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CLIMATE CHANGE AND THE THREAT OF SPECIES EXTINCTION



BIO4YOU
AR 2.0

BIO-INSPIRED STEM TOPICS FOR ENGAGING YOUNG GENERATIONS
THANKS TO THE USE OF AUGMENTED REALITY

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General topic of the learning path	Climate change and biodiversity conservation
Specific name of the learning unit	The impact of climate change on species extinction and ecosystem health
Age of the target users	14-18 years
Requirements for the learner	Basic understanding of climate change and biology. Ability to read short scientific texts, discuss environmental issues, and think critically about human impact on nature.
Description of the learning unit	This learning unit explores how human-induced climate change affects species survival and ecosystem health. Students learn how rising temperatures, changing habitats, and extreme weather events increase the risk of species extinction and disrupt natural systems. Through real examples of endangered species and ecosystems, learners understand how climate change creates feedback loops that make environmental problems worse. The unit also introduces conservation strategies and climate adaptation methods that help protect biodiversity. Augmented Reality (AR) is used to make these processes more visible and engaging. By exploring AR models, interactive scenes, and digital environments, students can better understand complex ecological relationships. The unit encourages awareness, critical thinking, and responsible attitudes toward environmental protection.





Subject: Parties involved	Students aged 14–18, biology and environmental science teachers, ICT support staff (if available).
Keywords	Climate change, biodiversity loss, species extinction, ecosystems, food chains, carbon sinks, invasive species, conservation, adaptation, Paris Agreement, augmented reality, environmental awareness.
Key qualifications, skills and knowledge that can be acquired	Students will: understand how climate change affects species and ecosystems; explain links between human activities and biodiversity loss; develop critical thinking when discussing conservation and adaptation strategies; gain awareness of global climate goals such as the Paris Agreement; understand key ecological concepts, including food chains, invasive species, and carbon cycles; improve digital and media literacy through the use of AR tools; practice communication and collaboration skills during discussions and group tasks.
Resources and didactic aids used	Adapted informational texts and teacher presentations; Short educational videos on climate change and species extinction; IUCN Red List website for real-world conservation data; Maps and infographics showing affected species and ecosystems; Case studies related to climate impacts on biodiversity; Delightex (CoSpaces Edu) for creating interactive AR scenes; Smartphones or tablets for viewing AR content; Optional worksheets and reflection prompts.
Assessment criteria and evaluation	Assessment is based on: active participation in class discussions and AR activities; completion of short quizzes on key concepts; contribution to group work and case study analysis; a reflective writing task on possible conservation actions; optional project or presentation using AR scenes created in Delightex; teacher feedback and peer evaluation.





Introduction:

Climate change is one of the most serious environmental challenges of the 21st century. It is mainly caused by human activities such as burning fossil fuels, deforestation, and intensive agriculture. As a result, global temperatures have increased, and natural systems are changing faster than many species can adapt.

Climate change affects not only weather patterns but also the survival of plants and animals. Rising temperatures, changing rainfall, melting ice, and extreme weather events place strong pressure on ecosystems around the world. Many species lose their habitats, struggle to find food, or face new diseases.

In this learning unit, students explore how climate change leads to species extinction and damages ecosystem health. They learn why biodiversity is important and how ecosystems support life on Earth, including human life. The unit also introduces conservation strategies and shows how protecting nature can help both people and the planet.

To support understanding, the unit uses Augmented Reality (AR) through Delightex. AR helps students visualize ecosystems, species interactions, and environmental changes that are difficult to observe in real life. This makes learning more engaging and meaningful.

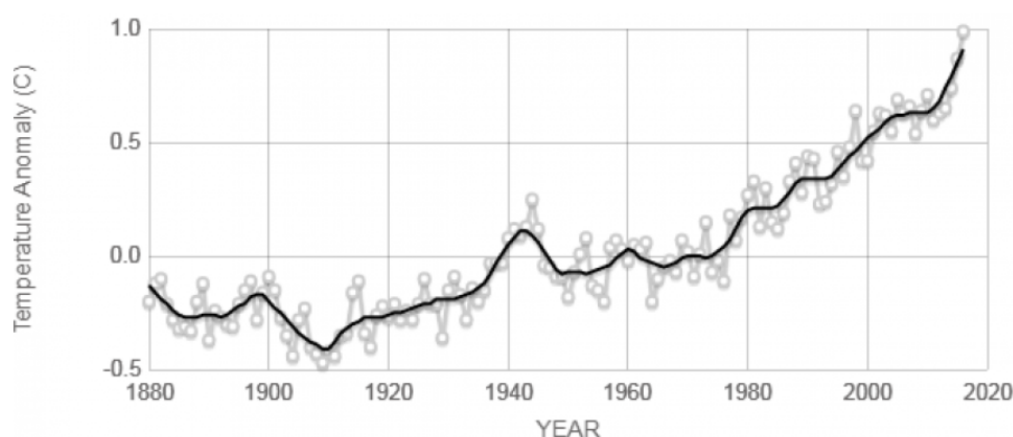




Section 1: Explore

Climate change and the threat of species extinction.

