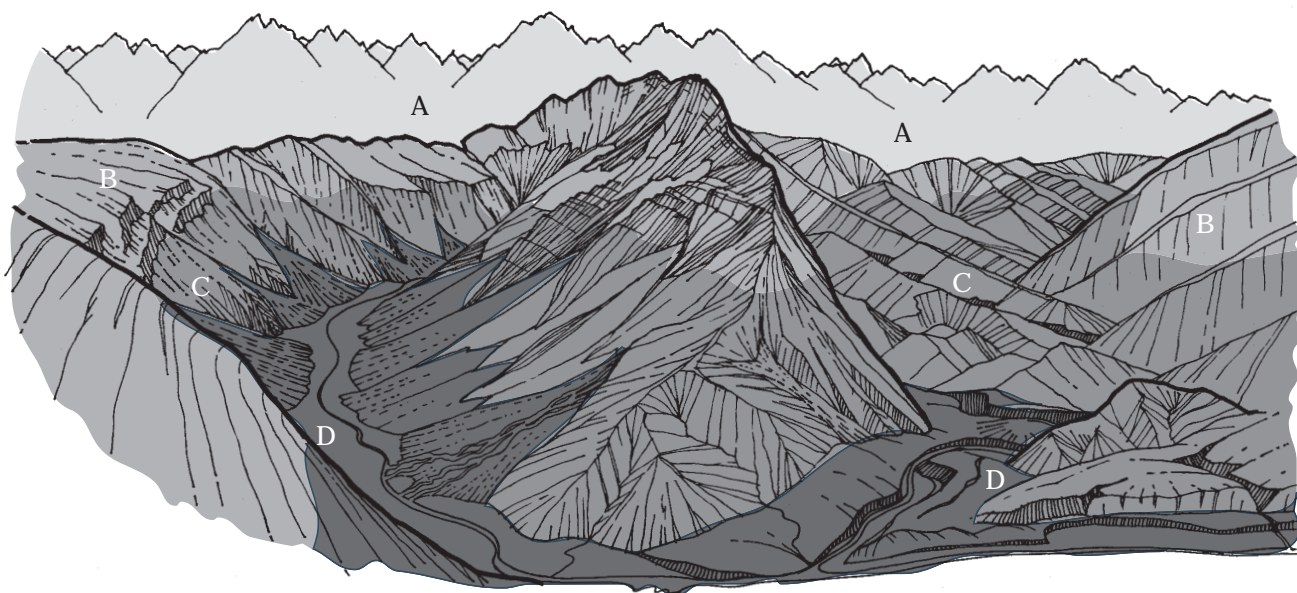
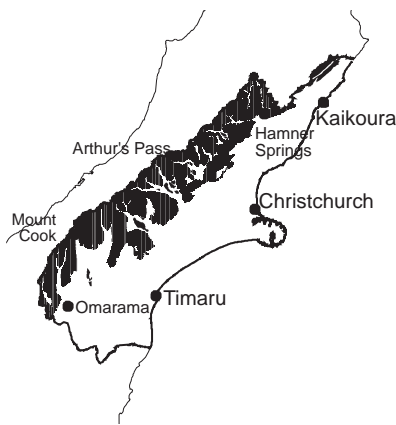


(a) High country: moist mountain ranges



Land form	Resource composition (biota, soil, water)	Natural stresses
A Main divide and associated ranges: steep to precipitous	<ul style="list-style-type: none"> • Largely indigenous vegetation: alpine and sub-alpine scrub, tussock grasslands, and beech forest • High rainfall > 2000mm • Skeletal soils: yellow-brown earths. High organic matter in thin topsoil • Extensive scree, snow, ice 	<ul style="list-style-type: none"> • Very cold temperatures restrict rate of recovery • Very high intensity rainfall • Freeze / thaw activity • Snow, ice, avalanche • Tectonic uplift • High winds • High natural erosion rates
B Upper mountain slopes > 1200m: steep to very steep	<ul style="list-style-type: none"> • Largely indigenous vegetation: tall tussock, alpine / subalpine scrub, fellfield, scree • Rainfall 1000-2000 mm • Yellow-brown earths; range from intact to severely eroded, relatively infertile, phosphorus and sulphur deficient • Deep regolith, significant storage for baseflow 	<ul style="list-style-type: none"> • Freeze / thaw activity • Strong winds • High intensity rainfall • Snow • Low temperature restricts rate of plant recovery • Moderately high rates of natural erosion: wind, water & localised channel erosion (significant source of sediment)
C Lower mountain and hill slopes <1200m: moderately steep to very steep	<ul style="list-style-type: none"> • Short and snow tussock grassland, matagouri, manuka, kanuka, beech, broad-leaved forest, herbs, remnant totara • Rainfall 700-2000 mm. • Yellow-brown earths - large variations in properties due to rainfall gradient; relatively low pH in higher rainfall areas. • Deep regolith, significant storage for baseflow, significant sediment source 	<ul style="list-style-type: none"> • Freeze / thaw activity • Wind and water erosion • High intensity rainfall • Strong winds
D Minor valley floors, fans, terraces, floodplains and colluvial side slopes: flat to rolling	<ul style="list-style-type: none"> • Short and red tussock grassland with matagouri, manuka-kanuka, beech, broad-leaved forest remnants. Introduced pasture species, weeds, some hieracium • Rainfall 1000 mm • Yellow-brown and yellow-grey earths and recent soils (shallow, low water holding capacity). All sulphur deficient; side-slope soils phosphorus and sulphur deficient. 	<ul style="list-style-type: none"> • Cold winter temperatures • Deposition zone - from erosion above (e.g., debris avalanches) and flooding • Occasional moisture stress • Strong winds • Streambank erosion



Location

The high rainfall Main Divide, with adjoining moist mountains that span the length of the region e.g. Glynn Wye, Craigieburn and Ben Ohau Ranges.



mountain beech-kea-
moist mountain ranges

Nature

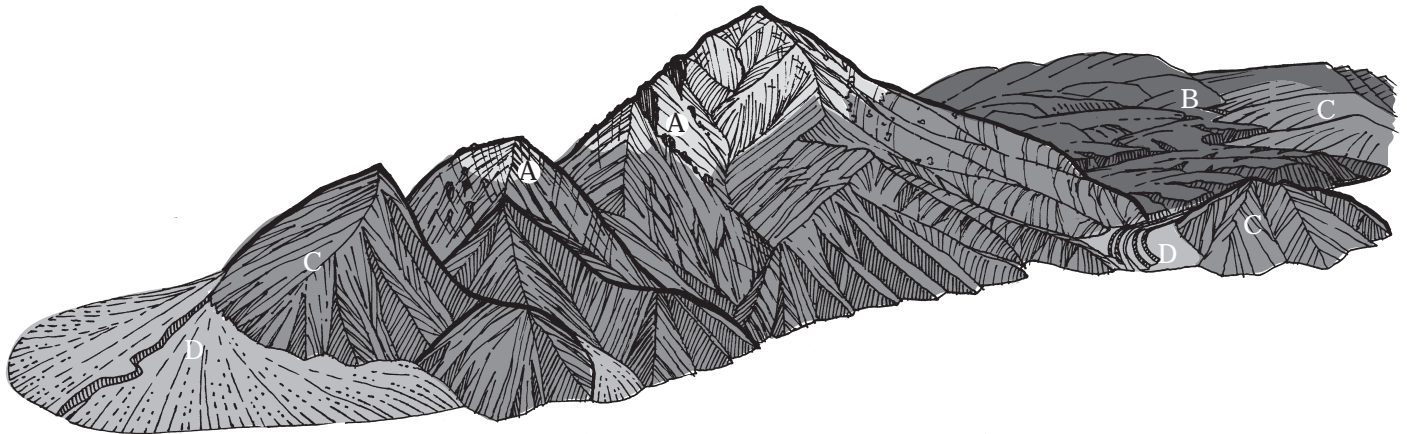
- Steep mountains with extensive bare rock, bluffs and scree on high slopes. Includes the most dramatic mountain chain in NZ.
- Alpine herbfields, shrublands and grasslands clothe upper slopes, snow tussock lower down, with podocarp and beech forest below 1200m. Kea are at home.
- Vegetation of wettest and highest mountains is largely intact. Remnant, induced and depleted, tussock grasslands & shrublands on less wet and lower slopes.

