Food and Agriculture Organization of the United Nations

YUNGA LEARNING AND ACTION SERIES

Soils Challenge Badge

CBD :: FAO :: GSP
UNCCD :: WAGGGS :: WOSM

This booklet is intended as a guide for teachers and youth leaders. These individuals are responsible for the development of programmes and activities which are suitable for their group and provide the required supervision and safety precautions to ensure all participants are safe and sound.

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YOUTH AND UNITED NATIONS GLOBAL ALLIANCE (YUNGA)

Soils Challenge Badge

Developed in collaboration with

Food and Agriculture Organization of the United Nations

SCOUTS

Convention on Biological Diversity

GLOBAL SOIL PARTNERSHIP

UNCCD
United Nations Convention to Combat Desertification

The World Association of Girl Guides and Girl Scouts (WAGGGS) and the World Organization of the Scout Movement (WOSM) endorse this educational badge framework for use by Guides and Scouts around the world, adapting it as necessary to their local needs and requirements.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS | 2015

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WELCOME

“Soil is essential for life – it provides nutrients, water and minerals to plants and trees, and is home to millions of insects, bacteria and small animals.

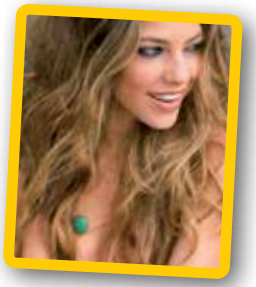
Without soil, we would not be able to grow any crops or other useful plants, support any livestock, or have materials for building shelter – soil really is a life-giver! Healthy soils also store and filter water, recycle nutrients and help us to deal with the negative effects of climate change by storing large amounts of carbon. But our soils are at risk; negative actions such as pollution and bad agricultural practices leave our soils exposed and damaged. We need healthy soils to support human well-being and a healthy planet.

This is where the Soils Challenge Badge comes in: let it take you on a journey to discover the ground beneath your feet! This booklet is packed with activities to help you learn about soil and how it is formed, the creatures that live in it, and just how important it is in our everyday lives. You will also discover how YOU can play a role in protecting soils for future generations. We hope you will be inspired to take the challenge and celebrate our planet’s soils. Dig in!”

YUNGA AMBASSADORS

Anggun

Carl Lewis



Debi Nova

Fanny Lu

Lea Salonga

Nadeah

Noa (Achinoam Nini)

Percance

Valentina Vezzali

BE SAFE AND SOUND!

DEAR LEADER OR TEACHER,

The Challenge Badges are designed to support you in undertaking educational activities. However, as you will be implementing these activities in different contexts and environments, it is up to you to ensure that the activities you choose are appropriate and safe.

LOOK AFTER YOURSELF

* Wash your hands carefully after every activity. Some soils may contain harmful chemicals and insects so it is very important that you keep your hands clean. You may even want to wear gloves.
* Be careful of insects and small animals when handling soil – some of them may bite.
* Always wear gloves when handling litter or garbage.
* Don't taste things you find unless you are absolutely certain that they are not poisonous.
* Don't drink water from natural sources unless you are sure it is safe.
* Don't look directly at the Sun.
* In some activities, you have the option of uploading pictures or videos to Web sites such as YouTube. Always make sure that everyone in the pictures or video, and/or their parents, have given their permission before you post anything online.

Please carefully plan and undertake activities with enough adult support to ensure that participants are safe, especially when near water or fire. Please consider the general precautions in the boxes below and carefully evaluate which other safety issues need to be taken into account before undertaking any activity.

LOOK AFTER THE NATURAL WORLD

- Treat nature with respect.
- It is better to leave nature as you found it. Never pick protected species. Before collecting plants, picking flowers, or taking a soil sample, get permission. Only take what you really need and make sure you leave at least one third of anything you find in the wild.
- Minimize your impact: stick to designated paths if you are walking through nature, carefully refill any holes you dig in the soil and be careful not to introduce any alien (non-native) species to a habitat.
- Be careful if you are working with animals. Wear protection if necessary. Be gentle. Make sure animals have appropriate food, water, shelter and air. When you're done, return them to where you found them.
- Do not leave any litter. Recycle or reuse the materials used in the activities as much as possible.

THE CHALLENGE BADGE SERIES

Developed in collaboration with United Nations agencies, civil society and other organizations, the YUNGA Challenge Badges are intended to raise awareness, educate and motivate young people to change their behaviour and be active agents of change in their local communities. The Challenge Badge series can be used by teachers in school classes, youth leaders and especially Guide or Scout groups.

To see existing badges go to www.fao/yunga. To receive updates on new releases and other YUNGA news, register for the free YUNGA newsletter by emailing yunga@fao.org.

YUNGA has or is currently developing badges on the following topics:

AGRICULTURE: How can we grow food in a sustainable way?

BIODIVERSITY: Let's make sure no more of the world's glorious animals and plants disappear!

CLIMATE CHANGE: Join the fight against climate change!

ENERGY: The world needs a healthy environment as well as electricity – how can we have both?

FORESTS: Forests provide homes for millions of plant and animal species, help regulate the atmosphere and provide us with essential resources. How can we ensure they have a sustainable future?

GENDER: What actions can be taken to create a more equal and fair world for girls and boys, women and men?

GOVERNANCE: Discover how decision-making can affect your rights and equality between people around the world.

HUNGER: Having enough to eat is a basic human right. What can we do to help the 1 billion people who still go hungry every day?

NUTRITION: What is a healthy diet and how can we make food choices which are environmentally friendly?

OCEAN: The ocean is mesmerizing and amazing. It helps regulate temperatures on Earth, provides us with resources and much, much more.

SOILS: Without good soil, nothing grows. How can we take care of the ground under our feet?

WATER: Water is life. What can we do to safeguard this precious resource?

CREATING BEHAVIOUR CHANGE

We work with young people because we want to support them in leading fulfilling lives, help them prepare for their futures, and to encourage them to believe that they can make a difference in the world. The best way to make this difference is by encouraging young people to embrace long-term behaviour change. Many current social and environmental problems are caused by unhealthy or unsustainable human behaviour. Most people need to adapt their behaviour – and not just for the duration of a project such as working on this badge, but for life. Many young people today know that doing good is more than an extracurricular activity: it's about how you lead your life. Small changes to your daily behaviours can really help us create a brighter future.

So what can you do?

There are some proven ways of promoting behaviour change, so to increase the long-term impact of this Challenge Badge, try to do the following:

FOCUS ON SPECIFIC, ACHIEVABLE BEHAVIOURAL CHANGE
Prioritize activities which target very clear and specific behaviour change (e.g. 'dispose of all litter properly and carefully and reuse and recycle what you can', instead of 'keep your environment clean').

ENCOURAGE ACTION PLANNING AND EMPOWERMENT
Put young people in charge: let them choose their own activities and plan how to carry them out.

CHALLENGE CURRENT BEHAVIOUR AND TACKLE BARRIERS TO ACTION Encourage participants to scrutinize their current behaviour and think about how it could be changed. Everyone has excuses for why they don't behave in a particular way; lack of time, lack of money, not knowing what to do… the list goes on. Encourage young people to voice these excuses and then find ways around them.

PRACTISE ACTION SKILLS You'd like to take public transport more often? Collect and practise reading timetables, plot out routes on a map, take a walk to the bus stop, find out what the fare is, do a trial journey. You'd like to eat more healthfully? Try lots of healthy foods to see which you like, experiment with recipes, learn how to read food labels, create meal planners, visit the shops to find healthy foods on their shelves. Keep practising until it becomes a habit.

SPEND TIME OUTDOORS No one is going to look after something they don't care about. Time spent in natural environments – whether that is the local park or a pristine wilderness – encourages an emotional connection with the natural world which is proven to lead to more pro-environmental behaviour.

GET FAMILIES AND COMMUNITIES INVOLVED Why change the behaviour of just one young person when you could change the behaviour of their entire family, or even the whole community? Spread your message more widely: showcase what you have been doing for the local community and encourage young people to pester their family or friends to join in. For an even bigger impact, get political and lobby your local or national government.

MAKE A PUBLIC COMMITMENT People are far more likely to do something if they agree to do it in front of witnesses or in a written statement – why not take advantage of this? Young people are more likely to achieve their goals if they share them with friends and family who support them and hold them accountable.

MONITOR CHANGE AND CELEBRATE SUCCESS Behaviour change is hard work! Revisit tasks regularly to monitor achievement and reward continued success in an appropriate way.

LEAD BY EXAMPLE The young people you work with look up to you. They respect you, care about what you think and want to make you proud. If you want them to embrace the behaviour you are advocating, then you must lead by example and make those changes yourself.

TIPS ON UNDERTAKING THE BADGE WITH YOUR GROUP

In addition to the suggestions on pp.10-11 encouraging behavioural change, the following ideas will help you develop a programme to undertake the Challenge Badge with your group.

STEP 1 INVESTIGATE

Encourage your group to learn about soil – how a thin layer of the Earth's surface supports all life on the planet, and the risks that we will face if we do not start looking after it. This video called 'The Value of Soil' provides a useful summary: **www.youtube.com/watch?v=fH0wZS0705E&list=PLsQcCFzasV6orJM3yYYTc5q0a9Yj7fT76**. Start by raising participants' awareness about our dependence on soil: soil plays an essential role in producing the majority of our food, our fuel, and the fibres we use for clothing and textiles; soil provides the basis for natural beauty in our environments; soil helps in regulating water and atmospheric gases and sequesters carbon. Make sure they understand that soil is a non-renewable resource in the human timeline and that human activity is causing severe soil degradation in different parts of the world. Explain how this degradation affects people's lives and livelihoods, and entire ecosystems. Then discuss with the group how our individual choices and actions can help make a positive difference.

STEP 2 SELECT

Apart from the compulsory activities, which ensure that participants understand basic concepts and issues related to soil, participants are encouraged to select the activities that best match their needs, interests and culture. As far as possible, let the participants choose which activities they want to do. Some activities can be done individually, others in small groups. If you have another activity that is especially appropriate for your group or area, you may also include it as an additional option.

STEP 3 ACT

Allow enough time for the group to carry out the activities. Support and guide them through the process but make sure they carry out their tasks as independently as possible. Many activities can be conducted in several different ways. Encourage participants to think and act creatively when undertaking their activities.

STEP 4 DISCUSS

Have participants present the results of their Challenge Badge activities to the rest of the group. Do you notice any changes in their attitudes and behaviour? Encourage participants to think about how their daily activities both depend upon and affect soil. Discuss the experience and reflect on how they can continue to apply it in their lives.

STEP 5 CELEBRATE

Organize a celebration for those who successfully complete the badge curriculum. Invite families, friends, teachers, journalists and community leaders to participate in the celebration. Encourage your group to present the results of their project to the community in a creative way. Award them with certificates and Challenge Badges (see p.102 for details).

STEP 6 SHARE WITH YUNGA!

Send us your stories, photos, drawings, ideas and suggestions: **yunga@fao.org**.

BADGE STRUCTURE AND CURRICULUM

The Soils Challenge Badge is designed to help educate children and young people about the crucial role that soils play for life on our planet. This booklet will help you develop an appropriate, enjoyable and engaging educational programme for your class or group.

This booklet includes basic **background information** on relevant educational topics, aiming to help teachers and youth leaders to prepare their sessions and group activities without having to search for the information. Contents include: how soil is formed, the different layers of soil, soil functions and uses, the factors damaging soils around the world, and what steps we can take to help conserve and manage soils sustainably. Naturally, not all the materials provided will be required or appropriate for all age groups and activities. Leaders and teachers should therefore select the topics and level of detail most appropriate for their group.

The second part of the booklet contains the **badge curriculum**, a range of activities and ideas to stimulate learning and motivate children and young people to engage in soil issues. A checklist to help participants keep track of the activities they have completed is provided at the end of the curriculum. Additional resources, useful Web sites and a glossary explaining key terms (which are highlighted in the text like **this**) are provided at the end of the booklet.

Badge structure

For ease of use and to ensure that all the main topics are addressed, both the background information (pp.24-75) and the activities (pp.76-101) are divided into four main sections:

A. **ALL ABOUT SOILS**: explains how soil is formed, what it contains, and the biodiversity found within it.

B. **SOIL USES**: describes the myriad ways in which soil supports life on Earth.

C. **SOIL AT RISK**: explains the various factors causing soil degradation.

D. **TAKE ACTION**: provides tangible ideas for helping to conserve soil and manage it sustainably.

Requirements: To earn the badge, participants must complete one of the two compulsory activities presented at the beginning of each section, plus (at least) one additional activity from each section, chosen individually or as a group (see graphic on p.16). Participants can also complete additional activities considered appropriate by the teacher or leader.

Section A: ALL ABOUT SOIL

1 compulsory activity (A.1 or A.2) & at least 1 optional activity (A.3 - A.14)

+

Section B: SOIL USES

1 compulsory activity (B.1 or B.2) & at least 1 optional activity (B.3 - B.15)

+

Section C: SOIL AT RISK

1 compulsory activity (C.1 or C.2) & at least 1 optional activity (C.3 - C.14)

+

Section D: TAKE ACTION

1 compulsory activity (D.1 or D.2) & at least 1 optional activity (D.3 - D.13)

=

Soils Challenge Badge
COMPLETED!

Age ranges and appropriate activities

To help you and your group select the most appropriate activities, a coding system is provided to indicate the age group(s) for which each activity is most suitable. Next to each activity, a code (for example 'Levels 1 and 2') indicates that the activity should be suitable for five to ten year olds and eleven to fifteen year olds.

However, please note that this coding is only indicative. You may find that an activity listed at one level is suitable for another age group in your particular circumstances. As teachers and youth leaders you should use your judgement and experience to develop an appropriate curriculum for your group or class. This could incorporate additional activities not listed in this booklet but which allow you to achieve all the educational requirements.

LEVEL

1 **Five to Ten years old**

2 **Eleven to Fifteen years old**

3 **Sixteen plus years old**

REMEMBER!

The key objectives of the Challenge Badge are to educate, inspire, stimulate interest in soil issues and motivate individuals to change their behaviour and create local and international action. However, most of all, the activities should be **fun**! Participants should enjoy the process of earning the badge and learning about soil and its importance.

SAMPLE BADGE CURRICULA

The sample curricula for the different age groups below provide examples of how the badge could be earned and are intended help you develop your own programme.

LEVEL

1 **Five to Ten years old**

2 **Eleven to Fifteen years old**

3 **Sixteen plus years old**

Each activity has a specific learning objective, but in addition to this, children will also be expected to learn more general skills including:

* TEAMWORK
* IMAGINATION AND CREATIVITY
* OBSERVATION SKILLS
* ENVIRONMENTAL AWARENESS
* NUMERACY AND LITERACY SKILLS

SECTION	ACTIVITY	LEARNING OBJECTIVE
A All about soil	**A.1: Dig Deep** (p.77)	To visit local soil ecosystems and make observations.
	A.5: Insect Insights (p.79)	To research and explore how one particular soil organism uses and survives in the soil ecosystem.
B Soil uses	**B.1: Soil Survey** (p.85)	To list and present the wide range of ways that soil affects people's everyday lives.
	B.6: Dusty Drawings (p.87)	To paint with soils in order to discover different soil textures and appearances.
C Soil at risk	**C.1: Soil Check-up** (p.91)	To identify the factors that harm soil locally.
	C.7: Watching the Weather (p.93)	To observe the connection between climate and soil quality.
D Take action	**D.1: Soil Celebration** (p.97)	To organize a 'Soil Day' to motivate activism among family and friends.
	D.5: Green Gardening (p.98)	To prepare a compost bin or a poster about the importance of soil.

LEVEL

1 Five to Ten years old

2 **Eleven to Fifteen years old**

3 Sixteen plus years old

As in Level 1, each activity in Level 2 has a specific learning aim, but also fosters additional, more general skills including:

* TEAMWORK
* INDEPENDENT STUDY SKILLS
* IMAGINATION AND CREATIVITY
* OBSERVATION SKILLS
* ENVIRONMENTAL AWARENESS
* RESEARCH SKILLS
* PRESENTATION AND PUBLIC SPEAKING SKILLS
* DEBATING SKILLS

SECTION	ACTIVITY	LEARNING OBJECTIVE
A All about soil	**A.2: Earthy Analysis** (p.77)	To learn about the different soil types and where they exist around the world.
	A.7: Rooting About (p.79)	To plant a tree or another plant and care for it, in order to discover the importance of healthy soil for plant growth.
B Soil uses	**B.2: Soil and Health** (p.85)	To make a poster about the relationship between soil and human health.
	B.13: Foraging for Facts (p.89)	To list favourite foods and investigate what type of soil is used in their production.
C Soil at risk	**C.2: Global Grounds** (p.91)	To study a region with severe soil degradation and the problems that this degradation causes.
	C.9: Q & A (p.94)	To prepare concrete questions and answers about soil's role in agriculture.
D Take action	**D.2: Dishing Out Dirt** (p.97)	To create an exhibit about soil to motivate activism among family and friends.
	D.6: House Watch (p.99)	To alter behaviour at home, such as using less water and turning off the lights.

LEVEL

1 Five to Ten years old

2 Eleven to Fifteen years old

3 Sixteen plus years old

General skills a Level 3 curriculum seeks to develop include:

* **TEAMWORK**
* **INDEPENDENT STUDY**
* **IMAGINATION AND CREATIVITY**
* **OBSERVATION SKILLS**
* **ENVIRONMENTAL AWARENESS**
* **TECHNICAL SKILLS**
* **RESEARCH SKILLS**
* **PRESENTATION AND PUBLIC SPEAKING SKILLS**
* **DEBATING SKILLS**

SECTION	ACTIVITY	LEARNING OBJECTIVE
A All about soil	**A.1: Dig Deep** (p.77)	To visit local soil ecosystems and make observations.
	A.9: Growing Pains and Gains (p.80)	To visit a farm and prepare relevant questions for farmers about soil and agriculture.
B Soil uses	**B.2: Soil and Health** (p.85)	To make a poster about the relationship between soil and human health.
	B14: Changing Climates (p.89)	To make a presentation about the connection between soil and climate change.
C Soil at risk	**C.1: Soil Check-Up** (p.91)	To identify the factors that harm soil locally.
	C.12: SOMething Good (p.95)	To make a presentation about the importance of SOM and how to prevent SOM damage.
D Take action	**D.2: Dishing Out Dirt** (p.97)	To create an exhibit about soil to motivate activism among family and friends.
	D.10: Shop-Soiled (p.100)	To investigate organic and fair trade products in local supermarkets and create a presentation about their role in protecting soil.

