Projekti:

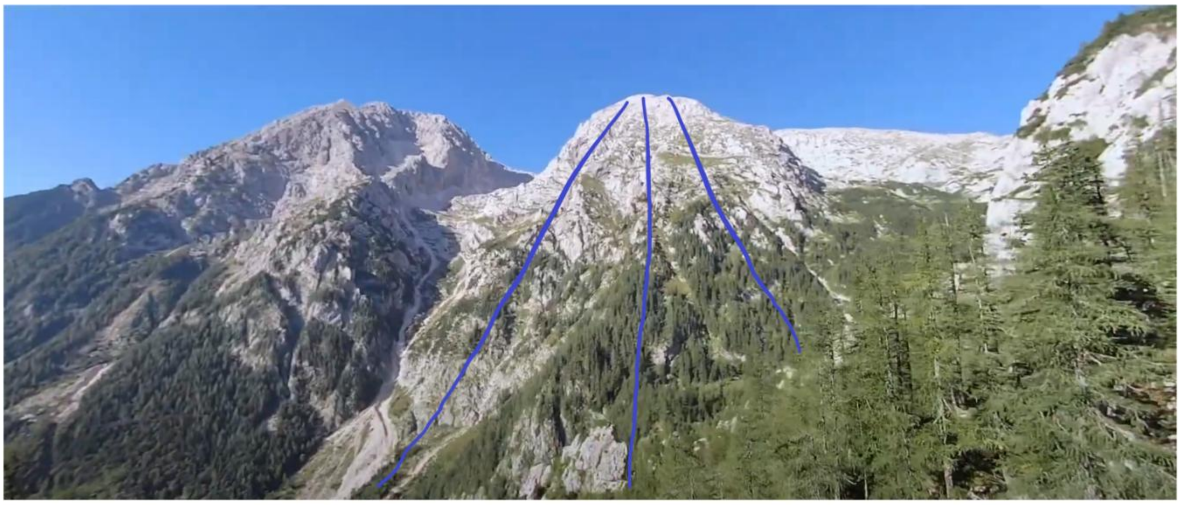
1. Analiza conacije vegetacije v gorah (primer Kočne in Grintavca)
2. Analiza procentualne sestave gozda (primer območja pod Kalškim grebenom)
3. Geomorfološke spremembe zaradi klimatskih sprememb
4. Fenomenološka analiza habitatov (gozdovi, ruševje, travniki, sklani samotarji itd...)
5. Opazovanje živali v gorah (gnezdenje ptic pod Grintavcem, Gamsi pod Kočno itd...)
6. Opazovanje golosekov v gorah (primer nad Kokro)
7. Opazovanje tektonskih prelomov v gorah
8. NGRDI vegetacijski indeks kmetijskih površin na osnovi dronskih posnetkov
9. Analiza vetrolomov (primer Kukove špice in območja Martuljka)
10. Monitoring izgradnje gorskih cest in posledične erozije tal (primer nad Kokro ali pod Storžičem)
11. Monitoring železovih orudenj na Kočni

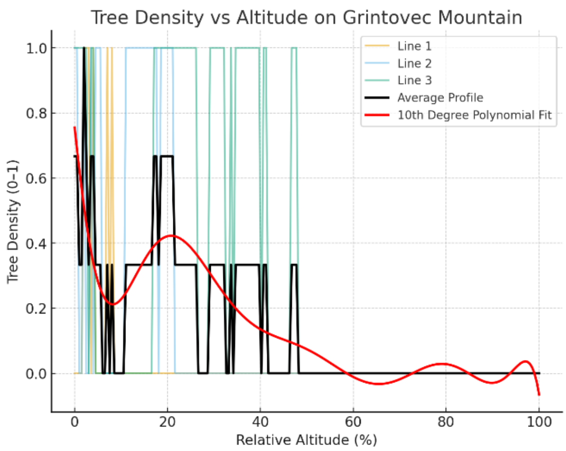
Projects:

