Multi-Criteria Analysis project

Introduction – why do we do this project?

With a Bachelor or Master degree in your pocket and off to work in the big wide digital world of geoscience, sooner or later, **you will likely end up being confronted with some kind of spatially-related problem** – maybe just a very simple one, maybe even a large project! Even more likely, you will use digital spatial data stored in some form in a database, and end up trying to automatize repetitive workflows.

This multi-week lab project takes up **all the elements and skills you want to have** in a group project where you **define the topic yourself**, according to your interests. While every group works on their own research question, we follow the same workflow and work in the same area, so that we can **share our findings and help each other** out with technical, topical and methodological challenges.

The project includes a presentation and a report for each group. This is not to satisfy the teachers, but reflects an important aspect of working as a geoscientist: **You need to be able to communicate your results** to whoever gave you the task (or, for this project, to whoever is the imaginary "client" for your task)!

Learning outcomes

After this project, you will know **how to get from a spatial problem to a result map, and work on convincing others of your results.**
More precisely:

- how to **tackle a spatially-related problem in a structured and objective way**, using the multi-criteria analysis approach
- what "traps" there are in a MCA problem, what your **results are most sensitive to**
- how to use **geodatabases** and **metadata** to keep overview in a larger project
- why **flowcharts** are important, and how to use **models** for a multi-step analysis
- how to **automatize workflows** with scripting, and how to make your own GIS tools from scripts
- how to convincingly **present** your research question and findings in a variety of ways :
    - **orally to a critical client** (GEO4460 or voluntarily if GEO3460)
    - **written report including maps** to a decision panel including experts and shareholders
    - as a **poster advertising to the affected/benefiting** public (depending on the project, the tone might be very different)
    - as **a StoryMap** as seen in dynamic news pieces

The project

You are free to choose your own study area. You have to work individually if you take GEO4460 or in groups of 2 students (if you take GEO3460, solo project possible). The project lasts over several weeks.

- Each group **defines a spatially-related research question**/problem to solve, and subsequently solves it using all the elements and steps of a **multi-criteria analysis**.
  - We will make sure that all projects are different!
  - The project needs to define a "client" (investors seeking advice on a project location, administration looking for the most efficient way to address a public service need…)
- You will need to **find and download data** for your chosen criteria (e.g. www.geonorge.no)
- All your data will be stored in a **geodatabase or geopackage** that you will share at the end. You need to **document** all datasets with **metadata, including their source and license**.
- You will use ArcGIS **ModelBuilder and/or Python scripts** in your project (or the **QGIS Graphical modeler/PyQGIS**)
- You have to perform a **sensitivity analysis** of your approach/results.
- You **document** the project, including result **map**(s) according to cartographic standards.

Hand-in of a **project description** after the first lab **(deadline 2025-03-16)** and good **data handling** is required (geodatabase and toolbox documented with metadata). The requirements are defined clearly at the end of this document.

Grading

The grade follows the *Grade=Ambition * Realization* concept, which encourages choosing a more complicated task.
Ambition is graded from 0.5 to 1.
Realization is a combination of grades from the different elements:

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*Realization(GEO4460) = 0.6 * Report + 0.2 * Presentation + 0.1 * Poster + 0.1 * StoryMap*

*Realization(GEO3460) = 0.7 * Report + 0.15 * Poster + 0.15 * StoryMap*

The final grade will be computed relative to other students (with a minimal expectation level), independently for GEO3460 and GEO4460 students.

MCA workflow – as in the MCA lecture

1. Define the problem: goals? Related questions?
   Define your **research question**
2. Find **criteria** and **data**:
   a. What is related to my project goal?
   b. What are possible criteria?
   c. Which criteria have the highest impact on the process? – decide for **3 to max. 5 criteria** (we won't have time for more)
   d. How can these criteria be expressed in relation to spatial data? Which data represent the chosen criteria?

   -> make a **geodatabase** for the project and import all the datasets you need!

   -> draw a **flowchart** of the MCA model!

   -> make a **table of the criteria**, **data that represents them**, weights… (next steps) – see example below

3. **Reclassify**

   How to get from spatial data to classes/criteria: operationalise your data to aptly represent the criteria, i.e. get from (theoretical) criteria to (digital/spatially related) classes that are fit for arithmetic operations.