ALL ABOUT SOIL

Why do you think we call our planet 'Earth'? Because without the earth underneath our feet, life as we know it wouldn't exist! You may even have heard of our world being referred to as 'Mother Earth' – that's because soil (aka earth) provides us with so many benefits and supports virtually all land-based plant and animal life directly or indirectly. If you're thinking 'what on Earth are they on about?' keep reading. Fun facts and nitty-gritty details await...

WHAT IS SOIL?

Soil makes up the outermost layer of the Earth, in which plants and trees grow. We use many different words for it: earth, soil, dirt, mud, the ground; but what's the difference? Let's check out these different terms before we start.

* **Earth**: A general word for soil as well as a common name for our planet as a whole. 'Earth' with a capital 'E' refers to our planet, whereas 'earth' with a small 'e' refers to the soil.
* **Soil**: The top layer of the Earth's surface in which plants have their roots. Soil type and quality varies from place to place.
* **Dirt**: Displaced or loose soil.
* **Mud**: A liquid or semi-liquid mixture of soil and water.
* **Ground**: The solid surface that you walk on, which could be made of soil but also rock, sand or a manmade material.

DID YOU KNOW?

Roughly, soil is made up of air (25 percent of its volume), water (25 percent), **inorganic** **mineral** particles (45 percent), and **organic** matter (5 percent).

Organic material in soil

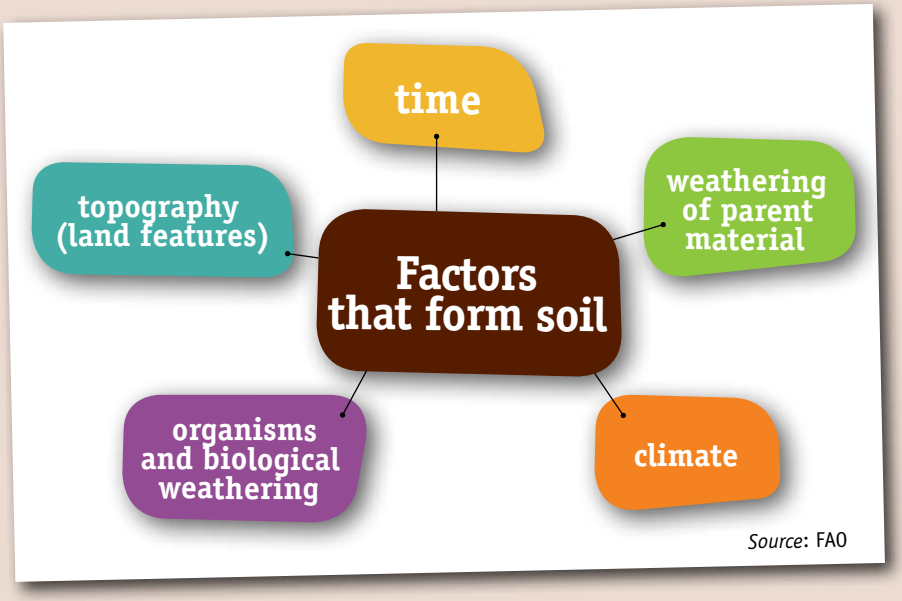
Scientists call the **organic** parts of soil '**soil organic matter**' (**SOM**) or **humus**. **Humus** is made up of dead plant and animal materials at different stages of decay, or **decomposition**. Fallen leaves that have rotted to the point where they are completely broken down and unrecognizable are an example of **SOM**. That may sound gross, but **SOM** contains a lot of **nutrients** (such as **carbon**) that are essential for plant growth. It is really important for the overall health of the soil, plants and crops, as well as the animals, insects and other **organisms** (living beings) that live in the soil. Dark coloured, moist soil is a sign of healthy soil that is rich in **humus**. Do the soils in your area look like they have a lot of **humus**? If not, don't worry – we will discover how you can add more **organic** materials to the soil later!

Inorganic materials in soil

Inorganic materials are the non-living parts of the soil, such as silt, clay and sand. They are made up of many solid particles of different shapes and sizes, and are really important for building the soil texture (learn more on p.33).

HOW IS SOIL FORMED?

There are many different factors that come together to create soil, and the process can take thousands of years. Let's take a look at the five main factors that influence soil formation.



DID YOU KNOW?

When the Earth was first formed, there was no **vegetation**, only rocks, lava and water. Millions of years ago, during the Ice Age and other geological periods, some of these huge rocks were broken down into gravel, clays and sand – making it easier to form soils from these smaller materials. The Earth as we know it today wouldn't exist in the same way without the Ice Age. Pretty 'cool', right?!

Weathering of parent material

Think of all the different types of **weather**: frost, wind, rain, snow, sunshine, etc. Well, these forces have a big impact on rocks, in a process called **weathering**. Over hundreds of years, **weathering** and **erosion** break down the bedrock (known as **parent material**) into smaller and smaller particles. These particles make up the **inorganic** material of soils, such as clay, sand and silt.

DO YOU KNOW THE DIFFERENCE BETWEEN WEATHER AND CLIMATE?

• **Weather** is fixed to a specific place and takes place within a fairly short time. For example, one day might be overcast and drizzly, another day could be sunny with fluffy clouds.

• **Climate** is what we call the average or typical **weather** conditions for a particular area. This 'area' could be a single city (e.g. some regions have a dry, hot **climate** while others may be cool and rainy) or the whole planet (e.g. we can calculate average global temperatures, or the average amount of rainfall globally).

Remember: **Climate** *helps you decide which clothes you need generally for where you live. Looking out of the window and seeing the* **weather** *helps you decide which of those clothes to wear each day!*

Organisms and biological weathering

Plants and animals (**organisms**) play a big role in how soil is formed. After bedrock is broken down by the physical **weathering** described above, it then faces a process of 'biological **weathering**'. This happens in a number of ways:

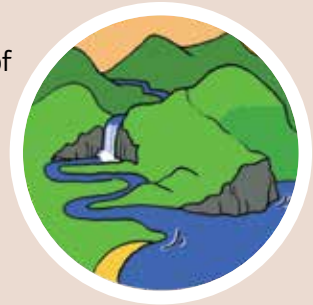
- When **organisms** such as moss or **lichen** start growing on the **parent material**, their roots produce a weak **acid** that helps them to get **nutrients** from the rock. Over time, this **acid** eventually dissolves the rock into smaller particles. Plant roots often grow in cracks too, widening them and sometimes even breaking up the rock as the plants grow bigger.
- Animals and **micro-organisms** also mix soils when they move around, forming burrows and small spaces between soil particles. Some examples of burrowing animals are earthworms, moles, rabbits and armadillos. Rabbits can even split rocks by working their ways into cracks!
- **Micro-organisms** also have a part to play, by helping chemical exchanges take place between roots and soil (learn more on p.39).
- Both plants and animals which are living **organisms** eventually become part of the **soil organic matter** when they **decompose** after dying.
- Humans are also **organisms** and we affect soil formation too. Human activities such as building, **deforestation**, and agriculture can affect the soil by adding or changing chemicals and changing how quickly soil is worn away (learn more in Section C).

Climate

You've probably noticed that soils are not the same in all parts of the world. One reason for this is because soils vary according to the **climate**:

* Temperature and moisture levels affect the amount and speed of **weathering** and **nutrient** loss (**leaching**). For example, rocks will be broken down quicker in warm, wet **climates** because the reactions happen quicker and **nutrients** are washed away more quickly.
* The amount, force, timing, and type of **precipitation** (rain, hail, snow, etc.) also influence how the soil is formed. For example, if it often rains hard in an area, then the **weathering** of **parent materials** will happen faster.
* Wind redistributes sand and other particles, especially in dry **climates**.
* **Climate** also affects the materials found in soil because **climate** affects the number of plants and animals in an area, as well as how quickly they **decompose** after dying to produce **SOM** (it is slower in cold and dry **climates**).

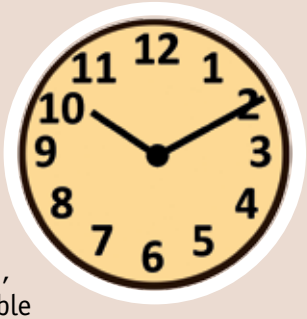
Topography



The **topography** of a place means 'the lay of the land', i.e. the land's physical features or shape, which can be flat, hilly or steep. **Topography** plays an important role in the type of soil that is created in an area. For example, the slope of a hill or mountain affects the moisture and temperature of its soil. Also, on steep slopes, soil can be washed away or blown away more easily. This means that instead

of building up a thick layer of **topsoil** over time, the **topsoil** on steep slopes is washed away (**eroded**) quicker than new soil can form there. These deposits go down the mountain, where they collect and stay in flatter, more level areas. This is why the soil on the steep parts of a mountain is thinner than on the flatter parts and thus less fertile. You will find different soil types in different topographical areas such as coastlines, rivers, **wetlands** or forests. How is the soil different in these locations and why do you think this is?

Time



Soil formation is a slow process that takes hundreds or even thousands of years. Depending where you are, it can take between 100 to 1 000 years to form just one centimetre of soil, yet this one centimetre can be washed away in few days if soil is not protected. For this reason, soils can be considered to be a non-renewable resource in the human time frame. With time soils develop their internal structure and **soil horizons** (layers) are formed. These present different properties – see the next section to learn more about them.

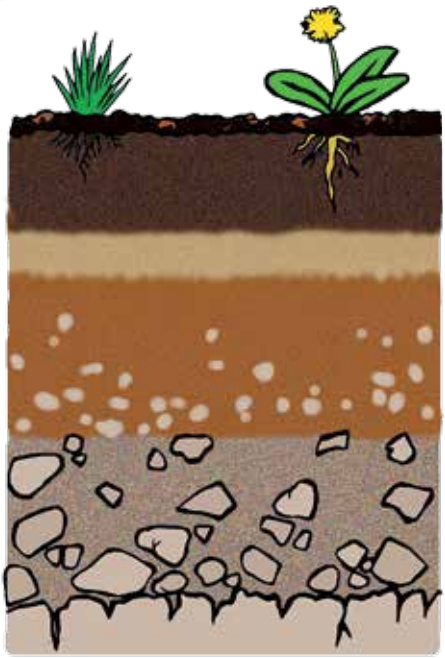
DID YOU KNOW?

It can take up to 1 000 years to produce just 2-3 cm of soil. If humans grew that slowly, it would take 80 000 years to grow a basketball player. Imagine that!

Source: **www.childrenoftheearth.org/soil-facts-for-kids/soil-facts-for-kids-11.htm**

Soil layers

Soil is formed when **organic** and **inorganic** materials are broken down. This process can take thousands of years. As a result of this very slow process, soil forms in different layers, also called **soil horizons**. There are six main horizons or layers, known as 'master **horizons**'. As you travel deeper underground, these horizons differ in texture, colour, biological activity and structure. Take a look at the diagram below.



Source: YUNGA, Emily Donegan

* **O horizon**: This layer is generally the uppermost layer of the soil. It is mainly made up of an accumulation of **organic** material (which is why it is called the 'O' horizon), such as leaves, needles, twigs, mosses and **lichens**, in various stages of decay. This horizon does not have much **mineral** content.

- **A horizon**: This horizon is found very close to the surface and is commonly called **topsoil**. Because it is the first horizon after 'O' it is called the A horizon. It contains large amounts of **minerals** (sand, silt, and clay) and **organic** materials. It is often the most fertile layer of the soil, rich in **humus**.

- **E horizon**: This horizon is light in colour and is prone to being **leached**. Leaching occurs when **nutrients** that are dissolved in the soil are lost because **precipitation** (rain, snow, etc.) or **irrigation** washes them away. 'E' stands for 'eluviate', which happens when minerals are **leached** from the soil.

- **B horizon**: Also called subsoil, this layer is usually lighter in colour than the A horizon because it contains less **organic** matter. It is formed through the accumulation of **minerals leached** from the A and E horizons. It is called the 'B' horizon because it is found below the A and E horizons.

- **C horizon**: This horizon lies between the soil and the underlying bedrock, or R layer. It is less **weathered**, or broken down, than the upper horizons. It contains loose, partially disintegrated material from the R layer. It is called the 'C' horizon because it is found below the A and B horizons.

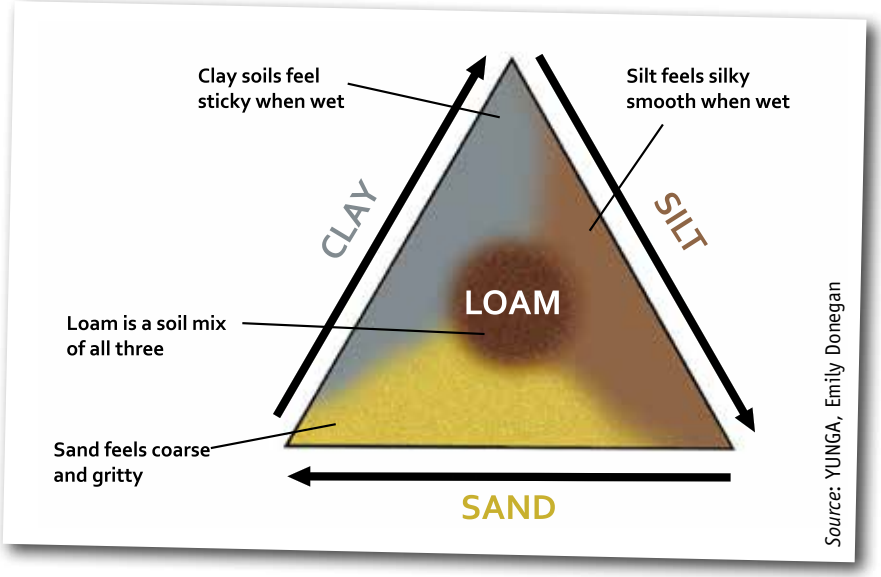
- **R horizon**: This layer is made up of solid rock which lies under the soil. This rock is also known as the 'bedrock' (because it's the 'bed' of all the other soil layers) or '**parent material**'. Granite, basalt, and hardened limestone or sandstone are examples of bedrock that belong to this category. The bedrock may contain cracks, but these are so few and so small that only a few roots can penetrate them. 'R' stands for rock.

Are you still with us after all those letters? The combination of all these **soil horizons**, from the top to the bottom, is called the **soil profile**. Note that in some cases, not all horizons will be present. For example, in fields the typical **soil profile** is A-B-C, whereas in forests it may be O-A-E-B-C. The R horizon may be very shallow or

very deep, depending on the **topography** and **climate** of the area. By studying the **soil profile**, soil scientists (called 'pedologists') and crop scientists (called 'agronomists') can figure out how that area's soil was formed. They can also understand the processes influencing the soil's health and condition and plan what the soils will be most appropriate for: for example, natural conditions, agriculture or forestry.

Soil texture

As you go deeper into the soil horizons, the soil texture changes. Why do you think that is? Well, the soil texture depends on the number of inorganic particles that are present in the soil. These have been divided into three groups based on their size: clay, silt and sand. Soil scientists can work out the soil texture using a textural soil triangle (see the graphic below). This is a practical exercise where you feel the soil to find out its texture. Grab a handful of soil and try this exercise yourself in Activity A.1 (p.77)! What type of particles do you feel in your hand?



Source: YUNGA, Emily Donegan

The size of the particles affects the soil properties, for example, clay particles are usually small and are very important since they can hold water and **nutrients** for the plants and other animals much better than sand and stones.

DID YOU KNOW?

If you collected all of the Earth's clay and spread it into one even layer, it would measure more than one and a half kilometres thick over the whole planet.

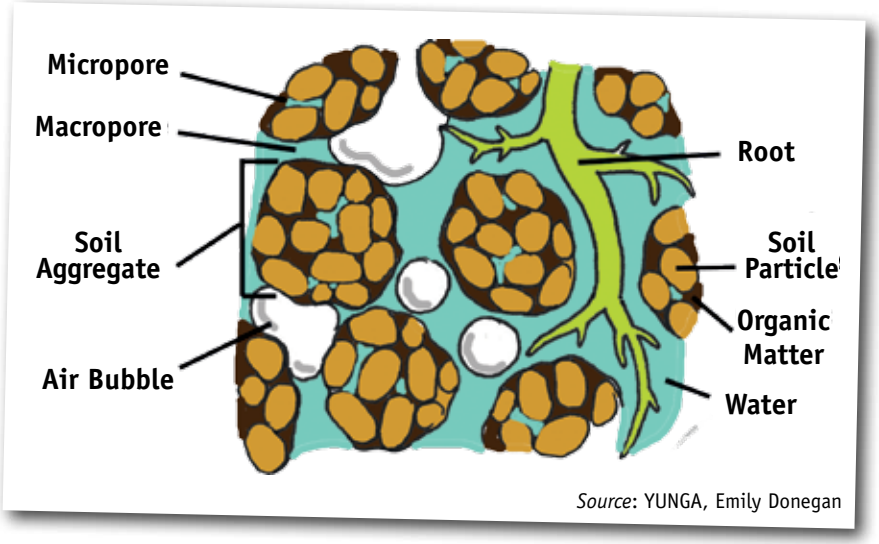
Source: **www.hgtvgardens.com/soil/fun-facts-about-garden-soil**

Soil structure

Just as the human body is made up of different parts such as organs and bones, the soil also has its own 'body', which we call the soil structure. Different **soil horizons** will have different soil structures. For example, the A horizon usually has a finer, more crumb-like structure; whereas a more blocky structure is more likely to be found in the B horizon. Soil structure is composed of little clumps known as '**aggregates**' and **pores** (the spaces between individual soil particles). Soil **aggregates** are particles that are stuck to each other, using **soil organic matter** like a glue to bind them together. The **aggregates** can vary in both size and shape depending on the soil properties. The **pores** that surround individual clumps are called 'macropores' ('big' **pores**). Water, air, animals and plant roots can pass through these 'macropores'. Roots and animals can also make their way in between these clumps through the 'micropores' ('small **pores**') where they find stored water and **nutrients** thanks to the clay particles. A soil structure in good condition will contain both macro and micropores that make it easy for plant roots and other animals to reach water and **nutrients**.

