Appendix B: Processes, examples and results for prioritising investment

B.1 Data sources, types and quality

The data used in the GIS analysis was obtained from the Corangamite Catchment Management Authority, Department of Sustainability and Environment, Department of Primary Industries and the University of Ballarat.

The data are three distinct types: factual data, derived data and interpretive data.

Factual data includes the located polygons, lines and points representing an asset (lake, road or stream) or threatening process (landslide or gully). This data provides the highest resolution data for targeting the exact intersection of the asset and threat.

Derived data is either interpolated or classified from factual data, such as land-use polygons classified from satellite imagery or aerial photographs. Derived data is useful for determining areas of interest, but cannot generally be used to specify locations.

Interpretive data layers are those where a value is assigned to a particular landscape parameter, usually delineated as a polygon, to represent the data value. As an example, landform units are assigned a number to indicate their susceptibility to soil waterlogging, soil structure decline or soil acidification. Interpretive data provides a much broader intersection of threats and assets, compared to factual or derived data.

Intersecting assets and potential soil-threatening processes

The intersection of assets with soil-related threatening processes was undertaken using MapInfo GIS (version 8), with Vertical Mapper (version 3.1) and Encom Discover (version 7.1) as additional tools. The Spatial Query Language (SQL) tool in MapInfo allows for three main types of queries:

- contains (object A contains object B if B's centroid is anywhere within A's boundary)
- within (object A is within object B if its centroid is within B's boundary)
- intersects (object A intersects object B if they have at least one point in common).

An SQL query can be written to instruct the program to count objects, sum the area or perimeter of objects (and other functions), and report the results in a particular order.

Care was taken to ensure that the SQL queries did not misrepresent the data by reporting a misleading result. For example, where two polygons – gully erosion polygon and native vegetation with very high conservation significance potential – intersected, the area of native vegetation potentially threatened by the gully was reported as the overlapping area of the polygons. Whereas, if the gully intersected the 50-metre buffer zone alongside a waterway, then the area of the entire gully was counted as the threat to the waterway. The results are outlined in the next section of this Appendix.

In the GIS analysis, it was recognised that each process may not potentially threaten each asset. For example, soil waterlogging may not be a threat to a wetland and it could be argued that a loss of soil waterlogging would be more threatening. The relationship of assets to potential threatening processes was determined at a meeting of the Corangamite SHS Steering Committee.

B.2 Relative severity of threats

The relative severity of threatening processes has a greater range to account for the variation in the types of data used. Some threats, such as a landslide or gully erosion sites, have been mapped to a high resolution and are represented by discrete polygons which have a relatively small area of intersection with an asset, such as a road or stream. By contrast, the area of land with a high susceptibility to soil structure decline is mapped at a very coarse scale (i.e. a large polygon), and the area of intersection with an asset such as the land used for cropping is generally quite a large number. To adjust for the different data sets, threats with high resolution (e.g. gully erosion), have been assigned a Relative Severity Factor (RSF) of 5, whereas the high threat of soil structure decline has been assigned an RSF of 100 *(Table B1)*. Because division was used in the calculations, the lower the RSF for a threat, the higher was the resolution and confidence in the data. Conversely the higher the RSF for a threat, the lower was the resolution and confidence in the data.

Factual Data	
Threat	**Relative Severity Factor (RSF)**
Gully erosion	5
Sheet/rill erosion	5
Landslides	3
Secondary salinity	10

Factual Data		
Threat	**Relative Severity Factor (RSF)**	
Susceptibility to soil structure decline	Very High High Moderate	50 100 150
Susceptibility to soil waterlogging	Very High High Moderate	50 100 150
Susceptibility to soil nutrient decline	Very High High Moderate	50 100 150
Susceptibility to soil acidification	Very High High Moderate	50 100 150
Susceptibility to soil erosion by wind	Very High High Moderate	50 100 150
Potential acid sulphate soils		25

Table B1: Relative Severity Factor (RSF) assigned to threatening processes

B.3 Example calculation of relative risk

As an example, the relative risk to assets for the threatening process of soil waterlogging in the Upper Barwon Landscape Zone was calculated using the interpretive data, as tabulated in *Table B2*.

