II Physical Environment

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Climate

Few climatic data for the Study Area are available with only Bullfinch recording daily rainfall over a sufficient period for calculating meaningful averages. Rainfall averages were based on data from Bullfinch, Kalgoorlie, Menzies and Diemals (Figure 2). Temperature averages and extremes were based on data from Kalgoorlie, Southern Cross and Diemals (Figure 2).

The Study Area experiences warm winters and hot summers. Slightly more rain falls during winter than summer. The climate of the south-western third is Sub-desert (Attenuated) and the remainder is Sub-desert (Accentuated)(UNESCO-FAO 1963). The boundaries of Köppen's classification are very similar (Dick 1975). The south-western third is Hot Dry Continental and the remainder Hot Arid Desert.

Temperature

The average monthly maximum temperatures increase slightly from south to north. January is the hottest month (34° to 36°C) and July the coldest (16° to 17°C). Average minimum temperatures have a similar trend. Hottest is January (18° to 20°C) and coldest is July (4° to 5°C). Extremes of temperature are Kalgoorlie (45.2°C and −3.0°C), Southern Cross (47.2°C and −5.0°C) and Diemals (46.5°C and −4.6°C). Snow has not been recorded.

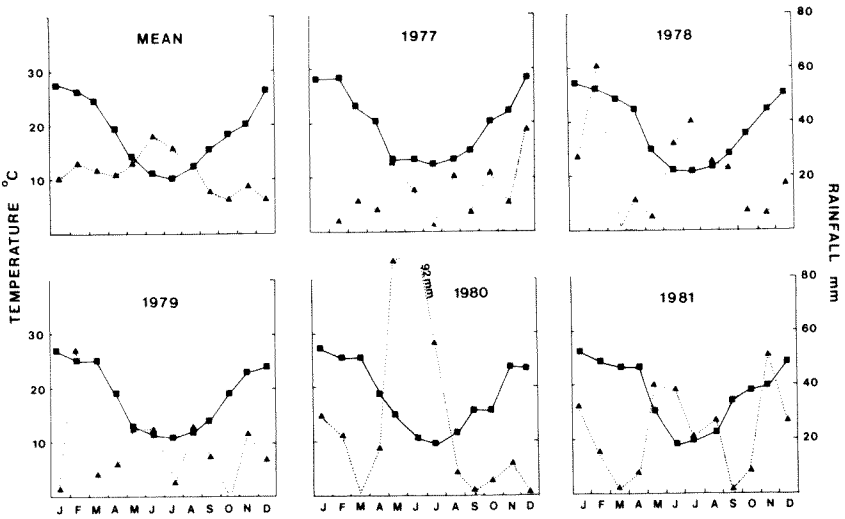

Figure 2 Ombrothermic diagrams showing the mean monthly rainfall and average monthly temperature for the years 1977-1981 and the long term mean. These figures incorporate data from the Bullfinch, Diemals, Kalgoorlie, Menzies and Southern Cross meteorological stations.

Rainfall

The average annual rainfall varies from 300 mm in the south-western corner to 265 mm in the north-eastern corner (Anon 1981). Winter is the wettest period in the west, grading to January-August being the wettest period near the eastern boundary. Winter rains consist mainly of small falls associated with the passage of cold fronts. Summer rains occur from thunderstorms or tropical cyclones that have denegrated into rain-bearing depressions. Individual falls are sporadic, unreliable and sometimes exceed 100 mm. The mean annual evaporation grades from *c.* 2780 mm at the southern boundary to *c.* 3100 mm at the northern boundary (Anon 1981).

Winds

During spring, summer and autumn most wind is from NE to SE, and grades from 6-20 km/hour near the western boundary to 11-30 km/hour near the eastern boundary. During winter the winds are predominantly W to NE, and grade from 0-10 km/hour in the west to 11-30 km/hour in the east. The monthly maxima recorded at Kalgoorlie were mainly 60-80 km/hour. The highest recordings were 138 km/hour (November 1979), 132 km/hour (October 1955) and 121 km/hour (May 1975). Physical damage to the vegetation was not sighted during field work.

