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A predictive GIS methodology for mapping potential mining induced rock falls

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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:


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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.
# Table of Contents

Affirmation.......................................................................................................................... I
Acknowledgments................................................................................................................ II
Abstract................................................................................................................................. III
Table of contents.................................................................................................................. IV
List of figures........................................................................................................................ VII
List of tables........................................................................................................................ IX
List of symbols and abbreviations......................................................................................... X

## Chapter 1: General Introduction

1.1 Introduction............................................................................................................. 1
1.2 Managing subsidence impacts .............................................................................. 5
1.3 Definition of problem ............................................................................................ 8
1.4 Thesis objectives..................................................................................................... 9
1.5 Scope of work ........................................................................................................ 10

## Chapter 2: Geographical Information Systems (GIS)

2.1 Introduction......................................................................................................... 12
2.2 GIS functions ...................................................................................................... 14
2.3 Reasons for a GIS based approach ....................................................................... 15
2.4 Spatial datasets.................................................................................................... 16
2.5 Spatial analysis..................................................................................................... 19
2.6 GIS and spatial modelling................................................................................... 19
2.7 GIS and Weights-of-Evidence method ............................................................... 20

## Chapter 3: Weights-of-Evidence Method

3.1 Introduction......................................................................................................... 21
3.2 The Bayesian concept ......................................................................................... 23
  3.2.1 Odds and likelihood ratios ...................................................................... 27
  3.2.2 Combining datasets................................................................................. 29
3.3 Implementation of weights-of-evidence method .............................................. 32
## Appendix

<table>
<thead>
<tr>
<th>Reference</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Aspect function</td>
<td>A-1</td>
</tr>
<tr>
<td>A2 Classification methods</td>
<td>A-2</td>
</tr>
<tr>
<td>A3 Combine functions</td>
<td>A-4</td>
</tr>
<tr>
<td>A4 Curvature function</td>
<td>A-5</td>
</tr>
<tr>
<td>A5 Integer (INT) function</td>
<td>A-6</td>
</tr>
<tr>
<td>A6 Merge function</td>
<td>A-7</td>
</tr>
<tr>
<td>A7 Mosaic function</td>
<td>A-9</td>
</tr>
<tr>
<td>A8 Reclass function</td>
<td>A-10</td>
</tr>
<tr>
<td>A9 Slope function</td>
<td>A-14</td>
</tr>
</tbody>
</table>
List of Figures

Figure 1.1 Cross-section of longwall mine subsidence (Ecological Australia, 2004) .......................................................... 2
Figure 1.2 Characteristics of trough subsidence (Holla and Barcy, 2000) ................................................................. 3
Figure 1.3 Mine subsidence impacts on natural features in Southern Coalfield, NSW .................................................. 5
Figure 1.4 Rock fall over the Tower Colliery, Appin area, Southern Coalfield (Wood, 2004) ............................................................ 8
Figure 1.5 Potentially unstable block over Cataract River, Appin area, Southern Coalfield (Wood, 2004) .................................................. 9
Figure 1.6 Scope of work .................................................................................................................................................. 10

Figure 2.1 GIS functions (Davis, 2001) .......................................................................................................................... 15
Figure 2.2 Positional data in raster and vector format ........................................................................................................ 17
Figure 2.3 Raster and vector format (Martensson, 2000) ..................................................................................................... 18

Figure 3.1 Binary map showing the location of rock falls and venn diagram summarising the spatial overlaps relationship between the map pattern and the rock fall pattern (After Harris et al., 2000) ........................................................................................................... 26
Figure 3.2 Diagrammatic representation of the weights calculation in weights-of-evidence method (After Harris et al., 2000) .......................................................................................................................... 29
Figure 3.3 Schematic GIS based weights-of-evidence method procedures .................................................................................. 33
Figure 3.4 General procedure for weights-of-evidence implementation ............................................................................. 34

Figure 4.1 a) Southern coalfield and location of Collieries (circle shows the area of study)
   b) specified area of study and nearby Collieries .................................................................................................................. 37
Figure 4.2 Location of sections and instabilities (Wood, 2004) .............................................................................................. 39
Figure 4.3 Schematic of slope theme processing .................................................................................................................. 43
Figure 4.4 a) DEM, b) Cliff line shown by slope theme .......................................................................................................... 45
Figure 4.5 Slope-related themes a) Slope theme, b) Generated the area of study based on slope theme (Slope >40), c) Slope aspect theme .................................................................................................................. 46
Figure 4.6 Structural geology themes .................................................................................................................................. 48
Figure 4.7 The area of study showing the location of the existing and proposed mine workings ............................................... 49

