it

Commission IV, WG IV/9

**KEY WORDS:** Periurban Parks, Green Areas, Cross-border Cooperation, Smart ICT, Information Systems, Sustainable Tourism

### ABSTRACT:

Green areas such as natural and periurban parks provide support to biodiversity and landscape preservation while boosting local economic growth in their hosting territories, thanks to the establishment of eco-tourism activities. Smart management and promotion actions are vital for the sustainable exploitation of such benefits for citizens and visitors. These tasks may be hindered by a lack of economic resources and digital skills of public authorities but also by fragmented local political contexts to which these areas may be subjected. The parks in the Insubria region (between Southern Switzerland and Northern Italy) represent a relevant example of the above. The INSUBRIPARKS project aims at the harmonisation of management and promotion practices for the Insubria parks. The project activities encompass multiple actions, from the establishment of unified territorial marketing strategies to the development of supporting IT tools. Accordingly, this paper provides an overview of the IT tools ecosystem which was designed and developed within the project and an outlook on its role in empowering smart monitoring and promotion for these parks. Tools include a Web portal (enriched with Web mapping components) for a unified presentation of the tourism offers, an analysis framework for social media data exploitation in park visitors' fluxes assessment, and a mobile tool for users' engagement in the park areas monitoring. Alongside technical descriptions, lessons learned and residual challenges for the operative adoption of the tools are discussed as to their future improvements.

### 1. INTRODUCTION

Green areas such as periurban natural parks provide citizens with a number of health and leisure benefits, often accessible within a few minutes of travel or walking distance from urban centres. These areas support biological diversity, landscape preservation, leisure activities and environmental education which have emerged among key aspects for sustainable management also of the neighbouring urban centres (Dobbs et al., 2018). Furthermore, periurban natural parks often contribute to the economic integrity of their hosting city outskirts thanks to the establishment of green and outdoor tourism activities (Di Minin et al., 2015).

Nevertheless, the physical presence of such areas does not always represent a sufficient condition to ensure the above benefits are entirely accessible by citizens and visitors. Smart planning, management and promotion of periurban natural parks remain critical tasks to ensure profitable exploitation of their assets. These tasks may be hindered by a lack of economic resources and digital competencies of public managing authorities (Chen et al., 2021) but also by fragmented local political contexts to which these areas may be subjected. This can prevent optimal management due to competitive actions as well as weak cooperation among the decision-makers (Prell et al., 2016).

An example of the above scenario is represented by parks in the Insubria region. Insubria is a historical-geographical region stretching between the Canton Ticino (Southern Switzerland) and the Lombardy Region (Northern Italy). This region encompasses a number of interconnected landscapes ranging

from the plain to the Alpine environment and includes many densely populated urban centres. In this context, the INSUBRIPARKS project, funded by the Interreg Co-operation Programme 2014-2020 of the European Union (<https://interreg-italiasvizzera.eu>) is developed. The project aims at the harmonisation of management and promotion practices for the Insubria periurban and natural parks. The project partners include the main parks of the area (see Figure 1). For the Italy side namely Spina Verde (<https://www.spinaverde.it>), Campo dei Fiori (<http://www.parcocampodeifiori.it>), and Pineta (<http://www.parcopineta.org>) parks. On the Swiss side, parks Gole della Breggia (<https://www.parcobreggia.ch>) and Penz (legally represented by the municipality of Chiasso - <https://www.chiasso.ch>) are involved. Parks are also identified as the primary stakeholders of the project. Historical and cultural aspects of the project are concerned by the non-profit organization Pro Val Mulini ONLUS (<http://www.provalmulini.eu>) while the Swiss Regional Tourism Office (OTR) Mendrisio Turismo (<https://www.mendrisiottoturismo.ch>) participates as a key institution for sharing tourism management practices. Finally, two universities, Politecnico di Milano (<https://www.polimi.it>) on the Italian side, and The University of Applied Sciences and Arts of Southern Switzerland (SUPSI, <http://www.supsi.ch>) on the Swiss side, are in charge of the technological developments of the project.

