Secondary
14-16

education resource pack

BIODIVERSITY AND HABITAT LOSS

Teacher guide and student worksheets

climate change initiative education resource pack –
BIODIVERSITY AND HABITAT LOSS
https://climate.esa.int/en/educate/

Activity concepts developed by University of Twente (NL) and
National Centre for Earth Observation (UK)

The ESA Climate Office welcomes feedback and comments
https://climate.esa.int/helpdesk/

Produced by the ESA Climate office

BIODIVERSITY AND HABITAT LOSS: Overview

Fast facts

Subjects: Geography, Science, Earth Science, Biology, Ecology

Age range: 14–16 years old

Type: reading, fieldwork, online research

Complexity: medium to advanced

Lesson time required: 4 hours

Cost: low (5–20 euros)

Location: indoors/outdoors

Includes the use of Internet, presentation and spreadsheet software, simple surveying equipment

Keywords: biodiversity, species, adaptations, habitat, ecosystem, biome, biotic and abiotic factors, community, population, resilience

Brief description

This set of activities begins with a reading assignment that introduces vocabulary and ideas that are key to considering the relationship between climate change and ecosystems.

A field survey of a local area, which can be carried out using home-made equipment, is extended to include a measurement of biodiversity that can later be used to compare the likely resilience of different regions.

In the final activity, students use the Climate from Space web application to explore how a range of appropriate factors describing the habitat of a local species have changed, relating this to recent and potential changes in the population of the species.

Intended learning outcomes

Having worked through these activities, students will be able to:

Define keywords related to the topic.

Explain why biodiversity is important, including climate impacts.

Carry out a field survey of plant life.

Calculate a measure of biodiversity from a field survey.

Use the Climate from Space web application to explore changes to abiotic factors affecting a habitat.

Evaluate the effect of habitat changes on a local species.

Summary of activities

	Title	Description	Outcome	Prior learning	Time
1	Key ideas	Reading assignment	Define keywords related to the topic. Explain why biodiversity is important, including climate impacts.	None	30 minutes
2	Measuring biodiversity	Field survey and calculation of a measure of biodiversity	Carry out a field survey of plant life. Calculate a measure of biodiversity from a field survey.	None	2 hours of which the central 30–60 minutes is fieldwork
3	Local habitats	Research activity using Climate from Space web application	Use the Climate from Space web application to explore changes to abiotic factors affecting a habitat. Evaluate the effect of habitat changes on a local species.	Able to use presentation software Understanding of key ideas covered in Activity 1	1½ hours

Times given are for the main exercises, assuming full IT access or/and distribution of repetitive calculations and plots around the class. They include time for sharing results, but not presentation of outcomes as this will vary depending on the size of the class and groups. Alternative approaches may take longer.

Practical notes for teachers

The **material required** for each activity is listed at the start of the relevant section, together with notes about any preparation that may be required beyond copying worksheets and information sheets.

Worksheets are designed for single use and can be copied in black and white.

Information sheets may contain larger images for you to insert into your classroom presentations, additional information for students, or data for them to work with. These resources are best printed or copied in colour but may be reused.

Any **additional spreadsheets, datasets or documents** required for the activity may be downloaded by following the links to this pack from https://climate.esa.int/en/educate/climate-for-schools/

Extension ideas and suggestions for **differentiation** are included at appropriate points in the description of each activity.

Worksheet answers and sample results for practical activities are included to support **assessment**. Opportunities for you to use local criteria to assess core skills such as communication or data handling are indicated in the relevant part of the activity description.

Health and safety

In all activities, we have assumed you will continue to follow your usual procedures relating to the use of common equipment (including electrical devices such as computers), movement within the learning environment, trips and spills, first aid, and so on. Since the need for these is universal but the details of their implementation vary considerably, we have not itemised them every time. Instead, we have highlighted hazards particular to a given practical activity to inform your risk assessment.

Some of these activities use the Climate from Space online resource. It is possible to navigate from here to other parts of the ESA Climate Change Initiative website and thence to external websites. If you are not able – or do not wish – to limit the pages students can view, do remind them of your local Internet safety rules.