Radiation

The average daily radiation grades from south to north (Anon 1975): January (800 to 825 $mWh.cm^{-2}$) and July (360 to 380 $mWh.cm^{-2}$).

Geology and Landforms

The geology of the Study Area is covered by the Jackson Sheet (Chin and Smith 1981) and the western half of the Kalgoorlie Sheet (Kriewaldt 1969). Archaean granites or gneisses underlie most of the Study Area. Later intrusions of Proterozoic granite are few and small. Trending NNW to SSE are linear belts of metamorphosed Archaean sediments of two distinct types. Greenstone consists of volcanic material, and banded ironstone formation consists of lacustrine deposits of iron oxides and quartz sands. Banded ironstone formation is more resistant to weathering than granites or gneisses and usually occurs as low ridges, hills or a mountain range. Greenstone weathers at rates between those of banded ironstone formation and granite. Mt Walter is an Archaean quartz intrusion.

Laterization occurred during the Cainozoic and alluvial, colluvial and aeolian deposits have formed since then. 'Gravel', nodules with concentric layers of iron oxides, developed during laterization and remains in patches of Sandplain soils.

The Study Area is within Salinaland of Jutson (1950). It has been tectonically stable for a great period of time and the last glaciation is believed to have occurred during the Permian (van de Graaff *et al.* 1977). As a result, most of the landscape has very little relief and slopes from north (470 m) to south (370 m). An extensive and almost flat plain developed and was dissected by sparse drainage lines during wet pre-Cainozoic periods. Under a succeeding dry climate the broad and shallow valleys of the major drainage lines became choked with colluvial, alluvial and aeolian deposits. Strings of shallow salt lakes have replaced the

drainage channels. The valley floors are 30-50 m below plain level. The highest point in the Study Area is Bungalbin Hill (684 m) that rises about 280 m above the surrounding plains.

As used in the present publication, the term 'granite' refers to all granitoid rocks. They all weather to similar soils that support vegetation of similar structure and species composition.

Landform Units

Newbey and Milewski have developed a classification of 10 units to describe the landscapes of the Eastern Goldfields. Seven of these units are present in the Study Area. They are shown in Figure 3 and briefly described below. The units not present are Drainage Line, Dune Field and Calcareous Plain. However, a few drainage lines were noted during field work but they were too small to be defined as Drainage Line; they consisted of either short (100-800 m) gullies originating from stony hills or narrow salinas connecting strings of salt lakes.

Breakaway (B): Underlying the plains is granite that has been highly weathered to a depth of several metres. The typical Breakaway occurs where the highly weathered rock has been laterized, and later exposed to case-harden the surface. Case-hardening is up to 2 m thick. The result is a summit with a shallow covering of soil and a rim with soil in shallow and small pockets. The back-cutting face has a scree slope. A pediment of colluvial material develops at the base. In the Study Area, breakaways to 20 m high were sighted. Occasionally, breakaways also form over banded ironstone formation and greenstone. Sometimes, breakaways are reduced to small areas where the weathered rock is only a few centimetres below the soil surface. Intermediates between this variant and the typical form were sighted during field work. Soil water regime is a major aspect of Breakaway. Shallow soils dry out quickly while the pediment receives run-off from the rim and scree slope.

Granite Exposure (G): The unit usually consists of exposed granite bedrock or intrusion, and a surrounding apron of skeletal to shallow soils overlying granite. The exposed granite varies from flat and a few metres across, to low domed and a kilometre wide. Aprons are 50-1,000 m wide. Sheets of skeletal or shallow soil may accumulate on the exposed granite but rarely cover more than 10% of the area. Another form of Granite Exposure occurs where the granite bedrock is within 1.5 m of the soil surface but it is not exposed. The soil is similar to that constituting the apron. An important aspect of the soils of Granite Exposure is the rate of change in their water regime. Thin soils dry out more quickly than thick soils. They also become waterlogged more quickly. Their soil moisture content is supplemented by run-off from adjacent bare rock. On the bare rock, small depressions, with ephemeral pools, are usually present. The depth of water rarely exceeds 35 cm.

