

Chapter 2 – Regional Overview

2.1. LOCATION

This project focuses on understanding groundwater resources within a 150 km radius of Broken Hill. The region occurs in a remote part of far western New South Wales, extending across the state border into central eastern South Australia (Figure 1.1). The total study area is approximately 70,000 km² and, apart from the city of Broken Hill, minimal urban infrastructure exists. As shown by the digital elevation model in Figure 2.1, most of the region's north-east to south-west half occurs within the relatively flat and low-lying Murray-Darling Basin, where the ground surface is generally less than 100 metres above sea-level. Low, flat-lying terrain also extends across the sand-covered plains near Lake Frome, to the north-west of Broken Hill. A relatively uplifted north-east-trending zone dominates the central study area, with topographic relief commonly 200–250 metres. This upland region consists mainly of geologically old basement rocks (originally formed up to 1600 million years ago), and corresponds with the north-west margin of the present-day Murray-Darling drainage basin (Figure 2.1).

2.2. SURFACE HYDROLOGY

There are very few permanent surface water bodies in the semi-arid to arid Broken Hill region. The low level of annual precipitation, coupled with high evaporation rates (over ten times greater than the amount of rainfall) mean that most surface drainages are ephemeral features which flow only during short periods of excessive rainfall, e.g., following severe thunderstorm events. Similarly, many surface depressions in the region naturally form shallow surface water storages (lakes) following high levels of precipitation, but these are generally non-perennial features. The main surface water bodies in the area are the Darling River and Menindee Lakes, about 100 km south-east of Broken Hill (Figure 1.1).

2.2.1. The Menindee Lakes

The Menindee Lakes comprise of a group of nine shallow lakes adjacent to the lower Darling River in far western New South Wales (Figure 1.2), some 300 km upstream of its confluence with the River Murray. These are a series of perennial and non-perennial lakes with a combined surface area of 463 km² and a total storage capacity of 1750 GL, although this can be increased to 2050 GL under certain flow conditions. Prior to development of the Menindee water storage scheme in the 1950's–60's, the lakes were filled only intermittently during periods of high flow in the Darling River. Much of the water in the lakes would then drain back into the river, or be lost via very high rates of evaporation which occur in the region (estimated at close to 400 GL per annum; Maunsell, 2007). Under the natural flow conditions of the Darling River, the Menindee Lakes would commonly have contained low volumes of water, and parts of the system would have remained dry for prolonged periods.

The major lakes in the Menindee system are Cawndilla, Menindee, Pamamaroo and Wetherell (Figure 1.2). The lakes are owned by the NSW government, although the Murray-Darling Basin Commission (MDBC) regulates water released from the lakes until the total storage volume drops below 480 GL. When that trigger value is reached, control of the remaining water passes to the NSW government, and remains under their aegis until the stored volume subsequently exceeds 640 GL (known as the 480/640 rule). In their natural state most of the lakes were isolated from each other; the development of the water storage scheme connected the lakes and the Darling River with a system of weirs, channels and levee banks. The initial purpose of the Menindee storage scheme was to secure water supply for Broken Hill (via pipeline) and to foster economic development in far-western NSW through irrigated agriculture. The lakes have subsequently been used to contribute regulated water supply to parts of Victoria and South Australia under the Murray-Darling Basin Agreement.

The Menindee Lakes are an important asset for a host of environmental, social and economic reasons. The lakes represent a unique ecosystem in the semi-arid environment, and are highly important breeding grounds and food supply areas for many native fish and migratory bird species. The lakes are also culturally important for the local aboriginal people, with many burial and other sacred sites. Economically, the Menindee Lakes are a focal point for regional tourism and recreational activities, and also support irrigated agricultural enterprises.