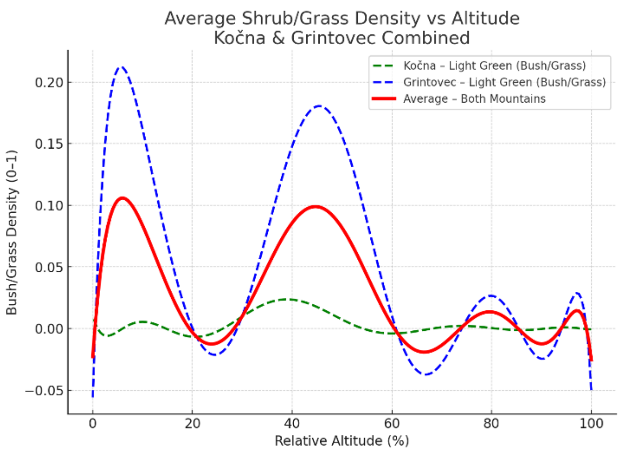
1. Analysis of vegetation zonation in the mountains (case study of Kočna and Grintovec)
2. Analysis of the percentage composition of forests (case study of the area below Kalški greben)
3. Geomorphological changes due to climate change
4. Phenomenological analysis of habitats (forests, dwarf pine stands, meadows, isolated rock outcrops, etc.)
5. Observation of animals in the mountains (bird nesting below Grintovec, chamois below Kočna, etc.)
6. Observation of clear-cuts in the mountains (case study above Kokra)
7. Observation of tectonic faults in the mountains
8. NGRDI vegetation index of agricultural land based on drone imagery
9. Analysis of windthrows (case study of Kukova špica and the Martuljek area)
10. Monitoring of mountain road construction and the resulting soil erosion (case study above Kokra or below Storžič)
11. Monitoring of iron ore mineralization on Kočna

Vegetation indices	Definition
RGB-VIs	
Visible-band difference vegetation index	$VDVI = (2 * G - R - B)/(2 * G + R + B)$
Normalized green–red difference index	$NGRDI = (G - R)/(G + R)$
Visible atmospherically resistant index	$VARI = (G - R)/(G + R - B)$
Green–red ratio index	$GRRI = G/R$
Vegetativen	$VEG = G/(R^a * B^{(1 - a)})$ $a = 0.667$
Modified green blue vegetation index	$MGRVI = (G^2 - R^2)/(G^2 + R^2)$
MS-VIs	
Normalized difference spectral index	$NDSI = (R_{\lambda1} - R_{\lambda2})/(R_{\lambda1} + R_{\lambda2})$
Simple ratio index	$SR = R_{\lambda1}/R_{\lambda2}$
Modified normalized difference spectral index	$MNDSI = (R_{\lambda1} - R_{\lambda2})/(R_{\lambda1} - R_{\lambda3})$

PROJECT 1: Drone-Based Analysis of Vegetation Zonation in Mountain Slopes







1. Introduction

- Briefly explain the purpose of the study.
    - Why study vegetation zonation?
    - Importance of altitude, slope, and human activity (logging, grazing, roads).
- Mention that drones provide a **high-resolution, low-cost method** for vegetation monitoring.

2. Materials and Methods

2.1 Drone Photography

- Describe the **drone type, camera, and settings** (flight height, resolution, area covered).
- Mention weather and lighting conditions.

2.2 Analytical Methods

- Explain the use of **RGB-only indices and segmentation**:

- **NGRDI** for vegetation density.
    - **HSV/Lab thresholds** for separating land cover classes (forest, grass, shrubs, bare soil, rock).
    - Polynomial fitting or gradient analysis to detect changes in vegetation density with altitude.
- **Prompts used in analysis:**
    - **Prompt A – Vegetation Index** → vegetation health map.
    - **Prompt B – Segmentation & Area Calculation** → classification and % cover.
    - **Prompt C – Change Detection** (if multiple flights available).

3. Results

3.1 Vegetation Index Maps

- Insert the **NGRDI heatmap** and **overlay** with the photo.
- Describe patterns (forest = green, bare/rock = red).

3.2 Segmentation Maps

- Present the **classified map** (forest, grass, logged patches, roads).
- Include a **table with pixel counts and % cover**.

Class	Pixel Count	% of Area
Dense forest	...	... %
Grass/shrub	...	... %
Logged patches	...	... %
Roads	...	... %
Other	...	... %

3.3 Altitudinal Gradient Analysis

- Plot vegetation density vs. relative altitude (0% bottom → 100% summit).
- Interpret transition zones: forest → bushes → bare rock.

3.4 (Optional) Change Detection

- If before/after photos are available:
    - Show forest loss map.
    - Report % forest lost.

4. Discussion

- Compare vegetation zones with ecological expectations (e.g., tree line, slope exposure).
- Discuss the impact of **logging, roads, erosion, or grazing**.
- Identify limitations of RGB-only analysis:
    - Shadows may appear as non-vegetated.
    - No infrared band → only approximate vegetation index.
- Suggest improvements (multispectral sensors, repeated seasonal monitoring).

5. Conclusion

- Summarize main findings:
  - What % of slope is forest, grass, bare rock?
  - How clear is the zonation pattern?
  - Were logging patches successfully detected?
- Reflect on the value of drones for nature protection.