Climate from Space

ESA satellites play an important role in monitoring climate change. Climate from Space (cfs.climate.esa.int) is an online resource that uses illustrated stories to summarise some of the ways in which our planet is changing and highlight the work of ESA scientists.

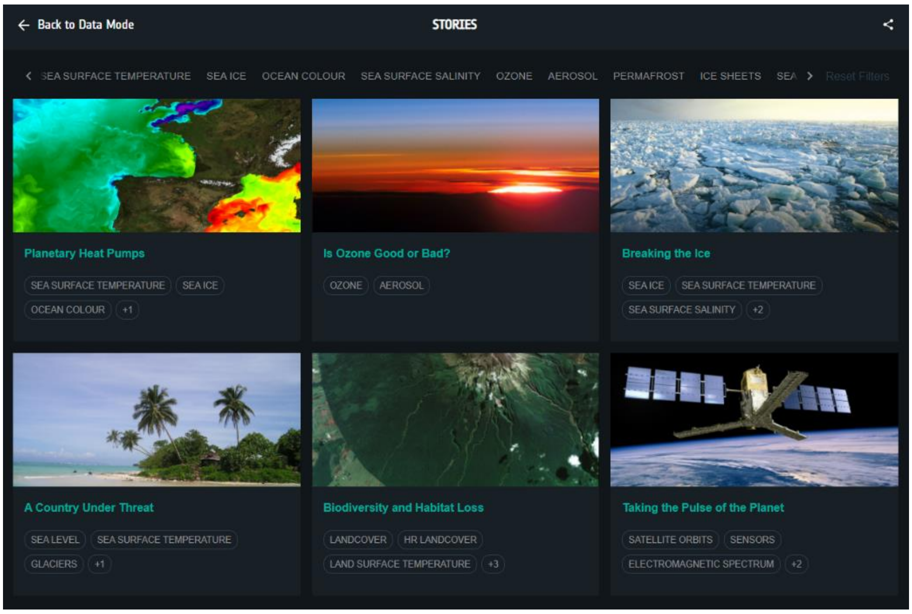


Figure 1: Stories in Climate from Space (Source: ESA CCI)

ESA's Climate Change Initiative programme produces reliable global records of some key aspects of the climate known as essential climate variables (ECVs). The Climate from Space web application allows you to find out more about the impacts of climate change by exploring this data for yourself.

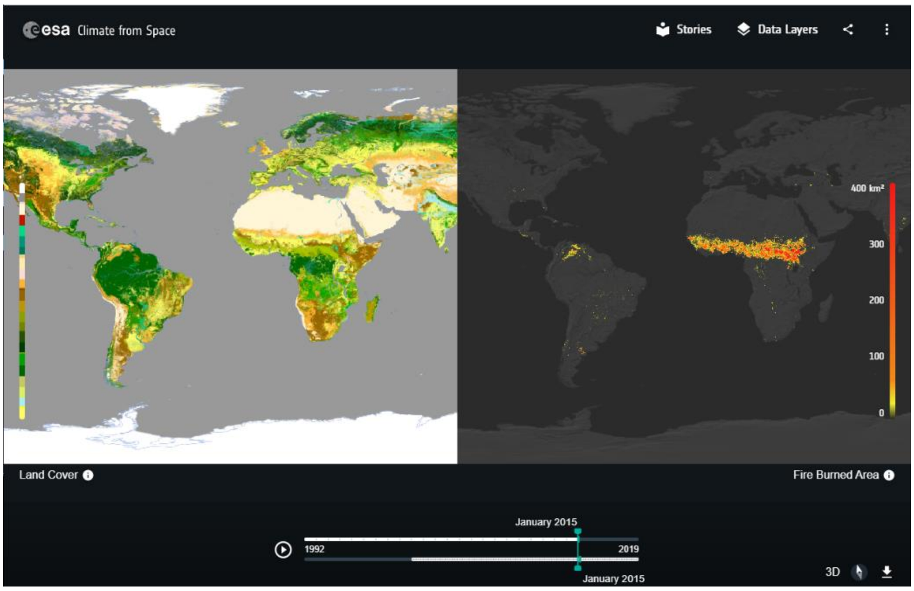


Figure 2: Exploring land cover and the effect of fire in the Climate from Space data viewer (Source: ESA CCI)

Climate and biodiversity: background information

Biodiverse ecosystems

All living things rely on each other and humans are no exception. We depend on plants, animals and other organisms for food, of course, but living things have impacts on the soil, the water cycle and the atmosphere that affect how we use these resources, or our health. These 'ecosystem services' depend on communities made up of many species interacting with each other and their habitats in ways which are often very complex and that we do not fully understand until something goes wrong.

