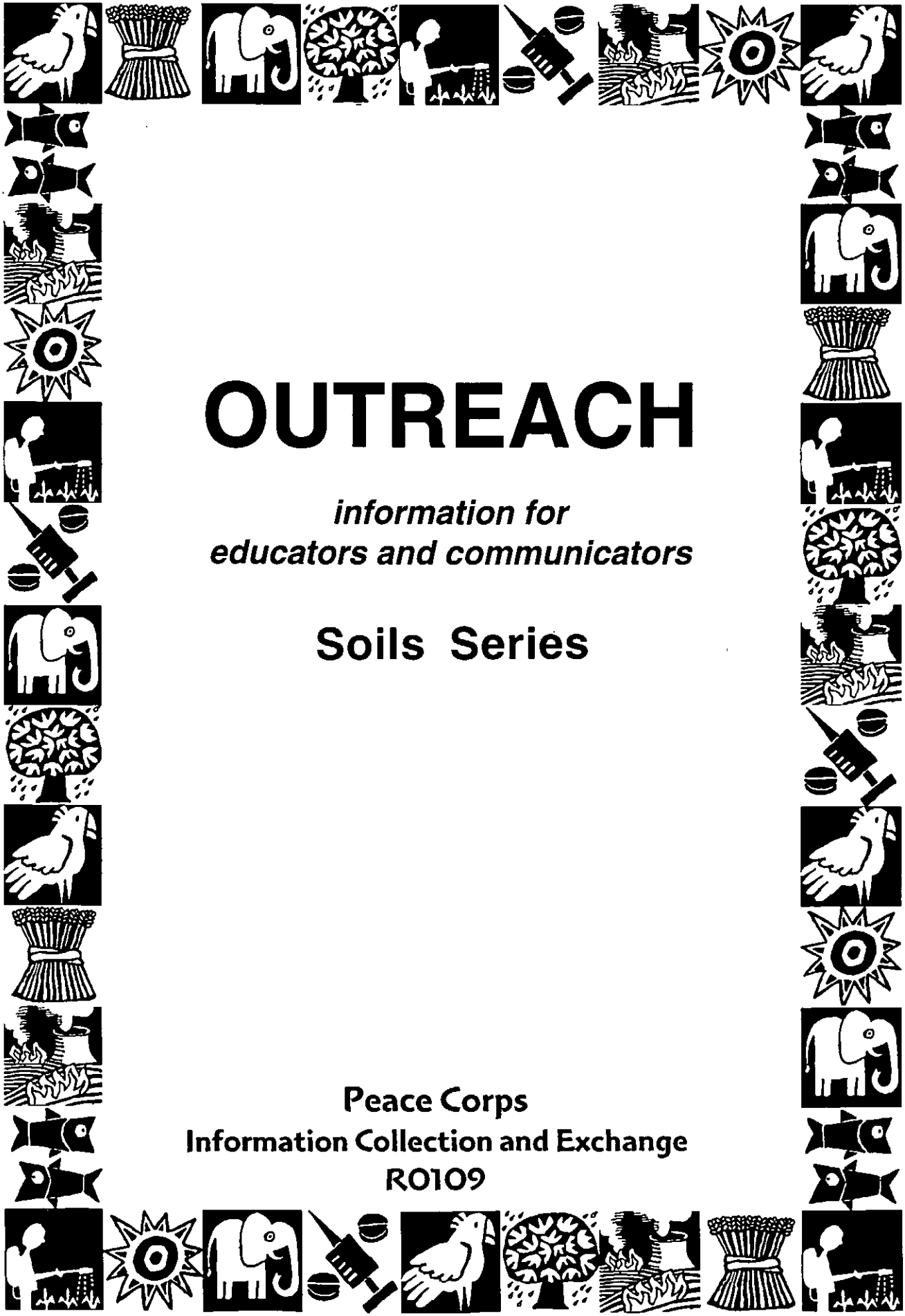

OUTREACH

information for
educators and communicators

Soils Series

Peace Corps
Information Collection and Exchange
R0109

OUTREACH

information for
educators and communicators

Soils Series

Issue 1: Soil Basics
Issue 2: Losing Soil

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Peace Corps
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May 1999
R0109

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ACKNOWLEDGMENTS

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SOIL SERIES

1: SOIL BASICS

BACK ISSUES OF OUTREACH

Back issues available in **A - ARABIC, C - CHINESE, E - ENGLISH, F - FRENCH, P - PORTUGUESE, S - SPANISH**

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33 Wetlands (1)			E		P	S
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71 Crops (5) Farming Issues			E		P	S
72 see Learning-By-Doing leaflet series "Gardening" part 1						
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74 Appropriate Technology (1) Introduction	A		E		P	S
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85 see Learning-By-Doing leaflet series "Inventing and Simple Machines"						
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87 see Learning-By-Doing leaflet series " Health Technologies"						
88 see Learning-By-Doing leaflet series "Building Technologies"						
89 not in print						
90 Growing Up			E			
91 Waste (1) Global Problems, Local Solutions			E	F		S
92 Waste (2) Conserving Natural Resources			E			S
93 Waste (3) Recycling			E			
94 Waste (4) What to do about Hazardous Waste			E			S
95 see Learning-By-Doing leaflet series "Waste and Recycling"						
96 Children in Especially Difficult Circumstances (1) Working and Street Children			E	F		
97 Children in Especially Difficult Circumstances (2) Children Affected by Catastrophes			E	F		
98 Indigenous Peoples (1)			E			
99 Indigenous Peoples (2)			E			
100 Land degradation (1) Soil Basics			E			
101 Land degradation (2) Causes and Effects			E			
102 Land degradation (3) Some Agric. Solutions			E			

LEARNING-BY-DOING LEAFLET SERIES

Gardening (1)	A		E	F	P	S
Gardening (2)	A		E	F	P	S
Inventing and Simple Machines			E			
Appropriate Water Technologies			E			
Appropriate Health Technologies			E			
Appropriate Building Technologies			E			
Waste and recycling			E			S
Energy (1) Work, Waves and Currents			E			
Energy (2) Animal and People Power, Biofuels and Conservation			E			
Energy (3) Energy from the Sun, Wind, Water and Earth			E			

OUTREACH packs

Who can use OUTREACH packs?

The OUTREACH packs are supplied free-of-charge to 'multipliers' in low-income countries. 'Multipliers' are people who can pass on environment and health messages to a wider audience. They include:

* *newspaper journalists* who can use the materials:
  - as 'fillers' in newspapers and magazines;
  - in articles;
  - in a series of articles;
  - in special editions, especially in children's health and environment newspaper supplements and magazines.
* *radio broadcasters/journalists* who can use the materials:
  - as 'spots' between programmes;
  - in reports;
  - in a series of programmes on a specific issue;
  - in a special programme devoted to a particular topic;
  - as background information for interviews with local experts on environment and health issues.
* *community workers and representatives from Non-Governmental Organizations* (NGOs) who can use the materials:
  - to inform their own networks;
  - as background information for programmes;
  - for meetings and activities with women; farmers; scouts, girl guides and other youth groups; community groups and leaders;
  - in environment and health campaigns;
  - in training workshops.
* *educators and curriculum developers* who can use the materials:
  - for background information for their own classes;
  - for classroom activities;
  - in teacher training workshops;
  - on field trips and in laboratories;
  - for curriculum development.

How to use OUTREACH packs?

The materials in OUTREACH packs may be used for non-commercial, educational purposes in low-income countries. Use the material as you wish:

ADOPT all or part of the materials for inclusion in articles, activities and programmes;
ADAPT materials so they have local relevance;
ADD materials to your own news articles or educational programmes.

You can write for more information to contributing organizations or those listed in resource sections.

Whatever way you use OUTREACH packs, **PLEASE CREDIT SOURCE** where indicated. Otherwise please credit **OUTREACH**.

What you can do for OUTREACH?

We need feedback on the packs. How useful is this material? How can we make it better? Are there special topics you need? Please let us know. Please send us material that you have developed from OUTREACH Information packs. We can pass it on to others to help them in their projects.

We also want to hear about the projects you are working on, and see the materials you produce. We would like to pass on your information and ideas to others in the OUTREACH Network. Here's how to contact OUTREACH staff:

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A new type of OUTREACH pack

In its effort to make information and educational materials on the environment and health more accessible to youth and the general public in Africa, Asia and Latin America, OUTREACH has been producing two kinds of packs:

- a general information pack comprising radio scripts, stories, games, articles and some practical activities for use by newspaper journalists, radio broadcasters, community workers, NGOs.
- school-based activity packs comprising Learning-by-Doing leaflets and teachers' notes aimed specifically at curriculum developers and teacher trainers in pre-service and in-service workshops.

In June 1998, these packs were reviewed by environmental educators from around the world, and in response to their suggestions, OUTREACH is now producing one type of pack.

This pack contains illustrated hands-on activities for use in the classroom and/or the field. While the majority of activities are aimed at upper primary level/ lower secondary level students, there are activities for younger and older students, and even adults. The activities are similar to those which appeared in Learning-By-Doing Leaflets in that they are practical exercises which focus on developing scientific skills needed to solve problems related to environment and/ or personal health issues. There are short-term classroom activities which can supplement school curricula; activities in the local environment/community which may be useful in both formal and non-formal educational settings; and practical activities which people can use as guidelines for solving real-life issues. Information for teachers/trainers is also included which explains how the individual activities might be used in different settings - from large or small classrooms to club meetings.

To complement these activities, there is background information on the topic presented in the form of questions and answers. This may serve as an introduction at teacher and community-based workshops or be adapted for use as a radio script. To meet the demand for more materials that can suit larger groups of students who might be learning in a more teacher-orientated setting, teaching aids in the form of posters, stories and play scripts are also included. Games and puzzles may be adapted for use in newspaper supplements, comics or as classroom worksheets. Each issue includes a list of resources, and relevant films available through the distribution service of TVE. Finally, a glossary of terms used in this issue is included.

The first series of issues in the new format is on SOILS. We hope you will find these packs more useful than past issues. Please let us know what you think.

OUTREACH Series on Soils

The following topics will be covered in the series on Soils:

- the non-living things that give a soil its physical characteristics and influence how a soil behaves;
- soil erosion: wind erosion, and ways to protect soil from wind damage; water erosion, and suggestions for repair and prevention;
- how water moves in different soils, with suggestions on how to conserve soil moisture and irrigate land;
- living things in soil, especially worms and bacteria, and the vital role they play in the cycle of life;
- ways of promoting a healthy soil through composting and worm composting;
- the relationship between plants and soil, and alternative farming techniques which promote the health of both;
- soil chemistry, soil nutrients and soil acidity, with a focus on such problems nutrient depletion, overfertilization, land pollution, acid rain, and suggestions for promoting a fertile and well-balanced soil;
- the social, political and economic aspects of land degradation, with a focus on drylands, which are especially vulnerable to land degradation;
- The Convention to Combat Desertification;
- local solutions and success stories in the struggle to conserve soils.

Suggested ways to use this OUTREACH pack

QUESTIONS AND ANSWERS

What's in a soil? (page 5);

Soil makers (page 6-7)

Ways to adapt material:

Children and radio presenters can ask the same questions of a local soil expert, adding questions of their own which are related to local soils and 'soil makers'.

How to use the material:

- As questions posed by the teacher to students to introduce project work on soils.
- As background information for the teacher doing project work on soils.
- As the basis of a children's radio programme on soils.

STORIES

The fox cub and the VISM (page 8-10)

Ways to adapt material:

The story may be the basis of a radio script or class play for children.

How to use the material:

- As an introduction to carrying out Activity Guide 3 on Soil Makers. After reading the story, the teacher should review the factors influencing the formation of soil.
- If classes are too large to conduct the hands-on activities in the Activity Guide, this story presents an alternative way of explaining factors influencing soil formation.
- As a class play, perhaps as a conclusion to work on soils.
- The story may be read to children after they have studied soil formation. It may inspire them to make up their own stories on how soil came to exist.

POSTERS

We all depend upon soil for.... (Page 11)

Aim:

To show how we rely on soil for many of the things we use and do. Direct relationships (e.g soil being used to grow food, clay as a building resource) are obvious, but the poster tries to show other ways we rely on soil as well.

Ways to adapt material:

The poster may be enlarged for display purposes. You may want to use the text but select other illustrations or photographs to reflect your culture. Or you may choose examples that are more familiar to your locality. For example, you might show local rural or urban businesses that are connected to soil as a resource – grocery stores, tanning and leather industries, seed dealers, packing plants.

How to use the material:

- The poster may be displayed on a community noticeboard.
- It can be used as a starting point for project work on soils. You might start a discussion by asking whose jobs are linked to soil. If the answer is 'a farmer's', then you could ask, "What are some of the products produced from the soil?" and then broaden the discussion to other ways we rely on soil. The message to get across is that we all depend on a healthy soil for survival.

Using Soils (page 12)

Aim:

To demonstrate that all soils are not alike, and they cannot be treated in the same way. For example, shallow mountain soils cannot support the same land uses as deeper soils found in lowland floodplains. Misconceptions about soils in certain habitats may be clarified through the poster. For example, the soil in a tropical rainforest is not very fertile despite the incredible variety of plants found there. Most of the nutrients that are used by plants are stored in the plants themselves, not in the soil. Tropical rainforest destruction results in the loss of valuable plant and animal species, and all that is left is a poor soil which is only able to support limited cultivation for a short time.

Ways to adapt material:

The poster may be enlarged for display purposes.

You may want to use the text but select other illustrations or photographs to reflect your culture. Or you may choose examples that are more familiar to your locality.

You may create a poster that shows the consequences of misuse of different soils in your locality.

How to use the material:

- The poster may be displayed on a community noticeboard.
- It can be used in project work which involves comparing different soil types.

PUZZLES AND GAMES

Soils around the world (page 10)

Aim:

To help older students appreciate the diversity of soils around the world.

How to use the material:

- As part of a lesson on different soils.

Why do we need soil? (page 13)

Aim:

To help younger students appreciate the links between everyday items and soil.

How to use the material:

- This activity may be used as part of a school project on soils.
- It can be adapted for use in a children's newspaper supplement/comic magazine.

ACTIVITY GUIDE ON SOIL BASICS

Ways to adapt the material:

Editors of children's comics and newspaper supplements may adapt some of the activities (e.g. activity 3 in Activity Guide 1: Be a Soil Detective) as practical projects that complement articles, games and puzzles on Soils.

How to use the material:

A summary of the activities in the guide is on pages 14-16.

The activity guide may be used as enrichment material by teachers to supplement their existing lessons on soil. National curriculum developers may include activities in school curricula. Representatives of NGOs and youth/wildlife club organizers may use selected activities in workshops as an introduction to practical projects for their members. Agricultural extension workers may use some activities in workshops for farmers' associations.

GLOSSARY (page 43)

How to use this material:

The glossary may serve as a source of reference, or the words can be used in word games and puzzles in comics and in the classroom.

What this Issue offers...

Primary level students:

The posters may serve as a starting point for a lesson on soils. The students may carry out the activity, "Why do we need soil?" , and an exploratory activity on soils (Activity Guide 1 Activity 3). Then, the story may be used to complete this introduction to soils.

Intermediates and Secondary students:

The comprehensive package of activities for studying the non-living things that give a soil its physical characteristics and influence how a soil behaves is aimed at this level. Individual activities can be incorporated into an existing school curriculum, or adapted for use by youth groups.

The information materials may be used by students to create their independent study projects, such as creating radio scripts, plays.

Youth and Adults:

A selection of activities may be used in courses for farmers so that they can appreciate the differences in composition/structure of local soil types, and appreciate the fact that, for all practical purposes, soil is a nonrenewable resource. Possible activities are all those in Activity Guide 1: Be a Soil Detective; activities 1 and 3 in Activity Guide 2: What makes up a soil? and activities 2 - 8 in Activity Guide 3: Soil Makers. Information in this pack is important for people in making land use decisions, and in the application of various farming techniques.

QUESTIONS AND ANSWERS

SUGGESTIONS FOR USE *(see page 3):*
Teachers: *As background information for project work on soils; as questions to introduce topic of soils to students.*
Radio producers, journalists: *As the basis of a children's radio programme or an article on soils.*

What's in a soil?

Q. We are all familiar with soil. It's the ground you walk on; the dust that blows in your face when you kick dry earth, and the dirt that gets under your fingernails when you sow seeds. But what is soil really made of?

A. Soil is made up of minerals, organic matter, water and air. And, of course, soil is home for millions of living things, many of them too small to see without a microscope.

Q. What are minerals?

A. Minerals are produced from parent rocks that are weathered and broken down into small pieces.

Q. What size are the mineral particles found in soils?

A. Other than the occasional stones, gravel and other rock debris, most mineral particles range in size from coarse sand particles to fine clay particles.

Q. How can you tell if a soil is sandy or made of clay?

A. Often by the feel. Sand particles feel gritty or sharp when rubbed between the fingers. Silt particles are smaller than sand and feel like powder. Clay particles are so tiny that they hold together in a lump when squeezed and feel sticky when wet. In general, mineral particles make up half— or almost half—of soil by volume.

Q. You mentioned soil contains organic matter. What is organic matter?

A. The remains and wastes of living things. Organic matter is being decomposed continually by bacteria, fungi and other microscopic organisms that live in soil. When the remains of plants and animals have completely decomposed in the soil, they form humus. Humus is dark, crumbly and feels spongy. It provides food for plants and can absorb and hold water for future use by plants.

Q. How much organic matter does a soil contain?

A. While certain bog soils are almost entirely made of organic matter, most soils contain only a small amount of organic matter - from almost nothing to rarely over 6%. Organic matter helps all soil. It lightens clay soil by creating more air spaces, and increases the amount of water a sandy soil can hold.

Q. If a little over half of soil is made up of rock particles and organic matter, what makes up the other half?

A. Spaces in between these solid particles. These spaces are filled with either air or water. Plant roots need air in soil to 'breathe' and air spaces make it possible for plant roots to spread out in search of food.

Q. How does water get into the soil?

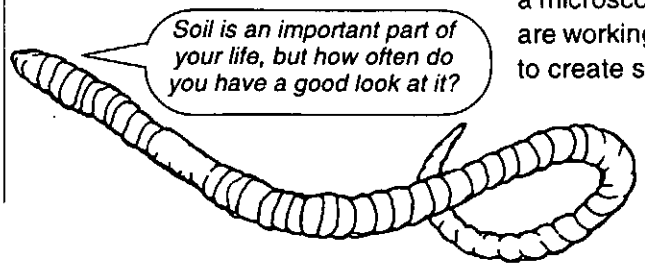
A. Water seeps into the air spaces in soil during a rainfall, and may be taken up by plant roots. Different soils hold water in different ways. Sandy soils have lots of large air spaces, and let water pass through them easily. Sometimes water passes too quickly for plants to take up all the water they need. Clay soils do not have enough large air spaces, and easily become water-logged. Plant roots have a hard time growing in clay soils because the heavy soils lack air spaces.

Q. What is the best kind of soil for growing crops?

A. A soil with a balance of different-sized particles (sand, silt and clay) and a high proportion of organic matter. Loam is a term used by gardeners and farmers to describe ideal soils.

Q. How many living things call soil 'home'?

A. Soil is home to millions of living creatures. In fact, scientists say that there are more living things under the ground than above it! Soil life includes animals such as earthworms, rodents and moles, beetles, centipedes, millipede, ants, termites and tiny worms called nematodes. And there are plants and animals, such as bacteria, fungi, algae and protozoa which are so tiny they can be seen only through a microscope. These creatures are working all the time, helping to create soil.



QUESTIONS AND ANSWERS

SUGGESTIONS FOR USE *(see page 3):*
Teachers: *As background information for project work on soils; as questions to introduce topic of soils to students.*
Radio producers, journalists: *As basis of a children's radio programme or an article on soils.*

Soil makers

Q. How long does it take a soil to form?

A. It can take hundreds, if not thousands, of years to make one inch (2.5 cm) of topsoil. The kind of soil that is created depends upon a number of different factors. These are the type of parent rock, the climate, living things, the shape of the land and time itself.

Q. How does the parent rock influence the nature of a soil and how long it takes to form?

A. Parent rock is the material from which soil particles are made. Parent rock can be volcanic deposits, such as ash, which have fallen on an area. It can be rock particles which have been carried to the area by wind, water and ice. Or it can be the underlying rock which is broken down and weathered. Different parent materials weather at different rates. Since transported rock particles are already partially weathered, then soils made from this material are likely to be created more rapidly than those made from underlying rock.

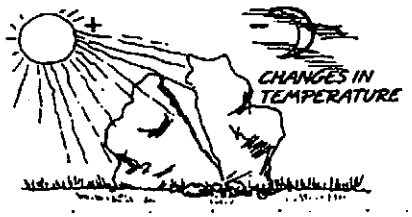
Q. How are rocks broken down?

A. A rock can be broken down into smaller and smaller pieces without its original character being changed. This is called **mechanical weathering.** An example of mechanical weathering is when water works its way into cracks in a rock and, upon freezing, expands, forcing the rock apart. When stones in running water rub against each other, they break into smaller fragments, too.

Even plants can break up rocks. Lichen grips onto bare rock, and loosens particles. Water can then get to work and weather the rock, enlarging the cracks.

Q. Are there other ways rocks are weathered?

A. When rock is heated during the day and cools down at night, tension occurs and the rock



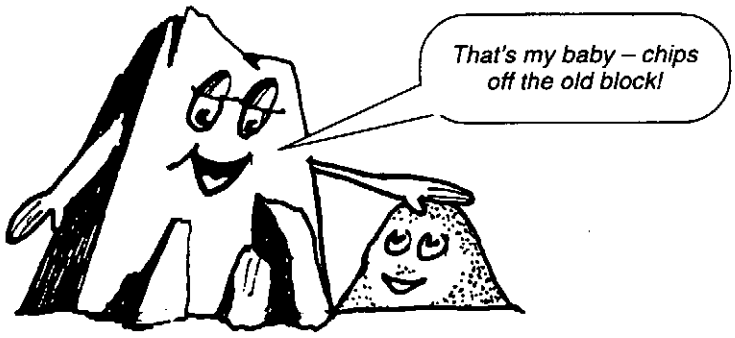
cracks into smaller and smaller pieces. This is called **thermal weathering.**

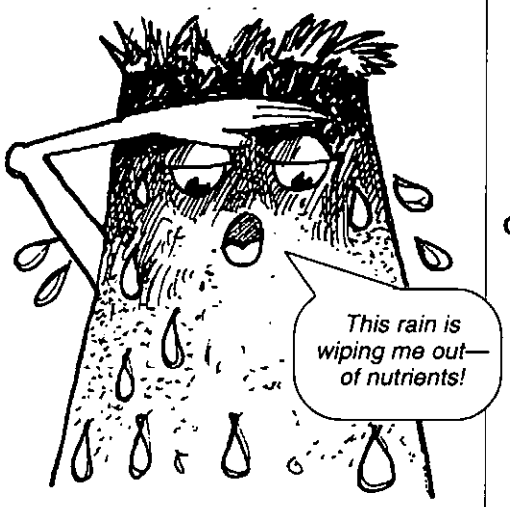
Q. Does weathering ever change the original rock into new substances?

A. Yes. One example is when plant roots take in oxygen from air in soil and give off carbon dioxide gas. Carbon dioxide dissolves in the soil moisture, forming weak carbonic acid. This acid, in the form of carbonated water, breaks down rocks such as limestone. The lime in limestone dissolves in the water and so is washed away leaving only the other materials as soil particles. In this way old rock decomposes into new substances. This is called **chemical weathering**.

Q. How can climate affect the type of soil produced and the speed at which it happens?

A. Climate is a strong influence upon soil formation. For example, a hot, wet climate may





produce a thick layer of chemically-weathered soil in the same time as a cold, dry climate produces a thin layer of debris broken down by mechanical weathering.

Q. Can rain affect the fertility of soil?

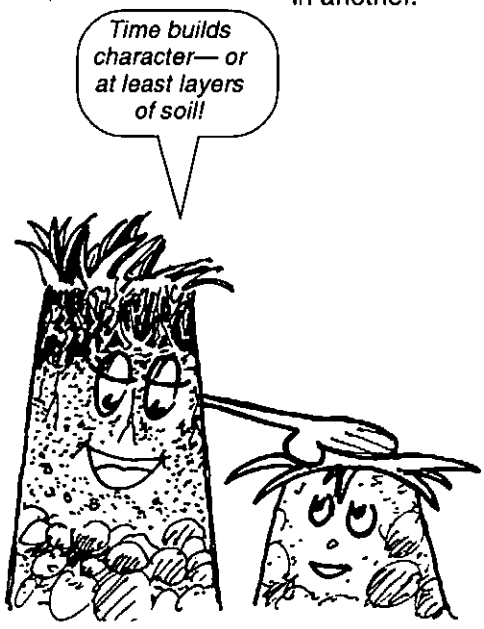
A. Yes. Rain may wash humus and dissolved chemicals, such a magnesium and potassium, downwards through the soil. These substances may be left fairly deep down in the ground or may be washed into rivers and streams. This process is called **leaching**.

Q. Does climate affect the amount of organic matter in soil?

A. In hot, wet places, such as tropical rain forests, dead plants and animals decay rapidly so the soil has only a thin layer of humus. But in colder lands decay is slower, and the humus layer is generally thicker.

Q. In what other ways does climate affect soil formation?

A. If the land is dry and has few plants to protect it, the soil is likely to be blown away by wind. Soil lost in one area is deposited in another.



Q. We have already learned of ways plants break down rock particles, but do living things contribute to the making of soil in other ways, too?

A. Yes. Microscopic plants and animals - bacteria, fungi, algae and protozoa - play an active role in the decay of plant and animal remains. The end product is humus which is vital for creating a fertile soil. Humus binds soil particles together and gives the soil good structure. The presence of earthworms and other burrowing animals improves soil fertility by mixing up soil particles and aerating the soil.

Q. What is topography and how does this influence the making of soil?

A. The hilliness, flatness or amount of slope of the land is called topography. Topography has an impact on the movement of water and soil particles. Soils on sloping land tend to be shallow because water, aided by gravity, continually carries soil down the hillside in streams and rivers. On flatter land, deeper soils are formed where the flow of water in rivers slows down and sediment is deposited. Moist, poorly-drained soils are often located in low areas and in depressions of land.

Q. How does time affect the formation of soil?

A. As a general rule, the longer a soil has been forming, the thicker it becomes and the less it looks like the parent material. The age of a soil must be thought of in thousands, even millions, of years since it may take hundreds of years to form one inch of topsoil.

STORY

SUGGESTIONS FOR USE *(see page 3):*
Teachers, youth leaders: *As an introduction to class/group activities on soil formation; as the basis of a class play.*
Radio producers: *As the basis of a children's radio script.*

The fox cub and the VISM

Everyone knows that foxes are cunning animals. But have you ever heard about the earthworm that outfoxed a fox cub? Let me tell you the story.

One evening, when the air was warm and damp, Wanda the earthworm popped her head out of her burrow to get a breath of fresh air and to search for food. Just as she discovered a tasty leaf to nibble, she felt the earth shake. Someone was coming. She began to wriggle back into her burrow, but she was too late. Freddie the fox cub had spotted her. He was just about to pounce, when Wanda shouted, "Hold it!"

Now I should point out that, generally-speaking, earthworms are not clever animals. They have simple brains. But on this particular evening, Wanda knew she would have to think quickly to save her own life.

"Hold it!" she repeated. "Before I become your next meal, you should know what you are doing."

Freddie hesitated, "What do you mean?"

"Don't you realise just who you're planning to eat?" asked Wanda.

"You're just a silly little earthworm..." replied the fox cub.

"That may be so," retorted the worm, "But do you realise that the lives of millions of living things depend upon the likes of me?"

Freddie gulped in amazement. "Why?"

"Because I'm a VISM, that's why!"

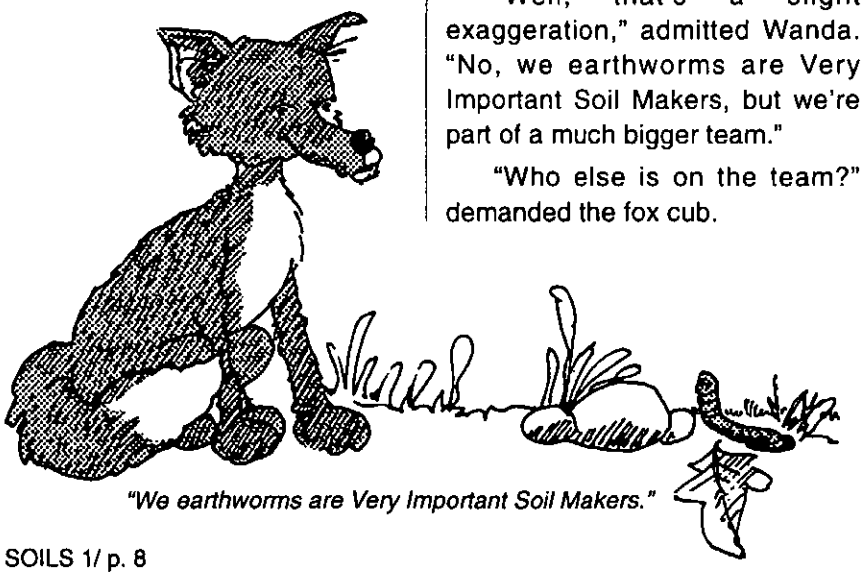
"VISM?"

"A Very Important Soil Maker," said Wanda. "Let me put it to you simply. Without soil, most plants could not grow. Without these plants, there would be no food for plant-eating animals. And without plant-eating animals....where would you be? You couldn't exist without me!"

"You mean to say that little earthworms make up all the soil upon which life depends?" exclaimed Freddie.

"Well, that's a slight exaggeration," admitted Wanda. "No, we earthworms are Very Important Soil Makers, but we're part of a much bigger team."

"Who else is on the team?" demanded the fox cub.



"We earthworms are Very Important Soil Makers."

"The sun, wind, and water," replied the earthworm.

"How do they help make soil?"

"Soil is made from rocks. The sun, wind and water work on these rocks. They wear them down and break them up into finer and finer pieces to make soil. This process is called weathering."

"I've never seen it happening," said the young fox dubiously.

"Well, you wouldn't because it happens so slowly. It takes hundreds, even thousands of years for even a couple of centimetres of soil to be formed."

The fox cub was puzzled. "But the sun is so far away. How can it break up rocks?"

"During the day, the sun shines on rocks and heats them. As a rock gets hot, it gets bigger. Then, in the cool of the night, the rock gets smaller. Repeated swelling and shrinking of the rock causes it to crumble into pieces."

"And how does wind weather rock?" wondered Freddie.

"Wind picks up grains of sand and sweeps them along the ground, grinding and polishing rock surfaces, and wearing them down."

" What does water do to rocks?"

"Different things. Water in the ground dissolves certain minerals in rocks, changing the rock's character. And if water seeps into small cracks in rocks and freezes, it expands with tremendous force and splits apart the rocks. Water in fast-flowing streams or rivers has the power to move rocks in the water, and these moving rocks act as

scraping and cutting tools, scraping the bottom and sides of river beds and wearing them down."

Wanda went on, "I bet you didn't know that plants can help to break down rocks and build up soil, too."

Freddie rolled his eyes, "Now I know you're kidding."

"No, it's true," insisted Wanda. There are plants called lichens (said: LY-kenz) that live on bare rock. They make mild acids which slowly crumble rocks like marble and limestone on which they grow."

As Wanda talked, she wriggled a little bit further into her burrow, hoping Freddie wouldn't notice. She continued, "Roots of plants break up rocks, too. Their secret strength is in their steady pressure. They use their strength very slowly but with great force."

"What do they do?" asked Freddie, looking warily at plants growing nearby.

"A plant root may grow through a crack in a rock. As the root slowly grows larger and larger, its force makes the rock around the crack crumble away."

"Well, this is all very well," said the fox cub, taking a threatening step forward. "But how is it that you're a Very Important Soil Maker? Don't tell me you can break up rocks, too."

"No, I can't break rocks, but soil is much more then bits of rock," exclaimed Wanda quickly. "It's made up of organic matter, too."

"What's organic matter?"

"Anything that was once alive, whether it was a plant or animal." Wanda paused. "Have you ever wondered what happens to animals and plants when they die?"

"I know where some animals go," smiled Freddie menacingly. But then he thought for a moment. "But some dead plants and animals do seem to disappear like magic."

"Mmmm, they do seem to vanish," agreed Wanda. "But it's not magic. It's all through the hard work of small animals and billions of tiny plants and animals that live in the soil."

