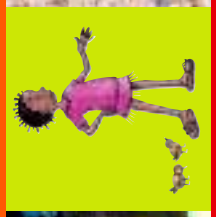
Education Kit on desertification

A Teacher's Guide



Learning to combat desertification

A Teacher's Guide

An activity and educational guide to understand and combat the phenomenon of desertification, developed from the United Nations Convention to Combat Desertification.

Learning to combat desertification

The oasis nourishes the body;
the desert nourishes the soul...

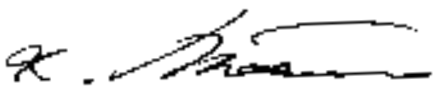
– (*Berber proverb*)

Foreword

Desertification is a wide-ranging problem as it has both natural and human dimensions. It generates environmental degradation and the depletion of natural resources that leads to poverty and hunger everywhere. To combat desertification is to contribute to the eradication of poverty. Every one of us can get involved at our own level to combat desertification. Children, who are particularly receptive and who demonstrate a spontaneous interest in questions relating to nature and the environment, can be the front line players in this collective combat. To help them better understand environmental problems and stimulate their search for possible solutions, the educational system should promote the notion of sustainable development.

Targeted to educators and their pupils during their final years at primary school, this educational kit aims to clarify scientific knowledge on desertification. Environmental problems present as many challenges as there are socially responsible and imaginative solutions to preserve and restore fertility in the world's drylands.

We are particularly grateful to the Governments of Italy and Switzerland for their support in the UNESCO and UNCCD Secretariat joint initiative, encouragement that has helped make this kit a reality. We hope that it will be a useful contribution to the on-going efforts of the international community to combat desertification, a phenomenon that can be contained once shared collective responsibility has been accepted and understood. Famine and poverty are not inevitable. Let's give the present generation, and those generations to come, the means to preserve themselves.



Koïchiro Matsuura
UNESCO Director General

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Contents

Teacher's notes

Concept

Fruit of international collaboration, this kit has been designed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Convention to Combat Desertification (UNCCD). It seeks to demonstrate that drought and desertification are worldwide problems affecting every region of the planet. A global effort from the international community is necessary to combat desertification and/or limit the effects of drought.

This kit will help bring the combat against desertification into the classroom.
It is composed of five elements:

1. a teacher's guide;

2. case studies from different regions throughout the world;

3. a cartoon '*The School Where the Magic Tree Grows*', inspired from one of the case studies;

4. a second cartoon '*There is No Rug Big Enough to Sweep the Desert Under*' created on the occasion of the UNCCD's First Conference of the Parties held in Rome, Italy in 1997;

5. a wall poster for the classroom.

Educational objectives of the kit

To improve the visibility of the United Nations Convention to Combat Desertification (UNCCD).

To explain in simple terms the content of the UNCCD.

To provide teachers with a solid educational foundation on the themes of desertification.

To encourage teachers and pupils to act locally to combat desertification.

To contribute to the diffusion of knowledge on the theme of desertification.

To present case studies intended to give teachers concrete examples of projects undertaken, conforming to the objectives and within the spirit of the United Nations Convention to Combat Desertification.

To demonstrate that desertification, although a serious problem, can be tackled in a fun and exciting way. This is the role of the two cartoons included in the kit.

Beneficaries of the kit:

The kit is especially aimed at teachers and their pupils at the end of primary school education.

How to use

The teacher's guide

(this document)

The educational guide contained in this kit is addressed to teachers around the world living in areas affected by or under threat from desertification. For this reason, the guide should be seen as a general presentation to be adapted to the specific realities and preoccupations of each region or country. The guide begins with the different problems of desertification, which the teachers could integrate into lessons (fauna, flora, crop varieties or rearing, methods of land exploitation, socio-economic problems etc.). It presents the major objectives of the Convention and proposes several solutions to combat desertification.

– Presentation by unit

The guide is composed of work units providing references for thought and activities for teachers and pupils with each work unit presenting a theme that contributes to the elaboration of small local projects. The teacher could compile the lesson by using several units depending on his/her time schedule, and could support each unit with his/her own experiences and problems encountered locally, without neglecting to explain the problems and specificities of other countries. After each lesson, it would be useful to provide the pupils with a short summary of the most important points.

– Classroom Activities
The class activities at the end of each unit can ideally be integrated throughout the school curriculum through the diverse subjects that act as a support to this teaching: geography, natural sciences, maths, writing and oral skills, history, gardening, art, theatre, music and song, sport and nature excursions. While they are only suggestions, everyone should take the initiative to adapt them to the specific geographic and socio-economic situation encountered locally (characteristics of your natural and human environment, production systems, etc) and to the teacher's work schedule.

– Partnerships
It is recommended that before beginning a unit, partnerships be forged, thus providing input to enhance lessons (in class or outdoor activities). Teachers could invite fauna and flora specialists who could present the results of their research work. The participation of elders and parents is also recommended. Invite and involve families who may require information to consolidate their knowledge so they can become involved in existing or future development projects while sharing their experiences. Surprise your pupils by taking unexpected initiatives. They could prove productive!

– Glossary
Words or expressions underlined throughout the text are explained at the end of the guide.

The case studies (accompanying document)
The commitment by pupils to undertake small school projects is the challenge posed by the kit. By way of concrete and successful examples, the teacher can draw upon each of the case studies that comprise the compilation, which have all been carried out within the spirit of the United Nations Convention to Combat Desertification and conform to its objectives. The teacher may accompany classroom lessons on desertification by using these positive examples. Attentive reading of the case studies should provide the teacher with the required knowledge base in the field of combating desertification. They are intended to encourage children to adopt an environmentally friendly attitude towards the rare natural resources found in their region and their natural world. The global approach of this collection, presenting both the causes and consequences of desertification as well as the possible solutions in the different continents affected by desertification, aims to raise awareness among the pupils to the universal character of environmental problems. In addition, comparing methods employed by different people will help all those concerned to think globally, enlarging the horizons for each of them.

– Pratical activities
At the end of each case study *classroom activities* are proposed to help the teacher incorporate the case studies throughout the course. When discussing a particular project in class, the teacher could invite the children to respond by asking them to locate the country on the map and compare the situations to those featured in the study. Finally, tasks including drawing assignments, question and answer discussions and role-playing, could be assigned to complement the classroom activities.

– Glossary
The words underlined throughout the text are explained in the glossary at the end of the collection.

The cartoons (accompanying documents)
The two cartoons demonstrate that despite the seriousness of desertification, the subject can be approached in an attractive way that encourages fun. The cartoons are intended for the pupils.
The cartoon *There is No Rug Big Enough to Sweep the Desert Under* has been reprinted from a previous version produced within the framework of the First Conference of the Parties of the UNCCD held in Rome, Italy in 1997.
The cartoon *The School Where the Magic Tree Grows* is a loose adaptation of a case study carried out by a NGO 'JUNDEP' that set up a school nursery project to combat desertification in Chile.

The wall poster (accompanying document)
The poster is designed to visually present the different regions of the world affected by desertification. It also proposes several simple techniques to combat desertification.

1

The situation

General presentation of desertification

1


1

What is desertification?

OBJECTIVE: To introduce the phenomenon of desertification

Definition of desertification

Is Earth, our planet, losing its name? The earth is being degraded. According to estimates, 24 billion tons of fertile soil disappear annually and over the past 20 years, the surface area lost is equal to all of the farmland of the United States of America. Roughly one third of the world's land surface is threatened by desertification, or put in another way; desertification already affects one quarter of the total land surface of the globe today.

The United Nations Convention to Combat Desertification defines the term desertification as 'land degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities' (UNCCD Art.1.a). Desertification is a dynamic process that is observed in dry and fragile ecosystems. It affects terrestrial areas (topsoil, earth, groundwater reserves, surface run-off), animal and plant populations, as well as human settlements and their amenities (for instance, terraces and dams).

1. Dead trees in **India**.
© Carole Equer, UNESCO

2. Sahelian lands.
© UNESCO-MAB

3. Village close to Gao in **Mali**. The land surrounding populated areas is particularly degraded.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

4. Forest fires in the south-west of Bouaké in Côte d'Ivoire.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

The causes

The United Nations Convention to Combat Desertification adopted a definition of desertification that attributes the causes of this phenomenon to both climatic variations and human activities. It adds, 'desertification is caused by complex interactions among physical, biological, political, social, cultural and economic factors'.

Climatic variations: High and sustained temperatures lasting for months with infrequent and irregular rainfall, leads to drought with the effect that vegetation has difficulty growing. This natural phenomenon occurs when rainfall is less than the average recorded levels. As a result, severe hydrological imbalances jeopardize production systems.

Human activities: in countries where major economic resources are dependent on agricultural activities, there are few or no alternative sources of income. Soils become damaged through excessive use when farmers neglect or reduce fallow periods, necessary to sufficiently produce enough food to feed the population. This in turn causes soil to lose organic matter, limiting plant growth and reducing vegetation cover as a consequence. The bare soils are thus more vulnerable to the effects of erosion.

When violent winds and heavy downpours destroy the vegetation, which is then carried away by the sudden gushes of water, the harvests tend to be poorer and the livestock suffer, they eventually become malnourished. As a consequence, the income of the rural communities diminishes. According to the Convention, land degradation brings about a decline or an end to soil productivity, vegetation, arable and grazing lands, as well as forests. In the most extreme cases, hunger and poverty set in and become both the cause and consequence of land degradation.

Desertification is caused by the complex interactions between physical, biological, social, cultural and economic factors. Spontaneous or human induced bush and forest fires can severely degrade the environment.

1 What is desertification?

5. California in the **USA**: Coachella Valley, Mecca Hills. Desertification is a global phenomenon that affects every continent regardless of its level of economic development. In developed regions, such as California, eroded areas and land degradation are also found.

United action

Combating desertification requires a coherent and co-ordinated policy that brings together the means and know-how of all those involved. It is within this framework that governments around the world have developed the United Nations Convention to Combat Desertification (See Unit 14).

The Convention is an agreement between developed and developing countries on the need for a global team effort to address desertification. It includes specific national commitments for concrete action at the local level where the combat against desertification must primarily and vigourously be fought.

Actions to undertake to combat desertification

Combating desertification comprises activities that improve lands in arid, semi-arid and sub-humid areas with a view to sustainable development (See Unit 17). Objectives include:

- anticipating and/or limiting land degradation.
- repairing degraded land.
- raising awareness and informing those who are affected by the problems of desertification at all levels.
- improving the social context: combating poverty, improving education and health conditions, developing knowledge of sustainable management practices and natural resources, eradicating military conflicts that kill men and destroy the environment.

Classroom ACTIVITIES

The moment has arrived to begin your wall chart!

All the pupils are invited to participate in classroom activities: drawing, writing, collages etc.

They will be proposed throughout the desertification course and can be added to the desertification wall chart. Begin by tracing the contours of the world's continents on a large piece of blank paper (See world map on the desertification poster).

Each pupil writes on a separate piece of paper a word that symbolizes the desert. The pieces of paper are then folded and collected.

A pupil then selects one of them by chance and draws on the blackboard, in the form of a pictogram, the word corresponding to the desert. The class must guess the word.

Each pupil can begin his/her desertification notebook by writing down activities on combating desertification.

The pupils can also draw, paint and paste photos about their environment and on the desert in their notebook.

Ask the pupils to define desertification at the beginning of their notebook.

2


1


2

Where does desertification occur?

OBJECTIVE: To identify regions affected by desertification

Surface area of the world's drylands

Almost half of the terrestrial land surface, equal to 6.45 billion hectares, is made up of drylands (47% according to the *World Atlas of Desertification*, UNEP 1997). They are distributed among all the great regions of the planet.
One billion hectares is hyper-arid: these are real deserts such as the Sahara. 5.45 billion hectares are made up of arid, semi-arid and sub-humid areas. Desertification occurs in this part of the planet. These areas are inhabited by one fifth of the world's population or 1.2 billion inhabitants in the year 2000. It is here— where the soils are especially fragile, vegetation is sparse and the climate particularly unforgiving— that desertification takes place. (Land degradation occurs everywhere, but can only be defined as 'desertification' when it occurs in the drylands). Some 70% of the 5.2 billion hectares of drylands used for agriculture around the world are already degraded. Thus desertification now damages practically one quarter of the total land surface area of the world.

Characteristics of the drylands

The world's drylands are particularly affected by desertification.
On an environmental basis, these regions are defined by:

- low precipitation that is infrequent, irregular and unpredictable.
- large variations between day and night temperatures.
- soil that is poor in organic matter.
- lack of water for consumption.
- plants and animals adapted to climatic variables (heat resistance, lack of water).

The drylands are comprised of arid, semi-arid and sub-humid areas, the difference being in their degree of aridity. Aridity is the result of the interaction between various climatic factors (rain, temperature, wind) and evapo-transpiration. These elements combine together to determine the growth of plants and the capacities of animals or humans to live fittingly in a harsh natural environment.

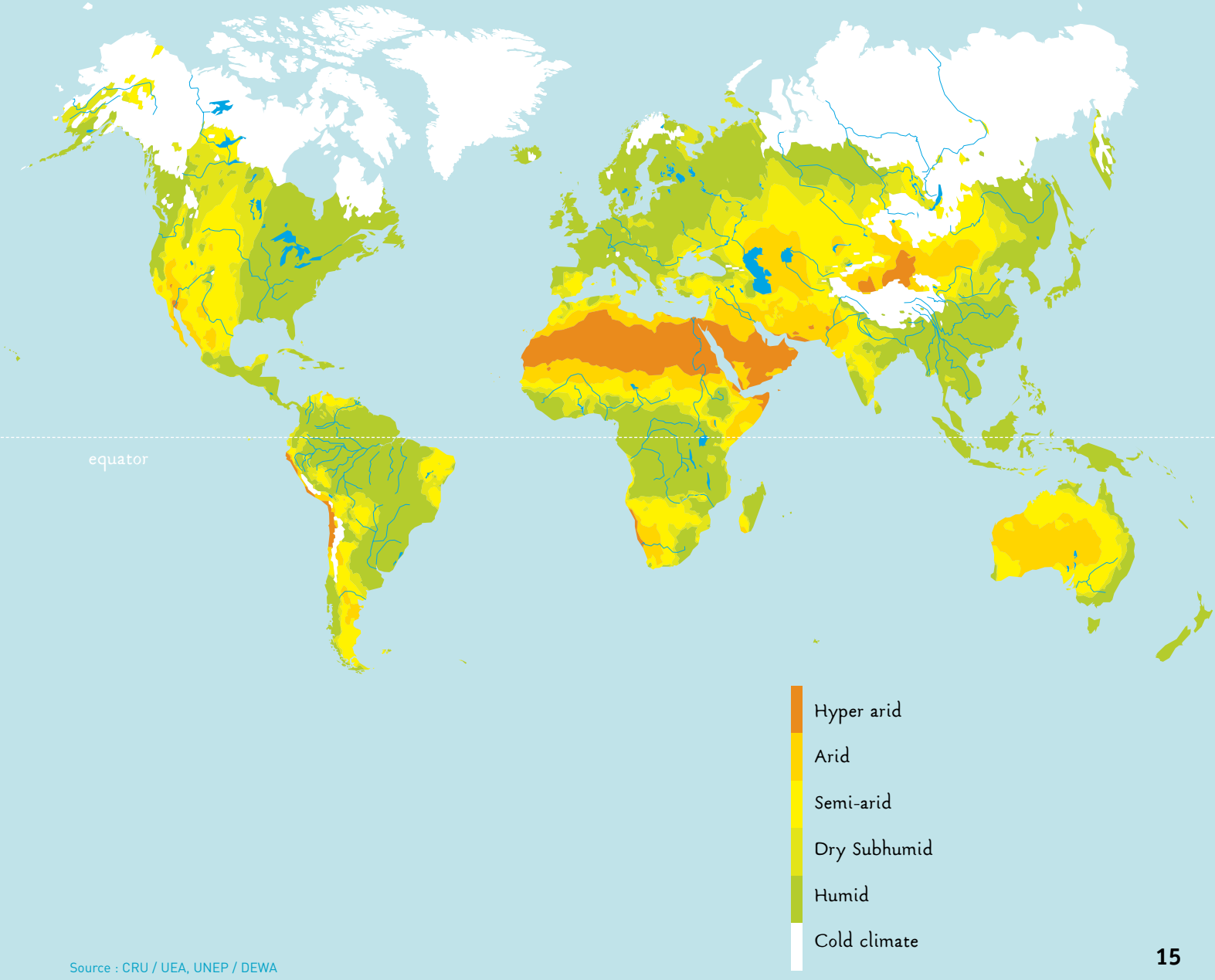
1. Gobi desert in **China**.
© Yazid Tizi

2. Sand dunes close to Ica in **Peru**.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

3. Kaokoland region in **Namibia**:
a general view of Himbas country.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

4. Nevada in the **USA**:
golf in the middle of the desert,
north of Las Vegas.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

World Map of Aridity Zones



Source : CRU / UEA, UNEP / DEWA

2 Where does desertification occur?

Different categories of drylands

There are four main categories that are distinguished by their temperatures and rain cycles.

- **Hyper-arid regions:** rainfall is less than 100 mm/year. Drought periods can last longer than a year. Biological productivity is low and the sole viable activity is nomadic pastoralism.
- **Arid regions:** generally rainfall does not exceed 200 mm/year. These regions are characterized by farming (sedentary or nomadic) and irrigated agriculture.
- **Semi-arid regions:** rainfall does not exceed 500 mm/year in areas of winter rains or 800 mm/year in areas of summer rains. These regions are characterized by cattle-rearing and sedentary agriculture.
- **Dry sub-humid regions:** rainfall cycles are highly seasonal. These regions are characterized by rain-fed agriculture. As with semi-arid regions, they are particularly vulnerable to the phenomenon of desertification due to pressure from the rising population.

These regions undergo the same processes of degradation as a result of natural resource over-exploitation and are all characterized by water shortages.

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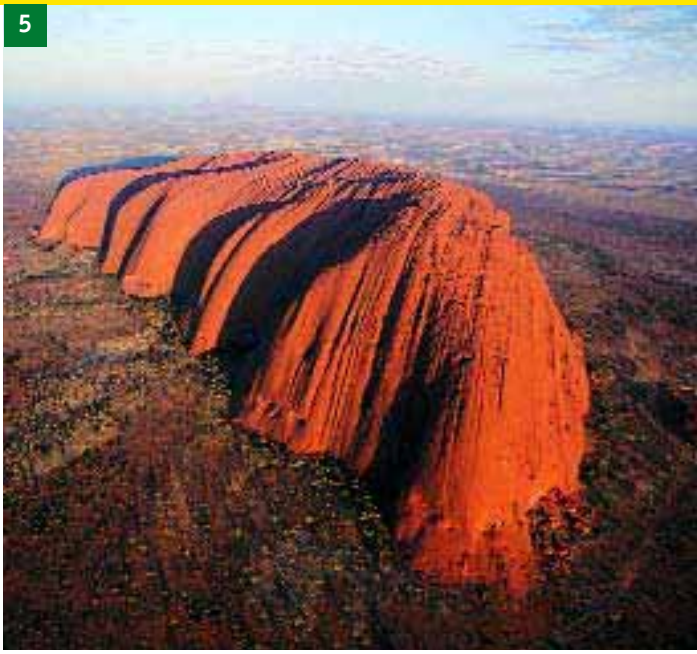


5. Ayers Rock Uluru in **Australia**: sand dunes.
© Yann Arthus-Bertrand *Earth from Above* / UNESCO

Desertification in the drylands

In all, more than 110 countries have drylands that are potentially at risk. In Africa, a billion hectares or 73% of its drylands are affected by desertification with another 1.4 billion hectares affected in Asia. But it is not just a problem for developing countries, in fact the continent that has the highest proportion of drylands subject to desertification is North America with 74% affected. Five countries of the European Union are also affected while many of the most affected areas are in the former Soviet Union.

Classroom ACTIVITIES

Locate your country and your region on the world map (See the poster).

Is your country located in a desertification zone?

Locate those countries that have arid zones and those that do not.

On the world map, colour the arid regions in yellow and write the names of the corresponding countries (or make and stick country flags on the map) in the desertification areas.

Colour the oceans in blue and the temperate zones in green.

What do you notice?

On a ball or a sphere made of paper maché, draw the continents and their deserts with a felt tip pen while respecting their dimensions.

Decorate the colourful globe by painting the ball and glue sand for the desert areas.

You could also use an orange or any round fruit to achieve the same effect.

Select 10 words that symbolize the desert.

Write a poem using these 10 words.

3

How does desertification occur?

2

OBJECTIVE: To explain the causes and factors that lead to desertification

1

Mato Grosso in **Brazil**: extensive deforestation to the north of Cacères © Yann Arthus-Bertrand *Earth from Above* / UNESCO

Over-exploitation of natural resources

Desertification is the accumulated result of ill-adapted land use and the effects of a harsh climate. Four human activities represent the most immediate causes: over-cultivation exhausts the soil, overgrazing removes the vegetation cover that protects it from erosion, deforestation destroys the trees that bind the soil to the land and poorly drained irrigation systems turn croplands salty. Moreover, the lack of education and knowledge, the movement of refugees in the case of war, the unfavourable trade conditions of developing countries and other socio-economic and political factors enhance the effects of desertification. The causes are multiple and interact in a complex manner.

3

2. Bush fires often have alarming and devastating effects on large planted areas. They are often started spontaneously but are occasionally started by people to improve visibility during hunting or to clear land for cultivation.
© Michel Le Berre

3. Overgrazing is one of the principal causes of desertification. When the herds are too numerous compared to the available vegetation, the vegetation is unable to regenerate.
© UNESCO-MAB

4. Katiola in the **Côte d'Ivoire**: diamond mines or precious metal open quarries are a cause of desertification. Large surfaces are cleared and turned upside down hundreds of metres into the ground. When the mines are then disaffected the environment is totally destroyed rendering land rehabilitation almost impossible.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

Due to the lack of alternative survival strategies, farmers tend to relentlessly exploit natural resources (food crops, water for drinking and washing, firewood) to the point that they are often over-exploited and cannot regenerate naturally. Soil nutrients and organic matter begin to diminish as intensive agriculture removes quantities of nutrients greater than the soil's natural regeneration capacities. As a consequence, the soil is unable to recover, as it does during fallow periods, resulting is an ever-increasing spiral of environmental degradation and poverty, the principal causes of desertification.

The principal causes exacerbating land degradation derives from the farmers' determination to maximize soil productivity, which include:

- crops cultivated in areas at high risk from drought.
- shortening of crop cycles and the reduction of fallow periods.
- insufficient use of fertilizer after harvesting.
- inadequate crop rotation or worse, monoculture.
- intensive labour.
- intense breeding and overgrazing with pressure on vegetation and soil trampling by livestock.
- separation of cattle rearing and agriculture, eliminating a source of natural fertilizer or organic matter (cattle dung) used to regenerate the soil.
- deforestation.
- bush and forest fires.
- in mountainous regions, crops are cultivated along the downward sloping face rather than following the natural contour lines of the mountain.
- deterioration of terraces and other soil and water conservation techniques.

4

3 How does desertification occur?

5. Deforestation is a major cause of desertification. In dry tropical zones, wood is the principal source of domestic energy and is also used in construction. In this way, large tracts of forest are destroyed. In the drylands, forest regeneration is very slow because of water scarcity.

Deforestation and energy

The use of firewood is one of the principal causes of desertification. In tropical arid areas, wood is the principal source of domestic energy for cooking and lighting both in rural and urban populations.
In order to limit the need for deforestation, only renewable sources of energy (hydraulic, wind, solar) and gas and petrol should be encouraged as it can replace wood consumption.
Due to the lack of water in the drylands, forest regeneration is very slow, reducing the dynamic growth of vegetation. However, allowing for rest periods from grazing and increasing fallow periods, generally have spectacular regenerating effects on the forest.

Population growth

Since the middle of the 20th century many countries have experienced significant population growth (a greater number of children are born while infant mortality decreases slightly, but also people tend to live longer). As a result, the rate of population growth is often high: between 2% and 3% a year, meaning that in certain countries, the population will double within the next 20 to 30 years and with it, a growing population to feed. The ensuing increase in agricultural pressure on land, with the added effect that the soil in the drylands is not given sufficient time to recover, leads to an eventual drop in productivity. Paradoxally, human intervention is required to regenerate degraded lands. People have both the ability to destroy the land and the capacity to restore and rehabilitate their environment.

Classroom ACTIVITIES

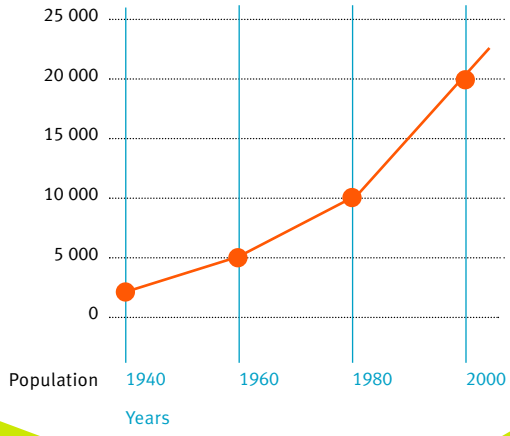
Ask your grandparents how many inhabitants there were in your village/town when they were your age. Find out how many people live in your village/town today.

On a piece of graph paper, draw a graph with the years shown along the horizontal axis and the size of the population shown along the vertical axis.

Show the evolution of the population in your village/town on the graph (See diagram).
Has the population increased or decreased? Why?

What are the environmental and economical consequences in your region?

A graphic example of population growth



Calculate the average number of children per family in your class.

Is the number more or less than the average number of children observed in your grandparents' generation?

What do you think are the reasons for the rise or fall of the population?

Ask your grandparents if there are more or less trees in your area today compared to the number of trees when they were your age.

Are deforestation activities taking place in your region? If so, why?

Is the wood needed for providing energy?

Are wooded areas cleared for agriculture?

In your view, what should be done to halt these activities?

Are there any alternatives?

4

Climate change and desertification

2

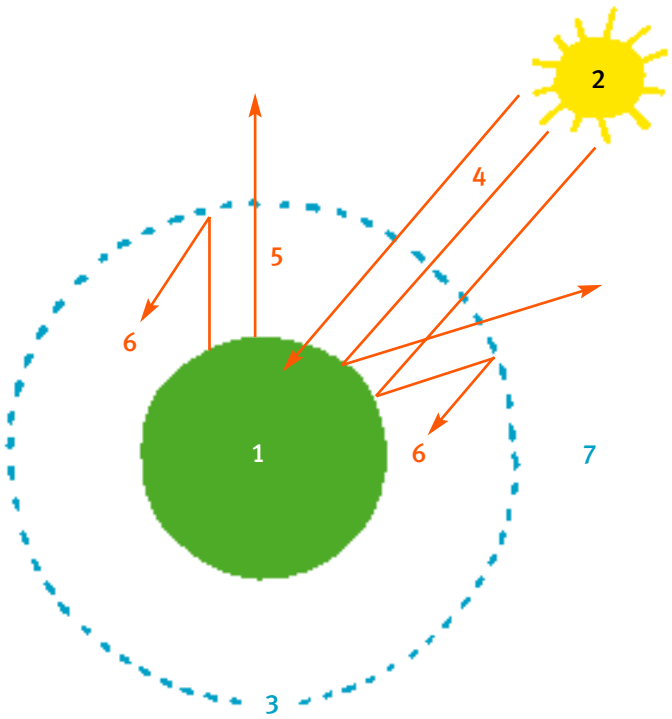
OBJECTIVE To introduce climatic change and its effects on desertification

1

The climate of the planet has changed over the course of history. Variations in arid and humid climates have been observed in most regions of the planet. Thus, a desert today, could have been a humid and fertile zone in the past and is still in the process of evolving. Moreover, today's forests originally developed from low-lying vegetation made up of grasses and shrubs. However, if man continues to over-exploit forest resources and influence the climat by gas emissions, who knows what will remain of the forests in the next few decades.

1. Region of Swakopmund in **Namibia**.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

2, 3, 4. Paintings of rhinoceros, giraffes and elephants on the cave wall in the Sahara. Several hundred thousand years ago the Saharan climate was hot and humid enabling elephants, giraffes and rhinoceros to roam in what today has become desert. Paintings can also be found in Tassili n'Ajjer in Algeria where the actual climate is now too dry for these animals.
© Michel Le Berre



The greenhouse effect:

Earth (1) receives thermal energy from the sun (2). Earth is surrounded by a gaseous layer, the atmosphere (3) protecting us from the ultraviolet rays from the sun. A portion of the energy is reflected by Earth and returns to the atmosphere (4,7). A portion is 'trapped' by the atmosphere and returns to Earth (6). Earth's radiation and thermic energy contributes to the heating of the atmosphere and as a consequence, the average temperature rises. Several gases contribute to the greenhouse effect (trapping energy): water vapour, carbonic gases or naturally occurring carbon dioxide (from plant and animal respiration), methane (from swamp fermentation, termite mounds and cattle-produced methane), nitrogen oxide, ozone, etc. These gases either occur naturally or come from human activity, principally from the combustion of fossil fuels (petrol, gas).

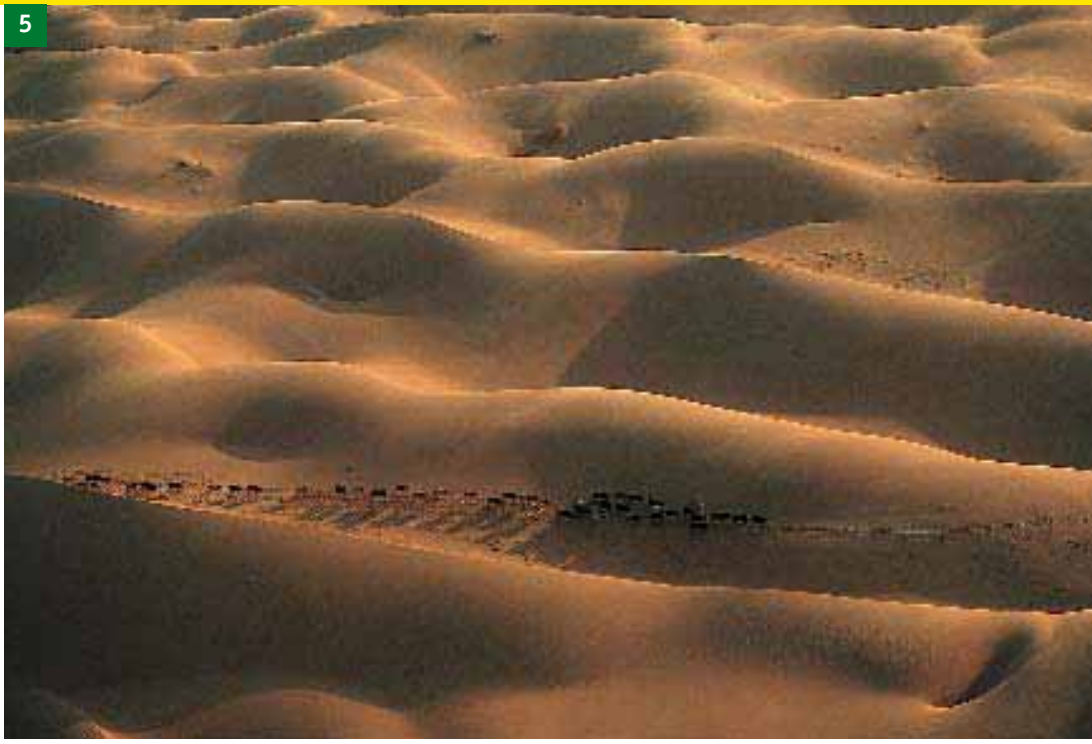
The evolution of climate

In arid regions, the observed climatic instability is an unpredictable and complex phenomenon mainly attributed to human activity and in particular to gas emissions, which seem to influence the global warming of the planet (a phenomenon known as the greenhouse effect).

The influence of man on climate change

The intensification of human activities, in part from petrol and coal combustion and also from firewood used for cooking, results in an ever-increasing quantity of greenhouse gases being released into the atmosphere (trapping energy). Other sources of gas include nitrogen-containing products used in intensive agriculture such as fertilizers.
La conséquence de l'augmentation de l'effet de serre est un réchauffement global de la planète.
Global warming is a consequence of the escalation of the greenhouse effect on the planet. A rise of a few degrees leads to the melting of snow at the poles and on mountain peaks, generating changes in climate that produce a rise in sea level (that threaten islands and low lying coastal regions). Storms and floods, variations in mean temperatures and changes in rain cycles and drought are additional pressures that can lead to famine and other catastrophes.

4 Climate change and desertification



5. Mauritania: cattle among the dunes close to Kiffa
Yann Arthus-Bertrand
Earth from Above / UNESCO

Global and regional variations in temperature at the ocean surface are directly linked to rain cycles. This is the case of the phenomenon known as 'El Niño' whose relentless and devastating rains affect the eastern coast of the Americas, Asia and even Africa.

The consequences of global warming in the drylands

During the course of the 20th Century, the average temperature has risen by between 0.3°C and 0.6°C. This is probably due to the effects of industrialization that has increased greenhouse gas emissions. Analysis of the consequences of this rise has led scientists to believe that temperatures in the drylands will rise by 2°C to 5°C every time the concentration of greenhouse gases doubles, a phenomenon expected to occur some time during the middle of the next century.

The general rise in temperature will predictably raise the rate of evapo-transpiration leading to a drop in soil humidity and an increase in the number of droughts.
The deterioration in the condition of topsoil, particularly in the drylands, is a consequence of temperature variations, rainfall and soil humidity that exacerbate the process of desertification.

However, it is very difficult to predict rainfall patterns for any given region under consideration. Another Convention, the *United Nations Framework Convention on Climate Change* adopted in 1992 is dedicated to finding solutions to global warming.

Classroom ACTIVITIES

Place a small low-lying plant (with its roots) inside a glass jar or a transparent plastic bag for a whole day.

What do you notice on the inside of the jar/bag?

Explain the phenomenon.

Does the sun shine brightly in your country?

Try this experiment: place a piece of metal, wood and plastic outdoors for a few hours.

What do you notice when you touch them? Be careful, they may be hot!

Try this several times during the year and at different times of the day.

Write down the results to learn and understand how much variation there is (or isn't) according to the climatic cycle in your country.

The wind is one factor that causes soil erosion.

Can you cite the principal names of the winds in your country?

If you can, indicate them on the world map, as well as their wind direction?

Repeat the experiment with a quantity of water in each receptacle or bowl made of the above mentioned materials.

Is there a difference in the temperature of the water?

Which receptacle absorbs more heat (and therefore energy)?

5

Man and the drylands

OBJECTIVE To discover how man has adapted to the drylands

1. The *Berkouchi* of Kazakhstan are nomads that hunt with trained and tamed eagles. © Yazid Tizi

It appears that the history of humanity began in Africa more than one million years ago. Successive periods of migration led progressively to the colonization of all Earth's regions, including the harsh and unforgiving areas that are the drylands.

The drylands, the cradle of civilizations

The drylands societies have developed traditional systems of territorial planning and management in order to benefit as much as possible from the diversity of available resources. In the various drylands, this has become a question of survival. Since the dawn of humanity, drylands have been significant centres of societal development. The drylands of the Middle East has been the cradle of pastoralism since Neolithic times and the centre of agricultural development. Drylands such as Mesopotamia, Egypt and the eastern Mediterranean demonstrate the earliest forms of urban civilization borne more than 8ooo years ago, and from which the notion of a centralized state developed. Up until very recently the drylands have also preserved cultures of hunters and gatherers such as populations of Australian aborigines and Boschimans from Southern Africa. These civilizations maintained their traditional lifestyles over a long period of time as they exercised only limited pressure on their environment.

2. The displacement of nomads enables the seasonal use of pastures. Traditional societies generally associate nomadism to pastoralism and transhumance. The herds are made up of animals adapted to drought conditions.
© UNESCO-MAB

3. Ksar of the Anti-Atlas in **Morocco**: over the course of the centuries, man has evolved in response to the harsh living conditions in the drylands by developing social and agricultural systems adapted to the environment.
© Michel Le Berre

Nomadism; a lifestyle adapted to the drylands

Nomads are herders who migrate throughout the year looking for watering holes and pasture for their animals in a way that allows them to utilize the limited resources of their environment over several weeks or months.

Traditional nomadic societies are generally associated with pastoralism or transhumance. Herds are made up of animals that are adapted to the drylands: dromedaries, camels, goats, sheep, horses, donkeys, cows, llamas, alpaca, etc. These animals, who can endure thirst for several days, are unaffected by adverse and variable temperatures and do not need shelter against the wind or bad weather. Certain among them can also transform vegetation of low nutritive value (straw from grasses) into meat and milk and can store fat reserves in their tail or back.

They are used for the transport of goods, labour, the functioning of mills and norias and for the production of milk, meat and wool. They are also used to create craft goods from leather, wool, bone, fat, etc. Nomads also cultivate land and set up small cultivation plots in hospitable areas. In pre-Saharan areas they generally sow barley while in Central Asia, millet and watermelon are grown.

4. Camel caravans at Nouakchott in **Mauritania**: pastoral nomadism provides the populations with an effective means to manage natural resources in the drylands. The caravan, a characteristic of all drylands and in particular in Africa and Asia, is at the origin of the great commercial exchange routes that are known as the Silk Road in Asia and the Trans-Saharan route in Africa.
© Yann Arthus-Bertrand *Earth from Above* / UNESCO

5 Man and the drylands

5. Wells between Kidal and Timbuctoo in Mali: in the drylands, good natural resource management, particularly water, is a question of survival. Here, in the drylands, the nomads assemble together with their herds around the well © Yann Arthus-Bertrand *Earth from Above* /UNESCO

Nomadic knowledge and the development of commerce

Several nomadic societies have developed an important economic activity at a time when sedentary nomads were still farmers. This is particularly the case in northern Africa, the Mediterranean basin and Asia where nomadic pastoralism provided the population with resource management skills, important in the drylands and acquired through their ability to migrate to hostile areas. Their knowledge of geography and the workings of the natural environment allowed them to diversify their resources.
The caravan originates from the drylands and is characteristic of arid areas, particularly in Africa and Asia.
This commercial activity created the great exchange routes that became the Silk Road (linking South East Asia and the Mediterranean basin in Europe) and the Trans-Saharan route in Africa.

Classroom ACTIVITIES

Imagine you are invited to visit a nomadic population. One of the children would like you to drive his herd.

Which animals would you take with you for two weeks and with very little water?

Make small paper cut-out walking figures to represent nomadic populations and sitting figures to represent sedentary populations and paste them to the world map in those areas where they are present.

Are there nomadic populations that live in your country?

What are the names of these populations?

Do you know how they live and the type of animals they rear?

Describe their way of life in your notebook. Estimate the distance covered by these nomadic populations.

Underline the following correct phrases:

- The opposite of a nomadic population is a sedentary population.
- Nomads are only found in Africa.
- Dromedaries, camels and alpacas are examples of the types of animals reared by nomads.
- The history of the Earth began in Europe.
- Nomads exercise limited pressure on their environment.

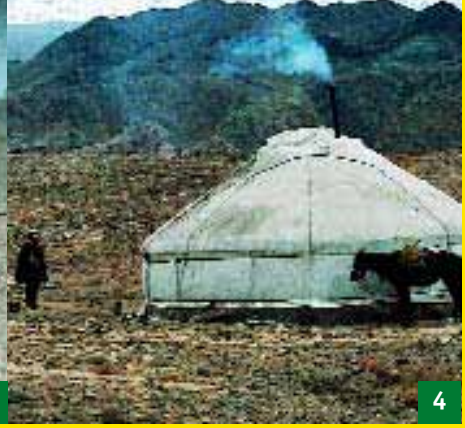
6

2

Dwellings of the drylands

OBJECTIVE To introduce the different types of dwellings adapted to drylands

1



1. Marsabit district in **Kenya**: nomadic dwellings constructed from animal skins.
© UNESCO-MAB

2. Terraced roofs in Mzab: urban dwellings in the **Algerian Sahara**.
© Michel Le Berre

3. **Kenya**: a mobile home, structure of a zareba.
© Gisbert Glaser

4. The yourt, unchanged for centuries, can be set up in less than an hour. Thick layers of felt cover its willow structure, it still shelters nomadic **Kazakh** shepherds today.
© Gilles Santantonio

Different types of dwellings in the drylands

In the majority of drylands, masons and architects have developed a know-how that allows them to utilize local resources in a sustainable way while providing comfort. The dryland dwelling must meet the constraints imposed by the climate. For instance, by preventing a rise in room temperature during the day while conserving heat at night, the occupants are assured a certain comfort. Other considerations include wind and dust resistance.
Two distinct dwelling types exist depending on whether sedentary or nomadic lifestyles are practiced. In some cases, both can be observed within the same population, for example, the Tuaregs Ajjer of central Sahara live under canvas during certain periods and in stone huts with thatched roofs at other times.

Six major categories of dwellings can be observed:

The urban dwelling

The urban dwelling, in sculpted stone or earth (toub, pisé), is generally made up of small clusters of huts. Due to irregular rainfall, the terraced roof is often preferred, providing additional space for drying certain products (fruits, grains) and for its ventilation. In certain regions, it is possible to find windmills that help facilitate the circulation of air to provide natural ventilation. Dwellings made of earth ie. rammed earth or clay for walls or floors as with pisé, are ill adapted to the torrential rains, which can destroy entire villages.

Oasis dwelling

Scattered throughout the oasis, thereby facilitating access to work and the surveillance of possessions, the oasis dwelling is more commonly found in Northern Africa and the Middle East.
The dwellings are most frequently of the patio type. Rather small rooms surround the courtyard that is both a space for recreation and a work area, so as to perform such tasks as weaving. The rooms shelter both the family unit and domestic animals.

The domed roof dwelling

This type of dwelling is more commonly found in the Sahara and the Middle East. The dome is made by assembling toub or stone bricks, reducing the use of wood that is particularly slow growing in the drylands. The dwellings' spiral form plays an important role in their ventilation by increasing air volume while minimising the surface area exposed to the sun. It is possible to amplify this effect by rough-casting the outer wall that reflects light while keeping the inner wall free of casing. Warm air rises and escapes to the outside due to the porous nature of the walls.

6 Dwellings of the drylands

The underground dwelling

In the quest for lower temperatures, some sedentary populations have been driven to move into caves or dug outs carved from the earth. In this way, they benefit from the insulating effect of the earth that guarantees homogenous temperatures throughout the year (See the case study from Italy).
The troglodytic dwelling existed in China and Turkey thousands of years ago.

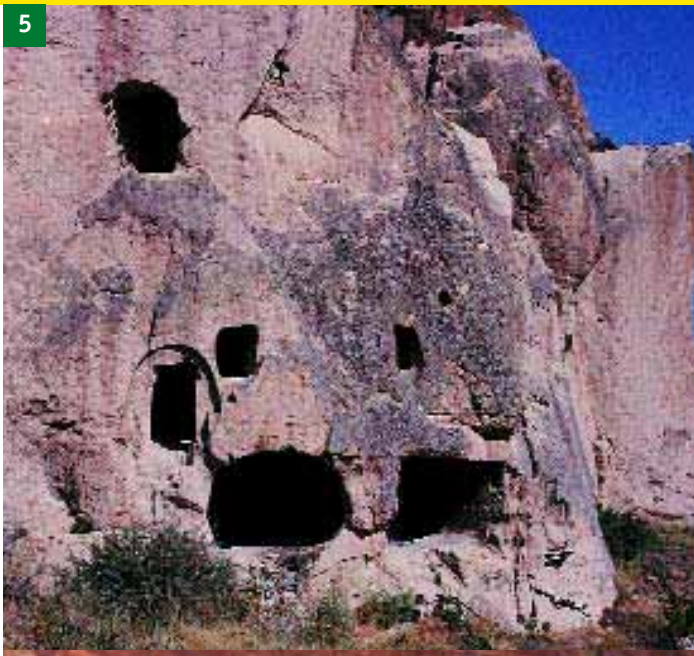
Tents and yourts

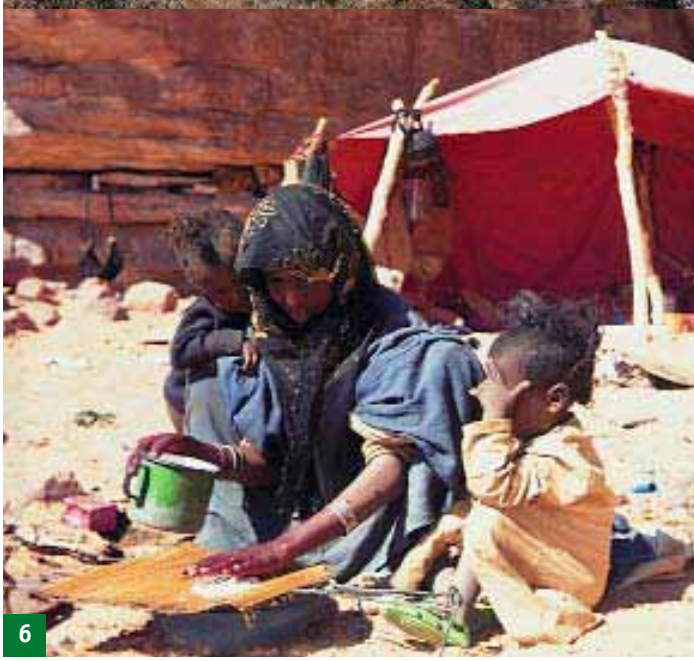
Characteristic of nomadic dwellings, tents are generally textile-based constructions. Depending on the region, they may be made of woven fabric, wool or goat's fur, as with tents found in the Middle East or made with felt or animal skins, typically used in Central Asia. Tents and yourts are stable, solid dwellings that are easy to set up with each move or relocation. Their heavy weight necessitates the use of powerful traction animals such as camels and dromedaries.
For populations living in tents, the herd is not surprisingly the primary source of fuel as well as raw materials for the dwelling.

Zareba and leafy shelters

Of diverse forms, pleated or boarded, the fragile constructions made of vegetation can be found throughout most of the world's drylands. It may comprise a principal dwelling for one of the transhumance sites or an additional volume close to the solid construction. In certain regions, these matted constructions are easily taken apart and can be easily relocated with each settlement. An intermediate dwelling between a tent and a hut is thus obtained.

5





6

5. Cappadoce in **Turkey**: underground dwellings or troglodytics.

6. **Algerian Sahara**: a mobile home, a family tent of the Tuaregs.

Classroom ACTIVITIES

In your notebook, draw and colour examples of traditional houses in your village/town that are adapted to combat heat and drought conditions.

Explain how these adaptations improve the comfort for the habitants.

Draw on a piece of paper a dwelling that you would like to live in and paste it to your notebook.

Explain the reasons behind your choice.

What clever tricks are used in your house to combat heat, wind and dust?

Describe them to your classmates and compare them, maybe certain adaptations can be used in your home.

Underline the following correct phrases:

In the drylands, traditional dwellings include:

- builidings with several floors (levels).
- low level buildings made from sculpted stone or earth.
- tents and yourts.
- igloos.
- houses with swimming pools.
- zarebas and other leafy shelters.
- shelters made from metal sheets.

Construct models of houses made from cardboard, straw or clay?

Which house is more resistant to rain? Which house is more wind resistant?

7


1


2

Water resources

OBJECTIVE To understand the importance of water in the drylands

The world's water

Water quality and the availability of freshwater resources are two of the major environmental issues confronting humanity today. In a way, they can be considered as the single most important issue since water related problems affect the lives of several million people. In the coming years, difficulties relating to water shortages will effectively concern everyone and enormous sums of money will have to be invested in water management. Despite this effort, it will be difficult to improve the situation of 33% of the total world population who do not have access to water, and some 50% of whom lack basic sanitary conditions.
This 'hydric stress' already affects 1.7 billion individuals and could affect 5 billion individuals by 2025. Floods and drought kill more people and create more environment damage than any other form of natural catastrophe. The international community is currently combining efforts to improve water management and distribution around the world to ensure a secure future for those populations threatened by the scarcity of freshwater.

The water cycle

Water is a natural resource vital to plant, animal and human life. All life is impossible without it as it regulates the metabolism of every living organism. 70% of the world's surface is covered with water but only 3% is freshwater of which 79% is in the form of polar ice and 20% exists as inaccessible underground sources. Only 1% is easily available from rivers, lakes and wells.
Under the impact of solar energy, water in lakes and oceans evaporates to the atmosphere in the form of water vapour. When the temperature drops, water vapour condenses and forms clouds, if the temperature drops still further, then the water contained in the clouds falls to earth as rain. Surface water in lakes, rivers and underground reserves originate from this rainfall. Surface or underground water sources finally rejoin the seas and oceans, thereby completing the cycle.

3

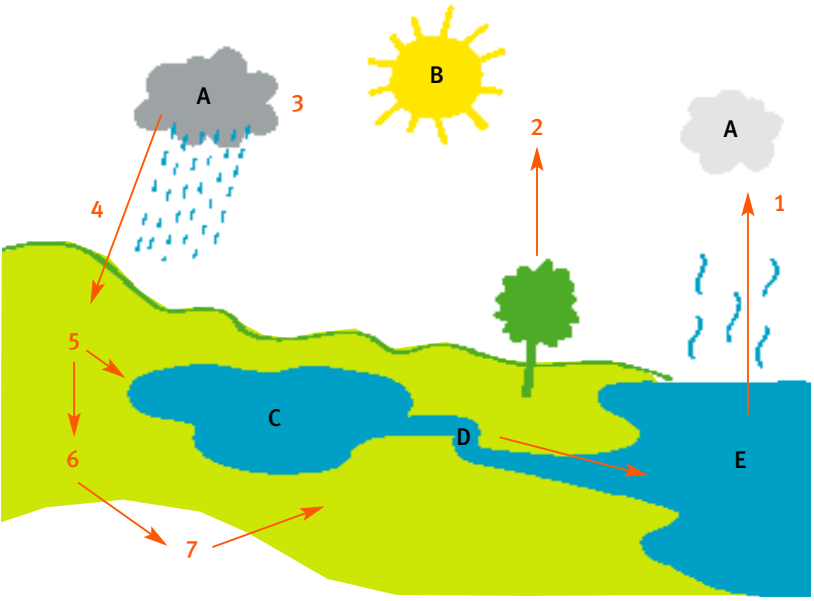
4

1. In the drylands more than anywhere else, water avalibility determines domestic living conditions as well as the development of pastoralism and agriculture.
© UNESCO-MAB

2. Good water management is vital to combat desertification.
In order to prevent water loss by evaporation, water should be given directly to the plant.
© Pleyton Johnson, FAO

3. Problems linked to water shortages, affecting 1.7 billion people already, could affect 5 billion people in 2025.
© Gisbert Glaser

4. Drylands are characterised by extreme evaporation and therefore surface water is extremely rare. People have to resort to different means to access underground reservoirs.
© UNESCO-MAB



A • clouds
B • sun
C • lake
D • rivière
E • ocean
F • trees

1 • evaporation
2 • transpiration
3 • condensation
4 • precipitation
5 • run-off
6 • percolation
7 • underground drainage

Water management

Water availability influences domestic life as well as the development of pastoralism or certain agricultural techniques. In drylands more than anywhere else, the availability of water is a vital requirement. These areas are characterized by a high rate of evaporation, and surface waters (rivers, lakes) generally tended to disappear relatively quickly. People therefore had to develop different ways to access underground sources (aquifers) to re-route the flow toward areas that require it, particularly the oases. Rainwater penetrates the earth as it flows and replenishes the underground reserves, the presence of trees, bushes and other plants help limit water loss (run-off).

People have invented diverse solutions to access, use and distribute water; they include the following:

- the collect and storage of rain water: impluvium; watertanks (See the case study from Italy).
- the transport of water by constructing canals or by digging galleries: foggaras or qanat; inclined galleries which drain and channel run-off and underground reserves along several kilometres, the water is then distributed through a system of canals and basins (See the case study from Algeria).
- the digging of wells to access underground water: pendulum wells and noria, systems using animal traction to raise water.
- irrigation by sprinkling: the fine droplets allow water to be more easily taken up by plants; drop by drop, water is delivered directly to the plant by irrigation canals.
- the setting up of water tribunals or assemblies that co-ordinate the use and distribution of water (See the case study from Algeria).

7 Water ressources

5. Douguia in **Chad**: a water pump at a local school. In certain regions of the world, freshwater is abundant and is consumed in large quantities, however, in other regions, the slighest water drop is treated as precious.

Differing water consumptions

Due to human activities, water use is continually rising and varies considerably in different countries according to lifestyles and water availability:

• Industrialized countries use on average 300 litres/per person/day, according to their lifestyle

Australia:	1430 l/pp/d
Ireland:	142 l/pp/d

• Developing countries consume a lot less water, between 10 to 30 litres/pp/day

Madagascar:	36 l/pp/d
Somalia:	8 l/pp/d

Water scarcity and poor water quality threatens public health, food and energy production and the regional economy.
It is estimated that 40% of the world's population (80 countries) suffer water shortages. In the drylands, pratically all water reserves are utilized and are often threatened with dessication or pollution.

Water for consumption

To be fit for consumption (potable), water should be transparent, should not contain soil/earth or silt in suspension and should not be polluted. Pollution has diverse origins: chemical substances (salts, metals, diverse minerals), agricultural and human waste (fertilizer, pesticides, manure, dung, washing water), bacteria, diverse larvae, etc.
Water can also be an agent for the spread of numerous diseases such as typhoid, poliomyelitis, dysentery and cholera.
In hot countries where high temperatures encourage germ proliferation, it is recommended to boil water to kill germs, rendering it fit for drinking and food preparation. The inaccessibilty and scarcity of potable water are important causes of mortality in developing countries: less than 50% of the population have ready access to potable water. Diseases related to water quality account for the death of almost 13 million people a year of which 5 million children die every year from dysentery.

Classroom ACTIVITIES

Water relay:

the class divides up into several teams. Each team receives a receptacle filled to the top with water. The receptacle should be of the same size.

One after the other, your team-mates have to carry the receptacle across a predefined obstacle course, spilling as little as possible.

The team who has spilled the least is pronounced the winner.

Do you know of ways to save water, maybe at home? Describe the techniques and add them to your notebook, then share them with your classmates.

The best of them will be noted on a sheet of paper and pasted to the wall chart.

Place several large receptacles outdoors to collect water during the rainy season. Measure the quantity of rainwater daily.

What do you think the rainwater could be used for?

Discuss this in class.

Set up a water assembly in your class. Designate roles among yourselves, some will play the role of the villagers, others could be the water deciders.

The water 'master' calculates the daily consumption of water for drinking, washing, cleaning, gardening etc.

The different actors devise together techniques for reducing water consumption.

Measure the quantity of water used in your home on a daily basis. Ask one of your parents to help you.

Compare your results with those of your classmates.

8

Plants


2


3

OBJECTIVE To understand how vegetation is adapted to heat and water shortage


1

1. The so-called Brush lily, with its characteristic form that corresponds to its reproduction cycle, is highly toxic, particularly for cattle. Its scientific name, *Boophane haemanthoides*, comes from boos, which means beef and phonos meaning to kill. The cricket *Dictyophorus spumans* absorbs the plant toxins that help protect it from predators. Its black carapace, trimmed with red and orange, warns predators of its toxic qualities.

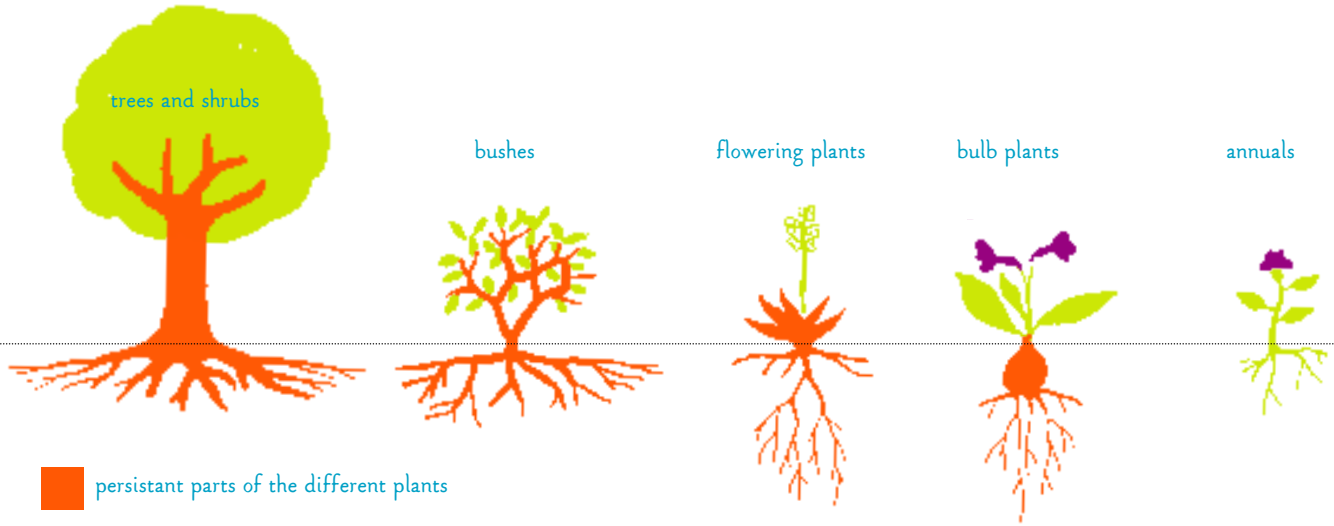
Plant adaptations to drought

It is known that living organisms have evolved throughout the course of Earth's history. The processes of evolution enable animals and plants to adapt progressively to their environment. In this way, animals from cold regions possess fur or thick plumage while animals from hot regions possess close-cropped fur and long legs, to distance their body from ground surface heat.
Moreover, vegetation in drylands present characteristics acquired over time that allows them to survive high temperatures and water shortages. To prevent dessication and therefore save water, the vegetation has reduced the number and surface area of leaves, which develop into scales or thorns. The loss of leaves during the hot and dry season also helps to save water.
They orient their leaves towards the shade, develop rounded or padded forms and stock water in specific organs such as thickened stems (fleshy, succulent plants, cacti) and oversized trunks (baobabs).
Such plants optimize water absorbtion by spreading out their roots horizontally over a large area below the plant or by driving their roots deep into groundwater reserves (See diagram).

2. 3. 4. 7. Succulent plants such as Cacti and euphorbias contain water reserves in their thick stalks, leaves and trunks.
© Jean-Michel Battin

5. Vegetation prevents soil erosion because of their developed roots that bind the earth. Cacti stabilize fragile soils.
© UNESCO-MAB

6. Bolivia: halophytes growing on salt-rich soils, they are particularly tolerant to high salt concentrations.
© Yazid Tizi



Only halophytes (salt-tolerant plants) develop in certain soils of the drylands where they contain a high salt content (salinity).

Plants protect themselves from herbivores in two ways:

- by transforming certain organs into thorns that ward off herbivores.
  This is the case of cacti, euphorbias and acacia thorns etc.
- by producing toxic substances (molecules): when giraffes chew on acacia leaves, the tree produces poisons that disturb the animal. The giraffe soon learns not to graze on the tree for too long.
  The majority of euphorbias are so toxic that they are not at all grazed by herbivores.

Types of plant formations and ecosystems

Depending on the climate and soil type, various groups of plants develop concurrently to form living communities that are the basis of terrestrial ecosystems. The phenomenon of desertification limits vegetation cover to a single level.
In drylands, six major types of plant formations are observed:

1. lichen forms that develop in coastal drylands.

2. the formation of fleshy or succulent plants (cacti, euphorbias, senecios).

3. shrubland steppes with discontinuous cover.

4. herbaceous savannah with open spaces where grasses predominate.

5. the shrub bushland (shrub, mallee, catinga) where plants often possess thorns.

6. dry forests with tall trees that shed leaves during the dry season.

7

Cacti

Cacti are plants that are characteristic of the arid environment. Originating from drylands in the Americas, they are found from the United States of America through Central America to Chile. Cacti, whose thorns replace leaves to limit evaporation, help combat desertification by providing structure to the soil with their roots. The fruits and branches of certain cacti (prickly pear) are fit for human and domestic animal consumption (See the case study from Ecuador). In Africa, euphorbias have developed similar adaptation strategies to drought. When animal or plant species, which are geographically distant and/or belong to different families, evolve in a similar way due to comparable environmental pressures, evolutionary convergence is said to occur. Euphorbias and cacti are a good example of this type of evolutionary convergence.

Classroom ACTIVITIES

Which plants characterize the arid environment in your region?

Which plants characterize other arid regions?

Are there any similarities in plant type?

Paste photos or pictures of these plants on the wall chart.

Place several of these plants in plastic pots (Only select plants that are abundant in your area). Calculate the quantity of water needed for watering. Do certain plants need more water than others to grow?

Why do you think this is so?

Which of the following plants have adapted to aridity over the course of evolution:

- cacti
- hyancinths
- orchids
- euphorbias
- palms
- baobabs
- water lilies
- ferns
- bamboo
- eucalyptus

Which tree plays an important economic role in your region?

Describe the tree and all its possible uses.

Identify a tree that you recognize well. Visit it regularly and keep a check on it. If needs be, water it occasionally, add some compost, etc.

Do you see any improvement in the condition of the tree over days, weeks?

9

2

3

Fauna

OBJECTIVE To understand the adaptations of animals to drylands

1

4

5

1. Like cameleons, the agama lizard can rapidly change its colour, from dull to iridescent.
© Jean-Michel Battin

2. Dromedaries are vital in the drylands; they hardly drink, they can travel very long distances and they can carry heavy loads. The females provide milk.
© Michel Le Berre

3. Thanks to its long neck, the giraffe can reach the highest branches to feed.
© UNESCO-MAB

4. National Park of Langebaan in **South Africa**: ostriches possess long legs that distance their body from ground surface heat.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

5. The chameleon can move around unnoticed thanks to its ability to change colour, depending on its environment.
© Amélie Dupuy

Some adaptations by animals in arid environments

In the drylands, animals, like plants, are confronted with two major problems: resistance to extreme heat and the lack or absence of water. While heat and drought are factors that limit the development of animal populations, maintaining animal populations in the drylands is linked to physical adaptations (morphology, physiology and behaviour) that compensate for the negative effects of these factors.

Adaptations that reduce the effects of heat

The majority of animal species (invertebrates, reptiles, rodents, sloths etc.) live at ground level where temperatures are at their highest. Here, temperatures can reach 57°C yet animals cannot survive temperatures beyond 42°C, so how do they protect themselves? Certain animals resist heat constraints by adaptation and evolution:

- The surface of their paws is greater, which helps them walk on shifting sands (the very large hooves of the addax antilopes are well adapted to walking on sand).
- Cushions and hairy paw pads isolate them from the heat (jerboas, hares). In arid areas, the large variability in soil texture coupled with high temperatures render movement difficult. Certain species have developed furry cushioned soles isolating them from the heat. Certain lizards possess enlarged scales the length of their digits to prevent them from sinking into the fine, dry sand.

© Michel Le Berre

- Their ears are elongated to help dissipate heat and act as a fan (fennecs, elephants, desert hedgehogs) as well as their long legs that distance their body from the ground (ostrich, antelope).
- They sweat to reduce body temperature by cooling the animal. Transpiration is the only physiological way to reduce heat that is known to humans and certain mammals.
- They stock food reserves as fat in certain parts of their body (the hump of the dromedary, zebu, sheep's tail). These reserves are transformed into energy and/or water during periods of drought. In this way, a dromedary can go without water for a week.

- Their behaviour enables them to isolate themselves from heat and limit evaporation. They remain in the shade or bury themselves in the ground (snakes) where thermal conditions are more favourable.
- They orientate their body according to the sun to either heat up or cool down (crickets).
- They forage at night or at dusk (rodents).

Compenstating for water scarcity

During the dry season in the drylands, vertebrates can lose up to 30% of their body weight in water (dromedary, rodent) and amphibians, from 40% to 50% (frogs, toads etc.). Certain species compensate for this by reducing evaporation (thanks to their waterproof skin) and the loss of water by excretion: urine is very concentrated and their faecal matter is dry, as seen in jerboas for instance. They also recuperate water from night mists and from the humid walls of their burrows. Certain species survive without having to drink on a daily basis (moufflons, dromedaries and goats) while others can transform starch found in grain into water (rodents).

All these adaptations enable animals to live in the hostile arid environment and are characterized by genetically inherited features acquired over a long period of evolution. Their co-existence with other animal and plant species provides an important balanced ecosystem that maintains life in the drylands and is a valuable resource to the populations that depend on them. The conservation of these organisms is thus of vital importance and a valuable asset to the development of these particular regions.

6

7

6. Young *Kobus kob kob* antelope.
Throughout Sub-Saharan Africa, different species of antelope are appreciated by hunters for their 'bushmeat'. However, their relentless hunting threatens the well-being of the population.
© Amélie Dupuy

7. Frog adapted to drought (*Hyperolius nitidulus*).
During the dry season, the frog changes colour becoming white in order to reflect light, heat and to conserve humidity. © Amélie Dupuy

Classroom ACTIVITIES

Choose 5 animals found in your region. Observe them if you can and find out as much information as possible about them, in books or by asking older members of your family.

Make 5 animal identity cards that describe their characteristics: family group, species, geographic location, behavioural and physical characteristics etc.

Organize a miming game using the above identity cards. Mimic an animal by imitating certain adaptations to heat, water shortage (behaviour, specificity of limbs, etc.)

The class must guess the animal.

Which of the following animals have developed adaptations to heat to over the course of evolution:

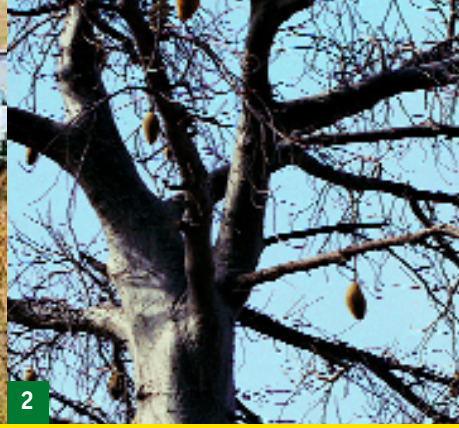
- frogs
- dromedaries
- ostriches
- horses
- chameleons
- fish
- dogs
- snakes
- elephants
- antelopes

Draw an imaginary animal that possesses all the characteristics necessary to resist heat and drought.

Give it a name and present it to the class.

10

1



2

Biological Diversity

OBJECTIVE To explain the roles of biological diversity or the diversity of life forms

What is biological diversity?

During the United Nations Conference on Environment and Development, commonly known as the 'Earth Summit' (Rio, June 1992), the international community elaborated the Convention of Biological Diversity. Biological diversity or biodiversity refers to the variety and variability of plants, animals and micro-organisms living on Earth. It is a recent concept used to describe the different expressions of life forms and includes multiple biological, ecological and economical considerations. Biodiversity includes genetic, species and ecosystem or habitat diversity.