Healthy ecosystems are resilient: they are able to respond to or recover from sudden changes. A diverse ecosystem can continue to function even though the population of a particular organism may crash or rise for a while. And, in the same way, genetic diversity within a population makes each species more resilient. Diversity offers options at every level.

Biodiversity can be a tricky concept because it is relative to an area: we can talk about the biodiversity of a continent (Europe), a particular biome or ecosystem (forests) or a more specific habitat (a named lake).

Monitoring habitats

The biodiversity of a habitat – and its suitability for a given species – depends on a range of abiotic and biotic factors. Abiotic factors include altitude, temperature range, alkalinity, salinity, sunshine, humidity, fire cycles, or the presence of a certain nutrient. Examples of biotic factors are competition, predation, grazing, pollination and seed distribution. Although human factors may be considered biotic, it can be helpful to think of them separately because of the magnitude of the effects of activities such as farming, deforestation, pollution and the ways humans change the landscape.

Climate change

The impact of climate change and other human actions on the wildlife in regions such as the Arctic and tropical rainforests is well known. As habitats are changed or destroyed, species that cannot respond quickly enough or are unable to migrate are weakened or become extinct. Similarly, most people are aware of the role forests can play in regulating the composition of the atmosphere.

These headline examples are only some of the ways in which the climate affects life and in which the biosphere – the sum total of living organisms on the planet – affects the climate. Unsurprisingly, therefore, there are sets of data that are useful to both ecologists and climate scientists, to farmers as well as meteorologists. Information about abiotic factors such as fire and cloud cover is useful to researchers trying to find out about changing populations of animals, and detailed maps of land use are used by people modelling how the atmosphere around us behaves.

Activity 1: KEY IDEAS

This reading-based activity leads students to create a glossary of key terms and is suitable for independent learning by students who are confident readers. It could be used at the start of a topic to assess students' understanding of concepts, some of which they may have met in earlier studies. In the classroom, you can use material from the related Climate from Space story to illustrate the text.

Equipment

- Information sheet 1 (2 pages)
- Student worksheet 1
- Climate from Space online resource: *Biodiversity and Habitat Loss* story (optional)
- Standard textbook(s) or/and Internet access (optional)

Exercise

1. Ask students to read Information sheet 1 and note or highlight any words that are new or whose meaning they are unsure of.
   If doing this in class, you could supplement the text with material from the Climate from Space story of the same title as follows:
   - The globe on slide 3 shows land cover types across the world at intervals from 1992 (step through rather than play continuously).
   - Slide 2 has a gallery of other fire images.
   - The animation on slide 4 shows changing land cover in the Amazon, around Shanghai, in the Eastern Congo and around an Andean lake – start at 2:08 and continue to 2:20.
   - The first part of the animation on slide 4 and the video on slide 5 (from 1:12) give more detail on how satellites are used to monitor land cover and how this relates to climate science, respectively. Both are quite technical so use only with older and more able students.
2. Ask students to answer the questions on Student worksheet 1.
   Students could also find and list definitions for any other words they have identified as new or unfamiliar.
   This could be done individually or in pairs/groups and, if you are not using this to assess initial understanding, you may wish to allow students access to additional sources such as textbooks or appropriate websites.
3. Peer-assess or/and discuss the answers to the questions.

Worksheet answers

1. a. A measure of the diversity or variety of species in an area.
   b. Variables such as temperature, rainfall and humidity that describe the conditions in an area (but do not depend on living organisms).
   c. Characteristics of an animal or plant that help it survive.
   d. The range of organisms in an ecosystem.
   e. Areas with similar environments that are home to similar communities.

f. The climate conditions in a small area of a region.
g. Able to recover from or adapt to change.
h. The number of individuals of a particular species in an area.

