3.1 Macroclimate

Fact sheet objectives

- To broadly define the scale of the *macroclimate* in both time and space.
- To highlight some of the potential macroclimate impacts on horticulture.
- Suggest some property-level response strategies that can mitigate impacts from macroclimatic factors.

Climatic scales

Scale	Time Dimensions
Microclimate	1 sec to 1 hour
Mesoclimate	1 hour to ½ day
Macroclimate	½ day to 1 week
Global climate	1 week and longer

Scale name	Horizontal dimensions
Microclimate	1 mm to 1 km
Mesoclimate	1 km to 100 km
Macroclimate	100 to 10,000 km
Global climate	10,000 km to global

Scale name	Vertical dimensions
Microclimate	1 mm to 10 m
Mesoclimate	10 m to 1 km
Macroclimate	1 km to 20 km
Global climate	20 km to 100 km

Macroclimate scale

How extensive is the macroclimate? Some typically used categories or scales of climate can each be viewed in three dimensions – time, horizontal distance, and vertical height above the ground. A working definition of these climate scales, by the World Meteorological Organization, is shown in the adjacent table.

In practice there is some overlap between the different climate scales, and so categories cannot be rigidly defined. A useful way to view climate in relation to site management is to think of the climate within the site (the *microclimate)*, and how that can be influenced to some extent by day-to-day management practices, and the climate beyond the site (the *macroclimate)*, which we cannot influence.

Macroclimate factors

In both planning an property location and its layout, and budgeting for long-term financial success, it is vital to be familiar with the macroclimate aspects of the location. This knowledge will ensure that site design and establishment makes best use of the climatic features of the location, and that the risk of crop damage or failure (as well as the potential for success) is well understood.

Some important macroclimate features (using the 'beyond the site' definition) are:

Distance from the sea

Land and sea breezes – land adjacent to the sea can become subjected to quite strong winds across the shore line that are caused by temperature differences over the land and the sea.

Cloudiness and fog – land near the sea can at times be persistently cloudy when there are periods of onshore, moist wind flow. Fog is also common in low coastal areas.

Proximity to the sea can result in some modification of extreme temperatures. For example the climate is less extreme (in terms of hot summers and cold winters) than Central Otago.

Latitude

Solar angle – the further south your property is, the lower will be the solar angle, and the lower will be radiation levels overall (although cloudiness is also a factor). For example, Gisborne averages global solar radiation of 14.5 megajoules per square metre per day on an annual basis, while at Dunedin Airport the figure is 12.4 MJ/m^2/day.

Length of daylight – a benefit of being further south is the summer daylight hours are longer.

Height above sea level

Air temperatures typically decrease with height at the rate of 0.6 °C per 100 metres. This factor influences the length of the growing season (shorter growing seasons at higher altitudes) and may influence the risk of frost (typically, more frosts at higher altitudes, but local topography is also a factor).

Topographic features

Valley winds – valleys produce their own local wind systems due to differences in the way air lying within valleys gains or loses heat, and because of the way valleys might modify regional scale wind flows.

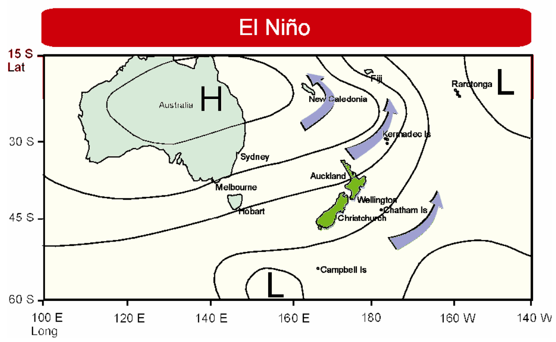
Other topgraphically modified winds – when air flows over terrain that is not uniform, for example the Southern Alps, regions of both high and low pressure are created. These cause acceleration of the wind speed, reverse-flows along the ground against the dominant wind flow, and turbulence in the low pressure regions, called *lee eddies*. There may also be turbulence at the face of the hill or obstacle, often referred to as *bolster eddies.*

Orographic influence on rainfall – moist air condenses on the windward slopes of mountain ranges, and precipitates out, leaving the air mass drier as it descends the lee side. Thus local climates are normally wetter on the side of mountain ranges, that is typically the windward side, and drier on the opposite or leeward side. Larger rainfall gradients across mountains are usually a result of this.

