Wind Erosion in SA – An Economic Perspective

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ABSTRACT:

Wind erosion has long been seen as a significant environmental issue within South Australia. But is it really an economic issue? This study suggests that even though it is acknowledged that wind erosion has an environmental cost, it is not economic to simply try and fix all wind erosion prone areas in South Australia. Land managers and therefore government policy needs to be selective about the areas they treat, and the strategies used, in order for there to be an economic benefit of ameliorating wind erosion in South Australia.

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The views expressed in this paper are the author's and should not be taken to represent the views of the South Australian Government.

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1. INTRODUCTION

Wind erosion of soil (that is, accelerated erosion since land was cleared) has long been considered as one of the major forms of land degradation not only in South Australia, but also Australia wide. Wind erosion is the process in which wind picks up soils from a particular point on the landscape and moves it to another. This is mostly seen as soil drift from one point in a paddock to another (local drift), or as raised dust (which comprises smaller, finer and easier to remove particles of soil), which can travel sometimes up to thousands of kilometres away.

In South Australia, around 13 million hectares of cleared land is used for agricultural purposes. About 6.8 million hectares of this land (56%) is susceptible[3] to wind erosion, with around 310,000 hectares (2%) being highly susceptible (see Appendix A for map). This land characteristically has sandy textured topsoils with a relatively loose structure (including many cleared sand dunes) (DWLBC, 2002). Of the land that has at least some potential for wind erosion, about 71% occurs in the lower rainfall zones (<400mm annual rainfall) where there can be considerable seasonal rainfall variability including droughts.

Changes in land management practices since the wheat-fallow period of the 1930s and '40s have greatly reduced the exposure of South Australia's soils to wind erosion but current levels of soil loss are still unstainable (EPA, 2003).

The challenge for South Australia is to increase the rate of adoption of financially viable land management strategies to reduce the economic impact of wind erosion. To date, this has been limited due to agronomic limitations, financial constraints, technical complexity of changes and varying land holder attitudes to soil conservation measures.

This paper highlights how the use of a Benefit Cost Analysis (BCA) can assist in the identification of the most viable options/strategies to address wind erosion, given the current costs, returns and technical assumptions relating to the applicable agricultural activities.

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[3] Minimal groundcover and/or unstable surface soil aggregation

2. BENEFIT-COST ANALYSIS

2.1 Methodology

A BCA is a decision making tool used in economics to try and quantify whether or not a particular project is worthwhile. Whether or not something is worthwhile is determined by comparing the associated benefits of a project (on-farm and off-farm including financial, social and environmental), with the associated costs (on-farm and off-farm including financial, social and environmental).

A BCA utilises two scenarios: a 'With Project ' scenario and a 'Without Project' scenario. The 'With Project' comprises the impacts, costs and returns that could be realised with the proposed program. In this study, the 'Without Project' is not a 'Do Nothing' scenario, but rather it takes into account the current trends (be it changes in productivity, strategy uptake etc) being realised currently.

For a project to be worthwhile, the associated benefits need to outweigh the associated costs (taking into account the 'With' versus 'Without' scenarios). Two of the most commonly used indicators to determine the worthwhileness[4] of a project are the:

- Benefit Cost Ratio (BCR), which is obtained by dividing the resulting benefits of a program by the costs; and the
- Net Present Value (NPV), which is obtained by subtracting the present value of the total project costs from the present value of the resulting benefits.

If the BCR is greater than 1 (and hence the NPV is greater than zero), then the project is said to be 'worthwhile' as it provides net benefits to the economy as a whole.

A time period of 20 years was chosen for the assessment period.

An important feature in the analysis is the assumption that a dollar available for spending today is more valuable than a dollar that won't become available until the future. This is due to the fact that if you had a dollar today, you could invest it and receive more than your dollar back in the future. Therefore it is necessary to discount future benefits and costs so that they are comparable with the current benefits and costs.

The rate of discount is the percentage rate of compound interest at which future benefits and costs are adjusted to their equivalent present-day values. A discount rate of 7 per cent was chosen, as it is the rate that is recommended in State Treasury guidelines for BCA's.

Sensitivity analysis was carried out by changing the values of some of the key variables in the model. Examples of the variables tested include: gross margins; yield effects of certain strategies; and the discount rate (see Section 2.4).

2.2 Identifying the Benefits

[4] Same meaning as economic viability

One of the major tasks when conducting a BCA is to determine the associated benefits and costs of the project in question. Benefits can either be direct (reducing the effects of wind erosion) or indirect (resulting from the implementation of strategies to reduce wind erosion), and these benefits could be realised at the farm level (private benefits) or regional level (public benefits).

2.2.1 Private Benefits

For this particular project, the private benefits identified included:

Direct:

- The value of an increase in yield from reduced soil fine loss (including organic matter, soil depth, soil biota and water use efficiency);
- The value of an increase in yield from reduced plant damage;
- The value of an increase in yield from reduced crop failure;
- The value of a decrease in fertiliser replacement;
- The value of reduced lamb mortality; and
- The value of a decrease in costs from reduced resowing; and
- Increase in gross margins of cropping and cropping and grazing industries due to paddocks not ploughed as early.

Indirect:

- Reduced stubble handling and tillage costs in cropping and grazing industries;
- The value of an increase in yield from cropping to land class;
- The value of an increase in yield from fencing to land class;
- The value of an increase in yield from feedlotting;
- The value of an increase in yield from planting perennial pastures;
- The value of an increase in yield from planting nurse crops in horticulture.
- The value of an increase in yield from clay spreading on non-wetting soils; and
- The value of an increase in yield from implementing reduced tillage.

2.2.2 Public (Non-Market) Benefits

Public benefits are the benefits that are realised off-farm (or in the wider community), due to strategies being implemented on-farm by farmers. For example, if a farmer erects a shelterbelt on their property, not only do they realise the private benefit of reduced soil loss due to wind erosion, but the wider community (society) benefits from an increase in biodiversity, reduced road accidents (due to increased visibility associated with less dust in the air) and the like. These off-farm impacts are termed externalities. An externality arises when other parties receive a benefit for which they did not pay, or incur a cost that they are not compensated for, during the production or consumption process of a firm (farmer).