The importance of biodiversity

Biodiversity contributes ecological goods that are indispensable to life on Earth such as oxygen production, water and nutrient cycling, waste assimilation, water and air cleansing and climate regulation. Furthermore, biodiversity provides a formidable stock of raw materials necessary for the development of food, medicine, science and technology. Thus it is of utmost importance to conserve biodiversity for both present and future generations. Human intervention has resulted in the loss of biodiversity, species extinction and the decline of genetic capital. These pressures are linked to human population growth, industrial development and the over-exploitation of natural resources that all contribute in accelerating environmental turmoil on a global scale.

The role of biodiversity in the drylands

The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and increasingly by the influence of humans. It forms the very web of life of which we are an integral part and upon which we so fully depend. More than anywhere else, societies in the drylands depend on the use of biodiversity for their daily needs and their economic and spiritual development. The greater the variety of resources at their disposal, the greater their capacity to survive climatic difficulties and the uncertainties of the environment.

1. Wildlife is a very lucrative market as tourists are ready to pay a lot of money to observe animals in the wild.
© Thomas Schaaf

2. Many plant species such as the baobab, are both a source of food, medicinal plants and fibres as well as firewood.
© Michel Le Berre

3. The co-existence of plants and animals adapted to their ecosystem is the basis for biological equilibrium.

4. Lichens, composed of an alga and a fungus. They are indicators of a pollution-free environment.
© Amélie Dupuy

5. **South Africa**: *Aloe dichtoma*. The variety of shapes and colours found in the wild are the result of millions of years of evolution, contributing to biodiversity richness.
© Jean-Michel Battin

Desertification threatens biological diversity

Land degradation transforms fertile soils into deserts that are no longer fit for cultivation. Organisms that cannot adapt to such hostile conditions do not survive, even though it is important to conserve a large diversity of species to guarantee a stable arid ecosystem. Survival adaptations of animals and plants in the drylands are determined by genetic characteristics that have evolved over the centuries. However, the rapidity of the desertification process means that organisms cannot adapt quickly enough to these sudden changes and therefore risk disappearing from these regions.

The co-existence of plants and animals, which are adapted to their environment, is at the heart of a balanced ecosystem, providing the life-supporting conditions in the drylands. Local populations use and depend on these essential resources to live.

10 Biological Diversity

6. Bouaké market in **Côte d'Ivoire** : by conserving biodiversity, populations assure the necessary resources for a balanced and healthy diet.
© Amélie Dupuy

7. In the drylands, trees and shrubs represent up to 50 % of cattle fodder during the dry season, but only 5 % during the humid season.
© UNESCO-MAB

Biodiversity, cultural richness and identity

Many wild species participate in the cultural life of local dryland populations, for instance, by providing elements used for jewellery or corporal decoration. Biodiversity also includes the numerous medicinal plants and other natural resources whose virtues are passed on from one generation to another. On a spiritual level, certain species play an important role as totems or mythical tribal ancestors. The fact that Tuaregs employ one hundred words to describe dromedaries (according to its age, sex, colour, physical form, origin etc) attests to their importance.

What is endemism?

A species is said to be endemic when it is found only in one place or specific region. The rate of endemism indicates that certain world regions are unique for their fauna and flora and represent particularly valuable conservation areas. However, due to the complexity of these ecosystems, these centres of endemism are often under threat from foreign species that risk spreading dangerously and threaten the local equilibrium. The rate of endemism varies between 10% to 25% in the drylands while islands tend to have a higher rate of endemism due to their isolation. In Madagascar, 70% of plants are endemic and in Australia, more than 90% are endemic plants. Lemurs, small primates found only in Madagascar, are endemic to Madagascar. The addax antelope is endemic to Sahara.

Classroom ACTIVITIES

Compile a list of all the animals you know that are found in your region.

Make a sculpture in papier mâché of your favourite animal of the drylands.

Which animal is linked to your daily life and/or the wealth of your culture?

Why is it important?

Is there a plant or animal in your country that is associated with a local legend or myth?

Ask the older members of your community.

Is it possible for your teacher/school to organize an excursion close to your school so that you can observe local animals closely?

Is it easy to identify an endemic plant or animal in your region?

Underline the following correct phrases:

- lemurs are endemic to Madagascar.
- cameleons are endemic to Chad.
- addax antelope are endemic to Central Europe.
- kangaroos are endemic to Australia.
- pineapple is endemic to Latin America.

Identify a plant or animal that is protected by law in your country.

11

Environmental consequences of desertification

OBJECTIVE To introduce the physical and biological consequences of desertification

1

Human activities in the drylands, together with climatic factors and drought conditions, influence changes in the natural environment and its productivity. In return, these changes bear consequences on human populations and the quality of life.

Soils erode or disappear

This precious covering, the very flesh of the planet, is painfully slow to form and can be destroyed terrifyingly fast. Just a thin layer of soil can take centuries to develop but, if mistreated, can be blown and washed away in a few seasons. Soil is now rapidly vanishing all over the planet.
Despite the fact that animals and plants are able to adapt to the drylands, desertification has serious consequences on the environment. Depending on the type of agricultural technique employed, different forms of land degradation occur.
The following have been observed:

- loss of nutritive matter (due to agricultural over-exploitation).
- loss of soil surface due to wind and rain erosion, particularly due to the loss of vegetation (See the case study from Spain).
- landslides occur by the action of water, also due to the effects of vegetation loss (See the case study from Kenya).
- increased salinity and soil acidification (due to irrigation malpractice) (See the case study from the Aral Sea).

1. Mustang in **Nepal**: wind erosion. In some cases, the wind causes land erosion, if violent enough, the superficial layers are blown away
© Yazid Tizi

2. When drought periods are sustained, the soil surface hardens and begins to break up. Cracks appear forming deep fissures that damage the soil structure. When rains eventual arrive, the water seeps into the cracks rather than being retained on the surface.
© Jean-Michel Battin

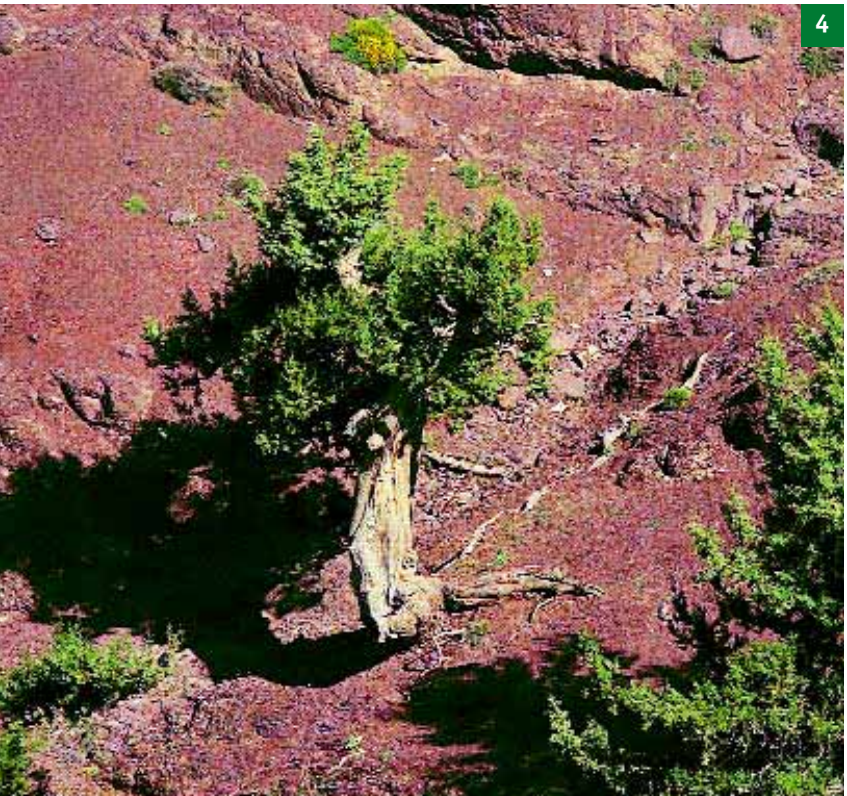
3. Soil salinity has immediate consequences on the ability of vegetation to maintain and regenerate itself.
© Michel Le Berre

4. Erosion removes part of the soil and often unearths root systems.
© Michel Le Berre

- soil pollution (due to the excessive use of chemical fertilizer).
- the effects of compression and the encrusting of the soil surface (due to heavy use of agricultural machinery).

Water becomes scarce or is threatened

Land degradation in the drylands can have direct consequences on the water cycle. If there is low rainfall then drought ensues: groundwater reserves do not refill, water sources become depleted, wells run dry, plants and animals die and humans have to migrate to more hospitable regions.

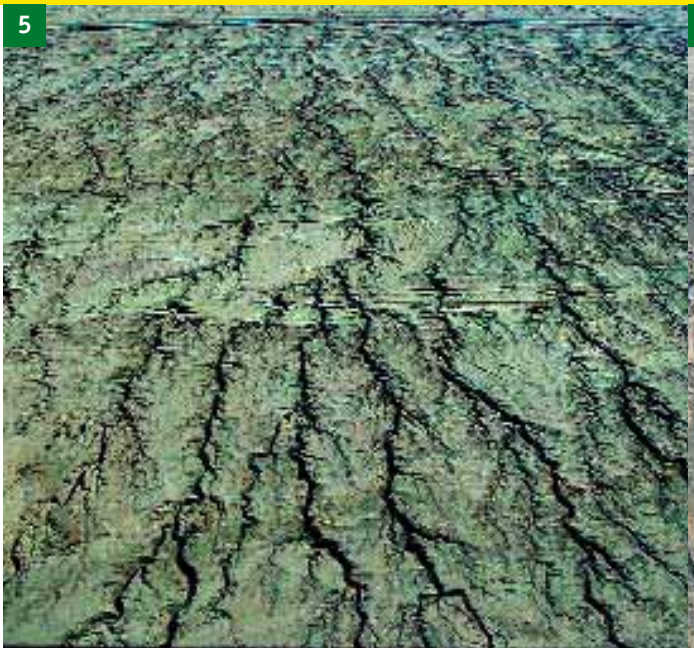


On the other hand, during periods of high rainfall, the ensuing floods kill people and animals, notably in regions where vegetation cover is reduced or totally destroyed. The torrential rain flow causes a substantial loss of soil, which is then flushed out by the rains, and when the land becomes dry again, a hard crust forms on the surface that renders it impermeable, reducing water infiltration.

Biodiversity decline

Land degradation due to drought, salinity or over-exploitation has immediate consequences on the capacity of vegetation to maintain or reconstruct itself. Animal species, dependant on this vegetation, have to migrate to other areas to find sufficient resources or they risk disappearing altogether. The importance of this loss derives from the fact that animal and plant species from the drylands are particularly well adapted to this extreme environment. They act as indicators of the environmental condition of these areas and their disappearance is a sign of significant habitat degradation. Moreover, these species remain important resources for the population. Their disappearance increases food insecurity and the impoverishment of the world's most fragile populations.

11 Environmental consequences of desertification



5. 6. Examples of hydraulic erosion. Soils are washed away by the rains, when they dry up, a crust forms that renders the soil impermeable, thereby reducing water infiltration. © Yann Arthus-Bertrand *Earth from Above* / UNESCO

Consequences of land degradation

(See also the case studies from Spain and Kenya)

- Erosion: the loose particles and nutritive elements of the soil are flushed out.
- In irrigated lands, where water from underground reserves is often polluted, evaporation leads to a rise in the mineral salts to the surface resulting in high salinity, rendering the soil unsuitable for crops, since they are intolerant of high salt concentrations and may consequently die.
- The vegetation cover is not given enough time to re-establish itself during intensive grazing periods or when grazing activities affect plots that have already been cultivated.
- Due to the acceleration of erosion by rain as a direct result of clearings and deforestation, the forest ecosystem disappears. This has severe consequences on soil fertility as well as on the preservation of animal and plant species. In fact, roots maintain soil structure and can limit soil erosion since they contribute to water infiltration, which reduces water run-off, encouraging the composition of a rich and productive soil. Also, tree leaves reduce the action of the wind on the soil surface. Dead tree parts that fall to the ground decompose and enrich the soil with organic matter.

Classroom ACTIVITIES

Organize an excursion close to your school. Look for an area damaged by erosion.

How could you stop the erosion process and make the soil more fertile?

Do you know of a polluted area nearby?

In your view, how long has this area existed and what needs to be done so that this area becomes less polluted and eventually restored?

Try this experiment:

Take 4 buckets filled with soil. Plant an equal number of grasses in each. Place two buckets permanently in the sun.

Place the other two in a shady area. Label the buckets. Regularly water one of the buckets placed in the sun and one in the shade.

Do the same with the other 2 buckets (water one of them and not the other). Keep a check on the buckets, and at the end of a few weeks describe and compare the grasses.

What do you notice? What do you think has happened?

Find 2 large buckets.

In the centre of one of them, place a compact mix of water and soil.

In the other bucket, place some plants and their accompanying soil, in the centre.

Now, water the 2 buckets with a substantial quantity of water. What do you notice?

12

Socio-economic consequences of desertification

OBJECTIVE To introduce the physical and biological consequences of desertification

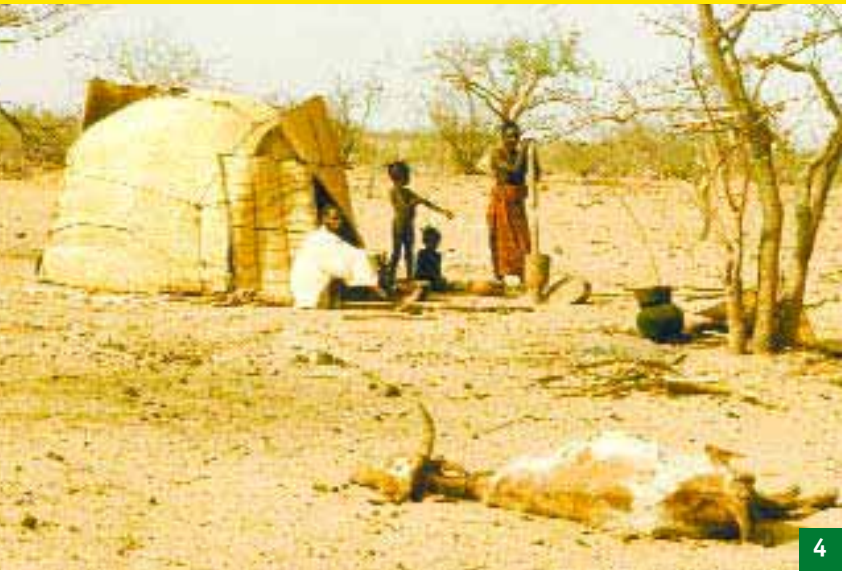
1

1. The encroachment of the desert around the oases necessitates permanent crop protection.
© Yann Arthus-Bertrand *Earth from Above* / UNESCO

2. In the drylands, rains tend to fall suddenly as violent downpours, leading to flooding along the length of rivers, particularly where embankments are degraded.
© UNESCO-MAB

3. When drought conditions and low soil fertility become overwhelming, people and animals do not have enough resources to feed themselves and they are obliged to move to other areas.
© R. Faidutti, FAO

4. Due to general drought conditions in the Sahel, the nomads in Mali encounter in neighbouring Burkina Faso, the same degraded lands and lack of food.
© F. Botts, FAO



Consequences of desertification on human populations

The growth of poverty and dependance

Desertification leads to poverty with all the social, economical and cutural consequences that this entails. Poverty then drives populations to over-exploit the remaining natural resources triggering a vicious cycle, accelerating land degradation still further. Poverty is thus both a cause and a consequence of desertification.
Desertification affects the lifestyles of nearly one billion of the world's population.

It weakens populations and institutions rendering them more vulnerable to global economic factors. The shortfall in earned tax receipts due to low productivity has consequences on the capacity of governments to reimburse their foreign debt and develop national socio-economic programmes. The persistance of drought and desertification reduces national food production and furthers the need to turn to foreign products. Moreover, food aid can eventually lead to a reduction in local agricultural production, particularly if it becomes more costly to produce locally than to resort to imported products that are distributed for free by the international community.

Socio-economic development in disequilibrium

Drought and diminishing soil fertility lead to the migration of the rural population.
This creates problems in the urban environment as well as in rural areas not yet affected by land degradation, yet witness the migration of new arrivals. The inflated growth of urban centres leads to a reduction in the state budget allowance intended for rural development, which accentuates the rural exodus and raises food insecurity.
Rural populations often lose their possessions during severe drought. Desertification can drive whole communities to migrate towards cities or regions where survival conditions are initially more promising but ultimately are very difficult: social stability and cultural identity are threatened and the makeshift dwellings, which are insanitary and illegal, are sometimes sources of ethnic or religious conflict.

12 Socio-economic consequences of desertification

Economic refugees are increasingly numerous: in Africa estimates place the number at 10 million individuals over the past twenty years.
The population of cities is swelling. Immigrants are often forced to settle in urban slums while rural areas are deserted. Between 1965 and 1988, the proportion of Mauritania's people living in the capital Nouakchott rose from 9% to 41%, while the proportion of nomads fell from 73% to 7%.

Currently, there are more Senegalese in the Bakel region of France than in the villages they left behind, yet, given the chance, people would prefer to stay.
Desertification does not only concern developing countries but also developed countries, this is due to the immigration of populations forced to abandon their land rendered unsuitable for cultivation, and the huge amounts of money spent on disaster relief and humanitarian aid.

Desertification also encourages political instablity and has played some part in sparking off about ten of the armed conflicts currently in progress in the drylands.
The displacement and migration of refugees (following war or natural catastrophe) has disastrous consequences on the environment (deforestation, reckless over-exploitation of natural resources), accelerating desertification. Harsh living conditions and the loss of cultural identity also diminish social stability.

5

6

5. Mobile, shifting sands gradually engulf dwellings thus leading to the abandonment of certain villages.
© UNESCO-MAB

6. During armed conflict, refugees are often obliged to settle temporarily in camps where they try to survive in often appalling conditions. Poor hygiene and relentless exploitation of resources contribute to the intensification of environmental degradation.
© F. Loock, UNESCO

Classroom ACTIVITIES

What are the principal causes of human and animal migration in your region and in your country?

Which type of person or population has recently settled in your region or recently moved away?

Would you like to leave your village or region? Why?

Where would you go? Explain your expectations of life elsewhere.

Do you know of someone that has left your community and leads another kind of life elsewhere, in another region?

What has this changed for him/her?

Do your family stock food reserves in case of hard times? Which types of foodstuffs are stored and how are they stored?

On average, how many animals make up a herd in your region?

Are the numbers more or less than the numbers found during your grandparents' generation?

2

The solutions

Solving the problems of desertification

13

Raising awareness about the problem

OBJECTIVE To introduce the history of public awareness to the global problem of desertification

1

1. 2. 3. Faced with desert encroachment, the international community has responded over the last few decades by developing programmes to combat land degradation. International conferences provide the forum to help in our understanding of environmental problems.
1. © Michel Le Berre
2. 3. © UNESCO-MAB

4. An oasis threatened by desert encroachment.
© J. Balderi, FAO

The role of the international community

The acceleration of land degradation in the drylands has mostly occurred from the middle of the 20th Century. The international community decided to respond to this by developing soil conservation programmes to:

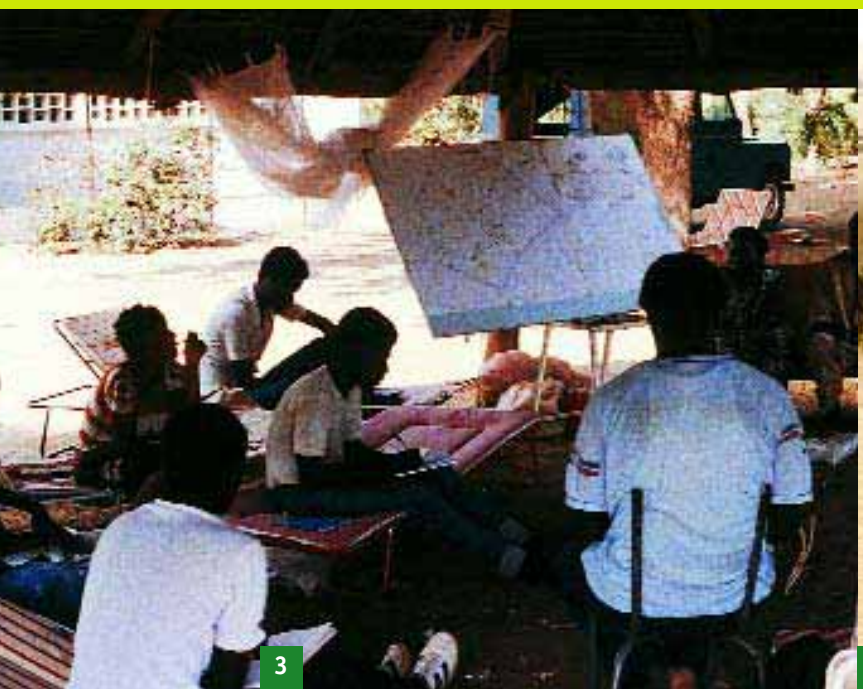
- ensure the continued reproduction and long term preservation of threatened natural resources (water, flora, fauna).
- satisfy the needs of the population that live in areas affected by degradation by better managing the natural resources that allow for a well-balanced economic and socio-cultural development while assuring ecological equilibrium.

International research programmes have been conducted to better understand the functioning of drylands. They have been supported by certain United Nations agencies (UNESCO, FAO, WMO, UNEP, etc.) and by regional intergovernmental organizations (CILSS, IGAD, SADC, UMA) or non-governmental organizations, NGOs.
The first determined effort to combat desertification began at the end of the great Sahelian drought and famine of 1968-1974 in which over 200,000 people and millions of their animals died. The United Nations Sudano-Sahelian office was set up in 1973 originally to assist 9 drought-prone countries in West Africa, though its activities spread to cover 22 countries south of the Sahara and north of the equator.
Over the decades international meetings have contributed to our knowledge of environmental problems and accords have been signed announcing concrete projects. Certain important conferences have marked the end of the 20th Century.

The Stockholm Conference (Sweden) 1972

This was the first international conference that addressed environmental issues related to those concerns linked to the future of human populations. Among the principles outlined during the summit, the international community recognized that under-development and population growth are at the root of most of the environmental problems encountered today. Man has a particular responsibilty to safeguard and manage this natural heritage in the long term. The use of non-renewable natural resources, the challenges of biodiversity conservation and the control of pollution make it necessary to plan long term co-ordinated action.

13 Raising awareness about the problem



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The Nairobi Conference (Kenya) 1977

This first conference on desertification manifested a response by the international community to the terrible droughts of the Sahel and to the 1968-1974 famine threatening economical and ecological equilibrium. It contributed to the in-depth analysis of the problems of desertification. A Plan of Action to combat desertification, along with a series of recommendations aimed at helping affected countries to define and implement measures, was established to mobilize and coordinate assistance among the international community.

The Rio de Janeiro Summit (Brazil) 1992

The United Nations Conference on Environment and Development (UNCED) was marked by firm commitments from countries and the international community, which appear in Agenda 21, a plan of action assuring both the protection of the environment and the notion of sustainable development. Two international conventions emerged as a direct result of the Rio Conference: the Convention of Biological Diversity (1992) and the United Nations Framework Convention on Climate Change (1993). Developing nations insisted that desertification as an issue plays an equally important role during talks held during the Earth Summit, and in 1994 the United Nations Convention to Combat Desertification was ready to be signed by governments. The three Conventions apply the principles of co-operation and international solidarity as they aim to find common solutions to environmental problems and socio-economic development.

Classroom ACTIVITIES

In class, design a questionnaire on the subject of desertification and carry out a survey in your village to determine the extent of people's knowledge on combating desertification?

Organize a class discussion. Each pupil is allocated a unit (lesson) and will give a class presentation on the chosen subject.

The class could interact freely during the discussion on the possible solutions to combat desertification and drought. It may help to read the case studies first.

Which agencies of the United Nations do you know?

Can you explain their role and purpose?

The class could divide up into small groups, each representing an agency of the United Nations developing a specific project.

Each group could then explain to the rest of the class how the project could be implemented, underlining its objectives!

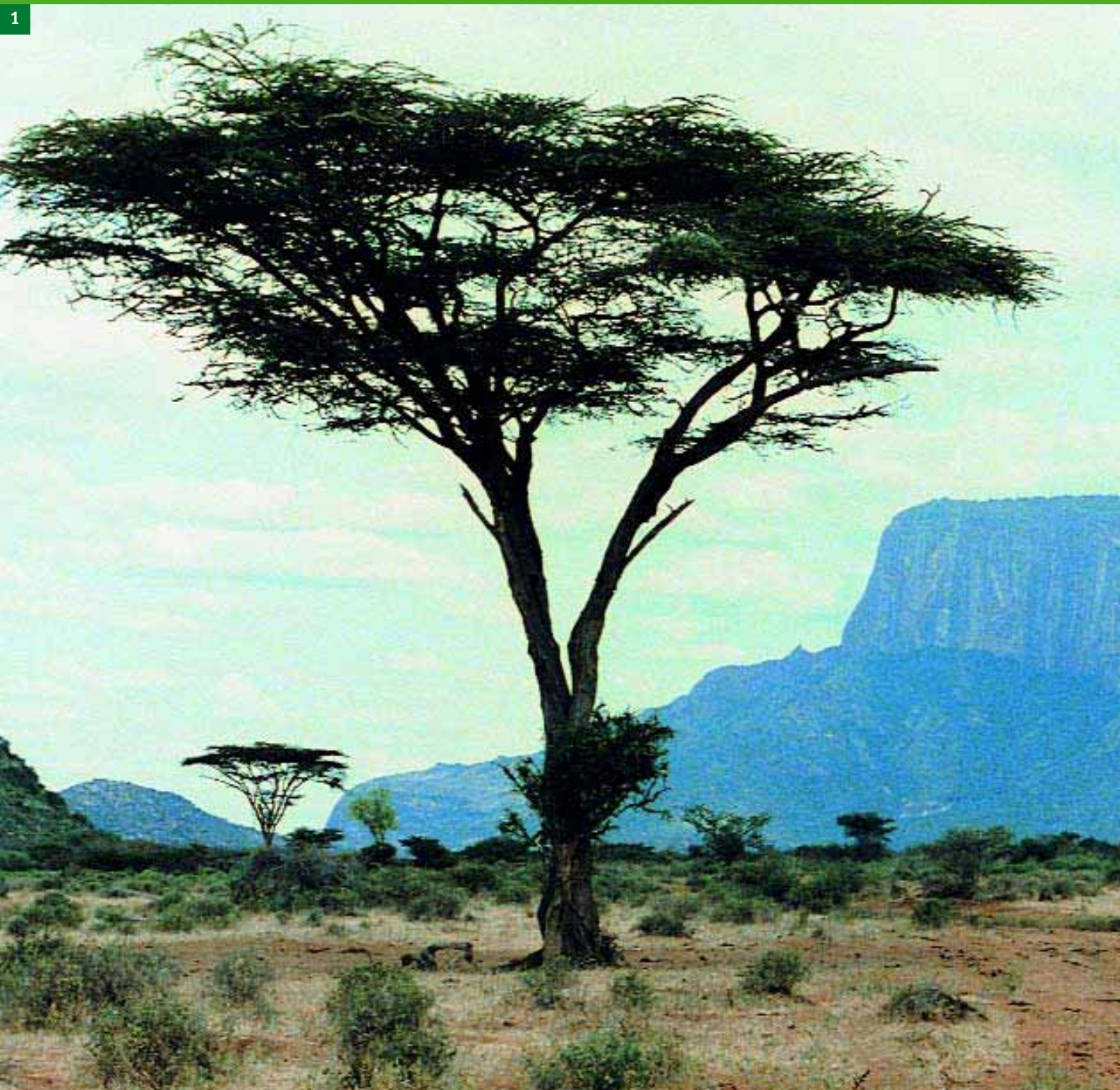
Underline the following correct phrases:

- International projects exist to combat desertification.
- The desertification problem should be tackled exclusively by developing countries.
- Once countries have signed the Convention they are not expected to do anything else.
- A Great Drought struck the Sahel during the years 1968-1974.
- The international community meets regularly to define conventions on environmental protection.
- If countries do not establish Nation Action Plans to combat desertification then the Convention is not doing what it set out to achieve.
- The Rio Conerence of 1992 is also known as:
  - the Earth Summit.
  - the UNCED.
  - the Convention of Biological Diversity.
  - the UNCCD.

14 The role of the United Nations Convention to Combat Desertification

OBJECTIVE To introduce the history of public awareness to the global problem of desertification

1



1. The African continent is the most seriously affected by desertification. African countries were the first to respond to the problem.
© UNESCO-MAB

2. 3. 4. One of the objectives of the UNCCD is to initiate active participation among populations in response to decisions taken by governments to combat desertification. It aims to facilitate co-operation between countries of the North and South while taking into consideration the particular needs of developing countries.
© UNESCO-MAB

General objectives of the Convention

Forging partnerships

The United Nations Convention to Combat Desertification (UNCCD) officially entitled *United Nations Convention to Combat Desertification in countries seriously affected by drought and/or desertification, particularly in Africa* is an international agreement adopted in 1994 in Paris, France. By the end of the year 2000, the Convention was ratified by 172 countries marking a turning point in international policy demonstrating a growing awareness of the importance assigned to the problems of desertification.

The Convention clearly emphasizes that the populations who suffer directly from desertification, and who therefore understand the fragility of their environment better than anyone, must be closely involved with decisions that influence their way of life. The Convention aims to combat desertification and ease the effects of drought in those countries seriously affected by drought and/or desertification.

The objectives of the UNCCD seeks to improve land productivity, to restore (or preserve) land, to establish more efficient water usage and to introduce sustainable development in the affected areas and more generally, improve the living conditions of those populations affected by drought and desertification.

The UNCCD is particularly committed to actively encouraging the participation of local populations to respond to government decisions made on desertification issues. The UNCCD seeks to facilitate co-operation between the different administrative sectors of countries of the North and South while paying particular attention to the needs of developing countries.

Focusing action on Africa

The continent of Africa is the most severely affected by drought and desertification. The African countries were the first to rally together to combat the problem in partnership with other countries in the world. Facilitating access to new technologies, knowledge and its transfer among populations to alleviate the effects of drought and to combat desertification, are the major challenges facing the Convention.

Specific objectives of the Convention

Promoting sustainable development

Sustainable development satisfies present human needs in an equitable way without compromising the needs of future generations. Thus, if one tree is cut down, then another should replace it, thereby connecting the economy and the environment in a way that is both harmonious and well balanced. Put another way, it is essential to consider the best way to use resources in the long term without exhausting its supply.

14 The role of the United Nations Convention to Combat Desertification

A variety of activities help achieve this objective such as limiting population growth and not carelessly wasting resources, so that our children can benefit from them too.

Developing education and training

It is important that every individual has access to information and understands the action proposals communicated by the media and literature. Reading and writing skills provide people the opportunity to become better informed and help them understand and organize projects that combat desertification. Education therefore enables them to share knowledge and better manage the available resources.

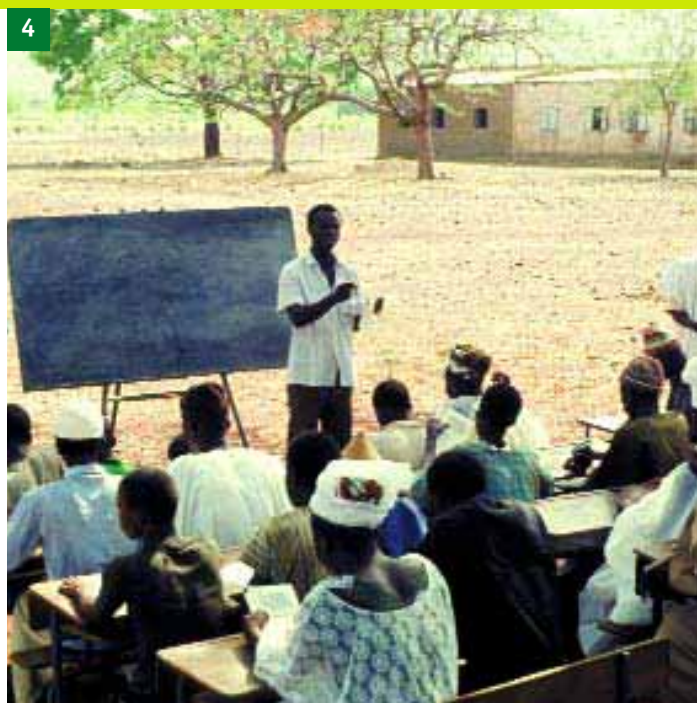
Measuring human development

Sustainable development reflects on the well being of human beings. The progress of human development can be measured by observing the advantages of populations to such benefits as education, health and income.
An indicator helps determine the state of human development in each country.
The HDI (human development index) is calculated on the basis of three indicators:

- the level of education evaluated by the literacy rate and the percentage of children in full time education.
- the level of health measured by life expectancy at birth.
- the income of citizens measured by GDP per capita.

These measurements help calculate the HDI of each country. By applying the yearly calculations to the country it is possible to see whether there is an improvement or deterioration in human development.

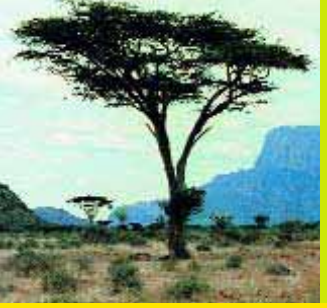
4



© Dominique Roger, UNESCO

Creating an enabling environment

For affected countries, and the people of the drylands, living conditions must be right if desertification is to be tackled effectively. It is hard for governments or local people to give much attention to the crisis if they are constantly preoccupied with economic and/or physical survival. Local people need to have secure and equitable rights to the land they tend, as they will be less willing to look after the land if they feel that it may be taken away from them. The Convention recognizes the need for an *enabling environment* making it possible for them to pursue sustainable development.
Combating desertification can only be achieved in the long term. Changes should be introduced at the international level as well as the local level.



Classroom ACTIVITIES

In your notebook, explain the role and importance of the United Nations Convention to Combat Desertification.

Carry out a study loosely based on the human development index (HDI) in your country. Place the statistics on your wall chart and attempt to associate the socio-economic situation of your country with the problems faced by desertification.

With your classmates, compile a catalogue showing the level of information available to you and your community on desertification, for example, books or other media available in your school, library, community centre etc. as well as local activities or projects on desertification.

Make a list of people who may be considered as experts on the various themes of desertification. Make this catalogue available to everyone, you could exhibit the catalogue alongside the wallchart for everyone to read.

Underline the following correct phrases:

The UNCCD:

- is an international Convention.
- does not involve countries of the Sahel.
- has been signed by at least 150 countries.
- is based on the notion of sustainable development.
- aims to improve the participation of local populations on decisions made by government.
- involves combating desertification.

15

2

3

Mobilizing and involving people

OBJECTIVE To explain the importance of uniting the whole community to achieve collective action to combat desertification

1

The most important partnership to be forged when tackling desertification is between aid donors, national governments, local administrations and the people of the drylands themselves. Over the years, experience has shown that the phenomenon cannot be tackled effectively unless the people concerned are fully committed and involved. The people of the drylands are their own greatest resource in this combat, as they know their land better than anyone. In some ways, their skills may be greater as they are confronted by far more difficult conditions than populations in other regions. Every man, woman and child is called upon to combat desertification.

4

5

1. 2. 4. 5. All levels of society are called upon to combat desertification. By organising information open days, workshops and local projects it is possible to involve the whole community including youth, women and the older generation.
© UNESCO-MAB

3. The phenomenon of desertification cannot be fought effectively unless everyone at all levels is fully involved.
© UNESCO-MAB

6. Knowing how to read and write helps develop and guide one's future, and to combat desertification.
© Ines Forbes, UNESCO

Broadening the focus

Most attempts to fight desertification have concentrated more on its symptoms than on its causes. They tended to concentrate on alleviating its effects and on reducing the human activities that seemed to immediately contribute to them. They sought to tackle over-cultivation, overgrazing, deforestation and faulty irrigation directly without addressing the underlying social and economic pressures that produced them. This often resulted in blaming the victims of desertification for the damage caused without making a serious attempt to understand the forces outside their control driving them to over-exploit their land.

National action programmes

Combating desertification is expensive. All countries, even the most developed among them and those who are unaffected by desertification, are called upon to finance projects to reverse the desertification process. Funds may come from co-operative projects, fund-raising, donations etc. The money is used to put a stop to deforestation, to curb soil erosion, to forge partnerships and common plans of action, to develop new methods while adapting existing methods to the conditions of each country, to educate the population and so on.

The Convention attempts to integrate social and economic issues into the heart of its analysis and implementation by attributing an equal focus on these issues as granted to the physical and biological aspects of desertification.

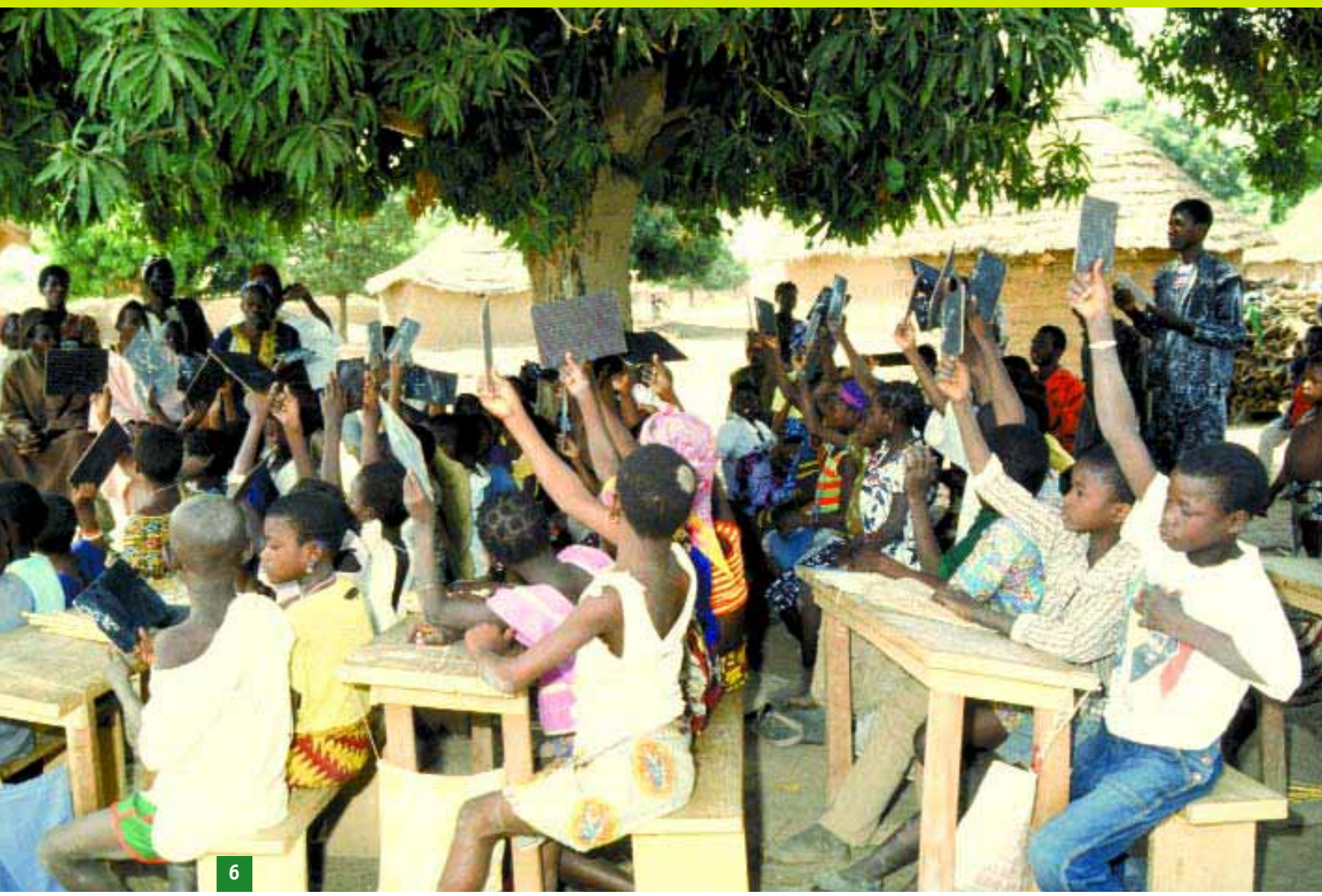
Combating desertification also relies on the elaboration of National Action Plans (NAP). Each country should adopt a participatory approach whereby all members of society join forces to combat land degradation and are supported by their government who accept, for example, to attribute power to women, farmers and livestock breeders in order to combine their joint efforts. In a broader sense, children should also play an active role in the protection of the environment.

Involving the whole population

Adults should be informed and made aware that there are inexpensive and easy ways to implement methods to combat drought. It is thus important to organize:

- information open days for rural communities organized by specialists who for example explain how to use solar or wind energy, biogas etc.
- collective action to elaborate common projects (for example reforestry projects, creation of a green shelterbelt surrounding the village) with the families (youth, women and the older generation) and with farmers, breeders and political representatives.

15 Mobilising and involving people



6

The older generation, as guardians of important traditional knowledge, should be involved in reducing land degradation and alleviating the effects of drought. In fact, the problems of desertification cannot be solved unless all levels of society are mobilized.

Learning to combat desertification in school

A basic education such as being able to add, read and write, is the first step towards combating desertification. School is an important means for the transfer and diffusion of information, which enables people to communicate with others affected by desertification. More importantly, it helps develop skills and techniques to combat desertification while promoting techniques that may help others. Technical manuals or educational guides developed for schools should not only be targeted at teachers and their pupils but also shared with parents and the local population via the children.

Classroom ACTIVITIES

Organize an interview with local political representatives: mayor, community leaders, chiefs, etc. and ask them about the concrete actions that are (or not) being undertaken in the community to counter the effects of drought and desertification.

Write what is being said in your notebook. Invite them to visit the school to talk on the subject.

Invite your parents and your local community to the meeting to discuss with the decision-makers the problems encountered at the local level, due to the effects of desertification.

Organize an exhibition on combating desertification.

Use the posters, sculptures, school assignments and the wall chart that the whole class has assembled together during the desertification lessons, and invite everyone from the village to attend.

Discuss in class how you would explain to an imaginary newcomer to your village/town, the importance of combating desertification, giving examples of the activities undertaken or to be undertaken at your school or home.

16

2

3

Measuring and evaluating problems

OBJECTIVE To explain how the Convention establishes the monitoring of the combat against desertification

1

1. Region of Burao in **Somalia**: dessicated riverbed.
© Yann Arthus-Bertrand *Earth from Above* / UNESCO

2. 3. Scientific research and the regular monitoring of environmental changes are vital for working effectively to combat desertification and the rehabilitation of degraded ecosystems.
© UNESCO-MAB

4. The range finder follows the movements of animals fitted with a tracker to study behavioural patterns and also to protect them.
© Amélie Dupuy

5. Satellite.
© European Space Agency

6. Mars Express spacecraft.
© European Space Agency

7. Teledetection.
© UNESCO

The Convention exercises follow-up activities

Action plans to combat desertification are undertaken in the long term and require regular monitoring. Observatories have been created to carry out measurements and collect data. Several stations perform observations on farmed and non-farmed plots of land. For example, the UNESCO MAB programme (*Man and the Biosphere*) studies the interaction between man and nature and in particular, the impact of man on the environment through the world network of biosphere reserves, among others.
They have been established as permanent representative sites of research, training, biodiversity conservation and development support. The Sahara and Sahel Observatory (OSS) and its network of observatories and long term ecological monitoring, ROSELT, (Réseau d'observatoires de surveillance écologique à long terme) measure the biological potential of drylands around the Sahara. There are several sites to the north and south of the Sahara and in the Sahel.

The ROSELT Observatories perform three main duties:

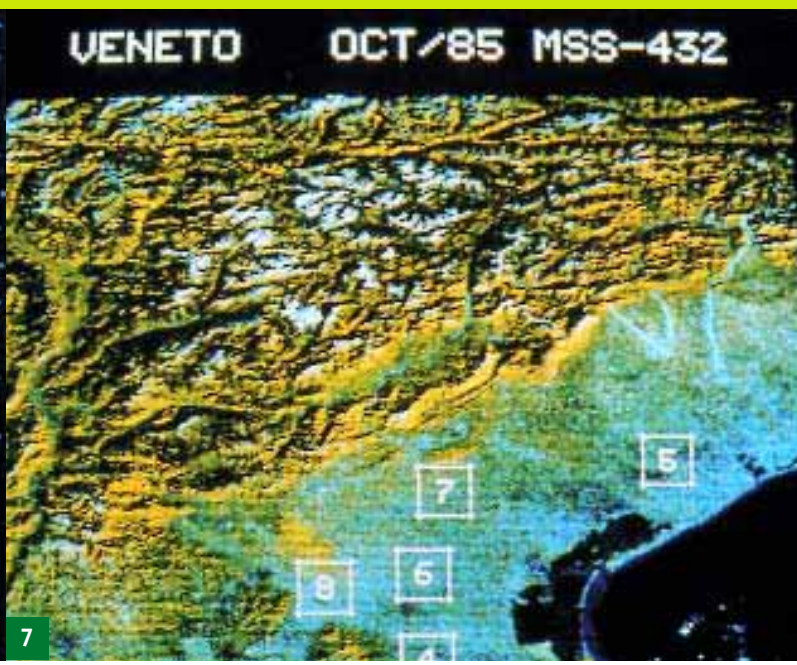
- the long term surveillance of changes in natural resources.
- monitoring the development of human activities on the territory.
- finding solutions to enable the restoration of biological resources in disturbed ecosystems.

Measuring the degradation

In order to measure land degradation as well as the advances made in combating desertification, quantitative and qualitative information needs to be made available on environmental and socio-economical factors. By taking advantage of this information, called indicators, scientists, organizations and governments can avoid duplication of efforts and save money, which could be deployed elsewhere.
An indicator is quantitative information that enables an evaluation of an activity or the development of a given situation (ie. the population growth in ten years) in view of better natural resources management for sustainable development.
Indicators have, for example, been created to measure water quality: the concentration of nitrates should not exceed 50 mg/l. a critical threshold beyond which human health can be affected. These base indicators help determine the progress made in combating desertification. They are employed in the evaluation, the follow-up and the prediction of effects of a given phenomenon or activity. The UNCCD explicitly recommends [Art.16] the study and use of indicators in the physical (climate, soil), biological (biodiversity), social (health, amenities) and economical (production, wealth) state.

16 Measuring and evaluating problems

6

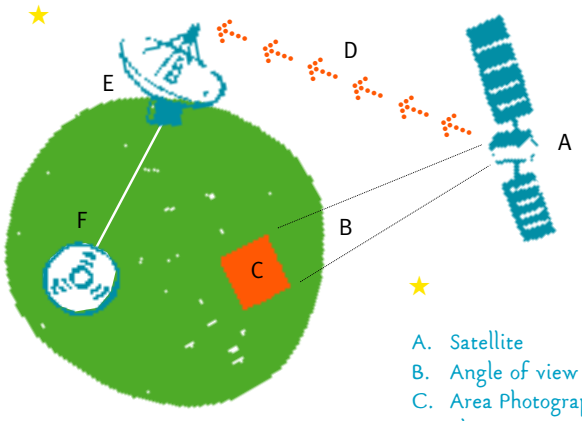


7

Photos taken by satellite (teledetection)

They are used to:

- provide a general overview of the state of the vegetation of a region and to rapidly obtain information; the same information gleaned from studies taken on the ground would be time consuming and more costly.
- regularly monitor observed changes: degradation, clearings, reforestation, etc.
  By taking photographs over several years it is possible to determine the development of the vegetation so as to make decisions on those crops to be favoured or avoided in case of drought.



A. Satellite
B. Angle of view
C. Area Photographed
D. Photos transmission
E. Receiving station
F. Data storage in electronic format

GIS

Only computers are able to exploit the numerous measurements taken on desertification. Geographers and computer scientists have developed geographic information systems (GIS) to produce maps, photographic pictures and virtual images. They aim to rapidly present regional characteristics in a global dimension: progression of drought, rain, temperature, water availability, human amenities (villages, settlements), infrastructure (trails, roads), etc.

Classroom ACTIVITIES

In class, organize the pupils into playing the roles of a mayor and his councillors.

You want to undertake a study on the situation of your environment (determine the factors that influence your environment) and need to define simple indicators in relation to combating desertification.

Think of 3 indicators that could be examined throughout the school year (i.e. weekly water consumption etc.)

Underline the following correct phrases:

UNESCO is:

- a NGO.
- an United Nations organization.
- involved in studying the relationship betwenn man and the environment.
- involved in the promotion of sustainable development.
- involved in financing projects in developing countries.

Tell the story of an imaginary satellite oX99 sent into space.

What does it photograph and study every day as it encircles Earth?

Draw a diagram of your nearby environment ie. between your village/town and your school. Mark on your drawing the points of interest as well as the fields, trees, watering points etc.

Show your drawing to older members of your family.

How has the surrounding area changed compared to when they were young?

17

Re-establishing a favourable environment

OBJECTIVE: To introduce concrete methods to combat desertification

1

1. 2. 4. Nurseries provide a source of young plants that can be replanted quickly. It is important to select local species that grow rapidly and are adapted to the harsh climate.
© UNESCO-MAB

3. Gour in **Nigeria**: construction of a windbreak to hold back the sand dunes.
© P. Cenini, FAO

5. Another example of a windbreak construction.
© UNESCO-MAB

Fertilize the land to restore it

To combat desertification it is necessary to restore and fertilize the land.
Nutritive elements such as nitrogen, phosphorus, calcium, magnesium etc. in the soil are necessary for plants to grow. When the soil has lost all its nutritive elements or a part of its constituents (removed by wind or water) it is said to be degraded or exhausted and its productivity diminishes as a consequence.
It can also accumulate such toxic elements as salt that need to be eliminated.

As these elements become exhausted through intensive agriculture it becomes necesssary to re-establish soil fertility either by using synthetic fertilizers or by preparing much cheaper compost. It is principally prepared from plant waste: manure, agricultural trimmings (straw), and biological household waste. Water hyacinths, though harmful in rivers, can be tranformed into fertile matter that supplies nutritive elements to the soil as compost.
After several weeks in a pit, and with the heat and humidity, humus is produced. It can then be spread among the crops and used to prepare the soil before seedlings are planted. The soil regenerated with organic matter in this way will produce more fruitful harvests. The restructuring of the soil is a very effective and particularly sustainable way to maintain soil fertility (See cartoon: *The School Where the Magic Tree Grows*).

The presence of livestock could also be exploited to enrich the soil. By consuming crop leftovers (millet, maize) the animals return nutritive elements to the soil that enriches it with nitrogenous matter in the form of dung. Dung also restores the capacity of soil to produce a more plentiful harvest. The herd also provides meat and milk. In this way, farmers and cattle rearers can help each other.

Combating the effects of wind

Some simple mechanical means to alleviate the effects of wind that prevent the displacement of sand and dust, include:

- the construction of fences or barriers from local plant species: woven palms, planted hedges (rows of maize or millet that protect beans and onions) or metal sheeting around villages and crops (See the case studies from China, Gambia and Ecuador).

17 Re-establishing a favourable environment

- planting vegetation whose roots protect and fix the soil.
- prohibiting livestock from grazing to protect the areas of plantation.

Reforestation

Reforestation requires the creation of nurseries to nurture young plants among local species selected for their rapid growth and adaptation to the harsh climate. Reforestation is a long-term action since tree growth is slow. Fortunately, trees have a long life cycle so the investment is generally viable. (See the case studies from Chile and India).

Trees play several roles:

- they fix soil elements and prevent their loss by water and wind.
- they act as obstacles to the wind (wind-breaker) to protect crops (trees should be pruned to be more effective).
- they enhance soil fertility: many trees produce nitrogen (due to the presence of bacteria in roots) that fertilizes and increases soil productivity.
- they facilitate water penetration into the soil during the rains and contributes to maintaining humidity for a long time.
- they provide shade for animals and people.
- they supply nutritive elements: fruit trees diversify food sources, trees provide fodder for livestock (during the dry season).
- they are a source of firewood (cooking) and construction materials (framing structures for huts). (See cartoon: *The School Where the Magic Tree Grows*).

However, they should be used in a sustainable way, trees should be replaced as they are being cut down. Alternative energy sources could also be explored to ease the pressure on tree logging (See Unit 19).

5

Actions to avoid

- Relentless tree logging.
- Bush fires that are not effective in the long term. It is common to lose control of such fires that have a destructive action on the soil and landscape (See the case study from Gambia).
- Neglecting natural manure in favour of synthetic fertilizer (industrially made products are costly). The continued use of natural fertilizer is recommended to maintain good harvests.
- The cultivation of only one type of crop, the monoculture.
- The shortening of crop cycles and the reduction of fallow periods.
- Intense breeding and overgrazing adding pressure on vegetation and aggravating the trampling of soil by livestock herds.
- The cultivation along the downward sloping face in mountainous regions rather than following the natural contour lines of the mountain and the deterioration of terraces.

Classroom ACTIVITIES

Make a poster demonstrating the dos and don'ts of combating desertification. Include the best farming practices that contribute to combating desertification as well as the farming techniques that should be avoided. You can paste it to the wall chart.

How does this list compare to the techniques/methods employed in your village/town?

Make a model that represents the vegetation that can be planted locally to combat desertification.

Ask the local farmers which plants are the most useful for combating desertification ie. bamboo plants used to stabilize the land.
(See the case study from Kenya)

With your parents, construct a windbreak from dry grasses to help them protect their crops.

Discuss in class the different roles played by trees.

Explain why it is important to protect them.

What in your view is the principal function of a tree?

Defend your point of view.

Underline the following correct phrases:

- the loss of soil nutrients leads to a drop in productivity (harvests are smaller).
- chemical fertilizers should replace manure whenever possible.
- windbreaks can be made from metal or plastic sheeting.
- tree planting is a short-term action since trees grow rapidly.
- trees have the effect of destroying the soil.
- fallow periods should be sufficiently long to allow the soil to recover.

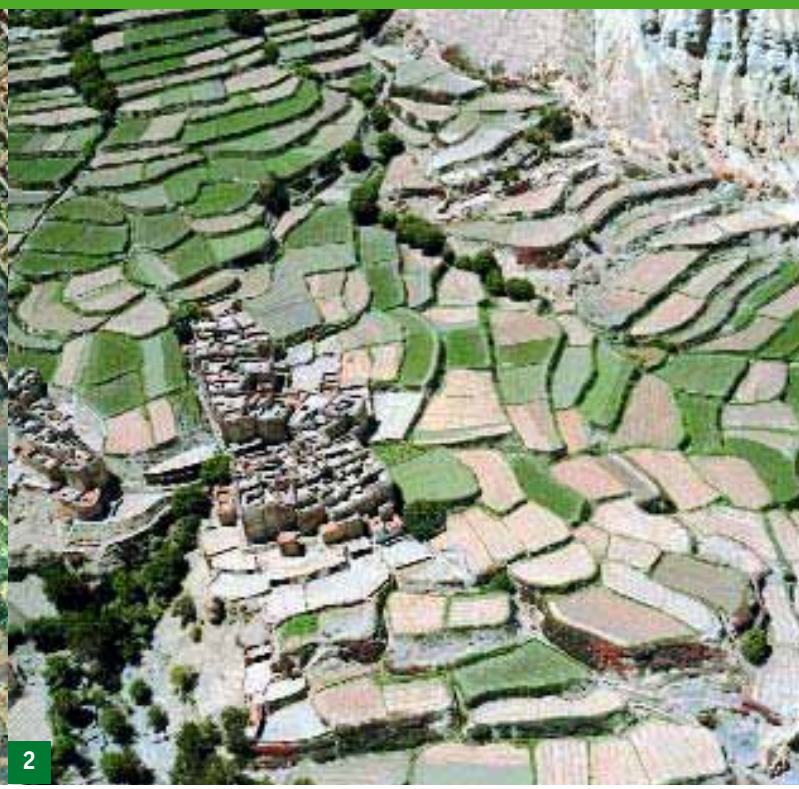
18

Developing sustainable agricultural practices

3

OBJECTIVE: To propose methods that combat desertification in agriculture

1



2

It is less costly to prevent the phenomena of desertification from taking place than to solve the problems it causes. Once the damage has been done, it has to be repaired, which is a long and costly process. Despite the severity of land degradation, it is not necessarily the final stage. By employing good agricultural practice, the trend can be reversed. To preserve soil productivity, sustainable long-term practices must be applied.

4

1. Mali. 5. Senegal: diversifying agricultural production better employs land resources and prevents over production of a sole product. In the drylands and oases, man has had to devise clever ways to exploit the fragile natural resources in a sustainable way.
© Yann Arthus-Bertrand
Earth from Above / UNESCO

2. Nepal: terraces stabilize soils on slopes and reduces erosion. They also benefit from the different microclimates characterising eachaltitude level.
© Yazid Tizi

3. Agroforesty as an agricultural practice is widely adopted because it has both economic and ecological advantages. By exploiting trees, cereals or other low-lying plants at the same time, greater yields are produced since the different types of crops benefit from each other.
© UNESCO-MAB

4. Tunisia: crops planted along the contour line is a judicious method to adapt agricultural practices to topographic realities.
© Yann Arthus-Bertrand
Earth from Above/ UNESCO

6. A small well-fed and healthy herd is better than a big herd of under-fed animals.
© UNESCO-MAB

Preventing soil exhaustion

As the population grows, and with it the demand for agricultural products, traditional farming systems are gradually abandoned and given way to the introduction of monoculture, accelerating the desertification process still further. As a result, an increasing number of productive lands are under pressure, to the point where they become sterile. Farmers and cattle breeders with little or no income seem to have no alternative but to exploit new marginal lands.

It is important to respect the capacity charge for each plot of land. This implies assuring the maximum production of a given resource on the land while preserving its long-term capacity to produce. If the capacity charge is exceeded, productivity declines (agricultural output falls, livestock require more time to fatten). Production methods must therefore be modified by prohibiting cultivation during a certain time period (fallow period) or by decreasing the time livestock spend grazing on the land.

5

Diversify production

Diversifying crop and animal production enables better use of land resources and prevents the over-production of a single product. A plot can sustain different plants and animals over long periods, since their nutritional needs vary and the resources they remove from the land are complementary. Polyculture reduces the loss of agricultural products in the case of a natural catastrophe: certain production methods are better adapted to counter drought than others.
Each plant species has specific nutritional needs (for example, maize rapidly exhausts the soil compared to other plants).
Prolonged monoculture should also be avoided on the same plot of land and a system of rotational crop production should be established to restore soil fertility.

18 Developing sustainable agricultural practices

Land restoration

Land degradation is not permanent. To restore degraded lands, crop techniques should be improved by: stabilizing the soil while enriching them with organic matter, selecting and associating different crop varieties as in polyculture and reducing land pressure (labour and irrigation) (See the case studies from Spain and the Aral Sea). The slightest water table or source can be used to irrigate small perimeters that diversify food sources and reduces pressure on non-irrigated lands. It is also important to combat marked soil salinity by employing the most effective system of irrigation: evacuate water surplus, monitor the changes in groundwater reserves (with a piezometer) and soil salinity in the problem areas, drain and irrigate and plant trees whose roots hamper the soil from drifting. Moreover, trees act as a windbreak and provide supplementary resources (wood, leaves and fruit).
Governments and NGOs can facilitate these activities by offering training courses on the use of new technologies adapted to drought. They can also contribute by reducing inappropriate and ill-adapted exploitation techniques and by promoting community land management.

6

Reducing the herd

It is not easy to convince local farmers to adopt the idea of giving land time in which to recover, while reducing herd numbers. However, improving cropping techniques in cultivated areas may release land for cattle rearing therefore possibly reducing pastoral pressure and the degradation that results from it. In many countries, the size of the herd is a source of pride and honour for the herder, his family or clan (See cartoon: *The School Where the Magic Tree Grows*). Education and public awareness can contribute to spreading another message, which is otherwise difficult to grasp: by producing livestock of better quality (and improving veterinary services), the herder's income can be maintained or increased despite the drop in herd numbers. Governments should intervene to resolve conflicts that may occur because of this. On a political level, regional, national and international measures should regulate market flows (the importation of cheap meat hampers the sale of local meat).

Classroom ACTIVITIES

Dig a large deep hole in the school garden to make a compost heap. Everyone can throw in fruit and vegetable leftovers, dead plants and animal droppings, which should be turned over occasionally. (See cartoon: *The School Where the Magic Tree Grows*).

Be careful not to add animal bones or milk, as it may get very smelly!

Create a nursery in the garden of your school.

Draw the plans, select the appropriate plants, and use the compost and the windbreak (see cartoon: *The School Where the Magic Tree Grows*).

Write a letter to the President or the Agricultural Minister of your country telling him /her the reasons behind the creation of the nursery.

Why not ask them, through their Ministries or NGOs who are undertaking work in this field, for financial help to buy young shoots and tools to get started

Underline the following correct phrases:

- The practice of polyculture is favoured over monoculture, which exhausts the soil.
- The charge capacity of land is equal to the maximum amount of crops that can be harvested.
- Every species of plant has the same nutritional needs.
- Land degradation is definite and irreversible.
- It is better to have fewer well-fed animals than a hungry herd.

19

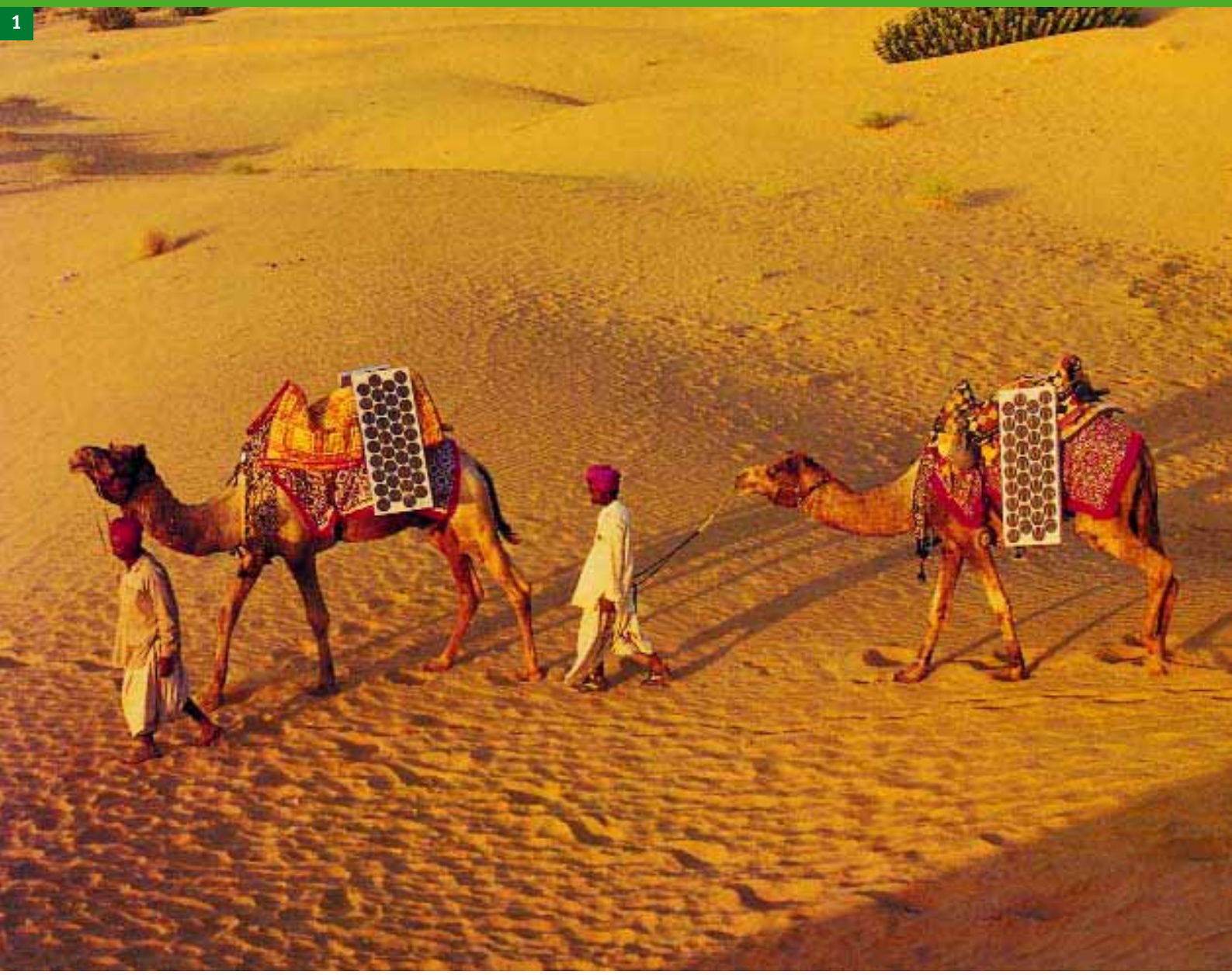
2

3

Using renewable energies

OBJECTIVE: To propose methods that combat desertification in agriculture

1



1. Rajasthan in India:
Camels transporting solar panels. Solar panels can be installed and used wherever there is enough sun.

2. 3. Improved ovens and hearths use less wood compared to classic systems because they concentrate the heat and are therefore fuel-efficient.
© Michel Le Berre

4. **Rajasthan in India:** women cooking with a solar oven.
© Madanjeet Singh / UNESCO

5. 6. Wind energy produces electricity without harmful effects to the environment.
5. © Jean-Michel Battin
6. © Michel Le Berre

Technological Innovations

Development can only be sustainable if it is founded on scientific and technical knowledge. The latest technological advances can provide solutions to desertification by improving on traditional systems of production combined with the use of new sources of energy that progressively restore the soil, increase cereal and meat production and prevent environmental degradation.

