GEODATA SCIENCE FOR MULTI-SECTORAL RESILIENCE

Educational Plan

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Content

Needs Assessment

Based on the workshop implementation and hands-on experiments, all participants independently selected the earthquake scenario over traffic and climate scenarios, indicating a clear learning demand in EO-based disaster preparedness analysis. Students expressed particular interest in understanding how spatial indicators derived from Copernicus datasets can support neighbourhood-scale risk decisions. This, in turn, revealed a competency gap in conducting reproducible geodata workflows, specifically in EO retrieval, preprocessing, indicator construction, and evidence-to-policy translation—for assessing the adequacy of earthquake assembly areas. Therefore, the educational plan anchors the curriculum around this single, representative urban challenge to ensure relevance, scalability, and competency-based learning progression. The earthquake preparedness use case was selected as it provides a well-defined, analytically robust context in which Copernicus EO products and UDENE-supported workflows can be applied consistently and reproducibly at neighbourhood scale.

The course design therefore prioritises learning-by-doing with UDENE tools, ensuring that students acquire operational competencies that are directly transferable to applied Copernicus-based workflows beyond the classroom.

Considering the earthquakes that struck Türkiye in 2023 and the high probability of future seismic events along the Marmara fault system, this case study focuses on earthquake preparedness in high-rise urban districts, where population density and built-up intensity significantly constrain emergency response capacity. The case is designed to support evidence-based land-use and preparedness planning, rather than post-event damage prediction, and aligns directly with SDG 11 (Sustainable Cities and Communities) and the Sendai Framework for Disaster Risk Reduction (2015–2030).

The case explicitly positions UDENE tools as practice software for applied geodata science by using the UDENE Exploration Tool as the mandatory interface for problem scoping, Area of Interest definition, Copernicus product selection, and analytical parameter validation. All analyses begin with UDENE-supported exploration to ensure consistency, reproducibility, and transferability of the workflow across different urban contexts.

The analytical workflow combines Copernicus Earth Observation datasets (e.g. Sentinel-2, CLMS products) with open-source spatial analysis tools to evaluate preparedness conditions at neighbourhood scale. Students focus on high-rise districts where vertical densification amplifies evacuation pressure and reduces effective open-space availability.

Competency Statement

Students will be able to independently conduct a comprehensive geodata-based assessment of neighbourhood-level earthquake assembly area adequacy using Copernicus EO datasets and open-source spatial analysis tools, generating reproducible analytical outputs and a decision-support policy brief.

To assess preparedness and land-use adequacy, students construct and interpret a set of complementary indicators:

- NDVI (Normalized Difference Vegetation Index) to evaluate existing open-space and green-area capacity relevant for safe gathering.
- NDBI (Normalized Difference Built-up Index) to capture built-up density and impervious surface expansion, highlighting spatial pressure from high-rise development.
- Open-space adequacy ratios, including per-capita open-space availability within accessible distances to designated assembly areas.
- Accessibility proxies, such as buffer-based distance measures between residential blocks and assembly areas.

Course Purpose

This course aims to build students' applied competencies in geodata science by enabling them to independently access, process, and interpret Copernicus Earth Observation datasets as well as apply open-source spatial analysis tools for problem-oriented urban assessment. The curriculum is anchored around a single, representative challenge: assessing the adequacy of earthquake assembly areas using EO-based indicators. Through this focal problem, students learn to integrate environmental and urban datasets with EO variables, detect spatial and temporal risk patterns, and generate evidence-based maps and metrics relevant to crisis preparedness and urban planning. Emphasis is placed on developing complete analytical workflows—from data acquisition and preprocessing to exploratory analysis, interpretation, and communication—supported by clear methodological reasoning and reproducible outputs. By the end of the course, students will be able to construct end-to-end "data–analysis–decision" pipelines and translate their findings into concise, decision-support-oriented narratives tailored to real urban development challenges.

In line with the general objective of the UDENE Open Call, this course is explicitly designed to position UDENE tools as practice software for applied geodata science education. Rather than treating UDENE as an auxiliary reference, the curriculum integrates the UDENE Exploration Tool as a mandatory interface for problem scoping, Copernicus product selection, and analytical parameter validation. Through repeated, hands-on use of UDENE within a real urban disaster-preparedness case, the course ensures that both the project outcomes (open-source tools) and practical competencies in using Copernicus-related products and services are systematically developed and disseminated among learners in Copernicus International Partner Countries.