Resource Values

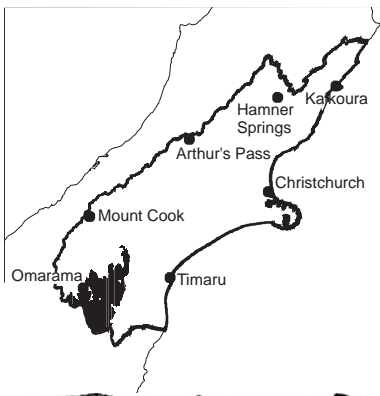
- Main Divide highly valued for wilderness & naturalness, water yield, tourism, recreation & for its wairua (spiritual value).
- Forested and tussock grassland clothed mountains have high nature conservation, landscape, recreation and tourism values.
- Grasslands are important for pastoral production.

Induced changes/disturbances	Effects/trends	Key issues for soil conservation
<ul style="list-style-type: none"> • A few roads & tracks • Wild animal grazing • Possum browsing 	<ul style="list-style-type: none"> • Localised loss of vegetation from wild grazing animals (mainly thar). Signs of recovery with recent targeted management • Localised forest damage by possums 	<ul style="list-style-type: none"> • Erosion risk: earthworks, extensive grazing (wild animals), vegetation clearance
<ul style="list-style-type: none"> • Wild animal grazing • Limited, extensive sheep grazing • A few roads & tracks • Main skifield zone 	<ul style="list-style-type: none"> • Reduced grazing (due to economics and Soil and Water Conservation Plans); destocking • Some modification of tussock grasslands; increase in shrubby and unpalatable species • Long term soil nutrient decline in <u>undeveloped areas</u>. 	<ul style="list-style-type: none"> • Erosion risk: earthworks, vegetation clearance, extensive grazing (wild animals), burning • Soil quality: nutrient decline if grazed <u>without inputs</u>
<ul style="list-style-type: none"> • Farm tracks • Extensive grazing, some developed areas (mainly on Tengawai & Hurunui soils) • Vegetation burning • Moderate rabbit-proneness in dry areas • Afforestation/forest harvesting • Possums in indigenous forests 	<ul style="list-style-type: none"> • Historic vegetation changes from forest to indigenous grassland, leading to a loss of biomass and organic matter (evidenced by exposed sub-soils) • Change to introduced pasture species in developed areas. Also some reversion to scrub (manuka, kanuka, matagouri, bracken fern) in wetter areas • Overall trend to lower stature plants with shallower rooting systems • Decline in nutrient status in undeveloped areas • Wilding spread • Possum damage to indigenous forests, TB risk 	<ul style="list-style-type: none"> • Erosion risk : earthworks, vegetation clearance, extensive grazing, • Soil quality: nutrient decline • Pest management (rabbits) • Reduced system resilience to extreme conditions/disturbance (loss of biomass and SOM) <p>Related issues:</p> <ul style="list-style-type: none"> • Change in landscape / natural character (wilding pines) • Reduced indigenous biodiversity
<ul style="list-style-type: none"> • Moderate rabbit proneness • Extensive grazing • Cultivation for pasture establishment and renewal • Afforestation/forest harvesting • Vegetation burning 	<ul style="list-style-type: none"> • Change from tussock, shrub to introduced pasture species. Pasture species also widespread throughout indigenous grass and shrublands • Exposure of soils to wind • Pastoral development leading to increased soil organic matter and soil nutrient status • Wilding spread 	<ul style="list-style-type: none"> • Erosion risk : cultivation, rabbits • Pest management (rabbits) <p>Related issues:</p> <ul style="list-style-type: none"> • Change in landscape / natural character (wilding pines)

(b) High country: dry mountain ranges



Land form	Resource composition (biota, soil, water)	Natural stresses	Induced changes/disturbances
A Upper mountain slopes > 1200 m: steep to very steep	<ul style="list-style-type: none"> • Snow tussock grasslands, alpine herbfields, scree, fellfields. • Rainfall moderate: 1000 - 1600 mm • Yellow-brown earths. Topsoil generally thin, with rock outcrops. Discontinuous scree. • Cloud, fog, snow 	<ul style="list-style-type: none"> • Low temperature restricts rate of plant recovery • Periods of moisture stress • Fluvial erosion in small drainage channels • Wind erosion • Freeze-thaw activity • Dessication • Snow debris avalanche 	<ul style="list-style-type: none"> • Farm tracks • Extensive grazing
B Elevated plateau: 750 - 1450 m. Steep - moderately steep	<ul style="list-style-type: none"> • Chionochloa macra and short tussock, subalpine shrubland. • Rainfall: 1000 mm. Winter snowpack significant source of downstream flow. • Yellow-grey and yellow-brown earths: reasonably deep, relatively infertile - phosphorus and sulphur deficient. 	<ul style="list-style-type: none"> • Freeze/thaw activity • Low temperatures and soil infertility restricts rate of plant recovery • Strong winds 	<ul style="list-style-type: none"> • Farm tracks • Extensive grazing, some semi-intensive grazing on developed land • Vegetation burning • Medium-high rabbit proneness at lower altitudes - occasional rabbit plagues
C Lower mountain and hill slopes < 1200 m: rolling - steeply rolling	<ul style="list-style-type: none"> • Depleted short tussock & matagouri; hieracium, except on driest sites; Echium dominates in driest, lower areas. • Rainfall low: 450-1000 mm • Thin topsoil with rock outcrops: dry yellow-grey, yellow-brown and brown-grey earths; low organic matter, sulphur deficient, phosphorus deficient at wetter end of zone. 	<ul style="list-style-type: none"> • Freeze/thaw activity • Low moisture • Low winter temperatures restrict rate of plant recovery • Wind erosion - strong drying wind (dessication) • Occasional fluvial erosion 	<ul style="list-style-type: none"> • Farm tracks • Extensive grazing, some semi-intensive grazing on developed land • Vegetation burning • High rabbit proneness - occasional rabbit plagues
D Alluvial fans, terraces, floodplains: flat - rolling	<ul style="list-style-type: none"> • Introduced pasture species, some short tussock, scabweed, matagouri. • Rainfall often < 600mm. • Dry yellow-brown, yellow-grey and brown-grey earths, recent soils: sulphur deficient. 	<p>Low moisture Wind erosion - dessication</p>	<ul style="list-style-type: none"> • Farm roads and tracks • Cultivation for limited cropping, pasture improvement • Intensive grazing, some extensive grazing • Vegetation burning • High rabbit proneness - occasional rabbit plagues • Irrigation canals



Location

Canterbury Dry Mountain Ranges, e.g., Hawkdun, Wether, Ewe, St Cuthbert, Benmore & Kirkliston Ranges



snow tussock grasshopper-
dry mountain ranges.

Nature

- Steep & dissected mountains, hills, and block mountains with rolling, rounded summits.
- Low annual rainfall, includes some of the driest parts of Canterbury.
- Intact snow tussock grasslands remaining at high altitudes, depleted short tussock with extensive bare ground on lower slopes.

Resource Values

- Tourism opportunities, focused on the Waitaki system and the grand and dramatic setting.
- Remnant indigenous tussock and shrublands.
- Fine merino wool.

Effects/trends

- Loss of intertussock vegetation leading to areas of bare ground and scree.
- Transition from snow tussock to more palatable blue and hard tussock in dry areas and cushion species on exposed ridges.
- Very slow decline in soil nutrient status in undeveloped areas

- Some loss of *C. macra*, opening up of tussock, intertussock species replaced by low shrubs and some expansion of bare ground
- Slow soil nutrient decline in undeveloped areas
- Wilding pine spread.

