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# 20 Indigenous Māori Values, Perspectives, and Knowledge of Soils in Aotearoa-New Zealand

## *B. Māori Use and Knowledge of Soils over Time*

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### 20.1 INTRODUCTION

Before Polynesian arrival (~1200 AD), about 85% of Aotearoa-New Zealand (NZ) was covered in indigenous or native forest (Ausseil et al. 2011). At this time, areas not in forest included glacial alpine environments, alpine herbaceous areas, high tussock-lands, and extensive sand country and wetlands. By the mid-eighteenth century, this indigenous forest area had reduced to about 52% of

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the total area of NZ (Ausseil et al. 2011), following large-scale burning of forests, much attributed to an early Polynesian hunting era from ~1000 to 1300 AD (e.g., moa and native bird hunters), and additional and repeated clearance of indigenous forest and scrub particularly on lower mountain slopes. Historically, these slopes were converted and harvested by Māori to extensive bracken fern (*Pteridium esculentum*, *Pteridium aquilinum*), along with large tracts of regenerating tea tree or mānuka (*Leptospermum scoparium*) and kānuka (*Kunzea ericoides*). The bracken fern provided starch food crops, such as breads/cakes, while the mixed mānuka/kānuka scrub provided tea, wood for cooking fires, framing for housing, and medicinal extracts. Fires lit by early Polynesians destroyed large areas of indigenous temperate evergreen conifer (podocarp—largely from the *Podocarpus* genus)—broadleaved (hardwoods) forest in the South Island and drier lowlands, particularly in the eastern regions of both the North and South Islands of NZ. However, in many *iwi/hapū* tribal regions of NZ, native forest stayed considerably intact into the nineteenth century before European colonization converted a large proportion of indigenous forest into an extensive pastoral landscape or grassland. The pioneering and development phase between 1860 and 1950 saw rapid and extensive deforestation of indigenous forest through clear-felling and burning, draining of wetlands, with the conversion to farmland and plantation forestry. By the mid- to late-1900s, native forest only covered 23% of NZ's total land area of 26 million km<sup>2</sup> (Ausseil et al. 2011).

Early Māori (from about 1500 to the 1700s) came to rely increasingly on the soil resource, and learnt how to manipulate it to derive maximum benefit. Activity surrounding food production or harvesting was structured with a strong relationship to the gods, stars, moon, and heavens for many crops (Best 1924, 1925; Roskrige 2011, 2012). This became particularly advanced with the advent of the Māori horticulturalist, who developed an acute awareness of different types of soils, and knowledge of how soils could be modified within regional climates to improve crop suitability, yield, growth, condition, survival rate, and how to expand the areas available for cropping (Roskrige 2011, 2012).

From about 1600 AD, Māori were developing a greater sustainability ethic and greater environmental knowledge because of declining natural resource areas and degrading resources. Māori agriculture became prolific from about 1700 and developed extensively in lowland areas in the 1800s with the cultivation of Polynesian and European food plants.

The following sections discuss developments in the uses and knowledge of soils by Māori with time in eras ranging from traditional (Section 20.2), time of first European contact (Section 20.3), and recent times (Section 20.4). These are discussed in the context of Māori beliefs and concepts of soils, the environment, and land that are outlined in our earlier chapter in this book (Harmsworth and Roskrige 2014), which also contains a glossary of relevant Māori terms.

## 20.2 SOILS AND THEIR USES IN PRE-EUROPEAN TIMES

### 20.2.1 TRADITIONAL USES FOR SOILS

Traditionally, soils had a wide range of uses. One important use was for organic dyes and these were applied to a range of materials, for example, clothing made from fibers, wood products, instruments, insides of *whare* (houses), and art designs. Many dyes were sourced from clays, muds, organic soils, peats, and plants typically found in wetter areas such as muds or *para* of a swamp. They included Parapara, a soft mud used for dyeing flax fiber; Paraharaha, a black mud used for dyeing flax fiber; Pukepoto, dark blue earth used as pigment, found in swamps; Tareha, an ochre; Kokowai, a red ochre; Te uku, a white clay; Uku, a blue clay; and Kura, a red ochre. Paru, a mud dye rich in iron salts, was unfortunately acidic and in later years led to progressive breakdown and damage of cloaks and garments.

