International Cartographic Association
Association Cartographique Internationale

Real-time in-situ biodiversity recording utilizing UAV mapping and web-application synergy

Ermioni Eirni Papadopoulou [a,*], Lemonia Moysidou [a], Georgios Tataris [a], Nikolaos Soulakellis [a], Christos Vasilakos [a], Stavros Proestakis [a], Thomas Tscheulin [a], Oliver Schweiger [b]

[a] *Department of Geography, University of the Aegean – epapa@aegean.gr, lemoniamoi@geo.aegean.gr, tataris@aegean.gr, nsoul@aegean.gr, chvas@aegean.gr, proest.st@aegean.gr, t.tscheulin@aegean.gr*

[b] *Helmholtz Zentrum für Umweltforschung, Leipzig, Germany – oliver.schweiger@ufz.de*

* Corresponding author

Keywords: dynamic dashboard, mobile mapping, UAVs, pollinators

Abstract:

In an era where ecological changes driven by human interventions and climate change are increasing rapidly, the spatial recording and preservation of biodiversity constitute a critical requirement for the sustainable maintenance and evolution of ecosystems. Currently, the predominant methods for recording species and biodiversity rely on conventional techniques including handwritten field observations (Crochard et al., 2026). However, recent advancements in real-time dynamic web mapping applications and high-resolution mapping through UAVs offer significant support to in-situ studies. These technologies provide data of high spatial resolution and horizontal accuracy, reduce the time required for digitizing field records and enable systematic spatiotemporal monitoring of areas of ecological importance.

The aim of this study is to develop a web-based mapping application that allows the in-situ recording of species and supports their dynamic visualization in a real-time dashboard. The development of an integrated digital solution that combines field measurements with dynamic visualization is a critical stage for the digital transformation and the transition to the digital ecological era (Reddy et al., 2025; Stephenson et al., 2020). To achieve this objective, an innovative methodology was developed that combines modern high-resolution mapping techniques such as UAVs, web maps, dashboards, and field measurements. The methodology consists of 4 basic stages: a) selection of the study areas, b) investigation of UAV flight characteristics and data acquisition, c) development of a dynamic cartographic web application – dashboard, and d) pilot use of the application.

Specifically, within the first stage, the study areas were selected based on specific topographic, geomorphological, and environmental characteristics. A total of 5 plots of 600×600 m. were selected on Lesvos Island, Greece. In each area, 9 pantraps were installed every 200 m. in a grid pattern, and pollinator samples were collected at 4 different dates during the months of February – August 2025. Subsequently, to support the cartographic imaging, a data acquisition protocol using UAV was developed, aiming to produce very high spatial resolution orthomosaics. The investigation of flight characteristics was deemed necessary as the observation scales were two: 1) the wider plot scale and 2) the pantrap scale. Specifically, for the plot scale, flights were conducted at a height of 100 m., yielding RGB images with a spatial resolution of 3 cm (Mavic 3Thermal, DJI). The flight pattern was based on parallel lines with an overlap of 70% along the length and 60% along the width, with the camera at -90° angle. For the pantrap scale, a flight plan was designed at a flight altitude of 25 m., achieving a spatial resolution of 0.67 cm. The flight plan followed a parallel line pattern with corresponding overlap rates, while in all cases a follow-terrain mode was applied, to maintain a constant ground sampling distance (GSD). In addition, images were also collected using UAV equipped with Ultra High Resolution Camera (PhaseOne Imx100) at different flight heights to investigate issues of flower recognition in images. In total, more than 170 flights were carried out, more than 5000 images were collected and more than 300 insects were recorded. The UAV-derived data processed with photogrammetric algorithms for generating: i) 3D dense point clouds, ii) Digital Surface Models (DSM) and iii) orthomosaics, which were integrated into the application as cartographic basemaps. High-resolution basemaps were embedded into a web map that allowed to visualize biodiversity records with high spatial resolution, enhancing the ability to analyze at a microscale. This was followed by the development of a dashboard and a digital application for recording species on the web map. In this environment, a specially designed digital recording form was developed, which functions as an application on mobile devices that allow users to record field observations,

https://doi.org/10.5194/ica-abs-12-109-2026

utilizing the positioning system (GPS). The form enables the entry of species characteristics, such as genus and others, while also allowing the uploading of photos. The recordings are automatically uploaded to the database, which is connected to the web map and by extension to the dashboard. Entries are visualized immediately on the map as well as by automatically updated dynamic diagrams. The following Figure 1 shows the number of pollinators per trap in one of the study areas (Plot Chita, Lesvos Island, Greece) as well as the dynamic diagrams that filter the thematic information according to species.

