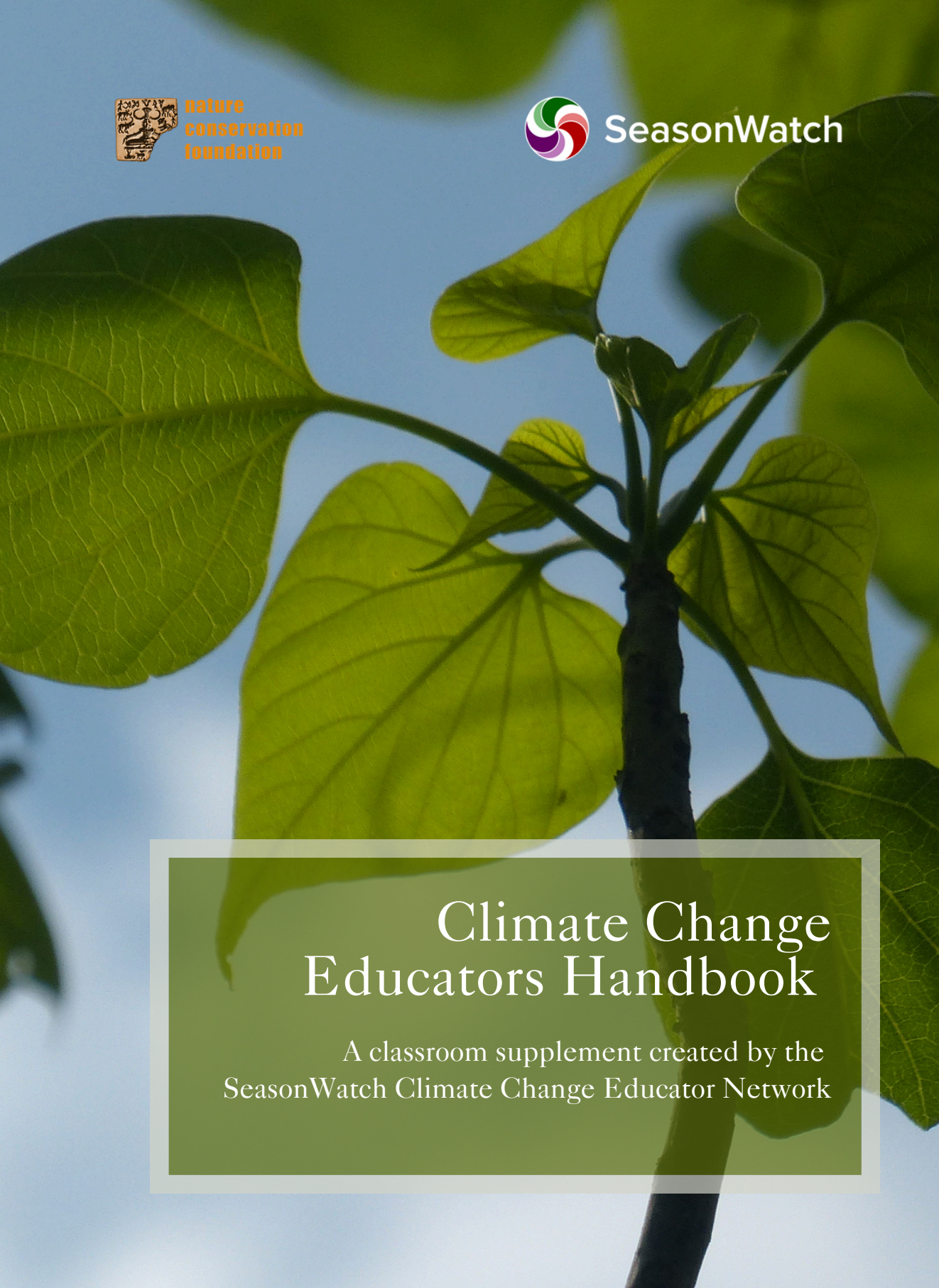

nature conservation foundation

SeasonWatch

Climate Change Educators Handbook

A classroom supplement created by the SeasonWatch Climate Change Educator Network

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SeasonWatch Climate Change Educator Network

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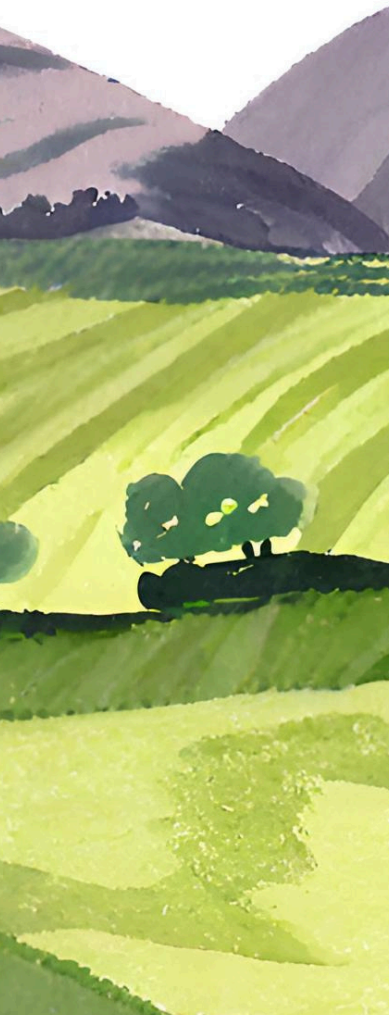
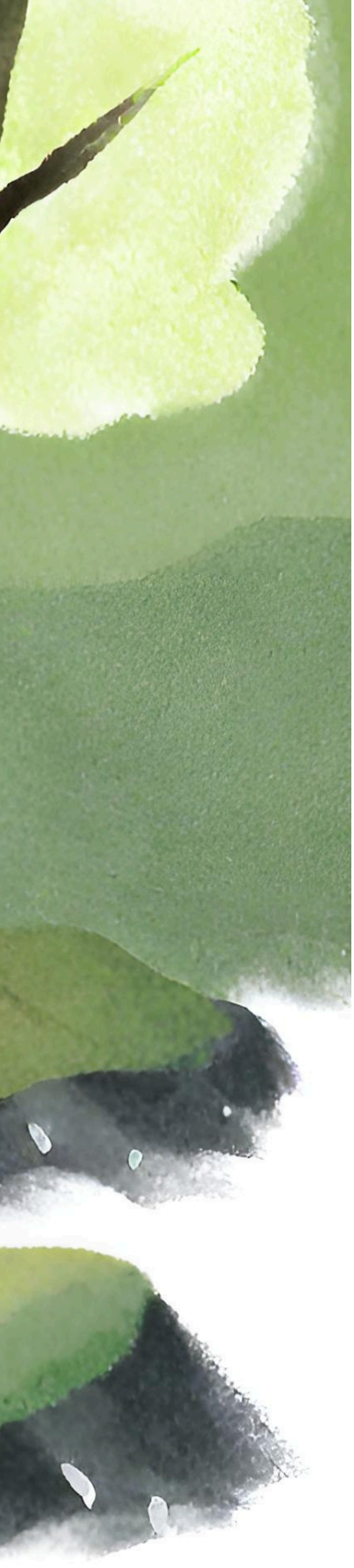
Introduction

Rising global temperatures, shifts in weather patterns, and more frequent and severe weather events are becoming the norm. Now, more than ever, we are beginning to experience the impacts of climate change firsthand and gaining a deeper understanding of its effects on human livelihoods, biodiversity, and the environment. Climate change education plays a crucial role in equipping children to tackle the challenges posed by this phenomenon. However, information about climate change often feels distant in environmental science textbooks, providing little opportunity for children to relate it to their own lives. Examples of climate change in textbooks often focus on faraway occurrences like melting polar ice sheets or receding glaciers, which seem disconnected from the everyday experiences of the majority of the Indian school-going children.



To address this gap in school curricula, we at SeasonWatch (www.seasonwatch.in) set out to understand how educators perceive climate change and whether they found it necessary to communicate the same to their students. To this end, we conducted a teachers' survey in 2021. Most of the 191 survey respondents acknowledged the effects of climate change on the environment and also shared their own lived experiences of climatic change. Many of the teachers felt that their students, though aware of climate change as a phenomenon, were unable to relate to such a large-scale process in their own immediate surroundings. We then collaborated with a volunteer group of teachers to develop this resource - which integrates local environmental examples into existing school curricula, ensuring that students can relate to and understand the impacts of climate change in their own communities.

We believe that a deep understanding of one's own environment, with a connectivity to biodiversity, local geography, and culture will bring about a sense of ownership, awareness, resilience, and action. We hope this resource book will enable teachers to talk about climate change to students by observing and documenting the changes that are taking place around them.



How to use this resource?

Climate change directly impacts the seasonality of the environment and living beings around us. Observing and documenting this seasonality can be a great way to understand change, and preparing for it in a way that is not damaging for children's well-being. This resource contains activities to document the seasonality of biodiversity, weather, water, food, and soil.

This resource is primarily intended for school teachers of classes 6-12. Teachers can review the activity list and select those that are most aligned with their academic calendar. This resource can also be utilized by educators from alternative schools, parents involved in homeschooling, as well as nature educators.

Each activity includes the following sections -
Overview: A brief introduction to the concept that will be explored through the activity
Age Group: The appropriate age group or class for which the activity is designed.
Period of Activity: Many activities can be conducted throughout the year, while some are seasonal, occurring in specific months. This section suggests a suitable time/season in the year to conduct the activity
Learning Objective: What a child is expected to learn at the end of the activity
Detailed Activity: Step-by-step instructions for educators to conduct the activity with children.
Curricular Links: Some activities in this resource can be used as supplementary/practical for chapters/topics in school text books. This section contains suggested connects between the state and central board curricula and the activity, for school teachers.
Discussion: Guides/prompts/questions for educators to discuss with children post-activity. Typically the relationship of a local phenomenon with climate change will emerge at the end of discussions based on these prompts. .
Local/Cultural References: References to local culture that make the activity more place-based, and relatable for children.
Resources: Additional information or links for teachers to explore, self-learn, or share with children

Addressing climate anxiety

We all remember the apprehension we went through as individuals and as a society during the COVID-19 pandemic. Climate change is a global issue that we now have to face as a society, that too without immediate, universally generalisable, or easy solutions. While it is important and necessary to address climate change and its effects, it is equally important to consider the mental well-being of the child learning about climate change.

Information on climate change can evoke a sense of fear, grief, and anxiety among children who have experienced natural disasters in the past. Research has shown that students who have had no experience of natural calamities also develop climate anxiety with increasing media coverage on climate change. Since climate change is a future-oriented anxiety, people tend to adapt and adjust to the changing environment. However, when individuals are unable to adapt and are in a constant state of worry, it affects their mental well-being. Some individuals are likely to experience more fear and anxiety than others due to their lived experiences.

Teachers should ensure that climate change-related topics are conveyed in a sensitive manner, ensuring that:

- Facts and information are **age-appropriate**.
- They **avoid being overly pessimistic about the future** and instead **provide hope**
- They **validate children's emotional state** by inquiring about their feelings

It is important to keep in mind both individual well-being and the efforts we engage in to mitigate climate change for societal well-being.

Connect to nature

- Go outdoors on a clear day when it is pleasant to sit in the shade of a tree
- Close your eyes and breathe deeply, count to 10
- With your eyes closed, recall a vivid memory connected to nature from your childhood
- Remember with your senses - what colours, smells, textures, tastes, or sounds of nature made that memory special
- Write this memory down, or make a drawing about it, or share it with another person, or simply relive it at that moment!
- Notice what you feel when you think about these memories

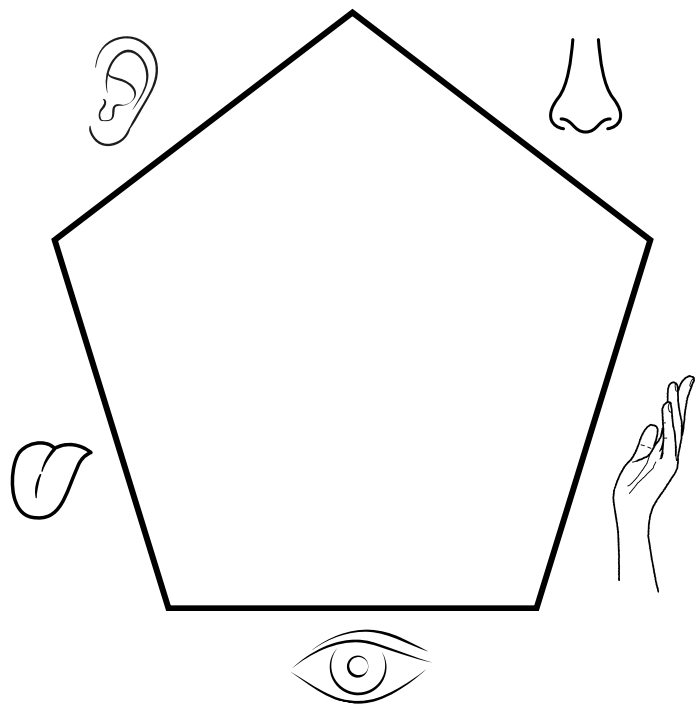
Going outdoors

Overview

If you are unfamiliar with going outdoors and exploring the natural world, your first experience taking children out can be overwhelming. Try beginning your explorations with the two **sensory activities** given here, either by yourself, with a colleague, a family member. These activities help to orient our senses to our environment, and have no bigger learning goal other than to experience nature fully! Once you are comfortable with the outdoors, do the activity given below to orient students.

Make a sensory map of your surroundings

Go outdoors on a pleasant day, and walk for 10 minutes in your surroundings **where it is safe**. Observe the world with all your senses - sight, sound, smell, taste, touch. In the space below, write or draw the things that stimulated each sense on your walk. Feel free to use another sheet of paper/journal/notebook if you think you need more space to express yourself.



Biodiversity

All living beings (together known as 'biodiversity') respond to the seasons - it is after all, a very reliable indicator of what is a good time to grow, when food will be available, or what is a good time to breed. And all living beings, just like humans, know about seasons through local weather - how hot or cold it is, how rainy or windy, how dry or humid.

Climate change is affecting these weather patterns - summers are becoming longer; extremely hot, cold or rainy days occur more often now; and the monsoon season has become even more unpredictable than before.

What happens to trees, birds, and insects when weather changes? Biodiversity responds to changing climate by changing their own behaviour. Trees may be flowering earlier than before, insects and birds may be migrating at a different time than before.

This section has activities on observing the year-round or specific seasonal behaviour of living beings. Engaging in these activities will help students explore the interconnectedness of biodiversity and the physical environment. Let's start with the very important friendship between plants and insects, and how climate affects them.

Flowering, pollination, & climate change

Pollinators are organisms that perform the very important function of transferring pollen between plants, so that seeds can form. Plants use flowers to attract these pollinators through colour, scent, shape, and form.

Insects are great pollinators! Nearly one third of the world's plants are pollinated by insects, and of these, bees are especially important. Changing climate is affecting the flowering patterns of many trees, and this can lead to a **timing mismatch** between insects and flowers.

For example, if a forest tree that usually flowers in April blooms earlier in March, the bees that are adapted to foraging in April may not get any nectar. How do you think this will affect the food chain? There may be a decline in insect populations, and eventually low food production for people, because many crop plants that we consume are also pollinated by insects. When some insects pollinate only very specific species, these changes may be especially damaging to plants, pollinators, and people.

The following activity helps children understand the close relationship between plants, insects, and climate, and why it matters to humans.

Flowering & pollination

Class/Grade
6-12

Activity
Outdoor -3 days (10 min a day)
Indoor (1 class hour for discussion)

Period of activity
Any time of the year

Materials Needed
Pen/Pencil, a notebook, a stopwatch

Curricular links
NCERT
- Class 12 Biology , Chapter 2 Sexual reproduction in flowering plants
- Class 12 Biology, Chapter 9 Strategies for enhancement in food production

Overview
Students will examine a flower or inflorescence and observe the pollinators that interact with them. They will note the characteristics of these pollinators, including their shape, size, and species. Through discussion, students will explore the significance of pollinators and the vital role of pollination in ecosystems. Additionally, they will engage in discussion concerning honey gathering.

Learning Objective
Observe and document the organisms that visit a flower and understand their role in pollination, food chain, and human livelihoods; infer impacts of climate change on pollination ecology through discussion

Detailed Activity
- Start with a discussion on what are seeds, how they are formed, and the role of animals in this process
- Some common animal visitors and pollinators of plants are given on page 6 and 7 - share this information with students
- Ask students to find a flowering plant in their school or home. Students should then select flowers to observe, making sure that they are close to their eye-level or at a lower level, for ease of observation
- Students should stand at a distance of 1m or more from the plant and observe an open flower for ten minutes everyday for **three consecutive days**, and note all the animals that come to the flower in the observation sheet on page 8. Provide each student with a copy of the observation sheet.
- Ask students to answer Q 1-5, then create a minute-by-minute activity log for insects on their flower as given in Q6, then answer the next set of questions

Three major honey bee species found in India

Apis dorsata or Rock Bee

Rock Bee hive
Constructs single comb

Apis cerana indica or Indian Honey Bee

Indian Honey Bee hive
Constructs multiple parallel combs

Apis florea or Little Bee/Red dwarf honey bee

Little Bee hive

Other pollinators

Purple rumped Sunbird

Indian flying Fox

Three-striped Palm Squirrel

Blue Tiger Butterfly

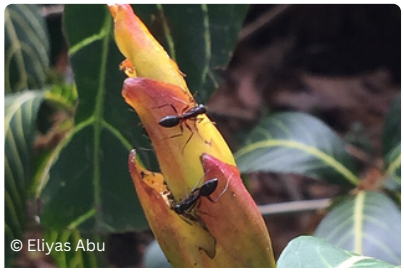
Carpenter Bee

Blue-banded Bee

Common Mormon Butterfly

Baccha Hoverfly

Grey Langur



Ants

Hummingbird hawk moth

Flies

Observation sheet

Date:..... **Day(1/2/3)**.....

Start Time:..... **End time:** .....

Weather: Sunny/rainy/cloudy/windy

1. **Name of tree/plant** .....
2. **Colour of flower petals**.....
3. **Can you see the pollen grains in the flower (tick yes or no)? Yes.....No.....**
4. **What colour is the pollen grain?**.....
5. **Does your flower have a smell? Describe it**

   .....

   .....
6. **List down all the insects/other animals that visit the flower at the time of observation (bees, wasps, ants, butterflies, moths, birds, squirrels, monkeys)? Note it down in this activity log below (the first row is filled in as an example) -**

SNo.	Time	Activity
1	10:00	2 bees hovering, 7 ants seen, one of bee sitting on flower
2	10:01	
3	10:02	
4	10:03	
5	10:04	
6	10:05	
7	10:06	
8	10:07	
9	10:08	
10	10:09	

<u>After filling this log, answer the following questions -</u>

1. **Did you see bees carrying pollen grains (tick yes or no) ? Yes.....No.....**
2. **Do all insects that visit the plant carry pollen grains (tick yes or no)? Yes.....No.....**
3. **On which part of the bees/insects are the pollen grains seen?**.....
4. **Do you think the bees also visited adjacent flowers (tick yes or no)? Yes.....No.....**
5. **Did you see any other animals feeding on the flowers (tick yes or no)? Yes.....No.....**
6. **Could you identify any of the insect species ? Write their names here**.....
7. **Could you identify any of the bee species ? Write their names here**.....
8. **Draw a picture of the flower you observed and visitors to the flower, on the blank side of this sheet**

Note to teachers

For resources and materials that can support your classroom discussions on this topic click on the links below:

- *Types of honey bees in India:*
- *Bee flora and pollination of crops*

Discussion

Here are some questions you could ask students during the discussion (feel free to add your own depending on the learning goals):

- What insects/animals came to the flowers observed by students? What did they do on the flowers?
- What did students feel while doing this activity?
- How is pollination important in the food chain? What would happen to food production if insects were not there for pollination?
- What if there were no flowering trees/plants in your area?
- What does pollen contain and why do bees need them?
- What is nectar?
- What qualities do bees have that make them good pollinators? (E.g body covered with hair, body size and tongue length, does not injure plants, can easily carry nectar and pollen)
- What will happen to pollinators if plants and trees start flowering at unusual times? Do you know if this is happening in your locality?
- How does unseasonal rain affect flowering in trees? Do you know if this is happening in your locality?
- What will happen to bees and other insects if it becomes too hot due to climate change?
- Are some insect populations declining? What can we do to revive them?

Other activities

Watch this short movie on wild honey gathering. Discuss the risks involved for people who depend on wild honey collection for their livelihood, and the dependence on seasonal flowering trees for the honey bee populations.

- Honey hunters vs bees vs tigers,

Pollinators in our culture

Pollinators like bees make honey that is stored in beehives. Honey is an important seasonal food source for people, and fewer bees means lesser honey!

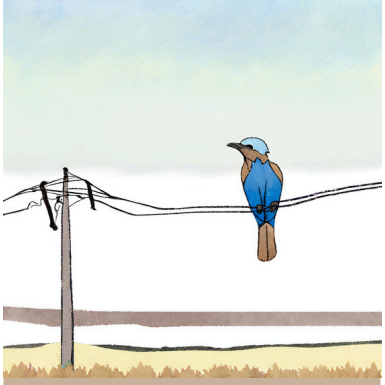
In the Sundarbans of West Bengal and Nilgiris in Tamil Nadu, honey is typically collected from forests during April, May and June. Do you know when honey is gathered in your region? How do you use honey in your meals, and on what occasions?

Birds & climate change

Birds are constantly adapting to the changing climate. Every aspect of a bird's life depends on seasons — from the right seasons for breeding, migrating, nesting, and egg-laying, to the availability of food. Changing weather patterns the world over are altering these bird behaviours.

Birds migrating from colder temperate regions to tropical regions in winter is a well known phenomenon and each species follows a regular path to arrive at warmer breeding or feeding sites. In recent years, scientists have found that birds' migratory pathways are shifting due to changes in temperature along the route, or due to loss of suitable habitats. Birds also discontinue their journey, or stop abruptly if they find unfavourable conditions along their migration route - affecting their breeding, and eventually their populations. Biological events such as flowering, insect emergence, and prey availability that are affected by climate change also have an impact on bird populations.

In the activities listed below, students will observe birds to understand about about migration, their habitats, and the interdependence of species within ecosystems.



