Is there any Role for Surveyors in Sustainable Environment Management? Case Study of the Silva Nympha Polish-Turkish Project on Sustainable Forest Use and Management

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Key words: Silva Nympha, Internet of Things, Artificial Intelligence

SUMMARY

Traditionally, surveyors are associated with map-making, land subdivision, construction works, and quantity surveying but are less often associated with environmental management, which involves monitoring ecological variables, decision-making, and even predicting the future state of the environment. However, the recent development of new surveying-grade tools, including Light Detection and Ranging (LiDAR), Global Navigation Satellite System (GNSS) receivers, robotic total stations, drones, and datasets, such as state-of-the-art multispectral/hyperspectral aerial/satellite images, invites surveyors to become active agents participating in multidisciplinary teams responsible for environmental business. Many new tools and datasets for environmental management are being integrated with the latest technology, including the Internet of Things (IoT) and rapidly developing artificial intelligence (AI). The presentation will demonstrate the setup and initial results of deploying the aforementioned tools and technologies for the "Sustainable Use and Smart Forest Management" project, Silva Nympha, a Polish-Turkish initiative. Silva Nympha is a two-year project funded by the Polish National Centre for Research and Development and its Turkish twin, TÜBİTAK. An international consortium of seven institutions from both countries has formed, including research institutions and businesses acting in forest management and surveying. The leaders represent Wroclaw University of Technology, Poland, and Yildiz Technical University, Istanbul, Türkiye. Selected test forest fields in both countries have been observed using a multilayer set of sensors, including Remote Sensing multispectral imagery, aerial and drone RGB+NIR orthophotography, ALS and TLS LiDAR, and in situ sensors. This ultra-temporal resolution and multivariable monitoring system transmits observations wirelessly or via Bluetooth protocol for further processing and use. Data analysis focuses on threats to forests in both countries, including forest fires, drought, insect infestations, canopy thinning, and soil and nutrient erosion. Data sets collected by the system are placed in the context of historical, long-term meteorological data available from the government's meteorological agencies. This enables the application of machine learning methods to predict the future state of forests in the context of climate change and adverse factors affecting civilisation. We conclude that surveyors have a significant amount of work to do in sustainable forest management and, more broadly, in sustainable environmental management.

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1. INTRODUCTION

The role and functions of surveying and cartography have been gradually evolving following the rapid development of hardware and software, ubiquitous connectivity (the Internet and GSM), availability of Positioning, Navigation, and Timing (PNT) services, high Spatial-, Radiometric-, Spectral- and Temporal-resolution (SRST) Remote Sensing data and Artificial Intelligence (AI). The traditional role of Surveying and Cartography, as an art, science, and skill of capturing the dimensions of space and things and visualising them to make informed decisions, is perceived by younger generations as less intellectually challenging and less attractive as a career path. These processes trigger mechanisms within surveying to adjust to the new realm. One of the self-sustaining mechanisms is to offer unique knowledge and specific skills that surveyors possess for supporting emerging tasks beyond land subdivisions or engineering surveying, such as environmental monitoring, assessing the characteristics of changes, and forecasting the impact of these processes on the environment and society. Focusing on the three current issues that shape the concerns and activities of our societies — climate change, Artificial Intelligence (AI), and the Internet of Things (IoT) —we propose a path of progress for surveying and cartography under these regimes. Based on the example of the fruitful involvement of surveyors in a "non-surveying" research program so far, we identify areas where surveyors should be trained to acquire sufficient knowledge and skills to participate in resolving current and future societal issues. In ancient Greek folklore, a Nymph (also spelt Nympha) is a female deity. They are regarded as personifications of natural things such as trees, specific places, and streams and are typically depicted as maidens. Hence, Silva Nympha means the goodness of forests. This name, Silva Nympha (SN), has been adopted as an acronym for a research project titled "Sustainable Use and Smart Forest Management." This Polish-Turkish project is funded by the Polish National Centre for Research and Development (NCBR) and its Turkish twin, TÜBİTAK. It is a two-year project that is expected to conclude by the end of May 2025 formally. However, the equipment and settings, including the dissemination of results and data analysis, will be sustained for years to come. The SN involves several agencies from Poland and Türkiye, representing the IT industry, forestry experts, telecommunications experts, and surveyors. In the following, we present the SN project, which aims to demonstrate that surveying can be a more engaging approach in a multidisciplinary research project encompassing all aspects of the environment. We identify knowledge and skill gaps in the surveyors' education and training to achieve that.