The fox cub's eyes lit up. "What do the tiny plants and animals look like?" he asked eagerly, thinking there may be more creatures to gobble up.

"They're called micro-organisms because they're so tiny you can't see them except under a powerful microscope. Just imagine! A teaspoon of soil can contain billions of these life forms."

Freddie was disappointed. Micro-organisms didn't sound too appetizing after all.

Wanda continued, "Without these micro-organisms, life would stop. These invisible workers bring about decay. They break down dead things such as grass or mice into simple chemicals that plants can use as food...."

"Oh, the circle of life.." pondered the fox cub philosophically.

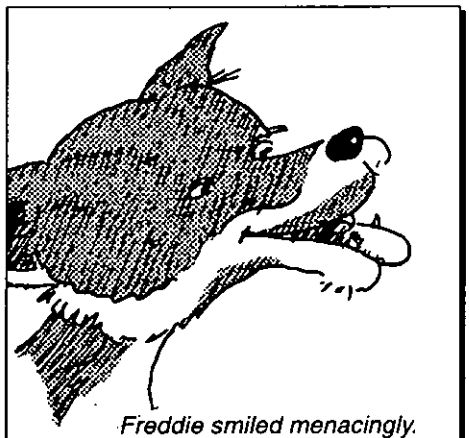
"Umm," said the worm, and went on. "The decaying material is called humus (said: HUU-muss). Only when humus builds up, does a thriving soil begin to take shape."

Freddie yawned. "This lesson on soil is all very well. But you still haven't told me why you're such a Very Important Soil Maker.....and I'm still hungry!"

Wanda squirmed, "I do lots of things to help make good soil."

"Go on..."

She nodded to the leaf she had been nibbling, and bravely tugged it closer to her. "I drag dead plant parts, like this leaf, and the bodies of insects and other animals, down into my tunnels to eat. By bringing them into the soil, they rot more quickly. I also eat soil which is full of bits of dead plants and animals. I suck soil in through my mouth, and my gizzard grinds it into fine pieces."



Freddie smiled menacingly.

"What's a gizzard?"

"It's a tube with strong muscles around it, and lots of gritty grains inside it. The muscles and grit grind up whatever I swallow. And the ground-up stuff becomes a paste."

"Is that paste your worm droppings, the piles of earth that look like coils of string?"

"Not right away. The paste has to go through my long, narrow gut. As it does, my body soaks up the food I need from the paste. Then I push the rest of the paste out of my body. That's the leftover stuff called a worm's cast that you've seen."

The earthworm added proudly, "By bringing up fine soil, I make important minerals available to plants. And while I eat the soil, I make skinny tunnels, especially near the surface of the soil. My tunnels let air into the ground. Soil dwellers need air to live. And my tunnels let water reach plant roots, and allow spare water to drain away. I'm like a little plough, pushing, shoving and breaking up clods of soil."

Suddenly, something caught Freddie's eye. It was a procession of ants scurrying home to their

underground nest. The fox cub leaped high off the ground then landed on the ants. The insects scattered in panic.

"You shouldn't have done that," scolded Wanda, retreating a little further into her burrow. Freddie stared at the earthworm, who spoke again.

"Ants help to make soil, too. In building their underground cities, they move tremendous amounts of soil, grain by grain. They plough the soil by bringing it to the surface and taking organic matter below the ground. By tunnelling through dead trees and animals, they make openings for micro-organisms to do their job of decay."

Wanda stopped speaking. She sensed Freddie was tired of all her talk. Yet by talking, Wanda could keep the fox's mind off eating, and this might give her time to escape!

"Perhaps a bit of flattery might help," thought Wanda. Aloud she said, "Of course, you help to make good soil, too."

Freddie's ears pricked up. "I do?"

"Yes." The earthworm wriggled further into the ground. "By digging your underground home, you help to plough up the soil. You bring humus to the surface, and dig in dead leaves and twigs. Your droppings enrich the soil. And when you die, your body will rot, and add important nutrients to the soil."

The fox cub raised his head proudly. "So I'm a Very Important Soil Maker, too." Then he licked his lips and smirked. "Well, if I'm to do my job properly, I must keep up my strength, so I'd better eat." He stabbed his snout into the ground to catch Wanda, but the earthworm was gone! She had disappeared into her burrow. Freddie had been out-foxed!

"Next time," he muttered to himself. "Just you wait until next time, earthworm." And the young fox wandered off into the night.

ACTIVITY

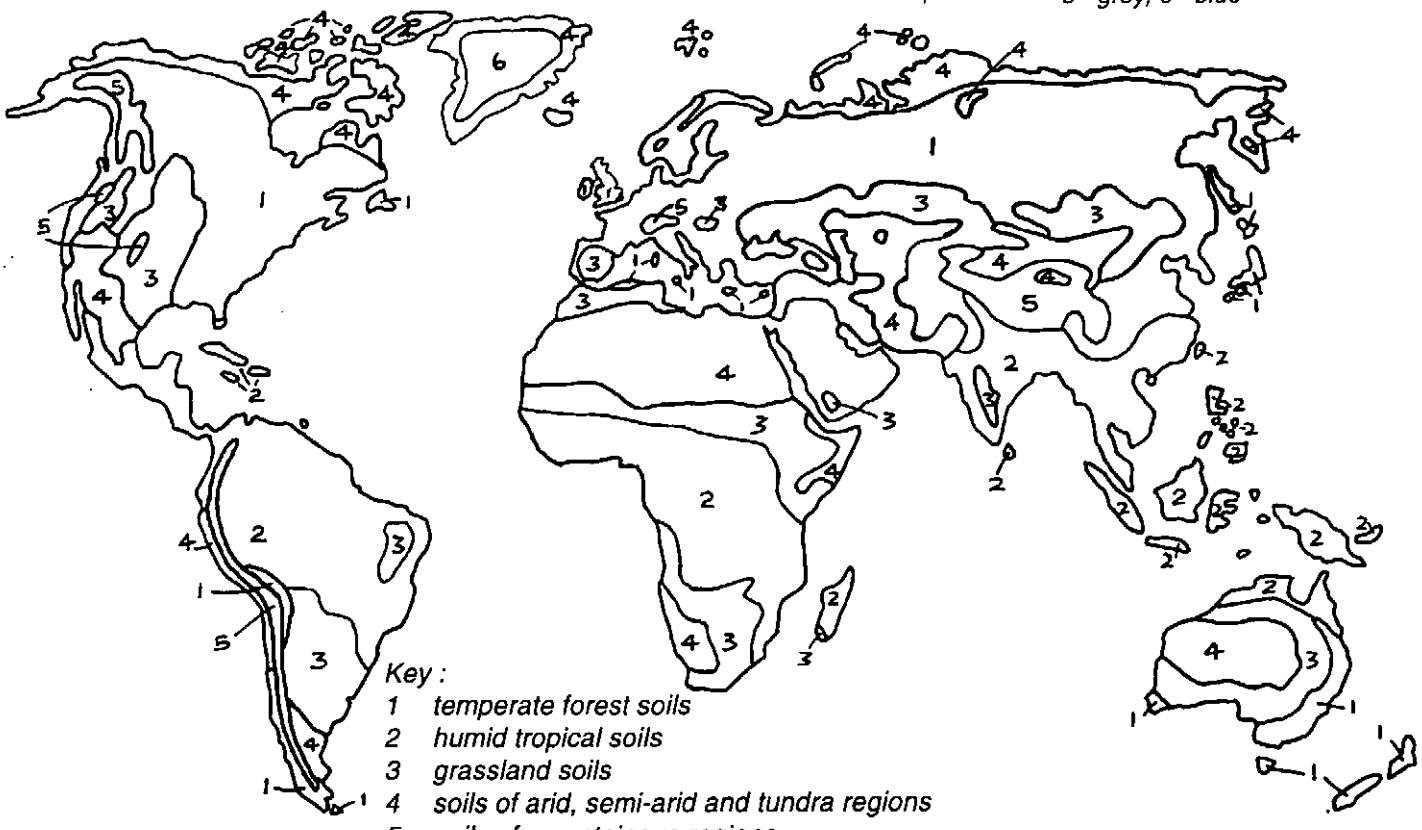
SUGGESTIONS FOR USE *(see page 4):*
***Teachers**: As an exercise for older students on the diversity of soil.*

Soils around the world

There are many different kinds of soils around the world. Soil types differ as much as plant species. Expecting one soil type to perform like another is like expecting a mahogany to behave like a cactus. This is sometimes misunderstood, and as a result, soils are not used to their best advantage.

This map shows the main groups of soils found throughout the world. Use the number key to colour the map:

1-brown; 2 - red; 3 - green; 4 - yellow; 5 - grey; 6 - blue



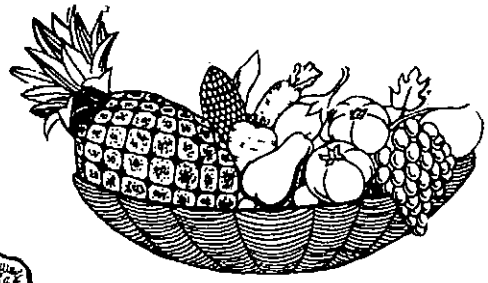
Key :

1 *temperate forest soils*
2 *humid tropical soils*
3 *grassland soils*
4 *soils of arid, semi-arid and tundra regions*
5 *soils of mountainous regions*
6 *ice cap*

POSTER

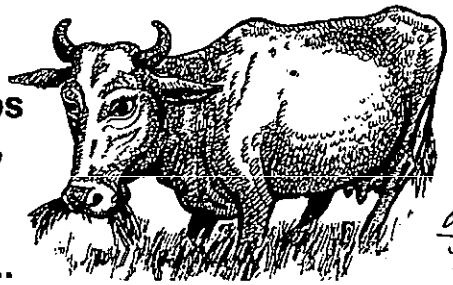
SUGGESTIONS FOR USE *(see page 3)*:
Teachers: *As a starting point for project work on soils.*
Community workers: *As an introduction for practical soil conservation activities.*

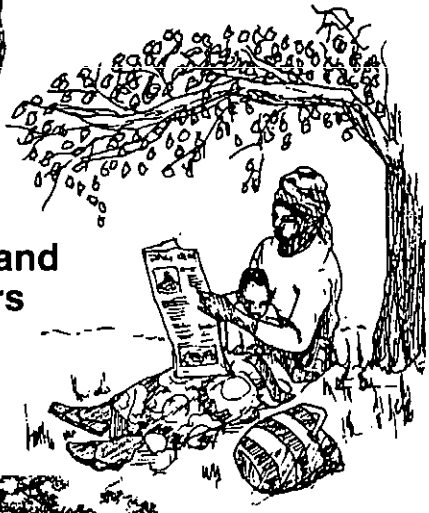
We all depend upon soil for...



...the food we eat...

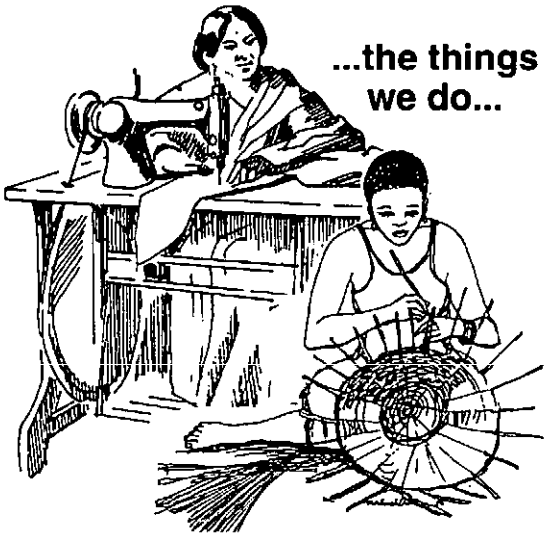
...the crops we grow, and the animals we raise...

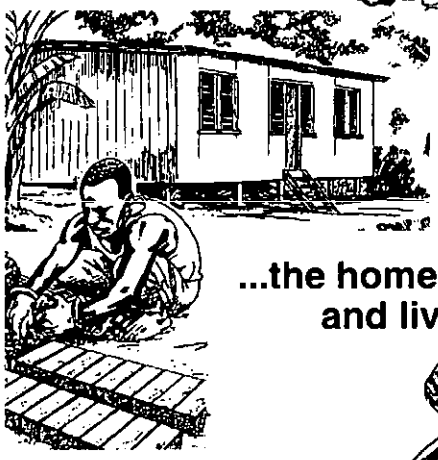




...the books and newspapers we read...

...the things we do...





...the homes we build and live in...

...the clothes we wear...

...and the things we use.

We even depend upon soil creatures to get rid of our waste.

POSTER

SUGGESTIONS FOR USE *(see page 3)*:
Teachers: *As a starting point for project work on soils.*
Community workers: *As an introduction to practical soil conservation activities.*

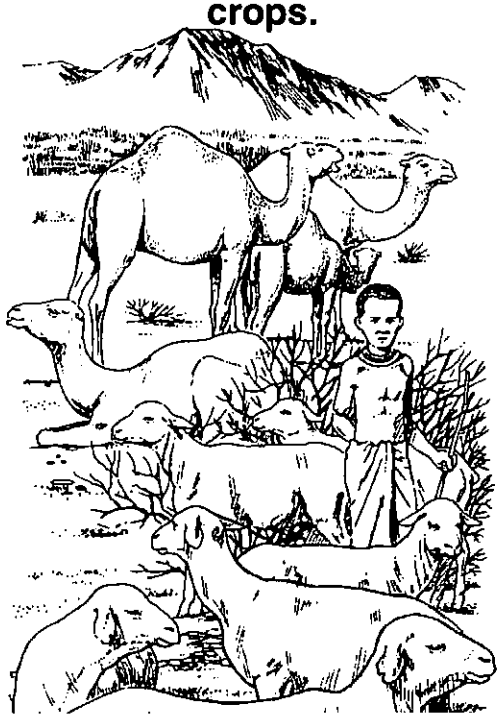
USING SOIL

There are many different kinds of soil...

Some are well-suited for growing crops...

...and some are not.

Some soils can be used as rangeland, but not for growing crops.



Other soils are best for growing forests.

Use *your* soil wisely.
Or it may be lost forever.

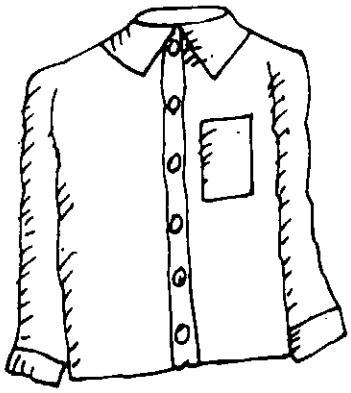
PUZZLE

SUGGESTIONS FOR USE *(see page 4):*
Teachers: *As part of project work on soils for younger students.*
Editors of children's comics/newspaper supplements: *As part of an activity page on the theme of soils.*

Why do we need soil?

Explain why we need soil to produce the items shown in the pictures below. Colour the pictures. Then, use the words to complete the puzzle

Words across:



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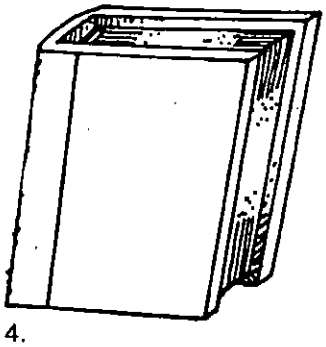

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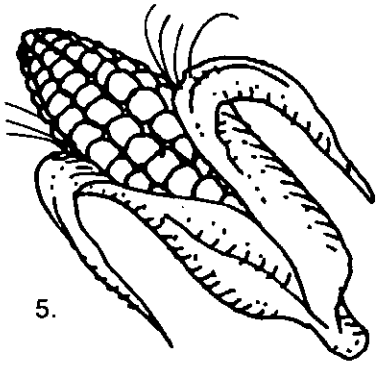

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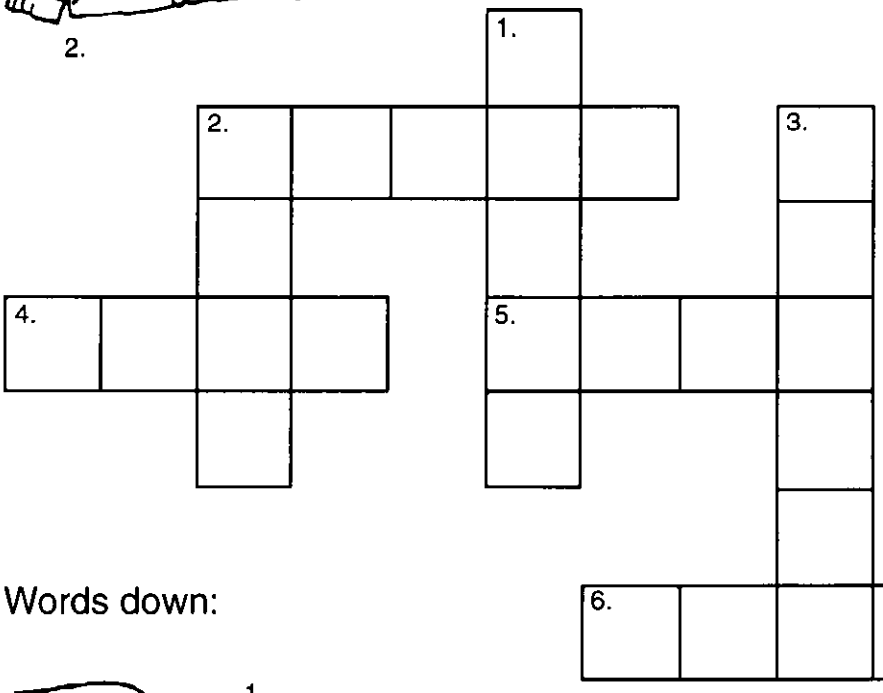
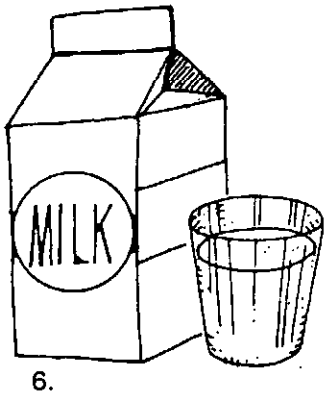
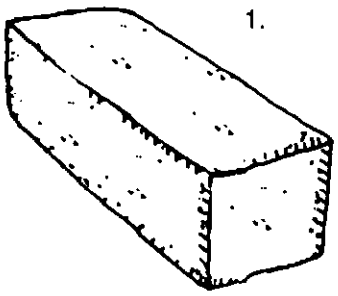


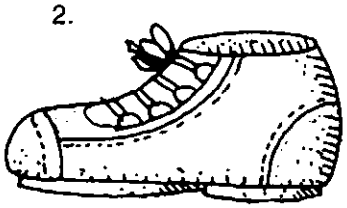


6.

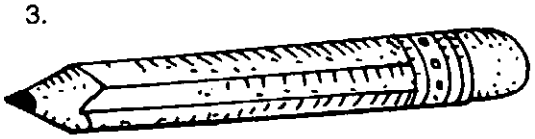
Words down:



1.



2.



3.

Answer to puzzle: Across: 2. shirt; 4. book; 5. corn; 6. milk. Down: 1. brick; 2. shoe; 3. pencil.

Learning-by-Doing Activity Guides on Soil Basics

There are three Activity Guides on **SOIL BASICS**:

1: **Be a Soil Detective** offers students some practical suggestions for carrying out a soil survey.

2. **What makes up a soil?** helps students examine the ingredients that make up a soil. Non-living things, such as rock particles, organic matter, air and water, all help to give a soil its physical characteristics, and influence how a soil behaves.

3. **Soil makers** invites students to explore the factors that influence soil formation and the character of soils: parent rock, climate, living things, topography and time.

The chart on the next page summarizes the activities included in these guides. The suggested age groups are: Primary (ages 5 to 8 years); Intermediate (ages 9 to 11 years); Secondary (ages 11 - 14 years); Youth (ages 15 - 18 years); Adult (over 18 years). However, you should not feel bound by the age groups we have suggested. Teachers, wildlife club leaders, youth workers and extension workers can adapt most of the activities to suit their particular target group – school students, wildlife club members, farmers groups, women's groups and so on.

Essentially, there are three types of activities: classroom activities; activities that involve the study of the local environment/community; and practical projects.

1. **Classroom activities:** These activities introduce students to basic scientific principles. Most of the activities may be conducted in the classroom (or other indoor space). If they require more space or if indoor facilities, such as electricity, are not required, these activities may be conducted outside. Many of these activities may be used to supplement existing school science curricula. An example is Activity 6 in Activity Guide 3: Soil makers. In this activity, students observe how chemical weathering occurs. Classroom activities are short term, usually taking from one to several hours to complete. Occasionally, an activity involves observations and record-keeping over a long period of time.

2. **Studies of the local environment/community:** These activities draw students out into their locality to identify or better understand phenomena, or analyze issues in the locality. An example of this type of activity is Activity 7 in Activity Guide 3: Soil makers. In this activity, students study how different environmental factors influence the character of a soil. If school timetables allow, these activities are useful as field activities for students. They also have appeal to other community groups such as wildlife clubs. These activities are generally longer-term projects than those conducted in the classroom.

3. **Practical projects:** The aim of these projects is to improve the health and the environmental conditions in the community. Through these activities, students learn skills that they can use for a lifetime. They give school students an opportunity to apply theoretical knowledge they have learned in the classroom to real-life settings. They also are useful step-by-step guides for adults currently dealing with real-life situations. These activities are generally longer-term projects that require more thought and planning.

Summary of Activity Guides on SOIL BASICS

Key:
Activity type: C - classroom activity; E/C - activity studying local environment/community; P - practical project

Activity Guide on SOIL BASICS 1: Be a Soil Detective

Activity	Type	Objectives	Ages	Subjects	Materials	Location
1	E/C	Identify and discuss suitable sites to study soil.	Secondary, Youth, Adult	Geography		on location
2	E/C	Describe soil study sites	Intermediate, Secondary, Youth, Adult	Science, Geography	pencil and paper	on location
3	E/C	Observe and record living and dead things in soil.	Primary, Intermediates, Secondary, Youth, Adult	Science	trowel or spade; newspaper; glass jars; sieve (optional); magnifying lens	on location
4	E/C	Observe and record characteristics of different layers of soil.	Intermediates, Secondary, Youth, Adult	Science, Geography	a shovel; a supply of bags for holding soil; twine; a six-foot ruler; paper and pencil; soil thermometer (optional); newspaper	on location

Activity Guide on SOIL BASICS 2: Soil Make-Up

Activity	Type	Objectives	Ages	Subjects	Materials	Location
1	C	Work out proportions of sand, silt and clay in a soil by using hand texturing techniques.	Intermediate, Secondary, Youth, Adult	Science	small, moist clod of soil; water	classroom or outside
2	C	Use settling technique to determine proportions of rock particles in soil by size.	Intermediate, Secondary, Youth	Science	a cupful (about 200 cc) of soil; a straight-sided, flat-bottomed, narrow, tall glass jar with a tight-fitting lid; a pinch of salt (to help break apart the clay grains); measuring tape	classroom or outside
3	C	Examine soil structure and stability.	Secondary, Youth, Adult	Science	2 spadefuls from various soil samples (include in the selection a clayey soil, a loamy soil, compacted clay soil); sawdust; water; newspaper; two trays	outside
4	C	Investigate whether or not air may be found in soil, and if some soils hold more air than others. Measure and compare the porosity of different soils.	Intermediate, Secondary, Youth	Science	soil samples; three plastic cups of equal size for each soil sample; a large bowl; water; timer	classroom or outside
5	C	Demonstrate that water is present in soil.	Secondary, Youth	Science	soil in a metal can; a lid; weighing scales; a stand; heat source	classroom or outside

Activity Guide on SOIL BASICS 3: Soil Makers

Activity	Type	Objectives	Ages	Subjects	Materials	Location
1	E/C	Collect and identify rocks.	Intermediate, Secondary, Youth	Science, Language Arts	magnifying lens (optional)	on location
2	C	Recognize that it takes time to create rock particles through erosion.	Intermediate, Secondary, Youth	Science, Geography	samples of two different types of rock (for example, sandstone or limestone and granite); newspaper; teaspoon; watch	classroom or outside
3	C	Demonstrate mechanical weathering.	Intermediate, Secondary, Youth	Science, Geography	a closed plastic container; water; freezer	classroom or inside space
4	C	Demonstrate thermal weathering.	Secondary, Youth	Science, Geography	a piece of limestone or slate; tongs; cooking pot; pot of cold water	classroom or inside space
5	E/C	Observe how plants cause mechanical weathering.	Intermediate, Secondary, Youth, Adult	Science		on location
6	C	Observe how chemical weathering happens.	Secondary, Youth	Science	small pieces of limestone; vinegar; heat source (e.g. burner or hot plate); glass jar	classroom or inside space
7	E/C	Compare soil makers in different habitats.	Secondary, Youth, Adult	Science		on location
8	C	Demonstrate the effect of slope on soil erosion.	Intermediate, Secondary, Youth	Science, Geography	a tray or cardboard box; much larger trays; newspaper; can with holes punched in the bottom; soil; stiff piece of cardboard; bricks or large stones of varying thicknesses	classroom or outside
9	C	Recognize the effect of time on soil formation	Secondary, Youth	Science, Language Arts	pencil and paper	classroom
10	C	Try to create soil that has qualities of natural soil	Secondary, Youth	Science	2 small pots or tin cans with drainage holes punched in the bottom; some natural soil; four seeds of the same type; pencil and paper; a selection of materials which students can draw upon, such as crushed rocks; clay; sand; water; leaves; worms; broken egg shells	classroom or outside

LEARNING-BY-DOING ACTIVITY GUIDE ON SOIL BASICS

1. Be a Soil Detective

INTRODUCTION

You walk on it, sit on it, dig in it, build with it, plant in it, play with it. Your very life depends upon it. But if you're not careful, you exhaust it or allow it to be washed or blown away. "It" is soil. Have you ever taken a really close look at it?

What do you think makes up soil? Do you think all the soils around your home are alike or do they differ? In this Activity Guide you will collect soil samples from various locations and take a close look at them. These activities should not be done when soils are very wet, dry or frozen.

ACTIVITY 1 Site selection

Objectives:
Identify and discuss suitable sites to study soil
Place:
On location

You and your friends are going to examine soils from three or four locations. The soils may be from:

- a garden
- a forest floor
- a field or pasture
- near a stream or river
- the school grounds
- a well worn dirt track

At least one site should be where plants are growing well, and one site should be where few plants grow.

1. Use a map or take a walk around the neighbourhood, and identify suitable sites where you could examine the soil more closely.
2. Discuss which three or four sites should be chosen. You may carry out the following activities at any or all of the chosen sites.

ACTIVITY 2 About the soil site

Objectives:
Describe soil study sites
Materials:
- pencil and paper

Place:
On location

1. Consider the landscape. For example, is the site near the bed of a fast-flowing stream? Is it in a valley where a slow-moving stream or river flows? Is the land flat or sloping? Is it on the top or bottom of a hill?
2. Think about the type of climate at the site. Does the site receive a lot of heavy rain, or very little rain? Is it a sunny spot? Is the site exposed to strong winds?
3. Study the vegetation on the site. Is the ground covered by vegetation? What kinds of plants grow there?
4. Make a note of the purpose for which the site is used. Is it used as a school playground? For growing crops? Has it been left natural?

ACTIVITY 3

Living and dead things in the soil

Objectives:
Observe and record living and dead things in soil

Materials:
- trowel or spade
- newspaper
- glass jars
- sieve (optional)
- magnifying lens

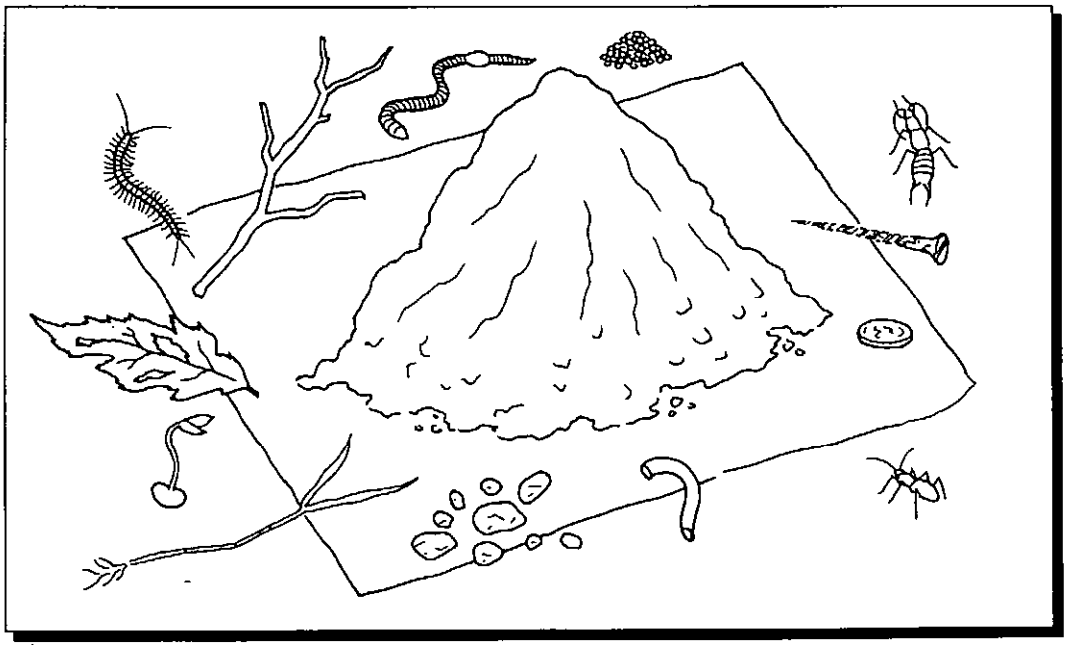
Place:
On location

1. At each site, select an area about 2 feet (61 cm) square on the ground, and gently dig up the top 3 inches (7.6 cm).
2. Place the soil onto newspaper to look more closely for signs of plant and animal life. If you use a sieve to sift the soil, some of the larger soil creatures such as worms and millipedes will be left in the sieve. Put these in glass jars so that you can observe them more closely. Use the magnifying lens to spot even smaller creatures.
3. Record what you see on a chart like the one below. If possible, draw pictures of the creatures on the chart. Return living things to where you found them.

Name or description of item in soil	Quantity	Possible effect on soil
ant	about 50	tunnels help aerate the soil

4. The terms litter, duff and humus are used to describe organic matter at the top of the soil. From the study above, complete the following chart:

Terms	Describe feel	List the identifiable parts of plants and animals you found
litter (identifiable dead things on the surface)		
duff (practically decomposed organic matter - compacted)		
humus (almost completely decomposed non - identifiable organic matter)		



ACTIVITY 4

Soil layers

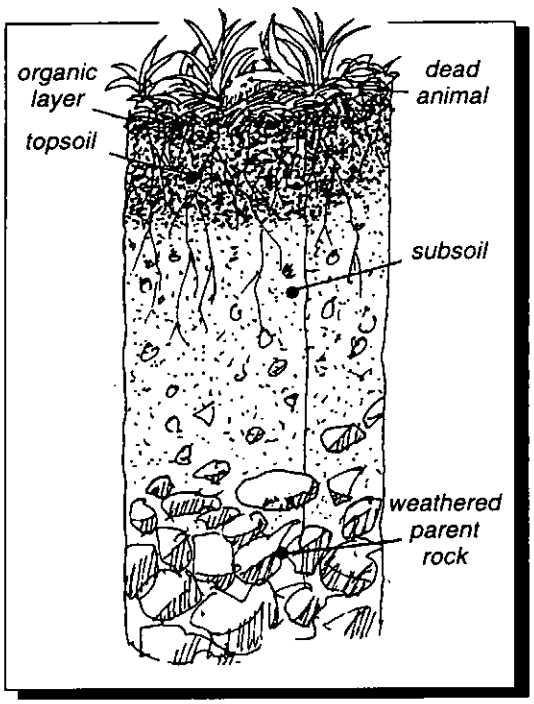
Objectives:
Observe and record characteristics of different layers of soil

Materials:
- a shovel
- a supply of bags for holding soil
- twine
- a six-foot ruler
- paper and pencil
- soil thermometer (optional)
- newspaper

Place:
On location

At each study site do the following:

1. If you have a thermometer, take the temperature 3 feet (91.4 cm) above the ground, and just above the soil surface. Do this early in the morning and during the hottest time of day.
2. Dig a pit in the ground. If you have chosen a site where a deep cut has already been made in the land for a road to go through, or where there is a gully which has exposed several feet of soil, you can study soil layers without digging.
3. As you dig, mark where there are changes in the general appearance of the soil. Many soils have three major layers or horizons: topsoil, subsoil and parent material (see picture). Some soils have more layers, some have fewer. As you come to a new layer, take the temperature of the soil by placing the thermometer into the soil.
4. Describe the layer above the topsoil (if existing):



Litter:
Duff:
Humus:
Total depth of layer of organic matter:

5. Describe the feel, look, smell and sound of soil in each layer. Rub the soil between your fingers. Can you think of three words to describe how the soil feels? What does the feel of soil remind you of? How does the soil sound when you rub it between your fingers. Drop a shovelful of soil onto the ground, and see how it breaks apart? When you have explored a soil layer with your senses, complete a chart similar to the one below:

Description (or profile) of soil layer (circle one): topsoil subsoil parent rock
Depth:
Colour:
Feel: circle one: mostly gritty
smooth and slick or somewhat gritty and sticky
smooth, plastic, very sticky
Shape: (Drop a clod of soil onto the ground, and draw the shapes of the broken pieces):

Temperature of soil layer:
Are plant roots visible?
Describe the size and number of rocks in the soil layer:

6. Collect soil samples from the top soil layer and subsoil layer(s) for each location, and label each bag.

You can do further studies on these soils (see following Activity Guides).