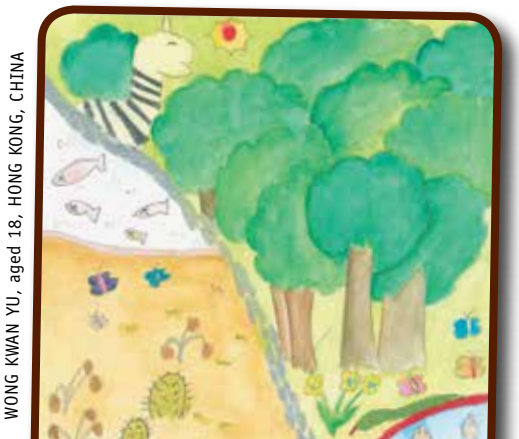
DID YOU KNOW?

Half of soil is made up of **pore** space. Generally, these **pore** spaces are half filled with water, and half filled with air, though it varies greatly depending on the soil texture, plant water use and **weather**.



Source: YUNGA, Emily Donegan

The soil structure differs depending on depth, soil types, land use and the **weather**. It will also change over time. Most changes in the soil structure are found on the surface layers of the soil.



WONG KWAN YU, aged 18, HONG KONG, CHINA

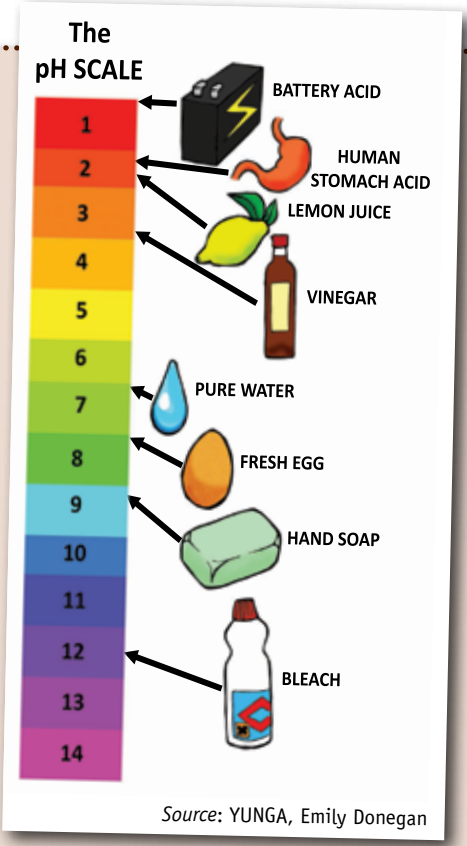
WHAT IS PH?

Another factor that affects soils is the **pH**. Chemicals can be classed along a **pH** scale between two extremes – **acidic** or **basic** – just as other substances can be classed along a temperature range between hot and cold. **pH** is simply a way to measure how **acidic** or how **basic** a substance is. The **pH** scale ranges from 0-14 (**acidic** – **basic**). An **acidic** chemical is one which when it is dissolved in water, gives a **pH** of less than 7. A **basic** chemical (also called an **alkali**) dissolves in water to give a **pH** of more than 7. Examples of **acidic** liquids are vinegar and lemon juice, whereas examples of **basic** liquids are ammonia and toothpaste. A **pH** of 7 is neutral (it is neither **acidic** or **basic**). An example of a neutral chemical is water. Check out the **pH** scale diagram to see the standard pH of some well-known substances.

The **pH** of soil is an important sign of its health, influencing the amount of **nutrients** in the soil and the health of the animals and plants that live in it. A soil **pH** level of less than 7 is **acidic**. In very acidic soils, such as those soils found under boreal forests (found

Soil types around the world

The soil in your garden or local area is very different from soil found in other parts of the world. You might have visited or seen pictures of **deserts**, tropical forests, and bogs. Did you notice that they all have very different soil types? Soils vary based on the environment, how old they are, and the plants and animals that live in them. In fact, there are thousands of soil types around the world! In the same way that we give trees such as beech, pine or eucalyptus names to tell them apart from each other, we also need to classify and give different soil types names. The World Reference



Source: YUNGA, Emily Donegan

in the northern hemisphere), **nutrients** in the soil dissolve quickly and **leach** away when water drains. A soil **pH** of more than 7 is **alkaline**. **Alkaline** soils are found where there is a lot of clay in the soil, or in limestone environments. Here the **nutrients** will not dissolve so quickly. In general, the most fertile soils have a **pH** between 6 and 7. Different animals and plants have different preferences when it comes to soil **pH** levels, so the **pH** is one factor that determines the type of **ecosystem** found in an area.

Base (WRB) has identified the 28 most common soil types in the world. See the global soil map to find out more: **www.fao.org/nr/land/soils/soil/wrb-soil-maps/en**. You can also refer to YUNGA's soil types factsheet to learn more about each type. What are the main or dominant soil types in your country? How do they differ from other soil groups?

Find out more:

http://forces.si.edu/soils/swf/soilorders.html

www.hutton.ac.uk/learning/dirt-doctor

www.isric.org

SOIL BIODIVERSITY

Did you know that the diversity and abundance of life that exists within the soil is greater than that which is found above ground? According to the Soil Science Society of America, there are more living individual **organisms** in one tablespoon of soil than there are people on the Earth! Bear in mind that there are only seven billion humans on Earth in total...! So, who are some of the creatures you might encounter in that tablespoon?

DID YOU KNOW?

It's estimated that one acre of soil may contain up to 400 kg of earthworms, 1 089 kg of **fungi**, 680 kg of bacteria, 400 kg of **arthropods** and algae, and even some small mammals such as moles. One gram of soil may hold one billion bacteria, of which only five percent are currently known to science.

Source: the Earth Institute.

Arthropods

Arthropods are animals that do not have backbones but instead have their skeleton outside their body. This group includes insects and spiders, many of whom live in the soil. **Arthropods** help bacteria to eat by shredding dead plant material into more accessible portion sizes for them. They also help to spread **nutrients** throughout the soil, by carrying bacteria on their bodies and through their digestive systems. They add **minerals** to the soil with their waste, and also improve soil quality by burrowing through it. **Arthropods** can also help with pest control, by eating bugs and insects that eat crops.

Bacteria

Bacteria are often portrayed as the enemy, usually thought of as giving people diseases. However, many bacteria are good, useful contributors to our **ecosystems**. In fact, life as we know it would not exist without bacteria! **Ecosystems** on both land and in the water depend on their endless recycling of **nutrients** like **carbon**, **nitrogen** and sulphur back into the soil. Without this recycling, the **primary producers** would not be able to produce energy. Bacteria were some of the earliest forms of life on Earth and were also the first **organisms** to start producing **oxygen**, the gas which we all rely on to stay alive. Bacteria are literally everywhere, but they are so tiny that you cannot see them. Your own body provides a welcoming home for **trillions** of them! It is bacteria which enable you to gain energy from food in your gut. Bacteria also enable plant roots to gain **nutrients** from the soil. This is because bacteria are necessary for releasing **nutrients** into the soil, where they can be used by plants and other soil-dwelling **organisms** (find out how in the box below). Even more amazingly, bacteria can break down pesticides, helping to keep the soil clean. So you can see that they are pretty important for life!

WHO ARE RHIZOBIA, CLOSTRIDIUM AND AZOTERBACTER?

No, they're not characters out of *Harry Potter or Lord of the Rings*. They're bacteria who perform a very useful soil service. **Nitrogen** is a key **nutrient** for plants, but plants cannot use gaseous **nitrogen** from the **atmosphere**. Enter these three bacteria, who turn gaseous **nitrogen** into plant-friendly compounds in a process called **nitrogen-fixing** (find out more on p.50).

Worms

Earthworms are often called 'soil engineers' because they perform all sorts of useful duties. If earthworms are around, it's usually a sign that the soil is healthy. Earthworms tunnel through soil, which lets air circulate and helps **oxygen** to reach plant roots and soil-dwelling **organisms**. The tunnels increase the soil's capacity to hold water, loosen it, and improve its drainage. One of the biggest ways earthworms make a difference is by bringing **nutrients** into the soil. When they eat the soil (many worms eat up to their own weight of soil each day!), earthworms are actually breaking down **organic** matter, and when they excrete the waste (politely called 'worm castings', otherwise known as worm poo), they are releasing **nutrients** – in a broken down form – back into the soil which can then be used by plants. Earthworm **humus** is generally believed to be the best natural **fertilizer** for crop and plant growth. Earthworms also help to balance out the **pH** of the soil – their castings are always closer to neutral (pH 7) than the original soil.

DID YOU KNOW?

An earthworm has one brain, five hearts and 'breathes' through its skin. The smallest earthworm discovered was smaller than 2.5 cm and the largest was found in South Africa at a whopping 6.5 metres – imagine how much soil that worm would have eaten in its lifetime!

Source: **http://deq.louisiana.gov/portal/Portals/0/assistance/educate/DYK-earthworms.pdf**

Fungi

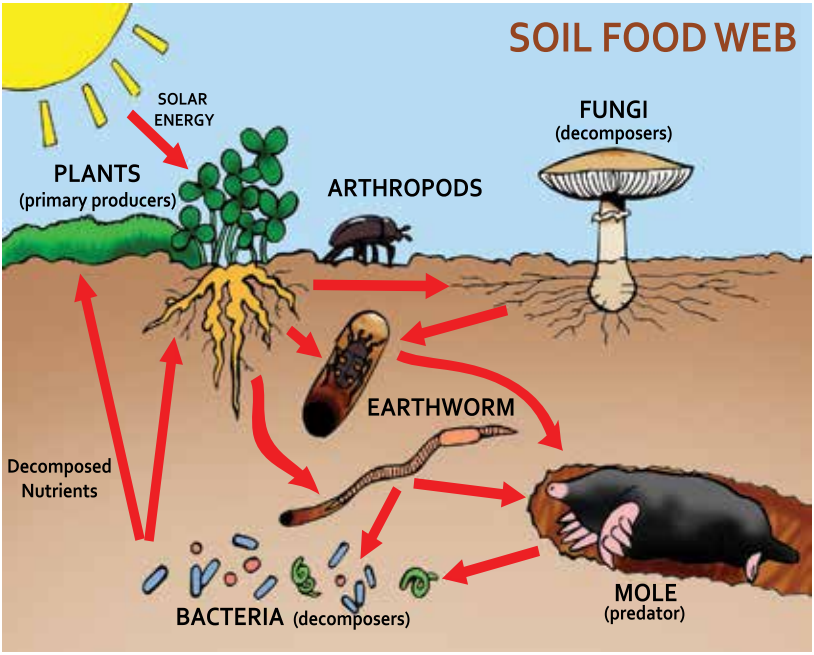
You have probably seen and eaten mushrooms. Well, mushrooms are part of a **fungus** (plural '**fungi**'), but there is much more to **fungi** than the mushrooms that grow on the ground surface – there is a whole network attached, often hidden underground, which can sometimes span for kilometres. In the same way that people often think about bacteria as being bad, people can think of **fungi** as bad – causing disease in plants and animals, or spoiling food. However, **fungi** also perform important soil services related to water, **nutrients** and disease prevention. Along with bacteria, **fungi** **decompose** **organic** material into forms that other **organisms** can use. Over 90 percent of all plant species directly depend on **fungi** to get **nutrients** like **nitrogen** and phosphorus from the soil. **Fungi** also help to hold soil particles together, which helps to increase water absorption and the soil's capacity to hold water.

DID YOU KNOW?

In Oregon, USA, there is one **fungus** (*Armillaria ostoyae*) that is thought to spread underground to cover an area of over 1 600 football pitches! It is the largest **organism** on Earth and is thought to be 2 400 years old – though some scientists think it could be as old as 8 650 years. Think of all the amazing and useful ways in which that single **organism** is helping the soil in this area...

The soil food web

The soil **food web** is the community of **organisms** that live either all or part of their lives in the soil. Energy and **nutrients** are converted and exchanged throughout the **food web** as one **organism** eats another. In this way, soil **ecosystems** are an important place for **nutrient cycling**. Soils store and renew common **nutrients** such as **nitrogen**, phosphorus, potassium, calcium, magnesium, and sulphur. Soil **organisms** living in the soil **ecosystem** **decompose** these **nutrients**, making them available to other **organisms** and spreading them throughout the soil.



Source: YUNGA, Emily Donegan

SAFIRA RAHMA, aged 15, INDONESIA

All **food webs** start with **primary producers** who make their own food. Here's how it works: some **organisms** can use the Sun's energy to turn **carbon dioxide** from the **atmosphere** into **organic** compounds (i.e. food) that gives them the energy they need to grow. This process is known as **photosynthesis**. **Primary producers** include plants, **lichens**, moss, algae and some types of bacteria. Most other soil **organisms** (e.g. insects, worms and moles) cannot **photosynthesize**, so they get the energy and **carbon** that they need by eating **primary producers**, other **organisms**, or waste. Almost all plants – grass, trees, shrubs, and crops – depend on the soil **food web** for their **nutrition**. As humans, we also depend on the soil **food web** when we eat plants, fruits and vegetables that were grown in the soil. This is just one reason why we need to be thankful for soils – let's dig a little deeper in Section B to find out about some other important soil services.

SOIL USES

As mentioned in Section A, soils are home to a mind-boggling number of plants, animals and **micro-organisms**, from slugs, snails, earthworms and moles, to bacteria, algae, and of course trees, shrubs, and flowers. So, how exactly do soils help these plants and creatures out?

ECOSYSTEM SERVICES

Soils and the great **biodiversity** found within them make up underground **ecosystems** that provide essential **ecosystem services**, just like what we can see above ground. **Ecosystem services** are benefits (such as resources and processes) produced by the environment that are necessary for healthy plant, animal and human life on Earth. For example, soils are essential for plant growth and for crop, forest and livestock production; they provide **nutrients** and water for plants to absorb through their roots; and they even help to regulate water and gases in the **atmosphere**. Let's take a deeper look at these essential **ecosystem services**.

MAKAH KHEMKA, aged 10, INDIA

Physical support

You might not think soil adds much to the beauty of our planet, but can you imagine our world without trees, flowers, cacti, and other plants? Without soil, they wouldn't be here either. Soil provides a physical support system for plants, without which they would be unable to grow. So next time you are enjoying looking at a beautiful landscape, spare a thought for the soil that makes it all possible!

Health care

Soil **biodiversity** helps prevent pests and diseases. **Micro-organisms** in the soil break down waste materials such as manure, remains of plants, **fertilizers**, and pesticides, which prevents them from building up to toxic levels, entering water supplies and becoming pollutants.

Babysitting

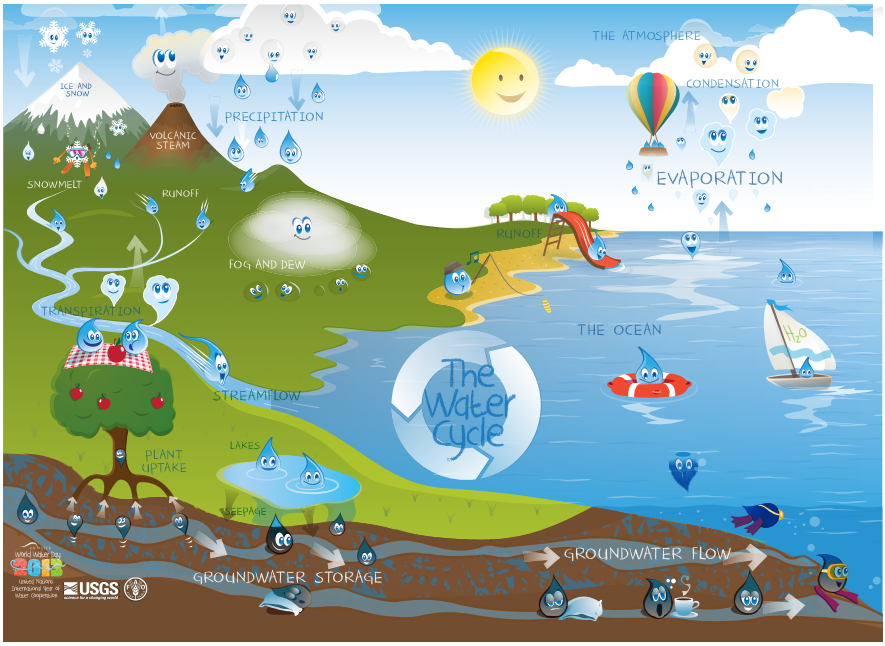
The soil **ecosystem** looks after seeds, providing an environment for them to spread or sprout into plants, so that they can continue to grow. Sometimes, these babysitting services last for years, while seeds wait for the best conditions to sprout.

Water issues

Soil is able to both hold and release water, which is essential to the life that depends on it. It all starts when water gets into the spaces, or **pores**, between soil particles. The rate at which this happens (how quickly or slowly water filters into soil) is called the **infiltration** rate. The higher the infiltration rate, the more water will be available to plants and less will run off the surface, **erode** soil, and wash away **nutrients**. Plants and a rough soil surface can help to increase the **infiltration** rate.

Soils also play an important role in the **water cycle**, which is the process by which the Earth's supply of water gets reused over and over again. Soils act as a barrier or filter for the **precipitation** (rain, snow, hail or sleet) that falls on the Earth and either becomes '**groundwater**' – the world's biggest storehouse of drinkable water – or becomes **run-off** (water running over the land because the soil can't absorb any more), flowing into streams, rivers, and eventually the ocean. In this way, the soil plays a central role in regulating the amount of water available on land and in the **atmosphere**. To learn more about the **water cycle** and water issues, check out YUNGA's ***Water Challenge Badge***.

By absorbing water, soils also help prevent flooding. Certain soil types such as bogs, marshes, and swamps are hugely important in preventing and controlling floods. These **wetlands** act as giant sponges, soaking up huge amounts of water and letting it run off slowly. This is an extremely important function because if too much soil enters the rivers and coastal **ecosystems** it can damage the **biodiversity** living there, as well as impacting human livelihoods. This process of soil build-up is known as siltation and can have serious environmental impacts.