Birds of all seasons

Class/Grade
6-12

Activity
Outdoor (once a week)
Indoor (1 class hour for discussion)

Period of Activity
June - March

Materials Needed
Field guides, pencil/pen, notebook, binoculars (if available)

Curricular links
NCERT

- Class 12 Biology , Chapter 2 Sexual reproduction in flowering plants
- Class 12 Biology, Chapter 9 Strategies for enhancement in food production

Overview
Students will observe and document the bird communities in their school campus. They will monitor and record different bird species and their behaviours. They will also discuss about migration of bird species, and examine the potential impacts of climate change on this phenomenon.

Learning Objective
Know more about the birds in your vicinity along with their typical behaviours.

Detailed Activity
- Introduce students to some common birds of your region. This can be done by going birding with your students for a few sessions within your school campus or nearby, and familiarise them with common local birds
- Make use of a bird pocket guide (e.g. Early Bird regional pocket guides: https://www.early-bird.in/)
- Select a few spots within your school campus where it is convenient to observe birds.
- Divide the class into four or five groups.
- Each group should visit selected spots every week for 20-30 mins, and make a note of the different birds that are present. Encourage students to draw the bird if they are unable to identify it, and note down its colour, size and shape and get it identified by an expert at a later stage.
- Identification of birds by name is not essential. What matters more is observing birds carefully, as this helps students understand how different species behave.
- Familiarise students with common behaviours of birds- they call, eat, prey on other animals, build nests etc. During the post-activity session ask students to remember and recall any bird calls they heard during the activity

- Ask students to fill the observation sheet below every week between June (monsoon) and March (spring/summer). The first row is filled as an example. Add as many more rows as required for every week, or copy this format onto a notebook with a fresh page every week.
- OPTIONAL: You can choose to register on the citizen science portal of eBird (ebird.org/home) to upload your bird observations. eBird also hosts an interactive visualization page (science.ebird.org/en/status-and-trends) through which migration and seasonality can be easily tracked .

Observation Sheet
Date: _____ Day: _____ Time:_____ Week: 1
Weather_____

S.No	Bird species	Numbers	Behaviours
1	Jungle crow	2	Building nest, feeding chicks

Add more rows as needed

Discussion

- Are some bird species seen throughout the year? What are these species?
- What birds did you see only during a particular season?
- From the list of birds that visited the school, were any of them migratory? (Make use of the explore page in eBird, to look at the seasonality of birds visiting your area)
- How do seasons change?
- Why do you think birds migrate? How do birds migrate? Do they travel in one go or make stops? How do they remember their migratory pathways?
- What factors affect the birds making a safe journey during migration. Birds forage a lot during the migratory season, what happens if they do not find enough food?
- How does the timing of seasons affect the food availability for birds? What will happen if the seasons change and become longer/shorter/more unpredictable?

Resources

Click the links below to open the resource

- Early Bird contains wonderful resources to introduce children to birds including pocket guides, games, posters, interactive multimedia and activities
- Climate change and bird migration

Birds in our culture

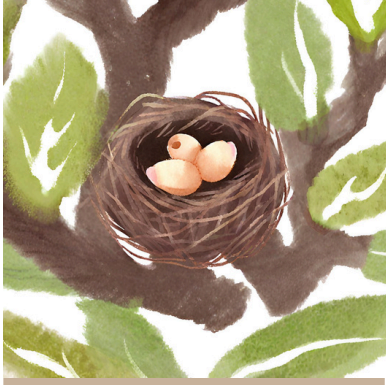
Humans have been fascinated by the magical ability of birds to fly since time immemorial. Birds have featured in our culture for centuries, just like the following account of bird migration in ancient Tamil verses from the Sangam period (2300-700 CE).

Sangam literature songs describe the way of life of people during those times and the poems reflect how deeply interconnected they were with nature, often comparing various aspects of life to the natural world around them. They also describe the habits and habitats of the wildlife they observed. One such poem is "Narai Vidu Thoothu" (Message through the migratory bird White Stork), written by Sathi Muthu Pulavar.

"*Narai, Narai, Sengal Narai*" —
Oh stork, with your beautiful red legs,
your beak sharp like a splitten tuber of the palm —
as you journey south with your mate,
to the southern shores of Kanyakumari,
and when you return northward,
stop by my village of Sathi Mutthu, which has a lake
With a house whose walls and roof are damp with rain,
please pass a message to my wife:
Tell her I am here to meet my king, Maran Valuthi.
Tell her I have grown lean from the chill of the northern winds,
and I lie coiled like a snake, shivering in this cold weather.

-SathiMuthupulavar, song from Purananooru

Do you know of any poems or folk songs that talk about birds?



Nesting behaviour of birds

Overview

In this exercise, students will observe a bird's nesting site, its location, the materials utilised for nest construction, the timing involved in nest building, and the seasonal aspects of nesting behaviour. Through group discussion, students can explore the potential impacts of climate change on bird nesting behaviours.

Learning Objective

Observe the different materials, locations and seasonality of bird nests

Detailed Activity

Activity 1

- Begin by giving students examples of different kinds of bird nests. Freely available images can be downloaded from the internet and shown to students.
- On a weekend, ask students to list down the nests they observe around their home. Nests could be in tree tops, under window slabs, in a shrub, hanging on the twigs, a tree hole, a folded leaf or even on the ground depending on the species.
- Ask students to use a paper/notebook to mark the locations of bird nests that they spot and create a map of nest locations around their homes.
- From a safe distance, ask them to observe and note the type of materials used in the making of the nest (twigs, leaf, straw, sponge like soft materials) and fill the observation sheet on page 16. The first row is filled in as an example

Class/Grade
6-8

Activity
Outdoor (on a weekend)
Indoor (1 class hour for discussion)

Period of Activity
Any time of the year

Materials Needed
Field guides, pencil/pen, notebook, binoculars (if available)

Notes to teachers
Some birds might perceive our presence near the nest as a threat, and could abandon or relocate their nesting site. Therefore, it's advised for students to avoid approaching nests too close and keep a safe distance from nesting areas while observing them.

Curricular links
NCERT
Class 7, Social studies -Our home, social studies

Observation sheet

Date: _____ Day: _____ Time:_____ Weather_____

SNo	Nest	Twigs	Leaves	Straw	Man-made materials	others
1	*Crow nest*	*yes*	*no*	*no*	*Cloth, wire, aluminium hanger*	*Fluffy seeds, tree holes*

Resources

Click the links below to open the resource

- How birds defend their nests
- Nest building in a changing climate

Activity 2

If your students find a bird actively building a nest in their locality, (eg tailor bird, woodpeckers, coppersmith barbets, bulbuls etc), they can be encouraged to monitor bird behaviour whenever possible. Especially, observation on how long it takes to build the nest, whether it is done in pairs or by the male/female bird individually, where the birds are sourcing the raw material etc.

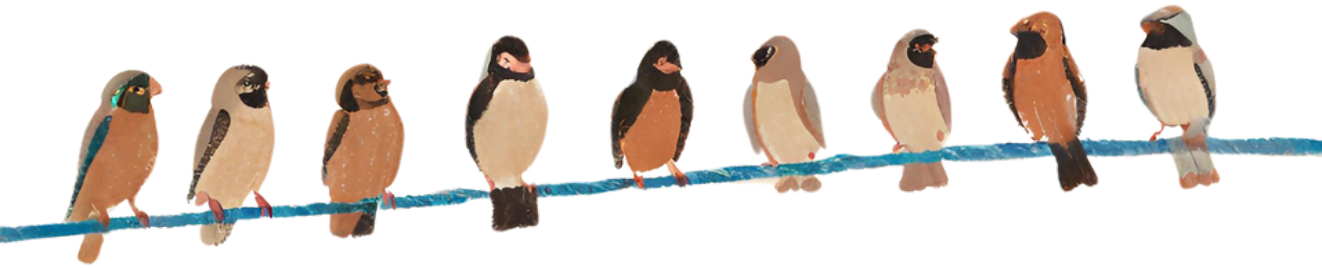
Discussion

- Why do different birds have different ways of building nests?
- How do birds collect different materials for the nest?
- What techniques do birds use to protect their nests from predators?
- What factors could affect bird nests and successful fledging?
- What happens when there is unseasonal weather like extremely heavy rainfall or wind and how does it affect the nests or bird chicks?

- What will happen if the timing of nesting does not match with the availability of food (like insects, fruits and nectar)?
- What can cause lots of birds to nest in a small area? How will it affect the birds?

Nesting birds in our culture

Hornbills are a group of large birds that mostly eat fruits. They have fascinating nesting behaviour, where the male bird seals in the female bird along with nestlings in a nest cavity till the chicks fledge. In this duration, the male bird feeds the female bird and nestlings. The bird and its nesting are both so fascinating! In North Eastern India, the Great Hornbill is facing threats due to habitat loss and climate change. You can read about the indigineous Nyishi tribe and their quest to save the hornbills to understand the intimate connection that people have with nature in this landscape



Trees through the seasons

Trees play a crucial role in the ecosystem, with their most captivating feature being their transformation throughout the seasons. While some trees look different in different seasons, others, like evergreen trees, maintain their appearance year-round. The study of the seasonal cycle of change in trees, the emergence of new leaves, flowering, and fruiting, is known as phenology. Tree phenology changes according to the weather and any climate change can affect this seasonal tree behaviour. Changes in tree phenology can affect organisms like pollinators, whose life cycles depend on the timing of tree flowering. What animals visit a tree in any season will depend on what services a tree is providing animals at that time. One can expect different kinds of animal visitors to a tree in different seasons.

SeasonWatch is a citizen science project that tracks tree seasonality across India (more details on the website - www.seasonwatch.in), and is a hands-on way of introducing children to changes in biodiversity through the year

Visitors to a tree

Overview

Students will engage in observing trees and the organisms that frequent them. Students will try to observe how certain organisms rely on specific phenological aspects of a tree and understand plant-animal interaction

Learning Objective:

Understanding what animals depend on the different seasonal phases of trees

Detailed Activity:

- Familiarise yourself with the SeasonWatch activity by visiting the project website and watching tutorials
- Select one or more trees from the SeasonWatch list of species that are found in your school campus. Register the tree(s) with SeasonWatch. Assign 2-5 students to monitor each tree.
- Ask students to visit their tree every week and make observations on leaf, flower, fruit quantity on trees using the SeasonWatch app or observation sheets. As and when possible, the data on the observation sheets can be uploaded on the project website
- In a separate notebook, ask students to note down the date, and make a list of all animals that they can see on the tree (this includes insects, birds, reptiles, and mammals). These observations should be made on the same day as the tree observations.
- Ask students to note what each animal was doing - perching, running up and down, building a nest etc. Cattle or goats grazing under the tree or feeding on the fruits from the tree can also be recorded. Ask students to pay special attention to the relationship between animal behaviour and tree phases - leaves, flowers, and fruits, and record these.
- If possible, animals can be identified with the help of an expert or field guides, but this is not important. Ask students to give their own names for the animals they observe.

Class/Grade

6-9

Activity

Outdoor (20 min-once a week)
Indoor (1 class hour for discussion)

Period of Activity

Year-round

Materials Needed

A smart phone with the SeasonWatch app if available or a note book and an observation sheet, pen or pencils, binoculars (if available)

Notes to teachers

Introduce the class to SeasonWatch and talk about the importance of observing seasonal variations in trees.

Curricular links

NCERT
Class 12 Biology, Chapter 9 Strategies for enhancement in food production

Resources

Click the links below to open the resource

- seasonwatch.in
- How to SeasonWatch
- Why trees are essential for Animal habitats

Discussion

At the end of 1 year, ask the groups to make a presentation (a video, journal, play, essay) on their tree specifically highlighting seasonal changes on the tree and in the animals that use the tree. Conduct a Q/A session with discussion suggestions given below:

- Which animals visited your tree and why do you think they had to visit the tree?
- Are leaves of trees important for animals? how does seasonal falling of leaves affect animals?
- How does a tree benefit from its visitors?
- What will happen to leaves, flowers and fruits on a tree if the summer season becomes hotter or less rain falls during the monsoon?
- During the flowering season, if there is unseasonal that affects the fruiting of the tree leading to low yields, how will it affect the animal visitors to your tree?
- If the tree lacks the necessary resources (fruits/flowers/leaves), do visiting animals have alternative options?
- Do you think animals will fight for food and space when there are only a few good trees in a given area?

Trees in our culture

*The Flame of the Forest (*Butea monosperma*), or Palash tree, is commonly found in arid regions, preferring rocky areas, sandy soils, and a dry terrain. The tree blooms in March, producing striking flowers, the flowers have traditionally been used as a natural dye for the Holi festival. In Maharashtra, the flowers are used to prepare a cooling sharbat, though this practice is no longer common. In southern Chhattisgarh, fresh leaves are placed on the head and secured with a scarf before going out in the sun. Similarly, in Gujarat, the flowers are collected, packed in a cotton sack, and placed under a running tap. The water that flows through is considered a coolant and is used for bathing. Read more here 'Flame that cools'*

Do you know of any tree in your community that is used in a similar way?

Invasive Plants

An invasive species is a non-native organism (plant, animal, or microorganism) introduced by humans into a new ecosystem where they can have adverse ecological and economic impacts. Some of the mst well-known invasive species are plants For example, *Lantana camara* is a tropical American plant that was introduced to India 200 years ago as a garden ornamental, but has since then become a huge problem in urban, rural, and forest areas of India, reducing native plant diversity, changing soil and water, and causing economic losses to people.

Climate change is likely to make the impacts of invasive plants on native species and ecosystems worse than what it is! With warming temperatures, some invasive species will be able to spread and survive in newer regions. Some invasive plants benefit from warmer temperatures and grow more vigorously, outcompeting native vegetation that are less tolerant to changing temperatures.
Invasive plants can reduce agricultural productivity, degrade ecosystem services, and even cause loss of biodiversity.

Teachers can use this activity to supplement curricular topics on habitat loss, climate change, seed dispersal, farming practices, interdependence of species.. Students will learn to recognise invasive plants and identify problems associated with invasive species.

Invasive plants

Class/Grade
6-12

Activity
Outdoor (Half a day)
Indoor (2 class hours for discussion)

Period of Activity
Any time of the year

Materials Needed
Note book, A4 size sheet, pen/pencil , colours

Curricular links
NCERT Class 12, Biology- Chapter 15 Biodiversity and Conservation
Class 12, Ecology- Chapter 10 Organisms and Population Resources

Overview

In this activity, students will learn to identify invasive plants from their surroundings. They will observe and document the characteristics of both invasive and native plants and discuss the implications climate change may have on the further spread of invasive species

Learning Objective

Identify and document invasive plant species in your locality and learn their impact on local biodiversity

Detailed Activity

- Familiarise yourself with invasive plants present in your region using the provided link (http://nbaindia.org/uploaded/pdf/Iaslist.pdf). You can also look at the book 'Guests who never left' which describes some common invasive plants of Peninsular India. Try identifying specific invasive plants located near your school premises and designate a plot for conducting taking students outside the activity.
- In the class, introduce students to invasive plants- explaining their origin and why they are labelled 'invasive'.
- Show the students photographs of invasive plants found in your locality (the species provided on Page 24 are likely to be found in nearly all habitats). Find out if they are familiar with any of the plants/can identify them/ know where they grow and know their local names.
- Choose a site close to your school, maybe an empty plot or a stretch of area next to the road, that has overgrown vegetation and contains some invasive plants. This will be where you take your students for field observation of invasive plants

- Take your students to the study plot and show them the different plants growing there. Together try to distinguish between the invasive plants and other native plants. If unable to identify certain plants, collect samples or take photographs for later identification with the assistance of a plant enthusiast. It is not mandatory to identify every plant, the aim of this exercise is to illustrate to students the widespread distribution of invasive plants in our landscape.
- Count the number of invasive plants in each plot, if difficult, assess the spread of each type of invasive plant (as percentage) on the study plot and note it in an observation table, like the example provided below
- Observe the characteristics of the plants, such as leaf type, presence of thorns, whether they are creepers or shrubs. Note the kind of flowers, fruits, and seeds produced by these plants, and look for undergrowth below these plants.
- Ask students to create a map showing the location and size of invasive plants in the plot, similar to the example provided on Page 25
- After returning to class, facilitate a discussion among students about invasive plants.

Observation sheet

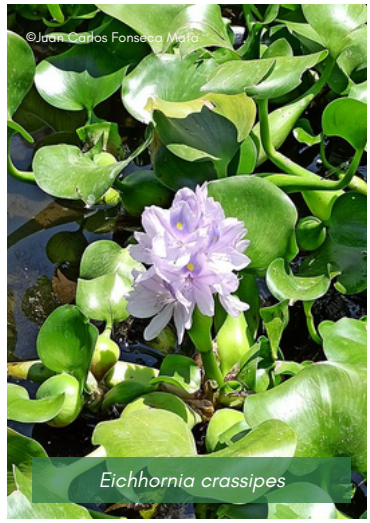
Date: -_____

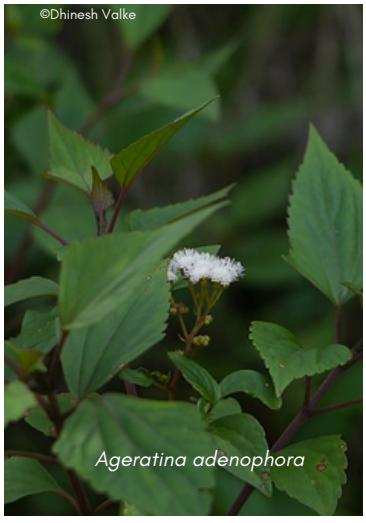
S.No	Species	No of plants/Percentage	Characteristics
1	*Prosopis julifora*	*30*	*Thorny, seed pods - yellow in colour*

(Add more rows as needed)

Note any other observation: _____
_____

Common invasive plants





Invasive species along a stream bed

An example of mapping invasive species in your locality. Green patches are invasive species in the plot

Discussion

- In the plot you observed, how many different invasive plant species did you observe?
- Did you observe any bird/insect/animal visiting or feeding from the invasive plant?
- What percentage of the plot was occupied by invasive plants?
- How did invasive species in your plot arrive in the country, and reach your region?
- Why do you think they are able to survive in new environments?
- When one plant species dominates a space and suppresses the growth of other local vegetation, in what way will it affect local biodiversity? - (you can give example of how butterflies and moths depend on specific host plants to lay their eggs, and the leaves of the host plants are larval food. When native host species are replaced by invasive plants, what can happen to these moths and butterflies?)
- When some invasive species are able to survive in high temperatures, what do you think global temperature rise could contribute to the spread of invasive species? How will it affect local biodiversity and landscapes in the future?
- What can we do to mitigate the spread of invasive plant species?

Resources

Click the links below to open the resource

- What are invasive plants
- Invasive Alien species of India
- Invasive species, A handbook
- Guests who never left
- Invasive species are blooming in India despite climate change
- Invasive pest fact sheet- Parthenium hysterophorus
- Invasive pest fact sheet: Lantana camara
- Invasive plant species threaten 66% of India's natural systems

Invasive species in our culture

*'In the lean months of the south west monsoon (June-August) in Kerala, the intense downpour kept people indoors and farming activities remained dormant. During this period, meals were simple, with fresh greens from the surroundings and native snails collected from paddy fields were cooked and eaten as a delicacy. Now the fields are infested with the African giant snails (*Achatina achatina*) which have taken over the land, these snails are not consumable and moreover do not have natural predators. They easily multiply and proliferate during monsoon, leaving a trail of destruction on crops and other native plants'- as recounted by a school teacher from Kerala.*

Have you seen African Giant Snails in your locality? You can read more about them here - The News Minute, 16 Nov, 2021, Spotting Giant African Snails everywhere in Chennai post rains? Here's why

Do you know of similar examples from your region, share them with us at sw@seasonwatch.in !

Butterfly migration

The migration of milkweed butterflies in Peninsular India, though less studied than the Monarch butterflies of North America, is a fascinating annual event involving around 10 species (mostly Dark Blue tiger and Common crow butterflies). It happens twice a year, once in April-May and again after the monsoonal rains in September-October. The Danaid butterflies moves from the Western Ghats towards the Eastern Ghats in April-May and the reverse happens in October when the North East monsoon picks up and the butterflies move towards western ghats.The reason for this migration remains unclear but is a remarkable spectacle. Similarly, few other butterfly species are found to make local migrations in other parts of India (Kashmir, Arunachal Pradesh). Climate change threatens this phenomenon by disrupting the seasonal events, potentially affecting the synchronized interaction between plants and butterfly that are crucial for migration.

Teachers can make use of this activity to understand animal movement and migration, life cycle of butterflies and plant- animal interaction. Through this activity students will be able to learn to identify butterflies, make systematic observations and have an outdoor learning experience.

Tigers and Crows Fly

Overview

In this activity, students will observe the seasonal migration patterns of Danainae butterflies and explore the factors influencing their movement, as well as discuss factors potentially impacting their population. This activity is suitable for peninsular India only, where such migration is known to occur.

Learning Objective

Understanding the seasonal migration of the Danainae butterflies in Peninsular India.

Detailed Activity

- Begin by introducing children to butterfly migration – one of the best known examples of this is the migration of the Monarch butterfly journeying from Canada to Mexico.
- Engage students by asking if they have witnessed significant butterfly movements around them during the year. Then familiarize students with the Danaine butterfly migration in Southern India by showing images of the six major species involved in the migration (Page 29).
- Designate three locations within the school campus where butterfly movement can be readily observed. Divide students into three groups, assigning each group to a different location.
- Butterfly activity has to be observed within 'belts' of 3 x 10 meters and the direction of movement has to be noted using a compass
- Ask students to visit their locations daily during the migration season. Students can observe flying butterflies during morning break (10-11 am), afternoon break (12-2 pm), and possibly during the evening break (3-5 pm), each session lasting approximately 10-15 minutes.
- During an observation session, each group will, a) group and count butterflies as 'Blue' Tigers, Crows, or 'Orange' Tigers within the observation plot, b) record the direction of movement and note it in the observation sheet as the shown on Page 29 (first row filled as an example)

Class/Grade

6-12

Activity

Outdoor (3 months)
Indoor (1 class hour)

Period of Activity

April-May & September-October-November in Peninsular India

Materials Needed

Notebook-pen, stop-watch/timer, compass

Curricular links

NCERT
Class 10, Science, Chapter 15 'Our environment'
Class 12, Geography, Chapter 2- 'Migration'

Danainae butterfly species that migrate seasonally in Peninsular India

Tirumala septentrionis

Tirumala limniace

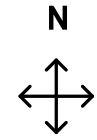
Euploea core

Euploea sylvester

Danaus chryssipus

Danaus genutia

Observation sheet

SNo.	Date	Time	 Blue tigers (Blue + Dark blue tiger	 Crows (Common + Banded crow)	 Orange tigers (Plain + striped tiger)	 Directions
1	10th April	10-10:15 am	14	0	30	⟵

Add more rows as needed

Resources

Click the links below to open the resource

- Watch-How to use a compass?
- More activities on butterflies and climate change are available here: Climate, Biodiversity and People curriculum by Palluyir trust. Butterfly and climate change module
- Scientist crack secrets of internal compass of monarch butterflies
- Butterflies of India: ifoundbutterflies.org

Background information

- Vinayan, P.A., Yathumon, M.A., Sujin, N.S. et al. Pattern and drivers of danaine butterfly migration in Southern India: implications for conservation. J Insect Conserv 27, 505-516 (2023). https://link.springer.com/article/10.1007/s10841-023-00473-z

- Times of India article, May 27, 2022 Swarm Song

- Mongabay, August 12, 2025 Why are butterflies migrating across India

Discussion

At the conclusion of the migratory season, compile the gathered information and transform it into a graph. Plot a graph with the x axis denoting the days of observation and y axis denoting the total number of butterflies observed everyday. Analyze which week had the peak movement of butterflies.

