GEOS 373 Term Project, Spring 2023

This project will give you a chance to synthesize your learning in this course by exploring landscape change in a region of your choosing using data from Landsat 8 or 9. You will choose a region, identify relevant imagery, process that imagery to assess change, and assess the accuracy of your results. You will write a report detailing your methods and results, and prepare a virtual presentation. Finally, you will watch other groups' presentations and provide feedback on their project and presentation.

After completing this project, you will be able to:

- Develop a simple remote sensing scenario and identify appropriate methods
- Search and download imagery relevant to an application
- Apply what you learned in lab to conduct all the steps of the digital image processing pipeline
- Generate maps and simple figures with your results
- Develop a collaborative project management work plan and work collaboratively to conduct a remote sensing analysis.
- Create and present a poster presentation of your results.
- Evaluate and provide feedback to your peers.

The project is worth 25% of your final grade.

Deliverables:

Your deliverables for this project will consist of the following:

1. Project Proposal, including a work plan (10% of your project grade)
2. A poster presentation (85% of your project grade)
3. Written peer-review comments for two other group's presentations (5% of your project grade)

Groups:

You will work in groups of 4 or 5 people. You may choose your own group or elect to be assigned a group. You will submit one proposal, presentation, and writeup per group, and your grade will be a group grade. However, you will submit written peer-review comments as an individual (deliverable #3) and you will also submit a one-page individual/group evaluation which can be used at the professor's discretion to adjust the project marks. With your proposal, you will submit a group agreement that lays out individual duties on the project. When you submit your final project report, you will also submit an individual and group evaluation that will assess the extent to which individuals fulfilled their responsibilities to the group as laid out in the group agreement.

Process

1. Identify a project focus.

For your project, you will use Landsat data to assess change in a region of your choosing, at a time scale of your choosing. The change you assess could include land cover change (e.g. urbanization, forest cover change), impacts of a natural disaster (e.g. flooding, a hurricane, drought, or a wildfire), intra-annual seasonal change (e.g. comparing vegetation during summer/winter or wet/dry seasons), or interannual

variability in some landscape characteristics (e.g. comparing snow extent between years, etc.). The only requirement is that this change is something that can be assessed using data from Landsat 8 or 9. This means that the spatial resolution (30m), spectral resolution (7 spectral bands) and temporal resolution (every 16 days since 2013) must be sufficient to detect the change you identify, and that you must consider images taken since the launch of Landsat 8 (2013). Using earlier data (from Landsat 4, 5, or 7) is possible if you'd like to go back further in time, but please talk to Dr. Schwartz before you decide to go down this route because it can complicate things.

Your region can be anywhere in the world. I strongly suggest that your region be contained within one Landsat tile (i.e. one single Path/Row combination.) This is to avoid needing to mosaic multiple images together, which is beyond the scope of this course. This website can help you identify the path/row corresponding to your region of interest. You might want to consider subsetting the tile further, to speed up processing times.

The goal of your project will be to assess change in your region, using at least two methods for characterizing change. This could include comparing two different spectral indices and/or different classification algorithms. You are welcome to use only techniques we covered in labs, but are encouraged to explore some different methods (i.e. a different classification algorithm, or spectral indices we didn't calculate in lab, improving classifications by including NDVI, etc) The creativity and sophistication of your approach will be factored into your grade on the project, so keep that in mind!

You will be analyzing both the characteristics of the change, and also the relative accuracy and usefulness of the different methods for mapping change. Some example project ideas are below. Feel free to use any of these, adapt them for your own interests/regions, or come up with something altogether different!

Project ideas

- Choose an area that recently underwent a wildfire. Quantify fire effects with NBR (like we did in lab 3) and NDVI, and compare and discuss the maps of fire effects generated with both indices. Assess the accuracy of NBR and NDVI for identifying fire refugia (unburnt areas within fire polygons).
- Choose a rapidly changing metropolitan area. (See here for some US-specific ideas, or this article for a map of the world's fastest growing cities.) Map land cover change from 2013-2022, comparing the results and accuracy of two different classification algorithms (e.g. k-means, maximum likelihood, parallelepiped, and/or minimum distance).
- Choose a region that has experienced large changes in forest cover in recent years. (You can explore this dataset to identify tree cover change hotspots.) Compare change as mapped with a maximum likelihood classification and with change in NDVI (or another vegetation index). As a bonus, compare your map with the Hansen et al. data (linked above).
- Compare impacts of a drought on vegetation using NDVI and NDWI.
- Compare vegetation characteristics across seasons, using NDVI, EVI, the simple ratio, and/or other spectral indices.

2. Identify imagery.

Once you've come up with a project idea, the next step is to identify the two images that you will use in your analyses. Sometimes, imagery relevant to the question you've chosen isn't available. For example,

it's very hard to get a cloud free image of Vancouver in the winter. So, you may have to reconsider the focus of your project depending on available imagery.

If you haven't, identify the Landsat tile path/row that you'll use for your project (link above). Then, use Earth Explorer, as we did in Lab 2, to search for available Landsat 8 and/or 9 data. When selecting images, you'll want to pay attention to the cloud cover and the time of year. Getting a completely cloud-free image may be unfeasible and you will likely have to mask out clouds using the pixel_qa band (like in Lab 3), but you'll want to make sure cloud cover doesn't interfere with your ability to explore the question at hand. It is also important to consider whether the time of year of the images is appropriate for the objective. For example, if you are comparing vegetation characteristics during a drought year and a normal year, it will be important to ensure that the images are from the same time of year, so that differences you observe are due to the drought and not due to the time of year.

Once you've ensured that relevant imagery is available, note the names of the images you plan to use to use (they will look something like this: LC08_L1TP_047024_20170822_20170912_01_T1) and order them from USGS.

