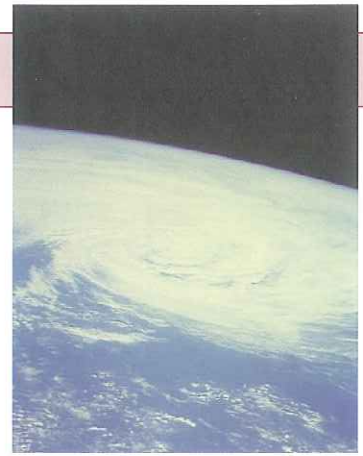


Unit 2

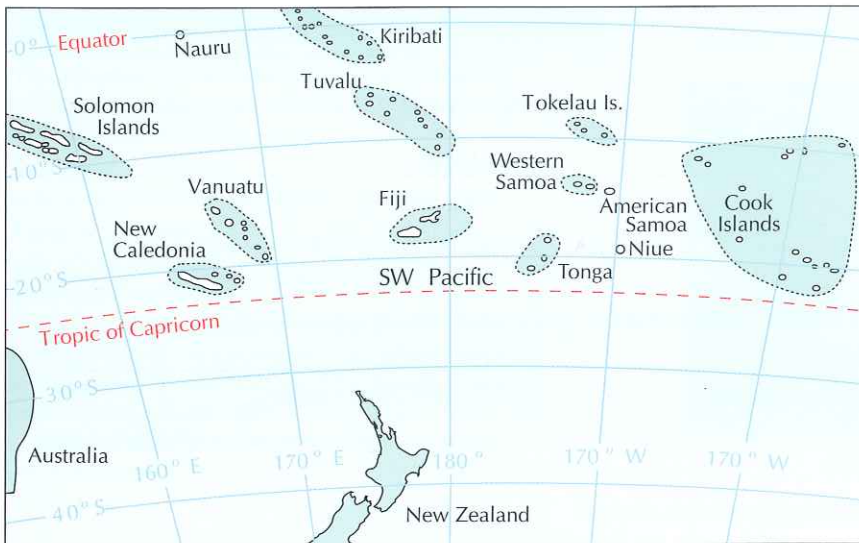
What Causes Tropical Cyclones?



Learning Outcomes – On completion of this unit you should be able to:

- describe the location of the South-west Pacific islands
- describe the environment of the South-west Pacific islands
- outline the processes which produce tropical cyclones
- understand how tropical cyclones are described and measured
- read a weather map.

South-west Pacific Islands



Country	Population
American Samoa	58 000
Cook Islands	21 200
Fiji	880 900
Kiribati	100 800
New Caledonia	213 700
Niue	1500
Samoa	177 700
Solomon Islands	523 600
Tokelau	1400
Tonga	110 200
Tuvalu	11 500
Vanuatu	202 600
Wallis and Futuna	15 900

■ The South-west Pacific islands include all the island groups between the **equator** and the **tropic of Capricorn** from the Solomon Islands in the west to the Cook Islands in the east. All these islands are affected by tropical cyclones.

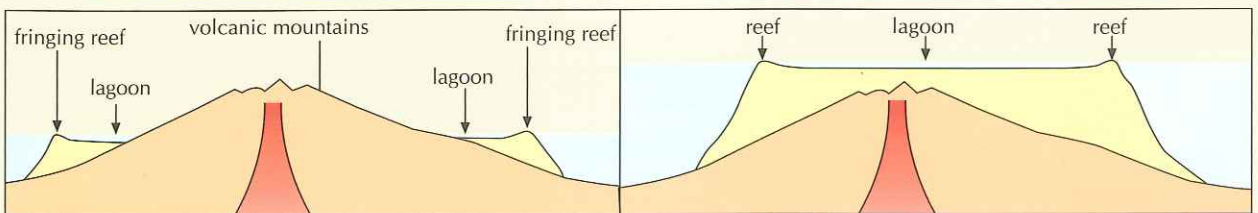
Pacific Island Environments

■ The islands can be divided into two types – **high islands** and **low islands**.