Substituting wood

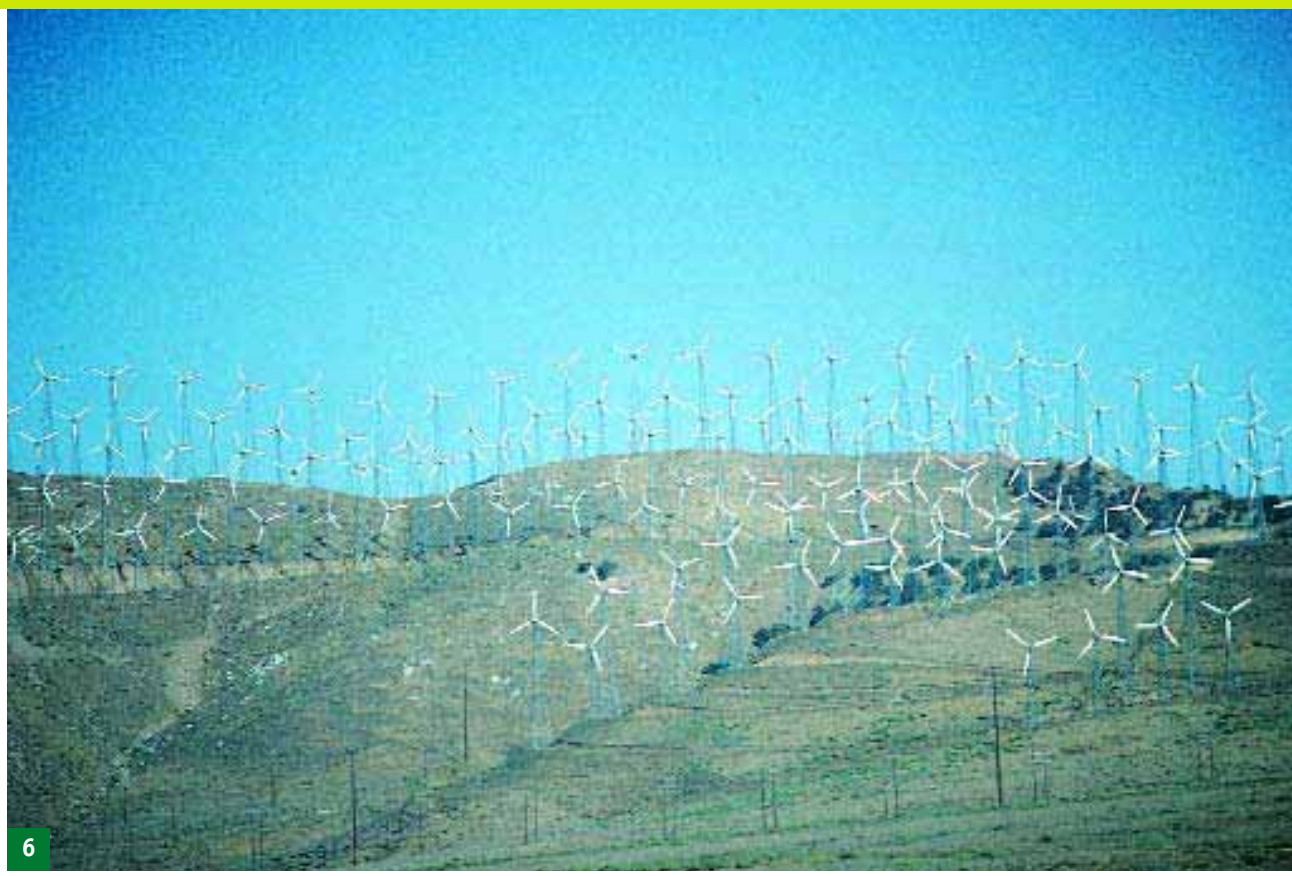
All human societies use energy, which is vital for its proper functioning and development. Today, however, a large number of populations use wood as their major source of energy, which contributes further to desertification (through deforestation) and increases the greenhouse effect (by releasing carbon dioxide).
The non-sustainable use of forest resources (firewood) as a source of energy is a factor leading to desertification. Therefore, identifying and employing alternative renewable energy sources is important in the fight against desertification.
Non-polluting and infinite or renewable energies can replace wood at limited or no cost (the energy source is free) and they can easily be used by families in villages.

Solar energy

Bright sunny conditions, characteristic of arid and semi-arid regions, can satisfy energy needs in these areas.
Solar energy can be used in multiple ways:

- greenhouses integrated into the structure of the dwelling with panels that store energy from the sun in reservoirs (to supply hot water).
- parabolic mirrors help cook food, produce water vapour and run electric water turbines.
- panels transform sunrays into electricity. The electric current is stored in batteries and can be used day or night. Despite the present high cost, it is hoped that this option will become more affordable in the future.
- the evaporation power of the sun can produce distilled water, free of salt and germs, by using a solar distiller.

19 Using renewable energies



6

Wind

The force of the wind can drive wind propellers that produce electricity. A large rudder orientates the wheel so that it faces the wind, while a small blade reduces the speed of the wheel during strong winds. The rotational movement made by the wind produces both electricity and mechanical force. The wind energy can generate a pump to extract water from wells, fill watering holes or irrigation basins or activate mills to transform grain into flour (windmill).
In California, North America, the production of electricity from wind power has reached industrial proportions. In the drylands where winds are frequent (trade winds, harmattan, scirocco), this form of energy could be an important complement in the long term. This type of energy will facilitate land irrigation and the supply of water to the livestock.

Biogas

Biogas is a gaseous mix produced in a fermentation tank (airtight reservoir) or a digestor that derives from the decomposition of organic matter (dung and plant waste). The process of fermentation, that removes odours and pollution from the treated matter, lasts between 1 and 3 weeks and the biogas produced accumulates in the reservoir. The residues from the fermentation can be used as natural fertilizer (compost). The high temperatures in the drylands are beneficial to the creation of biogas. Its advantages: it is uncostly and can be used for lighting, cooking or to drive motors (generators, tractors and cars).
Biogas can also be produced in small installations. This technique can most effectively be developed in regions where agriculture and cattle rearing coexist.

Classroom ACTIVITIES

Compile a list of the different types of energy sources found in your village: wood, wind, sun, petrol, gas etc.

Which energy type does your family mostly use? Why?

Is it the most economic or environmentally friendly form of energy?

Contact a company that specializes in renewable energies and ask them to make a presentation of their products during the school exhibition on desertification.

Invite all the villagers to the meeting.

Construct a windmill.

To do this, take a square sheet of paper and fold it diagonally.

Cut along 2/3 of the diagonal from the edge of the sheet. You now have two corners for each angle.

Fold one of the corners and position it at the centre of the square, repeat this with the four alternate tips.

Then fix the four tips at the centre of the square with a pin attached to a wooden stick, this will act as a support handle. (See drawing).

Construct a 'windspeed tester' by attaching four plastic cups at the extremities of two branches or rods in the shape of a cross that rotates on its axis.

Notice the speed of the rotation of the cross (the number of rotations per minute) in areas exposed to the wind and sheltered from the wind.

Explain how windspeed affects the environment.

20

Reintroducing indigenous knowledge

OBJECTIVE: To propose methods that combat desertification in agriculture

1

2

Associate ancient and new practices

In the past, development planners often tended to neglect the populations of the drylands. Old sustainable ways of using the land were frequently disrupted and nomads and other dryland populations had to abandon their livelihoods as the systems inherited by the colonial era were maintained by young independent states. Even though these techniques worked in the home countries, where conditions were very different, in the drylands they proved disastrous, often alienating the local people and deepening their poverty. Some projects, however, did succeed. The best among them were often run by organizations that had set out to listen to the local people, learn about their techniques and priorities, while working out solutions with them.

Increasingly development projects combined new technologies with traditional practices, and community know-how often reinforced efforts to combat desertification. The adoption of traditional techniques to combat desertification has the double advantage of low cost (in general, simple means are employed and are within the reach of

1. River Chari in **Chad**: crops protected by small dikes the length of the river.
© Amélie Dupuy

2. **Nepal**: terrace cropping.
© G.d. Onofrio, FAO

3. 4. Local farmers constructing small dikes and mini dams to retain irrigation water and protect the crops.
3. © G. Bizzarri, FAO
4. © J. Van Acker, FAO

5. **Zimbawe**: women removing weeds.
© Wagner Horst, UNESCO

communities in developing countries) and are environmentally-friendly in the long term (as they generally rely on attentive observations of nature gleaned over generations).

Dynamic traditional knowledge

The know-how and techniques of traditional knowledge are dynamic and progressive. Communities continue to transfer knowledge through their relationships with neighbours, marriages with people from distant lands, the adaptation to new cultural environments as a result of conquests and so on. (See the case study from Algeria). Many cultures are also inspired by developments in modern science.

Re-establishing ancient techniques of irrigation

Traditional irrigation techniques can be re-established in modern development projects respectful of the environment. In Algeria, populations of the Saharan oases, confronted with population growth and environmental deterioration, have realized that by restoring traditional irrigation techniques they are supporting practices that respect the environment. They chose to restore palm trees and rehabilitate foggaras, an ingenious, effective and sustainable traditional irrigation system consisting of underground galleries that drain water by the force of gravity. Water is captured at depth and transported by canals that do not damage the ecosystem (See the case study from Algeria; the case study from Italy demonstrates another system of water storage by traditional methods).

Techniques to combat land sterility and improve crops

Mulching and the use of agricultural residues

Dead vegetation, such as dry grass, straw, maize stalks, dead leaves or other agricultural residues (mulch) spread out over the naked soil or scattered around the plants can limit erosion and conserve humidity. The straw prevents the soil from compacting, retains water and allows it to penetrate gradually into the soil.

20 Reintroducing indigenous knowledge

5

The Zaï

One of the most effective techniques to rehabilitate degraded land is the zaï that consists of improving the hole used for plantation, a technique perfected by a farmer from Burkina Faso. During the dry season, the diameter and depth of the hole is widened and manure is added.
By concentrating water and fertilizer in this way, millet and sorghum can be grown during dry spells throughout the rainy season (since rains are not regular even during the rainy season). Tens of thousands of hectares of degraded lands in the Sahel have been restored for crop production using this technique.

The role of women

(See the case study from India)
There are many cases where women, through their multiple daily activities, employ or exercise ancestral knowledge transmitted from mother to daughter.
These activities contribute to alleviating poverty and often respond to innumerable environmental challenges: recovering sterile land fto establish small family plots and restoring unproductive lands. Regardless of the situation in which they live, the rational management of energy resources, preservation of soil quality or medicinal plant knowledge, women are confronted with the fundamental problem of meeting the daily needs of their family while preserving the environment in which they live.

Classroom ACTIVITIES

Interview women or village elders in your village /town about ancient medicinal recipes prepared with local plants. Compile the recipes into a book, describing the symptoms and the illness and the positive effects of the medicine.

Compare recipes and select one of them that can be made in class. Then, go back to the elders and show them the new recipes in the collection.

Ask your family whether cultural practices are different today than they were many years ago.

Draw a village where the hills are cultivated using the terracing technique.

Is there a village of this type in your region/country?

What types of crops are cultivated in this way? Why?

Underline the following correct phrases:

- development projects increasingly associate new technologies with traditional practices.
- traditional techniques are expensive.
- erosion can be limited by spreading dead leaves and plants on the soil surface.
- the foggara is a modern system of irrigation.
- all levels of society should be involved in combating desertification, particularly women and children.
- zai is a technique that reverses land degradation.

Glossary

a

Aborigine (n.): a native of a country whose ancestors are considered to be the original population of a particular area. They are indigenous or native to the country ie. aborigines in Australia.

addax (n.m.) : an antelope found in Saharan Africa with spiral, ringed antlers.

Agenda 21: : an action plan developed by world governments during the United Nations Conference on Development and Environment (Rio de Janeiro, June 1992). *Agenda 21* alerts us to the urgent problems faced today and aims to prepare the world for the coming challenges of this century. It reflects a global agreement and growing political awareness at the highest level for co-operation in the domain of environment and development. It is primarily a role of government to effectively implement the action plans.

alpaca (n.): a cud-chewing grazing mammal domesticated in South America and closely related to the llama.
It possesses a long fleece of fine, long wool. The alpaca belongs to the family of Camelidae (camels, dromedaries, llamas etc.)

amphibian (n.): a group of scaleless four-legged vertebrates of which the young (larvae) live in water while the adults live on land. They are made up of families of newts, salamanders, frogs and toads.

antelope (n.): a ruminant herbivorous mammal possessing hooves. They are particularly found in the steppes of Asia and Africa.

arable (adj.): désigne les terres cultivées ou aptes à l'agriculture.

arid (adj.): characterized by lack of rain. In scientific terms: rainfall is less than 200 mm/year thereby constituting an arid climate.

atmosphere(n.): the gaseous envelope that surrounds the earth.

b

baobab (n.): a tree found in Africa and specially adapted to drought. Its swollen trunk stores water while the twisted branches are reduced in size. Almost all of the baobab can be used (trunk, fruits, leaves).

barley (n.): a flowering grass cultivated as a cereal for food and used in the production of beer.

biogaz (n.): domestic or commercial gas obtained by the conversion of organic waste into fertilizer and gas used to drive a generator.

biosphere (n.): a limited space made up of air, earth and water and in which life is possible.

biosphere reserve (n.): a zone supporting terrestrial ecosystems, recognized internationally by UNESCO as a favoured site for research and the promotion of balanced interaction between man and nature.

Boschiman (n.): hunter-gatherers living in the semi-arid regions of the Cape, South Africa. .

c

cactus (n.), cacti (pl.): family of plants found in the Americas with green fleshy stems in the form of columns containing water reserves. Their leaves are reduced to thorns to help conserve water.

capacity charge (n.): a theoretical value representing the load limits (animal population density, agricultural density...) that an ecosystem can support without becoming degraded, taking into account the resources available in the local environment.

CILSS: Permanent Interstates Committee for Drought Control in the Sahel (Comité permanent inter-états de lutte contre la sécheresse dans le Sahel). Created in response to the Great Drought of 1968-1993, its mission is to invest in research and food security and to combat the effects of drought and desertification. The CILSS brings together nine countries in West Africa: Burkina Faso, Cape-Verde, Chad, Gambia, Guinea-Bissau, Mali, Mauritania, Niger and Senegal.

cholera (n.): a bacteria responsible for a contagious disease acquired by ingesting food or water contaminated by the vibio cholerae bacteria.

clearing(s) (n.): the act of removing trees or vegetation from a natural ecosystem, such as a forest or woodland, to render it fit for cultivation.

compost (n.): natural fertilizer made from organic animal or plant waste used as fertlizer for crops.

Conference of the Parties (n.):
It is the highest decision-making body as established by the Convention.
It brings together the representatives of all the governments having ratified the Convention (UNCCD) and administers its application.

contour lines (n.): imaginary lines that follow the same altitude or height above sea level. They can define the edges of terraces in terrace farming.

d

deforestation (n.): the process whereby people destroy forest ecosystems by activities such as bush and forest fires that clear areas for cultivation and the over-exploitation of wood for energy needs.

dromedary (n.): a plant-eating mammal, possessing a hump on its back, adapted to drought conditions. They belong to the family of Camelidae (alpacas, camels, llamas etc.).

dry sub-humid (adj.): characterized by heavy seasonal rainfall and rainfall variations of less than 25% from one year to the next.

dysentery (n.): an intestinal infection caused by germs or amoebae (micro-organisms of ever-changing shape).

e

ecosystem (n.): consists of a group of living organisms interacting with their physical and chemical environment in which they evolve.

erosion (n.): a phenomenon resulting from the action of the wind (wind erosion) or from water (hydraulic erosion) that brings about the removal of top soil and the degradation of rocks.

euphorbia (n.): herbaceous plant of the tropics, often tree-like, they ressemble cacti of Latin America.

evapo-transpiration (n.): the return of water into the atmosphere as vapour, by evaporation from soil or water bodies, and emissions of plant transpiration.

evolution (n.): the cumulative change in the characteristics of a population of organisms over succeding generations resulting in the adaptation of populations to variations in environmental factors.

f

fallow (n.): the practice of voluntarily interrupting farming activities on the land for a period of two years or more so as to allow the natural vegetation cover to restore the soil when it has been exhausted by a succession of crop production or overgrazing.

FAO: Food and Agricultural Organization of the United Nations contributes to improving agricultural productivity, food security and the living standards of rural populations.

fennec (n.): a small African desert fox with large ears.

foggara (n.): an underground gallery that taps underground water reserves (or aquifers) from which it drains water towards the fields to be irrigated.

g

GDP (gross domestic product): an indicator of income levels. The sum of products and services produced by a country during a period of one year and calculated before the deduction of economic expenditure.

GIS: a computer operated Geographic Information System producing maps, pictures and virtual images that help better define a situation or problem.

groundwater reserve (n.): layer of underground water, these so-called aquifers can be found at varying depths according to its source. Groundwater reserves play an important role in the drylands where they constitute major water sources.

h

habitat (n.): a place where living plants, animals and humans are found.

halophyte (n.): a plant adapted to salt-rich soils.

harmattan (n.): a dry, dusty wind from the desert in West Africa.

humus (n.): a brown coloured layer at the soil surface made up of decomposed vegetation rich in organic matter and nutritive elements that enrich the soil.

i

IGAD: the *Intergovernmental Authority on Development*, which aims to support regional efforts to combat the effects of drought and desertification. The members of State are: Djibouti, Eritrea, Ethiopia, Kenya, Uganda, Somalia and Sudan.

impluvium (n.): in Roman dwellings, it was the basin placed below the open space in the roof to receive rainwater.

intensive agriculture (n.): a method of crop production based on crop farming and cattle rearing that attempts to maximize production in areas of reduced size. Intensive agriculture often leads to overgrazing, monoculture and the end of fallow periods, practices which in turn exhaust the land.

irrigation (n.): a technique used to collect and distribute water in the drylands by various methods.

j

jerboa (n.): a desert rodent with long hind legs and a long tail that helps it balance for jumping.

l

land degradation (n.): a process leading to a loss of soil fertility that can be linked to a drop in the concentration of organic matter in the soil, an accumulation of minerals and/or a change in the soil structure by desiccation or erosion.

lichen (n.): a plant composed of a fungus and an algae. It is often used as an indicator of pollution-free environments.

m

mallee (n.): any tree belonging to the genus Eucalyptus. Also mallee scrub, an area where mallee forms the predominant vegetation.

Mesopotamia (n.): a once fertile region of Central Asia situated between the Tigris and Euphrates valleys. Often marshy, Mesopotamia was irrigated since antiquity. The fertility of the region established the foundations of future civilisations. Their contributions include the wheel, glass, the alphabet, calendars, bronze, iron, poetry, farming and irrigation.

metabolism (n.): the sum total of the physiological and biochemical processes in an organism.

micro-organism (n.): a plant or animal that is invisible to the naked eye and can only be seen through a microscope.

migration (n.): seasonal displacement of an animal from one region to another in order to reproduce, search for food, or seek a better climate or living conditions. Human populations are also said to migrate for economic or political reasons.

millet (n.): a grass cultivated as a cereal or foraging plant.

monoculture (n.): the growing of only one type of crop, or a large area over which it is grown.

moufflon (n.): a big-horned wild sheep.

mulch (n.): a loose material such as strawy dung, laid on the soil around plants to protect roots, retain moisture and to control weeds. It often has a nutritional function for the plants as well.

n

Neolithic (n. and adj.): a prehistoric period corresponding to the Stone Age between 5000BC and 2500BC and the beginning of agriculture and cattle rearing.

NGO (n.): a non-profit non-governmental organization whose work is carried out independently from governments.

nitrates (n. pl.): minerals salts of nitric acid, they are nutritive mineral elements for plants. In zones of intensive agriculture the use of nitrate based fertilizer can frequently lead to pollution of surface and underground water tables.

noria (n.): a long chain of buckets or receptacles on a wheel used for raising water form a stream into irrigation channels.

nutrient (n.): a basic nutritional substance vital to plants or animals that can be absorbed by the organism without the need for digestion.

o

oasis (n.): a small fertile isolated region emerging from a watering hole in the desert.

organic matter (n.): substance originating from living organisms.

ostrich (n.): the largest bird in the world found, it is found in the desert savannah of Africa. It is flightless but is remarkable for its speed in running and can be domesticated.

p

pesticide (n.): a dangerous chemical product intended to eliminate pests usually animals (insects) that damage crop harvests and are therefore considered a nuisance. Pesticides are a major contributor to pollution.

pastoralism (n.): a method of farming based on cattle rearing, it depicts a nomadic, rural lifestyle.

piezometer (n.): an instrument usd to measure the water level in groundwater reserves.

poliomyelitis (n.): an infectious and contagious viral disease that can lead to paralysis.

polyculture (n.): the simultaneous production of several different crops and types of livestock in one region.

r

rain-fed agriculture (n): a method of crop production relying on natural rainfall without artificial irrigation systems.

reforestation (n.): tree replanting activity particularly in an area previously forested or woody.

run-off (n.): to cause to flow out, usually relates to surface water flow from rainfall.

s

SADC: *Southern African Development Community*. This organization aims to achieve development and economic growth and enhance the standard and quality of life of the peoples of Southern Africa. The member States are: Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Seychelles, Swaziland, Tanzania, The Zambia and Zimbabwe.

Sahara and Sahel Observatory (OSS): Its primary objective is to promote the development and the optimisation of data intended for desertification control. Its members are: Algeria, Burkina Faso, Cape Verde, Chad, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Guinea Bissau, Kenya, Libya, Mali, Mauritania, Morocco, Niger, Uganda, Somalia, Sudan, Senegal and Tunisia.

Sahel (adj./n.): the group of countries located south of the Sahara desert, generally between the desert and the Savannah regions.

salinity (n.): mineral salt concentrations in the soil or water. A high salinity results in the loss of fertility and pollutes underground reserves.

satellite (n.): a man-made device launched into space and revolving around the planet. It can receive and send information, take photographs, measure temperature, magnetism etc.

scirroco (n.): a hot, dry, dusty wind blowing from North Africa to the North Meditteranean coast.

semi-arid (adj.): characterized by rainfall not exceeding 500 mm/year (winter rains) or 800 mm/year (summer rains) giving rise to a semi-arid climate.

senecio (n.): any plant from the genus Senecio, distributed throughout most parts of the world.

shelterbelt (n.): fence of planted trees and shrubs that create a barrier against outside influences (fire, sand, wind, animal invasions etc.) (See the case study from China).

sorghum (n.): a drought-resistant plant cultivated for human food consumption and found in Africa and Asia.

sub-humid (adj.): characterized by rainfall whose total equals at least half the evaporation rate but less than the total loss by evaporation resulting in a sub-humid climate.

sustainable development (n.): the management of natural resources that satisfies the needs of present generations without compromising resources for future generations.

t

troglodytic (n.): a cave dwelling either formed naturally or artificially carved out from the rock. The cave dweller is known as a troglodyte.

Tuareg (n.): a nomadic people of the Sahara in Africa.

transhumance (n.): periodic migration of cattle following changes in the seasons, from summer to winter or from winter to summer pastures. They are often led by nomadic populations.

typhoid (n.): an infectious disease, often occuring in epidemic proportions characterized by high fever, loss of concentration and serious digestive disorders.

u

UMA: Union maghrébine Arabe. Member States are: Algeria, Libyan Arab Jamahiriya, Morocco, Mauritania and Tunisia.

UNDP: United Nations Development Programme. Implements projects for social and economic progress and the alleviation of poverty. The organization annually measures the indices (GDP, HDI) on the development of every country in the world.

UNEP: United Nations Environment Programme. Encourages the application of environmentally friendly activities around the world.

UNESCO: United Nations Educational, Scientific and Cultural Organization. Certain UNESCO scientific programmes contribute to combat desertification, notably the Man and the Biosphere Programme (MAB), the International Hydrological Programme (IHP) and the International Geological Correlation Programme (IGCP).

v

vegetation cover (n.): the total sum of plants (generally low-lying plants) covering the ground.

vertebrate (n.): an animal possessing a spinal chord, including fishes, amphibians, reptiles, birds and mammals.

w

water tribunal or assembly (n.): set up by the local community, it reunites the local population to make collective decisions on the distribution of water according to the specific needs of the community. A water 'agent' is appointed who calculates and measures the quantity of water required daily by the locals for washing and drinking etc.

WMO: World Meteorological Organization, a United Nations agency. Encourages scientific research, climate change analysis and promotes the world exchange of meteorological data.

z

zebu (n.): a type of humped domestic ox, originating in India, it is found in China, the east coast of Africa and Madagascar.

List of countries or economic regional organizations signatories to the United Nations Convention to Combat Desertification

(as of December 2000)

(Classification by date of ratification, accession or acceptance)

1. Mexico 03/04/95
2. Cape Verde 08/05/95
3. The Netherlands 27/06/95
4. Egypt 07/07/95
5. Senegal 26/07/95
6. Ecuador 06/09/95
7. Lesotho 12/09/95
8. Finland 20/09/95
9. Togo 04/10/95
10. Tunisia 11/10/95
11. Guinea-Bissau 27/10/95
12. Mali 31/10/95
13. Uzbekistan 31/10/95
14. Afghanistan 01/11/95
15. Peru 09/11/95
16. Sudan 24/11/95
17. Canada 01/12/95
18. Sweden 12/12/95
19. Denmark 22/12/95
20. Switzerland 19/01/96
21. Niger 19/01/96
22. Mauritius 23/01/96
23. Bangladesh 26/01/96
24. Burkina Faso 26/01/96
25. Spain 30/01/96
26. Micronesia 25/03/96
27. Israel 26/03/96
28. Portugal 01/04/96
29. Panama 04/04/96
30. Lebanon 16/05/96
31. Algeria 22/05/96
32. Gambia 11/06/96
33. Malawi 13/06/96
34. Germany 10/07/96
35. Libyan Arab Jamahiriya 22/07/96
36. Oman 23/07/96
37. Bolivia 01/08/96
38. Mauritania 07/08/96
39. Eritrea 14/08/96
40. Benin 29/08/96
41. Norway 30/08/96
42. Mongolia 03/09/96
43. Central African Republic 05/09/96
44. Gabon 06/09/96
45. Botswana 11/09/96
46. Turkmenistan 18/09/96
47. Zambia 19/09/96
48. Lao People's Democratic Republic 20/09/96
49. Haiti 25/09/96
50. Chad 27/09/96
51. Swaziland 07/10/96
52. Nepal 15/10/96
53. United Kingdom of Great Britian and Northern Ireland 18/10/96
54. Jordan 21/10/96
55. Morocco 12/11/96
56. India 17/12/96
57. Ghana 27/12/96
58. Myanmar 02/01/97
59. Argentine 06/01/97
60. Burundi 06/01/97
61. Yemen 04/01/97
62. Paraguay 15/01/97
63. Luxembourg 04/02/97
64. Chine 18/02/97
65. Pakistan 24/02/97
66. Côte d'Ivoire 04/03/97
67. Cuba 13/03/97
68. Mozambique 13/03/97
69. Iran (Islamic Republic of) 29/04/97
70. Greece 05/05/97
71. Barbados 14/05/97
72. Namibia 16/05/97
73. Grenada 28/05/97
74. Cameroon 29/05/97
75. Austria 02/06/97
76. Iceland 03/06/97
77. Antigua and Barbados 06/06/97
78. Syrian Arab Republic 10/06/97
79. Djibouti 12/06/97
80. France 12/06/97
81. United Republic of Tanzania 19/06/97
82. Guinea 23/06/97
83. Italy 23/06/97
84. Kenya 24/06/97
85. Brazil 25/06/97
86. Honduras 25/06/97
87. Madagascar 25/06/97
88. Malaysia 25/06/97
89. Saudi Arabia 25/06/97
90. Uganda 25/06/97
91. Dominican Republic 26/06/97
92. Equitorial Guinea 26/06/97

Liste des pays ou organisations économiques régionales d'intégration ayant ratifié la Convention des Nations Unies sur la lutte contre la désertification (situation décembre 2000)

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Learning
to combat desertification

This document is part of the Environmental Education Kit on Desertification published by UNESCO and the UNCCD.
The kit is available in three languages (English, French and Spanish) and comprises five documents:
A Teacher's Guide: *Learning to Combat Desertification*
A Series of Case Studies: *Combating Desertification Bears Fruit*
A Cartoon: *The School Where the Magic Tree Grows*
A Cartoon: *There is No Rug Big Enough to Sweep the Desert Under*
A Poster: *Desertification in the World*.

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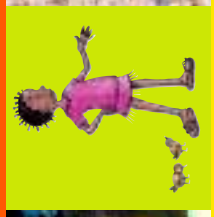
Education Kit on desertification

Case studies



Combating desertification bears fruit

Case studies

Case studies compiled within the spirit of the **United Nations Convention to Combat Desertification**

Combating desertification bears fruit

What makes the desert beautiful is that somewhere hides a well...

– Antoine de Saint-Exupéry

The case studies in this compilation are designed to provide concrete examples of successful projects undertaken within the spirit of the United Nations Convention to Combat Desertification (UNCCD).

All statistics mentioned in this document are provided by the *United Nations World Statistics Pocketbook* (United Nations publications, 1999)

How to use the case studies series

The case studies are addressed to teachers at the end of primary school education

and make up part of the pedagogical kit on desertification devised by UNESCO and the UNCCD. They were submitted by the UNCCD national focal points and by non-governmental organisations, (NGOs) working in the field of combating desertification in response to a joint letter sent from UNESCO and UNCCD inviting them to submit examples of projects to combat desertification. Two case studies were retained from UNEP (United Nations Environment Programme) within the framework of the 'Saving the Drylands' award. Choosing the case studies from the numerous replies received was no easy task, but the final selection attempts to provide a global vision of the root causes and consequences of drought and desertification in the different regions of the world. We would like to thank all the UNCCD national focal points and the NGOs who have participated, and in particular those involved with the case studies that were not included for reasons of a structural nature.

Attentive reading of the case studies should provide the teacher with the knowledge base necessary to help combat desertification.

In the classroom, he/she will be able to enhance his course on desertification with positive examples intended to persuade children to adopt a healthy attitude towards their environment and the scarce natural resources present in their region. The global approach of this compilation, introducing the causes and consequences of desertification as well as solutions in the continents affected, aims to raise awareness among children affected by universal environmental problems. In addition, comparing methods employed by different people will help all those concerned to think globally, enlarging the horizons for each of them.

At the end of each case study, 'classroom activities' are proposed that will help the teacher incorporate the case studies throughout the course.

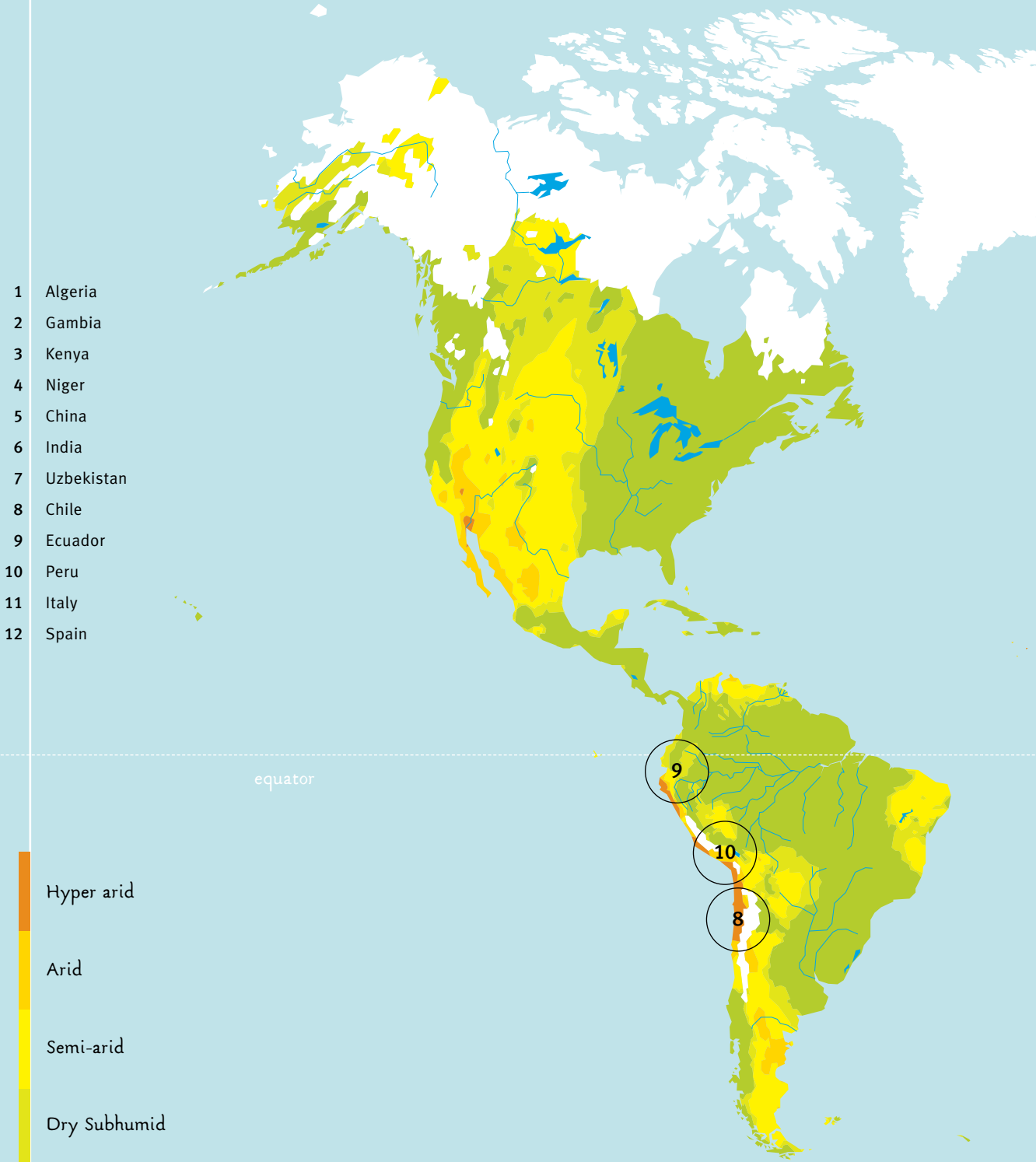
When discussing a particular project in class, the teacher could invite the children to respond by asking them to locate the country in question on a map and compare them with their own situation. Finally, tasks including drawing assignments, questions and answers and role-playing could be assigned to complement the study.

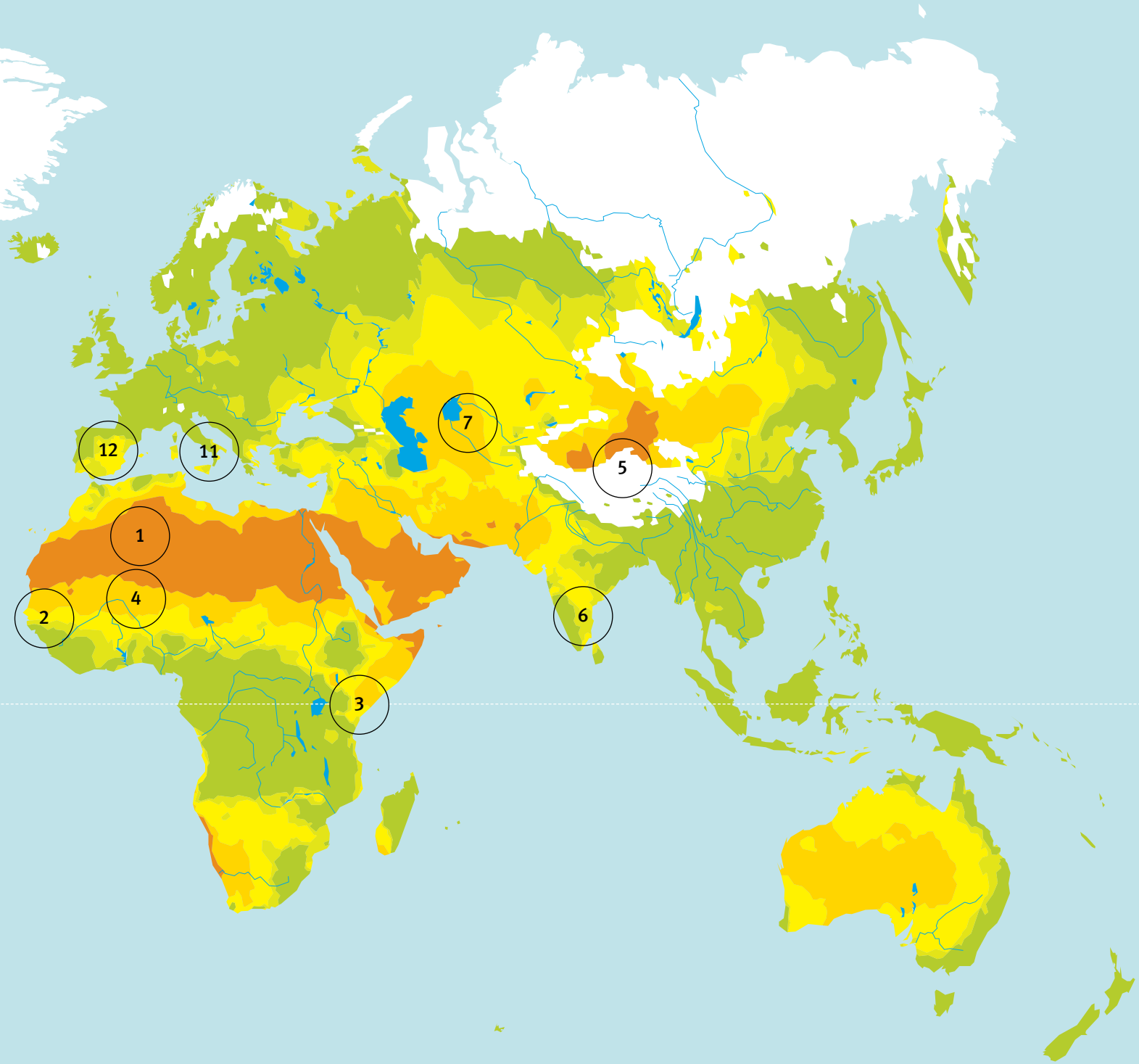
The words underlined throughout the text are explained in the glossary at the end of the collection.

Happy reading and good work! You'll see. Combating desertification bears fruit!

Contents

World Map of Aridity Zones





Source : CRU / UEA, UNEP / DEWA

COUNTRY	THEME	EXAMPLE	SOLUTION
Algeria	Irrigation	Algerian Oases	Foggaras

A rehabilitation model of traditional techniques:

Oasis irrigation and the use of the foggaras system

The oases in the Algerian Sahara illustrate effectively how man has succeeded in surviving hostile conditions. Over the centuries, an efficient and sustainable irrigation system has been applied that has allowed the inhabitants of the oasis to live in conditions of extreme aridity while respecting the particular properties of these unstable ecosystems. However, over the course of the past few years, the Saharan oases have come to experience strong demographic growth along with the intensification of agricultural production. In this particularly fragile environment, the inhabitants of the oases tend to forgo traditional knowledge regarding water resources. Also, modern techniques to pump water from underground sources dry up the groundwater reserves in a way that is irreversible. For this reason, the rehabilitation of the *foggaras*, a system of traditional irrigation, is recommended in the oasis of Touat in south-eastern Algeria.

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Photo 1. The foggaras system distributes water throughout the oasis.

The Saharan oases

The majority of Saharan oases in southern Algeria are made up of marginal areas where the extremely arid climate and low rainfall, averaging only 50 mm a year, result in areas that are greatly affected by the degradation of water resources and where the level and flow decreases daily. In addition, the population has grown rapidly in the past few years. This strong population growth is accompanied by agricultural intensification. The arid areas, where most of the degradation occurs, are largely the result of the consequences of ill-adapted human practices that jeopardize biological diversity in the Saharan region.

COUNTRY DATA: ALGERIA

Africa | Algeria | Oasis du Touat

Region:	**North Africa**
Capital:	**Algiers**
Surface area:	**2,381,741 km²**
Population :	**30,775,000 inhab.**
Population density:	**12 inhab./km²**
Infant mortality rate (per thousand births):	**44**
Fertility rate (births per woman):	**3,8**
Population growth rate (per annum):	**2,3 %**
Life expectancy ♀ – ♂:	**70 – 68 years**
Average temperatures (min./max.):	**5.9 / 31.2°C**
Forest cover:	**1 %**

Causes and effects
of the drying up of the oases

The intensification of irrigated agriculture in this fragile environment contributes to the over-exploitation of natural resources. The inhabitants of the oases have to dig deeper wells and cultivate ever-increasing areas. They have introduced industrial products such as chemical fertilizers while gradually neglecting traditional knowledge.

In fact, the immense agricultural areas are cultivated for the production of cereal for export. The system uses a jet watering system that is ill adapted to desert conditions, the degree of evaporation is very high while the tube openings are at risk from being obstructed by sand. The level of groundwater reserves decreases to a critically low level due to the vigorous pumping of large quantities of water from great depth.

Possible solutions

The Mediterranean Co-operation of the MED Forum, a network of Mediterranean non-governmental organisations (NGOs) for ecology and sustainable development, and the Algerian association Touiza, agreed to set up a programme to protect the oasis ecosystem. Its principal objective is to integrate respectful environmental practices and traditional local customs in the affected areas.

The programme covers four representative oases in the Touat region, close to Adrar in the south-eastern part of Algeria (See map). Activities include a programme to restore palm trees and a public awareness campaign that produced a practical guide on the preservation of the oases through the rehabilitation and repair of traditional systems called *foggaras*.

The foggaras

The *foggaras* are manmade underground galleries that harvest water. They effectively capture water found at depth and transport it to the surface. Underground piping runs almost horizontally and transports the groundwater to the oasis by means of a slight incline of one or two millimetres per metre.

For the system to work, the oasis must be located in a valley or at the foot of a rift, so that it is below the level of the underground source. The Adrar oases are all located below the plateau of Tadmait where the groundwater source flows. The first wells are dug upstream from the oasis. The gradual sloping of the galleries reduces the speed of the flow, thus preventing the water from dragging the soil with it, which would result in the erosion of the galleries. This ingenious method uses gravity to transport water throughout the year.

The materials used for the construction of the *foggaras* come from the surrounding area. Blocks of stone are cut, clay and straw are combined to make a cementing mix and palm trunks are used to consolidate the underground galleries. The average length of the galleries is 2.5 km and they include vertical wells found every 20 to 30 metres used to aerate and repair the *foggaras* (Fig. 1).

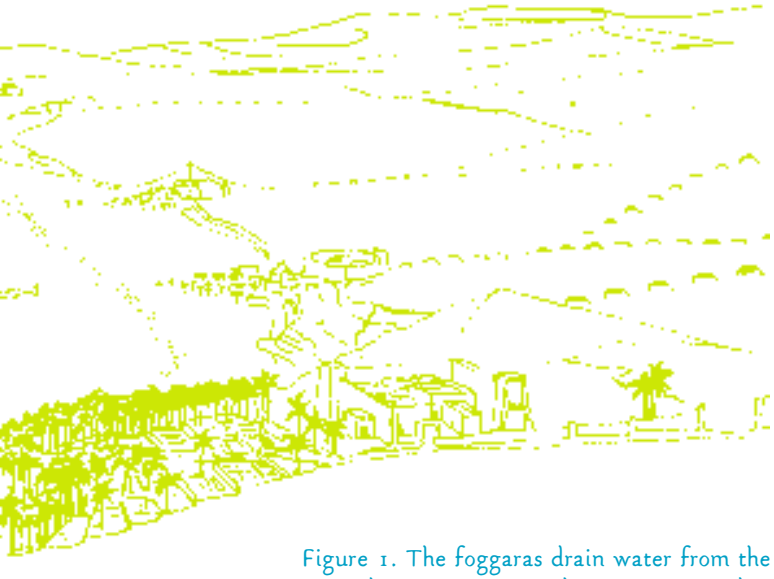


Figure 1. The foggaras drain water from the groundwater sources to the oases. Vertical wells along the underground galleries provide aeration and allow for maintenance. (Illustration: Concetta Fornaro and Debora Giorgi, Milan 1996)

The *foggaras* allow for the passive transport of water, relying only on the force of gravity. Water is captured underground and flows under the earth, which prevents its evaporation, until it is close to the oasis where it flows into an open-air canal (*seguia*). A small triangular basin (*quasri*) collects water that arrives at the oasis by way of the seguia (photo 1 and 2).
With the help of a stone device in the shape of a comb (*kesria*), the water continues to irrigate the oasis (Fig. 2). The community sets up a 'water assembly' where decisions are made on who receives how much water among those who possess water rights in response to variations in water supply. Everyone is free to exercise his or her rights and demands for water.
The 'water deciders' are then responsible for the distribution of water.

The *foggaras* almost certainly originated in Iran, where they have been known for 3,000 years and are called *ghanat* or *quanat*. They are also used in Morocco, where they are called *rhettaras*. In Algeria, the work of maintaining the *foggaras* is considered to be very unrewarding and dangerous and has gradually been abandoned (Photo 3).

In their present state, galleries that have collapsed allow the flow of only a small trickle of water. Moreover, the development of so-called modern agriculture requires that large quantities of water be pumped under high pressure. The water on the same level as the *foggaras* is thus depleted, and the groundwater levels decline, resulting in the drying up of the *foggaras*.

To overcome this crisis situation, local communities dig new wells upstream from the foggaras to improve the flow of water. Meanwhile in the oases that have electricity, wells are dug downstream from the *foggara* exit and an electric pump is used to draw water from the *foggaras* to the recuperation basin.

Photo 2. The *kesria* permits water distribution in the oasis.

The populations of the four Touat oases that have been chosen, are the direct beneficiaries of the Touiza project. However, other developments in the future are expected. Touiza and the MED Forum intend to pursue their work in the field after completion of the project, by supporting initiatives and projects in which the population continues to participate once projects have been implemented.

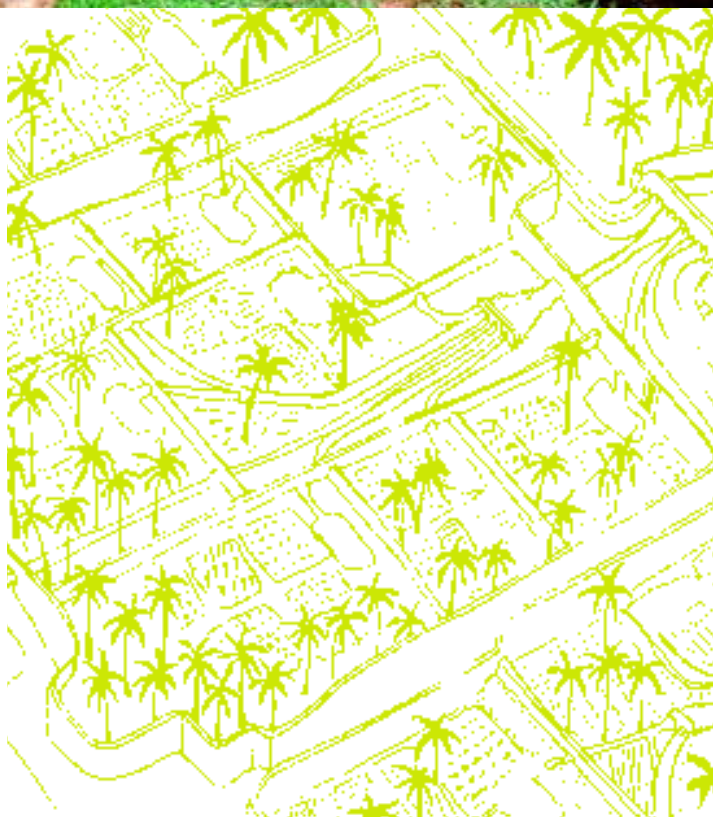
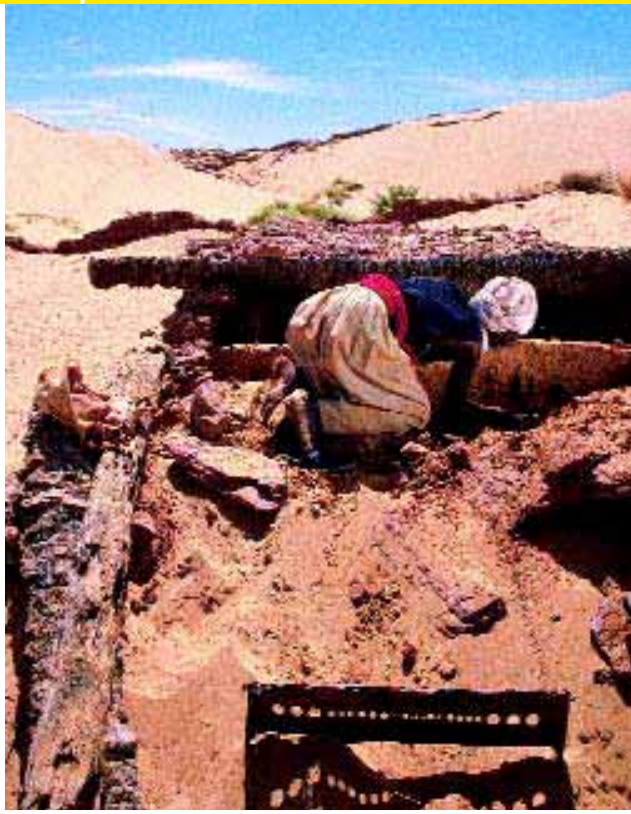


Figure 2. Water is distributed throughout the oasis according to a complex system of ownership. Water is tapped into open-air piping that distributes water to the various fields.
(Illustration from Concetta Fornaro and Debora Giorgi, Milan 1996)



© Pietro Laureano

Photo 3.
In Algeria, the foggaras had been progressively abandoned: today they are being restored.

Even after local participation has been secured, the population will benefit from workshops on how to save water, combat pollution and desertification and how to preserve palm trees and rehabilitate *foggaras*. In addition, the know-how acquired during the project will be compiled in a manual to be applied to other oases in Algeria as well as in other countries.

Conclusion

The objectives of the MED Forum and the Touiza Association are to promote sustainable development and the preservation of the oases in the Saharan region of Algeria while ensuring the well being of their populations by simultaneously fighting poverty and desertification. Their specific goal is to guarantee an integrated approach and the participatory management of natural resources and of agricultural ecosystems in the four oases near Adrar.

Activities comprise:

1. Diagnostic

* Compilation of an inventory of the natural resources being depleted and the traditional techniques that can be used to tackle the problem.

2. Capacity-building

* Training courses on environmental education for teachers.
* Workshops for the preservation of palm trees and *foggaras*.
* Workshops on water conservation.
* Workshops on small-scale cattle-rearing.
* Introduction to project management and development.

3. Participatory management: Pilot projects

* Organization of volunteers for the rehabilitation of the *foggaras*.
* Micro-projects involving raising domestic animals (purchase of 200 goats to distribute to women and youth).
* Institutional support for communities and local NGOs.
* Surveys and participatory workshops.

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Classroom ACTIVITIES

The teacher explains the *foggara* irrigation system to the class.

Draw the Saharan desert: sand dunes and an oasis. You can paste your picture to the wall chart. (See Teacher's guide).

Where is Algeria located? Is your country on the same continent as Algeria? What characterizes the Algerian climate compared to your country? Are the problems of desertification in Algeria the same as those found in your region? What are the differences? What are the similarities?

What do you think of the idea of rehabilitating the *foggaras*? Do you know of traditional irrigation techniques in your country that are friendlier to the environment than modern techniques and that might be re-utilized? Or have modern techniques improved the water supply? Ask the elders in your village and your grandparents how they acquired water when they were young. Has it changed today? For the better or for the worse?

Imagine a 'water assembly' in your school. Some of the pupils can play the role of 'water deciders' who decide how the water will be distributed. The others could explain why they need water. They could be farmers, cattle breeders, have large families, etc. They discuss among themselves the best ways to save water so that there is enough water for everyone and that it is distributed intelligently.

Tick the correct answers from the following:

In Algeria the foggaras are used to:

- eliminate sewers.
- transport water.
- irrigate the oasis.
- feed the animals.
- transport people.
- prevent the drying up of groundwater reserves.

Draw a map of an oasis with its system of foggaras, which distributes water across the land (Fig. 2).

COUNTRY	THEME	EXAMPLE	SOLUTION
Gambia	Bush fires	Community forestry	Green belt

How to reduce bush fires:

Creation of a green belt around the forest perimeter

Gambia is one of the poorest and most densely populated countries in Africa. Situated in the Sahelian region of West Africa, it is characterized by a Sudano-sahelian climate. Since the late 1960s, Gambia has been subject to severe devastating drought, the worst being the drought of 1968-74.

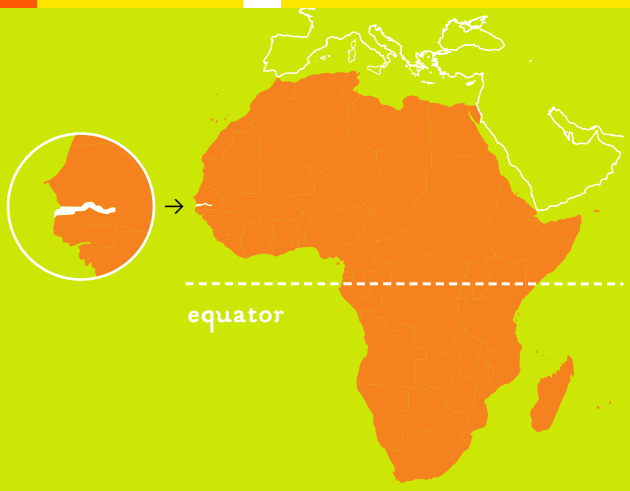
Gambia has a predominantly agricultural based economy with an estimated 72% of the population directly engaged in agricultural activities. The agricultural system of extensive cropping is widespread and includes massive clearings and deforestation since productivity depends on the agricultural land available. The deforestation rate in Gambia is 6% per year. In addition to deforestation, the country suffers serious land degradation caused by cattle. Ill-adapted agricultural practices such as continuous cropping without the use of natural fertilizers and the application of bush fires have left their mark on the environment with disastrous consequences.

Community forestry

The Forestry Department of Gambia has developed a community forestry programme that operates on an exchange system of ownership rights, from a model managed solely by the government to a system of community and forest authorities management. In fact, the rural communities and non-governmental organisations (NGOs) are directly involved in forest protection. The objective of community forestry is to meet the needs of the growing population in a way that is sustainable by making forest products available to them, ranging from fruits, grains and medicinal plants to wood for energy and construction. In particular, the community forestry policy aims to protect forest resources by supervising bush fires, controlling the harvesting of forest products and preventing illegal tree felling.

COUNTRY DATA: GAMBIA

Africa | Gambia



Region:	**West Africa**
Capital:	**Banjul**
Surface area:	**11,295 km²**
Population:	**1,268,000 inhab.**
Population density:	**103 inhab./km²**
Infant mortality rate (per thousand births):	**122**
Fertility rate (births per woman):	**5,2**
Population growth rate (per annum):	**3,2 %**
Life expectancy ♀ – ♂:	**49 – 45 ans**
Forest cover:	**9 %**

Photo 1.
Bush fires can spread dangerously. They are often started by hunters and can easily become uncontrollable.

Community forestry also intends to combat the effects of drought. Environmental rehabilitation measures have been taken, such as planting trees, agro-forestry and introducting certain forest crops without the need to cut down trees. Furthermore, the programme is designed to provide sufficient fodder for cattle, through forest products, so that overgrazing at the forest borders will be reduced or entirely eliminated.

The government also provides technical assistance in the form of forest management with demonstration activities, training courses and advisory services in keeping with the community forestry concept.

COUNTRY	THEME	EXAMPLE	SOLUTION
Gambia	Bush fires	Community forestry	Green belt

Causes and effects of deforestation

In Gambia, deforestation is mainly a consequence of bush fires and the illegal logging of trees.
Bush fires have a variety of origins.
For example, beekeepers traditionally use fire and smoke to harvest honey, but this sometimes leads to forest fires and vegetation loss. Bush fires are often used to facilitate hunting, since animals are more visible in a treeless landscape. Finally, slash and burn techniques are applied on the edge of forests. It is easy to lose control of these fires that significantly destroy vegetation and the landscape. In addition, cigarettes that are carelessly discarded in the forest can start fires (Photo 1).

Trees are extensively felled for firewood for commercial and domestic heating or as a raw material for the construction of fences, roofs and boats. Trees are also burned to produce charcoal for heating, even though the practice has been legally banned in the country since 1980. Forests are cleared for the extension or establishment of villages and cities. Livestock breeding or rearing often calls for bush clearings and the cattle are often allowed to overgraze on marginal forested areas. Certain forest zones are cleared for mining and extraction of sand and gravel.

The resulting effects of deforestation are soil erosion and land degradation, characterized by the deterioration of soil properties, the structure and the texture of the soil are modified, which results in stretches of hard clay and very sandy soils. In Gambia, 43% of the total land area is classified as forest. However, 78% of this forest has been degraded. The vegetation cover has been destroyed and the soil is desiccated. Poverty, malnutrition and disease have increased due to the lack of natural resources.

Photo 2. The most widespread agricultural system in Gambia is extensive cropping, which explains the massive clearings and deforestation.

Possible solutions

In Gambia, attempts are being made to resolve the problems related to desertification through an integrated approach of co-operation between different institutions. NGOs have elaborated a programme in partnership with government authorities. These institutions support the Forestry Department and its programme to combat desertification.
The programme's objective is to protect the forest from the annual cycles of fire, and on a national scale, to reduce illegal tree felling and to control the irrational exploitation of forest resources. Certain aspects of the programme contain an educational component.
This case study is centred on the establishment of a community forest programme of the Forestry Department and on the creation of green belts to combat forest fires.

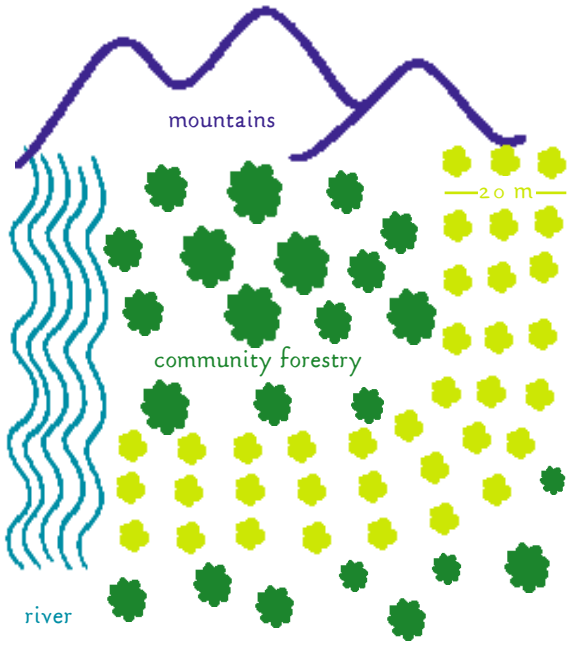


Fig. 1: The green belt is composed of three rows of trees on a deforested strip.
© Kebba Bojang UNESCO

The green belt

In the initial phase of the programme, interested local communities were made aware of the concept of community forestry. This enabled them to organize a committee to represent, prepare and implement their own forestry management plans.
In the implementation phase of the programme, the community created a green belt (composed of trees) around the forest to protect it from fire (Fig.1). This green belt is created by felling trees within a strip of 20 metres around the forest, except in forest borders that are naturally protected by rivers and hills. On the deforested strip, at least three rows of trees are planted. The planted species are *Gmelina arborea*, *Anarcadium occidentale* and *Cassia spp*. They are fire resistant and grow rapidly.

Mature trees form a thick crown of vegetation that prevents grasses from growing and protects the interior of the forest from fires. These areas increasingly represent an economic and social value for the communities.
An evaluation report showed that the community forests did not experience bush fires or illegal activities for at least three consecutive years. The communities benefited from 85% of forest revenues and from the domestic use of the harvested wood. The Forestry Department receives 15% of forest revenues, which is then reinvested through the National Forestry Fund.

COUNTRY	THEME	EXAMPLE	SOLUTION
Gambia	Bush fires	Community forestry	Green belt

© Rex Keating UNESCO

Photo 3. The Gambian economy is dependant on agriculture. 72% of the population is directly involved in agricultural activities.

© Rex Keating UNESCO

Conclusion

The Community Forestry Programme brings technical support to the institutions involved in natural resource conservation and their sustainable use.

• A revision of the Forestry Law of 1998 enabled communities to take action on any forest destruction observed in community forests.
• Associations were established to promote community participation on forest management.
• Profitable use of forestry resources is encouraged and their value has increased.
• More importantly, the concept of community forestry introduces the notion of forest ownership and of community resource management.

The activities of the Community Forestry Programme are organized by the Forestry Department and by the German government, which offers technical and financial assistance (a forestry project between Germany and Gambia). Furthermore, the forestry projects undertaken in the river basin of the central shore and the high basin area of Gambia are engaged in the Community Forest Programme.

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Classroom ACTIVITIES

The teacher explains the green belt system to the class.

Imagine creating a green belt surrounding a wood or a forest in your region. Where would you begin? Which species would you plant? Discuss this with your classmates.

Learn to locate Gambia on the world map. Is your country located on the same continent as Gambia? What characterizes the climate of Gambia compared to your country? Are the problems in Gambia the same as those found in your region?
What are the differences?
What are the similarities?

Have you already seen bush fires or forest fires in your region? How did they start? How can you avoid them?

In your desertification notebook, draw a diagram of a forest surrounded by a green belt that stops fire.
(See Fig.1).

What do you think of the idea to create a green belt around the forest to protect it from fire?

Tick the correct answers from the following:

In Gambia, bush fires are started by:

- poachers.
- cigarettes.
- campers.
- lightning.
- beekeepers.
- local farmers.
- animals.

Draw a bush fire with animals that cannot hide from the burning trees. Explain what you have drawn.

COUNTRY	THEME	EXAMPLE	SOLUTION
Kenya	Sustainable agriculture	Thugi River	Rehabilitation of embankments

Sustainable agriculture driven by local volunteers:

Rehabilitation of the banks of the Thugi River

Photo 1. A vegetable plantation in Kenya.

COUNTRY DATA: KENYA

Africa | Kenya | Muruka

Region:	**East Africa**
Capital:	**Nairobi**
Surface area:	**580,367 km²**
Population :	**29,549,000 inhab.**
Population density:	**57 inhab./km²**
Infant mortality rate (per thousand births):	**66**
Fertility rate (births per woman):	**4,4**
Population growth rate (per annum):	**2,0 %**
Life expectancy ♀ – ♂:	**53 – 51 years**
Average temperatures (min. - max.):	**9.1 / 26.8°C**
Forest cover:	**2 %**

Desertification presents a major obstacle to development. One of the causes of desertification is poor land use. In Kenya, the objectives of the School and Dropout Services' project are to raise awareness among the community and to use natural resources in a sustainable way so as to maximize production of small agricultural tracts.

The rehabilitation project of the Thugi riverbanks in the Kandara Division began in 1981. It was conducted with local volunteers on a self-help basis. Its projected goals were to educate the population on proper land use techniques and tree planting to combat land degradation. The local community was also encouraged to use alternative energy sources and to render agricultural production more efficient while developing other income generating activities. Controls for measuring land erosion and water conservation were also established (Photo 1).

The Thugi River

Muruka is a densely populated region situated in the southern part of Kenya, intersected by the Thugi River (See map). Over 54,000 inhabitants live in the area covering 13 km² mainly from the Gikuyu ethnic group. In general, women and children occupy and tend the land. Thirty-five years ago, the region was covered with bushes and natural forests where many wild fruits were available.

More than twenty years ago, Muruka benefited from abundant rains, and planting was rotated twice a year during the long rain and short rain seasons. Millet, sorghum, yams, bananas, cowpeas and other crops grew easily. Today, the area has become very dry. Most of the crops have disappeared with the exception of corn, beans and potatoes, and even these do not grow well.

COUNTRY	THEME	EXAMPLE	SOLUTION
Kenya	Sustainable agriculture	Thugi River	Rehabilitation of embankments

Causes and effects of land degradation

As a result of uncontrolled exploitation of the forest, overgrazing and agricultural malpractice, the land has become barren and suffers from serious erosion.
The furrows along the length of the river were communally used for seasonal crops such as bananas, arrowroot and sugar cane. However, now the banks of the river are very dry and the soil lacks fertility. Vegetation cover is scarce in the areas surrounding the river, the superficial top layer of soil is washed away by the rains and succumbs to erosion right up to the embankments.

Land degradation is observed among the majority of land plots. The majority of inhabitants of the region are small farmers who have been using the same agricultural methods for generations. The land has been over-exploited for many years by practices that include foraging for cattle fodder and firewood. Vegetation cover can no longer develop and animals generally trample on the edge of the paths. The area of a typical plot of land is small, starting at 1,200 m^2 up to 1.5 hectares for a family of 5 to 10 individuals (one hectare is equal to 10,000 m^2).

With coffee plantations taking up most of the land, the small portions remaining are mainly used for subsistence farming and the majority of local farmers use chemical fertilizers. (Natural fertilizers such as compost are often preferred to chemical fertlizers. Also, the overuse of chemical fertilizers can have negative effects on the land however, only the specific characteristics of each area as well as the production method practised can truly determine whether the use of fertilizer, and its concentration, is advantageous).
For the past twenty years, the rains have not been very reliable. The prevailing dry periods have created food supply problems.
The rains have been unfavourable to basic crops such as corn, potatoes and beans and food insecurity has resulted. Many local farmers are obliged to buy food to meet the needs of their family because the soil has become completely sterile.

Poverty is growing and the majority of households survive on a day-to-day basis through their work in the nearby coffee plantations, with much of the work performed by children whose schooling is interrupted before the end of primary school education.
From the 1920s up until around the 1970s, every household possessed food granaries or pantries containing provisions covering periods of difficulty. Following each harvest, the local farmers stored corn, beans or pumpkin in reserve and every household possessed a specially devised container to ripen bananas. Today these granaries have disappeared or they are used for storing tools and other family household objects.

Possible solutions

Women perform most of the domestic chores such as gathering wood for fuel, rearing livestock, fetching water, cooking and cleaning as well as raising the children. Also, many other agricultural tasks are assigned to women, from overseeing ploughing to harvesting and drying fruit. Women are entirely dependent on their land and spend most of their life tending it. They place all their hopes in this land. However, the income earned from this work belongs to the man of the household.

With this in mind and faced with the difficulties confronted by women, the members of the association School and Dropout Services organized a public awareness seminar to combat desertification and encourage sustainable development targeted at women. The idea of rehabilitating the Thugi riverbanks was hatched during

discussions on the difficulties faced by women when fetching water. The riverbed is very deep, and it became increasingly dangerous to collect water because of the slippery banks. The women often had to walk between 1 km and 3 km on hilly ground, transporting water on their backs (Fig. 1).

The School and Dropout Services Association decided to launch a pilot project with very limited financial resources to rehabilitate the banks of the Thugi River. To begin with, its members had little idea of how to achieve this. Then someone proposed planting trees. But trees do not always grow to adult size, as they are often cut down young for firewood. However, planting bamboo seemed to be a good alternative, since it grows in clusters that are beautiful to look at.

Photo 2. Tomato crops in Kenya.

Embankment rehabilitation

The area around the Thugi River in the 1950s–1960s used to be marshy with reeds, but the lands were cleared for agricultural purposes. During the rainy season, the river flooded the agricultural plots. In the dry season, the local farmers dug trenches so that water flowed from the river to the individual plots.
In this way, the farmers were able to grow arrowroot, sugar cane, vegetables, maize, potatoes and other crops (Photo 2).