While the course implementation focuses on a single, high-impact earthquake preparedness use case, the underlying analytical template is designed for transferability to other urban challenges such as climate adaptation, food system resilience, and public health access. This modular structure reflects the broader interdisciplinary vision outlined in the initial proposal, while ensuring pedagogical depth and feasibility within a 3 ECTS format. The curriculum can be readily adapted for different learner groups, including public sector professionals and civil society actors, through case substitution and contextual data inputs.

Learning Outcomes

LO1: Access, select, and pre-process Copernicus EO datasets (e.g., Sentinel-1/2/3, CLMS, CEMS) required to assess open-space availability, built-up change, and environmental conditions relevant to earthquake assembly area adequacy.

Performance: The student retrieves and prepares problem-specific EO layers for the defined neighbourhood.

LO2: Design and run spatial analysis workflows using the UDENE Exploration Tool to define the Area of Interest, select appropriate Copernicus EO products, and configure analysis parameters prior to processing in open-source tools.
Performance: The student runs a complete UDENE-based experiment and documents a reproducible workflow for the anchor problem.

LO3: Integrate EO-derived indicators (e.g. NDVI trends, surface sealing, open-space change) with socio-spatial datasets (population proxies, vulnerability layers) to evaluate whether existing assembly areas meet minimum adequacy thresholds.
Performance: The student generates analytical maps and interprets spatial patterns relevant to assembly-area sufficiency.

LO4: Apply EO-based spatial analyses to the focal urban challenge of: assessing earthquake assembly area adequacy. Students learn how to quantify open-space capacity, detect long-term changes, and evaluate neighbourhood-level preparedness.
Performance: The student completes one structured case-study assignment focused exclusively on the anchor problem.

LO5: Critically interpret analytical results, assess uncertainties, and articulate the limitations of EO-derived indicators and spatial analysis outputs in evaluating assembly-area capacity.
Performance: The student submits a written reflection evaluating uncertainty, data quality, and assumptions in the earthquake scenario.

LO6: Develop a concise policy brief translating the analysis into actionable recommendations for improving earthquake assembly area adequacy and preparedness at the neighbourhood scale.
Performance: The student produces a one-page policy note integrating maps, indicators, and mitigation options.

LO7: Apply ethical principles—including data justice, transparency, reproducibility—when using EO and socio-spatial data to assess risk and vulnerability in disaster preparedness contexts.
Performance: The student completes an ethics reflection explicitly tied to the earthquake-preparedness use case.

LO8: Independently complete an end-to-end EO-based assessment workflow to evaluate earthquake assembly-area adequacy encompassing data acquisition, preprocessing, spatial analysis, indicator construction, mapping, interpretation, and policy recommendation.
Performance: The student submits a final project that demonstrates mastery of the complete workflow for the anchor problem.

Modules

Module 1 — Foundations of Applied Geodata Science

This module introduces the foundations of geodata science using Copernicus EO datasets (Sentinel-1/2/3, CLMS, CEMS). Students learn key EO concepts—including spectral indices, temporal resolution, spatial accuracy, metadata, and pre-processing requirements. The anchor problem (earthquake assembly area adequacy) is presented as a unifying applied challenge, showing how EO data can support open-space assessment, built-up change detection, and urban risk analysis.

Tools: UDENE Exploration Tool (AOI definition, Copernicus product discovery and validation), Copernicus Browser, QGIS, ESA SNAP (optional).

Key competencies:

- Understanding EO data structures
- Accessing and downloading EO datasets
- Performing basic preprocessing (cloud check, cropping, masking)
- Framing the focal problem analytically

Module 2 — Practical EO Data Handling & Spatial Workflows

Students learn how to design and implement reproducible geodata workflows using open-source tools. The module covers vector and raster operations, spatial boundary definition, temporal filtering, indicator extraction (including NDVI, and built-up proxy measures), and multi-year change analysis.

Tools: UDENE Exploration Tool (parameter checking and dataset consistency validation), QGIS (core), SNAP (optional), Python notebooks (optional).