DRAWING CONCLUSIONS

After gathering the data from each location, are you able to draw any conclusions about the soils from the different places? Consider the following questions:

- What are soils made up of?
- How are the soils alike? How are they different? For example, do some soils feel more gritty than others? Are some darker than others? Can you think of reasons why some soils look, feel and smell differently? Can you explain any differences in soil temperatures?
- How do you think soils are formed?
- What is the relationship between plants and soil?
- What are the characteristics of fertile soils? Infertile soils?

OBJECTIVES

To have students:

- observe soils at different sites and at different depths
- compare soil types
- draw conclusions based upon their own observations

(Subsequent units will focus more on the various soil components and soil processes.)

GENERAL TEACHING TIPS

In your introduction to investigations about soils, determine your students' level of understanding of soils by asking them what they think about when they hear the word, "soil". Explain that the best way to understand soil is by examining it.

The activities in this Activity Guide should not be done when soils are very wet, dry or frozen.

Students can undertake the activities in small groups, with older students supervising younger ones at each location. This would require some preliminary instruction for older students on how to supervise younger children, on safety measures and on expectations for each activity. Alternatively, if you have too many students to take on site visits or are unable to organize a small group activity, then many of these activities may be adapted so that you can give demonstrations to the class. Whether the demonstrations are on site or in the classroom, you should try to call on student volunteers to help with individual tasks. At every stage, invite students to predict or explain outcomes.

If students are working in groups, have each group make observations and record its findings in a soil log. Then the group can present its findings to the class. After all presentations, the class can draw comparisons about the different soils.

In this introductory Activity Guide on soils it is important that students are given time to investigate soil(s) in any way they like. Free exploration may lead to chance observations, and innumerable questions. It might also govern the way you will proceed with the other Learning-By-Doing Activity Guides.

ACTIVITY 1

Students should study at least three types of soil. Look around the neighbourhood prior to this activity and consider suitable sites to which you can direct students if necessary. Things to consider:

- safety
- sites that offer a wide variety of soil types. (You should have at least one fertile soil and one that is infertile.)
- accessible sites (Do you need to obtain the permission of landowners/ land users for students to have access to a site, to dig soil, and to take samples. If there are places unsafe for students to collect samples (e.g. on a cliff or near water), you should collect samples yourself.

ACTIVITY 2

When groups have presented their site descriptions, discuss why the information collected in this exercise is important for understanding the factors that influence the formation and character of soils. Here are some notes to help you:

Topography: On mountain slopes soil is often shallow and well-drained as water, aided by gravity, continually carries the soil down hillsides. On lowland floodplains, the soils are generally deeper and more fertile because topsoil washed from higher ground is being continually deposited by rivers. Where drainage is poor, soils may be waterlogged.

Climate: Soils may be affected by general climatic conditions such as temperature and precipitation as well as micro-climatic conditions, for example, a slope that is exposed to sun, wind, etc. In hot dry places, high evaporation causes water to be drawn up in the soil, leading to a build-up of salts in the topsoil. Dry soils, with no plants to protect them, are more likely to be blown away by wind. In hot, wet places, like tropical rainforests, recycling of nutrients is rapid so the soil is poor in humus. Heavy rain may have humus and dissolved nutrients carried down through the soil

Soil Classification

Soil classification is the technique by which soils can be grouped into categories to understand their origin, their properties and behaviour. A profusion of soil classification systems has arisen in the absence of international standardization. The USA, the former USSR and most W. European countries have devised independent systems which were extended for use in dependent colonial territories.

Rural people all over the world use many different names and categories to describe types of soil. These names and categories usually differ from those used by scientists. The criteria for classification is usually based upon how the soils are used rather than on criteria derived from physical sciences.

To overcome the profusion of soil classification systems, the United Nations Food and Agricultural Organization (FAO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) set out to produce an internationally-accepted classification system. In 1974 a map legend, as it was called, was published. This system is already in wide use as a means of international communication to convey rapidly the meaning of a national or local soil term.

(a process called leaching) and either leave them fairly deep down in the soil or wash them into rivers and streams. Grasses with short roots grow where leaching is not so heavy, but tree roots can reach down to the deeper mineral-rich layers.

Vegetation: The type of natural vegetation can provide hints as to the soil type. For example, coniferous trees keep their leaves all year. Once they die, the woody, waxy leaves of these trees take a long time to rot, making the soil acidic. Few plants grow in the acid soil beneath darkly-lit coniferous forests, and few creatures live in very acidic soil. So the leaf litter, never mixed into the soil, forms a slow decaying layer on the surface.

Land-use: How land is used and the intensity of that use affects the character of the soil. For example, if the same crops are grown and harvested year after year without the land being replenished with nutrients, then the land will become exhausted. Land becomes compacted and vulnerable to erosion when it is heavily trampled by the feet of children (as in a school playground) or by livestock.

ACTIVITY 3

The study of soil life is dealt with in more detail in a subsequent issue in the SOIL series. Please read this issue and the accompanying teachers' note prior to your students doing this investigation. If students show particular interest in this activity, you could immediately follow up with the activities in that issue.

ACTIVITY 4

Before students do this activity, explain that by slicing into the ground, it is possible to study the layers of a soils' profile. These layers or horizons, tell the story of the soil, and help scientists classify the world's soils (see box: Soil Classification).

To save time and energy, you can have students study a cross-section of soil where land has been excavated and soil layers exposed (e.g. a building site, road cuts, a well being dug). Otherwise, a pit about 4 feet (about 130 cm) deep and 4 feet (130 cm) in diameter is necessary. The topsoil and subsoil horizons are usually evident within that depth.

In demonstrating the feel of soil, you may want to have samples of sand, silt and clay in cans so that students can feel these before determining the feel of their soils.

If the students want to study more about soil texture, have them try the activities in Activity Guide on Soil Basics 2: What makes up a soil.

You could extend this exercise by inviting students to grow plants in soils taken from the different layers. Always add the same amount of water and keep the plants under similar light conditions. Have the students keep daily records of plant growth by measuring height and counting leaves. Discuss reasons for growth differences.

Activity Results

Results from existing excavations versus results from purposely-dug pits may differ: for example, bulldozers may have removed topsoil. Some soils have clearly defined layers (see picture on page 19). But sometimes layers may not be easy to distinguish. For example, if the land has been ploughed, the organic matter will have been mixed into the topsoil layer, and the soil may be looser and have higher porosity.

When students describe the colour of their samples, explain that the colour of the soils can tell you a lot about the amount of organic matter present in the soil. If the soil is dark brown, then it probably has a good supply of organic matter. If you are in a humid region and the soil is yellow, then it probably is low in organic matter and nutrients. If you live in a dry region, and your soil is white, then the soil is probably low in organic matter. The chart below provides some relationships between topsoil colour and soil conditions.

Topsoil (A Horizon)

Condition	Colour		
	Dark (dark grey brown to black)	Moderately dark (brown to yellow-brown)	Light (pale brown to yellow)
Amount of organic matter	High	Medium	Low
Erosion factor	Low	Medium	High
Aeration	High	Medium	Low
Fertility	High	Medium	Low

Caution your students that while colour gives us a clue about the presence of organic matter in a soil, it is only a partial picture. This is because soil colours are influenced by factors other than organic matter. For example, the natural colour of rocks from which the soil has been formed has a major effect on soil colour. So does the effect of water draining through soils (see chart below).

Subsurface soil (B Horizon)

Subsurface	soil colour
Dull grey (if in low rainfall 0-20")	Waterlogged soils, poor aeration
Yellow, red-brown, black (if in forest soil)	Well-drained soils
Mottled grey (if in humid soils)	Somewhat poorly to poorly drained soils

One of the reasons why soils feel differently is because they are made up of rock particles of different sizes. Other than the occasional stones and gravel, most mineral particles range in size from coarse sand particles

to fine clay particles. Sand particles are large enough to feel gritty or sharp when rubbed together. Silt particles are smaller than sand, and feel like powder. Individual clay particles are too tiny to see with the naked eye. All soils are made up of a mixture of clay, silt and sand. When about a quarter of soil is clay, and the remainder is made up of equal amounts of sand and silt, the soil is called a loam.

Some of the effects of structure on soil conditions are shown in the chart below:

Some Effects of Structure on Soil Conditions

Structure	Penetration of water	Drainage	Aeration
Columnar	Good	Good	Good
Blocky	Good	Moderate	Moderate
Granular	Good	Best	Best
Platey	Moderate	Moderate	Moderate

Another characteristic of soils is their acidity. This is examined in more detail in a subsequent issue of OUTREACH which looks at soil chemistry.

Although temperatures within a soil do not vary as much as air temperatures, extremes of heat or cold occur and are detrimental to most soil organisms. The greatest fluctuations occur in the top inches (centimetres) of the soil, particularly when the soil is bare. During hot days the direct solar radiation on to a dark soil surface may cause the temperature in this surface layer to reach 35°C. During cold, clear nights, the land may cool down rapidly. Under a vegetation cover, or deeper in the soil, the fluctuations in temperature are considerably reduced.

Some of the relationships of soil temperature to plant growth is shown in the chart below:

Some Relationships of Soil Temperature to Plant Growth

Soil temperature	Plant growth during growing season
less than 40°F (4.4°C)	No growth, soil bacteria and fungi not very active
40°F - 65°F (4.4°C - 18.3°C)	Some growth
65°F - 70°F (18.3°C - 21.1°C)	Fastest growth
70°F - 85°F (21.1°C - 29.4°C)	Some growth
Above 85°F (29.4°C)	No growth

The charts in this section are reprinted from Investigating Your Environment series, Forest Service, United States Department of Agriculture FS-349-3 SI-1

LEARNING-BY-DOING ACTIVITY GUIDE ON SOIL BASICS

2. What makes up a soil?

INTRODUCTION

Have you ever worked with soil? Have you found that some soils are crumbly and easy to dig, and other soils are heavy and hard to dig? Why is that so? If you take a close look at the type of solid particles which make up a soil, and the way they are packed together then you can find out.

Soil texture

Scoop up a handful of soil from one location, and compare the feel of it with that of a handful of soil taken from a different location. Soils feel differently, partly because they are made up of rock particles of different sizes. For example, a soil composed mainly of coarse particles feels light and gritty.

The feel of a soil is known as its texture. Soil texture depends upon the sizes of the particles that are in it. There are three sizes of particles: sand, silt and clay. The sizes of these particles are as follows:

sand 0.05 mm - 2 mm
silt 0.002 mm - 0.05 mm
clay less than 0.002 mm.

Sand feels gritty and sounds raspy when the particles are rubbed together. Silt feels silky and smooth. A soil made up mostly of silt feels fluffy or feathery. Clay is sticky: the tiny particles stick to each other as well as to the skin.

ACTIVITY 1

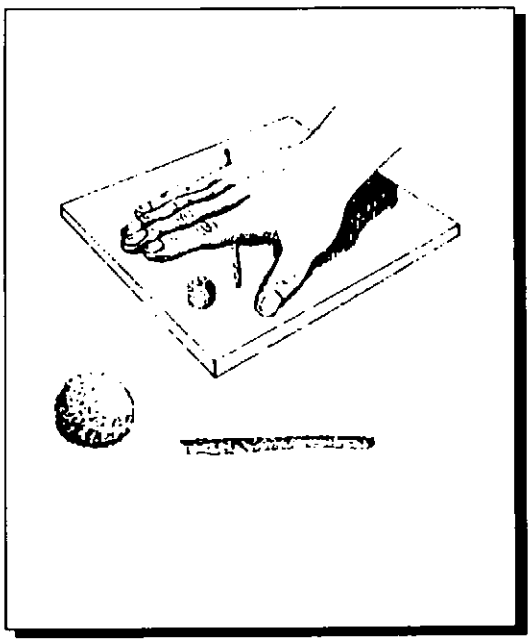
Hand texturing

Objectives:
Work out proportions of sand, silt and clay in a soil by using hand texturing techniques

Materials:
- small moist clod of soil
- water

Place:
Outside or classroom

1. Rub the soil between your fingers and assess the grittiness, smoothness (silkiness) and stickiness of the soil.
2. Moisten the soil, and then rub your thumb over the surface to see if it leaves a smooth, polished surface. If it does, the soil contains moderate amounts of clay (20% or more).
3. Try to form the soil into a cube shape. Soils with about 5% or more of clay can be made into reasonably firm cubes.
4. Place a tablespoon of soil in your hand and add a few drops of water to it. Carefully roll the soil into a thread. This is only possible if clay is present in large amounts (10-



15% or more). A sandy soil will not make any kind of thread. Where clay is very abundant (over 25%), the thread can be bent into a ring, and the higher the clay content, the firmer the ring will be.

From these tests, can you estimate the particle content of your soil samples?

You should remember these are simplified tests. Factors other than sand, silt and clay content influence the feel of soil. Organic matter often makes the soil feel rather smooth and silt-like; dry soil often feels coarser than it really is.

ACTIVITY 2

Soil particles – that settles it!

Objectives:
Use settling technique to determine proportions of rock particles in soil by size

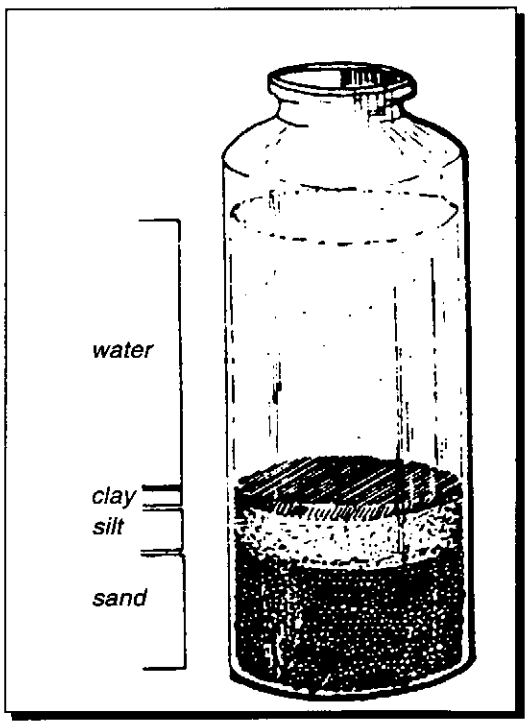
Materials:
- a cupful (about 200 cc) of soil
- a straight-sided, flat bottomed glass jar (the narrower and taller the better) with a tight-fitting lid
- a pinch of salt (used to help break apart the clay grains)
- measuring tape or scale

Place:
Outside or classroom

Here is another way of finding out about the sizes of the particles that make up a soil:

1. On the side of the jar, mark off one third of its height, and record the height.
2. Fill the jar with dry soil to just above the 1/3 mark. Press the soil down slightly, and remove any soil that is above the 1/3 mark.
3. Add water until the jar is about 3/4 full. Add a pinch of salt, and mix the soil, water and salt together.
4. Place the lid securely on the jar, and then shake the jar vigorously until the soil particles are mixed up (suspended) in the water. Leave the jar undisturbed for an hour.
5. Shake the jar vigorously again, let it stand, and wait one minute. When the minute is up, what do you notice? Mark on the side of the jar, without moving it, how much soil has settled to the bottom.
6. After 2 or so hours, can you see distinct layers of soil forming at the bottom of the jar. Again mark how much soil has settled to the bottom.
7. After 1-2 days, mark again how much soil has settled to the bottom. Is the water clear? Has the volume of soil changed from what it was at the beginning of the activity?

Where do the sand particles settle? The silt particles? The clay particles? If definite layers appear in the jar, measure the depth of the layers and calculate the percentage of each type



of particle using the following formula:
depth of each layer X 100 = _____ %
total depth of soil.

You may observe a layer of material floating on the surface of the water. This may be a layer of organic matter. Organic matter is the remains and waste products of plants and animals. You will probably see some of this material fall slowly to the bottom as it soaks up water.

Repeat this activity with different soil samples. Do different soils have different layers? How are they different? Can you explain why you find more of one layer of soil in some locations and not in others?

If you look closely at soil, you will see that the individual grains of soil - sand, silt and clay - do not occur as loose particles, but are bound together in clumps. These clumps - or peds as they are sometimes called - give the soil its structure.

The structure of a soil depends in part upon the way the particles are held together in peds. For example, clay particles and organic matter in the soil have a natural adhesion. This means they have a natural tendency to hold water and other particles to their surfaces. In addition, there are other substances in soil which bind particles together. Chemical cements, such as calcium carbonate and organic gums produced by soil animals and decaying plant materials help bind particles.

One of the main characteristics of soil peds is their shape. Another is their stability. In the next activity, you will examine these characteristics.

ACTIVITY 3

Ped characteristics

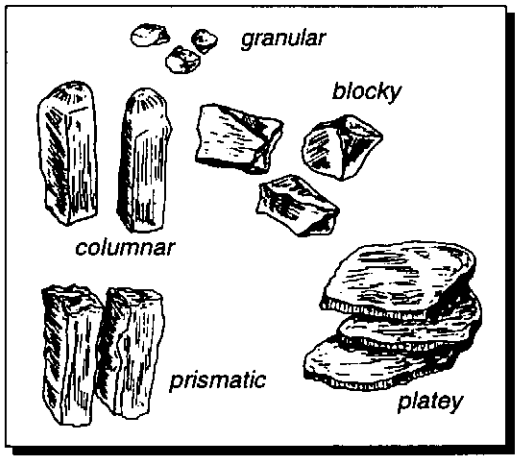
Objectives:
Examine soil structure and stability

Materials:
- 2 spadefuls from various soil samples (include in the selection a clayey soil, a loamy soil, compacted clayey soil)
- sawdust
- water
- newspaper
- two trays

Place:
Outside

(a) Ped shape

1. Drop a spadeful of each soil sample onto newspaper spread on the ground, and examine the shape of the clods (peds). Match the soil shape to one of these shapes:



(b) Ped stability

2. Take a handful of clayey soil, and moisten it with enough water to make a ball of mud.
3. Mix some clayey soil together with half the amount of sawdust. Moisten the mixture with water to make another mud ball the same size as the first.
4. Put both trays in the sun to dry, and observe what happens. Record your observations.

Can you draw any conclusions about the stability of each soil ped?

A ped tends to be less stable when wetted than when it is dry. Water may affect the forces that bind particles together, or it may dissolve some of the cements that bind particles together. Some soils become more unstable than others when they are wetted.

The stability of a soil structure is important for a variety of reasons. Soils which are not structurally stable break down rapidly when it rains, especially when it rains heavily. As a result, these soils tend to form compact surface crusts which prevent water from infiltrating into the soil. If rainwater cannot soak into the soil, it flows over the soil surface. On sloping land, this may lead to serious soil erosion, as the water picks up and carries away individual particles. A surface crust may hinder plant growth, too. Seedlings may be unable to force their way up through the compact surface layer.

Carefully put a lump of soil in a bucket of water. What do you notice that tells you that air was inside the lump of soil?

Porosity is the proportion of a soil's volume that consists of air (pore spaces). Small spaces exist between soil particles because the particles do not fit perfectly together. The amount of pore spaces depends on the size and shape of the soil particles, and how tightly they are packed together. Larger spaces occur between the soil peds.

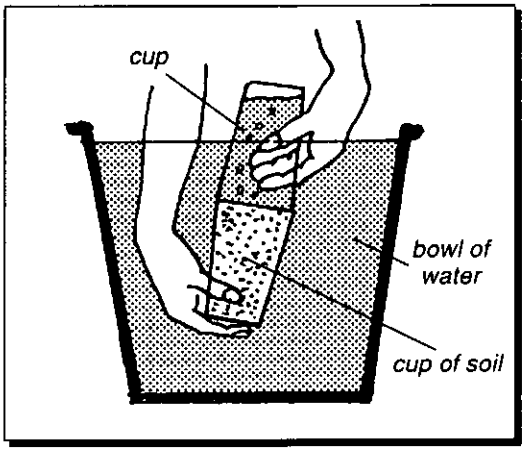
ACTIVITY 4 How much air is in soil?

Objectives:
Measure and compare the porosity of different soils

Materials:
- soil samples
- two plastic cups of equal size for each soil sample
- a large bowl
- water
- timer

Place:
Outside or classroom

1. Fill one plastic cup completely with a soil sample, and level it off.
2. Fill the bowl with water to a depth of at least 11/2 times the height of the cup. Immerse the empty cup in the large bowl of water so that it is full of water.
3. Turn the cup upside down under water and pull it up so that the cup is a little more than half out of water. What happens to the water inside the cup? Do you know why this happens?
4. Quickly slip the cup of soil under the upside down cup, and hold the cups mouth to mouth (as shown in the picture).
5. Holding the cups in this position, observe what happens. The water from the top cup flows down into the soil cup, and the air from the soil cup begins to escape into the top cup, replacing some of the water. Record the time from the release of the first bubble to the last. Can you count the bubbles? How fast do the bubbles escape?
6. When air bubbles from the soil are no longer being released, mark and measure how much air there is in the upside down cup. The volume of air trapped at the top of the upside down cup equals the volume of air spaces inside the soil.
7. Repeat steps 1 - 6 for each soil sample. Record your results on the chart below, and compare the results.



Do all soils hold the same amount of air? Which soil holds the most air? Does it take some soils longer to release their air than other soils? If so, can you explain why this may be so?

Why is it important that there is air in soil? What is in the soil that might need air?

Soil sample	Time that bubbles were being released	Amount of air space inside soil

Mineral particles, organic matter and air are important ingredients of a soil. Another important ingredient in soil is water. How do you know water is present in soil? One way to find out is by doing the following activity:

ACTIVITY 5

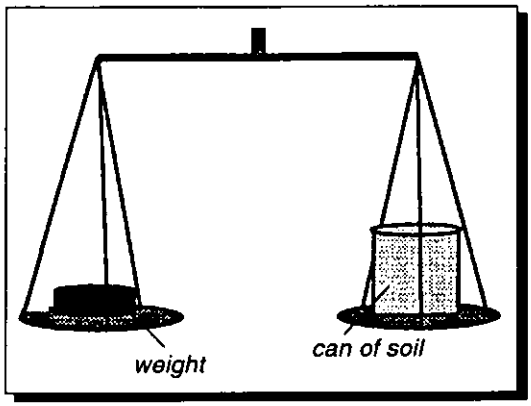
Is water present in soil?

Objectives:
Demonstrate that water is present in soil

Materials:
- Soil in a metal can
- a lid
- weighing scales
- a stand
- heat source

Place:
Classroom or outside

1. Weigh the can of soil, and record the weight.
2. Cover the can loosely with a lid, and heat over a medium flame for two minutes.
3. Remove the lid and note the inside of the can. What do you see? Where has the water come from?
4. Heat the can again for five more minutes, without the lid.
5. Let the can cool. Now weigh the can with the soil. Does it weigh more or less than before? Why?



In this Activity Guide you have explored some of the ingredients that make up a soil. Non-living things such as rock particles, organic matter, air and water all help to give a soil its physical characteristics, and influence how the soil behaves. But it is important to remember that soil is not just made up of non-living materials. It is a complex living system made up of living and non-living things that interact, change and combine over thousands of years. In other Activity Guides, you will investigate the living things in soil.

OBJECTIVES

To have students:

- observe the non-living components of soil, their characteristics and inter-relationships;
- compare texture, structure and porosity of different soils

GENERAL TEACHING TIPS

An understanding of the non-living components of soil is necessary before any steps can be taken to improve soil for growing crops or to protect land from erosion. Students may be assigned to teams to perform the activities described. Then, they can compare their findings with the rest of the class.

Some of the activities are best carried out in small groups. If this is not possible because of supervision problems or because supplies are limited, then try to adapt the activities for class demonstrations with student volunteers.

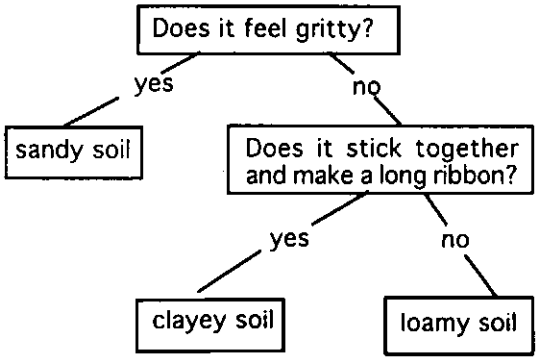
Encourage students to use bar charts, pie diagrams and annotated sketches to record and present their findings. For example, in activity 1, when students compare the length of ribbons that can be rolled from various soils, have the students make a bar chart of the results.

Have the students grow seeds of the same type, and under the same conditions, in all the soils used in the activities in this Activity Guide. Compare the growth rates of plants in the different soil types.

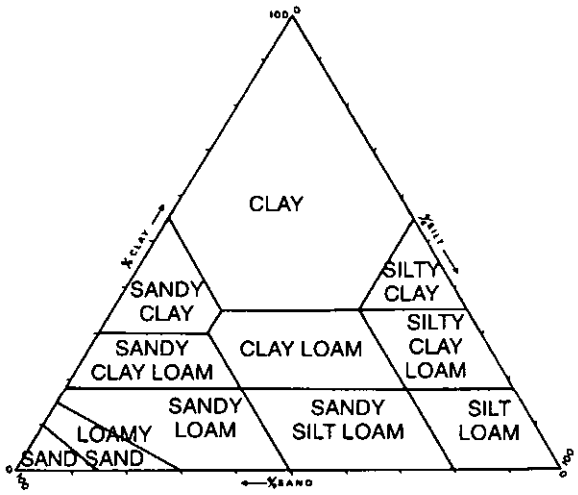
ACTIVITY 1

After your students have explored the texture of various soil samples, you might invite them to make a simple soil key to determine the make-up of other soils. Here is an example of a simple key:

Moisten your soil sample and rub it between your thumb and forefinger.



When students have investigated the texture of various soils, you might introduce the following chart which expresses soils in terms of sand, silt and clay content.



Activity results

The principle of hand texturing is that the three main particle sizes have a different feel when rubbed between the fingers. The problem is to determine the relative proportions when all three size particles are present. In such cases the characteristics of clay, sand or silt are masked. Therefore, other tests have to be carried out, such as rubbing the thumb over moist soil to determine if a moderate amount of clay exists in the soil.

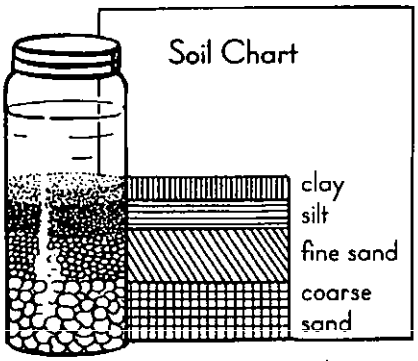
ACTIVITY 2

If you compare different soil samples, make sure you use the same size jars, and the same amount of soil in each experiment.

After a few days, when the layers in each soil are well-settled, you can make bar charts to show the results. Hold a card or heavy piece of paper against the side of the jar, and draw a diagram showing the depths of the different layers. Label each layer (see picture).

Activity results

The process is called sedimentation. The students will have to let the jar sit for several days to let all the particles settle. The coarser materials will be on the bottom, and finer materials on the top. Materials will settle from



bottom to top in this order: coarse sand; fine sand; silt; clay, organic matter. Clay particles are very small, and take a long time to settle. Some particles are so fine, they do not settle at all. They just stay "suspended" in water. That is why the water looks dirty for quite a while.

ACTIVITY 3

A soil's structure determines how much water a soil can hold, and how much water drains through the soil. Soil structure affects the air spaces, water content and temperature of a soil. These conditions produce a variety of habitats for soil life.

Your students can explore ped stability further by holding an eye dropper full of water at a height of 18 inches (0.5 metre) above a ped, and releasing the water drop by drop. Have them observe and record what happens. (For further details, see Activity 3 in Activity Guide on Losing Soil).

Activity results

The shape of peds gives students some idea of the make-up of soil. For example, granular peds are found in cultivated loamy soils.

The structural properties of a soil depend upon the character of the individual grains and the way they are held together. Clay particles have a very large surface area relative to their size and weight. Therefore, they have a high capacity to hold water and other molecules to their surfaces. Clay particles stick together easily and are difficult to separate. They retain a high proportion of water in dry conditions. They hold, by chemical forces, soluble minerals which are unlikely to be washed away. When dry, clay forms hard clods which do not break down readily with ploughing. Small distances between particles tend to produce poor aeration and drainage: clay-rich soil may form a compacted layer through which water and plants cannot penetrate.

The wider separation of sand particles leads to better aeration and drainage, but there is a smaller surface area to which a water film can adhere. Sand particles separate easily in ploughing and digging. Sandy soil loses water rapidly in dry conditions.

The addition of sawdust to a clayey soil demonstrates how organic matter or humus in the soil helps soil structure. It is easier to work because the soil is crumbly, causing the individual soil particles to stick together tightly in clumps. These clumps act, in effect, like much larger particles, in letting water and air move through the soil more readily. The larger clumps tend to stick together, too, because of the binding effect of the humus. Organic material can retain 3-5 times its own weight in soil water. A mixture of 2-3 times as much sand as clay produces a structure ideal for the growth of many plants.

A soil lacking in clay or humus tends to be a poorly-structured soil and is more likely to be washed or blown away. Plant cover and a leaf litter layer (dead leaves and other things on the soil surface) offer some protection from erosion, but clearance of natural vegetation for farming may leave these soils exposed. Well-structured soils are more resistant to erosion: they can absorb water and reduce surface run-off of rainwater. The cohesion of their particles resists wind erosion.

The chart below describes the physical traits of some soils.

ACTIVITY 4

Activity results

Air bubbles come out of the soil immersed in water as air spaces are filled with water. The more air spaces in a soil, the more air bubbles there are.

Water remains inside the cup as it is raised inside the bowl of water. This happens because the pressure of air acting down on the surface of the water in the bowl is stronger than the pressure of water acting down in the upside down cup.

The differences in the porosity of various soils will be more dramatic if widely different soil samples under the same conditions are compared.

ACTIVITY 5

Soils can be dried in an oven. In fact that is how agronomists dry soil samples. If no heating source is available, simply lay the soil samples out in the sun to dry.

Activity results

The soil should weigh more before being heated because before heating it contained water. The water evaporated during heating.

Soil type by texture	Feel when wet	Looseness of soil	Water-holding capacity	Aeration
clayey	very sticky, smooth, slick	poor	high (water is held so tightly that less is available for plants)	low
loamy	somewhat gritty and sticky	good, loose, crumbly	good to excellent	high
sandy	very gritty	good, loose, crumbly	poor	high

LEARNING-BY-DOING ACTIVITY GUIDE ON SOIL BASICS

3. Soil Makers

INTRODUCTION

Does your family own a family heirloom? Perhaps, it is something old that has been handed down through the generations. Maybe it is something to which different family members over time have all contributed. Or maybe the family history is closely entwined with the object. If this is so, then this heirloom is probably treasured greatly, and is well looked after. It is certainly not something to be squandered.