These public benefits can sometimes be relatively large, and are very important to consider when assessing the case for Government investment. That is, suppose the wider community is potentially going to benefit from on-farm works conducted by private landholders. If the full costs of these works cannot be covered by the private benefits, then there may be some justification for government to subsidise this activity to enable more of this activity, and hence more publicly beneficial outcomes, to arise.

For this study, the following externality benefits from reducing wind erosion were identified:

- Increased public benefits from reductions in agricultural land susceptible to wind erosion;
- Increased public benefits from increases in revegetation on land prone to wind erosion;
- The value of decreasing cleaning costs for households and power transformers;
- The value of reduced road accidents due to poor visibility;
- The value of reduced airline diversion costs; and
- The value of decreasing costs associated with removing soil from roads.

It should be noted that some of the private and external benefits were conservatively estimated due to limited data, and in a couple of instances were not included in the analysis (eg Human health costs from dust in the air and reduced saline groundwater recharge from planting perennial pastures). It is therefore likely that the overall benefits of reducing wind erosion are likely to be higher than that proposed in this model.

2.2.3 Data Sources

The land use data used in this study was obtained from the Planning SA Digital Cadastre Database (DCDB) updated in July 2004. This database was then overlayed, using GIS mapping, to a recently updated (April - November 2004) environmental database of land susceptibility to wind erosion in South Australia. This environmental database was compiled by the Soil and Land Information group of the Department of Water Land and Biodiversity Conservation.

The DCDB database was chosen because it was the most up-to-date spatial set of land use data covering the whole of the State. This database provides a breakdown of agricultural activity to over 70 industries. As wind erosion does not affect all agricultural industries in the same way, the land use data was classified into four broad activities. These include:

- Cropping;
- Grazing;
- Cropping and Grazing[5]; and
- Annual Horticulture[6].

Data on the costs and returns (gross margins) was obtained from a number of sources. These included:

- Primary Industries and Resources South Australia, Horticulture Group;
- Primary Industries and Resources South Australia, ScoreCard 2003;
- EconSearch and Schofield Robinson Horticultural Services (SRHS); and
- Rural Solutions South Australia, Farm Gross Margin Guide 2004;

[5] For the purposes of this study, it has been assumed that an area designated as Cropping and Grazing will comprise of 2/3 Cropping and 1/3 Grazing
[6] Includes all horticulture except for perennial crops (Viticulture, Stonefruit, Nuts, and Citrus)

2.2.4 Assumptions

To conduct the BCA, assumptions needed to be made regarding the reduction in the area affected by wind erosion that was going to take place in the 'without plan' scenario, and the 'with plan' scenario'. These assumptions are listed by rainfall zone, land use, land class and management strategy over the page in table 1. Other assumptions regarding the impacts, costs and benefits are listed in Appendix E.

Table 1: 'With plan' Vs 'Without plan' Scenarios reductions in area affected by wind erosion after 20 years

	<400 mm Rainfall Zone		> 400 mm Rainfall Zone	
	WITHOUT	WITH	WITHOUT	WITH
Cropping Management Strategies for Wind Erosion for Class 2-4 land				
Cropped to land class	1.0%	5.0%	1.0%	5.0%
Min Tillage/No Tillage/Direct Drill	30.0%	60.0%	30.0%	60.0%
Shelterbelts	1.0%	5.0%	1.0%	5.0%
Alleys	0.5%	2.5%	0.5%	2.5%
Clayspreading	6.0%	6.0%*	6.0%	6.0%*
Grazing Management Strategies for Wind Erosion for Class 2-4 land				
Amt of land to be fenced	5.0%	20.0%	5.0%	20.0%
Amt of land to be destocked/feedlotted	30.0%	70.0%	10.0%	20.0%
Amt of land to be shelterbelts	1.0%	5.0%	1.0%	5.0%
Clayspreading	6.0%	6.0%*	6.0%	6.0%*
Cropping and Grazing together in 2-7 land				
Cropped to land class	0.6%	3.2%	0.6%	3.2%
Min Tillage/No Tillage/Direct Drill	19.4%	38.8%	19.4%	38.8%
Alleys	0.3%	1.6%	0.3%	1.6%
Clayspreading	6.0%	6.0%*	6.0%	6.0%*
Shelterbelts	1.0%	5.0%	1.0%	5.0%
Fenced to land class	1.7%	6.7%	1.7%	6.7%
Destocked/feedlotted	10.0%	23.3%	3.3%	6.7%
Perennial pasture	0.0%	0.2%	0.0%	0.2%
Cropping Management Strategies for Wind Erosion for Class 5-7 land				
Shelterbelts	1.0%	5.0%	1.0%	5.0%
Clayspreading	6.0%	6.0%*	6.0%	6.0%*
Grazing Management Strategies for Wind Erosion for Class 5-7 land				
Amt of land to be fenced	5.0%	20.0%	5.0%	20.0%
Amt of land to be destocked/feedlotted	30.0%	70.0%	10.0%	20.0%
Perennial pasture	2.0%	20.0%	2.0%	20.0%
Shelterbelts	1.0%	2.0%	1.0%	2.0%
Clayspreading	6.0%	6.0%*	6.0%	6.0%*
Horticulture Management Strategies for Wind Erosion for Class 2-7 land				
Min Tillage/No Tillage/Direct Drill	5.0%	25.0%	5.0%	25.0%
Nurse crops between rows and plots	5.0%	25.0%	5.0%	25.0%
Shelterbelts	1.0%	5.0%	1.0%	5.0%
Irrigation	4.0%	20.0%	4.0%	20.0%
Cover crops	5.0%	25.0%	5.0%	25.0%
Clayspreading	6.0%	6.0%*	6.0%	6.0%*

***** It has been assumed that the Clayspreading in the 'With Project' scenario takes place over 10 years (instead of 20 as in the 'Without Project' scenario).

Source: Giles Forward

2.3 Results

Table 2 below represents the overall results, giving the present values of the costs and benefits (including externalities), as well as the NPV and BCR, by region in South Australia. Table 3 provides a little more detail in that it highlights the resulting NPV and BCR by region and by rainfall zone.

