A Resource for Teachers

Soils and Us

Environment Waikato
REGIONAL COUNCIL

Contents

About Soils and Us

What is the Soils and Us Resource Unit?

The *Soils and Us* resource unit is an environmental education unit designed for levels two to four that focuses on the relationship between people and soil resources in the Waikato Region. As an environmental education unit it seeks to cover all the facets of environmental education outlined in the *'Guidelines for Environmental Education in New Zealand'* (Ministry of Education, 1999).

In this unit there are three key dimensions of environmental education:

- Education *in* the environment - using field studies and other outdoor activties to increase knowledge and skill development
- Education *about* the environment - providing information about environmental phenomena and processes
- Education *for* the environment - activities which influence environmental outcomes.

Throughout the unit are the five key aims of environmental education:

1. **Awareness and sensitivity** to the environment and related issues.
2. **Knowledge and understanding** of the environment and the effect of people on it.
3. **Attitudes and values** that reflect concern for the environment.
4. **Skills** in identifying, investigating and problem solving for environmental issues.
5. A sense of responsibility through **participation and action** as individuals or members of groups, whanau or iwi, in addressing environmental issues.

Environmental education in New Zealand also examines **interdependence, sustainability, biodiversity and personal and social responsibility for action.** These concepts underpin many of the issues discussed in this unit and highlight how our actions often upset natural balance in the environment. The unit also investigates how our actions might need to change if we are to live in balance with nature.

Environmental Education is an investment in our future. It is widely recognised that successful environmental education achieves long-term changes in knowledge and attitudes, develops strong environmental ethics and encourages environmentally responsible behaviour.

Because environmental education is about people making a difference to the world we live in, the processes and methods used to teach the key ideas in this unit will have a major influence on the attitudes and behaviours that students develop. Using a hands-on, action-oriented approach allows students to be involved in a style of learning that encourages creative and critical thinking, open questioning and long-term understanding of issues and concepts. This unit also deals with local relevant issues related to soil use and quality, and contains up-to-date, scientifically correct information.

As a result, this unit incorporates knowledge objectives from the seven essential learning areas, and many of the essential skills, attitudes and values outlined in the *New Zealand Curriculum Framework*. Being multi-levelled, the unit is suitable for composite classes and can be adapted for use with level five students, up to year 10.

Why is Environment Waikato involved in Environmental Education?

Environment Waikato (Waikato Regional Council) is responsible for the sustainable management of the Region's natural and physical resources. The best means of achieving this is with the understanding, co-operation and partnership of the people who live in the Waikato.

Environment Waikato's role in managing our Region's soil is mostly concerned with the issues related to land use. Different soils have different characteristics and are located in different micro-climates (with varying amounts of rainfall and sunshine). This results in different limitations on what they can be used for.

As the population and development of the Waikato Region increases, so too will the intensity of land use and its effect on the environment. The Waikato Region covers 25,000km^2 of land. Over the last 150 years people have made massive changes to this land - forests have been cleared and wetlands drained. We haven't always understood the effects of what we have done or managed these effects well.

Increased stocking rates, traffic density, use of herbicides and pesticides and forest harvesting regimes can all contribute to loss of soil quality and quantity in our Region.

Environment Waikato aims to manage the soil resources in the Waikato in a sustainable way for the social, cultural and economic well-being of present

and future generations in the Waikato. Environmental education is the principal non-regulatory means the Council uses to implement its policies and these environmental aims.

Toitu te whenua, whatua ngarongaro te tangata
People come and go, the land remains

How to use this unit

Environmental Education is about working with people to help them develop life-long behaviours and attitudes that will enable the Region's natural resources to be used for generations to come. Successful learning occurs in an environment where the concepts and knowledge are relevant to the learner. This unit is not designed to be a 'fill-in' to complete curriculum requirements.

Who is it for?