Here are some questions you could ask students during the discussion following this activity:

- From your observation, at what time of the day did you observe the highest level of activity?
- Among the three groups you observed, which group had the highest number of individuals during the migration?
- Did the butterflies fly close to the ground or high up in the air?
- Did you notice any other butterfly species other than the 6 species?
- Did you observe butterflies perching and feeding on plants?
- Why do you think butterflies migrate?
- What role do plants play in the life cycle and survival of migrating butterflies?
- What is a host-plant?
- How might delays in rainfall impact butterflies' ability to locate suitable host plants for egg laying?
- Do you believe invasive plants like *Lantana camara*, which produce abundant flowers, are beneficial for butterflies?
- What measures can be taken to preserve host plants and thereby butterflies?

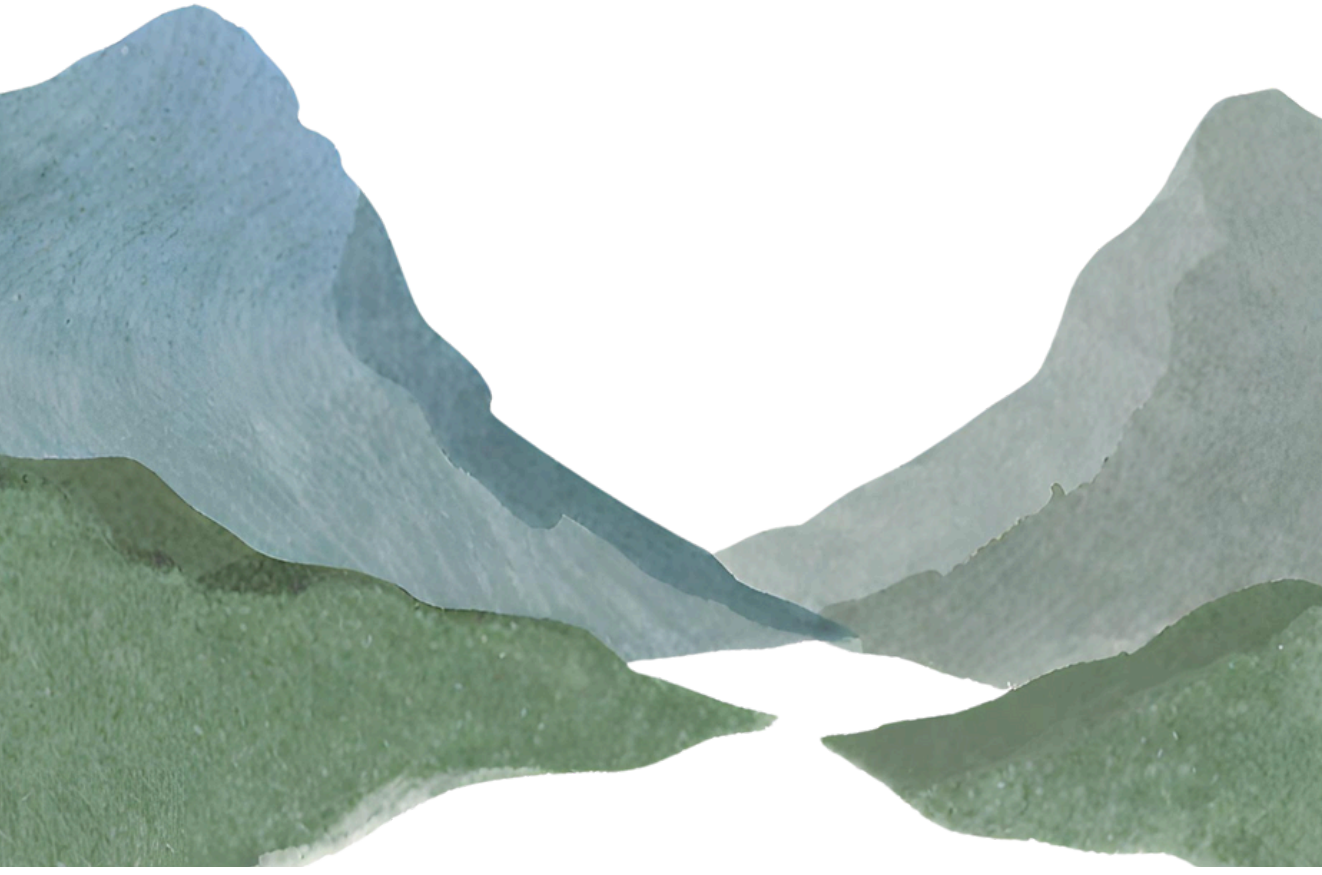
Butterflies in our culture

People in Peninsular India have long been observing the migration of butterflies and people even use it as an indicator of when it is likely to rain. Here is an excerpt from a natural history note about the same:

In June 1897, in Mumbai, E.H. Aitken observed numerous Euplaea core *(Common crow butterflies) migrating steadily northwards. Upon questioning the locals, who had witnessed this event previously, they mentioned that rain (SW monsoon) would arrive three days after the butterflies.*

-- *Aitken EH (1897) The migration of butterflies. J Bombay Nat Hist Soc 11:336–337*

Find out if locals in your area observed similar movement of butterflies?



Dragonflies & Climate change

Dragonflies are amphibious insects, that need both aquatic and terrestrial ecosystems for their survival. They are known to be very sensitive to environmental changes and serve as indicators of the health of the habitat. Different species of dragonflies have different and specific habitat requirements - some prefer forest streams, some prefer rivers, while others prefer ponds, lakes, stagnant road-side pools, or even water in tree holes! Ecologists have found that any changes to these water features can affect dragonfly populations. Climate change can affect seasonal rain, which in-turn can affect water bodies, and therefore dragonflies. Not surprisingly, dragonflies are culturally known to be the harbingers of the monsoon.

Dragon flies often emerge all-together in a season. For example, the Wandering glider (*Pantala flavescens*) dragonflies emerge and move around in large numbers after the south-west monsoon ends every year. This dragonfly undertakes the longest non-stop migratory route of any insect, from the Indian sub-continent towards the East coast of Africa!

Observing dragonfly swarms offers teachers an opportunity to integrate curricular topics such as predator-prey interactions, food chains, wetland ecosystems, and the impact of pollution on insect populations. Engaging in this outdoor learning experience allows students to witness this annual phenomenon, which might otherwise go unnoticed.

Class/Grade

8-10

Activiy

Outdoor (2 months)
Indoor (1 class hour for discussion)

Period of Activity

August-November

Materials Needed

Notebook and Pen

Curricular links

NCERT

- Class 10, Science, Chapter 15 Our environment
- NCERT Class 12, Geography, Chapter 2- 'Migration'

Spot the wanderer

Overview

The migratory phenomenon of *Pantala flavescens* (Wandering glider) from India to East Africa is a remarkable journey spanning thousands of kilometers. These dragonflies undertake this epic migration, crossing oceans and continents, in search of suitable breeding grounds. Their migration is one of the longest non-stop journeys undertaken by any insect species. Scientists speculate that favorable winds aid their journey, allowing them to cover vast distances. In this outdoor activity, students will learn to identify Wandering glider dragonflies and observe their swarming behavior. They'll record observations of habitat preferences, such as perching locations and water bodies, behaviors like rapid flight movements and territorial interactions, and gain insights into this unique seasonal migratory phenomenon.

Learning Objective

Understanding seasonal migration through the observation of a non-charismatic animal, the wandering glider dragonfly.

Detailed Activity

- Familiarise students with the dragonfly species *Pantala flavescens* (reference picture on Page 34). Inquire if they have spotted this dragonfly before.
- Discuss the amphibious nature of dragonflies, highlighting that eggs and larvae inhabit water while adults exist as terrestrial organisms. Talk about the behavior of these dragonflies which appear in swarms in large numbers in the months from August-November.
- Discuss how the monsoon is an important season - it forms the waterbodies in which dragonflies lay eggs
- Next, go outdoors daily and try to spot wandering glider swarms - they look like the picture on Page 34. Observations can be made from from August and up to November (or upon the appearance of Pantala dragonflies in their region).

Over a 15 minute observation window -

- Ask students to observe dragonfly swarms and count the number of individuals(if possible), and noting their locations (e.g., tree tops, ground level) at any time of day and record these details in a notebook.
- Students can attempt to estimate how high the swarms fly, by using reference points (e.g., as high as myself, higher than a 2m tall tree, lower than a 2 story building etc.).
- Students can also observe individual dragonflies, and document their behaviors such as rapid flight movements, feeding, egg-laying, perching on electric lines, fighting with other dragonflies etc.
- Ask students to note down if they any birds or other animals preyed upon the dragonflies
- If possible, students can be made to observe dragonflies prey on mosquitoes in the early morning and evenings using rapid flight movements.
- Make a note of the weather conditions- such as sunny, cloudy, overcast, rainy on every observation day.

Consolidation and interpretation of observations:

- Help students to identify the week(s) when most amount of swarming was seen between August and November
- Help students to figure out the highest that the swarms flew in this period.
- Encourage students to talk about some of the behavior of the wandering gliders that they observed in this period in the classroom.

Wandering glider swarm observed in Karaivetti Bird Sanctuary, Ariyalur district, Tamil Nadu on November 4th, 2014. Photo by P. Jeganathan

Resources

Click the links below to open the resource

- How the globe skimmer migrates across the Indian ocean
- Kerala: Tracking the migratory dragonflies
- Watch: An epic migration driven by water

Discussion

Here are some questions you could ask students during the discussion:

- What was the largest swarm count you observed?
- Where did you most often find dragonfly swarms?
- Did you notice them preying on other insects?
- Did you notice dragonflies flying close to the ground or very high in the air?
- How are they able to stay in flight for a long time?
- What caused such a huge number of dragonflies to emerge?
- Where are the dragonflies migrating? How do you think they will be able to travel so far?
- If the monsoonal rains were poor, how do you think it will affect the wandering gliders?
- How do dragonflies control mosquitoes? What will happen to humans if all dragonflies disappear?
- Discuss how dragonflies are sensitive to temperature and water quality, indicating the overall health of the habitat

Dragonflies in our culture

In Tamil Nadu, there's a popular saying that goes 'Thattan thala paranthal thappathu mazhai', meaning when a dragonfly flies close to the ground, then rain is imminent'

Are there any folk songs, proverbs or cultural references for dragonflies you know of from your region ?

Termite swarms

Have you noticed clouds of winged insects emerging from the ground just before it starts raining? These are swarming, social, colony-building insects called termites. They may not seem important, but these mighty little beings perform the very important job of eating up dead and decaying plant matter and recycling nutrients back to the earth. Termite swarms are also prey for a number of animals - birds, reptiles, and even feral dogs - and can result in a "feeding frenzy" from predators that can be easily observed

Termite swarms can emerge depending on what species it is, the climate, and micro-climate. In tropical regions with distinct wet and dry seasons, swarms may coincide with the onset of rains (that creates optimal soil moisture conditions), boosting termite activity and colony expansion.

Termites are ectothermic organisms - their activity and development are influenced by the external temperature. Climate change, and rise in global mean temperatures can potentially alter the timing of their emergence. Given their crucial role in ecosystem processes , climate-induced changes in termite behavior can disrupt ecosystem functions, impacting plant communities, soil health, and ecosystem services.

Class/Grade

6-9

Activity

Outdoor &
Indoor (1 class hours)

Period of Activity

During/After the rains

Materials Needed

Pen/pencil and note book

Notes to teachers

Introduce students to this activity before the rainy season, encourage them to make observations, whenever this event occurs.

Curricular links

NCERT

- Class 10, Science, Chapter 15 Our environment
- Class 12, Geography, Chapter 2- 'Migration'

A monsoon feast

Overview

In this activity students will observe a termite swarm, noting the diversity of birds, bats, and other animals attracted to it. Through careful observation, they will note down feeding behaviors, interspecies interactions, and understand the impact of rainfall on termite emergence. This hands-on experience enhances their understanding of species interactions and underscores the need for specific environmental cues for termite emergence.

Learning Objective:

Understanding the swarming behaviour of termites, and how it supports other species

Detailed Activity:

- Begin by discussing the role of termites in ecosystems and their significance, and how this can get affected by environmental changes.
- Ask students to locate a newly formed termite swarm and guide them to sit at a safe distance (at least 5m) to observe the emergence. Swarms can be easily located - many winged termites will be slowly flying out of one or two small holes in the soil and forming a visible cluster in the air
- Ask students to note down the different types and number of birds, bats, reptiles or other animals that come close to the site of emergence.
- Ask students to observe what the other animals are doing - are birds gathering termites from the ground or in flight? How long did the feeding frenzy last? How many animals visited the swarm?
- Students are not required to identify any of the animals by their names, but should be encouraged to notice their features like size, colour etc.

Resources

Click the links to open the resource below

- An observation of fauna feeding on termite alates in the tropical rainforest

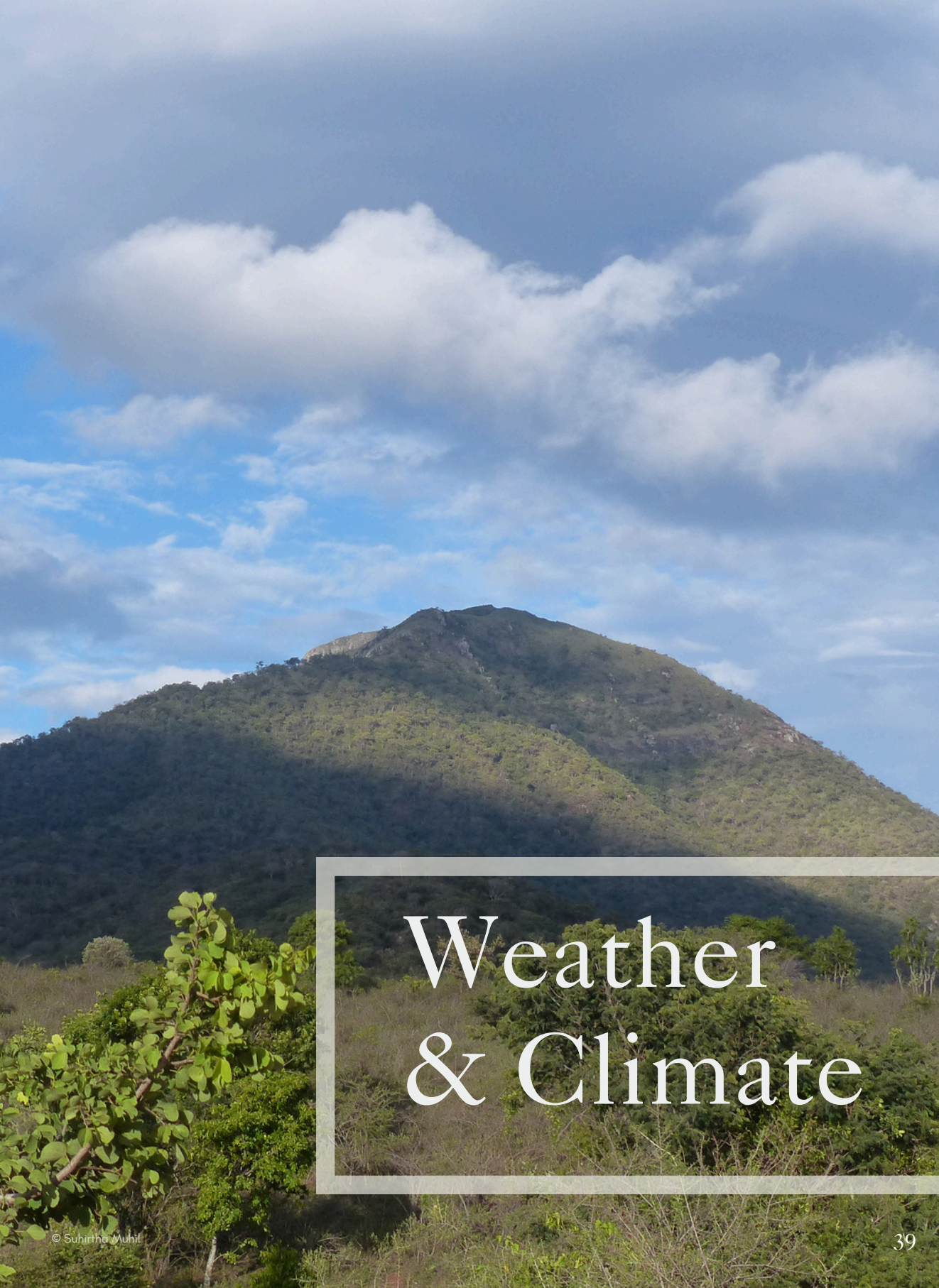
- It may be particularly interesting to note any interactions among the visiting species - like do some animals chase away others so that they can eat more termites?
- Ask students to notice the weather during and after swarm formation. Comparing this to the weather just before swarming can help understand what makes termites come out!

Discussion

- When and which season have you mostly seen termites swarms?
- What animals came to the swarm you observed? What were their behaviours that you found most interesting?
- Look up the word "alates". How does the emergence of alates during high humid weather or after the rains help termites? (helps in colonisation, termite reproduction and colony formation)
- Discuss the life cycle of termites and if all types of termites within a colony swarm?
- Why do some frugivore/granivorous birds also consume termites occasionally?
- Termites are most active in hot and humid weather. With rising temperature what do you think would happen to termite colonies?
- Do you think unseasonal rains can affect termite nests?
- How could spread of termites affect human settlements?

Termites in local ecology

How are the rains, termites, and mushrooms connected? Read about this fascinating story here - Goa's monsoon tales of mushrooms on termite hills



Weather & Climate

Weather plays a crucial role in our daily existence. Every aspect of life, from agricultural practices, to migratory patterns of birds, to the seasonal blooming of trees, all life forms are intricately linked to the seasonal changes in weather. However, climate change has disrupted many of these familiar patterns that humans and other organisms have relied upon for centuries. Unpredictable rains and temperature extremes have become increasingly common occurrences.

Weather patterns affect biodiversity and in-turn impact us humans who are dependent for our food on other living beings! It is no surprise then, that our cultural festivals and traditions often revolve around seasonal changes in the natural world.

Learning about local weather, seasons, and extreme weather events is a vital life skill for children, and something that is not fostered in classrooms anymore. Understanding weather can also be an interdisciplinary exercise across subjects like science, geography, and mathematics, and can serve as a practical/hands-on exercise for all of these subjects.

Documenting local climate

Class/Grade

6-11

Activity

Outdoor &
Indoor (2 class hours)

Period of Activity

A Rainy day

Materials Needed

Chart, pencils, colour pens and pencils, scissors, glue, cellotape, papers/notebooks

Curricular links

NCERT

- Class 7, Science, Chapter 16- 'Water a precious resource'
- Class 9, Social Science, Chapter 3- 'Drainage'
- Class 10- Geography contemporary India- 'Water resources'

Overview

Climate is the long-term weather pattern of a geographic region. Depending on where you are in India, you may experience different weather at the same time of the year. Sometimes within a geographical region too, a particular location may have a different weather pattern than its surrounding areas which could be due to the elevation, local vegetation, or topography. This local weather is slowly but constantly changing over time, and one way to know more about it is through the lived experiences of elders in the community.

Students will first create a "season chart" based on their understanding of weather, and then interview community elders to create a wholistic understanding of how contemporary weather is changing over a span of 20-30 years.

Learning Objective

Understanding changes in local weather through spoken and traditional knowledge of community elders.