Source: FAO

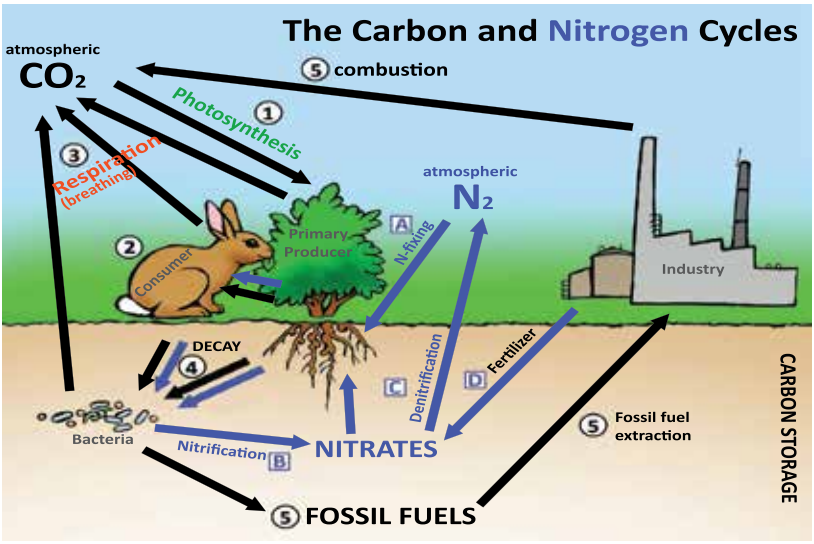
UNUSUAL SOILS

Although they cover just six percent of Earth's land surface, **wetlands** (including marshes, peat bogs, swamps, river deltas, mangroves, tundra, lagoons and river floodplains) currently store up to 20 percent (850 billion tons) of **terrestrial carbon** (**carbon** stored in the land). This is equivalent to the **carbon** content of today's **atmosphere** (where **carbon** exists as **carbon dioxide** gas).

Source: **www.envirothon.org/pdf/CG/Why_Soil_is_Important.pdf**

Atmospheric assistance

Soil has an essential part to play in regulating the amounts of **carbon**, **oxygen**, and **nitrogen** in the **atmosphere**.



Source: YUNGA, Emily Donegan

CRUCIAL CARBON

Carbon is essential to all life forms on this planet. Every **organism** on this planet is built from **carbon** and relies on it as a fuel for life in one way or another. **Carbon** in the **atmosphere** takes the form of **carbon dioxide** (CO_2), an important gas made of **carbon** and **oxygen**. Burning **fossil fuels** and cutting down forests causes imbalances in the natural **carbon cycle** and increases the levels of **carbon dioxide** in the **atmosphere**, which can harm our environment by contributing to **climate change**. Have you noticed or heard about any changes in the **climate** where you live, or other regions of the world? Unfortunately, some areas are drying out while others are being flooded or being hit by massive storms.

Carbon Cycle

Most of the **carbon dioxide** in the atmosphere comes from biological reactions that take place in the soil. (Take a look at the diagram on p.48 and follow the numbering as you read on.)

1. As we have mentioned, plants use **carbon dioxide** from the **atmosphere**, water from the soil and sunlight to make their own food and grow in a process called **photosynthesis**. The **carbon** they absorb from the air becomes part of the plant.

2. Animals that feed on the plants pass the **carbon** compounds along the **food chain**.

3. Most of the **carbon** the animals consume is converted into **carbon dioxide** as they breathe (also known as respiration), and is released back into the **atmosphere**.

4. When the animals and plants die, the dead **organisms** are eaten by decomposers in the soil (our friends the bacteria and **fungi**) and the **carbon** in their bodies is again returned to the **atmosphere** as **carbon dioxide**.

5. In some cases, the dead plants and animals are buried and turn into **fossil fuels**, such as coal and oil, over millions of years. Humans burn **fossil fuels** to create energy, which sends most of the **carbon** back into the atmosphere in the form of **carbon dioxide**.

As well as forming **fossil fuels**, soil is also an important storehouse of **carbon**. This ability of soil to store **carbon** is also known as '**carbon sequestration**'. This is an important function because the more **carbon** that is stored in the soil, the less **carbon dioxide** there will be in the **atmosphere** contributing to **climate change**.

Oxygen cycle

Plants also release **oxygen** into the **atmosphere** during **photosynthesis**, which is a gas that nearly every living being needs in order to survive. Therefore, by supporting plants, soil plays a part

in regulating **oxygen** supply, too. Almost 99 percent of the Earth's **oxygen** supply is stored in rocks and **minerals** in the Earth's crust below the soil.

Nitrogen cycle

Soils also play a large part in regulating our **atmosphere's nitrogen** content. **Nitrogen** (N_2) is the most common gas found in the Earth's **atmosphere**, and it is essential for plant growth. In fact, it's necessary for all **ecosystems** to survive! (Take a look at the diagram on p.48 and follow the lettering as you read on.)

A. We read earlier about **nitrogen-fixing** bacteria living in the soil and on certain plant roots (p.39) that use atmospheric **nitrogen** and change it to a form (usually nitrates) that plants can use. This process is called 'nitrogen fixation'.

B. There are other bacteria in the soil that also change **nitrogen** into nitrates. However, instead of getting **nitrogen** from the **atmosphere** like the **nitrogen-fixing** bacteria, these bacteria get theirs from decaying matter in the soil. These bacteria are called nitrifying bacteria, and they carry out the process of changing the **nitrogen** in decaying matter to nitrates. This is called 'nitrification'.

C. Some other soil-dwelling bacteria do the opposite of what the nitrifying bacteria do! They take the **nitrogen** compounds such as nitrates from the soil and turn them back into **nitrogen** gas, which returns to the **atmosphere**. This process, known as 'denitrification', keeps **nitrogen** levels in balance.

D. To increase plant growth some farmers add artificial **fertilizers** to the soil to increase **nitrogen** levels in the soil and provide the plant with more **nutrients**. **Fertilizer** production is just one example of human activity that uses **fossil fuels** and adds more **carbon dioxide** to the **atmosphere**.

It's pretty amazing how important soils are for life on Earth, isn't it? Can you imagine what life would be like without good, healthy soils?

HUMAN USES

Apart from their contributions to plant and animal life, soils also provide a lot of direct services to humans.

Food

Soil is the foundation of agriculture, supporting crops and livestock, and therefore having healthy soils are absolutely vital to be able to feed the 7 billion people living on Earth. Without good quality soils, crops cannot survive, which can lead to famine and starvation. Think about the foods you have eaten today. If you had bread, cereal or fruit for breakfast, these foods all come from crops and plants which depend on soil for **nutrients** and water to grow. Can you think of any foods that don't rely on soil?

DID YOU KNOW?

* According to FAO, 99 percent of our food comes from our soil. That only leaves 1 percent coming from water **ecosystems** such as the ocean and rivers!

* About one acre of land is used to supply the food for each person in the world. That's just a little bit smaller than the size of a football (soccer) field. What would you choose to grow in your field?

Fibres

Natural fibres such as jute and cotton also come from plants, which of course also need soil to survive. We use these natural fibres for clothing, textiles, house furnishings and a number of other uses. According to Cotton Incorporated, 68 percent of women's clothing and 85 percent of men's clothing contains cotton. Are you wearing cotton or any other natural fibres today?

Fuel

In supporting plant and animal life, soil also plays a part in providing us with **biomass**. **Biomass** – such as wood, straw and food or animal waste – is an important energy source that is made from plant and animal matter. Unlike **fossil fuels**, **biomass** refers to fresh material that does not take millions of years to form. Earlier, we learnt about how plants absorb energy from sunlight during **photosynthesis**. This energy gets stored in the plant and is released as heat when it is burned. For example, the wood from trees that gets used for burning in a fireplace is a **biomass** fuel. **Biomass** is a simple fuel option for many people in countries where access to electricity or other energy services is scarce. In fact, according to the World Health Organization, 2.4 billion people (about 1 in 3 people) around the world use **biomass** fuels for cooking and heating.

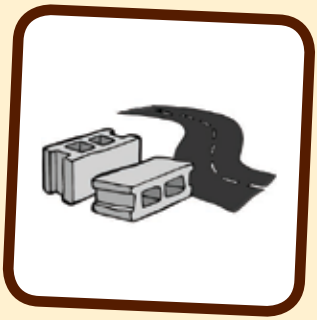
Earth cures

Soils have another great use for humans: they are vast, vital pharmacies! Did you know that almost all of the antibiotics that we take to help us fight infections were made using soil **micro-organisms**? (*Source*: Soils Science Society of America). Other medicines derived from soil include skin ointments, tuberculosis drugs, and tumour-fighting drugs.

Digs of soil

Throughout history, people have combined soil with water and materials such as straw to create mud bricks to build with. Have you seen such houses in your region, or seen pictures of them? All sorts of mud brick architecture exists around the world, from 1 000-year-old forts (called ksars) in Morocco, 6 000-year-old arches, vaults and domes in the Nile Valley, to the traditional multi-storeyed adobe houses (sun-baked bricks of mud and straw) in much of Latin America (*Source*: India Environment Portal). Even the Great Wall of China was built from dried mud bricks. Mud brick construction is a good option for many people around the world because it does not need mechanical equipment and it is very simple, using the natural material found at the location. Well-designed mud brick houses have good insulation and tend to be very comfortable – they are warm in winter and cool in summer (*Source*: Engineers Without Borders).

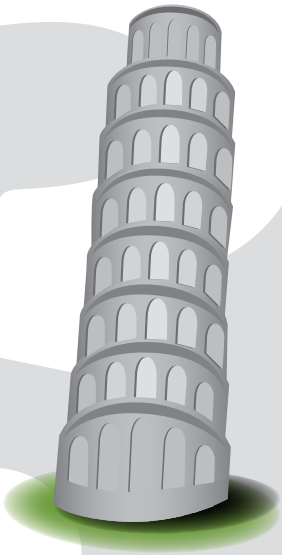
Infrastructure



In addition, soil provides support and materials for urban settlement and **infrastructure**. The construction industry uses lots of sand and gravel: these materials are used in making concrete, construction fill, as snow and ice control, in water filtration systems, and they are also mixed with bitumen (a sticky black substance and a **fossil fuel**) to create road surfaces. Soils also support the physical foundations for houses, offices, roads, runways, and other constructions. While certain soils are unsuitable for building because they tend to shrink and cannot bear much weight, others, such as sandy soils, provide strong, solid foundations to build upon.

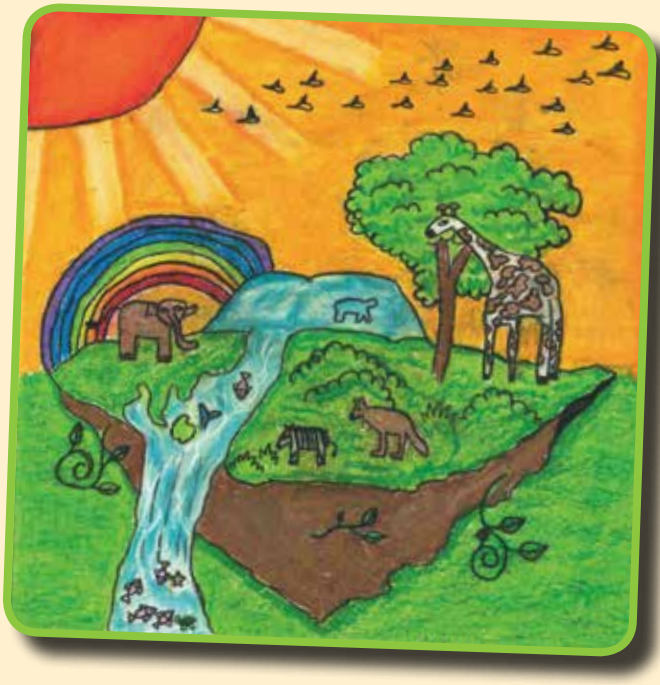
DID YOU KNOW?

Have you ever heard about or seen pictures of the Leaning Tower of Pisa? Like the name suggests, this bell tower in Italy leans on one side, making one side almost one metre taller than the other! It leans like this because it was built on soft subsoil that struggled to support the weight of the 14 500 ton building. The Italians began building the tower in the year 1173 and it took 199 years to finish because two wars created long pauses in the construction. If it wasn't for these pauses, the soil wouldn't have had time to compact and settle, and the tower would probably have toppled!



Soil in industry

Soil provides raw materials such as clay, sands, **minerals** and peat that are used in many different industrial applications. The clay **minerals** in soil have an important commercial role. Kaolinite (also called 'china clay') is widely used in the ceramics industry and also used to coat paper and as filler in paints. Vermiculite is widely used for insulation and as a packaging material. It is highly absorbent and therefore prevents packed materials, such as hazardous chemicals, from leaking. Montmorillonite is used in some hair care products, such as shampoo and as a treatment for some skin conditions (*Source*: European Commission Joint Research Centre).



THEERTHALA SREE ALEKHYA, aged 9, INDIA

Recreation – muddy fun!

Throughout the ages, we've relied on soil for cultural ties, artistic expression, and good, old-fashioned fun. As kids, many of us enjoy playing in the soil. We create mud pies and sand castles, and roll about on the ground until our clothes are a laundry nightmare. While this is a fun way to interact with nature, some studies show that it also helps children build stronger immune systems and develop greater curiosity and a spirit of adventure.

Of course, soil is a staple in our planet's most beautiful landscapes. Whenever we visit parks, forests, mountains, and other areas of natural beauty, it's easy to overlook the fact that soil is a founding factor in that place's existence, and in our ability to explore it. Hiking, long walks, camping, dirt biking, jogging, skiing – all these activities involve soil's presence. In this way soil contributes to **ecotourism**, too, which is becoming increasingly important in many parts of the world. **Ecotourism** is a kind of tourism that not only provides fun, recreational activities but also promotes conservation, benefits local communities, gives people a chance to explore nature while learning, and introduces people to local cultures.

> **"The land is the only thing in the world worth working for, worth fighting for, worth dying for, because it's the only thing that lasts."**
>
> Margaret Mitchell, *Gone with the Wind*

Cultural value

For centuries and even millennia, soil has worked its way into our cultures, revealing itself in our art, literature, customs, and beliefs. Many people feel emotional ties to their home soil, for its significance as the place of their birth and the ground their ancestors tread for generations. Some cultures bury their dead, symbolically returning their people to the ground. Others cremate their dead, letting the ash become part of nature – and the soil – once again, too.

Soil is also an important part of our artwork. Clay from soil is used for pottery and sculptures, which have been around for millennia. Soils have also been used as pigment (colouring) for paintings for thousands of years. Cultures in Australia, Europe and South America used soil paintings as a form of communication in caves and other sheltered areas. Typically, red, yellow and orange colours were used (called ochres), coming from iron that is present in the soil. Try creating your own soil paintings in activity B.6 (p.87)!

Soil also has other practical contributions to culture. Did you know that the best china dishes are made from soil? Books too, rely on soil – in fact, about 70 percent of the weight of a textbook or glossy-paged magazine is made from soil resources (*Source*: www.envirothon.org/pdf/CG/Why_Soil_is_Important.pdf).

Soil has always been used for beauty treatments, too. Mud baths are ancient treatments that date all the way back to the days of Cleopatra, who used mud from the Dead Sea. People also use clay for facial treatments in the form of 'mud masks' to cleanse their skin.

SOIL AT RISK

WHAT'S HURTING OUR SOILS?

What could possibly hurt the soil, you might ask. We walk on it, drive on it, even build giant stadiums and skyscrapers on it. Soil is tough!

Sadly, it's not tough enough to stand up to all the damage caused by our many activities. Did you know that globally, we are losing 10 million hectares of fertile soil each year? That equals about 30 football pitches every minute! When the soil is damaged in a way that makes it less productive for crop growth as well as less biologically diverse, we call it **degradation**. The majority of this **degradation** (75 percent) is due to unsustainable agricultural practices – the ways in which we currently farm the soils (*Source*: www.summerofsoil.se/soil).

Soil is a non-renewable resource in the human timeline, meaning we cannot replace all the healthy soil we lose – it would take millions of years to do so. Remember, it takes roughly 2 000 years to make just 10 cm of **topsoil**! Still, there is a lot we can do to prevent further loss, and there are also ways to help make soil healthy again. Before getting into the practical steps we can take, let's take a closer look at the factors behind soil **degradation**.

Erosion

Erosion means 'wearing down' and is a major cause of soil **degradation**. **Erosion** causes **topsoil** loss, and therefore makes the land less suitable for growing crops. Many agricultural practices contribute to **erosion** because they are not carried out in a **sustainable** way (i.e. in a way that protects and preserves the soils so that they can be used in the future). On p.59 you will find some of the main agricultural practices that cause **erosion**:

- **Overgrazing** (having too many animals feeding off an area of land) is one example. The animals eat the plants faster than they can grow back, and ultimately the land loses its **vegetation**. The loss of **vegetation** makes the land more vulnerable to **erosion** and worsens water quality in the soil. Animals also wear down **topsoil** with their feet – and the more animals, the more feet...

- **Deforestation** (converting forested areas into land for farms and ranches by cutting down trees) is also a huge contributor to soil **erosion**. Trees anchor the soil, help keep it moist and healthy, and serve as a natural shelter against wind and water **erosion**. Removing them makes the soil very vulnerable to **erosion**.

- **Growing crops on sloping land** is a major cause of **erosion**, especially when this is done without any conservation measures such as contour farming (ploughing, planting and weeding across the slope rather than down it). Soil is thinner on steep slopes, and growing crops here can increase **run-off** once the crops have been harvested and the soil is exposed.

Contamination

Soil **contamination** happens when harmful substances (contaminants) are mixed into the soil. For example, water that contains contaminants, such as wastewater from a factory or industrial plant, deposits these substances in the soil as it flows over or through it. More than 200 years of industrialization around the world has made soil **contamination** a widespread problem. The most frequent contaminants are heavy metals and **mineral** oil, causing pollution at approximately 3 million sites worldwide (*Source*: www.summerofsoil.se/soil/threats-to-soil/2). Contaminated soil can hurt plants when they take up the **contamination** through their roots. It also damages the health of animals and humans when they ingest, inhale, or touch contaminated soil, or when they eat plants or animals that have been affected by soil **contamination** (*Source*: US Environmental Protection Agency).

Organic matter and nutrient depletion

'Organic matter depletion' is the loss of **organic** material from soils ('to deplete' means to 'reduce' or 'use up'). For example, this occurs when trees are cut down (**deforestation**), when **biomass** is burned, when **wetlands** are drained, when soil is ploughed, or when pesticides and other chemicals are overused. **Monocropping** also depletes soil **nutrients**. **Monocropping** is a type of farming where only one highly profitable crop or plant species is grown over a large area. This exhausts the soil more quickly than if different kinds of crops were grown and rotated over the same area, as a single crop constantly takes the same **nutrients** out of the soil. If different crops are rotated, slightly different **nutrients** will be absorbed from the soil – or fed back into the soil system as the different crops **decompose**.

DID YOU KNOW?