The project activities incorporate multiple actions, including the provision of physical infrastructures for pedestrian mobility, the establishment of unified territorial marketing strategies, and the development of supporting IT tools to improve information sharing and consumption among and between parks managers and users (Eusebio et al., 2021). Accordingly, this pa-

\* Corresponding author



**Figure 1.** Schematic of the Insubria region with its parks (green polygons) and main urban centres (black triangles). Reference map background: Bing Satellite © 2022 Microsoft. Adapted from <https://insubriparksturismo.eu>.

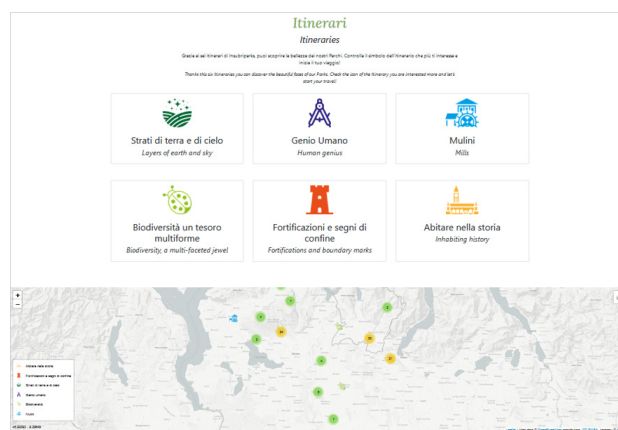
per provides an overview of the IT tools ecosystem which has been designed and developed within the INSUBRIPARKS project and an outlook on its role in empowering smart monitoring and promotion operations for the Insubria parks. Tools include a Web portal (enriched with Web mapping components) for a unified presentation of the tourism and recreational offers, demonstrator frameworks on the use of social media data for park visitors' fluxes analysis and a mobile tool for users' engagement in the park areas monitoring. To that end, free and open-source geospatial technologies and software (in combination with multimedia content and both mobile and Web technology) are leveraged in the development of the tools to aid coordination across the involved park management offices, by reducing technological barriers and costs of decision making that are relevant to these geographically distributed institutions (Sturgeon, 2021). Many of the presented tools are currently in a pre-operational or demonstrator phase and thereof adoption into actual parks management operations is under discussion as of the time of writing.

The remaining of the paper is as follows. Section 2 presents the project Web portal and related tools. Section 3 describes the framework developed for park visitors' fluxes analysis using social media data. Section 4 introduces a mobile tool conceived for filed data collection and reporting by users. Section 5 presents an overview of supporting or complementing actions delivered by other partners as well as implementation issues faced during the project development. Finally, Section 6 includes overviews and discussion of the achieved results as well as future directions and expectations for the presented work.

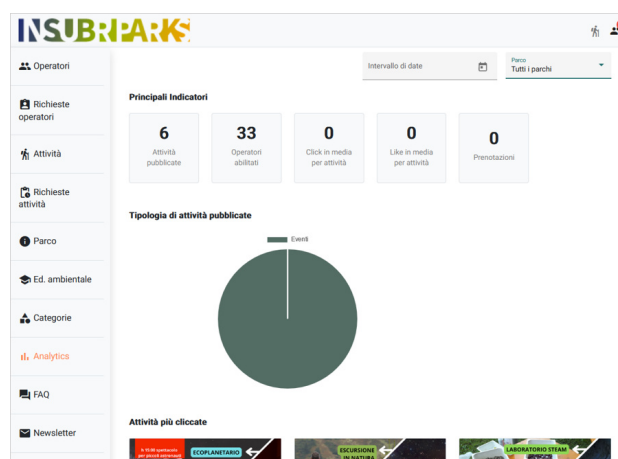
## 2. WEB TOOLS

The leading goal of the INSUBRIPARKS project is to provide a single channel - jointly managed by the partner parks - for disseminating information and services to visitors and promoting the label of Insubria parks through coordinated territorial

marketing actions. The underlying need was to divert tourism-related information from the Web-portals of every single park to a shared container, thus improving both visibility and accessibility of such information to the users. To that end, the INSUBRIPARKS Web portal (<https://insubriparksturismo.eu>) was developed. The portal embeds textual, graphical and web mapping content together with a database of tours and visiting experiences directly uploaded by both local guides and parks staff (see Figure 2).