High islands



Low islands



The Natural Environment

Features	High Island	Low Island
Relief and Origins	<ul style="list-style-type: none"> Mountainous volcanic centre. Narrow coastal plain, surrounded by shallow lagoon and fringing reef. 	<ul style="list-style-type: none"> Volcanic centre now under sea and covered by coral. Atoll – small coral islands (<i>motu</i>) around a shallow lagoon.
Climate	<ul style="list-style-type: none"> Tropical, hot all year. Very hot and wet in summer when mountains receive orographic rain from south-east trade winds. Tropical cyclones from October – April. 	<ul style="list-style-type: none"> Tropical, hot all year. Very hot in summer, but no mountains to cause orographic rain from south-east trade winds. Tropical cyclones from October – April.
Drainage	<ul style="list-style-type: none"> Small rivers, streams. 	<ul style="list-style-type: none"> No rivers or streams.
Soils and Natural Vegetation	<ul style="list-style-type: none"> Fertile volcanic soils with dense forest cover on mountains. Coconut palms and pandanus on coast. 	<ul style="list-style-type: none"> Little natural soil (mainly coral sand). Coconut palms and pandanus.

The Cultural Environment

Features	High Island	Low Island
Population	<ul style="list-style-type: none"> Larger population, some urban. In-migration of youthful and working-age from outer islands. Out-migration to New Zealand, Australia, USA for employment and education. 	<ul style="list-style-type: none"> Small, declining, rural population. Out-migration of youthful and working-age for employment and education. Mainly old and very young remain.
Infrastructure	<ul style="list-style-type: none"> More reliable electric power supplies. More modern communication links (satellite, telephone, Internet, TV). Sealed roads, regular shipping and airline services. Mainly low living standards (unless living on income from overseas). 	<ul style="list-style-type: none"> No regular power supplies. Poor communication links with outside world (mainly radio). Few, if any, sealed roads. Irregular shipping and airline services.
Resources and Economy	<ul style="list-style-type: none"> Struggling cash economy based on tourism (main export earner); remittances (cash sent from family in New Zealand, Australia, USA); small export of agricultural produce (sugar, copra, bananas, oranges, coffee, pineapples). 	<ul style="list-style-type: none"> Very low living standards (unless living on income from overseas). Mainly subsistence economy (fishing, coconuts, breadfruit, taro). Small cash income from overseas remittances and small (and unreliable) copra exports. Remoteness and unreliable shipping makes economic development difficult.
Society	<ul style="list-style-type: none"> Less traditional lifestyle influenced by 'Western' media (TV, films/video), education, tourists. Large, extended families. More education opportunities (primary and secondary schools). Limited tertiary-level opportunities. Western-style buildings made of imported, permanent materials (concrete, glass, roofing iron). 	<ul style="list-style-type: none"> Traditional village lifestyle, dominated by elders and church. Large, extended families. Very limited education opportunities (primary). Semi-traditional buildings made of local materials, and some imported materials (e.g. roofing iron).

Unit 3

When the Cyclone Hits

Learning Outcomes – On completion of this unit you should be able to:

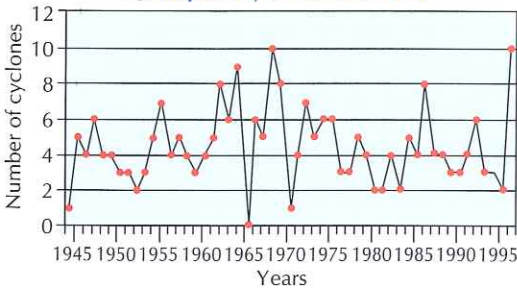
- describe when and where tropical cyclones occur in the South-west Pacific
- describe the movement of tropical cyclones
- outline the sequence of natural events when a cyclone passes
- identify the effects of a tropical cyclone on the natural environment
- interpret a line graph.



Cyclone Season

■ Most tropical cyclones in the South-west Pacific occur between November and April. This **cyclone season is the hottest time** of the year. On average the South-west Pacific experiences about six tropical cyclones per year.