- Increased vegetation cover with land development
- Decline in organic matter and nutrient status in undeveloped areas (carbon, nitrogen, sulphur)
- Increase in hieracium, especially on shady faces
- Tendency for weed invasions (e.g., *E. chium*, briar)
- Persistent bare ground
- Ongoing soil loss by wind erosion

- Extensive replacement of short tussock with introduced pasture species.
- In non-irrigated areas, prone to vegetation loss during extreme conditions or with overgrazing.
- Loss of topsoil in cultivated areas. Decline in organic matter and nutrients (sulphur) due to erosion.
- Some improvement in soil quality on developed land

Key issues for soil conservation

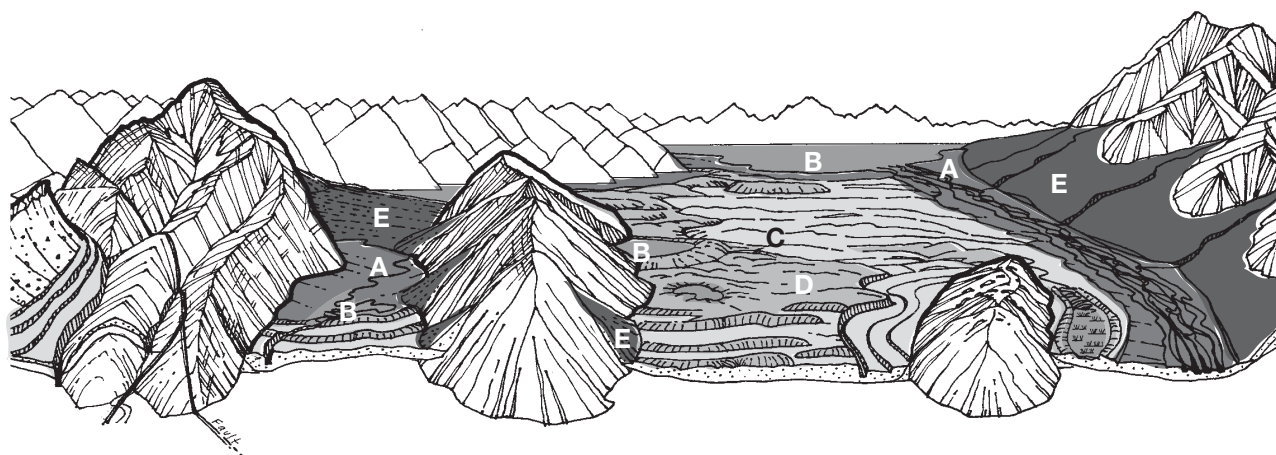
- Erosion risk: extensive grazing
- Reduced system resilience due to reduced vegetation cover, biomass and soil organic matter.
- Related issues:
- Reduced indigenous biodiversity

- Erosion risk: extensive grazing
- Soil quality: nutrient decline
- Pest management (rabbits)
- Change of landscape / natural character (wilding pines)
- Related issues:

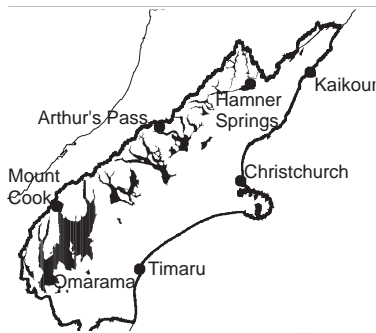
- Erosion risk: extensive grazing
- Soil quality: loss of surface cover, soil nutrients, soil organic matter, soil biology in undeveloped areas
- Pest management (rabbits)
- Reduced system resilience due to reduced vegetation cover, moisture stress and limited rates of plant recovery.
- Related issues:
- Reduced indigenous biodiversity

- Erosion: cultivation, rabbits
- Soil quality: loss of surface cover, soil nutrients, soil organic matter and soil biology in undeveloped areas.
- Pest management (rabbits)
- Related issues:
- Reduced indigenous biodiversity

(c) Inland basins and major river valleys



Land form	Resource composition (biota, soil, water)	Natural stresses	Induced changes/disturbances
A Floodplains - active and infrequently flooded (older/higher)	<ul style="list-style-type: none"> Vegetation sequence from active riverbed to scabweeds, fescue tussock and matagouri on higher floodplains. Small areas of developed pasture on deeper soils. Rainfall 700-1000 mm Recent soils - relatively fertile but weakly developed, generally shallow and stony, low water holding capacity. 	<ul style="list-style-type: none"> Flooding - fluvial erosion and deposition Drought and strong winds - desiccation Freeze / thaw activity 	<ul style="list-style-type: none"> High rabbit proneness - occasional rabbit plagues Cultivation for pasture renewal Extensive grazing on drier areas
B Wetlands and lakes - including valley floor and terrace moraine	<ul style="list-style-type: none"> Wetlands, tarns, and lakes (including hydro lakes) Sedge, reed and rushlands, red tussock, raupo Rainfall 700 - 1000 mm Fertile gley and organic soils 	<ul style="list-style-type: none"> Seasonal drought Flooding 	<ul style="list-style-type: none"> Intensive cattle and sheep grazing, particularly in lake and wetland margins Drainage of wetlands and surrounding land Cultivation for pasture renewal Water abstraction from lakes
C Intermediate terraces	<ul style="list-style-type: none"> Depleted short tussock; sorrel is dominant, some hieracium and scabweed. Rainfall 600 - 800 mm High % bare ground: 50% is common Infertile yellow-brown earths; stony and shallow, high aluminium content. 	<ul style="list-style-type: none"> Seasonal drought Soil factors limit plant growth / recovery Freeze / thaw activity Strong drying winds - wind erosion and desiccation 	<ul style="list-style-type: none"> High rabbit proneness - occasional rabbit plagues Extensive sheep grazing Forestry planting
D High terraces and moraines	<ul style="list-style-type: none"> Short tussock grassland, hieracium in undeveloped areas, oversown and topdressed tussock grasslands, fertilised pastures (except on moraine soils). Rainfall 800 mm. Yellow-brown earths, relatively deep & fertile. 	<ul style="list-style-type: none"> Some freeze/thaw activity Seasonal drought Strong drying winds - wind erosion and desiccation 	<ul style="list-style-type: none"> High rabbit proneness - occasional rabbit plagues Extensive sheep grazing, plus intensive grazing on terraces Cultivation for pasture renewal, cash crops on terraces Irrigation Forestry planting
E Fans	<ul style="list-style-type: none"> Short tussock, matagouri, fertilised pastures. Low rainfall 500-800 mm. Yellow-brown earths, stony & relatively drought-prone. 	<ul style="list-style-type: none"> Seasonal drought Some freeze/thaw activity Strong drying winds - wind erosion and desiccation 	<ul style="list-style-type: none"> High rabbit proneness - occasional rabbit plagues Extensive sheep grazing, plus intensive grazing Cultivation for pasture renewal, cash crops Irrigation Forestry planting



red tussock-crested grebe-intermontane basins

Location

Includes basin floors of the Mackenzie in the south, the Rangitata and Ashburton lakes, upper Rakaia and Lake Coleridge, upper Waimakariri, with smaller scale basins in the north.

Nature

- Basins are drier in the south and east.
- Drier terraces, fans, moraines and floodplains including matagouri shrublands, tussock grasslands, cushion and gravel fields.
- Remnant beech forest on older, higher terraces.
- Major lake systems in most basins, with associated red tussock and raupo wetlands supporting native fishes, insects and birdlife (e.g., crested grebe).
- Distinctive limestone country (not shown), e.g., Castle Hill basin.

Resource Values

- Intensive pastoral production on basin floors, includes most productive parts of the high country.
- Lakes and rivers provide significant landscape, Ngai Tahu, recreation, and tourism values and hydro resources.
- Most high country settlement is in the basins.