(a)



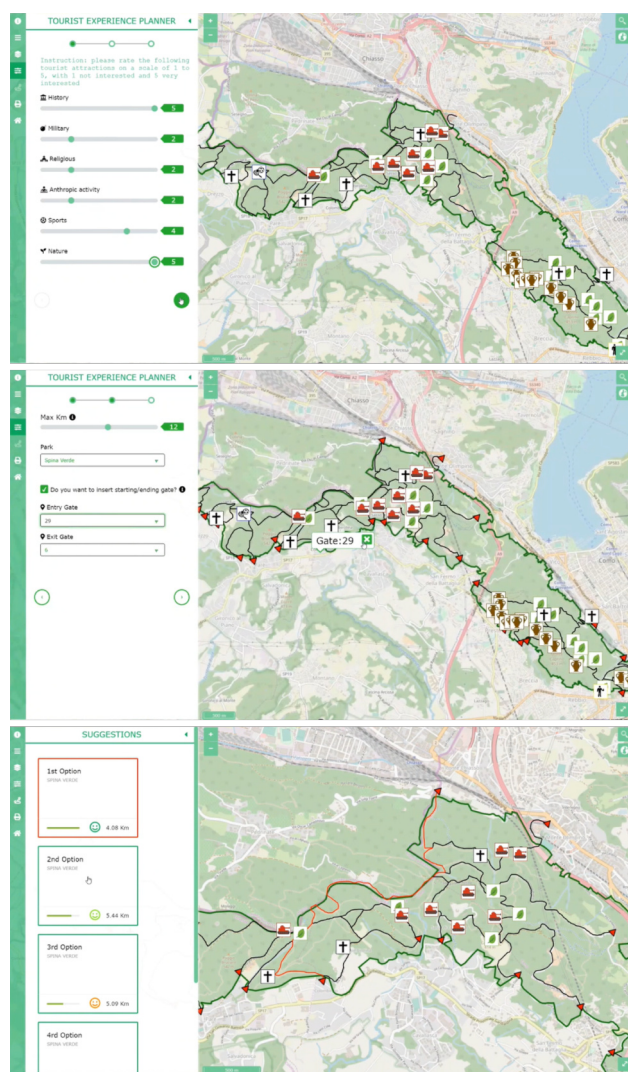
(b)

**Figure 2.** Sample map content of the INSUBRIPARKS Web portal (<https://insubriparksturismo.eu/itinerari>) (a) and a preview of the analytic Web dashboard interface (b).

The portal is enriched with Web mapping and analytic dashboard components respectively to highlight the territorial contiguity of Insubria parks and to enable park managers to retrieve insights into the users' interactions with activities and experiences promoted therein. The deployment of dynamic Web maps (see Figure 2a), embedded in the portal, was supported by the development of a geospatial data package including background cartographic information, path networks and point of interest (with pictures) for the whole study area. This package was published with an open licence to favour its re-use by the project partners and beyond (Oxoli, 2022). The analytic dashboard (<https://staff.insubriparksturismo.eu>) supplies reports and statistics from the Web portal usage to the affiliated park managers thus empowering the monitoring of the users' engagement with the activities promoted online (see Figure 2b).

A prototype Web Geographic Information System (WebGIS)

application was also developed to support the selection of the "best path to walk" within the parks (see Figure 3) by implementing multi-criteria decision-making procedures applied to path network layers (Oxoli et al., 2020, Oxoli et al., 2021). The source code of the application is available on GitHub ([https://gitlab.com/geolab.com/insubria\\_parks\\_itinfrastructure/-/tree/master/webgis](https://gitlab.com/geolab.com/insubria_parks_itinfrastructure/-/tree/master/webgis)). The application was conceived to provide an immersive virtual experience to the visitor, who could interact with its data of interest improving its connection and involvement with the parks. Currently, the application is demonstrator-only and it has not been included in the Web portal yet.