The Soils and Us unit is a resource for teachers and students who would like to learn more about their environment. They may need to learn more about soils as a consequence of natural phenomena such as major storm or flood events, which result in slips and slumps, property damage and stock and pasture loss such as occurred in the Manawatu area in 2004. Or it may be a response to community concern for the increasing levels of sediments in a harbour or estuary. Whatever the trigger, the value of this unit is going to be greatly enhanced if the students already have some prior motivation to learn more about the soils around them. It is in this context that life-long attitudes and behaviours can be established and true environmental education begins.

The Environmental Education guidelines for schools, encourages teachers to educate in, about and for the environment. This unit has been completed with these goals in mind. All the activities are springboards to get you and your students started on the topic of soil. All of the activities and information are free for you to use, photocopy and enhance to meet the educational requirements of your students. We are eager to hear about your environmental education actions and are available to provide technical and informational support.

You don't have to be an 'expert' to use this kit

A second aim of this unit is to provide teachers with technical information about soils and their characteristics in the Waikato Region so that personal levels of teacher knowledge are not a limiting factor in students learning about soils. If more detailed information is required you can either use the references listed at the back of this resource or contact the Environmental Education Officer for Schools at Environment Waikato.

Soil – more than a load of dirt

Soils form the foundation for life on earth. Along with air and water, soil is one of the most precious natural resources on earth. Without soil, we wouldn't have land plants, and without land plants we wouldn't have our land-based animals.

Soils are the mainstay of our economy in New Zealand. Cattle, sheep, goats, deer and horses graze the grass that grows on our rich soils, and we grow our fruit, vegetables, crops and trees in them. We build our houses, offices, factories, roads, railways and schools on soil and we play our games on them.

However, we are losing soil from our earth faster then it is being created. We must protect and conserve our soils from erosion and carefully manage and sustain them for life on earth, now and in the future.

What is soil?

Soil is a mixture of:

- **mineral particles**, such as sand grains, which are formed from weathered down rock
- **organic matte**r, which is formed from plant and animal matter that has decomposed and broken down to form humus or compost
- **water and air**, which makes up about half the volume of good quality soil. Water and air sit in the spaces and pores between and through the soil particles.

How is soil formed?

Five soil-forming factors are involved in the formation of soil: parent material, time, climate, topography and living organisms.

1. Parent material

'Parent material' refers to the type of rock or material from which the soil has developed. Some examples of parent materials in New Zealand include:

- weathered rock, such as sandstones, mudstones, limestones and lava flows volcanic rock
- peat deposits
- volcanic tephra (ash) from eruptions
- loess (windblown particles)
- glacial drift (transported by glaciers)
- alluvium (transported and deposited by rivers and floods).

2. Time

The amount of time it takes for soil to develop varies from place to place. Factors causing this variation can include the type of parent material present, climate and the type and rate of decay of organic matter. However, soil generally needs about 100,000 years to fully develop.

Soils that develop on young parent material are generally shallower than those on much older parent material. Young parent materials in New Zealand include lava and tephra from Mount Tarawera's most recent eruption in 1884, sand dunes in the Bay of Plenty deposited about 10,000 years ago and alluvium deposited after Lake Taupo erupted in 186 AD.

3. Climate

Climate, in particular temperature and rainfall, influences soil formation. Water is required for the chemical and physical weathering of rock and materials that form soil, and temperature affects the rate and effects of weathering. Therefore, warmer temperatures usually result in rocks weathering more quickly.

4. Topography

The natural shape and 'lie' of the land influences soil depth. Land topography influences the movement of water across the landscape and the patterns of erosion that occur. Soils on steep slopes are generally shallower than soils formed on flatter land.

5. Living Organisms

The living organisms that inhabit the soil are responsible for the cycling of nutrients. Organisms in soil include insect larvae, worms and micro-organisms (such as bacteria and fungi). They are able to break down organic material and make nutrients available to plants.

Describing different soil types

In order to study soils we need to be able to describe the different types as accurately as possible. A number of soil properties have been identified to help us describe and understand different soil types. Different soils have different properties. By having a better understanding of these properties, we can better match different land uses with different soil types.