6. References

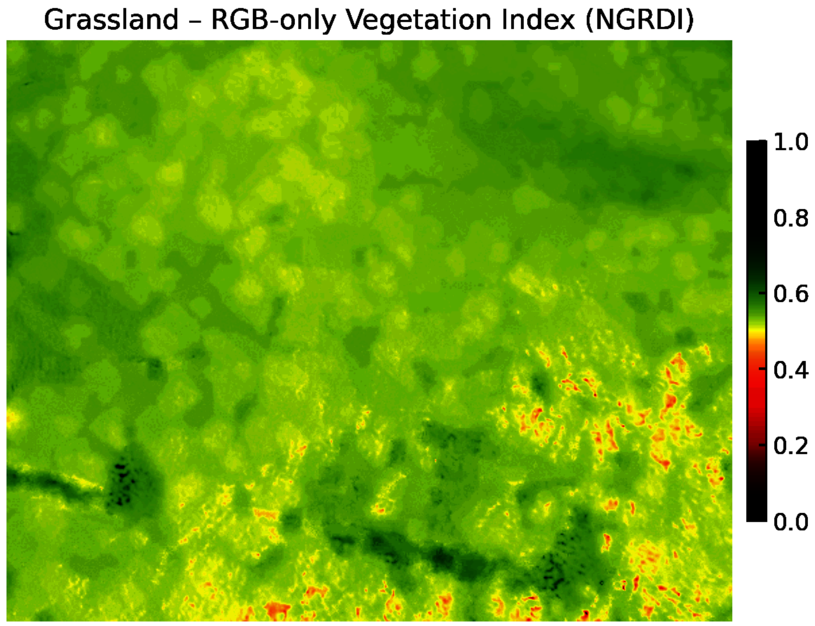
- Include any scientific sources (e.g., vegetation indices, ecological zonation, drone-based monitoring).

7. Appendices

- Original photos (annotated if needed).
- Code snippets or ChatGPT prompts used for analysis.

✅ **Deliverables**:
Each student (or group) should hand in a **report of 4–6 pages**, including maps, overlays, tables, and an interpretation of ecological meaning.

PROJECT 2: NGRDI index



Instructions for Vegetation Index Analysis with RGB Drone Images

1. What are Vegetation Indices?

Vegetation indices are **numerical indicators** that describe the presence, density, and condition of vegetation based on how plants reflect light.

- Healthy plants reflect **a lot of green light** (visible spectrum) and even more **near-infrared (NIR)**.
- Stressed or sparse vegetation reflects **less green** and more red or blue.
- By comparing color channels, we can estimate how dense and healthy the vegetation is.

2. Common Vegetation Indices

- **NDVI (Normalized Difference Vegetation Index)**

$$NDVI = \frac{NIR - R}{NIR + R}$$

Requires a **near-infrared (NIR) camera**. Gold standard for vegetation monitoring.

- **EVI (Enhanced Vegetation Index)**
  Corrects for atmospheric effects and soil background. Also requires NIR.
- **RGB-based indices (no NIR needed, only normal photos):**
  Useful for drones and cameras that do **not** capture NIR. Examples:
  - **NGRDI (Normalized Green-Red Difference Index)**

$$NGRDI = \frac{G - R}{G + R}$$

Uses only Green and Red channels. Works well for separating vegetation from soil/rock.

- **VARI (Visible Atmospherically Resistant Index)**

$$VARI = \frac{G - R}{G + R - B}$$

More robust to shadows and atmospheric effects.

- **Excess Green Index (ExG)**
  Emphasizes green dominance: $ExG = 2G - R - B$.

In our exercises, we use **NGRDI**, since it's easy to compute from any RGB photo.

3. How to Interpret NGRDI Maps

- **High NGRDI (green in maps)** → Dense and healthy vegetation (forest, lush grass).
- **Moderate NGRDI (yellow)** → Sparse vegetation, grassland, stressed plants.
- **Low NGRDI (red)** → Bare soil, rock, gravel, or damaged vegetation.
- **Caution:** Shadows may also appear as "low vegetation index."

4. How Students Can Work with ChatGPT

To calculate NGRDI from their own photos, students should upload an image and give a clear **prompt**.

Example prompt to use:

"*Here is my drone photo. Please calculate the RGB-only vegetation index map (NGRDI) for this image. Show the result as a color heatmap with a red–yellow–green scale*."

Optional additions:

- **Overlay:**

"Please also create an overlay where the NGRDI map is blended with the original photo."

- **Comparison:**

"Can you also calculate VARI and show it side by side with NGRDI?"

- **Interpretation:**

"Explain what the red, yellow, and green areas in my NGRDI map mean in ecological terms."

5. What You Will Get

- A **false-colour vegetation map** (red → low vegetation, green → healthy vegetation).
- Optionally, an **overlay map** combining vegetation index with the real photo.
- A short **interpretation of patterns**: what each color means in terms of vegetation density, soil exposure, or ecological conditions.