Effects/trends

- Bare ground precedes an increase in briar. Increased briar cover reduces exposure of soil to erosion processes.
- On shallow, stony soils replacement of tussock with browntop and sweet vernal leads to increasing vulnerability to vegetation loss and soil exposure to erosion processes.
- Invasion of lupins and willows into riverbeds.

Key issues for soil conservation

- Erosion risk: cultivation, extensive grazing in drier areas
- Pest management (rabbits)

Related issues:

- Change in landscape / natural character (lupins, willows, briar)

- Declining extent and reduced quality of wetland systems
- Compaction of wetland soils due to grazing and drainage leads to desiccation of wetlands
- Reduction of vegetation stature and narrowing of riparian buffer strips.
- Increased risk of eutrophication of small lakes.

Related issues:

- Reduced indigenous biodiversity and aquatic habitat
- Change in landscape and natural character (loss of wetlands)

- Vegetation depletion due to cumulative effects of sheep and rabbit grazing, opening up short tussock cover to sorrel / hieracium.
- Evidence of wind erosion (pedestalled vegetation)

- Erosion risk: grazing
- Soil quality: loss of surface cover, soil organic matter, soil nutrients and soil biology
- Pest management (rabbits)
- Note - This landform component includes the most depleted areas in Canterbury - rehabilitation will require more active measures than just removing grazing pressure.
- Loss of system resilience due to loss of vegetation cover, moisture stress & limited rates of vegetation recovery.

Related issues:

- Reduced indigenous biodiversity

- In developed areas, improved soil quality (organic matter, nutrients).
- In undeveloped areas replacement of short tussock dominated system with hieracium / browntop / bare ground.
- Evidence of wind erosion (pedestalled vegetation), due to opening up of vegetation cover (e.g., by grazing, cultivation). This land is able to recover vegetation cover much better than land type C above, but species diversity will be very low, consisting mainly of low stature plants.
- Wilding spread

- Erosion risk: extensive grazing, cultivation.
- Soil quality: in undeveloped areas, loss of surface cover, organic matter, soil nutrients, soil biology.
- Pest management (rabbits)

Related issues:

- Change in landscape / natural character
- Reduced indigenous biodiversity (wildings)

- In developed areas, improved soil quality (organic matter, nutrients).
- Replacement of tussock with exotic grasses. Spread of matagouri on more disturbed areas. Increase in hieracium, particularly in drier areas.
- Evidence of wind erosion associated with cultivation of drought-prone soils.
- Wilding spread

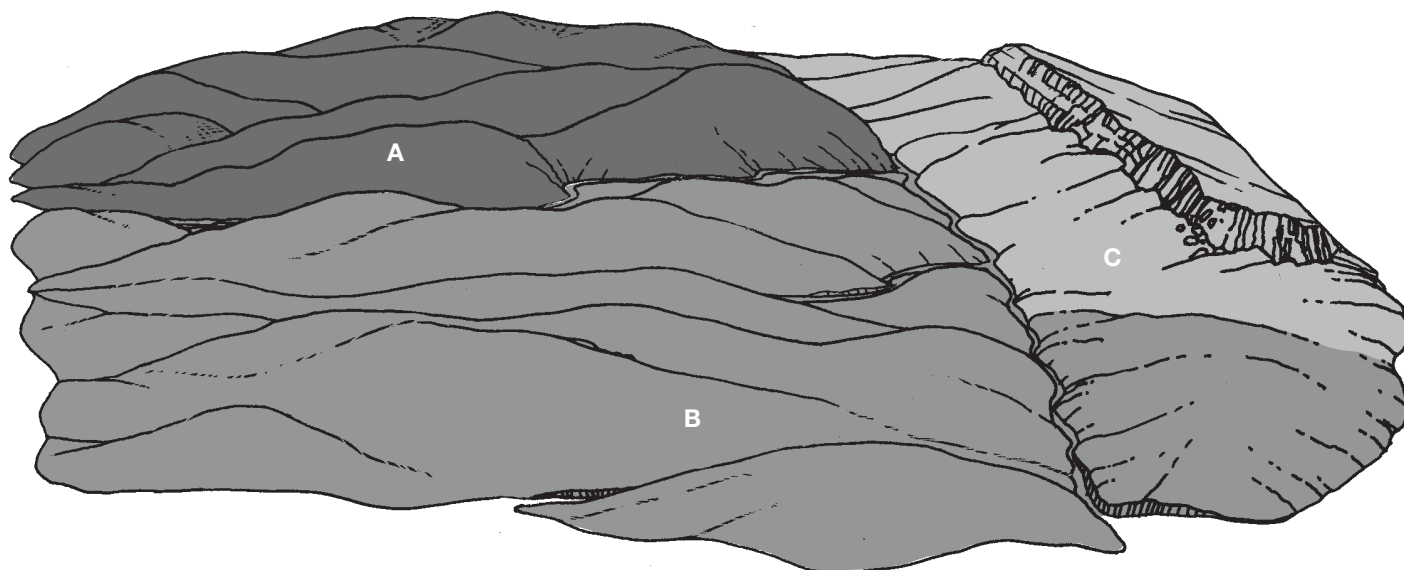
- Erosion risk: extensive grazing, cultivation, rabbits
- Pest management (rabbits)

Related issues:

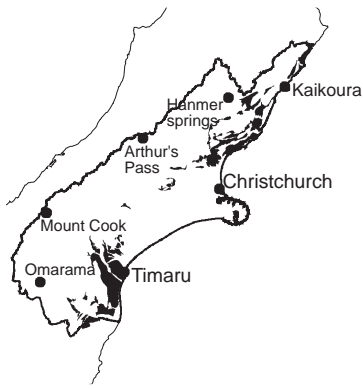
- Change in landscape / natural character
- Reduced indigenous biodiversity (wildings)

(d) Soft rock hill country & downs

(e.g., loess, sandstone, mudstone)



Land form	Resource composition (biota, soil, water)	Natural stresses
A Erosional hillslopes	<ul style="list-style-type: none"> • Steep hillslopes mantled with loess or weathered soft rock. Altitude generally < 700m. • Mixed short tussock, pasture and scrub, particularly matagouri, manuka and coprosma. • Plantation forestry. • Rainfall 600 -1200mm. • Yellow-grey to yellow-brown earth steepland, loessial soils (moderately dispersible). Natural fertility relatively low, but higher than hard rock hill country soils. • Small hill country streams, subject to pronounced seasonal low flows. 	<ul style="list-style-type: none"> • Subject to deep-seated forms of erosion. • Seasonally dry at lower altitudes.
B Low relief downs, crests & summits	<ul style="list-style-type: none"> • Smooth, rolling, loess-mantled downlands. Altitude generally < 500 m. • Improved pasture, crops, woodlots, silver tussock. • Rainfall 600-900mm. • Mainly yellow-grey earths. Relatively low fertility. • Small streams subject to pronounced seasonal low flows. 	<ul style="list-style-type: none"> • Seasonally dry. • Relatively exposed to westerly winds.
C Limestone landforms	<ul style="list-style-type: none"> • Stronger, more stable landforms than A or B. • Improved pasture, some exotic forest, pockets of remnant native scrub and broadleaf shrubland, silver tussock. • Rainfall 600-900 mm. • Soils derived from limestone (rendzinas), moderately fertile. 	<ul style="list-style-type: none"> • Seasonally dry.



Location
 Scattered hill country through both north and south Canterbury, the larger areas including the Timaru and North Canterbury downlands, such as the Ashley Forest and Waikari Valley areas.



matai-long tailed bat-
 soft rock hill country

Nature

- Smooth, rounded, rolling to strongly rolling downland landforms. Includes distinctive limestone landform features, with pronounced escarpments and dip slopes.
- Introduced grasses predominate, with scrub and remnant, induced tussock grasslands and shrublands.

Resource Values

- Pastoral grazing and forestry.
- Remnant indigenous forest and shrublands.