Different colors were derived from muds mixed with plant materials and oils, such as

- Black: Hinau (*Elaeocarpus dentatus*) bark soaked in dark-colored mud; Harakeke flax fiber was often dyed black

- Reddish-brown: Tanekaha (*Phyllocladus trichomanoides*) bark, pounded, soaked in water, fiber immersed in the water
- Blue black: Tupakihi (*Coriaria*), Whawhakou (*Eugenia*), Mako (*Aristotelia*)
- Yellow: Raurekau (*Coprosma*)
- Yellow: Tanekaha (*Phyllocladus trichomanoides*) bark and a small plant, Kakariki
- Brownish-yellow: Puriri (*Vitex lucens*) mixed with Tanekaha (*Phyllocladus trichomanoides*)
- Red paint: (shark liver oil with kōkōwai (iron oxide stained earth), kōkōwai—red ochre
- Black: charcoal, soot often mixed with fish oil
- White: halloysite, kaolinite white clays

Clays had many uses. Red ochre, found in clay, was smeared on people's faces and bodies as a sign of chiefly status. It was also used on carved items such as *waka* (canoes) or houses, and even on the bones of the dead. Kōkōwai, one type of red ochre, was rolled into balls, baked in fire or hot ashes, and mixed with shark oil to form dyes. Tākou was another type of red ochre. Red ochre, found in clay, was baked in a fire and mixed with shark oil. Taioma, a white paint, was created by burning and pulverizing the clay, and then mixing it with oil. Pukepoto was a cobalt blue color found in clay. Uku, a white or bluish clay with a soapy consistency and feel, was used for washing. Food was sometimes cooked by enveloping it in clay mixed with water and placing it in a hot fire.

## 20.2.2 INDIGENOUS FOREST AND SCRUB PLANTS CULTIVATED BY MĀORI

From around 1400, Māori increasingly modified soils within forest and scrubland (shrubland) and brought wild plant variants into a kind of cultivation (Best 1925; Buck 1950; Challis 1978; Leach 1984; Park 1995; King 2003; Roskrige 2012). These plants became dominant in early stages of revegetation in cleared and modified sites, providing roots, shoots, leaves, and rhizomes, which, when mixed together, became a major part of the Māori diet. Traditional Māori vegetable foods before the nineteenth century included numerous edible ferns, raupō (*Typha augustifolia*), harakeke—a flax (*Phormium tenax*), and nikau palm (*Rhopalostylis sapida*). Probably the most important food was aruhe, rauaruhe rahurahu, rarahu or bracken fern (*Pteridium esculentum*, *Pteridium aquilinum*), a starchy food that became a staple diet (Shawcross 1967; Challis 1991). The aruhe root was dug out with a stick (a *koo*), harvested, cleaned, dried, soaked, dried again, and beaten or ground to soften it. Areas that produced good aruhe would be burnt in August every 3–5 years to prevent mānuka (*Leptospermum scoparium*) and kānuka (*Kunzea ericoides*) shrubland and other small trees from taking over. The burning, which was said to improve the flavor of the bracken fern roots, was very much controlled and seasonal. Other wild species utilized by Māori included ti kouka—cabbage tree species (*Cordyline terminalis*, *Cordyline australis*), a hardier variety ti pore (*Cordyline stricta*), many podocarp species, the berries from *Coprosma* species, Ngaio (*Myoporum laetum*), kawakawa (*Macropiper excelsum*), fuschia species (e.g., *Fuchsia excorticata*), tutu (*Coriariaceae*), mainly used for juice, hīnau (*Elaeocarpus dentatus*), tawa (*Beilschmiedia tawa*), and karaka (*Corynocarpus laevigatus*). A wide variety of forest and cultivated plants were also used for Māori medicines (Riley 1994).