Figure 5.1 Area of study and watercourse a) before editing  b) after editing ............................................................................. 53
Figure 5.2 Buffered watercourse theme based on distance from feature and training point locations .................................................. 54
Figure 5.3 Contrast and Studentized Contrast versus distance from watercourse .......................................................... 57
Figure 5.4 Weights for watercourse .................................................................................................................................. 58
Figure 5.5 The reclassified classes of slope theme .................................................................................................................. 59
Figure 5.6 Generalised slope theme, location of the training points and final weights .......................................................... 60
Figure 5.7 Cliff heights, theme attribute and training point locations .......................................................................................... 61
Figure 5.8 Contrast and Studentized Contrast values against Cliff heights .................................................................................. 62
Figure 5.9 Generalised cliff height theme and calculated final weights ..................................................................................... 63
Figure 5.10 Slope aspect theme and locations of training points ............................................................................................. 64
Figure 5.11 Generalised slope aspect theme and location of training points ............................................................................. 65
Figure 5.12 Planform (a) and profile curvature (b) before theme generalizing.........................66
Figure 5.13 Generalised plan curvature theme and calculated final weights .........................68
Figure 5.14 Generalised profile curvature theme and calculated weights............................69
Figure 5.15 Faults theme and location of training points.......................................................70
Figure 5.16 Dyke theme and location of training points........................................................70
Figure 5.17 Old Douglas Park theme, existing mine working and location of training points.....73
Figure 5.18 New Douglas Park theme, existing mine working and location of training points ....74
Figure 5.19 Generalised Old Douglas Park theme and the calculated weights.......................76
Figure 5.20 Generalised New Douglas Park theme and the calculated weights.....................77
Figure 5.21 Response theme showing the probability of the rock fall occurrence based on the Old Douglas Park longwall configuration .................................................................81
Figure 5.22 Response theme showing the probability of the rock fall occurrence based on the New Douglas Park longwall configuration ........................................................................81
Figure 5.23 Response theme showing the probability of the rock fall occurrence based on the New Douglas Park longwall configuration ........................................................................82
Figure 5.24 Response theme showing the probability of the rock fall occurrence based on the New Douglas Park longwall configuration ........................................................................82
Figure 5.25 Parallel snap shots taken from the old and new response themes .......................83
Figure 5.26 Classified Probability of rock fall occurrence against related area.......................84
Figure 5.27 Five areas of interest through which the model results are interpreted..................86
Figure 5.28 Mean probability for rock fall occurrence within each zone..................................87
List of Tables

Table 4.1 Selected evidential themes (representing controlling factors) ........................................41
Table 4.2 Evidential themes used in the case study ........................................................................50

Table 5.1 Calculated data in weighting tables for each evidential theme ........................................52
Table 5.2 Initial model parameters ................................................................................................52
Table 5.3 A summary table for the watercourse theme (Highlighted row shows cut-off distance of 76 m based on Contrast and Studentized Contrast) .................................................................56
Table 5.4 Slope weights ..................................................................................................................59
Table 5.5 Result of the primary weighting for cliff height theme (Highlighted row shows cut-off height, Contrast and Studentized Contrast at 47 m) .................................................................62
Table 5.6 Slope aspect theme weights ............................................................................................64
Table 5.7 Calculated weights for plan curvature theme .................................................................67
Table 5.8 Calculated weights for profile curvature theme ............................................................67
Table 5.9 Result of primary weighting for fault theme (highlighted row shows possible cut-off distance, Contrast and Studentized Contrast at 871 m) .................................................................71
Table 5.10 Result of primary weighting for dyke theme (highlighted row shows possible cut-off distance, Contrast and Studentized Contrast at 2773 m) .................................................................71
Table 5.11 Weights calculated for the Old Douglas Park theme ..................................................75
Table 5.12 Weights calculated for the New Douglas Park theme ..................................................75
Table 5.13 Summary of weighting results .....................................................................................78
Table 5.14 Degree of freedom between evidential themes ............................................................79
Table 5.15 Chi-square statistics calculated between evidential themes ........................................79
Table 5.16 Descriptive statistics of the probabilities of the response themes .............................84
Table 5.17 Statistical summary of Probabilities (%) of zones .......................................................86
## List of Symbols and Abbreviations

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(D</td>
<td>B)</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>Chi-square</td>
</tr>
<tr>
<td>A{x}</td>
<td>Area covered by theme x</td>
</tr>
<tr>
<td>B</td>
<td>Evidential theme</td>
</tr>
<tr>
<td>C</td>
<td>Contrast</td>
</tr>
<tr>
<td>D</td>
<td>Training theme</td>
</tr>
<tr>
<td>DEM</td>
<td>Digital Elevation Model</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Primary Industries</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>LN</td>
<td>Necessity ratio</td>
</tr>
<tr>
<td>Logits{x}</td>
<td>Logarithm of odd for x</td>
</tr>
<tr>
<td>LS</td>
<td>Sufficiency ratio</td>
</tr>
<tr>
<td>N{x}</td>
<td>Count of unit cells in theme x</td>
</tr>
<tr>
<td>O{x}</td>
<td>Odd for x</td>
</tr>
<tr>
<td>P{x}</td>
<td>Probability of occurrence of x</td>
</tr>
<tr>
<td>S(C)</td>
<td>Studentized Contrast</td>
</tr>
<tr>
<td>SDM</td>
<td>Spatial Data Modeler</td>
</tr>
<tr>
<td>SMP</td>
<td>Subsidence Management Plan</td>
</tr>
<tr>
<td>T</td>
<td>Area of study</td>
</tr>
<tr>
<td>u</td>
<td>Unit cell area</td>
</tr>
<tr>
<td>$W^-$</td>
<td>Negative weight calculated for evidential theme</td>
</tr>
<tr>
<td>WofE</td>
<td>Weights-of-evidence</td>
</tr>
<tr>
<td>$W^+$</td>
<td>Positive weight calculated for evidential theme</td>
</tr>
</tbody>
</table>