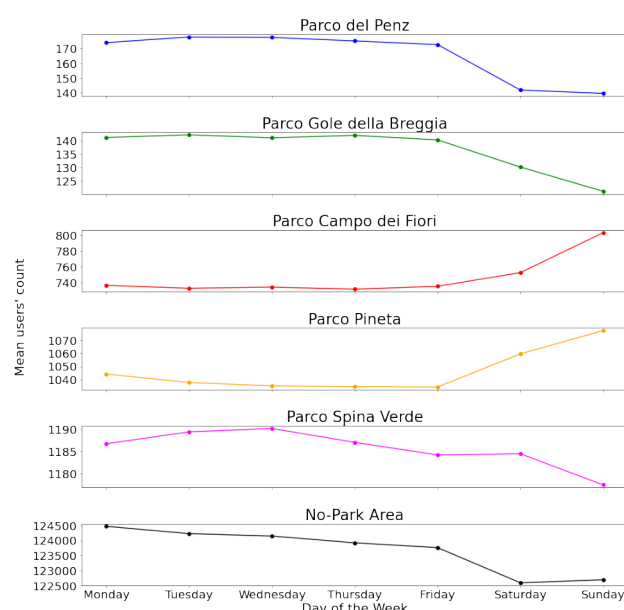


**Figure 3.** Prototype WebGIS application supporting the selection of the "best path to walk" using multi-criteria decision-making procedures.

### 3. VIRTUAL MONITORING OF PARKS VISITORS

Concurrently with the Web portal development, some research activities have been carried out. One of the objectives of the INSUBRIPARKS project is to explore emerging or unconventional data sources to monitor visitors' presence in the parks. Specifically, an investigation of the use of social media data for the above purpose was addressed. A procedure to infer and describe average space-time trends of people fluxes in

the Insubria parks was developed by exploiting user-generated geodata from the Data for Good initiative promoted by ©Meta (<https://dataforgood.fb.com>). This initiative provides aggregated records of Facebook users' positions in time (called *Facebook Population Maps*). The dataset is distributed as a geographic grid in CSV format. One grid every 8 hours is released. The outlined procedure exploits these data to retrieve descriptive space-time local statistics enabling pointing out destination preferences as well as seasonal/weekly people fluxes variations within the parks and differences with the surrounding areas (see Figure 4). The main findings from the above activity highlighted the potential of citizen-generated geodata to inform on space-time trends characterization and to supply metrics of people fluxes across territories that are difficult to retrieve using traditional monitoring tools, such as surveys (Hausmann et al., 2018). Details on the procedure and results are published in different scientific papers (Oxoli and Brovelli, 2021, Oxoli et al., 2022b, Vavassori et al., 2022), which were co-authored by the authors of this paper.



**Figure 4.** Variation of Facebook mean users' population count per day of the week in the Insubria parks and surrounding areas for the period May 2020-December 2021. Illustration by (Oxoli et al., 2022b) licensed under CC BY 4.0.

### 4. MOBILE TOOLS

The IT ecosystem of the INSUBRIPARKS project incorporates also a mobile tool for georeferenced field data collection which is designed to stimulate visitors' participation in the monitoring and reporting of events, issues or feedback on points of interest during their stay in the parks (Oxoli et al., 2022a). This tool, called Geo Collector Bot, is a configurable Telegram-based chatbot enabling the dispatching of data collection forms that can be activated and filled through Telegram chats (Telegram Messenger Inc., 2022), therefore avoiding the development and/or the installation of a specific mobile app on visitors' devices (Steinberg et al., 2019). From the developer's perspective, the use of an open and cross-platform external mobile client, such as the Telegram app, allows for maintaining a single code base for the Geo Collector Bot, which results in a significant reduction of the development effort.



To collect the data, the Bot asks (through a programmable form) a series of questions to the user including location coordinates, media, textual annotations, multiple-choice checkboxes, etc. and persists the answers to a spatial database (see Figure 5).

The Geo Collector Bot currently consists of a back-end application written in Typescript and running on Node.js. The Geo Collector Bot source code, documentation and a demo are available on GitHub (<https://github.com/opengeolab/geocollectorbot>) and local deployments of the system are facilitated by the provision of a Docker container (<https://hub.docker.com/r/geolabpolimi/geo-collector-bot>).

The development work for the Geo Collector Bot - at the time of writing - is still ongoing. Activities are focusing mainly on the generalization of system configuration patterns, and the improvement of both users and developer documentation (<https://geocollectorbot-doc.readthedocs.io>). In parallel, a Web dashboard to facilitate the Bot management is being included in the stack of the Geo Collector Bot ([https://github.com/opengeolab/geocollectorbot\\_dashboard](https://github.com/opengeolab/geocollectorbot_dashboard)). The dashboard (see Figure 5) will allow to configure the Geo Collector Bot system, create and customize data collection projects, dispatch survey forms, manage users, send personalized feedback directly through chats, and access and analyse data through simplified interfaces.