The portion of the Thugi River in Kiranga, in the district of Maragwa, was selected for the rehabilitation of the embankments (Fig. 2). A shamba, a small plot of land used in subsistence farming, was selected in 1981 and bamboo was planted along the banks. An agricultural counsellor from the region became interested in the project and the financing was assured by donations.

One of the difficulties consisted of finding bamboo seedlings to plant. The volunteers identified an area in Nairobi with a large quantity of bamboo, about 100 km from Muruka.
Several individuals volunteered to uproot bamboo shoots with the roots, a process that is rather difficult to achieve. A few days were required to arrange the bamboo shoots for replanting. It was not certain that the bamboo would grow again once it had been transplanted. After a few weeks, the shoots, which were watered every day, started to produce new leaves and within no time a hedge began to take shape. Today, after a few years, the plants are mature and can be harvested as fence poles.

COUNTRY	THEME	EXAMPLE	SOLUTION
Kenya	Sustainable agriculture	Thugi River	Rehabilitation of embankments

In the shamba that was chosen, bamboo was planted despite strong resistance from the farmers. They argued that the bamboo roots would ruin the earth of the shamba and that nothing else would grow there.

Today, the bamboo is mature and has thrived. The embankment mounds have become firm and stable, so that a rise in water level does not immediately flood the surrounding plots despite the depth of the riverbed.
The plot directly opposite the planted shamba, on the other side of the river, belongs to an owner who did not want to plant bamboo: instead he extended his plot right up to the riverbank. There, the riverbank has widened and even encroached on agricultural land (Fig. 3). This clearly demonstrates that planting bamboo contributes to the rehabilitation of the banks of the Thugi River.

Conclusion

The rehabilitation of the Thugi River embankment controls the evolution of the riverbed, which continues to eat away the riverbank.
The bamboo plantation has proven to be effective in stabilizing and reinforcing the soil and in preventing bank erosion. Thus, the land surrounding the river embankments can be cultivated without the fear of gully erosion or flooding.
The following measures were necessary for the rehabilitation of the Thugi River banks:
- **Training the population in adequate farming methods.**
- **Rehabilitation of regions affected by desertification.**
- **Environmental education.**
- **Public awareness campaigns.**
- **Funds for supporting community projects.**

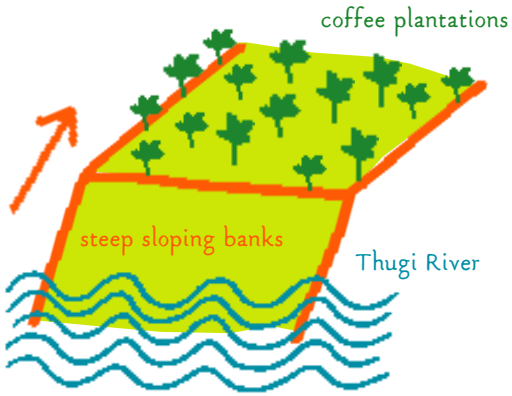

Figure 1. Illustration showing the shores of the Thugi River in Kenya. © School and Dropout Services

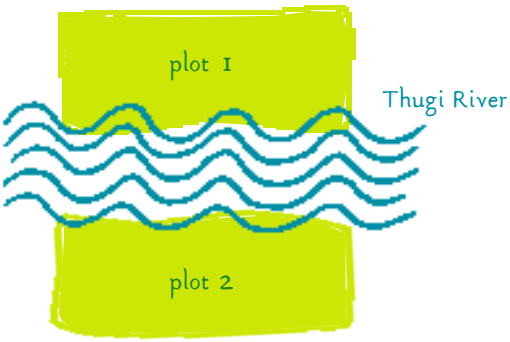

Figure 2. Diagram of the banks of the river Thugi. © School and Dropout Services

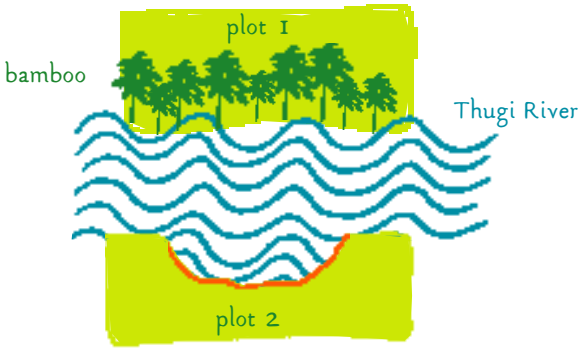

Figure 3. Plantations on the shores of the river. In the first plot, erosion has been reduced. © School and Dropout Services

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Classroom ACTIVITIES

The teacher tells the class how planting bamboo rehabilitates the banks of the Thugi River.

Where is Kenya located?
Is your country on the same continent as Kenya?
What characterizes the climate of Kenya compared to your country? Does your region encounter the same problems of desertification?
What are the differences?
What are the similarities?

Design the Thugi River banks with one side planted with bamboo and the other side cleared. In your drawing, show how the planted side is stabilized compared to the cleared side that is collapsing and eroding.
Explain your picture.

Is there are a river in your region? What are the banks like? Would it be useful to plant bamboo or other local species to stabilize the banks?

Devise a play showing two owners who own an agricultural plot on either side of the river. One of them has planted bamboo trees on his bank, the other has refused saying that it would interfere with crops.
It's up to you to imagine the rest!

Tick the correct answers from the following:

In Kenya, bamboo is planted on the Thugi River embankment to:

- prevent the local farmers from cultivating coffee.
- facilitate access to the river.
- act as a sand barrier.
- act as a windbreak.
- reduce noise.
- stabilize the riverbed.
- prevent flooding.

COUNTRY	THEME	EXAMPLE	SOLUTION
Niger	Exploitation of firewood	Domestic Energy Strategy (DES)	Rural markets

How to control the exploitation of wood:

Rural markets and domestic energy strategy

© Thomas Schaaf

Photo 1.
In Niger, the process of desertification is accelerated by the uncontrollable exploitation of firewood.

During the past twenty years, Niger has experienced rapid population growth with greatly increasing pressure on energy sources. Wood is the primary source of domestic energy and collection of this resource has reached alarming proportions. This situation adds to the current constraints placed on food reserves and adds to other factors such as drought, poor development of agriculture and overgrazing.

The consequences of this are clear: the forests are damaged and the process of desertification has accelerated. In an attempt to contain the phenomenon and promote sustainable development through the controlled exploitation of wood resources, the Government of Niger has introduced a system of 'domestic energy strategy' (DES) insisting on the need for participation among rural communities to sell wood within a controlled system of rural markets.

COUNTRY DATA: NIGER

Africa | Niger | Niamey

Region:	**West Africa**
Capital:	**Niamey**
Surface area:	**1,267,000 km2**
Population :	**10,401,000**
Population density:	**8 inhab./km2**
Infant mortality rate (per thousand births):	**115**
Fertility rate (births per woman):	**6,8**
Population growth rate (per annum):	**3,2 %**
Life expectancy ♀ – ♂:	**50 – 47 years**
Forest cover:	**2 %**

Wood as a principal source of domestic energy

Studies undertaken in 1990 show that the town of Niamey consumes as much as 133,000 tons of wood a year. By 1994, the growing population led to an increase in demand, which has now reached 150,000 tons. This trend is continuing (Photo 1). However, it is possible to preserve the forest without exploitation, providing it is done in a way that is reasonable and selective.

Photo 2. Rural firewood markets take place close to the villages and near to exploitation sites. Transport to urban areas is carried out by trader-transporters.

Causes and effects of uncontrolled forest exploitation

It is estimated that 98% of families use wood to meet their energy needs for cooking. Some ten to twenty years ago, firewood came from dead trees or branches, while today the use of 'live' trees has been observed. This is often due to logging linked to deforestation practices. Over the past twelve years, the exploitation of wood has proved to be more lucrative than traditional agricultural activities or cattle rearing (Photo 5).
The trader-transporters leave their men in the forest for several weeks to collect wood without any restrictions.

The situation has been aggravated by the fraudulent means to obtain the transport of wood to the markets, since high profits are at stake.
It soon became urgent for the environmental services to rethink their intervention policy or else suffer the consequences of the massive destruction of ecosystems.

COUNTRY	THEME	EXAMPLE	SOLUTION
Niger	Exploitation of firewood	Domestic Energy Strategy (DES)	Rural markets

Possible solutions

To succeed, development policy must take into account its principal potential users, in this case, the local villagers from the forest areas. Starting in 1981, the state initiated and tested a new control policy for the exploitation of wood while managing the protected forest of Guesselbodi, among others. Other forest planning developments have been implemented, such as in the forest region of Gorou Bassounga and Faira, to name but two. Furthermore, DES has been developed so that the wood consumption of households is managed in a way that will not cause shortages in the future, particularly in towns. DES also seeks to promote alternatives to wood by promoting the use of petrol or gas. Although these are non-renewable energy sources, they do present less immediate damage to the environment (See Unit 19 of the *Teacher's Guide*).

DES and the rural markets

DES was launched in Niger in 1989. The programme consists of making wood production more efficient, as well as the commercialization of the products. It involves putting the villagers at the heart of the strategy and making them the true custodians of the rural landscape (Photo 1). They manage their forest capital and in return they recuperate an income generated by their activity. This policy preserves biological diversity, provides jobs and revenue to the villagers and boosts the states' tax receipts.

DES is associated with the production and distribution of wood, the commercialization of which takes place in rural markets. Set up by private operators, these markets are places where wood is sold (wood and charcoal) and are managed by local producers, away from large cities.

The DES policy not only ensures that the wood comes from controlled production, which is more competitive than traditional production, but also more importantly, it insists on the rational and controlled utilization of wood resources. Satisfying the energy needs of the Niger population, without destroying their production source, is a major concern. The rural firewood markets are held close to the plantation sites and it is the responsibility of the wood trader-transporters to deliver the wood to urban centres (Photo 2).

Their costs are incurred at three levels:
- the cost of the wood bought from the managing committees of the rural markets.
- the on-site payment of taxes demanded by the committees.
- the transport and conditioning of the product, necessary for the delivery of wood to the consumers.

Photo 3. Firewood is used by 98% of households.

The most important aspect of the plan remains the levy of transport tax deducted when the wood is purchased by the traders. A portion of the total sum of the transport tax is paid back to the state so that it may continue its supervisory task and provide the means to finance rural development and reforestation programmes. In fact, between 40% and 60% of fiscal receipts are allocated to forest planning programmes such as agro-forestry plantations, nurseries, fire-breakers and measures to counter erosion so as to ensure the sustainable exploitation of the forest. A portion of the revenues retained by the villagers (between 30% and 50% of the tax, depending on the operating method adopted) is reinvested in forest planning. The remaining sum can be invested according to the wishes of the villagers.

Photo 4. Niger is a country in the Sahel belt that is seriously affected by desertification.

DES is now fully established on institutional and regulatory foundations, and is functioning satisfactorily. A precise plan has been established to multiply structures of production among villages to enable responsible local people to take control of their forested land and resources. Since 1989 the strategy has developed around the following points outlined below:

- the elaboration of guidelines for the supply of wood that focuses on an even distribution in the towns of Niamey, Maradi and Zinder. DES is a forest resource planning instrument that defines priority areas for intervention and thus determines the management model to be applied.
- forest resources management responsibilities are transferred to the benefit of local populations by means of rural markets.
- the improvement of control methods to ensure regular tax payments. The forester is in charge of supervising the conditions of production defined at the time the rural markets are established. He (she) may also help the villagers develop projects from tax receipts intended for local forest development.
- experimental action plans implemented to follow-up on reforestation activities. It involves defining the long-term impact of controlled wood exploitation.

Since January 1994, the control plan is entirely under the responsibility of the environmental services. They regularly publish the status of the receipts as from 1989 to 1994 for the four principal urban centres of Niamey, Maradi, Zinder and Tahoua. The state receipts collected by this system are greater than the sums collected under the former exploitation system, which was inadequately controlled.

COUNTRY	THEME	EXAMPLE	SOLUTION
Niger	Exploitation of firewood	Domestic Energy Strategy (DES)	Rural markets

Photo 5.
Ploughing fields close to Maradi, Niger.

Conclusion

Between 1992 and 1995, fifty rural markets were set up in the major cities of Niger. In Niamey, the rural markets assure supplies for 10% to 13% of annual consumption. The challenge for the DES consists of elaborating a development plan that is both easy to understand and implement for the administration and the local villagers.

Strict controls at the entrance to towns reduce the possibility of fraud in terms of wood 'smuggling' (uncontrolled forest exploitation). The ultimate objective of rural markets is to have the rural population managing production and thus negotiating prices with the trader-transporters.

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Classroom ACTIVITIES

The teacher explains the system of rural markets to the class.

Where is Niger located?
Is your country on the same continent as Niger?
What characterizes the climate of Niger? What desertification problems are found in Niger?
Are they the same as those found in your region?
What are the differences?
What are the similarities?

Draw a forest with lots of trees and greenery. Next to it, draw a forest that has been deforested and has very few trees. Explain your picture.

Explain the uses of wood and why trees are cut down. Is there a way in which forest resources can be used without degrading the environment? Explain how wood can be exploited so that there is enough for the future.

Devise a role-playing game on the over-exploitation and trade of wood in Niger. Imagine the dialogue between trader-transporters, produce-vendors, woodcutters and those responsible for the environment, with each person (character) defending his/her position. Finally, the system of rural markets is introduced.

Tick the correct answers from the following:

In Niger, desertification is caused by:

- the lack of rain.
- tree logging.
- cars.
- wind.
- poor forest management (not enough trees are replanted).
- big animals.
- pollution.

COUNTRY	THEME	EXAMPLE	SOLUTION
China	Desert encroachment	Xinjiang Oasis	Shelterbelts

A new technique to halt desert encroachment:

Shelterbelts surrounding the oases of Xinjiang

Photo 1. Tree plantations used to stabilize the sand in the Xinjiang desert. © Yang Youlin

Surrounded by mountains and far from any sea or ocean, the autonomous region of Xinjiang Uygur in the north-west region of the People's Republic of China represents the largest stretch of drylands in China.
Xinjiang territory stretches over 1,650,000 km² of which 49.5% are mountainous zones and 22.5% is desert. This temperate desert is subject to winds uplifted by the Tibetan Plateau and differs from sub-tropical deserts found in other regions of the world in that it is much cooler and is influenced by a continental climate.
The Xinjiang oases are distributed according to the availability of water supplies. To prevent the desert sands from encroaching on the oases, the local populations have developed a shelterbelt system of green hedges: trees and shrubs stabilize the dunes and reduce wind erosion thus halting desert encroachment.

COUNTRY DATA: CHINA

Asia | China | Xinjiang Oasis

Region:	**Eastern Asia**
Capital:	**Beijing**
Surface area:	**9,596,961 km2**
Population :	**1,266,838,000 inhab.**
Population density:	**130 inhab./km2**
Infant mortality rate (per thousand births):	**41**
Fertility rate (births per woman):	**1,8**
Population growth rate (per annum):	**0,9 %**
Life expectancy ♀ – ♂:	**72 – 68 years**
Average temperatures (min. - max.):	**-9.4 / 31.6°C**
Forest cover:	**14 %**

The Xinjiang oases

The most prominent landscape feature of the oases are the vivid green colours of the cultivated and natural woods, in stark contrast to the yellow or grey colours that predominate in oases of other deserts.
The trees of the oases indicate the key role that water plays in the oases ecosystem and the relative abundance of water resources available on surface and underground areas.
The mechanical and chemical weathering of rocks, their granular and sandy textures containing low levels of organic matter, form desert soils that are relatively poor in nutrients. On the other hand, soluble minerals are abundant and accumulate on the surface.
The stresses subjected by the inhabitants in Chinese oases can be summarized as follows: severe drought, accompanied by large variations in the quantity of available water, which produce unfavourable conditions for agriculture; severe temperature fluctuations during the year and even during the day; violent winds that frequently generate sand drifts and serious wind erosion. The region equally suffers from intense evapo-transpiration, aridity, excessive soil and groundwater salinity from the lack of organic matter and nitrates in the soil.

Causes and effects of desert encroachment

China is one of the countries in the world that is seriously confronted with the problems of desertification (Photo 2). The affected land surface covers approximately 2,622 million km², representing 27.3% of the total land territory in China. Despite partial improvement and effective control, desertification is spreading and the land is deteriorating at an estimated rate of 2,460 km² a year across the whole of the country. It is estimated that 400 million people are suffering from the impact of desertification and the effects of sand dust that attack skin and lungs.

Desertification in China is mainly caused by human induced factors and by extreme climatic conditions. Human factors such as population growth, intensive agriculture, irrational use of steppe for cereal production, overgrazing, unsustainable exploitation of firewood and medicinal plants, poor water resource management, oil exploitation and excessive mining are all significant factors. These activities, coupled with poor awareness on combating desertification and environmental protection, have destroyed the vegetation cover and accelerated the uncontrolled advance of the desertification process.

COUNTRY	THEME	EXAMPLE	SOLUTION
China	Desert encroachment	Xinjiang Oasis	Shelterbelts

Photo 2. In Xinjiang Province in China, due to its continental climate, the arid zone is characterized by cooler sub-tropical deserts.

Possible solutions

There are two basic ways to protect the oases so that they conserve a balanced and stable ecosystem, favourable to human activities. Artificial oases can rely on important energy and technical inputs to create an artificial environment in the form of a closed system. On the other hand, ecological oases can protect themselves from desert encroachment mainly by biological factors. Providing water resources are sufficient, if they are used in a traditional way, the shelterbelt system has shown itself to be efficient in establishing and protecting ecological oases.

Shelterbelt systems

According to the characteristics of the Xinjiang oases, various construction models of shelterbelts have been employed:

- around the perimeter of the oasis, shelterbelts are made up of shrubs and grasses that obstruct wind and sand movements.
- within the inner zone of the oasis, a forest belt of mature trees reinforces the function of the shelterbelt.
- inside the oasis, a forest network protects agricultural lands.

Thus, from the perimeter to the interior of the oases, different kinds of shelterbelt systems and forest networks could be introduced according to the specific needs of the area under consideration. The shelterbelts are composed of diverse plantations since it involves constructing a complex ecosystem composed of trees, shrubs and grasses.

The shelterbelt or shrub-grass belt at the perimeter of the oases is designed to control sand movements and to prevent the fringe area from being overwhelmed by desert sand or threatened by wind erosion. Studies show that due to its roughness and friction, the ground wind speed is very much reduced by the presence of a shrub-grass shelterbelt standing 50 cm to 60 cm high.
The effectiveness of the shelterbelt depends on its width, vegetation cover and plant composition.

In areas threatened by erosion, land degradation can be curbed when vegetation cover reaches 65% and the soil surface becomes stable. In areas where sand accumulates, vegetation can reduce the development of dunes once the vegetation covers 40% of the surface. The wider the barrier, the greater its effectiveness in protecting the oases. In general, the width of the shelterbelt should not be less than 200 metres.

Based on observations of sand movements caused by wind and avalanches, the shelterbelt with a width of 100 metres controls 90% of total sand movements.
A belt of 244 metres wide fixes 97% of moving sand.

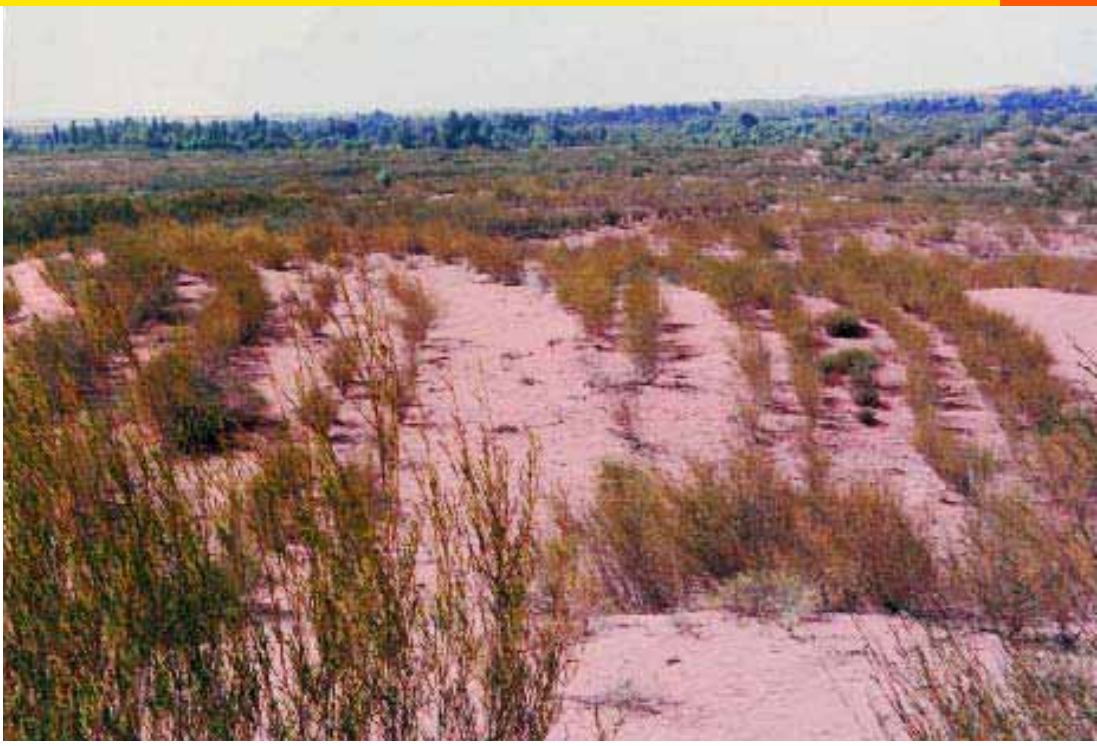

Photo 3.
A shelterbed of shrub-grass in the fringe area of the oasis.

Moreover, it can be noted that certain species of grass and shrubs supply fodder and food rich in nutrients for cattle in the desert zones.

In the fringe areas of the oases, planting trees especially poplars and elm prevents sand from accumulating around the oases.

In areas of dense plantations, the moving sands accumulate at the edge of the shelterbelt, on the windward side to form high, large longitudinal dunes. The average sand accumulation around the shelterbelt is 12.48 m^2 per metre whereas if the structure of the plantation is more sparse, the sand accumulates on the sheltered side of the shelterbelt to form long and flat longitudinal dunes resulting in an average sand accumulation of 9.1 m^2 per metre.

In order to conserve irrigation water and minimize reforestation investment, narrow belts composed of two rows of tamarisk species is recommended (as opposed to poplars and elms planted to prevent sand accumulation in fringe areas).

In the interior of the oases, forest networks composed of four to six narrow rows of trees protect agricultural land. The protective role of the forest network is closely related to the distance between the trunks and for this reason, in Xinjiang, the distance between the principal rows has been reduced to increase the effectiveness of the shelterbelt against the spreading of the desert.
The shelterbelt also acts as a biological drainage system that plays an important role in improving the soil in the Xinjiang oases. In Anjiahi, in the northern part of Xinjiang, the groundwater level of farmland could thus be lowered by between 20 cm to 70 cm and the salt concentration of the topsoil could be reduced.

In addition, shelterbelts protecting farmland also supply a great deal of timber and other wood by-products. The tree network creates a microclimate improving the ecological environment of the farmlands. For instance, the rate of water consumption for one kilogram of wheat or corn has decreased by between 15% to 22.8% with the tree network.

COUNTRY	THEME	EXAMPLE	SOLUTION
China	Desert encroachment	Xinjiang Oasis	Shelterbelts

Conclusion

In the Xinjiang oases, the shrub-grass shelterbelt systems and the tree networks inside the oases prevents the fragile ecosystems from degrading. Since the construction of shelterbelts in Xinjiang, it has been observed that:

- **wind speed has decreased.**
- **soil surface roughness has increased due to the shrubs and grasses.**
- **sand invasion has been reduced and the mobile dunes have stabilized.**
- **light reflection rate has decreased due to vegetation cover.**
- **the concentration of air humidity has increased due to forest transpiration.**
- **the microclimate has improved agricultural productivity.**
- **the forest network supplies the inhabitants with firewood, wood by-products and fodder.**
- **trees provide shade during the hot season.**
- **poverty has decreased thanks to the large plantations of fruit trees and the harvesting of seeds and fruit.**

Thus the shelterbelt system to protect the oases in the Xinjiang desert of northern China brings about positive effects for preventing desertification and improving production and living conditions in the desert.

Photo 4. Forest network at the interior of the oasis. Rows of trees stop the wind and sand and protects the crops.

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Classroom ACTIVITIES

The teacher explains the shelterbelt system to the class.

Where is China situated?
What characterizes the climate of China compared to your country?
Are the problems of desertification in the Xinjiang oases similar to those in your region?
What are the differences?
What are the similarities?

Draw the oases of the Xinjiang desert.
Show how the sand dunes are displaced by the wind.
Draw the tree plantations that protect the oases.
Are there some found in the interior of the oases to protect the crops?

What role does each tree play in the shelterbelt? Imagine trees that speak who tell us of its fight against desertification. What would they say? People plant trees around their crops to protect them from the wind and also to harvest fruits and wood.

Imagine that you construct a shelterbelt in your region.
Where do you think such a system could be useful?
Which species would you plant?
What would you have to do to ensure the effectiveness of the shelterbelt?

Tick the correct answers from the following:

In China, the shelterbelts:

- stabilize the soil.
- act as a windbreak.
- are wooden barriers.
- protect the oasis.
- prevent sand from covering farmland and crops.
- combat violent rainfall.

COUNTRY	THEME	EXAMPLE	SOLUTION
India	Deforestation	Women's initiative	Tree plantations

Combating the effects of deforestation:

Tree planting carried out by women in a rural region of India

Though the causes of desertification are complex, in India, as in many countries affected by the phenomenon, desertification is due to the combined effects of natural factors such as climatic variations and ill adapted human activities, such as intensive agriculture, overgrazing, deforestation and poor irrigation practices.

Human population growth and its accompanying poverty lead to irregular or over-exploitation of natural resources resulting in soil erosion thus reducing land productivity. As a consequence, many young men abandon the degraded lands of the rural regions to look for work in towns and cities, leaving the women behind to cultivate the unproductive lands. The NGO Youth for Action (YFA) decided to concentrate its efforts on helping the women develop their environmental knowledge and skills to take the initiative to improve their living conditions.

Their commitment

YFA chose to focus their varied environmental protection activities on women since they suffer the consequences of desertification more directly than men. Traditionally, women have cultivated and managed common natural resources such as water, fuel, fodder and fruits. In the Mahaboobnagar district (in the state of Andhra Pradesh, in south-east India), a great majority of women work, many of them work in agriculture.
In general, it can be said that the greater the levels of poverty, the more women have to work (Photo 1).

Women also suffer from the effects of male migration as the men leave for the cities in search of alternative lifestyles leaving the women behind to fend for themselves on meagre subsistence activities and the threat of famine. According to a survey undertaken in Arepally, 10% of all households are headed by women who are single, separated, widowed or divorced. Women are more receptive to and affected by their natural environment and are therefore the principal victims of resource degradation (Photo 4).

COUNTRY DATA: INDIA

Asia | India | Mahaboobnagar district

Region:	**South-central Asia**
Capital:	**New Delhi**
Surface area:	**3,287,263 km²**
Population:	**998,056,000 inhab.**
Population density:	**291 inhab./km²**
Infant mortality rate (per thousand births):	**72**
Fertility rate (births per woman):	**3.1**
Population growth rate (per annum):	**1.6 %**
Life expectancy ♀ – ♂:	**63 – 62 years**
Average temperatures (min./max.):	**19.3 / 33.4 °C**
Forest cover:	**22 %**

Photo 1. Indian women in Arepally market.

Women, especially the most impoverished among them, lack the organization and environmental management strategies, due to limited access to information and education, compared to men.

Before engaging in any specific project, YFA wanted to invest primarily in training women to develop group leadership skills that would enable them to co-ordinate their activities more effectively. YFA concentrated their efforts on the Karyakathas, a name given to women who have a higher level of education and certain leadership qualities and are concerned about their environment and their social situation. Women were elected by the self-help group, composed of active women in the Sangha community. YFA completed their training by helping them strengthen existing skills. To encourage the women to stay in the region and from migrating to other regions of India, YFA explored alternative income generating activities such as mango plantations, vegetable cultivation, dairy production and leaf plate or bamboo basket making (Photo 2).

Photo 2. An Indian woman performing an income generating activity: pepper pressing.

Causes and effects of intensive farming

Traditionally, India favours rain-fed agriculture for the cultivation of millet, pulses and oilseeds. The basic staple crop was jowar, commonly known as sorghum *(sorghum vulgare)*, which grows in arid regions, but the change in food habits and the pressure of the international market spurred the population to intensify rice (paddy) and cotton cultivation using groundwater reserves, thus increasing soil salt content due to evaporation.

Furthermore, the cycle of fallow periods that restore land fertility was gradually abandoned or reduced and replaced by the excessive use of chemical fertilizers, destroying the natural soil balance. The soil became degraded and prone to the harmful effects of water and wind erosion with the formation of gullies, diminishing agricultural productivity. The socio-economic fall-out of soil degradation is multiple and disastrous: despite a relatively low rate of unemployment, 70% of the population find themselves below the poverty line in Mahaboobnagar district. Furthermore, this region is affected by the migration of young people and malnutrition.

Possible solutions

The project was carried out in a small peaceful village called Arepally in Atmakoor Mandal, situated in the Mahaboobnagar district of Andhra Pradesh, a region vulnerable to severe drought. Here, the farmers have always depended on subsistence living because of the hilly landscape.

When strolling through Arepally today, you can see the many trees planted by the Sangha community. As the children sing on their way to school, which incidentally is managed by the women, the whole village gives a neat impression and it is apparent that the women feel confident again. How can this be explained?

About thirty-five years ago, the government offered 'Inam' land to the villagers. The land, belonging to the state and situated on rocky and steep hills distant from the village, was generally in very poor condition and seemed unfit for cultivation. So when YFA proposed the land to the men of the village, they were far from enthusiastic.

On the other hand, the women showed a keen interest in cultivating the land for fodder and tree plantations.

Photo 4.
Women carrying water.

Women leading reforestation

During the summer of 1992–1993, the women of Arepally began by improving water retention on the arable land by establishing mounds of earth called bunding, on the borders of the fields.

Photo 3. A nursery created by the women of Arepally.

A small nursery was started and species such as subabul and mango were later replanted on the hill (Photo 3). Convinced of the determination shown by the women, the district inspector visited the fields and approved a pipeline to irrigate the hill that prompted the women to begin horticulture plantations, selecting the species they wished to cultivate.

In 1995-96 reservoirs or percolation tanks, were installed with the help of the government to collect rainwater. Indeed, around the reservoir area the farmers took advantage of the increased humidity to grow cereal crops such as jowar and pulses.
These initiatives soon interested the men and they agreed to contribute to the cultivation of the entire patch of 34 hectares. The men and women finally agreed on an arrangement to share responsibility of the land.
The trees have since grown and the hill has taken on a green colour. In a couple of years, the women will be able to sell their produce at the local market.

Conclusion

NGOs are well accepted in many regions of India where their activities are often considered an important complement to government programmes. The social orientation of NGOs generally predominate over their technical capabilities and they place great effort in fund-raising, bridging relationships with appropriate government bodies and training. Youth for Action (YFA) has been working since 1986 in the drought prone regions of Mahaboobnagar district.

The priorities of YFA in the Arepally village are:
• Mobilizing and raising awareness among women, since they are more directly affected by drought related problems than men.
• Education and training of women and the development of group leadership skills to help them take on more responsibility.
• The construction of earth dikes to retain rainwater on arable lands, thereby influencing their flow.
• The creation of a nursery and the cultivation of species adapted to arid environments.
• Responsibility-sharing among men and women.
The projects initiated by YFA have had a very positive impact on the population of the village. Among the 80 families belonging to the eight different castes, all but three of the castes participated in the project to combat desertification. The species planted created an advantageous microclimate supplying fodder for cattle, timber for construction and firewood and fruits for consumption and sale. More importantly, the women gained self-confidence: their activities are directly related to combating desertification.

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Classroom ACTIVITIES

The teacher tells the story of the Arepally women in class.

Do women in your village work hard in the fields? Do they have to manage on their own because the men have migrated to towns and cities?

Draw the story of the Arepally women in cartoon form with captions. Describe their solitude and anger. Describe the intervention of the NGO and their proposition to cultivate abandoned land. Describe the ideas to create a nursery and reforest a hill, the recognition by the men of the work carried out by the women and their pride in accomplishing a useful project to restart the local economy and combat desertification.

(This work can be carried out in teams: each team could draw a different cartoon scene).

Where is India located? Is your country on the same continent as India? What characterizes the climate of Arepally compared to your country? Are the problems faced in Arepally similar to the problems you encounter in your village/town? What are the differences? What are the similarities?

Draw Arepally village before and after the project to combat desertification. In the first picture, draw the degraded land around the village, the sparse vegetation, next to it, draw the village after the project: the nursery run by the women, the numerous trees on the hill, the happy villagers. Glue your picture to the wall chart (See *Teacher's Guide*).

By role-playing, tell the story of the Arepally women. How are the women, men and the environmental instructors organized? What is the role of the women in the project and how does this compare to the men? How did they manage to achieve the rehabilitation of the land and combat desertification?

COUNTRY	THEME	EXAMPLE	SOLUTION
Uzbekistan	Human influences on desertification	Aral Sea	Soil rehabilitation

Rehabilitation of lands degraded by human activities:

Stabilizing the dry soil of the Aral Sea basin

The ambitious irrigation projects undertaken in Central Asia at the time of the Soviet Empire are the principal causes of the catastrophic desiccation of the Aral Sea. Excessive pumping of water from the Amu-Dar'ya and Syr-Dar'ya rivers to farmlands has led to the total imbalance of the Aral Sea ecosystem and water resources of the entire region. The drying up of the Aral Sea is often cited as the greatest environmental disaster caused by mankind.

The breaking up of the Aral Sea into smaller water bodies has begun and is likely to continue. The expression 'Aral Sea syndrome' suggests the complex desertification process taking place in the region. In an attempt to rehabilitate the desiccated Aral Sea bed, scientists have planted salt resistant plant species introduced to stabilize and enrich the soil.

Photo 1. Stranded ships in the bay of Birlestik.
© Yann Arthus-Bertrand *Earth from Above* / UNESCO

The Aral Sea

The Aral Sea, once covering an area of 68,000 km^2 , has for a long time been one of the biggest salt lakes in the world, principally drawing its source from two rivers, the Amur-Dar'ya and the Syr-Dar'ya. The Aral Sea began drying up in the 1960s as water was pumped to irrigate cotton fields and other thirsty crops. Over the last few decades the Aral Sea has shrunk to half its original size. Up until the mid 1980s, the sea used to receive 50 km^3 to 60 km^3 of water per year from its two main feeder rivers, the present flow stands at 2 km^3 to 5 km^3 per year.

COUNTRY DATA: UZBEKISTAN

Asia | Uzbekistan | Aral Sea

Region:	**Central Asia**
Capital:	**Tashkent**
Surface area:	**447,400 km²**
Population:	**23,941,000 inhab.**
Population density:	**53 inhab./km²**
Infant mortality rate (per thousand births):	**44**
Fertility rate (births per woman):	**3.5**
Population growth rate (per annum):	**1.6 %**
Life expectancy ♂ – ♀:	**71 – 64 years**
Average temperatures (min./max.):	**-3.1 / 35.6 °C**
Forest cover:	**22 %**

With the shrinking of the Aral Sea, traditional fishing communities have long since lost their source of revenue as salt levels have increased resulting in the disappearance of a large number of fish species (Photo 1).

By studying the available literature, it is clear that the catastrophic environmental consequences were already foreseen during the planning stages of the major irrigation project. It was believed that the economic advantages of the undertaking counterbalanced the negative ecological effects.

Indeed, the economic benefits in the region were substantial during the first ten to fifteen years of the project. However, in the long term, the harmful consequences of the natural imbalance has made itself felt at every level while the economic objectives were never reached. Due to the difference between the planning and realization of the project, the socio-economic situation around the Aral Sea worsened. The region of the two river deltas has been seriously affected by the drying up of the lake. The drop in the volume of water has resulted in an increase in the concentration of pesticides, minerals, fertilizers and herbicides in the soil, all used in large quantities in cotton monoculture. These factors have all contributed in disturbing the quality of life of the local people, especially in the regions of Amur-Dar'ya and Syr-Dar'ya. Deprived of its water reserves and potable water supplies and unable to pursue traditional agriculture or fishing, the local populations have lost their livelihood.

In 1988, the USSR declared the zone around the Aral Sea a 'natural disaster area' and for the first time, the USSR turned to the international community for help. Following the break-up of the Soviet Union, the five newly independent states of the Aral Sea basin, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan have been seeking to mobilize regional and international support for measures to rehabilitate the degraded land and water resources in the basin. Among the scientific initiatives has been an eight-year ecological monitoring and research project in the river delta areas of the Aral.
The project is supported by the German Ministry of Education, Science, Research and Technology (BMBF) and is co-ordinated by Hamburg University and UNESCO.

COUNTRY	THEME	EXAMPLE	SOLUTION
Uzbekistan	Human influences on desertification	Aral Sea	Soil rehabilitation

Figure 1 : The desiccation the Aral Sea over the years.

Causes and effects of Aral Sea desiccation

The lowering of the Aral Sea water table is still continuing and is the cause of two major environmental problems:

- the threat to Barsa-Kelmes nature reserve.
- the formation of a huge new salt desert between the island of Vozrozhdenie and the eastern coast as well as the area surrounding the Aral Sea.

In 1939, the island of Barsa-Kelmes was designated a nature reserve, one of the more precious Central Asian deserts. The flora of the island comprises some 257 species, in particular *Artemesia* and *Anabasis*. Some antelope species *(Gazella subgutturosa* and *Saiga tatarica)* as well as the onager *(Equus hemionus)* were introduced on the island several years ago. Certain species have recently been added to the Red Fauna List of threatened species (a list of the world's most threatened fauna and flora species). The isolated nature of this reserve has secured its absolute protection and only as recently as 1999 has the island become accessible from the mainland. If special efforts are not made to preserve the unique character of this ancient island, it will rapidly lose its status as one of the most important nature reserves in Central Asia.
The emergent strip of land has been named the Aralkum desert. The surface area of the desiccated seabed is about 40,300 km². Unintentionally, the massive scale of human experimentation has thrust the local population into an uncertain future.

Possible solution

The problems of the Arulkum desert had not been dealt with since the middle of the 1980s. In 1992 this prompted a new inter-disciplinary research programme with special emphasis on the delta areas. The UNESCO-BMBF project was begun, financed by BMBF and co-ordinated by Bielefeld University (Germany). The international project focuses on plant succession on the dry Aral Sea bed and the prospect of improving soil fertility for agriculture (Photo 2). The project has two main objectives:

- the study of ecosystem dynamics in the Aralkum desert. Research and evaluation of the environment is of crucial importance to the inhabitants of the region.
- the choice of measures to accelerate the natural colonization of plants.
The experimental planted areas should help stabilize the dry seabed and improve its quality.

The desiccated Aral Sea bed forms a virgin land surface on which plants (including seeds) and animals have never before existed, though it is actively populated by various micro-organisms. The Aralkum desert seabed thus represents the largest terrestrial area where primary succession is currently taking place: it is possible to observe how different vegetation cover successively colonizes the bare sandy salt bed.

Photo 2. Plantations to rehabilitate the soil in the Aral Sea region.

Knowledge acquired through observation of the vegetation is very important for the understanding of ecosystem dynamics in the whole Central Asian area.

Since the 1980s only salt deserts have formed on the dry seabed. Today, the open dry seabed area is a huge salt flat and a source of salt dust in the vicinity. The direct influence of aerosols, such as salt particles and dust, on the natural ecosystem and the health of the local people remain controversial.

Saline soils and salt specific vegetation, made up of halophytes, are characteristic of these deserts and steppes and are most typical in the Caspian region, the Aral Sea and the Balkhash basin in Central Asia. Over a period of 40 years, the Aral Sea basin has been transformed into an immense salt desert that is gradually expanding. Comparable to the Great Iranian Salt desert and even greater than the Great Salt desert of Utah in the United States, the coastal plain and the dry seabed of the Aral Sea are perfect models for studying salt desertification.

Phytomelioration: improving the quality of the saline soils by plants

The phytomelioration technique consists of improving soil properties by planting species resistant to harsh desert conditions that prompt plant succession. It is essential to understand the mechanisms of the different types of salt-tolerant species in order to improve the vegetation composition on these saline soils. The salinity of the dry seabed varies enormously from one place to another, resulting in a considerable variety of saline soil types.

Among the 266 known species in the region, 200 (75.2%) species appear on the saline soils of the seabed. The remaining species may be influenced by salt after germination or during the other stages of their development. The result is rich halophyte flora that is, on the one hand, affected by the various degrees of salinity, and on the other hand, has developed adaptation strategies to resist salt conditions.
Thus, the following species lend themselves particularly well to phytomelioration: *Halocnemun strobilaceum, Halostachys caspica, Halidium caspicum, Haloxylon aphyllum, Tamarix* and *Climacoptera* species.

Photo 3. Vegetation cover of 30% to 40% helps to stabilize the dry seabed on the eastern coast of the Aral Sea.

COUNTRY	THEME	EXAMPLE	SOLUTION
Uzbekistan	Human influences on desertification	Aral Sea	Soil rehabilitation

Photo 4. Landscape of the desiccated banks of the Aral Sea.

Conclusion

Soil improvement by vegetation cover is a realistic way to stabilize the dry seabed surface. This process will reinforce the natural colonization of the area by plant propagation and the creation of seed banks (a reserve for growing plants in the future) for natural dissemination.

The following conclusions can be drawn from experiments carried out in the region of Kaskakulan Island:

- **The rate of aridity during the first vegetative period plays a major role in the survival rate of seedlings and saplings.**
- **Species of local flora are more effective in improving the soil.**
- **Sandy soils of the 1960s and 1970s are more favourable for soil improvement by plants than the clay soils of the 1980s and 1990s.**

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Classroom ACTIVITIES

The teacher tells the story of the Aral Sea to the class.

Where is Central Asia?
Locate the Aral Sea basin on the world map. Can you find Uzbekistan and Kazakhstan?
How is desertification occurring in the Aral Sea basin?
Do you know of similar phenomena of desertification induced by human activities?
Is there a similar problem like the Aral Sea in your region?

How do scientists attempt to rehabilitate the Aral Sea?
What role do plants play?
Will the Aral Sea ever become like its former past?
How do you envisage the future of the Aral Sea basin?
Imagine the life of the inhabitants of the region.

Part of the class could draw the Aral Sea as it was before the irrigation project while another group could draw the desiccated Aral Sea after the project: the boats that have run aground, the dead fish, the angry fishermen.
The others could draw the dry seabed after the plantation of vegetation cover.
Which new activities could be adopted by the local population?

Imagine that you are a fisherman from Kazakhstan or Uzbekistan.
How would you react faced with the desiccation of the Aral Sea?
What would you say about a scientific project to grow plants on the bare soil?
How do you imagine your future?

COUNTRY	THEME	EXAMPLE	SOLUTION
Chile	Land degradation	Education	Creation of a nursery

Children combating land degradation:

A rural school creates a nursery

Photo 1. Pupils in Recoleta often live alone with their mothers far from their school so they have to travel by bus.

Faced with the phenomenon of land degradation in Chile, an environmental education programme on desertification was implemented in a rural school by a non-governmental organisation (NGO) and financed by the Royal Embassy of the Netherlands. The goal of the pilot project was to raise the level of theoretical knowledge and raise environmental awareness in children. Gardening skills were also taught enabling the children to create a nursery on their own.

To achieve this, the environmental education project comprised of concrete activities that halt or even reverse the desertification process, was integrated into the normal school curriculum. Considerable attention was dedicated to teacher training and the involvement of parents and community leaders. The children were able to sell the nursery products to their local community thereby supplementing their family incomes.

South America | Chile | Region of Ovalle

COUNTRY DATA: CHILE

Region:	**South America**
Capital:	**Santiago**
Surface area:	**756,626 km$_2$**
Population:	**15,019,000 inhab.**
Population density:	**19 inhab./km²**
Infant mortality rate (per thousand births):	**13**
Fertility rate (births per woman):	**2.4**
Population growth rate (per annum):	**1.4 %**
Life expectancy ♀ – ♂:	**78 – 72 years**
Forest cover:	**11 %**

The Recoleta School

The Recoleta School is a small village school in the region of Ovalle, 250 km north of the capital, Santiago. It is made up of eight elementary classes with 110 pupils enrolled and nine teachers, seven of whom hold a university degree. The pupils arrive by bus from neighbouring areas. Their socio-economic situation is consistent with the official government classification for extreme poverty and few children have the financial possibility to go to secondary school beyond their primary school education. A quarter of pupils live alone with their mothers who work in the vineyards or peach plantations (Photo 1).

Causes and effects of land degradation

The region of Recoleta is an area that is heavily exploited. The principal activities in Recoleta are sheep rearing, viticulture and mining, though natural resources are seriously under threat by the process of desert encroachment. Ever since the Spanish conquest and occupation, the population that settled rapidly in the region pursuing subsistence activities.

The destruction of vegetation cover for mining work and the production of coal, as well as the practice of rain-fed agriculture and the effect of overgrazing, have completely degraded the land. Generally, it can be said that the over-exploitation of land and the abusive extraction of mineral resources, linked to inadequate production methods and techniques, such as cereal cultivation on ill adapted land, are the principal causes of desertification in Chile. In addition, low levels of rainfall and periods of intense drought intensify the phenomenon. As a consequence, the population lacks fodder for their animals and the land becomes degraded.

Possible solutions

Faced with alarming environmental degradation, an active NGO in Chile, JUNDEP, Juventudes para el Desarrollo y la Producciòn *(Youth for development and Production)* decided to respond to these problems through public awareness activities targeting children. Children tend to be more open to new ideas and more importantly, they are the decision-makers of the future. The JUNDEP fieldworkers are convinced that social, cultural, economical and environmental changes, necessary to improve the situation, can only happen

if accompanied by changed behaviour and values among individuals. It is for this reason that JUNDEP chose to target the project to combat desertification at primary school level pupils.
It is essential that children acquire ecological knowledge and become aware of the importance of protecting their natural environment by undertaking projects and activities that are within their scope, and that can realistically be achieved.

The school initiative

The JUNDEP environmental education project relies on the following activities:

- education of pupils and teacher training.
- creation of a nursery and arboretum.
- drilling of wells.
- maintenance of gardening tools.
- sale of cultivated produce.

Education and training

Training began by introducing the teachers to the basics of environmental protection and specific themes such as the causes and effects of desertification. They were taught how to set up a nursery and an orchard at the school. Training days took place at the school with the JUNDEP professionals: a forest and an agricultural engineer, a lawyer and several educators.
Following training, the teachers were reassembled to develop an education programme on environmental protection.

Practical activities

The pupils were organized into 'ecological teams' of 15 girls and 15 boys each, supervised by a teacher. They were taught the necessary gardening techniques needed for working in the nursery and arboretum. They were taught how to select seeds and properly use fertilizers, they were also taught irrigation methods, planting and planting out (Photo 3).

Each plant was identified with labels indicating its common and scientific name and the origin of the species. Local species were given priority as well as certain exotic species whose use is particularly important for the agricultural economy of the region: cypress, acacias, eucalyptus, willows, poplars, palm trees, carob and peppers. The cultivated species of fruit trees were principally apricots, vines, figs and olives.

The pupils making up the 'ecological teams' were responsible for the tidying up and storing of the tools. They also participated in drilling a well with the help of their parents and environmental educators. Although all the activities were undertaken on a voluntary basis, the rate of participation was very high (90% during the school year and 50% during the holidays).

Cultivated plants were then sold.

Photo 3. The pupils were taught gardening techniques, necessary for working in the nursery and the arboretum.

The follow up

The programme and the school activities organized by JUNDEP on the theme of desertification had a considerable impact throughout the whole community as well as within the school. The parents of the schoolchildren and the environmental educators were regularly invited to conferences and debates organized by JUNDEP on the theme of desertification. Teachers from other regions also visited the Recoleta School.

Videos, slides, a wall chart (Photo 2) and manuals on the theme of desertification have been designed within the framework of the project to assist in the pedagogic support. The materials were provided by JUNDEP.
The cultivated plants in the nursery and the orchard were commercialized within the community and notably in other rural schools that demonstrated an interest. Buyers could order certain species. While most of the profits made were reinvested in the nursery some were used to organize a big party at the end of the year for the pupils, with gifts for every one of them.

Photo 2. The pupils from the Recoleta school designed a wall chart that told of their work.

COUNTRY	THEME	EXAMPLE	SOLUTION
Chile	Land degradation	Education	Creation of a nursery

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Photo 4. The plants are sold to the community and the profits are reinvested in the nursery. A portion of which is used to organize a big party.

Conclusion

The objective of the project was to prepare the children to a self-help system of agricultural management, particularly since most pupils do not continue their studies beyond the eight-year cycle of elementary education. The method employed by JUNDEP consisted of consolidating the role of teachers as educators by developing teacher awareness and know-how that facilitated knowledge transfer. This preferred learning technique requires a participatory approach that includes many practical activities.

At the end of the programme, an evaluation of environmental knowledge acquired demonstrated the effectiveness of the method. The pupils were very motivated and families were very much involved with the project. The nursery is currently self-financed with the production of fruit trees, ornamental plant species or forest species that are sold in town with the help of the Department of Parks and Gardens.

One of the major problems encountered was the lack of water: the pump did not function adequately (but was subsequently repaired). Also, the limited space available to the pupils meant that the pupils spread out the cycle of crops by planting new plants when the first batch were commercialized. Another factor that potentially had a detrimental effect on the project was teacher turnover. Many of the teachers only stayed at the school for one or two years. However, the method employed by JUNDEP consisted of involving all the teachers in the project, which guarantees a certain continuity since the former teachers can initiate the new arrivals to the programme. In addition, it is hoped that the teachers that move from one school to another transfer their recently acquired knowledge on the environment and desertification to their new institution.

The authors of the cartoon *'The School Where the Magic Tree Grows'* were inspired by this case study.

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Classroom ACTIVITIES

The teacher tells the story of the Recoleta School to the class.

Locate your region on the world map. Find the region of Recoleta in Chile. Is your country on the same continent as Chile? Are their problems similar to yours?

Write a play telling the story of the Recoleta School. Everyone has a role; there are pupils, teachers and environmental educators, people who buy plants from the nursery, etc.

Imagine creating a nursery in your school. What species would you plant? Where would you go to sell them? What would you do with the money you made from the sale of the trees?

Tell the story of the Recoleta children in the form of a cartoon with captions: children that travel large distances to attend school, the environmental educators that observe land degradation, the environmental education project, the gardening activities in the nursery, the sale of plants, the party organized with the money made.

Tick the correct answers from the following:

To create a nursery, it is necessary to have:

- a lot of money.
- a water source.
- mature trees.
- gardening tools.
- degraded lands.
- plant seeds.
- earth.
- exotic plants.

Draw the Recoleta School before and after the project on combating desertification. In the first drawing, show the degraded lands around the school and the sparse vegetation. Beside it, draw the school after the implementation of the project: the nursery and the orchards, the many trees, the happy children.

Read the cartoon *'The School Where the Magic Tree Grows'*.

COUNTRY	THEME	EXAMPLE	SOLUTION
Ecuador	Mountain ecosystems	Farming of nopal and cochineal	Live fences

How to achieve both ecological and economical advantages:

The creation of live nopal fences

The province of Loja is located at the border with Peru in the southern part of Ecuador. Geographically, the area is characterized by an extremely irregular mountain range where few areas are fit for cultivation.

Erosion and the encroaching desertification process in the region affect nearly 80% of Loja province. The vegetation is damaged and the number of animals has fallen. Local communities have witnessed a drop in their productivity while the dry periods gradually grow longer from year to year.

The National University of Loja has selected an ingenious way to satisfy the needs of the population during the dry season with the introduction of live fences, which counter the erosion of mountainous lands while protecting crops. This was achieved by introducing drought-resistant nopal crops, a cactus possessing various nutritional and therapeutic effects and which is associated with the exploitation of cochineal, used for centuries in the production of dyes.

Mountainous ecosystems

In Loja province, the only land available for agriculture is found in the Andean valleys at an altitude that varies between 140 metres in the south and 4,000 metres in the north. Due to the mountainous nature of the region, the climate here is extremely variable with temperatures fluctuating between 0°C to 22 °C, whereas the majority of the province benefits from a tropical climate. Generally, the soils of the province are very poor, superficial in depth and rocky in texture. The land used for agriculture has low fertility and is deficient in water content, characteristic of soils that have been subjected to deforestation practices. Without natural vegetation cover to enrich the soils with organic matter that protect them from outside aggressions such as erosion, the soils become barren.

Photo 1. By introducing the nopal crop in Loja province, the National University of Loja created a source of income for the local farmers while at the same time, protecting the environment. © UNEP

COUNTRY DATA: ECUADOR

South America | ecuador | Province of Loja

Region:	**South America**
Capital:	**Quito**
Surface area:	**283,561 km²**
Population:	**12,411,000 inhab.**
Population density:	**42 inhab./km²**
Infant mortality rate (per thousand births):	**46**
Fertility rate (births per woman):	**3.1**
Population growth rate (per annum):	**2.0 %**
Life expectancy ♀ – ♂:	**73 – 67 years**
Forest cover:	**40 %**

Causes and effects of population and soil deterioration

In Loja province, land occupation began in 1750 with the arrival of the Spaniards who founded the first villages and began the indiscriminate exploitation of the existing natural resources. From the indigenous population, the settlers learned of the therapeutic properties of the cinchona bark *(Sinchona officiales)*, a native tree of the region containing quinine, the only remedy until the twentieth century known to be effective against malaria.

The use and exploitation of quinine contributed significantly to the deforestation of enormous areas in Loja province, especially in the forests located between 1,500 m and 2,900 m altitude. The quinine produced in Loja was exported throughout the world. Between 1755 and 1758, customs authorities recorded the export of 717,156 kg of quinine. Given that approximately 15 trees are needed to produce 12 kg of quinine, it has been estimated that 900,000 trees were felled in the region over a period of three years.

Photo 2. Nopal, or prickly pear cactus possesses fruit and leaves that have been appreciated by indigenous peoples for centuries. They are being rediscovered today.

In the nineteenth century with the introduction of livestock (bovine, ovine, equine) and the development of hillside agriculture, the destruction of the remaining forests was accelerated and the areas converted into grazing pastures and marginal agricultural zones. In most cases, the Spanish settlers neglected the environmental characteristics of the region by using ill-adapted techniques such as ploughing that seriously contributed to soil erosion. The settlers imported the method from Europe without realising that it contributed to the erosion of the terraced hills of Loja province.

COUNTRY	THEME	EXAMPLE	SOLUTION
Ecuador	Mountain ecosystems	Farming of nopal and cochineal	Live fences

Agricultural terracing techniques and other systems used by pre-Columbian communities were also completely ignored. Due to a shortage of flat lands for farming, the planting of crops on slopes or hillsides was introduced, however the necessary measures needed to prevent erosion and provide the irrigation needed for this particular topography, were not taken into consideration.

Clearings and slash and burn techniques also contributed to, and accelerated, the destruction of soil, fauna, water and forest ecosystems. In addition to the destruction of forests, the introduction of goats to these fragile ecosystems soon transformed the region in to an ecological catastrophe.

The local population of Loja inherited the damaging practices harmful to local ecological conditions. The results were devastating: advanced erosion and soil deterioration and the loss of fertility were responsible for the constant drop in productivity over the decades, adding to the financial insecurities of the families concerned. As well as effects from human intervention, the long periods of drought that occasionally affected the region, drove the rural population to increasingly migrate to the cities. In the first half of the 1990s, 160,000 inhabitants from the total population of 400,000 left the region.

The agricultural policy reform introduced in 1964 did not achieve the expected results. The majority of the local populations were allocated land of poor quality on the steepest slopes and without the possibility of irrigation. The tendency to over-exploit the barren lands using ill-adapted techniques is hardly surprising.

According to the official 1990 census, 78% of rural workers live in poverty without economic alternatives.
During the first months of the year and taking advantage of the scarce rainfall, the farmers plant short cycle crops such as maize, yam, peanut and beans and are left with little or few options for the rest of the year.

Possible solutions

Despite the environmental difficulties and the devastating influences of the colonial system of production, the communities of the Loja province have maintained some of the pre-Columbian traditions as well as tried and tested knowledge of local flora and fauna. This traditional knowledge continues to be appreciated by farmers, particularly among the elders who still recognize the source of income it represents during long periods of drought.

Chief among these is the planting of optunia or nopal *(Opuntia ficus-indica)*, also known as the prickly pear, these fruits have been appreciated by indigenous people for centuries and have persisted up to the present day (Photo 1). This cactus possesses many benefits: its fruits (the prickly pear) are excellent, its leaves are edible in salads or can be used for cattle fodder (Photo 4). Another ancient tradition is the harvesting of cochineal *(Dactilopius coccus)* a small insect obtained from the nopal and from which indigenous peoples have traditionally extracted dyes. A cotton-like envelope that is filled with a red crimson liquid protects the insects (Photo 3). After collecting the cochineal found on the nopal leaves, they are dried and a pigment is extracted, which is used as a dye for clothing, ceramics and ceremonial ornaments.

Photo 3. Cochineal protect themselves by secreting a white cotton-like substance. From the body of the insect, a red liquid is extracted.

Nopal fences and associated species

In view of the social, economic and environmental conditions, the National University of Loja considered bringing together both the reintroduction of traditional knowledge and the combat against desertification by planting nopal fences and other associated species (Photo 2). The idea of the project was based on the ancestral harvesting of nopal in the region and the exploitation of cochineal. Not only can farmers benefit from traditional nopal and cochineal products that they consume, but also its reintroduction combats the desertification process. To achieve this, the nopal was grown in the form of live fences and was associated with local drought-resistant vegetation. Planted along the length of small terraces that follow the contour lines, these fences stabilize the soils on the slopes and protect the crops from wind and the effects of erosion.

Since the pilot project sought to be visible by all, it was implemented in strategic locations that were regularly visited by farmers. The live fences should respond to two criteria: the plants should be healthy and vigorous, as they will function as barriers for as long as thirty years, and ensure the production of fruit and fodder. The selected species of nopal should also be attractive to the cochineal, the main source of income derived from the project.

The live fences were installed in an area of 2 hectares in the vicinity of the road linking Malacatos to Vilcabamba, where around 1000 and 800 farmers live respectively. At the time of implementation, the soils were very damaged and showed signs of marked erosion.

The implementation of the project hinged on the following points:

- selection of nopal varieties adapted to the ecosystem.
- construction of small terraces 0.8m to 1 metre wide.
- construction of irrigation ditches following the contour lines.

The live fences were planted along the contour lines, the nopal alternating with local flora species that would eventually become a source of firewood.
During the course of the project, Loja University looked to involve the population and local organizations (schools, NGOs, churches). To do this, the person responsible for the project visited the different sectors of the province to identify the ecosystem and discuss the project with the local farmers. Certain members of the community participated directly in the project following demonstrations held at the University, while other groups undertook nopal cultivation and cochineal exploitation supported by other initiatives.

COUNTRY	THEME	EXAMPLE	SOLUTION
Ecuador	Mountain ecosystems	Farming of nopal and cochineal	Live fences

Photo 4. Nopal, or pickly pear containing many small seeds, provides round-shaped fruits whose colour varies between orange and red.

Conclusion

The project of live fences of nopal and associated species has effectively contributed to combating desertification in the province of Loja in Ecuador. The following benefits have been observed:

• the agro-ecological approach of the project restores degraded land by the construction of fences with nopal and local species, which halt the process of erosion.

• the production of fruits and fodder from nopal and dyes from cochineal improves the income of the local population, particularly during drought periods.

• the use of traditional knowledge with the reintroduction of nopal and the exploitation of cochineal, improves the relationship between the local farmers and their economic development.

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Classroom ACTIVITIES

The teacher tells the story of nopal cultivation and the exploitation of cochineal to the class.

Locate the region of Loja in Ecuador. Is your country on the same continent as Ecuador? Are your problems similar to those experienced by the Loja farmers? What are the differences? What are the similarities?

Draw the prickly pear with its curved form, its leaves and its large fruits and the small thorns on its leaves and the fruits.

Draw a live nopal fence and other associated species. Paste your picture to your notebook.

Do you know how to extract colour from cochineal to make dyes? Do you know other ways to make dyes from natural products?

Tick the correct answers from the following:

In Ecuador, live fences made of nopal are used to:

- farm cochineal.
- produce firewood.
- protect crops.
- farm prickly pear.
- prick children.
- halt erosion.
- attract rain.

Do you know of nopal or any other cactus whose fruits and leaves can be eaten? Invent a recipe with the leaves and fruits of the cactus in class. If this cactus can be found in your region, follow the recipe in class so that everyone can enjoy it!

COUNTRY	THEME	EXAMPLE	SOLUTION
Peru	Decline in productivity	Mountainous land degradation	Terrace cropping

How to improve land productivity on slopes:

The rehabilitation of crop terraces

Photo 1. The rehabilitation of terraces permit both the farming of sloping lands and the prevention of erosion. © UNEP

The Colca Valley is situated in an Andean valley in the mid-western part of Caylloma Province in the Department of Arequipa. Its altitude ranges from 2,200 metres to 4,500 metres above sea level, the limit for livestock farming. Large mountains dominate the valley, characterized by a deep canyon more than 100 km in length and carved by the Colca River.
Well before the Inca period, the local population farmed the lands through terracing so as to benefit from the specific characteristics of different altitudes; however, this technique has been more or less abandoned since the colonial era. The remaining terraces are poorly maintained and rarely irrigated. The Peruvian NGO, DESCO, have undertaken to restore the terraces and the irrigation canals while raising awareness on their usefulness. The results speak for themselves, land productivity and crop production has increased, erosion and water loss has been reduced and the managed landscape attracts tourism.

Ecosystem levels and altitude

The Colca Valley was initially inhabited by the Collahuas who, even before the period of the Incas, developed a production system based on terraces and irrigation schemes. By terrace farming, the local population benefited from the characteristics specific to the different altitudes. Beyond 3,800 metres, Camelidae (alpacas, llamas and vicuñas) are bred. Mixed livestock and agriculture are found below this altitude and in the past, the valley sustained a population of 60,000 inhabitants solely due to its resources (crops and livestock). However, as a result of the colonial period, the technique has been abandoned and the population has been reduced to 6,000 inhabitants.

South America | Peru | Colca Valley

COUNTRY DATA: PERU

Region:	**South America**
Capital:	**Lima**
Surface area:	**1,285,216 km²**
Population:	**25,230,000 inhab.**
Population density:	**19 inhab./km²**
Infant mortality rate (per thousand births):	**45**
Fertility rate (births per woman):	**3.0**
Population growth rate (per annum):	**1.7 %**
Life expectancy ♀ – ♂:	**71 – 66 years**
Forest cover:	**5.3 %**

From an ecological viewpoint, the zone is rich in varied species with up to fifteen ecosystems identified by scientists. However, from a productive viewpoint, three main systems are identified: the high Andean zone at over 3,800 m altitude is restricted to Camelidae breeding; the inter-Andean valley, between 3,000 m and 3,800 m with mixed livestock and cropping systems and the low Andean zone, ideal for fruit production.

Causes and effects in the drop of land productivity

Land productivity has greatly diminished in the Colca Valley since the colonial era. According to official estimations, 30% of arable land has been lost due to the degradation of terraces and the lack of maintenance of the irrigation systems. Poor land management has also contributed to a drop in soil fertility. In fact, farmers have forgotten the agricultural practices of their ancestors, which consisted of enriching the soil with mulch and compost, as well as crop rotation and mixed cropping techniques or polyculture. Short-term agricultural production, that takes full advantage of immediate returns, was preferred to the detriment of sustainable development that exhausted resources and damaged the land.

Tree logging for firewood is another well-known cause of desertification.
The mountainous zones are characterized by dramatic water shortages, steep slopes and serious climatic limitations on agriculture (frosts, low atmospheric humidity). Average annual rainfall is 350 mm, of which 60% is concentrated between January and March with only one harvest a year. Small land properties are common and on average, each family possesses 1.2 hectares, split up into several smaller plots distributed among different ecological zones. In general, farmers cultivate between eight and sixteen different crop varieties, maize, beans, potatoes, barley and quinoa being the more common among them. The traditional techniques adopted to overcome environmental difficulties consisted essentially of terraces, irrigation networks and the beneficial effects of the microclimate present at varying altitudinal levels.

COUNTRY	THEME	EXAMPLE	SOLUTION
Peru	Decline in productivity	Mountainous land degradation	Terrace cropping

Possible solutions

DESCO, a Peruvian NGO based in Lima and founded in 1965, implemented its project in the district of Lari in the Colca Valley located between an altitude of 3,200 m and 4,500 m. The project aims to restore the terraces, improve irrigation structures and introduce agro-forestry practices in the region. The expected results include the improvement of agricultural productivity and renewed ecological awareness among local farmers. Thus, local traditional knowledge should be re-evaluated and complemented by means of modern techniques and sustainable agricultural systems such as agro-forestry and reforestation.

The Lari terrace rehabilitation project began in 1992 (Photo 1). In 1998, a surface area of 1,050 hectares of terraces was restored. However, certain terraces are so badly damaged and difficult to irrigate that they are beyond repair.

Terrace rehabilitation

A terrace may be defined as an area for cultivation whose slopes have been levelled or raised and stabilized by a small wall made of stones (Photos 1 and 3). The advantages of terraces go beyond their capacity to transform slopes into arable land; they are also effective in the control of erosion and improve water management, they maintain soil humidity and reduce the risk of frosts. They enable farmers to better utilize the microclimatic and ecological characteristics at different altitudes. On the whole, terrace cropping transforms the agricultural potential of land otherwise limited to tree planting, into irrigated farming land (Photo 2).

Photo 2. Agriculture on mountainous regions is rendered difficult by its steep slopes and the risks of erosion. Here the men plough the flat fields thanks to the construction of terraces.

In order to restore Andean terraces, three elements are required; the stone wall, the terrace itself and the access route or pathway.

- **The stone wall:** the main purpose of this structure is to support the terrace. A hole is dug 50 cm below the terrace level where large stones are laid to act as foundations and provide the wall with stability. The wall is then constructed from ground level by placing stones of different sizes on top of each other, slightly inclined towards the slope. The height of the wall depends on the width of the terrace. Smaller stones are then added behind the wall and between the gaps made by the larger blocks so as to strengthen it.

- **The terrace:** is essentially made up of soil originating from the slope itself that is then levelled. However, certain terraces are more elaborate and are made up of several layers: a base layer made up of large stones that act as drainage filters; an intermediate layer made up of smaller stones, sand and clay and an upper layer of 50-80 cm of agricultural land. The terraces are slightly inclined towards the slope rim, allowing water to flow gradually without causing erosion.