Waterlogging only impacts on agricultural production, therefore other asset classes in which waterlogging does not have an impact was given an RSF of zero. This means that all waterlogged areas that overlap with conservation, urban and peri-urban areas were not included in the final Relative Risk Value. The RSF for very high waterlogging susceptibility was 50 and is the highest likelihood of risk to agricultural production. The RSF for high waterlogging susceptibility was 100 and moderate waterlogging was 150 as the likelihood of risk is lower. The RSF is divided in the calculations, therefore the lower the RSF number, the higher the risk value.

The totals for all asset classes were added to determine the overall risk value for waterlogging in the Upper Barwon, which in this case was 233. However, because landscape zones vary in size, larger landscape zones are likely to have higher Relative Risk Values than smaller landscape zones, as there is more land area to be susceptible. To measure waterlogging and other soil-threatening processes amongst landscape zones, the total risk values were multiplied by the percentage of area they cover within the Corangamite region. This standardised the values in a fair way. However, with landslides and erosion, because actual sites were used in the analysis these were not standardised according to the size of the landscape zone *(Table B2)*.

Asset	RAV	Very high susceptibility (hectares)	RSF	High susceptibility (hectares)	RSF	Moderate susceptibility (hectares)	RSF	Total Relative Risk
Land use								
Conservation	0	966	50	1903	100	2926	150	0
Urban	0	19	50	167	100	66	150	0
Peri-urban	0	0	50	96	100	14	150	0
Horticulture	5	0	50	141	100	0	150	7
Dairy	4	0	50	1903	100	2926	150	154
Cropping	3	0	50	3035	100	563	150	102
Grazing	2	4755	50	33255	100	15865	150	1067
Forestry	3	200	50	1741	100	15367	150	372
Animal Production	7	0	50	0	100	0	150	0
Raw Total								**1702**
Normalised to CCMA region (the raw total is multiplied by 7.3%, which is the proportional area of the Corangamite CMA region covered by the Upper Barwon Landscape Zone)							**Final total**	**233**

Table B2: Calculation of relative risk from soil waterlogging in the Upper Barwon Landscape Zone

By contrast, the relative risk to assets for the threatening process of gully erosion in the Upper Barwon Landscape Zone was calculated using the factual data, as shown in *Table B3.* The main difference between gully/tunnel erosion and waterlogging, is that gully/tunnel erosion has the potential to impact on all asset classes. Therefore, if there was an overlap of erosion with any asset class, the figure was included in the final Relative Risk Value.

The other difference is that actual mapped gully erosion sites were used in this calculation, therefore a much lower RSF number was used to produce a high Relative Risk Value. Unlike waterlogging, because actual gully sites were used, no standardised processes were needed to make the results consistent amongst the varying sizes of landscape zones *(Table B3).*

Asset	RAV	Actual area under threat (hectares)	RSF	Relative Risk Value
Land use				
Water Supply	10	0	5	0
Conservation	10	7	5	13
Urban	9	0	5	0
Peri-urban	7	0	5	0
Infrastructure	10	0	5	0
Horticulture	5	0	5	0
Dairy	4	0	5	0
Cropping	3	0	5	0
Grazing	2	68	5	27
Forestry	3	40	5	24
Animal Production	7	0	5	0
Mining	8	0	5	0
Public Land	7	82	5	114
Conservation	10	31	5	62
Wetlands	10	85	5	170
Waterways	10	124	5	249
Roads	10	42	5	85
				Total 743

Table B3: Calculation of relative risk from gully erosion in the Upper Barwon Landscape Zone

The combined relative risk for each threatening process is illustrated in *Figure B1*, showing that landslides present the greatest relative risk to assets, and wind erosion the least relative risk. It is stressed that the risk values are relative, and not absolute values.

B.4 Sensitivity analysis

Since the ranking of the relative risk is dependent on both the RAV chosen for assets and the RSF assigned to the soil-threatening processes, an analysis was undertaken to determine the sensitivity of the calculations. A series of tests were conducted where the RAV and/or the RSF were significantly changed (e.g. doubled) and the final results compared.

