
CHAPTER ONE



INTRODUCTION

1.1 BACKGROUND

Geoscience Australia's Urban Geohazards Group is assessing the risk of natural hazards to the Perth community through its Risk Modelling Project and Cities Perth Project. Natural hazards including flood, earthquake, landslide, severe wind and storm tide are studied on a regional scale in collaboration with State and Local Government Departments, the Fire and Emergency Service Authority of Western Australia (FESA), the Bureau of Meteorology and local stakeholders. The Project aims to increase awareness and understanding of natural hazard impacts. It also examines better ways in addressing the risks posed by natural hazards by providing policy makers and hazard managers with tools and information that will assist in mitigation. The ultimate outcome is the reduction of loss of life, property damage and economic disruption associated with natural hazards.

1.2 URBAN/REGIONAL SETTING

The City of Wanneroo is situated approximately 20 km north of Perth, Western Australia and has an approximate population of 88,401. The Local Government Areas (LGA's) in Perth increased in population by 7.3% during 1996-2001 (ABS, 2003). The pressure of new developments and the subdivision of land pose a risk to the Wanneroo community due to its geological setting. Numerous lakes, caves and sinkholes exist in Wanneroo as a result of the underlying carbonate bedrock which contains karst features. Urbanisation of karst regions is a geological hazard affecting 10% of the global population (Jennings, 1971).

In Australia, approximately 15% of the continent is karstic. However, due to a thick blanket of Quaternary sediments, only around 4% is exposed and mapped (Figure 1.1), (Gillieson & Spate, 2003). Australia's karstic areas are concentrated along the southern margin with the Nullarbor karst being one of the largest karst regions in the world. Small karstic regions are intermittently distributed around the eastern and western margins of Australia.



Figure 1.1 Distribution of karst in Australia

1.3 HAZARDS ASSOCIATED WITH URBANISATION ON KARSTIC AREAS

Karst terrains are driven by the hydrological cycle and generally refer to limestone regions with distinctive hydrology and landforms, resulting from increased rock solubility and heightened secondary porosity (Ford and Williams, 1989). Karstification results from geochemical, climatological and geomorphological processes that affect and expose soluble rock, soil and alluvium (Atapur and Aftabi, 2002).

Karst regions are sporadically distributed over the Earth and are generally located between 30° and 50° latitude north (Komatina, 1975). However, karst is encountered at all elevations and geographic latitudes that favoured the right climatic and geotectonic environments for carbonate deposition, followed by flowing water (Komatina, 1975).

There are many distinctive landform features that define karst terrains including: sinkholes (dolines), caves, dry valleys, tube structures, vaults and solution flutes (Figure 1.2a and b). Deep water tables, large springs and disappearing streams are also common characteristics (Atapur and Aftabi, 2002).

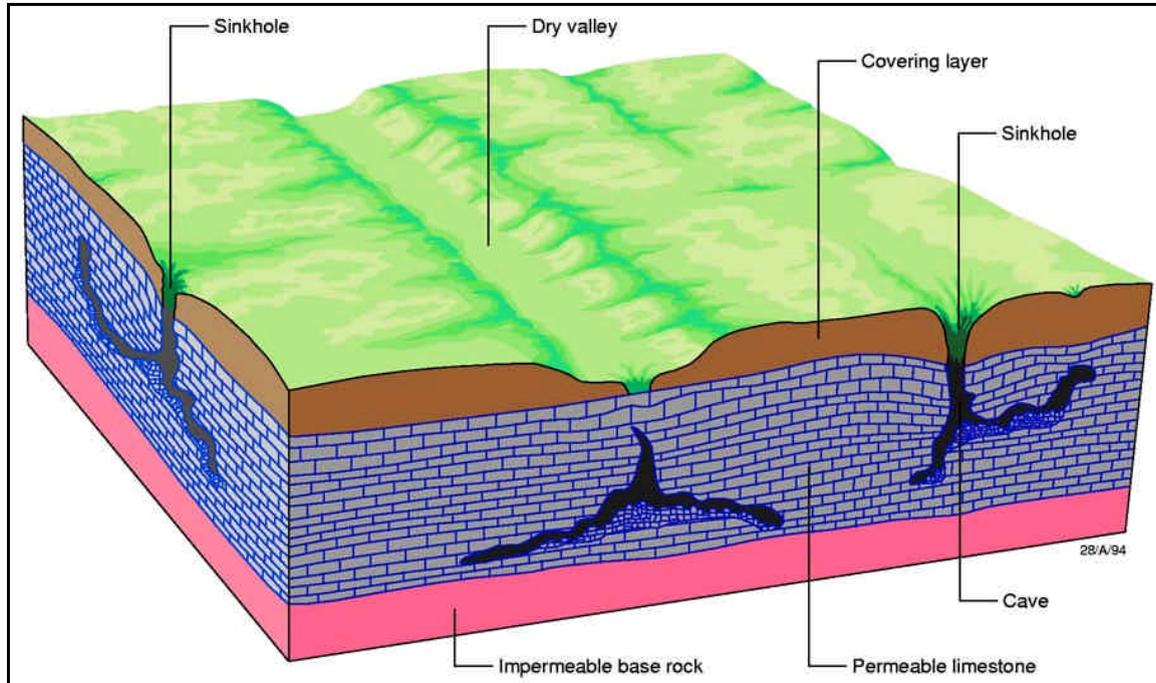


Figure 1.2a Block diagram of a karst terrain with varied karstic features and topography.