## 20.3 SOILS AND THEIR USES AROUND THE TIME OF FIRST EUROPEAN CONTACT

### 20.3.1 SOILS FOR HORTICULTURE

At the time of the first European contact, Māori already recognized the soil properties and soil types that were most important for the establishment and management of gardens (Best 1925; Leach 1984; Keane 2011a,b). Climate, however, was an extremely important factor for horticulture. New Zealand, with relatively high rainfall, much lower temperatures, shorter seasons, and cold winter

seasons than the tropics and subtropics, meant that soils needed to be improved to compensate for the poorer climatic growing conditions.

In conjunction with the required conditions and management of crops, Māori knowledge and Māori taxonomy of soils advanced greatly (Hargreaves 1959, 1963; Macnab 1969; Clarke 1977; Leach 1984; Singleton 1988; Hewitt 1992; Furey 2006; Roskrige 2009, 2011). Māori naming and categorizing of soils was not a systematic taxonomy but apparently intended for the management of root crops. Soil properties and conditions in the temperate climate needed to be improved and many soils were modified accordingly to lift crop success and productivity and extend the range, both geographic/areal and climatic, in which crops could be grown (Clarke 1977; McFadgen 1980; Leach 1984; Singleton 1988; McKinnon et al. 1997; Roskrige 2009, 2011). The soil qualities emphasized most were coarse texture, friable consistence, and fertility (Hewitt 1992). The increasing use of Māori terms for soils and the classification of soils went hand in hand with advances Māori made in horticulture and the planting of crops to increase planting success and yields.

### 20.3.2 MĀORI HORTICULTURE

From the 1700s onwards, Māori acquired considerable horticultural and soils knowledge through trial and error (Best 1925; Taylor 1958; Jones 1984, 1986; Leach 1984, 1989; Mitchell and Mitchell 2004b; Horrocks et al. 2008). Agriculture and horticulture were essentially the same thing—subsistence farming of crops, managing natural resources for natural harvests, all in the absence of grazing animals (Keane 2011a,b; Roskrige 2012).

As horticultural knowledge grew, Māori became increasingly aware of the importance of soils, crop selection, crop cultivars, and microclimate, and were able to grow the subtropical sweet potato or kūmara (*Ipomoea batatas*—brought from South America and across to central Polynesia around 700 AD) to near the limit of its climatic tolerance. Some 80 varieties of kūmara were grown. Today's kūmara, hardier and more prolific than the original varieties, was introduced by Europeans.

The first crops were mostly tropical in origin and limited in climatic tolerance, and few were suited to the temperate climate of NZ. At first, these plants had a low survival rate. However, new crops became increasingly widespread in small localized gardens in forest clearings, and the staple diet for Māori between ~1600 to the late 1900s regularly included the kūmara (*Ipomoea batatas*), taewa (*Solanum tuberosum*, traditional potato varieties), taro (*Colocasia esculenta*), uwhi or yam (*Dioscorea* sp.), the hue or bottle gourd (*Lagenaria siceraria*, *Lagenaria vulgaris*); these were mainly grown on the soils of the coastal lowlands, floodplains, and low terraces of the North Island and particularly in the north of the South Island in sheltered valleys and plains (Best 1925; Hargreaves 1959; Macnab 1969; Challis 1978; Leach 1984; Molloy 1988; McKinnon et al. 1997; Mitchell and Mitchell 2004b; Furey 2006; Horrocks et al. 2008; WRC 2011; Roskrige 2012).