Over the last century, global average temperatures have increased by about **1°C** due to human activities such as burning fossil fuels, deforestation, and industrial development. This warming has caused serious environmental changes, including more frequent heatwaves, droughts, floods, hurricanes, and rising sea levels. These changes strongly affect natural ecosystems and the species that depend on them (IUCN, 2021).



Source: climate.nasa.gov

NASA 2017

Human-induced climate change is already having a direct impact on many plant and animal species. Because environmental conditions are changing very fast, many species do not have enough time to adapt. According to the IUCN Red List of Threatened Species, more than 10,000 species are currently affected by climate change, which increases their risk of extinction (IUCN, 2021).

One well-known example is the Bramble Cay melomys (*Melomys rubicola*), which became the first mammal officially declared extinct due to climate change. Rising sea levels destroyed its island habitat near the Great Barrier Reef.





Introductory video for students:

<https://www.youtube.com/watch?v=ztWHqUFJRTs> (WWF – Climate change and wildlife)

Coral reefs are another ecosystem under serious threat. Rising ocean temperatures and ocean acidification cause coral bleaching, diseases, and large-scale die-offs. Coral reefs are among the most biodiverse ecosystems on Earth, and their loss affects millions of marine species. Scientists warn that keeping global warming below 2°C, as stated in the Paris Agreement, is essential for coral reef survival (WWF, 2023).

👉 *AR/3D visualisation for learners:*

<https://artsandculture.google.com/asset/stunning-wilson-reef-great-barrier-reef-christophe-bailhache/hQEF7U6ddbajXw> (Google Arts & Culture – Coral reefs)

Climate change also changes species behaviour and biology. For example:

- Chinook salmon have shifted their migration routes northwards.
- North American tree swallows now start breeding earlier in the year. These examples show that climate change can affect animals in many ways: behaviour, reproduction, and even genetics.
- Green sea turtles are affected by higher nest temperatures, leading to extreme female-biased sex ratios (up to 99% female hatchlings in some areas).
- In southern Europe, climate-driven habitat changes have caused hybridisation between species such as the common toad and green toad.

These examples show that climate change affects species at ecological, behavioural, physiological, and genetic levels.

Why is it important?

Protecting species is important not only because they have value on their own, but also because they support healthy ecosystems. Ecosystems provide humans with food, clean water, climate regulation, and protection from natural disasters (WWF, 2023). Climate change increases existing threats such as habitat loss and pollution,





creating a negative feedback loop: damaged ecosystems store less carbon and become more vulnerable to climate impacts (NASA, 2023).

Disrupted food chains

Climate change affects even the smallest organisms. In the Arctic Ocean, melting sea ice and ocean acidification reduce krill populations, which are a key food source for whales, penguins, and seals (IUCN, 2021). When species at the bottom of the food chain decline, the effects spread through the entire ecosystem and may only become visible many years later.

Climate change also affects agriculture. Warmer and wetter conditions increase crop diseases such as Fusarium ear blight in wheat, causing serious food losses and health risks due to toxic substances (WWF, 2023).

Invasive non-native species

Climate change makes it easier for invasive species to spread into new regions. One example is the water hyacinth, originally from South America. It grows quickly in warmer waters, reduces oxygen levels in rivers, and causes fish die-offs, which affects biodiversity and local communities (IUCN, 2021).



Figure 1. water hyacinth (*Euchhorina crassipes*). Source: Aquatic Biologist Inc.





Carbon sinks turning into carbon sources

Forests, wetlands, and tundra normally act as carbon sinks, absorbing carbon dioxide from the atmosphere. Climate change increases droughts, fires, and diseases, leading to tree death and releasing stored carbon back into the air. This process further accelerates global warming (NASA, 2023).

What actions can be taken?

To protect species and ecosystems, several actions are necessary:

- Reduce CO₂ emissions to meet the Paris Agreement goals.
- Protect and restore ecosystems such as forests, wetlands, mangroves, and coral reefs.
- Support species adaptation by reducing non-climate stress factors and planning for extreme weather events.
- Use conservation tools such as the IUCN Red List and the Integrated Biodiversity Assessment Tool (IBAT) to support informed decision-making (IUCN, 2021).