4. Data integration:

   Scale, type (raster/vector), resolution, spatial reference: needs to be the same for all data so that you can do arithmetic operations on them.

5. Aggregation: Boolean, weighted, fuzzy?
   a. How to assign **weights**?

      Assign weights systematically using one of the methods introduced in the lectures.
      -> after this step you will have a **result map**

6. Quality control:
   a. Verification
   b. Sensitivity analysis: change weights, buffers… etc
   c. **Metadata** – for the most important datasets (original data, input criteria, result map(s) of different runs of the model). The metadata should allow someone who didn't do the analysis him/herself to understand where the data are from/what they are used for.

   Does your map **make sense**, is it realistic? Do you need to change something in your model? What happens when you change parameters/weights, **are your results robust**, what are they sensitive to?

7. Recommendation:
    a. **Suitability map** (maybe with alternatives)
    b. **Report** -> Transparency! includes quality measures

Example for a criteria table

Example: build a new hotel

Criteria	***Data***	***Classes in criteria***	***Meaning***	***(Values)***	***Normalised***	***Weight***
Distance to existing roads	roads.shp -> buffer	<20m	Not possible	0	NaN (hard)	3
		20-500m	ideal	20	1	
		>500m	Not ideal	500	0.2	
Criterion 2						
Criterion 3…						

Example structure of the report

Title page

Table of contents

Introduction
Definition of the problem and research question.(1 page)

The case study and area
Description of the case study area. (1 pages including map of the case study area)

Evaluation criteria and operationalisation (2 pages including table listing the criteria)
Description of the used criteria, and what data was used to reflect the criteria (possibly with literature references).
Description of the data used.

Data integration (2 pages including table with classes and flow chart)
Description on how the classes were chosen (possibly with literature references).

Data aggregation (1 page, with equations and table of used weights)
Description and justification of the selected method.

Results including Discussion/Sensitivity and Robustness analysis (3 pages with figures/tables)
Description and discussion of the results, statistics, sensitivities, critical points, outlook…

Conclusion/Recommendation (1 page)

References

(Appendix)

Requirements

Project description (to be uploaded in Canvas):

- Prepare a **2-slide presentation** of your project idea for the other groups (to be presented 2025-03-12).
- **0.5 page** including **names** of all group members, your **research question**, who your **"client"** is, and the **criteria** you chose to solve your spatial problem. **Deadline 2025-03-16.**

Initial presentation (to be uploaded in Canvas):

- Each project and preliminary results are presented to the whole class
- The presentations are given in **English**.
- You **give feedback** to the other groups' work, and each group subsequently **implements the feedback** in their final results/report.
- Presentations are **maximum 5 minutes**, followed by 5 minutes discussion.
- Presentation is mandatory (**2025-03-(25|26)**). Get in touch if you can't attend that day, so we can reschedule or arrange a remote option.

Report (to be uploaded in Canvas):

- **Max 15p**, good **structure** with title, TOC, tables/figures/maps/flowchart including captions, **references**
- Language: Norwegian or English. **Proofread!**
- **Optional: If you want feedback submit your report before 2025-04-27**
- **Mandatory, Final report deadline: 2025-05-11**

Data (to be uploaded the course folder):

- **Geodatabase/Geopackage** that includes **metadata** of all datasets.
- If applicable: all used own **models** / own **tools** (in tool box) briefly documented with **metadata**, and **own arcpy/pyqgis scripts (commented,** in appendix of report).
- **Mandatory, alongside final report, deadline: 2025-05-11**

Poster (to be uploaded in Canvas):

- A3 sized poster advertising your solution to the public affected/benefiting.
- **Mandatory, deadline: 2025-05-18**

StoryMap (link to be provided in Canvas):

- Present your project using storytelling, and show how each criteria comes in play.
- In ArcOnline or another tool if you want to try something out.
- **Mandatory, deadline: 2025-05-18**

Final presentation (GEO4460 or voluntarily if GEO3460 to be uploaded in Canvas):

- Each project is presented to the class and evaluators representing the "client"
- The presentations are given in **English**.
- Presentations are **maximum 10 minutes**, followed by 5 minutes Q&A from the evaluators.
- Presentation is mandatory (2025-05-(20|21|27|28)). Get in touch if you can't attend some/any of those days, so we can reschedule or arrange a remote option.