Table 2: BCA Results of all Strategies by Region in South Australia

REGION	PV Benefits	PV Costs	NPV	BCR
Adelaide	$1,097,268	$475,900	**$621,368**	**2.31**
Outer Adelaide	$5,860,668	$2,009,643	**$3,851,024**	**2.92**
Murraylands	$146,427,456	$60,161,893	**$86,265,563**	**2.43**
South East	$121,463,570	$31,618,425	**$89,845,145**	**3.84**
Yorke & Lower North	$13,695,613	$6,578,167	**$7,117,447**	**2.08**
Eyre	$190,672,823	$91,169,639	**$99,503,185**	**2.09**
Northern	$34,479,763	$16,059,790	**$18,419,973**	**2.15**
TOTAL	**$513,697,161**	**$208,073,455**	**$305,623,705**	**2.47**

Table 2 above shows that there is definitely a case for addressing South Australia's wind erosion problems at a broad level. There is an opportunity for the state to gain $305 million in benefits over the next 20 years if it can ameliorate its wind erosion problem effectively. Even so, additional opportunities to increase the benefits to the state may exist, and more detailed analysis of the costs and benefits of each strategy is required.

Table 3: BCA Results of all Strategies by Region and Rainfall Zone for South Australia

REGION	< 400mm		400-500mm		> 500mm	
	NPV	**BCR**	**NPV**	**BCR**	**NPV**	**BCR**
Adelaide	$0	-	$339,408	2.16	$281,960	2.54
Outer Adelaide	$163,359	1.98	$692,915	2.35	$2,994,750	3.25
Murraylands	$43,812,548	2.04	$12,354,352	2.74	$30,098,663	3.75
South East	$8,501	2.00	$2,914,919	2.13	$86,921,726	3.99
Yorke & Lower North	$4,687,064	1.90	$2,067,847	2.64	$362,536	3.67
Eyre	$81,113,649	1.99	$11,133,134	2.62	$7,256,402	3.62
Northern	$17,180,630	2.12	$1,068,466	2.65	$170,877	3.70
TOTAL	**$146,965,750**	**2.02**	**$30,571,042**	**2.59**	**$128,086,913**	**3.88**

Tables 2 and 3 illustrate that the results varied not only by region, but also by rainfall zone. Not surprisingly, the highest rainfall zone (> 500 mm) returned the highest BCR of 3.88, while the lowest rainfall zone returned the most positive NPV of around $147 million (as 72% of land effected by wind erosion was in the <400 mm rainfall zone).

Tables 4 and 5 illustrate the NPV's and BCR's achieved by region, by industry and by management strategy. These numbers represent only the on-farm benefits of addressing wind erosion, and therefore exclude externality (off-farm) benefits.

This highlights the fact that net on-farm benefits can be achieved by all strategies except:

- Shelterbelts for all land uses in all regions;
- Alleys for Cropping and Cropping and Grazing industries in all regions;

- Fencing to Land Class for the Cropping and Grazing industry in the Murraylands, Yorke and Lower North, Eyre, and Northern regions;
- Destocking/Feedlotting for the Cropping and Grazing industry in all regions; and
- Nurse Crops, Irrigation, and Cover Crops for annual horticulture in all regions.

Even though some of the management strategies returned negative on-farm NPV's there still may be a case for them if they can create significant off-farm or externality benefits.

These off-farm benefits include things like reduced soil on roads (reduced cleaning costs and road accidents), reduced power transformer and household cleaning costs, reduced air traffic diversions, and benefits derived from values society places on increased perennial pasture and having less wind erosion prone land. Table 6 shows that if all wind erosion were addressed in South Australia, there are around $44 million in off-farm benefits that could be achieved.

Table 4: Net Present Values by Region, Industry and Management Strategy

NPV's	ADELAIDE	OUTER ADELAIDE	MURRAYLANDS	SOUTH EAST	YORKE AND LOWER NORTH	EYRE	NORTHERN
Cropping	$12,472	$58,057	$356,558	$402,550	$43,069	$163,633	$53,933
Cropped to land class	$774	$3,736	$26,948	$23,517	$3,616	$14,174	$4,624
Minimum Tillage	$5,534	$25,985	$167,488	$170,652	$21,626	$83,571	$27,398
Shelterbelts	($742)	($3,833)	($36,986)	($23,420)	($4,867)	($19,424)	($6,294)
Alleys	($569)	($3,040)	($31,169)	($16,294)	($4,552)	($18,416)	($5,944)
Clay spread	$7,474	$35,208	$230,276	$248,095	$27,245	$103,728	$34,149
Grazing	$91,323	$1,965,142	$38,956,960	$82,740,425	$885,029	$20,192,078	$13,045,500
Fenced to land class	$65,640	$1,353,082	$24,165,131	$49,365,518	$546,321	$12,745,502	$8,214,801
Destocked/Feedlotted	$1,295	$29,023	$892,168	$969,391	$65,879	$1,061,135	$1,000,783
Perennial Pasture	$9	$58,168	$4,448,898	$13,867,585	$23,096	$1,060,241	$123,010
Shelterbelts	($3,099)	($76,493)	($1,294,910)	($2,099,903)	($53,134)	($918,111)	($776,641)
Clay spread	$27,478	$601,362	$10,745,672	$20,637,834	$302,869	$6,243,310	$4,483,546
Cropping and Grazing	$24,621	$1,164,412	$24,474,342	$2,487,739	$4,499,309	$56,047,625	$2,226,036
Cropped to land class	$756	$39,995	$1,283,557	$76,157	$230,933	$3,033,894	$112,581
Minimum Tillage	$8,012	$401,649	$11,344,631	$808,401	$2,036,410	$26,696,575	$997,634
Alleys	($848)	($52,144)	($2,092,537)	($85,135)	($381,096)	($4,958,116)	($184,254)
Clay spread	$16,123	$816,861	$21,600,491	$1,626,650	$3,957,017	$50,196,432	$1,938,317
Shelterbelts	($1,342)	($81,285)	($3,158,761)	($134,810)	($576,304)	($7,471,056)	($278,785)
Fenced to land class	$1,513	$20,722	($4,212,209)	$155,426	($741,369)	($10,517,409)	($347,938)
Destocked/Feedlotted	($339)	($19,502)	($1,317,563)	($34,263)	($214,446)	($3,320,349)	($103,619)
Perennial Pasture	$747	$38,114	$1,026,733	$75,314	$188,165	$2,387,655	$92,100
Annual Horticulture	$466,477	$356,160	$10,795,478	$312,227	$4,054	$2,639	$0
Minimum Tillage	$412,475	$306,216	$9,093,478	$267,572	$2,641	$2,860	$0
Nurse crops between rows and plots	($243,035)	($173,310)	($4,988,597)	($150,706)	($786)	($2,116)	$0
Shelterbelts	($68,759)	($50,871)	($1,506,777)	($44,433)	($421)	($487)	$0
Irrigation	($27,041)	($19,264)	($554,080)	($16,750)	($85)	($237)	$0
Cover Crops	($62,026)	($44,231)	($1,273,140)	($38,462)	($200)	($540)	$0
Clay spread	$454,863	$337,620	$10,024,594	$295,006	$2,905	$3,158	$0