Key competencies:

- Performing spatial clipping, reprojection, and layer management
- Computing indicators from EO raster data
- Documenting reproducible analytical workflow
- Selecting variables relevant to the anchor problem

Module 3 — Spatial Analysis & Indicator Construction

This module focuses on integrating EO-derived indicators with socio-spatial datasets including population proxies, land-use classifications, access networks, and vulnerability layers. Students compute adequacy ratios, perform cluster analysis, and interpret spatial patterns in relation to preparedness and the sufficiency of open spaces.

Tools: QGIS, simple Python tools (optional), open datasets (population grids, OSM, CLMS).

Key competencies:

- Creating indicators (NDVI trends, open-space ratios, built-up change)
- Integrating multiple datasets
- Detecting spatial clusters and risk concentrations

- Producing analytical maps suitable for decision-making

Module 4 — Applied Case: Earthquake Assembly Area Adequacy Assessment

This capstone module focuses on implementing an end-to-end applied workflow addressing the anchor question: Is the neighbourhood's assembly area adequate? Students combine EO indicators, socio-spatial data, and analytical reasoning to produce a one-page evidence-based assessment and policy recommendation.

Tools: QGIS (core), any supplementary geodata tools (optional).

Key competencies:

- Executing a complete end-to-end analytical pipeline
- Interpreting limitations, uncertainty, and sensitivity
- Communicating insights to planners and decision-makers
- Applying ethical and responsible geodata practices

Weekly Schedule

Week 1 — Introduction to Geodata Science & the Anchor Problem

Topics: EO systems, Copernicus architecture, Sentinel datasets, and framing of the anchor problem.
Practice: Selecting a neighbourhood for analysis.
Output: Defined study area and rationale.

Week 2 — Accessing & Preparing EO Data (Sentinel, CLMS, CEMS)

Topics: How to retrieve and pre-process Sentinel-2 imagery; NDVI basics.
Practice: Using the UDENE Exploration Tool to define the neighbourhood AOI, identify suitable Copernicus EO products (Sentinel-2, CLMS), and validate spatial and temporal parameters before data download.
Output: UDENE-based dataset selection summary (selected products, dates, resolution, AOI).

Week 3 - Raster Analysis: NDVI, Built-Up Indicators, Open-Space Metrics

Topics: Spectral indices, built-up proxies, and masking of urban areas.
Practice: Verifying indicator relevance and data consistency using the UDENE Exploration Tool before proceeding to spatial analysis.
Output: Short UDENE validation note (screenshots or parameter list).

Week 4 - Vector Analysis: Boundaries, Buffers, Accessibility, Networks

Topics: Spatial boundaries, buffer zones, distance calculations, and accessibility constraints.
Practice: Buffering assembly areas; analyze access routes.
Output: Access-map for assembly areas.

Week 5 - Integrating Socio-Spatial Data (Population, Vulnerability, Land Use)

Topics: Population grids, density estimation, and vulnerability layers.
Practice: Validating indicator relevance and data consistency using the UDENE Exploration Tool prior to integrating EO and socio-spatial datasets.
Output: Short UDENE validation note (screenshots or parameter list).

Week 6 - Interpreting Results & Evaluating Uncertainty

Topics: Data quality, assumptions, uncertainty sources (clouds, resolution, proxies).
Practice: Reflection on analytical limitations.
Output: Short written uncertainty analysis.

Week 7 - Policy Translation & Decision-Support Communication

Topics: Writing evidence-based briefs and visual storytelling.
Practice: Preparing concise maps and indicators for planners.
Output: Draft one-page policy note.

Week 8 - Final Project Presentation: Complete Workflow

Topics: Coherence, reproducibility, and ethical practice.
Practice: Presentation and+ peer evaluation.
Output: A final, documented end-to-end workflow demonstrating the complete progression from data acquisition and analysis to decision-support and policy recommendations.