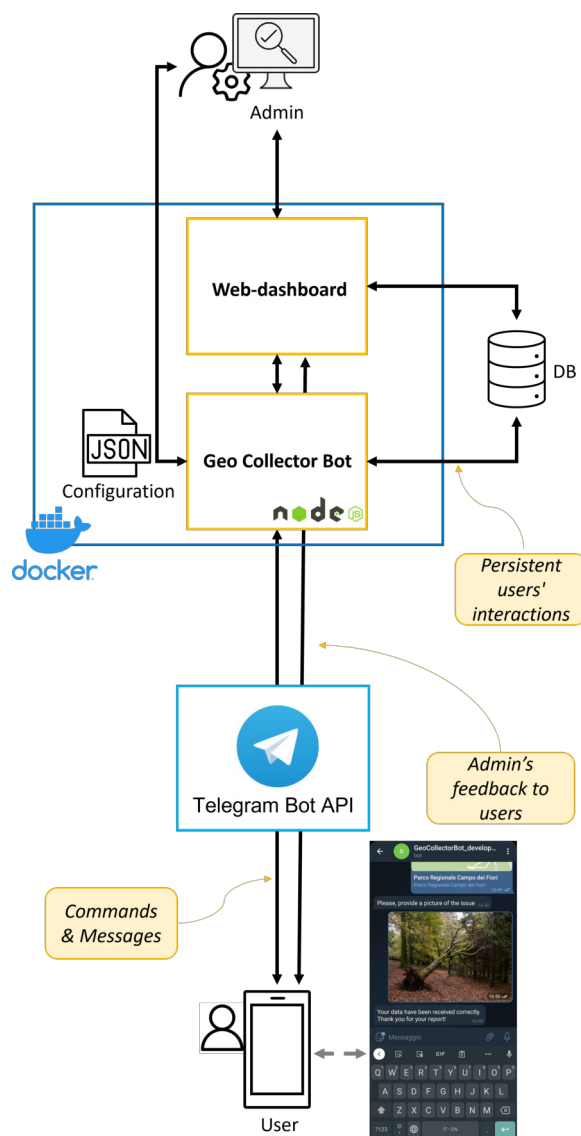
The Geo Collector Bot was primarily conceived to actively involve visitors in supporting park managers for ordinary surveys and maintenance of the park areas. However, it provides an open and general-purpose data collection software framework suitable for multi-purpose applications. A beta version of the full system is expected within the fourth quarter of the Year 2022 (corresponding to the INSUBRIPARKS project end). A first extensive test phase for the Geo Collector Bot is planned. Project park managers and rangers will be involved with the aim of testing and assessing the advantages of the system against current partners' practices of managing visitors' reports via direct communication channels (i.e. phone calls, SMS, WhatsApp messages, etc.).

## 5. SUPPORTING ACTIONS AND IMPLEMENTATION ISSUES

In the previous sections, the contribution of the Politecnico di Milano team to the IT tools ecosystem of the INSUBRIPARKS project was presented. Nevertheless, other synergistic activities supporting the enhancement of land management and promotion practices for the Insubria parks have been carried out by the project partners (see Section 1).

Concerning the tourism infrastructure, the partner parks built and/or refurbished some of their museums and educational centres to extend their tourism offer as well as empower their traditional activities connected to environmental education and landscape heritage conservation. Interventions such as securing the main walking path networks and improving their signage were also completed. Additional intangible key actions were implemented. These include signed agreements for the coordinated communication of the tourism activities as well as the development of cross-boundary thematic itineraries to promote visitors circulation between Italian and Swiss project areas.

The IT tools ecosystem is also contributed by the Swiss technical partner SUPSI. Specific aspects addressed by SUPSI re-



**Figure 5.** The Geo Collector Bot system architecture with a sample Telegram chat interface for data collection in the field.

gard the creation of 3D models for historical building conservation and analysis, the physical monitoring of touristic fluxes using smart sensors and the development of a prototype software platform to support natural areas management processes (Canata, 2022). The last two aspects intersect and complement the work presented in sections 3 and 4 and their integration is currently under discussion. In particular, the Geo Collector Bot is designed to dispatch collected data in a compatible format with the prototype software platform to support natural areas management and the two developments are being carried out in parallel.