Māori horticultural practice adhered to elaborate *tikanga* (rules and custom) but was also focused on improving soil drainage and moisture retention, and increasing soil temperature to sustain warmth for crops. Sites for horticulture, therefore, were more sheltered, warmer, and on better-drained, friable soils. Māori seldom used any form of irrigation, so site and landform selection was paramount (Roskrige 2011). Māori also grew crops away from flood-prone areas and avoided foot slopes at the base of steep hills due to higher runoff. Māori cropping and horticulture was commonly located adjacent to and above river and stream terraces, and on raised coastal flats, warm-facing hillsides, and sheltered forest clearings forming suitable microclimates to grow crops. Locations were carefully selected to offer protection from the wind and reduce frost damage risk by providing cold air drainage and constant air movement (Jones 1986; Roskrige 2011). This resulted in slightly higher mean day and mean night temperatures and improved soil moisture retention. Crop rotation was also a common practice and repeated cropping was undertaken for no more than 3 years at most sites (Roskrige 2011).

### 20.3.2.1 Some Important Horticultural Practices Developed and Applied by Māori

The following practices, to ensure sustainable crop success, were identified by Roskruge (2012):

1. Crop rotation.
2. Controlled burning of fern lands to manage overcrowding and encourage vigorous regrowth and therefore edible fern root production and other regenerating weeds used as greens.
3. Crop storage mechanisms (both storage houses above ground and insulated storage pits below ground).
4. Sophisticated processes developed to transform poisonous or otherwise inedible plants to make them edible, for example, tutu (*Coriaria arborea*) juice had to be strained through finely woven bags to separate it from highly toxic seeds and stems.
5. Managing wild populations of particular plants for use as food, *rongoa* or various utility such as harakeke (flax) para fern or ti.
6. The role of ritual to ensure protection of crops and success. *Tauamata-atua* shrines or stones representing the Ātua Rongo-o-maraeroa were strategically placed and a section of the garden set aside for appeasement of the gods through the first harvest.

### 20.3.3 MATARIKI

Traditionally, Māori celebrated a good cropping year and then planned the New Year in the winter months of late May/June/early July, following the harvesting of the year's crops and the planning of new crops for the spring. Māori named this significant time of year Matariki (Tiny Eyes or Mata Ariki—Eyes of God), after the cluster of stars that appears in the pre-dawn sky over NZ to the northeast in late May or early June. Also known as the Pleiades system, Matariki is located at the bottom left of Orion's Belt. The cluster consists of over 500 stars—and usually 6–7 of these stars can be seen clearly to the naked eye. For most *iwi/hapū*, traditional Matariki celebrations, representing the end of one phase and the beginning of another, take place when the first new moon appears after the Matariki have risen and can be seen.

## 20.4 SOILS AND THEIR USES IN RECENT TIMES

### 20.4.1 MĀORI FOOD PRODUCTION

Between the eighteenth and early twentieth centuries Māori settlement throughout NZ became increasingly confined to lowland areas, such as river valleys, near river mouths, low terraces, floodplains, coastal terraces, coastal sand country and estuaries, and the edges of lakes. As the Māori population grew, settlements increased, and higher levels of food production and crop yield were needed. By around 1840, the Māori population was estimated at around 100,000–200,000 (King 2003), and Māori agriculture started to increase rapidly in area with a variety of new and old crops (Hargreaves 1959, 1963; Macnab 1969; Leach 1984; Singleton 1988; Roskruge 2011, 2012). Māori increasingly developed knowledge of pests and disease of crops (Roskruge et al. 2012). In the mid-1800s, kūmara was still an important part of the Māori diet, but other European crops (e.g., potatoes, maize, corn, hops) were becoming increasingly popular and economic. Maize was an enjoyed delicacy and by the early 1840s, major potato gardens were evident on many flats in the North and South Islands of NZ. “By 1860 large areas of land in the Waimea, Whakatu, Motueka, Marahau, Riwaka and Golden Bay were beginning to be cultivated with crops like corn and potatoes” (Challis 1978; Mitchell and Mitchell 2004a,b). Farming of animals became a common practice after about 1850 throughout many parts of NZ.