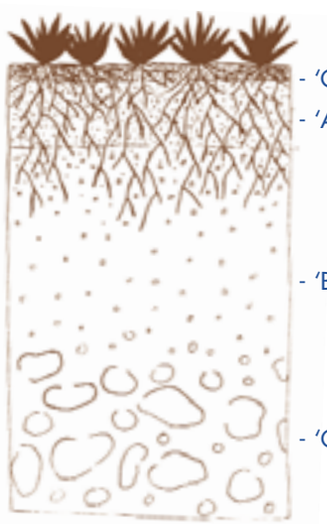
The best way to describe and examine a soil is to either dig a soil pit (deep hole) or choose a safe road cutting that shows the different layers (horizons) that extend down to the parent material.

This vertical section of soil through all its horizons is known as the soil profile.

The study of a soil profile and its individual horizons is made by describing some or all of the following soil properties: soil horizons, soil colour, soil texture, soil structure and soil consistence properties.

Soil horizons

By looking at a cutting or cross-section of a soil profile you'll see one or more soil layers or 'horizons'. These are made up of materials that differ from the underlying rock or parent material.



There are four main soil horizons that we will be investigating in this kit. Each horizon has a symbol that is used in profile description to indicate the general nature of the horizon and its relationship to other horizons. The horizons in descending order, from the top to bottom of a soil profile are:

- 'O' horizon - very top layer of topsoil, mostly made up of organic matter such as leaves.
- 'A' horizon - dark, rich layer of topsoil. This is the most important horizon in terms of growing plants.
- 'B' horizon - the subsoil. It is usually a brighter colour and more clayey than the topsoil.
- 'C' horizon - weathered parent material.

Soil colour

Soil colour is the most obvious and easily determined soil characteristic. Generally topsoils are brown to black in colour. The subsoils and parent materials that lie beneath topsoil can be a spectacular range of colours. Look out for orange, red and blue clays in road cuttings, especially around the Coromandel Peninsula.

Soil texture

Soil texture describes the proportions of sand, silt and clay particles in the soil. Rub some soil between your fingers. If the soil feels gritty it is a sandy soil, if it feels slippery it is a silty soil and if it feels sticky then it is a clay soil.

Soil structure

Soil structure is formed when particles of sand, silt and clay cluster together into various shapes. These are called 'aggregates' or 'peds'. Aggregates are formed by earthworms burrowing and plant roots expanding and growing in the soil. Aggregates can form into different shapes, and are classified according to their shapes, for example plate-like (flat lying plates), prism-like (vertical columns), block-like (blocky or nutty) and spheroid-like (granular or crumb shaped).

Soil consistence properties

Soil consistence properties include soil strength, plasticity and stickiness. They are measured with different moisture contents present in the soil.

Other properties

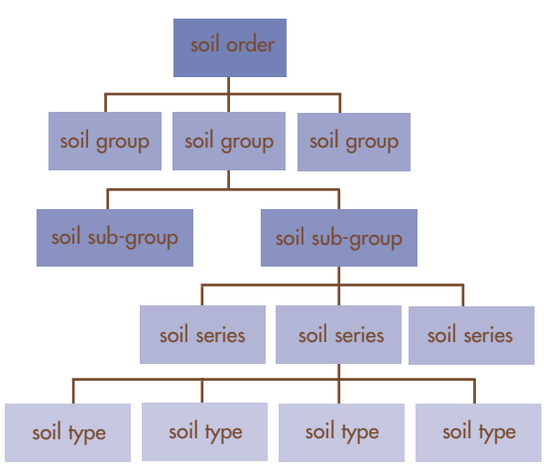
Other soil properties include soil porosity, bulk density of soil, soil reaction, soil organic matter, soil thickness and soil depth.

Soil classification and soil mapping

Different soil types make up the basic units of soil mapping. The units are identified by both geographic (location) names and the textural class of their topsoil (the 'A' horizon). For example 'Hamilton clay loam' is a soil found on the hills of Hamilton City and the surrounding hills within the Hamilton Basin.