Table 5: Benefit Cost Ratios by Region, Industry and Management Strategy

BCR's	ADELAIDE	OUTER ADELAIDE	MURRAYLANDS	SOUTH EAST	YORKE AND LOWER NORTH	EYRE	NORTHERN
Cropping	**5.16**	**4.50**	**2.80**	**5.61**	**2.51**	**2.41**	**2.44**
Cropped to land class	-	-	-	-	-	-	-
Minimum Tillage	6.05	5.16	3.14	6.64	2.84	2.73	2.77
Shelterbelts	0.02	0.03	0.13	0.01	0.14	0.15	0.15
Alleys	0.01	0.02	0.07	0.01	0.08	0.08	0.08
Clay spread	14.15	11.84	6.22	15.61	5.46	5.14	5.25
Grazing	**3.31**	**2.91**	**2.99**	**3.73**	**1.97**	**2.33**	**1.98**
Fenced to land class	3.28	2.79	2.78	3.30	1.93	2.29	1.97
Destocked/Feedlotted	1.34	1.32	1.34	1.34	1.34	1.36	1.35
Perennial Pasture	16.35	10.29	12.60	15.92	9.11	10.69	9.23
Shelterbelts	0.19	0.17	0.18	0.18	0.16	0.17	0.16
Clay spread	9.55	8.12	8.10	9.59	5.61	6.67	5.71
Cropping and Grazing	**3.43**	**2.77**	**1.78**	**3.45**	**1.80**	**1.74**	**1.82**
Cropped to land class	-	-	-	-	-	-	-
Minimum Tillage	5.90	4.67	3.19	5.94	3.18	3.16	3.22
Alleys	0.01	0.02	0.07	0.01	0.06	0.07	0.06
Clay spread	13.27	10.29	6.20	13.37	6.28	6.05	6.36
Shelterbelts	0.22	0.21	0.21	0.22	0.21	0.22	0.21
Fenced to land class	1.39	1.08	0.66	1.40	0.67	0.65	0.68
Destocked/Feedlotted	0.47	0.52	0.62	0.47	0.62	0.62	0.62
Perennial Pasture	19.53	15.13	9.05	19.67	9.18	8.83	9.31
Annual Horticulture	**2.10**	**2.17**	**2.23**	**2.18**	**3.58**	**1.74**	-
Minimum Tillage	44.61	46.40	47.83	46.62	87.13	35.76	-
Nurse crops between rows and plots	0.01	0.01	0.01	0.01	0.01	0.01	-
Shelterbelts	0.01	0.01	0.01	0.01	0.00	0.01	-
Irrigation	0.07	0.08	0.08	0.08	0.10	0.07	-
Cover Crops	0.01	0.01	0.01	0.01	0.01	0.01	-
Clay spread	62.76	65.28	67.30	65.59	122.68	50.29	-

Table 6: Externality (Off-Farm) Values or Benefits of Addressing Wind Erosion by Region in South Australia

	ADELAIDE	OUTER ADELAIDE	MURRAYLANDS	SOUTH EAST	YORKE AND LOWER NORTH	EYRE	NORTHERN	TOTAL
Cost savings due to reduction in road clearance costs, road crashes and cleaning of power supplies ($) (all)	$3,615	$39,318	$1,576,264	$495,073	$228,517	$3,145,983	$433,433	$5,922,203
Public benefits associated with reductions in wind erosion problems	$17,311	$188,264	$7,547,547	$2,370,531	$1,094,198	$15,063,750	$2,075,385	$28,356,986
Public benefits associated with increases in Perennial Pasture/shelterbelts	$5,548	$79,671	$2,558,414	$1,036,600	$363,270	$4,887,478	$585,686	$9,516,668
Total Externality Values	**$26,474**	**$307,253**	**$11,682,226**	**$3,902,204**	**$1,685,986**	**$23,097,211**	**$3,094,504**	**$43,795,857**

2.3.1 Sensitivity Testing Results

The following variables were considered tentative in the model, and hence were the ones that were altered for the purpose of sensitivity testing. They included:

- The discount rate (which was changed from 7% to 5%);
- The average annual soil loss by industry;
- The impact on yield from soil losses; and
- The gross margins of all industries.

If all these factors were increased by 25%, then the results change considerably. Table 7 illustrates that there is now over $522 million that could be made by addressing wind erosion statewide.

Table 7: Sensitivity Testing of BCA Results for Regions in South Australia for all Agricultural Land (25% increase in soil loss, yield gains and gross margins)

REGION	PV Benefits	PV Costs	NPV	BCR
Adelaide	$1,642,025	$595,025	**$1,047,000**	**2.76**
Outer Adelaide	$8,784,007	$2,380,827	**$6,403,181**	**3.69**
Murraylands	$219,103,542	$71,724,350	**$147,379,192**	**3.05**
South East	$184,102,769	$37,146,808	**$146,955,961**	**4.96**
Yorke & Lower North	$20,309,174	$7,755,960	**$12,553,214**	**2.62**
Eyre	$283,498,635	$107,917,010	**$175,581,625**	**2.63**
Northern	$51,712,412	$19,347,772	**$32,364,640**	**2.67**
TOTAL	**$769,152,565**	**$246,867,752**	**$522,284,813**	**3.12**

2.4 Targeted Strategies Where NPV is Positive

Table 2 in section 2.3 highlighted that addressing wind erosion was economically viable in all regions of the State. Table 4 then went on to show that even though there were large benefits to be realised from addressing wind erosion using all the strategies identified, there may be further gains to be made by only implementing the economically viable management strategies on hand.