Fiji Tropical Cyclones 1945–1997



Where Cyclones are Born

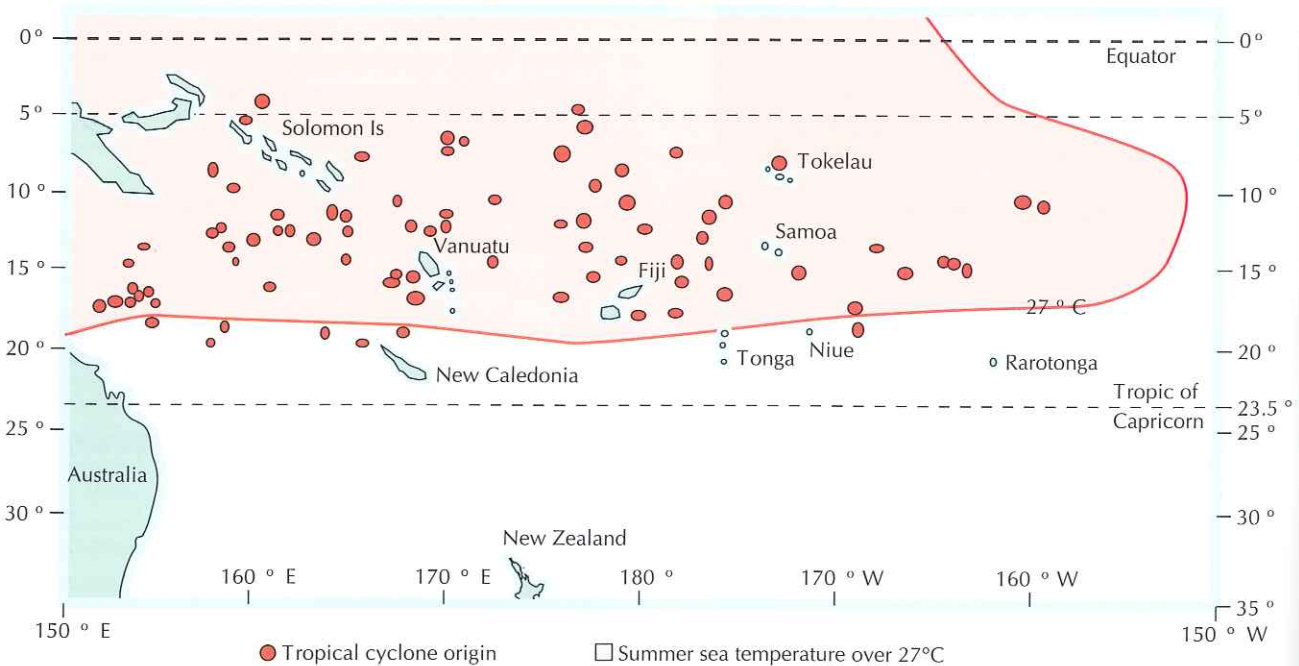
■ Most cyclones in the South-west Pacific form between about 5° and 20° south of the equator, along the SPCZ. Any closer to the equator and the lack of a coriolis force prevents a circular wind motion developing. Further south the sea is too cool.



■ Warm ocean currents between Australia and the Cook Islands provide perfect sea conditions for cyclone development, known as **cyclogenesis**.

■ The area which experiences tropical cyclones most frequently lies between Vanuatu and Fiji.

