GEOSCIENCE FOR LEAVING CERTIFICATE GEOGRAPHY

Continuing Professional Development Course 2022

KARST LANDSCAPES LESSON PLAN

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iCRAG
SFI RESEARCH CENTRE IN APPLIED GEOSCIENCES

Geological Survey
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An Roinn Comhshaoil, Aeráide agus Cumarsáide
Department of the Environment, Climate and Communications

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Geoscience for Leaving Certificate Geography Teachers CPD programme

About the Geoscience for Leaving Certificate Geography Teachers CPD programme

Geoscience is vital for our sustainable future, and geography is the key gateway to geoscience for most students. The Geoscience for Leaving Certificate Geography Teachers CPD programme has been developed by iCRAG (the Science Foundation Ireland Centre for Research in Applied Geosciences) and Geological Survey Ireland to create an opportunity for teachers and geoscience professionals to come together to increase the awareness of geoscience within the Leaving Certificate geography curriculum.

During the CPD course, teachers and geoscience professionals from both research and industry are paired together to co-create curriculum facing resources that are freely available for use. Over the course of six evening sessions, teachers learn more about the cutting-edge geoscience being undertaken by their partnered geoscientists, before working together to develop a curriculum-facing resource using their interests, teaching expertise and the knowledge of the geoscientist. In 2021, the resources produced have included lesson plans, module plans and field guides and the accompanying teacher notes and slides/field booklets for each resource.

The resources link the most recent advances in geoscience to the geography curriculum in a way that is both understandable and relevant. The resources are freely available to be used for classes anywhere in the world. We hope that you and your students enjoy using them.

This resource

This resource has been developed by Sinead Burke, a geography teacher at Gort Community School, iCRAG researcher Laurence Gill and geoscience professional Patrick Morrissey. The resource is a deep dive Irish Karst Landscapes. Included in this resource pack is a full lesson plan and associated teacher notes, and an ArcGIS Storymap. It is suitable for Leaving Certificate Students.

Sincerely,

Elspeth Sinclair

Elspeth Sinclair, Amrine Dubois Gafar, Fergus McAuliffe, Siobhán Power
Programme Managers – Geoscience for Leaving Certificate Geography Teachers

Geological Survey Ireland, a division of the Department of Environment, Climate and Communications, has been mapping Ireland since 1845. They continue to map the Irish land and marine territories, as well as mineral and groundwater resources. They have responsibility for actions in the current Climate Action Plan including monitoring coastal change, the Just Transition in the midland counties, and providing data for de-risking offshore renewable energy. Irish geoscience research, particularly as it contributes to the development of government policy, is an important part of their work and they fund and co-fund many research projects, including some of the iCRAG research work. Their data and maps are freely available to all at www.gsi.ie.

iCRAG, the Science Foundation Ireland (SFI) Research Centre in Applied Geosciences, are a team of researchers creating solutions for a sustainable society. They develop innovative science and technologies to better understand Earth's past, present, and future and how people are connected to it. iCRAG drives research into areas that are critical to society, including:

- The minerals and metals we need for decarbonisation and sustainable energy.
- Securing and protecting groundwater and marine resources.
- Protecting society from Earth's hazards, such as floods and landslides.

Further information is available at: www.icrag-centre.org

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Lesson plan: Karst Landscapes

Contents

Lesson plan:

Rational for the resource

This Leaving Certificate resource has been an idea in progress for several years. As a Geography teacher in the south Galway area, I have noticed that students, whilst living among these features every day, do not understand the complexity associated with Karst regions and especially Karst hydrology. This area has been synonymous with flooding over the past number of years making news headlines year after year. Many locals have had both homes and livelihoods affected. Understanding the movement of water in this area is key to understanding the problems faced by locals. The area has a unique landscape which is difficult to understand or even see with the naked eye. This resource aims to help understand how water flows in a Karst region by following the route of one river flowing through the area. It is designed to be an aid to the understanding the development of a Karst region and includes an introduction to the associated features. The resource can also be used as an introduction to the area before completing a field study.

Links to curriculum

Core Unit 1 Patterns and Processes in the Physical Environment
OL Learning outcomes:

- Show an understanding of the processes of rock formation, weathering and erosion.
- Explain the processes of landform development involving the interaction of the tectonic cycle, rock cycle and surface processes.
- Show how human activities can affect these processes.
- Understand and use the skills listed to describe the physical environment.