Induced changes/disturbances	Effects/trends	Key issues for soil conservation
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- Predominantly semi-intensive grazing.
- Vegetation clearance. Cultivation for pasture renewal.
- Plantation forestry.
- Farm roads and tracks.

- Intensification of use over last 30 years (includes inputs of fertiliser & pasture species, vegetation burning). Reversion to scrub in some areas.
- Increased vulnerability to erosion following replacement of forest with shallow rooting species. Deep - seated erosion following rainfall storm events.
- Continuing loss of indigenous forest, shrubland remnants and riparian vegetation in developed areas.

- Erosion risk: grazing, cultivation for pasture renewal, earthworks, vegetation clearance, removal of deep-rooted vegetation.
- Pest management: rabbits.

Related issues:

- Water yield: potential reduction in stream flows with extensive exotic forestry.

- Intensive grazing.
- Mixed cropping, small areas of intensive cropping.

- Improved soil fertility and structure under pasture.
- Local redistribution of soil due to cultivation, leading to increased variability of topsoil depth.
- Almost total loss of indigenous vegetation. Increase in silver tussock with topdressing.

- Erosion risk: intensive arable, horticulture, mixed cropping

Related issues:

- Loss of indigenous biodiversity.
- Water quality degradation: sediment, nutrients, microbial in the downs area.

- Extensive to intensive grazing.

- Habitat loss - last strongholds for scrub / tussock progressively disappearing.

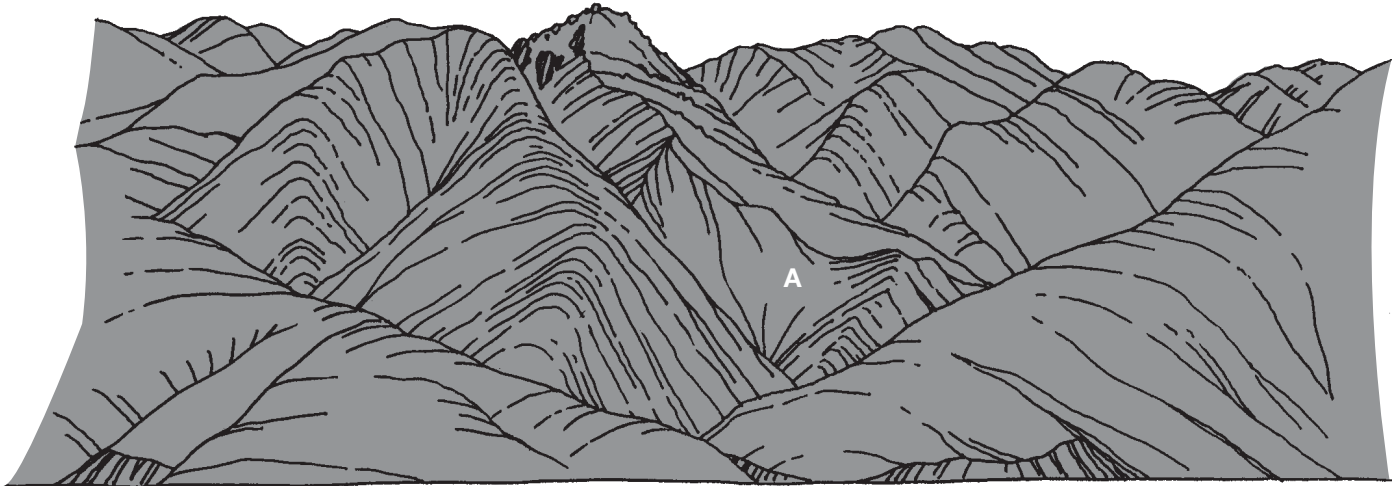
- Erosion risk: cultivation for pasture renewal.

Related issues:

- Loss of indigenous biodiversity.

(e) Hard rock hill country

(e.g., greywacke)



Land form

Resource composition (biota, soil, water)

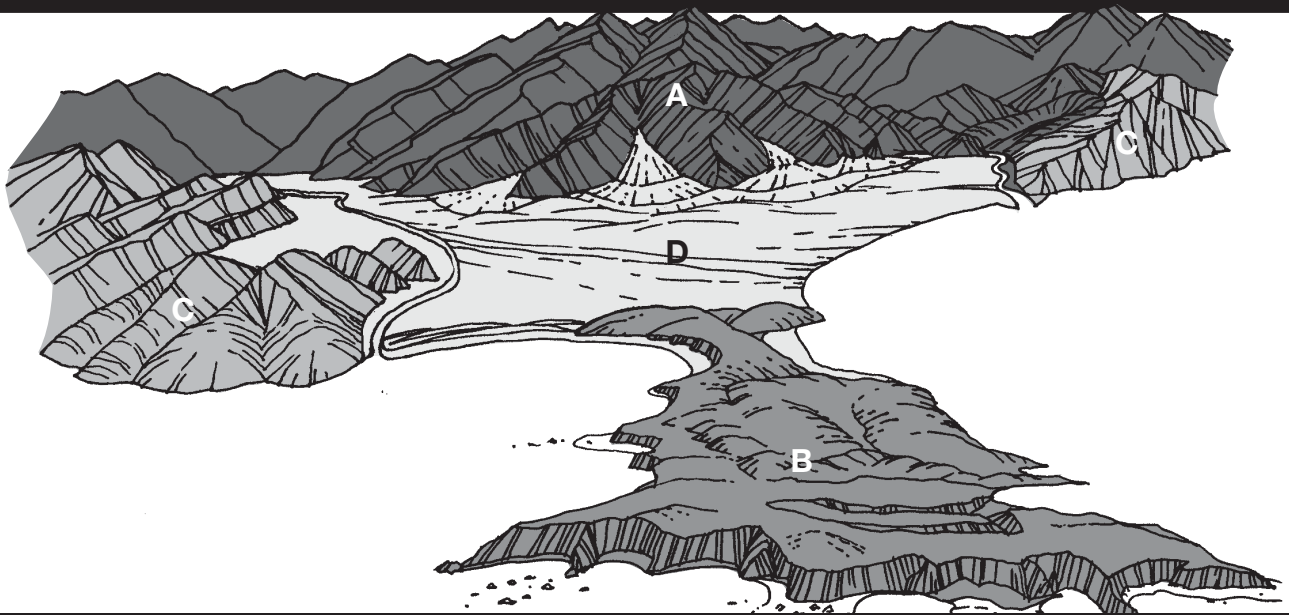
Natural stresses

A

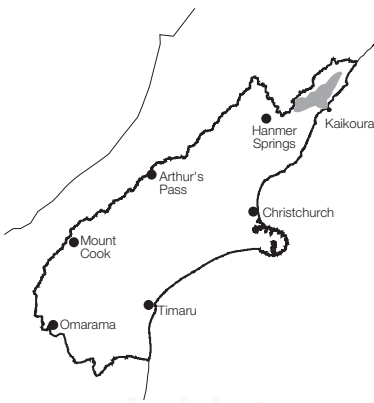
Erosional hillslopes, crests & summits

- Predominantly steep colluvial-mantled, hard rock hillslopes. Relatively stable. Minor areas of easier sloping ridge and spur crests and loess-mantled lower slopes. Altitude generally < 1000 m.
 - Mixed short tussock, pasture and scrub, particularly matagouri, manuka and coprosma. Plantation forestry. Remnant pockets of indigenous forest and shrubland.
 - Rainfall 600 - 1200mm.
 - Yellow-grey to yellow-brown earth steepland soils. Natural fertility relatively low.
 - Hill country streams subject to pronounced seasonal low flows.
- Seasonal drought at lower altitudes.
 - Exposed sites subject to seasonal cold, dry winds.