The aim of this section is to highlight that the net benefits could be greatly improved if land managers were 'smart' about which strategies they adopted to address wind erosion for particular industries in certain regions. That is, only implement the strategies returning net benefits.

2.4.1 Targeted Strategies Results

From table 4, the 'smart' management strategies include:

- Cropping to Land Class for Cropping and Cropping and Grazing industries in all regions;
- Clayspreading for all land uses in all regions;
- Implementing Minimum Tillage for Cropping, Cropping and Grazing, and Annual Horticulture in all regions;

- Fencing to Land Class for:
    - the Grazing industry in all regions;
    - the Cropping and Grazing industry in the Adelaide, Outer Adelaide and South East regions;
- Establishing Perennial Pasture for Grazing and Cropping and Grazing Industries in all regions; and
- Destocking/Feedlotting for the Grazing industry in all regions.

If these were the only management strategies to be adopted, then the results would look like those in table 8 below.

Table 8: Targeted Strategies BCA Results for Regions in South Australia for all Agricultural Land

REGION	PV Benefits	PV Costs	NPV	BCR
Adelaide	$1,063,856	$61,162	**$1,002,694**	**17.39**
Outer Adelaide	$5,490,751	$1,423,009	**$4,067,742**	**3.86**
Murraylands	$123,007,471	$27,957,405	**$95,050,067**	**4.40**
South East	$117,013,195	$28,426,077	**$88,587,118**	**4.12**
Yorke & Lower North	$9,982,579	$2,573,858	**$7,408,721**	**3.88**
Eyre	$140,363,593	$36,731,357	**$103,632,236**	**3.82**
Northern	$30,250,333	$13,221,388	**$17,028,945**	**2.29**
TOTAL	**$427,171,778**	**$110,394,256**	**$316,777,522**	**3.87**

Please note that table 8 is not directly comparable with table 2 above, as it does not include the externality benefits that are included in table 2. These targeted strategies have an externality benefit of around $40 million, making the total NPV equal to around $357 million.

2.4.2 Gains Due to Targeted Strategies

As highlighted in section 2.3.1 earlier, the NPV of addressing the issue at the State level was around $306 million. If land managers are smart about which strategies they use for certain industries in particular regions, then this number can be improved to $357 million, an increase of nearly $51 million. It is important however to look at the resulting BCA's for each case. The BCA in the base case was 2.47, and for the targeted strategies, 3.87. This shows that even though there is only $51 million in additional gains to be made, this is realised with $92 million less up front costs.

Given that in the targeted strategy approach there is now less actual land being treated for wind erosion (as not all strategies are applied in all regions and industries), the off-farm or externality benefits reduces from around $43 million down to about $40 million.

3. CONCLUSION

As the results show, the use of a BCA can greatly improve the level of detail about worthwhileness, not just for this wind erosion program, but also for any other project.

The results here suggest that even though it was viable to address wind erosion at the state level (NPV of $306m), there are significant further gains to be made by utilising the results of the targeted strategies approach identified in the BCA (approximately $357m).

With the significant level of benefits to be made, there is a case for addressing erosion, if not at the state level, then using the targeted strategies approach identified. However, to reap the most benefit out of addressing wind erosion, land managers need to understand their particular circumstances. This requires them to understand their soil's potential, as well as the most financially viable strategies for addressing their wind erosion problem, given their current soil's characteristics.

The benefits mentioned above however, come at a cost. The question then is who should be funding these on ground works to reduce wind erosion? The farmers?, as they are the ones reaping the private benefits from ameliorating wind erosion. The community/society?, as it benefits from reduced externalities associated with reduced wind erosion. The government?, as their land clearance policies of the past have lead to increased land degradation. This is something for the government and private land holders to negotiate, with a BCA as calculated here forming the base for an informed discussion around the public/private benefit split, and associated cost sharing arrangements.

4. FURTHER RESEARCH

After conducting the sensitivity analysis, the BCA was found to be very volatile to the gross margins used. Changing a gross margin from $100/ha to $200/ha, which is quite feasible given changing market conditions, has the same result as implementing a strategy that effectively doubles your productivity. There are not too many strategies that would claim to double productivity, highlighting the fact that getting these gross margins correct, or at least in the ballpark, is a very important matter. Further research into actual gross margins, not estimates or averages, by land use and region etc would greatly improve the BCA and usefulness of the results derived.

Provided that landholders understand their current and likely strategy mixes, surveys around the likely uptake rates of certain strategies would make the results of the BCA more reflective of the land management changes likely to take place in the near future.

There is also scope for some GIS presentation of the data inputs to improve some of the understanding related to Clayspreading. The soil susceptibility to wind erosion data could get mapped simultaneously with water repellence data. This would determine the extent of the indirect benefits associated with Clayspreading for wind erosion.