Your family may have in its possession one kind of heirloom which has immense value, upon which your very survival depends. Its formation may have begun thousands, even millions of years ago, and indeed, it is likely to be still evolving. Many forces may have contributed to its creation. Past generations may have cared for it, and used it. Do you know what it is? Soil!

The activities in this Activity Guide will help you to appreciate how long and how complicated the process is to create even an inch (2.4 cm) of topsoil. You will look at five important influences upon soil creation: parent rock, climate, living things, topography and time. In understanding how soil is formed, you may realise how important it is that soil, like other heirlooms, must not be squandered.

PARENT ROCK

Parent rock is the material which soil particles come from. Parent rock can be volcanic deposits such as ash which have fallen on an area. It can be rock particles that have been transported and deposited as sediment by wind or water or by glaciers. Weathered (broken down) bedrock is another example of parent material.

The minerals plants need to grow healthy come from rock particles. What do you think happens when a soil comes from parent rock that lacks valuable minerals?

ACTIVITY 1

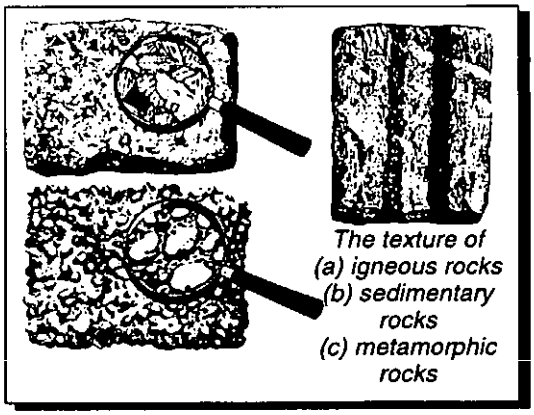
Identify parent rocks

Objectives:
Collect and identify rocks

Materials:
- magnifying lens

Place:
On location

Collect samples of rock from outcrops at construction sites or road cuts. Describe the different rocks you find. Use books from your library, or the knowledge of local rock experts to help identify the parent material in your area.



The texture of (a) igneous rocks (b) sedimentary rocks (c) metamorphic rocks

HOW ARE ROCKS BROKEN APART?

Parent rock is broken down into finer particles by a process called weathering. When rocks are broken into smaller pieces without its original character being changed, this is called mechanical weathering. All types of rock weather, but some weather more quickly than others. Below are some activities which demonstrate mechanical weathering.

CAUTION: These activities should be carried out only under adult supervision.

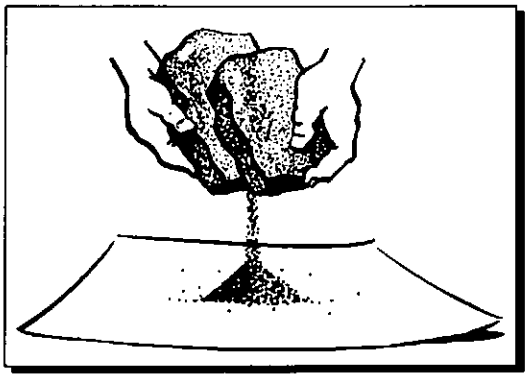
ACTIVITY 2 When rocks rub together

Objectives:
Appreciate time to create rock particles through erosion

Materials:
- samples of two different types of rock (for example, sandstone or limestone and granite)
- newspaper
- teaspoon
- watch

Place:
Classroom or outside

1. Wash and dry two rocks of the same type to remove dust and dirt on their surfaces. Hold them over a piece of newspaper, and rub together. What happens? Do this for exactly 10 minutes.
2. Rub the rocks together for exactly 10 minutes, and then measure the amount of dust or sand you have made by carefully pouring it into a teaspoon or measuring cylinder.
3. If it took 10 minutes to make that much sand, how long would it take you to make 100 level teaspoons of sand? 1,000,000 level teaspoons of sand takes up is an equivalent volume to 1.31 cubic yards (one cubic metre). If a tree needs at least this amount of soil in which to grow, how long would it take to make enough soil particles for a tree?
4. Repeat step 1-3 but rub together two different rocks. Do you find that one type of rock breaks down faster than the other?



Can you think of when rocks might weather in this way?

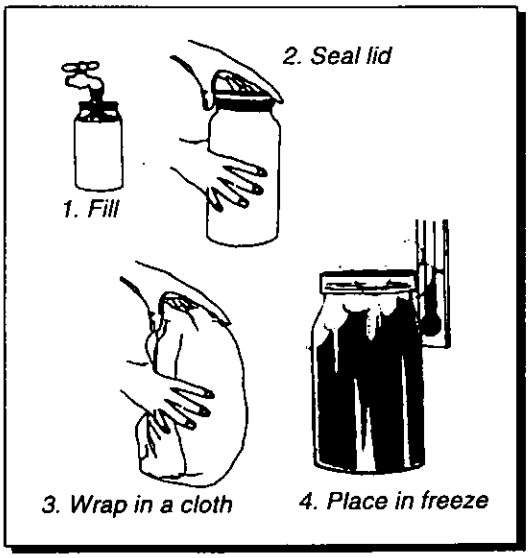
ACTIVITY 3 Freeze/thaw action

Objectives:
To demonstrate mechanical weathering

Materials:
- a small glass jar with a screw lid
- water
- freezer

Place:
Classroom or inside space

1. Fill a small glass jar full of water, screw the lid on tightly, and wrap the jar with a towel.
2. Put the jar into a freezer.
3. What happens? Record your results. In what parts of the world does this type of mechanical weathering take place?



The following activity illustrates another way climatic forces can influence weathering.

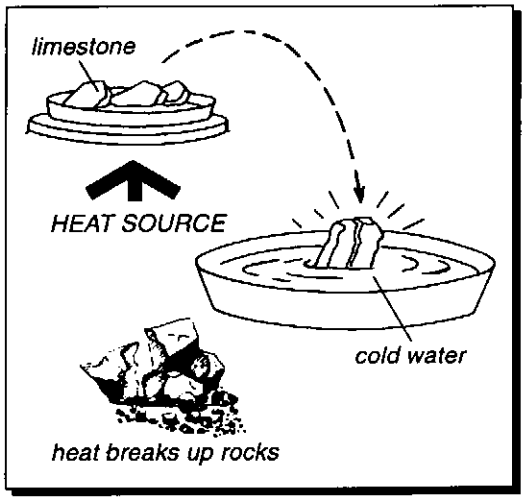
ACTIVITY 4 Effect of heat on rocks

Objectives:
Demonstrate thermal weathering
Materials:
- a piece of slate or limestone
- tongs
- cooking pot
- pot of cold water

Place:
Inside or outside

1. Heat the limestone or slate over a flame or stove.
2. Use the tongs to drop the hot rock into the pot of cold water.
3. What happens? Record your results.
   In what parts of the world would this type of weathering take place?

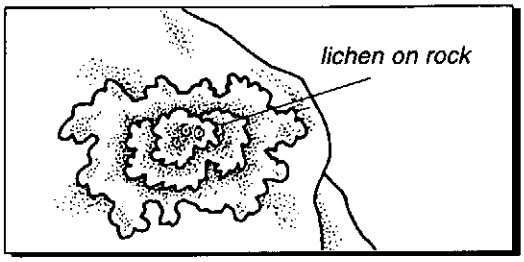
Climate in a given location affects how parent rock is weathered. Plants, too, can help parent rock physically break down.



ACTIVITY 5 How plants break up rocks

Objectives:
Observe how plants cause mechanical weathering
Place:
On location

1. Study the condition of concrete and stone pavements near big trees. You may notice how tree roots have raised up pavements. This demonstrates the power of roots in breaking up large rocks.
2. Look for lichen growing on bare rocks. As lichen grip onto bare rock, they loosen particles. Water can then get to work and weather the rock, enlarging the cracks. Over time, the crevices fill with rock particles and dead lichen - ingredients of soil - and mosses and ferns can grow in them.



HOW ROCKS ARE CHEMICALLY BROKEN DOWN

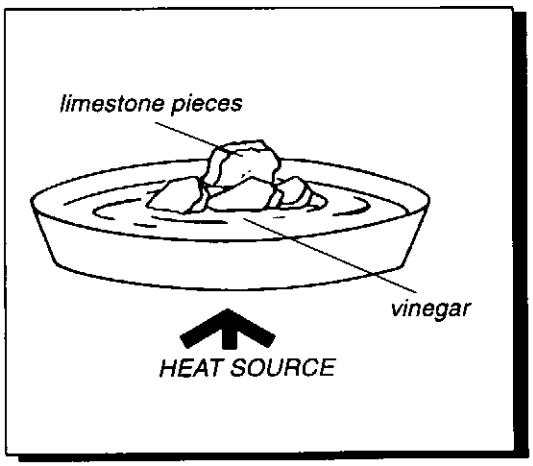
Rocks weathered by the methods described above do not change the original character of the rock. But sometimes rocks are chemically broken down. When this happens the rocks are changed into new substances.

ACTIVITY 6 How plant roots help to chemically weather rock

Objectives:
Observe chemical weathering
Materials:
- small pieces of limestone
- vinegar
- heat source, e.g. burner or hot plate
- glass jar

Place:
Classroom or inside space

1. Put some limestone pieces into the glass jar, and add a little vinegar.
2. Heat the vinegar on a hot plate or over a burner. What do you observe? Bubbles form on the pieces of stone. These bubbles are carbon dioxide, a gas made from carbon and oxygen released from the limestone by a chemical change in the rock caused by the acid in the vinegar. If you continued this process long enough, all the limestone would gradually break down.



This activity shows in a small way what plants do. Plant roots take in oxygen from the soil air and give off carbon dioxide gas. Carbon dioxide gas dissolves in the soil moisture, forming weak carbonic acid. This acid reacts just as the acetic acid in vinegar does with the limestone rock. Carbonic acid breaks down limestone and marble. The dissolving effect of this carbonated water is several times that of pure water. Since the lime in limestone is soluble, it gradually washes away leaving only the other materials as soil. This type of weathering is called chemical weathering because the original rock (e.g. limestone) decomposes into new substances.

HOW ORGANIC MATTER IS ADDED TO THE SOIL

Various forces of nature reduce the size of original rock to a variety of sizes ranging from gravel and sand to fine clay particles. But it takes more than the weathering of parent rock to create soil. Other factors influence the character of a soil.

Both plants and animals help create soil. As they die, plants and animals add organic matter to rock particles to help form subsoil and topsoil. The character of some soils is more influenced by plants and animals than other soils.

ACTIVITY 7 Comparing micro-habitats

Objectives:
Compare soil makers in different habitats
Place:
On location

Go into the area near your school, and look for a patch of ground that is worn. You will see the soil is packed very hard and there are no plants. When it is hot, all the heat goes into the earth. When it rains, not much water soaks in. See if you can find any evidence of living things in this area?

Now go to a place which has tall plants and grass growing together. This place may be near a fence, tree or building. It may also be hot there, but you may see more evidence of water. Plant roots make soil loose, and the leaves keep drying air away from the soil. Count the different types of plants growing there. Look underneath the vegetation for decaying plants. Look for evidence of animal life.

Compare the plant and animal life you see in the two areas. Can you explain the differences? In what ways might the soils be different in these two areas? Use your observations to think how the soil in a deciduous woodland might differ from the soil found in an area with sparse vegetation.

HOW CLIMATE AFFECTS SOIL FORMATION

Climate is a very important factor in the development of soil. You have seen how climate can influence how rocks break down into soil particles. Cold weather, rapid changes in temperature, water and wind all can help to weather rock.

But climate can influence the character of a soil in other ways, too. For example, in places where heavy rainfall soaks into the ground, the water may wash humus and dissolved chemicals, such as magnesium and potassium, downwards through the soil to be left fairly deep down in the soil or to be washed into rivers and streams. This process is called leaching. In dry areas of the world, where water evaporates from ground, there can be a build-up of salt deposits in the surface soil.

Temperature directly affects the rate of chemical and biological activity in soil. In hot, wet places, such as

tropical forests, dead plants and animals decay and nutrients recycle so rapidly that soil has only a thin layer of humus. In colder climates, the layer of organic matter is much thicker.

HOW TOPOGRAPHY AFFECTS SOIL FORMATION

Topography is the hilliness, flatness or amount of slope of the land. Can you think how topography might affect the character of soil?

ACTIVITY 8

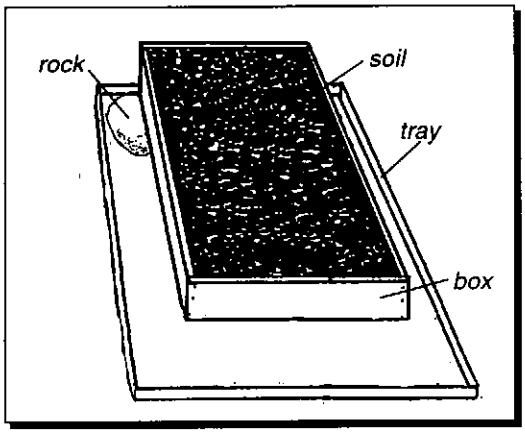
A model slope

Objectives:
Demonstrate the effect of slope on soil erosion

Materials:
- a tray or cardboard box
- much larger trays
- newspaper
- can with holes punched in the bottom
- soil
- stiff piece of cardboard
- bricks or large stones of varying thicknesses

Place:
Classroom or outside

1. Line the smaller tray or box with several sheets of newspaper, and then fill to the top with soil. Firm the soil down.
2. Put the smaller box in the larger tray, resting one end on a shallow stone so that the box slopes gently (see picture).
3. Expose the box to strong wind by fanning the soil with a piece of cardboard. What happens?
4. Hold the can with holes over the soil, and sprinkle 2 pints (or 1 litre) of water from the can onto the soil in the box. Allow the water to fall in drops and with some force. (Try to make it similar to rain.) What happens?
5. Some soil and water will run off into the larger tray. When water stops draining into the larger tray, label this tray "run-off from gentle slope" and put aside.
6. Refill the smaller box with newspaper and soil, and firm the soil down. Put the refilled box into another larger tray, but this time rest the box on a bigger stone so that the slope is steeper.



7. Repeat steps 3 - 5, labelling the large tray "run-off from medium slope".
8. Repeat steps 6 and 7, but this time see how much run-off there is from a steep slope, and label accordingly.
9. Compare the amount of run-off from all three slopes. Which box lost more water? Why?
10 The water that has stayed in the boxes has soaked into the soil. Why is it important that water soaks into the soil?

Generally speaking, which soil do you think is likely to be more fertile - soil on a steep slope or soil on flat land?

HOW TIME AFFECTS SOIL FORMATION

Some soils evolve from the underlying bedrock, and have been thousands of years in the making. Others have formed from deposits which have been carried to the area by wind, water and ice, and may have taken only a hundred years to be created.

A young soil may have almost no distinct soil layers, while a mature soil may have well-defined layers. If left alone, these distinct layers may change little over time.

ACTIVITY 9 An aging soil

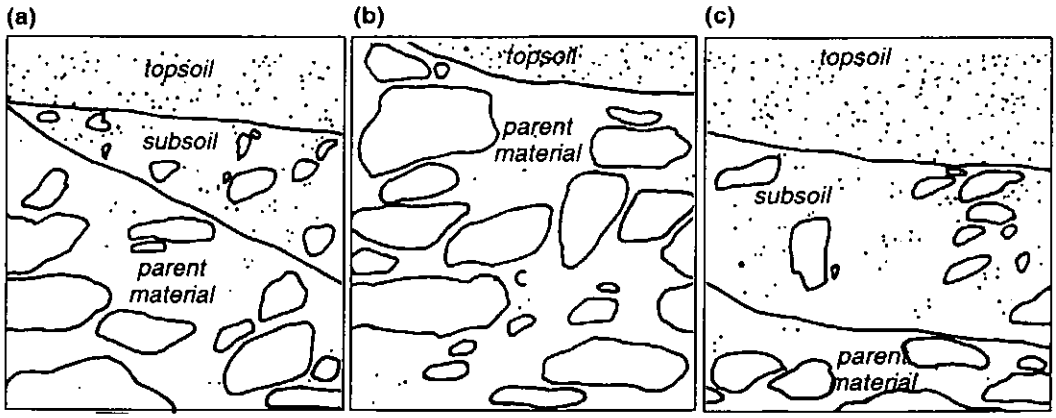
Objectives:
Work out the effect of time on soil formation

Materials:
- pencil and paper

Place:
Classroom

The pictures below show a soil in a given place at different stages of its development. Put the pictures in the correct order. How do you think climate, living organisms and topography have changed the soil over time?

Not all soils undergo these changes, and the time for changes differs from place to place. Write a story about the formation of the soil shown in the picture.



ACTIVITY 10 Can you make your own soil?

Objectives:
Try to create soil that has qualities of natural soil

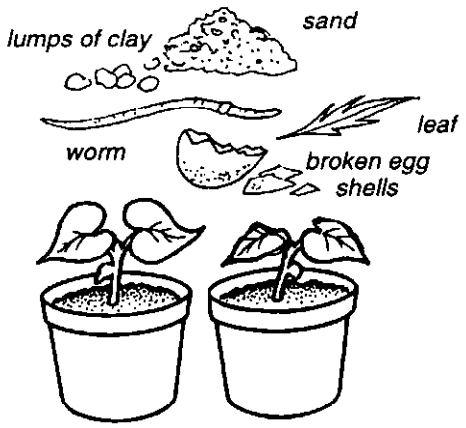
Materials:
- 2 small pots or tin cans with drainage holes punched in the bottom
- some natural soil
- four seeds of the same type
- pencil and paper
- a selection of materials which students can draw upon, such as crushed rocks, clay, sand, water, leaves, worms, broken egg shells

Place:
Classroom or outside

Here's a challenge for you: Can you make a soil in which a plant will grow? In this activity you will work in small groups to make a 'soil' recipe, and then create and test your 'soil'.

1. Make a list of the ingredients you need to make a soil, and explain why you have chosen each of ingredient. For example, you may have chosen clay to help support plants.
2. Collect all the materials you think you need, and work out how much of each ingredient needs to be mixed together in order to produce something that looks, feels and behaves like natural soil. Make sure you keep a record of anything you do to the ingredients. For example, if you crush leaves, you should note this down. You should also keep a record of the quantity of any ingredients you mix together.
3. Write down your final recipe. List the quantities of ingredients, why they have been chosen and explain your method.
4. Follow your recipe to create a 'soil'.

SOME POSSIBLE SOIL INGREDIENTS



How well do plants grow in your 'soil'?

5. Fill one pot with your home-made soil and one pot with natural soil. Plant two seeds in each pot and care for them equally until shoots appear. Record the growth of the plants.
6. Discuss in class the differences between the soils, and any differences in plant growth.

OBJECTIVES:

To have students:

- understand that the nature of a soil is determined by its ingredients and how it was made;
- recognize that the main influences upon a soil's character are climate, parent rock, plants and animals, topography and time;
- explore the physical and che;mical processes that change and combine soil components;
- appreciate how long soil formation takes and how quickly the resource may be lost, thus fostering the importance of soil conservation.

GENERAL TEACHING TIPS

Some of the activities, such as Activity 2 and Activity 3, may be carried out in small groups. If class size is too large, or supplies are limited, then these activities may be performed as demonstrations in front of the class. Student involvement should be encouraged by inviting student volunteers to carry out some of the tasks, and having other students predict and explain outcomes. If the class comprises students with a wide age span, it may be possible to train older students to serve as supervisors of groups of younger students. This would require preparatory time spent explaining the activities to older students, and instructing them in safety and discipline procedures. You would be available as general supervisor. Class discussion of activities should be conducted at the beginning and end of the activities.

ACTIVITY 1

Encourage students to look for similarities and differences between rock types. Start by having them look at rock samples that are more obviously different and easy to classify. Begin by looking at a piece of chalk (not blackboard chalk) or limestone, a fairly coarse sandstone, a piece of slate and a piece of granite or another igneous rock containing visible crystals. Here are some clues:

- If a rock appears to be made of fine sand grains cemented together, it is probably sandstone.
- If it is made up of larger pebbles cemented together, it is probably another sedimentary rock called a conglomerate.
- If the rock appears rounded, it is probably the result of the stream action of water.
- If it contains little flecks and crystals, it is a granite-like rock and was probably pushed up from deep inside the earth long ago.

Encourage the students to describe the samples carefully in words and through drawings.

The rocks may be chipped into smaller fragments: place a rock in a sealed plastic or cloth bag, put the rock on the ground and see how many blows of a hammer are necessary to start to break the rock into smaller pieces. (Keep the students out of the way, and wear goggles when doing this activity.) Examine the freshly-chipped surfaces through a magnifying lens. (Have each student hold the lens close to his/her eyes, and then move rocks closer to the face until the rocks are clearly visible.) The students will notice that some rocks are made up of several minerals. For example, granite contains quartz, mica and feldspar. Other rocks only contain one mineral: chalk is pure calcium carbonate. Have the students observe and record colour, shape, size, etc.

ACTIVITY 2

Emphasize that in nature rocks are not usually rubbed together as continuously as in this activity. Have students take turns rubbing rocks together.

Explain that the force of moving water in streams or rivers causes stones to rub against each other. The fragments may be carried away by water, and settle when the flowing water slows down. Have the students study pebbles on a beach and along streams, and notice the smoothness of their surfaces. When stones rub together, the rough parts are worn down. (If a site visit is not possible, it may be a good idea to collect a few stones from a river to illustrate the smoothness and roundness as a result of being washed and rolled along for hundreds of years.) The battering action of wind also helps to break rocks into smaller and smaller pieces.

Activity results

Students will discover that it takes a long time to create dust.

ACTIVITY 3

An alternative method to demonstrate freeze/thaw action is to find a rock with a crack already in it, and pour water into the crack. Then, place the rock into the freezer to see what happens when the water freezes. You can also demonstrate this action if you can obtain some plaster of Paris, a small balloon and two plastic containers (such as the bottom half of plastic milk cartons). Fill the balloon with water until it is about the size of a table tennis ball, and tie a knot in the end. Mix water with plaster of Paris until the mixture is as thick as yoghurt. Pour half of the plaster in one plastic container and the other half in the other. Push the balloon down into one container until it is about $1/4$ inch (0.5 cm) under the surface. Hold the balloon there until the plaster sets enough so that the balloon

does not rise to the surface. Let the plaster harden for about one hour. Put both containers into the freezer for 24 hours. Remove the containers to see what has happened. The plaster containing the balloon should have cracked as the water in the balloon froze and expanded. This is the same effect as water seeping into cracks in rocks and freezing. Eventually rocks can break apart.

jar with frozen water

Activity results

The water freezes and expands. If the jar is full of water, the pressure of the expanded frozen water will crack the jar (see picture). Water trapped in cracks in rocks will, upon freezing, expand, forcing the rock to break apart. This process will happen in colder climates where temperatures are cold enough to make water freeze.

ACTIVITY 4

Activity results

The limestone cracks and breaks into smaller pieces as it contracts after expanding from the heat. This type of mechanical weathering, called thermal weathering, occurs in places where rocks are heated by the sun during the day, but cool down at night, such as in hot deserts.

ACTIVITY 6

You can have students see if other rocks in their collection react to acids such as lemon juice or vinegar. Do this by taking a rock fragment, placing it in a jar lid, and adding a small amount of acid to the rock dust. Listen for a fizz. If the rock reacts, it contains lime (calcium carbonate - the substance in blackboard chalk).

Point out to the students that it takes 40 to 50 feet (12 -15 metres) of limestone to make only a few inches of soil.

ACTIVITY 7

This activity gives students an opportunity to see how different environmental factors influence the character of a soil.

Here are some suggestions for comparing plant and animal life in the two habitats:

(a) Search for worm casts. Earthworms digest soil underground, taking from it the food they need as it passes through their digestive systems. Sometimes, the waste is seen on the ground as small piles called worm casts.

(b) Look for holes, diggings and tracks of such animals as foxes, rabbits, moles, earthworms, ants, centipedes, slugs and snails. These animals spend much of their time burrowing in, and mixing up the soil as they look for food and shelter. They dig in undecayed plant litter, and their tunnels help drain soil and let air and water move around plant roots.

(c) Look for plant and animal remains at different stages of decomposition, and consider which decomposers might have already been at work. Examine the droppings of animals such as cows or horses. What decomposers do you find there? Find out about dung beetles, or see if you can find any in the wild. These are important decomposers because they return animal dung to the soil.

ACTIVITY 8

Students could try this activity using soil with seedlings growing in it. In order to simulate forested land, sow some wheat or mustard seeds two weeks beforehand.

Have students visit sites of different topography, and discuss how landscape features might influence soil formation. Also take into account micro-climate (e.g. exposure to sun, wind).

Activity results

The steeper the incline, the more soil and water collects in the larger tray. On mountain slopes, the soil is often shallow and well-drained because water, aided by gravity, continually carries the soil down the hillside in streams and rivers. On flatter land, where the flow of water in streams and rivers slows and sediment is deposited, deeper soil layers may form. Where drainage is poor, these areas may become waterlogged.

ACTIVITY 9

The purpose of this activity is to reinforce the fact that soil is continually evolving from parent rock.

Activity results

The correct order is (b), (a), and (c).

ACTIVITY 10

Encourage discussion among students by having them work in small groups. Students can either gather their own materials, or you may wish to have a large supply of different materials on hand. Encourage them to experiment to work out how much of the ingredients are needed in order to produce something that looks, feels and behaves like natural soil. Have some natural soil samples available for comparison. Allow students to adjust their recipes provided they can justify any adjustment. When they have created a made-up soil they can compare it to natural soil by undertaking tests such as those described in Activiy Guide on SOIL BASICS 2 . A simple test is to compare the made-up soil and natural soil as growing mediums. Ask the students "What are the major differences between your soil and natural soil? How could you make your soil more natural?"

FILM RESOURCES

SUGGESTIONS FOR USE:
TV stations and representatives of NGOs, community groups and schools: *As possible films to broadcast as part of an awareness campaign on soils.*

TVE films on soils

Here is a selection of films covering soil-related topics that are available through the Moving Pictures distribution service of TVE (see box). Customers for the Moving Pictures service include global broadcasters, national television stations, schools and community organizations.

The descriptions of the films are taken from TVE's Moving Pictures 6 catalogue. The ✔ helps you identify which of the programmes or series is available to you, your station or your organization.

Because TVE is a non-profit organization (that is, with no shareholders), any profit from commercial sales is put back into helping the poorest countries receive the programmes copyright free at a token charge. This is why TVE operates a 'sliding scale' of charges - ranging from commerical rates, charged to the rich, industrialized countries, to token payments in local 'non-convertible' currency in the poorest nations.

If you are a broadcaster, please contact TVE's distribution office by e-mail or fax with the titles you require for screening, and TVE will provide you with a quotation for the costs.

If you are a non-broadcast user (non-governmental organization, government or intergovernmental or local government organization, educational institution, community, women's group or other) please contact TVE for an order form. TVE's address, fax and e-mail details are given below. When ordering, please do not forget to provide details of the language, television standard (PAL, NTSC, SECAM) and format (VHS, Umatic etc.) required. As soon as your order is received, TVE will send you a proforma invoice by the fastest possible means - e-mail or fax, where available - and your order will be dispatched immediately on receipt of payment.

For order forms and/or details about other available films, please write to:

TVE, Prince Albert Road, London NW1 4RZ, UK

tel: +44 171 586 5526.

fax: +44 171 586 4866

e-mail: tve-dist@tve.org.uk

URL: http//www.oneworld.org.tve

About TVE

Television Trust for the Environment (TVE) is an independent, non-profit organization founded in 1984 by the United Nations Environment Programme (UNEP), the World Wide Fund for Nature (WWF) and Carlton (formerly Central) Television in order to promote global public awareness of sustainable development through television and other audio-visual media. To do this, TVE:

- produces and co-produces television and video programmes to international broadcast standards;
- runs a video and film distribution service, supplying broadcasters, civil society organizations and other mulitpliers throughout the world;
- provides capacity-building support and expertise to 46 video resource centres in low and middle income countries, with the aim of building up a self-sustaining network throughout the developing world;
- promotes more widespread exhibition of environment, development, health and human rights programmes worldwide via a range of publications and an on-line Internet catalogue.

Taro's Journey

Japanese director Junko Murayama's charming animation follows young Taro on his travels with the spirit of Old Man Tree. A valuable educational aid for children over 10 years, the film provides a clear introduction to the relationship between water, forests and soil. Taro, with the spirit to guide him, discovers many wonderful things in the course of his journey. He learns that leaves absorb carbon dioxide and give out oxygen. He discovers that forests store water; that soil contains bacteria and moulds which aid the decomposition of leaves. When he realises that production of the paper and pencils he uses at school involves the destruction of forests. Taro determines to take action. Combining puppetry with animation, his story is an informative and captivating look at a complex subject.

Genre: Animation
Year: 1993
Duration: 22 minutes
Country: Japan
Language: Japanese, English
Credits: Director: Murayama Junko
Rights:
- ✖ Broadcast: lower and middle income countries
- ✖ Broadcast: industrialized countries
- ✔ Non-broadcast: lower and middle income countries
- ✔ Non-broadcast: industrialized countries

Sertão

The barren hinterlands of North Eastern Brazil are a harsh environment for the subsistence farmers who try to scratch a living from the arid soil, In drought years many thousands migrate to the cities simply to avoid starvation, exchanging grinding rural hardship for the poverty of the overcrowded, crime-ridden shanty towns. Sarah Bailey's short film 'Sertão' looks at a unique educational programme which is helping a new generation of the region's rural poor to stay on their land and to start making a viable living from it.

Founded in 1991 by Caatinga, an NGO based in the heart of the North East, the rural school in Ouricuri has a curriculum which combines local wisdom with technical input on agriculture and ecology as well as literacy and numeracy. Interviews with pupils, parents and teachers provide eloquent testimonies to the school's achievements in revitalizing the community.

Genre: documentary
Year: 1995
Duration: 26 minutes
Country: Brazil
Language: Portuguese, English
Credits: Producer/Director: Sarah Bailey
Rights:

- ✔ Broadcast: lower and middle income countries
- ✔ Broadcast: industrialized countries
- ✔ Non-broadcast: lower and middle income countries
- ✔ Non-broadcast: industrialized countries

Earth Report

What is the link between bandity and erosion? How can agro-forestry save the gorilla? Why do fishermen dynamite coral reefs? Should tropical forests be felled to pay off debt? EARTH REPORT is a series of 52 topical stories from all corners of the world which break the mould of gloom and doom coverage of the environment, and show how people are rising to the challenge of sustainable development.

46 x 5 minutes

1. Black Sea: Death or Reprieve; 2. Papua New Guinea: Forest to Woodchip; 3. Uganda: Gorillas on the Slopes; 4. Estonia: A New Future; 5. Patagonia: The Whales Return; 6. India: Energy from Waste; 7. India: bandits and Ravines; 8. Kenya: TV as Contraception; 9. Guyana: Timber to Pay Off Debt; 10. Guatemala: Investing in Health; 11. Peru: Taking on the Giant; 12. Bosnia: Water in War; 13. Patagonia: Comeback of the Penguins; 14. Indonesia: Eco-Labelling; 15. Haiti: Rubbish Crisis; 16. Colombia: A Dynamite Issue; 17. Colombia: Coca for Trees; 18. Botswana: Welcome the Great White Hunter; 19. Biodiversity: Wealth or Wilderness; 20. Kazakhstan: The Sea That Was; 21. Guinea Bissau: Getting Healthier; 22. Saudi Arabia: Going Home; 23. USA: Manatee Rescue; 24. Guinea Bissau: Wetland Patrol; 25. Indonesia: Bamboo Boom; 26. Australia: Green Olympics; 27. Australia: Aliens in Kakadu; 28. Philippines: Turtle Treaty; 29. UK: Tiger Matchmakers; 30. Armenia: Nuclear Alert; 31. Kenya: Guardians of Africa? 32. Peru: Fields of Trees; 33. Mauritius: Cane Power; 34. Guatemala: Stealing the Rainforest; 35. Malaysia: The Messenger; 36. Suriname: Fighting for Survival; 37. Afghanistan: Tanks to Trowels; **38. China: Defeating the Desert;** 39. USA: Smog Valley; 40. Estonia: After the Revolution; 41: The Mediterranean: Saving the Sea; 42. South Africa: Table Mountain; 43. Sri Lanka: Jungle Pharmacy; 44. Japan: Tee'd Off; 45. Bhutan: Best of Both Worlds; 46. Cities: Feeling the Heat.

7 x 26 minutes

1. Fate of the Forest; 2. Food for Thought; 3. Growing Up II; 4. Home Sweet Home; 5. Living with Disasters; 6. Millennium; 7. Not the Numbers Game.