3. Plan analyses and write proposal (Due Friday March 24, 11:59 pm)

Before you begin your project, you must write a proposal and have it approved by your instructors. Your proposal should be structured according to the four stages of the remote sensing process, as discussed in class:

1) **Statement of the problem:** brief (1 paragraph) description of the project objective, including justification for why you chose the topic and area that you did.
2) **Data collection:** What Landsat images will you use? Include the satellite, path/row and the image dates (in table form if so desired). What are your plans for collecting training and validation data (if necessary)? (1 paragraph)
3) **Data-to-information conversion:** What steps will you take to process your imagery? Here, you should include a flowchart illustrating the image processing steps, and a brief (1-2 paragraph) description of the analyses you will do. Feel free to put this in bulleted form.
4) **Information presentation:** Here, include a list of the outputs from your analyses that you plan to include on your poster. Your poster should include maps, tables, and/or figures (e.g. confusion matrices, histograms, scatterplots, etc.).

Your proposal must also include a **detailed work plan**, which should list all tasks, who will be the main person responsible for them and when they will be done by (see example on Canvas). Not everyone needs to be involved in everything – for example, if some of you are great at graphic design and others prefer writing, you can divvy up responsibility along those lines. It's up to you to divide the work evenly, fairly, and according to everyone's strengths and interests and to agree on a work plan. However, I do request that everyone take some responsibility for some aspect of the image processing.

Finally, you should include a **data management plan**, indicating where and how you will store shared data. Ideas for doing this include on Google Drive, Dropbox, Canvas (though you only have 100 mb storage here), or by sharing one Geography computer lab account. I don't mind what you do, as long as you provide a plan (just a few sentences).

4. Data collection

If you haven't already, download your Landsat data. Collect any training and validation data you need. (On Canvas, I've included instructions for collecting training/validation data in Google Earth, should you wish to do so.) If you are collecting training and validation data, make sure to include a table in your final project report detailing the number of pixels and polygons you used for training and validation for each class.

5. Data-to-information conversion (i.e. image processing)

This is where you'll do all the stuff you said you'd do in your proposal! Keep careful track of the steps you take, the parameters you set in ENVI, etc. You will need to detail all of this in your writeup!

On canvas, I've added a few links for doing a few things in ENVI that might be useful for this project that we didn't cover in class. You should also consider the ENVI help documentation your friend! Also, feel free to ask me or your TA for help with additional analyses and processing tools. I will be holding office hours in the computer labs during the project period to assist.

6. Information presentation

With the results of your image processing, generate tables and figures to summarize your results. These may include maps, tables (confusion matrices, change summaries), and figures (histograms, scatterplots). You may make your maps in ENVI, or you are welcome to do so in ArcGIS (export images from ENVI as .tif files to open in ArcGIS) if you'd like to add inset maps, base layers, other polygon layers, etc. You can make other figures in ENVI, Excel, R, or any other software you are familiar with.

7. **Poster presentation**

You will present your results in the form of an academic poster. As a group, you will create a poster that uses text and images to communicate your key results. Posters are a standard way to present work or research to an interested audience, and you will likely present a poster, or something like it, at some point during your career. There is a vast amount of helpful information available through the library and through the internet on academic posters, concerning content, design, templates and more. In all cases, visuals are essential, as is the amount of information (not too much, not too little) and how it is communicated (clearly, concisely, and well-organized). See below for some resources on poster design.

You must submit your poster to Prof. Schwartz by 9 pm on April 11 so that she can print it before class on the 13th. If the poster is not submitted by then students will be responsible for printing their own posters.

You will present your project during a poster session on the last day of class (April 13). During the poster session, you and your classmates will visit each other's posters, and your instructors will be stopping by too. Every group member should be prepared to present the poster with a brief "elevator pitch" of your project and findings (~2-3 minutes), and to answer any questions about the work. During this time, you will also visit other groups' posters and provide them with peer review comments.

Poster guidelines:

Your poster should be 36” x 48”. Prof Schwartz will handle the printing. You can make the poster in powerpoint, or another design software if you prefer (see resources below). You will be evaluated on the poster content, design, and presentation quality (see rubric on Canvas).

Your poster presentation should touch on all of the following:

Introduction/problem statement: Present your project objective. Provide justification for why you chose to focus on this objective. Give some background and context about the study area.

Methodology: What were the steps you took to acquire and process your imagery? How were training and validation data collected, if relevant? You may choose to represent your methods graphically (as in, with a flow chart) in this section.

Results: What were your key findings? Are observed changes are consistent or different across the two methods you compared? If relevant, present accuracy of your classifications and the major errors. This section should consist of mostly figures and tables, with a few words for necessary context.

Discussion and conclusions: What are the major takeaways from your project? How did the results differ (or not) between the two methods tested? What were the major sources of error? What were the limitations of your analysis, and how might you do things differently?

IMPORTANT NOTE: A key aspect of poster design is including the right amount of information – not too much, and not too little. A poster should not just be a large format version of a paper; rather, it should include just the information necessary to convey key results, with additional detail and context provided by the presenter if and when asked.

Resources for poster design:

https://colinpurrington.com/tips/poster-design/ This site contains lots of great tips for poster design, and some downloadable powerpoint templates.

https://www.sciencegraphicdesign.com/blog/how-do-you-make-your-first-scientific-poster

https://www.posternerd.com/tutorials Lots of helpful details on poster design in the tabs on the left.

8. Peer evaluation

You will be assigned three groups’ posters. You will visit these posters during the poster session, and fill out a feedback form for each group.

9. Group evaluation

Last but not least, you will fill in the group evaluation form on canvas, assessing your individual and group performance on the project. In exceptional cases, these evaluations can be used to adjust final marks on the project.