

INVESTIGATION - LEARNING MODULE

Landscape and Climate Change



Marmolada glacier, Italy

Introduction

Over the past 50 years human activities have been altering Earth's climate with an increase of extreme meteorological events and global temperature, with inevitable effects on physical landscape processes. Heat waves and rising temperatures have reduced the glacial ice and snow cover with a shift from snow to rain, but also have increased the number of extreme rainstorms, droughts with consequent risk of wildfires as the vegetation becomes more flammable.

Such climate changes affect landscapes as they cause increased erosion, flood and landslides risks, but also drier soil and land degradation due to greater evapotranspiration. Therefore, we would expect to see more landslides, more sediment accumulation in watersheds, river channels that are made more dynamic by increases in sediment and high flows, and more wind-blown sediment transport in deserts activating sand dunes and dust storms.

The geophysical changes also affect the land cover and use. The vegetation cover is a response to the geo-morphology and the ecological characteristics of an area, but it is also very much influenced by climate. Climate adaptation is a pre-requisite to the vegetation growth, but when environmental conditions change plants undergo a stress that may affect their vegetative response up to a point that if the condition persists, they start showing signs (e.g. dry branches after prolonged drought). However, recurrent higher air temperatures may favour some species instead of others, so that agricultural areas may have changed the landscape with the introduction of new species suitable to the new conditions.