Origins of Tropical Cyclones: November 1969–April 1979



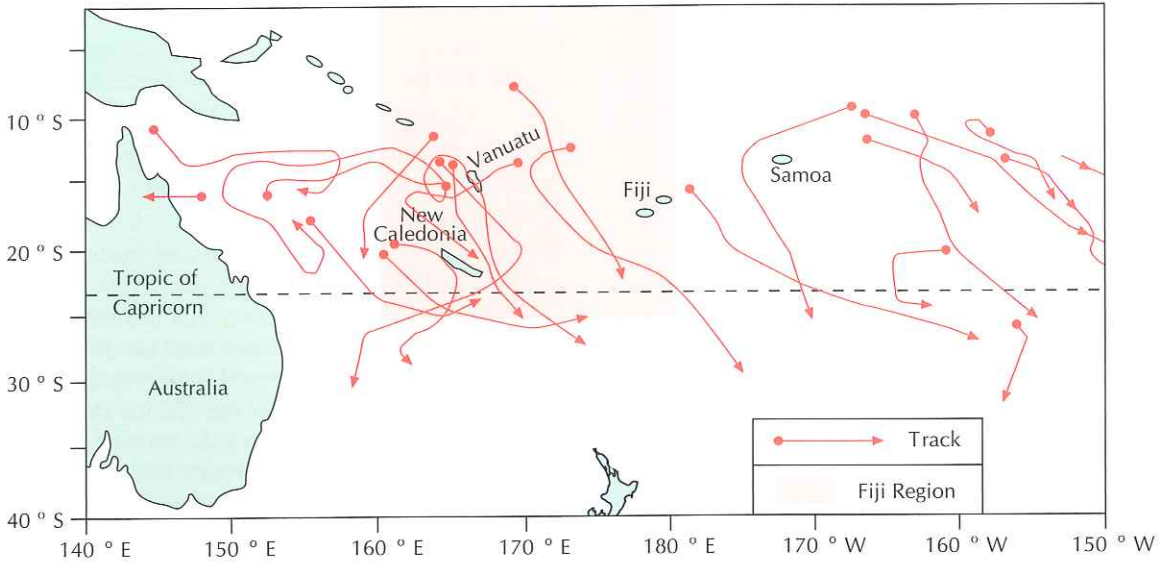
Making Tracks

■ The route taken by a cyclone is known as a **track**. Tropical cyclone tracks in the South-west Pacific move *away* from the equator, often moving first in a south-westerly direction before turning towards the south-east.

■ Tropical cyclones move at about 15–25 kph, but they are unpredictable. They can suddenly change direction, speed up, slow down or even become stationary for a while.

■ Tropical cyclones ‘die’ when they move over cooler seas (south of the tropic of Capricorn) or over large land masses, e.g. Australia.

Tropical Cyclone Tracks 1997/98



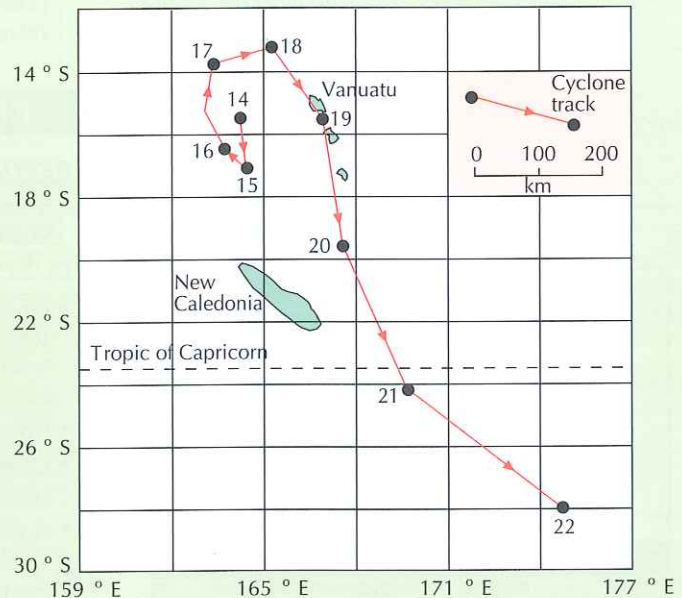
Case Study

Tropical Cyclone Dani

The track of tropical cyclone Dani, which struck Vanuatu in January 1999, demonstrated the following features of cyclone movement in the South-west Pacific:

- unpredictability: between 14–19 January, Dani made a full 360° turn
- speed variability: slow moving at first (14–16 January), Dani later accelerated (18–22 January)
- south-easterly trend: despite its early loop Dani eventually moved towards the south-east.