- **Access routes or pathways:** small transversal stairs that link the various terraces and facilitate access. The stairway is generally part of the stone wall.

The irrigation systems were also restored. Water from melting snow or from springs is collected in reservoirs upstream from irrigation canals then distributed from one terrace to another.

Agro-forestry is strongly recommended on the terraces. It involves farming a combination of annual crops such as cereals and perennials such as fruit trees. This type of production system generates both economic and ecological benefits since local farmers diversify their produce while enriching the land. A technique used to maintain the terraces involves planting woody species close to the walls to act as both support and as windshields (See Ecuador case study). The recommended tree species are capuli *(Prunus sp.)*, cypress *(Cupresus macrocarpa)* and pine *(Pinus sp.)* noted for their physical properties and their ability to recycle nutrients.

Photo 3. A terrace may be defined as an area for cultivation whose slopes have been levelled or raised and stabilized, usually with stone walls.

COUNTRY	THEME	EXAMPLE	SOLUTION
Peru	Decline in productivity	Mountainous land degradation	Terrace cropping

Conclusion

The effectiveness of the project can best be measured by using crop productivity as an indicator. Productivity has increased by 29% between 1990 (before the project) and 1998 (after the project) in the region chosen by DESCO. Crops showing greater productivity are quinoa (80%), potatoes (51.6%) and sweet peas (33%).

The results can thus be summarized as follows:

- **the methods and know-how to construct terraces as well as water and soil conservation practices, have been reintroduced.**
- **317 hectares of terraces have been restored and 101 hectares of arable land has been reclaimed, benefiting 364 families.**
- **the irrigation canals have been repairedo and improved, whose flow is now 30 to 50 litres/second on average.**
- **the network of irrigation canals has been optimized allowing wider distribution.**
- **41,000 trees of local species have been planted in the framework of agro-forestry.**
- **productivity has increased for the principal crops (quinoa, maïze, potatoes).**
- **the role of women has been encouraged and reinforced during community meetings.**
- **the notion of terraces to attract tourists has been promoted.**

This case study was proposed by Mr Francisco Brzovic and José Torrico within the framework of the United Nations Environment Programme 'Saving the Drylands' award.
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Classroom ACTIVITIES

The teacher explains the terrace cropping system in class.

What do you think of the case study? Do you live in a mountainous region?
Do you face similar problems to those faced by the inhabitants of the Colca Valley in Peru?

Locate Colca Valley in Peru. Is your country on the same continent as Peru? Does your region encounter the same problems as those found in Colca Valley in Peru? Are their problems similar to yours? What are the differences? What are the similarities?

Draw the terraced crops on the mountains with the local farmers that work and grow plants there. Paste your picture to your notebook.

Outdoors, on a heap or mound of earth, construct mini-terraces by flattening the earth at different levels, which is stabilized with stones and small branches. With your classmates, start a competition to construct the best mini-terraces.

Tick the correct answers from the following:

In Peru, terraces are used to:

- construct steps.
- act as a windbreak.
- reduce noise levels.
- combat erosion.
- enlarge the agricultural land area.
- farm in mountainous regions.
- raise goats.

COUNTRY	THEME	EXAMPLE	SOLUTION
Italy	Water collection	The Sassi of Matera	Rehabilitation of traditional systems

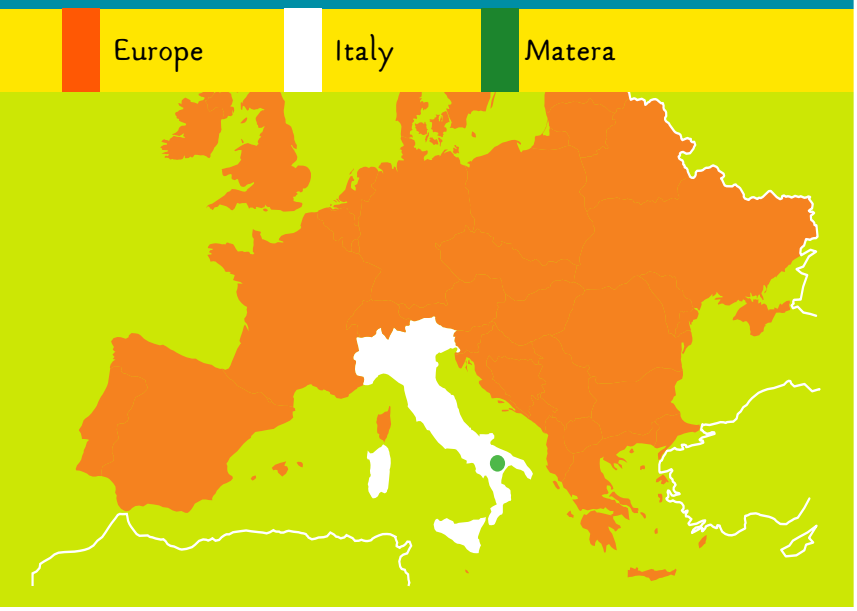
A judicious system of water collection:

The restoration of ancestral techniques in Sassi of Matera

Photo 1. A town carved entirely from chalk stone. Sassi means "stones" in Italian.

Matera is a town famous for its traditional urban system. Located in the heart of the Basilicate in southern Italy, it owes its celebrity to its exceptional historical centre called the 'Sassi'.
The Sassi, meaning literally 'stones', make up a town carved out entirely from chalk stone. The traditional dwellings are formed from the actual sloping wall of a deep ravine.
The techniques used to hollow out the chalk plateau and to collect water, employed up until contemporary times, appeared in the Neolithic era.
The ingenious arrangement of stones helped create natural ventilation systems and the collection of water from humidity. The evolution of archaic structures for the collection of water in towns is responsible for the Sassi of Matera found today.

COUNTRY DATA: ITALY



Region:	**Europe**
Capital:	**Italy**
Surface area:	**301,318 km²**
Population:	**57,343,000 inhab.**
Population density:	**191 inhab./km²**
Infant mortality rate (per thousand births):	**7**
Fertility rate (births per woman):	**1.2**
Population growth rate (per annum):	**0.0 %**
Life expectancy ♀ – ♂:	**81 – 75 years**
Average temperatures (min./max.):	**-1,9 / 28,9°C**
Forest cover:	**22 %**

The Sassi of Matera

Over the centuries, the low water levels in rivers and groundwater reserves, alternating with violent and intense rain, has rendered the practice of conservation of underground sources of water and water collection indispensable. The case of Sassi of Matera is a perfect example of how the regional natural topography favours this type of dwelling. The town is constructed on the edges of profound ravines, the Gravine. The inhabited areas are not situated at the foot of the canyon as might be expected, but on their steep flanks and at its summit. In fact, water coming from rain and frost is collected by the drainage system and in caves, unlike water used for drinking and cooking, which comes from river sources.

To maximize the use of rainwater, the dwellings are constructed around a courtyard. Here, a large tank for the community is dug out that collects water from the roofs, the edges of which never go beyond the walls of the houses. Because the roof is part of the stone work, not a single drop of water is lost. It is then channelled directly to the tank by means of descending terracotta canals (Photo 3).

Galleries radiating from these central wells maintain a constant temperature throughout the year and constitute an ideal refuge for people and livestock as well as serving as perfect storage places for wheat and water.

Photo 2. Tumulus structures and arches carved from the rock.

Another type of dwelling and method of collecting water is formed from simple piles of stones or created by vaults carved from the rock (Photo 2). These structures are formed in tumulus. These devices fulfil their function during the day as well as at night. During the day, the high humidity winds percolate into the spaces between the numerous stones.

COUNTRY	THEME	EXAMPLE	SOLUTION
Italy	Water collection	The Sassi of Matera	Rehabilitation of traditional systems

Photo 3. The roofs are part of the stone work; not a single drop of rain is lost. © Pietro Laureano

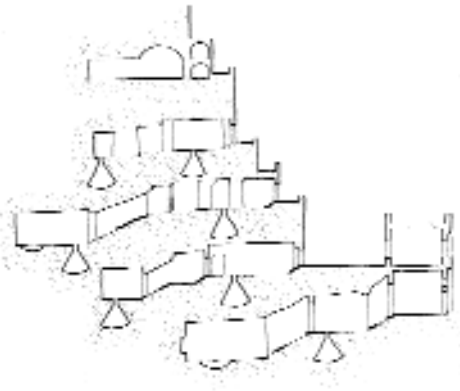


Figure 1. Bell-shaped water tanks are inter-linked by canals across several levels. © Pietro Laureano

The inner wall not exposed to the sun remains cooler than the outside. The drop in temperature brings about condensation of the droplets that fall into a cavity. The water accumulates, providing humidity and a cooler environment, which enhances the effectiveness of condensation. At night, the process is reversed, the exterior is cooler than the interior and condensation occurs, producing similar results. The humidity condenses and produces frost on the exterior of the dwellings. The following day the frost melts and filters down between the spaces into the cavity.

The system of dwellings of the Sassi of Matera has been constructed from prehistoric techniques by combining various principles for the collection of water: its capture, percolation and condensation and is thus adapted to its surroundings. During the violent rains, the terraces and the system of water collection protect the slopes from erosion. During the dry season, the hollowed out cavities work like an "inhaler" of air humidity (system explained above).

There are about ten superimposed levels accompanied by ten bell-shaped tanks linked between them by canals and water filter systems (Figs. 1 and 2).

The vertical development of the town means that the effect of gravity is used for the distribution of water while protecting the dwellings from the sweeping winds of the high plateau. The network of pathways, steps and underground passages continues to follow the ancient hydraulic structure.

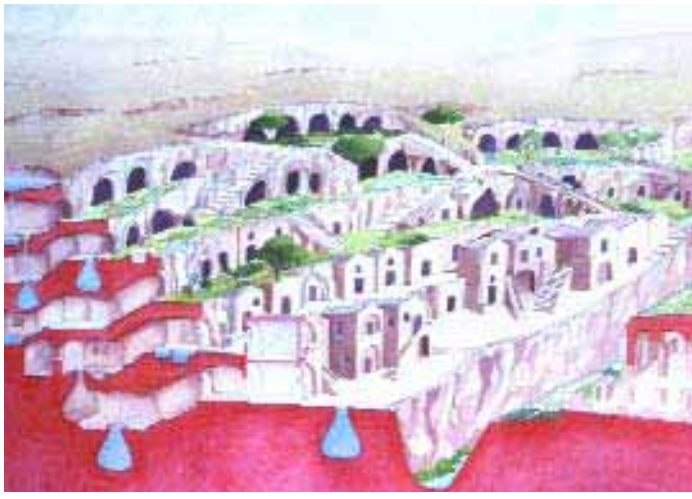


Figure 2. Illustration of the vertical structure of the Sassi of Matera

Causes and effects of abusive modernisation

During the 1950s the Sassi of Matera was closed due to their neglected condition, and the 20,000 inhabitants were moved to other neighbourhoods. The abandoned houses became the property of the state and a wall was erected to prevent them from being occupied.

The Sassi of Matera was transformed into a ghost town, the greatest historical troglodytic centre in the whole of Europe was completely abandoned. The dwellings were neither occupied nor ventilated, leading to rapid degradation. The churches carved from the rock and decorated with beautiful medieval frescoes soon crumbled away as a result of theft and pillage.

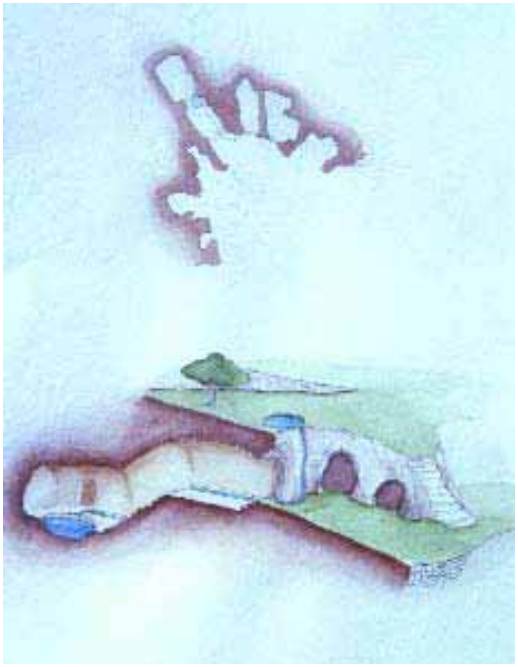


Figure 3. Galleries radiate from the courtyard wells. The last section is designed to collect waste to make humus.

Possible solutions

In 1986, largely thanks to the motivation of individuals involved in cultural activities, the Italian Government allocated 100 billion lires to restore the Sassi and to undertake the work necessary to improve its sanitary conditions and urbanization, and to encourage private individuals to take up residence there. All the state properties were entrusted to the Mayor of Matera, responsible for financing the project.
The turning point in the management of the Sassi came about with their inscription in 1993 as an UNESCO World Heritage Site. Matera became a destination for both national and international tourists and the individual requests to return and live in the Sassi multiplied. The Mayor of Matera equipped the Sassi with a network of water systems, drains, gas, electricity and telecommunications whose cables were buried in underground trenches so not to disturb its architectural qualities or the landscape. Around 3,000 people now live in the typical cave-homes, half- built, half-hollowed out.

The restoration of traditional systems of water collection

The Sassi of Matera illustrates the natural resource management capabilities (water, sun and energy) that were once perfectly employed but are so often neglected today.

The international debate on urban development makes this problem current and relevant. It is necessary to maximize the potential of a town at a local level to assure its harmonious and sustainable development. It is for this reason that the Ministry of the Environment chose Matera as an urban rehabilitation model within the framework of the Rio Conference and

the United Nations Convention to Combat Desertification (UNCCD), in its directives and action plans.

The very encouraging experiment in Matera could be adopted in other urban centres such as the inland region of Lucanie and the dwelling systems of the Gravine (canyons). Indeed, these sites offer similar architectural and environmental characteristics but have not benefited from similar renovation. Above all, this experiment is an exceptional example for those countries situated on the southern Mediterranean rim. In these countries, the progress of modernization often destroys traditional methods of managing space and threatens the ecological equilibrium of the whole region. Only by demonstrating the success of rich industrialized countries, like Italy, to restore traditional systems can countries that are less industrialized, be persuaded to do the same.

Conclusion

The objective of the international campaign to restore the Sassi of Matera was to revive innovative traditional methods:

- **the restoration of tanks for the use of rainwater.**
- **the use of terraces supported by walls to prevent landslides and land degradation.**
- **the rehabilitation of hanging gardens to provide green urban spaces.**
- **the reutilization of caves and cavities for natural ventilation.**

These measures do not imply that modern techniques should be ignored, but that these traditional techniques can also present sustainable solutions for the future.

Photo 4. In the 1950s, the Sassi dwellings were completely abandoned transforming Matera into a ghost town.

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Classroom ACTIVITIES

The teacher explains the Sassi of Matera in class.

Where is Italy?
Is your country on the same continent as Italy?
What distinguishes the southern European climate compared to your country?
Are the problems of desertification in Italy the same as those found in your region?
What are the differences?
What are the similarities?

Draw the Sassi of Matera on the hill (see photos and illustrations in the study) with their multi-layered houses and water reservoirs.
Draw the flow of rainwater leading to the reservoirs in the courtyard.
You can add your picture to the wall chart (See *Teacher's Guide*).

How is water condensation produced?
Ask an adult (teacher, parent) to boil water in a pan. Collect the water vapour by pivoting a glass or ceramic object over the vapour. Ask an adult to perform this task.
Did you notice how water trickles down the ceramic/glass object due to the effect of condensation? In your view, is there are a difference in temperature between the object and the boiling water?

What characterizes the temperature of the inside of a cave compared to the outside?
Perhaps you have visited a cave and have noticed the difference in temperature. In general, how is the water temperature different from the temperature of the surrounding air?
If possible use a thermometer to accurately measure the temperature. Give examples where you have noticed these differences in temperature?

How would you construct a house that allows you to collect rainwater falling on the roof. Describe the shape of the roof. How would you position the receptacles to collect the water? Would it be possible to collect rainwater from your school roof and/or your home?
Discuss this with your family (See cartoon: *There is No Rug Big Enough to Sweep the Desert Under*).

COUNTRY	THEME	EXAMPLE	SOLUTION
Spain	Erosion	Olive tree plantation	Vegetation cover

An European example to combat desertification:

Vegetation cover to improve olive harvests

Photo 1. Vegetation cover of shrub trees protects the soil between the olive trees. © Asociación española agricultura de conservación

The moving and sparse soils on the steep slopes of the cultivated lands coupled with the semi-arid Mediterranean climate comprising irregular rains and seasonal droughts provide ideal conditions for erosion and desertification. Poor natural resource management further compounds these conditions. Water is the principal cause of (hydraulic) erosion even though wind erosion, caused by violent sweeping winds, can play a significant role. Generally, soil degradation by hydraulic or wind erosion represents a serious threat to both agriculture and forestry and to the environment of the Mediterranean rim.

Europe is also threatened by desertification. Countries of the Mediterranean basin are the principal victims of a form of desertification afflicted by the effects of erosion. This problem is highlighted in the case study on olive cropping in Spain.
It is estimated that one third of the agricultural surface in the Mediterranean region is affected by land degradation. In Spain, it is largely the southern regions that are affected.

Olive crops

The following example shows how ill adapted agro-forestry practices, such as traditional olive cropping in Andalousia, can ruin soil by erosion.
Soil degradation is indeed much more pronounced for olive tree cultivation than for the cultivation of cereals, sunflowers, or even grazing areas. According to official estimates, more than 80 tons of soil per hectare is lost every year in Andalusian olive tree plantations.

COUNTRY DATA: SPAIN

Europe Spain Eroded region

Region:	**Europe**
Capital:	**Spain**
Surface area:	**505,992 km²**
Population:	**39,633,000 inhab.**
Population density:	**78 inhab./km²**
Infant mortality rate (per thousand births):	**7**
Fertility rate (births per woman):	**1.1**
Population growth rate (per annum):	**0.0 %**
Life expectancy ♀ – ♂:	**82 – 75 years**
Forest cover:	**17 %**

These losses are greater than the regenerative capacity of the soil. Furthermore, residues of chemical fertilizers may infiltrate and pollute the superficial layers of groundwater sources.

Causes and effects of erosion

The Mediterranean climate is characterized by periods of drought alternating with violent rainfall during brief time periods. The hard, cracked soil makes it difficult for the rainwater to seep into lower levels. In addition, the steep topography of the cultivated lands tends to result in the downward flow of surface water.

Erosion occurs by the action of violent rains that disintegrate the soil when heavy rain flow downward along the slope. This causes earth particles to be torn away from the ground forming mudslides that scrape the soil still further. The hilly character of Andalusia accentuates this double process of erosion. In this way, a large amount of arable land is lost after each downpour.

The traditional ploughing system, commonly used in agriculture, generates most soil losses. In the dry regions, hard superficial layers of earth are formed after ploughing. The soil structure disintegrates when this upper layer breaks up, forming numerous fissures through which water escapes without being retained by the clay layer.

Photo 2. Land eroded by violent rainfall.

COUNTRY	THEME	EXAMPLE	SOLUTION
Spain	Erosion	Olive tree plantation	Vegetation cover

Possible solutions

The solutions to combat erosion therefore consist of using agricultural practices that curb the disintegration of the soil, favour water percolation and reduce the speed of water flow throughout the area of cultivation.

Therefore, discontinuing ploughing techniques could essentially halt the phenomenon of erosion and with time, the ground could become firmer (reducing disaggregation or disintegration of the soil) to better tolerate the impact of heavy rainfall without weathering.
However, it cannot be said that discontinuing ploughing in certain areas alone is enough to combat erosion particularly on the steeper slopes, since the natural flow of water as well as the effect of heavy rainfall would continue to erode the soil.

Vegetation cover

The International University of Andalusia recommended a particularly effective method to prevent erosion with the formation of vegetation cover on the arable land. In traditional olive plantations, the bare soil is eroded between the trees, whereas with this method, low shrubs are planted between the olive trees to help retain the soil and protect them from erosion. Most of the scientists who participated in the study agree that the layer of low vegetation cover is the most effective method to combat erosion.

Vegetation cover has multiple functions:

- it reduces the quantity and impact of rainfall on the soil surface.
- it increases soil permeability.
- it reduces the speed of water flows.

Photo 3. Olive plantations without vegetation cover.

Photo 4. Olive plantations with vegetation cover.

Soil management systems applying the technique of vegetation cover have been adapted and developed for olive tree plantations on 50,000 hectares of land across Spain. This system has indeed proved to be very effective in combating erosion. The investment and agricultural education departments of the Andalusian government decided to spread the knowledge of this new agricultural technique to other regions.

As well as combating erosion, the combined effects of olive tree plantations and vegetation cover are advantageous to agricultural ecosystems, and a rise in biological diversity has been observed. Productivity is enhanced compared with traditional olive tree ploughing techniques and there is a rise in nutrients in the deeper soil layers. The vegetation cover provides a good deal of organic matter that is very beneficial to the olive tree ecosystem. Cereals or pulses such as soy or beans and even weeds can be planted to form vegetation cover. It is recommended to use species that grow fast, propagate naturally and have a superficial root system.

The only vital condition to be met in order to obtain satisfactory results is to prevent competition for water and nutrients between the olive tree plantations and the vegetation cover. To achieve this, it is important to interrupt the growth of the vegetation cover by chemical or mechanical means: by properly applying herbicide treatment or pulling out the plants regularly. This ensures that the area directly under the tree is free from vegetation, which facilitates the harvesting of the olives (Fig. 1).

Studies conducted over a period of more than five years have revealed that the cultivation of olive trees, using the system of vegetation cover, is very competitive when well managed compared to traditional methods, with or without ploughing. In certain cases, an improvement of olive tree productivity was observed compared to cultivation on bare soil.

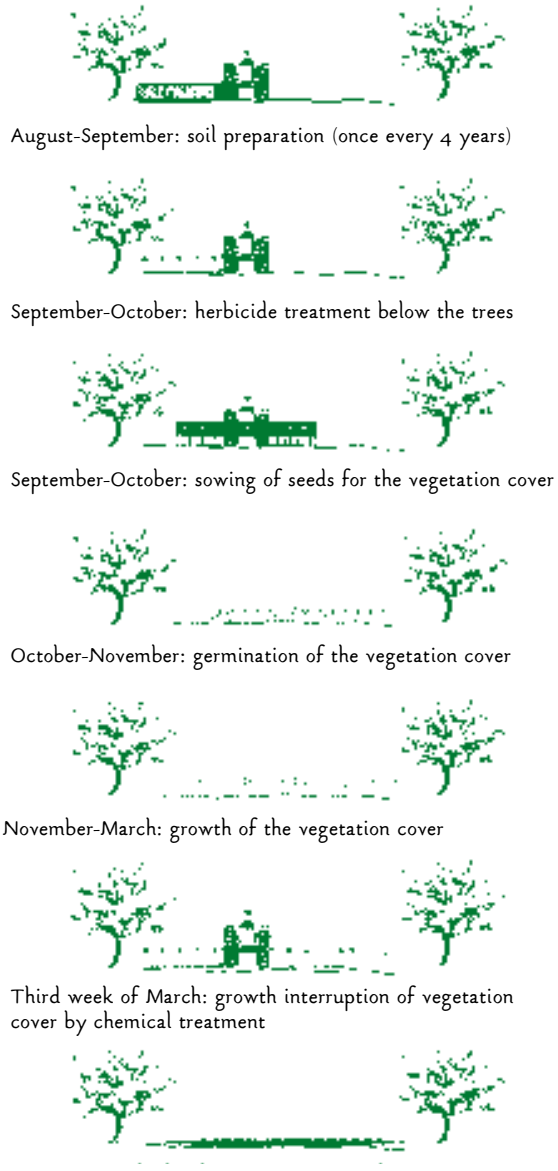

Fig. 1. Stages in the construction of vegetation cover.

COUNTRY	THEME	EXAMPLE	SOLUTION
Spain	Erosion	Olive tree plantation	Vegetation cover

Conclusion

It is necessary to promote the sustainable exploitation of arable lands compatible with the management of natural resources, landscape protection and the conservation of genetic diversity.

Cultivation of the olive tree with vegetation cover offers numerous advantages in this regard:

- **soil losses due to erosion are reduced.**
- **soil permeability has risen, which improves water filtration in the soil.**
- **evapo-transpiration of the soil has diminished.**
- **certain vegetation covers help combat weeds.**
- **more water is available to the olive tree during its vegetative cycle, especially in Spring.**
- **the vegetation cover shelters numerous species of insects and birds that construct their nests close to the ground and thereby increase biological diversity.**
- **eventually, vegetation cover as forage could benefit cattle.**

There are however some negative effects:

- **wild fires may propagate more easily throughout the landscape;**
- **poor management of the vegetation cover could lead to increased water consumption due to compétition that could affect productivity;**
- **the vegetation cover may hinder the harvesting of olives.**

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Classroom ACTIVITIES

The teacher explains the methods of olive cultivation to the class.

Where is Spain?
Is your country on the same continent as Spain?
What characterizes the climate of Spain compared to your country?

Are the desertification problems in Andalusia similar to those of your region?
What are the differences?
What are the similarities?

How would you arrange the vegetation cover to protect the soil in your region?
Where would it be necessary and possible to plant?
Which plants would you use?

Draw the Andalusian olive plantations before and after the project to combat desertification and erosion. In your first drawing, show how the earth around the olive trees is bare and eroded. In your second drawing, draw the vegetation cover growing around the olive trees that protect the soil. Paste your picture to the wall chart (**See** *Teacher's Guide*).

Tick the correct answers from the following:

In Spain, vegetation cover is planted between the olive trees to:

- improve the olive harvest.
- combat parasites.
- combat land degradation.
- act as a firebreak.
- increase biological diversity.
- improve soil quality.
- combat erosion.

Glossary

a

adaptation (adj.): an appropriate reaction by an individual or a population confronted by a change in environmental factors.

aerosol (n.): droplets or microscopic particles suspended in the atmosphere or air.

agro-forestry (n): method of food production combining tree and shrub plantations and the farming of low-lying herbaceous plants. Agro-forestry is often recommended to enhance the biodiversity of agricultural ecosystems and improve production while reducing land degradation.

alternative energy (n.): the exploitation of naturally occurring energy sources such as solar energy, wind energy, hydraulic energy as a less polluting alternative to fossil fuels. The availability and possibilities of this form of energy are considerable.

arable (adj.): land fit for ploughing or crop production.

arboretum (n.): a park designed to conserve a variety of local and exotic tree species.

arboriculture (n.): tree plantation for cultivation, particularly fruit trees.

aridity (n.): climatic conditions marked by low rainfall (less than 200 mm/year).

avalanche (n.): a mass of matter (snow, sand, earth) hurtling down a slope at high speed.

b

biological diversity or biodiversity (n.): the variety and variability of living species (animals, plants, fungi, micro-organisms) that make up an ecosystem.

bunding (n.): the act of constructing a man-made embankment or dam (bund).

c

clearings (n.pl.): an area that has been cleared by removing trees or vegetation present in a natural ecosystem, such as a forest or woodland, to render it fit for cultivation.

cochineal (n.): a small flattened insect that feeds on the sap of several plant species, notably the prickly pear. It gives its name to a dark red substance used as a colouring for foodstuffs extracted from the insect.

colonization (n.): a phenomenon by which a small portion of a plant or animal population is introduced to a new ecosystem and settles until it becomes omnipresent, found almost everywhere.

compost (n.): natural fertilizer made from organic plant and animal waste used to fertilise crops.

condensation (n.): the transformation of water vapour (gas) into water (liquid).

continental climate (n.): weather conditions or patterns characterised by very cold winters and very hot summers, the transition seasons being brief. Regions characterised by a continental climate are generally distant from the sea and ocean.

contour lines (n. pl.): imaginary lines that follow the same altitude or height above sea level. They can define the edges of terraces in terrace farming.

d

deforestation (n.): the destruction of forest ecosystems by human activities such as the over-exploitation of wood, forest fires and farming in wooded areas.

delta (n.): the zone that divides a river in two or more branches before it flows into the sea.

desiccate (vb.): to dry up or to become dry.
dike (n.): a man-made trench or ditch or a raised mound formed to prevent flooding.

e

ecological monitoring (n.): the control and follow-up of changes occurring between the natural and physical environment of an ecosystem and their interaction.

ecology (n.): a study of inter-relationships between living organisms and their environment and the mechanisms that explain their distribution, numbers and behaviour.

ecosystem (n.): a group of living organisms interacting with their physical and chemical environment in which they evolve.

encroachment (of the desert) (n.): the advancement of the desert fringe towards arable lands.

environmental education (n.): teaching relating to knowledge on topics such as ecology, desertification, climatic change, sustainable development etc.

erosion (n.): the removal of topsoil and the breakdown of rocks due to the action of the wind (wind erosion) or water (hydraulic erosion).

evaporation (n.): the transformation of liquid water into water vapour in the atmosphere without being absorbed by living organisms.

evapo-transpiration (n.): the return of water into the atmosphere as vapour, by evaporation from soil or water bodies, and emissions of plant transpiration.

exotic species (n.): foreign species found in a given biogeographical region that has been accidentally or voluntarily introduced by humans.

extensive cropping (n.): a method of crop production that enlarges agricultural areas to increase productivity. Extensive cropping is often accompanied by deforestation and clearings that increase arable lands.

f

fallow (n.): the practice of voluntarily interrupting farming activities on the land for a period of two years or more to allow the natural vegetation cover to restore the soil when it has been exhausted by a series of cropping.

fertility (n.): in the case of land, it is the ability of the soil to support and sustain life. A fertile soil contains enough organic matter and minerals to assure plant development and growth.

fertility rate (n.): number of infants born to a woman of child-bearing age; if she gave birth to the number of infants corresponding to the estimated age-specific fertility rate during the given period.

fodder (n.): grass, straw and hay that comprise food for cattle. Plants upon which animals can forage can be used as fodder.

foggaras (n.): an underground gallery that taps underground water reserves (or aquifers) from which it drains water towards fields to be irrigated.

g

gravity (n.): force of attraction exercised by one body upon another ie. a body that is strongly attracted and moves towards the earth.

groundwater (reserves) (n. pl.): layer of underground water, these so-called aquifers can be found at varying depths according to its source. The groundwater reserves play an important role in the drylands where they are the major source of water.

gullies (n.pl): channels worn (shaped) by running water.

h

halophyte (n.): a plant adapted to salt-rich soils, often termed salt-tolerant plants.

herbicide (n.): a chemical product that acts as a weed killer.

horticulture (n.): the cultivation of fruits, vegetables and ornamental species.

humus (n.): a brown coloured layer at the soil surface made up of decomposed vegetation rich in organic matter and nutritive elements that enrich the soil.

i

impluvium (n.): in Roman dwellings, it is a basin placed beneath the roof opening to collect rain water.

infant mortality rate (n.): the number of deaths of infants and children under the age of one year old, in a year, out of 1000 births in the same year.

intensive agriculture (n.): a method of food production based on crop farming and cattle rearing in a way that maximizes production in areas of reduced size in the short term. Intensive agriculture often leads to overgrazing, monoculture and the end of fallow periods that exhausts the land and reduces fertility and production in the long term.

intensive cropping (n.): crop production to increase the productivity of small agricultural plots. Intensive cropping generally leads to land degradation. (See intensive agriculture).

irrigation (n.): any of a variety of methods to collect and distribute water in drylands.

l

land degradation (n.): loss of soil fertlity linked to a drop in the concentration of organic matter in the soil, an accumulation of minerals, or a change in the soil structure by desiccation or erosion.

live fences (n. pl.): barriers formed using live trees or shrubs to counter the effects of wind and erosion while protecting crops. They can be constructed as cattle enclosures and provide fodder to the animals.

local species (n.): species adapted to the local biogeographic region, called indigenous species of the region.

m

malaria (n.): a serious illness caused by a parasite and transmitted by the mosquito, *Anopheles maculipennis*. Malaria occurs pratically throughout the world's tropical zones and affects several hundred million people. It can be fatal if not treated.

malnutrition (n.): the result of insufficient and ill-adapted food, in other words an inadequate diet that can lead to sickness.

microclimate (n.): the climate of a small or restricted area whose climate is different and distinct from the surrounding area.

micro-organism (n.): a plant or animal that is invisible to the naked eye and can only been seen through a microscope.

migration (n.): seasonal displacement of an animal from one region to another to reproduce, search for food or seek better climate or living conditions. Human populations also migrate for economical or political reasons.

minerals (n. pl.): solid inorganic particles that make up rocks of the terrestrial crust.

monoculture (n.): the growing of only one type of crop, or a large area over which it is grown.

mulch (n.): a loose material such as dung mixed with straw, laid on the soil around plants to protect roots, retain moisture and control weeds. It often has a nutritional function for the soil and therefore the plants.

n

Neolithic (n. and adj): prehistoric period corresponding to the later Stone Age and the start of agriculture.

NGO (n.): a non-profit non-governmental organisation whose work is carried out independently from governments.

nitrates (n.pl.): mineral salts of nitric acid, they are nutritive mineral elements for plants. However, in zones of intensive agriculture the use of nitrate based fertilizer in excessive quantities can frequently lead to the pollution of surface and underground water reserves.

nursery (n.): an area reserved for the cultivation of trees.

nutrients (n.pl.): a term that includes various nutritional minerals vital to the well-being of organisms. The major nutrients for terrestrial green plants are phosphates, nitrates, potassium and mineral salts.

o

oasis (n.): plural form: oases. A fertile ecosystem situated in a desert zone around a watering hole or in depressions where groundwater reserves are close to the surface.

oilseed (n.): an oil-rich plant from which oil is extracted for consumption.

orchard (n.): an area reserved for the cultivation of fruit trees.

organic (adj.): that comes from living organisms.

ornamental species (n.pl.): a plant species that is intended to be decorative and not serve as a foodstuff.

over-exploitation (n.): improper and excessive use leading to the degradation of that which is used (land, water, vegetation).

overgrazing (n.): excess feeding or foraging of domestic animals leading to the degradation of vegetation cover.

p

percolation (n.): penetration and filtration of water through pores of rock or earth.

perennial (n. or adj.): a plant that lives for more than two years, or simply, coming back year after year.

permeability (n.): the ability to have water, liquid or air pass through or penetrate a barrier like the soil through its pores.

pilot project (n.): a leading experimental programme whose goal is to measure results so that further action can be planned, thereby applying the knowledge acquired over the initial testing stage.

planting out (n.): the transfer or transplantation of young healthy plants as seedlings from small pots into the soil, often in a nursery.

plant succession (n.): the progressive pattern of different forms of vegetation cover that dominate a given ecosystem. It has been observed that pioneer species, small annual plants, initially colonize virgin lands. They are then succeeded by herbaceous species then by shrubs and finally by trees.

ploughing (n.): the act of turning up the soil to make furrows or ridges that aerate the soil and prepare it for sowing.

population growth rate (n.): increase or decrease of a population.
Population growth = (birth rate – mortality rate) + (rate of immigration – rate of emigration)

potable (adj.): fit for consumption. Potable water should be clean and not endanger the health of those who drink it.

pulses (n. pl.): protein-rich plants capable of growing on poor soils due to their ability to fix nitrogen present in the atmosphere. Acacias, lentils, soy and peas are all examples of pulses.

r

rain-fed agriculture (n.): a method of crop production that relies on natural rainfall without the need for artificial irrigation systems.

reforestation (n.): tree replanting activity particularly in an area previously forested or woody.

rehabilitation (n.): to restore the state of something into its original form. For example, the rehabilitation of degraded lands by reforestation helps the fragile ecosystem to regenerate.

S

Sahelian (adj.): concerning the countries south of the Sahara desert, generally between the desert and the Savannah regions.

salinity (n.): rate of salt present in the soil.

self-help (n.): doing things for oneself without assistance from others.

self-management (n.): administration and organization of an enterprise or activity by the very workers involved.

shelterbelt (n.): fence of planted trees and shrubs that create a barrier against outside influences (fire, sand, wind, animal invasions etc.)

slash and burn (n.): a crop farming method that consists of setting fire to a wooded area to transform it into agricultural land.

sorghum (n.): a plant grown in Africa and in Asia for human consumption. It is particularly drought-resistant.

steppes (n.): a dry grassy ecosystem that is generally treeless due to low levels of rainfall. This type of landscape is found in Central Europe and Asia.

subsistence (n.): a subsistence activity or subsistence living implies production methods that barely produce enough to meet the basic needs of the farmer or worker. There is no surplus that can be sold and no profits are made.

sub-tropical (adj.): situated close to the tropics. The sub-tropical climate is characterised by hot temperatures and the long dry season.

succession (n.): the colonisation of a physical environment by a series of vegetation or plant communities until equilibrium is reached.

Sudano-sahelian climate (adj.): the predominant climate prevailing in the Sahel, the southern regions between Senegal and the Sahara. It is characterized by a long dry season and one very brief rainy season.

sustainable agriculture (n.): method of food production based on crop cultivation and cattle rearing that uses natural resources in a way that maintain and replenish (renew) them over time without jeopardizing the future of coming generations.
(See sustainable development)

sustainable development (n.): a means of progress that takes the environment into consideration by its wise and rational use, based on the reasonable and moderate exploitation of nature and its resources to ensure the continued maintenance of biological productivity in the biosphere.

t

topography (n.): the detailed study of, or description of the features of an area.

traditional knowledge (n.): the wisdom and experience base which represents the accumulated know-how of ancestors of a given population and is transmitted from one generation to another.

transpiration (n.): a phenomenon in which liquid water is absorbed by an organism and is released into the atmosphere in the form of water vapour.

troglodytic (adj.): a cave dwelling, hollowed out from the rock face, originally inhabited by a cave dweller known as a troglodyte.

tumulus (n.): a structure formed by the accumulation of earth or stones above a tomb during the Bronze Age

u

urbanization (n.): the development of cities and towns and their infrastructure leading to the concentration of the population in these areas.

v

vegetation cover (n.): the collective term for vegetation (especially low growing plants) covering the ground.

vegetative (adj.): concerning the growth process and maintenance of plant and animals.

viticulture (n.): the cultivation of the vine (grape).

w

wall chart (n.): updated information presented in the form of a poster that is available for all to read.

World Heritage (n.): natural and cultural sites listed by the UNESCO World Heritage Convention for their exceptional features of scientific, cultural or aesthetic importance so that they can be preserved for humanity.

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Combating desertification bears fruit

This document is part of the Environmental Education Kit on Desertification published by UNESCO and the UNCCD.
The kit is available in three languages (English, French and Spanish) and comprises five documents:
A Teacher's Guide: *Learning to Combat Desertification*
A Series of Case Studies: *Combating Desertification Bears Fruit*
A Cartoon: *The School Where the Magic Tree Grows*
A Cartoon: *There is No Rug Big Enough to Sweep the Desert Under*
A Poster: *Desertification in the World*.

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Kit pédagogique sur la désertification Education kit on desertification Kit pedagógico sobre la desertificación

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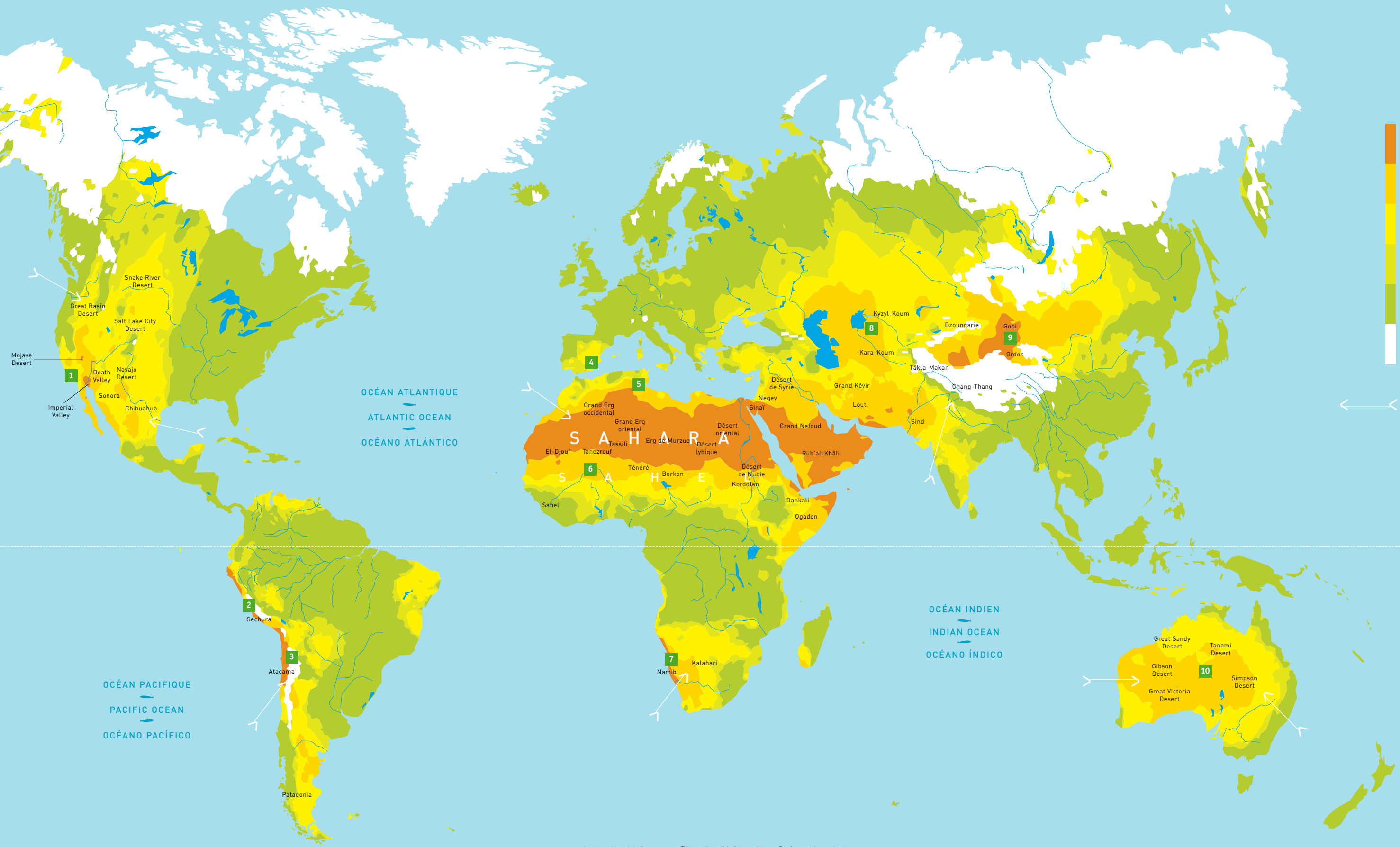

Hyper aride Hyper arid Hiperárido
Aride Arid Árido
Semi-aride Semi-arid Semiárido
Subhumide sec Dry Subhumid Seco subhúmedo
Humide Humid Húmedo
Climat froid Cold climate Clima frío

Vents desséchants Desiccating winds Vientos secos

équateur / equator / ecuador

Source : CRU / UEA, UNEP / DEWA

Comment peux-tu lutter contre la désertification?
What role can you play to combat desertification?
¿Cómo puedes luchar contra la desertificación?

Pépinière
Nursery
Vivero

Cultiver de nouvelles pousses permet d'obtenir des arbres pour reboiser les terres.
The cultivation of new shoots provides trees used to reforest land. Cultivar nuevos brotes permite obtener árboles para reforestar las tierras.

Barrage vert
Green belt
Barrera verde

En plantant des haies d'arbres, d'arbustes et d'herbes, on protège les cultures contre le vent, le sable, le ruissellement de l'eau et les bêtes. Planting tree, shrub or grass hedges protects crops against wind, sand, erosion and animals. Plantando barreras de árboles, arbustos y hierbas se logran proteger los cultivos contra el viento, la arena, la erosión y el ganado.

Compost
Compost
Abono orgánico

Produit à partir de débris de végétaux et d'excréments, cet engrais naturel est indispensable à la fertilisation des terres. Produced from plant waste and manure, this natural fertiliser is vital for the fertilisation of land. Producido a partir de desechos vegetales y excrementos animales, este abono natural es indispensable para la fertilización de la tierra.

Polyculture
Polyculture
Policultivos

La culture simultanée de plusieurs espèces permet de mieux exploiter les ressources de la terre et de limiter l'épuisement du sol. Planting several varieties of crops enables better distribution of land resources and limits soil exhaustion. El cultivo simultáneo de diversas especies permite una mejor explotación de los recursos de la tierra y limitar el desgaste de los suelos.

Diguettes
Dikes
Diques

Les diguettes retiennent l'eau autour des cultures, ce qui limite l'érosion due à l'effet du ruissellement. Dikes retain water around the crops, which curbs erosion due to runoff. Los diques retienen el agua alrededor de los cultivos frenando la erosión por escurrimiento.

Foyer amélioré
Improved oven
Estufa mejorada

Dans le foyer amélioré le bois brûle moins vite, ce qui permet d'économiser l'énergie. With improved ovens, the slow-burning wood helps save energy. En las estufas mejoradas, la leña se quema más lentamente economizando energía.

La désertification dans le monde / Desertification in the world / La desertificación en el mundo

Ce document fait partie du *Kit pédagogique sur la désertification* publié par l'UNESCO et l'UNCCD. Le kit est disponible en trois langues (français, anglais, espagnol) et il se compose de cinq documents : le guide de l'enseignant, *Apprendre à lutter contre la désertification* ; les études de cas, *La lutte contre la désertification porte ses fruits* ; les bandes dessinées, *L'école où pousse l'arbre magique* et *Aucun tapis n'est assez grand pour que l'on y cache le désert* ; et le poster *La désertification dans le monde.*

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Este documento forma parte del *Kit pedagógico sobre la desertificación* publicado por la UNESCO y la UNCCD. El kit está disponible en tres idiomas (francés, inglés y español) y se compone de 5 documentos: la guía del maestro *Aprendiendo a luchar contra la desertificación*, la serie de estudios de caso *La lucha contra la desertificación da sus frutos*, la tira cómica *La escuela donde crece el árbol mágico*, la tira cómica *No hay alfombra tan grande que pueda esconder el desierto* y el afiche *La desertificación en el mundo.*

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Kit pédagogique sur la désertification Education Kit on desertification Kit pedagógico sobre la desertificación
La désertification dans le monde / Desertification in the world / La desertificación en el mundo

THE SCHOOL WHERE THE MAGIC TREE GROWS

THE SCHOOL WHERE THE MAGIC TREE GROWS

Script:
Sophia Gazza, Amélie Dupuy,
et Marie Kyprianou

Cartoons:
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We are especially grateful to JUNDEP for the commitment demonstrated through their work at the Recoleta School and for inspiring the authors in the creation of this cartoon.

INTRODUCTION OF THE CHARACTERS

Iris

Pupo

Diego

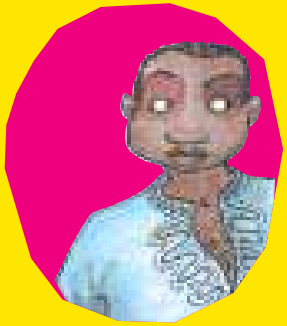
Mr. Tomatozzino

The Teacher

Kumba

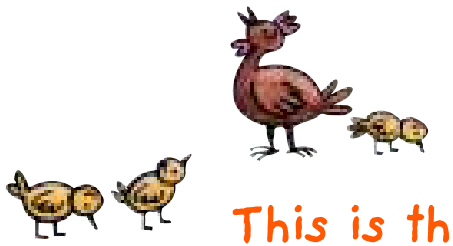
Moussa

Golo



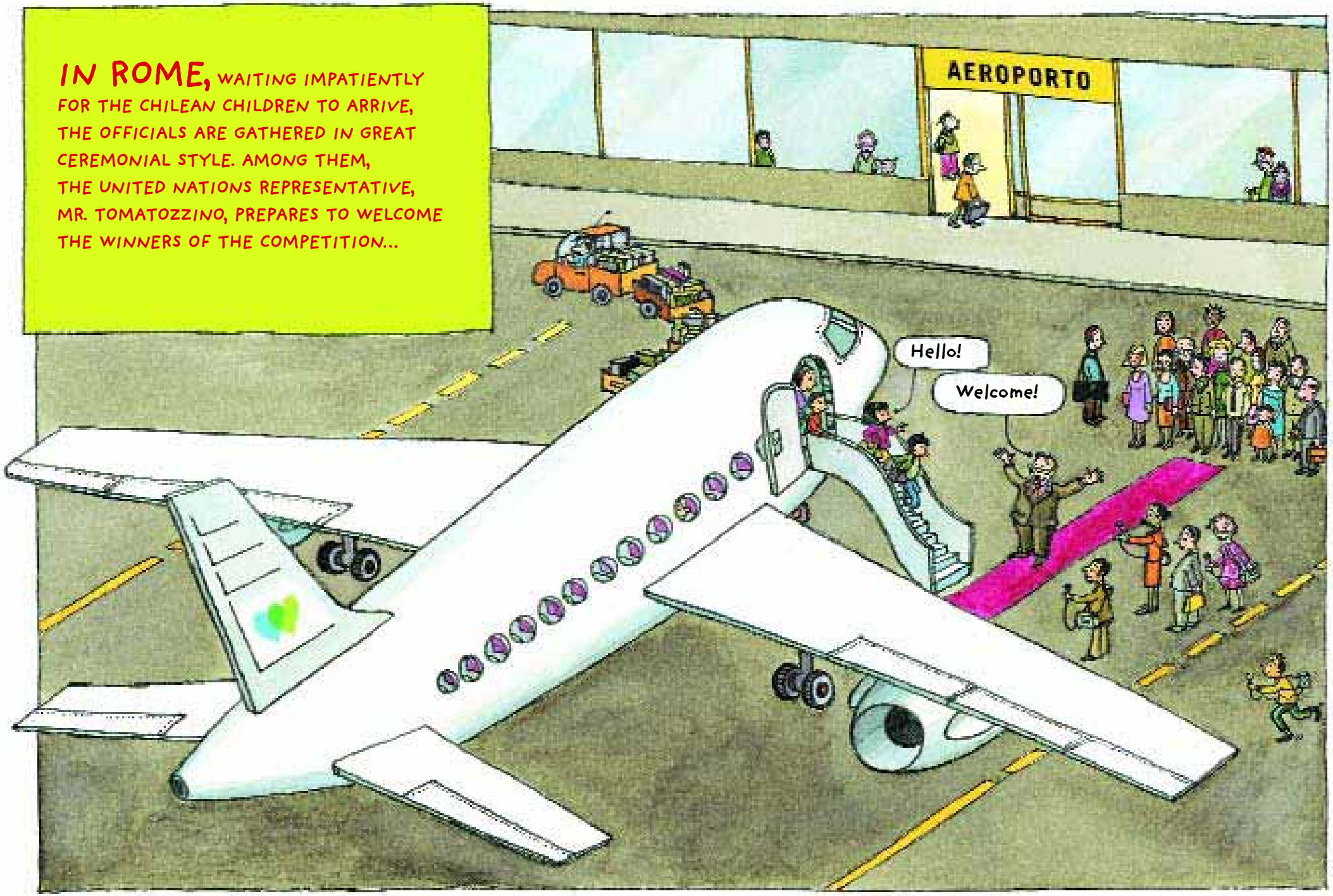
Adama

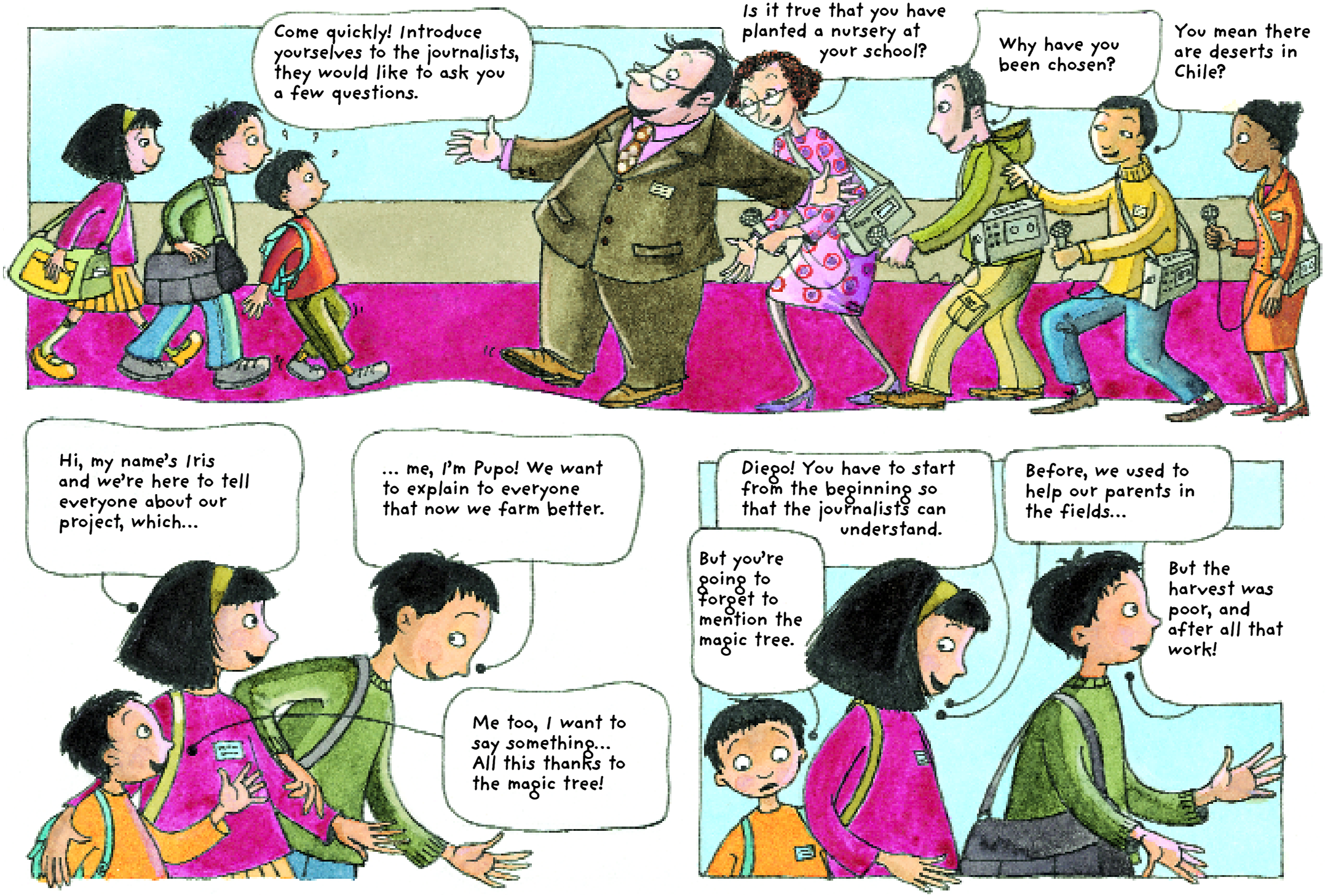
The Old Sage



This is the story of a group of children who won a competition organised by the United Nations* TO COMBAT DESERTIFICATION.
The children from the Recoleta School in Chile won with their school "tree nursery*" project and for a few months, they have become child ambassadors on combating desertification*.
Here they are, globetrotting to the schools of Europe and Africa.

When you spot an asterisk at the end of a word, go to page 30 where you will discover its meaning.


IN ROME, WAITING IMPATIENTLY FOR THE CHILEAN CHILDREN TO ARRIVE, THE OFFICIALS ARE GATHERED IN GREAT CEREMONIAL STYLE. AMONG THEM, THE UNITED NATIONS REPRESENTATIVE, MR. TOMATOZZINO, PREPARES TO WELCOME THE WINNERS OF THE COMPETITION...
AEROPORTO
Hello!
Welcome!


Come quickly! Introduce yourselves to the journalists, they would like to ask you a few questions.
Is it true that you have planted a nursery at your school?
Why have you been chosen?
You mean there are deserts in Chile?
Hi, my name's Iris and we're here to tell everyone about our project, which...
... me, I'm Pupo! We want to explain to everyone that now we farm better.
Me too, I want to say something... All this thanks to the magic tree!
Diego! You have to start from the beginning so that the journalists can understand.
But you're going to forget to mention the magic tree.
Before, we used to help our parents in the fields...
But the harvest was poor, and after all that work!


In fact, in our region, people are poor because they have a lot of problems. It hardly rains and the land is damaged ... so the crops go from bad to worse.
Then luckily one day, a NGO* explained to us that we could improve our farming methods.
They chose us, the children from Recoleta, to show people that things really can change...
How's that?
They visited our school and showed us how to farm differently. With their help we managed to grow our plants.
Yeah! And now we know how the magic tree grows!
Children! They are waiting for us at the school. You can continue to explain your project over there...
We'll follow you. We still have a lot of questions to ask you!

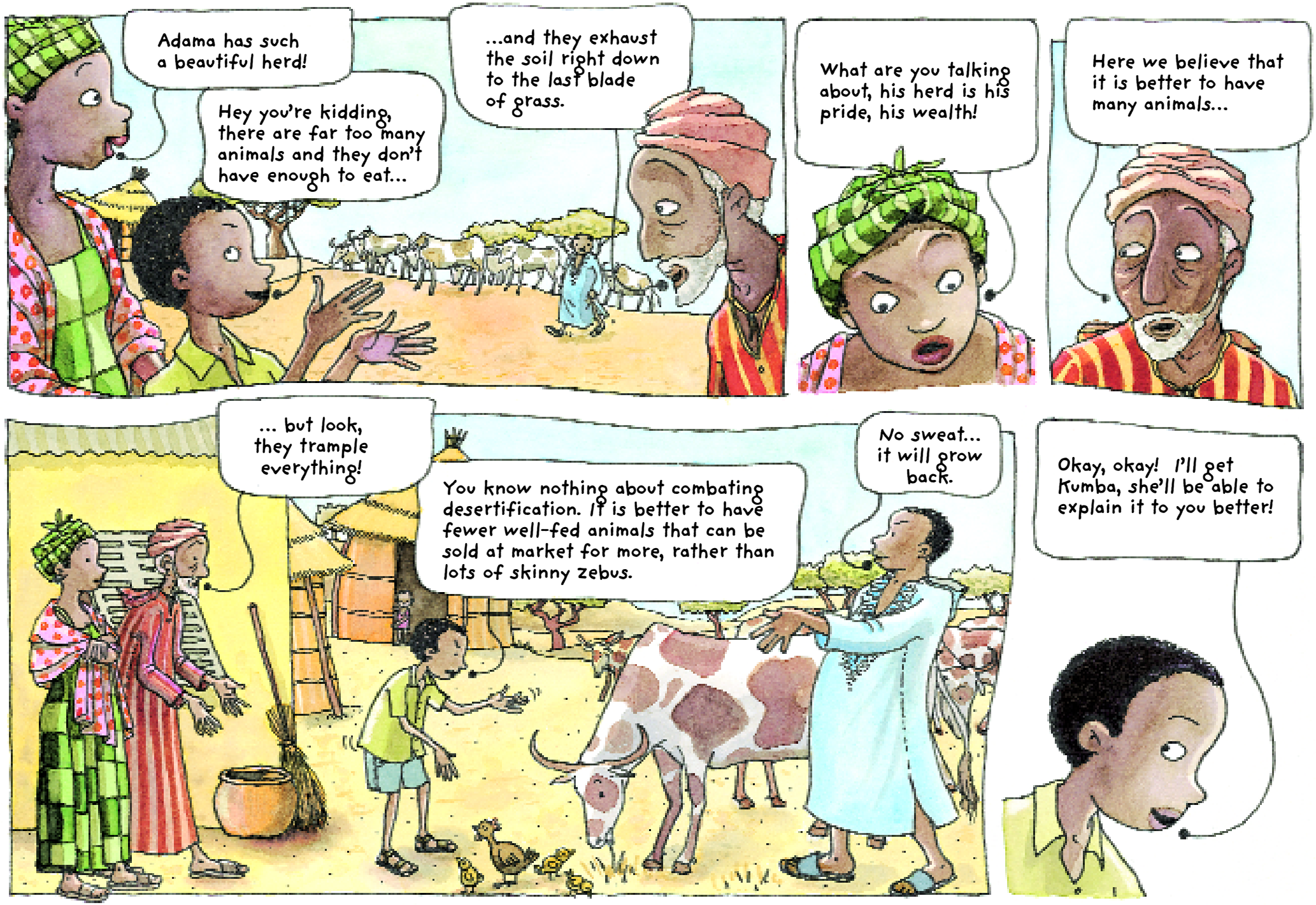

AT A SCHOOL IN THE HEART OF ROME, ITALIAN SCHOOL CHILDREN DISCOVER THE EXCITING ADVENTURE OF OUR LITTLE CHILEAN GARDENERS.
In our school nursery*, we plant and grow trees. When they become tall enough, we sell them...
Yes, we split ourselves up into "ecology teams" with 5 boys and 5 girls in each. Each team is responsible for its own trees.
Did you learn gardening?
As for me, I'm responsible for all the magic trees...
Did you have the idea of the nursery all by yourself?
No, it's thanks to an organization called the JUNDEP*...
They visited our school to explain to us that the north of Chile is under threat from desertification*.
Ooh! He's so lucky, all those magic trees...

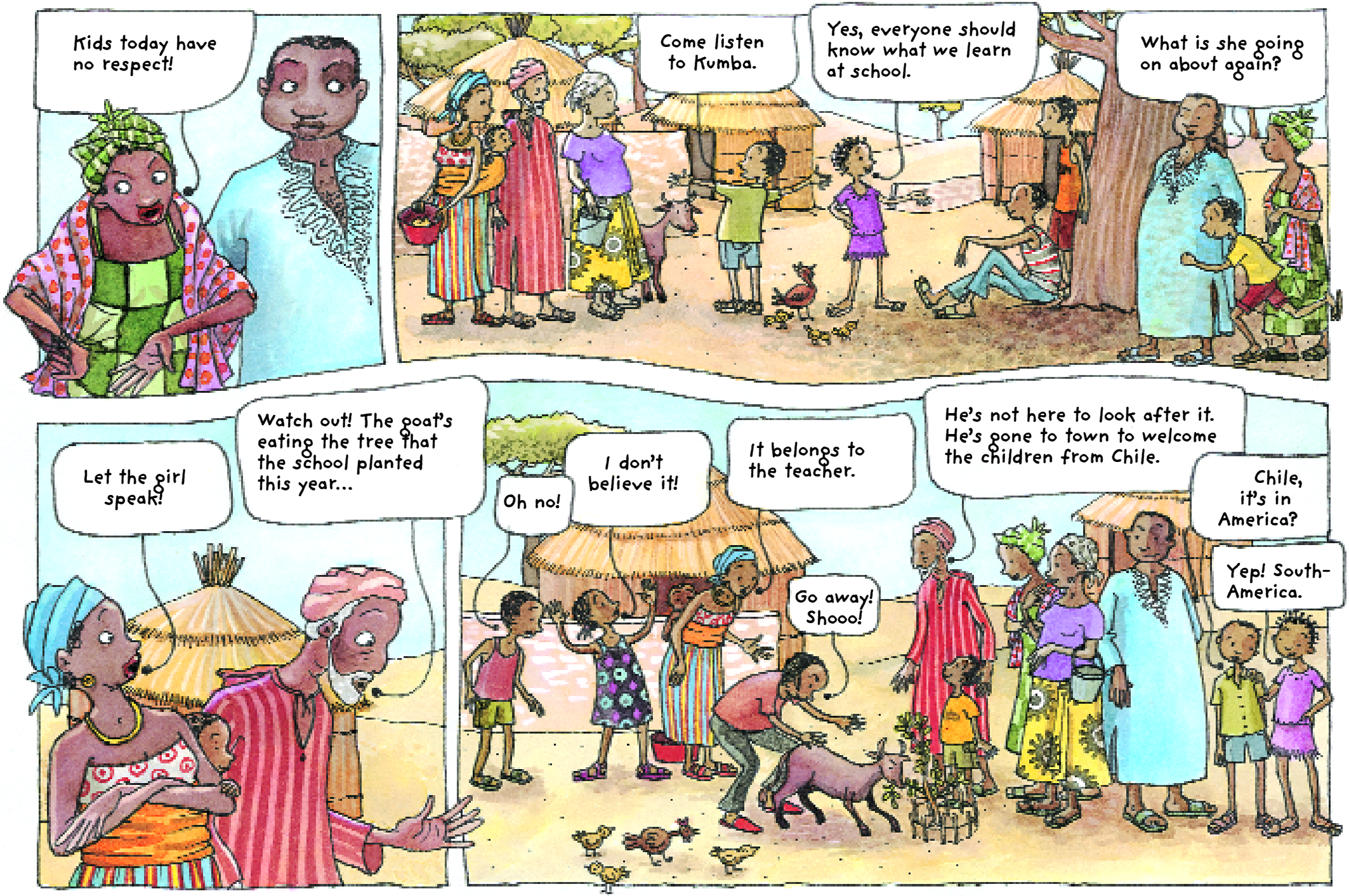

Luckily, here in Italy we don't suffer from these problems, we don't have deserts...
You're wrong, even if there are no deserts in Europe, desertification begins here too! The soil of the Mediterranean* region is already damaged.
In Spain, Greece and here in Italy the land along the coastline is eroding and is becoming more and more fragile. The situation is made worse during the summer months by forest and bush fires.
So you're saying that desertification is not quite desert, but if we don't do anything the Sahara could invade Italy!
Mamma mia!
What? The desert in Italy? Taking over the whole of Europe? Gosh!
Er! We're not quite there yet...
Ha ha ha! That would be funny, sand dunes everywhere and camels roaming the streets of Rome...!
Pupo! That would be a NATURAL disaster!
Aha! If you want, I can give you the solution. You'll just have to plant magic trees.


So for you, having taken the future into your own hands, how has the nursery changed your daily lives?
Well, everything's changed! We race to school every morning and...
...even our parents who used to keep us back to work in the fields no longer want us to miss school...
... because what we learn is really important!
Do you think that desertification is retreating at Recoleta because of your nursery?
Desertification doesn't go away in a few days, but we've already made enormous progress...
We sure have! Thanks to the JUNDEP instructors we've learned really useful techniques such as, how to save water and how to choose the right plants that are best suited to our region.
What a pleasure to hear that the work of the NGO bears fruit!
They're the ones that taught us about magic trees.
Psstt! You couldn't tell us where we could find magic tree seeds, could you?


For several years now we have been encouraging small local projects and helping affected countries combat desertification.
That's how we became...
...ambassadors in the fight against desertification!
Yes, but why is the nursery project run by kids?
Ssshh! Wouldn't you like to do the same as them and plant trees?
Now we have lots of magic trees that grow at home!
They explained to us that if we learn about our problems at an early age and work the land better, then we'll have fewer problems as we grow older...
And also adults don't believe in magic trees, while we do!
You're absolutely right, adults tend to give up too easily.
I congratulate you on your enthusiasm.
Let's give them a round of applause!