Overall, the outcomes were much the same, indicating the relative insensitivity of the calculations to the RAV and RSF. Even though the values were significantly changed in the sensitivity analysis, the final ranking of the soil-threatening processes within a landscape zone and between the landscape zones remained virtually unchanged.

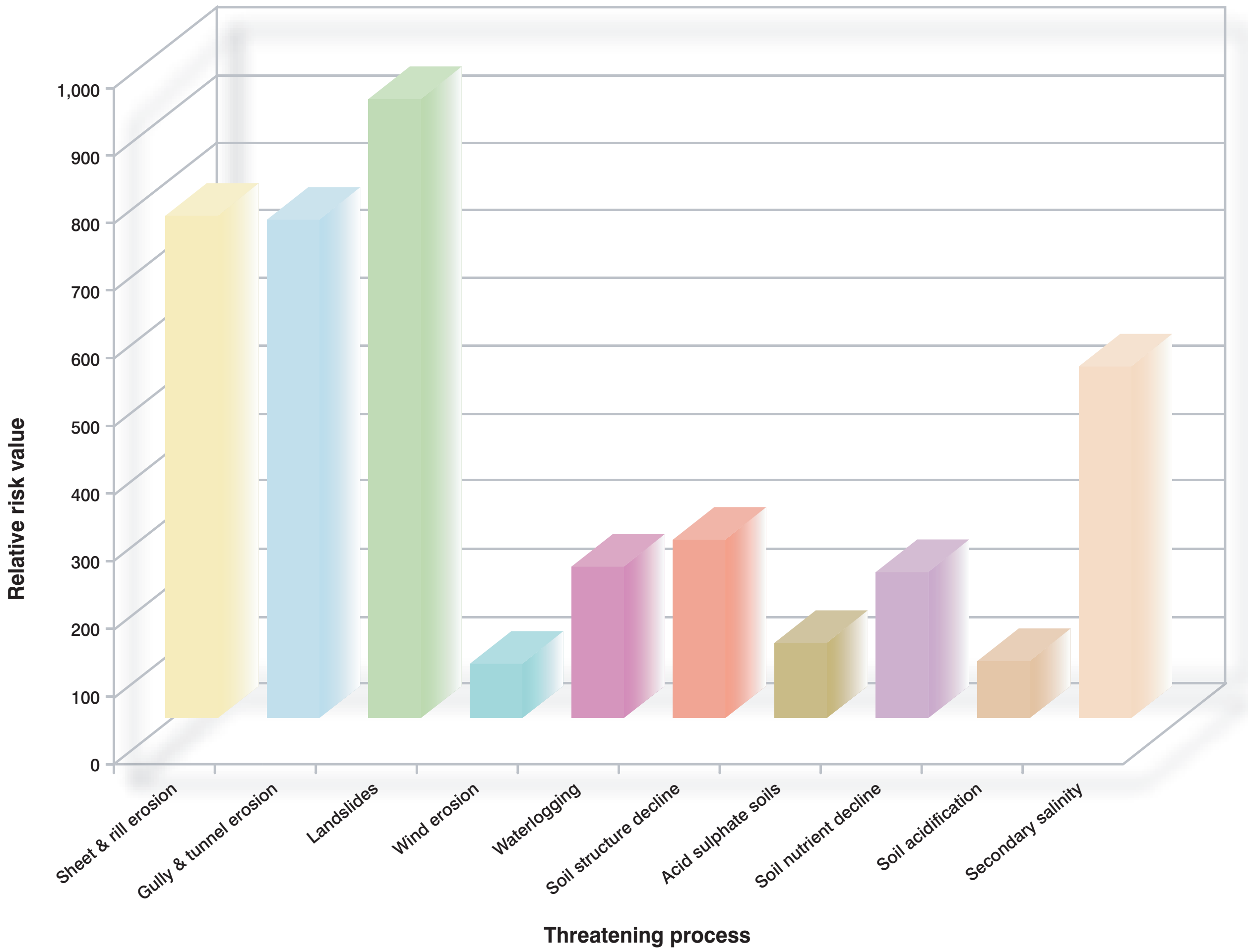

Figure B1: Relative Risk Values for the Upper Barwon Landscape Zone

B.5 Relative Risk Values for all threats across all landscape zones

Rank	Threat	Landscape Zone	Relative Risk Value
1	Landslides	Gellibrand	3167
2	Secondary Salinity	Lismore	2886
3	Acid Sulphate Soils	Bellarine	2748
4	Gully/tunnel Erosion	Woady Yaloak	2501
5	Sheet/rill Erosion	Woady Yaloak	2317
6	Secondary Salinity	Stony Rises	1925
7	Landslides	Curdies	1903
8	Landslides	Otway Coast	1872
9	Sheet/rill Erosion	Thompsons	1804
10	Secondary Salinity	Woady Yaloak	1646
11	Sheet/rill Erosion	Moorabool	1154
12	Secondary Salinity	Murdeduke	1090
13	Gully/tunnel Erosion	Leigh	938
14	Landslides	Upper Barwon	917
15	Gully/tunnel Erosion	Moorabool	893
16	Sheet/rill Erosion	Upper Barwon	752
17	Gully/tunnel Erosion	Upper Barwon	743
18	Sheet/rill Erosion	Leigh	734
19	Acid Sulphate Soils	Thompsons	557
20	Landslides	Aire	548
21	Secondary Salinity	Upper Barwon	525
22	Landslides	Thompsons	518
23	Acid Sulphate Soils	Hovells	506
24	Secondary Salinity	Leigh	502
25	Secondary Salinity	Bellarine	485
26	Waterlogging	Curdies	482
27	Sheet/rill Erosion	Hovells	444
28	Secondary Salinity	Gellibrand	424
29	Soil Structure Decline	Curdies	416
30	Acid Sulphate Soils	Aire	402
31	Secondary Salinity	Curdies	399