Student-friendly explainer video (used for concept introduction):
NASA Climate Change Overview (NASA, 2023):
https://www.youtube.com/watch?v=G4H1N_yXBiA





Section 2: Execute

Learning Through AR and Interactive Exploration (Delightex)

To help students better understand the complex relationship between climate change and biodiversity loss, this learning unit uses Augmented Reality (AR) through Delightex (CoSpaces Edu). AR makes abstract and distant environmental processes visible and interactive, allowing students to explore ecosystems and species that are normally difficult or impossible to observe directly.

How Delightex Will Be Used (Teacher + Students)

In this unit, the teacher creates one interactive AR “world” in Delightex (CoSpaces Edu). The world includes 3–5 simple AR scenes (for example: coral reef, Arctic food chain, forest fire). Students open the teacher’s link or QR code on their phones/tablets and explore the scenes in AR mode.

Each scene contains short info panels, images, and task prompts (questions). Students complete a worksheet or digital exit ticket while exploring. They can work individually or in pairs, and then compare findings in a short class discussion.

Instead of learning only from texts or videos, students actively explore, observe, and interact with digital models. This supports deeper understanding, especially for visual and kinaesthetic learners, and helps students connect scientific knowledge to real-world environmental problems.

Species	Focus	Tasks
Students interact with AR objects representing endangered or climate-sensitive species. Each AR object includes:		

- a short description of the species;





- information about climate-related threats (temperature rise, habitat loss, ocean acidification);
- guiding questions such as:
 - *How does climate change affect this species?*
 - *What happens if this species disappears from the ecosystem?*

This task helps students understand that species extinction does not happen in isolation, but affects entire food chains and ecosystems.

Interactive

AR

Challenges

Students complete short AR-based challenges designed as simple quests. Examples include:

- matching species to the ecosystems they live in;
- identifying main climate threats for a species;
- linking adaptations (e.g. migration, camouflage, root systems) to environmental conditions.

These challenges support active learning, keep students motivated, and help teachers check understanding without formal testing.

Reflection and Discussion

After the AR activities, students take part in guided reflection:

- short group discussions;
- written answers to reflection questions;
- comparison of observations between different ecosystems or species.

This step helps students verbalise what they learned, connect AR experiences to scientific concepts, and practise communication skills.

Pedagogical Value

Using AR in this section supports:

- better understanding of complex environmental processes;





- increased student engagement and motivation;
- stronger emotional connection to biodiversity loss;
- development of critical thinking and environmental responsibility.

Research shows that AR-based learning improves conceptual understanding and long-term retention in environmental education (Chong & Kiew, 2020).

Section 3: Enhance

How Augmented Reality (AR) Improves Learning

Augmented Reality (AR) tools significantly improve the learning process by turning abstract and complex environmental processes into clear, interactive experiences. Topics such as climate change, species extinction, and ecosystem collapse are often difficult for students to understand because they happen on a global scale or over a long period of time. AR helps make these processes visible and easier to understand by showing them in a visual and interactive way (Chong & Kiew, 2020).

In this unit, Delightex is the main tool for AR scenes, while Google Arts & Culture and Seek by iNaturalist can be used as optional extra resources. In this learning unit, AR is used to support understanding, emotional engagement, and active participation. Instead of only reading texts or watching videos, students can explore ecosystems, species, and environmental changes through digital 3D content and interactive tasks.

Visualising Complex Environmental Processes

Many effects of climate change on biodiversity cannot be observed directly in everyday life. Examples include coral bleaching, melting polar ice, changing migration routes, or ecosystem collapse. AR applications such as Google Arts & Culture – Expeditions allow students to explore realistic 3D models of coral reefs, forests, and endangered species affected by climate change (UNESCO, n.d.).

Through these visual experiences, students can better understand how rising temperatures, ocean acidification, and habitat loss affect living organisms. Seeing





ecosystems in AR helps learners understand relationships between species and their environments, instead of memorising isolated facts.

AR visual inspiration: <https://artsandculture.google.com/project/expeditions>

Promoting Active Exploration and Real-World Connection

AR also supports active learning by encouraging students to explore their real environment. The application Seek by iNaturalist allows students to identify plants and animals using their device camera. This helps learners connect classroom knowledge with local biodiversity and understand that climate change also affects species close to home (iNaturalist, n.d.).

By observing real organisms and linking them to climate-related threats, students develop ecological literacy and a sense of responsibility. Learning becomes more meaningful when students see that global problems have local consequences.



AR-supported

biodiversity

exploration:

https://www.inaturalist.org/pages/seek_app

Increasing Engagement, Motivation, and Empathy

AR experiences are immersive and interactive, which increases student motivation and attention. Virtual field trips and AR-based exploration turn students into active participants instead of passive learners. This approach supports deeper understanding and long-term memory (Chong & Kiew, 2020).

In addition, AR can create emotional engagement. When students see endangered species or damaged ecosystems in AR, they are more likely to feel empathy and concern. This emotional connection is important for developing positive attitudes toward environmental protection and conservation (WWF, 2023).