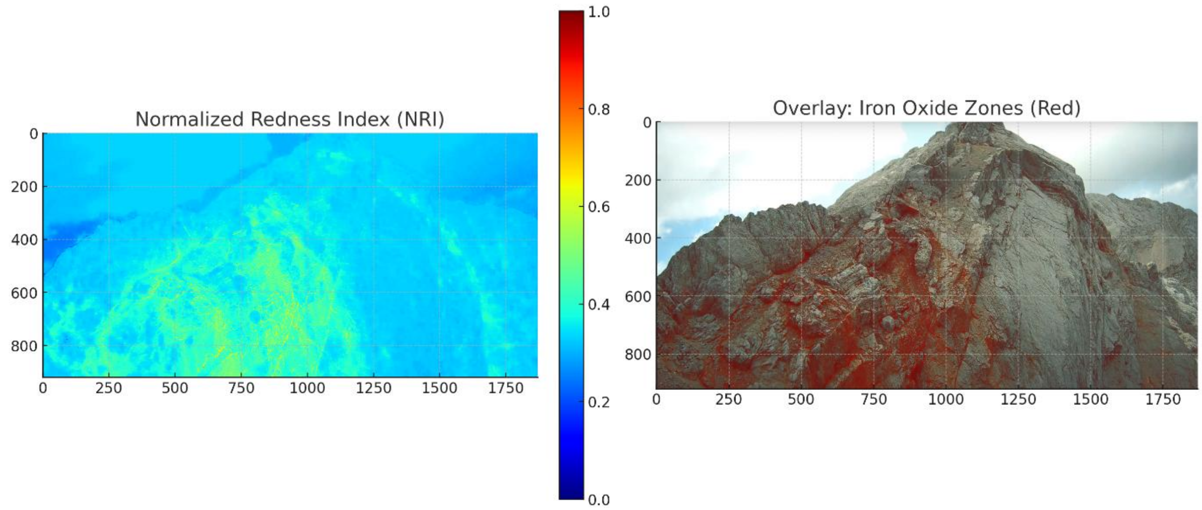
📌 **Important for students:**

- Use **daylight images without heavy shadows** for best results.
- The results are **approximations**, not a replacement for NIR-based NDVI.

- Still, they are very useful for learning how vegetation health can be mapped using drones.

👉 Would you like me to now prepare this in a **1-page formatted student handout** (with short explanations + example prompts + small diagrams), so they can use it directly in class?

PROJECT 3: Detection of Iron Ore Staining in Limestone Using RGB Drone Imagery



Objective

Students will learn how to use drone photographs and simple RGB-based indices to detect iron oxide staining in limestone outcrops. By the end of this exercise, students should be able to:

- Explain why iron oxides appear reddish compared to limestone.
- Calculate a simple **Normalized Redness Index (NRI)** from RGB data.
- Apply different thresholds to highlight weak, moderate, and strong iron staining.
- Interpret results in a geological context.

1. Theoretical Background

- **Iron oxides** (hematite, limonite, goethite) appear **reddish-brown** because of high reflectance in the **red (R)** channel compared to green (G) and blue (B).
- **Limestone** appears **grey-white**, with balanced R, G, B values.
- A **redness index** highlights ore-bearing zones.

Normalized Redness Index (NRI):

$$\text{NRI} = \frac{R - \frac{(G+B)}{2}}{R + G + B + \epsilon}$$

- High NRI → iron oxides.
- Low NRI → limestone background.

2. Data

- Drone photo of Mt. Kočna limestone wall with visible red iron staining.
- File format: .png or .jpg.

3. Prompts for Analysis

Students will interact with ChatGPT (or another AI tool) using these **prompts**:

Prompt A – Compute NRI

"Here is my drone photo of a limestone wall with red staining. Please calculate the RGB-only Normalized Redness Index (NRI) for this image and show it as a heatmap (blue = limestone, red = iron oxide zones). Normalize values between 0 and 1."

Prompt B – Overlay with Threshold

"Using the same photo, apply thresholds at NRI ≥ 0.50, NRI ≥ 0.60, and NRI ≥ 0.70. Create overlay maps where red pixels show ore-rich zones on the original photo."

Prompt C – Multi-Class Map

"Please classify the photo into three ore intensity classes based on NRI: weak (0.50–0.60), moderate (0.60–0.70), strong (≥0.70). Produce a color-coded overlay map (orange = weak, red-orange = moderate, red = strong)."

Prompt D – Quantitative Assessment

"Please calculate the percentage of the rock face classified as weak, moderate, and strong ore staining using the thresholds above. Report the results in a table."

4. Tasks

1. Generate the **NRI heatmap** (Prompt A).
2. Apply the **three thresholds** (Prompt B).
3. Create a **multi-class ore map** (Prompt C).
4. Compute the **percentages of ore coverage** (Prompt D).