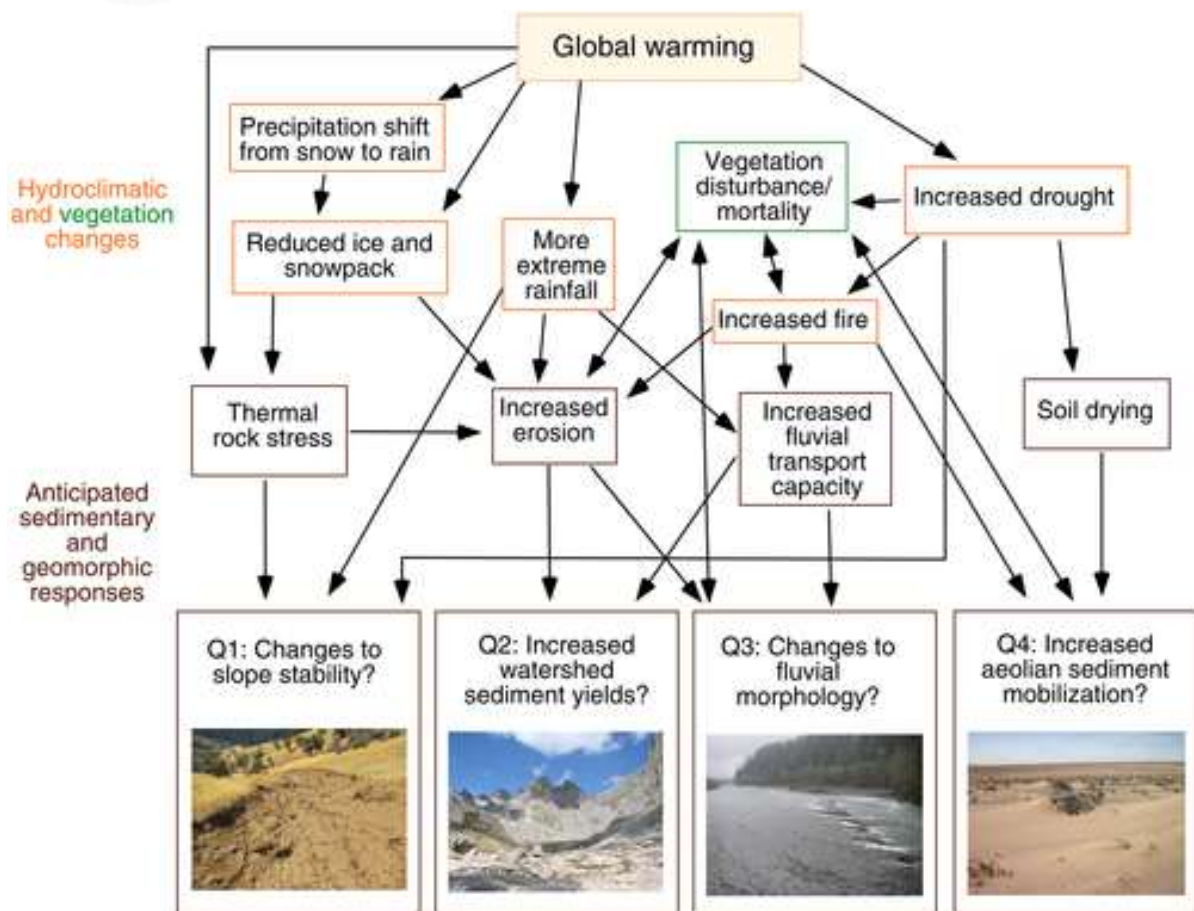


Figure. Conceptual diagram showing links between hydroclimatic effects of global warming (orange boxes) and sedimentary and geomorphic responses anticipated from theory and empirical evidence (brown boxes). Source: East A.E., Sankey J.B. 2020, *Geomorphic and Sedimentary Effects of Modern Climate Change: Current and Anticipated Future Conditions in the Western United States*. *Reviews of Geophysics*, 58(4). <https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2019RG000692>

Are there signals of climate change visible in the landscape around? How did the landscape look like 50 years ago? How will the landscape look like in 50 years?

How man has responded to climate change and how this affected landscape?

The investigation can be implemented by following these steps:

1) Planning

In Planning, students and teachers design their investigation activities on landscape, for instance they decide what to do, how to do it, when to do it, where to do it.

According to the topic or issue chosen for investigation, the class will need to identify what kind of actions to undertake in terms of literature review, hands-on research activities, and it will identify the most suitable methods and list the needed materials to gather the necessary information.



Expert stakeholders from local research centres, universities and local authorities can be contacted as a valuable opportunity to access up-to-date knowledge and to make use of scientific equipment.

2) **Performing**

In Performing the investigation, the class implements the devised plan, and follows the steps of action along the project timeline. Data collection can regard environmental data during a field trip, a survey on the perceptions and views of the local community, or investigations on historical and artistic documents regarding the landscape of interest. Specific materials, equipment and worksheets can be used, allowing students to approach methods and software of common use in research. Experiments can be performed to understand the reason for certain phenomena.

3) **Data analysis and interpretation**

In Data analysis and interpretation, the collected data are analysed and interpreted in order to understand the extent of the issue (generating new knowledge) and the relations between the factors and variables that are involved in the investigation.

Objectives of the Investigation

To learn about:

- ✓ Difference between meteorology and climate, climate series
- ✓ Climate change events
- ✓ (Water) Landscapes elements (glaciers, lakes, rivers, streams, canals, seafronts, landslides, sedimentation, landcover, land use etc.) and geomorphology
- ✓ Effects of extreme weather events (heavy rains, droughts) on landscape elements
- ✓ Human exploitations of landscapes

To be able to:

- ✓ Work in groups
- ✓ Exercise online research skills and develop field research and interview skills
- ✓ Develop analytical skills and exercise in teamwork and collaborative techniques
- ✓ Develop skills in using AR and GIS software in order to visualize and communicate spatial information
- ✓ Enhance their awareness and attitudes regarding nature conservation.

HOW TO INVESTIGATE

When: After the Conceptualization Phase (Step 2)

Time estimated: 3 teaching sessions and one half-day field trip (at least 6 hours in total),

Where the activity takes place: in the classroom and outdoors

Method (how the students have to work): group-work



Art activity - in every step of investigation students are invited to produce an artistic product inspired by their investigations: texts, photos, drawing, videos, music or sound, meme (<https://en.wikipedia.org/wiki/Meme>), patchwork/collage, theatrical performances.