Besides the technical implementation of the outlined IT tools, some barrier to bringing them into the actual digital operational workflows of the partner park offices has been faced. Issues are two different types. The first one is connected to the intrinsic diversity of organizational patterns followed by the park offices. This difference is remarkable between the two countries involved in the project (i.e. Italy and Swiss). For the Italian parks, managers are in charge of both administrative and promotional activities. The latter are neither supervised nor fully supported

by regional or national tourism offices. In the past, this has often resulted in uncoordinated actions held on by single park offices which have limited budgets and capabilities to fast adopt innovative promotion strategies or tools (e.g. the one proposed by the INSUBRIPARKS project) as well as discuss and co-create them with external partners. This scenario is not typical for the Swiss parks, which are instead coordinated by local, regional and national tourism offices working in a well-regulated framework. No project actions have been possible to mitigate this issue because it derives exclusively from existing policy and regulation contexts.

The second barrier has been identified in the lack of specific IT expertise of the park officers. Outsourcing for the development and maintenance of digital assets is a common practice. In some cases, this has an impact on the effective exploitation of IT tools due both to poor training of the park employees as well the poor suitability of the IT tools to meet real operational requirements or needs. This second type of issue has been addressed by the INSUBRIPARKS project through an iterative re-design of the proposed solutions by also radically adjusting the initial project plan (Oxoli et al., 2019). Accordingly, some of the expected outcomes of the IT tools ecosystem have been simplified and adapted to ensure their maintainability beyond the project lifetime (e.g. the Web portal mapping content) while other outcomes have been limited to demonstrators or research outputs (e.g. the virtual monitoring of visitors through social media data).

It is worth noticing also that the time schedule of the project activities plan has been marginally affected by the COVID-19 pandemic due to mobility restrictions that were in place both in Italy and Switzerland during the project period.

## 6. CONCLUSIONS AND OUTLOOK

We presented here the work carried out for the INSUBRIPARKS IT tools ecosystem development. The ecosystem composes of several software platforms which are conceived to support both marketing activities for the Insubria parks and the management of the park areas. To that end, the developed tools mainly consist of a Web portal (enriched with Web mapping components) for a coordinated presentation of the tourism landmarks of the partner parks and a mobile application for users' engagement in the park areas monitoring. Furthermore, a prototype software platform to support natural areas management processes and a network of smart sensors to monitor visitors' fluxes (developed in parallel by other project partners that the authors) complement the IT toolkit. Additional studies were performed to explore the contribution of unconventional digital data, such as Facebook records, to assess space-time trends of visitor fluxes. This IT tools ecosystem, coupled with the amelioration of physical tourism infrastructure and the definition of a coordinated territorial marketing strategy - subscribed by the partner parks - represent the final outcome of the three-year Interreg funded project INSUBRIPARKS.

The long-term goal of the project consists of producing a positive economic impact across the project areas by facilitating the circulation of visitors between the Italian and Swiss sides of the Insubria region. In the context of the INSUBRIPARKS, where neighbouring periurban parks are subjected to different local and national (Italy and Swiss) political contexts, the availability of shared management procedures and information is key

to fully unpin the potential of these green areas to the benefit of communities and citizens. The presented solutions are an example of how smart IT tools can support the cooperation between park managers in the ordinary promotion and monitoring operations. These tools promise to empower the project partners with new digital assets to be spent in those activities.

The role of free and open-source geospatial technologies and software in developing the tools was spelt out according to both the technical and the economic perspectives. Indeed, the provision of most of the developed platforms with open licenses guarantees usability and provides the system with the potential to be empowered, replicated and customized with reduced development and economic efforts.

Lessons learned from the implementation of the project activities highlighted the need for digital capacity building within park offices. Proposed future developments for this work will aim to foster collaborations among academia and park offices to enhance these internal skills that are key in the current tourism market.

The presented tools are currently only partially operative. In the next months, the park offices will perform pilot tests and provide feedback for their empowerment and improvements. The foreseen testing and integration activities are expected to be concluded within the fourth quarter of the Year 2022, corresponding with the INSUBRIPARKS project end date.