2. They may adapt to the change, or the population may crash or even become extinct.

3. The key feature mentioned in the text is that communities with higher diversity are likely to be more resilient. Students may add other ideas from other reading or research such as the role of healthy (thus, diverse) ecosystems in maintaining climate, food production, medical research and so on.

Activity 2: MEASURING BIODIVERSITY

In this class activity, students use the results of a local field survey to calculate a measure of biodiversity. Each group of students will need to take random samples of the area they choose to survey. Standard textbooks and sources describe various ways of doing this and an appropriate method to the specific situation (ability of students, size of survey area and class, local hazards, *etc.*) should be used.

Equipment

- Quadrat – one per group
- Camera or smartphone – one per group (optional)
- Internet access or/and field guide to local plants – one per group
- Student worksheet 2 (2 pages)
- Biodiversity Activity 2 spreadsheet from the Biodiversity and habitat loss section of the ESA Climate for Schools webpage (https://climate.esa.int/en/educate/climate-for-schools/) or/and calculator

Preparation

Choosing areas to use Ideally, each section of the class would survey a different area – for example: a woodland edge, a field, a lawn, a surfaced area (often not as barren as they appear). However, if this is not possible, groups could sample opposite sides of a playing field.

Quadrats You do not need quadrats from a scientific supplier for this activity. You can use old frames or make them from strips of wood, pizza boxes or lengths of card although the latter two may not work so well if grass is long or the ground is wet (see Figure 3).

If you want to subdivide the area, you can do this using regularly placed wires or strings. The important thing is to make sure that the frame is rigid and the area enclosed is known. Making the area a round number is helpful. Smaller quadrats (say 15 cm × 15 cm) are easier to handle and allow quicker counting but may need more samples; larger quadrats (say 30 cm × 30 cm) are more appropriate if the area to be surveyed includes plants that cover an extensive area.

Field guides It may be helpful to create your own one- or two-sided mini field guides using photographs of plants that are expected to be found in the area(s) to be surveyed. This will make the task of identification more straightforward, particularly for less able students and, thus, speeding up this step of the activity.

Health and safety

This activity involves students working outdoors across a wide area. Ensure they are aware of any local hazards (e.g., ponds, busy roads) and supervised in accordance with local requirements.

Students should be appropriately clothed for the terrain and weather, using sunscreen if required.

Exercise

1. Split the class into pairs or small groups and allocate each pair/small group to one of the two or more areas to be surveyed.
2. Discuss how they will survey the area (see below), including how to ensure they have a random sample of locations and, if necessary, how to get a count of the number of grass plants (see student worksheet: you may want to make mini quadrats for this task).
   Note: A faster alternative, which may be simpler for less able students, is to estimate the percentage cover of each species from the photograph and use these relative abundances instead of population numbers. For less able students, overlaying the photo with a 10 × 10 grid means this can be done by simply counting the number of squares mostly filled by each plant.
3. Take students outside to collect their data. They may complete the table immediately, using field guides to identify species, or take photographs of their quadrat at each sample site and use online resources to analyse the images upon their return to the classroom.
4. Ask each pair/small group to compare their findings with those of another that surveyed a different area. What similarities and differences have they found? Did other groups comparing the same areas see the same pattern?
5. Ask how we can use our data to decide how biodiverse the areas they surveyed are, reinforcing the idea that both the number of species and the population of each species matter. A perfect lawn will have low biodiversity because all the ground is covered with a single type of plant. A flowerbed may contain lots of different plants, but is it more diverse than a rainforest? How can we compare when we would have to take samples over vastly different areas to find out?
6. Introduce the idea of an index as a fraction that scientists use to get around problems like this. By doing a calculation that compares some part of what we are looking at to the whole, we end up with a number that is always between zero and one no matter how big or small our sample is.
7. Ask students to calculate the species diversity index either by following the instructions on Student worksheet 2.2 or using the spreadsheet.
8. Collate the values from each pair or small group and discuss the questions at the end of Student worksheet 2.2. These discussions could form the basis of a display or further work into improving the biodiversity of the school environment.