In the classroom, the students are divided in groups. The teacher/facilitator could follow the steps suggested in the table below:

<p>Planning</p>	<p>Preliminary step: the teacher identifies a specific landscape for the investigation. Such landscape should show signs of climate change effects (e.g. soil erosion as results of extreme rains, dry woodlands as result of prolonged droughts etc.)</p> <p>In a field trip or from a satellite image of the landscape (Google Maps/Google Earth) Ask students “Can you identify in the landscape the effect generated by weather extreme event(s)?” “How did the landscape look like in the past?” “Make your hypothesis about the environmental variables and drivers that generated such effect?”</p> <p>Set the framework by introducing different investigation techniques, i.e. literature review, photographic search, field visit, interview with an expert (local authority official, environmental guides etc.), interview or survey with locals (i.e. their parents, etc.).</p> <p>Give the student groups 20 minutes to generate an investigation plan each. The objective is assessing the variables (weather event, geology, geomorphology, land use, land cover) that have caused the effect. By generating their investigation plan, students need to:</p> <ul style="list-style-type: none"> - Select on the map the area where they want to focus the investigation - Decide how to perform the investigation (techniques, equipment needed, materials). - Create a timetable where they set the order of the investigation activities. <p>The groups present their investigation plans and reach an agreement for the most reliable and feasible. It could be a combination of the plans presented.</p> <p>The teacher may then offer feedback, proposing alternatives or adjustments to the investigation plan proposed by the students. The feedback should aim at making the plan feasible and concrete in terms of time management, access to proposed resources and availability of the persons to be interviewed/consulted.</p>
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	<p>The outcome should be an investigation plan complete with the activities to be implemented, the timetable for implementing them, the groups/persons responsible for implementing them, the necessary equipment and software, and the communication and info sharing arrangements.</p>
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<p>Performing</p>	<p>The investigation plan can be implemented on the basis of the following activities:</p> <ul style="list-style-type: none"> ✓ The students perform an online research regarding the climate series of the area and find out the extreme events that occurred from the local weather authority (weather forecast service). For instance, they can identify the amount of rain that provoked the event (e.g. landslide, flood), or the drought periods that provoked dry woodlands. Duration: 1 hour home-work and 45 minutes for data analysis such as meteorological data analysis at school. ✓ Students may also gather images and photos or videos through the internet or their family archives, that document the change of the landscape selected through time. They can interview foresters, agronomist and weather experts to identify specific extreme events. The interview questions should be prepared and communicated to the expert prior to the interview. Duration: 1 hour plus home-work. ✓ Field visit: The students can visit the area selected and document the main landscape elements (geology of the area, geomorphological characteristics, current land cover / use and evidences of climate effect). Printed maps, mapping software introduced for that purpose (such as Siftr and Google My Maps can be used to locate specific relevancies). Students will collect documentation material, i.e. photos and/or videos, to support their findings. The field visit can include the presence of an expert that students may interview. Duration: 3 hours.
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<p>Data analysis and interpretation</p>	<p>In the school computer lab or at home, students proceed to the analysis of the data collected and report the main findings. The analysis may vary depending on different research techniques employed:</p> <ul style="list-style-type: none"> ✓ Climate data: Outline the main findings from such analysis. Students can identify: number and intensity of rainy events, number of dry summer days, summer maximum temperatures. They can compare such values to the monthly average values. ✓ Photographic report from the field trip or satellite images and timeline collage of pictures of the landscape from ex ante to ex post extreme event. ✓ Field visit: analysis of the area from several points of view: geology, slopes, expositions, land use and land cover. The analysis includes the
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	<p>interpretation of the variables that have concurred to the climate effect on the landscape.</p> <ul style="list-style-type: none">✓ Expert interview: Outline the main findings from the interview.
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