32	Acid Sulphate Soils	Gellibrand	398
33	Sheet/rill Erosion	Gellibrand	336
34	Gully/tunnel Erosion	Bellarine	317
35	Secondary Salinity	Middle Barwon	296
36	Sheet/rill Erosion	Middle Barwon	294
37	Soil Structure Decline	Gellibrand	273
=38	Waterlogging	Gellibrand	270
=38	Soil Nutrient Decline	Gellibrand	270
=40	Soil Structure Decline	Upper Barwon	268
=40	Soil Structure Decline	Middle Barwon	268
42	Waterlogging	Middle Barwon	257
43	Soil Structure Decline	Stony Rises	256
44	Waterlogging	Stony Rises	254
45	Acid Sulphate Soils	Woady Yaloak	246
46	Soil Structure Decline	Hovells	244
47	Secondary Salinity	Hovells	243
48	Gully/tunnel Erosion	Hovells	236
49	Secondary Salinity	Thompsons	233
=50	Waterlogging	Upper Barwon	232
=50	Waterlogging	Woady Yaloak	232
52	Waterlogging	Moorabool	230
53	Waterlogging	Lismore	228
54	Soil Structure Decline	Woady Yaloak	227
=55	Soil Structure Decline	Otway Coast	225
=55	Acid Sulphate Soils	Lismore	225
57	Soil Structure Decline	Moorabool	219
58	Waterlogging	Murdeduke	218
59	Soil Nutrient Decline	Upper Barwon	217
60	Soil Nutrient Decline	Stony Rises	211
61	Soil Nutrient Decline	Otway Coast	197
=62	Soil Structure Decline	Murdeduke	196
=62	Waterlogging	Leigh	196
64	Wind Erosion	Thompsons	195
65	Soil Structure Decline	Leigh	192
=66	Soil Structure Decline	Thompsons	184
=66	Soil Nutrient Decline	Aire	184
68	Soil Nutrient Decline	Curdies	175
69	Soil Acidification	Curdies	173
=70	Soil Structure Decline	Bellarine	167
=70	Soil Acidification	Bellarine	167
72	Soil Structure Decline	Lismore	165
73	Soil Nutrient Decline	Thompsons	164
=74	Waterlogging	Thompsons	160
=74	Waterlogging	Bellarine	160
76	Waterlogging	Otway Coast	149