Notes to teachers

The calendar created for this activity can be re-used and linked with other activities in this handbook

Detailed Activity

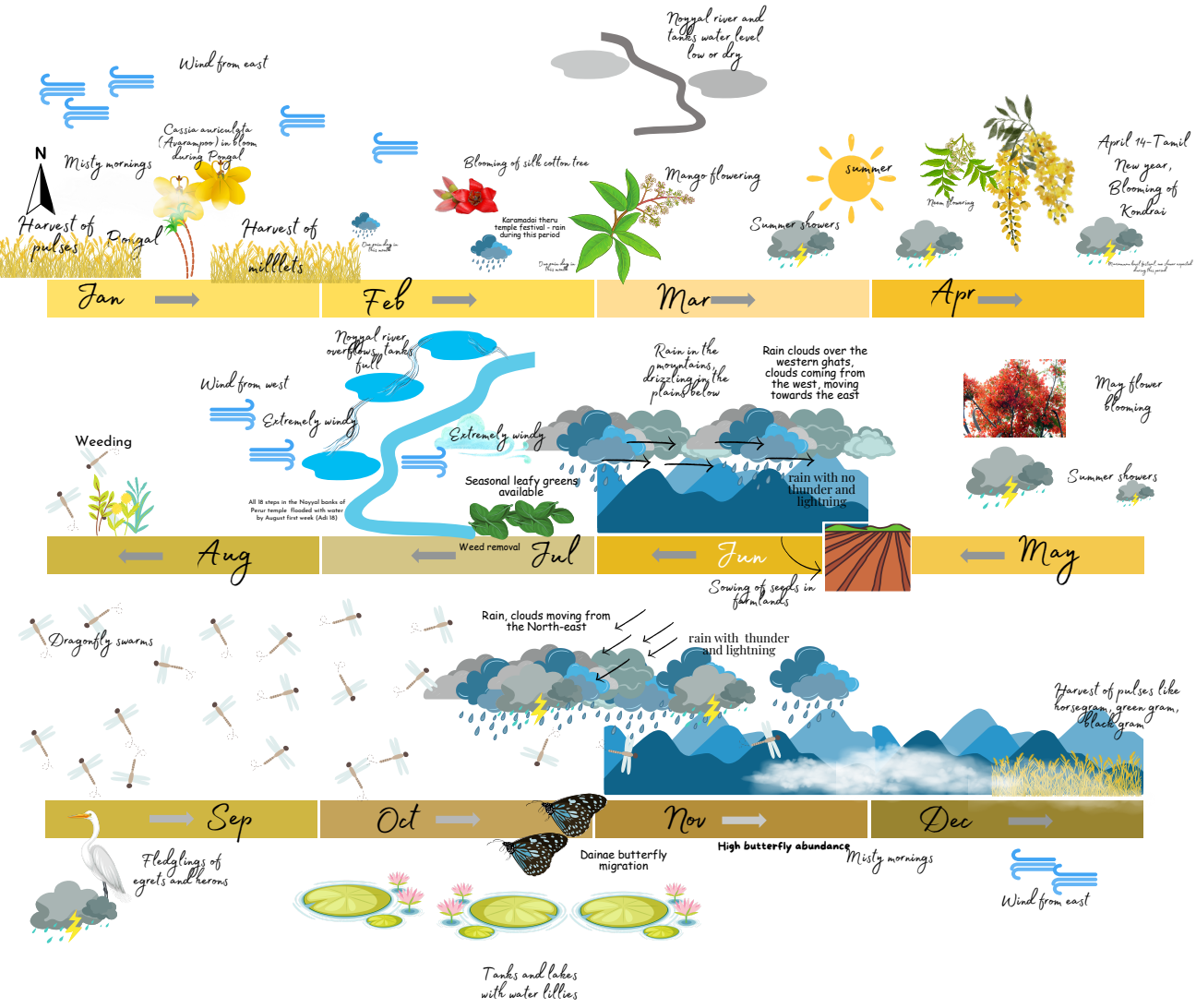
- Divide the class into five groups.
- Give each group an empty chart paper. This will be a 'Season Chart'. Ask each group to draw a line with different months of the year marked on it (see example image on Page 43).
- Ask students to note down their perception of seasons is across different months. E.g., monsoon in July, summer in May etc. (see example image on Page 43).

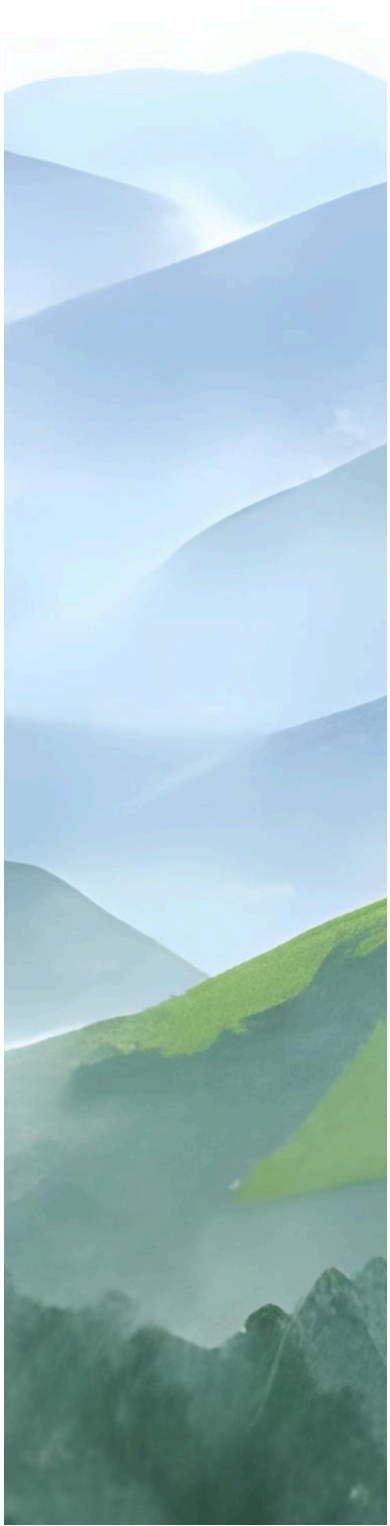
- Together with students, create a list of 10 questions that can be asked to local elders which can help understand the local climate. There is a sample list of questions provided below - you can use the same questions or make up new ones.
- Each group should survey a total of 1-3 elders (grandparents, parents, neighbours) outside of school hours over the span of one week.
- In the survey, the questions about local weather should be asked to elders, and their responses should be noted
- At the end of the survey, each group should collate and depict the answers to their questions as illustrations, poems, anecdotes, or stories on their seasonality chart.
- Ideally the timing of seasonal patterns like onset of rain, pre-monsoon showers, windy months, fruiting/flowering in plants, seasonal festivals and cultural practices, local farming practices, should emerge as observations on the chart
- Once the chart is complete, spend one class hour discussing the seasonality charts. Together, list down the biodiversity they think is dependent on a particular season and habitat, based on their survey of elders. List down human livelihoods that are season-dependent
- Display the seasonality chart prominently on the classroom bulletin board and encourage students to continuously contribute by noting observations and marking each seasonal occurrence that corresponds with the events depicted on the chart. It would be useful to revisit the chart at the end of a calendar year to see what got added after the initial activity!

Some sample questions to ask elders

- How long have you lived here?
- How many seasons are there in a year in your village/town/city?
- When does it rain here?
- The general direction of clouds when it rains?
- Is the timing of rains/summer/spring this year different from what you remember from your childhood?
- Which of our festivals coincide with the different seasons?
- Why do we celebrate these festivals at this time?
- What are some special foods in any particular season?
- Do you think these food habits have changed now, and how?
- How do you know that the season has changed?
- What changes do you see in trees with the seasons?
- What changes do you see in birds with the seasons?
- Do different animals behave differently in different seasons?

Example "Season Chart" based on real seasonal events from the westernmost part of Coimbatore city (Tamil Nadu). This should be created by filling in students personal observations, and adding any additional details from survey of community elders





Discussion

- Are there similarities and differences between what the five groups found?
- What were some of the patterns that most elders noticed?
- What is your favorite seasonal festival and food?
- Do the local seasonal patterns you documented match with what you have read in the textbook (such as spring, summer, autumn and winter)?
- What are some of the seasonal patterns that elders noted are very different now from their childhood.
- What could be the reason behind these shifts, and how might they impact local culture and biodiversity?

Weather in our culture

- *There is name for a peculiar kind of thunder that occurs in the month of July in Kerala, called the 'Koon idi' or 'Kumi idi', meaning the thunder which causes mushrooms to sprout. Read more about it here*

- *Check out these Ovi songs from Maharashtra that celebrate the Pre-monsoon showers.*

Do you have any songs, poems, or stories about the seasons in your area?

Class/Grade

7-11

Activity

Outdoor (15 min/day)
Indoor (2 class hours)

Period of Activity

Can be a year round activity

Materials Needed

Room thermometer, Hygrometer, Rain gauge, Anemometer, Wind Vane, Types of cloud chart and Oktas scale (Details on materials and links for DIY given on Page 48)

Curricular links

NCERT

- Class 11, Geography Chapter 10, Atmospheric circulations and weather systems
- Class 11, Practicals in Geography, Weather Instruments, maps and charts

Monitoring Daily Weather

Overview

Weather monitoring generates valuable scientific data that helps us predict short-term weather conditions and track long-term climate changes. Having a weather monitoring station within your location is essential because it provides localised and accurate data, we can better understand weather patterns and make informed decisions (e.g in agriculture, construction), and even mitigate the impacts of extreme weather events (disaster preparedness and management). Through this activity students will have hands-on experience in using weather monitoring equipment and collecting data on temperature, rainfall, humidity, cloud cover, and wind speed. This activity also integrates topics from science, mathematics, geography and technology. Students will gain insights into seasonal weather fluctuations by generating summary patterns

Learning Objective

Observe and understand seasonal variations in weather

Detailed Activity

Begin by discussing the importance of weather monitoring and how it helps us predict weather in the immediate future, as well as climate change far into the future. Talk to students about the nearest weather monitoring station in your region and the importance of having one within your location.

Understanding weather

Introduce students to the following weather components, instruments used for their measurement techniques, and units of measurement

- Temperature (Min/Max)- °C, °F
- Relative humidity- (Explain the difference between absolute humidity (g/m3) and relative humidity(%)
- Cloud cover (Oktas measuring scale) and types of cloud
- Rainfall (mm/cm/inches)
- Wind speed (km/hr) - how to build an anemometer and calculate the wind speed and wind direction (by using a wind vane or other techniques)

Exploring weather components

Divide the class into five groups. Assign each group ONE of the weather components in 3., to monitor. Rotate groups periodically to monitor different parameters throughout the observation period. Students are expected to collect data daily, excluding weekends and holidays for the entire year if possible, or a minimum of 3 months.

Data collection

- *Temperature*: Utilize a wall thermometer or digital thermometer positioned within the school, away from direct sunlight or sources of heat and accessible for students to take regular readings. Demonstrate to students how to interpret the displayed temperature. Instruct them to record both the minimum and maximum temperatures consistently at 8:30 am and 2:00 pm daily.
- *Relative humidity*: Utilize a hygrometer from the science lab or a digital hygrometer accompanying a digital thermometer. Instruct students to record relative humidity at 8:30 am and 2:00 pm consistently each day. Explain the inverse relationship between relative humidity and temperature: as temperature rises, relative humidity decreases, and vice versa
- *Cloud cover* : Encourage students to observe the clouds consistently at the same time every day, perhaps during their lunch break or interval, to monitor both cloud cover and cloud type. Provide them with printouts of the oktas scale and types of clouds chart.
- *Rainfall* : Make your own rain gauge (instructions here) along with the students. Choose a place that is suitable for placing the rain gauge in the school. It should be placed in an open area away from obstacles such as buildings or trees that could block rain. Make sure it doesn't tip over or get blown over by the wind. Measurements must be taken every day **following a rain event** at 8:30 am. Using a ruler students should measure the depth of water and note it down. Students should empty the rain gauge after every measurement and keep it ready for the next rain event. If no rain occurs, it should be noted as '0 mm'.

Resources

Click the links below to open the resource

- Oktas cloud cover scale
- Ten main types of cloud chart
- Watch and learn about Ten main types of cloud chart
- Make your own rain gauge
- Watch: How to make your own anemometer
- Watch: How to make a wind vane
- Watch: How to make a wind vane
- How to identify wind directions
- A wonderful interactive portal for visualizing weather and other climatic information:
- These school children in India are learning to read the weather

- *Windspeed*: Together with the students build an anemometer. Once ready, trial it out outdoors, count the number of rotations of the cups per minute using a stopwatch. Once back in class, calculate the wind speed using the formula

Wind speed = Circumference of the cup (cm) X rotations per minute

For example an anemometer with cups of radius 5 cm, rotates 30 time within a minute.
Let's calculate the wind speed:

Circumference of the cup (cm) X rotations per minute
$= 2 \pi r \times 30$
$= 2 (3.14) \times 5 \times 30 = 942$ cm/minute
we know that 1 km=100000cm & 1hr=60min,
so, 942/100000 = 0.009km/minute
Converting minutes to hour
0.009 x 60 = 0.54km/hr
Wind speed=0.54 km/hr

- *Wind direction*: Along with the students, build a wind vane to identify the direction of wind, you can show some other techniques to identify the wind direction to the students. If using a wind vane, try it out in an open spot in your school grounds where wind is not obstructed. Ensure correct orientation by marking the ground with a north-facing indicator, guiding students to position the wind vane accordingly.

Display

Create a chart or other display materials where these daily records can be noted and seen clearly by all students. Encourage student groups to discuss among themselves about any surprising or unusual records. Encourage students to look up and explore for themselves why some weather components may be appearing unusual.

Data analyses

At the end of 3 months (or the maximum duration of the observation study), ask students to summarise their weather component, preferably in the following ways

Temperature

- Using a graph sheet plot daily minimum and maximum temperatures across the year to identify seasonal trends(x asis - dates, y axis- temperature) , Calculate average temperatures for each month and compare them over the observation period.

Relative humidity (RH)

- Use the same approach to graph daily relative humidity readings to observe fluctuations over time.
- Compare temperature and RH graphs - as temperature rises, RH should correspondingly reduce

Cloud cover and types

- How often did students see certain types of clouds based on the Oktas scale? What was the most common type of cloud seen?
- Check whether some types of could tend to form in certain types of weather

Rainfall

Summarize daily rainfall measurements to identify rainy periods or dry spells. Calculate monthly or seasonal rainfall averages to assess precipitation patterns.

Wind Speed and Direction

- Plot a graph of wind speed and direction against date - which days during the observation time were the windiest? Which direction was most frequent? Compare this pattern with temperature and RH graphs.

Visualize long term weather patterns in your region (or close to your region) using this website - https://cdsp.imdpune.gov.in/home_riturang_sn.php. Find out if it matches with what you have observed in your city/town/village over the one year period.

Use questions from the Discussion section to build a more holistic understanding of the patterns observed by the students.

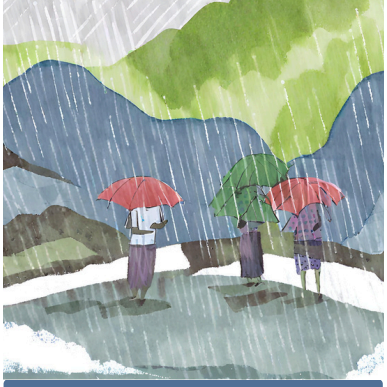
Discussion

- How did you feel while doing this activity? What part of the weather was most fun to observe?
- What are the seasons you experience in your town/village?
- Which period is the most windy period in your town?
- How often do you see cumulonimbus clouds in your town?
- How long does the rainy season last in your town/city/village?
- Which month recorded the highest maximum temperature last year? What was the maximum temperature in that month in this year?
- Do you notice a fluctuation in weather patterns across the months? Why do you think they change? Why do seasons change?
- During this period have you noticed how changing seasons affect life cycles of plants and animals?
- What was the most challenging part of doing this activity?
- Did you record temperature/rainfall patterns that were known to be abnormally high or low according to your teachers or elders in your community?
- How can a change in the seasonal cycle, such as unanticipated torrential rain or exceptionally high temperatures, affect your local area?

Weather in our culture

In Kerala, there's a popular saying: "Atham Karuthal, Onam velukkum," which means "If it rains on Atham day, Onam day will be bright and clear." Atham typically occurs in mid-August, ten days prior to Onam.

Do you have similar quotes on seasons and months in your place?



Class/Grade

9-12

Activity

Indoor (2 class hours)

Period of Activity

Any time of the year

Materials Needed

a computer, internet connection, projector in the classroom (if available)

Curricular links

NCERT
Class 11, Geography, Chapter 10, Atmospheric circulations and weather systems

Extreme weather events

Overview

Extreme weather events and weather 'anomalies' are meteorological phenomena that are unusually greater or lesser in impact from the typical weather patterns in a particular region for that time of the year. Examples of these events include extremely low temperatures, intense rainfall, flooding, drought, heat waves, cyclones, and more. Although extreme weather events have happened all through earth's history, climate change exacerbates and changes the frequency, intensity, and duration of extreme weather events. Through this activity students will learn what kind of extreme weather events are likely to occur in their region by exploring freely available long-term climate data and data-visualizations. This activity also helps understand the importance of quantifying weather to be able to predict it better.

Learning Objective

Understanding extreme weather events and unusual weather patterns

Detailed Activity

- Before the class activity, please take some time to explore the glossary, conceptual, and data visualization links given on Page 52
- Begin by explaining the concepts of extreme weather event and weather anomalies to students

Climate hazard vulnerability

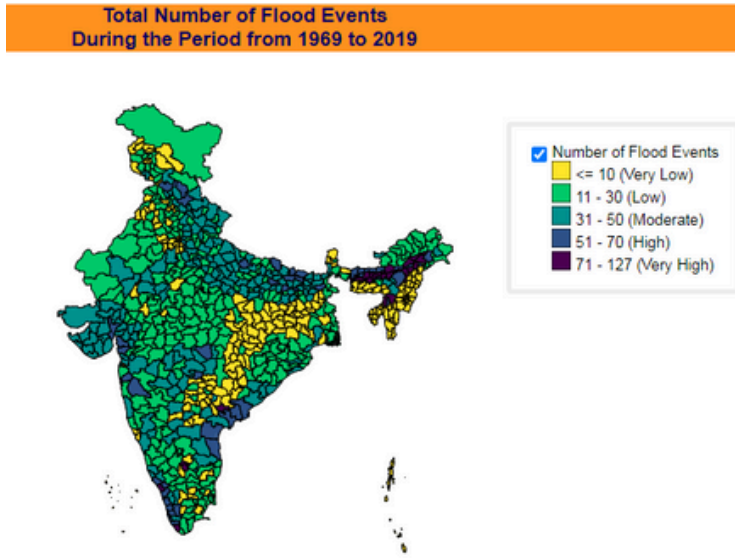
- Visit the climate hazard vulnerability atlas (https://imdpune.gov.in/hazardatlas/index.html) and project the interactive screen in your classroom
- Select the weather events given in the page (like Cyclone, thunderstorm, heat wave, drought, cold wave)
- From the India map , find out what is the severity zone of your district
- Use the side tab to visualize annual or monthly weather events

Resources

Click the links below to open the resource

- *Climate data portal service: https://cdsp.imdpune.gov.in/*
- *Across India, minimum temperature are rising far more than maximum*

- From the visualisation, infer what extreme weather event is likely to occur in your district.
- Inquire if your students have experienced any such event in recent times, and how they coped with it



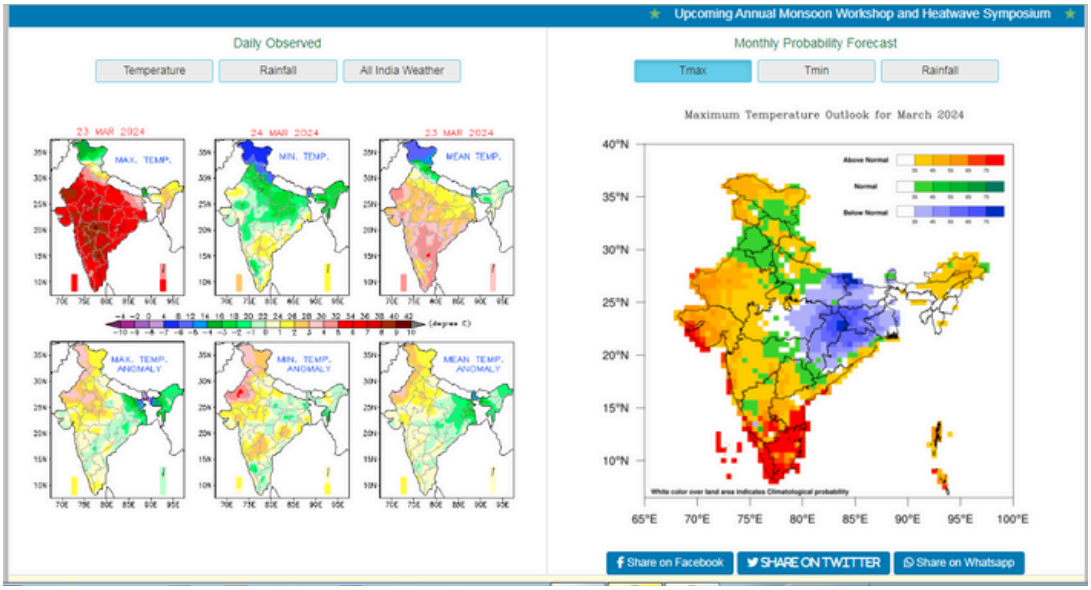
Glossary

Extreme weather events refer to severe and uncommon weather phenomena that are significantly different from average weather conditions in a particular area. These events include cyclones, thunderstorms, heatwaves, droughts, and cold waves.

A **weather anomaly** measures how different the current weather pattern is compared to the average pattern over many years. It helps in identifying unusual weather patterns over long time scales, usually decades.

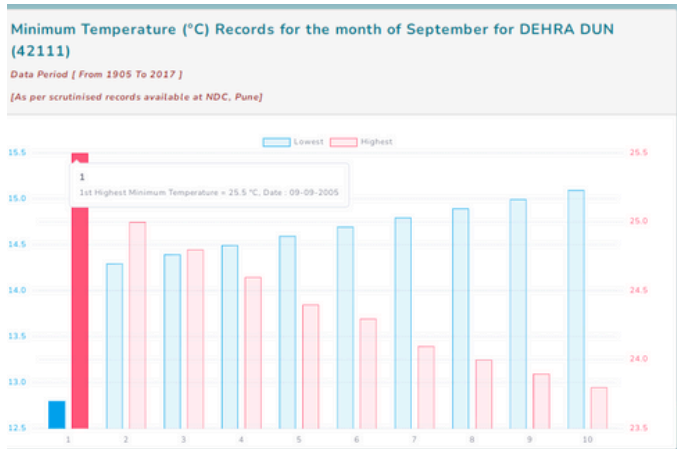
Weather anomalies:

- You can look at monthly anomalies of temperature and rainfall from the all India chart here – https://www.imdpune.gov.in/index.php.
- Identify your region or district from on this map.
- Using the colour scale provided in the chart, ask students to figure out if their region falls in the 'normal', 'above normal' or 'below normal' category of weather anomaly.