### 20.4.2 MĀORI SOIL CLASSIFICATION

Soil classification proper began in NZ with the Māori gardeners and horticulturalists (Best 1925; Hewitt 1992; Roskrige 2009) focused on food production. Terminology was often hierarchical, and became progressively more specific and descriptive at the *iwi/hapu* level, denoting specific and local knowledge of soil characteristics and cropping needs at certain localities and places. Māori terms of soil texture and soil types are given in Tables 20.1 and 20.2.

The list of traditional soil names (Table 20.2) was first compiled by Best (1925) and is not comprehensive. Many variations in names occur between regions and *iwi/hapū* groups. Based on location, and specific descriptions from *iwi/hapu* oral knowledge and literature, Table 20.3 has been compiled showing the “best fit” Māori correlation to the modern NZ soil classification (Hewitt 1998).

### 20.4.3 IMPROVING SOILS FOR CROPPING AND HORTICULTURE

Māori realized that to benefit horticulture they had to improve soils in various ways (Best 1925; Challis 1976, 1978; Clarke 1977; McFadgen 1980; Leach 1984, 1989; Singleton 1988; Gumbley

**TABLE 20.1**  
**Māori Terms and Descriptors for Soil Texture**

Māori Term	Description	Māori Term	Description
<i>Kenepuru</i>	Silt, sandy silt, fresh alluvial deposit	<i>One</i>	Sand
<i>One pārahiwai, parahiwai, parahua</i>	Silt	<i>Onepū, pū</i>	Sand, loose sand
<i>Oneuku, uku, hāmoamo</i>	Clay	<i>Kirikiri, tahoru</i>	Sand
<i>Keretū</i>	Clay	<i>One tai</i>	Sandy soil, coastal/alluvial
<i>Keremātua</i>	Stiff clay	<i>One hunga</i>	Marine and estuarine sand, sandy beach, sometimes mixed with mud
<i>One wawata</i>	Lumpy soil	<i>Poharu, oru, paru (mud for dyeing fiber)</i>	Mud
<i>Kerepehi, kerepei</i>	Clod of earth or clay loam	<i>Kaitara, taratara</i>	Coarse
<i>One matua</i>	Loam	<i>Pōhatu, kāmaka, kōhatu</i>	Stone
<i>One haruru</i>	A light but good sandy loam	<i>Pōhatuhatu</i>	Stony
<i>Oneone punga</i>	Light spongy soil, lacks substance	<i>One pākirikiri</i>	Soil containing gravel
		<i>One kōkopu</i>	Gravel, or very gravelly soil
		<i>Kirikiri, matakirikiri</i>	Gravel, gravelly sand
		<i>Pōhatu</i>	Pebble
		<i>Tokatoka</i>	Rock—hard
		<i>Pōhatuhatu</i>	Rocky
		<i>Toka</i>	Boulder

*Source:* Adapted from Best, E. 1925 (reprinted 1976). Māori agriculture: The cultivated food plants of the natives of New Zealand: With some account of native methods of agriculture, its ritual and origin myths. *Dominion Museum Bulletin No. 9*. Wellington: A.R. Shearer, Government Printer. pp. 42–43; Williams, H.W. 1975. *A Dictionary of the Māori Language*. 7th ed. Wellington, New Zealand: A.R. Shearer, Government Printer. 507p.; Hewitt A.E. 1992. *Australian Journal of Soil Research* 30:843–54; Roskrige, N. 2012. *Tahua-roa: Food for Your Visitors. Korare: Māori Green Vegetables Their History and Tips on Their Use*. Palmerston North: Institute of Natural Resources, Massey University. 110p.