Classifying soils can be a difficult task. Because different soils form a continuous cover over the land, there is rarely a distinct cut-off point where one soil ends and another begins. Often there will be a gradual change in soil type.

There are at least 2,000 different soil types in New Zealand. These are all put into a classification system that recognises 15 soil 'orders'. Soil orders are subdivided into different soil groups, which are in turn subdivided into different soil sub-groups. Soil sub-groups are sub-divided into different soil series, and soil series are sub-divided into the different soil types.



The following soil orders can be found in the Waikato Region:

Granular soils

This is a group of strongly weathered clayey soils developed mainly from tephra (volcanic ash). They can be found on the easy-rolling to moderately steep hills of the Waikato Basin.

Brown soils

This is the most common soil order found in New Zealand. These soils are usually found on sedimentary rocks. However, in the Waikato Region a large proportion of sedimentary rocks are covered by tephra. Brown soils can be found in areas where there is little risk of summer drought and winter waterlogging.

Gley Soils

Gley soils are poorly drained soils that occur in low-lying areas affected by waterlogging. They usually have light grey coloured subsoils, high ground water tables, shallow potential rooting depth for plants and relatively high bulk density.

Large areas of these soils have been artificially drained to support agricultural land, and require special management procedures. They are prone to damage by livestock, especially in the wetter winter months. The water saturated conditions of these soils means there is little oxygen available, making it difficult for soils animals such as worms to live in them.

Organic soils

Peat soils act as giant sponges in the landscape and can hold up to 20 times their weight in water. They formed in the partly decomposed remains of wetland plants that accumulated for thousands of years in the lowland depressions of the Waikato Basin. Due to their organic make up and waterlogging they are extremely acid and have low nutrient reserves. However, today only a small proportion of these areas remain in their original state as vast areas of them have been drained and limed to establish highly productive pastures that support large dairy herds. With further careful control of the watertable, crops such as potatoes, onions, maize and blueberries can also be grown successfully.

Recent soils

These soils have only minimal soil development, but usually have distinct topsoils. The most common recent soils are those of the flood plains, which regularly receive inputs of new sediment after flooding. Where these soils have a loamy texture they are some of the most fertile and versatile soils in the Region, especially where they have been protected by stop-banks.

Pumice soils

Pumice soils are mostly derived from the Taupo eruption of about 186 AD. They have relatively shallow topsoils with sandy or gravelly texture, dominated by pumice or pumice sand. Drainage of excess water is rapid but they are capable of storing large amounts of water for plants. Pumice soils occur in tephras ranging from 700 to 3,500 years old. Pumice soils are susceptible to erosion if disturbed but are generally resistant to livestock treading. They are low in nutrients and likely to be deficient in trace elements, especially cobalt.

Allophanic soils

These soils are dominated by allophane, a clay mineral with a large surface area, which coats the sand and silt grains in the soil. They have low bulk density and are therefore ideal for root growth with topsoils that are also stable and resistant to the impact of machinery. Allophane soils are associated with relatively young (less than 20,000 years old) tephras that have erupted from the Taupo Volcanic Zone.

Podzol soils

Podzol soils are strongly acid and usually have a bleached horizon immediately beneath the topsoil. They occur in areas of high rainfall and are usually associated with forest trees and an acidic plant litter. They are mainly formed on silica-rich rocks. The 'B' horizon is often compacted with slow permeability and limited root depth for plants. Podzols have low natural fertility, low base saturation and low biological activity.

Soils of the Waikato Region

The Waikato Region has a wide variety of different soil types. Different soil forming factors in different parts of the Region have resulted in different soils forming. Soils in the Waikato Region have formed from:

- volcanic ash (tephra)
- pumice
- volcanic rock
- alluvium deposits laid down by the ancestral Waikato River system before it entrenched into its present day channel
- organic material - forming peat soils.

Soils have also formed on the steep hillsides from sedimentary rocks, and some soils have been modified by early Polynesian settlers - these are the Maori or Tamahere soils.