Reduction or loss of **organic** matter in the soil can cause:

* **Biodiversity** loss, because most soil **organisms** eat **organic** matter to survive.
* Reduction of **ecosystem services**, such as water storage and filtering.
* Reduction in soil quality for most land uses, particularly agriculture.
* The release of **carbon dioxide** into the **atmosphere**, accelerating **climate change**.
* The potential for increased water pollution, as many pollutants (e.g. heavy metals, **nitrogen**, phosphorous and pesticides) are less harmful when they are fixed to **organic** matter.

Unsustainable soil management

Practices such as **overgrazing**, **deforestation**, **monocropping** and contamination are all forms of unsustainable soil management that can cause serious soil **degradation**. Exploiting soil resources season after season exhausts the soil and is also a serious issue. However, it is in our power to change this! Practising more **sustainable** techniques such as crop and livestock rotation can help to maintain **nutrient** levels and keep soils healthy.

Sealing

'Sealing' is the permanent covering of soil with urban **infrastructure** such as roads and buildings. It happens when rural, undeveloped land is lost as a result of urban sprawl, industrial development or the construction of transport **infrastructure**. Sealing normally involves the removal of **topsoil** layers which results in the loss of important soil functions, such as food production, water storage or temperature regulation. Sealing not only destroys productive, agricultural land, but also destroys the **habitat** of a wide variety of **organisms**. Additionally, it increases the risk of flooding by increasing the amount of water that runs over the land as **run-off** because the ground can't absorb any more.

Compaction

Soil is said to be 'compacted' when its particles are forced closer together, reducing the number and size of **pores** in the soil and damaging its structure. It is often caused by the use of heavy machinery, such as tractors, in agriculture. Compaction reduces the soil's ability to store water and prevents water **infiltration**, making water less available to plant roots and also increasing **run-off**, which can increase the risk of flooding. It also raises the risk of soil **erosion**. Compaction reduces the amount of **oxygen** available to **organisms**, which poses a danger to soil **biodiversity**, as soil **pores** become too small to allow creatures living in the soil to tunnel their way through.

Salinization

Salinization occurs when the salt-level of the soil becomes too high. Agriculture, again, is the main culprit here when soil is artificially watered (this is known as **irrigation**). Poor **irrigation** practices can cause an increase in soil **salinity**, while also causing water pollution. High levels of salt make soils unsuitable for plant growth. Another problem with badly managed **irrigation** is that it can sometimes result in **waterlogging**. This means that air spaces in the soil get filled with water, which cuts off the supply of **oxygen** to plant roots and causes them to die. Waterlogged soils also allow denitrifying bacteria to flourish, resulting in high levels of **nitrogen** being lost from the soil. This can badly affect plant growth because plants need **nitrogen** to grow.

DID YOU KNOW?

Ancient civilizations from Mesopotamia and Western Europe already knew about the negative effects of soil **salinization**. As a punishment to rebels, traitors or enemies, the land they used would be sown with salt to prevent these unfortunates from being able to grow any more food. This meant that they had no choice but to move away. Harsh but true!

Acidification and alkalinization

Soil **acidification** takes place when **acids** build up in the soil and reduce its **pH** level (take a look back at the diagram on p.37 explaining the **pH** scale). **Acids** can build up in the soil because of **acid rain** or using too much of certain **fertilizers**. Pollution can also directly cause **acidification**, as **nitrogen** emissions in the air may end up getting absorbed into the soil. **Acidic** soils lack essential **nutrients** while containing very high levels of other **nutrients**, making it harder for crops to grow and thrive there.

On the other hand, soil **alkalization** occurs when the soil **pH** level is high (i.e. the soil is **basic**). Such soils have less (or smaller) pores and therefore have a low water **infiltration** capacity. Soil **alkalization** can happen as a result of human, agricultural, industrial, and domestic activities that release salts into rivers and ground water. This eventually increases soil **salinity**, damaging the soil's health and quality.

Climate Change

Climate change is expected to cause all kinds of changes to **weather** patterns around the world. Some places are already facing reduced or erratic rainfall, or suffering more frequent and severe **drought** periods. Others are seeing more intense rainfall and storms. Overall, these changes will increasingly affect soil by causing:

* Soil **erosion** because of heavier and more frequent rainfall.
* Loss of **organic** matter because of quicker **decomposition** rates as a result of hotter temperatures and higher air humidity.
* Reduction in soil fertility.
* Reduction in the amount of water available to plants and crops as a result of **drought**.
* Reduction of the soil's **carbon sequestration** potential (its ability to store **carbon**).
* Increased pest outbreaks.

Find out more:

The Economics of Land Degradation: **http://inweh.unu.edu/eld** and **www.eld-initiative.org**

A CASE STUDY IN DEGRADATION: DESERTIFICATION

Desertification is a global problem that directly affects 250 million people and one third of the Earth's land surface (over 4 billion hectares). The world's **drylands** are some of the highest risk areas; in fact, around 70 percent of the 5.2 billion hectares of **drylands** used for agriculture worldwide are already **degraded** and threatened by **desertification**.

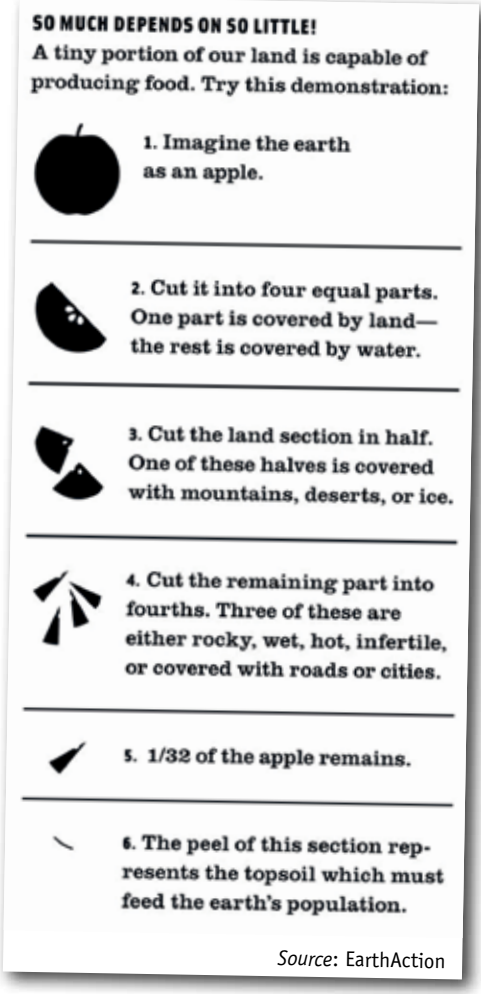
As we learned earlier, **salinization**, **erosion** and poor land management are all factors leading towards land **degradation**. If these factors are intensified, **desertification** becomes a real threat. It is not only a **climate change** related issue: unsustainable irrigation practices that use local water supplies for agriculture can cause rivers and lakes to dry out – the Aral Sea (between Kazakhstan and Uzbekistan) and Lake Chad (between Chad, Niger and Nigeria) have both seen their shorelines dramatically shrink in this way.

Land **degradation** and **desertification** also threaten the amount of food that we can produce. One in three crops being grown today comes from **drylands**. These regions also support 50 percent of the world's livestock and are important wildlife **habitats**. In short, in order to combat hunger and poverty, it is essential that we improve soil management in these regions and prevent further **degradation**.

Desertification can also cause political and socio-economic problems and poses a threat to the overall environmental balance of affected regions. When land becomes less productive, poverty increases and farmers must move to more fertile lands or into cities. In fact, 135 million people – the equivalent to the population of Germany and France combined – are at risk of being displaced as a result of **desertification**. Over the next 20 years, some 60 million people are eventually expected to move from the desertified areas in Sub-Saharan Africa towards northern Africa and Europe. **Desertification** can also lead to conflict as people struggle over access to limited water supplies and fertile land.

(*Source*: UNCCD).

SOILS AND POVERTY



SO MUCH DEPENDS ON SO LITTLE!
A tiny portion of our land is capable of producing food. Try this demonstration:

1. Imagine the earth as an apple.

2. Cut it into four equal parts. One part is covered by land—the rest is covered by water.

3. Cut the land section in half. One of these halves is covered with mountains, deserts, or ice.

4. Cut the remaining part into fourths. Three of these are either rocky, wet, hot, infertile, or covered with roads or cities.

5. 1/32 of the apple remains.

6. The peel of this section represents the topsoil which must feed the earth's population.

Source: EarthAction

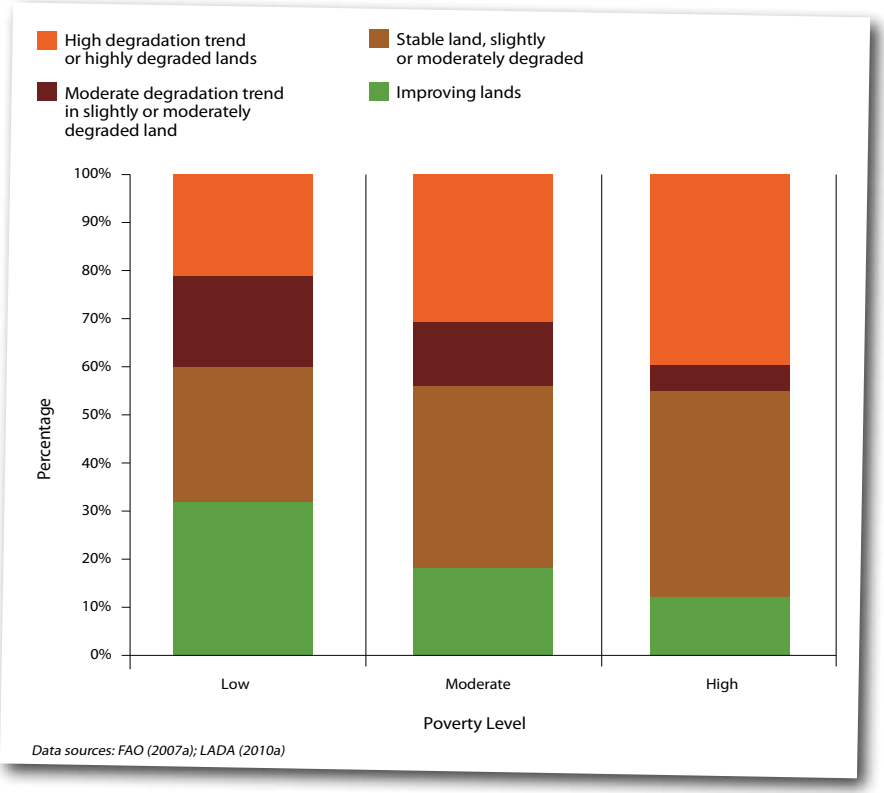
As you can imagine, the threats to soil health are extremely threatening to human welfare. We are now 7 billion people on the planet, and by 2050 our population is expected to increase by another 2 billion. It is estimated that 870 million people worldwide suffer from hunger, and feeding the planet is an issue that will only become more serious. You can learn more about these issues in YUNGA's ***Ending Hunger Challenge Badge***. The more soil we lose, the harder it will be to grow the food necessary to feed everyone. Already, agriculture is slowing in many areas and there is an increasing imbalance between the availability and demand for land and water resources. Many areas are reaching the limits of their ability to produce food (*Source*: FAO).

Land **degradation** is a serious problem for many of the world's poorest people. They are particularly vulnerable as they have limited access to land and water, which locks them in a poverty trap. Many survive by maintaining small farms that have poor quality soils and are at high risk of **climatic** uncertainties such as floods

and **droughts**. The technologies and farming systems available to the poor tend to be low quality systems that contribute to land **degradation**. For this reason, land **degradation** is highest in areas with largely poor populations (*Source*: The State of the World's Land and Water Resources for Food and Agriculture, FAO).

The figure below shows that the higher the poverty level, the higher the level of land **degradation**.

However, with **sustainable** soils management practices we can help to boost healthy soils and avoid soil **degradation**! Find out more in Section D.



Data sources: FAO (2007a); LADA (2010a)

next page: CHO KIU WONG, aged 17, HONG KONG, CHINA

TAKE ACTION

CALL FOR SOIL PROTECTION

Our world's soils are under pressure. Both human and natural activities are damaging soil, to the extent that 25 percent of the Earth's lands are degraded, i.e. severely damaged (*Source*: FAO). When they are degraded they are unable to perform their vital functions. Read on to find out what things we can do to protect and preserve soils around the world. Take on the challenge and get involved to save our soils!

ACTIONS FOR GOVERNMENTS AND INTERNATIONAL ORGANIZATIONS

We have just learnt about the risks to our world's precious store of soil; now it's time for some good news. A lot of people and organizations around the world are working hard to protect soil, and a lot of great work is being done. Here are some of the ways that a difference is being made:

Promoting sustainable agriculture and sustainable soil management

Many governments, international organizations and environmental groups are working to improve agricultural practices and soil management around the world. This includes fighting **deforestation**, **overgrazing**, the overuse of chemicals, and other factors that contribute to soil **degradation**. Better laws and policies can help to make sure people follow more **sustainable**

farming techniques, as well as providing farmers with the necessary information and resources. For example, Paraguay passed a Zero Deforestation Act in 2004, after which it managed to reduce the rate of **deforestation** by 85 percent (*Source*: WWF).

Improving water efficiency

Improving the efficiency of water use in agriculture is another important task for farmers, leaders and governments. **Water scarcity** poses a huge risk to soil health, leading to **degradation** and, ultimately, **desertification**. Most **irrigation** systems across the world do not use water in the most efficient way. A combination of improved **irrigation** scheme management, investment in local knowledge and modern technology, knowledge development and training can increase water-use efficiency.

Adaptation

Adaptation is the process of preparing or adjusting something or someone in order to survive in a specific environment. Adaptation is very important in the face of **climate change**, because we need to plan how to alter our lifestyles, agriculture, **infrastructure**, etc. in order to be prepared for changes in temperature, **weather** patterns, and other expected effects of **climate change**. Soils play a crucial role here. Agriculture and climate change are very closely linked because soil health, crop yield, **biodiversity** and water use are directly affected by a changing **climate**. Scientists, agricultural experts, and policymakers are working on ways to help make the soil more resilient to the impacts of **climate change**; in other words, better able to cope with these changes.

Raising awareness

Spreading the word is one of the best ways to create change, and a lot of international organizations, non-governmental organizations and other groups are speaking out for soils. On their Web sites, you will find facts and figures, detailed information, and ideas about how you can join in their efforts – take a look at the Resources and

Additional Information section on pp.102-107 to get started. The FAO Global Soil Partnership, along with its partners, has established World Soil Day on December 5th and the International Year of Soils in 2015. The United Nations General Assembly also declared June 17th as the World Day to Combat Desertification and Drought. These are three valuable opportunities for raising awareness about the importance of soils!

LEKSI JARINA, aged 18, UKRAINE

ACTIONS FOR YOU!

You can make a difference! Here are a few steps all of us can take to make sure our actions contribute to the conservation and **sustainable** use of soils:

Get the facts

We hope that this background information has provided you with a good overview on soils, their benefits, and the risks they face. Now it's time to learn about soil in your community. Are there areas in which the soil is not well-managed? Learn about the connections between the health and vitality of your natural environment and your own health. There are many different sources of information, for example, you can talk to people in your local municipality, local government, or national government about ways soil can be more **sustainably** used and managed in your area.

Shop smart

Buy products from **certification schemes**, which guarantee that certain environmental and social principles are followed in producing the product. Also ask your parents and friends to change their shopping habits to become more soil/environmentally-friendly. There are several credible labels to look out for when buying such products: for example, the national or international organic labels and the labels of the Fairtrade Foundation (**www.fairtrade.org.uk**) and the Forest Stewardship Council (**ic.fsc.org**). Find out more about various shopping choices on p.72.

ORGANIC, LOCAL AND FAIRTRADE

Organic farming is an agricultural method that respects the natural life cycles of plants and livestock. To practise **organic farming**, only certain methods may be used, such as growing and rotating a mixture of crops, only adding organic **fertilizers** such as **compost** or animal manure or other biological products. These practices benefit the living **organisms** in the soil and also increase soil **carbon sequestration**, preserve **biodiversity**, and contribute to the overall wellbeing of the soil **ecosystem**.

At the same time, sometimes it is better to buy products that are **locally produced** in your area, rather than buying organic tomatoes imported from another country (whose transportation requires more energy and produces more **greenhouse gases**).

Ethical or fair trade schemes promote the rights of farmers by ensuring they get a fair salary for their work and that their human rights are respected. Ethical or fair trade practices can also promote environmental **sustainability**, using methods such as **sustainable irrigation** practices and **sustainable** pest and waste management.

To be certified as a fair trade or organic producer, farms must comply with certain standards and legislations. The labelling and logos found on the products will guarantee if it is an organic, traditional, local or fair-trade product. Take a look for these labels next time you are shopping!

Making compost

Composting is a great way to use left-over food and garden waste to add more **nutrients** to your soil! **Compost** can be made by combining **biodegradable** materials such as weeds and old plants from the garden with vegetable peelings and fruit cores from your kitchen. After the collected material has been **decomposed** by the bacteria and other **organisms** feeding on it, you can add it to your soil. **Compost** enhances the soil's nutrition, and helps some plants resist common diseases. It also helps the soil stay moist by increasing the **SOM** levels. By **composting**, you improve your garden's health, reduce your volume of trash, and you also get a chance to see all the creepy crawlies that live and feed on our waste!

Plant power

As you know, soil, water and **vegetation** are best friends, so keep your soil happy by looking after its green friends. Identify the natural areas and 'green spaces' in your communities, even small neighbourhood parks, and check how they're doing. Does the area seem healthy and cared for, or does it need some help? If you find a space without any plants, one fun and useful activity you can do is to plant trees, grass and flowers there. By planting local species in areas where they would naturally occur, you can help prevent soil from eroding, make your surroundings more beautiful and also help combat **climate change**. This can also be a great way to raise awareness among your family, friends, and in your wider community about the multiple benefits of **vegetation** for soil.

Planting something is not the end, though. You have to be prepared to look after it, too! Learn about **sustainable** farming methods. Along with managing the soil, you can try encouraging 'beneficial bugs' to your plants and using **fertilizers** made of natural matter, which are not harmful like chemical **fertilizers**.

Keep the soil clean

Help keep your environment clean and beautiful; keep an eye out for litter; and choose household products (cleaners, paints, etc.) that do not contain pollutants such as bleach or other strong chemicals. By using eco-friendly products you can reduce the amount of **contaminants** entering the water system and eventually ending up in the soil.

