FloraFlux: Collaborative AI-Based Plant Data Collection at Flux Tower Sites

1. Introduction: What is FloraFlux?

FloraFlux is a collaborative initiative designed to collect plant species occurrence data from flux tower sites worldwide. The project is open and inclusive, requiring no botanical expertise and minimal time and costs for participants. Only a smartphone is needed, leveraging automated plant identification via the **Flora Incognita** app (Mäder et al., 2021). Participants are encouraged to "take pictures of as many species in the footprint as you like, the more the better," while we also facilitate optional additional information. **FloraFlux** complements and extends traditional, resource-intensive vegetation surveys, enabling widespread data collection across a global network of sites.

The data collected by **FloraFlux** will be shared with participants and ultimately the scientific community by a joint publication in an open access format, enhancing the collective knowledge of plant diversity and ecosystem functions.

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2. Rationale: Why FloraFlux Matters?

Vegetation is essential for ecosystem functions such as carbon uptake, water cycling, and energy exchange (Reichstein et al., 2014; Migliavacca et al., 2021). However, understanding these functions globally remains challenging due to limited data on plant composition and traits at flux tower sites. Recent studies highlight the value of community-sourced, unstructured plant occurrence data for addressing ecosystem-level questions:

- **Mapping Plant Traits:** Demonstrates effectiveness over traditional methods (Wolf et al., 2023).
- **Bioindication:** Decodes soil, micro-climate, and disturbance conditions using plant`s ecological indicator values (Tautenhahn et al., in prep).
- **Phenological Observations:** Tracks species-specific and macro-phenological stages (Katal et al., 2023; Rzanny et al., 2024; Mora et al., 2024).

By enabling community-sourced data at flux tower sites, **FloraFlux** enhances ecological research through synthesis, modeling, and process-based understanding of ecosystem functions.

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3. Simple Implementation: How FloraFlux Works?

FloraFlux is based on the **Flora Incognita** app—a free, ad-free, and non-commercial plant identification tool available on Google Play and the Apple Store. FloraFlux is an add-on to Flora Incognita that helps to merge the data to flux towers, enables users to document optional additional information on vegetation coverage, layer, and health. For details on installation of FloraFlux see our website: https://floraincognita.com/floraflux/

Key Features:

- **Inclusive:** Open to participants at all flux tower sites.
- **Low Barrier to Entry:** Accessible for anyone, no botanical expertise is needed.
- **Adaptable:** Supports vegetation surveys following specific protocols.
- **Updatable:** Improves data accuracy as AI advances.

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4. Data Collected: Description, Access, and Sharing

Participants are encouraged to take plant pictures during work or teaching activities at the tower, conducting multiple campaigns annually to capture seasonal variations. Data recorded includes:

Automatically Recorded:

- **Images of Plants:** For re-identification as AI improves and additional data extraction from images.
- **Species Name (AI):** Automated identification via **Flora Incognita**.
- **Coordinates:** Assigns data to specific tower sites and footprints.
- **Date:** Enables phenology and trend analysis.
- **Participant's Email:** Facilitates communication and collaboration.

Optional Data:

- **Flux Tower Site Code:** Relevant for sites with multiple towers.
- **Known Species Name:** Validates and enhances **Flora Incognita**'s accuracy.
- **Vegetation Layer:** Categories include "surface" (herbaceous), "intermediate" (shrubs), "tall" (trees).
- **Coverage:** Estimated coverage within a radius depending on the vegetation layer ("rare," "some individuals," "frequent").
- **Health Status:** Categories include "healthy," "non-healthy," "disturbed."

Data Access and Sharing:

Data collected through **FloraFlux** will be accessible for personal or research use. All community-contributed data will be synthesized and published in an open access format. Participants will be invited to contribute as co-authors.

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5. Team: Expertise to Guide Your FloraFlux Journey

FloraFlux is led by Susanne Tautenhahn, a quantitative geoecologist from the Bio.AI group at the Max Planck Institute for Biogeochemistry in Jena, Germany. Building on the expertise behind the

Flora Incognita app (joint development of Bio.AI group and TU Ilmenau), the team ensures access to professional infrastructures and robust scientific integration of **FloraFlux:**

- **AI Development: Flora Incognita**`s AI can be tailored to address specific challenges at flux tower sites, such as recognizing unidentified species. Contact us for this option.
- **Data Pipelines:** Efficient collection, storage, and processing.
- **Scientific Integration:** Connections with networks like ICOS, FLUXNET, or modelling initiatives such as FLUXCOM foster collaboration.
- **Outreach and Support:** Comprehensive documentation, responsive email support, and participant engagement.
- **Helpdesk:** For any issues and questions contact floraflux@bgc-jena.mpg.de

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6. Join the FloraFlux Community

FloraFlux will officially launch in Spring 2025. Get involved:

- **FloraFlux Newsletter:** Subscribe at FloraFlux Newsletter. https://mail.bgc-jena.mpg.de/mailman/listinfo/floraflux-participants
- **FloraFlux Homepage:** Visit FloraFlux Homepage for more information. https://floraincognita.com/floraflux/
- **First FloraFlux Meeting:** Join our first online meeting in autumn 2025. Details will be shared via the newsletter.

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7. Contact

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References

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