Sample results and worksheet answers

Counting grass

Defining what counts as an individual grass plant is somewhat tricky but, for the purposes of this exercise, we are counting the number of stems to get a measure we can compare to the numbers of other plants. These results are from a UK lawn using a 50 cm × 50 cm quadrat.

- Number of stems in three 5 cm × 5 cm sample areas: 22, 10, 15

- Average number of grass plants in 25 cm^2 = 15.6
- Average number of grass plants in 1 cm^2 = 0.626

	Sample 1	Sample 2	Sample 3	Sample 4
Grass: % of quadrat area covered	100	75	10	40
Grass: area covered / cm^2	2500	1875	25	100
Species	**Number of plants**			
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**
Grass	1567	1175	157	63

Survey results

Figure 3 shows the survey in progress using two different home-made quadrats: one rectangular (21 cm × 33 cm) and one square (14 cm × 14 cm). In this field in the Netherlands, the grass plants were sparse enough to be counted separately.

Figure 3: Field survey of two areas using home-made quadrats. Top row is area 1, bottom row is area 2 Data from the rectangular quadrat has been transferred to the tables below. (Source: ESA CCI)

AREA 1 Species	**Number of plants**			
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**
Grass	8	9	12	
Dandelion	5		3	
Creeping Charlie	2	6		
Clover				2
Plantain				2

AREA 2 Species	**Number of plants**			
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**
Grass	12	8	9	1
Dandelion	2	7	2	2
Small leaf	1			
New leaf			2	
Clover			2	
Fern				12

You will notice that scientific names have not been used and some are descriptive rather than specific. Unless you want to reinforce the use of keys or/and taxonomic naming systems, it is perfectly acceptable for students to make up names for plants they cannot identify – as long as they are clear what it refers to when they are counting, of course.

Area 2 has more types of plant than area 1. However, it also has more plants in total so we cannot be certain it has greater biodiversity in terms of species concentration.

Species diversity index (SDI)

AREA 1 Species	n_i	$n_i(n_i - 1)$
Grass	29	812
Dandelion	8	56
Creeping Charlie	8	56
Clover	2	2
Plantain	2	2
Column totals	49	928

$N(N-1) = 2352$

$$\frac{\sum n_i(n_i-1)}{N(N-1)} = 0.395$$

$SDI = 0.605$

AREA 2 Species	n_i	$n_i(n_i - 1)$
Grass	30	870
Dandelion	13	156
Small leaf	1	0
New leaf	2	2
Clover	2	2
Fern	12	132
Column totals	60	1162

$N(N-1) = 3540$

$$\frac{\sum n_i(n_i-1)}{N(N-1)} = 0.328$$

$SDI = 0.672$

The calculation shows that area 2 does indeed have greater biodiversity than area 1.

Comparing diversity – discussion questions

The discussion questions are deliberately open and the answers are dependent on the areas chosen and how different they are.

In areas of the same type – such as parts of a lawn – you might prompt students to think about factors such as differences in the microclimate of each area (due to things such as depressions in the ground or shade), or the compaction of the ground where people walk regularly, that may make it more difficult for some plants to grow. If students are comparing areas with different types of vegetation, they might want to consider, for example, what animals may be present or the nutrient levels.

This activity could be used to assess student's abilities to hypothesise and draw conclusions from data against local criteria.

Activity 3: LOCAL HABITATS

In this activity, students identify the factors describing the habitat of a local species, use the Climate from Space web application to determine how some of those factors have changed over recent years, and consider the reasons for and impacts of these changes. It may be carried out by individuals or pairs/small groups. If students are working together or/and are unfamiliar with the web application, it would be useful to do at least the first part of the exercise in class, although the activity is suitable for independent learning.