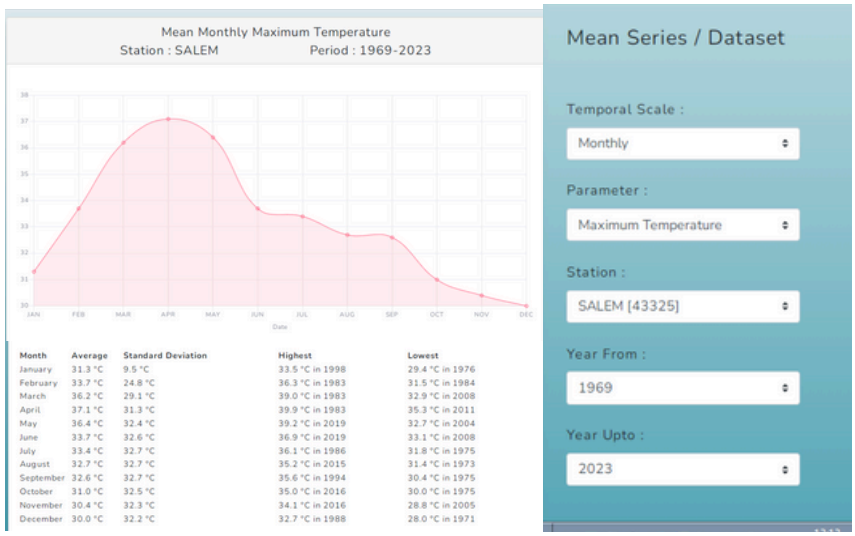


E**xtreme weather events**

- Visualize the ten extreme rainfall and temperature events that have occurred in a particular month over the years in your region, by selecting the district and month here – https://cdsp.imdpune.gov.in/home_lab_2.php#extremes



- Additionally, observe the general trend of temperature and rainfall in your region since these records are also available. You can look at the highest and lowest monthly recordings for each weather component throughout the years here - https://cdsp.imdpune.gov.in/home_riturang_sn.php#snormals
- Use questions from the Discussion section to build a wholistic understanding of climate change and extreme weather events



Month	Average	Standard Deviation	Highest	Lowest
January	31.3 °C	9.5 °C	33.5 °C in 1998	29.4 °C in 1976
February	33.7 °C	24.8 °C	36.3 °C in 1983	31.5 °C in 1984
March	36.2 °C	29.1 °C	39.0 °C in 1983	32.9 °C in 2008
April	37.1 °C	31.3 °C	39.9 °C in 1983	35.3 °C in 2011
May	36.4 °C	32.4 °C	39.2 °C in 2019	32.7 °C in 2004
June	33.7 °C	32.6 °C	36.9 °C in 2019	33.1 °C in 2008
July	33.4 °C	32.7 °C	36.1 °C in 1986	31.8 °C in 1975
August	32.7 °C	32.7 °C	35.2 °C in 2015	31.4 °C in 1973
September	32.6 °C	32.7 °C	35.6 °C in 1994	30.4 °C in 1975
October	31.0 °C	32.5 °C	35.0 °C in 2016	30.0 °C in 1975
November	30.4 °C	32.3 °C	34.1 °C in 2016	28.8 °C in 2005
December	30.0 °C	32.2 °C	32.7 °C in 1988	28.0 °C in 1971

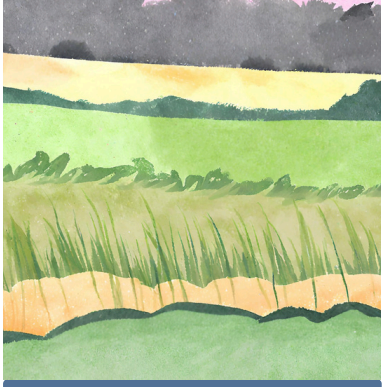
Discussion

- What kinds of extreme weather events is your area prone to according to the climate hazard vulnerability atlas? Have you faced any such extreme event lately?
- Does the highest record of maximum temperature in India fall in your region within the past 5 years?
- Does the lowest record of minimum temperature in India fall in your region within the past 5 years?
- Looking at the weather anomaly chart, is rainfall above or below normal this year in your region?
- What causes an extreme weather event?
- How do you think we should be prepared to face such events?
- What type of precautions are taken by your state to prepare for extreme weather events?
- Are extreme weather events preventable? What do you think can reduce the frequency of such events?

How do people deal with extreme weather?

Extreme heat, cold, rain, or lack of rain can all affect human lives and well-being. Imagine living in a region with a high climate vulnerability index - many aspects of your life may be linked to the vagaries of weather! In a diverse country like India, one part may be experiencing extremes of heat and drought, while another might be experiencing flooding. How do people cope with these extremes? Read more in the links below -

- *How extreme heat affected this farming community in Bihar in 2023. Extreme weather plays havoc with Magahi paan*
- *How torrential rain affected this region in Madhya Pradesh Our village was under water for three days*



Class/Grade

8-12

Activity

Indoor (2 class hours)

Period of Activity

Anytime of the year

Materials Needed

Graph sheet, scale and pencil

Curricular links

NCERT
Class 11, Geography
Chapter 10, Atmospheric circulations and weather systems

Tracking rising temperature

Overview

One of the most noticable effects of climate change is increase in average temperature of many geographic regions. In this activity, students will utilize an open-access weather dataset to generate a graphical representation of increase in average temperatures across India in comparison to historical averages.

Learning Objective

Understanding long-term increase in average temperatures across India

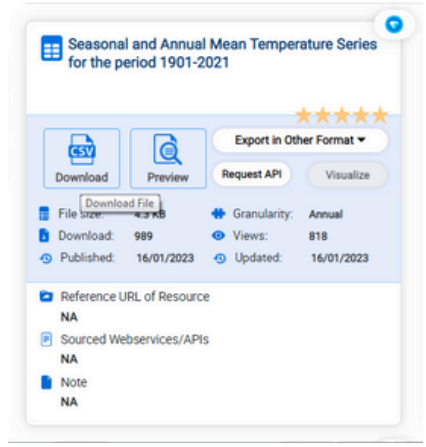
Detailed Activity

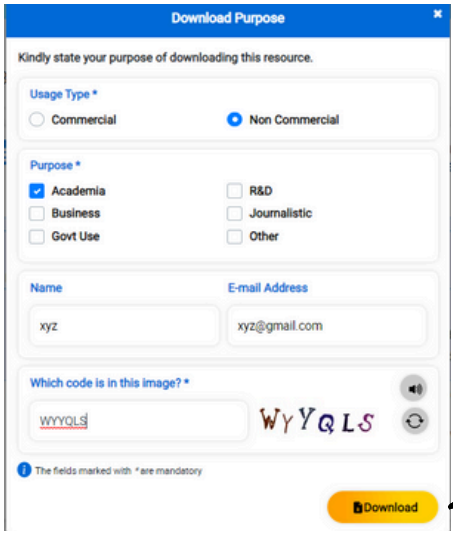
- Begin by talking to students about weather components, especially temperature as suggested in Monitoring Daily Weather activity on page 46.
- Visit the data.gov.in portal to obtain the mean, maximum, and minimum temperature data of India for the years 1901-2021.
- Follow the step by step process given on Page 57 for downloading data
- Explore this page before introducing to students.
- Begin by explaining to the students the concept of maximum and minimum temperature

Maximum temperature refers to the highest temperature recorded within a specific period, while **minimum temperature** refers to the lowest temperature recorded within the same period. The **mean annual temperature** can be defined as the approximate average/mean of the maximum and minimum temperatures of the hottest and the coldest months of the year

STEPS to download open-access temperature data for India:

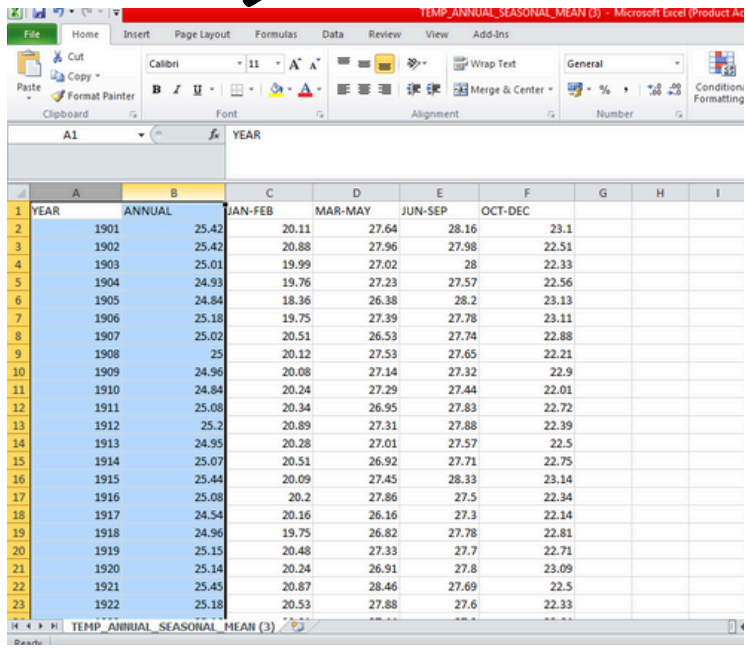
1. Visit www.data.gov.in, and type “all India mean temperature data”, in the “Search Datasets” tab
2. From the many data sets , scroll down and select the ‘Seasonal and annual mean temperature series for the period 1901-2021’.
3. Click the ‘CSV Download’ icon





4. Provide the necessary credentials as shown in the image on the left and download the file.

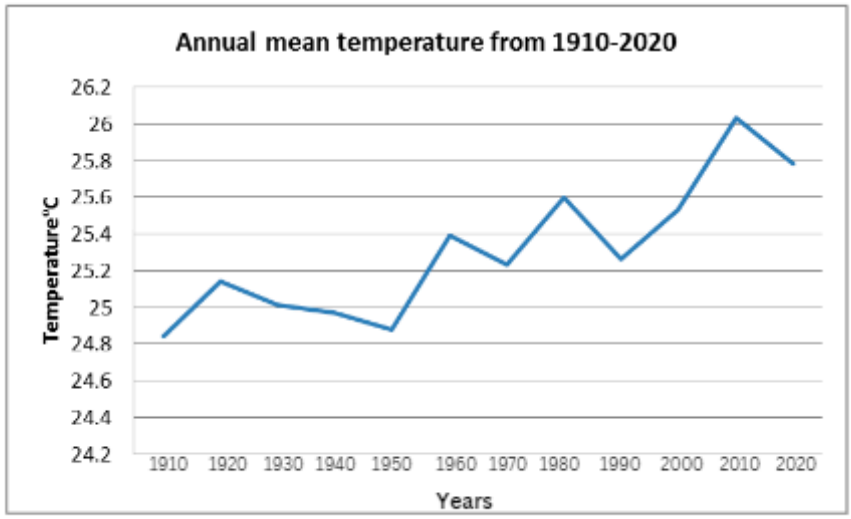
5. You should be able to get an excel sheet as shown in the image on the right, with annual and seasonal mean temperature data from 1901-2021



	A	B	C	D	E	F
1	YEAR	ANNUAL	JAN-FEB	MAR-MAY	JUN-SEP	OCT-DEC
2	1901	25.42	20.11	27.64	28.16	23.1
3	1902	25.42	20.88	27.96	27.98	22.51
4	1903	25.01	19.99	27.02	28	22.33
5	1904	24.93	19.76	27.23	27.57	22.56
6	1905	24.84	18.36	26.38	28.2	23.13
7	1906	25.18	19.75	27.39	27.78	23.11
8	1907	25.02	20.51	26.53	27.74	22.88
9	1908	25	20.12	27.53	27.65	22.21
10	1909	24.96	20.08	27.14	27.32	22.9
11	1910	24.84	20.24	27.29	27.44	22.01
12	1911	25.08	20.34	26.95	27.83	22.72
13	1912	25.2	20.89	27.31	27.88	22.39
14	1913	24.95	20.28	27.01	27.57	22.5
15	1914	25.07	20.51	26.92	27.71	22.75
16	1915	25.44	20.09	27.45	28.33	23.14
17	1916	25.08	20.2	27.86	27.5	22.34
18	1917	24.54	20.16	26.16	27.3	22.14
19	1918	24.96	19.75	26.82	27.78	22.81
20	1919	25.15	20.48	27.33	27.7	22.71
21	1920	25.14	20.24	26.91	27.8	23.09
22	1921	25.45	20.87	28.46	27.69	22.5
23	1922	25.18	20.53	27.88	27.6	22.33

Plotting Data Points

- In the class, provide each student with a graph sheet
- From the downloaded dataset, share the **average annual temperature** (column 2, titled "ANNUAL") for the first year of every decade (i.e. 1910, 1920,....2020) as a table with students
- On the graph sheet, ask students to mark years (1910, 1920,..., 2020) on the x axis, and temperature (22°C to 32°C) on the y axis
- Ask students to plot the average temperature corresponding to the year on the graph sheet.
- The plotted graph should show a trend of rising average temperature, as shown in the example plot below



Interpreting Temperature Trends

Students should be prompted to interpret the graph by asking the following questions

- What is the trend in average temperature across India? Is it increasing or decreasing?
- From which year is an increase or decrease very apparent?
- which was the coolest year in the past 100 years based on this dataset?
- was 1910 cooler or hotter in India than 2020?

Resources

Click the links below to open the resource

- *The 1.5C threshold explained*
- *https://data.gov.in/catalog/all-india-seasonal-and-annual-temperature-series*

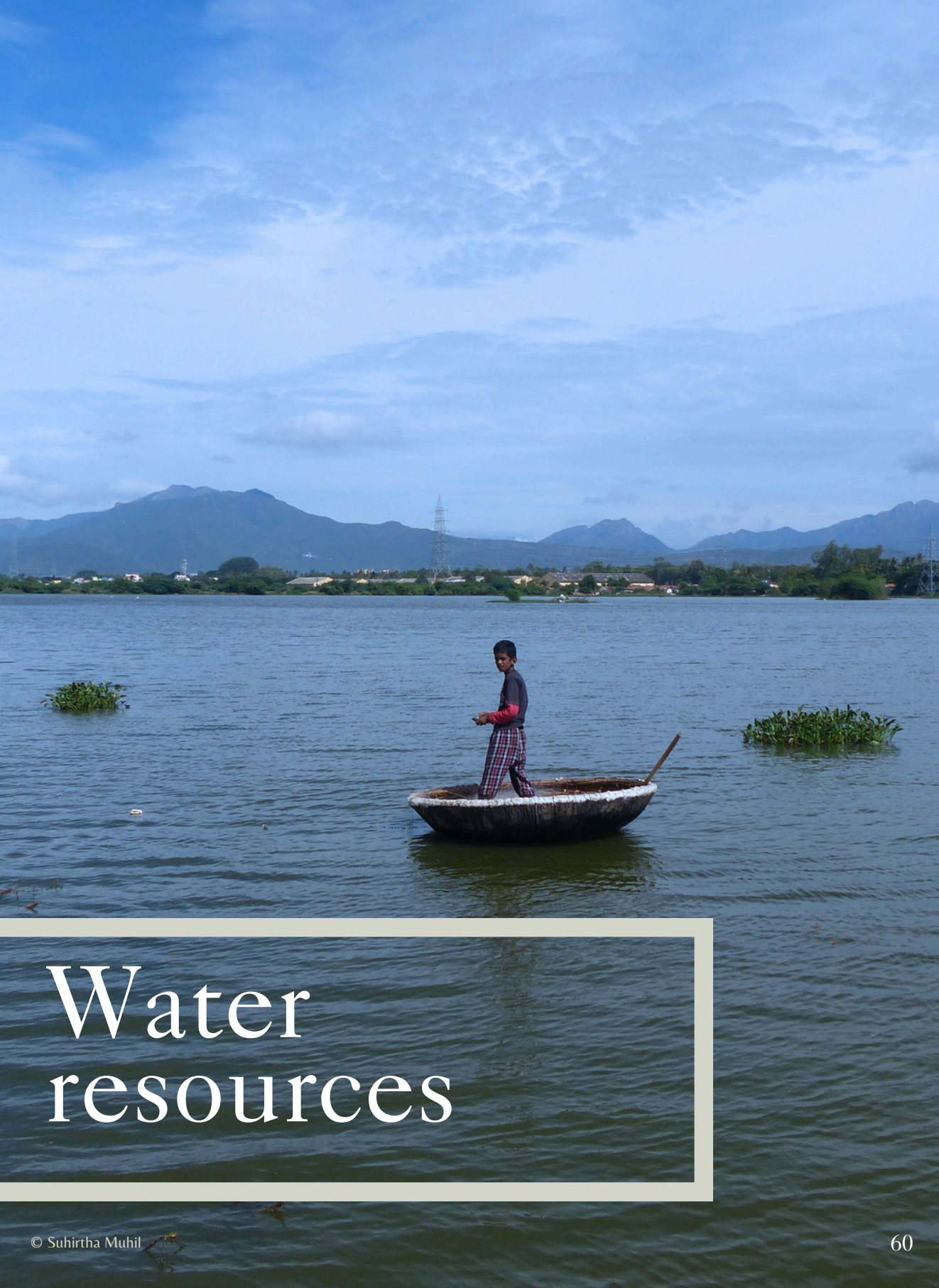
Discussion

- From the graph you can observe that the temperature has risen 1 degree celsius. Why is it a cause of concern?
- How can 1 or 1.5 degree celsius affect human population and biodiversity?
- Why do you think temperature is increasing?
- Have you noticed any increase in temperature compared to when you were younger?
- Have you heard of green house gases?
- What are the individual and collective measures required to mitigate greenhouse gas emissions?
- How does it make you feel to know that India has become warmer in the past 100 years?

Indicators of weather in our culture

The Cassia fistula flowers are an integral component of Vishu festival celebrations in Kerala, which occur in mid-April. Historically, these trees have had their peak blooming period around the Vishu festival for centuries. Nowadays, the flowering of these trees tends to occur earlier, with some trees blooming throughout the year. Similar instances of change in Mango flowering and Cherry flower flowering in Japan. Could these observations be explained by climate change? In the case of the cherry tree - yes! But the jury is still out on the Cassia and mango trees. Read more about how our cultural practices helped detect changes in Cassia flowering here -

- *The Case of the Confusing Kanikonna Trees*
- *Where have all the Vishu Kanikonna's gone?*



Water resources

Water and climate change are inherently interconnected. The impacts of climate change on water resources can be seen through events like floods, droughts, torrential rains, storms, and the melting of glaciers. These changes significantly influence the water cycle and disrupt access to water resources for living beings. Both surface water and groundwater play pivotal roles for the survival of living organisms, and also forming integral components of the hydrological cycle. Unfortunately, both surface water and groundwater resources face man-made problems like overexploitation, pollution-induced contamination, and depletion from excessive pumping. These issues are being compounded by the other impacts of climate change. Traditional water management practices, often aimed at conserving and utilising water optimally, can provide valuable lessons for addressing contemporary water challenges.

Teachers can leverage these activities to enhance understanding where and why water occurs, through mapping and exploration of local water bodies, explore biodiversity and insect life cycles, and examine weather and water management practices. This outdoor learning experience enables students to engage actively with a contemporary environmental issue by observing, monitoring, and working collaboratively in groups, especially through interviewing adults, offering them a holistic understanding of the intricate relationship between water and climate change.

Class/Grade

6-10

Activity

Outdoor &
Indoor (2 class hours)

Period of Activity

Any time of the year

Materials Needed

Chart/ paper, color pens/pencils/watercolors

Notes to teachers

Students should be cautioned against approaching water bodies without the presence of adult supervision.

Curricular links

NCERT

- Class 7, Science, Chapter 16- 'Water a precious resource'
- Class 9, Social Science, Chapter 3- 'Drainage'
- Class 10- Geography contemporary India- 'Water resources'

Mapping water bodies

Overview

Students will identify water bodies in their surroundings, examine their features, record the environment, and produce labeled maps. They will also participate in conversations with the teacher regarding the possible impacts of climate change on these water bodies.

Learning Objective

Learn to identify, observe, and understand where and how water bodies occur in their neighborhood

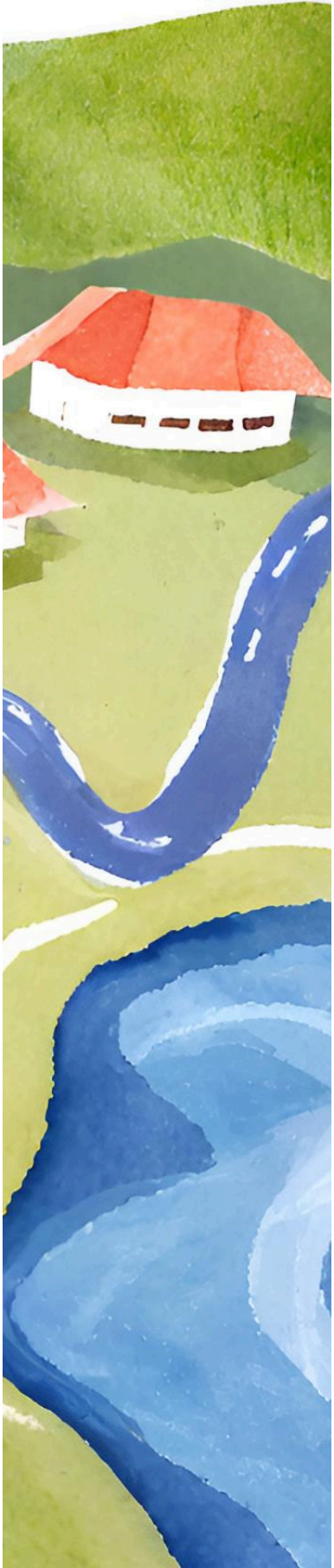
Detailed Activity

Introduction to water bodies

- Introduce the concept of how surface water bodies and groundwater are interlinked. Explain how the surface waterbody replenishes underground aquifers. And underground aquifers sometimes feed into surface water bodies.
- Ask students about the various types of water bodies they have seen on their way to school.
- Use the blackboard to categorize them into surface and underground water. For example: River, lakes, streams, ponds will fall under surface water bodies; water from farm wells and underground borewells will fall under ground water.

Documenting personal experience

- Ask students to describe the routes to nearby water bodies, roads, or common landmarks (such as the lake near the city center, the river beneath XYZ bridge, the pond by the school, the lake close to the town bus stop, etc.).
- The students' inputs should be used to sketch a map of the local water bodies on the blackboard.
- Remember to include legends and symbols where needed and provide instructions on the map.



Individual mapping exercise

- Ask students to create similar maps individually. Using a chart or A4 sheet ask them to create a visual representation of the water bodies they have encountered close to their homes
- Give students a few days to prepare their maps ready
- Following completion, let students present their maps, with relevant information about the waterbody. Each student should explain their map, highlighting the water bodies they have marked and providing any relevant information about the legends and symbols in their map.
- Use questions from the Discussion section to develop a holistic understanding of the water bodies and climate

Discussion

- What is the biggest water body you mapped? What is the oldest water body you mapped?
- How did you feel when you saw the water body you mapped?
- Did you see people around the water bodies? what were they doing?
- How will severe drought affect the water bodies near you?
- If there is a sudden spurt of very heavy rainfall, will the water bodies near your area be able to hold the water?
- Can soil and vegetation absorb such a copious amount of water?
- When water is not absorbed by vegetation, it leads to soil erosion, loss of top soil, and washing off of pollutants into water bodies. Inquire what kind of pollutants from the soil can be carried off through soil runoff (e.g. fertilizers, pesticides etc)
- How is it going to affect us? (polluted waterways) How will it affect farmers/fishermen in your area?
- How lack of rainfall or increased rainfall can alter the quality of surface water and ground water?
- Is groundwater an everlasting source of water?
- What happens when the salt water from the sea enters groundwater aquifers?