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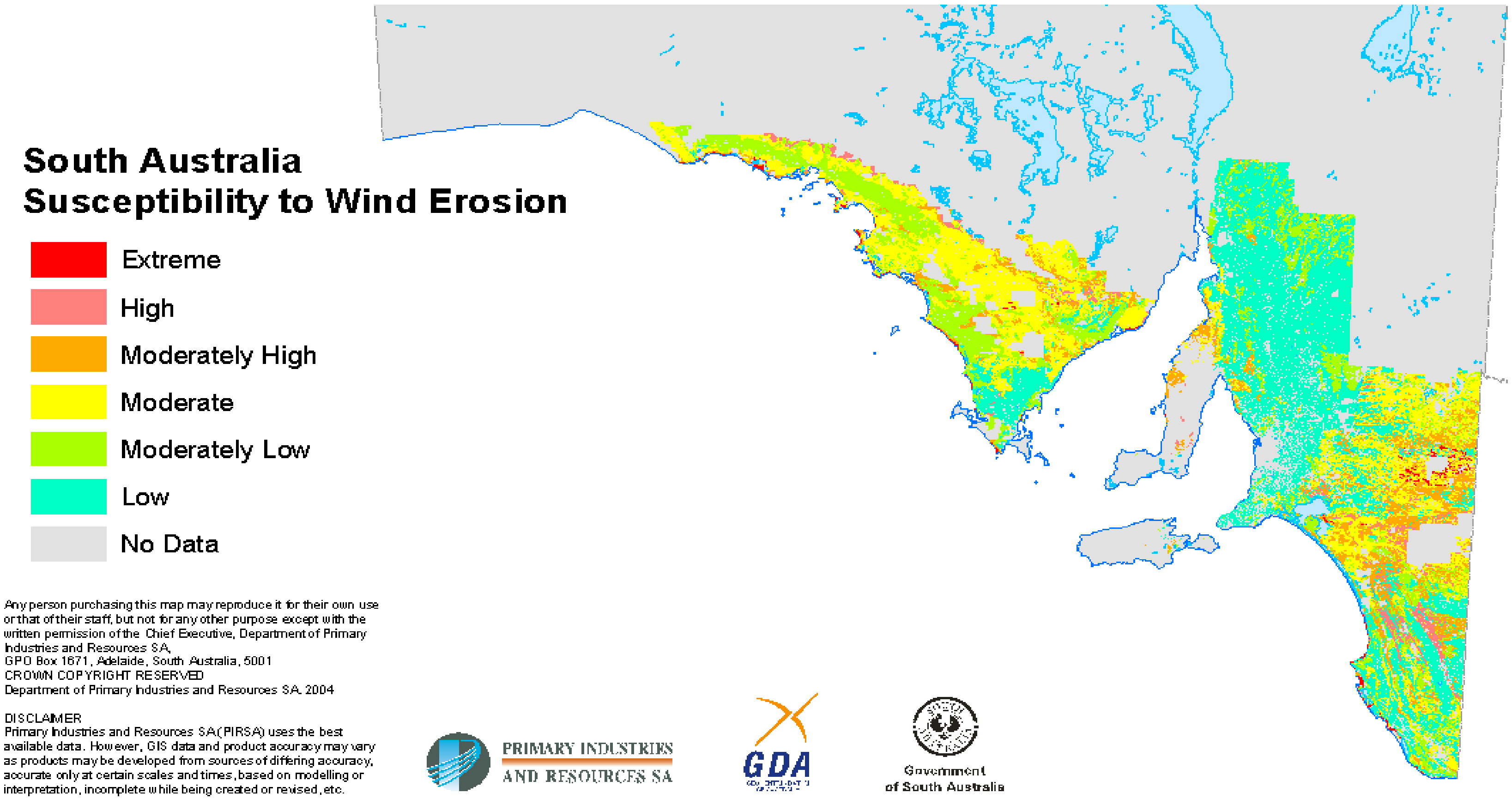
APPENDIX A: WIND EROSION POTENTIAL MAP



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GDA

Government of South Australia

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Soils Landscape - Supplied by Soil and Land Information Group, Department of Water, Land and Biodiversity Conservation
Datum - Geocentric Datum of Australia, 1994

APPENDIX B: LAND MANAGEMENT

Climatic extremes mean that wind erosion in South Australia can never be totally ameliorated. For example, strong wind events during droughts, may inevitably result in some wind erosion even where appropriate land management practices are used. This applies particularly to dryland annual agricultural cropping/pasture systems that rely on winter rainfall to produce seasonal plant growth and hence vegetative cover.

In the past decade or so, many landholders have adopted conservation farming systems or land management systems better suited to land capability, which have effectively minimised the risk and impact of wind erosion. However, not all farmers have made such changes, for a number of reasons. Changing from a more traditional multiple tillage pass cropping system to minimum till, particularly direct drill or no-till, usually involves significant initial capital outlay for the seeding implement etc., significant interdependent agronomic changes (weed, pest control etc.) a higher level of agronomic management and associated risks. The increased risk of herbicide resistance in weeds in intensive, no-till cropping systems is a major constraint to a high level of adoption. Changes to livestock management systems to minimise wind erosion risk are relatively achievable except in relation to the cost and practicality of fencing to segregate different land classes in many situations.

The actual level of risk that farmers are willing to bear will affect the actual rate of adoption of new farm management systems. More conservative farmers will predominantly prefer to stick with their conventional methods until they are certain there are benefits to be gained for them from changing their farming practices.

In addition, a landholder’s soil conservation ethic will have a significant bearing on decision-making in relation to land management practices. Some farmers do not properly recognise the soil degrading effects of wind erosion, and some actually believe that wind erosion can be associated with improved crop yields. In severe drought conditions where paddocks are largely bare, there can be the natural creation of a long fallow, which tends to reduce cereal crop diseases (DWLBC, 2002). A minority of farmers have the attitude that wind erosion is the product of adverse weather conditions rather than their (at risk) farming practices.

Finally, many farmers are in financial situations that make it very difficult to afford capital outlays for conservation farming strategies, or at least are able to do so in the short term.

B.1 Land Management Options

Effective management options for reducing soil susceptibility to wind erosion are those that achieve:

- Retention of adequate surface cover;
- Minimal disturbance of surface soil structure (maintenance of stable aggregation); and
- Substantial structures or vegetative shelterbelts in place to reduce the wind speed over the surface of the soil.

There are a number of strategies that land managers can adopt for achieving the above objectives. These include:

- Cropping to land class;
- Minimum tillage;
- Shelterbelts;
- Alley farming;
- Planting perennial pasture;
- Fencing to land class;
- Earlier destocking / feedlotting;
- Clay spreading;
- Irrigating;
- Cover crops; and
- Nurse crops.

These strategies will not be applicable to all land uses, eg. Fencing to land class is only applicable to land used for grazing.

To have maximum effect, the application of each strategy needs to be assessed in conjunction with the land use and land class, and hence wind erosion potential, of the soil.

APPENDIX C: SOIL EROSION RATES

Estimation of wind erosion rates on susceptible agricultural land in South Australia under various management systems is difficult due to the scarcity of data on actual erosion rates. During the dust storm event of May 1994, it was estimated that the quantities of topsoil in the dust plume over SA equated to about 8 million tonnes (Butler et al 1995). However, a proportion of this may have been sourced from the State's arid Rangelands, and hence it is unclear what proportion of this may have come from the State's agricultural soils.