Table B4: Ranking of soil-based threats for each landscape zone according to calculated Relative Risk Values (continued next page)

Rank	Threat	Landscape Zone	Relative Risk Value
77	Waterlogging	Hovells	146
=78	Wind Erosion	Bellarine	145
=78	Soil Structure Decline	Aire	145
80	Soil Acidification	Stony Rises	144
81	Acid Sulphate Soils	Curdies	141
82	Landslides	Moorabool	136
83	Soil Nutrient Decline	Moorabool	135
84	Soil Acidification	Leigh	134
85	Soil Nutrient Decline	Leigh	133
86	Soil Acidification	Moorabool	132
87	Soil Nutrient Decline	Woady Yaloak	131
=88	Soil Acidification	Woady Yaloak	130
=88	Acid Sulphate Soils	Moorabool	130
90	Soil Acidification	Thompsons	127
91	Sheet/rill Erosion	Bellarine	120
92	Landslides	Bellarine	119
93	Wind Erosion	Aire	118
=94	Acid Sulphate Soils	Upper Barwon	113
=94	Soil Nutrient Decline	Bellarine	113
96	Wind Erosion	Woady Yaloak	109
97	Landslides	Middle Barwon	107
98	Wind Erosion	Stony Rises	105
99	Wind Erosion	Gellibrand	102
100	Secondary Salinity	Moorabool	101
=101	Soil Acidification	Upper Barwon	99
=101	Wind Erosion	Leigh	99
103	Acid Sulphate Soils	Middle Barwon	95
=104	Wind Erosion	Murdeduke	93
=104	Acid Sulphate Soils	Murdeduke	93
=104	Wind Erosion	Middle Barwon	93
107	Acid Sulphate Soils	Stony Rises	88
=108	Acid Sulphate Soils	Otway Coast	81
=108	Soil Acidification	Gellibrand	81
110	Soil Nutrient Decline	Middle Barwon	80
111	Wind Erosion	Moorabool	79
112	Wind Erosion	Lismore	78
=113	Wind Erosion	Upper Barwon	72
=113	Soil Acidification	Middle Barwon	72
115	Acid Sulphate Soils	Leigh	70
116	Gully/tunnel Erosion	Middle Barwon	66
117	Wind Erosion	Curdies	65
118	Waterlogging	Aire	58
119	Gully/tunnel Erosion	Curdies	54
=120	Soil Nutrient Decline	Lismore	49
=120	Soil Acidification	Lismore	49
=122	Sheet/rill Erosion	Otway Coast	43
=122	Wind Erosion	Hovells	43
=122	Soil Nutrient Decline	Hovells	43
=122	Soil Acidification	Hovells	43
126	Soil Acidification	Aire	38
127	Sheet/rill Erosion	Murdeduke	35
128	Gully/tunnel Erosion	Gellibrand	31
129	Gully/tunnel Erosion	Thompsons	28
130	Gully/tunnel Erosion	Lismore	27
131	Sheet/rill Erosion	Aire	26
132	Sheet/rill Erosion	Lismore	24
=133	Landslides	Leigh	20
=133	Landslides	Hovells	20
=135	Soil Nutrient Decline	Murdeduke	19
=135	Soil Acidification	Murdeduke	19
137	Landslides	Stony Rises	16
138	Sheet/rill Erosion	Curdies	13
139	Wind Erosion	Otway Coast	12
140	Sheet/rill Erosion	Stony Rises	10
141	Gully/tunnel Erosion	Stony Rises	6
142	Soil Acidification	Otway Coast	3
=143	Landslides	Woady Yaloak	0
=143	Gully/tunnel Erosion	Otway Coast	0
=143	Secondary Salinity	Otway Coast	0
=143	Gully/tunnel Erosion	Murdeduke	0
=143	Landslides	Murdeduke	0
=143	Landslides	Lismore	0
=143	Gully/tunnel Erosion	Aire	0
=143	Secondary Salinity	Aire	0

Table B4: (Cont.)