Resources

Click the links below to open the resource

- How climate change Impacts water access
- Watch this short film on the Mekong river and the accumulative effects of climate change and hydropower dams on the river and the communities dependent on them:
- Make use of Google earth, to showcase different landforms and water bodies: https://www.google.com/earth/.

Glossary

- **Surface water** refers to any water found on the Earth's surface, such as rivers, lakes, streams, ponds, and oceans.
- **Groundwater** is water located under the Earth's surface in soil, sand, and rocks, filling pores and crevices to form aquifers.
- **Aquifers** are underground layers of permeable rock, sediment, or soil that hold and transmit groundwater. They serve as natural reservoirs that store and supply groundwater to wells, springs, rivers, and other surface water bodies.

Water bodies in our culture

Our very life depends on water - it is no wonder then that water bodies find their way into our stories, poems, art, and more! In some places, the qualities of water bodies have been documented and remembered through cultural knowledge.

In Tamil Nadu, over the centuries water bodies have been classified into 46 different types according to their usage and characteristics. Here are a few examples:

- *'Kaataru'- meaning forest stream where flash floods can occur,*
- *'Odai' - a stream that arises from a spring,*
- *'Oorani' a pond/lake that is used only for drinking purposes, and*
- *'Eri' or 'Kamvai' which means a large tank used for irrigation.*

Do you have any local names for water bodies like the ones above in your region?

Class/Grade

8-12.
Mini activity (Pg 65) for class 5-7

Activity

Outdoor (30 min once a month)
Indoor- 1 class hour

Period of Activity

Can be a year round activity

Materials Needed

Field guides, pencil/pen, notebook, binoculars (if available), printed observation sheets, room thermometer

Notes to teachers

- For field visits obtain necessary permissions from parents and local authorities
- Students should be cautioned against approaching waterbodies without adult supervision

Seasonality of waterbodies

Overview

Students will investigate how water bodies experience seasonal fluctuations based on water level. Throughout this dynamic period, biodiversity in these water bodies changes in response to the availability of water. Students will observe and track weather, water levels, aquatic vegetation, bird populations, and other insect activity at various times of the year.

Learning Objective

Understanding seasonal changes in waterbodies and its consequence for biodiversity

Detailed Activity

Background and water body selection
Select a waterbody close to your school, that is safe to access for frequent observations. This could be any type of waterbody such as streams, rivulets, rivers, ponds, lakes, or even wells. Most inland water bodies are seasonal (with a period of high and lows), but some wetlands can be perineal.

- Take your class to this water body once a month, for at least 4-6 months. Spend a minimum of 30 to 45 minutes at the water body any time between 8:00 am and 4:00 pm.
- Divide your class into five groups, and ask them to monitor one of the following aspects of the water body - weather & water level, birds and mammals, insects, fish, and vegetation (see Page 66 for suggested group observations - you can choose to modify this based on observable components of the waterbody).
- Opt for either stationary observations from a fixed location near the water body or employ a transect method, establishing a small stretch of line spanning a few meters (approximately 200-500m) along the water's edge.

Monitoring Weather and Water Levels:

- Group 1 will monitor field weather conditions (sunny, cloudy, overcast, or windy) and temperature. Temperature can be measured using a weather app or you can use a room thermometer from your school's science lab.
- Group 1 will also monitor water level - identify a permanent structure near the water body. For instance, if monitoring a lake- identify a tree, rock, or edge of the road as reference points. Describe the water level in relation to these markers, like " water level is three meters below the rock" or "water level covering the base of the tree". Use this same reference point every time you visit the site to note whether water level has increased or decreased (Use the observation sheet on Page 69 to note this.)

Insect Monitoring:

Group 2 will monitor the presence of aquatic insects like dragonflies, damselflies near the water body and water striders and water beetles inside the water body noting their colors and behavior observed. Additionally also make note of butterflies, grasshoppers, bees close to the waterbody if any. (See observation sheet on Page 70 & 71)

Bird and other animals Observation:

Group 3 students will observe birds/mammals, and documenting their behavior. While precise species identification is not necessary, students should note the bird/mammal characteristics such as color, size, and behavior. Record whether the bird/mammal was solitary or in a group, its position near the water body (See observation sheet provided on Page 72)

Vegetation

Group 4 will estimate the proportion of shrubs, grasses, and trees bordering the water body, in a square patch of roughly 10m x 10m. They will also record the percentage of floating aquatic vegetation and document any flowering plants, in a 2m x 2m patch at the waterbody. Every month, the same patches should be monitored, and any seasonal changes in proportion of plants should be noted. If there are trees close by, you can monitor the seasonality of trees through SeasonWatch.

Fishes

If there is a fishing community near your water body, Group 5 should find out from them about the kind of fishes found in the waters. Find out if they are exotic or native variety of fishes? What methods are used for fishing? Do they have lean months during fish breeding season?

Looking at data

Once the data is collected, assist the students in identifying patterns between different parameters and seasonal fluctuations. For example, you can examine if the water level has remained constant throughout the observation period, did you notice a corresponding change in biodiversity? Use questions from the Discussion section to lead a collective interpretation of climate impacts on waterbodies

Curricular links

NCERT

- Class 7, Science, Chapter 16- 'Water a precious resource'
- Class 9, Social Science, Chapter 3- 'Drainage'
- Class 10- Geography contemporary India- 'Water resources'
- Class 10- Science, Chapter 15- Our Environment
- Class 12, Biology, Ecology, Chapter 14- Ecosystem

Resources

Click the links below to open the resource

- Wetlands and climate change
- What are wetlands and why are they so critical to life on earth
- Ephemeral ponds and wetlands

Mini Activity (for class 5-7)
Ask students to observe a small puddle in the school grounds after a bout of rain. Mark the edge of the puddle with chalk powder , visit the puddle after 2 hours and observe if the puddle has receded further and mark the edge with chalk powder again. Discuss where the water goes?

Discussion

- What are some of the things about the water body that changed through the monitoring duration? What things remained the same?
- How did you feel when you looked at the waterbody and biodiversity in it through the seasons?
- Did the waterbody get show seasonal fluctuations or did it maintain a constant flow throughout the year?
- Across your observations, have you detected any noticeable shifts in biodiversity corresponding to changes in the water body?
- If the waterbody unexpectedly dries up at the time it is expected to have abundant, what repercussions might this have on aquatic life and surrounding biodiversity?
- In what ways could unanticipated rainfall disrupt the usual ecological balance and biodiversity of the waterbody?
- What impacts would the local communities experience if the water bodies undergo changes that deviate from their expected seasonal patterns? How will it affect their livelihoods?
- How can we take action to reduce the harmful effects of climate change on waterbodies and the ecosystems they support?

Seasonality of waterbodies in our culture

A small river known as Noyyal meanders through the city of Coimbatore. Despite much of Coimbatore being situated in a rain shadow region, this river receives replenishment during the southwest monsoon from the mountains of the Western Ghats, filling its streams, tanks, and river. Consequently, by the end of June, these water bodies flourish with vitality despite the scarcity of rainfall. In August, the locals commemorate the 'Aadi Perukku' festival, a celebration marked by the overflowing waters of the Noyyal's banks, where locals worship their ancestors near the river bank.. As November draws to a close, the water gradually recedes, and by March, the tanks and streams run dry, only to commence the cycle anew by June.

Are there any waterbodies associated with festivities or cultural significance in your region?

Weather and Water monitoring observation sheet

Date_____ **Time_____**

Weather

- **Temperature_____ (note from room temperature/ weather app)**
- **it is ☐ Sunny ☐ Partially cloudy ☐ Cloudy ☐ Overcast**
- **Did it rain in the last week ____Yes/No. If yes, was it ☐ Heavy ☐ Moderate ☐ Scanty**

Water

- **Water level_____ (rough estimate of depth from the nearest reference point)**
- **Flow speed of stream/river_____(Rapid/fast/slow/still)**
- **Percentage of rock or boulders you see exposed in the water body _____**

Observation sheet for aquatic insects

Tick if you find these aquatic insects during your visit. Add any additional characteristics or behaviour that you observe	Dragonfly (near water and vegetations close by)	Damselfly (near water and vegetations close by)	Water strider (in water)	Water beetles (in water)
Date				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				
--/--/--				

Observation sheet for terrestrial insects

Tick if you find these terrestrial insects during your visit. Add any additional characteristics or behaviour that you observe	Butterfly	Grasshopper	Cricket	Bees	Other
Date					
--/--/--					
--/--/--					
--/--/--					
--/--/--					
--/--/--					
--/--/--					
--/--/--					
--/--/--					
--/--/--					
--/--/--					

Observation sheet for birds and mammals

Date_____ **Time**_____

Bird/mammal (draw or describe the animal if unable to identify)	Behaviour	Location at the site

Class/Grade

6-9

Activity

Outdoor + 1 class hour discussion

Period of Activity

Can be a year round activity

Materials Needed

Pen and notepad for survey

Notes to teachers

Advise students to approach the interviews with sensitivity and consideration, acknowledging the experiences of the individuals they interview.

Curricular links

NCERT

- Class 7, Science, Chapter 16- 'Water a precious resource'
- Class 9, Social Science, Chapter 3- 'Drainage'

Traditional water management systems

Overview

In this activity, students will investigate what were the traditional ways of managing water before municipality supplied water came into existence. They will interview elders on traditional water management practices. This activity can provide valuable insights on past traditional practices and present challenges and lessons on local ecological history.

Learning Objective

Understanding traditional water management practices and their underlying rationale

Detailed Activity

Ask students to interview 5 elders from their community on how water was managed for the community when they were younger. They could ask the following questions -

- From where do you obtain your drinking water? is it different from your childhood?
- Did you always have piped water? Prior to the availability of household water pipes, how and from where did you procure water?
- How did you manage to get water for your house in different seasons? Did you use different sources of water (pond, river etc.) or only a single source?
- In instances where water was abundant only during specific seasons, what methods did you employ to conserve water for the remainder of the year when water was less?
- Describe the techniques utilized for rainwater collection, including the design of rooftops and housing structures for this purpose.
- Where did you store collected water, and what types of vessels, containers, or tanks were commonly used for storage?
- Were there any traditional methods or techniques employed in your region for water conservation?
- Have you encountered situations resembling drought? If so, how did you navigate through those challenging circumstances?

Resources

Click the links below to open the resource

- For a similar activity on understanding ground water and water usage please look at this article by Kavita Krishna
- Nature classroom's water module
- Some traditional water management practices in India:
- How a 15th century water system in Bidar could quench its thirst during drought.

- In your experience, what were the primary areas of water usage within the community?
- How was water utilized for agricultural irrigation, including the utilization of wells, canals, or rainfall?
- Have you observed changes in local weather patterns and rainfall over the years?
- What are the merits and drawbacks of the present water management practices?
- Which practices from traditional water management systems do you believe should be upheld or reintroduced?

Once the survey is completed, use the questions from the Discussion section to arrive at common inferences about traditional water management practices in your community

Discussion

- How did you feel talking to your elders and knowing about a time long before yours?
- From your conversation with elders, do you think water was available in your town/village/city throughout the year? Were there periods of scarcity?
- Are there any water management practices mentioned by the elders that are still followed?
- In your opinion, what are some pressing climate-related threats to water resources in your area?
- How might the reducing water resources affect your community?
- What are some of the traditional water management practices that can be implemented today to mitigate climate change related pressure on water resources?
- What additional daily practices can contribute to the conservation of water resources?

Water management in our culture

In Kadaladi, a small town in the Ramanathapuram district of Tamil Nadu water has always been a luxury and people have always depended on storing and conserving water.This region predominantly recieves rain from the North-East Monsoon (Oct-Nov), alternative sources like underground water have been rendered impractical due to the proximity of the sea and its high salt content.

Up until 30-40 years ago, many of the houses in this region were built in a way that conserved water from rainfall. Roof tops were cleaned regularly and rainwater from the roof tops were channeled to a tank, that was was a few meters deeper than the rest of the house (called pallam). Also, rainwater that did not pass over any dirty surfaces was directly collected in bronze containers. Rainwater that flowed over any surface was filtered through a piece of white cloth and kept under the sun. Remarkably, the collected rainwater could last for 6-7 months, remaining clean and potable throughout this period.

Today this region reels under immense water shortage, can practicing this time tested water conservation method be of help now? What do you think?

Watch : https://www.thehindu.com/news/national/tamil-nadu/watch-in-this-tamil-nadu-village-fetching-water-is-a-daily-struggle/article67379096.ece

Food & Climate change

Humans have constantly migrated all over the world, bringing with them new food materials that often found their way into local cuisines. Now, more than ever, globalisation has increased the accessibility of food from distant corners of the world especially in Indian cities, introducing fruits, vegetables, and cereals, that were once unfamiliar in our daily diets. While our dietary habits have evolved over time to incorporate diverse food sources, this transformation has come at an environmental cost. Nevertheless, within our traditional food practices, there exist numerous resilient options that can serve as sustainable choices during uncertain times of climate change.

Teachers can highlight the connections between agricultural practices, food choices, plant growth, native food crops, and fossil fuels. When students learn about traditional food practices, teachers can provide valuable insights to students about the origins of their food, fostering an understanding of the community's culinary heritage. This approach not only enhances awareness about sustainable food choices but also encourages a connection to local traditions and agriculture, making students more conscious consumers in the face of environmental challenges.

Class/Grade

6-9

Activity

Indoor (2 class hours)

Period of Activity

Any time of the year

Materials Needed

Notebooks, pencil/pen

Curricular links

NCERT

- Class 6, Science, chapter 2 - 'Components of food'
- Class 9, Economics, Chapter 4- 'Food security in India'
- Class 9, Agriculture, Chapter 15- 'Improvement in food resources'

Forgotten foods

Overview

In this activity, students conduct interviews with adults of different ages to document some lesser known foods and explore how food habits have evolved over time. Together with their teacher, students will analyze whether certain food practices could offer a more sustainable approach amidst the challenges of climate change.

Learning Objective

Document lesser known foods and understand that food and food habits of humans change over time

Detailed Activity

- Ask students to collect information on the food items that are no longer eaten in your household/community by interviewing at least 3 adults at home or nearby using the questionnaire given on Page 79.
- Once the students return with the survey, allow students to discuss among themselves, especially what they feel has changed in the present day.
- Group the students based on the age of the interviewees (e.g. 30-40y, 40-50y, 50y and above), ask them to discuss their findings. Encourage them to identify any similarities in food preferences both among and within the different age groups.
- Together with the students, read and discuss the articles provided in the resource section, and follow up with questions suggested in the discussion section

Questionnaire

Date:_____ Time: _____ Location: _____

Name of adult:_____

1. Which year were you born?
2. What food do you eat - name 5-10 dishes that you regularly eat?
3. List down food items/dishes that you ate as a child/young person but which are no longer available or cooked in households now

   _____
4. Why do you think these food items are no longer cooked/available?
5. Which of the listed food items are seasonal? What were the seasons in which you ate these dishes?
6. Do you think it was easier to grow/collect/procure these foods before? Yes/No
7. What are the local names for the plant/fish/animal varieties that were consumed earlier but are not available now?
8. Which of the dishes noted in response to 3. were prepared during cultural festivals or celebrations? Note the name and timing of these festivals if possible.
9. Did unusual weather/climate affect the availability of some foods? What alternatives were consumed when these foods were missing?
10. What do you think about the nutritional quality of your present diet?
11. Would you like to switch back to eating some of your old favourite foods more regularly?

Discussion

- Did you feel like cooking/eating any forgotten dishes? What do you think these dishes will taste like?
- why are some food items/varieties are no longer available? could it be unfavourable weather conditions, change in cropping patterns, green revolution, invasive species, or change in living lifestyle?
- What are some foods eaten only in your locality and nowhere else. Discuss how some foods are available based on the landscape and favorable climatic conditions of a particular place.
- Do you think previous food habits were easier to adapt to extreme weather conditions? Could some of these dishes be a more reliable source of food in a changing climate?

Resources

Click the links below to open the resource

- A village nurtures traditional food systems in response to climate change
- Climate change impacts Assam's cuisine and culture
- Songs of survival: The cultural memory that kept millets alive

Food and culture

Food and culture are inseparable. Humans often define their identities with what they eat! Every culture has its special food that they cherish and are proud of, and every culture has developed its cuisine based on the local ecology, available ingredients, and ingenious inclusion of introduced items.

The food that we grow and consume is fascinating! Before tubers like potato were introduced to India by the Portugese (from South America), locals everywhere consumed a diversity of other types of tubers. Have you heard of tubers that are the size of an average man? Read about some of the traditional tubers that were part of our diet in Nature's Hidden treasure, Deccan Herald, Jan 2019

Old is gold: cooking challenge

Class/Grade

6-8

Activity

Indoor (Home activity +1 class hour discussion)

Period of Activity

Any time of the year

Materials Needed

Notebooks, pencil/pen

Notes to teachers

Advise children to get the help of an adult at home before preparing a dish in the kitchen.

Curricular links

NCERT

- Class 6, Science, chapter 2 - 'Components of food'

Overview

Students will learn to cook a traditional recipe by gathering information about the recipe, its ingredients and cooking method. They will then discuss the cooking process and the factors that contribute to the limited consumption of these foods in the present.

Learning Objective

Learning to prepare a traditional recipe and understanding the reasons for its limited consumption in modern times.

Detailed Activity

- Ask students to find out an old recipe from adults at home that has fallen out of regular consumption. Alternatively, if no such recipe is available, students can craft their own dish utilizing traditional, locally-sourced, and fresh ingredients.
- On a designated day, ask all students to prepare the dish with assistance from someone at home and bring it to class. This can also be a group activity if possible.
- Exhibit all food dishes prepared by the students
- Each student can talk about the history of the dish, its nutritional value, where the recipe comes from, and any other cultural significance.
- Once the presentations are over, invite the students to share the yummy food with their classmates and enjoy all dishes!
- Use this opportunity to discuss how food and food habits can change with the geography and over time.

Discussion

The teacher must sensitise students about the idea that each food item has its own value and history, and everyone's food habits must be respected. Ensure that discussions remain considerate, keeping in mind that food items have many intersectionalities embedded in caste and class.

- Discuss the experience of preparing these dishes - was it fun, laborious, easy, complex, simple, or multi-step?
- What was your most favorite part about making this dish?
- How long does the dish take to cook?
- How much water is consumed in making the food?
- What components of the recipe are seasonal?
- Can the seasonal ingredients be cultivated/foraged/harvested/caught from your backyard?
- As human use of spaces changes or as landscape get altered, what will happen to these ingredients?

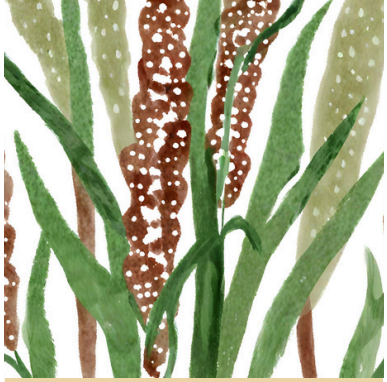
Food in our songs

We Indians love our food so much that we have made songs to celebrate it!

Baromashi (Bengali)
Aaj amader aaj amader/
Shapla phool bhaja/
Roshun diye moja.../
Ilsha maachh phalsha diye/
Methi diye bhejechhi

Translation : waterlily cooked with garlic; hilsa combined with tart, fleshy 'phalsa' berries and fried with fragrant fenugreek.
(source: https://scroll.in/magazine/1058684/bengali-food-is-baked-into-the-lilt-of-its-folk-music)

Do you have any local songs about your food?



Class/Grade

7-9

Activity

Outdoor (3 months)

Period of Activity

Any time of the year

Materials Needed

9 earthen pots with soil (taken from the same source, well-aerated), Seeds of 2 types of millet grown locally, and seeds of a cereal crop like wheat/rice/corn, Measuring jar/mug

Curricular links

NCERT

- Class 11- Biology, Chapter 7 Structural organization in plants and animals'
- Class 11- Biology, Chapter 15- Plant Growth and Development Class 11- Biology- Chapter 11- Plant Physiology

Resilient foods

Overview

Historically, India thrived on millets as they could grow in drier areas and needed less fertile soil. They were source of nutrition and food security in drought and harsh climates. They were central to our traditional farming practices long before rice and wheat became dominant. In this activity, students will experiment with three species of crops (2 millets and a cereal) to assess their ability to withstand water stress.

Learning Objective

Understanding that some crops (such as millets) can withstand water scarcity better than others (such as wheat), through an experiment

Detailed Activity

- Begin by discussing the importance of water in crop growth and how water requirement varies for growing different crops.
- Arrange 9 pots in three rows, each row containing three pots, and fill with well-aerated soil. In the first row of the pots plant 50 seeds of a millet of your choice in every pot (e.g. Sorghum), mark it as A1, A2, A3.
- Plant 50 seeds of the second type of millet (e.g. Finger millet) in every pot of the second row mark the pots as (B1, B2, B3)
- In the third row, plant 50 seeds of seeds of a cereal crop in all three pots mark the pots as C1, C2, C3
- Once all the seeds are planted, add equal amounts of water to all the pots using a measuring jar or a gradated mug/beaker

- Make sure all the pots are placed at a spot where there is adequate sunlight but not any rainfall. The only water the pots should receive is from you!
- To the pots A1, B1, C1, after first day of watering, water the plants everyday (see the diagram and chart below)
- To the pots A2, B2, C2, after first day of watering, water the plants only every 7 days
- To the pots A3, B3, C3,..., water the plants only every 15 days
- Make sure that the quantity of water being added to the pots is the exact same every time.
- Observe the number of plants that germinate in every pot, and measure the height of each plant every 5 days. Note down the measurements of each potted plant.
- Observe the potted plants for a period of three months from the day of sowing
- Use questions provided in the discussion section to understand the experiment outcomes

A1, A2, A3
(e.g millet like Sorghum)

B1, B2, B3
(e.g millet like Finger millet)

C1, C2, C3
(e.g cereal like Rice)

A1	B1	C1	Water everyday after first watering
A2	B2	C2	Water every 7 days after first watering
A3	B3	C3	Water every 15 days after first watering

Experimental set up of potted plants

Resources

Click the links to open the resource below

- Six reasons to bring millets to the market
- The story of millets
- Sorghum, the right choice- Growth and development

Discussion

- Which pot had the most number of germinated seeds?
- Which type of crop showed most amount of germination and growth when watered everyday?
- Which type of crop showed most amount of germination and growth when watered once in 7 days?
- Which type of crop showed most amount of germination and growth when watered once in 15 days?
- Of the three crops in the experiment, which one do you think will be able to withstand low rainfall or drought conditions?
- Why do certain crops need more water while others do not?
- How will extreme weather events like drought pose a threat to some of our major cereal crops like rice/wheat growing in agricultural fields? Imagine the water requirement for such a large area!
- Are there any local crop varieties in your region that are adapted to local weather and soil conditions?
- Will more water help plants grow? How will events like flooding affect plants?
- If you live near a coastal region, have you heard about saltwater intrusion? how can it affect plant growth?
- Does drought or flood make your food costlier? Why or why not?