There have also been numerous experimental attempts to calculate the rates of wind erosion on erosion susceptible soils in SA's lower rainfall regions (Leys et al – Various). These experiments used a wind tunnel to estimate the amount of soil lost from soils in an 'exposed' condition (insufficient plant cover and/or unstable aggregation), as well as the soil loss from areas that were deemed to be 'safe' (sufficient plant cover and stable aggregation). The results showed that there was typically a 10 to 20-fold difference in erosion rate, depending on whether the soil was 'exposed' or 'safe'. Limited measurement of actual wind erosion on some susceptible land on Eyre Peninsula (DWLBC, 2002) supported these experimental findings.

Table C2 below shows the estimated annual erosion rates for Cropping and Grazing properties in SA by rainfall zone based on that proposed in DWLBC, 2002. In this table, 'At Risk' means that the soil has insufficient plant cover and/or insufficient stable aggregation to control erosion, with 'Safe' meaning the soil has sufficient plant cover and stable aggregation. Erosion event categories and frequencies are based on 20 years of meteorological observations in South Australia (Williams and Young, 1999).

Table C3 depicts the same information for annual horticultural crops.

To determine the estimated soil loss in SA based on the data supplied by SALI, estimates of relative erosion risk factors for land use phases are also needed. That is, some land uses tend to cause soil to be eroded faster than others, and this needs to be taken into account when using the estimates provided. These relative erosion risk factors can be found in Table C1.

Table C1: Land Use Phase Relative Erosion Risk Factors

Cropping	0.9
Grazing	0.5
Cropping and Grazing	1
Horticulture	1

These estimates are based on several years of paddock scale erosion risk survey data (McCord and Payne, 2003) and 'local' experience. Overall, grazing phases are considered to result in half the relative erosion risk of cropping phases

Using tables C1, C2 and C3, we can estimate the average annual soil loss by rainfall zone for each different land use (Table C4).

Table C2: Cropping and Grazing Annual Erosion Rates in SA, by Rainfall Zone

Rainfall Zone	Erosion Event	Frequency #/year	% Land Affected 'At Risk'	% Land Affected 'Safe'	Erosion Rate 'At Risk' t/ha	Erosion Rate 'Safe' t/ha	Mean Erosion Rate t/ha	Annual Erosion Rate t/ha
< 400 mm	Severe	0.10	50%	50%	2.5	0.125	1.31	0.13
	Moderate	0.52	30%	70%	1	0.05	0.34	0.17
	Mild	15.80	5%	95%	0.025	0	0.00	0.02
	All							**0.33**
400 - 500 mm	Severe	0.09	30%	70%	2.5	0.125	0.84	0.08
	Moderate	0.26	15%	85%	1	0.05	0.19	0.05
	Mild	8.80	3%	97%	0.025	0	0.001	0.01
	All							**0.13**
> 500 mm	Severe	0.07	20%	80%	2.5	0.125	0.60	0.04
	Moderate	0.13	10%	90%	1	0.05	0.15	0.02
	Mild	5.00	2%	98%	0.025	0	0.001	0.00
	All							**0.06**

Table C3: Horticultural Annual Erosion Rates in SA, all Rainfall Zones

Rainfall Zone	Erosion Event	Frequency #/year	% Land Affected 'At Risk'	% Land Affected 'Safe'	Erosion Rate 'At Risk'	Erosion Rate 'Safe'	Mean Erosion Rate t/ha	Annual Erosion Rate t/ha
All	Severe	0.10	20%	80%	5	0.25	1.20	0.12
	Moderate	0.35	10%	90%	2	0.1	0.29	0.10
	Mild	12.00	2%	98%	0.05	0	0.001	0.01
	All							**0.23**

Table C4: Estimated Annual Soil Loss per Ha by Land Use by Rainfall Zone (t/ha)

	Rainfall Zone (annual rainfall)		
Land Use	**< 400 mm**	**400 - 500 mm**	**> 500 mm**
Cropping	0.29	0.12	0.06
Grazing	0.16	0.07	0.03
Cropping and Grazing	0.33	0.13	0.06
Annual Horticulture	0.23	0.23	0.23

APPENDIX D: LAND CAPABILITY CLASSIFICATION

Land Capability Classification is “a system used worldwide to classify land according to productive limitations and/or susceptibility to degradation” (DWLBC, 2002). The South Australian Department of Water Land and Biodiversity Conservation’s Soil and Land Information Group has classified all of the State’s agricultural soils into such classes.

“This assessment is intended to indicate where wind erosion could be a problem, given a particular set of conditions. The data do not refer to land where wind erosion has been or is currently a problem. The assessment is made according to inherent landscape characteristics, irrespective of vegetative or other protective cover which can vary significantly within and between seasons. Soil characteristics, mainly surface texture, and thickness of erodible soil material, together with topographic features, are used in assessing wind erosion potential. Class limits are adjusted for rainfall, on the basis that the higher the rainfall, the lower the long term potential for wind erosion” (DWLBC, 2004).

Table D1 outlines the extent of such classes across all regions in South Australia.

Table D1: Wind Erosion Potential of Agricultural Land in SA by Statistical Divisions

	Total Area	**Low**	**Moderately Low**	**Moderate**	**Moderately High**	**High**	**Extreme**	**% Of Total Area at Risk**
	All	**I**	**IIa**	**IIIa**	**IVa**	**Va**	**VIIa**	**(IIa, IIIa, IVa, Va and VIIa)**
Statistical Division	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)	(%)
Adelaide	44,288	35,247	8,171	752	112	2	4	20%
Outer Adelaide	490,823	414,673	46,044	21,293	6,968	1,815	30	16%
Murraylands	2,993,649	1,147,216	736,911	677,116	311,762	90,798	29,846	62%
South East	1,827,560	964,698	465,658	168,404	126,239	86,841	15,720	47%
Yorke and Lower North	1,217,751	967,964	148,977	42,058	53,830	4,661	261	21%
Eyre	3,797,369	434,959	2,324,040	835,580	124,127	52,912	25,751	89%
Northern	1,752,465	1,353,806	359,609	31,322	5,504	2,007	217	23%
Total	12,123,905	5,318,563	4,089,410	1,776,525	628,542	239,036	71,829	56%