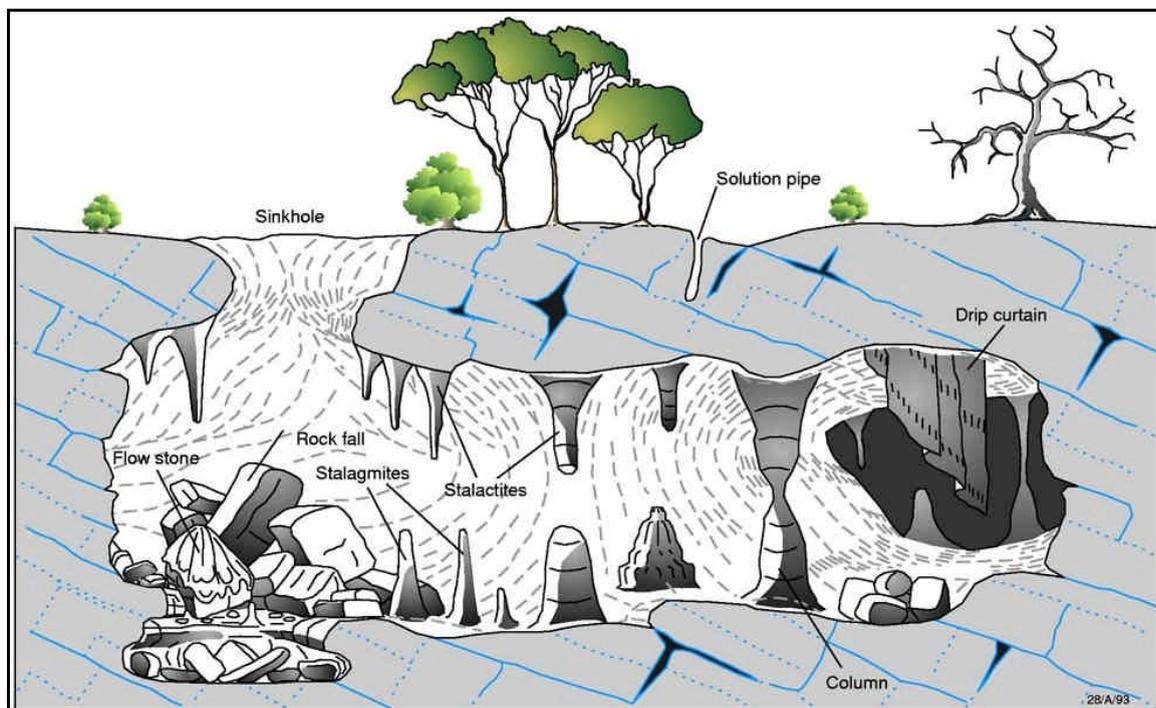


Figure 1.2b Schematic diagram of a 2-D, karst terrain with caves, solutions pipes and sinkholes

Often it is hard to separate human and natural impacts. However, human impacts occur at a faster rate than natural ones (Williams, 1993). Human induced impacts in karst environments have occurred due to cave occupation, deforestation, quarrying, mining, water exploitation, agriculture, urbanisation, tourism and recreation (Williams, 1993).

Human made impermeable surfaces such as highways, roofs and parking lots redirect runoff into various sinks posing a threat when the water table is low (Ford and Williams, 1989). Rerouting of stormwater can cause soil piping under neighbouring properties and damage properties outside their margins (White, 1988). Sinkholes can be associated with building failure, groundwater contamination and the draining of lakes and ponds (Thomas and Roth, 1999). Urbanization of karst terrains has caused flooding, pollution and ground collapse (Ford and Williams, 1989).

Surface collapse can be triggered by various mechanisms such as: wetting - including rainfall and snowmelt; droughts which result in drying; shaking by earthquakes; and loading by construction (Salvati and Sasowsky, 2002). However, a void must pre-exist. Loading events of small magnitude are a common cause for the formation of sinkholes. Human induced dynamic loading, blasting, vibrating equipment and vibro-compaction are frequent triggers, as are small earthquakes (Tharp, 1999). Air pressure sent transiently through a cave system produces stress below the soil voids and frequently causes partial soil structure collapse. This increases pore pressure, resulting in greater pore pressure gradient at the surface (Tharp, 1999). When structural failure occurs, it most likely related to pre-existing cavities or voids or overburden (Atapur and Aftabi, 2002).

Caves represent potential ground stability hazards to surface structures and engineering work (Wilson *et al.*, 1995). Caves and karst regions have been globally recognised as a geologic hazard with collapse and subsidence being of greatest concern (White, 1988). Collapse potential can only be evaluated by the nature and distribution of cave types within the region (Wilson *et al.*, 1995).

1.4 AIMS

This project has been carried out as part of Geoscience Australia's Graduate Program. The City of Wanneroo expressed concerns to the Geohazards Group regarding the hazards associated with urbanisation on karstic areas. Limited published work exists for the Wanneroo region and most knowledge is anecdotal. Therefore the aims of this project are:

- To identify the hazards associated with urbanisation of karstic areas in Wanneroo
- To identify ways at reducing karst-associated hazards
- To produce a karst hazard map (Appendix 2)

This report is intended to provide regional karst awareness within the Wanneroo Local Government Area and to promote the need for proper karstic documentation, hazard management and prevention measures. In addition to the report, a brochure 'Karst Hazards' was developed to promote karst awareness in Australia.