HL Learning outcomes:

- Explain and illustrate the continual process of rock formation, change and destruction.
- Explain and illustrate how landforms develop from the interaction of the tectonic cycle, rock cycle, and surface forces.
- Illustrate how landforms represent a balance through time between endogenic (internal) and exogenic (external) forces.
- Assess, at different scales, the impact of human activity on the physical processes at work on the landscape.
- Understand and use the skills listed above to interpret the physical environment.

Skills
In the study of this unit, students understand and use, where appropriate, the geographical skills of

- Map interpretation
- Figure interpretation
- Photograph analysis
- Statistical analysis
- Figure drawing
- Information technology applications.

Core unit 2 – Regional Geography
OL Learning outcomes:

- Show how physical, economic, and human processes interact within regions in Ireland, Europe and in one continental/sub-continental region.
- Use the skills listed above, where possible, in the study of regions.

HL Learning outcomes:

- Explain and illustrate, at different scales, the concept of a region as identified by selected criteria.
- Show a detailed understanding of how physical, economic, and human processes interact in Irish and European regions in one continental/sub-continental region.
- Use the skills listed above where possible, to interpret how economic, human, and physical processes interact in a regional setting.

Skills

In the study of this unit, students should understand and use, where appropriate, the geographical skills of

- Map interpretation
- Figure interpretation
- Statistical analysis
- Information technology applications.

Core Unit 3 - The Geographical Investigation and Skills Unit

OL Learning outcomes:

- Understand and use some or all of skills listed.
- Work through the distinct stages of a geographical investigation
- Use statistical analysis and information technology in the interpretation of basic results and conclusions.
- Apply some or all of the geographical skills listed to complete a geographical investigation.
- Experience, where possible, working conditions similar to those likely to be encountered in employment.

HL Learning outcomes:

- Understand, use and apply the skills listed to complete a geographical investigation.
- Work through the distinct stages of a geographical investigation.
- Use statistical analysis and information technology in the interpretation and analysis of results and conclusions.
- Analyse and evaluate their work, and make comparisons with other studies.
- Experience, where possible, working conditions similar to those likely to be encountered in the world of work.

Skills

In the study of this unit, students should understand and use, where appropriate, the geographical skills of

- map interpretation
- photograph analysis
- statistical analysis
- information technology applications
- geographical information systems
- planning a geographical investigation
- data collection
- the use of documentary sources

- report planning
- analysis and presentation of results and conclusions.

Keywords

Some of the main keywords associated with this topic and the resource have been listed below:

Clints	Polje
Grikes	Uvula
Limestone pavement	Dolines
Swallow hole	Turloughs
Sink hole	Carbonation
Disappearing stream	Solution
Emergent stream	Weak carbonic acid
Dry valleys	Chemical reaction
Cave / cavern	Calcium carbonate
Stalactites	Limestone
Stalagmites	Confluence
Pillars / columns	Drainage basin
Curtains	River mouth
Gorge	Commonage

Linkage and Integration

Linkages

Science

Many chemical reactions occur in karst landscapes. Carbonation is a chemical reaction between carbon dioxide in the atmosphere and rainwater. When these two combine a weak carbonic acid is formed. Another chemical reaction occurs when the calcium carbonate is dissolved in the limestone. Evaporation occurs after the calcium carbonate rich water passes through the porous limestone and forms stalactites, stalagmites and pillars.

Gaeilge

Many of the local placenames are derived from the landscape around them. When looking at OS maps of the area, placenames such as Ceannahowna (Ceann na hAbhainn) - meaning head of the river, Kinnincha (Cinn Inse) - meaning head on the island/river meadow and Kinvara (Cinn Mhara) - meaning

head of the sea; all show how there is a huge interconnection between the water, landscape and the placenames.

Differentiation

As indicated in the syllabus document, the syllabus is designed to be taught at both Ordinary and Higher levels. The levels are differentiated through the learning outcomes set down in the introduction to each unit in the syllabus document. There are common learning outcomes for the two levels with additional learning outcomes for Higher level students. Higher level students will be expected to show greater understanding of concepts and a greater proficiency in skills. Some material has been designated for Higher level students only, who must study one of four optional units.