Shrink your carbon footprint

Saving energy helps soil! It might not seem obvious at first, but everything is connected. Many of the things we do on a daily basis consume energy, such as driving a car or leaving appliances plugged in even when they are not in use. Since most of our energy comes from **fossil fuels**, these actions contribute to **climate change** and air pollution, both of which are major threats to soil.

Avoid sealing the soil

Keep a lookout for construction projects in your area that are destroying areas rich in natural resources, and talk to your local municipality about preventing such building from taking place. You probably won't be able to stop all construction in your area (nobody is asking you to give up the comfort of having a roof over your head!), but, on a smaller scale, you can at least talk to your parents, neighbours, and wider community about the importance of protecting the soil as best possible. Even rethinking whether you really need a new patio makes a difference! There are eco-friendly options for construction projects, such as building homes on stilts so that the soil is not locked and sealed, or driveways that use a honeycomb structure so that not all of the ground surface is covered with tarmac. Can you think of some other examples?

Spread the word

Throw some soily facts at your family, friends, and community members. Get them to join forces with you in helping to protect this key source of life! Even a small action like posting an update on your social media profile about soils is a good way to get your friends thinking about their importance. Perhaps you can start a blog, or write an article for a magazine or newspaper.

Of course, the activities in this Challenge Badge are a great way to get started on all of these steps... So what are you waiting for? Dig in!

NAYLEE NAGDA, aged 13, KENYA

SECTION A:

ALL ABOUT SOIL

DO EITHER A.1. OR A.2. AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR ALL ABOUT SOIL ACTIVITIES, YOU WILL:

- **UNDERSTAND the basics about soil composition, layers, etc.**
- **BE FAMILIAR with the soil situation in your area.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

A.01 DIG DEEP Visit a few different natural spaces in your area: local parks, gardens or even a forest, if possible. Examine the soil in each place. Do you notice any similarities or differences? Is the soil dark and moist, with lots of **vegetation**, or is it dry and bare? What kinds of trees and plants are present? Use a small shovel (without destroying the plants) to dig a hole at least 30 cm deep (be sure to get permission from the owners or managers of the land first!). Observe the soil structure at the different depths. Can you see distinct **soil horizons**? What is in each horizon? What is the texture like? Make a soil texture assessment using the textural triangle (see p.33). How moist is the soil? Do you notice any worms, insects or spiders? Make sketches or photos. Be sure to fill in the hole before you leave. Prepare a booklet combining your notes and pictures. Share and discuss your booklets with your group. What is the most common soil type found in the area? Did you notice the same things? What did you find in some locations that you didn't find in others? What do you think that means?

LEVEL 3 2 1

A.02 EARTHY ANALYSIS Thousands of soil types exist around the world, which scientists have placed into basic categories: **http://forces.si.edu/soils/swf/soilorders.html**. You can find some information about each category on our Soils Factsheet. Split into groups with each group focusing on a different soil type. After doing some research, each group should hold a presentation about their soil type. Where is it found? What kind of **biodiversity** lives in it? What are its main characteristics? If that soil is found in your area, bring along a sample to display with your presentation.

LEVEL 3 2 1

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

A.03 TALES OF TEAMWORK Time, weather, and other factors team up to create soil. Learn about each factor. Next, sit down as a group and tell a 'soil story' together, in which each person says one sentence and the next person has to continue from where they left off. Each of you should somehow incorporate one of the soil-forming factors in your sentence.

LEVEL ● 2 1

A.04 WORMY WONDERS Create your own 'wormery' and watch what these wonderful creatures do in and for the soil! A 'wormery' is very easy to make. You just need a clear container, soil, some fine sand, and of course, some worms! Place the soil and sand in layers throughout the container and watch as they move through each layer. Worms do not like bright light, so when you are not watching their activity, cover your wormery with a towel or newspaper to keep out the light. When the experiment is over after 2-3 days, return the worms safely to where you found them. As a group, discuss how the worms have used the soil and how they help to keep the soil healthy. For more details about how to make a wormery, take a look at this Web site: **www.soil-net.com/dev/page.cfm?pageid=activities_wormery**.

LEVEL ● 2 1

A.05 INSECT INSIGHTS From worms to snails to beetles and spiders, soil is home to many creepy crawlies. Choose one insect, mollusc or **arthropod** to study. What does it look like? How does it contribute to the **ecosystem**? How does it depend on soil? Where does it belong in the **food web**? Is it found in your region? Make a poster starring your creature. If you find a dead one, you might even want to attach it to your exhibit (but be careful not to take any live creatures from their natural **habitats**!).

LEVEL 1 2

A.06 QUIZ CONTEST Split into two teams. One will compile a list of questions on soil properties and benefits and the other on the threats to soil. Examples could be: How many people rely on soil for their incomes? What are three factors that cause soil erosion? Then quiz each other and see which team gets the most correct answers. *Hint: check out the additional resources listed at the end of this booklet for some cool facts...*

LEVEL 1 2 3

A.07 ROOTING ABOUT Survey the available soils in your area where you could get permission to plant something, e.g. your garden, a friend's garden, or your schoolyard. Is the soil fertile? If not, perhaps you could make this a longer-term project, where you first spend time preparing and pampering the soil with **organic compost** and other soil goodies. Find some good tips at this Web site: **http://urbanext.illinois.edu/firstgarden/basics/dirt.cfm**. Do some research to find out what plants would be suitable to grow in your area. Get advice from an adult, preferably someone who knows about gardening. After the planting, take turns to water and care for the plants. Keep an eye on the soil to prevent dryness, **waterlogging**, and other problems. You may need to add **organic fertilizers** from time to time.

A.08 ROCK 'N' RESEARCH Collect different rocks from your garden, local parks, school yard, and roadside. Study their shapes, colours, and sizes. Compare them to pictures of rocks online or in an encyclopaedia. Can you identify the rocks you found? Compare rock collections within your group. Which are the most interesting to look at? If possible, invite a local naturalist, environmentalist, natural museum curator, or **geologist** to speak to your group. Have your questions ready. Which rocks are these? How were they formed? What are their characteristics? Would the same rocks be found across the world in a different environment? What kinds of soils would be formed from the breakdown of these rocks?

LEVEL 3 2 1

A.09 GROWING PAINS AND GAINS Organize a group visit to a local farm, community garden or community-supported agriculture project. Talk to the farmers there about what it takes to keep the soil fertile and productive. What challenges do they face? What type of farming do they do, **organic farming** or conventional? If the answer is organic: What are the main problems they face in their production? Bugs? Pests? How do they get rid of them? If it is conventional farming: What main problems do they face in their production? Is it expensive to buy the **fertilizers** and pesticides and how much do they have to use? What steps do they take to protect other vegetation and water courses close to their land? After the trip, discuss your impressions as a group. Did the trip inspire you to get into farming?

LEVEL 3 2 1

GOOD IDEA

A.10 SQUINTING AT SOIL If you have access to a microscope, for example in your school's laboratory, collect a few soil samples and take a closer look. Are the particles large or small? What insects or other **organisms** can you spot? You could also use a magnifying glass instead. Find useful tips on this Web site: **www.education.com/science-fair/article/grainy**. What conclusions can you draw about your soil samples from your observations?

LEVEL 3 2

A.11 ELEMENTARY INVESTIGATIONS Soil contains **nutrients**, such as calcium, potassium and iron, which support energy production and other vital biological processes. Research the different **minerals** found in soil. Find out which minerals are to be found in the different soil types. What is each of them good for? Look them up on the periodic table of elements to further understand their position among other chemical elements. Create a presentation containing interesting facts and information based on your research.

LEVEL 3 2

A.12 SOIL STORIES Soil has many different layers, also called **soil horizons**. Pick one **soil horizon** for this project. Pick a creature that lives in this horizon and put yourself in its position to write an 'autobiography'. What is life like for you as this creature? What are your surroundings like? What do you do on a daily basis? How do you interact with the soil and other **organisms** that live nearby? Re-group and read your autobiographies out loud in turn. Maybe you can even draw a picture of your creature and create a display in your class or meeting room?

A.13 A STUDY IN PH Different soils have different **pH** types. Find out the **pH** levels of different soils (e.g. clay soils, sandy soils, etc.). What types of plants and animals do each of these soils support? What conditions came together to give each soil type its particular **pH**? Are any of these soils found in your area? Collect as many samples as you can and label them with your research notes. Share with the group.

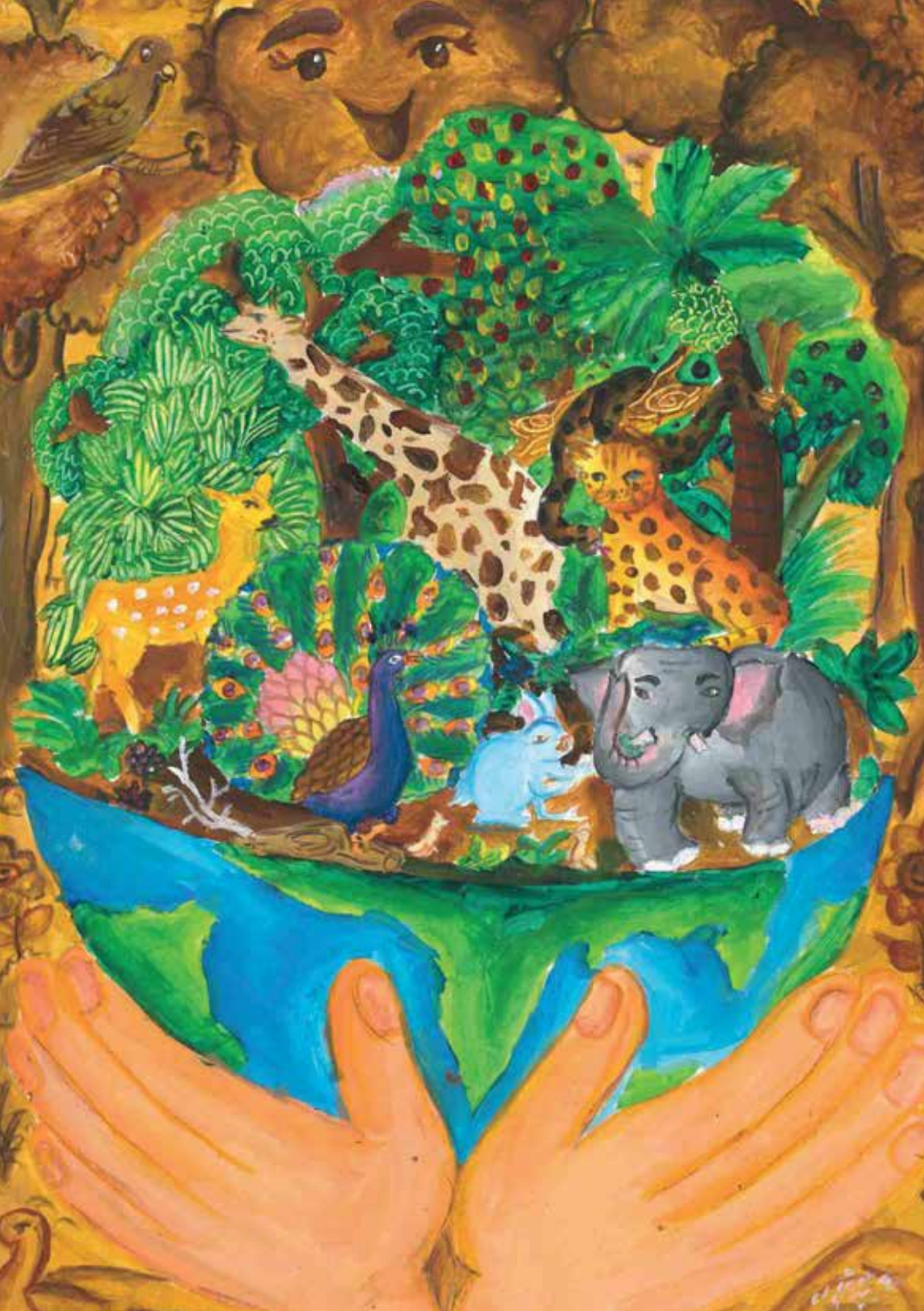
LEVEL 3

A.14 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

BERNADETTE JASMIN D. GUIAO, aged 16, PHILIPPINES

Next page: SANCHANA LAXMAN JADHAR, aged 12, INDIA



SECTION B:

SOIL USES

DO EITHER B.1. OR B.2. AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR SOIL USES ACTIVITIES, YOU WILL:

- **UNDERSTAND the numerous ways in which soils support plant and animal life.**
- **APPRECIATE how important soils are for human well-being.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

B.01 SOIL SURVEY Ask as many people as you can – friends, parents, siblings, teachers – about the role soil plays in their life. Are they into gardening? Do they play lawn or field games? Do they study soil, or soil-related topics such as geology or botany? In case they tell you that soil plays no role in their life, have a few facts ready about the ways in which we all depend on soil (e.g. that most of our food comes from soil; we'd have no clothes to wear without soil or materials to build houses from; and soil helps fight **climate change**). Put together a creative display showcasing your interviewees and their responses. Hold an 'open day' for your family and friends to come and consider the display.

LEVEL 3 2 1

B.02 SOIL AND HEALTH Soil is connected to our health in a lot of different ways. It provides important **nutrients** to plants and crops, which humans later eat. Many of the bacteria found in soils are used in our medicines. Make a poster showing all the ways in which our soil is connected to human health. Include extra facts on the side, such as the main **nutrients** that are important for healthy soils. Are they the same **nutrients** that we need as humans?

LEVEL 3 2 1

TIFFANY HUANG, aged 7, PHILIPPINES.

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

B.03 FAVOURITE FLOWER What is your favourite fruit or flower and why? Did you ever think that it might not exist without the presence of soil? Find out what soil conditions are best for it. Write a poem about it and all the ways that the soil is important for it.

LEVEL 1

B.04 MUD PIES Give each member of your group a small bag of soil, making sure that it doesn't have any stones, twigs or leaves in it. You can do this activity inside, or outside in an area of soil (though that could make it even messier!). Experiment by adding different amounts of water to the soil and mixing it together to make mud pies or bricks. Leave your 'pies' to bake in the sun for a couple of hours and then see if you can build something with them. Are the bricks strong? Think of all the different human uses for soils and discuss them with the group.

LEVEL 2 1

B.05 DIRTY SHIRTS Did you know that your wardrobe is full of soil? Well, perhaps not quite, but many of your clothes originate from soil. In fact fibres, which are used to make textiles, are one of soil's most important contributions to humans. Pick your favourite clothing item and check the label to see what it is made of. Then research where the material comes from and where the fibre is grown. Share your findings in the group.

GOOD IDEA

B.06 DUSTY DRAWINGS Collect soils of different colours, crush them into powders and mix them with a little bit of water. You could also mix them with different coloured paints! Experiment with the different colours and textures, and then paint pictures with your 'soil paint'. Find more detailed instructions on this Web site: **www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/kthru6/?cid=nrcs142p2_054304**

LEVEL 2 1

B.07 ANIMAL HABITS It's not just us humans that make use of soils; many animals interact with the soil in lots of ways, too. Birds are known to take 'dust baths' to clean their feathers, and some animals, such as chimpanzees, have been caught eating dirt. Visit your local zoo, park or public farm and observe the animals. How do they interact with the soil? If possible, make a video and present your findings as a documentary. Otherwise, make drawings of your observations. Present everything as a group.

LEVEL 3 2 1

GOOD IDEA

B.08 DUST OFF THE OLD BOOKS Read a book in which soil features in a big or small way. Examples are *Jack and the Beanstalk, James and the Giant Peach, Watership Down, Run to Earth, The Great Escape, or the Grapes of Wrath*. What role did the soil play in the story? What relationship do the characters have to the soil? How could things have been different if the soil wasn't a part of the action?

LEVEL 3 2 1

B.09 POTTERING ABOUT Organize a group trip to a pottery studio, where an instructor can get you started. Ask them to explain what materials you are using and where soil enters the picture. Then get creative and make anything you like!

LEVEL 3 2 1

B.10 SOILY SANITATION Soils are great water filters. Collect some soil samples and conduct an experiment to see how soil removes impurities from water. Visit this Web site to learn how: **www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050949.pdf**. In your group, discuss the results. Did it work better with some soils than others? Why is that? Why is it important that soils act as filters? How might this be useful for **ecosystems**, as well as households, industry, and agriculture?

LEVEL 3 2

B.11 GUESSING GAME Different soils help us in different ways. For example, **drylands** are very important for agriculture, while **wetlands** play a huge role in flood prevention. Put up a poster listing different soil types. Then play a 'guessing game' in your group about which **ecosystem services** you think each soil type provides. Do you mostly agree or disagree with each other? Back up your choices with reasons. Then look up the soil properties later to see how close you were.

LEVEL 3 2

B.12 MUSEUM MUSINGS Visit a local art museum exhibiting clay pottery or sculptures. Which is your favourite? What does it tell you about the person who created it or the civilization from which it originates? Ask someone at the museum about the process involved in making it. What kind of soil was used? What was added to the soil and how was the soil treated to create this piece?

LEVEL 3 2

B.13 FORAGING FOR FACTS Have you ever thought about where your food comes from? You might be surprised to discover how much of it depends on soil. Take an inventory of the food in your home. Find out how much of it needs soil to be produced. What about your favourite dishes? What are they made of, and do those ingredients also come from the soil? Make a list of each food item and what type of soil it needs in order to grow. Share your findings as a group.

LEVEL 3

B.14 CHANGING CLIMATES What is the connection between soil and **climate change**? How are soils affected by **climate change**? What types of soils are the best **carbon** storehouses? What are some of the challenges in trying to increase soil's potential to store **carbon**? As a group, research the facts about soil's role in **carbon sequestration** and present your findings to a wider group of friends, parents, teachers, etc. as a panel discussion, with one of you acting as moderator.

LEVEL 3

B.15 Do any other activity approved by your teacher or leader.
LEVEL 1 2 3

SECTION C:

SOIL AT RISK

DO EITHER C.1. OR C.2. AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR SOIL AT RISK ACTIVITIES, YOU WILL:

- **UNDERSTAND the factors that are endangering soils around the world.**
- **RECOGNIZE why soil is important for lives, livelihoods and ecosystems.**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

C.01 SOIL CHECK-UP Conduct a soil investigation in your area. Find some soil experts (e.g. local farmers, **geologists**, or your local department of agriculture, etc.) and talk to them about soil issues in your area. What are the risks that soil faces in the region? Is **contamination** a problem? Have they noticed any effects of **climate change**? How are other things being affected as a result of soil risks, such as agriculture, horticulture, water quality, etc.? You can also talk to your neighbours about any difficulties they might face with their garden soils. Compile all the information and share your findings with your group.