Competency Alignment Table

Module	Learning Outcomes Covered	Competency Cluster Alignment	Description of Competency Development
Module 1: Foundations of Applied Geodata Science	LO1, LO3, LO4, LO7	Cluster A: EO Literacy & Data Foundations Cluster D: Ethical Foundations	Students gain foundational literacy in Copernicus EO datasets, including metadata, spatial and temporal resolution, and indicator logic. Using the earthquake assembly-area adequacy problem as an anchor, they learn how EO data supports preparedness-oriented urban analysis. Ethical principles such as transparency, data limitations, and responsible interpretation are introduced at the outset to frame subsequent analytical work.
Module 2: Practical EO Handling & Spatial Workflows	LO1, LO2, LO3, LO8	Cluster B: Spatial Workflow & Technical Skills	Students operationalize EO datasets through reproducible spatial workflows. They use the UDENE Exploration Tool to define the Area of Interest, select and validate Copernicus products, and configure analytical parameters before performing raster and vector operations (clipping, preprocessing, indicator extraction). This module establishes the first complete,

Module	Learning Outcomes Covered	Competency Cluster Alignment	Description of Competency Development
			UDENE-supported workflow components for the anchor problem.
Module 3: Spatial Analysis & Indicator Construction	LO3, LO4, LO5, LO8	Cluster C: Analytical Reasoning & Interpretation	Students integrate EO-derived indicators (NDVI, NDBI, open-space ratios) with socio-spatial datasets such as population and vulnerability proxies. They compute adequacy indicators, detect spatial patterns and trends, and interpret preparedness gaps in high-rise neighbourhoods, while critically evaluating analytical assumptions and data limitations.
Module 4: Applied Case: Earthquake Assembly Area Adequacy	LO4, LO5, LO6, LO7, LO8	Cluster E: Decision-Support, Communication & Ethical Practice	Students execute the problem-specific workflow (data → analysis → decision) using a UDENE-supported analytical pipeline. They translate EO-based evidence and functional assessment into a one-page policy brief, justify recommendations with spatial indicators, and reflect on uncertainty, ethics, and real-world applicability in earthquake preparedness planning.

<u>Competency Cluster Definitions</u>:
Cluster A - EO Literacy & Data Foundations: Understanding Sentinel/CLMS/CEMS datasets, selecting the appropriate EO product(s), preprocessing and metadata interpretation.

Cluster B - Spatial Workflow & Technical Skills: Raster-vector processing, NDVI and built-up indicator extraction, temporal analysis, reproducible geodata workflows.

Cluster C - Analytical Reasoning & Interpretation: Identifying spatial patterns, performing change detection and cluster analysis, integrating socio-spatial datasets, and interpreting assembly-area adequacy.

Cluster D - Ethical Geodata Practice: Data justice, transparency, recognition of limitations, uncertainty awareness, and responsible use of sensitive spatial data.

Cluster E - Decision-Support & Policy Communication: Producing actionable maps, designing indicators for decision-makers, translating evidence, and writing concise policy briefs.

Assignments & Rubrics

ASSIGNMENT 1 RUBRIC - EO DATA PREPARATION (100 points)

Purpose: To assess the student's ability to download, preprocess, and prepare Sentinel, CLMS, and CEMS EO datasets in an analysis-ready and reproducible format suitable for neighbourhood-scale assessment.

Criterion	Description	Points
Dataset Selection	Chosen datasets are appropriate for assessing open-space and built-up conditions; clear justification for dataset choice provided.	20
Data Retrieval	The student correctly downloads EO data (e.g., Sentinel-2 tiles, CLMS layers, etc.) for the defined neighbourhood. Student demonstrates the use of the UDENE Exploration Tool for AOI definition and dataset selection (e.g. screenshot, parameter list, or short justification note).	20
Pre-processing Steps	Cropping, masking, cloud checking, and temporal filtering are applied correctly and reproducibly.	25
Documentation Quality	Processing steps are clearly explained; filenames, spatial coordinates, acquisition dates and relevant metadata included.	20
Accuracy & Completeness	All required EO layers are included and free of errors or missing components.	15

Total: 100 points

ASSIGNMENT 2 RUBRIC - SPATIAL ANALYSIS & INDICATOR CONSTRUCTION (100 points)

Purpose: To assess the student's ability to conduct spatial analysis by constructing EO-based indicators (e.g., NDVI, built-up change, open-space metrics) and population-normalised adequacy measures.