Approaches to teaching and learning

Resources

Students

- Copy
- Pen
- Pencil
- Ruler
- Eraser
- Optional: laptop/PC for examination of ESRI map

Teachers

- Laptop / PC
- Internet connection
- Projector
- Whiteboard
- Teacher guidelines

Further development of resource

- The resource can be adapted to work as a pre-teaching tool for the Geographical Investigation. Activities can be added to investigate karst features and river processes and features.
- Schools signed up to ArcGIS 4 Schools through ESRI could create a digital worksheet for a field study using Survey123.
- It can also be used as a base resource for a Transition Year module on Karst Landscapes. Some of the information contained in this StoryMap is at a more advanced level for Junior Cycle Geography students, but it may be used to introduce the topic of ~Karst landscapes to them, while also linking in with other parts of the geography course e.g. drainage patterns, energy, conflict, flooding, tourism etc.

Sources

- ‘Earth’ Leaving Certificate Geography textbook by Michael Organ (Educate.ie)
- ‘Landscapes’ Leaving Certificate Geography textbook by Declan Fitzgerald & P.J. White (Gill)
- Geological Survey Ireland website (gsi.ie)

Resource link:

https://storymaps.arcgis.com/stories/11b608f395de496b84b70892e135f8c3

Teacher Notes

Lesson plan

As this resource is designed to complement teaching this topic alongside a textbook, there is no real lesson plan per se, but suggested activities and questions for discussion or further investigation prompted throughout the StoryMap. It can also be used as a resource to teach about karst landscapes, rivers or even energy and conflict at Junior Cycle level.

The following are possible discussion points or activities which can be carried out under each section of the StoryMap:

Introduction to Karst

- In this section teachers can examine both maps shown of karst areas, firstly on a world-wide scale and then in more detail at a European level.
- Examine the map of Ireland and take note of the areas of limestone in the country and where they are located.
- Keyword Activity: Students find definitions to the keywords listed in the table above.

Carbonation

- Draw diagram showing how karst forms and develops.
- Watch the YouTube video about the process of carbonation and take notes.
- Draw a labelled diagram of karst features. Examine both the diagrams on the ArcGIS StoryMap and add any extra information found in the second diagram to your own diagram. This is to allow for differentiation – students learn to compare and contrast two different diagrams and to add as much additional information as they can while also working on their drawing skills.

Karst Landforms

- Bedding planes
    - Discuss bedding planes with students.
    - Display the pictures of the Burren attached to the StoryMap.
- Limestone pavement
    - Discuss how limestone pavements are formed.
    - Show pictures of limestone pavements and ask students to identify the features e.g. clints, grikes.
- Caves
    - Discuss the formation of caves and caverns.
    - Show pictures attached and discuss the flow of water through the caves and how it has shaped the walls inside the caves e.g. picture attached of patterns/imprints of water flows on the walls of the caves.
- Turloughs
    - Discuss the formation of turloughs.
    - Display the pictures of a turlough in full flood Vs. drained.
- Springs
    - Discuss how springs flow from underground passages in karst areas.
    - Show the picture of springs draining water from Gort lowlands in the sea at Dunguaire Castle, Kinvara, Co. Galway.
- Disappearing streams

    - Discuss how rivers/streams disappear through swallow holes/sink holes.
    - Show the attached video of Ballycahalan River flowing underground through a swallow hole.
    - Show the picture of swallow hole at Castletown, Gort.
- Re-emergence
    - Discuss how streams re-emerge in karst areas.
    - Show the picture of the re-emerging river in Kiltartan, Gort – at this point of the rivers course, three different rivers in the area join together (R. Ballycahalan, R. Owenshree and R. Owendalulagh). The volume of water within this river system can be discussed here and other topics explored.
        → What can this volume of water lead to?
        → Has there been any flooding events in the area?

      Newspaper articles, news reports and documentaries can be found online documenting the severe flooding that the Gort Lowlands area experienced particularly in 2010. Flood management in a unique area can also be explored here.

- Swallow holes
    - Discuss what swallow holes are and their purpose in a karst landscape.
    - Show the attached picture of a swallow hole.
    - Take note of the keywords associated e.g. doline, sink hole and identify them from the picture.
- Polje
    - Discuss what poljes are.
    - Show the attached picture and have students identify where the polje is located.
- Cave features
    - Discuss the formation of caves with a focus on the underground features e.g. stalagmite, stalactite, pillars/columns and curtains.
    - Display the pictures of the features and identify.
    - Discuss Ailwee Caves, Co. Clare as an example and explain how it also has a tourist function – it is one of many caves in the area but is the most accessible to see the karst underground features.