Hill: Two sub-units are present based on bedrock type.

a. *Hill (banded ironstone formation)* (HI): The hills rise to 100 m above the surrounding plains and have stony slopes with bedrock exposures common on steep slopes and crests. The eroding upper slopes are inclined at 10°-20°, while the lower colluvial slopes are 5°-10°. Soils on the upper slopes are mainly skeletal, becoming shallow on the lower slopes. Aurora Range (15 km long) and Koolyanobbing Range (30 km long) are the most prominent features. Linear exposures of banded ironstone formation, up to 80 m wide, which occur with extensive areas of Undulating Plain (greenstone) support the same vegetation types as Hill (HI) and therefore have been included in that unit.

b. *Hill (quartz)* (HQ): Mt Walter rises about 65 m above the surrounding plains. Slopes of 5°-20° are covered with skeletal or shallow soils. Small exposures of quartz bedrock are common, however, low on the east side, a bedrock of greenstone was found in the area sampled.

Salt Lake Feature (L): The lakes are remnants of former drainage lines. They are flat-floored, and may be covered with up to 25 cm of water following floods. Peripheral to most lakes are dunes formed of material blown off the lake floor. Dunes are usually 1-2 m high but have been seen to 15 m. They are usually vegetated. Three distinct types of flats were associated with the salt lakes. The types are based on soil salt content and waterlogging.

a) Saline flats — up to 30 cm above the salt lake floor, highly saline and damp to waterlogged.

b) Damp flats — 15-30 cm above the lake floor but with a very low salt content.

c) Well-drained flats — 1-2 m above the salt lake floor and mainly well-drained.

Sandplain (S): The almost flat upland plain and the upper and middle valley slopes are referred to as Sandplain. The dividing line between Sandplain and Broad Valley is the change from erosional to colluvial valley slopes. Sandplain slopes rarely exceed 2° and the internal relief is rarely more than 15 m. Soils of the Sandplain have developed over a great period of time and have been laterized to some extent. In some places extensive sand sheets have developed with a major component of colluvium from slightly higher places on the Sandplain. Occasionally, vegetated remnants of small dunes from drier periods are present. The last major dry period appears to have occurred about 15,000 years ago (Bowler 1976). Definite drainage lines are absent but flows may occur over short distances following heavy and intense falls of rain.

Undulating Plain *(greenstone)* (UN): The unit consists of low rises and ridges interspersed with colluvial flats 50-500 m wide. Most rises and ridges are less than 5 m above the flats. Slopes on the latter rarely exceed 10°. Soils are shallow on the rises and skeletal amongst bedrock exposures on the ridges. Broad colluvial

flats are each drained by a single channel up to 1 m deep and 5 m wide. Soils of the colluvial flats rarely exceed 1 m in thickness.

Broad Valley (V): Broad Valley is the choked remnant of a former drainage system which was active under a higher rainfall regime than occurs now. The valley floors are flat to gentle-concave, with slopes of less than 2°, and 20-50 m below the surrounding Sandplain. The soils have an intricate history of *in situ* weathering, colluvial, alluvial and aeolian action. An important soil aspect is the calcareous B horizon. Valley carbonates have been largely leached from the surrounding Sandplain.

Freshwater

The only source of permanent freshwater are a few dams of 1,000-3,000 m^3 capacity constructed for agriculture, pastoral leases, mining or the Woodline. For the latter, the main drainage lines of Wallaroo Rock are dammed. Granite Exposure usually contains small depressions holding up to 50 cm of water following the rain. Gnamma holes are rare e.g. Pittosporum Rock.