APPENDIX E: MODEL ASSUMPTIONS

< 400 mm Annual Rainfall Zone					
	(Units)	**Cropping**	**Grazing**	**Cropping and Grazing**	**Annual Horticulture**
Average annual soil loss during wind erosion by industry	t/ha	0.29	0.16	0.33	0.23
Impact on gross margin of 1 t/ha soil fines loss	%/t/ha	0.64%	0.16%	0.48%	0.03%
Impact on gross margin due to reduced plant damage	%/t/ha	0.44%	0.11%	0.33%	0.00%
Impact on gross margin due to cropping damage losses	%/t/ha	0.35%	N/A	0.23%	N/A
Impact on gross margin from yield increase from clay spreading	%/t/ha	64.88%	56.54%	62.10%	21.39%
Impact on gross margin from reduced resowing costs	%/ha	0.50%	N/A	0.33%	N/A
400 - 500 mm Annual Rainfall Zone					
		Cropping	**Grazing**	**Cropping and Grazing**	**Annual Horticulture**
Average annual soil loss during wind erosion by industry	t/ha	0.12	0.07	0.13	0.23
Impact on gross margin of 1 t/ha soil fines loss	%/t/ha	0.64%	0.16%	0.48%	0.03%
Impact on gross margin due to reduced plant damage	%/t/ha	0.04%	0.01%	0.03%	0.00%
Impact on gross margin due to cropping damage losses	%/t/ha	0.07%	N/A	0.04%	N/A
Impact on gross margin from yield increase from clay spreading	%/t/ha	64.88%	56.54%	62.10%	21.39%
Impact on gross margin from reduced resowing costs	%/ha	0.00%	N/A	0.00%	N/A
> 500 mm Annual Rainfall Zone					
		Cropping	**Grazing**	**Cropping and Grazing**	**Annual Horticulture**
Average annual soil loss during wind erosion by industry	t/ha	0.02	0.01	0.02	0.23
Impact on gross margin of 1 t/ha soil fines loss	%/t/ha	0.64%	0.16%	0.48%	0.03%
Impact on gross margin due to reduced plant damage	%/t/ha	0.04%	0.01%	0.03%	0.00%
Impact on gross margin due to cropping damage losses	%/t/ha	0.05%	N/A	0.03%	N/A
Impact on gross margin from yield increase from clay spreading	%/t/ha	64.88%	56.54%	62.10%	21.39%
Impact on gross margin from reduced resowing costs	%/ha	0.00%	N/A	0.00%	N/A

Source: Giles Forward, DWLBC NWS Strategy 2002

Other Private Benefits of Reducing Wind Erosion	Unit	
Increase in gross margin from decrease in Lamb mortality	%	3%
Increase in gross margin from cropping to land class	%	10%
Increase in gross margin from fencing to land class	%	25%
Area affected from fencing to land class	%	200%
Increase in gross margin from feedlotting	%	4%
Increase in gross margin from Perennial Pastures	%	63%
Increase in gross margin from Implementing Minimum Tillage	%	6%
Increased biodiversity benefits from revegetation	$/ha	10.5
Increased social benefits from reduced wind erosion land	$/ha	2.4
Fertiliser replacement cost per tonne eroded soil	$/t	4.14
Area under cropping in cropping and grazing industry	%	0.67
Area under grazing in cropping and grazing industry	%	0.33
Area of Grazing in Sheep	%	50%
Public Benefits of Reducing Wind Erosion	**Unit**	
Cost of removing soil from roads	$/ha	0.01533
Reduced road accidents	$/ha	0.00034
Power Supplies	$/ha	0.03674
Household Cleaning	$/ha	0.44670
Reduced air traffic diversions	$/ha	0.00004

Source: Giles Forward
DWLBC Soils Database
NLWRA (2002)
Williams and Young (1999)

COSTS FOR ALL RAINFALL ZONES		
MANAGEMENT STRATEGY	**COST**	**UNIT**
Shelterbelts (Capital Cost Only - Not Forgone Production)	100	$/ha/one-off
Alleys (Capital Cost Only - Not Forgone Production)	202	$/ha/one-off
Perennial Pasture on Sandhills	100	$/ha/one-off
Fencing to Land Class	350	$/ha/one-off
Clay Spreading	300	$/ha/one-off
Cropping to land class	0	$/ha/pa
Minimum Tillage (including increased herbicides & pest control costs)	4.53	$/ha/pa
Horticulture - cover crops	30	$/ha/pa
Horticulture - nurse crops	117.5	$/ha/pa
Horticulture - irrigation	17.5	$/ha/pa
Earlier Destocking/feedlots (Not Forgone Production)	1	$/ha/pa
% of land lost under shelterbelts and alleys	20%	%/ha
% of land lost under destocking/feedlotting	2%	%/ha

Source: Giles Forward

Gross Margins by Land Use, Region and Rainfall Zone

	Adelaide	Outer Adelaide	Murraylands	South East	Yorke & Lower North	Eyre	Northern
< 400 mm Rainfall Zone	($/ha)	($/ha)	($/ha)	($/ha)	($/ha)	($/ha)	($/ha)
Cropping	168	168	168	168	168	168	168
Grazing	253	179	237	198	214	248	219
Cropping and Grazing	196	172	191	178	183	195	185
Annual Horticulture	6393	6649	6855	6681	12500	5121	6745
400-500 mm Rainfall Zone							
Cropping	345	345	345	345	345	345	345
Grazing	253	179	237	198	214	248	219
Cropping and Grazing	314	290	309	296	301	313	303
Annual Horticulture	6393	6649	6855	6681	12500	5121	6745
> 500 mm Rainfall Zone							
Cropping	524	524	524	524	524	524	524
Grazing	390	345	380	387	357	366	369
Cropping and Grazing	479	464	476	478	468	471	472
Annual Horticulture	6393	6649	6855	6681	12500	5121	6745

Source: 2004 Farm Gross Margin Handbook, Rural Solutions SA, PIRSA
2004 ScoreCard, Corporate Strategy and Policy, PIRSA
Horticulture Unit, Rural Solutions SA, PIRSA (Personal Communication)
EconSearch (2000)
EconSearch et al (2004)