Equipment

- Internet access
- Climate from Space web application
- Student worksheet 3 (2 pages)
- Presentation software such as PowerPoint

Exercise

1. Students first need to identify a local species to investigate. You may wish to provide a list of suggestions to ensure that the class covers a range of organisms (plants and 'pests' as well as the wildlife that may first spring to mind) and habitats (including urban areas), or allocate a subject to each individual or pair as a way of achieving differentiation.
2. Ask students to research the species and the habitat using the Climate from Space web application and other resources. The student worksheet provides instructions and questions to guide and focus this research. You may wish to ask students to omit some questions if time is limited or they are not appropriate for your syllabus.
   Note: The land cover data is reasonably detailed, with each pixel covering an area of 300 m × 300 m. Many of the other datasets have a coarser resolution with one pixel covering an area that is tens of kilometres on each side – although there may be data for each month (or even day) rather than each year. If this is likely to confuse less able students, then they could omit question 4.
3. Ask students to create a presentation to summarise their findings. Question 9 on Student worksheet 3.2 suggests a structure for this. If students are to present their findings to others in class, you may also wish to impose a time limit. If the presentations are to be used solely for assessment, or shared as documents or posters, you may want to reinforce that the slides should stand alone.

Worksheet answers

Most questions on the worksheet are open and the answers are heavily dependent on region and the species chosen.

The activity could be used to assess research skills, and the presentation to assess communication skills, against local criteria.

Worksheet 1: KEY IDEAS

Read the information sheet *Biodiversity and habitat loss.*

Use information from the sheet or/and other sources to help you answer the questions below.

1. Explain what these keywords mean.

a. biodiversity ______________________________

b. abiotic factors ______________________________

c. adaptations ______________________________

d. community ______________________________

e. biome ______________________________

f. microclimate ______________________________

g. resilient ______________________________

h. population ______________________________

2. What may happen to animals and plants if their habitat changes?
Your answer should include two main ideas.

____

____

____

____

3. Why is biodiversity important?
List as many ideas as you can.

____

____

____

____

____

____

Worksheet 2: MEASURING BIODIVERSITY

Survey details

What area did you sample? ____

How did you decide where to take your samples? _________________________

____

What was the area of the quadrat you used? ____________________________

Counting grass

You need to do this while you are still outside if the area you are surveying is a field, lawn or other area with too many grass plants to count easily.

1. Choose three 5 cm × 5 cm sample areas completely covered by grass and count the number of grass stems in each area. _______ _______ _______
2. Work out the average number of grass plants in 25 cm^2. _________________
3. Work out the average number of grass plants in 1 cm^2. _________________

You can use this figure and the percentage of the quadrat that is filled by grass to calculate the number of grass plants.

Survey results

Use the table below to record the results of your survey.

	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**
Grass: % of quadrat area covered					
Grass: area covered / cm^2					
Species	**Number of plants**				
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**
Grass					

Species diversity index

Places with low biodiversity have a species diversity index of zero.
The nearer the species diversity index is to 1, the more biodiverse the area.

We calculate it using the equation $SDI = 1 - \left(\frac{\sum n_i (n_i - 1)}{N(N-1)} \right)$

where: *SDI* = species diversity index,
n_i = the population of an individual species in the sample, and
N = the total number of plants in the sample.

It looks very complicated, but we can use a table to help us calculate it. Follow these instructions to calculate the SDI for the area you surveyed.

Your teacher may give you a spreadsheet to help you do this calculation.

Species	n_i Total number of plants of this species (add up results from all your samples)	$n_i(n_i - 1)$
Column totals		

The second column total is *N*. Use this to work out *N*(*N* –1).

N(*N* –1) = ______________

The total of the third column is $\sum n_i (n_i - 1)$. Use this to work out $\frac{\sum n_i (n_i - 1)}{N(N-1)}$

$\frac{\sum n_i (n_i - 1)}{N(N-1)}$ = ____________

Use this value to work out $SDI = 1 - \left(\frac{\sum n_i (n_i - 1)}{N(N-1)} \right)$

SDI = __________________

Comparing diversity – discussion questions

Compare your value of *SDI* with those of other groups that sampled the same area. Are they the same? Why?

Now compare your value of *SDI* with those of groups who sampled a different area. Are they the same? Why?

If the *SDI*s are different, which area is more diverse?
What reasons might there be for the differences?