Criterion	Description	Points
Indicator Design	The student constructs relevant indicators, such as NDVI trend, open-space ratio, built-up change, per-capita adequacy measures.	25
Data Integration	EO, population, land-use, and vulnerability datasets are correctly integrated and aligned for spatial analysis.	20
Spatial Accuracy	Maps are clipped correctly, projections are consistent, and indicators align spatially across datasets.	15
Analytical Interpretation	The student clearly explains spatial patterns, including trends, clusters, hot and cold spots, and emerging risks, and relates them to the assessment objective.	25
Visualization Quality	Maps are readable and well- designed. Labels are accurate, colour scales are appropriate, and legends are complete and correctly applied.	15

Total: 100 points

ASSIGNMENT 3 RUBRIC - POLICY BRIEF (One-Page) (100 points)

Purpose: To assess the student's ability to translate analytical findings into clear, actionable, and evidence-based policy recommendations that are understandable and usable for decision-makers.

Criterion	Description	Points
Problem Definition	The assembly-area adequacy problem is clearly defined and situated within the neighbourhood context.	15
Use of Evidence	Maps, indicators, and analytical findings are incorporated accurately and persuasively.	25
Clarity of Policy Recommendations	Recommendations are specific, actionable, and linked to the presented evidence and analysis.	25
Structure & Writing Quality	The policy brief is concise, coherent, and formatted appropriately for decision-makers.	20
Correct Representation of Limitations	Key uncertainties, assumptions and limitations are briefly acknowledged.	15

Total: 100 points

FINAL PROJECT RUBRIC - DATA-TO-DECISION WORKFLOW (100 points)

Purpose: To assess the student's ability to independently design and execute a complete end-to-end workflow addressing the anchor problem (earthquake assembly-area-adequacy).

Criterion	Description	Points
Workflow Completeness	The project includes all required stages: EO retrieval → preprocessing → spatial analysis → indicator construction → mapping → interpretation → policy- oriented recommendations.	20
Technical Correctness	EO, vector, and raster operations are executed accurately, with appropriate parameter choices and without major errors.	20
Analytical Depth	Spatial patterns are clearly explained; comparisons, slopes, trends, and changes are quantified where appropriate; and spatial meaning of results coherently articulated.	20
Decision-Support Quality	Final recommendations are well-justified and explicitly linked to analytical evidence and findings.	20
Reproducibility & Ethics	The workflow is documented step-by-step. Ethical considerations and limitations acknowledged and addressed.	20

Total: 100 points

Case Study Description

Case Title: Neighbourhood-Level Earthquake Assembly Area Adequacy Assessment
The core case study used in this course examines whether designated earthquake assembly areas in a given neighbourhood provide sufficient, accessible, and reliable open space for the local population. Students adopt the role of junior analysts supporting an urban resilience or disaster preparedness unit within a metropolitan municipality. Using Copernicus Earth Observation datasets and open-source spatial analysis tools, they build an end-to-end workflow to assess the adequacy of assembly areas under current and evolving urban conditions.

In many cities, assembly areas have been formally designated on paper; however, rapid densification, land-use change, informally occupied spaces, and evolving risk patterns may have undermined their actual capacity and usability. The case addresses this gap by asking students to quantify and interpret whether existing assembly areas are still fit for purpose, given population pressures, built-up expansion, and environmental constraints. The case directly responds to the identified need for EO-based disaster preparedness competencies and is aligned with the course's competency statement and learning outcomes.

As part of the case study, students are required to research and synthesise existing guidelines, regulations, and best practices regarding earthquake assembly areas, including minimum size requirements (e.g. square meters per capita), accessibility criteria, safety considerations, and common spatial characteristics observed in officially designated assembly areas.

Students critically assess whether the assembly areas identified in the study area effectively fulfil their intended function by examining their current land use, physical condition, and spatial integrity, including cases where designated areas have been partially or completely transformed into parking lots, commercial developments, or other incompatible uses.

To complement EO-based analysis, students investigate the on-the-ground visibility and public awareness of assembly areas by reviewing available online street-level imagery (e.g. Google Maps), focusing on the presence of signage, wayfinding elements, and indications of whether local residents can realistically identify and access these areas during an emergency.

The case study is structured around a clearly defined focal question: Are existing earthquake assembly areas in high-rise districts sufficient, accessible, and functionally viable to support neighbourhood-level preparedness under current and evolving urban density conditions?

To answer this, students are guided through the following analytical components:

1. Spatial Scoping and Data Preparation
    - Selecting one neighbourhood as the Area of Interest (AOI).
    - Identifying the boundaries and locations of official assembly areas.
    - Retrieving and pre-processing relevant Copernicus EO datasets (e.g., Sentinel-2, CLMS products) to represent open-space and built-up dynamics.