5. Interpretation

- Compare results from different thresholds.
- Which threshold is most realistic for detecting ore zones?
- Estimate the % of cliff surface covered by iron oxides.
- Discuss geological meaning:
    - Why do iron oxides appear along fractures or weathered zones?
    - What do they indicate about past fluid movement or mineralization processes?
- Suggest improvements (e.g., using multispectral sensors).

6. Deliverables

Each student/group should submit:

1. **Figures**: NRI heatmap, three overlays, multi-class map.
2. **Table of Results**:

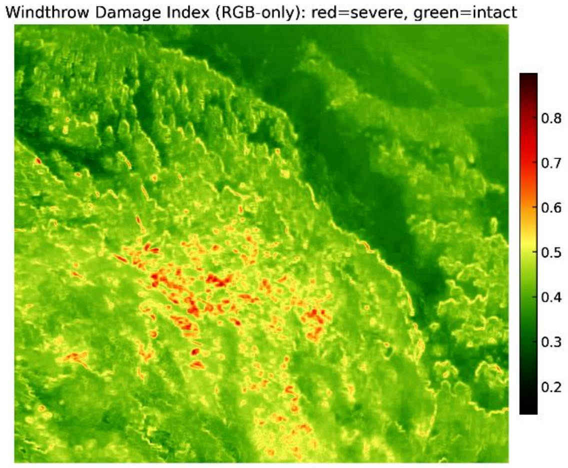
Threshold/Class	% of Surface	Notes
NRI ≥ 0.50	... %	...

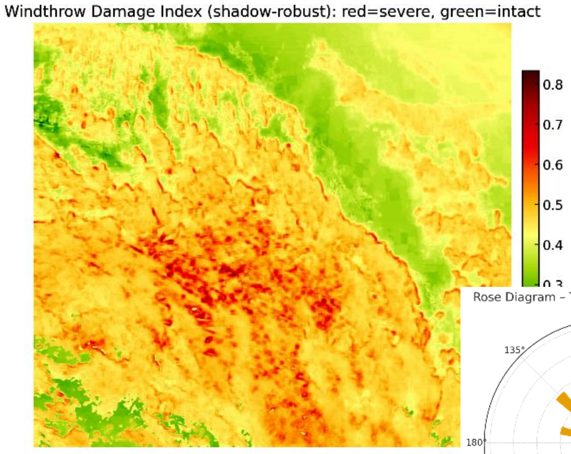
Threshold/Class	% of Surface	Notes
NRI ≥ 0.60	... %	...
NRI ≥ 0.70	... %	...
Weak (0.50–0.60)	... %	...
Moderate (0.60–0.70)	... %	...
Strong (≥0.70)	... %	...

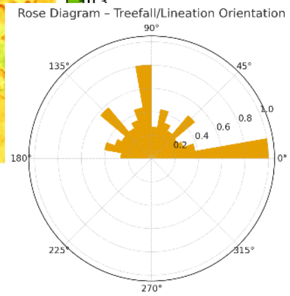
3. **Short report (1–2 pages)** discussing:
   - Which map best shows ore zones.
   - Geological interpretation of iron staining.
   - Limitations of RGB-only analysis.

✅ With these **step-by-step prompts**, students won't get lost — they'll be able to reproduce the full workflow: from spectral index → thresholding → classification → geological interpretation.

PROJECT 4: Drone-based Analysis of Windthrow Damage







1. Problem Definition

In recent years, extreme weather events such as strong winds have caused widespread damage to mountain forests. One example is the **Kukova Špica slope**, where entire patches of trees were uprooted and thrown downslope.

Such **windthrow events** are ecologically important because they:

- change forest structure,
- influence erosion and slope stability,
- create new habitats for pioneer species.

Our task is to use **drone RGB photographs** to **detect, map, and quantify windthrow damage**.

2. Theoretical Background

a) What happens in windthrow?

- Trees are uprooted and fall in the same direction.
- The canopy becomes broken: instead of a uniform “green carpet,” we see **gaps, trunks, and soil patches**.
- The new texture is much more **heterogeneous**.

b) Options for assessing damage from images

1. **Vegetation indices from RGB**
   - **NGRDI** = (G − R) / (G + R)
   - **VARI** = (G − R) / (G + R − B)
   - Both highlight vegetation cover. Low values = exposed soil/wood.
2. **Texture analysis**
   - Windthrow creates many linear features (fallen logs).
   - By measuring **local variance** or edge density, we detect chaotic texture vs. intact canopy.