Worksheet 3: LOCAL HABITATS

You are going to consider how changes to land use and climate may affect a species that lives in your country.

1. Choose a local species and list the key features of its habitat.

Species ____

Habitat ____

____

____

2. Open the Climate from Space web application (cfs.climate.esa.int).
   Click on the Data Layers symbol (top right) and select Land Cover.
   Open the key using the ⓘ button.
   Which land cover type or types best describe this habitat?

____

____

3. Zoom in on your country.
   Step along the timeline to explore how the type or types of land cover that the species you have chosen needs has changed since 1992.
   Use the questions below to get you started but make notes about anything else you notice that may affect the habitat of your species.

a. Has the amount of this land cover changed? If so, how?

____

b. Are areas with this type of land cover fragmented (scattered around the country) or connected to each other? Has this changed?

____

c. Make an estimate of the largest area of this type of land cover in your country. (Each pixel is 300 m × 300 m.)

____

Other notes ____

____

____

4. Explore any other data layers that might tell you more about how the habitat of the species has changed since 1992. Make a note of anything relevant.

____

____

You may need to do some extra research to answer the questions on this page.

5. What were the reasons for any changes to land cover you noticed?

____

____

____

____

6. What effect have the changes to the habitat since 1992 had on the species?

____

____

____

____

7. What may happen to the habitat you are investigating as climate changes?
Be as specific as you can.

____

____

____

____

8. How would these changes affect the species you have chosen?
Remember that the surrounding areas may change as well as those where the species lives today.

____

____

____

____

9. Make a presentation to share a summary of your findings with the rest of the class. You might include the following slides:
   - Slide 1: the species and its habitat (use your answers to questions 1 and 2).
   - Slide 2: how the habitat has changed (questions 3 to 5).
   - Slide 3: the effect this has had on the species (question 6).
   - Slide 4: how the habitat might change in future (question 7).
   - Slide 5: the impact this would have on the species (question 8).

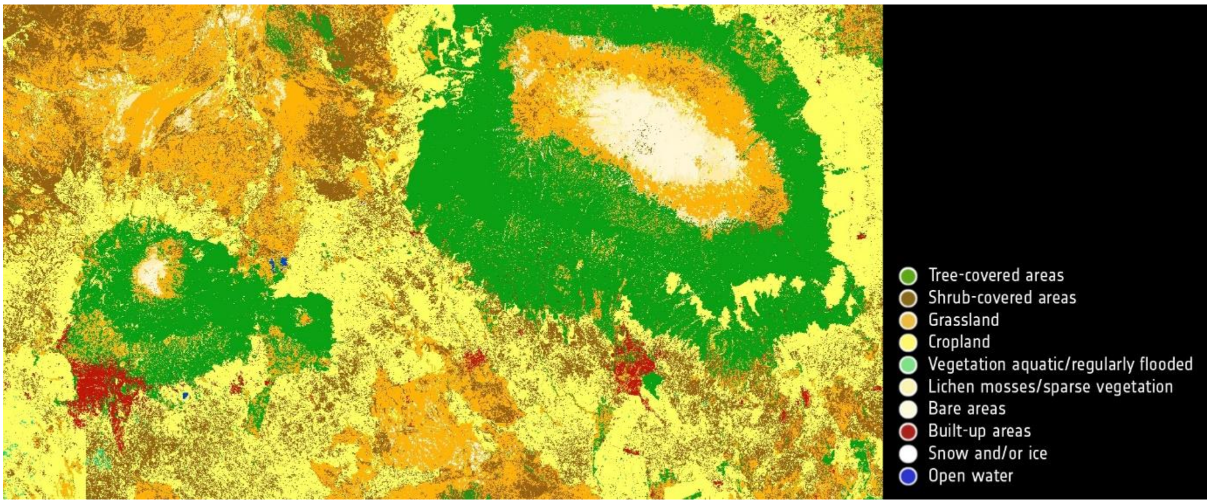
Information sheet 1: BIODIVERSITY AND HABITAT LOSS

We share our planet with millions of other living species – animals, plants, fungi and smaller organisms. Scientists refer to this variety of life as **biodiversity**. Healthy land ecosystems are home to many herbivores (animals that feed on plants), fewer carnivores (animals that feed on herbivores) and a small number of top carnivores (carnivores that feed on other carnivores). Biodiversity sustains this pyramid and is one way we can measure the health of the planet or areas of it. Biodiversity is especially high in forests, which contain more than 80% of all land-based animal and plant species.

