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OER Planning Template

Instruction: *Use this template to create your learning unit. The goal is to actually implement the learning unit based on this template as a OER learning unit or as a teaching concept in an OER repository. Therefore, please be careful about the formulation of input materials (e.g. slides, texts) and applications tasks as well as the selection of scientific literature, data sets and all other resources for hands-on activities and practical work. This template consists of five major sections: Introduction, Input, Application, Assessment & Wrap up, Appendix with Materials.*

Section 1: Introduction to the learning unit

Title	Geospatial Approach to Monitoring of Plant Species: Hands-on Practice
Duration	5 modules, approximately 7-9 days total.
Introduction	This learning unit provides a comprehensive introduction to using open-source geospatial tools for monitoring plant species. It covers the entire workflow from acquiring and preprocessing satellite imagery (Sentinel-2) and species occurrence data (GBIF), to performing land cover classification and spatial analysis, and finally communicating results through an interactive ArcGIS StoryMap. The skills gained are vital for understanding ecosystem changes, tracking forest health, detecting invasive species, and supporting conservation and land management decisions. A case study on Fogo Island is used to contextualize the learning activities.

Learning outcomes	1. Identify and acquire key geospatial datasets such as Sentinel-2 imagery, DEMs, and species occurrence records from open platforms. 2. Apply preprocessing techniques to satellite imagery and species data using QGIS and R. 3. Generate a land cover classification map and assess its accuracy using a Random Forest model. 4. Integrate species distribution data with environmental layers to perform spatial analysis and derive ecological insights. 5. Create an interactive ArcGIS StoryMap to effectively communicate geospatial analysis results for a non-technical audience.
Material	• Laptop with internet access • QGIS software with Semi-Automatic Classification Plugin (SCP) • RStudio with packages: terra, sf, tidyverse • ArcGIS Online account (free institutional/student account) • Datasets: Sentinel-2 imagery, Digital Elevation Models (DEM), species occurrence data from GBIF/iNaturalist, land cover maps, GIS shapefiles (e.g., settlements, roads).
Literature	• • Drusch, M. et al. (2012). Sentinel-2: ESA's Optical High-Resolution Mission for GMES Operational Services. *Remote Sensing of Environment*, 120, 25–36. • Elith, J., & Leathwick, J. R. (2009). Species distribution models: Ecological explanation and prediction across space and time. *Annual Review of Ecology, Evolution, and Systematics*, 40, 677–697. • Guisan, A., & Zimmermann, N. E. (2000). Predictive habitat distribution models in

	ecology. *Ecological Modelling*, 135(2–3), 147–186. • Pebesma, E. (2018). Simple Features for R: Standardized Support for Spatial Vector Data. *The R Journal*, 10(1), 439–446.
Metadata	**Name:** Geospatial Monitoring of Plant Species **Resource Type:** Teaching Concept / Course Module Series **Description:** A 5-module course teaching the application of open-source remote sensing and GIS tools for plant species monitoring, from data acquisition to interactive storytelling. **Keyword(s):** Remote Sensing, GIS, QGIS, R, Biodiversity, Land Cover Classification, Sentinel-2, StoryMaps **Author(s):** [Anahi Rodriguez Gonzalez, Mohammed Radman AL-Matari, Nancy M. Mubanga, Dukundane Didier, Faraja Omary Nelusigwa] **Language:** English **License:** Creative Commons (to be determined, e.g., CC BY-SA) **Creation Date:** 26 September 2025

Section 2: Input

The input for this learning unit is delivered across five sequential modules, combining conceptual knowledge with practical software guidance.