2. Indicator Construction
    - Computing EO-based indicators such as NDVI, surface sealing, and built-up change over a multi-year period.
    - In addition to NDVI-based open-space assessment, the workflow incorporates the Normalized Difference Built-up Index (NDBI) to systematically capture built-up density and urban surface expansion, allowing students to evaluate how increasing impervious surfaces constrain the functional capacity of designated earthquake assembly areas over time.
    - Integrating socio-spatial datasets (e.g., population grids, vulnerability or exposure proxies) to calculate per-capita open-space adequacy and assembly-area demand.
3. Spatial Analysis and Interpretation
    - Assessing accessibility using buffers, distance measures, and simple network-based measures around assembly areas.
    - Identifying spatial patterns, such as loss of open space, clustering of high-demand blocks, or emerging bottlenecks.
    - Evaluating uncertainty and limitations related to EO resolution, data timeliness, and proxy choices.
4. Decision-Support Outputs
    - The case study explicitly combines EO-derived indicators (NDVI, NDBI, open-space ratios) with desk-based qualitative assessment of assembly-area criteria and local visibility to produce a more realistic and decision-relevant evaluation of earthquake preparedness at neighbourhood scale.
    - Producing analytical maps and key indicators that summarise adequacy levels and gaps in the current assembly-area system.
    - Drafting a one-page policy brief that translates analytical findings into concrete recommendations (e.g., re-designation of sites, expansion of existing areas, identification of new potential locations, accessibility improvements, or communication measures).
    - Reflecting on ethical considerations and the responsible use of spatial data in disaster preparedness planning.

Rather than using multiple unrelated case studies, the course applies one coherent case template that is instantiated by each student (or group) in a different neighbourhood. This approach ensures:

- A consistent analytical structure and competency progression across the cohort.
- Multiple context-specific examples (e.g., densely built central districts, peri-urban neighbourhoods, mixed residential-commercial areas) collectively demonstrate the transferability of the workflow.
- A clear link between technical skills (EO handling, indicator construction) and their direct application to a high-impact, real-world urban resilience challenge.

By completing the case study, students produce:

- A prepared EO dataset package for their selected neighbourhood.
- A set of analytical indicators and maps evaluating assembly-area adequacy.
- A short-written reflection on data quality, uncertainty, and analytical limitations.
- A one-page policy brief summarising key findings and recommendations for municipal decision-makers.

These outputs collectively demonstrate mastery of the course's complete data-analysis-decision workflow and serve as evidence of the targeted competency in geodata-based disaster preparedness analysis.

ECTS Workload Table

Activity	**Description**	**Hours**
Lectures	8 weeks × 2 hours (theoretical concepts, analytical frameworks, case framing)	16
Hands-on sessions	8 weeks × 2 hours (QGIS practice, EO workflows, spatial mapping)	16
Independent EO data retrieval & preprocessing	Searching, downloading, and preparing Copernicus EO data according to the Selected Area of Interest (AOI)	6
Independent spatial analysis practice	NDVI/built-up indicator computation, raster-vector operations, basic indicator development	10
Socio-spatial data integration work	Integration of population grids, vulnerability layers, and adequacy ratios	6
Readings & conceptual study	Required readings, EO documentations, and disaster risk and resilience frameworks	8
Assignment 1 preparation	EO data preparation assignment	6
Assignment 2 preparation	Spatial analysis, map production, and short analytical interpretation	8
Assignment 3 preparation	One- page policy brief preparation	6
Final project preparation	Consolidation of the complete workflow and refinement of analytical outputs	6
Final presentation preparation	Slide preparation and rehearsal	2
TOTAL WORKLOAD		90 hours