FOR OUR CHILD AMBASSADORS, IT'S TIME TO LEAVE ITALY AND MEET OTHER CHILDREN WHO ARE ALSO LEARNING TO COMBAT DESERTIFICATION.
Bon voyage!
MEANWHILE, IN A LITTLE VILLAGE IN MALI
Don't trim the hedge so low, you can see everything in my house!
If you think it's here to hide you!
Rather the hedge is used to put a stop to the wind blowing and protect our crops.
Oh...over there! Adama's cattle...


Adama has such a beautiful herd!
Hey you're kidding, there are far too many animals and they don't have enough to eat...
...and they exhaust the soil right down to the last blade of grass.
What are you talking about, his herd is his pride, his wealth!
Here we believe that it is better to have many animals...
... but look, they trample everything!
You know nothing about combating desertification. It is better to have fewer well-fed animals that can be sold at market for more, rather than lots of skinny zebus.
No sweat... it will grow back.
Okay, okay! I'll get Kumba, she'll be able to explain it to you better!


Kids today have no respect!
Come listen to Kumba.
Yes, everyone should know what we learn at school.
What is she going on about again?
Let the girl speak!
Watch out! The goat's eating the tree that the school planted this year...
Oh no!
I don't believe it!
It belongs to the teacher.
He's not here to look after it. He's gone to town to welcome the children from Chile.
Chile, it's in America?
Yep! South-America.
Go away! Shooo!


Who has he gone to pick up?
Kids of our age?
Yep! Children who have planted magic trees!
Sure, magic trees!
Huh!... magic trees... they're telling stories...
Well, I think I know why they call them magic trees.
We'll be arriving in Kitiko in less than an hour.
Wow, what amazing birds...
MEANWHILE, AS KUMBA PROUDLY REVEALS WHAT THE TEACHER HAS TAUGHT THEM AT SCHOOL, OUR CHILEAN FRIENDS ARE MAKING THEIR WAY IN A VERY BIG CAR.


It's true, we have a lot of beautiful birds here as well as many other animals.
But such treasures risk disappearing because of desertification. It's a catastrophe....
Fortunately, here in Mali we are leading numerous projects to solve this terrible problem.
Yes, moreover, all the Sahel* countries have signed the Convention* and they are very active.
ONE HOUR LATER
Hello, I'm Moussa from the Sahel Institute. For two years now we have been working together with teachers from the region ...
Hello
...and let me welcome Iris, Pupo and Diego from Chile who will tell you about their adventure.
Will we get books to read?
Yes and we know how to make magic trees grow!
Oh!

We help train teachers and we distribute activity books to children. The books contain lots of drawings to explain in simple terms how to combat desertification.

Brilliant! I want one.

It's not with books that we'll solve the water shortage here.

And what about you, Adama! With your animals that trample everything! You would be better off listening to our guests that have come all this way.

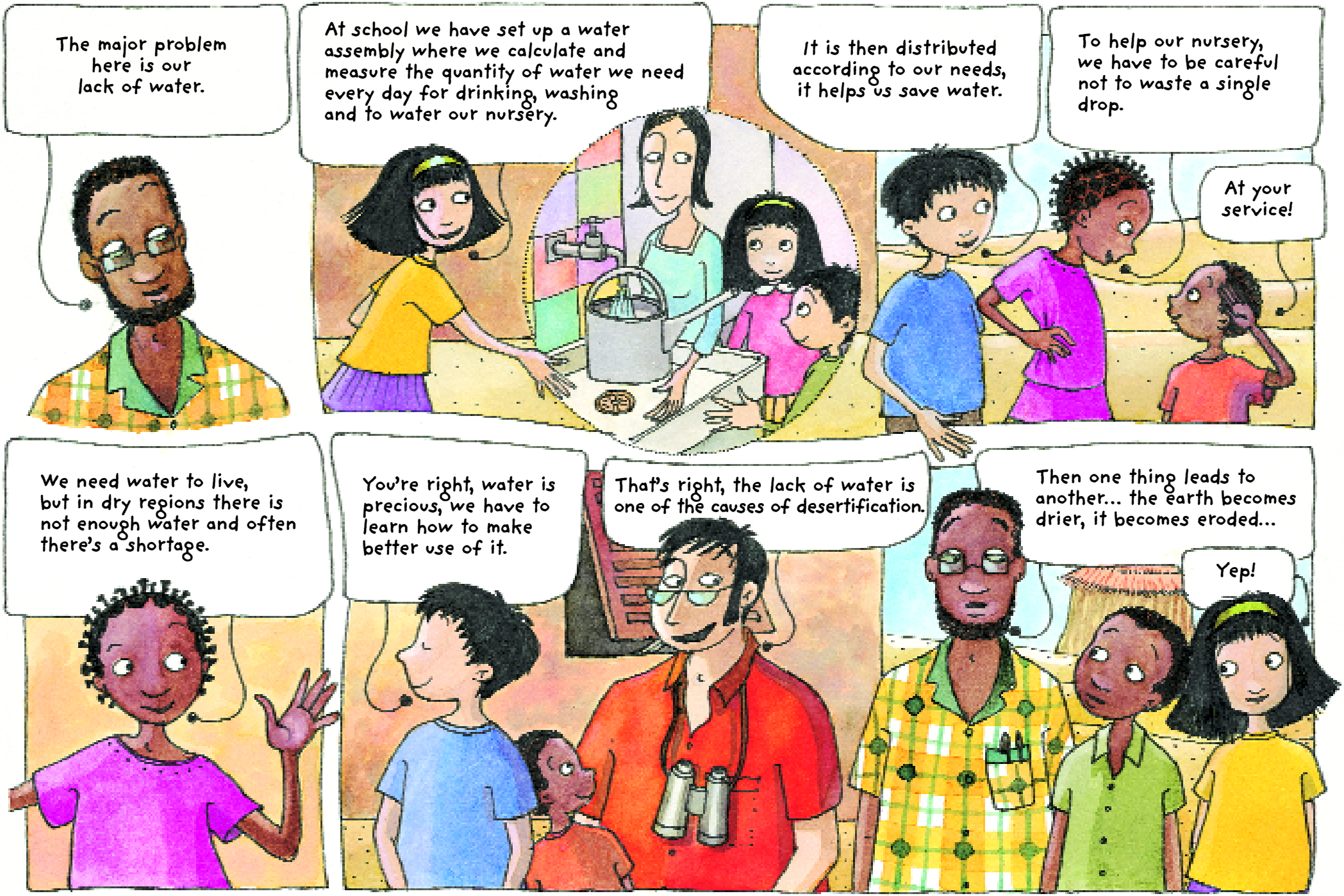
Mummy doesn't know how to grow magic trees, but she's sure got a lot of character.

Gather round the tree and listen everybody. Our guests are going to tell us how they created their nursery.

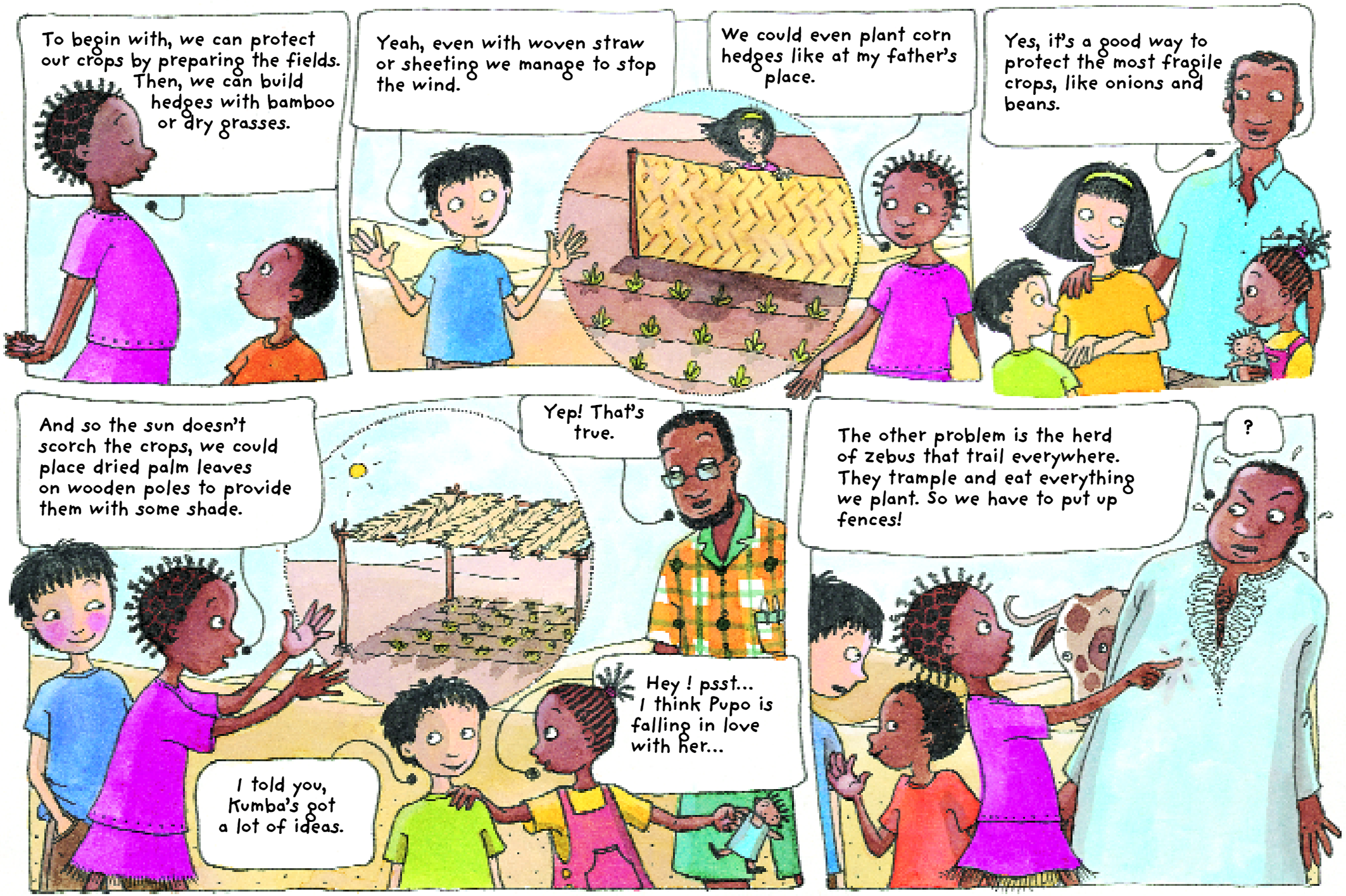
I can help you if you're shy.

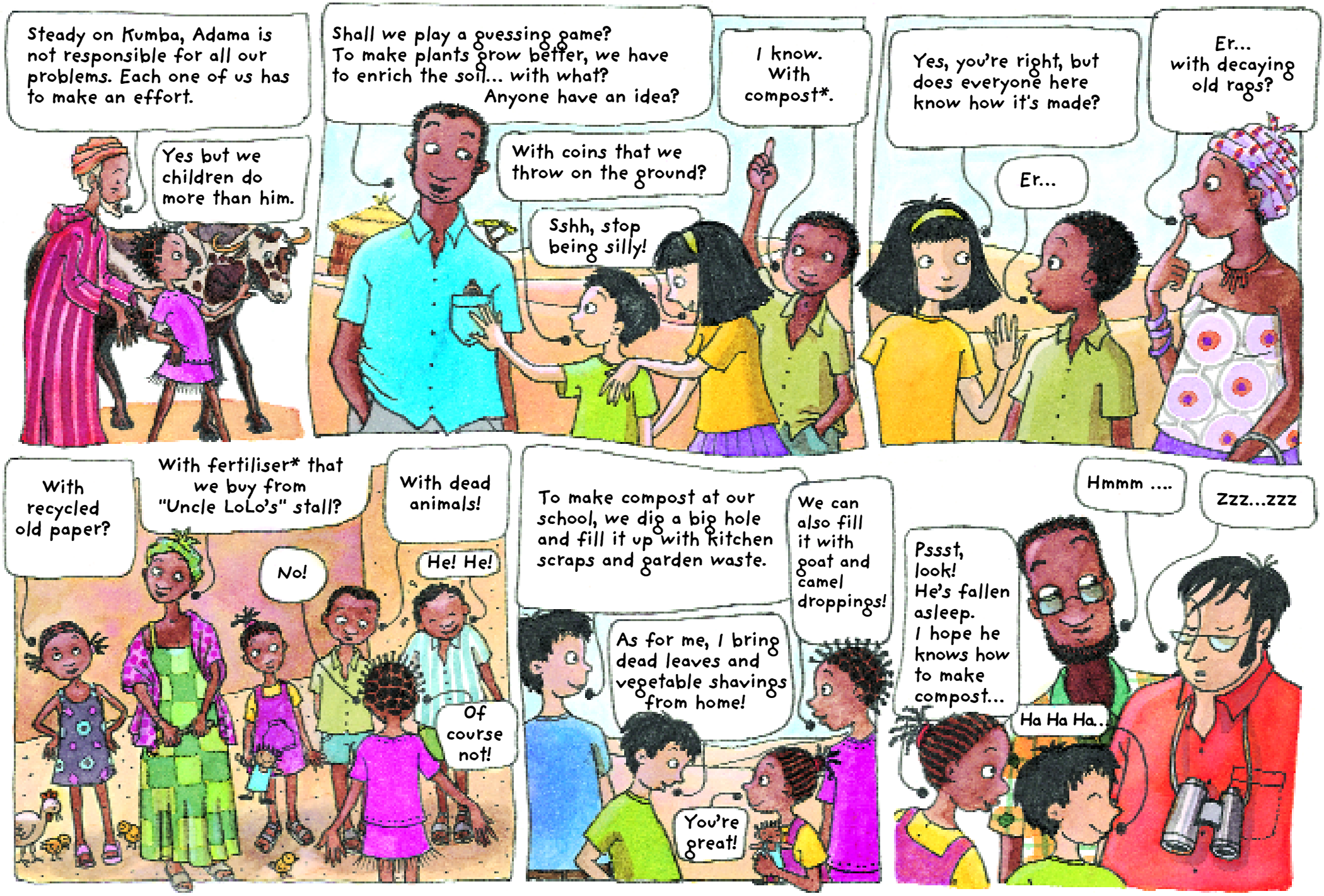
Hello everybody. We come from the north of Chile where the earth is very dry, like it is here. At school we learn why the land is becoming eroded*.

Our teacher also explained to us that when we understand the root of the problem, it's easier to find solutions.


The major problem here is our lack of water.
At school we have set up a water assembly where we calculate and measure the quantity of water we need every day for drinking, washing and to water our nursery.
It is then distributed according to our needs, it helps us save water.
To help our nursery, we have to be careful not to waste a single drop.
At your service!
We need water to live, but in dry regions there is not enough water and often there's a shortage.
You're right, water is precious, we have to learn how to make better use of it.
That's right, the lack of water is one of the causes of desertification.
Then one thing leads to another... the earth becomes drier, it becomes eroded...
Yep!


How does the soil become so fragile?
Well, it hardly rains and the sun shines brightly for months on end and the plants and animals suffer as a result.
The plants die if they don't have enough water. Their roots wither away and they can no longer hold the soil together, then the wind blows everything away. All that's left are stones.
And nothing grows on stones.
And when the rains finally arrive, it's a disaster. It rains so hard that everything is flushed out. It's terrible!
That's too bad!
And you forgot to mention that if the plants die, we can't feed the herd and if the animals die of hunger, then we have nothing left to eat.
What you're saying is not at all funny! Luckily there's the magic tree!
Phew!
You kids are all very sweet, but we know all this... we can't stop the sun from shining or the rain that ravages everything from falling...
Yes, but Mr. Adama, if we don't do anything it will get worse and we children are bursting with ideas.
There are inexpensive solutions to beat the wind, sun and violent rains.
And when we do plant magic trees, you'll not be allowed to chomp on their leaves.
Wow! Is Mr Adama always like that?


To begin with, we can protect our crops by preparing the fields. Then, we can build hedges with bamboo or dry grasses.
Yeah, even with woven straw or sheeting we manage to stop the wind.
We could even plant corn hedges like at my father's place.
Yes, it's a good way to protect the most fragile crops, like onions and beans.
And so the sun doesn't scorch the crops, we could place dried palm leaves on wooden poles to provide them with some shade.
Yep! That's true.
I told you, Kumba's got a lot of ideas.
Hey ! psst... I think Pupo is falling in love with her...
The other problem is the herd of zebus that trail everywhere. They trample and eat everything we plant. So we have to put up fences!
?


Steady on Kumba, Adama is not responsible for all our problems. Each one of us has to make an effort.
Yes but we children do more than him.
Shall we play a guessing game? To make plants grow better, we have to enrich the soil... with what? Anyone have an idea?
I know. With compost*.
With coins that we throw on the ground?
Sshh, stop being silly!
Yes, you're right, but does everyone here know how it's made?
Er...
Er... with decaying old rags?
With recycled old paper?
With fertiliser* that we buy from "Uncle LoLo's" stall?
With dead animals!
No!
He! He!
Of course not!
To make compost at our school, we dig a big hole and fill it up with kitchen scraps and garden waste.
We can also fill it with goat and camel droppings!
As for me, I bring dead leaves and vegetable shavings from home!
You're great!
Hmmm ....
Zzz...zzz
Pssst, look! He's fallen asleep. I hope he knows how to make compost...
Ha Ha Ha..

To make our compost I even brought straw left over from my parents' harvest.

We then covered the compost with a layer of earth and left it for several weeks...

Then our teacher showed us how to turn it over and water it often so that the whole thing decomposes.

And with the heat and humidity, it turns a dark brown colour and that's compost. And that's fertiliser* for the crops!

Yep! and then we add some to the magic trees to make them even more magic!

Really?

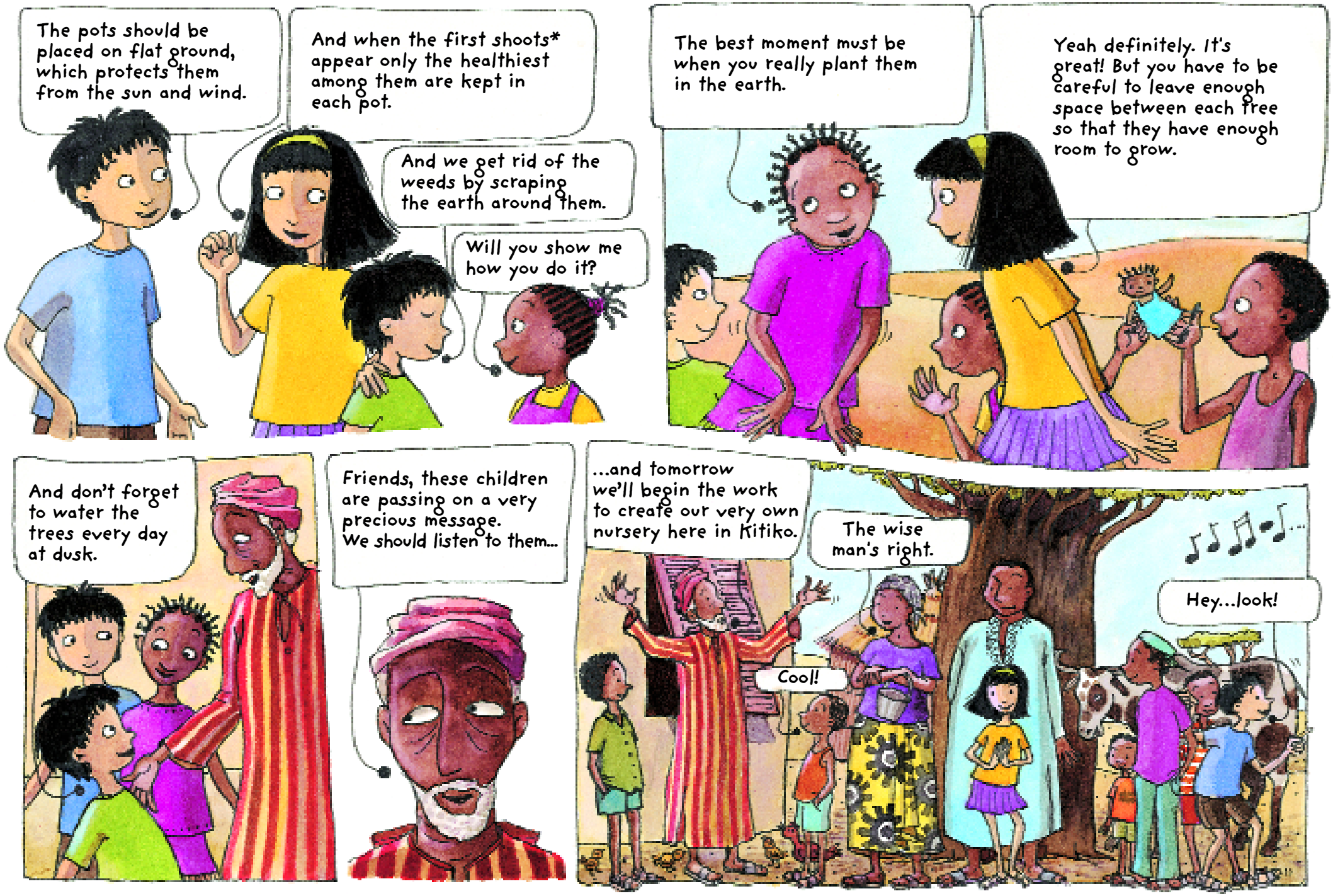
But, be careful, I strongly advise you not to add chicken bones or milk! Otherwise it will get very, very smelly!

And it will only attract animals!

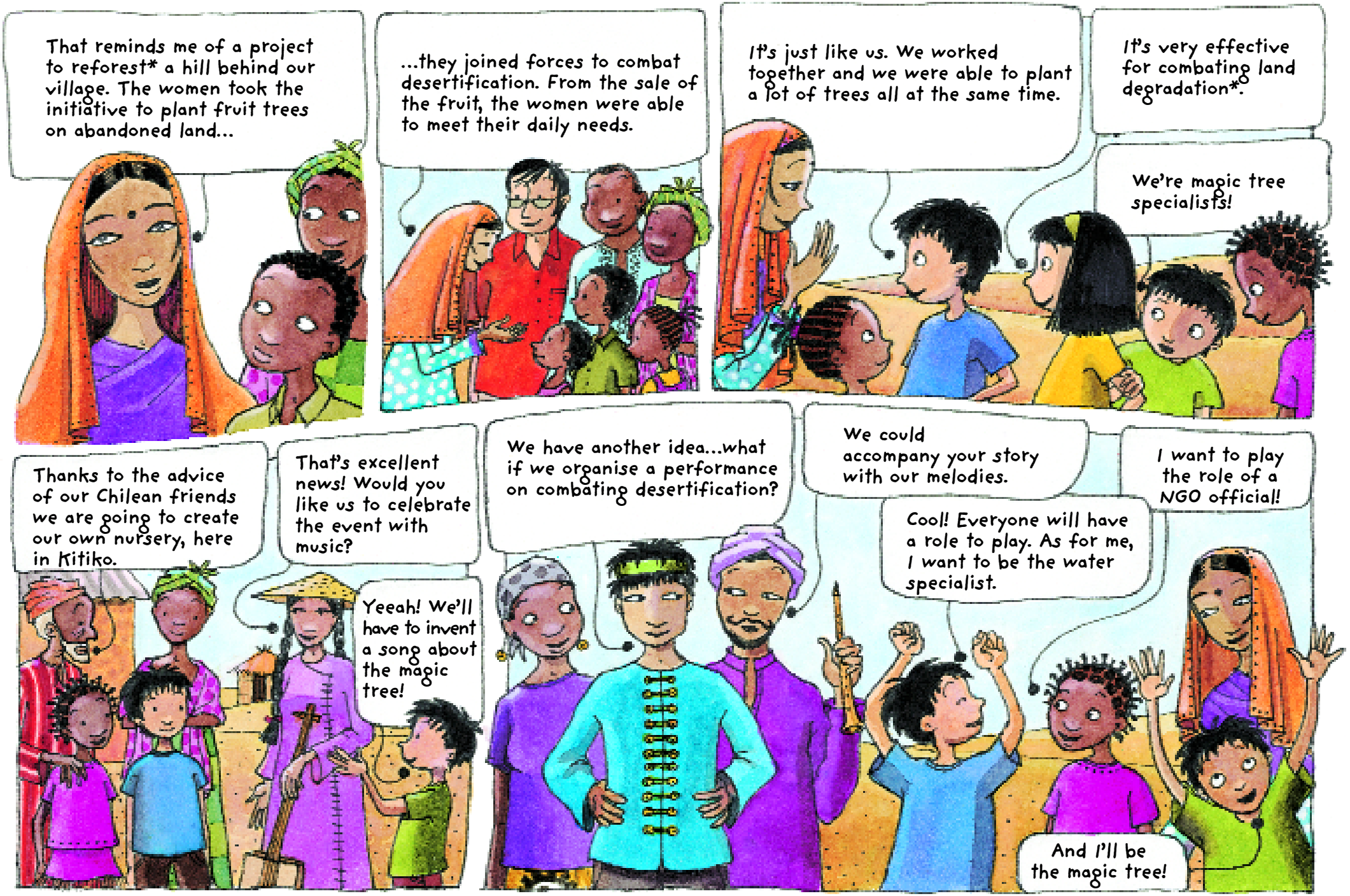
The compost will help the plants to grow.

For your nursery, you'll have to sow the seeds in pots.

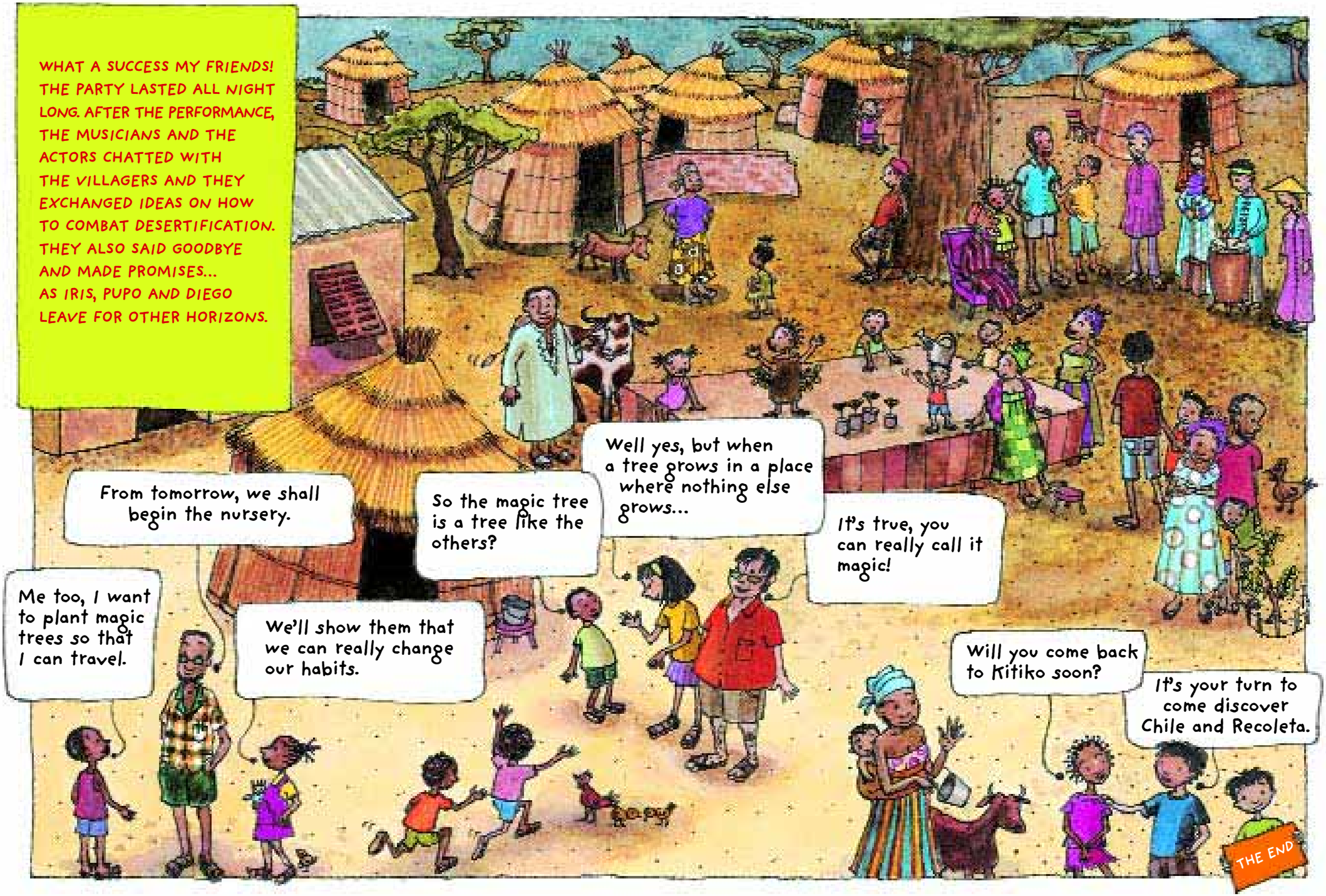
Yeah! We can gather seeds from ripened fruit or even grind acacia pods or tamarind.


The pots should be placed on flat ground, which protects them from the sun and wind.
And when the first shoots* appear only the healthiest among them are kept in each pot.
And we get rid of the weeds by scraping the earth around them.
Will you show me how you do it?
The best moment must be when you really plant them in the earth.
Yeah definitely. It's great! But you have to be careful to leave enough space between each tree so that they have enough room to grow.
And don't forget to water the trees every day at dusk.
Friends, these children are passing on a very precious message. We should listen to them...
...and tomorrow we'll begin the work to create our very own nursery here in Kitiko.
The wise man's right.
Hey...look!
Cool!


So, who's coming tomorrow to start work on the nursery?
What nobody?
Er! But where are they going?
What beautiful music!
It's lovely
It's so wonderful...
Bravo!
You play so well, where do you come from?
We come from Asia: China, India and Nepal. We travel the world to share our art and culture with children from all over the world.
That's so funny! We also travel around the world to help children combat desertification!
Ah! desertification. It's a problem that affects Asia as well.
Yes, in China we have cold deserts with howling winds that blow sand right up to the farmlands.


That reminds me of a project to reforest* a hill behind our village. The women took the initiative to plant fruit trees on abandoned land...
...they joined forces to combat desertification. From the sale of the fruit, the women were able to meet their daily needs.
It's just like us. We worked together and we were able to plant a lot of trees all at the same time.
It's very effective for combating land degradation*.
We're magic tree specialists!
Thanks to the advice of our Chilean friends we are going to create our own nursery, here in Kitiko.
That's excellent news! Would you like us to celebrate the event with music?
Yeeah! We'll have to invent a song about the magic tree!
We have another idea...what if we organise a performance on combating desertification?
We could accompany your story with our melodies.
I want to play the role of a NGO official!
Cool! Everyone will have a role to play. As for me, I want to be the water specialist.
And I'll be the magic tree!


WITHIN A FEW HOURS KUMBA AND PUPO HAVE WRITTEN THE TEXT FOR THE PLAY. MOUSSA AND THE TEACHER GIVE THEM A HELPING HAND. THE FOLLOWING DAY, AFTER A GOOD NIGHT'S SLEEP, EVERYONE IS BUSILY AND JOYFULLY PREPARING FOR THE PLAY.
Who wants to play parents that don't know anything about good farming practices?
We need tree-planters, someone to water the plants and put the gardening tools away.
I need more leaves so that I look more like a magic tree!
I want to be the President!
Come with me, I need sticks to make some picks.
THE VERY SAME EVENING, EVERYONE IS READY TO PERFORM "THE MAGIC TREE". THE TEACHER EVEN SOLD TICKETS FOR THE PLAY. WITH THE MONEY COLLECTED, THEY WILL BE ABLE TO BUY THE FIRST SEEDS FOR THE NURSERY.
By working together, we can shrink desertification. And that's magic!


WHAT A SUCCESS MY FRIENDS! THE PARTY LASTED ALL NIGHT LONG. AFTER THE PERFORMANCE, THE MUSICIANS AND THE ACTORS CHATTED WITH THE VILLAGERS AND THEY EXCHANGED IDEAS ON HOW TO COMBAT DESERTIFICATION. THEY ALSO SAID GOODBYE AND MADE PROMISES... AS IRIS, PUPO AND DIEGO LEAVE FOR OTHER HORIZONS.
From tomorrow, we shall begin the nursery.
So the magic tree is a tree like the others?
Well yes, but when a tree grows in a place where nothing else grows...
It's true, you can really call it magic!
Me too, I want to plant magic trees so that I can travel.
We'll show them that we can really change our habits.
Will you come back to Kitiko soon?
It's your turn to come discover Chile and Recoleta.
THE END

QUIZ

YES OR NO ?

1 Is it expensive to create a nursery?

2 Can children have a role to play in combating desertification?

3 Does desertification threaten Europe?

4 Is it possible to grow plants in drylands*?

5 Does desertification only occur in deserts?

6 Is it possible to feed a large herd with limited quantities of grass?

7 Is it necessary to protect crops from the sun and from the herds?

8 Can bamboo hedges protect plants from the wind?

9 Is it possible to water the garden with compost?

10 Can we add chicken bones to prepare compost?

11 In the nursery, do we have to keep all the shoots in each pot?

12 Does tree planting help to combat land degradation?

13 Are all the deserts in the world hot deserts?

14 Can we really change our bad habits?

15 Is UNESCO part of the United Nations?

Answers:

1-no ; 2-yes ; 3-yes ; 4-yes ; 5-no ;
6-no ; 7-yes ; 8-yes ; 9-no ; 10-no ;
11-no ; 12-yes ; 13-no ; 14-yes ; 15-yes.

Glossary

compost (n.): natural fertiliser made from mainly decomposed vegetable waste. The compost is used to fertilise the soil for crops.

convention (n.): Agreement, pact or contract concluded between persons or countries to settle particular issues. The countries that have signed the Convention to Combat Desertification agree to implement projects designed to combat desertification.

decomposition (n.): the process of breaking up an original mass into its basic parts.

desertification (n.): process that transforms land that could otherwise be used for farming into unexploitable drylands, ie. it cannot be used for agriculture nor support life. The process of desertification only occurs in the drylands, everywhere else it is called land degradation*.

drylands (n): the official term that regroups all the dry regions of the planet.

erosion (n): the gradual wearing away of soil material or any other hard material by the effect of wind, rain etc.

fertiliser (n.): a natural or artificial product that helps to improve the quality of the soil by preparing it for agriculture to increase its productivity because plants grow better. (see compost* and fertilisation*).

JUNDEP (n): “Joventudes para el Desarrollo y la Producción” (Youth for development and production), a Chilean NGO* that concentrates its efforts on youth and development.

land degradation (n.): decrease in soil quality due to ill adapted human activities (deforestation, intensive farming, herds of animals left to trample the land preventing plant regrowth) and climatic variations (violent winds, driving rain, drought etc.)

Mediterranean region (n.): region around the Mediterranean Sea that comprises North Africa, the Middle East and southern Europe.

NGO (n.): a non-governmental organisation. Groups of people defending worthwhile causes and increasing public awareness, independent of governments. Many NGO’s fight for the protection of the environment.

nursery (n.): a protected area where tree seeds are sown. Plants are grown and only the healthiest among the trees are selected and planted out.

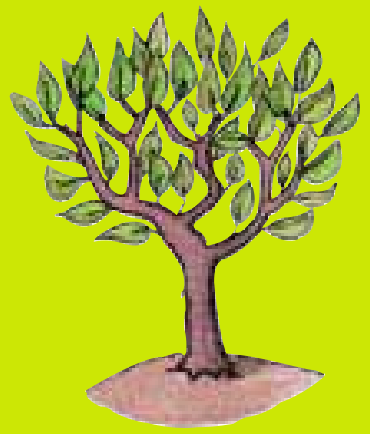
reforestation (n.): an activity that involves replanting trees or shrubs in areas where they are few or no longer found.

Sahel (n.): zone in Africa that stretches to the south of the Sahara, between Senegal and Somalia (see map).

shoots (n. pl.): once the seeds have germinated and the shoots have grown, small trees are obtained, which will grow into full size once they are planted in soil and given enough water.

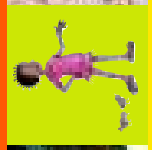
UNESCO (n.): Organisation of the United Nations* that assemble numerous countries to support and encourage education, science and culture. Certain programmes involve combating desertification.

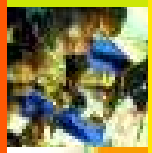
United Nations (n.): the United Nations Organisation is involved in trying to resolve problems faced by humanity: the fight against poverty and disease, development aid, the respect of human rights, protection of the environment, etc. More than 30 organisations collaborate to achieve this.
(See UNESCO*)

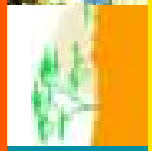


Education Kit on Desertification

Cartoon







This cartoon is part of the **Environmental Education Kit on Desertification** published by UNESCO and the UNCCD.
The kit is available in three languages (English, French and Spanish) and comprises five documents:
The Teacher's Guide: *Learning to Combat Desertification*
A Series of Case Studies: *Combating Desertification Bears Fruit*
A Cartoon: *The School Where the Magic Tree Grows*
A Cartoon: *There is No Rug Big Enough to Sweep the Desert Under*
A Poster: *Desertification in the World*.

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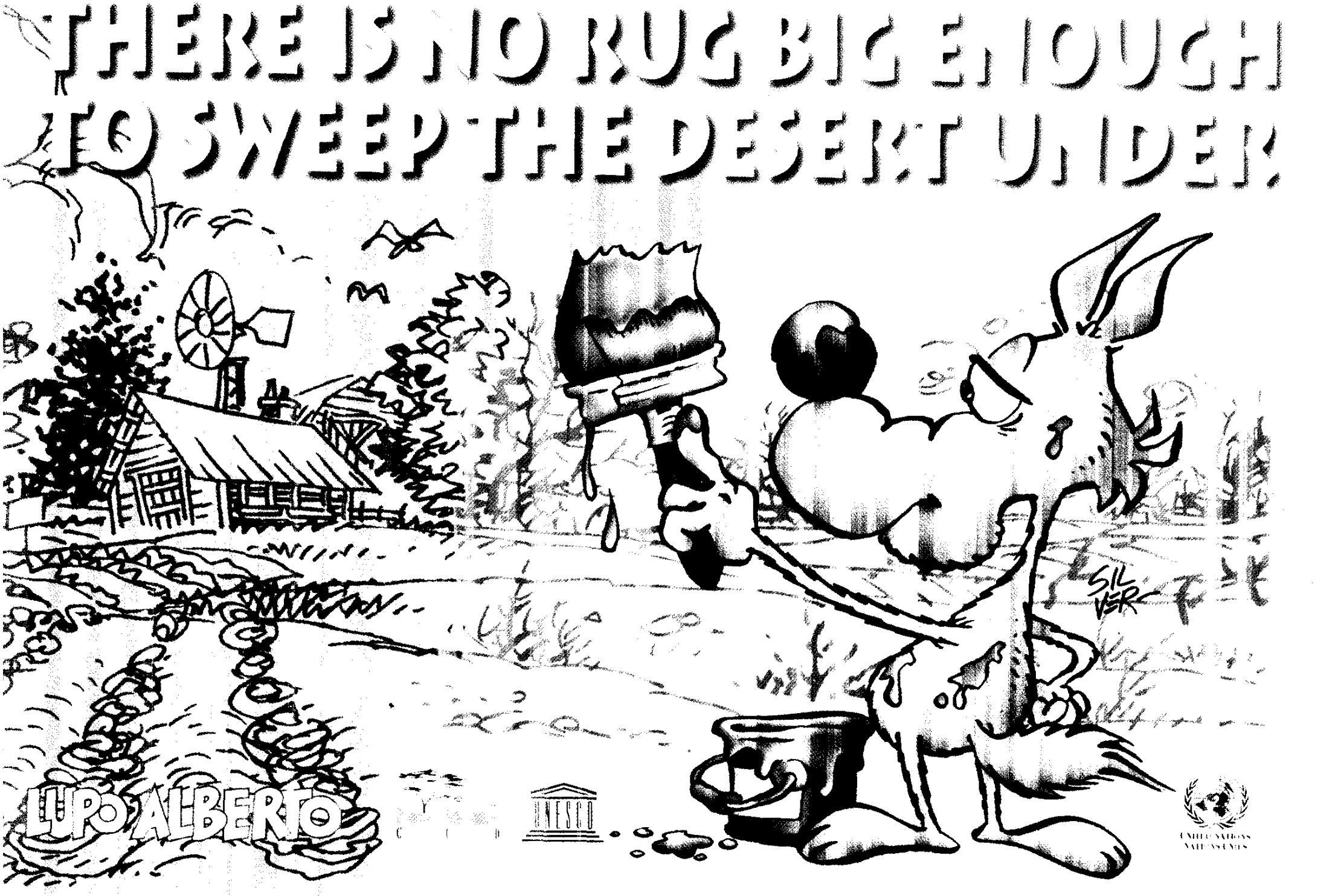

THERE IS NO RUG BIG ENOUGH
TO SWEEP THE DESERT UNDER
SILVER
LUPO ALBERTO
UNESCO
UNITED NATIONS

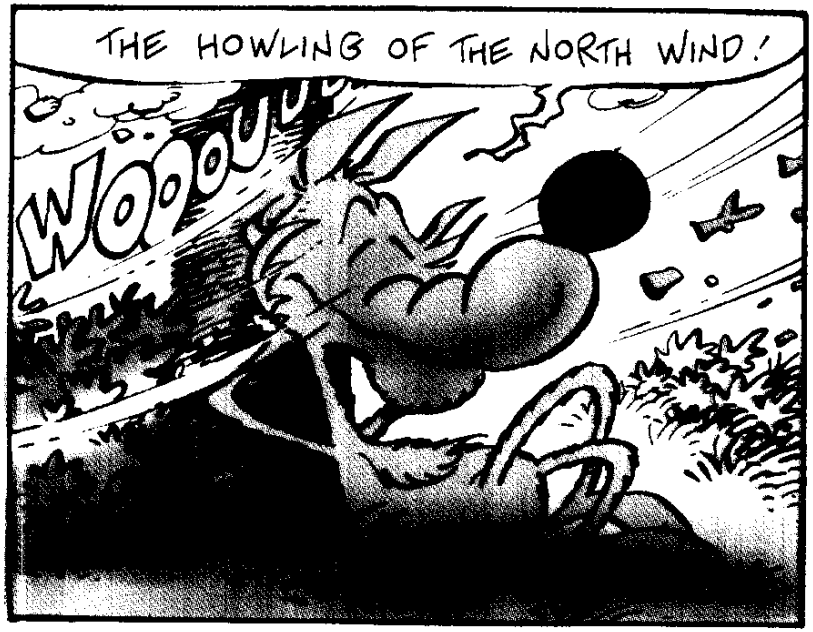
It is no accident that our planet is called Earth. All terrestrial life depends on the fragile, friable crust of soil that coats the continents.

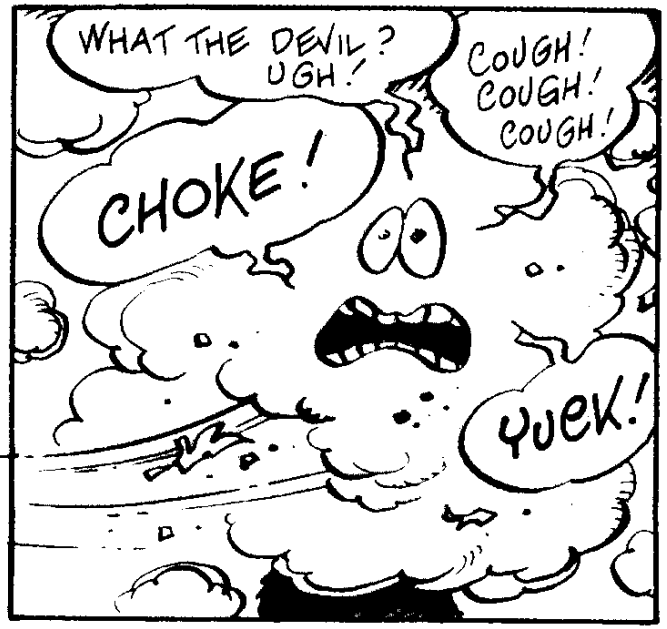
This precious covering is painfully slow to form and can be destroyed terrifyingly fast. Just a single inch of soil can take centuries to build up!

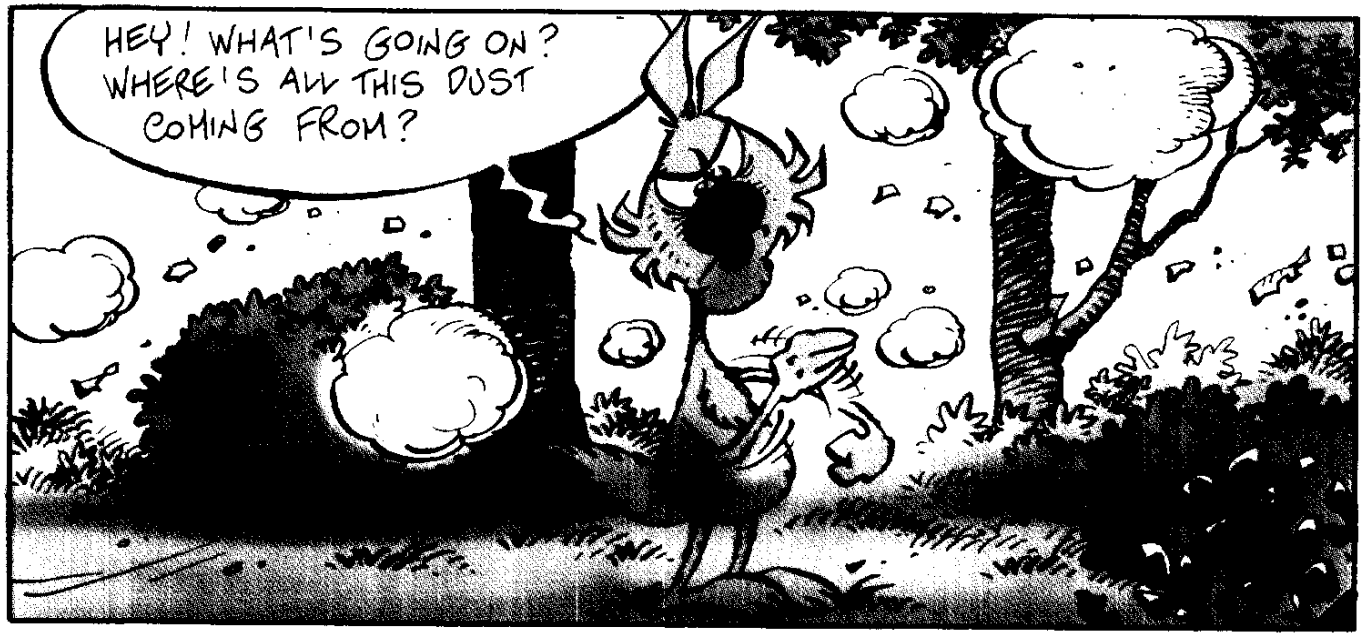
But, if mistreated, it can be blown and washed away in a few seasons.
And earth is now rapidly vanishing all over the planet that bears its name.
Nowhere is the crisis more acute than in the drylands which stretch across more than a third of the Earth's land surface. It is here that desertification takes hold.

Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. It threatens the livelihoods of more than one billion people and may drive over 135 million away from their land.
The situation is especially dramatic in Africa, but action is also needed in other regions: Asia, Europe, Latin America and the Caribbean, and North America.
Furthermore, countries which are not directly affected bear some of its consequences, for desertification contributes to food insecurity, economic hardship, poverty and political unrest, which in turn lead to population movements.

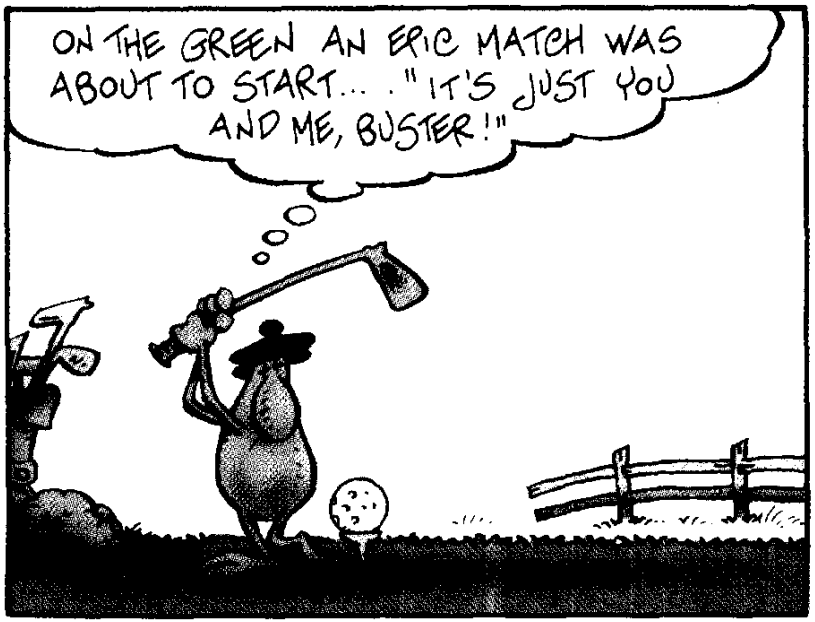

AH! WHAT PEACE! THE ONLY THING MISSING IS...

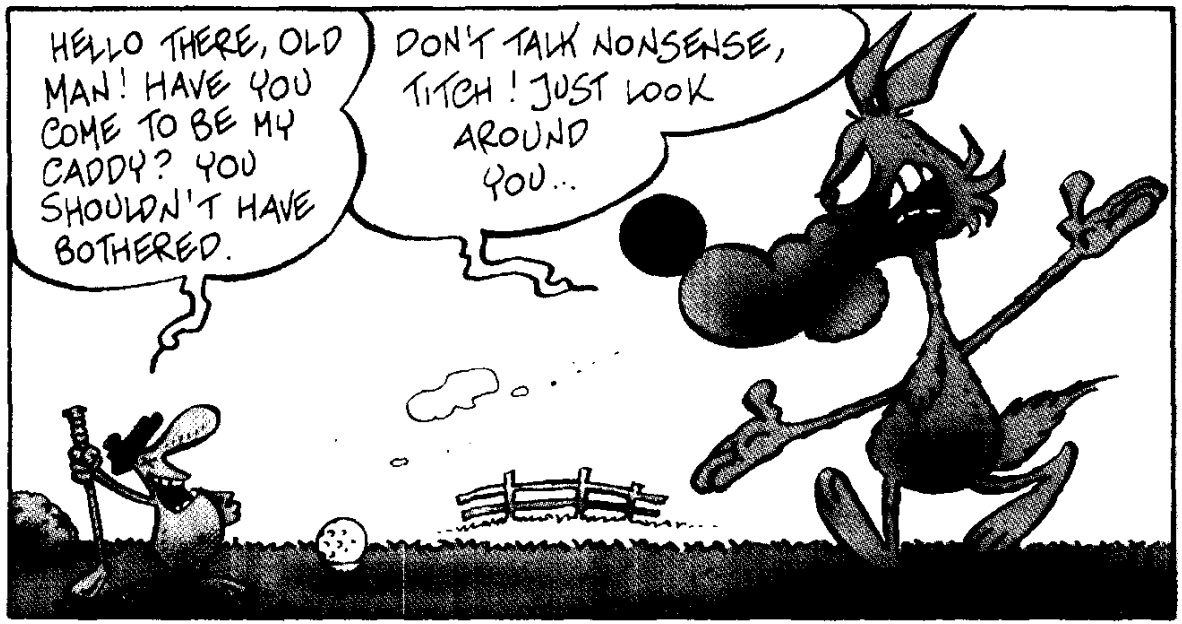

THE HOWLING OF THE NORTH WIND!
WOOOU

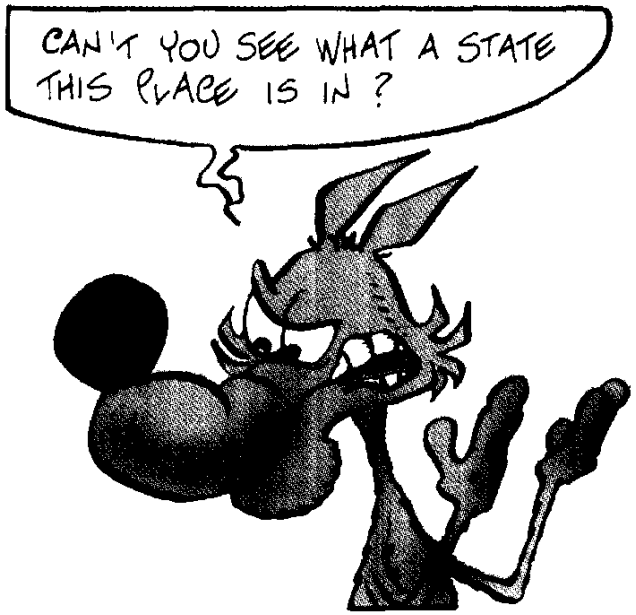

WHAT THE DEVIL? UGH!
COUGH! COUGH! COUGH!
CHOKE!
YUCK!

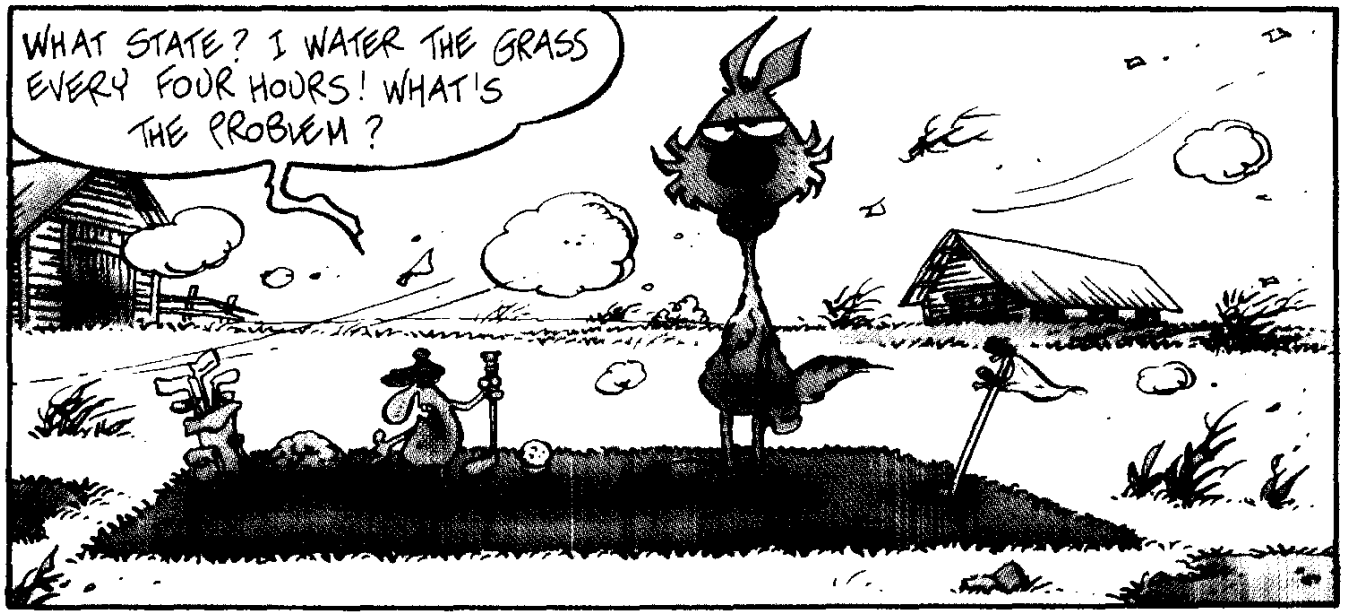

HEY! WHAT'S GOING ON? WHERE'S ALL THIS DUST COMING FROM?


HMM! I THINK I KNOW WHAT'S HAPPENING.. WHAT A DISASTER! I'D BETTER GO DOWN THERE AND TAKE A LOOK!
1

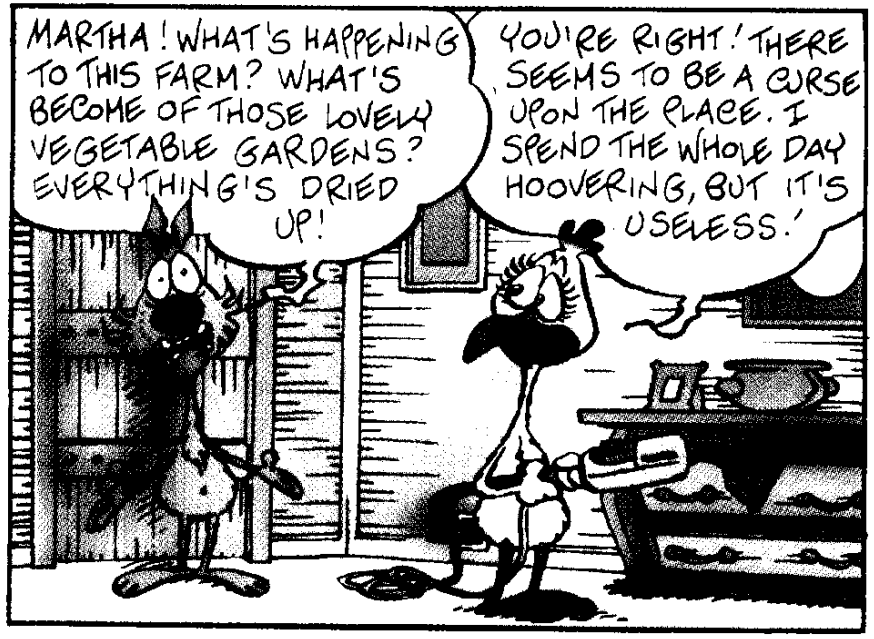

ON THE GREEN AN ERIC MATCH WAS ABOUT TO START... "IT'S JUST YOU AND ME, BUSTER!"

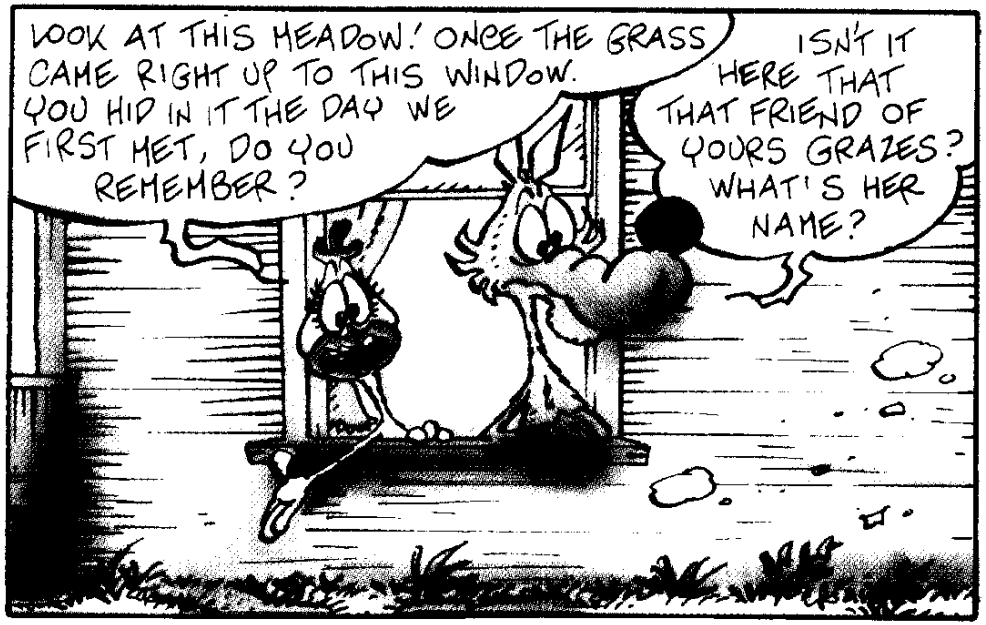

HELLO THERE, OLD MAN! HAVE YOU COME TO BE MY CADDY? YOU SHOULDN'T HAVE BOTHERED.
DON'T TALK NONSENSE, TITCH! JUST LOOK AROUND YOU...

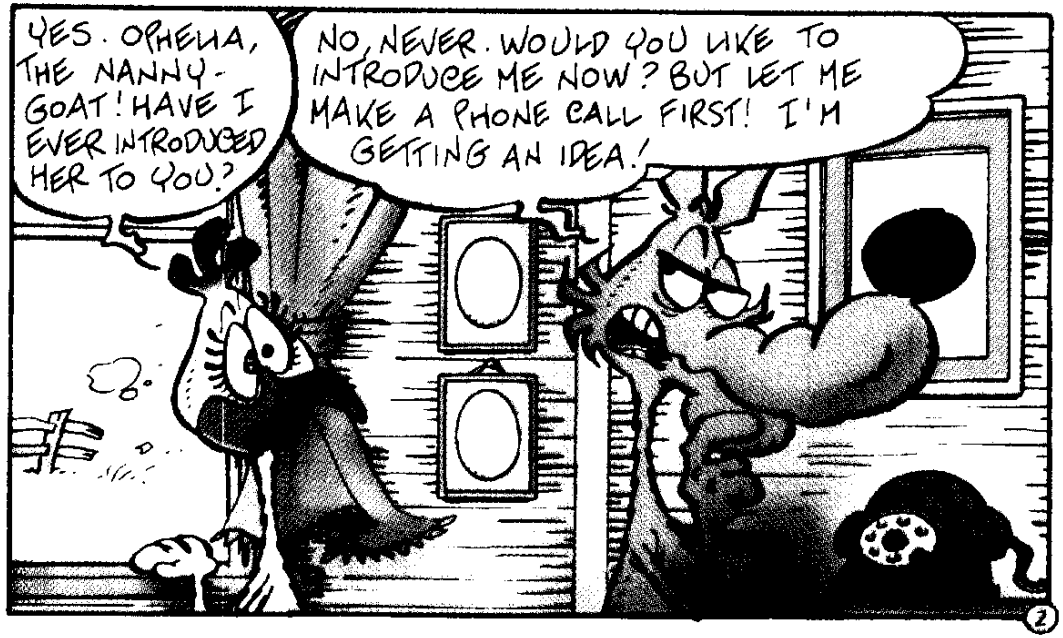

CAN'T YOU SEE WHAT A STATE THIS PLACE IS IN?

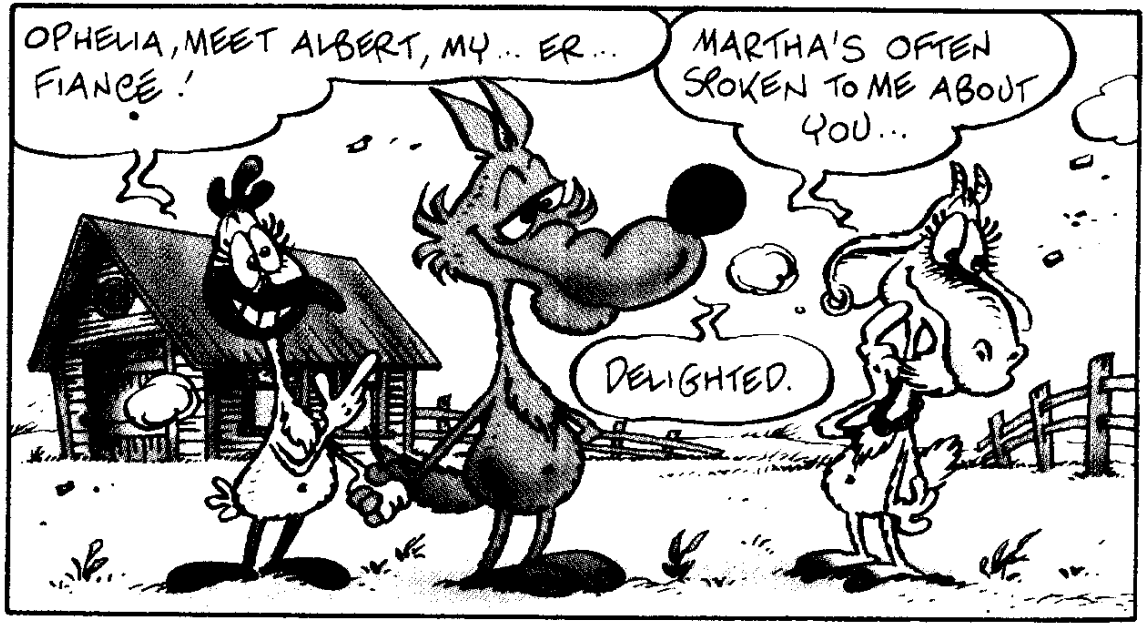

WHAT STATE? I WATER THE GRASS EVERY FOUR HOURS! WHAT'S THE PROBLEM?


HELL! I JUST DON'T UNDERSTAND THESE WOLVES.
HEN HOUS
KNOCK! KNOCK!

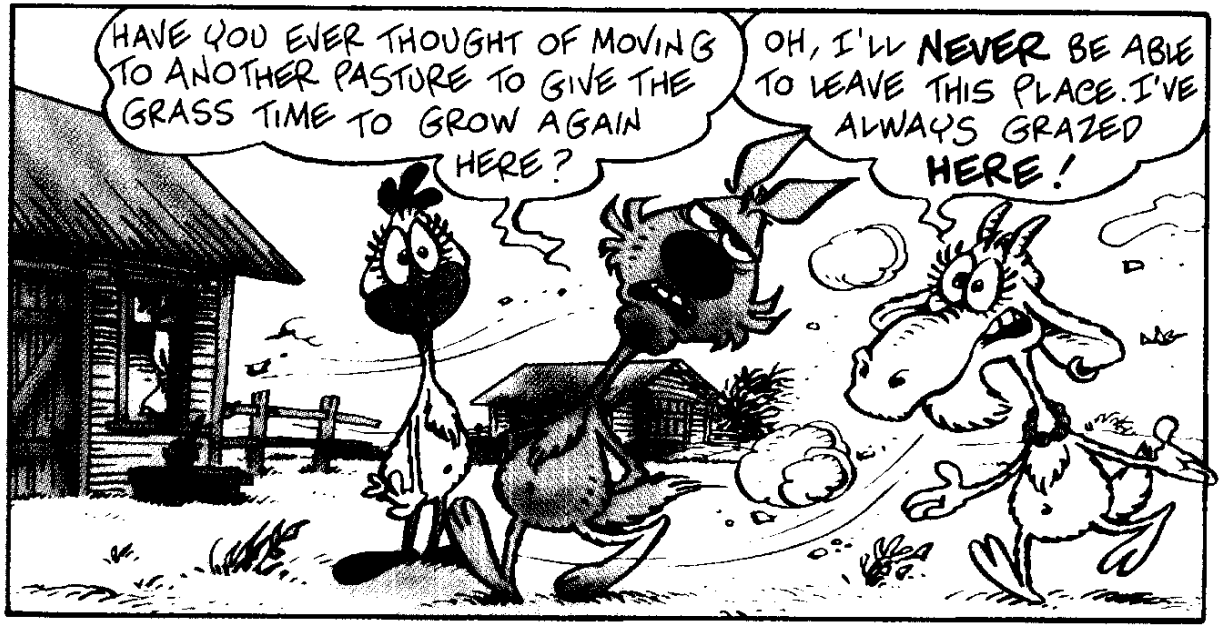

MARTHA! WHAT'S HAPPENING TO THIS FARM? WHAT'S BECOME OF THOSE LOVELY VEGETABLE GARDENS? EVERYTHING'S DRIED UP!
YOU'RE RIGHT! THERE SEEMS TO BE A CURSE UPON THE PLACE. I SPEND THE WHOLE DAY HOOVERING, BUT IT'S USELESS.'

