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**The Use of GIS and Remote Sensing  
to Identify Areas at Risk from Erosion  
in Indonesian Forests:  
A Case Study in Central Java**

A thesis presented in partial fulfilment of the requirements for the  
degree of Doctor of Philosophy  
in Natural Resource Management  
at Massey University, Palmerston North,  
New Zealand



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*[Since they have become oblivious of God] corruption  
has appeared on land and in the sea as an outcome of  
what men's hands have wrought: and so He will let  
them taste [the evil of] some of their doings, so that they  
might return [to the right path]*

*Ar Ruum 30:41*



## ABSTRACT

Environmental degradation and soil erosion begins when production forests are harvested. Unfortunately, logging cannot be avoided in plantation forests and since this operation can render the land more susceptible to erosion, any negative impacts need to be addressed properly.

Erosion potential is predicted by evaluating the response of land cover, soil and slope to the impact of rainfall and human activities. The role of remote sensing and geographical information systems (GIS) in erosion prediction is to collect information from images and maps; combine and analyse these data so that it is possible to predict the erosion risk.

The objective of this study was to produce a method to identify areas most susceptible to erosion and predict erosion risk. It is intended that the method be used particularly by forestry planners and decision makers so that they can improve forest management, especially during logging.

The study area was within Kebumen and Banjarnegara districts of Central Java, Indonesia. Imagery used included a Landsat 7 satellite image (28<sup>th</sup> April 2001) and panchromatic aerial photos (5<sup>th</sup> July 1993). Other data was derived from topographical, soil, and geological maps, and 10 years of daily rainfall data from 17 rainfall stations.

Predicting erosion in this study was done by combining rainfall, slope, geology, and land cover data. The erosion risk was predicted using land cover and soil type and depth. A rainfall map was generated using a thin plate spline method. A slope map was derived from a DEM which was generated by digitizing contours and spot heights from topographic maps. A geological map was derived from Landsat image classification with assistance from a 1:100000 scale geological map; and a land cover map was produced from an interpretation of the Landsat image and aerial photographs.

A stratified classification technique was used to delineate land covers in the study area with an accuracy of 44%. The low accuracy could be attributed to the complexity of the area and the temporal variation in the data acquisition.

The analysis of erosion risk showed that mixed forests and monotype forest experienced high and moderately high erosion risk. This condition supported the contention that harvest plans must incorporate soil conservation measures.

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## ABBREVIATIONS

asl	: above sea level
<i>Bakosurtanal</i>	: <i>Badan Koordinasi Survey dan Pemetaan Nasional</i> (National Coordinating Agency for Surveys and Mapping)
CRES	: Centre for Resource and Environmental Studies
DEM	: Digital Elevation Model
DN	: Digital Number
DOS	: Dark Object Subtraction
DPI	: Dot per Inch
ETM	: Enhanced Thematic Mapper
GCP	: Ground Control Point
GIS	: Geographical Information System
IDW	: Inverse Distance Weighted
ISODATA	: Iterative Self-Organizing Data Analysis
ITTO	: International Timber Trade Organization
LAI	: Leaf Area Index
<i>LIPi</i>	: <i>Lembaga Ilmu Pengetahuan Indonesia</i> (Indonesian Institute of Sciences)
NDVI	: Normalised Difference Vegetation Index
RGB	: Red – Green – Blue
RMS Error	: Root Mean Square Error
RTGCV	: (Square) Root of Generalised Cross Validation
RTMSE	: (Square) Root of Mean Square Error
SCS	: Sun – Canopy – Sensor
SFM	: Sustainable Forest Management
SJFCSP	: South Java Flood Control Sector Project
SPOT	: <i>Satellite pour l'Observation de la Terre</i>

STS : Sun – Terrain – Sensor  
USLE : Universal Soil Loss Equation  
UTM : Universal Transverse Mercator  
WRS : World Reference System

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