(f) Kaikoura coastal zone



Land form	Resource composition (biota, soil, water)	Natural stresses
A Coastal mountain ranges	<ul style="list-style-type: none"> • Steep to very steep, dissected mountain ranges with extensive rock, sharp bluffy summits >1200m & colluvial foot slopes. • Mainly beech forest on south faces, with induced grassland & scrub on north faces. • Rainfall 1200 - 1700 mm. • High country yellow brown earths & alpine soils at higher altitudes. • Short, steep streams to coast. High sediment loads. 	<ul style="list-style-type: none"> • Geologically unstable due to effects of rapid tectonic uplift & faulting on bedrock. • High wind velocities. • Freeze/thaw activity. • Intense cyclonic storms & earthquakes. • High energy fluvial regimes. • A wide range of erosion types and copious sediment sources.
B Coastal soft rock hill country	<ul style="list-style-type: none"> • Strongly rolling to steep, dissected coastal hill country to 500m & mountain country up to 1200m, underlain by hard limestone and mudstones. • Mixture of tussock grassland, some improved grasses, extensive scrub & areas of indigenous and exotic forest on steep lands. • Rainfall 800 - 1500 mm. • Yellow-grey to yellow-brown earths, with some limestone derived soils (fertility low-moderate). 	<ul style="list-style-type: none"> • Mudstone-derived soils prone to severe slip erosion. • Intense cyclonic storms trigger slope failures which contribute to high sediment loadings of streams.
C Coastal hard rock hill country	<ul style="list-style-type: none"> • Steep to very steep coastal hill & mountain country on hard sedimentary rock; rock outcrops & scree. • Mixture of tussock grassland, some improved grasses, reverted shrubland & areas of indigenous forest. • Rainfall 1200 - 1500 mm. • Yellow-brown earths. Topsoil generally thin. • Short, steep streams to coast. Rapid response to rainfall. High sediment loads. Sparse aquatic flora and fauna. 	<ul style="list-style-type: none"> • Vulnerability to slope failure in greywacke-argillite bedrock is mainly influenced by structural discontinuities, depth of weathered mantle and seepage and joint water pressure. • High intensity rainstorms trigger slope failures.
D Aggradational fan plain	<ul style="list-style-type: none"> • Rolling to undulating fan to 160m asl, with wetland fringe. • Originally wetlands with dense bush. Now drained and developed for pastoral use with improved pasture species. Remnant coastal forest. • Rainfall 750 - 1300mm • Recent soils with high fertility. • Spring-fed streams. A shallow unconfined aquifer underlies the entire Plains; two small confined aquifers. 	<ul style="list-style-type: none"> • Active fan building of Kowhai river, Mt Fyffe streams, and steep coastal streams where they meet narrow coastal plains. • Flooding, sediment deposition and scouring. • High water tables. • Tsunami risk.



Location

A narrow coastal zone extending east from the tops of the Seaward Kaikoura Range through to the sea.



marlborough rock daisy
-black eyed gecko-
kaikoura coastal zone

Nature

- A zone of complex landforms, including the Seaward Kaikoura Mountain range, steep coastal hill country, active fans, former wetland areas of the Kaikoura Plains, and the Kaikoura Peninsula.
- Steep, intensely faulted, and unstable catchments subject to intense storms and tectonic movement.
- The meeting place of Marlborough and Canterbury vegetation types with some unique plant associations.
- Unique fauna such as Hutton's Shearwater (*Puffinus huttoni*)

Resource Values

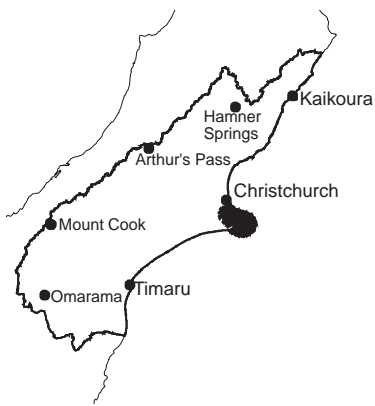
- High natural values with a rocky seascape, towering mountain backdrop and extensive native flora and fauna bounding national transport routes. Important for recreation and tourism.
- Dairy and pastoral farming.
- Maori settlement once concentrated along the Kaikoura coast (particularly the Peninsula); many mahinga kai and wahi tapu sites.

Induced changes/disturbances	Effects/trends	Key issues for soil conservation
<ul style="list-style-type: none"> • Extensive grazing - by domestic stock mainly at lower altitudes. • Vegetation clearance (burning, mechanical clearance)- lower altitude sites. • Few farm tracks. 	<ul style="list-style-type: none"> • Significant areas of high altitude land retired from domestic stock grazing. • Significant areas under conservation management plans (re-vegetation with exotics: localised area on Mt Fyffe). • Improving ecosystems on retired lands and other areas under DOC management. • Increased proneness to animal and plant pests, including wilding pines. • Potential for increased streambank erosion due to removal of riparian vegetation at lower altitudes. 	<ul style="list-style-type: none"> • Erosion risk: uncontrolled wild animals, extensive grazing, earthworks, vegetation clearance. • Bush-cleared slopes vulnerable to erosion. • Pest management: goats, rabbits. <p>Related issues:</p> <ul style="list-style-type: none"> • Pest management: nodding thistle. • Lost of natural character, landscape values, wilding pines.
<ul style="list-style-type: none"> • Extensive to semi-intensive grazing. • Roads / tracks. • Vegetation clearance (burning, mechanical clearance). 	<ul style="list-style-type: none"> • Increased deep-seated forms of erosion following extensive removal of bush. • Increased stream bank erosion due to removal of riparian vegetation. • Increased proneness to animal and plant pests. 	<ul style="list-style-type: none"> • Erosion risk: cultivation for pasture renewal (localised), grazing, vegetation clearance, earthworks, bush cleared slopes vulnerable to mass movement. [Coastal road and railway links at risk] • Pest management: goats, rabbits, possums. <p>Related issues:</p> <ul style="list-style-type: none"> • Habitat degradation and loss of indigenous biodiversity. • Loss of landscape values. • Pest management: nassella, gorse, broom.
<ul style="list-style-type: none"> • Extensive to semi-intensive grazing. • Roads / tracks. • Vegetation clearance (burning, mechanical clearance). 	<ul style="list-style-type: none"> • Increased stream bank erosion due to removal of riparian vegetation. • Increased proneness to animal and plant pests. • Increased mass-movement and fluvial erosion following high intensity rainstorms. • Increased sediment loading in streams following removal of deep-rooted vegetation. 	<ul style="list-style-type: none"> • Erosion risk: vegetation clearance, earthworks, bush cleared slopes vulnerable to mass movement. [Coastal road and railway links at risk] • Pest management: goats, rabbits, possums. <p>Related issues:</p> <ul style="list-style-type: none"> • Habitat degradation. • Water quality degradation: sediment and nutrients into surface water. • Loss of landscape values. • Pest management: nassella, nodding thistle, gorse, broom.
<ul style="list-style-type: none"> • Roads / tracks (including works related to maintenance of national road and rail links). • Intensive grazing, horticulture, some production forestry. • Livestock access to streams. • Effluent disposal. • Minor urban development. • Increased settlement in rural areas. • Wetland drainage 	<ul style="list-style-type: none"> • Improved soil quality (organic matter and nutrients). • Improved pastures and use of pastures • Increased animal and plant pests. • Reduction in surface water quality. • Potential for reduced quality of groundwater. • Dune erosion due to removal of vegetation cover 	<ul style="list-style-type: none"> • Erosion risk: earthworks & vegetation clearance in braided floodplains and fan channels. • Pest management: possums, rabbits. • Hazards: flooding, gravel inundation, gully erosion, coastal erosion. <p>Related issues:</p> <ul style="list-style-type: none"> • Habitat degradation, including wetlands. • Pest management: rooks, African feather grass, old man's beard, ragwort, gorse, broom. • Water quality degradation: surface water - sedimentation and nutrients; groundwater - microbial and nutrients.