**TABLE 20.2**  
**Māori Terms for Soils Types**

Māori Term	Description	Māori Term	Description
<i>Oneone</i>	Soil, earth general term	<i>One, onepū, pū</i>	Sand, loose sand, sandy soil
<i>One pārakiwai, parahua</i>	Silt	<i>Onewhero</i>	Red sand
<i>One mātua</i>	Loam (suitable for all types of horticulture)	<i>One tea</i>	White sand
<i>One haruru</i>	A light but good sandy loam	<i>One tai</i>	Sandy soil (near beach)
<i>One takataka</i>	Friable soil	<i>One rua</i>	Reddish pumiceous sand
<i>One matā</i>	Dark-colored fertile soil, topsoil	<i>One para huhu, parahua</i>	Alluvium
<i>Paraumu</i>	Humus	<i>Kōtae</i>	Alluvial soil
<i>One paraumu</i>	Dark, fertile, friable soil	<i>One kopuru</i>	Soil found in wet situations
<i>One rere</i>	Good draining soil	<i>Pāra-ki-wai</i>	Alluvial soils, sediment carried by water, silt
<i>Momona</i>	Good, fertile land	<i>One rei</i>	Peat
<i>One punga</i>	Light spongy soil	<i>Para</i>	Fragments, sediment, muddy, waste
<i>Kirikiri tuatara</i>	Fertile brown soil	<i>Reporepo</i>	Soft mud
<i>One tuatara</i>	Stiff brown soil, fertile, but requiring sand or gravel to be worked in	<i>Keretū</i>	Clay
<i>Tuatara wawata</i>	Brown friable, fertile soil suitable for kūmara	<i>One uku, uku, hāmoamo</i>	Clay, unctuous clay, white or bluish color
<i>One nui</i>	Rich soil consisting of clay, sand, and decayed organic material	<i>Taioma</i>	White soil, pipeclay
<i>One kōkopu</i>	Gravel, or very gravelly soil	<i>Kōtore, te uku</i>	White clay
<i>One pākirikiri, one-kirikiri</i>	Gravelly soil, soil containing gravel	<i>Kerewhenua</i>	Yellow clay
<i>One wawata</i>	Lumpy soil	<i>Keremātua</i>	Stiff clay
<i>One puia</i>	Volcanic soil	<i>Matapaia</i>	A clay which when baked hard was used as a stone for cooking
<i>One tea</i>	White soil from sandy volcanic ash	<i>One pohatu</i>	Stony soil
<i>Hunua</i>	Infertile, high country	<i>One hanahana</i>	Dark soil mixed with gravel or small stones, apparently a talus soil
<i>Pākihi</i>	Flat land, dried up and infertile	<i>One kura</i>	Reddish, poor soil

*Source:* From Best, E. 1925 (reprinted 1976). Māori agriculture: The cultivated food plants of the natives of New Zealand: With some account of native methods of agriculture, its ritual and origin myths. *Dominion Museum Bulletin No. 9*. Wellington: A.R. Shearer, Government Printer. pp. 42–43; adapted from Hewitt A.E. 1992. *Australian Journal of Soil Research* 30:843–54.

et al. 2004; Roskrige 2011, 2012; WRC 2011). Modified soils are found in both the North and South Islands and have been described as “Artefact fill anthropic soils,” “Māori plaggen soils” (Rigg and Bruce 1923; Challis 1976, 1978; McFadgen 1980; Gumbley et al. 2004), or simply “Māori soils” (Challis 1976). Modification was mainly carried out to increase soil temperature, improve texture and drainage, improve workability and tillage of the soils for cropping, and to