## ACKNOWLEDGEMENTS

This work has been funded by the project "INSUBRIPARKS" within the Interreg V-A Italia-Svizzera Co-operation Programme 2014 - 2020 (ID 605472).

## REFERENCES

- Cannata, M., 2022. Tourism, natural protected areas and open source geospatial technologies. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences. (in press).
- Chen, C.-L., Lin, Y.-C., Chen, W.-H., Chao, C.-F., Pandia, H., 2021. Role of government to enhance digital transformation in small service business. *Sustainability*, 13(3), 1028.
- Di Minin, E., Tenkanen, H., Toivonen, T., 2015. Prospects and challenges for social media data in conservation science. *Frontiers in Environmental Science*, 3, 63.
- Dobbs, C., Eleuterio, A., Amaya, J., Montoya, J., Kendal, D. et al., 2018. The benefits of urban and peri-urban forestry. *Unasylva*, 69(250), 22–29.
- Eusebio, C., Teixeira, L., Carneiro, M. J., 2021. *ICT Tools and Applications for Accessible Tourism*. IGI Global.
- Hausmann, A., Toivonen, T., Slotow, R., Tenkanen, H., Moilanen, A., Heikinheimo, V., Di Minin, E., 2018. Social Media Data Can Be Used to Understand Tourists' Preferences for Nature-Based Experiences in Protected Areas. *Conserv. Lett.*, 11(1), e12343.
- Oxoli, D., 2022. INSUBRIPARKS Interreg IT-CH GeoData (Version 1) [Data set]. <https://doi.org/10.5281/zenodo.6565928>. Accessed 29.06.2022.

Oxoli, D., Brovelli, M., 2021. CITIZEN-GENERATED GEODATA FOR NATURAL PARKS USE ANALYSIS: INSIGHTS FROM FACEBOOK IN THE INSUBRIA REGION. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 43, B4–2021.

Oxoli, D., Cannata, M., Terza, V., Brovelli, M., 2019. NATURAL HERITAGE MANAGEMENT AND PROMOTION THROUGH FREE AND OPEN SOURCE SOFTWARE: A PRELIMINARY SYSTEM DESIGN FOR THE INSUBRI-PARKS PROJECT. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42, 179–183.

Oxoli, D., Pessina, E., Brovelli, M. A., 2022a. Geo collector bot: A telegram-based open toolkit to support field data collection. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*. (in press).

Oxoli, D., Rizzi, M., Garcia Borges de Souza, D., Brovelli, M. A., 2021. Multi-criteria and routing algorithms blending to support complex decision tasks in webgis applications. *Atti AS-ITA*, Federazione delle Associazioni Scientifiche per le Informazioni Territoriali e Ambientali, 305–308.

Oxoli, D., Terza, V., Cannata, M., Brovelli, M., Verde, P. R. S., 2020. An Open IT Infrastructure for Green Tourism Management and Promotion: The INSUBRI.PARKS Project. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 43, B4–2020.

Oxoli, D., Vavassori, A., Jimenez, J. C., Brovelli, M., 2022b. OPEN DATA CUBE APPLICATION TO USER-GENERATED GEODATA: VISITORS TURNOUT INVESTIGATION IN THE INSUBRIA NATURAL PARKS. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 43, B4–2022.

Prell, C., Hubacek, K., Reed, M., 2016. Stakeholder analysis and social network analysis in natural resource management. *Handbook of applied system science*, Routledge, 367–383.

Steinberg, M., Schindler, S., Klan, F., 2019. Software solutions for form-based, mobile data collection—A comparative evaluation. *BTW 2019–Workshopband*.

Sturgeon, T. J., 2021. Upgrading strategies for the digital economy. *Global Strategy Journal*, 11(1), 34–57.

Telegram Messenger Inc., 2022. Telegram. <https://telegram.org>. Accessed 23.05.2022.

Vavassori, A., Oxoli, D., Brovelli, M. A., 2022. Population Space–Time Patterns Analysis and Anthropic Pressure Assessment of the Insubric Lakes Using User-Generated Geodata. *IS-PRS International Journal of Geo-Information*, 11(3), 206.