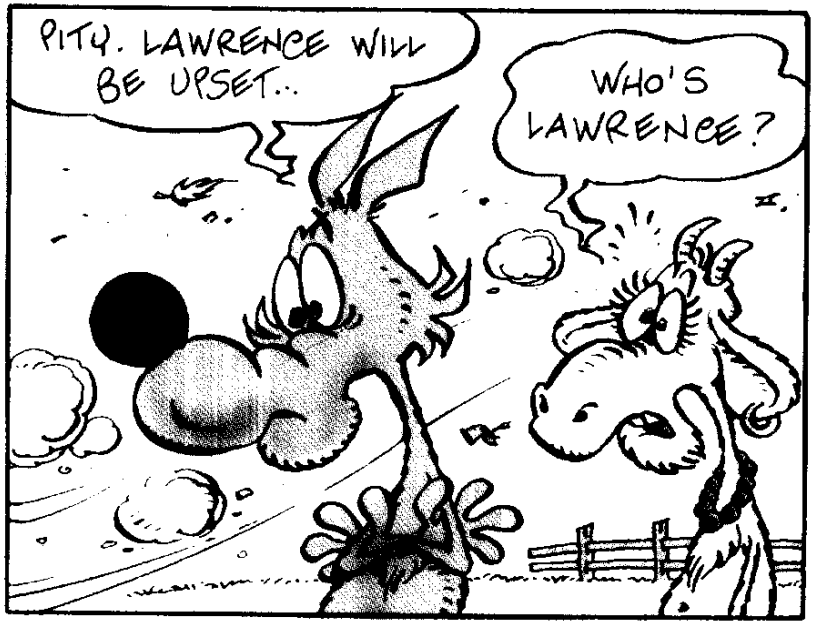

LOOK AT THIS MEADOW! ONCE THE GRASS CAME RIGHT UP TO THIS WINDOW. YOU HID IN IT THE DAY WE FIRST MET, DO YOU REMEMBER?
ISN'T IT HERE THAT THAT FRIEND OF YOURS GRAZES? WHAT'S HER NAME?


YES. OPHELIA, THE NANNY-GOAT! HAVE I EVER INTRODUCED HER TO YOU?
NO, NEVER. WOULD YOU LIKE TO INTRODUCE ME NOW? BUT LET ME MAKE A PHONE CALL FIRST! I'M GETTING AN IDEA!
2

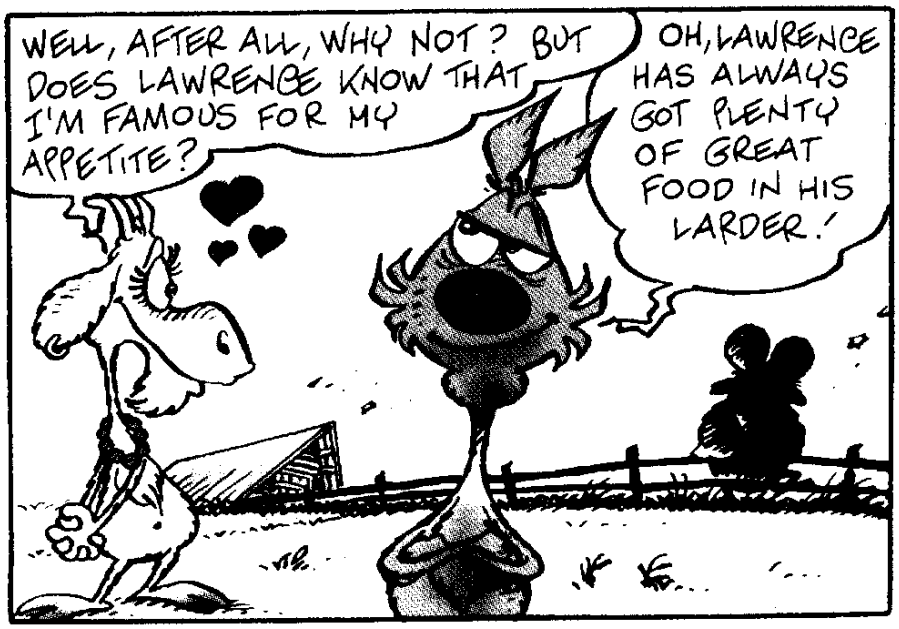

OPHELIA, MEET ALBERT, MY... ER... FIANCÉ!
MARTHA'S OFTEN SPOKEN TO ME ABOUT YOU...
DELIGHTED.

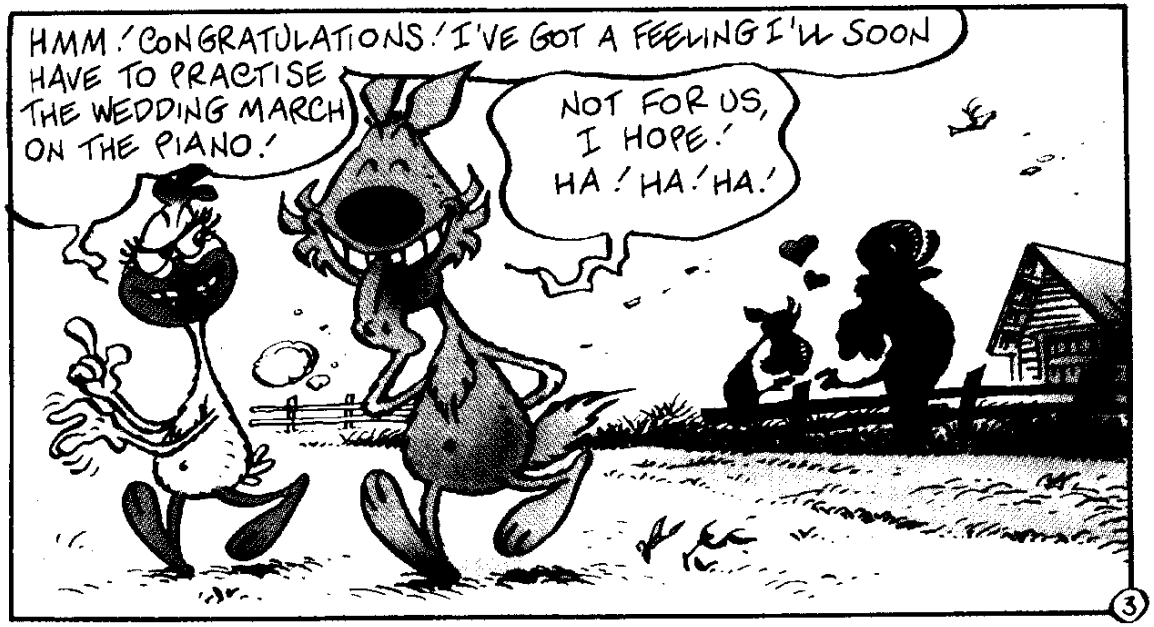

IT'S A BIT BARE, HERE, DON'T YOU FIND, OPHELIA?
YES, IT IS... THERE'S HARDLY ANY FRESH GRASS AND NOW I HAVE TO GNAW ON THE ROOTS!


HAVE YOU EVER THOUGHT OF MOVING TO ANOTHER PASTURE TO GIVE THE GRASS TIME TO GROW AGAIN HERE?
OH, I'LL NEVER BE ABLE TO LEAVE THIS PLACE. I'VE ALWAYS GRAZED HERE!


PITY. LAWRENCE WILL BE UPSET...
WHO'S LAWRENCE?


A FRIEND OF MINE! HE WAS DYING TO INVITE YOU TO DINNER ON HIS PASTURE!
OH!

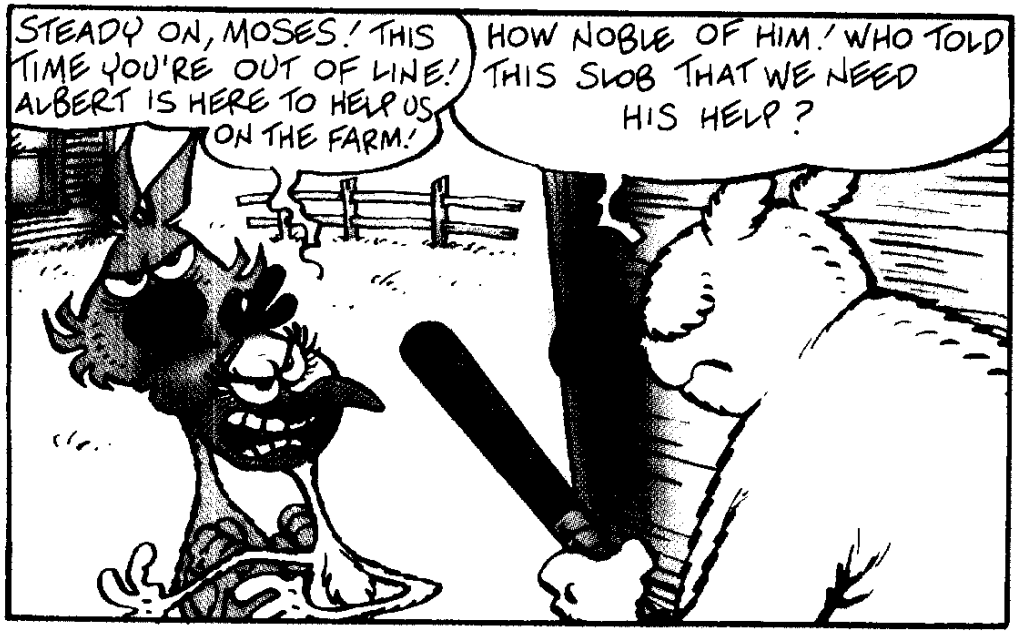

WELL, AFTER ALL, WHY NOT? BUT DOES LAWRENCE KNOW THAT I'M FAMOUS FOR MY APPETITE?
OH, LAWRENCE HAS ALWAYS GOT PLENTY OF GREAT FOOD IN HIS LARDER!

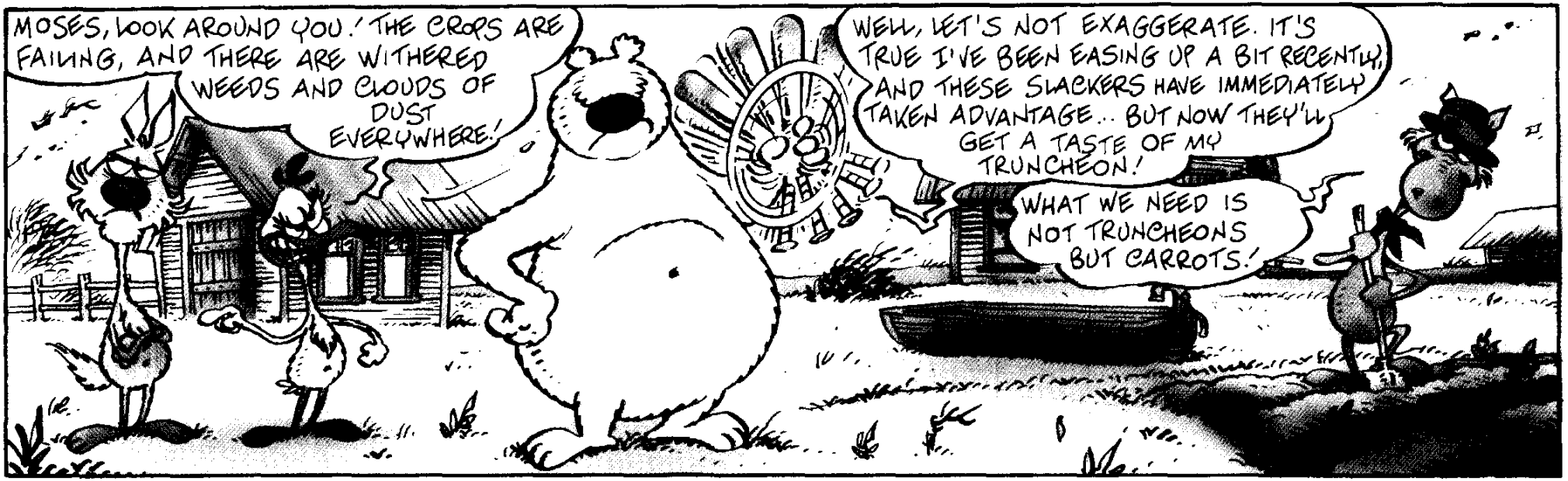

HMM! CONGRATULATIONS! I'VE GOT A FEELING I'LL SOON HAVE TO PRACTISE THE WEDDING MARCH ON THE PIANO!
NOT FOR US, I HOPE! HA! HA! HA!
3

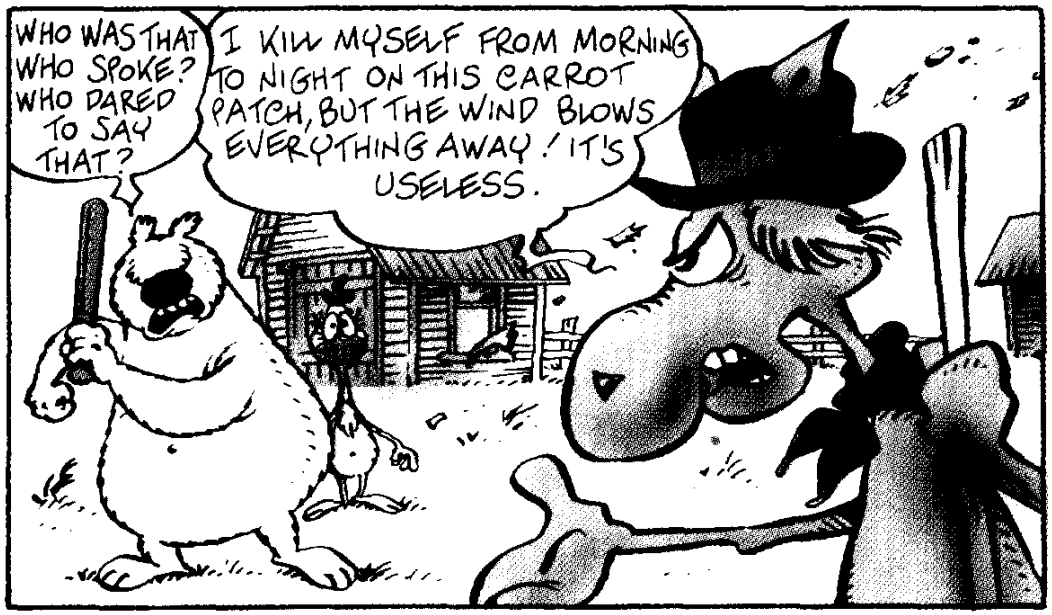

YOU DIDN'T NEED TO SAY "I HOPE"!
OOPS!

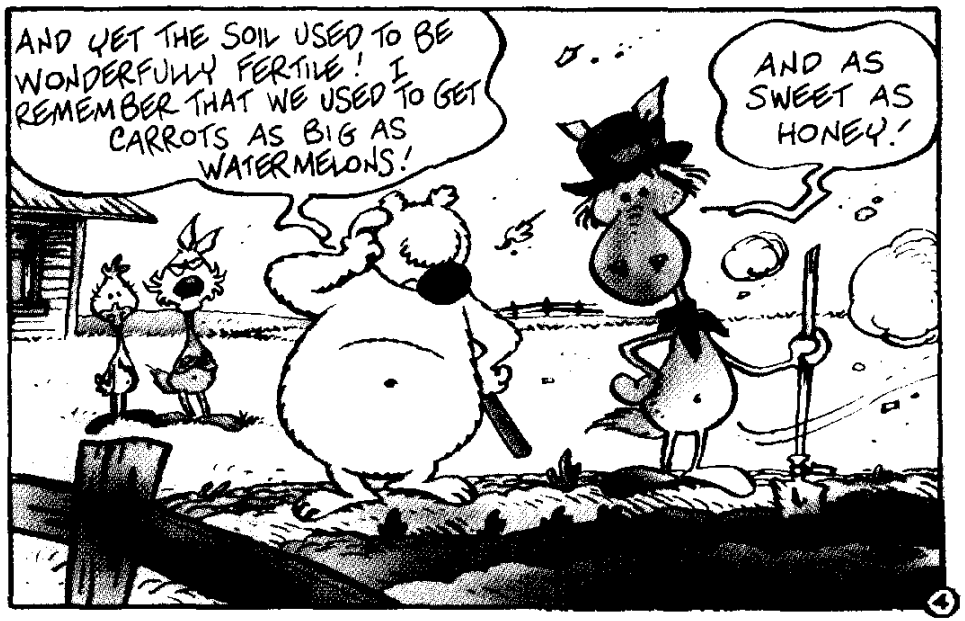

UHHUM! SORRY, MARTHA, I DIDN'T WANT... BUT DO WE WANT TO TRY TO FIND OUT WHAT'S HAPPENING HERE?
YES, I THINK IT WOULD BE BEST TO DROP THE SUBJECT OF MARRIAGE...
I AGREE!

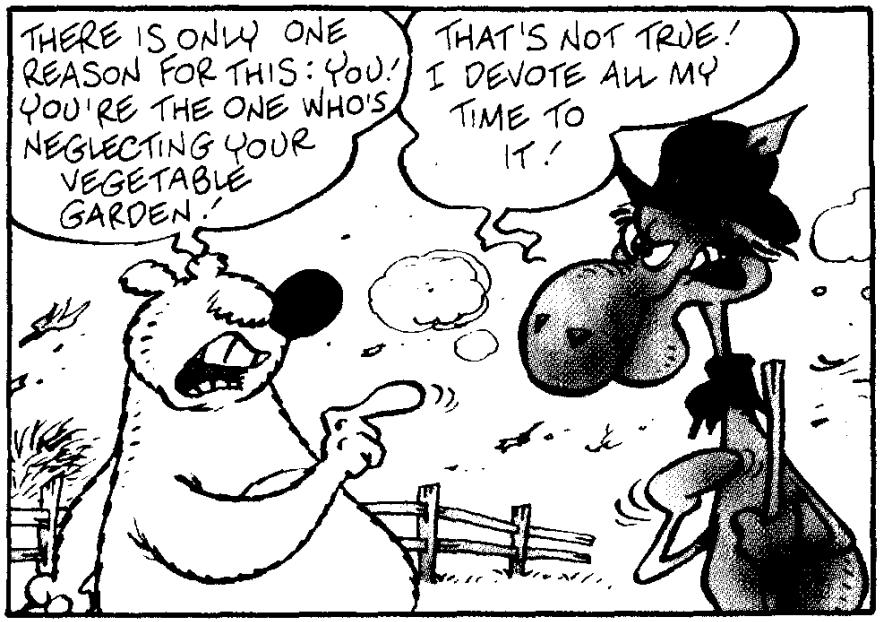

MOSES!
OH, NO! IT'S FATSO!
MARTHA, I SEEM TO REMEMBER THAT I WARNED YOU ABOUT THIS ROGUE! STAND ASIDE WHILE I TEACH HIM A LESSON!

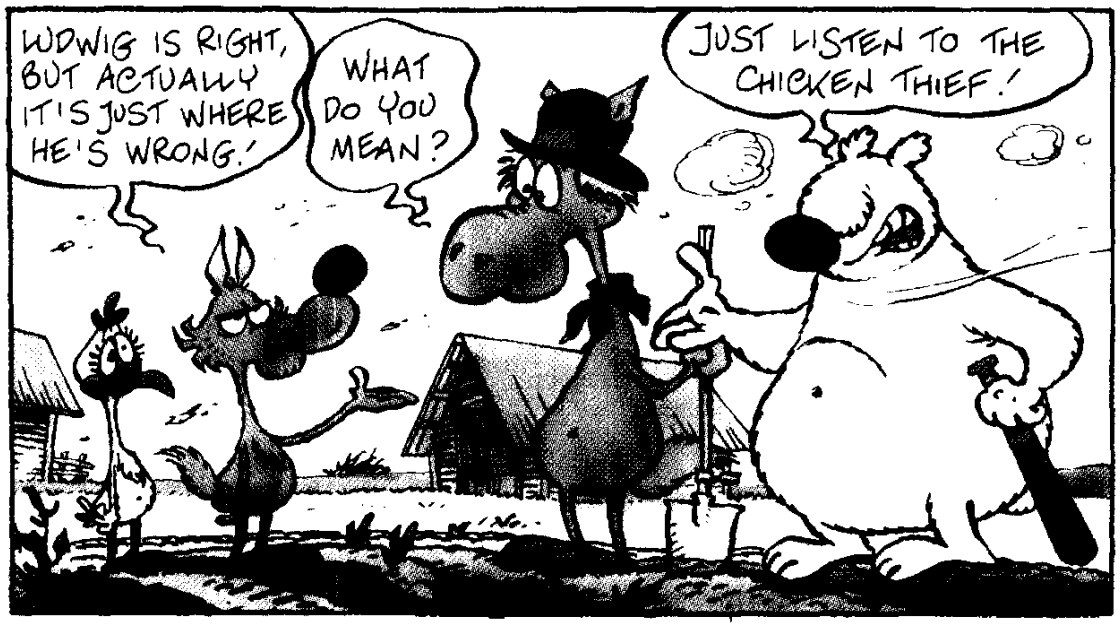

STEADY ON, MOSES! THIS TIME YOU'RE OUT OF LINE! ALBERT IS HERE TO HELP US ON THE FARM!
HOW NOBLE OF HIM! WHO TOLD THIS SLOB THAT WE NEED HIS HELP?

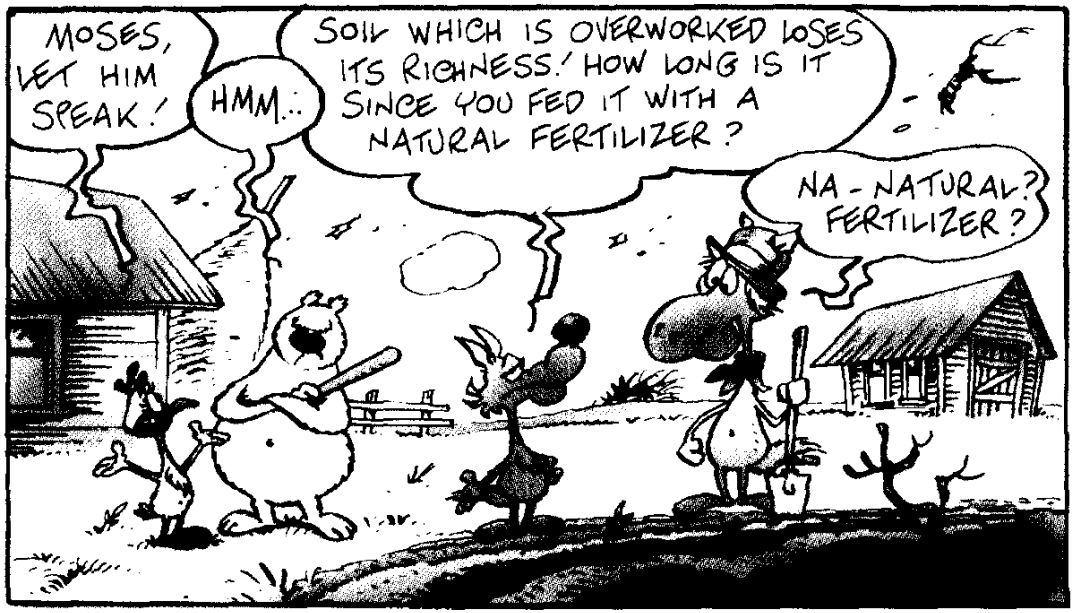

MOSES, LOOK AROUND YOU! THE CROPS ARE FAILING, AND THERE ARE WITHERED WEEDS AND CLOUDS OF DUST EVERYWHERE!
WELL, LET'S NOT EXAGGERATE. IT'S TRUE I'VE BEEN EASING UP A BIT RECENTLY, AND THESE SLACKERS HAVE IMMEDIATELY TAKEN ADVANTAGE... BUT NOW THEY'LL GET A TASTE OF MY TRUNCHEON!
WHAT WE NEED IS NOT TRUNCHEONS BUT CARROTS!

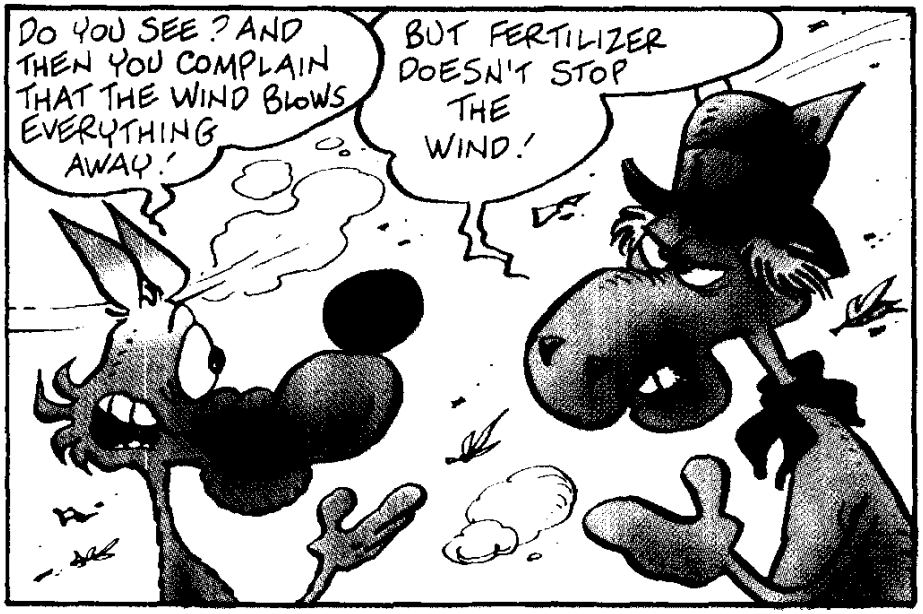

WHO WAS THAT WHO SPOKE? WHO DARED TO SAY THAT?
I KILL MYSELF FROM MORNING TO NIGHT ON THIS CARROT PATCH, BUT THE WIND BLOWS EVERYTHING AWAY! IT'S USELESS.

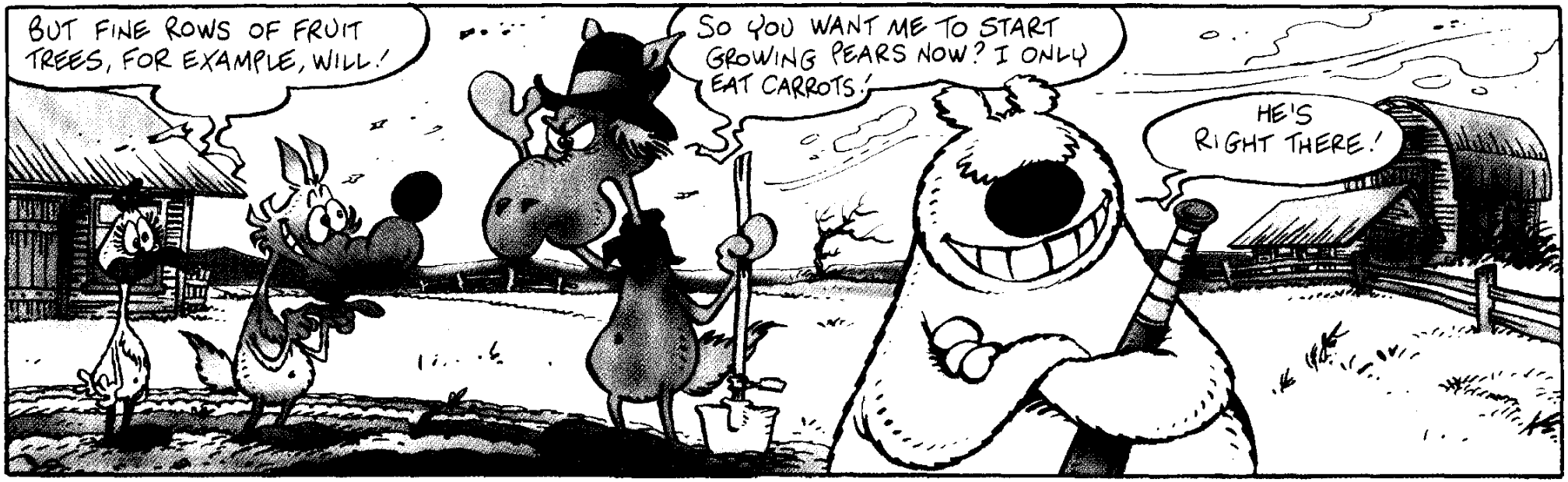

AND YET THE SOIL USED TO BE WONDERFULLY FERTILE! I REMEMBER THAT WE USED TO GET CARROTS AS BIG AS WATERMELONS!
AND AS SWEET AS HONEY!
4

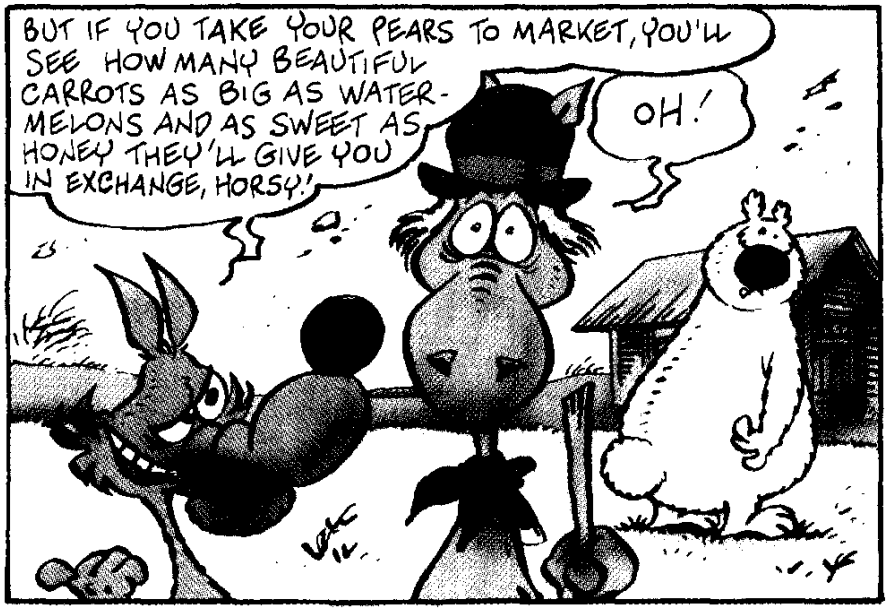

THERE IS ONLY ONE REASON FOR THIS: YOU! YOU'RE THE ONE WHO'S NEGLECTING YOUR VEGETABLE GARDEN!
THAT'S NOT TRUE! I DEVOTE ALL MY TIME TO IT!


LUDWIG IS RIGHT, BUT ACTUALLY IT'S JUST WHERE HE'S WRONG!
WHAT DO YOU MEAN?
JUST LISTEN TO THE CHICKEN THIEF!

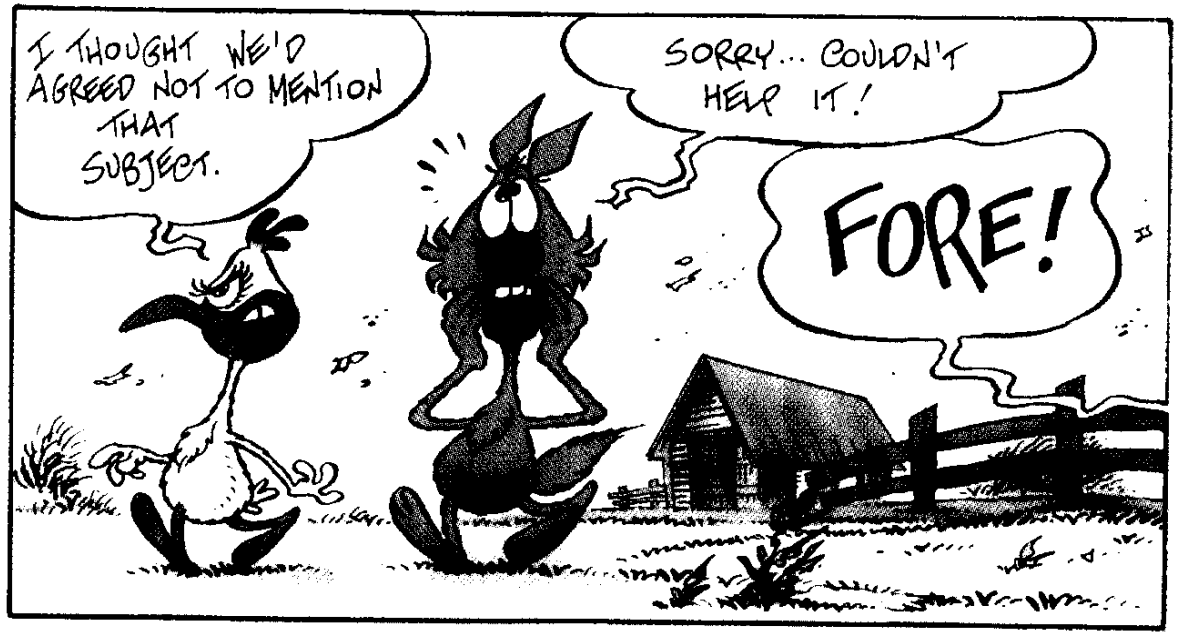

MOSES, LET HIM SPEAK!
HMM...
SOIL WHICH IS OVERWORKED LOSES ITS RICHNESS! HOW LONG IS IT SINCE YOU FED IT WITH A NATURAL FERTILIZER?
NA - NATURAL? FERTILIZER?


DO YOU SEE? AND THEN YOU COMPLAIN THAT THE WIND BLOWS EVERYTHING AWAY!
BUT FERTILIZER DOESN'T STOP THE WIND!

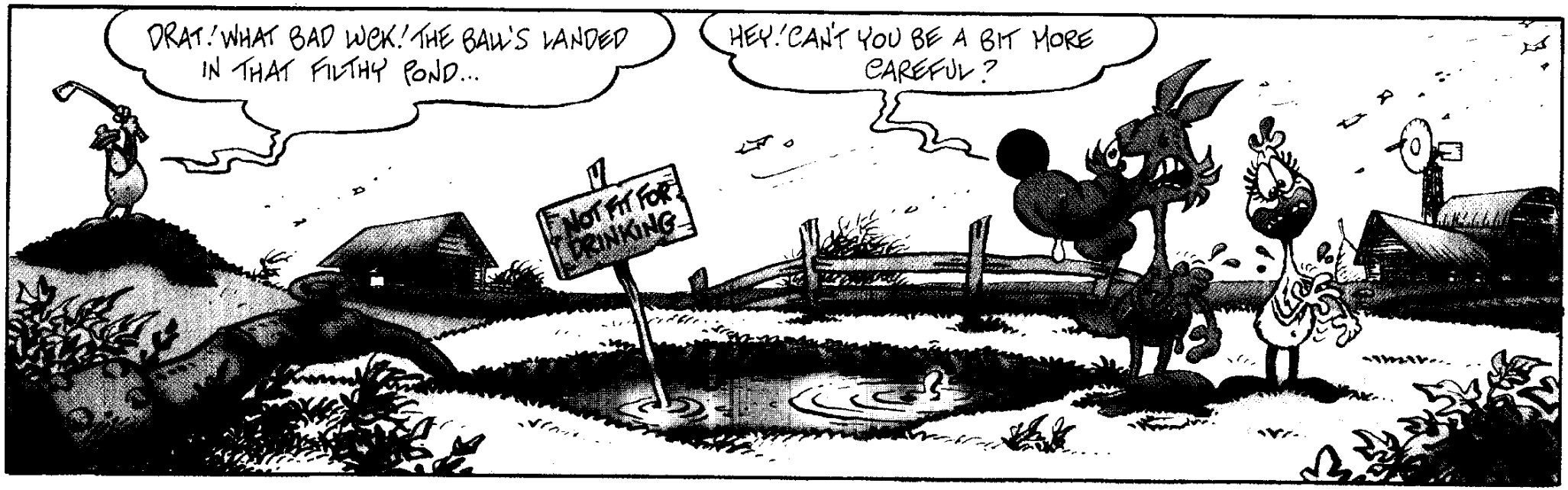

BUT FINE ROWS OF FRUIT TREES, FOR EXAMPLE, WILL!
SO YOU WANT ME TO START GROWING PEARS NOW? I ONLY EAT CARROTS!
HE'S RIGHT THERE!

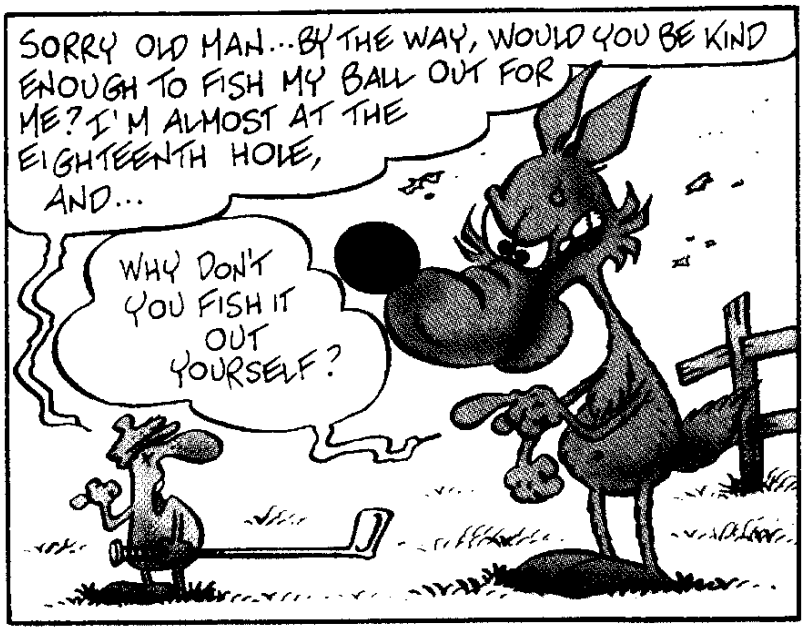

BUT IF YOU TAKE YOUR PEARS TO MARKET, YOU'LL SEE HOW MANY BEAUTIFUL CARROTS AS BIG AS WATER-MELONS AND AS SWEET AS HONEY THEY'LL GIVE YOU IN EXCHANGE, HORSY!
OH!

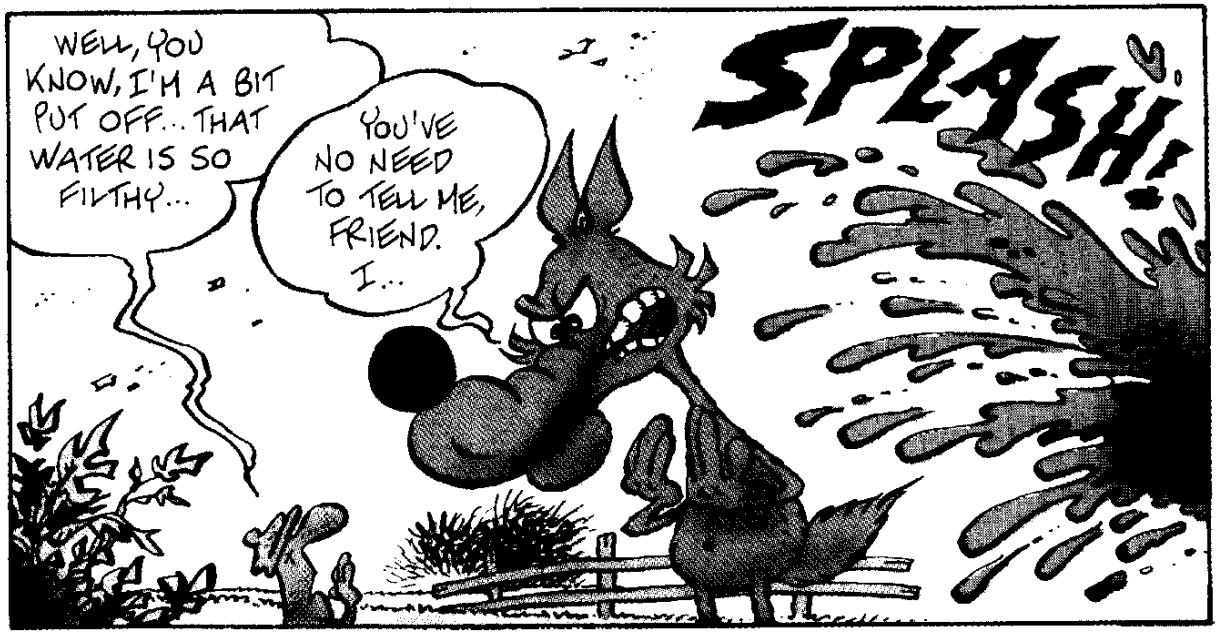

BUT WHAT IF I PUT SOME APPLES IN WITH THEM?
PEARS! HE SAID PEARS! D'YOU GET IT, HORSY? PEARS!
NOW THEY'LL BE ARGUING FOR HOURS!
YES, JUST LIKE HUSBAND AND WIFE...
5


I THOUGHT WE'D AGREED NOT TO MENTION THAT SUBJECT.
SORRY... COULDN'T HELP IT!
FORE!

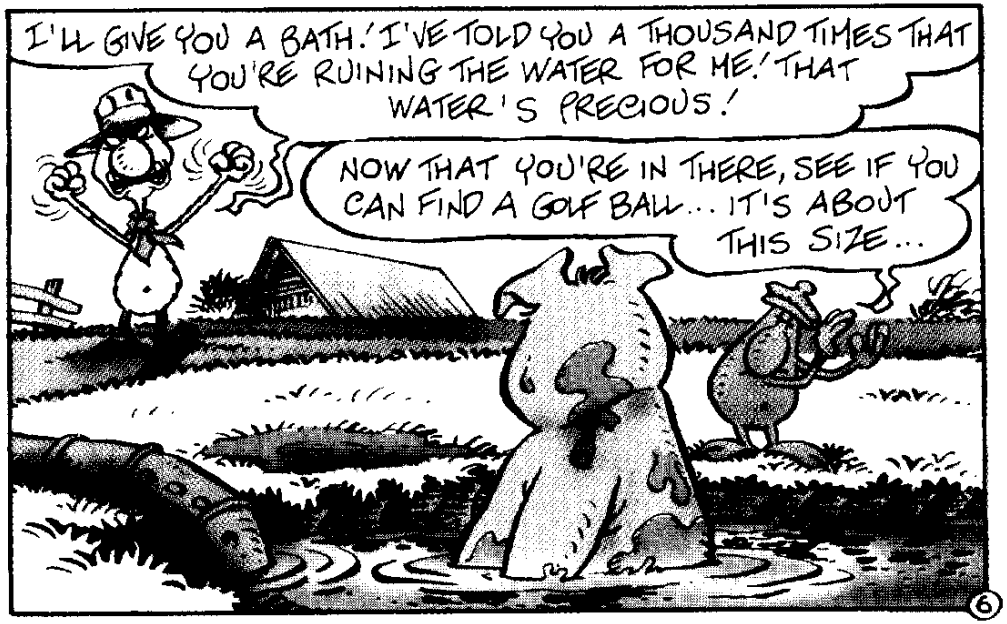

SPLASH!

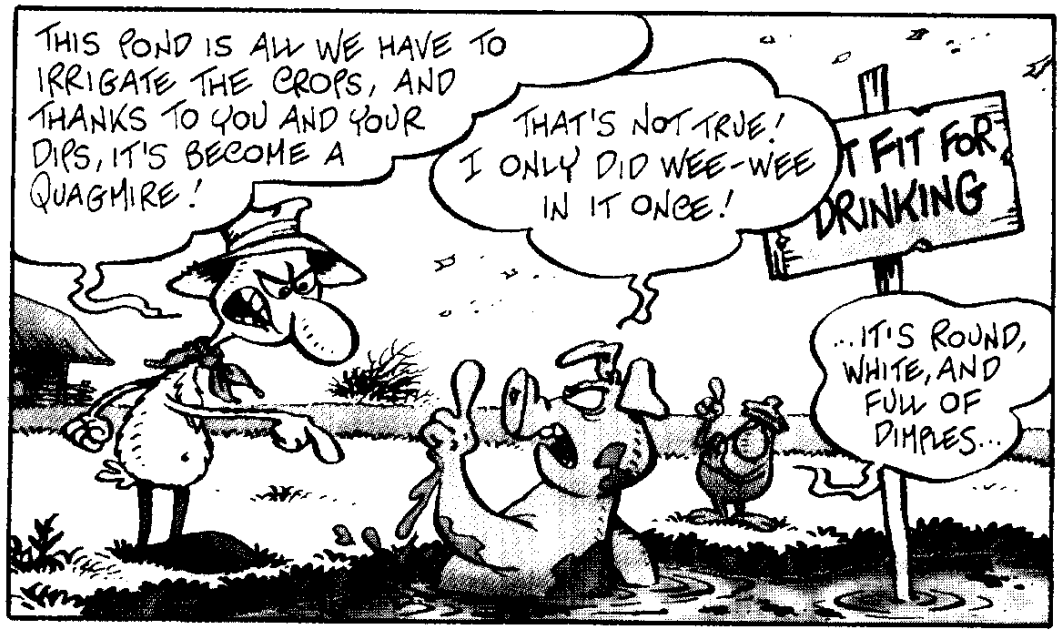

DRAT! WHAT BAD LUCK! THE BALL'S LANDED IN THAT FILTHY POND...
HEY! CAN'T YOU BE A BIT MORE CAREFUL?
NOT FIT FOR DRINKING

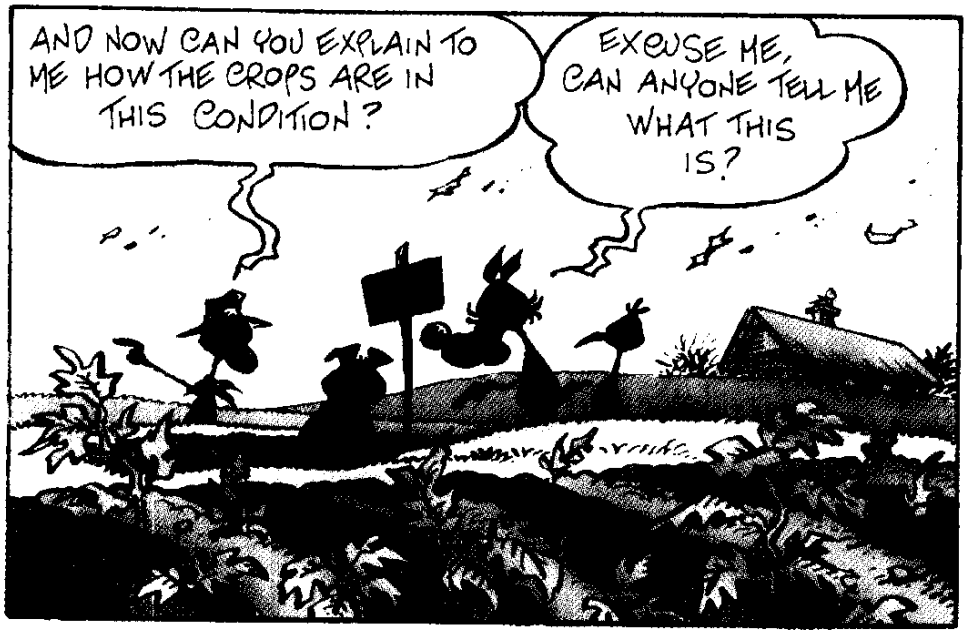

SORRY OLD MAN...BY THE WAY, WOULD YOU BE KIND ENOUGH TO FISH MY BALL OUT FOR ME? I'M ALMOST AT THE EIGHTEENTH HOLE, AND...
WHY DON'T YOU FISH IT OUT YOURSELF?


WELL, YOU KNOW, I'M A BIT PUT OFF... THAT WATER IS SO FILTHY...
YOU'VE NO NEED TO TELL ME, FRIEND. I...
SPLASH!

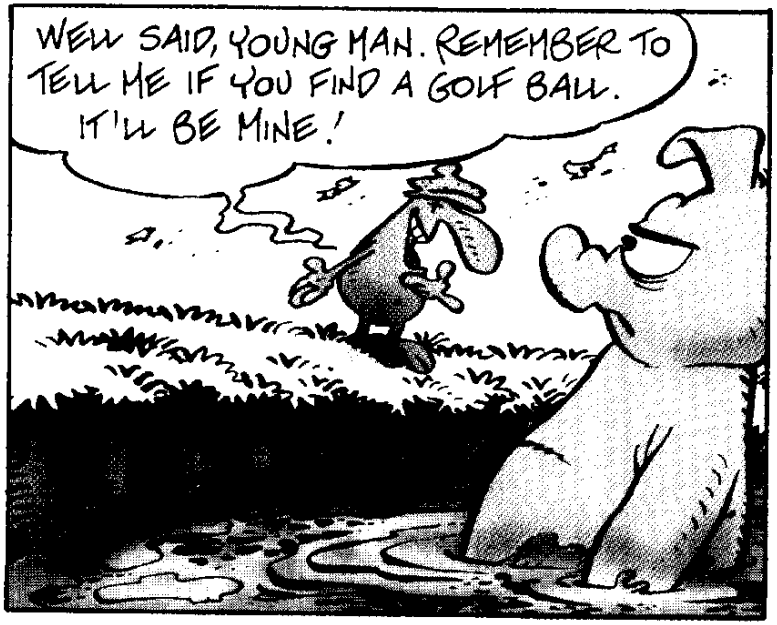

OH, EXCUSE ME... IT'S BATH TIME!
NOT FIT DRINK

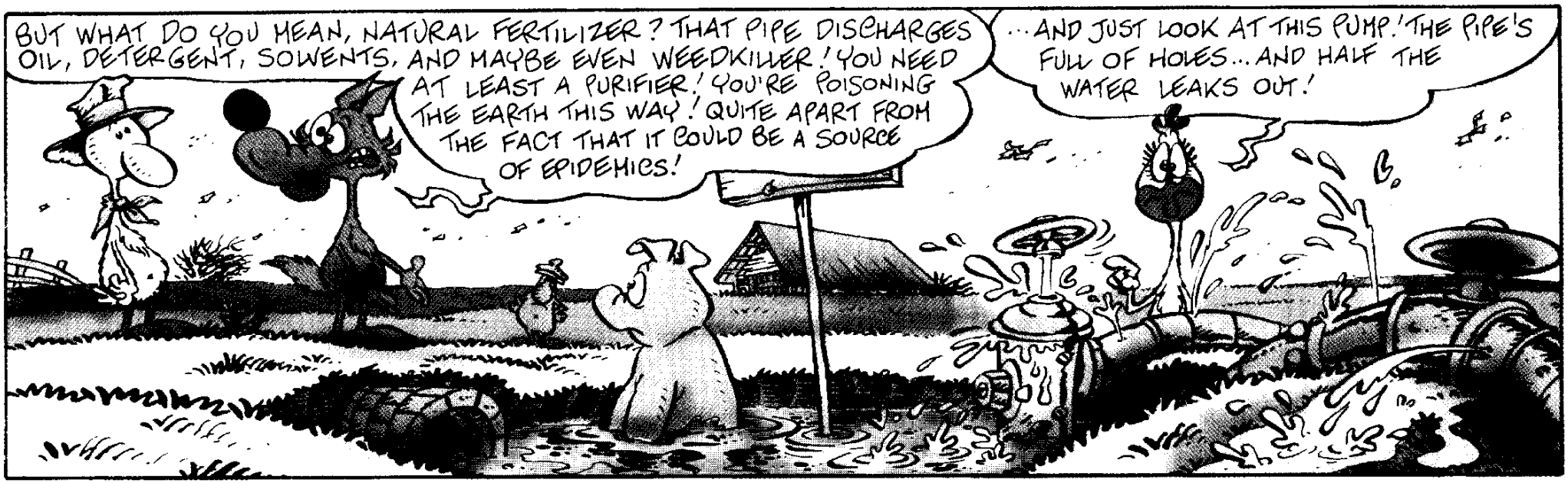

I'LL GIVE YOU A BATH! I'VE TOLD YOU A THOUSAND TIMES THAT YOU'RE RUINING THE WATER FOR ME! THAT WATER'S PRECIOUS!
NOW THAT YOU'RE IN THERE, SEE IF YOU CAN FIND A GOLF BALL... IT'S ABOUT THIS SIZE...
6

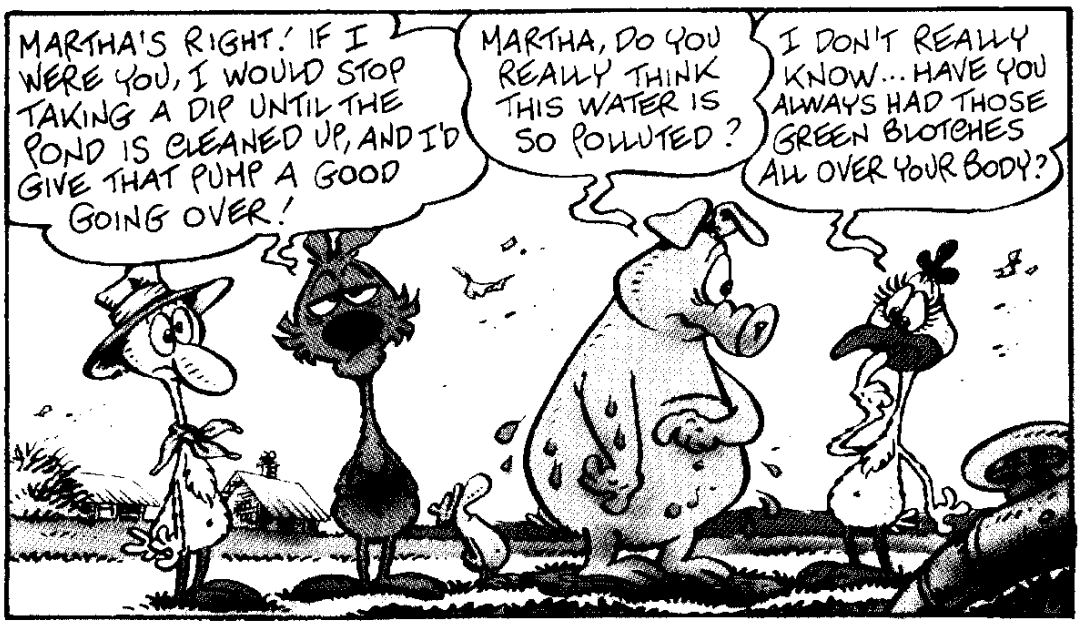

THIS POND IS ALL WE HAVE TO IRRIGATE THE CROPS, AND THANKS TO YOU AND YOUR DIPS, IT'S BECOME A QUAGMIRE!
THAT'S NOT TRUE! I ONLY DID WEE-WEE IN IT ONCE!
T FIT FOR DRINKING
...IT'S ROUND, WHITE, AND FULL OF DIMPLES...

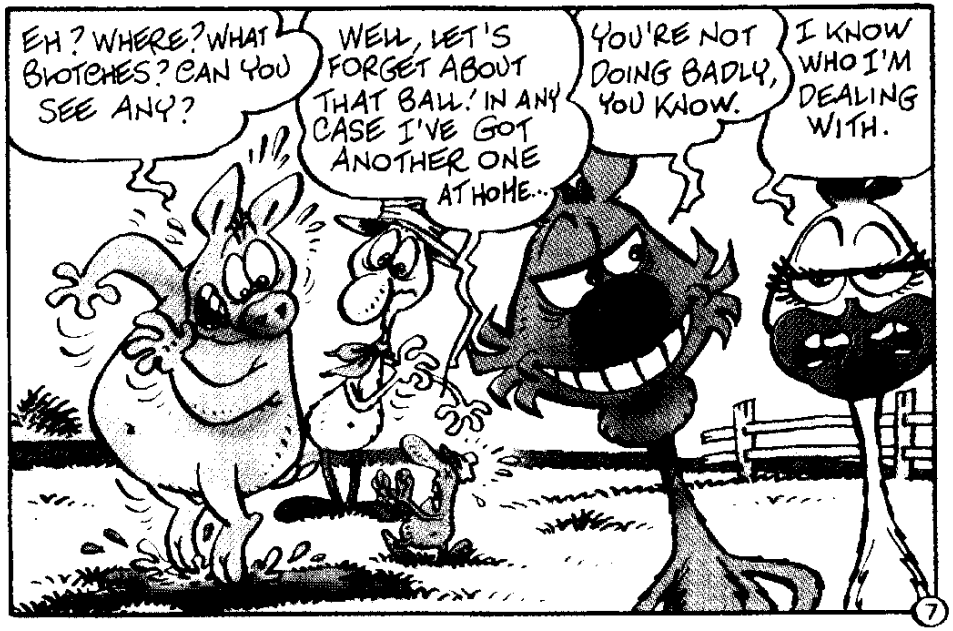

AND NOW CAN YOU EXPLAIN TO ME HOW THE CROPS ARE IN THIS CONDITION?
EXCUSE ME, CAN ANYONE TELL ME WHAT THIS IS?

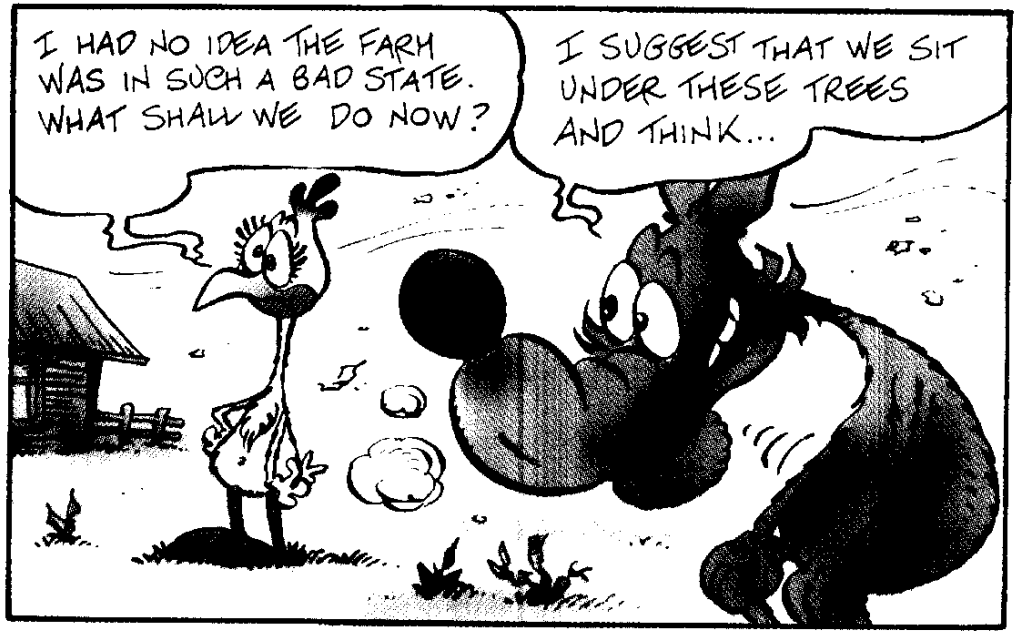

OH, IT'S THE DRAINAGE PIPE!
THE DRAINAGE PIPE HERE?
WELL, IT'S ALL NATURAL FERTILIZER!

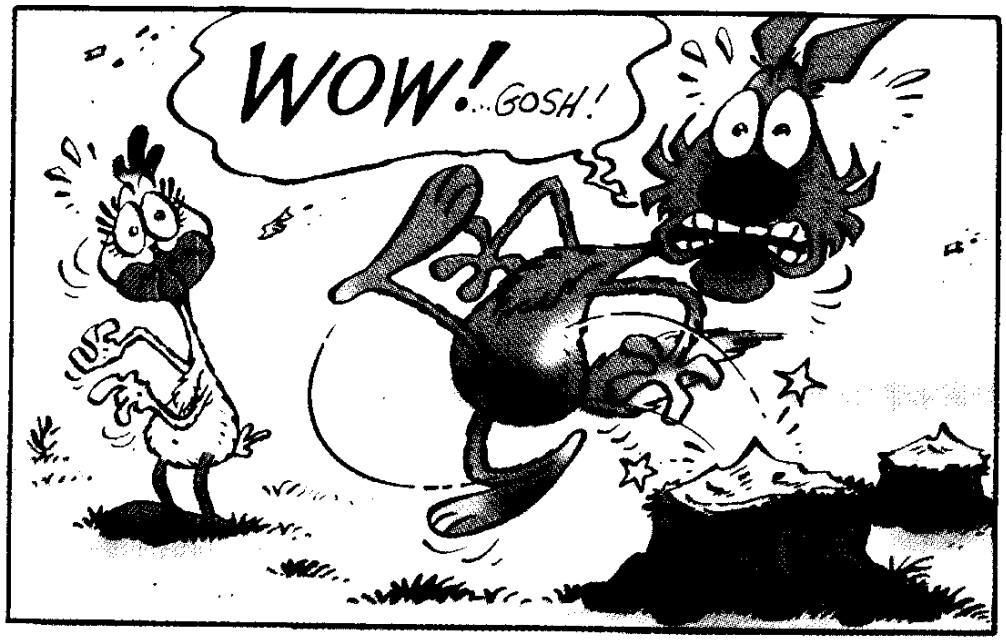

WELL SAID, YOUNG MAN. REMEMBER TO TELL ME IF YOU FIND A GOLF BALL. IT'LL BE MINE!

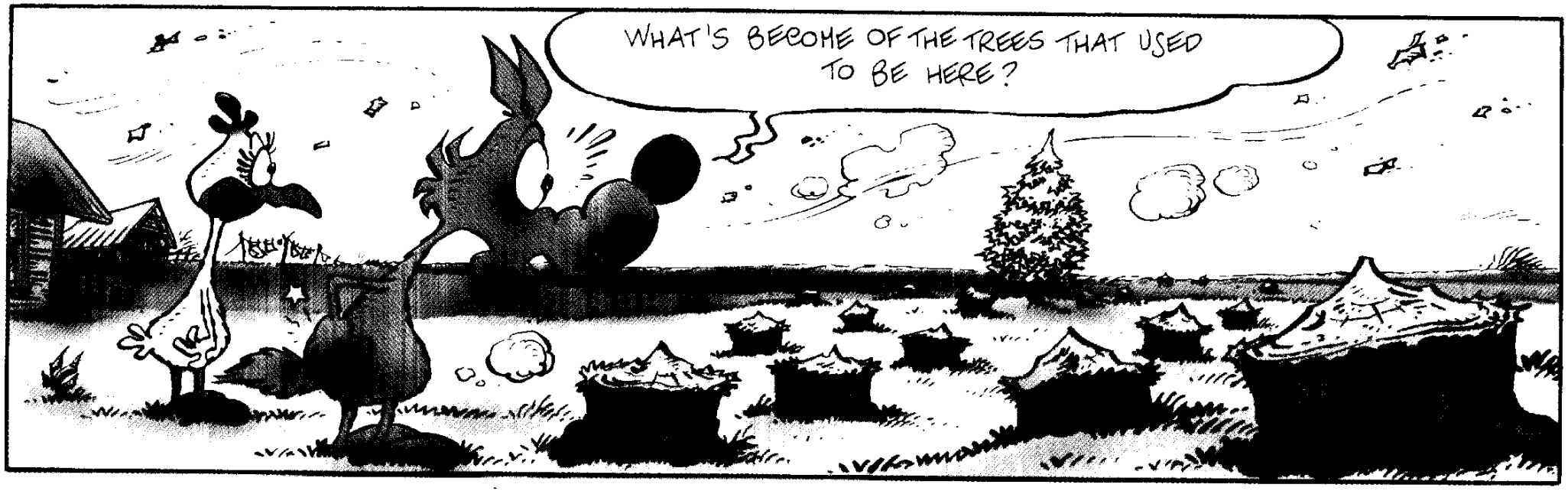

BUT WHAT DO YOU MEAN, NATURAL FERTILIZER? THAT PIPE DISCHARGES OIL, DETERGENT, SOWENTS, AND MAYBE EVEN WEEDKILLER! YOU NEED AT LEAST A PURIFIER! YOU'RE POISONING THE EARTH THIS WAY! QUITE APART FROM THE FACT THAT IT COULD BE A SOURCE OF EPIDEMICS!
...AND JUST LOOK AT THIS PUMP! THE PIPE'S FULL OF HOLES... AND HALF THE WATER LEAKS OUT!

