Photographic Feature

Landsliding in an urban area

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Introduction and Setting

The city of Wollongong is nestled within a narrow coastal plain approximately 70 km south of Sydney in the state of New South Wales (NSW), Australia (Fig. 1). Over the last 150 years of settlement the population of the Wollongong area, extending from Helensburgh in the north to Windang in the south has increased to about 200 000 people. The coastal plain is triangular in shape with a coastal length of 25 km. It is widest in the south at Yallah (14 km) and narrows sharply towards the north, disappearing north of Thirroul. The coastal plain is bounded to the north, west and south by an erosional escarpment ranging in height from 300 m up to 500 m.

The escarpment consists of slopes with moderate to steep inclinations with several intermediate benches and cliff lines. Spectacular cliffs of Hawkesbury Sandstone (Middle Triassic) cap the escarpment and there is dense vegetation over most of the escarpment below these cliffs (Fig. 2).

The main road link to Sydney is the F6 freeway that traverses the escarpment via Mount Ousley Road. There are several other road links from the coastal plain to the top of the escarpment and there is a coast road to the north (Figs 3 & 4).

Processes and mechanisms of slope failure are basically controlled by factors such as geology, geomorphology and pore water pressure. Prolonged and/or intense rainfall is often the trigger for significant landsliding. The average annual rainfall for Wollongong varies from 1200 mm on the coastal plain near the city centre to 1600 m along the top of the escarpment.

Fig. 1. Location plan.

Geology

The geological bedrock sequence of the Wollongong area is essentially flat-lying with a low angle dip, generally less than five degrees, towards the NW. The geological units encountered include the Shoalhaven Group, the Illawarra Coal Measures (including intrusives known as the Gerringong Volcanic facies), the Narrabeen Group and the Hawkesbury Sandstone. The Narrabeen Group

Fig. 2. Escarpment with large rock fall debris flow near Dombarton railway siding, 1974. Photo by Young.

Fig. 3. View south from northern suburbs. Lawrence Hargrave Drive in foreground near base of cliff.

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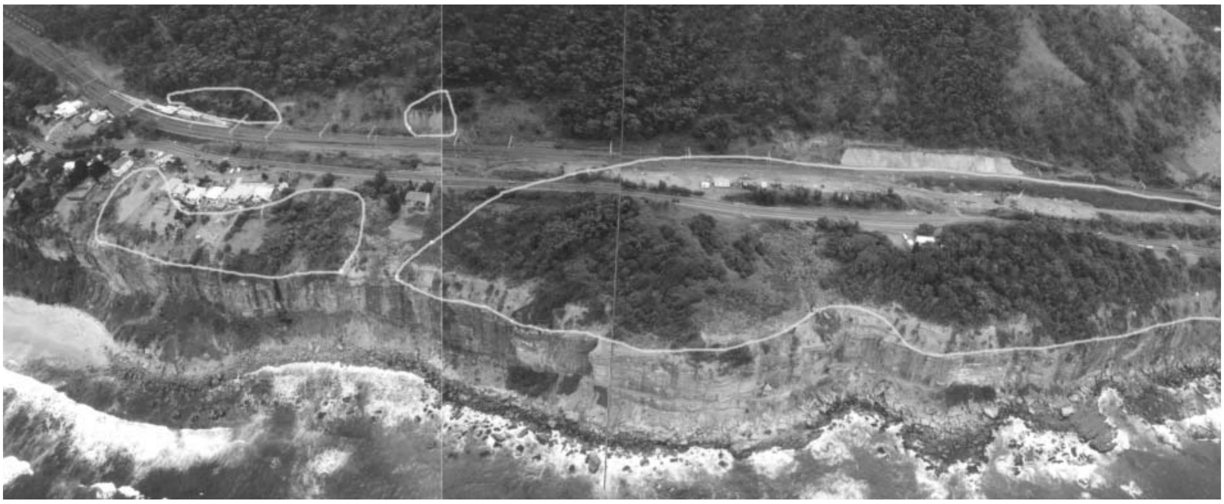

Fig. 4. Northern Coalcliff terrace and known instability, with the dual railway line, Lawrence Hargrave Drive and residential properties. Photo by Flentje 1992.

contains several claystone formations such as the Bald Hill, Stanwell Park and Wombarra Claystones. These claystone formations have been shown to have high correlations with the spatial distribution of landsliding (Flentje 1998).

The ground surface is frequently covered by debris of colluvial and/or alluvial origin. The colluvium comprises variably weathered bedrock fragments supported in a matrix of finer material dominantly weathered to sand, sandy clay and clay and brought down slope under the influence of gravity during the Quaternary period.

In recent years GIS based maps of geology and landslides have been prepared and printed at a scale of 1:4000. A comprehensive landslide database has been developed and subsurface movements and pore pressures have been monitored at a number of sites using inclinometers and piezometers (Flentje 1998; Flentje & Chowdhury 1999; Chowdhury & Flentje 1998).

A recent public enquiry on the Illawarra Escarpment considered slope stability as one of the major issues and recommended further research, better management and a freeze on further development of the escarpment (Commission of Inquiry 1999).

Landslides

A total of 478 landslides have currently been documented within the Wollongong Local Government area. The main landslide types in Wollongong are complex and composite slide-flows, debris-slides, debris-flows and rock-falls. Most of the landslides have volumes within the range from 100 m^3 to 100 000 m^3. Major rock-falls, such as the December 1969 Dombarton rock-fall, believed to have been triggered partly by mining subsidence, and shown in Figure 2 (volume 80 000 m^3) are infrequent relative to rainfall-triggered slides, small falls and flows in the middle and upper slopes.

The complex and composite slide-flow category poses a significant challenge to land management in the hilly suburbs of Wollongong (Fig. 4). Between major rainfall events these landslides typically move extremely slowly (16 mm per year according to WP/WLI (Working Party on World Landslide Inventory) 1995 in a 'slip and stick' fashion. Their re-activation leading to disruptive landsliding is a progressive, time-dependent and rainfall-triggered process.

An interesting example of other landslide types include the collapse of a 17 m high railway embankment at Coledale in the northern suburbs on the 30 April 1988 (Fig. 5). The slip surface first developed in the natural slope below the embankment and the catastrophic failure was caused by blocked drainage uphill and high pore water pressures in a layer of ash forming part of the embankment.

In the period 1887 to 2000 a total of 31 landslides of the 478 recorded, have destroyed 28 homes and caused significant damage to a further 55.

Fig. 5. Coledale Railway Station and Rawson Street Coledale debris flow, 30 April 1988. Photo by SRA.

Fig. 6. Close-up of one of several debris-flow source areas along toe of the deep seated slow moving Mount Kembla landslide, 20 August 1998. Photo by NSW Police.

Fig. 7. Complex slide-flow near residence above Harry Graham Drive in Mt Kembla, 20 August 1998. Photo by NSW Police.

During a recent rain-storm event in Wollongong, in August 1998, debris flows caused significant disruption to the city. Two debris flows inundated the suburb of Keiraville damaging several houses in their paths. Another debris flow that occurred during the night of the 20 August 1998 resulted in the 12 hour evacuation of a portion of the village of Mt Kembla, including approximately 50 houses and 130 residents (Fig. 6).

A complex debris slide-debris flow developed adjacent to a residence near Mount Kembla during the evening of the 17 August 1998 (Fig. 7). The rear main scarp of this landslide was approximately 7 m high. The displaced mass flowed downslope inundating a road that remained blocked for approximately 24 hours.

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Received 5 April 2001; accepted 5 July 2001.