2. THE SILVA NYMPHA (SN) PROJECT

According to the project's application, the SN aims to optimise the use of forest resources for societal benefits on its way to a climate-neutral circular economy and sustainable society. This direction aligns with the UN Sustainable Development Goals (UN-SDGs), the European Green Deal, and the forthcoming new EU Forest Strategy. SILVA NYMPHA will fill the gap in the forest management process, which is necessary for developing a broader analytics strategy and integrating it into planning, decision-making, and learning processes. SILVA NYMPHA utilises critical strategies relating to (1) stakeholder action/engagement as a management/governance strategy (2) local, national, trans-national governmental and governance mechanisms (3) developing technological applications by combining AI, data analytics, computer vision, Mobile LiDAR system, field sensors/systems, UAV/drone solutions, satellite imagery access to create new sustainable forest biotic-abiotic threat monitoring and management platforms for stakeholders to assess, predict and manage risks to preserve and increase the quality of forest ecosystem services. An intelligent and data-driven, environmentally sound forest products exploitation system will utilise data as an information input. It can serve as a tool to facilitate decision-making in cases of uncertainty. Additionally, using data-oriented approaches helps decision-makers make forest management more effective. It was decided that the aim would optimally be addressed by several objectives, including:

- Establishing forest research areas in Poland and Türkiye at selected forest stands
- Installation of various sensors to record and transmit to a cloud select types of environmental data in real- or near-real-time
- Conduct periodic aerial- and UAV-borne LiDAR/aerial photo acquisition
- Acquiring Copernicus Sentinel data and long-term meteorological records
- Acquiring other types of auxiliary data, including in situ observations
- Preparation of cloud-based data storage for unrestricted access to the data by interested parties
- Modelling of the forest above-ground biomass (AGB) changes based on the acquired and assimilated data using Artificial Intelligence/Machine Learning methods
- Forecasting the impact of biotic and abiotic threats on forest ecosystems.

The project's research scope consists of two 100-ha forest complexes in Poland (17.091043°E, 50.732251°N and 20.732984°E, 50.787232°N) and Türkiye. In technical terms, the project's scope assumes the use of freely available geospatial data, including satellite imagery, LiDAR, and orthophotos, in addition to data captured by the research team, such as UAV RGB + NIR imagery, sensors' Bluetooth readouts, and in situ forest observations. The proposed solution by the SN project might be considered a type of observatory, similar to an astronomical one. Similar Forest Observatories (on a larger scale or with slightly different objectives) exist, such as the EU Observatory on Deforestation and Forest Degradation (EU, 2025) or the Borneo Forest Observatory (Forest Observatory, 2025).

Universities and private/public agencies from Poland and Türkiye have been involved in the project. The parties involved are:

- Wroclaw University of Science and Technology,
- Forest Research Institute – government research agency
- Taxus IT – an IT company providing IT solutions for forestry
- Yildiz Technical University, Istanbul, Türkiye
- Duzce University, Duzce, Türkiye
- VESTEL Elektronik Sanayi ve Ticaret A.S., Istanbul, Türkiye, and
- General Directorate of Forestry, Istanbul, Türkiye.

The total budget for the SN project is approximately EUR 250,000 over two years. About twenty individuals are involved in the project's activities.

3. THREE PILLARS OF PROGRESS OF SURVEYING

One can quickly identify the latest phenomena that will profoundly revolutionise our civilisation relatively quickly, including surveying. We believe that the agents of change, or the pillars of the revolution, stem from direct and indirect human activities on this planet. These pillars include climate change, rapid progress in the applications of Artificial Intelligence (AI), and the proliferation of the Internet of Things (IoT).