3. **Lineation analysis**
    - Using edge detection (e.g., Hough transform), we can measure **treefall direction**.
    - Summarized in a **rose diagram**, this shows how wind channeled across the slope.
4. **Damage index**
    - Combine vegetation index + texture into one measure:

$$\text{Damage} = w_1\,(1 - \text{Vegetation}) + w_2\,(\text{Texture})$$

    - Colors: **green = intact**, **yellow/orange = partial damage**, **red = severe windthrow**.

3. Instructions for Students

Step A: Collect data

- Fly a drone across the damaged slope.
- Capture **nadir or oblique photos** with enough overlap.
- Select representative frames (or make an orthomosaic).

Step B: Prepare analysis

- Upload one drone photo into ChatGPT.
- Formulate a **clear analysis prompt**. For example:

"Here is my drone photo. Please calculate the RGB-only vegetation index map (NGRDI) for this image. Then calculate a damage index based on vegetation loss and texture, and show it as a red–yellow–green heatmap. Also create an overlay map where the damage is blended with the original photo. Finally, perform a lineation analysis of fallen trees and produce a rose diagram of orientations."

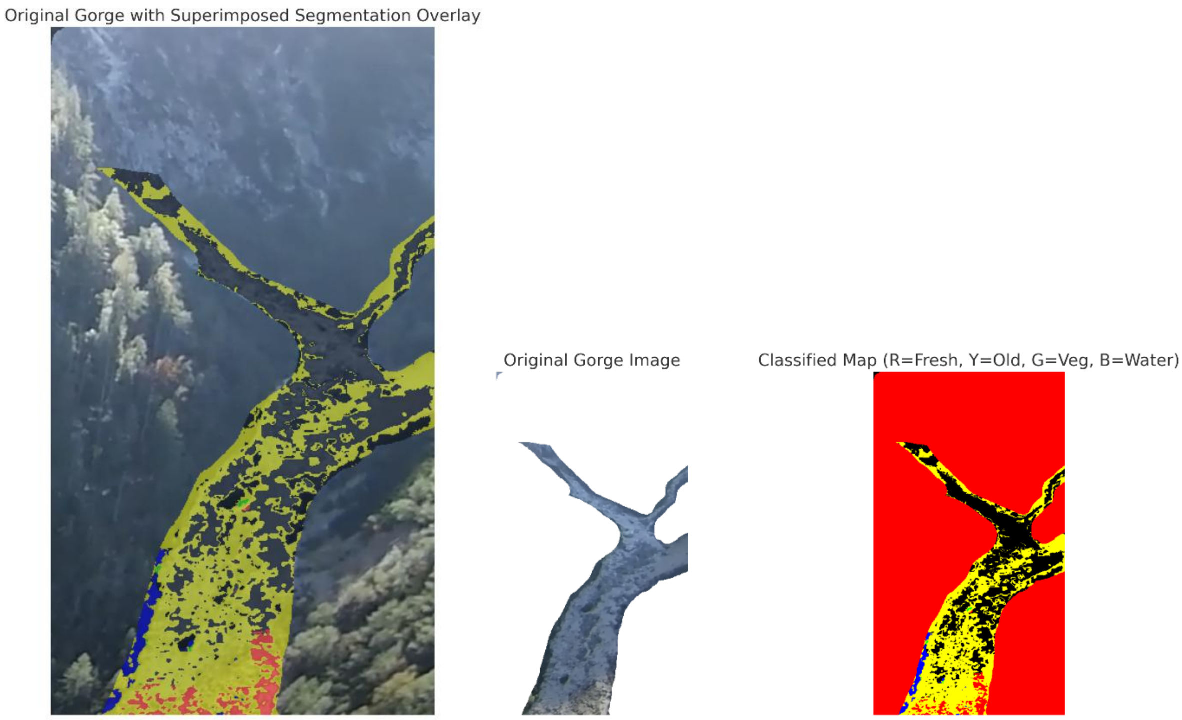
Step C: Interpret results

- Compare **green vs. red areas** → where is the damage most severe?
- Look at the **rose diagram** → which direction did most trees fall? Does this match the prevailing wind or valley orientation?
- Discuss ecological consequences:
    - How will forest regeneration occur?
    - What risks exist for erosion and avalanches?

4. Deliverables

- Heatmap of damage index.
- Overlay with original photo.
- Rose diagram of treefall directions.
- Short written interpretation (½ page).

PROJECT 5: Assessment of the Geomorphological and Sedimentological Changes in the Mountains Based on Drone Photography



1. Introduction and Problem Definition

Heavy rainfall in mountain regions often leads to **floods, debris flows, and sediment redistribution** in rivers and gorges. One important consequence is the accumulation of **fresh gravel deposits**, which can be clearly recognized in drone photographs:

- **Fresh gravel** appears **light grey to white**.
- **Old gravel** is **darker grey**, often compacted or colonized by vegetation.
- **Vegetation** appears green.
- **Water or shadow** appears dark blue/black.