Crops in our culture

Cereals form the main component of our meals - they are a source of carbohydrates and fibers - two food components that help us get energy and feel "full" after eating, respectively. Every other component of our daily meal is called a "side dish"! It is no surprise therefore that traditionally we had many types of cereals in our diet.

Sadly, some of these plants, especially millets, are getting lost from our daily cuisine, and we now need to conserve these crops. Read about some efforts to conserve local food varieties across India -

- *Grains of Life: How Chotanagpur's Adivasis Are Reviving Native Varieties of Rice, The Wire March, 2024*
- *Thirunelly's seed festival celebrates traditional climate-resilient seeds and farm produce Mongabay March, 2023*

What are some of the important millets grown in your region?

Class/Grade

7-9

Activity

Outdoor (weekend)
Indoor (2 class hours)

Period of Activity

Any time of the year (weekend)

Materials Needed

Notebook, pen and pencil

Curricular links

NCERT

- Class 9 Science Environment and Natural resources- Chapter 14
- Class 11 Chemistry Chapter 14 Environmental chemistry
- Class 11 Geography Chapter 14 Composition and structure of atmosphere

Carbon cost of food transportation

Overview

In this activity students will visit their local market and find out the place of origin of select food ingredients and the transportation process of the food from its origin to the destination. Through this activity students will learn how our food choices can play a role in CO_2 emissions

Learning Objective

Understand that our food consumption habits lead to carbon emission, especially via transport

Detailed Activity

- Begin by discussing ways in which green house gases are emitted, especially through transportation, and which contributes to our carbon footprint as individuals.
- Inquire where students procure their food items and how they think those items are available at that source.
- Students should visit the local market/grocery shop in the company of an adult during a weekend, and fill in the observation sheet on Page 88 (first row filled as example)
- Students should find out from the vendor, the origin/place of cultivation of each food item purchased.
- For packaged food items, students should look at the details provided on the back cover for the place of origin or region it was manufactured or packed.
- Students can also include food produce collected from their own garden
- Students should also enquire what mode of transport was used to get the produce to the market
- Students should be taught to calculate their carbon footprint as given on Page 88 and fill in the observation sheet

***Calculating CO_2 emissions**

- Use a map of India in the classroom and use stickers to pin point regions from where the materials have arrived at the local market.
- With the teacher's help, students should use the internet to find the rough milage of each vehicle (For ex: Lorry 17km/l, truck 15 km/l)
- Calculate the fuel used in travel (Petrol/diesel in litre) = kilometer covered/ mileage of vehicle

For the example below, onions from from Bellary was brought by a lorry.
Petrol used to bring onions from Bellary to Coimbatore, a distance of 550 km. If the mileage of the lorry is 17 km/l, then, 550/17= 32.3 litre of petrol was used
To find CO_2 emissions due to transportation, we need to find CO_2 produced for every unit of fossil fuel burned. For example, 2.3g of CO_2 is produced for burning 1l of petrol, while 2.68 g of CO_2 is produced for burning 1l of diesel.
So, total CO_2 emission for transporting onions from Bellary = 32.3 x 2.68 = 86.564g of CO_2 is emitted in the journey

Use questions given in the discussion section to understand the implications of this exercise.

S.No	Item	Place of origin	Distance from the market you visit	Mode of transport	Type of fuel used in transport	CO_2 generated
1	*Big onions*	*Bellary*	*550 km*	*Diesel Lorry*	*Diesel*	*86.5g*

add more rows as needed

Resources

Click the links to open the resource below

- Food miles here is how we can reduce them

Discussion

- How many of your food items came from more than 100 km away?
- What did you feel when you got to know that many things you eat everyday are actually grown/produced/packed very far away?
- Which types of vehicles emitted the most amount of CO_2?
- How can we reduce the amount of CO_2 emissions because of our food consumption?
- Which fruit/vegetables on the list contributed most to the CO_2 emissions?
- Is it better to eat foods that are grown locally or far away, if we want to reduce CO_2 emissions? Why?

Fossil fuels and society

Rapid and long distance transport has made som many things, especially food, highly accessible to people everywhere. This results in a huge consumption of fossil fuels just for the transport of food from here it is cultivated/processed/packaged, to where it is eaten. This can have some unforeseen repercussions for communities. You can read more about this story –
Petrol price hike fuels Sidhi's salesmen's struggles PARI, Nov, 2021

Soil and Land

Soil formation is a gradual process spanning centuries, shaped by interactions among climate, bedrock material, topography, biotic factors, and time. It begins with the weathering of rocks and minerals, while crucial organisms like microorganisms, fungi, earthworms, and insects decompose organic matter to produce humus, enriching soil fertility. This combined action of weathering and biological processes gradually alters soil properties.

Climate change significantly affects soil composition by altering weathering and enrichment processes though changes in weather and temperature. Shifts in rainfall patterns can lead to soil erosion and nutrient depletion, reducing soil quality. Likewise, higher temperatures can lead to faster decomposition of organic matter, releasing carbon dioxide back into the atmosphere, and impacting soil fertility. Changes in weather patterns and extreme events such as floods and droughts can exacerbate soil degradation.

Educators can utilize interdisciplinary activities in this section - blending science, geography, ecosystem studies, chemistry, and agriculture to enhance students' understanding of climate change impacts on soil. These activities provide students with practical experiences, impart scientific knowledge, and foster a deeper connection with the environment.

Class/Grade

6-9

Activity

Outdoor (half a day) & Indoor (1 class hour)

Period of Activity

Can be a year round activity

Materials Needed

Colour pens, crayons, pencils, charts, computer and projector (optional)

Curricular links

NCERT

- Class 7, Social Science, Geography, Chapter 3, Our changing Earth
- Class 9, Social Science, Geography, Chapter Physical Features of India

Mapping geographies

Overview

Our lands are blueprints to the events that take place on the earth. 'Land-use' refers to the way humans modify land over time. Mapping and categorising the land around is a vital first step to see the bigger picture of what our actions as a society is doing to the land and environment. This can be done through freely available satellite imagery, which can also visually depict the changes happening on land over time. Students will explore and learn how to categorize land cover and land-use types around their school and understand if this has changed over time using interactive media.

Learning Objective

Identify and characterize different land-use types, and changes since 1984, in your area.

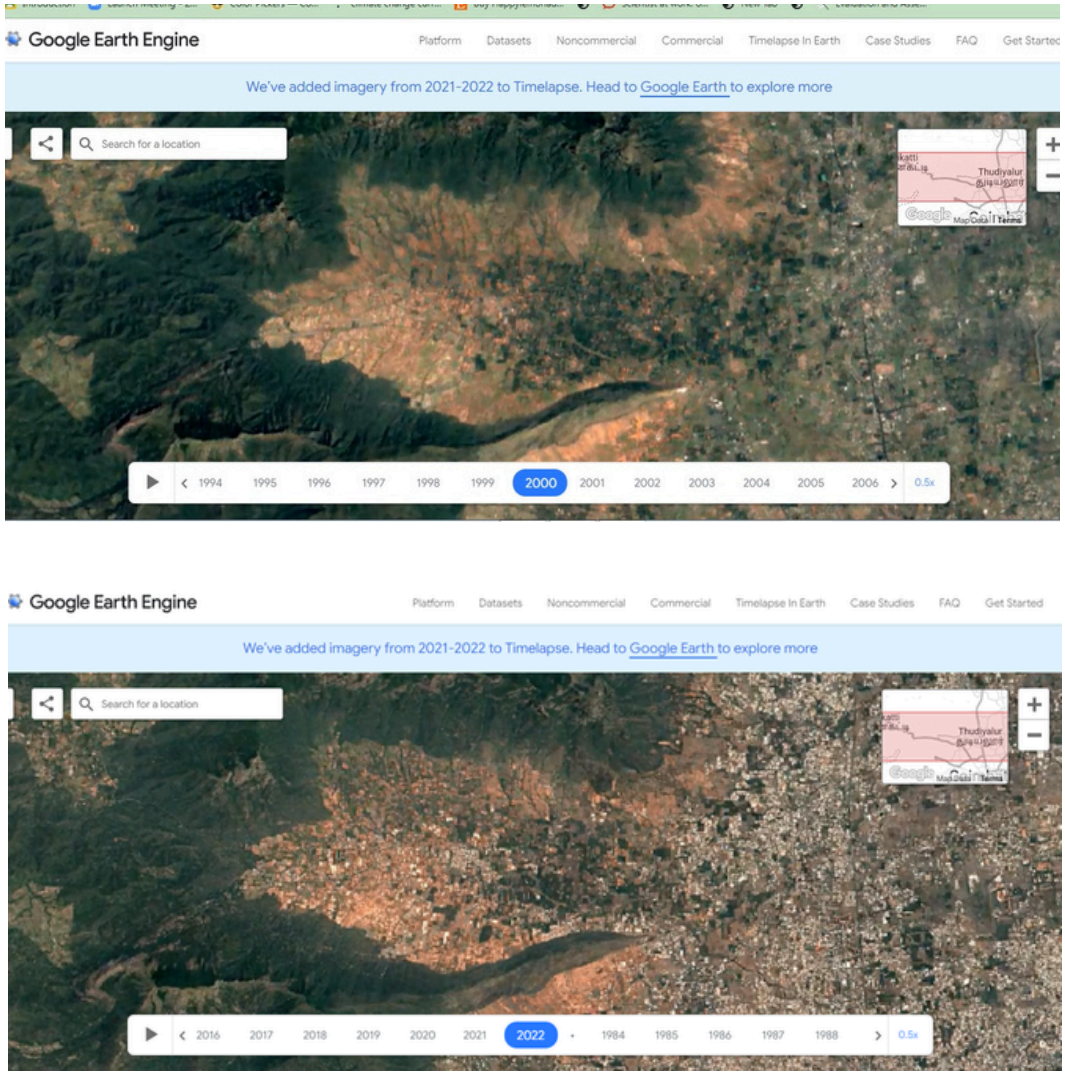
Detailed Activity

- Start by selecting a small area close to the school that can be surveyed for its use by humans or wildlife.
- Ask students to create an outline map of the school/locality in an A4 sheet , adding prominent locations as guiding point- e.g. School main office, play ground, back gate, road. Remind them to show directions in the map. It is useful to mark the geographic north on this map; students can use a compass or notice the direction of sunrise to determine this.
- Once the outline map is ready, take a walk outside the the school boundary with your students and familiarise them with the general categories of land-use types around the school. Identify and categorise the different land types using the list given on Page 93, and include any additional categories that may exist in your local area.

- Students should make an outline of each land category and note down the specific land type on their outline map. Once back to class, students can colour each of the land types, add symbols, and mark with appropriate labels.

Urban built up land	Places where people live or work in cities. Residential, commercial, industrial, land used for Transportation, communication, etc are all considered urban built-up land
Agricultural land	Places where plants are cultivated for food or other products. This land-use type is usually covered with crops and orchards
Plantations	Coffee, Tea, Areca nut, Coconut, Cashew and other monoculture of trees
Grasslands or Open Natural Environments	Places which have few trees, and the ground is covered with grasses. This land is used for grazing by pastoralists and can be covered with shrubs, bushes in addition to grasses
Forest land	Places that are covered with lots of different kinds of trees growing on their own. This includes vegetation types like evergreen, dry deciduous , alpine, shola,
Water	Places with running or stagnant water, like streams, canals, river, lakes, swamp, ponds, well, sea shore
Barren land	Places that are devoid of any vegetation cover because of human use such as quarries or mines
Plantations	Places where the same kind of timber or other commercial use trees are planted. These are different from forest because you will find only one kind of tree in a plantation, like - Eucalyptus, Australian acacia, rubber, tea, coffee etc.
Hedges	Biofences
Hill and rocky areas	These areas include rocky outcrops, boulders across the landscape, uneven and elevated landforms

- Make use of Google earth engine timelapse to see the land-use change in your area. Go to this link - https://earthengine.google.com/timelapse/, type in your location and zoom in to see the area around your school. Try to zoom in to the same location that the students surveyed and press the timelapse icon for map images from 1984. You can project this timelapse via a projector or copy the images on your computer for students to see. An example of the Thadagam Valley in Tamil Nadu is given below:

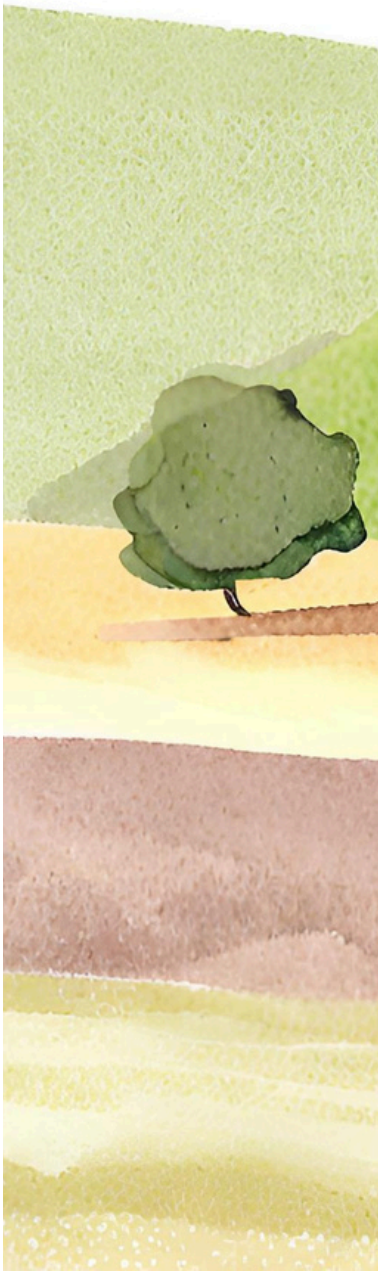


Satellite imagery of Thadagam Valley in 2000 (above) and 2022 (below).
The rapid urbanisation of this location is very apparent from these images over the span of 22 years

Resources

Click the links below to open the resource

- National Geographic map maker 4.0
- Google earth engine



Discussion

- What are the major land use patterns around the school?
- What did you feel when you saw the different types of land uses around your school? What type of land-use made you feel happy and why?
- What did you feel after looking at the time-lapse video of your area?
- What type of land-use was most common in 1984 v/s now? Why do you think land use has changed since then?
- Since 1984, has your area become more urbanised?
- Do you know what the urban heat island effect is? If you reside in an urban setting, do you believe that climate change could have a greater impact on you?
- Do you think grasslands, rocky areas and other open natural environments are wastelands? What use are such habitats?

Land and humans

Nestled between the Kurudi hills and the Marudamalai hills near Coimbatore lies Thadagam valley, once a verdant expanse of fertile land. However over the last three decades, extensive mining of red soil for brick kilns has left the land fractured, riddled with craters of varying depths, and rendered both the land and streams nearby largely unproductive. Farmers who cultivated plantain had no choice but to give up farming due to low crop yield resulting from the dust and pollution from the area. This valley also serves as an elephant corridor, which has witnessed numerous man-animal conflicts over the years due to its changing landscape. You can read more about this in the The Wire (Oct 2019): As Rogue Brick Kilns Wreck Thadagam Valley, Activists Hope for Aarey-Like Respite

Have you observed such dramatic changes in the landscape around your locality? Have you noticed how it can affect people and wildlife?

Soils around you

Class/Grade

6-9

Activity

Outdoor (Weekend)

Period of Activity

Any time of the year

Materials Needed

notebook/pen, paper collection bag, mortar and pestle, water, 3 identical glass jar with a lid (e.g. jam bottle), ruler/scale

Curricular links

NCERT

- Class 8- Geography- Chapter 2- Land, Soil, water and wildlife conservation.
- Class 9- Unit 4- Soil nutrient management in vegetable crops

Overview

Soil is composed of mineral particles such as sand, silt, and clay, along with organic matter from decomposed plants and animals. Water and air fill the spaces between these particles, essential for plant growth and microbial activity. Soil hosts various organisms like bacteria, fungi, and earthworms, pivotal for nutrient cycling and overall soil health. The composition of soil, including its mineral content and organic matter, influences important characteristics like water retention and fertility. Climate change can alter rainfall patterns, making it more intense or erratic, which in-turn can accelerate soil erosion, leading to degradation.

Students will explore and collect soil samples from their surroundings and understand how different soil types vary in their characteristics like colour, texture, soil moisture and temperature. They will then discuss their observations, along with suggested questions in the Discussion section to speculate about how climate change can affect the soil in their locality.

Learning Objective

Examining and understanding the unique traits of different soil types in your locality, and learn the impact of weather conditions on soil characteristics through observation and discussion

Detailed Activity

Activity 1

Collection of soil sample

- On a school holiday, ask each student to collect one soil sample from a place of their choice. It can be a farm, garden, stream bank, empty plot, road side, etc.
- Ask them to dig roughly 10cm deep in the point of collection and collect soil samples of about 250gm (two handfuls). The soil should be collected in a paper bag and labelled with the date and location of collection (e.g. 21/06/2025, from stream bank near main road)
- Ask students to observe and make a note of insects, spiders, snails, millipedes, and centipedes they notice while collecting the soil sample.

Introduction to Soil

- In the class, start by acquainting students with the intricate process of soil formation - gradual weathering of rocks, followed by sedimentation, over very long periods of time. Soil has abiotic components - minerals (soil particles), gases and water), and biotic components - plant, animal, fungi and other microorganisms.
- Discuss soil composition - most soil consists of sandy, silty, or clayey particles, depending on which it can retain more or less water.

Analysing soil texture by feeling

- Ask students to place their soil sample on a table and invite all students to look at the samples, and assess the colour and texture of the soil.
- From each sample, take 2 spoonful of soil in a plate and add few drops of water to it. This is for students to feel the soil sample in wet condition. Ask students to notice differences in the texture of dry and wet soils.
- Note down the colour and texture of soils in the observation sheet provided on Page 98 (the first two rows have been filled-in as an example).
- here are some ways to describe the texture of dry soil -can see individual grains, small particles, clumped together, tight, hard, smooth, fine, etc.
- here are some ways to describe the texture of wet soil - grainy and coarse, smooth and fine, silky, slippery etc.
- Encourage students to express and articulate observations in their own words and are not required to adhere to the above mentioned vocabulary
- Ask students to notice whether soils from different locations had differences in texture

S.No	Sample from	Colour of the soil	Dry sample	Wet sample
1	Farm	Red-orangish	Looks clumped and tight, feels smooth and fine, particles are small	Smooth and fine, slippery
2	Stream-bank	Light brown	Grainy, feels coarse, particles are small	Coarse and grainy

Add more rows as needed

Activity 2

- After the first activity, pick 3 soil samples, which are distinct in colour and texture
- Remove any rocks if present and air dry the 3 samples in the sun for a week. Ensure the soil samples are not disturbed during this period.
- After a week, students should grind the soil samples separately using a mortar and pestle
- Take three equal sized glass jars with a lid. Add quantity of soil sample to each jar - filling up to 1/3rd of the jar.
- To each jar add equal amounts of water, filling up the jar to 2/3rds
- Close the lid, shake vigorously and leave the jar in a place without disturbance for 24 hours.
- Next day, ask students to observe how soils have been segregated into zones within the jar. Sand settles at the bottom layer due its large particle size, followed by silt above it and clay with the smallest particles settles above silt. Organic matter and humus floats on the top of the water.
- With a ruler, measure the thickness to which each component has settled and calculate percentages of each soil component as given below:

Resources

Click the links below to open the resource

- Why soils are important to life on earth- and helps fight climate change
- Climate change is drying out earth's soils
- Characteristics of different soils
- Explore this teachers guide for activities on soil

Say, if the jar has 10 cm of settled soil, 24 hours post shaking vigorously, and the sand zone is for 5 cm, silt- 2 cm, clay-3cm

Thickness of soil component/ total thickness x100 = percentage of soil component

i.e., Sand (5cm) - 5/10 x100= 50%
Silt (2cm)- 2/10 x 100= 20%
Clay (3cm)- 2/10 x 100= 30%

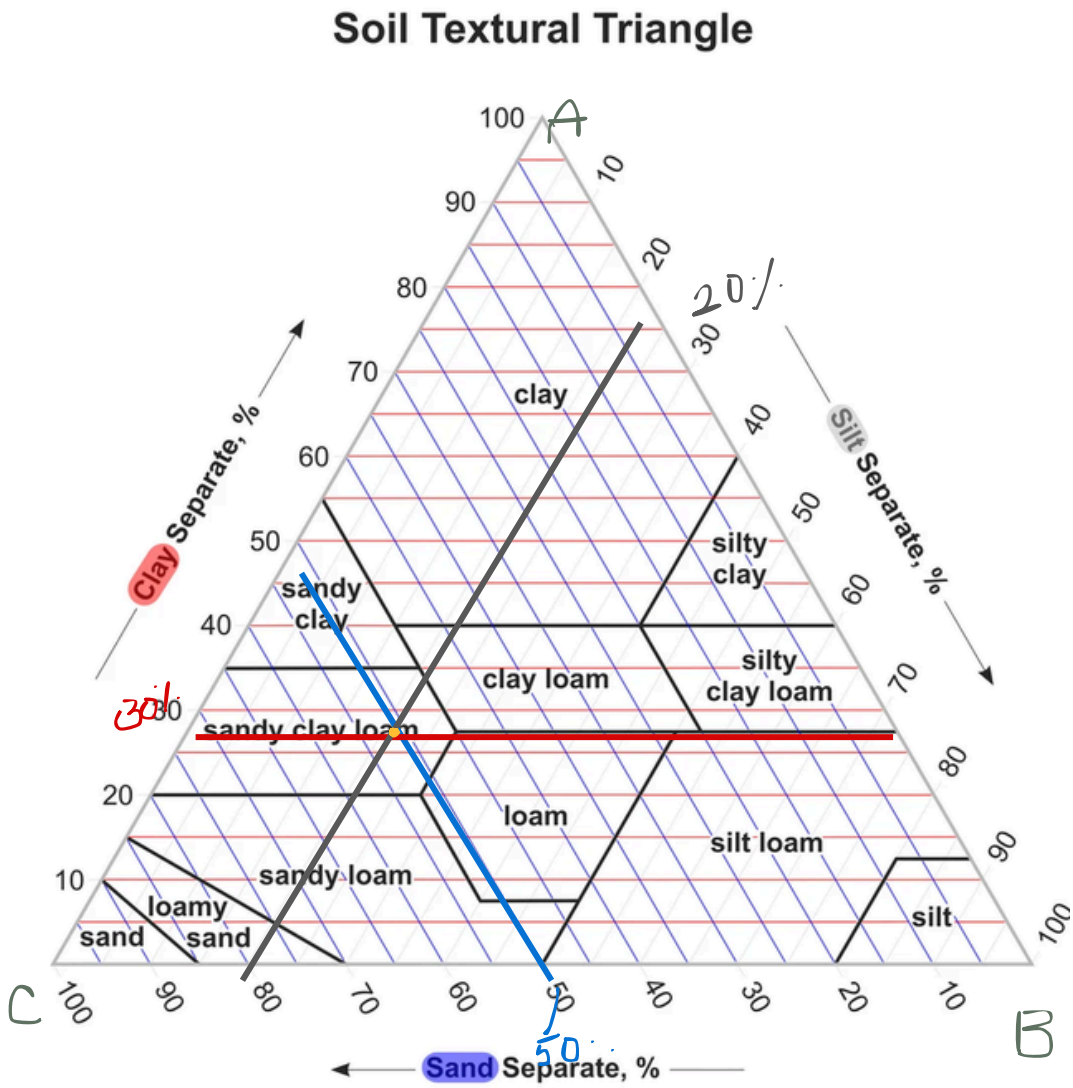
Glossary

- **Soil texture** refers to the relative proportions of sand, silt, and clay particles in a particular soil sample.
- **Soil porosity** refers to the volume of pore spaces or voids in the soil relative to the total volume of the soil. These pore spaces are the gaps between soil particles where air and water can reside.
- **Soil permeability** refers to the ability of soil to allow water, air, and other fluids to pass through it.
- **Water holding or retention capacity** of soil refers to the ability of soil to retain water against the force of gravity. It is a crucial property that determines the amount of water available to plants for uptake and use.