Genre: Documentary Shorts
Year: 1996
Duration: 412
Country: United Kingdom
Language: English
Credits: Producer: Marc de Beaufort
Rights:

- ✔ Broadcast: lower and middle income countries
- ✔ Broadcast: industrialized countries
- ✔ Non-broadcast: lower and middle income countries
- ✔ Non-broadcast: industrialized countries

RESOURCES

SUGGESTIONS FOR USE:
Curriculum developers, teachers: *To obtain additional resources; to contact contributors directly.*

Resources used in the production of this pack

EDUCATIONAL MATERIALS

Floods and Drought: an educational package for standards 5-8 produced by Centre for Environmental Education, Nehru Foundation for Development, Ahmedabad, India. *Floods and Drought* was produced to increase awareness of the relationship between the deterioration of the environment and the increasing incidence of floods and drought. The package consists of a booklet of 20 activities which aim to make students aware of the intricate links between soil, water and vegetation and how their mismanagement damages the environment. For further information, write to: CEE, Thalej Tekra, Ahmedabad 380054, India tel: (+91)79-442642; fax: (+91) 79-420242.

"We Care" an environmental education pack published by WWF SA Nature Foundation (1988). This package, developed for Southern Africa by a team of experienced educationalists, comprises a teacher/leaders handbook, a 150-page pack of 50 activities and a poster. The overall aim of the project is to encourage the development of environmental awareness, lasting values, commitment, personal involvement and caring attitudes to nature and the environment among the children of Southern Africa.The pack provides a series of ideas for the use of resources in both the natural and man-made environment to teach basic ecological and environmental principles. For further information, contact: WWF Africa, P.O. Box 456, Stellenbosch 7599, South Africa tel: (+27) 21 887 2801; fax: (+27) 21 887 9517. Internet address: userid%wwfsa@mhs.cstat.co.za

The following educational resources are available from WWF-UK:

"The Earth" from My World Pack by Julie Smart. *My World Pack* offers guidance and activities for teachers of 7-11 year olds to help the students understand the world in which they live. The pack contains nine 16-page supplements — Exploring; Earth; Air; Water; Weather; Plants and Animals; Ourselves; Food; Energy and The Future and a teachers resource pack.

Our World Environment Wallcharts produced by WWF-UK in association with Macmillan Education Ltd. Twelve colourful wallcharts, aimed at 7-12 year olds, highlight how natural systems work and how people's use of natural resources affects the environment. The charts include: Looking at: Our Environment; The Air We Breathe; Water; Freshwater Habitats; The Sea; How We Live; Food and Farming; Energy; Pollution; Waste and Recycling; Caring For Our World. The photographs portray aspects of life and the environment in an African context. A teachers' guide accompanies the charts.

"Soil" from Resources Wallcharts, a series of five wallcharts highlighting the use and abuse of resources, aimed at 11-16 year olds. Other charts in the series include Energy; Pollution (both recently updated); Waste; The Importance of Plants and Animals.

For further information about these resources and other educational materials, write to the Education and Awareness Department, WWF-UK, Weyside Park, Godalming, Surrey GU7 1XR United Kingdom tel: (+44) 01483 42644; fax: (+44) 01483 426409; internet address: http://www.wwf-uk.org

Grow Lab: Activities for Growing Minds published by the National Gardening Association (USA), 180 Flynn Avenue, Burlington, VT 05401, USA. This is a curriculum guide for 5-13 year olds for use with an indoor classroom garden, from a windowsill to a home-made or ready-to-assemble GrowLab Indoor Garden. The companion guide *GrowLab: A Complete Guide to Gardening in the Classroom*, contains comprehensive "how-to" indoor gardening information and plans to build an indoor garden unit. For more information on the GrowLab Indoor Gardening Program, contact NGA at the above address or tel: (+1) 802-863-1308; fax: (+1) 802-863-5962; e-mail: nga@together.org or visit the Kids and Classrooms Web site (www.garden.org/edu)

Lines on the Land - A "hands-on" soil and water conservation learning package for 11-14 year olds developed by Iowa teachers in conjunction with the Institute for Environmental Education at the University of Iowa published by Iowa Association of Soil and Water Conservation District Commissioners, USDA Soil Conservation Service; Iowa Dept. of Agriculture and Land Stewardship, Division of Soil Conversation; Institute for Environmental Education, University of Iowa, and distributed by the National Association of Conservation Districts. For more information, contact Dr. David McCalley, Institute for Environmental Education, University of Northern Iowa, Cedar Falls, Iowa 50614 (USA) tel: (+1) 319-273-2581

Conserving Soil, a publication of the National Association of Conservation Districts (revised 1990). Reprinted by permission of the U.S. Soil Conservation Service of the U.S. Department of Agriculture which was responsible for the original publication.

The National Association of Conservation Districts has a variety of educational materials including other conservation learning activities, resource pamphlets, and a videotape and film library service. Write to NACD Service Department, Box 855, League City, TX 77584 USA

Teaching Soil and Conservation: A Classroom and Field Guide produced by the United States Department of Agriculture, Soil Conservation Service, P.O. Box 2890, Washington, D.C. 20013, USA tel. (information): (+1) 202-720-3210

The Growing Classroom: Garden-based science, developed by LifeLab Science Program, Inc. And published by Addison-Welsey Publishing Co. (1990). For further information contact Life Lab Science Program, 1156 High Street, Santa Cruz, CA 95064 USA tel: (+1) 408-459-2001; fax: (+1) 408-459-3483; e-mail: lifelab@zzyx.ucsc.edu

RADIO SCRIPTS

Soil moisture: why plants need it, how humus holds it
Soil life improves the soil for crops

Two radio scripts produced by Developing Countries Farm Radio Network. For further information, contact DCFRN, 366 Adelaide Street West, Suite 706, Toronto, Ontario M5V 1R9 Canada tel: (416) 971-6333; fax: (416) 971-5295; e-mail: dcfrn@web.net. DCFRN's web site is www.web.net/-dcfrn

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OTHER RECOMMENDED RESOURCES:

COMICS

ACTION The Environmental Health Magazine no. 14: Let's find out about Soil

This children's magazine is published and distributed in Zimbabwe, Zambia, Botswana, Lesotho, Namibia and Swaziland by the Action team, Box 4696, Harare, Zimbabwe.
tel: (+ 263) 4 724924
fax: (+263) 4 795150;
e-mail: Action@Mango.zw

GLOSSARY

SUGGESTIONS FOR USE *(see page 4):*
***Teachers**: As a reference source; for word games to review work on soils.*
***Editors of children's comics/newspaper supplements**: As material for word games on soils.*

adhesion: The molecular attraction between two surfaces, such as between a soil particle, and a water molecule.

aggregate: Collected together into one body. Individual soil particles are generally arranged in aggregates or peds.

aggregate stability: The resistance of a soil to breakdown upon wetting. Aggregates tend to be less stable when wetted than they are when dry. Soils with low aggregate stability break down very rapidly under the influence of rainfall, and, as a consequence, tend to form compact surface crusts which prevent water soaking into the ground.

clay soil: This refers to either the mineral soil particles which are less than 0.002 millimetres in diameter or a soil material that contains 40% or more clay; less than 45% sand and less than 45% silt. A clay soil is plastic when moist but hard when dry.

climate: The usual weather a place has for a long time, including its temperature, rainfall and wind.

cohesion: The attraction of like molecules to each other: for example, between two clay particles or the attraction between one water molecule and another.

compacted: Packed together tightly; a compacted soil is one where the soil particles are packed tightly and there are very few air spaces.

duff: Practically decomposed organic matter that is compacted.

fertile soil: A soil that is good for plants to grow in; that promotes plant growth.

horizons: A layer of soil, approximately parallel to the surface, having distinct features that are produced by soil-making processes.

humus: Almost completely decomposed non-identifiable organic matter.

leaching: The process whereby substances in upper soil layers, such as humus and dissolved chemicals, are washed down in the soil.

litter: Identifiable dead plants and animals lying on the surface of the soil, such as dead leaves.

loam: The name of soil containing a mixture of clay, silt and sand in the approximate ratios of 1 part clay to 2 parts silt and 2 parts sand.

nutrients: Something that nourishes. In a soil, nutrients are dissolved chemicals available to plants which help plants grow healthy.

organic matter: The remains and wastes of living things in various stages of decomposition that may be part of the soil.

parent material: The earthy materials - both mineral and organic - from which soil is made.

ped: An aggregate of soil particles; a naturally-occurring unit within a soil.

percolates: Filter through: for example, when water enters the soil, it moves down, or percolates, through soil by flowing through gaps or pores between soil particles.

precipitation: Liquid or solid particles that form in the atmosphere and then fall to the earth's surface: for example, rain, snow and hail.

profile: A vertical section of the soil extending through all its horizons and into the parent material.

sandy soil: Individual soil particles having a diameter between 0.05 and 2.0 mm.

sediment: Soil deposited by water or wind.

sedimentation: The act or process of depositing sediment

silt: Individual soil particles having a diameter between 0.002 and 0.05 mm

soil: A naturally-occurring dynamic mixture of minerals, organic matter, water and air which has a definite structure and composition and forms on the surface of the land.

soil structure: The arrangement of individual soil particles into compound particles (aggregates or peds). The main forms of soil structure are: platey, prismatic, columnar, blockey and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without a regular cleavage - that is, no regular way in which the aggregate splits. Many hardpans are such soils.).

slope: The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. For example, a slope of 10% is a drop of 10 feet or metres) in a 100 feet (or metres) of horizontal distance.

subsoil: The layer beneath topsoil, where soil has not fully formed. This layer tends to comprise generally larger chunks of rock and less organic material than topsoil. It is often this layer into which soluble minerals and nutrients are moved and deposited by water percolating through the soil.

texture: The feel of soil which is determined by the relative amounts of sand, silt and clay particles in a given soil.

topsoil: Generally the most productive layer of soil. In cultivated areas, it is the ploughed layer. As water moves through topsoil, many soluble minerals and nutrients dissolve, and are leached from this layer.

weathering: The breaking down of rock into sediment by wind, water and living things.

SOILS SERIES

2. LOSING SOIL

OUTREACH packs

Who can use OUTREACH packs

The OUTREACH packs are supplied free-of-charge to 'multipliers' in low-income countries. 'Multipliers' are people who can pass on the environment and health messages to a wider audience. They include:

* *newspaper journalists* who can use the materials:
  - as 'fillers' in newspapers and magazines;
  - in articles;
  - in a series of articles;
  - in special editions, especially in children's health and environment newspaper supplements and magazines.
* *radio broadcasters/journalists* who can use the materials:
  - as 'spots' between programmes;
  - in reports;
  - in a series of programmes on a specific issue;
  - in a special programme devoted to a particular topic;
  - as background information for interviews with local experts on environment and health issues.
* *community workers and representatives from Non-Governmental Organizations (NGOs)* who can use the materials:
  - to inform their own networks;
  - as background information for programmes;
  - for meetings and activities with women; farmers; scouts, girl guides and other youth groups; community groups and leaders;
  - in environment and health campaigns;
  - in training workshops.
* *educators and curriculum developers* who can use the materials:
  - for background information for their own classes;
  - for classroom activities;
  - in teacher training workshops;
  - on field trips and in laboratories;
  - for curriculum development.

How to use OUTREACH packs

The materials in OUTREACH packs may be used for non-commercial, educational purposes in low-income countries. Use the material as you wish: **ADOPT** all or part of the materials for inclusion in articles, activities and programmes;

ADAPT materials so they have local relevance;

ADD materials to your own news articles or educational programmes.

You can write for more information to contributing organizations or those listed in resource sections.

Whatever way you use the OUTREACH pack, **PLEASE CREDIT SOURCE** where indicated. Otherwise please credit **OUTREACH.**

What you can do for OUTREACH

We need feedback on the packs. How useful is this material? How can we make it better? Are there special topics you need? Please let us know. Please send us material that you have developed from OUTREACH Information packs. We can pass it on to others to help them in their projects.

We also want to hear about the projects you are working on, and see the materials you produce. We would like to pass on your information and ideas to others in the OUTREACH Network. Here's how to contact OUTREACH staff:

Dr. James Connor, OUTREACH Director or
Gillian Dorfman, OUTREACH Editor:
TVE USA/OUTREACH, P.O. Box 820,
Shelburne, VT 05482, USA
tel: (1-802) 985 1492;
fax: (1-802) 985 2011
e-mail: tveusa@together.net
or
Mr. Richard Lumbe, OUTREACH Co-ordinator, Regional Office for Africa, UNEP, P.O.Box 30552, Nairobi, KENYA
tel: (254-2) 623469;
fax: (254-2) 623928
e-mail: Richard.Lumbe@unep.org

A new type of OUTREACH pack

In its effort to make information and educational materials on the environment and health more accessible to youth and the general public in Africa, Asia and Latin America, OUTREACH has been producing two kinds of packs:

- a general information pack comprising radio scripts, stories, games, articles and some practical activities for use by newspaper journalists, radio broadcasters, community workers, NGOs.
- school-based activity packs comprising Learning-by-Doing leaflets and teachers' notes aimed specifically at curriculum developers and teacher trainers in pre-service and in-service workshops.

In June 1998, these packs were reviewed by environmental educators from around the world, and in response to their suggestions, OUTREACH is now producing one type of pack.

This pack contains illustrated hands-on activities

for use in the classroom and/or the field. While the majority of activities are aimed at upper primary level/ lower secondary level students, there are activities for younger and older students, and even adults. The activities are similar to those which appeared in Learning-By-Doing Leaflets in that they are practical exercises which focus on developing scientific skills needed to solve problems related to environment and/ or personal health issues. There are short-term classroom activities which can supplement school curricula; activities in the local environment/community which may be useful in both formal and non-formal educational settings; and practical activities which people can use as guidelines for solving real-life issues. Information for teachers/trainers is also included which explains how the individual activities might be used in different settings - from large or small classrooms to club meetings.

To complement these activities, there is background information on the topic presented in the form of questions and answers. This may serve as an introduction at teacher and community-based workshops or be adapted for use as a radio script. To meet the demand for more materials that can suit larger groups of students who might be learning in a more teacher-orientated setting, teaching aids in the form of posters, stories and play scripts are also included. Games and puzzles may be adapted for use in newspaper supplements, comics or as classroom worksheets. Each issue includes a list of resources and relevant films available through the distribution service of TVE. Finally, a glossary of terms used in this issue is included.

The first series of issues in the new format is on SOILS. We hope you will find these packs more useful than past issues. Please let us know what you think.

OUTREACH Series on Soils

The following topics will be covered in the series on Soils:

- the non-living things that give a soil its physical characteristics and influence how a soil behaves;
- soil erosion including wind erosion, and ways to protect soil from wind damage, and water erosion, and suggestions for repair and prevention;
- how water moves in different soils, with suggestions on how to conserve soil moisture and irrigate land;
- living things in soil, especially worms and bacteria, and the vital role they play in the cycle of life;
- ways of promoting a healthy soil through composting and worm composting;
- the relationship between plants and soil, and alternative farming techniques which promote the health of both;
- soil chemistry, soil nutrients and soil acidity, with a focus on such problems nutrient depletion, overfertilization, land pollution, acid rain, and suggestions for promoting a fertile and well-balanced soil;
- the social, political and economic aspects of land degradation, with a focus on drylands, which are especially vulnerable to land degradation;
- The Convention to Combat Desertification;
- local solutions and success stories in the struggle to conserve soils.

Suggested ways to use this OUTREACH pack

QUESTIONS AND ANSWERS

A crumbling foundation (page 5-6)

Ways to adapt the material:

These questions and answers serve as a general introduction to land degradation. Specific information about local land degradation issues may be added to the text, or the same questions may be posed to local soil experts.

How to use the material:

- As background information for teachers and students carrying out project work on land degradation.
- As the introduction to a radio script aimed at farmers and local decision-makers on local land degradation issues.

POSTERS

It's time to protect soil now! (page 7)

Aim:

To illustrate that while soil erodes naturally, people's actions cause soil to erode at a much faster rate than the rate at which it forms. For all practical purposes, soil is practically a non-renewable resource, and one that should not be squandered.

Notes on measuring soil formation and erosion:

Here are two excerpts concerning soil formation and erosion:

"Soil formation is difficult to measure. Depending upon a host of conditions, it takes between 200 and 1,000 years to form 1 inch (2.5 centimetres) of topsoil....Most erosion is insidious. The loss of colossal amounts of material may be very difficult to detect. 6 metric tons of soil coming off 1 hectare would reduce the topsoil level by only 1 millimetre.

A complex set of factors, including rainfall, slope and farming practices past and present, determine the rate of erosion, and variation in any of the causes may greatly affect that rate.

Erosion rates can vary by a factor of 100 in a single agricultural region...In eastern Kenya, a study found that rangeland with more than 20 per cent vegetative cover erodes at a rate of 6-12 metric tons per hectare per year, while the rate for land with less than 20 per cent cover is several times higher.

Even within the same plot of earth, the forces of erosion do not act equally on all parts of the soil. Small particles—the ones most often bonded with nutrients—erodes easily; large particles are more stable."

(source: Elena Wilken "Assault of the Earth" *World Watch* magazine, Vol. 8, no. 2 (March-April 1995) published by Worldwatch Institute, 1776 Massachusetts Avenue N.W. Washington, D.C. 20036 USA.)

"Formation of 2.5 cm of topsoil can take anything from 100 years to 2,500 years depending upon soil type. Unfortunately, reversing the process is all too quick — we can destroy 2.5 cm of soil in as little as 10 years."

(source: *The Gaia Atlas of Planet Management*, general editor: Norman Myers, published by Pan Books, London 1985)

Ways to adapt the material:

This poster should be adapted to reflect your culture and soil erosion situation. Find out from the local agricultural college or Ministry of Agriculture what general rates of soil formation and erosion are applicable to your region.

How to use the material:

- It may be displayed on a community noticeboard.
- It may be used as a discussion point for an introductory lesson on soil erosion.
- It can be used as a sample in final project work on soil erosion when students are invited to create their own posters on the subject.

Signs of water and wind erosion (page 8):

Aim:

To illustrate the visible signs of wind and water erosion that may be seen in your region.

Ways to adapt the poster:

To substitute illustrations that show only signs of soil erosion common in your region. Signs of erosion may be more clearly depicted though photographs. For greater impact the poster should be enlarged.

How to use the material:

- The poster may be displayed on a community noticeboard
- It can be used as a resource for activities on soil erosion (see page 21)
- It may be used as a starting point in a farmers' workshop on recognizing soil erosion, and looking into ways to prevent it from happening.

When soil erodes.... (page 9)

Aim:

To demonstrate the consequences of soil erosion, not only in the local community but also in places much further away.

Ways to adapt the material:

To make it more locally or nationally relevant by featuring examples of consequences already experienced by people in your community and in the nation as a whole: for example, photographs may be used to show recent floods, damage to fishing industries dependent upon coastal fish nurseries.

How to use the material:

- An adapted poster may be used as a starting point for a discussion with local/national decision-makers on setting land use policies that have an impact on soil erosion problems.
- It can be used in a leaflet as part of a campaign to prevent soil erosion.
- As a resource for activities on the effects of soil erosion (e.g. Activity 6 in Activity Guide on Losing Soil).

SCRIPTS

Flash Flood! (pages 10-12 - shown as a comic strip on pages 16-17); **The S.O.S. Campaign is launched** (page 12-15)

Ways to adapt the material:

The text should be adapted to suit local circumstances. The scripts may be adapted to form short stories which may be read aloud. The comic strip Flash Flood on pages 16-17 provides an example of how the soil erosion scripts may be adapted for children's comics and /or newspaper supplements.

How to use the material:

- As a play for students to read/act as part of project work on soil erosion.
- As the basis of radio scripts on programmes aimed at increasing awareness of soil erosion problems.

- As a way of introducing the issue to youth club members to stimulate a youth community campaign on soil erosion prevention.
- The plays may be performed in the community to stimulate discussion and action on soil erosion prevention.

PUZZLES AND GAMES

As land degrades (page 18)

Aim:

To demonstrate the process of land degradation

Ways to adapt the material:

To use the same exercise to depict local changes in land use due to land degradation.

How to use the material:

- As part of project work on soil erosion.
- As an activity for inclusion in a children's comic or newspaper supplement.

Soil erosion puzzle (page 19)

Aim:

To help students review project work on soils

How to use the material:

- As a means of reviewing students' awareness and understanding of soil erosion.
- It can be adapted for use in a newspaper supplement or comic magazine for children.

Worms and Landslides (page 20)

Aim:

To demonstrate some of the causes and consequences of soil erosion.

How to use the material:

- As a board game for use in the classroom or youth club.
- As an activity in a comic magazine/children's newspaper supplement on the theme of soil erosion.

ACTIVITY GUIDE ON LOSING SOIL

Ways to adapt the material:

Editors of children's comics and newspaper supplements may adapt activity 4 in Activity Guide on Losing Soil as a practical activity to complement games and puzzles on Soils.

How to use the material:

A summary of the activities in the guide is on pages 21-22. The Activity Guide may be used as enrichment material by teachers to supplement their existing lessons on soil. National curriculum developers may include activities in school curricula. Representatives of NGOs and youth/wildlife club organizers may use selected activities in workshops as an introduction to practical projects for their members. Agricultural extension workers may use some activities in workshops for farmers' associations.

GLOSSARY (page 33)

How to use this material:

The glossary may simply serve as a source of refernece, or the words may be used in word games and puzzles in comics and in the classroom.

What this issue offers...

Primary level students:

Soil erosion may be introduced to students through the scripts and in the board game, "Worms and Landslides". They can use the poster "Signs of water and wind erosion" to look for evidence of soil erosion in their community.

Intermediates and Secondary students:

The comprehensive package of introductory activities on soil erosion in the Activity Guide on Losing soils can be incorporated into existing school curricula, or adapted for use by youth groups.

The scripts may be adapted by students, and read/performed in school or in the community at large.

The posters, activities and games and puzzles may be adapted for use in a children's comic magazine on the theme of soil erosion.

Youth and Adults:

A selection of activities may be used in workshops for farmers, community members and local/national decision-makers in order to increase awareness of soil erosion issues.

QUESTIONS AND ANSWERS

SUGGESTIONS FOR USE *(see page 2):*
Teachers: *As background information for projects on land degradation.*
Radio producers, journalists: *As an introduction to a radio script or article aimed at farmers and/or decision-makers on local land degradation issues.*

A crumbling foundation

Q. What is soil degradation?

A. When soil is degraded, it is made worse— it becomes less productive. Soil is painfully slow to form. Just one inch (2-3 centimetres) of soil can take centuries to build up. But soil can be destroyed terrifyingly fast by careless or inappropriate activities of people. If mistreated, it can be degraded in a few seasons.

Q. Is soil erosion the most common form of soil degradation?

A. Yes. Soil erosion is a natural process. Once soil forms, wind, water and ice move soil particles from one place to another. Soil erosion is the ultimate fate of all soil, but how fast a soil erodes varies greatly. It depends upon a soil's characteristics and such factors as climate and slope.

In the past, soil erosion occurred at slower rates than it does today. This was because more of the land surface was covered and protected by trees, shrubs, grasses and other plants. But people have dramatically speeded up the rate of soil erosion by removing and disturbing natural vegetation. Without the stabilizing effect of plants, nutrient-rich topsoil is more easily swept away by wind or carried down slopes by water, leaving only a less productive land.

Q. May soil be degraded even when it is not physically removed from the land?

A. A soil's productivity can be reduced by other physical processes and by chemical process, too.

Q. In what other ways can soil be physically damaged?

A. Soil may be compacted by the wheels of heavy machinery or by the hooves of large herds of animals. This compaction destroys the structure of soil, making the soil form a hard crust. Soil can also be damaged when land becomes waterlogged.

Q. What chemical processes degrade soils?

A. Nutrients can be lost from the soil. Loss of organic matter — and nutrients — happens when farmers harvest their crops from poor or moderately fertile land without replenishing the soil with nutrients. It also happens when natural forest or other vegetation is cleared from the land.

Land is also made unfit for farming when there is a build-up of salts in the topsoil. This can happen in poorly-managed irrigation schemes in hot drylands, Chemical spills, excessive use of pesticides and dumping of industrial and urban wastes can contaminate soil and reduce its productivity. Over-application of fertilizers can damage the soil by reducing the acidity of soil.

Q. Is land degradation something new?

A. Land degradation is as old as civilization itself. It has happened on the plains of ancient China, and on the peaks of the Inca empire. The world's first ever written story, a Sumerian epic, tells how a man felled the forest of Mesopotamia, bringing down a curse. The ancient Sumerians failed to heed the parable, and went on cutting down trees. Their literature of 400 years ago carried descriptions of land degradation. Their great city state of Uruk, which once contained 50,000 people and produced crop yields comparable to those of North America today, is now covered in sand.[1]

Q. People talk about soil degradation as one of the most serious problems facing the world today. How true is this?

A. Certainly it is a major problem, and one that is increasing at an alarming rate in many parts of the world. Huge areas of land are being degraded, with disastrous effects on the environment, on food production and on the lives of millions of people. Environmentalists have pointed with alarm to eroding hillsides and barren drylands, and have feared that the damage to land caused by poor land use practices is long-lasting and irreversible.

But there are some people who think that the problem of land degradation has been exaggerated. They have pointed to rising crop and livestock production as a sign that the problem is not as bad environmentalists claim. The lack of up-to-date scientific global assessments of soil degradation has left policy-makers without a solid information base on which to make decisions.[2]

Q. Have there been any attempts to assess the soil degradation problem?

A. Yes. The most recent effort was in 1990, when the United Nations Environment Programme (UNEP) commissioned the International Soil Reference and Information Centre (ISRIC) to assess the damage caused by people to the world's soils. The ISRIC brought together some 250 soil scientists and environmental experts to take part in the Global Assessment of Soil Degradation project, known as the GLASOD study. These experts used their knowledge of specific geographical regions to estimate the status of human-induced soil degradation since 1945.

The information was presented on a series of digitalized soil degradation maps. Because the scale of the maps is small (scale: 1:15 million), the information derived from the maps is not intended for use at the national level, and it offers only a preliminary and limited assessment of the condition of the world's soils. But, the report is important because it presents the best estimates available, and it does offer urgently-needed information to policy-makers.

Q. What are the findings of the study?

A. It demonstrates that soil — the very foundation of life — is under siege around the world. It shows that since 1945, an area approximately the size of China and India combined has suffered from moderate to extreme soil degradation. This area — 1.2 billion hectares — represents 11 per cent of the Earth's vegetated surface.[2]

Q. What is meant by "moderate" to "extreme" degradation?

A. Degraded land has lost its natural productivity to varying degrees. Most of it — 910 million hectares — suffers from "moderate" degradation. This means that its agricultural productivity is "greatly reduced" because the soil's ability to process nutrients into a form usable by plants has been partially destroyed. Only with major improvements can productivity of this land be restored. A smaller portion of vegetated land —300 million hectares, almost 3 per cent of the world's total — shows "severe" degradation. This land is reclaimable only with major international financial and technical assistance. Degradation of less than one per cent —9 million hectares— is classified as "extreme": This land is unreclaimable and beyond restoration.[2]

Q. How has this land become degraded?

A. Lands have become waterlogged, compacted, polluted and too salty. But by far the most common way soils have been degraded is by wind and water erosion. Erosion accounts for 84 per cent of affected areas in the U.N. study.

Q. Does this study demonstrate that soil degradation is an extremely serious problem?

A. Yes. People have argued that the steady increase of agricultural yields since 1945 means soil degradation is not a problem. Yet these increased yields are due to improved high-yielding crop varieties, expanded irrigation and the use of chemical fertilizers and pesticides. These technologies have sustained yields, but in doing so, they have masked the effects of soil degradation. These yields may have been even greater if soils had not been degraded so much. Over the past decade, there has been a marked slowdown in grain yield growth, and there is growing evidence that the deterioration of soil health is a contributing factor.[2]

SOURCES

1 Geoffrey Lean, *Down to Earth: a simplified guide to the Convention to Combat Desertification, why it is necessary and what is important and different about it* published by The Centre for Our Common Future in collaboration with the Interim Secretariat CCD, 1995

2 The World Resources Institute in collaboration with UNEP and UNDP. *World Resources 1992-93: A guide to the global environment,* published by Oxford University Press, 1992

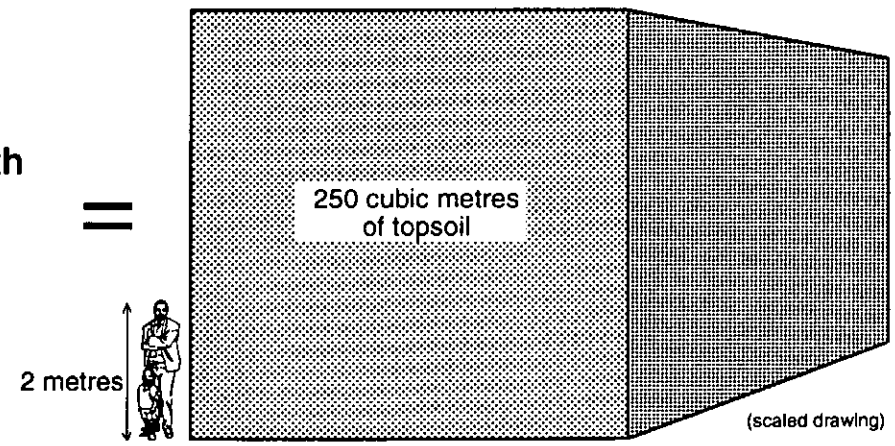
POSTER

SUGGESTIONS FOR USE *(see page 2):*
This poster should be adapted to reflect your culture and local soil erosion rates.
Teachers, community workers: *In discussions on rates of soil formation and erosion; as a starting point for students to design community posters promoting soil conservation.*

Soil eroded from the land during your lifetime may have taken hundreds, even thousands, of years to be created.

Topsoil of this depth
(25 mm or about 1 inch)
covering land of 1 hectare
(10,000 square metres)

=



It may have taken from the time Columbus landed in the Americas in 1492 until the present day, for an inch of new topsoil to form on your land.

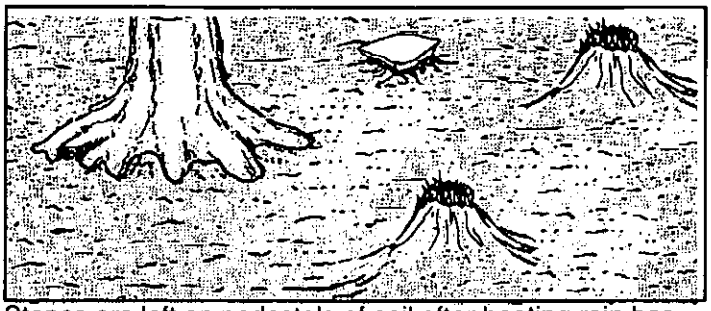
Since you have been born, that same amount of soil may have been lost through erosion.

It's time to protect soil now!

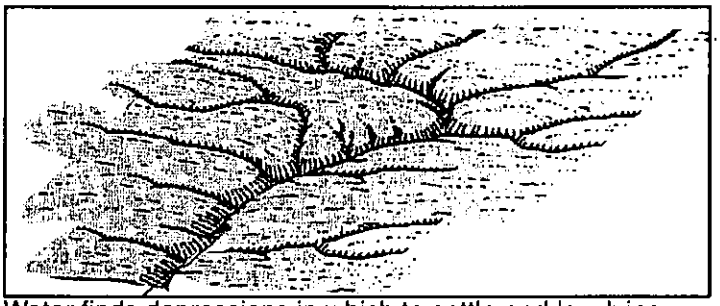
POSTER

SUGGESTIONS FOR USE *(see page 3):*
Teachers, youth leaders: *As a resource for practical activities on soil erosion.*
Community workers, agricultural extension workers: *In workshops on soil conservation which involve how to recognise signs of erosion and how to prevent/repair damage; as part of a soil erosion awareness campaign.*

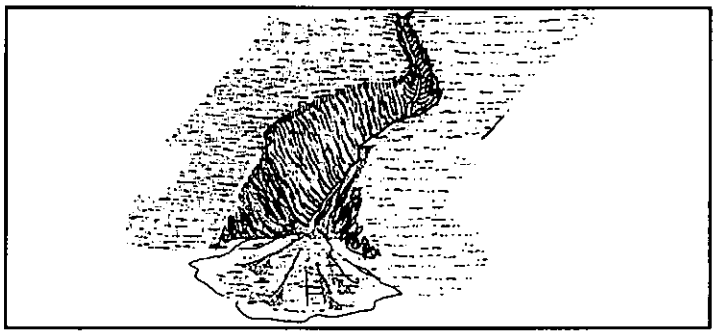
SIGNS OF WATER AND WIND EROSION



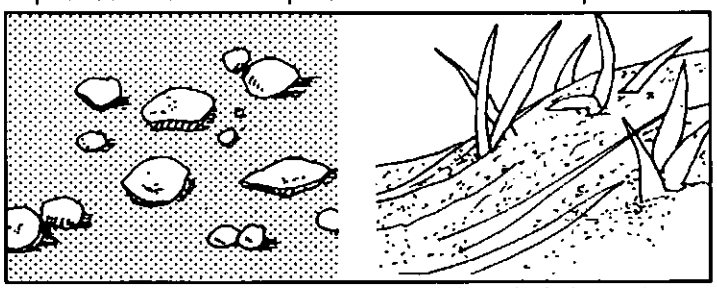
Stones are left on pedestals of soil after beating rain has carried away the soil around them. Roots of plants are increasingly exposed.