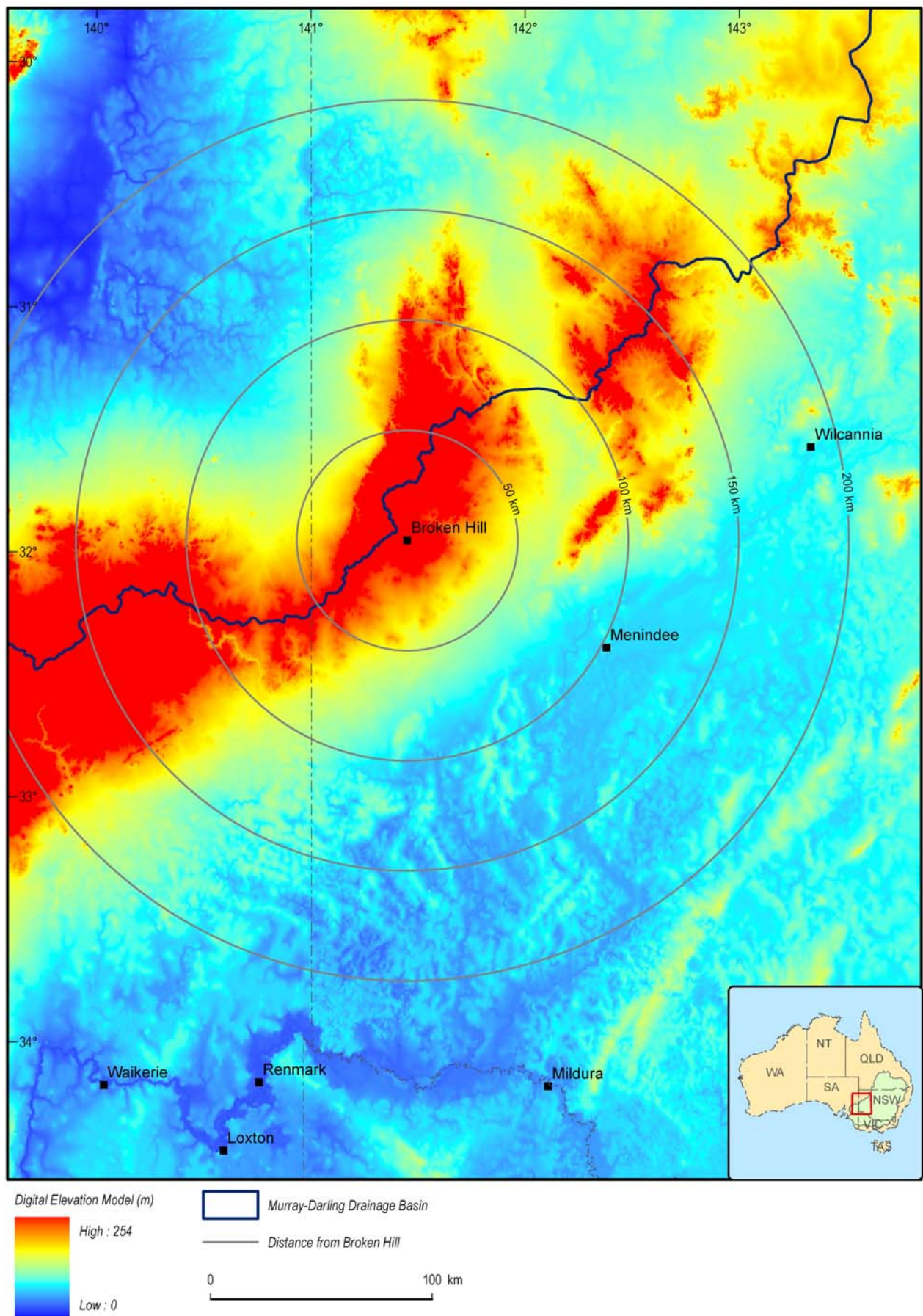


Figure 2.1: Shaded digital elevation model (DEM) of the Broken Hill region, based on the GEODATA 9-second DEM of Australia (version 2.1, which represents a 250 metre grid-size). The north-east trending zone of elevated topography cutting across the central part of the image corresponds with the oldest geological region in the study area.

2.2.2. Recent Inflows and Water Allocations for the Menindee Lakes

High rainfall throughout parts of the Queensland and northern New South Wales catchments of the Darling Basin resulted in approximately 800 GL of inflow to the Menindee Lakes between late December 2007 and April 2008. This inflow volume was in the upper 10th percentile compared to the historical record. Menindee Lakes achieved a maximum volume of about 620 GL stored in Lake Wetherell and Lake Pamamaroo, which effectively filled the surcharge volume of these lakes. By the end of August 2008 there was 511 GL of active storage (26 % capacity) in the Menindee Lakes (http://www.mdbc.gov.au/data/page/29/MDB_Water_Availability.pdf).

The existing water storage levels in the Menindee Lakes means that they are currently being managed by the NSW government (under the 480/640 rule). The water at present is fully committed to meet critical needs, such as ensuring that high security allocations in the lower Darling are available in 2008–09, securing ongoing water supply for Broken Hill’s urban requirements, supplementing critical supplies in the Murray Valley and providing possible tributary flows to underwrite the provision of critical human needs (if necessary). Final allocations for Darling River entitlement holders in 2008–09 are 100 % for high security users, and all licence holders have access to carryover from 2007–08. Thus, given that the existing surface water storages at Menindee are fully committed, and coupled with the problems of high evaporative losses and unfavourable projected climate patterns, conjunctive groundwater storage and supply options to help decouple Broken Hill’s water supply from Menindee warrant more thorough investigation.

2.3. CLIMATE

2.3.1. Overview

The Broken Hill region is generally hot and dry. Sparsely vegetated grassland and desert ecosystems occur within a semi-arid to arid climate. The area is characterised by low annual rainfall (average of between 200-250 mm/year) and high rates of evaporation (>2800 mm/year) (http://www.bom.gov.au/climate/averages/tables/cw_047031.shtml). Annual precipitation is highly variable, and mainly associated with thunderstorm activity and the showery remnants of tropical depressions during the summer months (Brown and Stephenson, 1991). The mean daily maximum temperature at Broken Hill is 24°C and the mean daily minimum is 12°C (Bureau of Meteorology). Summer maxima are commonly in excess of 35° C and temperatures may drop below zero during winter.