Activity 3 (Optional)

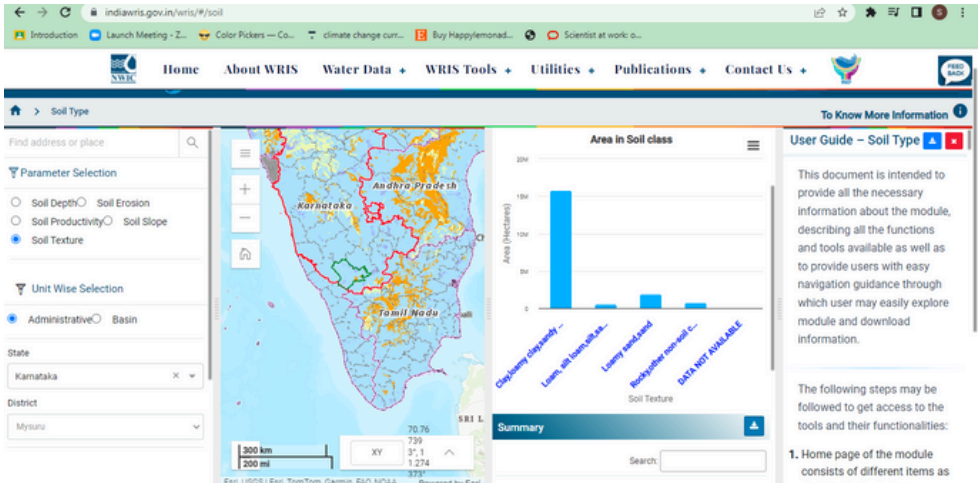
Using the soil texture triangle

- The soil texture triangle helps us categorise soils based on their texture and infer their permeability and water holding capacity. These characters influence what kind of plants grow in these soils and their erosion rates of soil
- Print the soil texture triangle from here for your class - https://cdn.agclassroom.org/media/uploads/2015/10/20/Soil_Texture_Triangle.pdf
- For the percentage of soil texture calculated above , look at the category in which our soil fall into in the triangle (see example on page 100)



- In the base of the triangle of sand category (side BC), mark the percentage of sand and draw a straight line from this point to side AC, parallel to side AB
- In the clay category (side AC), mark the percentage of clay and draw a straight line from this point to side AB, parallel to side BC.
- Similarly in silt category, mark the percentage on side AB, and draw a traight lint to side BC, parallel to AC.
- The point of intersection of all three lines is our soil category.
- Our example soil sample from Page 99 falls under the **Sandy Clay loam** category

- You can also get the soil texture information in your district, at this site https://indiawris.gov.in/wris/#/soil - Visit this link and select appropriate options on the side panel, such as state, district and select soil texture parameter
- Read more about the characteristics of each soil component here - https://ahdb.org.uk/knowledge-library/characteristics-of-different-soils
- Use the questions in the discussion section to connect soil characters to weather and climate change

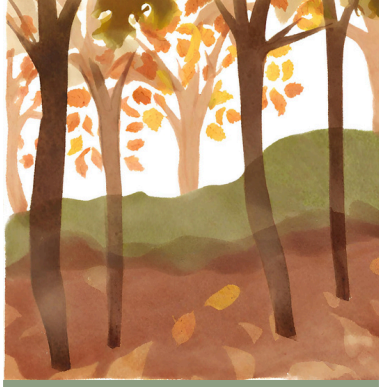


Discussion

- What was the percentage composition of the three soil samples you analysed?
- What was the most enjoyable part of doing the soil analysis - collecting samples, feeling texture, calculating composition, or figuring out soil type?
- What happens when soil is mostly clayey? Will it retain more water than soil that is mostly sandy? why or why not?
- What kind of soils do not get water logged, but at the same time hold enough water for plants to grow?
- How does organic matter help in water absorption during the monsoon?
- What are soil pores? What type of soil has the least amount of pores? What type of soil has most pores?
- Why is the top soil important?
- During drought and intense heat, soil particles lose moisture and soil particles reduce in size and come close together, becoming less porous. Imagine there is a sudden downpour of intense rainfall over this dry bed of soil, do you think water will get absorbed or will it run off?

Soil in our local ecology

The shola forests found in the Western Ghats, play a crucial for the maintenance of numerous rivers across the Indian peninsula. These forests primarily feature loamy soil, which is characterized by its abundance of organic matter. Notably, this soil type demonstrates exceptional water retention and permeability. The roots of these vegetation go deep into the soil, sometimes reaching depths of up to 80cm! Furthermore, a significant amount of leaf litter contributes to high levels of organic matter in the soil composition. Could these elements serve as the catalysts behind the shola forests' remarkable capacity to act like absorbent sponges, that soak up all moisture and gently release it? What do you think?



Class/Grade

6-12

Activity

Outdoor (Weekend)

Period of Activity

Any time of the year

Materials Needed

notebook/pen, plastic tray,

Curricular links

NCERT

- Class 7, Social Science, Geography, Chapter 3, Our changing Earth
- Class 9, Social Science, Geography, Chapter Physical Features of India
- Class 9, Agriculture, Unit 4- Soil nutrient management in vegetable crops - Vocational stream
- Class 12, Biotechnology, Chapter 11, Bioremediation

Vegetation and soil

Overview

Soil conditions in an area can determine what type of vegetation grows there. Vegetation, in turn, modifies soil conditions through leaf litter, weathering, and adherence. The presence of plants plays a crucial role in soil stabilization against erosion by rain and wind. Through decomposition of dead organic matter and the existence of root structures, soil develops a can absorb and retain more water, while simultaneously reducing soil erosion and water runoff. Beneath the soil surface, diverse life forms including earthworms, nematodes, insects, and microorganisms contribute to enriching the soil with essential nutrients. This interaction between vegetation and soil is mutually influential—a two-way exchange shaping the environment.

Students will investigate soils from three types of land-use - from beneath dense tree cover, another from within a home or school garden, and a third without any vegetation cover. In each plot, students will excavate soil to a depth of a few centimeters, analyzing and documenting the presence of dead plant and animal matter, as well as living organisms such as earthworms and insects. Additionally, they will examine the root structures of small plants in the plot. This activity aims to foster an understanding among students of the critical role played by soil organic matter in soil conservation.

Learning Objective

Observe and compare the influence of vegetation and decomposing organic matter on different soils

Detailed Activity

- Before starting the activity, identify safe and accessible locations suitable for exploration of soil, close to your school, or within your school if possible.
- Choose sites - a spot beneath a tree canopy where fallen leaves are not regularly removed, another spot in your school garden, and a third location with bare or exposed soil without vegetation.
- Begin by introducing the class to the concept of decomposition and its significance. On a clear day, visit the three sites and mark a 1m x 1m square plot, where all observations will take place.
- Students should dig a hole 20 cm deep at the centre of each 1m x 1m plot using a scoop. Remove the soil and place it in a tray for examination.
- Ask students to examine examine the soil from the tray, noting its texture, wetness, and color. Look for dry twigs, leaves, or decomposing flowers in the soil mixture. Additionally, search for dead insect parts, live earthworms, and other soil-dwelling animals. Observations should be recorded in the table provided below
- Examine any small plants in plot 1 and plot 2, if present. Uproot the plants and instruct students to identify whether they have taproots or fibrous roots. Observe how soil is clumped together in the roots. Underscore the importance of root structures in holding soils together.
- Use the questions in the Discussion section to develop an understanding about the interconnectedness of vegetation and soil

Observation table
(fill in details as given in the example, or tick the appropriate option)

Date_____

S.No	Observations	Plot 1 (under tree canopy)	Plot 2 (garden)	Plot 3(bare soil)
1	Soil texture (feel)	*Soft and smooth*		*Hard and clumped*
2	Soil moisture			
3	Soil colour			
4	Soil porosity	Good/Moderate/Poor		
5	Dead -leaf, flowers, twigs	Yes/No	Yes/No	Yes/No
6	Dead insect parts/earthworms	Yes/No	Yes/No	Yes/No
7	Live animals (earthworms, insects)	Yes/No	Yes/No	Yes/No

Resources

Click the links below to open the resource

- Our living soil
- Watch: How soil organisms break down plant components and create soil pores
- More than half of life on Earth is found in soil – here's why that's important

Glossary

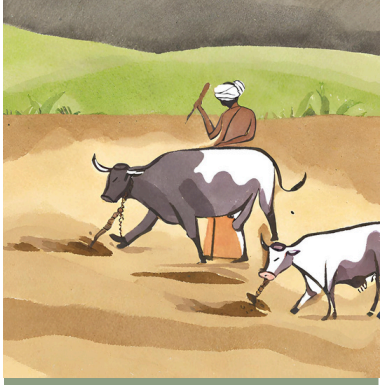
Soil Organic Matter (SOM) is the fraction of the soil consisting of various plant and animal residues.

Discussion

- What was the most striking difference between the soil in the three sites?
- What part of this activity was most interesting to you?
- Are the trees in your vicinity currently blossoming, bearing fruit, or shedding their leaves? Where do the fallen leaves and flowers typically accumulate?
- Which of the three soils exhibited a most number of living or dead animals?
- How does the decomposition process transform dry leaves, flowers, twigs, and deceased animals/insects into organic matter?
- What kind of soil texture did you notice in the plot lacking trees or plants?
- How do weather conditions and geological formations influence soil dynamics, affecting the suitability of plant growth?
- Why are earthworms and other microorganisms crucial in soil ecosystems?
- What types of plants and soil characteristics are typically observed in desert environments?
- In mountainous regions devoid of trees, how might an intense rainfall event affect the soil?
- If the ground experiences severe drought conditions, how will it impact the plants and other organisms residing beneath the soil?
- Do you believe planting trees across all landscapes is advisable?

Vegetation mirrors local ecology

Have you noticed the shape and size of leaves of the trees around you?
In semi-arid and desert regions, vegetation often features smaller leaves and thorny plants and trees. This adaptation helps minimize water loss through transpiration from the leaves. In these regions, the soil typically contains lower levels of organic matter, resulting in reduced water penetration.
What adaptations do the vegetation in your region have for conserving/accessing water from the soil?



Class/Grade

10-12

Activity

Indoor (Chemistry lab)

Period of Activity

Any time of the year

Materials Needed

Soil samples collected from three different habitats (eg farm, open natural environment, soil under a canopy of trees), titration reagents, chemicals and glassware as per Walkley-Black Method

Notes to teacher

This experiment should be facilitated by a Chemistry teacher, and will require a chemistry lab setup.

Curricular links

NCERT

- Class 11, Chemistry, Chapter 14, Environmental chemistry
- Class 12, Biology, Chapter 14, Ecosystems

Measuring soil organic carbon

Overview

The carbon component of soil organic matter is derived from decomposed plant and animal matter. It forms through the decomposition of organic materials by soil microorganisms, such as bacteria and fungi, in a process called mineralization. Soil Organic Carbon (SOC) levels are influenced by factors like climate, vegetation type, soil texture, and land management practices. It plays a vital role in soil fertility, structure, water retention, and carbon sequestration.

In this activity students will collect soil samples and measure the soil organic content using a chemical titration method. Soil organic content will be calculated for the different soils. Through this activity and the following discussion, students will understand how climate change can alter soil organic content

Learning Objective

Understand the variation of soil organic carbon content across different soil types and learn to quantify these differences through a standard lab technique

Detailed Activity

- Students should be grouped into 3 batches,
- Ask each batch to collect one soil sample of 100g each from three different habitats (eg farm, open natural environment, soil under a canopy of trees)
- The soil samples should be air dried for a week inside the school/classroom
- The indirect method of assessing soil carbon is by looking at the colour of the soils -, the darker the colour the higher the organic content. Ask students to evaluate which batch of soil is likely to have higher organic carbon content.

Resources

Click the links below to open the resource

Watch- The protocol and procedure for estimating percentage of organic carbon in soil

- To quantify the organic content of the soil, a titration experiment and calculation needs to be carried out using the Walkley-Black method that involves digesting the soil using chromic acid, ferrous sulphate, followed by titration as given in the Standard Operating Procedure by FAO. A more accessible form of the method, along with the background is available on this link.

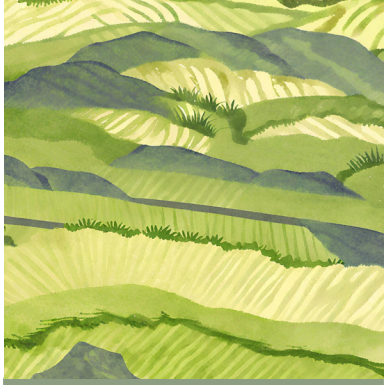
Discussion

The following questions can be asked to students to connect soil carbon with climate -

- Of the three samples of soils titrated, which soil had a high soil organic carbon content?
- Why do old growth forests store more carbon? How will deforestation of these forests contribute to increase in CO_2 emissions?
- In degraded landscapes do you think soil organic carbon will be high or low?
- What happens to soil carbon when a tree is uprooted?
- What kind of impact do you think tilling of farm lands have on soil organic carbon ? (Tillage can cause significant loss of carbon by disturbing the soil organic matter of the soil by CO_2 emissions)

Organic matter and lignite

1934, T.M.Jambulingam Mudaliyar was digging a well in his farm in Neyveli, in Tamil Nadu. Black liquid gushed out with the water. This turned out to be lignite- compressed peat soil. Peat soil are formed by the accumulation of dead vegetative or organic matter for several year. Today this site is a thermal power plant named the Neyveli lignite corporation. Do you know of any soil carbon stories from your region?



Soil Erosion

Class/Grade

6-9

Activity

Outdoor

Period of Activity

Any time of the year (after the rains)

Materials Needed

Notebook, pen/pencil

Curricular links

NCERT

- Class 11, Geography, Chapter 6 Soils
- Class 12, Biology, Chapter 14, Ecosystems

Overview

Soil erosion mainly happens when soil is exposed to strong winds, heavy rainfall, and flowing water. Human activities, such as farming and land clearing, can make soil more prone to erosion. Overgrazing and deforestation are additional causes of soil erosion. Climate change has exacerbated the situation with extreme weather events like heavy rainfall and flooding. Additionally, increasing temperatures impact soil moisture and its structure, leading to increased erosion by wind and water. Students will visit their school surroundings after a rainy day to identify the different types of soil erosion that occurs. They will also discuss how climate change exacerbates this condition, through discussion

Learning Objective

Observe and identify soil erosion that occurs in the environment through field exploration.

Detailed Activity

- Soil erosion is often easy to recognize - some common types of erosion are given on Page 109.
- Go outdoors on a field trip to any nearby ecologically significant site. This could be a wetland, forest, or hill.
- On the way to this site, stop at a few locations and see if you can observe soil erosion along the roadside. Typically you may observe soil run off along the side of the roads, edge of barren lands. Make a note of the places, landscape structure and features where you stop.
- At each stop, encourage students to look for signs of soil erosion and identify what kind of soil erosion it is (see reference photos on Page 109)
- Take pictures or make drawings of the location at which you observe soil erosion
- Repeat this activity at your field visit destination.

SHEET EROSION

©goseed.com

Sheet erosion occurs when the thin upper portion of the soil is displaced, usually due to heavy rain or water runoff.

RILL EROSION

©Donal Mullan

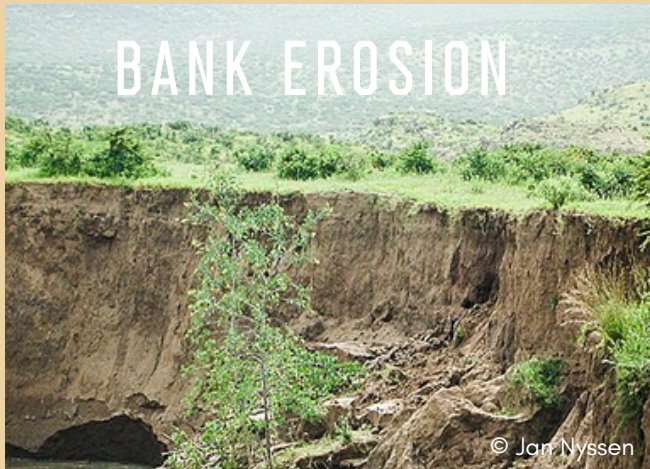
Rills are shallow drainage channels that form as rainwater flows into depressions in the land.

GULLY EROSION

© Sayvhior

Gully erosion occurs when runoff flows strongly and is concentrated in one location. Gullies often begin as a rill that transitions into a small "waterfall" that eats away topsoil.

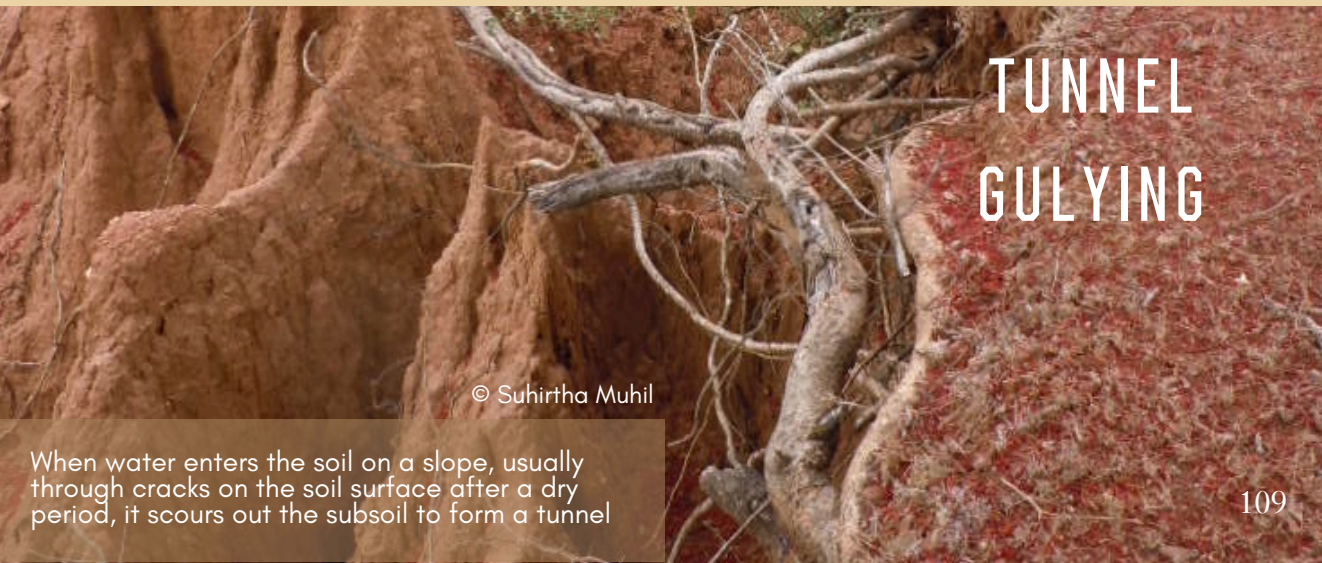
BANK EROSION



© Jan Nyssen

When the banks of rivers or ponds wear away, it is called bank erosion

TUNNEL GULYING



© Suhirtha Muhil

When water enters the soil on a slope, usually through cracks on the soil surface after a dry period, it scours out the subsoil to form a tunnel

Resources

Click the links below to open the resource

- *Soil erosion by water*
- *Types of erosion*
- *Soil erosion 101*
- *Soil water erosion and conservation*

Discussion

- From the field visit, list down the areas where you observed soil erosion
- How did it feel to observe the dramatic impact of rainfall on soil?
- What types of soil erosion did you observe?
- Can wind cause soil erosion? How do you think that occurs?
- How does soil organic matter help in preventing soil erosion?
- How will soil erosion affect a farmer? How can the farmer mitigate this problem?
- How can tree loss increase incidence of soil erosion?
- What happens to the soil after soil erosion? What important component does it lose? (Nutrients, topsoil)
- Why is it important to conserve the topsoil?
- What can we do to prevent soil erosion?
- How can climate change exacerbate soil erosion?

Soil degradation and people

Humans are dependent on soil for a vital part of their survival - food. Over time, before the advent of industrialised agriculture, humans have figured out ingenious ways to get more out of the same soil ! But things have changed - our overuse of soil for industrialised food production, deforestation and erosion, urbanisation, and soil pollution have all contributed to a decline is soil quality across India. What does this mean for our country? Read about this issue here -
Soil degradation in India spells doom for millions

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Illustration of *Tamarindus indica and Cassia fistula* flowers by Neelam Modi (www.byneelam.com)

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