Water finds depressions in which to settle and low-lying channels through which to run. As the soil from these channels is washed away, rills are formed.



Rapidly-moving water causes channels to grow wide and deep, forming gullies. Soil, carried with the water, may be deposited where the slope of the land is not steep.



When soil is exposed to strong winds, fine particles are blown away, leaving small stones and gravel.

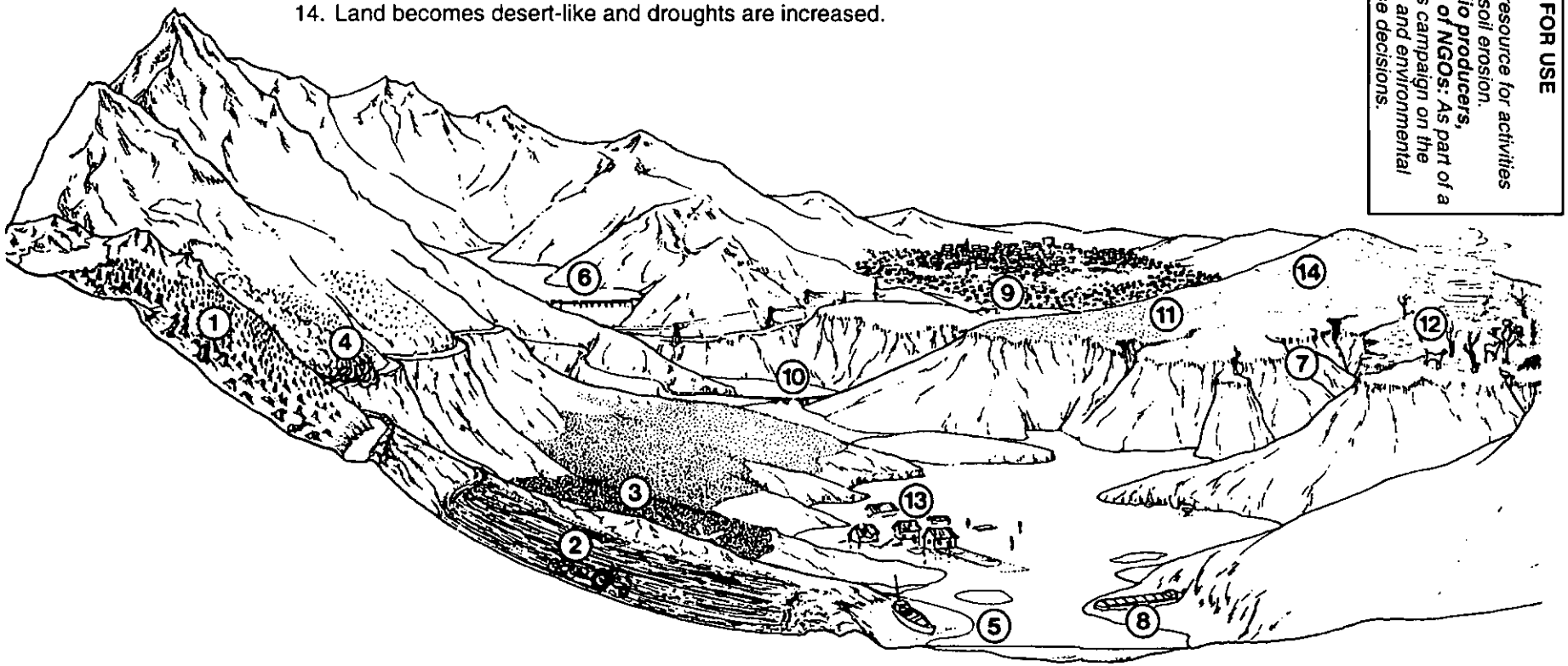
When the wind slows down and drops the soil particles, plants may get buried.

POSTER

WHEN SOIL ERODES....

1. Soil and water is lost from deforested upper mountain slopes.
2. Water erodes soil from steep land being ploughed down the slopes.
3. Soil becomes less fertile when a single crop (monoculture) is grown over a large area, causing land to be more likely to suffer from erosion.
4. Landslides block roads.
5. Fish catch is reduced in shallow coastal waters where silt is deposited, and habitat is covered.
6. Silt in reservoirs reduces the lifetime of hydroelectric plants.
7. Gully erosion eats into cropland.
8. Mud banks make it difficult for boats to travel on rivers.
9. Urban slums grow as rural people abandon farms and move to the city.
10. Bridges are destroyed by floods.
11. Soil erosion is likely when unprotected land on hillside slopes is used for growing crops.
12. Badly-managed pasture suffers from wind erosion.
13. Frequently-flooded villages are deserted.
14. Land becomes desert-like and droughts are increased.

SUGGESTIONS FOR USE
(see page 3):
Teachers: *As a resource for activities on the effects of soil erosion.*
Journalists, radio producers, representatives of NGOs: *As part of a public awareness campaign on the social, economic and environmental impact of land use decisions.*



SCRIPT

SUGGESTIONS FOR USE *(see page 3):*
Teachers, youth leaders: *As a play for students to read/perform as part of project work on soil erosion; as a play for youth to perform for the local community in order to stimulate community action on soil erosion prevention.*
Radio producers: *As the basis of a radio script to increase awareness of soil erosion problems.*
Journalists, editors of newspaper supplements: *As the basis of a short story to increase awareness of soil erosion.*

Flash Flood!

SOURCE
This script is adapted from "Ranger Rick and his friends Adventure #81 Flash Flood by J.A. Brownridge in the April 1975 issue of Ranger Rick magazine. The article may be used in non-profit educational programmes in low income countries provided all reprinted materials is accompanied by the following credit line:
Adapted from April 1975 issue of Ranger Rick magazine, with permission of the publisher, the National Wildlife Federation. Copyright 1975 by National Wildlife Federation.

Characters:

James, a seven year old
Sonia, James' nine-year-old sister
Gina, James' thirteen-year-old sister

Scene: The gully

James is running down a hillside near his home.

Sonia: *(not visible, shouts)* James!

James: *(turning round)* Who's calling me? *(Then, Sonia comes into view behind him.)*

Sonia: *(breathless)* Hey, James, wait. Don't go any further.

James: *(shouting)* What's the matter, Sonia? I'm in a hurry. I have to get home to milk the cow. *(He keeps walking but his eyes are on his sister. He's not looking where he's going. He speaks to himself.)* Why's Sonia waving so wildly? I wonder what's up with her. I haven't time to wait.... Aaaagh! *(Suddenly, the ground disappears beneath him and he goes tumbling head over heels into a deep ditch.)* What's happening? The ground's moving!

Sonia: *(screaming)* James! Oh, no! He's fallen into the gully! *(She rushes up to the gully.)* James, are you okay?

James: *(thrashing about in the gully)* I don't know! I'm sinking in all this loose soil! *(He tries to climb out of the gully but to no avail.)* Can you help me? I can't get out.

Sonia: *(peering into the gully)* I was worried for a moment. I thought you might be hurt. *(She starts laughing.)* You look so funny, thrashing about in the soil! You're covered with dirt!

James: *(exasperated)* Can you stop laughing for a minute, and help me out of here! I can't even stand up.

Sonia: *(trying to control her laughter)* I tried to warn you! I didn't think you knew about this gully! Here let me give you a hand.

James: *(Sonia helps to pull James out of the gully, and he looks around.)* This hole wasn't here a few days ago. How did it get here?

(Just at that moment, their thirteen-year-old sister, Gina, appears.)

Gina: Why aren't you hurrying home? Mother is waiting for you. James, what's happened to you? You're covered with dirt! What have you been doing? You didn't get into another fight, did you?

Sonia: No, he hasn't been fighting. You just missed James falling head over heels into the gully. He's a little shaken up.

James: No, I'm not. It just took me by surprise.

Sonia: I tried to warn him about the gullies on this hillside. Look, there are several deep scars cut into the ground.

James: How did these holes get here?

Gina: They're caused by soil erosion.

James: What's soil erosion?

Sonia: Don't you know? I thought everyone knew what soil erosion is.

Gina: I'm glad you do. Since you know so much, why don't you explain to James?

Sonia: I, er... I would if I felt like it. But he probably wouldn't understand....

James: *(sensing Sonia didn't really know, egged her on)* I bet I would. Go on, Sonia, tell me.

Sonia: Well, soil erosion is.... er, you know..... *(James starts to giggle as Sonia squirms.)* Okay, so I'm not quite sure....

Gina: All right, you two. I'll tell you what soil erosion is. It happens when wind or water — or sometimes ice — moves soil from one place to another.

Sonia: So it's something that happens naturally?

Gina: Yes, just as soils are formed over time, so they erode naturally, too. When land is undisturbed, soils generally build up faster than they erode. Climb down into the gully and let's look at the exposed sides. We might be able to see how

deep the soil is here.

James: *(hesitates)* Do we have to?

Sonia: *(mocking)* Oh, James. You're not scared, are you?

James: No, but.....

Gina: It won't take a minute. And then, we'd better dash home.

(The three children climb down into the gully.)

Gina: Look here*(pointing)* . You can get some idea of how deep the soil is. On this sloping land, the soil isn't naturally deep, and it's getting shallower. Things people have been doing to the land have speeded up soil erosion on these hillsides.

James: What do you mean?

Gina: Remember when a forest covered the top of this hill?

Sonia: Yes. But people have been cutting down the trees for fuelwood, and clearing the land for crops. Most of the forest is gone now.

Gina: Those trees used to slow down the rain, giving it a chance to soak into the ground. And the tree roots used to hold the soil in place. But since the trees have been removed, the soil is exposed to wind and rainwater. The rain just rushes down the hillside. It loosens more and more of the soil and carries it away. Now it's the rainy season, and the heavy rains have created this mess. *(She waves her hand at the gully.)*

Sonia: *(looking up)* Talking of heavy rains, just look how dark the sky is. It looks as though it's already raining at the top of the hill.

James: It's starting to rain.....

Gina: ....and it's coming down fast. We'd better get out of here.

(The children start to clamber out of the gully, but they keep slipping on the wet slopes.)

Sonia: It's hard to get a foothold on this wet slope. The soil has already turned to mud. Gina, maybe if you give me a leg up, I can clamber out, and then pull you up.

(Suddenly James stops trying to climb. He lifts his head to listen. There's a sound of rushing water, and the sound is getting louder.)

James: What's that funny noise, Gina? It sounds like a waterfall.

Gina: *(Turning to look over her shoulder, she starts to shout over the sound.)* Oh no, a flashflood. Let's get out of here fast!

Sonia: Look, there's a wall of water rushing down the gully....

James: What the....?

Gina: Run for your life!

(All three turn to run madly down the hill, scrambling over rocks and slipping in the mud, But as fast as they run, the water moves faster. Like a tidal wave, it catches up to the three terrified children and throws them head over heels. They were thrown from one side of the gully to the other.)

James: I can't stand up...Help! *(He thrashes about in the water.)*

Gina: Grab my hand, James.....That's it....Oh no, my fingers are slipping...

Sonia: The water.... it's sweeping me off my feet..I can't.....

Gina: Try to grab a branch... anything...Just hang on... Ohhh.....I'm slipping *(Even Gina could not hold herself right side up.)*

James: *(yelling between breaths)* I'm ...going under..

Sonia: Being swept.... down ...hill...

Gina: The road's ahead....level land... water's ....slowing down....

Sonia: I can..... put my feet down.

Gina: We're going to be all right.....Quick, James, grab my hand again. *(She screams)* Look out for that rock.....Oh, no, James has hit his head. Quick, Sonia, help me drag him to safety.

(The two girls grab James. Straining and puffing, they drag him to a some land away from the gully.)

Sonia: *(sobbing)* James. Wake up. Gina, he's going to be okay, isn't he?

Gina: I don't know. He cracked his head hard on that boulder. He's unconsious.

(They stand over James, looking very worried, and unsure of what to do.)

Gina: I think you should run home for help. I'll stay here.... No, wait, I think he's coming round. *(quietly to James)* James, can you hear me... everything's going to all right...

James: *(coughs and sputters)* What happened? Ohhh, my head hurts. *(He rubs a big lump that has appeared on his head.)* The water....where did it go?

Gina: The flashflood's over. The water spilled over the road into those fields. Are you okay?

James: I think so. But my head feels like a ton of bricks has fallen on it..

Gina: We'd better have mother look at it.

Sonia: Thank goodness you're all right, James. Wasn't that incredible? I've never seen anything like that before, have you?

Gina: *(grimly)* No. As you can see, soil erosion is bad in more ways than one.

Sonia: Something ought to be done about it.....before someone really gets hurt.

James: *(rubbing his head)* I think someone already did! I feel like I'm covered in bruises from head to toe.

Sonia: What can be done, Gina?

Gina: We've got to try to stop this erosion.

Sonia: How can we do that?

Gina: Well, first of all, we should tell people to be careful when they cut down trees or grow crops. That's usually when the trouble starts. When the land loses its plant cover, the bare soil can easily be eroded, especially on hillsides and in areas of heavy rainfall.

Sonia: But people need land to grow crops!

Gina: I know, but there are ways to farm that protect the soil, too. We must find out about them, and let the farmers know.

Sonia: You mean we can start a campaign to save our soils?

Gina: *(laughing)* Yes, and you've just come up with a great campaign slogan.

Sonia: *looking puzzled)* I have?

Gina: Save Our Soils — S.O.S. We can start a S.O.S. campaign.

Sonia: That's a great idea. After our chores are done, let's get our friends together, and start our S.O.S. campaign! *(The three children race each other home.)*

SCRIPT

SUGGESTIONS FOR USE *(see page 3):*
Teachers, youth leaders: *As a play for students to read/perform as part of project work on soil erosion; to perform for the local community in order to stimulate community action on soil erosion prevention.*
Radio producers: *As the basis of a radio script to increase awareness of soil erosion problems.*
Journalists, editors of newspaper supplements: *As the basis of a short story to increase awareness of soil erosion.*

The S.O.S. Campaign is launched

Characters:

Grace (a 13 year-old girl);

William (a 6 year-old boy), Grace's brother;

Gina (a 13 year-old girl), Grace friend;

Al (a 6 year-old boy), William's friend;

John, the forester;

2nd forester;

The other S.O.S. campaigners: James and Sonia, Gina's younger brother and sister; Sara, Sonia's friend; Joy, Gina's neighbour and John's cousin; Peter and George, two brothers;

Grace's mother.

Scene 1: The case of the missing soil

William and Grace are outside their home. Grace is sitting on the house step, trying to fix a toy wire truck. William is standing playing with a hoe which is lying on the ground. He puts his foot carefully on the metal end which is sticking up and presses. The handle swings up quickly, nearly hitting the six-year old in the face. He tries to grab the end but misses and the hoe falls back on the ground. He starts to try again when his older sister, Grace, looks up.

Grace: William! Stop playing with the hoe like that! You'll hurt yourself!

William *(ignores her and looks down the dirt track leading to the house)* Oh, I won't get hurt. Hey, look! Gina's coming.

(Grace gets up to greet her friend. William follows.)

Grace: Hi, Gina! What's up?

Gina: Hi, Grace. Did you hear what happened to Sonia, James and me the other day?

Grace and William: No. What?

Gina: We got caught in a mudslide. Boy, was it scary! James fell into a gully. We were helping him out, and then it started to rain hard. The water came rushing down the gully and swept us right away. James banged his head on a rock.

William: Wow! A mud bath ride down the hillside! That sounds like fun!

Gina: It wasn't fun, believe me!

Grace: James and the others could've been killed! *(She hands William the toy truck.)* Here, I fixed your truck. Look, there's Al. Why don't you go and play with him, and let Gina and me talk.

(The two girls sit down on the step. William pulls a face at his sister and then goes to his friend, Al.)

William: Hey, Al. Want to sneak up on Gina and Grace, and find out what they're talking about?

Al: Okay.

William: Let's hide behind this wall. Shhh! We have to be quiet so they don't hear us.

(The boys, hide at the side of the house, and try to hear the girls' conversation.)

Gina: ....And so the soil is disappearing! It's like theft! Sometimes it happens over time, and you don't realise it's happening until much of the soil has gone. Sometimes, the theft is sudden, perhaps violent.

William: *(whispers)* What are they talking about? Theft! Sounds like someone's been stealing soil! *(He moves closer to listen.)*

Gina: So that's why we're going to start the S.O.S. campaign.

Grace: What does S.O.S. stand for?

Gina: Save Our Soils. Do you want to come to the meeting tomorrow?

Grace: Yes. It's really important that we act... and soon!

William: *(stepping out from the side of the house)* Hey, can we come, too?

Grace: No, you're too young. *(She turns to Gina.)* He always wants to tag along. Sometimes I don't mind, but not all the time!

Scene 2: Search for the soil thief

It is the next day. William and his friend, Al are standing by the gully which Gina had described. The gully has been gouged out of a footpath that leads down to a dirt road. The road winds up the hillside in one direction, and down to the village in the other. The whole area is caked with mud, and there are tree stumps and rocks scattered around.

William: So you see, Al. We have to prove that we should be S.O.S. Campaigners, and to do that we have to find out who's stealing the soil!

Al: You mean, we're going to be detectives?

William: Yes.

Al: But how can we do it? Where do we begin?

William: Here at this gully where Gina and the others got caught in the flash flood. This must be where she found evidence of soil disappearing. We've got to hunt around and look for clues.

(The boys look around. Suddenly William spots tyre tracks leading up and down the hillside.)

William: Hey, look! Here's a clue!

Al: What is it?

William: See these tracks in the mud? The thief must've taken away the soil in a truck! All we have to do is find the truck, and we find the soil thief!

Al: But who has a truck around here?

William: Well, I know a few people who own wagons, but these tracks weren't made by wagon wheels.

Al: Doesn't this road lead up to the forest where a lumber company has been chopping down trees for timber?

William: Yes, and people have been collecting fuelwood there, too.

Al: Maybe the lumber company owns a truck.

William: Hey, yeah! What we have to do is find the truck with soil in it, and we'll have caught the thieves!

Al: You mean, we're going to capture the thieves red-handed?

William: No-one is going to believe us unless we have proof. Let's go up the hill, and look for the truck. If we find any evidence, we'll go to the police! Com'on! *(William starts hurrying up the hillside.)*

Al: What if we come face-to-face with the soil thieves? No-one knows where we are. What if we 'disappeared' too? *(Then he shouts to William.)* Wait for me.

Scene 3: Case solved!

The scene is a clearing in a small grove of trees near the top of the hill. A truck is standing in the clearing, with the back of the truck facing the audience who can see that the truck is not empty. Stacked against the back of the cab are some saplings with their roots bundled up in sackcloth. Beside them are some shovels, a few poles and an old tarpaulin. Beyond the truck are two men. One man has his back to the audience. The other is bending over a shovel. They are muttering to each other. Enter Willian with Al following. The two boys crouch behind some undergrowth.

Al: *(panting)* That was tough going walking up the hill on that muddy track!

William: *(hearing voices, whispers)* Shh! Look over there in the clearing. There's the truck. And see those two men. One has a shovel and he's digging. We've found the soil thieves!

Al: *(whispering, too)* William, they're not just after soil. Look in the truck. See the plants bundled in sackcloth. They're stealing plants, too!

William: Let's take a closer look in that truck.

(William nudges Al, points to the truck, and moves cautiously and quietly towards it. Al follows and a moment later they are standing behind the truck, hidden from the view of the men. William climbs onto the truck and looks around.)

Al: Why are your climbing into the truck? We shouldn't do that. What if the men see us? Let's go and tell the police. *(Al looks around the truck to see the men now walking towards them.)* Oh, no. The men are heading this way! What shall we do?

William: Quick. Get up here. Let's hide under this tarpaulin.

(Al scrambles on board the truck, and the two boys hurriedly duck under the cover.)

John: I think we've done enough today. I'll just toss this shovel in the back, and we'll be off.

2nd forester: What about the plants on the truck?

John: We'll take them with us. We'll take them over to the other side of the hill tomorrow.

(The forester tosses the shovel he is carrying onto the tarpaulin, and both men get into the cab. The tarpaulin moves and William is rubbing his head.)

William: Ow! He didn't have to throw that shovel so hard, did he?

Al: One of those voices sounded familiar. Where've I heard it before? I can't believe I

know a thief! What do we do now?

William: I'll think of something. *(He smiles ruefully.)* At least we'll get a lift home!

(The engine splutters into life and the truck moves off.)

Scene 4: Discovered!

The scene is the gully again. It is raining hard. The truck has just passed by the mudslide. The boys are huddled under the tarpaulin.

Al: It's raining hard.

William: I'm glad there's this tarpaulin! *(He points to the gully.)* Look half the road has vanished. Muddy water's rushing over it. It's a wonder the truck was able to pass by. Oh, the truck is stopping!

(The truck stops and the cab doors open. The two men walk to the back of the truck to survey the scene. They have their backs to the boys.)

2nd forester: What do you think?

John: This was what we were afraid of, wasn't it? We were lucky to get this far.

2nd forester: Yeah. The road looks ready to collapse.

John: If this rain continues, there's going to be real trouble. A flash flood could threaten the village below! The road and gully will have to be fixed as soon as possible. All we can do now is shovel away those boulders brought down by the rains. Com'on. Let's get those shovels.

(The men turn back to the truck in time to see the two boys trying to hide under the tarpaulin again.)

2nd forester: What the...

John: All

Al: John!

Wiliam: *(Turning to his friend)* You know this man?

Al: Yes. It's my neighbour's cousin, John.

John: What are you doing on the truck?

Al: I'm....We're.....umm...looking for soil thieves.

The two men: Soil thieves?

Al: *(speaking to William.)* We must've got it wrong. John is my neighbour's cousin. He's a forester. He can't be a soil thief...

William: But we've caught them red-handed, and they were stealing plants as well as soil!

John: Can one of you explain what's going on?

William: We had to find out who has been stealing the soil that's missing from this hillside. If we solve the crime, Gina and Grace will have to let us join the S.O.S. Campaign.....

John: Stolen soil, Gina, Grace, S.O.S. Campaign....I'm still confused.

(The boys climb down from the truck.)

William: S.O.S. Campaign is a new campaign to Save Our Soils.

(Silence for a moment. And then John starts to laugh. The others look puzzled.)

William: Why are you laughing? We've caught you red-handed stealing soil, and all you can do is laugh!

John: *(stops laughing, but continues to grin)* I've just realised what you've been thinking. We're not soil thieves.

William: Who is then?

John: *(pointing to water that was still flowing over the road)* It's not who but what. It's the rain. It's washing the soil down the hillside. Of course, rainwater wouldn't be able to steal so much soil if people didn't make it so easy.

William: What do you mean?

John: Well, if you owned something precious, would you leave it lying around for a thief to steal?

William: No.

John: Soil is a precious resource, but many people don't look after it as they should. They need to realise that if soil is lost, their future livelihoods are threatened.

William: Oh, I see! So that's what the S.O.S. campaign's about! Helping people to save their soil.

John: We were making a start today. We were planting trees to replace the ones people have chopped down on the upper slopes. The tree roots will help to bind the soil, and prevent it from being washed away. *(He nodded to the gully.)* Now we have to repair the damage caused by the rains.

Al: How can you do that?

John: We have to stop this erosion. Otherwise the gullies will grow deeper, and more good soil will be washed away during heavy rain. *(He pauses.)* Perhaps the S.O.S. Campaign can help.

William: Let's go! They're meeting right now at Gina's house.

Scene 5: The S.O.S. Campaigners meet

It is late afternoon outside Gina's house. Eight Campaigners — Gina, Sonia, James, Grace, Sara, Joy, Peter and George — are gathered together talking. Gina is sitting behind a table, while others are sitting on logs and on the ground. One or two are leaning against trees.

Gina: *(pounding a hammer on the table)* Okay everyone. The first meeting of the S.O.S. campaign will now come to order!

George: Wait a minute. Let's take a vote to find out who's interested in the campaign. Those in favour, say "aye". *(Everyone except his brother, Peter, says "aye".)*

George: Are you against the idea, Peter?

Peter: I'm not against it. I just have doubts about us

being able to get things done.

Gina: What do you mean?

Peter: Well, who's going to listen to a bunch of kids? My father just gives orders. I don't think he'll take advice from me.

Grace: But we'll be asking them for suggestions and help, too. I'm sure some of our parents have some good ideas about how to stop soil erosion.

Peter: But if they know the answers, then what we tell them isn't new!

Sara: Some people may know what to do, but there must be lots of people who need some advice. After all, if everyone's got all the answers, why do we still have soil erosion?"

Gina: And perhaps what's needed can't be done by just one person working alone. We might need everyone working together. I know some gullies that need to be fixed, but they cut through several people's land. If all the farmers don't get involved, the gullies can't be controlled.

Joy: We can try different ways to convince our parents to do something. How about asking our teacher if we can put up an exhibition in the school for people to see?

Sonia: And we can do demonstrations in the classroom, too.

George: Why not do demonstrations on a farm? If a farmer is doing something to protect the soil and is willing to let us, we can show everyone else.

James: We can make leaflets that show people how to do things.

Peter: Where are we going to get the paper? And besides, what if people can't read? My father can't.

Gina: *(reassuringly)* James, your idea's a good one. If we can't find enough paper for leaflets for everyone, perhaps, we can make a few posters and put them up around the village. For people who can't read, we can explain everything through pictures.

Grace: I bet your father listens to the radio. My cousin works for the local radio station. We can write some scripts to send him. Or I can ask him to interview someone who can talk about soil erosion on the radio.

Gina: These are all great ideas. I hope we can try several of them. *(She turns to Peter.)* What do you think? Are you interested?

Peter: I'm still doubtful. But it's worth a try.

Gina: Good.

(Just then John's truck pulls up in front of the house, and the children are amazed to see William and Al emerge from the cab.)

William: Hi. everybody. Guess what? We've got John to help in the campaign.

Joy: John! What are you doing here?

John: Hi, kids. It's a long story. But William and Al here have been telling me what you're planning to do, and I'd like to help in any way I can.

Gina: The more people involved, the better.

William: Does that mean you'll let Al and me be campaigners?

John: They're a resourceful pair. I think they'd be a great help!

Grace: *(laughing)* If it's okay with the others.... ("yeah" "why not?" "sure"....) Looks like you two are officially S.O.S. Campaigners!

Sara: So, John. What do you think we should do first?

John: I think you should find out what soil erosion problems exist in the community, and then meet again to talk about how you can tackle them. You could work in small groups to solve the problems.

Gina: That sounds like a good idea. Does everyone agree?

Everyone: Agreed.

William: How about checking out all the neighbourhood gullies?

John: Good idea. I'll help.

Joy and Peter: Me, too.

Gina's mother: *(from inside the house)* Gina, can you look after the baby while I prepare the meal?

Gina: Okay, mum. *(To the others)* Gotta go. Let's meet again tomorrow. Same time, same place. Everyone interested in helping with the survey, be here! *(pounding the hammer)* The first meeting of the S.O.S. campaign is hereby closed.

Postscript:

In the next few months, the S.O.S. campaigners work hard. When the children are not at school or doing chores, they are investigating soil erosion problems in the community, and meeting with other campaigners to discuss how the problems could be tackled. Then, they go to work to solve the problems.

At first the grown-ups in the community doubt that the children can do much about soil erosion, though some parents do support the children. Other parents complain that the S.O.S. campaign is taking their children's time away from the household and farm chores. But as time goes on, even these parents begin to realise that the S.O.S. campaign is beginning to make a difference.

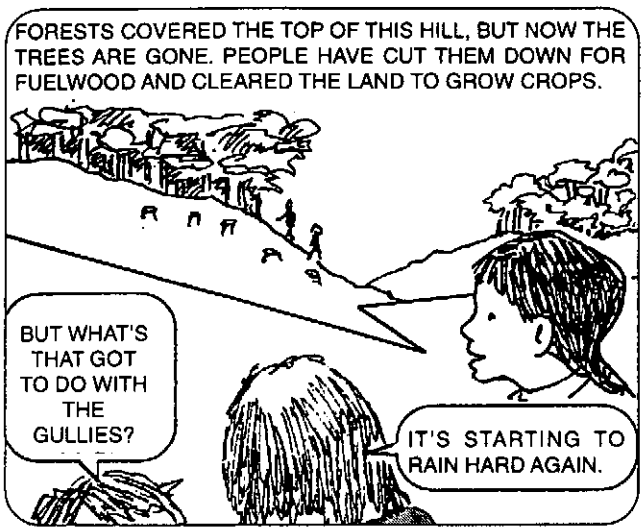
COMIC STRIP

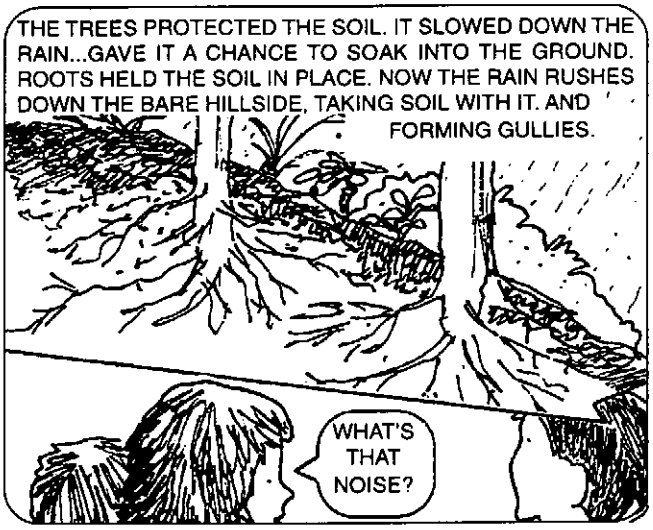
SUGGESTIONS FOR USE *(see page 3):*
This comic strip is based upon the soil erosion script, "Flash Flood!" on page10-12.
***Editors of newspaper supplements or comic magazines for children:** As an example of how the script may be adapted as a comic strip.*

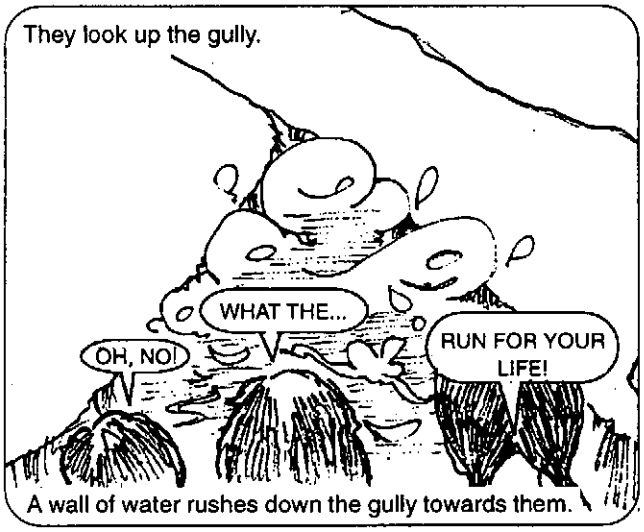
FLASH FLOOD!