(g) Banks Peninsula



	Land form	Resource composition (biota, soil, water)	Natural stresses
A	<p>Summit crests, upper rocky dip and scarp slopes, coastal cliffs</p>	<ul style="list-style-type: none"> • Volcanic rocks dominate, with minor loess. Steep to very steep. • Silver tussock amongst pasture grasses. • Rainfall 1000-1400 mm. Cloud, fog, occasional snow. • Topsoil generally thin, with rock outcrops. 	<ul style="list-style-type: none"> • Low temperatures and exposure to wind limit plant growth.
B	<p>Lower loess mantled slopes</p>	<ul style="list-style-type: none"> • Relatively thick colluvium slopes, particularly on N & W faces. • Introduced pasture grasses, oversown and topdressed short tussock (mostly silver tussock), regrowth hardwood forest in gullies, remnant podocarp forest. • Rainfall 600 - 1000 mm. • Soil naturally erodible (tunnel gullies & slips typical), particularly when forest removed. Loess soils - low natural fertility; volcanic soils - high natural fertility. • Steep, short streams, some spring-fed, often with severe summer low flows. 	<ul style="list-style-type: none"> • Some large-scale mass movement erosion following sustained wet conditions. • Desiccation, particularly on N & W faces.
C	<p>Poorly drained valley floors, flood plains, lagoons, harbourhead dunes</p>	<ul style="list-style-type: none"> • Flat, poorly drained. • Introduced pasture species and crops. Remnant wetland and salt marsh species. • Rainfall 600 mm. • Mix of gley (moderate fertility) & sandy (low fertility) soils. 	<ul style="list-style-type: none"> • High water tables. • Saline influence in coastal margins. • Tsunami



Location
Includes both Banks Peninsula and the Port Hills.



totara-kereru-banks peninsula

Nature

- Twin dissected volcanic cones; loess mantled lower slopes; indented, exposed coastline with deep harbours and sheltered, shallow bays.
- Many small catchments drain directly into harbour and estuarine areas.
- Originally tussock clad upper slopes, with lower slopes of mixed podocarp and broadleaf forest. Remnant indigenous vegetation now disjointed and highly modified.

Resource Values

- An important recreational area, especially for Christchurch.
- Predominantly pastoral, but with diverse speciality land uses.
- Once a major centre for Maori settlement - many mahinga kai and wahi tapu sites.
- Intensive urban development in some coastal areas.
- Sites of cultural significance protected.

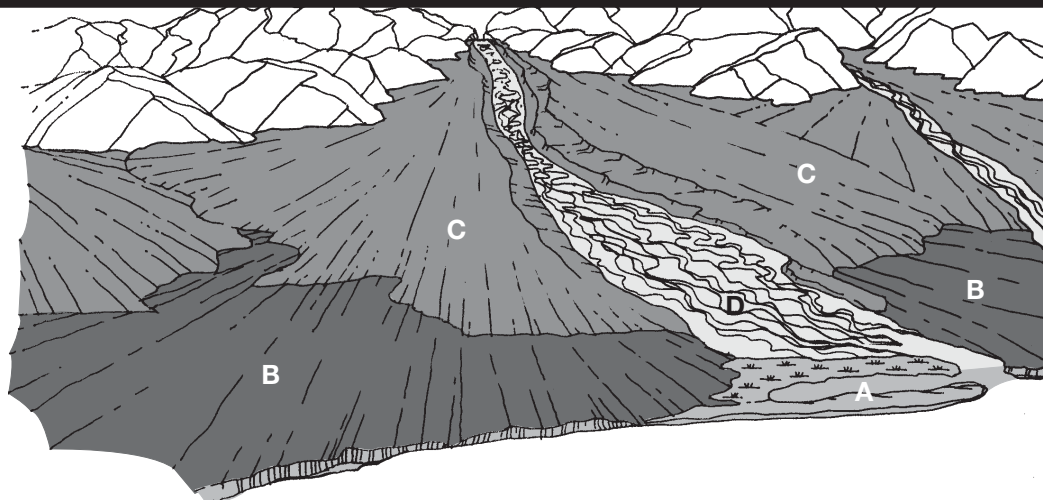
Induced changes/disturbances Effects/trends Key issues for soil conservation

<ul style="list-style-type: none"> • Extensive & semi-intensive grazing. • Few farm tracks & roads. • Uncontrolled wild animals (possums, goats, rabbits) 	<ul style="list-style-type: none"> • Change from tall to silver tussock (historical). • Localised loss of vegetation cover and habitat 	<p>Related issues:</p> <ul style="list-style-type: none"> • Loss of indigenous biodiversity and habitat.
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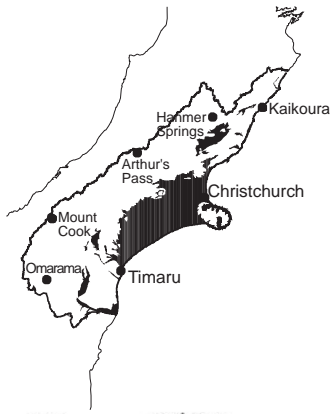
<ul style="list-style-type: none"> • Some farm tracks & roads. • Semi-intensive to intensive grazing. • Increasing diversification of use (e.g., pastoralism to forestry / horticulture). • Minor pasture cultivation for pasture renewal. • Removal of forest and shrub remnants, especially in gullies and waterway margins. • Vegetation clearance (including burning and mechanical clearance). • Stock water dams, ponds. • Channel maintenance adjacent to urban areas. • Continuing urbanisation & rural-residential development. • Uncontrolled wild animals (goats, possums, rabbits). 	<ul style="list-style-type: none"> • A few forest restoration projects under way. • Spread of gorse. • Increase in tunnel gully and soil slip following forest removal. • Increased demand for water. • Pesticide and microbial contamination of spring-fed streams. 	<ul style="list-style-type: none"> • Erosion risk: earthworks, vegetation clearance, intensive horticulture / cultivation, intensive and semi-intensive grazing. • Soil quality: Potential long term soil nutrient depletion in undeveloped pastoral areas; Potential acidification of yellow grey earths. • Pest management: goats, possums, rabbits. <p>Related issues:</p> <ul style="list-style-type: none"> • Loss of indigenous biodiversity / habitat degradation: Continued clearance of remnant bush, particularly riparian bush / fragmentation. • Change in landscape and natural character. • Water quality degradation: pesticides, nutrients, sediment - of particular concern where surface water used for drinking. • Water yield: potential reduction in stream flows with extensive exotic forestry.
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<ul style="list-style-type: none"> • Drainage / channel maintenance. • Semi-intensive to intensive grazing. • Some arable and horticultural use. 	<ul style="list-style-type: none"> • Loss of wetlands. • Sedimentation of harbours and sheltered bays. • Improved soil quality with increased fertility, organic matter. • Reduced water quality 	<ul style="list-style-type: none"> • Erosion risk: intensive cropping, sand mining. • Water quality degradation: sediment, localised microbial. <p>Related issues:</p> <ul style="list-style-type: none"> • Loss of indigenous biodiversity and habitat: wetlands, harbours / bays (sedimentation).
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(h) Canterbury Plains