Drone photography provides a powerful tool for mapping these geomorphological and sedimentological changes without physically entering hazardous areas.

In this exercise, you will use drone imagery to:

1. **Detect and classify fresh vs. old gravel surfaces.**
2. **Quantify the spatial extent of fresh deposits.**
3. **Visualize results by overlaying a color-coded segmentation map on the original image.**
4. **Interpret the geomorphological implications.**

2. Theoretical Background

- **Geomorphology of mountain streams:**
  Streams transport sediment during high flows. Floods mobilize large volumes of gravel, depositing new, light-colored layers on bars and in the channel bed.
- **Sedimentology:**
  Fresh deposits indicate recent high-energy events. Their proportion helps estimate flood intensity and sediment transport.
- **Remote sensing approach:**
  RGB drone images can be transformed into **color indices (HSV, Lab)** to distinguish between fresh, old, and vegetated surfaces.

3. Methodology

A) Data Acquisition

- Fly a drone over the gorge after a rainfall event.
- Capture vertical or oblique photographs of the channel.
- Crop images so that only the gorge and riverbed are visible.

B) Data Analysis (with ChatGPT + Python)

Step 1: Segmentation into classes

Use HSV/Lab thresholds to separate:

- **Fresh gravel** = high brightness, low saturation → **red**
- **Old gravel** = medium brightness, slightly darker → **yellow**
- **Vegetation** = green hues, higher saturation → **green**
- **Water/shadow** = low brightness → **blue**

Step 2: Quantification

- ChatGPT will calculate the **pixel counts** for each class.
- From these, compute the **% of fresh gravel** in the gorge.

Step 3: Visualization

- Produce a **segmentation map** (color-coded).
- Overlay this map on the original drone photo for interpretation.

4. Instructions for Prompts

When working with ChatGPT, use a clear and precise prompt. Example:
"Here is my drone photo from the gorge. Please segment the image into fresh gravel (light grey/white), old gravel (dark grey), vegetation, and water using HSV/Lab thresholds. Show a red–yellow–green–blue map where red = fresh gravel. Report the pixel counts and the % of the image that is fresh gravel. Also create an overlay where the segmentation is blended with the original photo."

5. Results to Deliver

Each student group should provide:

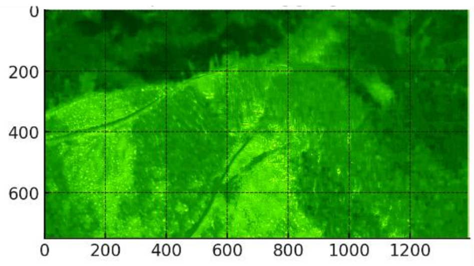
1. **Original photo** and **segmentation map**.
2. **Overlay image** with classification on the gorge.

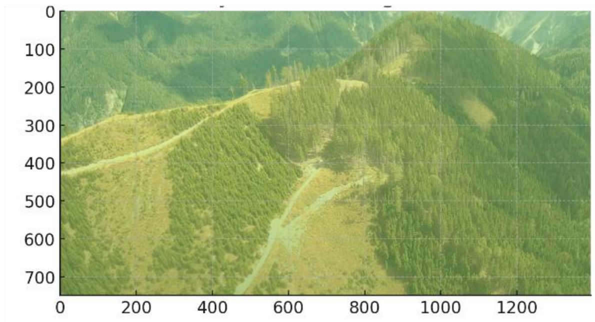
3. **Quantitative results:**
    - Number of pixels per class.
    - % of fresh gravel.
4. **Short interpretation (½–1 page):**
    - What proportion of the gorge was covered by fresh gravel?
    - What does this tell us about the strength of the rainfall event and sediment transport?
    - Where is fresh gravel concentrated (bars, channel thalweg, slopes)?

6. Ecological and Geomorphological Interpretation

- High % of fresh gravel → **intense flood transport, high energy**.
- Mixture of old + fresh gravel → **partial reworking** of channel bed.
- Vegetated patches → **stable surfaces** not reworked in recent floods.
- Results can be compared across multiple events for **long-term monitoring**.