Annexes

Duty-Task Table

Duty (D)	Tasks (T)	Subtasks / Observable Behaviours
D1. Prepare EO Data for Analysis	T1. Retrieve Copernicus datasets	Select Sentinel-2 tile; check metadata; verify cloud cover; download correct date range.
	T2. Pre-process raster data	Crop to AOI; reproject; mask clouds; generate clean raster stack.
	T3. Compute EO indicators	Calculate NDVI; compute built-up proxy; generate multi-year indicator layers.
D2. Build Spatial Workflow in Open-Source Tools	T4. Define study boundaries	Import AOI; ensure correct coordinate system; validate spatial extent.
	T5. Conduct raster operations	Clip, resample, and combine raster layers.
	T6. Conduct vector operations	Create buffers around assembly areas; calculate distances; import land-use layers.
D3. Construct and Interpret Indicators	T7. Integrate EO + socio-spatial datasets	Combine population grids, vulnerability layers, and land-use data.
	T8. Compute adequacy indicators	Calculate per-capita open space; NDVI trends; built-up trend; identify risk hotspots.
	T9. Interpret spatial patterns	Identify clusters, anomalies, and change trends; describe spatial meaning.
D4. Produce Decision-Support Outputs	T10. Create analytical maps	Apply appropriate styling; design legend; use consistent and meaningful colour scales.
	T11. Draft policy recommendations	Translate indicators to recommendations; identify risks; propose interventions.
	T12. Communicate findings ethically	Cite data sources; state uncertainty; ensure transparency; avoid misinterpretation.

Task Performance Criteria Table

Task (from Annex 1)	**Performance Criteria (PC)**
T1. Retrieve Copernicus datasets	Correct dataset and date range selected; metadata valid; no missing files; cloud percentage checked.
T2. Pre-process raster data	Raster correctly clipped; projection consistent; no tiling artefacts; workflow reproducible.
T3. Compute EO indicators	NDVI and built-up values computed without error; indicators correctly aligned spatially.

Task (from Annex 1)	Performance Criteria (PC)
T4. Define study boundaries	AOI geometry correct; CRS documented; spatial extent matches neighbourhood boundary.
T5. Conduct raster operations	Final rasters clean, aligned, and visually validated; processing steps documented.
T6. Conduct vector operations	Buffers correctly size; distance calculations logically accurate; all layers topologically valid.
T7. Integrate EO + socio-spatial data	All datasets correctly overlay; population and vulnerability layers appropriately normalized.
T8. Compute adequacy indicators	Ratios mathematically correct; units clearly stated; final values interpretable.
T9. Interpret spatial patterns	Interpretation evidence-based; trends justified; no overinterpretation.
T10. Create analytical maps	Maps readable; legends correct; colour schemes meaningful; all layers properly attributed.
T11. Draft policy recommendations	Recommendations feasible; clearly linked to indicators; concise and actionable.
T12. Communicate findings ethically	Uncertainties acknowledged; data sources cited; no misleading visualizations.

Module-Level Enabling Objectives

Module 1 - Foundations of Applied Geodata Science
Enabling Objectives:
1. Identify and distinguish Sentinel-1/2/3 data types
2. Evaluate EO data quality in terms of cloud cover, spatial resolution, and temporal suitability.
3. Delineate and display a neighbourhood Area of Interest (AOI) on a map
4. Explain the analytical need underlying the earthquake assembly- area adequacy problem.
5. Describe core EO ethics principles, including transparency and responsibility in data use, using concrete examples.

Module 2 - Practical EO Handling & Spatial Workflows
Enabling Objectives:
1. Load and visualise raster EO data in QGIS.
2. Clip raster datasets according to a defined AOI.
3. Apply band combinations for NDVI and built-up area analysis.
4. Manage raster and vector layers using the correct coordinate reference system.
5. Document analytical steps in a way that enables workflow reproducibility.

Module 3 - Spatial Analysis & Indicator Construction
Enabling Objectives:
1. Integrate population grids with EO-derived spatial layers.
2. Compute per-capita open-space adequacy indicators.

3. Conduct NDVI trend analysis over a multi-temporal period.
4. Assess accessibility using buffer-based and distance-based measures.
5. Identify and explain analytical uncertainties associated.

Module 4 - Applied Case: Earthquake Assembly Area Adequacy
Enabling Objectives:

1. Integrate all analytical components into a single, coherent assessment model.
2. Produce decision-support maps suitable for planners and decision-makers.
3. Present findings in the form of a concise, one-page policy brief.
4. Write a conclusion section that reflects ethical data use and acknowledges limitations.
5. Independently produce a complete workflow (data → analysis → interpretation → decision) addressing the earthquake assembly- area adequacy problem.

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