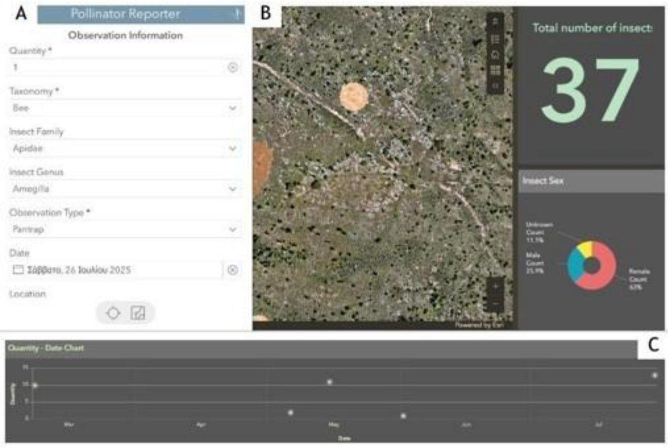

Figure 1. Web application - https://bit.ly/PolinatorObservation : A) mobile application, B) dynamic figures and C) date chart.

This specific dynamic cartographic application attempts to contribute to enhance the spatiotemporal analysis of biodiversity data by allowing the monitoring of changes in real time and proposing standardized recording process in which real-time spatial information is entered. International literature points out that integrated systems are a key tool for modeling ecological processes and developing conservation strategies (Darvishi et al., 2025; Torresani et al., 2024). The ability to directly record, spatially analyze, and visualize high-resolution data contributes substantially to the understanding of ecological processes and to making informed decisions. Finally, it should be noted that access to this specific platform and the control panel is limited to the research community as information regarding the exact location of biodiversity species is considered particularly sensitive. As future research, the evaluation of the application is planned both in terms of its usability and in terms of the quality of the data produced. The evaluation process will allow the optimization of the application and will determine its expansion potential.

Acknowledgements

The authors acknowledge the Cartography and Geoinformatics Laboratory, Department of Geography, University of Aegean, Greece. The "ANTENNA: Making technology work for monitoring pollinators" project was funded through the 2022-2023 Biodiversa+ and European Commission joint call for research proposals, under the BiodivMon programme, and with the funding organisation: General Secretariat for Research and Innovation Greece.

References

Crochard, L., Mariton, L., Fontaine, C., Baude, M., Ragué, M., Bas, D., Gaba, S., Bretagnolle, V., Julliard, R., & Bas, Y. (2026). Buzzy bees: Improving the monitoring of pollinator activity in sunflower fields with continuous acoustic recording and deep learning. Ecological Informatics, 94(July 2025). https://doi.org/10.1016/j.ecoinf.2026.103633

Darvishi, A., Dalton, D., Berger, V., & Schirrmann, M. (2025). Application of unmanned aerial vehicles (UAVs) in farmland biodiversity monitoring: A systematic review protocol. Methods in Ecology and Evolution, 16(12), 2760–2770. https://doi.org/10.1111/2041-210x.70172

Reddy, C. S., Athira, K., & Mudalkar, S. (2025). Evolution of Global Biodiversity Monitoring: Innovations, Modern Approaches and Integration with Essential Variables. Journal of the Indian Society of Remote Sensing, 53(7), 2017–2030. https://doi.org/10.1007/s12524-025-02211-1

Stephenson, P. J., Ntiamoa-Baidu, Y., & Simaika, J. P. (2020). The Use of Traditional and Modern Tools for Monitoring Wetlands Biodiversity in Africa: Challenges and Opportunities. Frontiers in Environmental Science, 8(June), 1–12. https://doi.org/10.3389/fenvs.2020.00061

Torresani, M., Rocchini, D., Ceola, G., de Vries, J. P. R., Feilhauer, H., Moudrý, V., Bartholomeus, H., Perrone, M., Anderle, M., Gamper, H. A., Chieffallo, L., Guatelli, E., Gatti, R. C., & Kleijn, D. (2024). Grassland vertical height heterogeneity predicts flower and bee diversity: an UAV photogrammetric approach. Scientific Reports, 14(1), 1–14. https://doi.org/10.1038/s41598-023-50308-9

https://doi.org/10.5194/ica-abs-12-109-2026