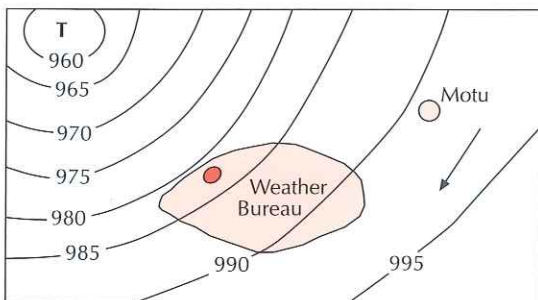
Tropical Cyclone Dani 14–22 January 1999



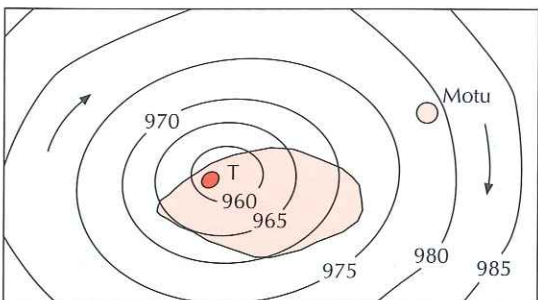
Sequence of Natural Events

Model cyclone

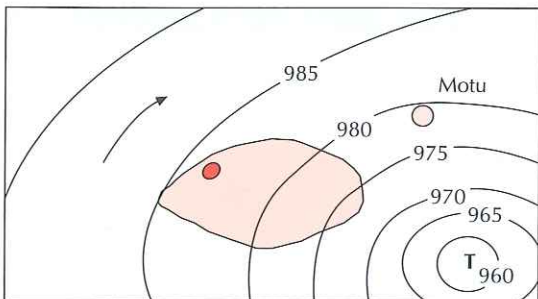
- 1 March 1800 hrs: Eye 100 km to NW
- 2 March 0900 hrs: Eye overhead
- 2 March 2100 hrs: Eye 100 km SE



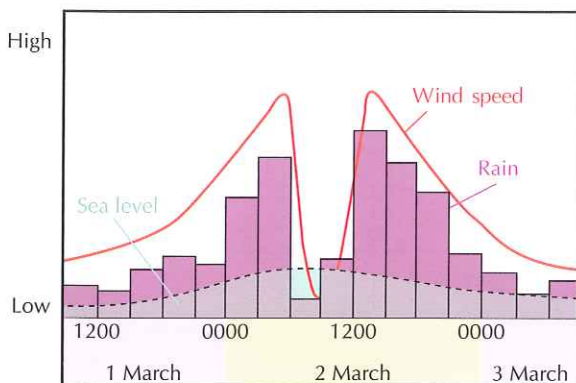
1 March 1800 hrs: Eye 100 km to NW



2 March 0900 hrs: Eye overhead



2 March 2100 hrs: Eye 100 km to SE



■ Natural events – *before, during and after* – tropical cyclones follow a fairly predictable sequence (order).

BEFORE: 2–3 days

- Atmospheric pressure starts to fall and winds increase in strength.

DURING: 1–2 days

- Pressure falls rapidly.
- Winds (usually easterly) increase to hurricane force, and rain becomes torrential. Seas become extremely rough.
- Strong winds and the ‘suction’ effect of very low atmospheric pressure may cause a **storm surge**. The sea is raised a metre or so above its usual level. Coastal flooding may occur, particularly at high tide. Waves may sweep right over a low island.
- On high islands, rivers flood and landslips erode hillsides.
- The worst conditions occur just before the eye passes by. Then for a short time (maybe a few hours) the wind calms and the skies clear.
- When the second half of the cyclone strikes, the violent conditions return but the wind comes from the opposite direction (usually the west).
- Atmospheric pressure rises rapidly, and the cyclone moves away.
- The full sequence may last only a few hours, or several days. It depends on how quickly the cyclone moves.

AFTER: 2–3 days

- As the cyclone moves further away, atmospheric pressure gets back to normal and fine weather returns.

Effects on the Natural Environment

BEFORE: 2–3 days

- Wind picks up speed, clouds build up and rain starts. Seas become rougher.