**TABLE 20.3**  
**Māori Terms and the Modern New Zealand Soil Classification**

Soil Order	Diagnostic Features	Best-Fit Māori Translation (Examples)
Organic soils (O)	Organic material, thick litters	<i>One rei</i> (peat soils)
Gley soils (G)	Reductimorphic near surface to depth	<i>One mākū</i> (wet), <i>one aro</i> (bog), <i>one kopuru</i> (soil in wet conditions)
Ultic soils (U)	Strongly weathered, acid, illuvial horizon	<i>One keretū</i> , <i>one keremātua</i> , <i>one tino uku</i> (very clayey)
Podzols (Z)	An E horizon and sesquioxidic/organic illuvial horizon	<i>One pākīhi</i> (naked land), <i>one hahore</i> (barren), <i>one inanga</i> (white), <i>one mā i runga paraumu pango</i> (white on dark humus)
Allophanic soils (L)	Dominated by short-range order minerals, volcanic	<i>One matua puia</i> (volcanic), <i>one rahoto</i> (scoria)
Pumice soils (M)	Dominated by pumiceous or glassy material	<i>One tāhoata</i> (pumiceous)
Melanic Soils (E)	Low color value, pedal A horizon and pedal high-base-status B horizon	<i>One pākeho</i> (limestone), <i>One karā</i> (basalt)
Semiarid soils (S)	Semiarid soil moisture regime, very weakly weathered and weakly leached	<i>One maroke</i> (arid, dry), <i>one pakapaka</i> (arid, dry)
Oxidic soils (X)	Strongly weathered, low-activity clay, fine polyhedral structure friable	<i>One uku</i> , <i>one uku taioma</i> (clays)
Granular soils (N)	Strongly weathered, mod-active clay, pedal cutanic horizon	<i>One kaitara</i> (coarse), <i>one tōpata kirikiri tini</i> (granular, many grains)
Pallic soils (P)	Pale colors, weakly weathered high base status, low sesquioxides, high slaking potential high subsoil density	<i>One kōmā</i> (soils—pale) <i>One tea</i> (soils—white)
Brown soils (B)	Yellow brown B horizon, low base saturation	<i>One pākākā</i> , <i>one parauri</i> (soils—brown)
Anthropic soils (A)	Soils substantially modified by man	<i>One whakarerekē</i> (soil modified)
Recent soils (R)	Distinct topsoil, absent or very thin b horizon, no fluid subsurface horizon	<i>One o nā noa nei</i> , <i>one para huhu</i> (soil recently developed, e.g., floods)
Raw soils (W)	Topsoil absent or with fluid subsurface horizons	<i>One tino pāpaku</i> (soils—very shallow, thin), <i>onepū</i> (soils—sandy, loose, raw, weak development)

Source: Adapted from Hewitt A.E. 1998. *New Zealand Soil Classification*. Landcare Research Science series 1. 2nd ed. Lincoln, New Zealand: Manaaki Whenua Press. 133p.

follow *tikanga* best practice management. Three main methods of soil improvement were defined by Roskrige 2012:

- Application of wood/ash plant material as a fertilizer
- Placement of stones around crops to increase soil temperature by improving heat retention
- Addition of sand or gravel to improve soil structure by lightening heavy clay soils

Archaeological evidence for horticulture during pre-European times shows numerous examples of Māori-modified soils. These features are recognized by redeposited mixtures of sand and gravel; garden walls, terraces, and mounds; relative levels of organic matter and effects from mulching or burning; garden implements such as the wooden *kō* used for digging, garden pits; and structures for storage (Rigg and Bruce 1923; Best 1925; Macnab 1969; Challis 1976, 1978, 1991; Clarke 1977; McFadgen 1980; Singleton 1988; Bagley 1992; Gumbley et al. 2004; Furey 2006; Horrocks et al.

2008). In the Waikato region alone, Māori modified about 2000 hectares of soil for growing crops, of which kūmara was the most important (Clarke 1977; Singleton 1988; WRC 2011), with kūmara gardens located near rivers and on river terraces. Typical kūmara plantations ranged in size from 0.2 ha to over 20 ha. Early Māori horticulturalists were aware that clayey soils needed to be graveled to improve friability and drainage. The preferred growing medium for kūmara was light, warm, and sandy soil. Where this was not available, Māori horticulturalists added gravel and sand, and, less commonly, charcoal and shells, to the existing soil to improve texture, consistency, and drainage. Many soils were also mulched with burnt-off vegetation that was first spread over the soils, and then worked in. The use of gravel was to build up a coarser layer on the original soil into which kūmara were planted. Large amounts of gravel were quarried for this purpose, and the holes left from this are known as borrow pits (Best 1925; Clarke 1977; McFadgen 1980; Singleton 1988; Gumbley et al. 2004). Soils were specific to certain crops; other crops such as taro preferred wetter or damper soils and were therefore grown near stream banks, swampy areas, and adjacent to the coast (Best 1925; Furey 2006).

