Multi-source IoT system prototype for the surveillance of *Xylella fastidiosa*

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The issue

Xylella fastidiosa (Xf) is a quarantine bacterium causing Olive Quick Decline (OQD) and represents one of the most serious threats to olive production. Once established, the pathogen is extremely difficult to eradicate, with major economic, environmental and social impacts.

Effective containment relies on **early, reliable surveillance** to detect infections before symptom expression and to support timely eradication or containment measures, in line with phytosanitary regulations. Conventional surveillance methods alone are often resource-intensive and may fail to detect early or asymptomatic infections.

Actions taken

A **Multi-Source IoT Surveillance System prototype** was developed through multiple research initiatives, integrating ICT, geomatics, diagnostics and predictive tools into a single platform. The system collects and streams heterogeneous data for real-time spatio-temporal monitoring of Xf infections.

Surveillance is implemented across multiple spatial scales:

- **Large scale**: multi-temporal Sentinel-2 satellite imagery identifies OQD-suspected olive groves through detection of progressive biomass loss.
- **Small scale**: a UAV-based multispectral sensor prototype with Xf-specific wavelength bands enables detection of early infections before symptom development.
- **Field scale**: XylApp[EU] integrates satellite and UAV data, vector monitoring using the "spy insect" approach supported by forecasting models, and robust sampling schemes (grid-based and risk-based).

Xf detection is performed using molecular real-time LAMP assays, applied either on-site or under laboratory conditions. The use of sealed tubes and membrane-based sampling allows safe sample transport without any risk of pathogen spread.

Key results

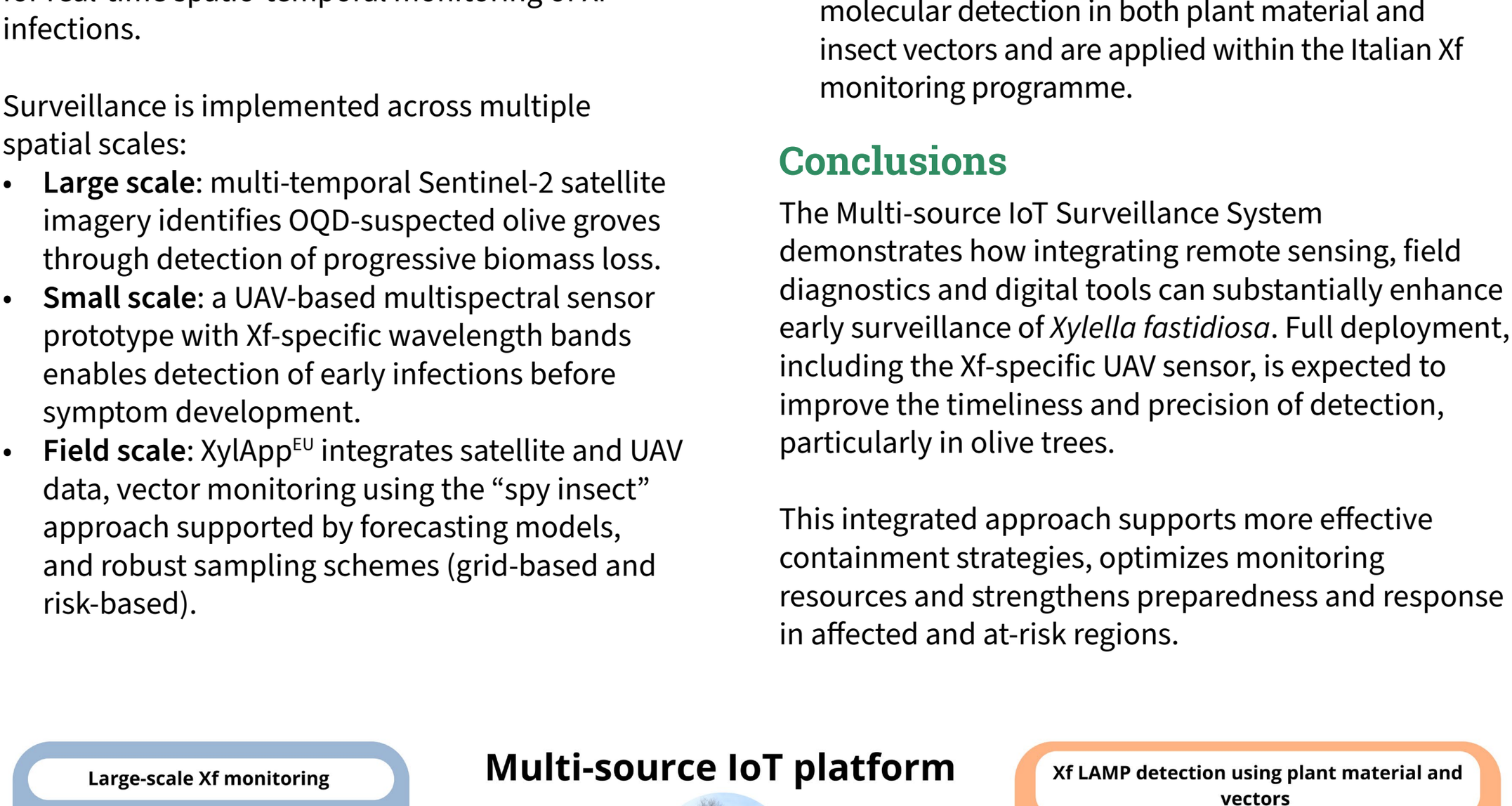
Although still at prototype stage, the system has already demonstrated strong potential to support early detection and field decision-making:

- The system has guided **ground inspections** towards OQD-suspected trees and enabled the identification of new infection foci in asymptomatic areas.
- **XylAppEU** supports real-time acquisition, storage and transmission of sampling data, ensuring accuracy and traceability. The app is freely available and currently used in several Italian regions and in NENA countries (in collaboration with FAO).
- The **"spy insect" approach** enabled the detection of additional *X. fastidiosa* subspecies in areas previously considered Xf-free.
- **Real-time LAMP assays**, performed on-site or in laboratories, provide reliable and user-friendly molecular detection in both plant material and insect vectors and are applied within the Italian Xf monitoring programme.

Conclusions

The Multi-source IoT Surveillance System demonstrates how integrating remote sensing, field diagnostics and digital tools can substantially enhance early surveillance of *Xylella fastidiosa*. Full deployment, including the Xf-specific UAV sensor, is expected to improve the timeliness and precision of detection, particularly in olive trees.

This integrated approach supports more effective containment strategies, optimizes monitoring resources and strengthens preparedness and response in affected and at-risk regions.



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