2.3.2. Seasonal Outlook for Winter and Spring 2008

The Bureau of Meteorology (BOM) reported on 26 June 2008 that most indicators of the El Niño event are now neutral and that the La Niña system in the Pacific Basin has dissipated. Neutral climatic conditions are expected to remain throughout the winter of 2008. The BOM’s seasonal climate outlook for August to October shows increased chances of drier conditions in both northern and southern parts of the Murray-Darling Basin, although the model estimates are of low to moderate confidence over the south. Central and eastern parts of the basin are expected to experience normal seasonal conditions.

The protracted nature of recent dry weather conditions, and consistent above average temperatures, has significantly dried out river catchments in the Murray-Darling Basin during autumn 2008. Even with continuing average rainfall in 2008–09, given the below average rainfall from March to June, inflows are likely to remain well below average. Full recovery of the system is projected to take at least several years of above average rainfall (Bureau of Meteorology).

2.4. GEOMORPHOLOGY

The study area comprises several distinctive geomorphic styles. These have differing landforms, geological compositions and vegetation systems, and include:

1. The Mallee Region;
2. Sand Plains;
3. The Darling River Valley;

4. Colluvial Foothlopes; and
5. Rocky Highlands.

2.4.1. Mallee Region

The major geomorphic features of the Mallee region are aeolian landforms and ‘mallee’ type vegetation (low, multi-stemmed eucalypt species). Wind-blown dunefields are widespread, and the region is dominated by internal drainage systems. Ephemeral and semi-permanent lakes (mostly dry) flanked by lunettes are commonly associated with the major drainages (e.g., the Darling River and the Darling Anabranche), ephemeral streams and isolated zones of groundwater discharge.

2.4.2. Sand Plains

Extensive areas of flat to gently undulating sand-covered plains occur in the Broken Hill region, especially around the Menindee Lakes and across much of the South Australian part of the study area (Figure 2.2). Vegetation is sparse and mainly consists of scattered mallee and hardy grasses such as spinifex. Low-lying sand dunes and localised fluvio-lacustrine depressions are widely dispersed on the plains. Incised stream channels are rare because rainfall runoff occurs mainly as sheetwash.



Figure 2.2: Typical sandplain terrain in the Broken Hill region, with scattered low-lying vegetation developed on red sandy regolith. The track leads to the groundwater bore and windmill at Farmcote Ext.1 on Redan Station, situated about 50 km south-east of Broken Hill (photograph taken October 2003 and used with the permission of Dr Patrice de Caritat, Geoscience Australia).

2.4.3. Darling River Valley

The floodplain landforms of the Darling River and Darling Anabranche occur within entrenched valleys which lie about 20 metres below the level of the adjacent aeolian land surface. In the Menindee Lakes area, the river floodplain and associated lakes are up to 100 km-wide and significantly disrupt the form and nature of the surrounding sand plains. However, aeolian processes also commonly modify the fluvio-lacustrine sediments of the floodplains. For example, the eastern margins of many ephemeral lakes are flanked by curvilinear lunette ridges (reflecting the dominant local wind direction), which may rise up to 40 metres above the level of the lake bed.

2.4.4. Colluvial Footslopes

Irregular deposits of colluvial talus and outwash sediments occur in relatively narrow zones adjacent to the north-western margins of the Murray Geological Basin. These flank the uplifted pre-Cenozoic bedrock terranes of the Broken Hill Block and the Adelaide Fold Belt, which include the Barrier Ranges. Valley-fill talus sediments are commonly coarse-grained and irregular-shaped, and may be cemented with iron-rich material precipitated from groundwater. Silcrete and calcrete deposits also occur. The outwash deposits comprise of much finer-grained sediments and have a laterally extensive fan-like architecture. In areas of sufficient thickness, the colluvial footslopes may be associated with localised groundwater resources (Section 5.3).

2.4.5. Rocky Highlands

Across the central part of the study area, away from the modern drainage system of the Murray-Darling Basin, is a relatively uplifted rocky highland region associated with the local geological basement, e.g., the Barrier Ranges (Figure 2.3). Bedrock crops out intermittently across these areas, commonly forming prominent sublinear-trending ridges. Well-developed fault scarps (some >50 km long) are associated with some major geological structures, e.g., the Mundi Mundi Fault. Thin surficial regolith and scattered low-lying vegetation obscure bedrock outcrop away from the ridges and scarps. Topographic relief is considerably more variable than the other geomorphic units, rising up to 473 metres above sea-level at Mt Robe in the Barrier Ranges.



Figure 2.3: Gently undulating rocky terrain with sparsely scattered vegetation is common in the vicinity of Broken Hill, seen here at Copper Mine Bore on McDougall's Well Station (photograph taken February 2000 and used with the permission of Dr Patrice de Caritat, Geoscience Australia).