Climate

and

ecosystem

visuals:

<https://climate.nasa.gov>

<https://wwf.panda.org>





Supporting Collaboration and Creative Thinking

AR also supports collaborative learning. Students can work in small groups to explore AR scenes, discuss observations, and solve environmental challenges together. After AR exploration, learners can take part in discussions or design-thinking tasks, such as proposing nature-inspired solutions to climate problems.

For example, after observing mangroves or coral reefs in AR, students can brainstorm how similar natural systems protect coastlines or store carbon. These activities support creativity, communication skills, and critical thinking.

Educational Value of AR Integration

By embedding AR tools into the curriculum, teachers create multisensory learning experiences that combine visual, spatial, and interactive elements. AR does not replace traditional teaching methods but strengthens them by adding exploration, interaction, and reflection. This approach helps students understand complex environmental topics in a clear and relatable way while developing environmental awareness and responsibility (WWF, 2023; Chong & Kiew, 2020).

Overall, AR supports deeper understanding, stronger engagement, and responsible attitudes toward biodiversity conservation and climate action. It helps students move from knowledge to awareness and from awareness to action.





Conclusion:

In this training unit, students explored how climate change affects biodiversity and ecosystem health, and why these changes are a serious global challenge. Through adapted scientific texts and real-world examples, learners developed a clearer understanding of species extinction, disrupted ecosystems, and the urgent need for conservation and climate action.

The use of Augmented Reality (AR) tools such as Google Arts & Culture – Expeditions and Seek by iNaturalist played an important role in supporting learning. AR helped students visualise complex environmental processes that are difficult to observe directly, such as coral bleaching, habitat loss, and species adaptation. By interacting with 3D models and exploring real ecosystems virtually and locally, students were able to connect theoretical knowledge with real-world situations.

This learning unit also encouraged active participation, critical thinking, and creativity. Through AR-based exploration, discussions, and collaborative tasks, students reflected on how nature adapts to change and how humans can learn from these strategies to build more sustainable and climate-resilient solutions. The combination of biology, technology, and environmental education supported meaningful STEAM learning and increased students' motivation and engagement.

Overall, the unit helped students move beyond facts and statistics toward awareness and responsibility. By understanding the links between climate change, biodiversity, and human actions, learners are better prepared to act as informed citizens and future decision-makers who care about protecting the natural world and supporting a resilient future.





Phase	Description
Explore	- Research and understanding: Students learn how climate change increases extinction risk through adapted texts, short videos, and reliable sources (IUCN, WWF, NASA).
	- Concept building: Students work with key ideas: biodiversity, ecosystem services, food chains, invasive species, and carbon sinks/carbon sources. Visual aids (infographics, maps, simple case studies) support comprehension.
	- Needs analysis: The teacher checks prior knowledge using a short warm-up quiz or discussion (e.g., “What is biodiversity?” “How can climate change affect animals?”). This helps adjust language level and task difficulty.
Execute	- AR-based implementation (Delightex): Students explore teacher-created AR scenes about ecosystems under climate stress (reef, Arctic, forest/wetland). Each scene includes short info panels and guiding questions.
	- Interactive exercises: Students complete small tasks: match species to threats, identify links in a food chain, and explain how ecosystem damage can increase climate impacts (feedback loop idea).
	- Feedback and reflection: Students submit a short exit ticket / worksheet and discuss answers in pairs or groups. Teacher collects responses (through discussions, digital forms, or observation) to monitor understanding and identify misconceptions.
Enhance	- Deeper AR learning: AR is used to visualise processes that are hard to observe directly (coral bleaching, habitat loss, migration shifts, carbon cycle changes).
	- Inquiry + creativity: Students work in groups on a mini challenge (e.g., “Design a protection plan for one ecosystem” or “Create an AR info point about one endangered species”).
	- Light gamification: Students earn points/badges for completing scenes, correct task answers, and good teamwork.
	- Quests and Challenges: Learning tasks are presented as simple missions or challenges, such as identifying threats to a species or matching adaptations to environments.
Enhance	- Collaborative Gamified Tasks: Students work in small groups to solve environmental problems, design climate-resilient habitats, or propose conservation actions inspired by nature.
	- AR-Based Assessments: Assessment in context: Assessment focuses on understanding, participation, correct use of key vocabulary, and the quality of student explanations/solutions based on AR observations.





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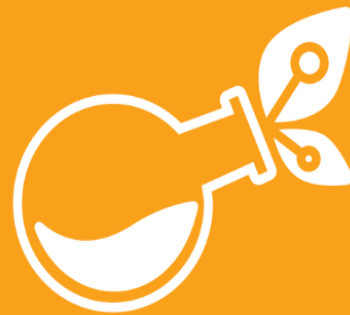
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