An Economic Assessment of Management Programs for Land Degradation on a Regional, Farm and Paddock Basis

A Thesis Submitted for the Degree of Doctor of Philosophy

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Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree.

I certify that, to the best of my knowledge, any help received in preparing this thesis, and all sources used, have been acknowledged.

Sandra Walpole

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All remaining shortcomings of this study are the responsibility of the author.

Abstract

This study is concerned with the economic assessment of programs to manage land degradation at a regional, farm and paddock level in New South Wales. It has been undertaken within an interdisciplinary framework by combining economic and environmental factors. The overall objective is to improve information for decision-making relating to the management of land degradation, through the integration of economic and bio-physical information. Despite increased funding support at Federal and State levels and a significant rise in the number of Landcare groups across Australia, land degradation continues to be a serious environmental problem. There is a lack of reliable information at various scales of management on the impact of land degradation on agricultural productivity, and the economic viability of land-management programs. Furthermore, few attempts have been made elsewhere to integrate economic and bio-physical data to provide prescriptive information to improve management decisions.

A method was developed to estimate the effect of land degradation on agricultural production from cross-sectional data. The analysis was conducted by estimating production functions, which include land degradation as a variable of land quality. Data sets were available on agricultural outputs and inputs such as gross value of agricultural production, area of land under agricultural production, labour, fertiliser and chemicals. Together with land-degradation data from a statewide survey of New South Wales (NSW), the relationship between agricultural output and land degradation was analysed at a regional level for NSW. Opportunity costs of forgone agricultural production were determined from these models to provide estimates of benefits from treatment for each of a number of agro-ecological regions. Costs associated with the management and repair of particular land-degradation types were then calculated. These benefits and costs were converted to present values, and benefit-cost ratios (BCRs) were calculated by region and for individual Local Government Areas (LGAs) within each region. The bio-physical and

management factors most influential in changing these BCRs were determined, and BCRs predicted according to these factors.

This method was then adapted to farm and paddock levels for an area near Gunnedah in north-western New South Wales. Personal interviews were conducted with 31 landholders, from which information on inputs and outputs to production for individual properties in a given financial year was gained. Data on a number of management factors were also recorded. Using an overlay of property boundaries on geographic information system (GIS) data, bio-physical information was determined for each farm. These bio-physical attributes included slope, terrain, land use, timber, erosion, soil type and soil-erosion control earthworks. Opportunity costs of forgone agricultural production were determined to provide estimates of benefits from treatment for each farm. The costs associated with the management and repair of soil erosion were then calculated. Having calculated the BCRs for each farm, the bio-physical and management factors that were most influential in changing these values were determined. Predictive modelling was then undertaken in the GIS, allowing the BCRs estimated at the farm level to be extended and interpolated across the study area.

A significant interdisciplinary contribution of this study is the successful integration of economic and bio-physical information. Using predictive modelling techniques in a GIS, economic information in the form of BCRs was integrated with bio-physical attributes, such as slope, soil type and land degradation, allowing the extrapolation and display of this information beyond conventional economic boundaries.

The main findings are as follows. (a) The general method of analysis was successfully applied at the regional, farm and paddock level. (b) Production functions estimated at the three levels of management showed that inputs such as area of land, labour, fertiliser and chemicals had a significant positive influence on agricultural output, and land degradation had a significant negative influence on agricultural output. (c) Benefit-cost ratios calculated at the regional, farm and paddock level indicate there are many profitable opportunities for undertaking management programs to combat or prevent land degradation.

Based on the above findings, recommendations are made for improving expenditure decisions at each of the management levels. At the regional level, the empirical results provide broad indicators of the impact of land degradation and where priorities should be given in terms of funding and management. At the farm and paddock levels, the

continued presence of profitable oppor unities for soil-conservation measures suggests that high levels of risk are involved ir this type of expenditure and that a risk-averse farmer may choose to invest elsewhere On the basis of the initial success of methods developed in this project, further resea ch that incorporates economic and bio-physical information in models is recommended.

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Abbreviations and Acronyms

AAGIS	Australian Agricultural and Grazing Industries Surveys
ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACIAR	Australian Centre for International Agricultural Research
AGPS	Australian Government Publishing Service
ASCC	Australian Soil Conservation Council
AUSLIG	Australian Surveying and Land Information Group
BCR	Benefit cost ratio
BPG	Breusch-Pagan-Godfrey (a heteroskedasticity test)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEST	Department of Environment, Sport and Territories
DLWC	Department of Land and Water Conservation
DSS	Decision Support System
DW	Durbin-Watson (an autocorrelation test)
E-RMS	Environmental Resource Mapping System
EPA	Environment Protection Authority
ESD	Ecologically sustainable development
FAO	Food and Agriculture Organisation
GIS	Geographic information system
GVAP	Gross value of agricultural production
ha	hectare
LGA	Local Government Area
LWRRDC	Land and Water Resources Research and Development Corporation
LRIS	Land Resource Information System
NPV	Net present value
NSW	New South Wales
OC	Opportunity cost

OLS	Ordinary least squares
pers. comm.	personal communication
PVB	Present value of benef t
PVC	Present value of cost
SCA	Standing Committee o ı Agriculture
SCARM	Standing Committee o ı Agriculture and Resource Management
t	tonne
TCM	Total catchment mana ement
TFP	Total Factor Productiv ity
UNE	University of New En gland
UNESCO	United Nations Educa ion, Science and Cultural Organisation
UNSW	University of New So ıth Wales
USLE	Universal Soil Loss E juation
WCED	World Commission or Environment and Development