3.1 Climate change

Many of us understand climate change as the weather becoming milder, which is not necessarily a bad thing, considering the impact on winter heating costs. Milder winters are good news for everyone, particularly those with limited budgets. On a personal level, we often assume that catastrophic events linked to climate change will never affect our family or business. Prolonged droughts, wildfires, floods, landslides, cyclones, and tornadoes are often featured in news headlines for most of us. However, we usually fail to notice small changes that occur over a long period. Some of these include the loss of biodiversity, the extinction of various species of fauna and flora, sea level rise, and the depletion of forests to sequester atmospheric CO_2. These small changes, over time, impact our lives, for example, by increasing the level of air pollution or, as we have recently experienced globally, outbreaks of hard-to-treat diseases. A practical approach to addressing global warming (also known as climate change) is based on current knowledge of the mechanisms responsible for global warming, precisely the greenhouse effect caused by the imbalance in the emission and absorption of greenhouse gases, and it involves reducing this imbalance. There are global-to-local-scale efforts to implement various strategies, including (sometimes even draconian) legislation that forces societies to reduce their reliance on carbohydrates as an energy source. However, these mitigation measures do not always work because of, for example, the resistance of population groups to change. On the other hand, some forces deny the human-induced component of climate change and promote adaptation to climate change while maintaining "business as usual" instead. Regardless of which approach prevails, objectively assessing the current state of the game and its direction is essential. An easily accessible environment allowing for observing climate change is a forest, as an epitome of the complex interaction between abiotic and biotic factors. Hence, many efforts involve surveyors to assess the conditions of forests quantitatively. Two prominent surveying-based technologies enable the achievement of ever-improving estimates of global-to-local forest resources: LiDAR, photogrammetry, and Remote Sensing. In addition, local forest monitoring projects involve surveyors for collecting geodata as the under-canopy environment is challenging for simple GNSS receivers. In the SN project, all these methods have been employed to collect and process geospatial data, creating a geospatial data hypercube. A hypercube is a container holding time-organised all available and relevant data for a unit of space, approximately 30 m x 30 m at the Equator, corresponding to one arcsecond of longitude or latitude. Note that this approach differs from that used in GIS, which arranges geodata in space rather than along a timeline.

3.2 The Internet of Things (IoT)

The second pillar of contemporary progress is the Internet of Things – an extension of the Internet where sensors representing things are data sources shared through a global network. Besides sensors, IoT solutions include actuators – devices designed to execute specific actions, e.g., switching an air conditioner on or off or opening a gate. The IoT concept involves data acquisition and triggering a simple action, such as switching on the air conditioner when the temperature reaches or drops to a specific level, as well as the autonomous operation of a group of sensors and actuators at its advanced development stage. The IoT was proposed at the turn of the century. Since then, over 20 billion IoT sensors have been installed and can be found everywhere – from fridges to advanced industrial installations (Kranz, 2016). Surveying, as a hardware-driven science and technology, is also slowly adopting IoT technology to acquire, process, and disseminate geospatial data. As suggested over 10 years ago at the FIG Congress in Kuala Lumpur, Malaysia, the IoT is likely to change the paradigm of surveying, making surveyors passive participants in the mapping process only (Becek, 2014). A cloud of ubiquitous interconnected virtual and real sensors representing things distributed in space will deliver the current status of things at the request of a surveyor sitting in an armchair. The adoption of IoT-based solutions in surveying remains low on the horizon, as indicated by INTERGEO 2024, where only a handful of exhibitors demonstrated their IoT-based products.

The IoT sensors have been deployed in the research plots of the SN project. They include an autonomous meteorological station that transmits weather parameters to the cloud in real-time, light intensity sensors, air and soil temperature sensors, and dendrometers to monitor the expansion and contraction of tree trunks. The latter are read out via the Bluetooth® regularly. However, solutions enable autonomous and long-term (years) data acquisition and cloud connectivity, e.g., LoRa (Semtech, 2025). Budget restrictions did not allow for their deployment in the SN project. These high-temporal-resolution environmental data significantly improve the quality of remote sensing-based modelling of forest ecosystems. The sensors are stationary, and their position was established using traditional surveying methods by surveyors. Operating the

IoT sensors requires additional knowledge and skills that are currently absent from the surveying courses' curriculum.