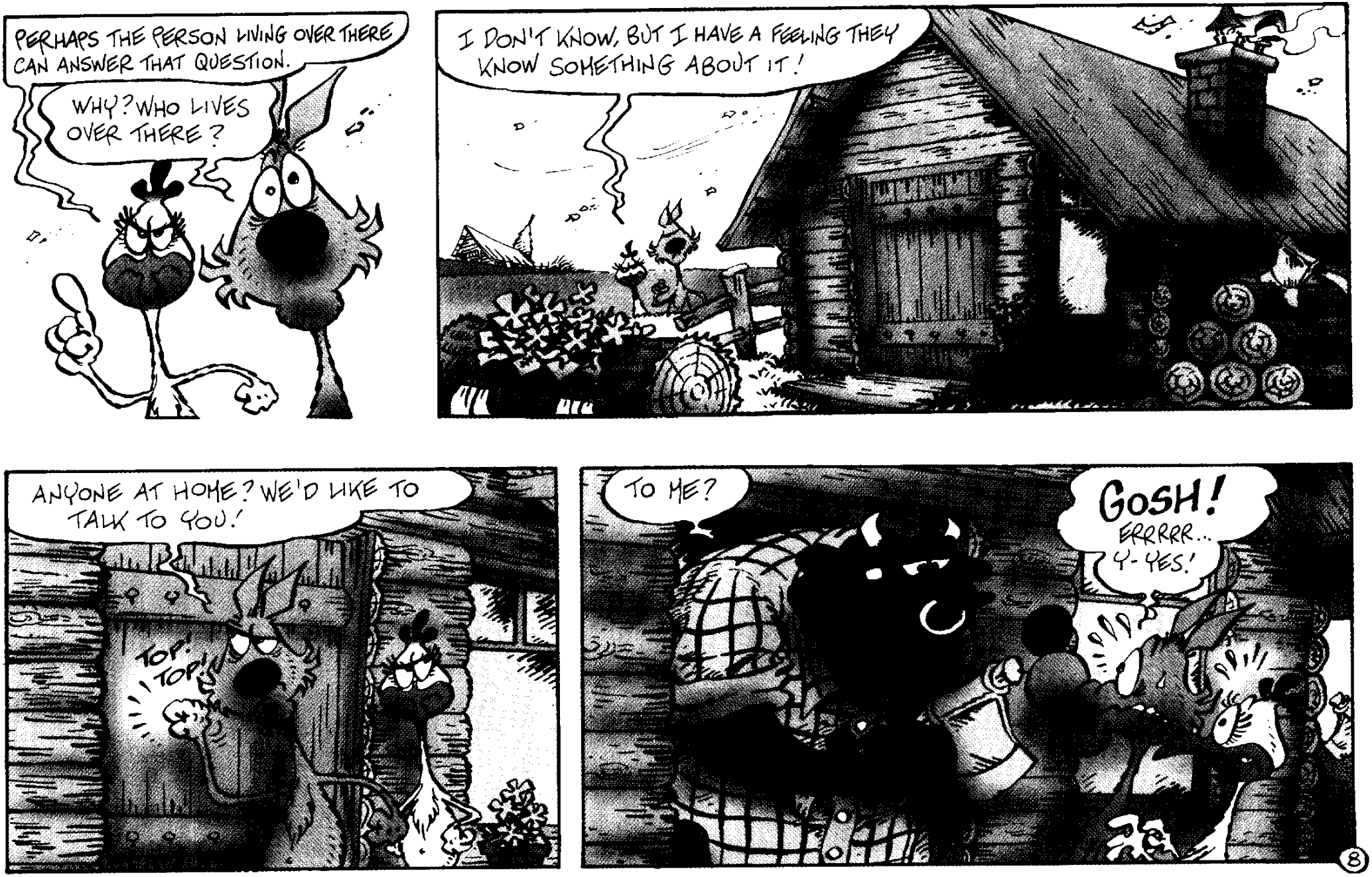

MARTHA'S RIGHT! IF I WERE YOU, I WOULD STOP TAKING A DIP UNTIL THE POND IS CLEANED UP, AND I'D GIVE THAT PUMP A GOOD GOING OVER!
MARTHA, DO YOU REALLY THINK THIS WATER IS SO POLLUTED?
I DON'T REALLY KNOW... HAVE YOU ALWAYS HAD THOSE GREEN BLOTCHES ALL OVER YOUR BODY?

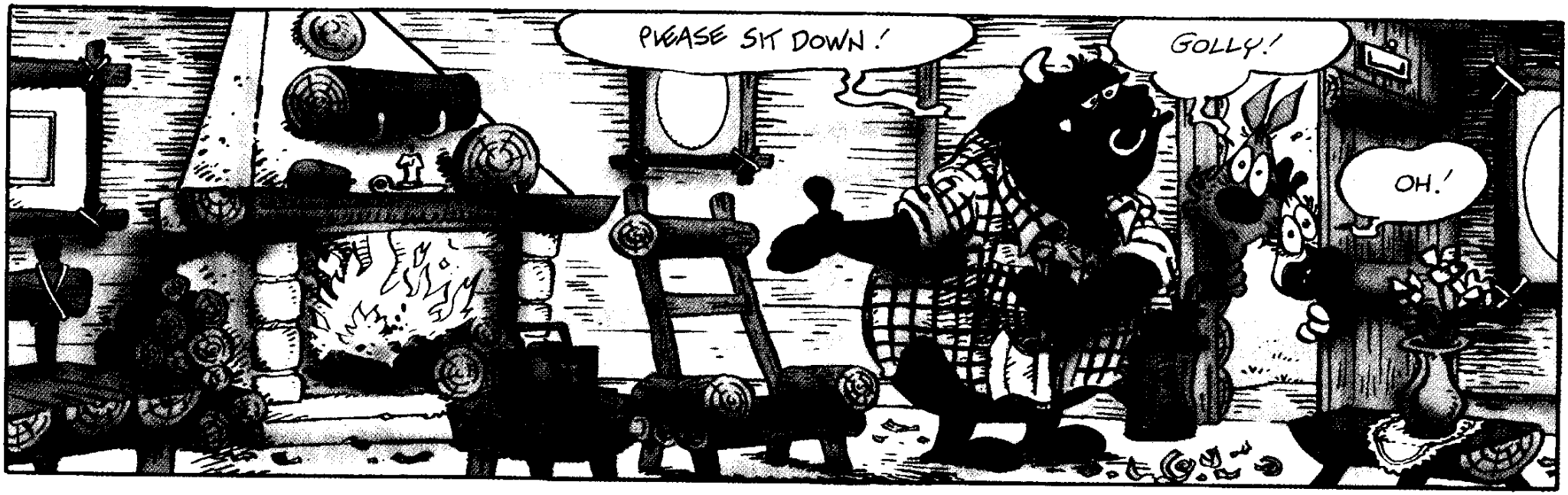

EH? WHERE? WHAT BLOTCHES? CAN YOU SEE ANY?
WELL, LET'S FORGET ABOUT THAT BALL! IN ANY CASE I'VE GOT ANOTHER ONE AT HOME...
YOU'RE NOT DOING BADLY, YOU KNOW.
I KNOW WHO I'M DEALING WITH.
7

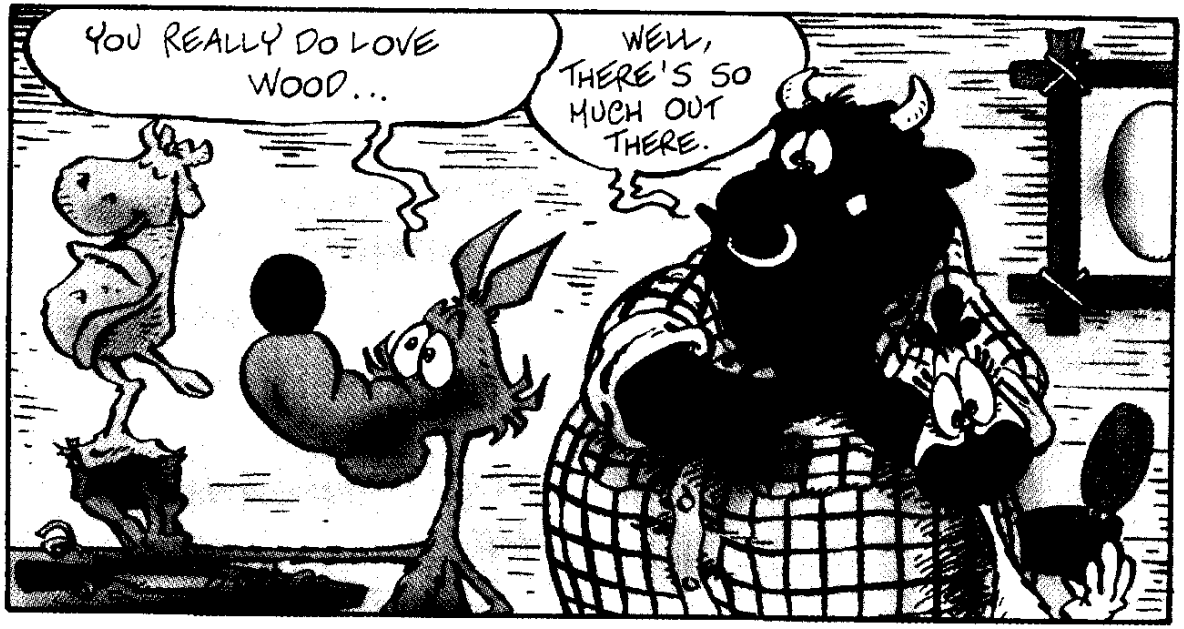

I HAD NO IDEA THE FARM WAS IN SUCH A BAD STATE. WHAT SHALL WE DO NOW?
I SUGGEST THAT WE SIT UNDER THESE TREES AND THINK...


WOW!...GOSH!

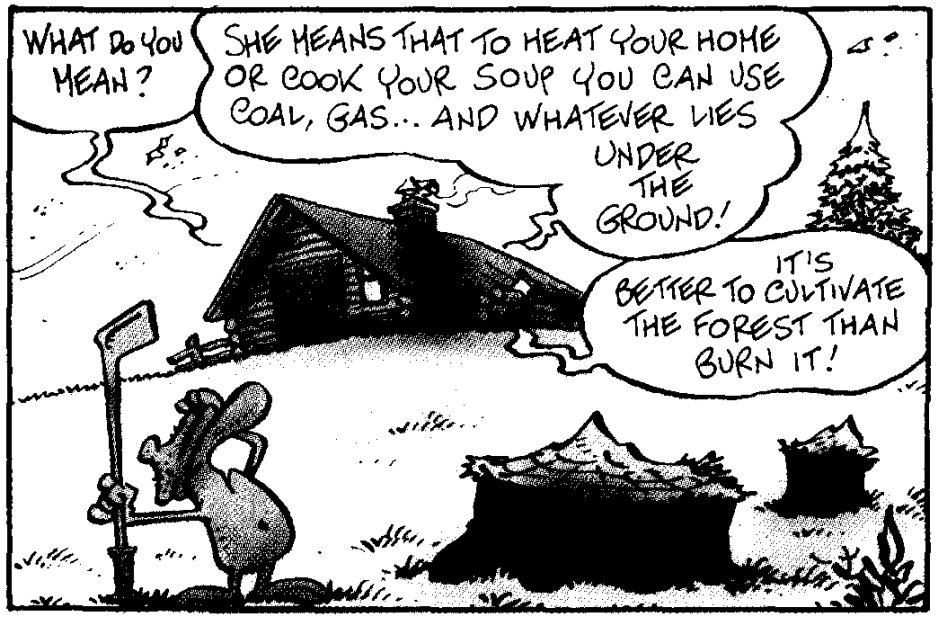

WHAT'S BECOME OF THE TREES THAT USED TO BE HERE?

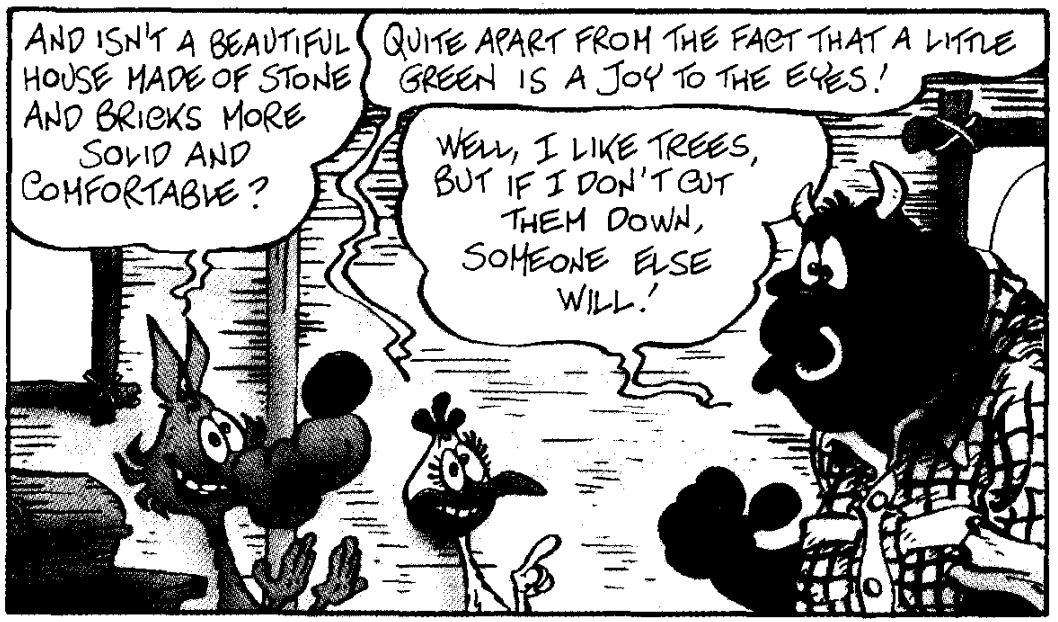

PERHAPS THE PERSON LIVING OVER THERE CAN ANSWER THAT QUESTION.
WHY? WHO LIVES OVER THERE?
I DON'T KNOW, BUT I HAVE A FEELING THEY KNOW SOMETHING ABOUT IT!
ANYONE AT HOME? WE'D LIKE TO TALK TO YOU!
TOP! TOP!
TO ME?
GOSH!
ERRRRR...
Y-YES!
8

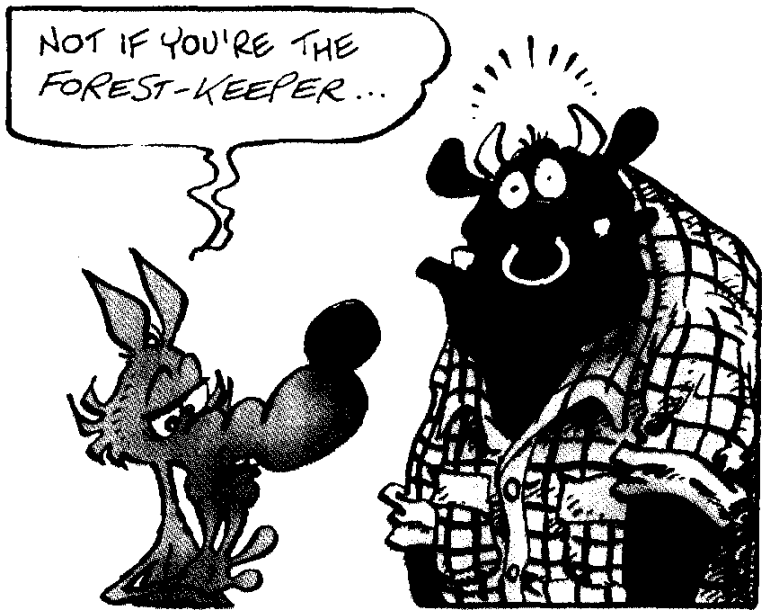

PLEASE SIT DOWN!
GOLLY!
OH.!

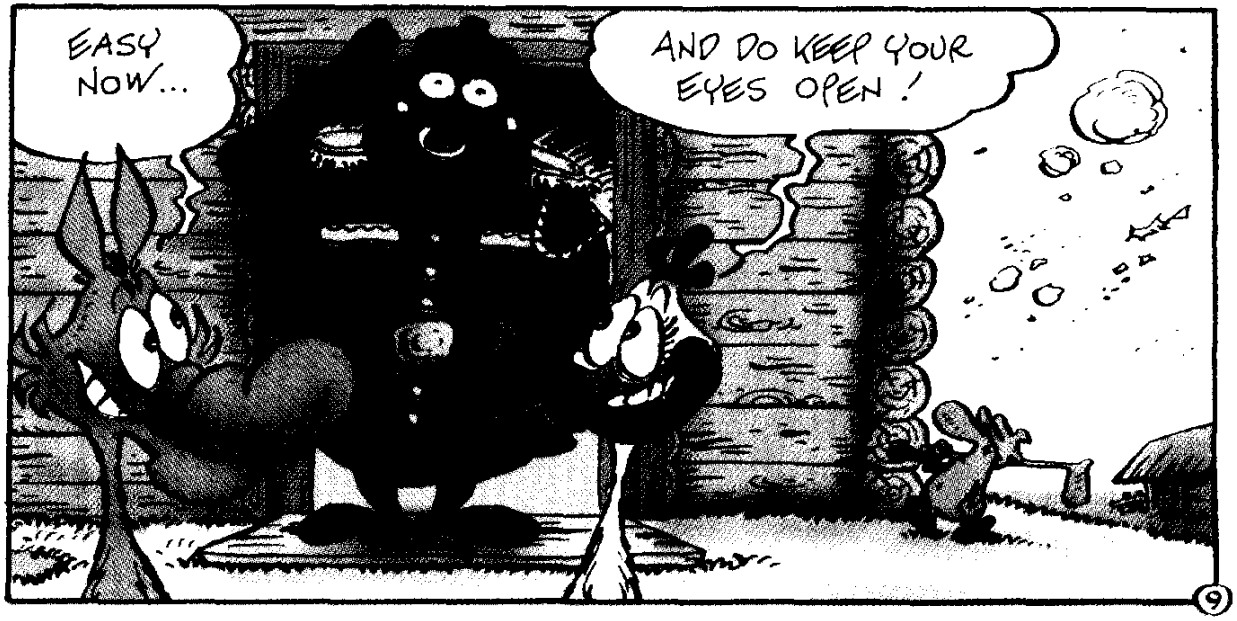

YOU REALLY DO LOVE WOOD...
WELL, THERE'S SO MUCH OUT THERE.

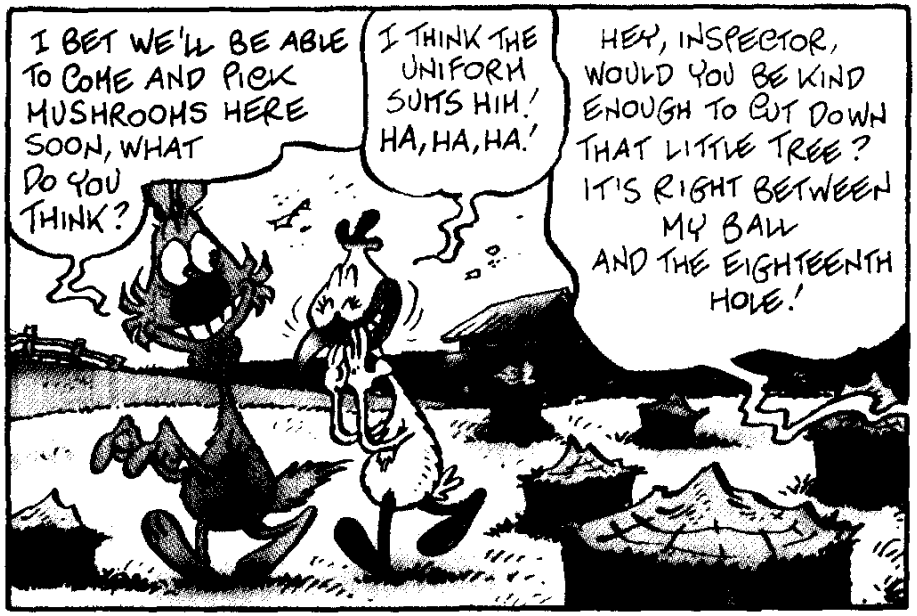

THERE WAS SO MUCH...
WELL, THE FACT IS IT'S MY ONLY RESOURCE AND THAT'S WHY...
...YOU'RE SENDING IT UP IN SMOKE?

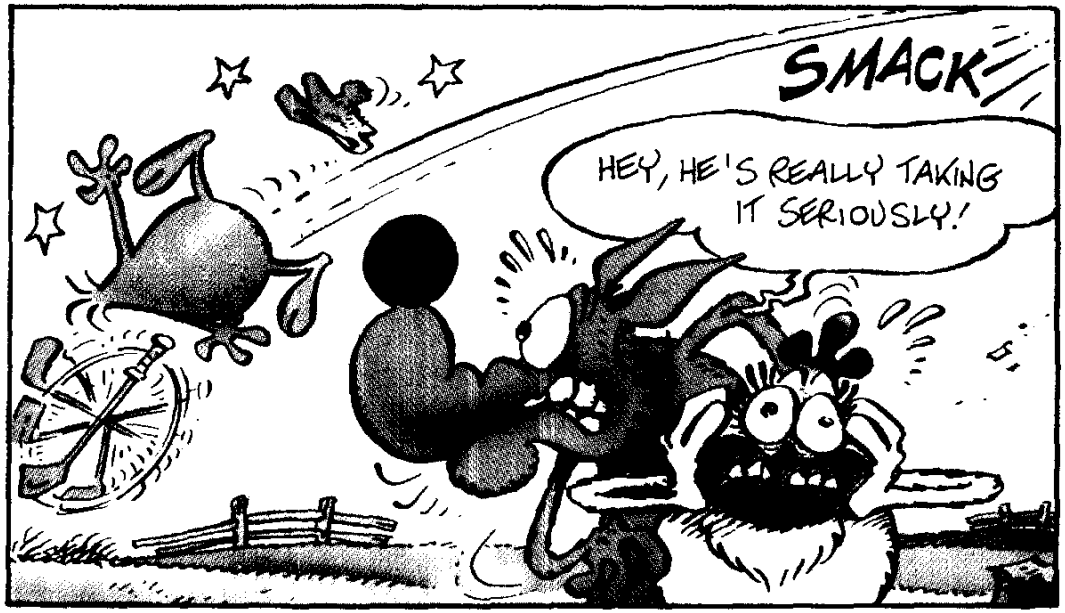

WHAT DO YOU MEAN?
SHE MEANS THAT TO HEAT YOUR HOME OR COOK YOUR SOUP YOU CAN USE COAL, GAS... AND WHATEVER LIES UNDER THE GROUND!
IT'S BETTER TO CULTIVATE THE FOREST THAN BURN IT!

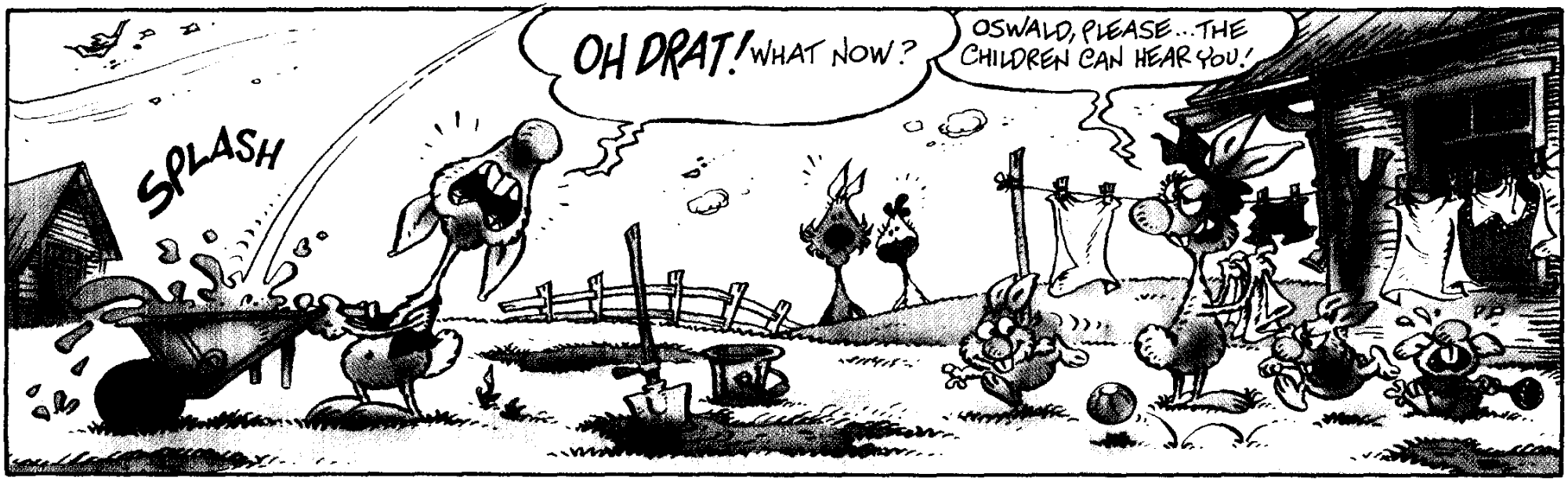

AND ISN'T A BEAUTIFUL HOUSE MADE OF STONE AND BRICKS MORE SOLID AND COMFORTABLE?
QUITE APART FROM THE FACT THAT A LITTLE GREEN IS A JOY TO THE EYES!
WELL, I LIKE TREES, BUT IF I DON'T CUT THEM DOWN, SOMEONE ELSE WILL!

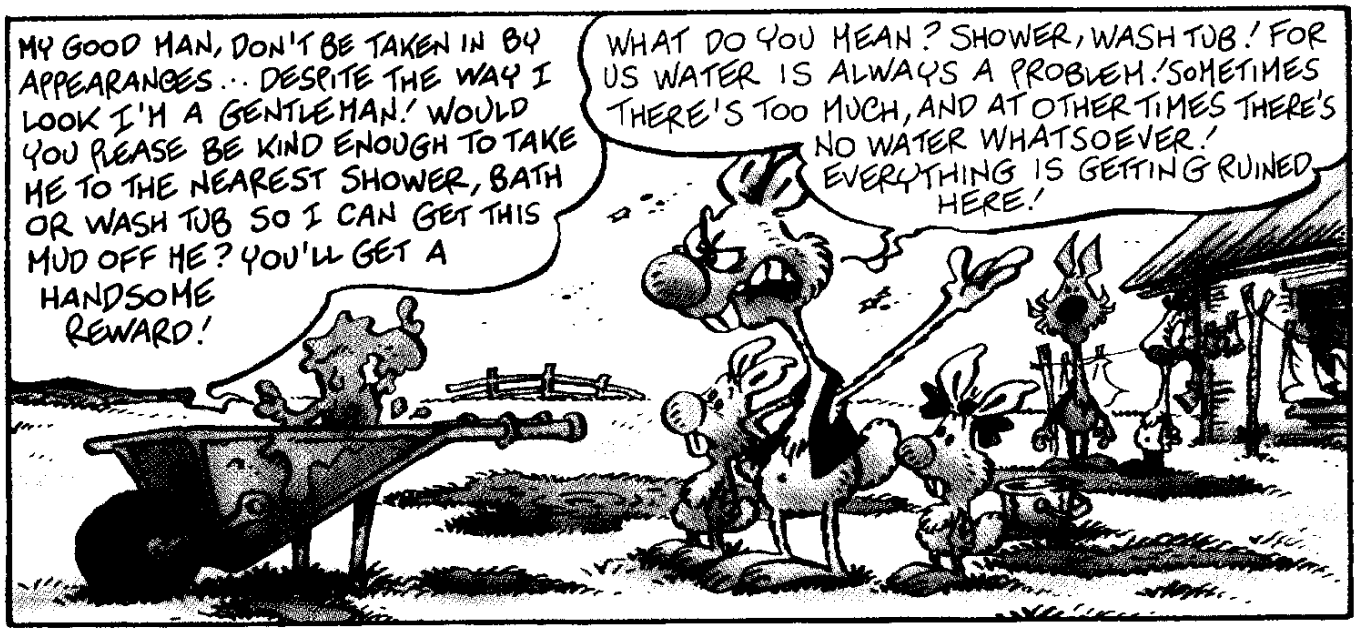

NOT IF YOU'RE THE FOREST-KEEPER...


EASY NOW...
AND DO KEEP YOUR EYES OPEN!
9

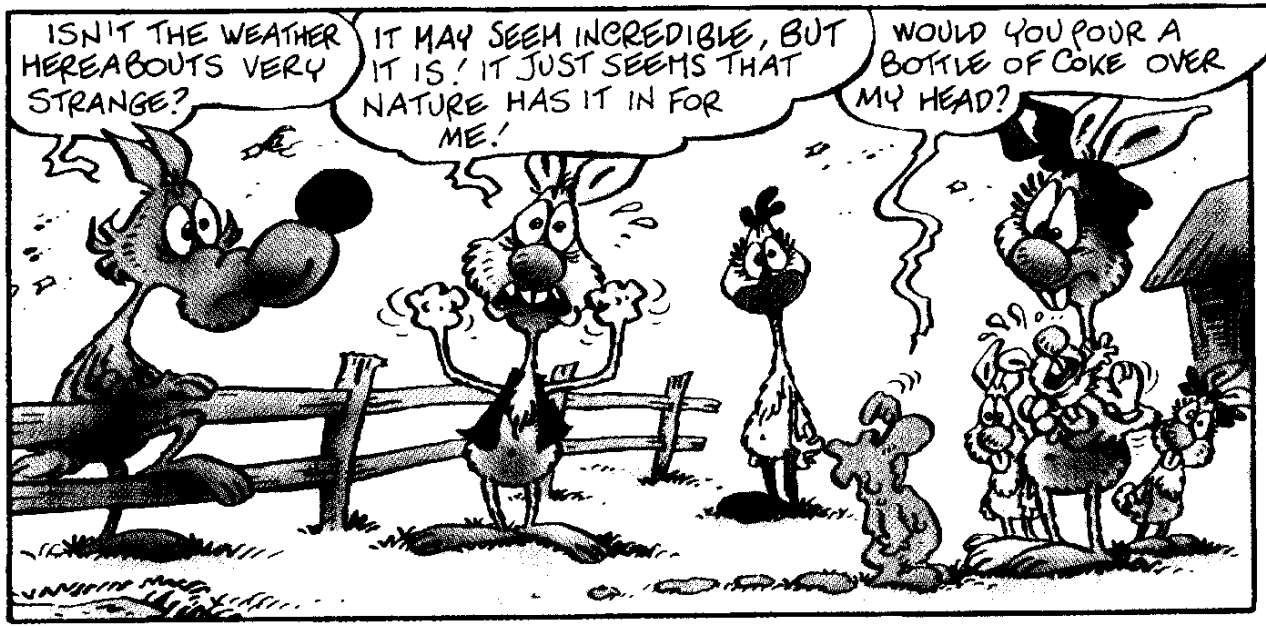

I BET WE'LL BE ABLE TO COME AND PICK MUSHROOMS HERE SOON, WHAT DO YOU THINK?
I THINK THE UNIFORM SUITS HIM! HA, HA, HA!
HEY, INSPECTOR, WOULD YOU BE KIND ENOUGH TO CUT DOWN THAT LITTLE TREE? IT'S RIGHT BETWEEN MY BALL AND THE EIGHTEENTH HOLE!

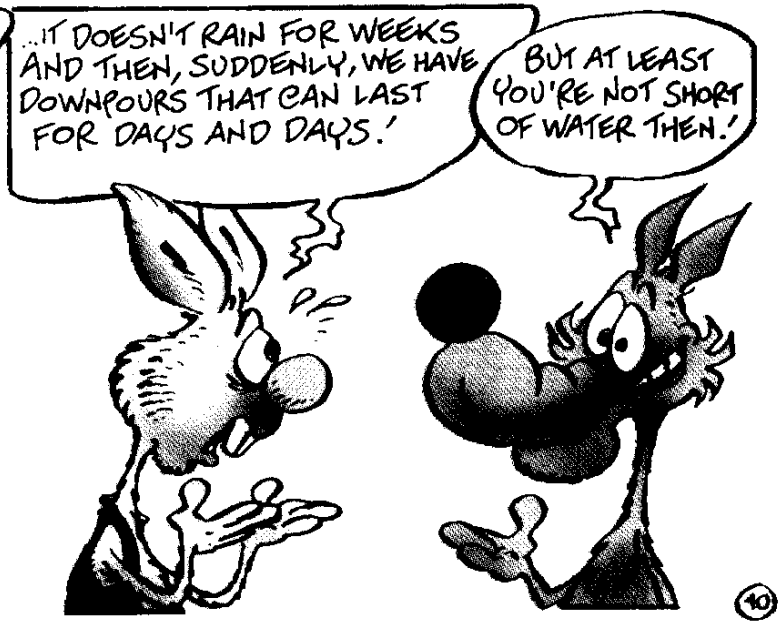

SMACK
HEY, HE'S REALLY TAKING IT SERIOUSLY!

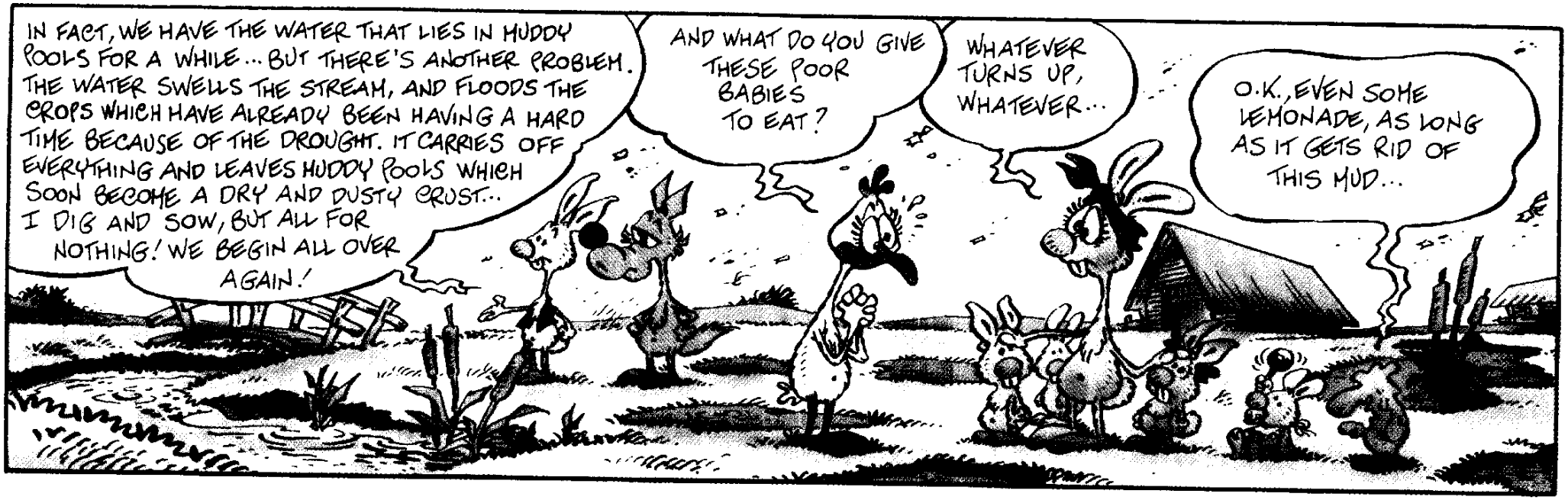

SPLASH
OH DRAT! WHAT NOW?
OSWALD, PLEASE... THE CHILDREN CAN HEAR YOU!

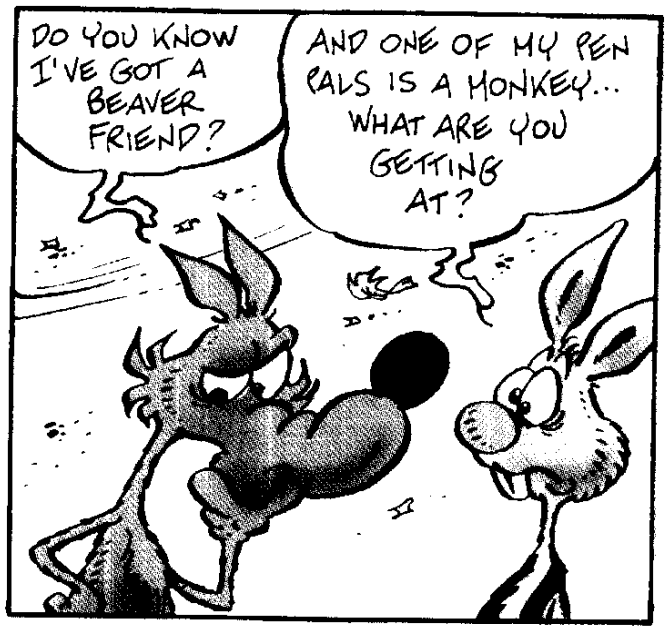

MY GOOD MAN, DON'T BE TAKEN IN BY APPEARANCES... DESPITE THE WAY I LOOK I'M A GENTLEMAN! WOULD YOU PLEASE BE KIND ENOUGH TO TAKE ME TO THE NEAREST SHOWER, BATH OR WASH TUB SO I CAN GET THIS MUD OFF ME? YOU'LL GET A HANDSOME REWARD!
WHAT DO YOU MEAN? SHOWER, WASH TUB! FOR US WATER IS ALWAYS A PROBLEM! SOMETIMES THERE'S TOO MUCH, AND AT OTHER TIMES THERE'S NO WATER WHATSOEVER! EVERYTHING IS GETTING RUINED HERE!

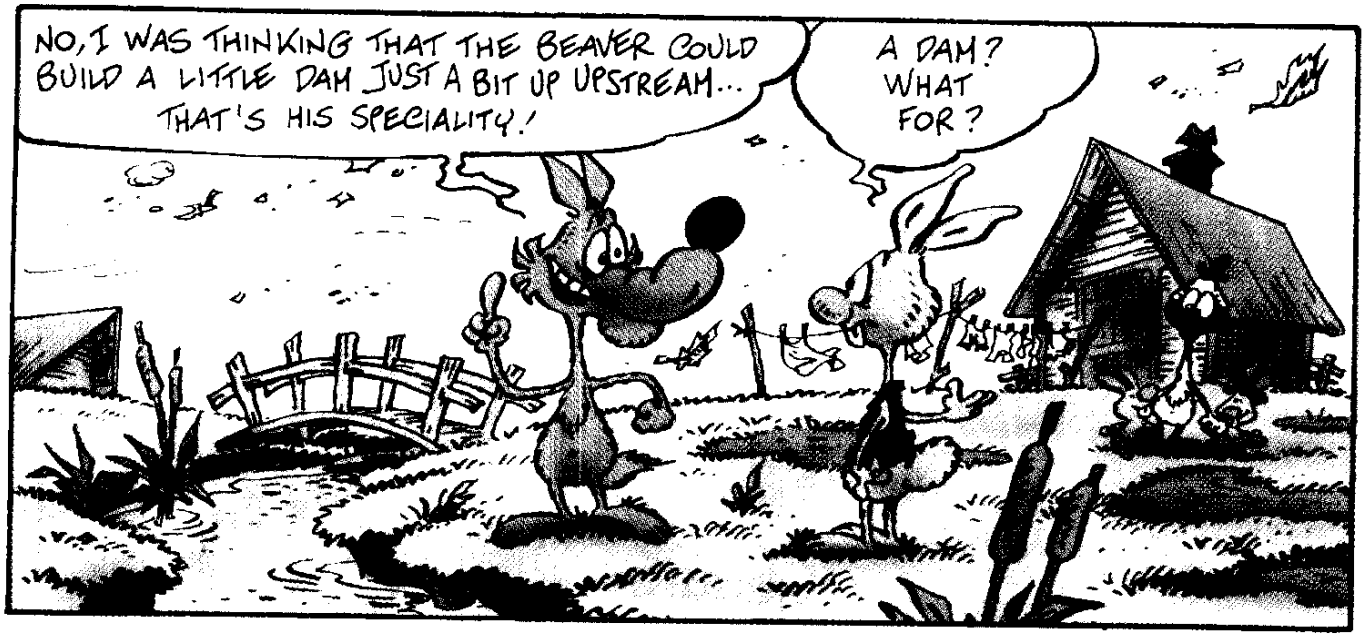

AND IS THERE TOO MUCH NOW?
NO, NOW THERE'S NO WATER AT ALL! JUST MUD! BECAUSE THE LAST TIME THERE WAS TOO MUCH!
OH BLAST!

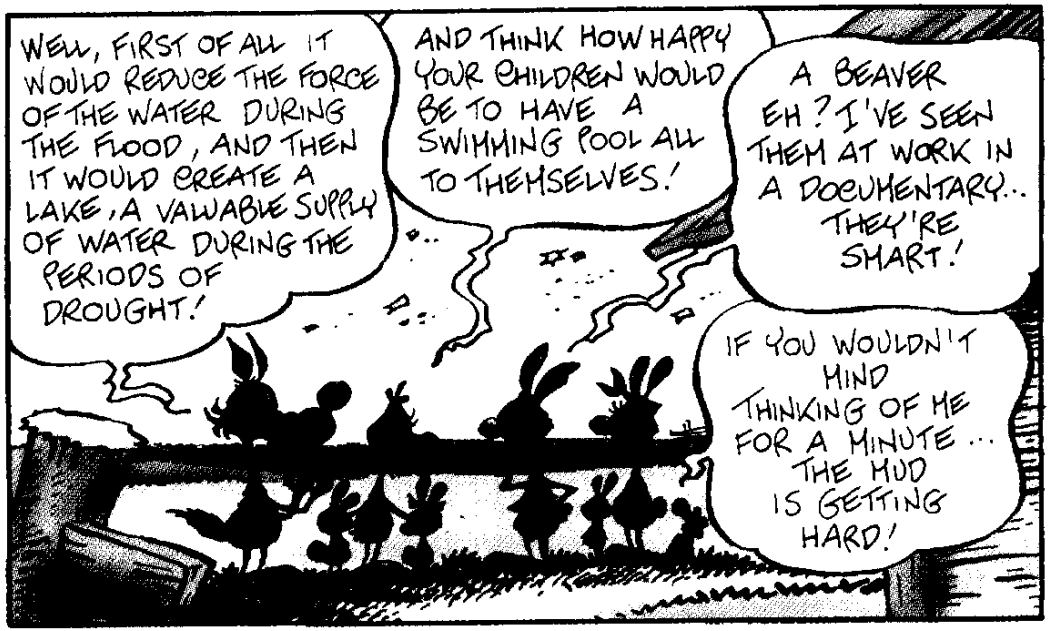

ISN'T THE WEATHER HEREABOUTS VERY STRANGE?
IT MAY SEEM INCREDIBLE, BUT IT IS! IT JUST SEEMS THAT NATURE HAS IT IN FOR ME!
WOULD YOU POUR A BOTTLE OF COKE OVER MY HEAD?

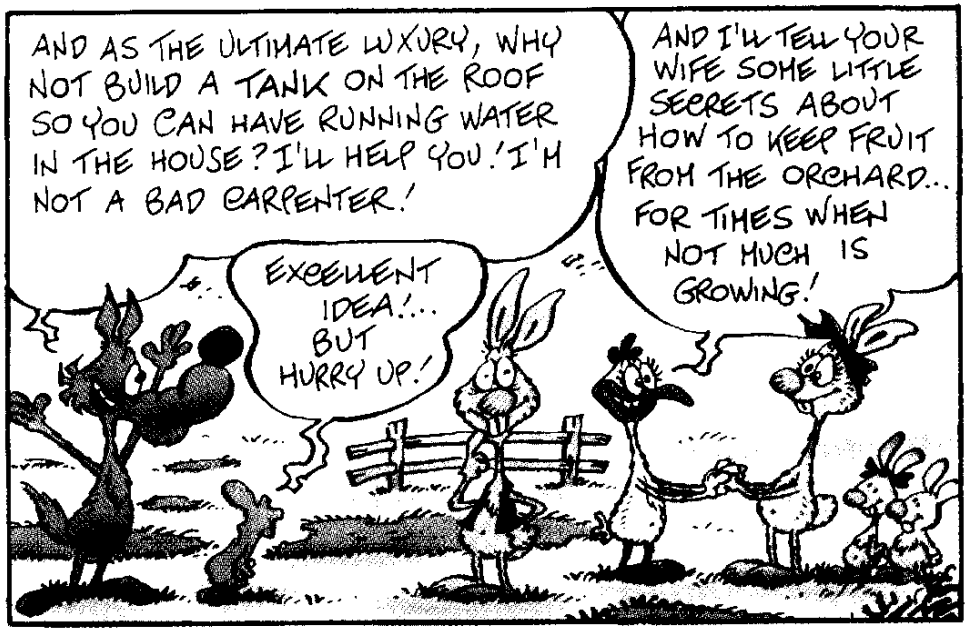

...IT DOESN'T RAIN FOR WEEKS AND THEN, SUDDENLY, WE HAVE DOWNPOURS THAT CAN LAST FOR DAYS AND DAYS!
BUT AT LEAST YOU'RE NOT SHORT OF WATER THEN!
10

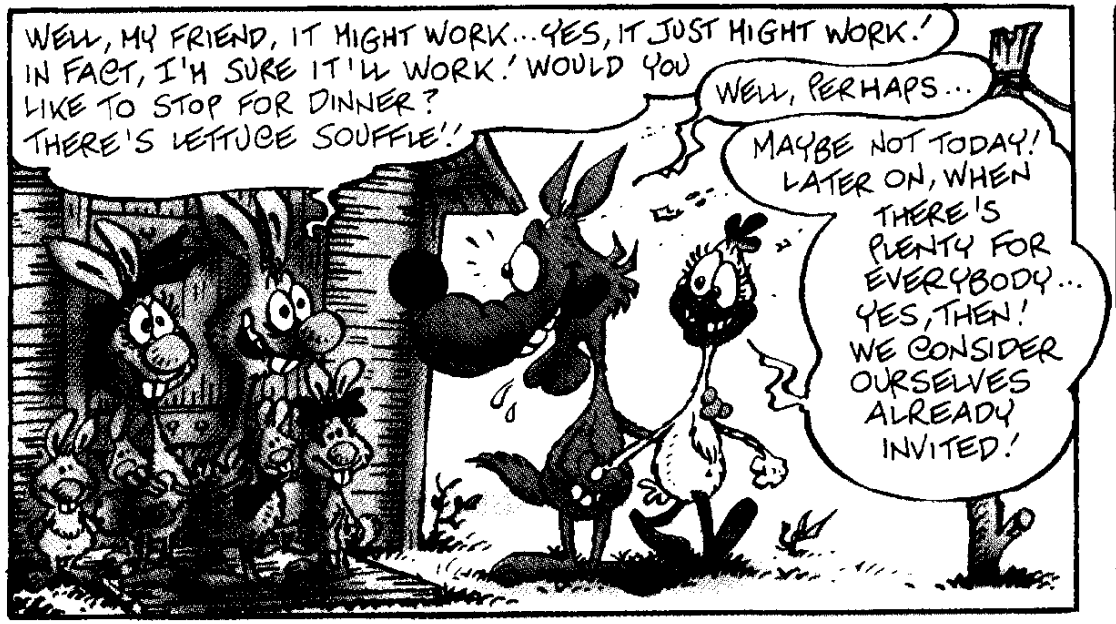

IN FACT, WE HAVE THE WATER THAT LIES IN MUDDY POOLS FOR A WHILE... BUT THERE'S ANOTHER PROBLEM. THE WATER SWELLS THE STREAM, AND FLOODS THE CROPS WHICH HAVE ALREADY BEEN HAVING A HARD TIME BECAUSE OF THE DROUGHT. IT CARRIES OFF EVERYTHING AND LEAVES MUDDY POOLS WHICH SOON BECOME A DRY AND DUSTY CRUST... I DIG AND SOW, BUT ALL FOR NOTHING! WE BEGIN ALL OVER AGAIN!
AND WHAT DO YOU GIVE THESE POOR BABIES TO EAT?
WHATEVER TURNS UP, WHATEVER...
O.K., EVEN SOME LEMONADE, AS LONG AS IT GETS RID OF THIS MUD...

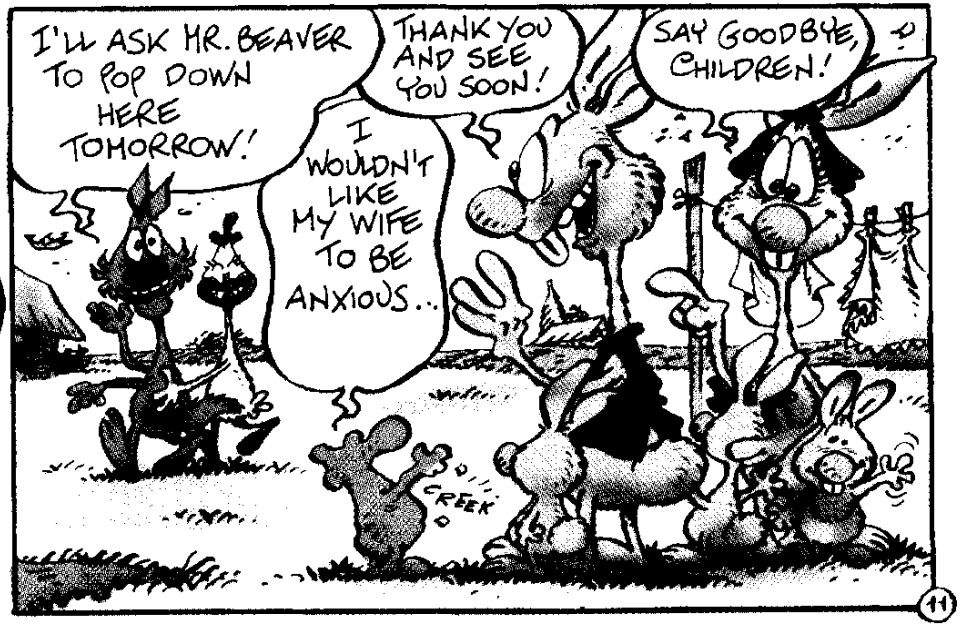

DO YOU KNOW I'VE GOT A BEAVER FRIEND?
AND ONE OF MY PEN PALS IS A MONKEY... WHAT ARE YOU GETTING AT?

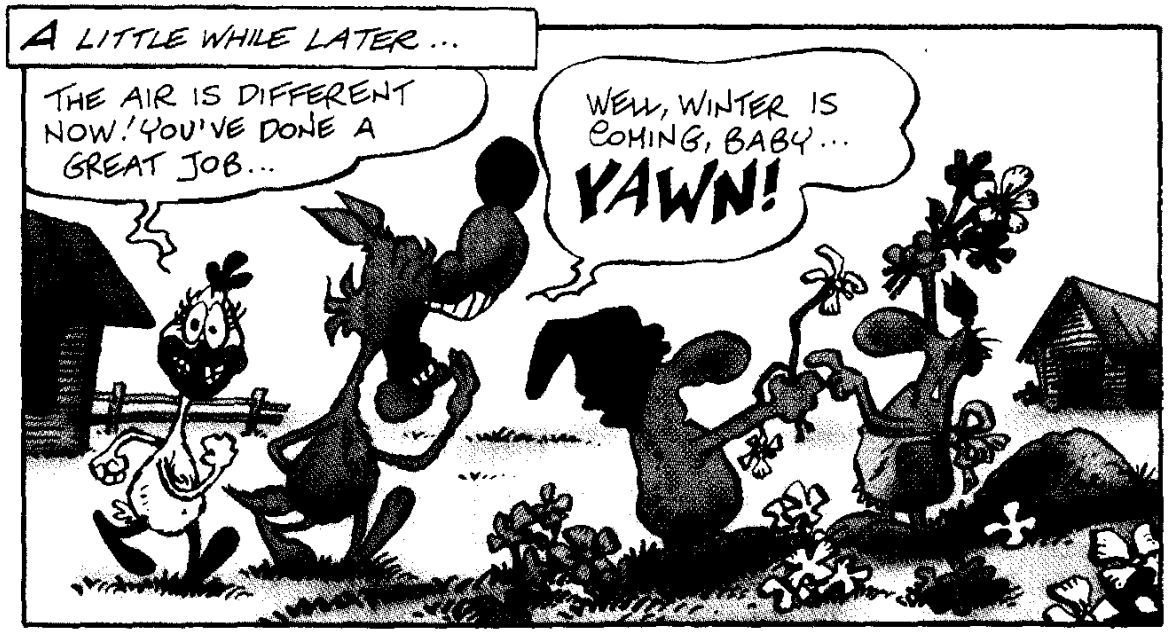

NO, I WAS THINKING THAT THE BEAVER COULD BUILD A LITTLE DAM JUST A BIT UP UPSTREAM... THAT'S HIS SPECIALITY!
A DAM? WHAT FOR?

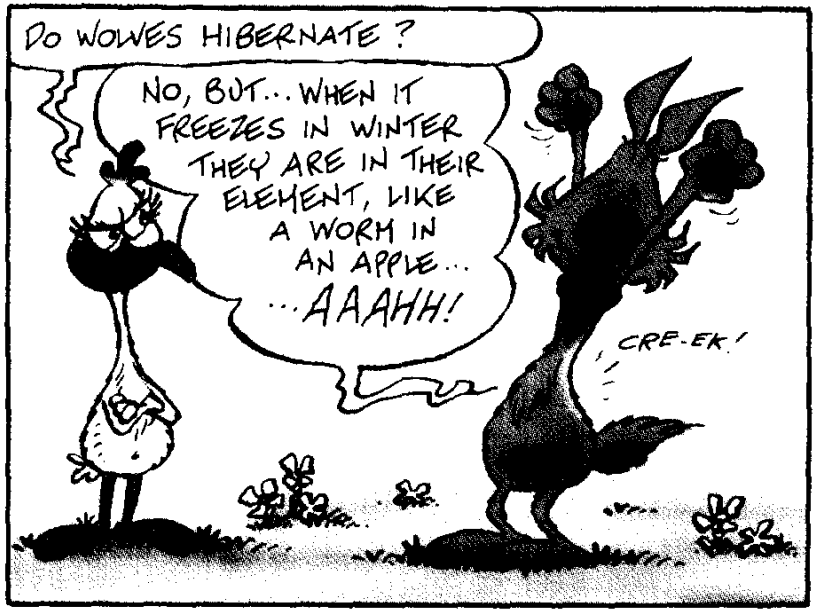

WELL, FIRST OF ALL IT WOULD REDUCE THE FORCE OF THE WATER DURING THE FLOOD, AND THEN IT WOULD CREATE A LAKE, A VALUABLE SUPPLY OF WATER DURING THE PERIODS OF DROUGHT!
AND THINK HOW HAPPY YOUR CHILDREN WOULD BE TO HAVE A SWIMMING POOL ALL TO THEMSELVES!
A BEAVER EH? I'VE SEEN THEM AT WORK IN A DOCUMENTARY... THEY'RE SMART!
IF YOU WOULDN'T MIND THINKING OF ME FOR A MINUTE... THE MUD IS GETTING HARD!

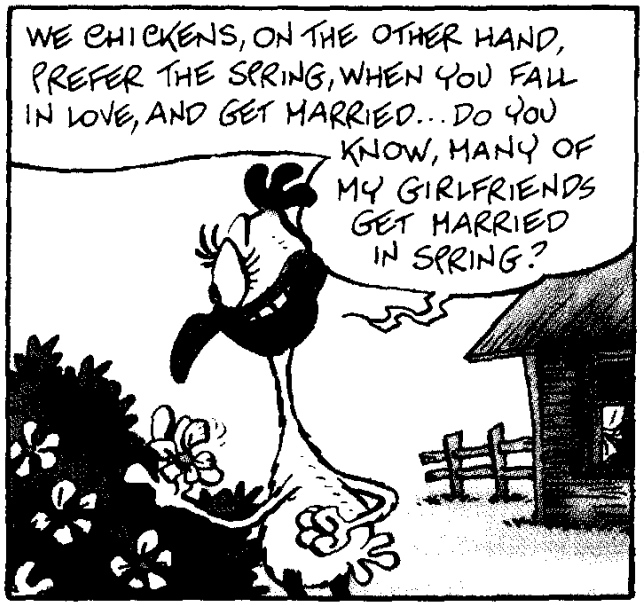

AND AS THE ULTIMATE LUXURY, WHY NOT BUILD A TANK ON THE ROOF SO YOU CAN HAVE RUNNING WATER IN THE HOUSE? I'LL HELP YOU! I'M NOT A BAD CARPENTER!
EXCELLENT IDEA!... BUT HURRY UP!
AND I'LL TELL YOUR WIFE SOME LITTLE SECRETS ABOUT HOW TO KEEP FRUIT FROM THE ORCHARD... FOR TIMES WHEN NOT MUCH IS GROWING!


WELL, MY FRIEND, IT MIGHT WORK... YES, IT JUST MIGHT WORK! IN FACT, I'M SURE IT'LL WORK! WOULD YOU LIKE TO STOP FOR DINNER? THERE'S LETTUCE SOUFFLE!
WELL, PERHAPS...
MAYBE NOT TODAY! LATER ON, WHEN THERE'S PLENTY FOR EVERYBODY... YES, THEN! WE CONSIDER OURSELVES ALREADY INVITED!

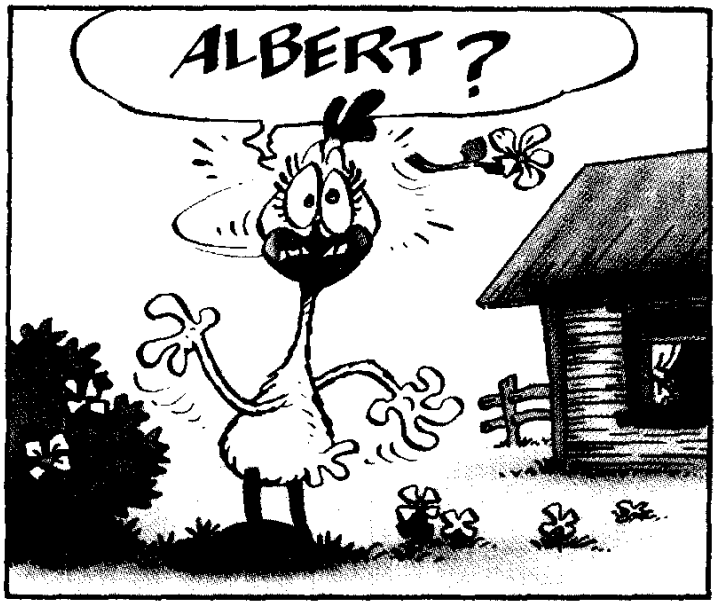

I'LL ASK MR. BEAVER TO POP DOWN HERE TOMORROW!
I WOULDN'T LIKE MY WIFE TO BE ANXIOUS...
THANK YOU AND SEE YOU SOON!
SAY GOODBYE, CHILDREN!
CREEK

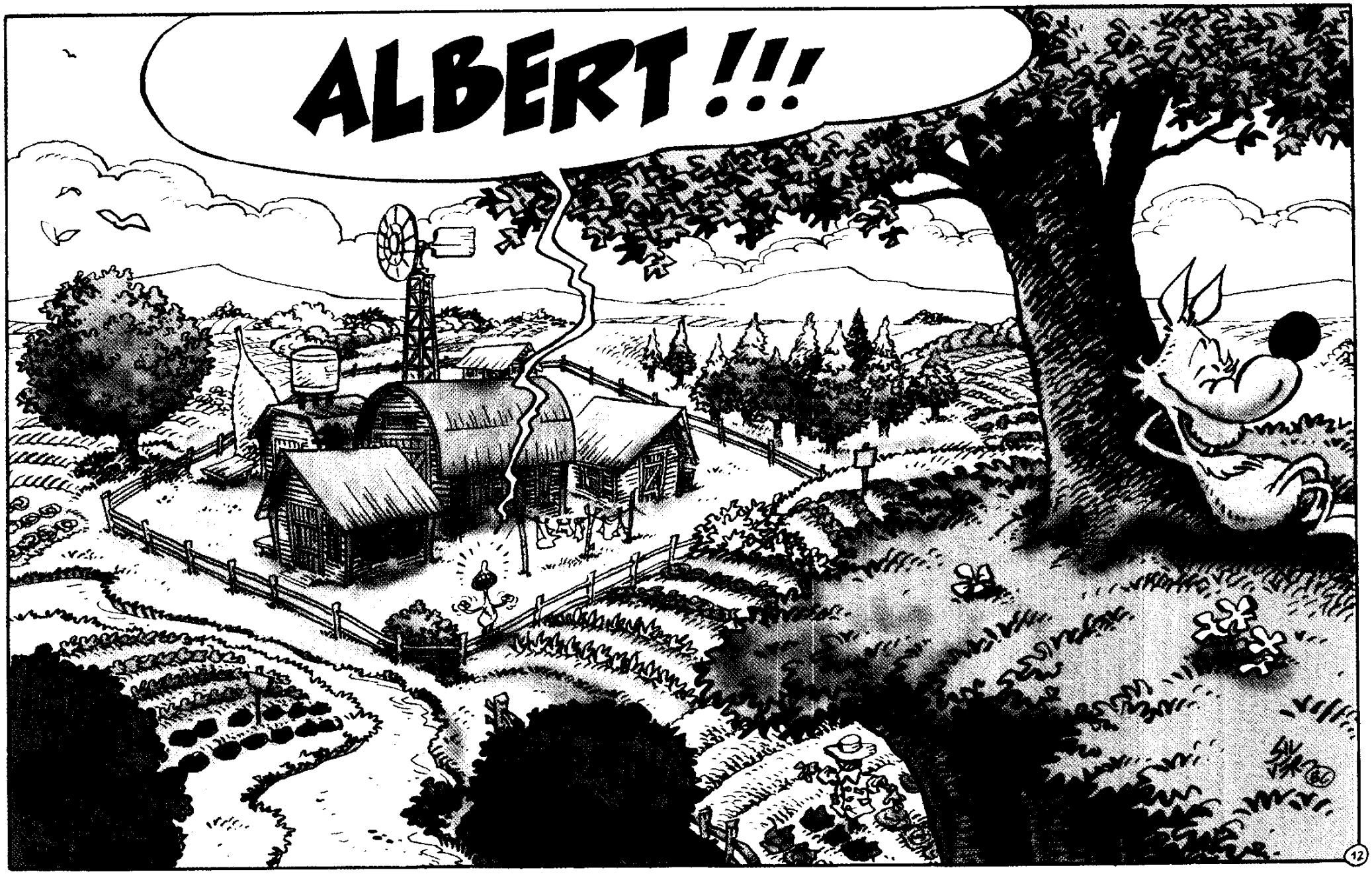

A LITTLE WHILE LATER...
THE AIR IS DIFFERENT NOW! YOU'VE DONE A GREAT JOB...
WELL, WINTER IS COMING, BABY...
YAWN!


DO WOLVES HIBERNATE?
NO, BUT... WHEN IT FREEZES IN WINTER THEY ARE IN THEIR ELEMENT, LIKE A WORM IN AN APPLE...
...AAAHH!
CRE-EK!


WE CHICKENS, ON THE OTHER HAND, PREFER THE SPRING, WHEN YOU FALL IN LOVE, AND GET MARRIED... DO YOU KNOW, MANY OF MY GIRLFRIENDS GET MARRIED IN SPRING?


MAYBE YOU KNOW ONE... ARE YOU LISTENING, ALBERT?


ALBERT?


ALBERT !!!
12

Recognizing the seriousness of the problem, the United Nations adopted the Convention to Combat Desertification in 1994. The Convention entered into force on 26 December 1996. Its core principle is the need for a participative approach directly involving citizens of both affected and not affected countries. The people living in the drylands understand the root causes of desertification, including activities such as unsustainable agriculture, overgrazing, deforestation, etc. However, they are often driven by poverty to get as much out of their land as possible in the short term.

The Convention to Combat Desertification was created to help the people of the drylands shoulder the risk of change to more sustainable practices. It acknowledges that the people of the drylands are the key to combating desertification, and that development must be human-oriented if it is to be sustainable, insisting that local people must be fully involved in deciding how to tackle the problem.

For further information please contact

Secretariat of the United Nations Convention to Combat Desertification
Haus Carstanjen
Martin Luther King Strasse 8
D-53175 Bonn - Germany
fax: (49-228) 8152899
email: secretariat@unccd.de
web site www.unccd.de

Other publications available in Arabic, Chinese, English, French, Spanish and Russian:
* the UNCCD kit, comprising the United Nations Convention to Combat Desertification, an explanatory leaflet and 14 fact sheets about the Convention.
* Down to Earth, a simplified guide to the Convention to Combat Desertification that explains why it is necessary and what is important and different about it.
* Down to Earth, the quarterly newsletter of the Convention to Combat Desertification (in English and French)

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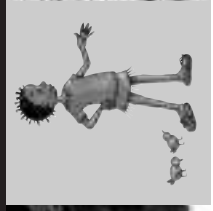
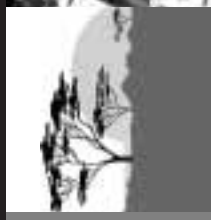
Environmental Education Kit on Desertification

Evaluation Form





Dear Teacher
in a country affected by desertification,

Enclosed is the Environmental **Education Kit on Desertification** produced by UNESCO and the UNCCD. This kit intends to provide material for improving the level of knowledge among school children on the phenomenon and process of desertification worldwide. Our know-how and our skills, as well as our hopes, are embodied in this package.

We are aware that some of the documents may need to be improved, and is why the kit is currently in an experimental phase. To optimise its potential, we need your feedback and guidance as real practitioners of environmental education in the world's drylands. Your daily teaching experience, based on the socio-economic realities in your region as well as your understanding of your pupils' real pedagogical needs and capacities, will be of enormous benefit in helping us to adapt the material to target groups in future editions.

We would be extremely grateful if you could kindly take the time to fill in the following evaluation form before 30 June 2002 and send it back to us at the following address:

UNESCO

Division of Ecological Sciences
Mr Thomas Schaaf/ Desertification Kit
1, rue Miollis, 75732 Paris Cedex 15, FRANCE

Fax: (+) 33 1 45 68 58 04

May we wish you every success and much pleasure when using the Desertification Kit. Thank you for your co-operation in helping to improve it!

Country: .....

School: .....

Full address: .....

.....

.....

.....

Tel.: ..... Fax: .....

E-mail: .....

Teacher: ☐ Mr ☐ Mrs ☐ Ms

Surname: .....

First name: .....

Subjects/Titles/Certificates: .....

Number of pupils in my class: .....

Average age of pupils: .....

1. Kit evaluation

On the whole, I found the Desertification Kit to be:

☐ very useful ☐ useful ☐ quite useful ☐ not useful

Please explain .....

.....

.....

.....

On the whole, I found the level of the documents that comprise the Kit to be:

☐ adequate
☐ too difficult
☐ too easy
☐ well adapted to pupils
☐ ill adapted to pupils

Please explain .....

.....

.....

.....

I found the graphic format (colours, layout, photos) of the Desertification Kit to be:

- very appealing
- appealing
- unappealing
- excellent pedagogical level
- average pedagogical level
- poor pedagogical level

Please explain

On the whole, I found the documents included in the Kit to be:

- well adapted to socio-cultural realities
- ill adapted to socio-cultural realities
- well adapted to economic realities
- ill adapted to economic realities
- well adapted to the problems of desertification found in my region
- ill adapted to the problems of desertification found in my region

Please explain

General comments and remarks:

What major problems (if any) have you encountered when using the Kit?

Do you have any suggestions on how the Kit could be improved?

Have you received any comments from your pupils on the lessons and activities proposed in the Kit?

Was the Kit used within the framework of the regular school curricula, or was it an extra-curricular activity?

school curricula extra-curricular activity both

Have other colleagues expressed a wish to receive the Desertification Kit? (Please print their names and addresses)

2. Detailed evaluation
of the different elements of the kit

Please rate the quality of the materials provided from 0 (poor) to 10 (excellent) on the utility of the documents used in class, the relevance of the proposed class activities and the suitability of the kit to the level of your pupils and to the socio-cultural realities of your country, on the following elements:

	quality of the materials	suitability in class	proposed activities	relevance to your country
Teachers guide				
Case studies				
Cartoon *"The School Where the Magic Tree Grows"*				
Cartoon *"No Rug is Big Enough to Sweep the Desert Under"*				
Poster				

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