#### 20.4.4 FERTILIZER

To improve soil condition, various materials were added, including mulch, seaweed, shells, and ash. Wood ash and charcoal from plants such as mānuka/kānuka (*Leptospermum scoparium*, *Kunzea ericoides*) was also used extensively as a fertilizer on soils (Best 1925; Buck 1950; Roskrige 2009, 2011). Cultivated areas were often weeded and cleared, and weeds and brushwood were then burned, and the ash worked back into the soil as fertilizer. In areas where ashes were used as a fertilizer, the old cultivation areas have been found to be richer in phosphoric acid than in adjacent areas (analysis by Cawthron Institute).

The application of manure and urine near any form of food crop, was, and still is, strongly repugnant to Māori, probably stemming from the central belief system and worldview that the Earth Mother, Papa-tū-ā-nuku, provides food, and it would be unwise to offend her by using something “unclean” and “*tapu*” (sacred). The laws of *tapu* (initially made to prevent human sickness) prevented any form of excrement being associated with food. In many cases, this opposition to manure was entrenched through Māori custom and lore, which continued through several generations. Before Europeans settled in NZ, there were few animals capable of producing manure—but even after stock were first introduced, Māori did not wish to use manure for agriculture. Māori agriculture was thus probably unique in that traditionally manure was never used as a fertilizer.

#### 20.4.5 TREATING EFFLUENT AND SEWAGE—LAND-BASED TREATMENTS

As described above, traditional Māori beliefs mean that using manure or human sewage in soils was repugnant and offensive to Māori, and still is (Awatere 2003; Pauling and Ataria 2010); the only soil amendments used, therefore, were the addition of gravel (Singleton 1988) sand, fish waste, seaweed, or wood ash (Pohlen 1957).

Much concern focused on the treatment and disposal of human effluent, especially where it was discharged into water, and the need to protect significant *mahinga kai* and *wāhi tapu* (Pauling and Ataria 2010). For Māori, there is an overwhelming preference for impure water (e.g., mixed water, polluted water, land effluent, treated sewage, industrial waste) to be treated through land and earth first (Awatere 2003), rather than enter directly into natural water ecosystems. This affirms Papa-tū-ā-nuku (earth mother) as the appropriate filter for impure water (e.g., such as through terrestrial and artificial wetlands), and emphasizes the importance of maintaining the integrity of the *mauri* of each water body, such as a lake, river, or stream (Durie 1994). These issues are of ongoing concern to Māori (Pauling and Ataria 2010).

## 20.5 CONCLUSIONS

This chapter provides insight into Māori knowledge, their use and management of soils, and how this knowledge continually evolved through time. The acquisition of this knowledge, together with its use and application, emerged from an elaborate set of traditional beliefs, values, and concepts (Harmsworth and Roskrige 2014). Before the coming of Europeans, Māori had an extremely detailed appreciation of landscapes and soils, largely based on spatial description and linked to tribal history. Soil classification proper began in NZ with the Māori gardeners and horticulturalists (Hewitt 1992; Roskrige 2012) focused on food production.

There has been renewed interest in and a revitalization of *mātauranga Māori* (Māori knowledge) in NZ, recognition that it is an important dynamic knowledge base that should be used alongside Western science to help broaden our perspective and worldview. New and innovative knowledge is often created at the interface of combined knowledge systems. In NZ and globally, we are faced with an array of challenging and increasingly complex issues, including deleterious impacts to the health of land, soils, and water ecosystems. To help protect and manage our land and soil environments sustainably, and to maintain and enhance human well-being, we need to respect the importance of different knowledge forms and perspectives, such as indigenous knowledge. To achieve intergenerational sustainability and management of our precious natural resources, such as soil, it is essential to include a range of societal, community, and indigenous values and expectations in all aspects of decision making, planning, and policy.

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