Earth's land cover

Whether or not a species can live in a particular environment depends in part on external conditions such as how hot it is, how humid it is or how wet it is. **Abiotic factors** such as these determine the conditions in which nature can strike a balance.

Organisms have characteristics that help them live and survive in the environment or ecosystem in which they evolved – their natural habitat. These **adaptations** may be related to aspects of the climate, or to interactions with others of their species (for reproduction, for example) or to other organisms in the **community** of the ecosystem (such as their predators or food source). Members of a community depend on others, especially those above or below them in a food chain and those that compete with them for food, space or other limited resources.



A map made from satellite data showing land cover around Mount Kilimanjaro in Tanzania. Can you spot the towns of Arusha and Moshi? (Source: ESA CCI)

The flora and fauna of a region are not only adapted to the local climate but also influence it: living things and climate work together to act as one healthy organism. Areas that have similar climates and are home to similar communities are called **biomes**. The climate and conditions within a biome may vary from place to place and so we talk about the **microclimate** of the smaller area. For example, the northern side of a hill may be cooler or get less rainfall than the southern side; a lake may cool and provide moisture for the land around it.

An ecological community made up of many different species – one with a high level of biodiversity – is likely to be more **resilient**, to be able to withstand and survive sudden changes. If all the animals in a food web are ultimately dependent on a single type of plant, then the entire ecosystem may collapse if that plant is affected by a disease or extreme weather.

World on fire

With global warming, wildfires, deforestation and other human activities, habitats are changing very quickly and becoming fragmented. Scientists estimate that a billion animals died when fire tore through eastern Australia in the summer of 2019–2020.

Wildfires in southeast Australia in 2020 (Source: Copernicus Sentinel data 2020, processed by ESA)

Responding to change

When a habitat changes, animals and plants may find that their adaptations are not helpful – or even a disadvantage – in the new environment and they may be forced to move elsewhere to survive. Some animals, such as pigeons and foxes (and we humans), have adapted to survive in cities. But small populations of species that are more specialised or have been driven into areas where they face greater competition, have become locally extinct as a result of increased urbanisation. In Belem, a large city at the mouth of the Amazon River in Brazil, destruction of the surrounding rainforest has caused snakes up to three metres long to head downtown. Imagine finding an anaconda in your plumbing! The World Wildlife Fund estimates that, across the globe, a million species face extinction if forest loss continues at the current rate.

Charting habitat change

The community of an area and the **population** of each species within it are directly related to the type of land cover. Using satellites to monitor this and other abiotic factors (such as fires, temperature and soil moisture) from space helps us to understand how habitats are changing and how we might preserve vulnerable biomes and biodiversity.

Links

ESA resources

Climate from Space online resource
https://cfs.climate.esa.int

Climate for schools
https://climate.esa.int/en/educate/climate-for-schools/

Teach with space
http://www.esa.int/Education/Teachers_Corner/Teach_with_space3

ESA space projects

ESA Climate Office
https://climate.esa.int/en/

Space for our climate
http://www.esa.int/Applications/Observing_the_Earth/Space_for_our_climate

ESA's Earth Observation missions
www.esa.int/Our_Activities/Observing_the_Earth/ESA_for_Earth

Earth Explorers
http://www.esa.int/Applications/Observing_the_Earth/The_Living_Planet_Programme/Earth_Explorers

Copernicus Sentinels
https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Overview4

Extra information

Biodiversity and habitats
http://www.esa.int/Applications/Observing_the_Earth/Securing_Our_Environment/Biodiversity_habitats

Earth from Space videos
http://www.esa.int/ESA_Multimedia/Sets/Earth_from_Space_programme

ESA Kids
https://www.esa.int/kids/en/learn/Earth/Climate_change/Climate_change