Karst hydrology

- Examine the map of the overall flow of water through the Gort Lowlands.
- Blue shows the rivers/streams overground while red shows the rivers/streams underground.
- Ask students to identify the spots where the water disappears underground/re-emerges.

Geology & surface hydrology

- Examine the map identifying the different rock types in the area.
- Make note of how the karst features become more apparent/noticeable in the limestone area.
- Also, take note of how these karst features are more prominent in locations that there are more pure bedded limestones and more water flows underground the further it travels into the pure bedded limestone area.
- Examine the drainage patterns and identify any that can be found.

  <u>Map viewer Activity:</u>
    - Students can access this interactive map themselves on a PC or tablet (Note that the map is not available on a mobile device).
    - Turn on the karst features and underlying bedrock.

- Turn on flooding feature to show the level of flooding that occurs in the area.
- Discuss impacts of this flooding using news reports, newspapers etc. which show the impact the flooding had on farming, housing, travel etc. in the area.
- Turn on hydrology features and examine the drainage patterns in the area – can students identify any?

Owendalulagh River Route

- River Source
  - Three rivers which flow into the Gort Lowlands have their source in the Sliabh Aughty mountains.
  - These mountains are home to the Derrybrien Wind Farm (currently not in operation and has been the cause of controversy in the past and presently).
  - The Owendalulagh River was polluted when a landslide occurred there in 2003. The water supply in the Gort area was unusable for quite some time after this and affected much of the population along its route.
- Lough Cutra
  - River flow is still overground at this point.
- Devils Punchbowl
  - A swallow hole is located here where the water from the 'Beagh River' flows underground.
  - Note: The name of the river changes as it re-emerges in different areas along its course.
- Blackwater Rising
  - The river reappears again, now called the 'Blackwater River'.
- Blackwater Sink
  - River disappears underground again.
- Ceannahowna
  - The link to the logainm (placename) *as* Gaeilge is very strong here. *Ceann* meaning 'head' and *na hAbhainn* meaning 'of the river'.
  - This directly explains what is happening on the landscape as the river re-emerges again.
- Karst swimming pools
  - These pools were used in the past as a recreational area for the youth to swim/paddle in and were located very close to the town.
  - Three different spots along this short stretch of the river were called *Big Hopes, Small Hopes* and *Sandies.*
  - Further along the river on the other side of the town, there is huge local controversy due to plans being granted for a major biogas plant. Further information about this can be found at the following link: https://gortbiogas.home.blog/blog/
- Castletown sink
  - The river flows overground up to this point where it disappears through a swallow hole.
- Kiltartan rising
  - At this point, three rivers; Owenshree, Ballycahalan and Owendalulagh (Gort River) join.
  - Flood defense works and dredging were carried out here in 2010.
- Kiltartan sink
  - The river disappears underground again and flows through a cave system.
  - Caves here have been explored by divers (explained further on in the StoryMap).

- These caves are home to a species of bat (Lesser Horseshoe Bat) which are protected under EU laws. Many of them drowned during the flooding of 2010.

**Between points 10 and 11, there was a 'natural bridge' in the landscape which allowed for the mammal overpass (or 'Bat Bridge' as it is known locally) to have been constructed along the M18 motorway. This shows the important role that Geography has in planning and engineering.*

- Coole River Rising
  - At this point the river re-emerges and during its flooding phase in the winter, it links with other turloughs as well as Garryland Turlough.
- Caherglassaun Turlough
  - Another turlough along this river route but it is unique in that it is influenced by the tide, although it is still located many kilometers from the sea.
- Cahermore Turlough
  - Much of the flooding during 2010 affected the area around this turlough.
  - Newspapers and reports found online will explain of the dredging that occurred to alleviate the flooding that occurred here.
- Kinvara Springs
  - This is the point at which the water from the 3 river systems drains into the sea.

What is a turlough?

- Three animations show different ways in which turloughs can fill and drain:
  - Animation 1 – River-fed turlough
  - Animation 2 – Diffuse-flow turlough
    This works like capillary action, where the water table must rise to fill the turlough.
  - Animation 3 – Bottom-filling turlough
    These turloughs are fed through an underground stream(s) that is(are) rising.

Cave Diving

- This section explores how divers had to swim underground to map the route of the water through the cave system at Kilatartan and the dangers associated with this type of work.

Exam Questions

- Long questions from Leaving Certificate State Examinations papers have been included for students to practice with simplified marking schemes attached.