Maori or Tamahere soils

Maori have strong spiritual bonds to the land. Papatuanuku, the Earth Mother, provides unity and identity to her people and sustains them. Soils are an important cultural resource and are regarded as taonga (treasure) with the tangata whenua (local people) being the kaitiaki (guardians) of their taonga. Kumara gardens were an important source of food for Maori. Early Maori added gravel to the soil used for growing kumara and many of the borrow pits (circular depressions with raised rims) are still visible today especially on the terraces bordering the Waikato River.

Soils of the Taupo and Central Plateau area

These soils are volcanic in origin and made up almost entirely of pumice and tephra. They are geologically young, as many volcanic eruptions over the past 50,000 years have continually buried land surfaces with new layers of tephra. This process has resulted in the preservation of buried soils (paleosols) that can clearly be seen as dark bands in road cuttings in the area.

Soils of the Waikato Basin and surrounding hills

The Waikato Basin is surrounded by hills of the Hakarimata range to the west, the Hapuakohe and Hunua Ranges to the north, the Kaimai/Mamaku Range to the east and Pureora and Central Plateau to the south.

Scattered across the Basin are a number of eroded basalt/andesite volcanoes, including Pirongia, Kakepuku and Maungatautari, which were active about two million years ago. In the middle of the Basin are younger more andesitic volcanoes, for example, Te Tapui and Maungakawa. On the eastern boundary of the Basin is the Kaimai/Mamaku range, comprising of ignimbrite and rhyolite volcanics.

The other major landform that has shaped soils of the Waikato Basin has been the path of the Waikato River. Until about 20,000 years ago the Waikato River flowed out through the Hinuera gap and into the Firth of Thames. Around that time it became choked with volcanic debris, probably due to a large volcanic eruption at that time. The river then cut through at Piarere and changed direction to flow north through Cambridge and into the Hamilton Basin. Over the next 5,000 years it built up a flood plain in the middle of the Basin depositing volcanic material and sediments as it continually changed its course. The alluvium, comprising of sands many metres thick, buried many of the smaller hills as it built up over time.

About 12,000 years ago the Waikato River began to develop into its present course. About 2,000 years ago, Taupo erupted enormous amounts of pumice. Some of this pumice was transported down the Waikato River and overflowed the river banks on either side to form a low terrace of Taupo pumice that can be traced from Cambridge down river to Rangiriri. The National Fielday site at Mystery Creek south of Hamilton is located on this terrace.

The great variety of geology, landform and parent materials has resulted in the formation of many different soil types in the Waikato Basin. They range from coarse sandy, sticky clay to peaty textures, from free draining to waterlogged and from fertile to infertile soils that have limited productive use.

Hauraki Plains

The Hauraki Plains lie just above sea level and are flanked by hills to the west and east. Depressions in the land have been in filled over time with alluvium and large areas of organic peat that have accumulated from the middle of the Plains towards the northern boundary with the Firth of Thames. Large areas of peatlands have been developed for dairy farming by draining and liming and also for flood protection schemes. Peat soils are naturally acid and wet but if carefully managed (with the addition of lime and drained) can grow very productive pasture.

Lower Waikato

Hamilton Ash is the most significant soil forming material on the rolling land from Hamilton to the Bombay Hills. This tephra was deposited about 150,000 years ago in a series of volcanic eruptions probably from the Taupo Volcanic Zone. The resulting soils are loamy clays that support good pasturelands. The lower lying lands support peat soils and are limited by poor drainage.

Coromandel Peninsula

The soils on the Coromandel Peninsula are significantly different from other Waikato soils. They are much older and have developed on older volcanic and sedimentary rocks. Coromandel soils more closely resemble the soils of Northland, as both areas have been covered by kauri/podocarp/broadleaf forests, which produced deep layers of highly acidic leaf litter and kauri gum. The soils are largely podzolised and gleyed (poorly drained) and of poor quality.

Soil quality (soil health) and land use in the Waikato Region

Soil quality (or soil health) defines whether soils are in good condition for their current use. Soils are not created equally, and vary greatly in their physical, chemical and biological characteristics. Different soils are suited to different uses. Where a soil's characteristics match those needed for its current use, then we can say that it is of good quality.