Soils

The soils of the Study Area have been discussed by Northcote *et al.* (1968). During the present survey, soil data were recorded at each vegetation site. A summary profile for each soil type is presented in Table 1 and the correlations between soil groups, geology, landform units and elements, and vegetation are presented in Table 2.

All the Sandplain soils have been formed over a great period of time on a granite bedrock. They are highly leached, siliceous and slightly acidic. Deep Sands are common. Gravelly Sands occur on some low rises. Near the northern boundary of the Study Area are a few small areas of Sandplain where the A horizon contains a high proportion of colluvium from nearby banded ironstone hills. They are referred to Red Sands because of their closer resemblance to this soil group than Deep Sands. Deep Calcareous Earths are common on Broad Valley but occasional small patches of Cracking Red Clays or Meta-granitic Soils also occur there. Cracking Red Clays are also found on the floor of a freshwater claypan while Alluvium is present on the floor of the other claypan. Saline Soils, Sub-saline Soils and Aeolian Sands are present on Salt Lake Feature. The colluvial flats of Undulating Plain, greenstone, consist of Deep Calcareous Earths while Shallow Calcareous Earths are present on the rises and ridges. Granitic Soils occur on Granite Exposure. The inner apron is skeletal, as well as the soil sheets on the exposed bedrock. The outer apron consists of shallow profiles. Hill (banded ironstone formation), is covered with Red Sands – skeletal on the crest, upper and middle slopes, and shallow on the colluvial lower slope. Gritty Sands are similar on Hill (quartz). On Breakaway, Gritty Loams occur in small pockets on the rim, sheets on the summit, and as shallow pediments. The scree slope has skeletal and stony soil.

Table 1 Soil Groups occurring in the Landform units of the Jackson-Kalgoorlie area.

Soil Group	A horizon	B horizon	Bedrock
BREAKAWAY (B)			
Gritty Loams	5-35 cm, pH 6.0-6.5	If present, 10-40 cm, higher clay content than A horizon	Kaolinized granite
GRANITE EXPOSURE (G)			
Granitic Soils	3-30 cm, pH 6.0-6.5	If present, 10-90 cm, sandy clay	Granite
HILL, BIF (HI)			
Red Sands	5-200 cm, pH 6.0-6.5	Rarely present	BIF (quartz)
HILL, QUARTZ (HQ)			
Gritty Sands	5-50 cm, pH 6.0-6.5	Absent	Quartz
SALT LAKE FEATURE (L)			
Aeolian Sands	5-400 cm, pH 6.0-7.0, sand to loam	If present, higher clay content than A horizon	Unknown
Saline Soils	2-15 cm, pH 7.0	Multi-strata	Unknown
Sub-saline Soils	As above	As above	Unknown
SANDPLAIN (S)			
Deep Sands	50–>200 cm, pH 6.0-6.5	Sandy clay, pH <6.5	Granite
Gravelly Sands	15-100 cm, 20-70% gravel, pH 6.0-6.5	Sandy clay, pH <6.5	Granite
Red Sands	5-200 cm, pH 6.0-6.5	Rarely present	BIF
UNDULATING PLAIN, greenstone (UN)			
Deep Calcareous Earths	10-20 cm, pH 7.5-8.25	>100 cm, pH 8.0-8.25, carbonate nodules usually present	Greenstone
Shallow Calcareous Earths	5-30 cm, pH 8.0-8.25	Rarely present	Greenstone
BROAD VALLEY (V)			
Alluvium	2-100 cm, pH 5.75-6.75	If present, multistrata	Unknown
Cracking Red Clays	5-8 cm, pH 8.0	>100 cm, medium clay, pH 8.25	Unknown
Deep Calcareous Earths	10-20 cm, pH 7.0-7.75	>100 cm, pH 8.0-8.25, carbonate nodules often present	Unknown
Meta-granitic Soils	30-60 cm, pH 6.5	Not present	?Kaolinite

BIF = Banded ironstone formation.