3.3 Artificial Intelligence (AI)

Predicting the innovations AI can bring to our civilisation and surveying is impossible. However, it can be expected that the impact will be primarily in exploring geospatial data in their geoscientific applications rather than on the hardware side of surveying, meaning that hardware-driven surveying will lose importance. This thesis can also be supported by the fact that the market for surveying equipment is about to reach a tipping point in terms of suppliers of state-of-the-art instrumentation and data sources. LiDAR and photogrammetry are already mature technologies that will likely see little progress in the foreseeable future. Therefore, the most significant impact of AI on surveying and cartography will be on the prominent tool for mapmaking and spatial analysis, namely Geographic Information Systems (GIS), particularly in its data analysis applications. It can be envisioned that GIS software, as we know it today, will evolve into a dashboard that defines (e.g., by the voice of the operator) what needs to be achieved (e.g., "produce a current cadastral map for postcode QLD4209"). Reducing human participation in specific surveying processes can also be inferred from potential scenarios of AI development, particularly when AI reaches singularity and becomes self-controllable (Newcomb, 2023). Some researchers say singularity may be achieved within a decade (Newcomb, 2023). Although the exact date is unknown, a profound change is already on the horizon.

SILVA NYMPHA will utilise existing datasets and services, including ESA Copernicus (EFFIS, Climate Change Service, and satellite imagery). Copernicus Sentinel imagery data will be used to create a SILVA NYMPHA digital twin for the early detection of forest biotic and abiotic threats on a global scale.

The high temporal resolution and diverse data collected within the framework of the SN project are subject to in-depth studies to identify signals of interest, specifically the impact of climate change on forests within selected research plots in Poland and Turkey. The team is seeking AI methods to study the severity of forest fires, insect infestations (e.g., Melolontha), and hydrological drought. Although the data record is short, the auxiliary data (long-term meteorological observations) and time series of aerial and satellite imagery are used for modelling long-term changes of forests. Our findings will be discussed, and various stakeholders will be consulted to gather feedback on refining the model.

4. CONCLUSION

The Silva Nympha project—an excellent example of collaboration among scientists, including surveyors from Poland and Turkey, funded by NCBR and TUBITAK, the national funding agencies—is currently addressing one of the most pressing issues: climate change and its impact on various forest ecosystems, as well as its broader implications for our lives. The project utilises the latest technologies, including the Internet of Things and AI methods, to achieve its goals. The approach used in the project was conceived by the Authors of this contribution – full-fledged surveyors eager to engage in projects where standard surveyors' knowledge and skills are insufficient and extra knowledge and skills are required. Based on our experience, we suggest that the surveyor training curriculum include topics related to the Internet of Things and Artificial Intelligence. These two subjects are set to work closely together in the future, described as the senses and brain of contemporary development (Kranz, 2026). Finally, we would like to note a recent survey of over 5,000 professionals to get the most precise picture of Australia's skills state (Hays, 2025). As it has been discovered, 87% of professionals believe that the skills required to carry out their roles will change within the next five years.

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BIOGRAPHICAL NOTES

Kazimierz Becek received a Dipl.-Ing. (M.Sc.) degree in land surveying from Wroclaw University of Agriculture, Poland, in 1978, a PhD degree in geodesy from Dresden University of Technology, Germany, in 1987, and a D.Sc. (Habitation) degree in remote sensing from the Dresden University of Technology, Germany, in 2010. He is currently a Professor at the Wroclaw University of Science and Technology, Poland. He worked with the School of Surveying at UNSW, Sydney, Australia, from 1989 to 1994, before joining a publishing house on the Gold Coast, Australia, in 1995. He has also worked for the Queensland state government and the Gold Coast City local government since 1998. From 2003 to 2013, he worked at the University of Brunei Darussalam. From 2015 to 2019, he worked with the Geomatics Engineering Department at the Zonguldak Bülent Ecevit University, Türkiye. His research interests include the mathematical modelling of environmental systems, including landslide monitoring, natural hazard mapping, and remote sensing methods for ecological studies.

Bulent Bayram was born in Erzurum, Turkey. He received a B.Sc. degree from Black Sea University, Trabzon, Turkey, in 1987, and M.Sc. and Ph.D. degrees from Yildiz Technical University, Istanbul, Turkey, in 1990 and 1998, respectively, all in geodesy and photogrammetry engineering. He worked as a Research Assistant from 1992 to 2000, Assistant Professor from 2000 to 2009, and Associate Professor from 2009 to 2014 in the Department of Geomatics Engineering, Yildiz Technical University, Istanbul. Since 2014, he has served as a full Professor in the same department. His research interests include deep learning, photogrammetry, image processing, LIDAR, and Remote Sensing.

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