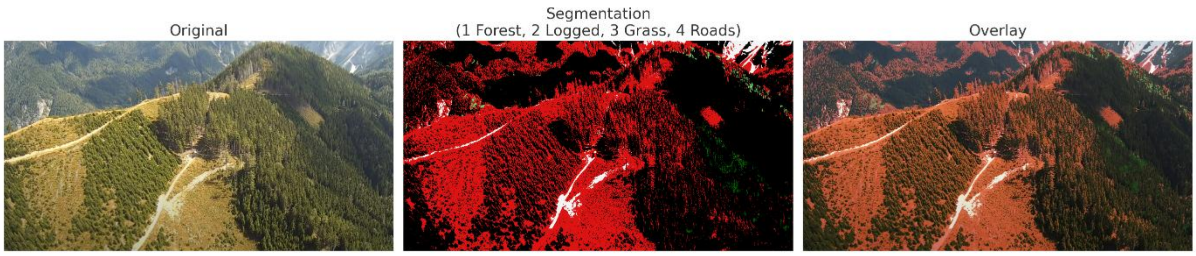
PROJECT 6: Exercise: Assessment of Logging Using Drone Photography





Objective

To learn how to apply **RGB-based vegetation analysis** to detect and quantify logging activity in mountain forests. Students will use drone photos and AI-based analysis to generate vegetation maps, classify land cover, and (if data is available) compare images before and after logging.



- **Background**
  - **Why monitor logging?**
    Logging alters ecosystems, increases erosion risk, and affects biodiversity. Monitoring with drones is a cost-effective way to assess forest health and land-use change.
  - **Tools:**
    - **NGRDI (Normalized Green-Red Difference Index):**

$$\text{NGRDI} = \frac{G - R}{G + R}$$

High values → dense forest (green); Low values → bare soil or logging (red).

- **HSV/Lab color thresholds:** Used to segment the photo into **forest, logging patches, grass/shrub, and roads**.
- **Change detection:** By comparing photos taken at different times, students can highlight areas of **forest loss**.

◆ **Step 1: Define the Problem**

Take or obtain a **drone photo of a forested slope** where logging activity is visible. If possible, also collect a **“before” photo** from the same location.

◆ **Step 2: Use the Prompts**

Prompt A – Vegetation Index (NGRDI)

"Here is my drone photo of a forested slope with logging patches. Please calculate the NGRDI map and show it as a red–yellow–green heatmap. Highlight logged areas in red and dense forest in green. Overlay the heatmap with the original photo."

Expected outcome:

- A heatmap of vegetation health (green = forest, red = logging).
- An overlay with the original photo.

Prompt B – Segmentation & Area Calculation

"Please segment this drone image into dense forest, logged patches, roads, and grass using HSV/Lab thresholds. Report pixel counts and % of the image in each class. Also create an overlay map where the segmentation is blended with the original photo."

Expected outcome:

- A segmentation map with color-coded classes:
    - Dark green = dense forest
    - Red = logged patches
    - Light green = grass/shrub
    - White = roads
- Pixel counts and percentages for each class.
- An overlay map combining segmentation with the original photo.

Prompt C – Change Detection (two images)

"Here are two drone photos of the same slope, one before and one after logging. Please calculate the difference in NGRDI between the two images, and highlight areas of forest loss in red. Report the % of forest lost."

Expected outcome:

- A difference map (forest loss in red).
- Quantitative estimate of % forest lost.

◆ **Step 3: Interpret the Results**

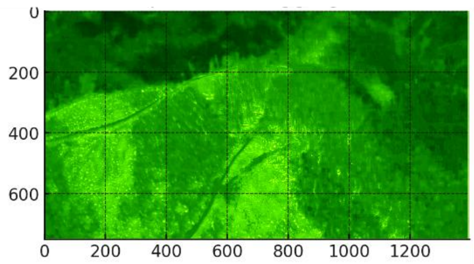
Students should answer:

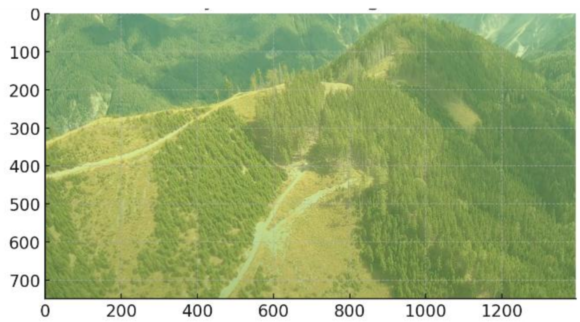
1. How extensive is the logging (% of slope)?
2. Where does logging occur most often (ridges, near roads)?
3. How do results differ between **Prompt A** and **Prompt B**?

4. If two photos are available: What does **Prompt C** reveal about forest change over time?
5. What are the **limitations** of RGB-only analysis (e.g., shadows, lighting, lack of infrared)?

🔹 **Step 4: Extensions**

- Convert pixel counts to **m^2 of logged forest** (if ground resolution is known).
- Compare different vegetation indices (NGRDI vs VARI).
- Discuss implications for **forest management and conservation**.





✅ By the end of the exercise, each student group should present:

1. NGRDI heatmap + overlay (**Prompt A**)
2. Segmentation map + area statistics (**Prompt B**)
3. (Optional) Change detection map + % forest loss (**Prompt C**)
4. A short written ecological interpretation.