LEVEL 3 2 1

C.02 GLOBAL GROUNDS Soil is said to be **degraded** when it has been badly damaged. Find out where the world's most **degraded** soils are found. What caused the **degradation**? What problems are occurring as a result? How are people trying to fix the problem? Pick one particular region and draw its map, shading in the areas where the **degraded** soils are. Include information about the causes and impacts on the map. Do a group exhibition of all of your maps and invite friends, parents and teachers to visit and learn about the world's soils and the threats that they face.

LEVEL 3 2 1

LEUNG, YAN NOK, aged 13, HONG KONG, CHINA

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

C.03 SOIL SONG Make up a song about soil, explaining the different factors that can damage it, such as **contamination** and **sealing**. (You could base it on a popular song that you like.) Perform the song together as a group.

LEVEL ● ● ①

C.04 WASH AWAY THE DIRT Observe the way soil wears down (erodes) by pouring water onto different kinds of soil (e.g. sand, mud, clay, etc.). Compare a river (water from a jug) with a rain shower (water from a watering can). Do some soils erode more easily than others? Why do you think that is?

LEVEL ● ② ①

C.05 GROUND GRAPHICS Create a comic strip about soil in an imaginary place that is at risk because of a particular problem (e.g. **climate change** or construction). Invent a superhero who saves the soil in a unique way. Your superhero doesn't have to be human; he/she could even be a bacterium or **fungus**. Make your characters as wacky as possible! Then pass the comic strips around your class or group and enjoy. Don't forget to email them to **yunga@fao.org** too!

LEVEL ● ② ①

GOOD IDEA

GOOD IDEA

C.06 EARTHY ALLIES Many animals and plants help our soil stay healthy, for example, earthworms recycle soil **nutrients** and trees help prevent **erosion**. Pick a soil 'ally' and list all the ways that it helps the soil. Is this particular **organism** facing any threats, too? What might happen to the soil if this **organism** disappears?

LEVEL 3 2 1

C.07 WATCHING THE WEATHER If you have a garden, start observing the **weather's** effect on its soil. If you do not have a garden, observe the soil in a local park or forest instead. If it rains heavily, does the soil get **waterlogged**? In hot **weather**, does it look too dry? What could be done to improve the soil's ability to respond to changing **climatic** conditions?

LEVEL 3 2 1

C.08 JOBS ON THE GROUND List as many jobs as you can think of that depend on soil, either directly or indirectly. With your group, play a game of charades in which one person acts out the job, and the other people try to guess it. Afterwards, have a group discussion about how each of these jobs might be affected by, or affect, soil **degradation**.

LEVEL 3 2 1

PABLO ARIEL FUENTES, aged 20, ARGENTINA

GOOD IDEA

C.09 Q & A Split into pairs, with one member of each pair playing the role of farmer and the other of interviewer/reporter. Pick a country for each pair. Each farmer should then spend some time researching soil issues in their country, while each interviewer prepares their questions. Then get together in your pairs and conduct an interview, with each reporter asking questions about soil conditions and each farmer responding and explaining how the soil is affecting their crops, why any problems are arising, and how this is affecting the overall agricultural **ecosystem**.

LEVEL 3 2

Extension: Make brief notes on the answers or record the interview and then use it to write an article about soil in your chosen country. Maybe you can make a newspaper with all your articles!

C.10 MONOLOGUES Split into two groups with one group made up of farmers and corporations who support **monocropping** and the other group comprising of farmers and other groups who believe that **monocropping** is damaging to society and the environment. Spend time researching the issue and then re-group to hold a lively debate supporting your positions.

LEVEL 3 2

GOOD IDEA

C.11 DIGGING FOR DIRT Form teams and set out to investigate different types of **contamination** or pollution in your area, for example water pollution (which can also take the form of **acid rain**), and soil pollution. How big a problem is it in your area? What are the causes? Is it affecting soil **biodiversity**, and if so, how? What can be done to prevent this pollution problem? Present your findings in the form of a news report.

LEVEL 3

C.12 SOMething GOOD **Soil Organic Matter** (**SOM**) is essential for good soil health and also supports **carbon sequestration**. Why is **SOM** so important to the soil? What are some of the biggest threats to **SOM**? How can **SOM** damage be prevented? Create a presentation of your findings and share with the group.

LEVEL 3

C.13 THE GM DEBATE Genetic Modification (GM) is a technique in which an **organism's** structure is manipulated through biotechnology. In many countries, it is widely used in agriculture to make crops more resistant to pests and diseases. However, it also very controversial, with many people claiming that it adds harmful substances to crops and soil. Research the issue and present your findings in a team as a news report. Include photos or even a video to make it more interesting.

LEVEL 3

C.14 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

SECTION D:

TAKE ACTION

DO EITHER D.1. OR D.2. AND (AT LEAST) ONE OTHER ACTIVITY OF YOUR CHOICE.

AFTER COMPLETING OUR TAKE ACTION ACTIVITIES, YOU WILL BE ABLE TO:

- **ORGANIZE and PARTICIPATE in a community initiative to help protect soils.**
- **CONVINCE other people to join in the efforts to protect the Earth's soils!**

DO ONE OF THE TWO COMPULSORY ACTIVITIES BELOW:

D.01 SOIL CELEBRATION Organize a fun day all about soil. Spread the word by putting up flyers in your school, local library, and local community centre, or by posting the event online and on your social media pages. Invite your friends, family, neighbours and community members to attend. At the Soil Day event, have posters and talks about all the benefits of soil and the factors that damage soil. Have snacks too, with labels about the role that soil played in their production. Include games and encourage people to think about the part that soil plays in the planet's natural beauty and in our recreational activities. If you hold your celebration on December 5th, you'll be a part of celebrations being held around the planet in support of World Soil Day.

LEVEL 3 2 1

D.02 DISHING OUT DIRT Get permission to display an exhibit about soil in a public space, such as a park or town square, and then get to work. Create posters explaining the factors that damage soil and how these affect people, plants, animals, and the environment as a whole. Include checklists reminding people about soil-friendly changes they can make in their lives. Show maps depicting the amount of soil **degradation** that has already happened on Earth. Put up the posters and tell everyone you know to check out the exhibit!

LEVEL 3 2 1

WERKEZ GILEKKI KOYU, aged 14, TURKEY

CHOOSE (AT LEAST) ONE ADDITIONAL ACTIVITY FROM THE LIST BELOW:

D.03 TOUR GUIDE Take a friend who does not know much about soil on a guided 'tour' around your garden or local park. Teach them some soil facts, such as the ways in which plants, animals, and we as humans depend on soils, and how different organisms work together to help keep the soil healthy. Look together to see if you can spot some earthworms, mosses, or other members of the soil food web.

LEVEL 1

D.04 LESS LITTER! Litter can be extremely damaging to soil. Start keeping an eye out for it in your hometown. Think about how you can help prevent more littering. Share your ideas with your family and friends. Perhaps you can organize a litter collecting day, to make more people aware of the issue. Carefully collect the garbage and dispose of it properly, in a bin or garbage can for example. Is any of the litter recyclable?

Wear gloves and protective clothing, if appropriate!

LEVEL 1 2 3

D.05 GREEN GARDENING Prepare a **compost** bin to help the soil in your garden, schoolyard or local forest or park. Find out how: **www2.epa.gov/recycle/composting-home**. Keep a diary of what you are putting in the bin and keep an eye on the plants to see if the **compost** makes a difference. If you do not have access to a garden, create a poster with instructions on **composting** and its importance in general, and share it with friends and family members who have gardens.

LEVEL 1 2 3

D.06 HOUSE WATCH Start monitoring your household's activities which may have environmental repercussions. For example, are you leaving lights on in empty rooms? Are unused appliances left plugged in? Do people leave the water running while brushing their teeth? Make a list of everything you notice and figure out how it might affect soil, directly or indirectly. What are the long term repercussions of this? Tell your family members and create a checklist of reminders to place in prominent places around the house.

LEVEL 3 2 1

D.07 POLLUTION PROTECTION Polluted water can cause serious damage to our soils. Prepare a poster that shows and explains the effects of pollution on soils, and what we can do to prevent further pollution and **contamination**. Display your poster around your school and places in the local community such as shops, bus stops, etc. Ask your friends and family to buy eco-friendly cleaning products and toiletries that do not add lots of chemicals to the water system.

LEVEL 3 2 1

D.08 BE AN ECOTOURIST Research some examples of **ecotourism** in your country. How does this help to protect soils? Design your own **ecotourism** activity and test it on your friends and family. For example, you could go on a hike in your local area and explore your natural environment. Explain how soils are essential to our experiences of nature – we couldn't survive without soils!

LEVEL 3 2

D.09 GETTING ORGANIZED As a group, research different organizations that are working on soil conservation around the world. What kinds of projects are they doing? What are some of the ways in which they've helped? Find out if they have youth activities, Web sites, or campaigns that your group can get involved in. Pick one way that your group can get involved, and then do it!

D.10 SHOP-SOILED Look out for organic and fair trade products available in your local supermarkets or farmer's markets. Where did the products come from? Were they locally grown or imported from farmers at the other end of the world? What are the pros and cons of each situation? Also, how might the production of these organic and fair trade goods be beneficial for soils and the environment in general? Is there a significant price difference between these and other products? Why is this the case? Put your findings together in the form of photos and graphics, and then present them to your peers, parents or other adults. Encourage them to buy more organic and fairly-traded goods, whenever possible.

LEVEL 3 2

D.11 SOCIAL MEDIA Use a blogging platform or social media site to spread the word on soils. Post interesting facts and news about soils, informing your audience in fun and creative ways. Post photos of soils in your area, with information about soil quality and health and invite your followers to post their own soil photos. See how many followers you can get. Try to start a lively virtual discussion about soils and how we can all help to conserve them.

LEVEL 3 2

D.12 SOIL ON STAGE As a group, script a play about a small community that relies primarily on soil to survive. Perhaps some of you have livestock, while others grow vegetables. Lately, your village has been facing soil damage. Is this because of climate change, or because of overgrazing? How is it affecting your lives? What are some solutions? Let your imaginations run wild and then practise a few times before announcing the play in your community and holding a performance.

LEVEL 3 2

D.13 Do any other activity approved by your teacher or leader.

LEVEL 1 2 3

CHECKLIST

Keep track of the activities you are undertaking in this checklist. When you show that you have completed them, you will have earned the Soils Challenge Badge!

YOUR NAME: .....

YOUR AGE: 1 (5 to 10 years) 2 (11 to 15 years) 3 (16+ years)

	Activity n°	Activity name	Completed on (date)	Approved by (leader's signature)
A All about soil				
B Soil uses				
C Soil at risk				
D Take action				

RESOURCES AND ADDITIONAL INFORMATION

STAY UPDATED

This Challenge Badge is one of several complementary resources and activities developed by YUNGA and its partners. Please visit **www.fao.org/yunga** for additional resources or subscribe to the free news letter to receive updates of new materials by sending an email to **yunga@fao.org**

SEND US YOUR NEWS

We would love to hear about your experience of undertaking the Challenge Badge! Which aspects did you particularly enjoy? Did you come up with any new ideas for activities? Please send us your materials so we can make them available to others and gather ideas about how to improve our curricula. Contact us at **yunga@fao.org**

CERTIFICATES AND BADGES

Email **yunga@fao.org** for certificates and badges to reward course completion! Certificates are FREE and Challenge Badges can be purchased. Alternatively, groups can print their own badges; YUNGA is happy to provide the template and graphics files free of charge on request.

WEB SITES

The **BUREAU OF LAND MANAGEMENT FOR KIDS** is a fun site that teaches you all about soil and includes some fun activities: **www.blm.gov/nstc/soil/Kids**

Convention on Biological Diversity

The **CONVENTION ON BIOLOGICAL DIVERSITY (CBD)** is working to protect the rich biodiversity that lives in soils: **www.cbd.int/agro/soil.shtml**

Food and Agriculture Organization of the United Nations

FAO SOILS PORTAL is a portal where you can find interesting maps and graphics about soil: **www.fao.org/soils-portal/en**

GLOBAL SOIL PARTNERSHIP

THE GLOBAL SOIL PARTNERSHIP is a mechanism that aims to improve the governance of our planet's limited soil resources in order to guarantee healthy and productive soils for food security, as well as support other essential ecosystem services: **www.fao.org/globalsoilpartnership/en**

THE GREEN WAVE

THE GREEN WAVE Web site is your gateway into an exciting biodiversity project for young people. It offers lots of resources and stories about how youth around the world are celebrating biodiversity: **www.greenwave.cbd.int**

THE GLOBAL YOUTH BIODIVERSITY NETWORK (GYBN) is a network of youth organizations and young people from all over the world to come together and unite over the common goal of halting the loss of biodiversity as soon as possible: **www.gybn.net**

The **'I HEART SOIL'** site has some great videos and animations explaining the importance of soil: **www.iheartsoil.org**

INTERNATIONAL YEAR OF SOILS 2015 will raise awareness on the importance of sustainable soil management as the basis for food systems, fuel and fibre production, essential ecosystem functions and better adaptation to climate change for present and future generations: **www.fao.org/globalsoilpartnership/iys-2015/en**

ISRIC – WORLD SOIL INFORMATION provides soil data and soil mapping, application of soil data in global development issues, and training and education: **www.isric.org**

SAVE OUR SOILS is a campaign by Nature & More aiming to raise consumer awareness about the importance of soil for our health, food security and climate. It is trying to make people aware of the problem of degraded soils, and point them towards soilutions: **www.saveoursoils.com**

SMITHSONIAN INSTITUTE'S Museum of Natural History site includes interesting facts and photos about soil:
http://forces.si.edu/soils/02_01_00.html

SOIL-NET has a wealth of information and educational resources about soils and their importance. Check out their teachers and student guides, case studies and activity ideas:
www.soil-net.com

SOILS4KIDS includes fun activities, experiments, and games related to soils: **www.soils4kids.org**

TUNZA: Soil – The forgotten element. UNEP's youth programme (TUNZA) has produced this special edition magazine all about soil, featuring stories on youth taking action to protect soils, case studies and much more:
www.unep.org/pdf/Tunza_9.2_Eng.pdf

UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD) is a legally binding international agreement linking environment, development and the promotion of healthy soils. Check out the Web site for information about drylands, how to maintain and restore the land's productivity, and mitigate the effects of drought:
www.unccd.int

UNITED NATIONS DECADE FOR DESERTS AND THE FIGHT AGAINST DESERTIFICATION (2012-2020) aims to promote action to protect drylands: **www.un.org/en/events/desertification_decade**

THE US DEPT OF AGRICULTURE's Web site for kids contains everything from lesson plans to art projects and conservation ideas: **www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/kthru6**

THE WORLD ASSOCIATION OF GIRL GUIDES AND GIRL SCOUTS (WAGGGS) is a worldwide movement providing non-formal education where girls and young women develop leadership and life skills through self-development, challenge and adventure. Girl Guides and Girl Scouts learn by doing: **www.wagggsworld.org**

WORLD DAY TO COMBAT DESERTIFICATION is held on 17 June each year. In 2014, the focus was on 'climate proofing' the land for future generations: **www.unccd.int/en/programmes/Event-and-campaigns/WDCD/Pages/WDCD-2014.aspx**

THE WORLD ORGANIZATION OF THE SCOUT MOVEMENT (WOSM) is an independent, worldwide, non-profit and non-partisan organization which serves the Scout Movement. The Scouts are doing some great work towards soil protection – learn more at: **www.scout.org**

WORLD SOIL DAY, is held on December 5 each year, highlights the importance of soils for our planet and spreads awareness about using soils sustainably. This video gives you the basics on soil, what needs to be done, and why we should support World Soil Day:
www.youtube.com/watch?v=TqGKwWo60yE

The **WORLD WILDLIFE FUND** is combating soil degradation around the world:
http://worldwildlife.org/threats/soil-erosion-and-degradation

GLOSSARY

ACID, ACIDIC: Acid is a substance that dissolves in water to give a **pH** of less than 7. Weak acids can taste sour, strong acids can burn your skin. Acidic soils are often found on peatlands or under boreal forests (forests in the northern hemisphere).

ACIDIFICATION: The process of becoming **acidic**.

ACID RAIN: Any type of **precipitation** that contains nitric and sulphuric **acids**, resulting from the burning of **fossil fuels**.

AGGREGATE: These are soil particles that are bound to each other, using **soil organic matter** as the 'glue' to bind them together. Aggregates vary in both size and shape depending on the soil's properties.

ALKALI, ALKALINE: An alkali is a soluble **base**. Alkalis will dissolve to give a solution of **pH** greater than 7. Alkaline soils are found where there is a lot of clay in the soil, or in limestone environments.

ALKALIZATION: When a substance turns **basic** (i.e. less **acidic**).

ARTHROPODS: Animals that do not have backbones but instead have external skeletons. For example, insects are arthropods.

ATMOSPHERE: A layer of gases around the Earth held in place by **gravity**. The gases in the atmosphere include **oxygen** (which humans and animals need to breathe) and **carbon dioxide** (which plants need to respire, which is like breathing for them).

ATOM: Everything in the world is made up of miniscule particles called 'atoms'. These particles are like small 'building blocks'. Different atoms combine to make up **molecules** of different substances.

BASE, BASIC: A substance that dissolves to give a **pH** of greater than 7. Weak bases are soapy and slippery to touch. Strong bases can burn your skin. An **alkali** is a type of base.

BIODEGRADABLE: Objects or material that can be **decomposed** by bacteria or other living **organisms**.

BIODIVERSITY: The variety of all the different kinds of plant and animal life on Earth, and the relationship between them.

BIOMASS: Plant material and animal waste used as a fuel or energy source.

CARBON: A very important substance that all life on Earth depends on. Carbon is found in nearly every biological compound that makes up our bodies, systems, organs, and cells. All plants have carbon as their most important element. Carbon is also found in charcoal, petroleum, plastics, and the lead of a pencil.

CARBON DIOXIDE (CO_2): A gas made up of **carbon** and **oxygen atoms**, which makes up less than one percent of the air. CO_2 is produced by animals and used by plants and trees. It is also produced by human activities such as burning **fossil fuels**. CO_2 is a **greenhouse gas** and can speed up **climate change**.

CARBON SEQUESTRATION: The natural process of removing **carbon** from the **atmosphere** and storing it somewhere else, for example in soils or the ocean.

