A predictive GIS methodology for mapping potential mining induced rock falls

Hani Zahiri
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A PREDICTIVE GIS METHODOLOGY FOR MAPPING
POTENTIAL MINING INDUCED ROCK FALLS

A thesis submitted in fulfilment of the requirements for the award of the degree

Master of Engineering by Research

from

UNIVERSITY OF WOLLONGONG

by

Hani Zahiri

B.Sc. Mining Engineering

School of Civil, Mining and Environmental Engineering

March 2006
IN THE NAME OF GOD

This thesis is especially dedicated to my family.

To my mother, Behjat Ayanfard, who taught me how to live and love and how to be,

To my father, Mahdi Zahiri, who taught me Erfan (mysticism) and how not to be,

To my sister, Hasti Zahiri, for her bright smile,

and also to my grandmother, Batool Ghari, for her love and support

I am truly grateful.
AFFIRMATION

I, Hani Zahiri, declare that this thesis, submitted in fulfilment of the requirements for the award of Master of Engineering by Research, in the School of Civil, Mining and Environmental Engineering, Faculty of Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The thesis was completed under the supervision of A/Prof. E. Baafi and has not been submitted for qualification at any other academic institution.

Hani Zahiri

March 2006

The following publications are the result of this thesis:


**Zahiri H., Brassington G.M., Baafi E.,** (2005), The use of the GIS based Weights-of-Evidence method for assessing mining induced rock fall, Sixth International Mining Geology Conference, Darwin, Australia, August 2006, 12 p. (Submitted)
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Abstract

Coal mining operations impact on various types of natural features, including cliff lines, steep slopes and natural watercourses. The introduction of longwall mining has led to subsidence depression due to the changing geometry of the mined out area. Subsidence can destabilise cliff lines and increase the probability of rock falls and cliff collapse. The current process for managing subsidence in New South Wales (NSW) involves the preparation of a Subsidence Management Plan (SMP).

One approach for managing the results of subsidence is to develop pre-mining methodologies for assessing potential mining impacts. This thesis deals with a quantitative Geographical Information Systems (GIS) based methodology for mapping potential mine subsidence-induced rock falls along cliffs and steep slopes along the Nepean River Gorge. The proposed methodology is developed using Weights-of-Evidence (WofE) method within a GIS framework to derive a probabilistic model of rock falls associated with mining-induced subsidence. The thesis uses ten (10) known mining-induced rock falls associated with longwall workings along the Cataract River to evaluate the impact of restricting mining to a region greater than 50 m of the Nepean cliffs. The results represent significant reduction of probabilities of rock fall occurrence when mining is conducted in this way.
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List of Symbols and Abbreviations

\( P(D|B) \)  
Conditional probability

\( \chi^2 \)  
Chi-square

A\{x\}  
Area covered by theme x

B  
Evidential theme

C  
Contrast

D  
Training theme

DEM  
Digital Elevation Model

DPI  
Department of Primary Industries

GIS  
Geographical Information System

GPS  
Global Positioning System

LN  
Necessity ratio

Logits\{x\}  
Logarithm of odd for x

LS  
 Sufficiency ratio

N\{x\}  
Count of unit cells in theme x

O\{x\}  
Odd for x

P\{x\}  
Probability of occurrence of x

S(C)  
Studentized Contrast

SDM  
Spatial Data Modeler

SMP  
Subsidence Management Plan

T  
Area of study

t  
Unit cell area

W^-  
Negative weight calculated for evidential theme

WofE  
Weights-of-evidence

W^+  
Positive weight calculated for evidential theme