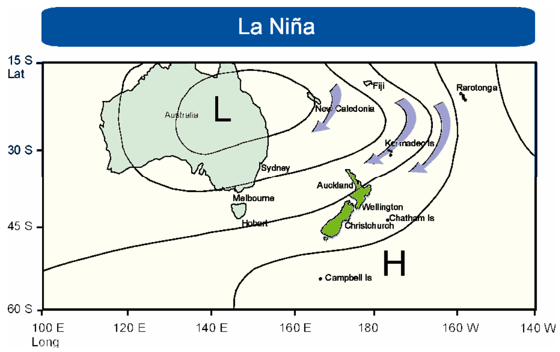
Foehn wind – a warm dry wind that occurs on the leeward slopes of a ridge of mountains, eg. the 'Canterbury nor'wester'. In this case the air is first forced upward over the western slopes of the Southern Alps, cooling as it encounters the lower pressures of higher altitudes. If, however, it reaches its condensation temperature, the cooling is somewhat reduced owing to the release of latent heat that results from water vapour condensing into liquid water. As the air flows downward over the leeward slopes, it is warmed as it encounters the greater pressures of lower altitudes. This warming, however, is greater than the cooling that occurred during the ascent if heat was added to the air as a result of condensation, so that the air is both warmer and drier than originally.

This central Otago orchard, with its prominent frost-fighting wind machine, will suffer frost both from cold air draining off the mountains, and from radiation frosts on calm nights. (Photograph by Alan Blacklock)

Pacific wide climate fluctuations, particularly the El Nino-Southern Oscillation, have partly predictable effects on New Zealand climate.



During an El Niño, New Zealand is typically cooler, with more winds from the southwest. The west coast of the South Island generally gets more rain.



During a La Niña, New Zealand is typically warmer, with more winds than usual from the northeast. The northeast coasts of the country are exposed to wetter conditions from the moist northeasterly air flow, particularly during summer, autumn and winter. In a La Niña spring, there is often an increase in westerly winds.

Global scale features

El Niño-Southern Oscillation (ENSO) – probably the most familiar global scale climate phenomenon that can affect New Zealand's climate. During El Niño seasons, when the tropical eastern Pacific Ocean becomes warmer than usual, in New Zealand we experience westerly and southwesterly winds more often. The result can be drier than average conditions and droughts along the east coast of the country, and cooler, wetter conditions along southern and southwestern coasts. The opposite ENSO phase, La Niña, coincides with lower than normal tropical Pacific seas surface temperatures. La Niña typically brings more frequent than normal warm, moist, easterly and northeasterly winds over the country, with higher chances of wetter than normal conditions along northern and eastern coastlines, especially in the North Island.

Climate shift

The Interdecadal Pacific Oscillation (IPO) is similar in some ways to ENSO, although its periodic changes occur on a much longer time scale, usually 20 years or more. The IPO appears to have links with ENSO although the relationship is complex. A recent change in the IPO may have occurred in 1998, which may mean that the El Niño weather pattern is less frequent over the next two decades than it has been since 1977.

Maximising macroclimate features and minimizing risks

Planning and management can lead to improved ways of maximising the helpful macroclimate features, and protecting the site environment against risks on the macroclimate scale.

Shelter belts across dominant wind directions – this can help to slow down the wind flow within your property, but be sure that you don't create turbulence by 'over-blocking' the wind flow (the porosity of the windbreak should be about 40%), or by blocking the outflow of cold air from the site.

Use of slope and aspect to maximise solar reception – planting an orchard on a north facing slope will improve the angle to the sun, and thus capture more incoming solar radiation. The crop layout – spacing and row direction – will also influence how much solar radition reaches the soil surface through gaps in the foliage.

Ensure best use of solar horizon – where possible plant in areas where sunshine is available for the longest period i.e., minimise interference from hills and tall trees.

Weather risk assessment – knowledge and frequency of the climatological risk of weather hazards in your areas (e.g. How strong is a 1-in-10 year wind storm?), and how to minimise their impact both through site design and robust budgeting. Weather hazards include frequency of frost, hail, dry spells, low rainfall, cool growing seasons. Also important are the expected frequencies of crop growth requirements, such as frost-free periods, and minimum accumulations of chill units or growing degree-days.

Summary Information

- Macroclimate can be defined as the climate beyond the environment that we cannot influence.
- Macroclimate impacts on a locality depend on local geographical features as well as regional and global scale climate patterns.
- Site location and layout planning can maximise good features of the macroclimate, and help to protect against climate risk.

Useful Websites

New Zealand climate overview:
www.niwa.co.nz/edu/resources/climate/
www.metservice.co.nz/learning/

Climate and weather terms and definitions:
www.bom.gov.au/climate/glossary/

El Niño-Southern Oscillation:
www.cdc.noaa.gov/ENSO/

Further reading and other sources of information

Regional climatologies – detailed descriptions of New Zealand's regional climates:
NZ Met. Service Miscellaneous Publications Series 115 (available from NIWA)

A MAF Sustainable Farming Fund Project:

Sustainable Farming Fund
www.maf.govt.nz/sff

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