Soil quality can be measured by assessing:

- the **fertility** of the soil, for example, what soil nutrients are available
- the **amount of humus** (organic matter) in the soil
- **physical condition**, for example,
  - whether it has become compacted by farm machinery or animals
  - whether it contains **beneficial soil life**, for example, earthworms and bacteria.

Soil fertility

The amount and balance of soil nutrients present in soil can determine what that soil is best used for. What the soil is being used for determines soil quality. Different crops, plants and trees require different amounts and ratios of soil nutrients for them to grow their best. The main soil nutrients required by plants are nitrogen, phosphorus and potassium.

A soil with low soil phosphate levels may be excellent for growing native trees, because they have adapted to poor soils. In this case the soil would be of good quality. However, the same soil would be totally inadequate for pastoral farming or horticulture, which need very fertile soil. In this case the soil would be of poor quality.

When a land use, such as pastoral framing or horticulture, is undertaken on soil that does not contain enough nutrients to sustain this use, fertiliser is often added. However, applying too much fertiliser can have negative affects on the environment. The application of too much fertiliser for a particular plant to use may result in leaching and losses to waterways, where the nutrients then feed the growth of waterweeds, resulting in polluted streams and rivers.

Measuring soil quality

Maintaining excellent soil quality is good for the environment but it requires skill and experience from the soil and land manager to get it right. Environment Waikato began to measure soil quality of key land use types in the Waikato Region in 1996. Monitoring shows that 80 percent of the Region's soils are of satisfactory quality for their current use. However, about 18 percent of land used for pastoral farming has soil quality that is of concern. Most of this 18 percent was located on dairy farms, which have problems with soil compaction and excessively high soil fertility.

Table 1: Land use types and soil combinations in the Waikato Region

Land use	Percentage of Regional land area in each soil type				
	Volcanic soil	Pumice soil	Peat soil	Sedimentary soil	All soil classes
Pastoral farming	15.4	11.5	3.5	27.9	58.3
Plantation forestry	0.3	8.4	0.0	3.6	12.3
Horticulture and cropping	0.1	0.1	0.0	0.1	0.3
Indigenous vegetation	2.9	5.0	0.1	18.7	26.7
All land uses	18.7	25.0	3.6	50.3	97.6

The table shows that nearly half the total area of pastoral farming in the Waikato Region is carried out on sedimentary soil. This is the most extensive land use in the Region. The majority of plantation forestry in our Region is on pumice soil. Horticulture and cropping only occupies about 0.3 percent of our Region's land area. Horticulture and cropping predominantly occurs on volcanic, pumice and sedimentary soil. Indigenous forest can be found on all soil types, however, most of it is found on sedimentary soil.

What affects soil quality?

As the world's population of five billion people continues to grow, our survival on earth is increasingly dependent on conserving, preserving and sustaining soils in order to grow the crops that animals and people depend on.

Unfortunately, many of our activities have the potential to harm and destroy soil. Poor agricultural, horticultural and forestry practices can lead to pollution of soil and waterways, to loss of good soil structure through compaction and to loss of soil on the hill slopes through removal of trees and subsequent erosion. Industrial activities can pollute our soils by dumping effluent onto the soil at greater rates than the soil can 'process' it. To ensure that soil is available for future generations, it is vital that we recognise the delicate balance that exists in nature and play our part in protecting and sustaining it.

Generally speaking there are three main threats to our soils:

- erosion
- compaction
- contamination.

Soil erosion

Soil erosion is the removal or loss of soil from the land. Soil erosion can either be a natural process or a process accelerated by inappropriate human activity.

Natural sources of soil erosion

Natural soil erosion can occur from wind, gravity, heavy rainfall, streams and rivers, the sea, freezing and thawing and glaciers.

Wind

When the soil is dry and bare, small particles of soil are picked up and carried away by the wind, sometimes for thousands of kilometres. Soil that is bare from cultivation is particularly prone to wind erosion.