DURING: 1–2 days

- On high and low islands, wind strips vegetation of leaves and fruit. Many tall trees are felled. Native fruit bats may be killed, reducing pollination of native vegetation.
- Coastal vegetation is ‘burned’ by salt spray.
- Coastal erosion strips beaches of sand. Live coral reefs are damaged.
- A storm surge may sweep right over a low island, washing away any soil.
- On high islands, rivers flood and landslips erode slopes.

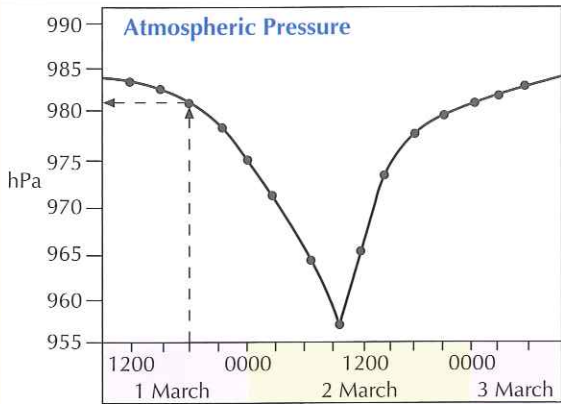
AFTER:

- On high islands, river floods recede leaving behind deep layers of mud, rocks and tree logs.
- Seawater floods recede, but soils are damaged by salt (**salinisation**).
- Mosquitoes breed in swampy areas.
- Nature gradually repairs the damage. New vegetation grows and eventually hides the scars. Forests may take decades to recover fully.

Skill Interpreting a Line Graph

Follow the steps to **interpret** this graph. This graph is part of the *Model Cyclone sequence* (page 14).

1. What is it about? Check title and **variables** on axes.
2. What units of measurement are used? Check labels on axes.
3. Calculate the pressure at 1800 hours (6 pm) on 1 March. Read vertically up from the x-axis and horizontally across to the y-axis.
4. Describe the trend of the graph from 1200 hours on 1 March to 1000 hours on 2 March. Comment on the general relationship between the variables.
5. When did the eye of the cyclone arrive?



Key Points Summary

In the South-west Pacific:

- the cyclone season is from November to April
- most tropical cyclones form between 5° and 20° south. Their tracks are unpredictable, but they usually move away from the equator
- tropical cyclones follow a fairly predictable sequence of natural events when they strike land
- tropical cyclones affect high and low islands in different ways.



Learning Activities

1 Match up descriptions with terms.

a) cyclone season	A calmer centre of cyclone
b) coriolis force	B route taken by cyclone
c) cyclogenesis	C November–April
d) track	D creates circular motion
e) storm surge	E salt damage
f) salinisation	F birth of a cyclone
g) eye	G rise in sea level

2 The following questions relate to the table shown below.

Weather Bureau recorded data: 1–2 March				
Time	Pressure (hPa)	Wind		Rain
		force	direction	
1400	1000	gale	NE	moderate
1600	994	gale	NE	moderate
1800	988	storm	NE	heavy
2000	980	storm	NE	heavy
2200	970	hurricane	NE	very heavy
0000	960	calm	–	no rain
0200	960	hurricane	SW	very heavy
0400	975	hurricane	SW	very heavy
0600	985	storm	SW	heavy
0800	991	storm	SW	moderate
1000	996	gale	SW	moderate
1200	1001	gale	SW	moderate

- When did the eye of the cyclone arrive?
- By how much did the pressure fall in the first 12 hours?
- Why did the wind direction change at 0200 hours?

3 Find evidence in Unit 3 to support this important geographic idea: Some changes are predictable or cyclic, while others are unpredictable or erratic.

4 Draw the track for the model cyclone (page 14).

Method: Trace the frame and island of the first map and mark the position of the eye. Move your tracing to the second map and mark the eye again. Repeat for the third map. Join the dots.

5 Refer to the Case Study of Cyclone Dani (page 13) to answer these questions.

- What does the track of Cyclone Dani tell you about the movement of tropical cyclones?
- On which day did Cyclone Dani move most slowly?
- On which day did Cyclone Dani move most quickly?
- Describe the movement of Cyclone Dani from 14–19 January.
- What was the general direction of movement of Cyclone Dani from 19–22 January?