CERTIFICATION SCHEMES: Certification schemes establish a set of rules and conditions that ensure natural resources are produced or sourced fairly and sustainably (without damaging the environment).

CLIMATE, CLIMATIC: This is the long-term average, or overall picture, of the everyday **weather** experienced in a location.

CLIMATE CHANGE: A change in the overall state of the Earth's **climate** caused by both natural processes and human activities. The build-up of **greenhouse gases**, such as **carbon dioxide**, in the Earth's **atmosphere** is an example of how some human activities (e.g. energy production, transportation, farming and the manufacturing of goods) can accelerate climate change.

COMPOST: Decayed **organic** material that is used as a plant **fertilizer**.

CONTAMINATION: When a resource such as soil or water is dirtied or polluted by the introduction of another substance.

DECOMPOSE, DECOMPOSITION: The process of breaking down or decaying (e.g. the leaves of a tree decompose after they fall).

DEFORESTATION: Removing a forest or part of a forest (e.g. by cutting it down or burning it) and using the land for something else (e.g. farming or building on it).

DEGRADED, DEGRADATION: Soil degradation happens when the soil is damaged in a way that reduces its fertility and makes it less productive for crop growth as well less biologically diverse (see **biodiversity**).

DESERT: An extremely dry area of land on which less than 250 mm of rain falls per year. Deserts have very little **vegetation** cover, instead they feature large surfaces of exposed, bare soil or sand.

DESERTIFICATION: The **degradation** of land in arid (dry), semi-arid, and dry sub-humid areas resulting from various factors, including **climatic** variations and human activities. Desertification causes the **degradation** of the natural **ecosystem** and reduces agricultural productivity.

DROUGHT: A long period of unusually low rainfall, leading to a shortage of water.

DRYLANDS: Regions with low rainfall.

ECOSYSTEM: A community of living **organisms** (plants and animals) and non-living things (water, air, soil, rocks, etc.) interacting in a certain area. Ecosystems don't have a defined size: depending on the interactions you are interested in, an ecosystem can be as small as a puddle or as big as an entire **desert**. Ultimately, the whole world is one big, very complex ecosystem.

ECOSYSTEM SERVICES: The benefits that humans and the natural environment can obtain from natural **ecosystems**. There are four types of ecosystem services: provisioning (e.g. providing food and water), regulating (e.g. healthy tree roots in the ground help with flood control), cultural (e.g. people enjoy spending time in nature; some cultures worship nature or parts of it) and supporting (e.g. the natural **water cycle** helps maintain life on Earth).

ECOTOURISM: Ecotourism is a kind of tourism that has a low impact on the environment and supports local livelihoods. Ecotourists often like going to areas of natural beauty to enjoy nature.

EROSION: Erosion means 'wearing down'. Rocks and soils are eroded when they are picked up or moved by ice, water, wind, **gravity** or other natural or human agents. Also see **weathering**.

FERTILIZER: A natural or **chemical** substance added to soil or land to increase its fertility (the amount of crops it can grow).

FOOD CHAIN: The links between a series of **organisms**, showing who eats whom or what. They show how energy passes between individuals, starting with **primary producers** (plants). Also see **food web**.

FOOD WEB: A more complicated version of a **food chain**, showing that more than one animal may have the same food source, meaning that different **food chains** are interconnected.

FOSSIL FUELS: Fossil fuels form over millions of years from prehistoric plant or animal remains. The three fossil fuels are coal, oil and natural gas. When we burn fossil fuels to fuel vehicles or generate energy, the **greenhouse gas** **carbon dioxide** is released into the **atmosphere**, contributing to **climate change**.

FUNGUS (PLURAL: FUNGI): An **organism** that grows in the soil, on dead matter or on other fungi by decomposing **organic** matter. This process means **nutrients** are reused ('**nutrient cycling**'). Mushrooms, for example, are the fruit of specific kinds of fungi.

GEOLOGIST: A rock specialist.

GRAVITY: A force that attracts everything on Earth towards its centre (and prevents us from floating around in space!).

GREENHOUSE GASES: Gases (such as **carbon dioxide**, methane or ozone) whose build-up in the **atmosphere** prevents heat from escaping (like the glass in a greenhouse). Human activities like

industrial production, energy production and transportation have increased the levels of greenhouse gases in the **atmosphere** to such an extent that the Earth's average temperature is starting to rise: this is known as **climate change**.

GROUNDWATER: Water located beneath the Earth's surface. This is the Earth's biggest storehouse of drinkable water.

HABITAT: The local environment within an **ecosystem** in which an **organism** usually lives.

HUMUS: The **organic** matter found in soil.

INFILTRATION: The process by which water on the ground is absorbed into the soil.

INFRASTRUCTURE: The basic facilities, services, and installations needed for a community or society to function effectively, such as transportation and communications systems, water and power lines, and public institutions including schools and post offices.

INORGANIC: Material that is not derived from living **organisms**.

IRRIGATION: Artificially watering land or soil to allow plants and crops to grow when there is too little rain or **groundwater** supply to feed them naturally.

LEACH, LEACHING: The process of soluble **nutrients** and other materials being dissolved or removed when water runs through a substance. In soil, **nutrients** are lost when **precipitation** or **irrigation** washes them away.

LICHEN: A simple plant formed by algae and **fungus** growing together.

MICRO-ORGANISM: A creature too small to be seen with the human eye alone, but which can be seen through a microscope. Within their natural **ecosystems**, micro-organisms help in recycling **nutrients**.

MINERAL: A solid, **inorganic** substance that occurs in nature. For example, gold and silver are minerals.

MOLECULE: When individual **atoms** stick together, they make up small clusters called 'molecules'. Different molecules make up different substances. For example, a **carbon dioxide** molecule is made up of one **carbon atom** (C) and two **oxygen atoms** (O_2), which is why its scientific name is **CO_2**.

MONOCROPPING: The agricultural practice of producing or growing only one crop or plant species over a large area.

NITROGEN: In its most common form, nitrogen is a colourless, odourless and tasteless gas that makes up around 78 percent of the air we breathe. Nitrogen also exists as a compound in soil: plants rely on nitrogen from the soil to develop the proteins and **acids** they need to grow healthy roots, stems, leaves, seeds and flowers.

NITROGEN-FIXING: The process of changing **atmospheric nitrogen** into compounds that plants are able to absorb.

NUTRIENTS: Chemicals which animals and plants need to live and grow.

NUTRIENT CYCLING: The continuous cycling of **nutrients** through an **ecosystem**.

ORGANISM: A living creature, like a plant, animal or **micro-organism**.

ORGANIC: As opposed to **inorganic** substances, organic materials are derived from living matter or **organisms**. They almost always contain **carbon**.

ORGANIC FARMING: A type of farming in which fruit, vegetables and livestock are farmed using only natural **nutrients** such as **compost** and manure, and natural methods of weed and pest control, instead of using chemical pesticides and **fertilizers**.

OVERGRAZING: When too many animals are feeding off an area of land so that its **vegetation** is lost and it is at risk of **erosion**, it is said to be overgrazed.

OXYGEN (O_2): A gas produced by plants and trees during **photosynthesis**, and used by humans and animals who need it to breathe. An oxygen **molecule** is made up of two oxygen **atoms** (O_2).

PARENT MATERIAL: The underlying material (i.e. bedrock), from which **soil horizons** are formed.

pH: A scale that is used to measure how **acidic** or **basic** a substance is. The scale ranges from 0 (**acidic**) to 14 (**basic**), with a pH of 7 representing a neutral substance.

PHOTOSYNTHESIS, PHOTOSYNTHESIZE: A biological process found in plants and algae that uses light as an energy source to convert **carbon dioxide** and water into a source of food (sugars and other useful **nutrients**).

PORES: The spaces between soil particles or **aggregates**. Healthy soil contains both 'macropores' (big spaces) and 'micropores' (small spaces).

PRECIPITATION: The process whereby water vapour in the **atmosphere** **condenses** and falls in the form of rain, sleet, snow or hail.

PRIMARY PRODUCERS: Those **organisms** at the beginning of a **food chain** that make their own food from a primary energy source (e.g. plants that make their own food from sunlight by **photosynthesis**).

RUN-OFF: The flow of water that occurs when the soil is saturated and excess water from rain, snow, or other forms of **precipitation** runs over the land surface, eventually returning to rivers and the ocean.

SALINITY: The level of salt in a substance, such as soil or water.

SOIL HORIZONS: The various layers of soil.

SOIL ORGANIC MATTER (SOM): SOM is made up of dead plant and animal materials in various stages of **decomposition**. SOM is mostly made of **organic** **carbon**, but it also contains **nutrients** that are essential for plant growth. Also see **humus**.

SOIL PROFILE: The combination of all the soil layers, from top to bottom.

SUSTAINABLE, SUSTAINABILITY: The state in which we humans use the natural environment to meet our needs without damaging it so that it can no longer be productive (no longer supports plant, animal or human life). Making sure that our actions are sustainable means that future generations will be able to live well, too.

TERRESTRIAL: Relating to the Earth. ('Terra' means 'Earth' in Latin – both in the sense of 'soil' and 'the world'.)

TOPOGRAPHY: The physical features of an area.

TOPSOIL: The top layer of soil, from which plants obtain most of their **nutrients**.

VEGETATION: The plants and trees in an area.

WATER CYCLE: The continuous movement of the Earth's water, on, above and below its surface.

WATERLOGGING: The soaking of agricultural land when too much water is present for the soil to absorb it properly.

WATER SCARCITY: Water supplies are considered 'scarce' (too little) when annual water supplies drop below 1 000 cubic metres per person per year (*Source*: UN). That's not even half an Olympic swimming pool per person each year!

WEATHER: The conditions outside experienced on an hour-by-hour or day-to-day basis in a particular place, including the cloud cover, rainfall, air temperature, air pressure, wind and humidity (the amount of water vapour in the air).

WEATHERING: The wearing away of a material or substance such as rock or soil due to natural factors (like wind, rain or growing tree roots) or human factors (like chemical pollution). Unlike **erosion**, weathering takes place without the material being moved.

WETLANDS: Land that is saturated (full) with water, such as bogs, marshes or swamps.

SZE WAI KWAN, aged 19, HONG KONG, CHINA

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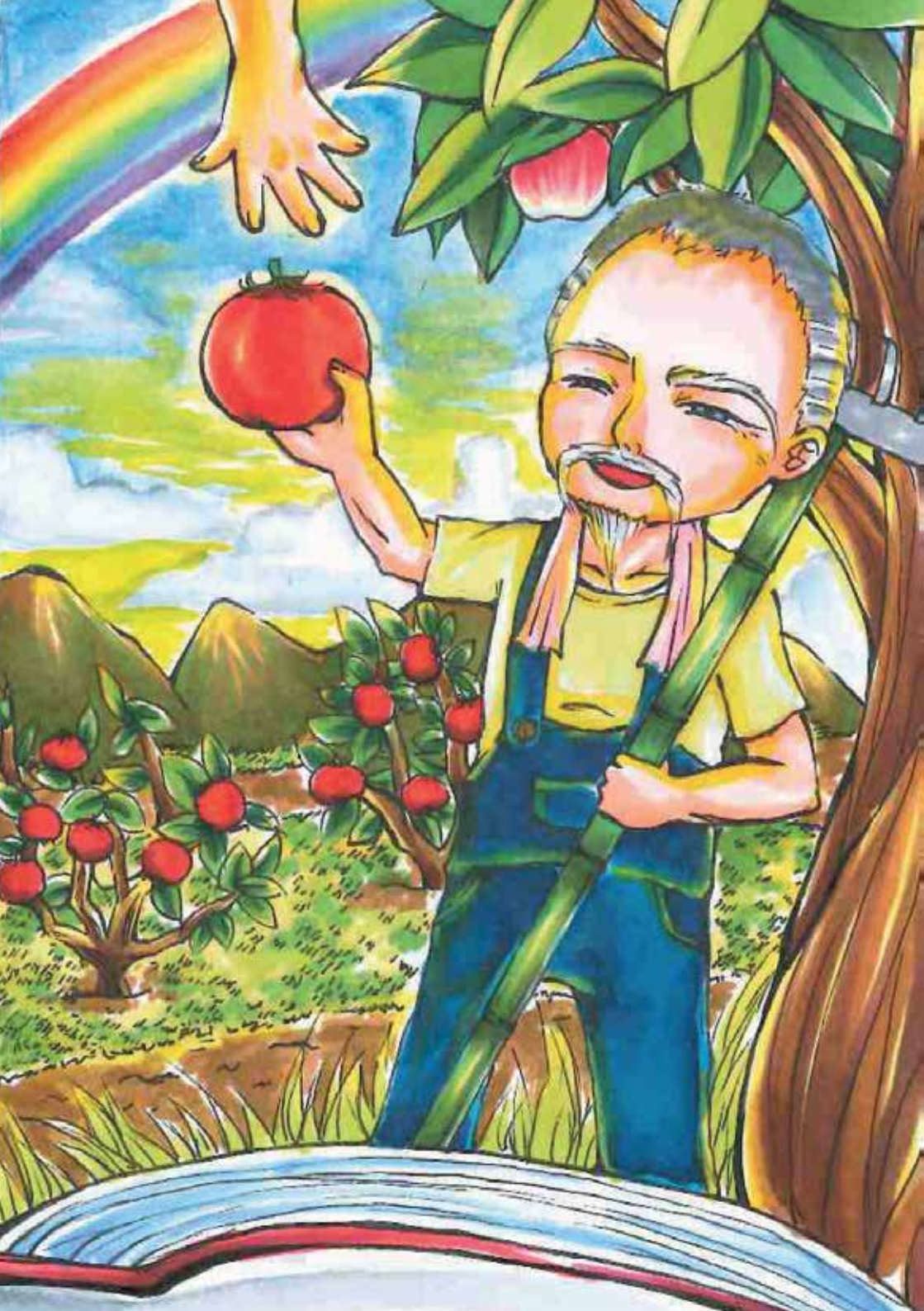
Some of the illustrations in this booklet are a selection from the over 10 000 drawings received from various drawing competitions. See our Web site (www.fao.org/yunga) or register to our free mailing list (email yunga@fao.org) to find out about current competitions and activities.



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www.sida.se

This badge was developed in collaboration with and is endorsed by:

Secretariat of the Convention on Biological Diversity (CBD)

The Convention on Biological Diversity came into force on 29 December 1993 with the objectives to conserve biodiversity, use it in a sustainable fashion and to share its benefits fairly and equitably. The CBD Secretariat manages biodiversity policy discussions, facilitates the participation of countries and groups in biodiversity processes and supports the implementation of the Convention.
www.cbd.int

Food and Agriculture Organization of the United Nations (FAO)

FAO leads international efforts to enhance global agricultural performance while promoting the sustainability of water use for food production. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information, helping countries to modernize and improve agricultural policies in relation to land and water management.
www.fao.org/climatechange/youth/en

Global Soil Partnership (GSP)

The Global Soil Partnership is a mechanism aiming to improve the governance of our planet's limited soil resources in order to guarantee healthy and productive soils for food security, as well as support other essential ecosystem services.
www.fao.org/globalsoilpartnership/en

United Nations Convention to Combat Desertification (UNCCD)

Desertification along with climate change and the loss of biodiversity were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit. At Rio+20 in 2012, world leaders agreed to strive to achieve a land-degradation neutral world to curb the growing threats of desertification, land degradation and drought. Established in 1994, UNCCD is the sole legally binding international agreement linking environment, development and the promotion of healthy soils. The Convention's 196 Parties work to alleviate poverty in the drylands, maintain and restore the land's productivity, and mitigate the effects of drought.
www.unccd.int

HO WAN WAN, aged 16,
HONG KONG, CHINA

The World Association of Girl Guides and Girl Scouts (WAGGGS)

The World Association of Girl Guides and Girl Scouts (WAGGGS) is a worldwide movement providing non-formal education where girls and young women develop leadership and life skills through self-development, challenge and adventure. Girl Guides and Girl Scouts learn by doing. The association brings together Girl Guiding and Girl Scouting associations from 145 countries, reaching 10 million members around the globe.
www.wagggsworld.org

The World Organization of the Scout Movement (WOSM)

The World Organization of the Scout Movement (WOSM) is an independent, worldwide, non-profit and non-partisan organization which serves the Scout Movement. Its purpose is to promote unity and the understanding of Scouting's purpose and principles while facilitating its expansion and development.
www.scout.org

Youth and United Nations Global Alliance (YUNGA)

YUNGA was created to allow children and young people to be involved and make a difference. Numerous partners, including UN agencies and civil society organizations, collaborate to develop initiatives, resources and opportunities for children and young people. YUNGA also acts as a gateway to allow children and youth to be involved in UN related activities such as the Millennium Development Goals (MDGs), food security, climate change and biodiversity.
www.fao.org/yunga

JEROME BOCCIA, aged 15, ITALY

THE YOUTH AND UNITED NATIONS GLOBAL ALLIANCE (YUNGA) IS A PARTNERSHIP BETWEEN UNITED NATIONS AGENCIES, CIVIL SOCIETY ORGANIZATIONS AND OTHER ENTITIES WHICH DEVELOPS INITIATIVES, RESOURCES AND OPPORTUNITIES FOR CHILDREN AND YOUNG PEOPLE TO LEARN, GET INVOLVED AND MAKE A DIFFERENCE.

YUNGA ACTS AS A GATEWAY FOR CHILDREN AND YOUTH TO PARTICIPATE IN THE ACTIVITIES AND INITIATIVES OF THE UNITED NATIONS.

WE ARE MANY. WE ARE YUNGA!

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The purpose of the United Nations Challenge Badges is to raise awareness, educate and, most of all, motivate young people to change their behaviour and be active agents of change in their local communities. Challenge Badges are appropriate for use with school classes and youth groups, and are endorsed by WAGGGS and WOSM. They include a wide range of activities and ideas that can easily be adapted by teachers or leaders. Additional badges are available or are being developed on a number of other topics, including: Agriculture, Biodiversity, Climate Change, Energy, Forests, Gender, Governance, Hunger, Nutrition, the Ocean, and Water.

The Soils Challenge Badge is designed to help educate children and young people about the vital role that soils play in supporting life on Earth. The badge looks at how soils are created, soil uses and how soils are being affected by human and climatic pressures. It includes a wide range of activities and ideas to stimulate learning about soil and how we can better manage soil resources to ensure that we have a sustainable future.

FOR MORE INFORMATION ON THIS AND OTHER MATERIALS CONTACT:

YOUTH AND UNITED NATIONS GLOBAL ALLIANCE (YUNGA)

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