Gravity

Soil gradually moves downhill under the influence of gravity. This slow and continuous process of soil creep can be seen as small terraces on grassed hillsides.

Heavy rainfall

Heavy rainfall falling on hill slopes soaks into and saturates the soil. The extra weight of water in the soil weakens it until it can fail and slip down the slope causing scars of bare earth, mudflows and slumps that can accumulate at the bottom of slopes as colluvium (heaps of mixed up soil). Raindrops landing on bare soil can also wash soil off slopes.

Streams and rivers

Flowing water cuts valleys into the land and erodes the beds and banks of the streams and rivers picking up colluvium and sediments and soil, making valleys deeper and wider. Streams and rivers transport vast quantities of this material out onto flood plains and eventually out into the sea. In the Manawatu floods of 2004, scientists measured the quantities of eroded sediments transported by the Manawatu River. At one point, the scientists measured about 180 truckloads of sediment being washed away per minute.

Sea

The relentless battering of waves against coastal land and cliffs grinds rocks into sand and cuts back the dunes and cliffs. Water currents transport the sand along the coast until it is deposited in calmer waters, building up sandbars and sometimes choking the entrances of estuaries and harbours.

Freezing and thawing

Freezing of the land in winter and subsequent thawing in spring shatters rocks, breaking them down into fragments, while melting snow carries particles downhill.

Glaciers

Glaciers are major agents of erosion. They grind and scrape soil and rock off the land as they slowly advance over it. When glaciers retreat they leave bare polished rock and great trails of a rock and soil mixture that drops out of the glacier as it melts.

Human-induced soil erosion

Major soil loss and erosion problems have been caused over the years in New Zealand by clearing native and exotic forests off hill-slopes in order to grow pasture and plant exotic pine trees.

The roots of trees and vegetation normally provide protection against erosion by anchoring and strengthening steep land. However, when they are removed, there is little to hold soil onto steep land, resulting in erosion and slips.

When the hills are cleared 'accelerated erosion' can occur, resulting in severe loss of soil, pasture and trees coupled with sedimentation problems in the valleys, streams and flood plains.

Soil conservation programmes – what Environment Waikato is doing

Environment Waikato reduces erosion through large-scale soil conservation schemes. With the support of Government grants, Environment Waikato and its predecessors implemented soil conservation programmes. These programmes focus on preventing erosion and sedimentation of waterways.

Soil conservation programmes include wide-ranging catchment control schemes and 500 separate property plans. Land Improvement Agreements, between landowners and Environment Waikato, set out the future maintenance and management needs for most of the soil conservation work.

Actions to help conserve the Region's soils include tree planting on hills and stream banks, retiring land, draining land, isolating springs, fencing off gully areas and waterways to prevent stock access.

Soil compaction

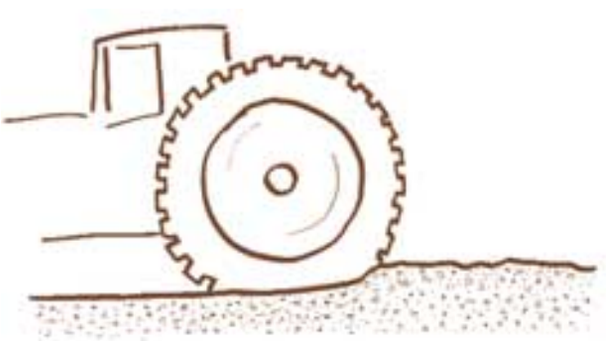
Soil compaction occurs when soil aggregates break down, and spaces in the soil are reduced. There are some instances when natural soil compaction can occur. However, human-induced soil compaction is more common in our Region.

Natural soil compaction

Natural soil compaction can occur during the formation of some soils. In these soils compact layers form where iron pans and clay pans occur. Where clay pans are present, soil is compressed to a smaller volume, making it more dense.