Land form	Resource composition (biota, soil, water)	Natural stresses
A Coastal fringe, including coastal wetlands, estuaries & lagoons	<ul style="list-style-type: none"> Sand dunes, interdune wetlands, sand plains, gravel beach ridges & bars, saline lakes, lagoons, estuaries & fringe wetlands. Sea cliffs on mid and north Canterbury coast. Marram on front dunes; saltmarsh & sedgeland vegetation around wetland and lake margins; mix of native & introduced coastal species & forestry elsewhere. Rainfall 600 - 800 mm. Predominantly saline soils, yellow-brown sands, organic and gley soils. 	<ul style="list-style-type: none"> Coastal inundation of gravel beaches fronting low lying coastal hinterland to north and south of Timaru. High water tables. Tsunami / coastal storm surge events. Coastal erosion due to coastal processes: coastal cliffs, mixed sand/gravel beaches, sandy beaches.
B Naturally poorly drained plains (tends to be lower plains)	<ul style="list-style-type: none"> Naturally poorly drained lower fans & swamps. Predominantly improved pastures & arable crops in drained areas. Remnant flax, toi-toi, & rushland swamp vegetation in undrained areas. Rainfall 600 - 800 mm. Soils strongly mottled & gleyed (alluvium) or peat. Spring-fed streams. Significant groundwater resource - water table close to surface (can be within 10 m). 	<ul style="list-style-type: none"> Seasonally high water tables in undrained areas leading to seasonal surface flooding
C Naturally well drained plains (tends to be upper plains) & inland basins (e.g., Culverden, Hakataramea)	<ul style="list-style-type: none"> Well drained fans and associated high & intermediate river terraces. Predominantly improved pastures, arable crops, plantation forestry. Tiny remnants of savannah vegetation, short tussock, kowhai, manuka. Rainfall 700 - 1000 mm. Gravels, variable loess & alluvium resulting in soils of variable depth & stoniness with a naturally weak structure (predominantly yellow-grey earths). Braided sections of alpine-sourced rivers. Significant groundwater resource: depth to aquifers much greater than in B above, can be as deep as 100 m. 	<ul style="list-style-type: none"> Strong drying winds. Periods of moisture stress.
D Recent floodplains (both alpine-sourced braided rivers and foothill rivers)	<ul style="list-style-type: none"> Active riverbeds & associated floodplains, low terraces & marginal wetlands. Mix of poplars, willows, gorse and broom within active beds; remnant rush /sedge in marginal wetlands. Improved pasture, arable crops, plantation forestry on adjacent floodplains and terraces. Rainfall 600 - 1000 mm. Active river gravels & recent alluvial soils. Zone of interconnected ground and surface water: groundwater flows to surface water in upper reaches, surface water flows to groundwater in lower reaches. 	<ul style="list-style-type: none"> Strong, drying winds. Periods of moisture stress. Flooding & associated gravel deposition outside natural channels. Bank erosion and reworking of river bed gravels.



Location

Includes the broad Canterbury Plains, extending north from Timaru through to Amberley, and the inland basins, such as Culverden and Hakataramea.



cabbage tree-pukeko-plains

Nature

- Extensive plains composed of multiple intersecting gravel fans. Exposed to strong, hot, dry north-west and strong westerly winds.
- Prominent braided rivers with extensive flood plains and significant estuarine zones. Spring-fed streams. Extensive, mainly unconfined, aquifers.
- Very little indigenous vegetation remains (pre-European savannah, podocarp forest and extensive wetlands).

Resource Values

- Human activity in Canterbury is concentrated on the Plains - includes major urban and rural settlements, intensive agricultural and industrial land uses.

Induced changes/disturbances	Effects/trends	Key issues for soil conservation
<ul style="list-style-type: none"> • Vegetation clearance. • Roads, tracks & vehicle disturbance in dunes . • Mining, groundshaping, building sites. • Increased urbanisation and industrial development around Christchurch & Timaru cities. • Drainage of coastal lagoon margins, wetlands. • Lake and river mouth opening. • Dune restoration. • Recreational activities. • Gravel extraction from beaches and rivers. • Upstream dams affect sediment supply. • Increase in plantation forestry. 	<ul style="list-style-type: none"> • Spread of wilding pines and lupins. • 70 % of Canterbury coast is eroding. • Most sandy beaches are prograding. • Increased nutrient concentrations in coastal lagoons, estuaries and lakes. • Changed hydrological regime in lagoons with managed mouth openings. • Loss of indigenous habitat, particularly wetlands & coastal dunes. • Upstream land uses and point discharges are sources of water quality contaminants. 	<ul style="list-style-type: none"> • Erosion risk (dune migration): Vegetation clearance, mining, groundshaping, building sites earthworks, vehicles in foredunes, grazing of foredunes. • Hazards: coastal erosion, inundation, storms. <p>Related issues:</p> <ul style="list-style-type: none"> • Water quality degradation: nutrients, microbial. • Loss of indigenous biodiversity / habitat: dunes, estuary, coastal fringe wetlands. • Loss of mahinga kai. • Change in landscape: spread of forestry and lupins.
<ul style="list-style-type: none"> • Extensive drainage network. • Cultivation. • Intensive grazing, especially dairying. • Stubble burning. • Frequent use of fertilisers and pesticides. • Replacement of wetland and other indigenous habitat with crops and pasture. • Removal of existing shelter belts with installation of irrigation systems. 	<ul style="list-style-type: none"> • Loss of organic matter due to drainage, especially of peat soils. • Soil contamination - DDT, cadmium residues. • Reduced seasonal flooding in drained areas. • Increased nutrient and microbial concentrations of surface water bodies. • Shallow unconfined aquifers vulnerable to contamination. • Aquatic and wetland habitat loss, especially in spring-fed streams. • Seasonal smoke. 	<ul style="list-style-type: none"> • Erosion risk: intensive cropping. • Soil quality: contamination (cadmium), <p>Related issues:</p> <ul style="list-style-type: none"> • Water quality degradation: nutrients, microbial. • Loss of indigenous biodiversity: wetlands, aquatic and riparian habitat. • Loss of mahinga kai. • Air quality degradation: (periodic)- stubble burning.
<ul style="list-style-type: none"> • Extensive network of stock water and irrigation races. • Intensification of land use: particularly dairying and deer farming. • Removal of existing shelter belts. • Cultivation - often intensive • Groundshaping (border dyking). • Stubble burning. • Extensive well network. • Frequent use of fertilisers and pesticides. • Intensive grazing, including increased dairying. • Intensive irrigation. 	<ul style="list-style-type: none"> • Overgrazing during droughts in inland basins exacerbating wind erosion. • Increased soil nutrient levels & improved soil structure in pastoral areas. • Soil contamination - DDT, cadmium residues. • Increased nutrient and microbial concentrations of surface water bodies, and unconfined aquifers. • Some areas of increased nitrates and pesticide concentrations. • Almost total loss of indigenous habitat (savannah vegetation) & loss of ecological links between coast and hills. • Seasonal smoke. 	<ul style="list-style-type: none"> • Erosion risk: intensive arable use, mixed cropping, intensive grazing in inland basins during drought conditions. • Soil quality: risk of soil structure decline due to continuous cropping; contamination (cadmium). <p>Related issues:</p> <ul style="list-style-type: none"> • Water quality degradation: nitrates, other nutrients, microbial, pesticides. • Loss of indigenous biodiversity / habitat : manuka / kanuka. • Air quality degradation: (periodic) - stubble burning
<ul style="list-style-type: none"> • Cultivation - often intensive. • Gravel extraction. • Channel clearance, including vegetation removal, maintenance & straightening works. • Tree planting within beds and berms for river control and production. • Intensive grazing, including dairying. • Stop banks development and maintenance. • Recreational activities, e.g., 4WD vehicles, boating. • Major zone of point source discharges. • Urban / rural-residential development. 	<p>Riverbeds</p> <ul style="list-style-type: none"> • Loss of indigenous vegetation within beds & margins. • Narrowing of active riverbed. • Initial trend of fairway clearance. More recent invasion of fairway with gorse and broom. • Clogging of minor riverbed channels, particularly outside of rating districts. <p>Adjacent floodplains, terraces</p> <ul style="list-style-type: none"> • Risk of wind erosion in areas with cultivated soils. • Improved soil structure under pasture. • Soil contamination - DDT, cadmium. • Wetland loss 	<ul style="list-style-type: none"> • Erosion risk: cropping, market gardening, intensive horticulture. • Soil quality: Contamination (DDT, cadmium). <p>Related issues:</p> <ul style="list-style-type: none"> • Pest management: weeds in riverbeds, leads to flood hazard and pest refuge. • Flood hazard due to human settlement. • Loss of indigenous biodiversity / habitat: riparian, wetland habitat. • Loss of mahinga kai. • Changes in natural character: particularly aquatic & riparian environments. • Water quality degradation