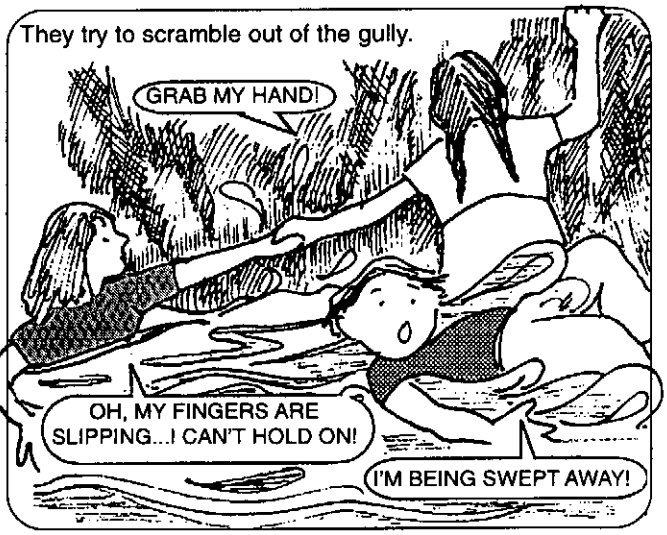
FLASH FLOOD! continued.....

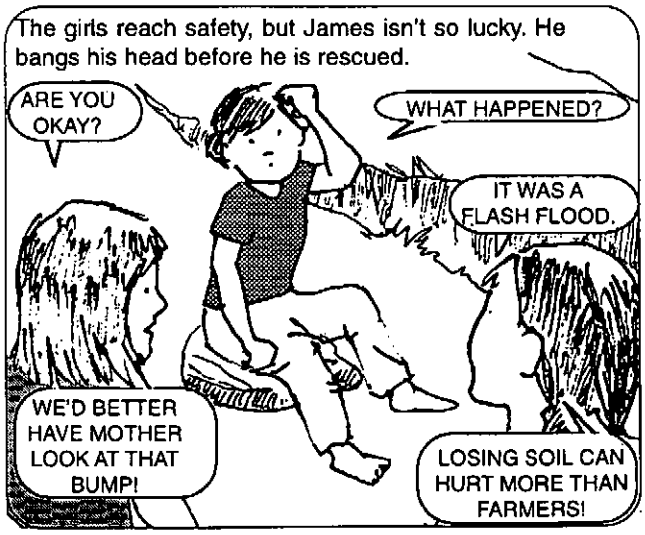
James and his sisters, Sonia and Gina, discover a gully on the hillside near their home. The children climb down into the gully to investigate, and Gina explains why the gully was formed.

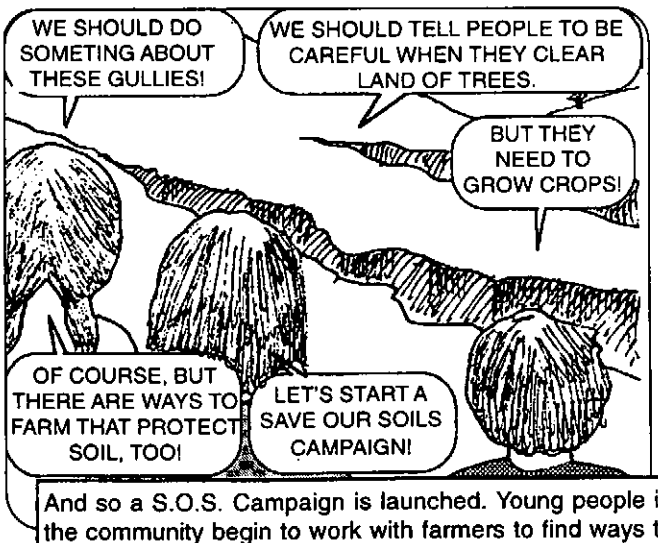












And so a S.O.S. Campaign is launched. Young people in the community begin to work with farmers to find ways to protect the soil on the hillside.

PUZZLE

SUGGESTIONS FOR USE *(see page 4)*:
Teachers: *As part of project work on soils.*
Editors of children's magazines: *As a puzzle in an issue on soil erosion.*

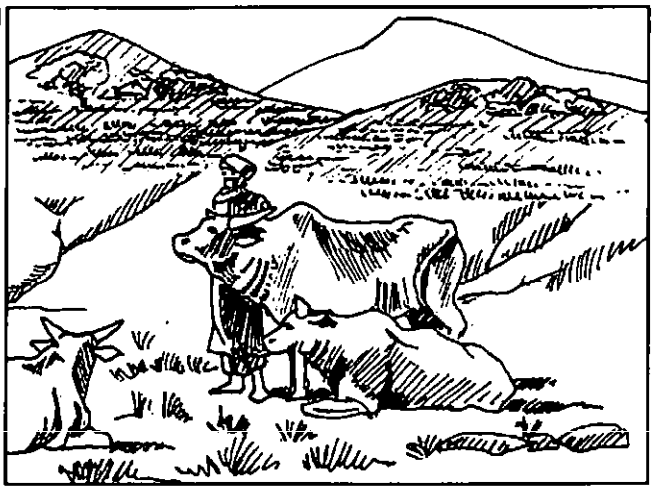
As land degrades

Put these pictures in order to show one way in which land degrades.

Make up a story about what's happening to the land and to the people shown in the pictures.

Can you think of places near your home where land is being degraded? Draw pictures to show what has been happening to the land where you live.

1



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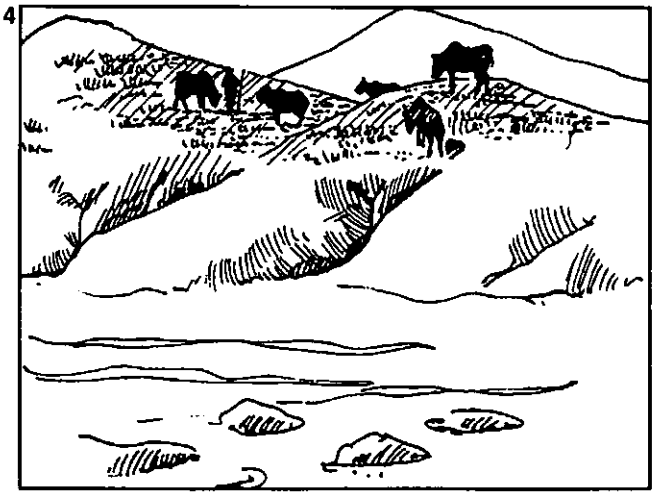
4



5

ANSWER: 3, 5, 1, 4, 2.

PUZZLE

SUGGESTIONS FOR USE *(see page 4):*
Teachers: *As a pre- or post-exercise related to project work on soils to assess understanding of soil erosion.*
Editors of children's magazines: *As a puzzle to include in an issue on soil erosion and conservation.*

Soil erosion puzzle

Use the words in the word bank to complete the following statements:

WORD BANK

(a) conservation	(f) gullies	(k) soil erosion
(b) dam	(g) lives	(l) steep
(c) different	(h) rainy	(m)terraces
(d) down	(i) sheet	(n) trees
(e) future	(j) shelterbelt	(o) wildlife

1. Trees planted as windbreaks create homes for birds and other _____.
2. _____ break steep slopes into a series of steps and help to stop water rushing down the hillside.
3. Planting on the sloping sides of _____ helps to stop them from getting bigger.
4. In the _____ season, fierce storms can cause serious soil erosion.
5. Trees planted around a field as a _____ can slow down wind blowing over the land and reduce soil erosion.
6. Bad farming methods speed up the process of _____.
7. Planting _____ crops on the land at different times of the year helps to keep the soil covered and protected from wind and rain.
8. When a _____, made of rocks or logs, is built across a gully, water flowing down the gully is slowed down, and soil will slowly collect behind the barrier.
9. Soil erosion can cause landslides and flooding, which may cost people their _____.
10. _____ land needs to be always covered with plants to stop soil from being washed away.
11. Planting crops in rows across a hillside, instead of up and _____, helps to stop soil erosion.
12. Soil _____ is an important part of good farming.
13. How much food we can grow on the land in the _____ depends upon how well we protect our soil now.
14. One way to stop _____ erosion is to divide a field into strips that run across the slope of the land, and then plant different crops in each strip.
15. Planting _____ is one of the best, and perhaps the most lasting, way to stop soil erosion.

The words from the word bank are hidden in the puzzle below. The words may be across, down or diagonal, but the letters of each word are always in order. Circle the ones you find.

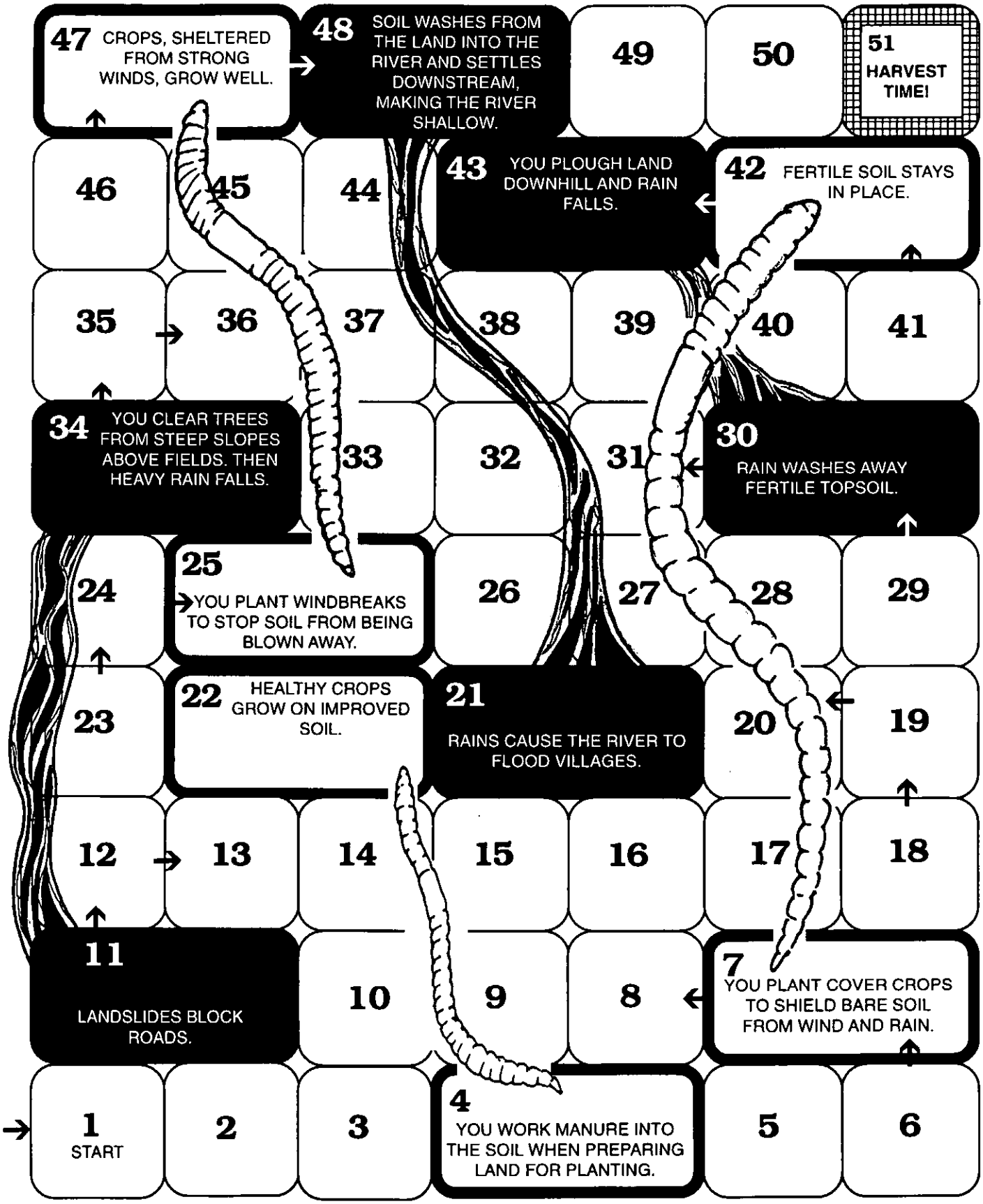
C	S	H	E	L	T	E	R	B	E	L	T
O	B	W	U	I	E	I	M	A	Q	P	C
N	A	D	X	V	Y	D	A	W	I	K	R
S	O	I	L	E	R	O	S	I	O	N	O
E	J	F	I	S	T	W	B	L	U	O	Y
R	D	F	E	I	W	N	G	D	A	M	T
V	P	E	D	D	F	K	A	L	M	H	E
A	R	R	V	G	U	L	L	I	E	S	S
T	S	E	A	Q	T	L	N	F	O	N	Z
I	F	N	R	R	U	S	T	E	E	P	X
O	U	T	E	R	R	A	C	E	S	W	E
N	Y	D	S	H	E	E	T	J	I	E	D

ANSWERS: 1 o; 2 m; 3 f; 4 h; 5 j; 6 k; 7 c; 8 b; 9 g; 10 l; 11 d; 12 a; 13 e; 14 i; 15 n.

GAME

SUGGESTIONS FOR USE *(see page 4):*
Teachers, youth leaders: *As a board game.*
Editors of children's magazines or newspaper supplements: *As an activity in an issue on the theme of soil erosion.*

WORMS AND LANDSLIDES



YOU NEED A DICE AND COUNTERS OR SMALL STONES TO PLAY. THROW A SIX TO START. YOU MOVE YOUR COUNTER UP WORMS AND DOWN LANDSLIDES. THE FIRST PERSON TO REACH HARVEST TIME IS THE WINNER.

Learning-By-Doing Activity Guide on LOSING SOIL

There is one Activity Guide on **LOSING SOIL**:

1: Soil on the Move explores soil erosion, the major process of land degradation. Activities help students understand how wind and water erode land, recognise the effects of erosion on the landscape, and consider actions to prevent erosion from taking place.

The chart on the next page summarizes the activities included in this Activity Guide. The suggested age groups are: Primary (ages 5 to 8 years); Intermediate (ages 9 to 11 years); Secondary (ages 11 - 14 years); Youth (ages 15 - 18 years); Adult (over 18 years). However, you should not feel bound by the age groups we have suggested. Teachers, wildlife club leaders, youth workers, extension workers can adapt most of the activities to suit their particular target group - school students, wildlife club members, farmers groups, women's groups and so on.

Essentially, there are three types of activities: classroom activities; activities that involve the study of the local environment/community; and practical projects.

1. **Classroom activities**: These activities introduce students to basic scientific principles. These may be conducted in the classroom (or other indoor space). If activities require more space, or if indoor facilities, such as electricity, are not required, these activities may be conducted outside. Many of these activities may be used to supplement existing school science curricula. An example is "How can soil move?", Activity 1 in the Activity Guide, Soil on the Move. In this activity, students identify causes of soil erosion. Classroom activities are short term, usually taking from one to several hours to complete. Occasionally, an activity involves observations and record-keeping over a long period of time.

2. **Studies of the local environment/community**: These activities draw students out into their locality to identify or better understand phenomena, and analyze issues in the locality. An example of this type of activity is "Is soil erosion a problem in your area?", Activity 5 in the Activity Guide, Soil on the Move. In this activity, students study their neighbourhood for signs of soil erosion. If school timetables allow, these activities are useful as field activities for students. They also have appeal to other community groups such as wildlife clubs. These activities are generally longer-term activities than those conducted in the classroom.

3. **Practical projects:** The aim of these projects is to improve the health and the environmental conditions in the community. Through these activities, students learn skills that they can use for a lifetime. They give school students an opportunity to apply theoretical knowledge they have learned in the classroom to real-life settings. They also are useful step-by-step guides for adults currently dealing with real-life situations. These activities are generally longer-term projects that require more thought and planning.

Summary of Activity Guide on LOSING SOIL

Key:
Activity type C - classroom activity; E/C - activity studying local environment/community; P - practical project

Activity Guide on LOSING SOIL 1: Soil on the move

Activity	Type	Objectives	Ages	Subjects	Materials	Location
1	C	Identify causes of soil erosion.	Intermediate, Secondary, Youth	Science, Language Arts	2 cupfuls of dry soil; a large shallow box lined with a large plastic bag or a shallow pan; a container full of water; hand-held hair dryer, fan, bellows or a large piece of stiff cardboard; straws	inside or outside
2	C	Observe the effect of wind erosion.	Intermediate, Secondary, Youth	Science	3 shallow pie tins or large lids from cardboard boxes; 2 cupfuls of sand 2 cupfuls of sifted garden soil; 2 cupfuls of sifted flour (flour has the same texture as dry clay particles); ruler; paper and pencil; an electric fan or bellows; a large piece of cardboard (if a fan/bellows are not available)	inside or outside
3	C and C/E	Observe and record rain's destructive force on soil Demonstrate ways to minimize it.	Intermediate, Secondary, Youth	Science	newspaper; eyedropper; container of water; soil (different types); jar lid; ruler; paper and pencil; several flat pieces of wood at least 4 inches (10 cm) wide and about 3 feet (1 metre) long; white paint; bricks; rubber bands	outside
4	C	Realize the beneficial role of plants in protecting soil from erosion.	Intermediate, Youth, Adult	Science	2 cardboard shoe boxes (or 2 boxes or equal dimensions); plastic sheets (e.g. cut up plastic bags); a piece of sod from a pasture to fit one of the boxes; soil for the other box; brick; sprinkling can or a tin can with holes punched in the bottom; tape; 2 glass measuring jars with wide openings; water	inside or outside
5	C/E	Recognize signs of soil erosion by water and wind.	Intermediates, Secondary, Youth, Adult	Geography, Science	poster on water and wind erosion; paper and pencil	on location
6	C/E	Relate sedimentation in rivers and streams to soil erosion.	Secondary, Youth, Adult	Science	jars of equal size; ruler; tape; pencil and paper	local rivers and streams
7	C	Recognize the conditions that lead to soil erosion.	Intermediate, Secondary, Youth, Adult	Science, Geography		inside or outside
8	C	Analyze possible actions that might alleviate soil erosion problems.	Secondary, Youth, Adult	Language Arts, Social Studies	pencil and paper (optional)	inside or outside

LEARNING-BY-DOING ACTIVITY GUIDE ON LOSING SOIL

1. Soil on the move

INTRODUCTION

If you live in places where the soil is dry, have you noticed that soil blows around the fields? Is the soil layer getting thinner, and have crops stopped growing? Or if you live where streams flow through fields, have you noticed gullies forming and ditches becoming clogged up with soil? These are some of the signs that land is being eroded.

Soil erosion is a natural process. It becomes a problem when human activity causes it to occur much faster than under natural conditions. If topsoil is being lost from the land, and nothing is done to stop it from happening, sooner or later there will be no soil left in which to grow crops. Then the land will have to be abandoned.

In this Activity Guide, you will investigate how soil erosion happens. You will learn how to recognize signs of soil erosion, and begin to appreciate the size and complexity of the problem.

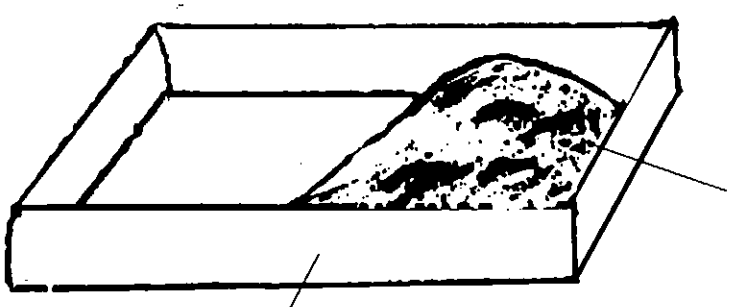
ACTIVITY 1 How can soil move?

Objectives:
Identify causes of soil erosion

Materials:
- 2 cupfuls of dry soil
- a large shallow box lined with a large plastic bag or a shallow pan
- a container full of water
- hand-held hair dryer, fan, bellows or a large piece of stiff cardboard
- straws

Place:
Inside or outside

1. Place the soil in a pile at one end of the pan (see picture).
2. Use the materials provided to move the soil. You cannot directly touch the soil or the pan.
3. Draw the results of your efforts and use them to explain to the class what methods were used to move the soil.
4. Discuss how soil in nature is moved.



ACTIVITY 2

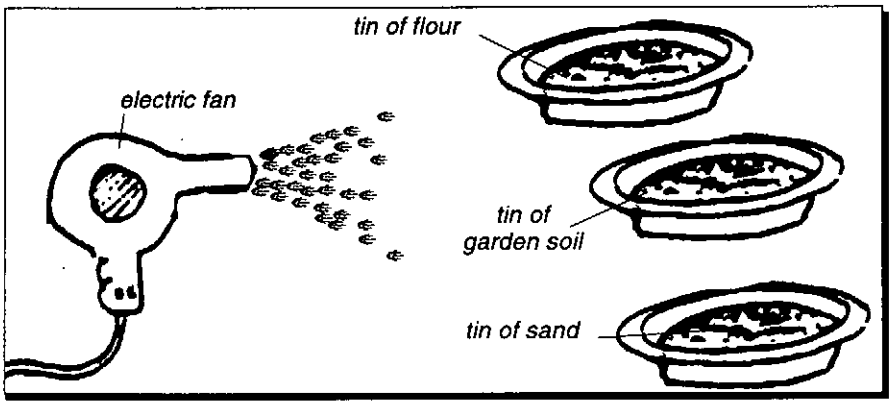
When the wind blows

Objectives:
Observe the effect of wind erosion

Materials:
- 3 shallow pie tins or large lids from cardboard boxes
- 2 cupfuls of sand
- 2 cupfuls of sifted garden soil
- 2 cupfuls of sifted flour (flour has the same texture as dry clay particles)
- ruler
- paper and pencil
- an electric fan or bellows
- a large piece of cardboard (if a fan/bellows are not available)

Place:
Inside or outside

1. Fill one pie tin with sand, one tin with garden soil and the third tin with flour. The surface of each material should be flat.
2. Place the tins 7 yards (about 7 metres) from an electric fan which is directed towards the tins. If a fan or bellows is not available, hold the cardboard the same distance from each tin and flap it hard.
3. Move each tin closer towards the source of wind in turn until there is a slight movement in the material. Record the distance of each tin from the wind source when each of the materials starts to move. Which material moves when the wind source is farthest away? Which materials move when the wind source is close? Can you explain why? Which material is most likely to be eroded by wind?
4. From all you have learned in this activity, can you design a way to prevent wind erosion? For example, could you cover the soils with something, or put a barrier between the soils and the wind source? Build models to test your theories.



ACTIVITY 3

All in a splash!

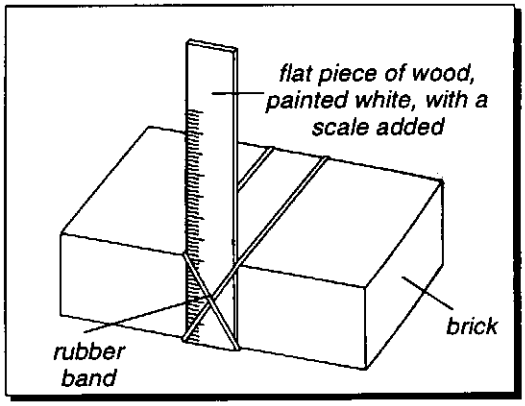
Objectives:
Observe and record splash erosion, and demonstrate ways to minimize it.

Materials:
- newspaper
- eyedropper
- container of water
- soil (different types)
- jar lid
- ruler
- paper and pencil
- several flat pieces of wood at least 4 in (10 cm) wide and about 3 feet (1metre) long
- white paint
- bricks
- rubber bands

Place:
Outside

(a) Make rain splashes

1. To make splash measurers, paint several flat pieces of wood white. Mark off the sticks in inches from 1 to 12 inches (or centimetres, from 0 to 30 cm). Secure each stick in an upright position by means of a brick and rubber band (see picture).
2. Spread out a sheet of newspaper. Place a jar lid full of soil in the middle of the paper. Place one splash measurer next to the lid of soil.
3. Fill the eyedropper with water. Stand over the soil, holding the eyedropper at a height of about three feet (1 metre). Release the water drop by drop.
4. Observe and record:
- how high up the splash measurer the soil splashed;
- how far the soil splashed;
- the effect of water drops on dry soil versus the effect of water drops on wet soil.



4. Repeat the activity, but (a) use different types of soil, and use a different splash measurer (or wipe the white stick clean) (b) use different size clods of soil or (c) make the "rain" fall harder.

5. Repeat the activity, but try to develop ways to minimize the effect of splashes on the soil.

(b) Observe real rain splashes

1. Place splash measurers in different areas in the neighbourhood. For example:
   - on bare soil in a garden
   - in a grassy area
   - under a tree
   - in a sandy area
2. Predict where the area of greatest splash erosion will be, and where the area of least splash erosion will be.
3. After a heavy rainstorm, note the height to which mud has been splashed on each stick. Make a chart or paper strip graph to record your observations. In which area was soil stirred up the most? Where would erosion be most likely to happen? Why? Compare your observations with your predictions.
4. Repeat the activity during other rainstorms to find out if all rainstorms produce the same effect.
5. Use the results of the activity to identify which sites are more likely to suffer from rain splash erosion. Can you suggest ways to protect this land?

Soil will not erode if rainfall cannot reach the soil to create a splash. Soil particles must be dislodged before they can be moved. When raindrops fall on bare soil, small clods and granules are broken down by the impact of falling drops of water. The splashed up soil consists of single particles that have been dislodged. These single particles are easily transported by any water movement over the soil surface, no matter how slow the water is moving.

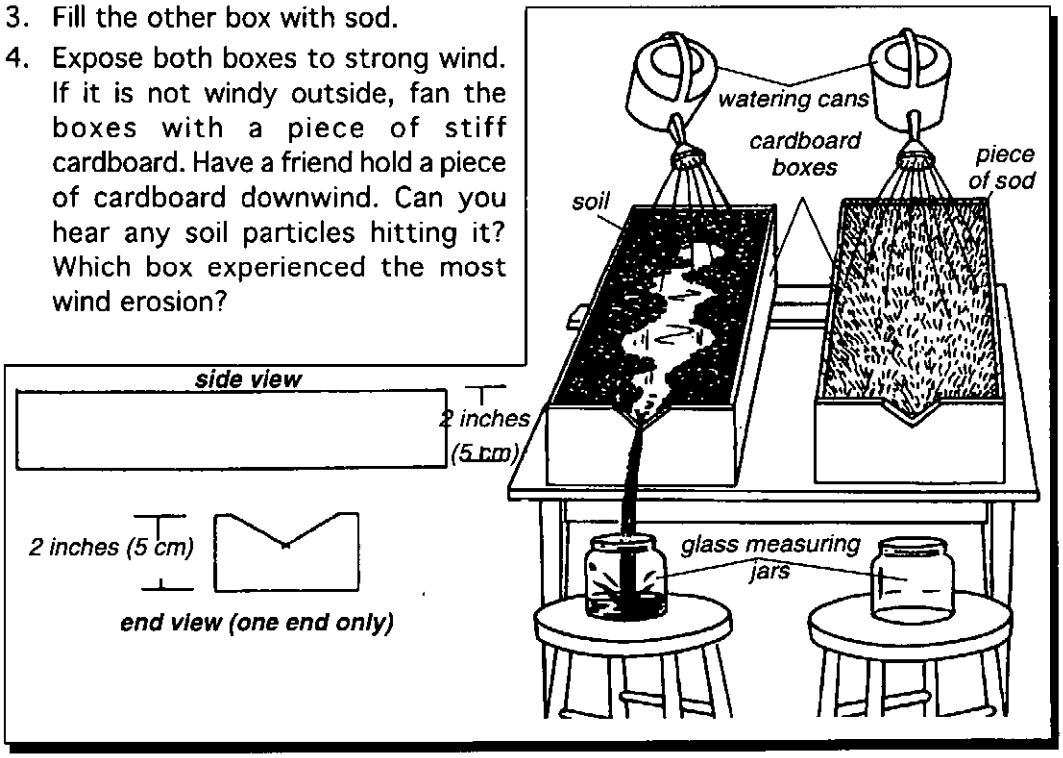
ACTIVITY 4 — Which land is most likely to suffer from soil erosion?

Objectives:
Realise the beneficial role of plants in protecting soil from erosion

Materials:
- 2 cardboard shoe boxes (or 2 boxes or equal dimensions)
- plastic sheets (e.g. cut up plastic bags)
- a piece of sod from a pasture to fit one of the boxes
- soil for the other box
- brick
- sprinkling can or a tin can with holes punched in the bottom
- tape
- 2 glass measuring jars with wide openings
- water

Place:
Inside or outside

1. Cut the shoe boxes to the dimensions shown below. After cutting them, line the boxes with plastic..
2. Fill one box with moist soil, packed down.
3. Fill the other box with sod.
4. Expose both boxes to strong wind. If it is not windy outside, fan the boxes with a piece of stiff cardboard. Have a friend hold a piece of cardboard downwind. Can you hear any soil particles hitting it? Which box experienced the most wind erosion?
5. Set the boxes up as shown in the picture, with the V cut-out facing downwards over the measuring containers.
6. Fill the sprinkling can with water. If you are using a tin can punched with



holes, tape over the holes, and then fill the can with water. (You will remove the tape when you are ready to release the water.)

7. Hold the can of water about 12 inches (30 cm) above the top end of the box with soil, and remove the tape so the water sprinkles down onto the soil. Hold in this way until all the water has sprinkled onto the soil. Observe water draining from the box into the measuring jar. Record how long a period water continues to flow from the box of soil.
8. Repeat steps 5-7, but this time test the box containing grass sod. Record how long it takes for water to drain through the sod and into the measuring jar.
9. Once water has settled in the jars, measure and record the amount of water and the amount of sediment (soil) that has drained into the two jars. Which box lost more water and sediment? Why?

ACTIVITY 5 Is soil erosion a problem in your area?

Objectives:
Recognize signs of soil erosion by water and wind

Materials:
- poster on water and wind erosion (page 8)
- paper and pencil

Place:
On location

1. Study the poster on page 8 to to recognize signs of water and wind erosion.
2. More signs of water and wind erosion are described below. Go into your neighbourhood and look for evidence of erosion. But remember, erosion can happen so gradually that signs of erosion may be hard to spot at any one time.

- After a rainfall when the soil has dried out, is the soil smooth and crusted over?
- Has soil collected behind stones, single sticks, straws and other objects on the uphill side sloping land?
- Are there fans of fresh silt or sand at the lower end of fields, across roads and along drains or ditch banks?
- Are there rills and furrows running down the slope Do two or more rills join up and form gullies?
- Have gullies formed? Can you see fans of soil at the mouths of gullies?
- Are field ditches becoming clogged with soil?
- Is there muddy water in ditches, local streams and rivers?
- Are there mounds of soil and other debris trapped under branches and twigs lying on the ground?
- Are roots of trees and other plants or bottom of fence posts exposed?

Location	Sign of erosion

- Is there dust in the air?
- Are there drifts of dust and sand in furrows and depressions? What are the drifts covering?
- Are small plants buried or plants or seedlings exposed?
- Do the leaves of plants look ragged and torn?
- Have dead plants and small bushes been piled against fences or rolled into hollows?
- Have fine soil particles been washed or blown away, leaving only small stones and gravel?
- Is the soil shallow with stones on the surface and many outcrops of rocks?

Record your observations in a chart similar to the one above.

Do you think the land in your neighbourhood suffers from - or is likely to suffer from - water and/or wind erosion?

3. Interview local farmers about soil erosion. Ask them if they think their soil is being washed or blown away. Ask them what evidence they have that soil erosion is happening. Have any farmers taken action to stop erosion?

ACTIVITY 6 Where does all the soil go?

Objectives:
Relate sedimentation in rivers and streams to soil erosion

Materials:
- jars of equal size
- ruler
- tape
- pencil and paper

Place:
Local rivers and streams

1. Collect samples of water from local streams, ditches and rivers. Collect the sample by positioning the bottle just below the water surface and fill completely. If possible, collect the samples from the same locations before and after a heavy rain.
2. Label each sample jar with the following information:
   - a description of the location;
   - use of land nearby - especially upstream from - the collection site (e.g. cropland, industry, pasture, woodland);
   - the number of days since the last heavy rainstorm.
3. Use a jar of drinking water for a control. Shake each sample for 5 seconds, and then compare the samples to the control sample. Observe and compare the contents after a few hours, and over the next three or four days. Complete a chart similar to the one below:
4. Discuss your findings in class. How does the amount and type of sediment in a stream or river before a storm compare to the amount after a rainstorm? Where is the most soil erosion occurring? Why? What might be washed from surrounding land into the water along with soil?
5. Where do you think sediment in the local streams and rivers might settle? To find the answers, you can either walk further downstream, ask elders or study a map to find out where the rivers and streams flow.
6. Can you identify problems caused by the settling of sediments further downstream? For example, are drainage channels, storage reservoirs, harbours, wetlands and coral reefs becoming clodded with sediment? What problems might this cause?