- **Module 1: Introduction to Plant Monitoring:** Sets the context, explaining the importance of plant monitoring for ecosystem health, agriculture, and climate change adaptation. Introduces key concepts like NDVI and the role of Remote Sensing & GIS.
- **Module 2: Tools & Data Acquisition:** Provides detailed input on the Sentinel-2 mission (spectral bands, resolution, applications) and guides on accessing data via Copernicus Open Access Hub and Google Earth Engine. Introduces the interfaces of QGIS and RStudio for remote sensing.
- **Module 3: Preprocessing & Land Cover Classification:** Offers conceptual input on using training polygons for supervised classification and the Random Forest algorithm. Provides step-by-step instructions for both QGIS (SCP plugin) and R scripts to achieve classification.
- **Module 4: Species Distribution & Spatial Analysis (Fogo Island Case Study):** Introduces ecological concepts for analyzing species-environment interactions, such as habitat preference and human disturbance. Explains spatial statistics methods like density calculation and buffer analysis.
- **Module 5: Results Communication and Presentation:** Defines ArcGIS StoryMaps and their components (maps, text, multimedia). Provides a workflow for creating a narrative-driven, interactive story to present geospatial findings effectively.

Section 3: Application / Learning Activities / Tasks

The learning activities are hands-on and build upon each other to form a complete project workflow.

- **Module 2 Activity:** Define an Area of Interest (AOI). Download Sentinel-2 imagery for two time points. Calculate NDVI and generate a difference map (ΔNDVI). Download and clean occurrence data for a specific species using R.
- **Module 3 Activity:** In QGIS, clip Sentinel-2 imagery to an AOI and digitize training polygons for land cover classes (e.g., forest, agriculture, settlements). In R, run a provided script to load training data, train a Random Forest model, and assess classification accuracy with a confusion matrix. In QGIS, use the SCP plugin to perform a parallel classification.
- **Module 4 Activity (Fogo Island Case Study):** Integrate cleaned species occurrence data with the land cover map from Module 3. Perform spatial analysis: calculate species density by land cover type, generate buffer zones around settlements/roads, and create maps visualizing species hotspots.
- **Module 5 Activity:** Replicate a provided example ArcGIS StoryMap on Fogo Island. Students must use the same content (maps, text, images) to learn the technical structure of StoryMaps, then add a brief personal reflection on the learning process.

Section 4: Assessment and Wrap up

Assessment Tasks:

- **Module 1 & 2 (Individual):** A short reflection note (300-400 words) on "Why does monitoring plant species matter, and how can geospatial tools improve it?"
- **Module 3 (Individual/Group):** Submission of a classified land cover raster, an accuracy report (confusion matrix, Kappa statistic), and a finalized map layout from QGIS with essential cartographic elements.
- **Module 4 (Group):** Submission of a GIS map showing species distribution overlaid on land cover, a short written interpretation of spatial patterns, and a group presentation discussing conservation implications for Fogo Island.
- **Module 5 (Individual):** Creation and submission of a replicated ArcGIS StoryMap, including a 2-3 sentence reflection on the experience.

Wrap-up

The final module wraps up the learning unit by summarizing how the integrated skills of data acquisition, analysis, and communication form a critical workflow for modern environmental monitoring. It emphasizes that effective storytelling with tools like StoryMaps is essential for translating technical results into actionable insights for conservation planners, policymakers, and the public. This bridges the gap between scientific analysis and real-world application.

Section 5: Appendix

Please copy or link all the materials, literature and data / applications / tools needed for this learning unit here.

Materials, Data, and Tools:

Software & Platforms:

- QGIS: https://qgis.org
- RStudio: https://posit.co/products/open-source/rstudio/
- Copernicus Open Access Hub: https://scihub.copernicus.eu
- GBIF: https://www.gbif.org
- ArcGIS Online: https://www.arcgis.com
- ArcGIS StoryMaps: https://storymaps.arcgis.com

Tutorials & Guides:

- Basic Land Cover Classification Using the Semi-Automatic Classification Plugin (QGIS): https://www.youtube.com/watch?v=7SZDCFXjIbA
- Esri StoryMaps Tutorials: https://www.esri.com/en-us/arcgis/products/arcgis-storymaps/resources

Example StoryMap:

- Fogo Island Example StoryMap: https://storymaps.arcgis.com/stories/853b960885ac478c8114bc20bb0c9058

Datasets (for Fogo Island Case Study):

- Species occurrence data from GBIF or provided field data.
- Classified land cover map of Fogo Island (output from Module 3).
- GIS shapefiles: settlements, roads, protected areas.

R Script:

- Script for Random Forest land cover classification (as referenced in Module 3).