Human-induced soil compaction

Human-induced soil compaction is much more common than natural soil compaction and can be a serious problem in the Waikato Region. Soil gets compacted by the use of heavy wheeled traffic and by livestock treading on the soil, especially when the soil is wet during the wetter winter months.



When livestock intensively trample wet soil, the soil aggregates break down and spaces in the soil are reduced. This process is called pugging. Soil compaction reduces the number and the size of the large soil pores and increases the soil density. Drainage of excess water through the soil is reduced and the soil is more likely to become waterlogged resulting in poor plant growth and a reduction in pasture yield.

Soil pugging and compaction can be minimised on farms by:

- grazing wetter paddocks before the wet season
- ensuring there is good pasture cover, which gives better protection against pugging
- grazing land that is at risk of pugging with young stock (that are lighter than fully grown animals)
- shifting stock onto loafing pads after three hours of grazing
- using the farm bike rather than heavy tractors
- varying the depth of cultivation annually to avoid a plough pan from forming
- avoiding cultivation when the soil is wet
- breaking up compacted layers by sub-soiling or aerating.

Contamination

Soil gets contaminated when hazardous substances (such as pesticides) are present in concentrations above naturally occurring local background levels. They are considered contaminated sites when the contamination is likely to pose an immediate or long-term risk to the environment and/or human health.

Contamination can occur as a result of natural disasters such as flooding, earthquakes or volcanic eruptions. However, contamination is usually thought of as a result of people's activities, such as chemical spills or addition of too much herbicide or pesticide or fertiliser to the soil. Contamination of the soils can result in the pollution of rivers and lakes.

Chemicals and fertilisers, such as nitrates and phosphates, can:

- leach through soil into ground water, where they make their way to streams and rivers
- wash off the soil surface into drains, streams and wetlands.

Whether a soil is contaminated actually depends on social, scientific and environmental factors and what or who is in danger if exposed to the contamination. For example, farmers in the early 1960s applied DDT super phosphate on their farms to control grass grubs. However, in the mid 1960s DDT was banned from use because of its risk to human health. The level of DDT in the soil on those farms today is in many cases still above safe levels for dairy farming. However, the farms can continue to be used for cropping and sheep farming.

From about 1880 until the 1950s sheep farmers dipped their sheep with arsenic based chemicals to control external parasites, such as lice and keds. Arsenic based sprays were also used in apple orchards to control insects until they were banned in the 1950s. Although these chemicals have not been used since those times their spillage and disposal have left long lasting toxic residues in the soils around dip sites and in the soils of some orchards.

Exposure to these chemicals either by eating soil, breathing in dust or by eating vegetables and fruit grown in these soils is hazardous to people, animals and the ecosystem. Toxic soil sites are gradually being identified and cleared up in our Region by using various remediation options.

Looking after your soil

Maintaining soil quality is not only good for the environment but it also improves plant growth and production from agriculture and horticulture, which in turn makes these businesses more environmentally and financially sustainable.

There are four main ways to ensure you have healthy soil:

1. Make sure the fertility level of your soil is right for what you are using the soil for. Do regular soil tests to check soil nutrient levels. Find out about nutrient budgets, which are used to check that the right amount of fertiliser is being applied at the right time of year for production needs. Avoid leaching of nutrients by not applying excess amounts of fertiliser.
2. Make sure your soil has the right amount of organic material. Organic matter helps the soil to store nutrients and water and improves its structure. Apply compost, organic manure and effluent to the soil to increase organic matter. Increase the organic matter in cropping soil by growing annual cover crops between productive crops, which can then be mulched into the ground. Reduce cultivation and soil disturbance to minimise the loss of organic matter.
3. Look after the soil structure by making sure it doesn't get compacted by machinery or animals.
4. Keep your soil 'alive' by making sure soil organisms have a healthy, contaminant-free environment. Good quality soils provide a healthy environment for such soil life as fungi, bacteria and other micro-organisms that are so important for making soil nutrients available for plant roots; they also recycle dead plant material into humus. Earthworms distribute this organic matter through the soil profile and improve soil structure, aeration and drainage.