Sample	sample 1	sample 2	sample 3
Location			
Time since the last rainstorm			
Colour of water			
Contents			
Time taken for sediment to settle			
Thickness of sediment in water after settling			
Make-up of sediment			
Where sediment came from			

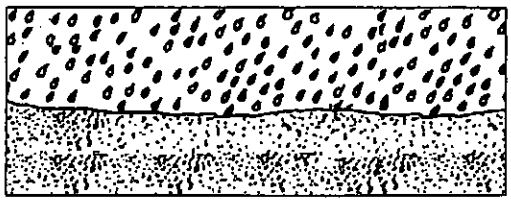
ACTIVITY 7 Erosional forces

Objectives:
Recognize the conditions that lead to soil erosion

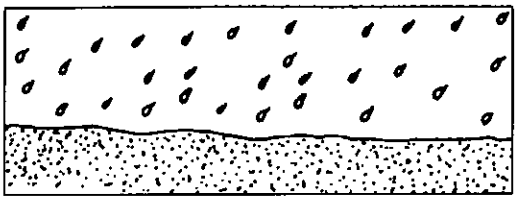
Place:
Inside or outside

Based upon what you have learned in the previous activities, look at each pair of weather conditions on the next page, and choose which of each pair would cause more erosion (all other things being equal):

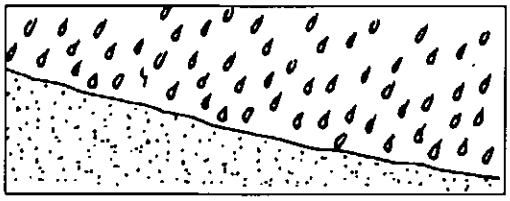
a) a heavy rain



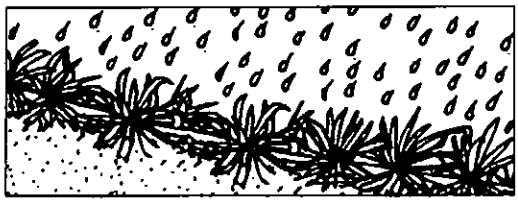
a light rain



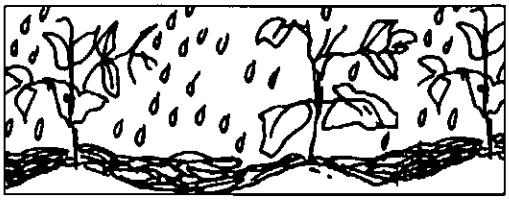
b) rain on a bare slope



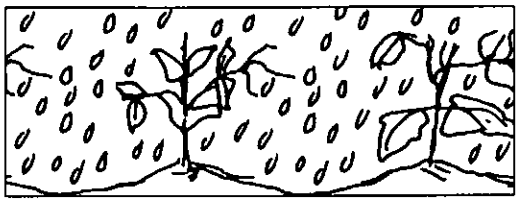
rain on a grassy slope



c) rain on a mulched garden

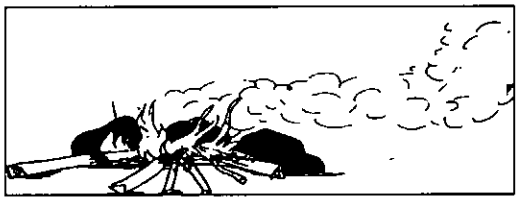


rain on an unmulched garden



d) strong winds

light breezes



ACTIVITY 8 Degradation dilemmas

Objectives:
Analyze possible actions that might alleviate soil erosion problems

Materials:
- pencil and paper (optional)

Place:
Inside or outside

1. Below are some descriptions of problems and possible options for action. Working in small groups, select a problem and discuss possible solutions, including your own ideas. Try to think of the advantages and disadvantages of each option.
2. Select the option you think will work best. Work out reasons for your choice.
3. Present your ideas to the rest of the class for discussion.
4. Repeat this activity for all five situations.

Situation 1

When you work in your fields, you notice several deep gullies. At the end of each gully, there is a large fan of soil. You do not have any spare money. You should:

- Plough the gullies up and plant your crops.
- Plant trees on the sides of the gullies.
- Find out from the agricultural extension worker which soil conservation practices would work best on your farm.
- Ask other local farmers what they do to reduce soil loss from gullies, and put their ideas into action on your farm.
- Other option.

Situation 2

You have grown up in the city, but you have just inherited a farm from your uncle. The farm is made up of woodland, some pastureland and some cropland. The land is hilly, with streams cutting through them. There are signs of soil erosion. You should:

- Go to school and take some courses in farm management and erosion control.
- Ask local farmers what they do to reduce soil erosion, and put their ideas into action on your farm.
- Try to tackle the problem as best you can.
- Ignore the problem since you don't know much about soil erosion.
- Sell the wood for fuel, and then sell the farm and return to the city.
- Other option.

Situation 3

Your harvest is disappointing. Strong winds have caused leaves on many plants to be torn and ragged. Some plants have suffered because their roots have been exposed. In other places, plants have been buried by dust. On parts of your field, there are exposed patches of hard, bare soil from which loose soil has blown away. You should:

- Take immediate action. Cover the bare earth with straw or manure, and leave as much crop residue cover as possible during the fallow period.
- Accept the disappointing harvest: after all, the weather has been dry and windy this year, and you were expecting yields to be lower than normal.
- Think about planting a windbreak to protect your fields from wind.
- Talk to the local agricultural extension worker and other farmers to find out which farming methods work best in your area to protect your fields from wind erosion.
- Other option.

Situation 4

You, along with several other small farmers, grow crops on a hillside. The fields are long and narrow and run down the hill. Farm boundaries often follow the course of streams. This year's harvests are poor for you and many of your neighbours. You notice that the stream running by your field is becoming clogged with soil. You should:

- Ignore the problem of soil erosion because you only rent the land.
- Try soil erosion prevention methods on your land.
- Encourage your neighbours to try soil conservation practices.
- Dredge the stream, and add the sediment to the land.
- Encourage the landlord to work with all the farmers to develop a plan of action.
- Other option.

Situation 5

You notice the rangeland that you and your fellow herders use is becoming compacted by the hooves of the large herds. More and more land is becoming bare. As grazing becomes more difficult, the health of the animals is beginning to suffer. You should:

- Encourage the herders to reduce the size of their herds.
- Keep all the animals in one area around the water source and take action to help the remaining rangeland recover.
- Work with local farmers to exchange animal manure fertilizer for hay to feed your animals.
- Use the rangelend until the land is totally exhausted, and then move on the new pastures.
- Other option.

ACTIVITY GUIDE ON LOSING SOIL 1: SOIL ON THE MOVE TEACHERS' NOTES

OBJECTIVES:

To have students:

- observe, understand and be able to explain the natural forces that cause soil erosion;
- recognize signs of soil erosion;
- appreciate the size and complexity of the problem;
- analyze soil erosion problems and draw their own conclusions.

GENERAL TEACHING TIPS

Many of these activities are best carried out by students in small groups. However, there may be too many students in your class for you to be able to supervise them working independently in small groups. Or you may not have enough sets of equipment available. In these cases, you can present the activity to the class as a whole, and invite individual volunteers to try out their ideas in front of the class. Encourage class discussion throughout the activity by asking why the volunteer might have taken the actions he/she did, and have other students try out alternative approaches.

ACTIVITY 1

If possible divide students into small groups to work on this challenge, and then invite the groups to present their findings to the class as a whole.

It is hoped that some students will think of blowing the soil or using water to move it. If students have a difficult time coming to these conclusions, then ask them how things in nature are moved.

ACTIVITY 2

Here are some other activities you can try:

- Shape the materials in the tins into mounds, and then place the mounds in the path of the 'wind'. Observe what happens to the materials. Try building steep mounds and gentle mounds and observe the effect of the wind. Note the places where the materials move from and to.
- Place objects, such as stones and twigs on top of the materials, and then observe where soil moves and where it is deposited.
- Mix equal proportions of dry garden soil, flour and sand together and place the mixture in a tin. Repeat steps 2 and 3 and observe what happens.

Activity results

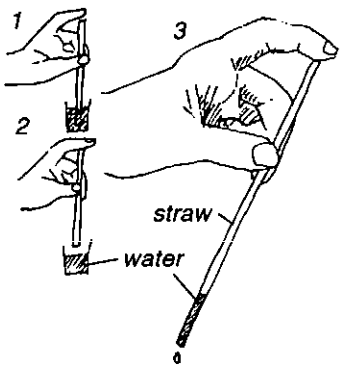
The flour moves when the fan is farthest away since flour particles are smallest and lightest. Clay particles, if they are dry, are most likely to be eroded by wind.

The students should try different ways to reduce wind erosion. One effective way is to cover the soil: this has the same effect as land being covered with growing vegetation or being covered with mulch (see activity 4). Another way to reduce erosion is to place a barrier between the fan and the pans. Soil immediately downwind of the barrier will be sheltered from the wind. A tall barrier will protect a greater area than a shorter barrier. In a garden, a windbreak of trees and bushes may be planted to reduce the force of the wind.

ACTIVITY 3

An eyedropper is suggested as a controlled way of releasing water onto the soil. If an eyedropper is not available, you could create your own by using a straw (see picture). Place the straw in water so that it fills up(1). Put your finger over the top end of the straw and then remove the straw from the water (2).

The water remains in the straw. Hold the straw vertically so that the open end is facing down over the soil. By removing your finger from the straw, you release the water onto the soil (3).



Make sure the students record all their observations and use this data to evaluate ways to minimize the destructive effect of water on soil.

By painting the flat pieces of wood, the splash marks are more clearly visible. You may wish to attach shields to the top of the flat pieces of wood. The shields will help prevent rain from washing off the splashed soil.

Make sure you include an area of bare earth and a grassy area as two of your sites.

Another way to note the removal of soil by splash erosion is to place some flat stones on bare soil and observe what happens in a heavy rainstorm. (They will be perched on pedestals after a hard rain.)

Activity results

During very heavy rainstorms, more soil will be splashed up than during light drizzle. More soil will splash up in areas with bare soil that is very loose. Therefore, soil erosion is more likely where soil is exposed and experiences heavy downpours. Less soil will splash up in areas where the soil is covered with a mulch or with growing plants.

There are two basic ways people can control soil erosion: either by placing a protective cover on the soil or by slowing down the flow of water running over the ground.

ACTIVITY 4

This activity illustrates one of the most fundamental principles of soil and water conservation - that a ground cover like grass gives soil protection from wind and rain, and slows the movement of water. The grass prevents wind from whipping up soil. It breaks the force of raindrops so that soil is not pounded and broken apart by the impact of rain on the ground. The grass roots open up channels to let water into the soil. As the water runs off the land, the stems of grass slow it down so that it does not have enough speed to disturb the soil.

You may wish to get the boxes ready before the lesson. If it is difficult to get enough supplies to have the students carry out the activity in groups, then begin the lesson by asking the students which type of land is likely to suffer most from wind and water erosion - bare earth or land covered by vegetation? Then have volunteer students carry out the activity in front of the class. Save the shoe boxes for similar activities in a later Guid on Water and Soil, in which students test out different land use practices to prevent water erosion.

Activity results

You will find that the water will rush off the bare soil into the jar, taking soil with it. The flow will stop soon, but the glass container will contain muddy water. The water that flows from the sod should be reasonably clear. It will take longer for the flow to start, and it will continue longer. Also, not as much water will reach the jar. The amount of water in the two samples will affect the results: the more saturated the sod and bare earth, the more water will drain into the jars. However, unless the soils are waterlogged, the activity should work. The samples need not be completely dry.

ACTIVITY 5

As an introduction to this exercise, discuss the poster on water and wind erosion (page 8). Some students may have stories to relate about their families' experiences of soil erosion.

It may be difficult to take the whole class on a walk around the neighbourhood. One alternative is for you, prior to the lesson, to look for one area that has obvious signs of soil erosion, and have the students visit that one site. Local farmers may be able to help you find a good example. Before the visit, ask the landowner/ farmer for permission to visit, and explain to students the importance of respecting the property, and not damaging crops, etc. If such an excursion is not possible, students may be able to identify signs of erosion in the school yard/garden, or you could assign this task as homework. Explain to the students that while erosion can be a major problem, it is not always evident at one particular time.

Here are some signs of very recent erosion:

- On cropland, especially after harvest, and in grassland, scrub and forest, little banks of soil can often be seen washed against the uphill side of single sticks and straws after rain, or against small dams of plant litter or roots.
- On cultivated land, soil may be washed away and plant roots exposed at the upper ends of furrows after storms. Fans of fresh silt or sand may be deposited at the lower end of fields, across roads, and along drains or ditch banks.
- Rills and furrows may form further down the slope. Some distance from the top of the hill, two or more of these rills may join up and form small gullies 8 -16 inches (20-40 cm) or more across, in which all or part of the cultivated soil layer has been removed. Many tons of topsoil can be washed off a field in this way during one storm, but the evidence may be hidden within a few weeks by a growing crop, and is largely removed by the next cultivation.
- On grassland, you have to look more closely for signs of soil erosion. Depending upon the slope and density of the grass cover, signs of rills and surface wash can often be seen higher up the field. The beginnings of small gullies may be found about two-thirds of the way down. Patches of recently deposited sand and silt may occur near the bottom of the slope, or where the slope changes to a more gradual slope.
- Water in drains, streams, etc. may be muddy.
- Signs of recent wind erosion include exposed patches of hard, bare soil from which loose material has blown off; small drifts of dust; exposed roots and seedlings; dead plants piled against fences.

Here are some signs of long term erosion:

- Soil may be shallow with many stones on the surface and small outcrops of rocks.
- There may be changes in soil surface texture and structure. Degraded soil has poor structure, little organic matter and coarser texture. The soil may be more sandy (indicating loss of finer particles) or more compact and impermeable (indicating loss of topsoil) or both. When uncultivated, the land usually tends to look bald and hard.
- Soil may build up in small drainage ways and valleys. Traces of former habitation (e.g. building stones, ash from fires, pottery fragments) are often under a deep layer of soil.
- There may be a build-up of soil on the uphill side of tree, and loss of soil on lower side of tree.
- Poor vegetation cover suggests a more degraded land, though the immediate cause may be overgrazing, fire or even drought.
- There may be steep banks between one field and another.
- More frequent and more serious flooding is usually a sign of deforestation and erosion in a catchment area.
- Signs of wind erosion over a long period include: build-up of sand and debris against fences and behind buses; saucer-shaped depressions around trees and rocks;

dunes; dust in the air; expansion of arid areas and deserts.

Some of the subtle signs of erosion may be hard for younger students to observe. Point out to students that a small loss in soil depth over a big area is an enormous volume of soil being displaced. Here are some facts to consider:

> "A typical hectare accumulates only a ton or so (a few millimetres) of new soil each year. Net erosion (the amount worn away from a hectare, less the amount that is washed or blown away to it from a different hectare) is difficult to measure, but the highest rates of gross erosion are certainly many times greater than the rate of creation. Reports of losses exceeding 100 tons per hectare are common for individual plots, especially on sloping terrain in many developing nations."
>
> Source: Gardner, Gary: Worldwatch Paper 131: *Shrinking Fields: Cropland Loss in a World of Eight Billion* (Worldwatch Institute, 1996)

> "Annual soil loss in South Africa is estimated at 300 - 400 million tonnes, nearly three tonnes for each hectare of land..... For every tonne of maize, wheat, sugar or other agricultural crop produced, South Africa loses an average of 20 tonnes of soil."
>
> Source: WWF-South Africa

You can help students visualize the extent of the erosion problem by having them do the following mathematical calculations:

1. Suppose a layer of soil one millimetre in depth is being lost from the land each year, what volume of soil is being lost from each hectare, and what does this amount look like? Calculate the volume of soil being lost from a hectare of land. A hectare is 10,000 m^2. Go outside and measure out this area so students have an idea what a hectare looks like. The volume of soil being lost is 10,000 x 0.001 m^3 = 10 m^3. Measure out this volume for the class to appreciate how much soil is being lost.
2. Enquire at a local agricultural college to find out what the typical soil erosion rate is for your region. You may be given a figure for the average amount (metric tonnes) of soil being lost from a typical hectare of land. You can calculate, with your students, approximately how much soil this represents by taking the following steps:

- Weigh an empty box (wt. A) kg
- Take the box's internal measurements (in cm)
- Fill the box to the brim with dry topsoil, and weigh it (wt.B) (in kg)
- Take A from B to find the weight of the soil in the box (B-A = C) (in kg)
- Calculate the volume of soil (vol. X) in (cc)
- If vol X weighs C, calculate the volume of 1 metric tonne of soil thus:

  C kg takes up X cc

  1 kg takes up X/C cc

  1 tonne takes up $\frac{X \times 1000}{C \times 1000000}$ m^3
- Using the average weight of soil (in tonnes) being lost from a typical hectare (provided by the agricultural college) and the volume a tonne of soil takes up, calculate an approximate volume this amount of soil represents. Again, demonstrate to the class what this volume may look like. You can roughly estimate the depth of soil being eroded by dividing the volume by 10,000 m^2 (area of hectare) to discover the average depth of soil lost from each hectare through erosion. Multiply this figure by 1000 to convert metres into millimetres. (If you use imperial measurements, you can follow the same procedure using lb, tons, cu ft and acres.)

You should point out that this is an approximate measurement: soils vary in density, and some soils erode more readily than others. But this exercise will give students a concrete idea of the extent of the erosion problem.

ACTIVITY 6

Before beginning this exercise, ask your students where they think all the eroded soil goes to. They may have observed sand drifting and engulfing nearby cropland and villages, or even being deposited in rivers, lakes and irrigation channels. But they may be surprised to learn that when strong winds carry dust high into the air, it may be carried hundreds, if not thousands of miles. The Harmattan, a strong northeasterly dry-season wind, may lift dust from the Sahara into clouds up to 6,500 yards (about 6,000 metres) high, and blow it westward into the Atlantic Ocean each summer. Some of the dust travels as far as South America.

This activity focuses on eroded soil being deposited into streams and rivers. Much of the sediment carried away by streams is topsoil, the best soil for growing crops. In discussions, have the students consider how the sediment might affect them and the lives of people around them. You can use the poster "When Land erodes" on page 9 as a point of discussion. Here are some ways that sediment affects everyone:

- Water supply reservoirs are losing water-storage capacity.
- Storage reservoirs for hydroelectric plants are gradually being filled with sediment.
- Sediment fills road and field ditches, and clogs streams. This can lead to flooding of farmland, and road and bridge damage.
- Downstream floods are more frequent and more

serious.

- Sediment harms fish by covering up spawning grounds and shading out light. During floods, many fish die when their gills are clogged with sediment.
- Sediment may destroy coral reefs in coastal waters.
- Rivers and harbours need to be dredged so that traffic can move along the waterways.
- Excess nutrients, in the form of fertilizers and pesticides, are washed off farmland into streams and rivers. These chemicals can kill fish and other water animals.

Activity results

There will be more sediment in streams after a rainstorm. The streams with the most sediment are being fed by run-off from areas that are being eroded, perhaps because they are bare.

ACTIVITY 7

Answers to questions:

The conditions which cause the most erosion are: a. A heavy rain; b. Rain on a bare slope; c. Rain on an unmulched garden; d. Strong winds.

ACTIVITY 8

You may wish to adapt the descriptions of the situations to suit your locality. Or you may wish to present other dilemmas for your students to consider. Each dilemma should have at least 3 options plus others. Encourage students to think of their own solutions. You can divide the class into five groups and have each group work on a particular dilemma. They can then report their decisions to the class. They should be able to defend their positions. Each situation requires value judgements to be made. Have each student or group of students be able to express their opinions based upon their own set of values. All opinions should be accepted with respect.

GLOSSARY

SUGGESTIONS FOR USE *(see page 4):*
***Teachers:** As a reference source; for word games to review work on soil erosion.*
***Editors of children's comics/newspaper supplements:** As material for word games on soil erosion.*

arid: A climate characterized by so little rainfall that rainfed agriculture is not possible, though nomadic livestock raising (pastoralism) is possible. In this pack, an arid area has an annual rainfall limit of between 80-150 mm to 200-350 mm (source: FAO)

compaction: The act of packing or pressing tightly together. When soil particles are compacted, there are fewer air spaces between soil particles.

degrade: To lower in quality, to make worse. For example, when soil is degraded, it is made less productive.

drylands: A collective name for arid, semi-arid and dry sub-humid areas (but excluding natural hyper-arid deserts), which have precipitation over evaporotranspiration ratios of between 0.05 and 0.65. (Source: UNEP).

erosion: The wearing away of the land surface by running water, wind, ice or movement due to gravity.

fallow: Land resting from cropping, which may be grazed or left unused, often colonized by natural vegetation.

gully: A deep, narrow channel cut into the soil by erosion.

irrigation: The supplying of water to land.

nutrient: A substance that provides nourishment for an organism to live. It can be food or chemicals depending upon the organism.

permeable: Allowing the movement of air, water or other materials. In a soil, it refers to the conditions favourable to the movement of water into and through the soil.

rangeland: Land on which livestock grazes.

rill erosion: The removal of soil by water in many small channels a few inches deep.

runoff: Rainfall or other water that does not soak into the ground but flows over the surface.

sediment: Matter that settles to the bottom of a liquid.

semi-arid: Refers to a climate with average annual rainfall from 200-250 mm to 450-500 mm in areas which have winter rains, but from 300-400 mm to 700-800 mm in areas which experience summer rains (source: FAO). In some years, rainfall is not sufficient to maintain crop cultivation.

sheet erosion: The removal of a fairly uniform layer of soil from the land surface by runoff water.

soil texture: The relative amounts of sand, silt, and clay in a given soil sample.

waterlogging: Saturated with water.

windbreak: A barrier of trees or shrubs that protects people, livestock, crops and soil from exposure to wind.

FILM RESOURCES

SUGGESTIONS FOR USE:
TV stations and representatives of NGOs, community groups, schools: *As possible films to broadcast as part of an awareness campaign on soil erosion.*

TVE films of soil erosion

Here is a selection of films covering soil-related topics that are available through the Moving Pictures distribution service of TVE (see box). Customers for the Moving Pictures service include global broadcasters, national television stations, schools and community organizations.

The descriptions of the films are taken from TVE's Moving Pictures 6 catalogue. The ✔ helps you identify which of the programmes or series is available to you, your station or your organization.

Because TVE is a non-profit organization (that is, with no shareholders), any profit from commercial sales is put back into helping the poorest countries receive the programmes copyright free at a token charge. This is why TVE operates a 'sliding scale' of charges - ranging from commerical rates, charged to the rich, industrialized countries, to token payments in local 'non-convertible' currency in the poorest nations.

If you are a broadcaster, please contact TVE's distribution office by e-mail or fax with the titles you require for screening, and TVE will provide you with a quotation for the costs.

If you are a non-broadcast user (non-governmental organization, government or intergovernmental or local government organization, educational institution, community, women's group or other) please contact TVE for an order form. TVE's address, fax and e-mail details are given below. When ordering, please do not forget to provide details of the language, television standard (PAL, NTSC, SECAM) and format (VHS, Umatic etc.) required. As soon as your order is received, TVE will send you a proforma invoice by the fastest possible means - e-mail or fax, where available - and your order will be dispatched immediately on receipt of payment.

For order forms and/or details about other available films, please write to:

TVE, Prince Albert Road, London NW1 4RZ, UK

tel: +44 171 586 5526.

fax: +44 171 586 4866

e-mail: tve-dist@tve.org.uk

URL: http//www.oneworld.org.tve

About TVE

Television Trust for the Environment (TVE) is an independent, non-profit organization founded in 1984 by the United Nations Environment Programme (UNEP), the World Wide Fund for Nature (WWF) and Carlton (formerly Central) Television in order to promote global public awareness of sustainable development through television and other audio-visual media. To do this, TVE:

- produces and co-produces television and video programmes to international broadcast standards;
- runs a video and film distribution service, supplying broadcasters, civil society organizations and other mulitpliers throughout the world;
- provides capacity-building support and expertise to 46 video resource centres in low and middle income countries, with the aim of building up a self-sustaining network throughout the developing world;
- promotes more widespread exhibition of environment, development, health and human rights programmes worldwide via a range of publcations and an on-line Internet catalogue.

Take Care of Your Soil

In Papua New Guinea 80 per cent of the population depend on the land for their survival. The adoption of intensive farming practices - to meet both the needs of an increasing population, and the move to cash crop production - has put the land under ever greater pressure. Local agronomist, Mose Woruba, uses popular theatre to show farmers how they can use traditional techniques in the fight against soil erosion.

Genre: Educational
Year: 1990
Duration: 21 minutes
Country: Papua New Guinea
Language: English
Credits: Producer: Vaughan Redfern, Director: Mark Jeffery
Rights:

✔ Broadcast: lower and middle income countries

✖ Broadcast: industrialized countries

✔ Non-broadcast: lower and middle income countries

✔ Non-broadcast: industrialized countries

Tears of the Dragon

In the 1950s, Chairman Mao Zedung announced on the 'Great Leap Forward' - a nationwide drive to industrialize China and compete with the West. Its legacy today is scarred lands, poisoned water and a daunting population crisis. Peter Nicholson's epic series charts China's recent development in three programmes. **'Earth' explores land management, from the sophisticated, sustainable farming methods - based upon the principle of Daoism - practised in Sichuan for 2000 years, to intensive farming methods elsewhere which have led to widespread deforestation, soil erosion and desertification.** The second film, 'Water', looks at water resource management, contrasting the ill-fated attempt to dam Lake Poyang with the centuries-old practice of combining fish farming with silk production. 'Fire', the final episode, examines how China's government is addressing its pressing social and environmental problems today.

Genre: documentary
Year: 1992
Duration: 180 minutes
Country: United Kingdom
Language: English
Production Company: Cicada Films for New Zealand TV and Channel 4
Credits: Producers: Francis J. Berrigan, Director: Peter Nicholson
Rights:

- ✔ Broadcast: lower and middle income countries
- ✖ Broadcast: industrialized countries
- ✔ Non-broadcast: lower and middle income countries
- ✔ Non-broadcast: industrialized countries

Global Environment Series

This highly-acclaimed series of ten short films includes an overview, 'Our Future World', which looks at current environmental problems and the positive initiatives being taken to deal with them. More specifically, 'In The Shadow Of The City' looks at the effects of urbanization in Bombay and London. **'Breaking Ground' deals with soil erosion in Nepal, Kenya and the United States.** 'A Breath Of Fresh Air' focuses on air pollution in Mexico and acid rain in Europe. 'What's On Tap' turns the spotlight on access to safe water in developing countries and water pollution in the industrialized world. 'Timber!' looks at forest destruction and regeneration in the Amazon, Nepal and Canada. And 'The Greenhouse Effect' focuses on the causes and effects of global warming, and on measures to halt it.

Genre: documentary
Year: 1991
Duration: 120 minutes
Country: United Kingdom
Language: English
Rights:

- ✔ Broadcast: lower and middle income countries
- ✖ Broadcast: industrialized countries
- ✔ Non-broadcast: lower and middle income countries
- ✖ Non-broadcast: industrialized countries

RESOURCES

SUGGESTIONS FOR USE:
Curriculum developers, teachers: *To obtain additional resources; to contact contributors directly.*

Resources used in the production of this pack

PUBLICATIONS

Jean-Louis Chleq and Hugues Dupriez, ***Vanishing Land and Water: soil conservation in drylands*** published by Macmillan Publishers Ltd. (London) in association with Terres et Vie, rue Laurent Delvaux 13, 1400 Nivelles, Belgium, from the French title Eau at terres en fruite, edited by Terres et Vie in association with HARMATTAN and ENDA (1988)

Geoffrey Lean, ***Down to Earth: a simplified guide to the Convention to Combat Desertification, why it is necessary and what is important and different about it*** published by The Centre for our Common Future in collaboration with the Interim Secretariat CCD, 1995

FOOTSTEPS No. 15 *Soil Erosion* (June 1993) edited by Isabel Carter published by the Tear Fund,100 Church Road, Teddington, TW11 8QE, UK. *Footsteps* is a quarterly paper linking health and development workers worldwide. It is free of charge to individuals working to promote health and development, and is available in English, French and Spanish.

EDUCATIONAL MATERIALS

The following educational resources are available from WWF-UK:

Our World Environment Wallcharts produced by WWF-UK in association with Macmillan Education Ltd. Twelve colourful wallcharts, aimed at 7-12 year olds, highlight how natural systems work and how people's use of natural resources affects the environment. The charts include: Looking at: Our Environment; The Air We Breathe; Water; Freshwater Habitats; The Sea; How We Live; Food and Farming; Energy; Pollution; Waste and Recycling; Caring For Our World. The photographs portray aspects of life and the environment in an African context. A teachers' guide accompanies the charts.

"Soil" from Resources Wallcharts, a series of five wallcharts highlighting the use and abuse of resources, aimed at 11-16 year olds. Other charts in the series include Energy; Pollution (both recently updated); Waste; The Importance of Plants and Animals

Desertification, a booklet which is part of **Only One Earth** multimedia pack published by WWF-UK in association with North-South Productions. This pack aimed at 14-16 year olds, focuses on pollution and control, urbanization in the developing world, desertification and its management, tropical forest management and commercialization of ocean fisheries. The pack's 3-hour video (an introductory film and 5 25-minute films) is fully supported by extensive materials which comprise worksheets, data and maps, role plays, and more. The pack was devised by North-South and co-produced in conjunction with the BBC, the International Institute for Environment and Development and a consortium of aid agencies and broadcast partners.

For further information about these resources and other educational materials, write to the Education and Awareness Department, WWF-UK, Weyside Park, Godalming, Surrey GU7 1XR United Kingdom

tel: (+44) 01483 42644;

fax: (+44) 01483 426409; internet address: http://www.wwfuk.org

Lines on the Land - A hands-on soil and water conservation learning package for 11-14 year olds developed by Iowa teachers in conjunction with the Institute for Environmental Education at the University of Iowa published by Iowa Association of Soil and Water Conservation District Commissioners, USDA Soil Conservation Service; Iowa Dept. of Agriculture and Land Stewardship, Division of Soil Conservation; Institute for Environmental Education, University of Iowa, and distributed by the National Association of Conservation Districts. For more information, contact Dr. David McCalley, Institute for Environmental Education, University of Northern Iowa, Cedar Falls, Iowa 50614 (USA) tel: (+1) 319273-2581

Conserving Soil, a publication of the National Association of Conservation Districts (revised 1990). Reprinted by permission of the U.S. Soil Conservation Service of the U.S. Department of Agriculture which was responsible for the original publication.

The National Association of Conservation Districts has a variety of educational materials including other conservation learning activities, resource pamphlet, and a videotape and film library service. Write to NACD Service Department, Box 855, League City, TX 77584 USA

Teaching Soil and Conservation: A Classroom and Field Guide produced by the United States Department of Agriculture, Soil Conservation Service, P.O. Box 2890, Washington, D.C. 20013, USA tel. (information): (+1) 202720-3210

OTHER RECOMMENDED RESOURCES:

PUBLICATIONS

Chris Reij, Ian Scoones and Camilla Toulmin, ***Sustaining the Soil, Indigenous Soil and Water Conservation in Africa*** published by Earthscan Ltd. (1996).

120 Pentonville Road, London N1 9JN, UK tel: (+44) 0171 278 0433; fax: (+44) 0171 278 1142. This book provides a very useful survey of the great variety of soil and water conservation techniques in use in Africa. As well as an overview history of soil and water conservation efforts in Africa, there are 27 case studies of traditional approaches from every part of the continent, mostly by African researchers. These range from planting pits in the Sahel and the Matengo highlands of Tanzania, through compost-rich planting mounds in Western Tanzania and Mali, to grass strips in Swaziland and stone and earth bunds in Ethiopia and Morocco.

INFORMATION KITS

Agroforestry Technology Information Kit (ATIK) published by the International Institute of Rural Reconstruction (revised in 1998). It is available from IIRR, Silang, Cavite 4118, Philippines

tel: (63-46) 4142417-19;

fax: (63-46) 414-2420;

e-mail pub-iirr@cav.pworld.net.ph

This up-dated kit is handy, easy-to-understand and full of illustrations. It widely uses indigenous technologies. There are 6 booklets: 1. Soil and water conservation technologies and agroforestry systems; 2. Trees and their management; 3. Crops and cropping systems; 4. Livestock and poultry production; 5. Seeds and plant propagation; 6. Related agroforestry and livelihood technologies.