An Index of Regional Sustainability (AIRS): Incorporating system processes into sustainability assessment

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Current research has made it apparent that an assessment tool for measuring progress towards sustainability will assist in understanding the success or otherwise of strategies for sustainable development. The majority of existing assessment tools are based on sets of indicators and indices, demonstrating the move toward a more integrated and systematic view of sustainability. As a result, sustainability research has now evolved to incorporate a whole systems approach, viewing domains such as society, economics and the environment as interacting sub-systems of a larger system.

A systems approach focuses on the processes working between sub-systems, which act as the driving forces of system performance and sustainability. Therefore, to ensure an accurate assessment of sustainability, these processes must be considered. Indicators represent interacting sub-systems, suggesting that relationships working between indicators reflect the underlying processes shaping sustainability.

This paper reports on a case study conducted in the south-west region of Victoria, which attempts to develop an index for measuring sustainability incorporating system processes. Relationships between a set of standardised sustainability indicators were quantified into Sustainability Impact Ratings (SIR) for each indicator, these were then used to calculate indicator weightings using the Analytic Hierarchy Process (AHP). These weightings form the basis for developing an index of regional sustainability. During the weighting process, the issue of balance between sub-systems representing sustainability within the region was also investigated. Results suggest that the method is a viable tool for objectively developing indicator weights, although it also shows similar outcomes to a study by Wallis (2004) that employed a subjective approach to prioritising south-west Victorian sustainability indicators.

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1. Introduction

To enable successful implementation of sustainable development strategies, they need to be guided by measurements of their success or otherwise (Becker, 2004; Bell and Morse, 2003; Morrissey *et al.*, 2006; Pintér *et al.*, 2005). There have already been numerous attempts to create a tool for measuring sustainability progress and the majority of these are based on the use of indicators, sets of indicators, and composite indicators (Becker, 2004; Bell and Morse, 1999; Moffatt *et al.*, 2001; Pepperdine, 2003; Schlossberg and Zimmerman, 2003). The use of composite indicators, or indices, stems from the fact that sustainable development assessment focuses on the need to integrate indicators representing social, economic and environmental pillars (Gorrie, 1999; Hardi and Zhan, 1997), among others. These pillars are recognised as interacting sub-systems of a whole system; therefore taking a whole systems approach to sustainable development is required.

The need for measuring system sustainability covering social, economic and environmental pillars using a systematic approach, strives for the consideration and inclusion of relationships between indicators representing the various sub-systems. These relationships between indicators represent the driving forces of system processes (Bossel, 2001; Duff *et al.*, 2000; Sustainable Seattle, 1998; Wallis, 2002; Yencken and Wilkinson, 2000), and therefore, need to be equated into the development of tools and indices for sustainability assessment. This need has been identified as the one of the most important requirements for producing an accurate assessment of sustainability and is found to be neglected to some degree in current tool development (Richards and Wallis, 2003). For example, many of the current tools for assessing sustainability (including the Compass Index of Sustainability, the CGSDI Dashboard of Sustainability and the Environmental Sustainability Index) express the need to determine indicator linkages to ensure the full impact of strategies for sustainability are identified (Richards and Wallis, 2003). Despite this, none of these or any other tools have yet been developed that quantitatively incorporate the relationships between indicators, which represent processes between system components, into an assessment tool for sustainability (Richards and Wallis, 2003).

This lack of agreed methods is not only the result of the need to incorporate system processes, but also due the complexity of the concepts being addressed and issues relating to the creation of an index. Firstly, index creation has been criticised because it attempts to simplify complex systems resulting in a foreseeable loss of information (Becker, 2004; OECD, 2002; Ronchi *et al.*, 2002).

On the other hand, there is a limit to the usefulness and manageability of a large, complex indicator set, which attempts to represent the system by measuring all aspects and issues of sustainability. This issue can be resolved by striving for a balance between complexity and manageability. To achieve this, the index needs to incorporate as much information about the system in question as possible; using a manageable, but reduced number of indicators that adequately addresses system components and sustainability.

Throughout the process of developing an index, there are many judgements that need to be made that will ultimately affect the results of applying the index (Freudenberg, 2003; Nardo *et al.*, 2005). For example, deciding what indicators to use, how many, what methods should be used for standardising, weighting and combining indicators, among others. Some of these issues can be overcome by ensuring local values of sustainability are identified though community and stakeholder consultation. These values can then be used as a basis for defining sustainability, identifying what measures are appropriate for the system in question and how these measures are valued.

Indicator weighting is one of the more criticised aspects of index development, although is unavoidable. Weights can be chosen to reflect many things, such as indicator reliability, statistical accuracy or priority; or equal weight could simply be given to all indicators (Freudenberg, 2003). The application of different weights implies that those higher weighted aspects are considered more important than others with regards to the concept being measured. Indicator weightings can have a considerable affect on the outcome of the composite indicator and its consequent application. Therefore, weights should be selected or calculated based on an underlying theoretical framework or conceptual rationale.

When developing an index to measure sustainability, this issue of weighting also extends to the need to establish how the integration of pillars is addressed by the index. For example, are pillars equally weighted, or are indicators measuring each of these pillars actually direct measures of sustainability? In the latter example, if equal weighting was given to all indicators and there were differing numbers of indicators measuring each pillar, then the pillars themselves would also be weighted differently. Pillar integration needs to be considered during the indicator weighting process, and should be based on the regional definition of sustainability.

In attempting to resolve some of the issues associated with the measurement of sustainability using indices and incorporating a systems approach, this paper aims to investigate how processes working within a system can be incorporated into a tool for measuring progress towards regional sustainability. Before outlining the methods used to fulfil this aim, a brief description of the south-west Victorian sustainability indicators that were used in the case study is provided.

South-west Victorian Sustainability Indicators

The 'Catchment to Regional Scale Indicators of Sustainability' project (Wallis and Barrot, 2005) initially involved the selection and prioritisation of keystone indicators for measuring sustainability in south-west Victoria. As a result the indicators were based on a local definition of sustainability and covered social, economic, environmental, and institutional pillars, which define sustainability within the region (South West Sustainability Partnership, 2001; Wallis and Barrot, 2005; Wallis, 2002). These indicators were prioritised by regional stakeholders based on a set of 92 indicators into a Priority Index of each indicator, which are comparable across all indicators (Wallis, 2002).

Data for this set of sustainability indicators was then collated from around the region, and has been presented in a report by Wallis and Barrot (2005). In continuing the research, these indicators and their data are being used to further investigate sustainability and its assessment in south-west Victoria, with this paper presenting a portion of those studies. Despite initially starting with 92 indicators, data limitations and subsequent research has reduced this number significantly. As a result, there are no indicators available to measure the institutional pillar and only 19 indicators were available for the current study.

Some of these 19 are not directly comparable to the original indicators prioritised by regional stakeholders. For example, in the reported study, a number of land-use indicators were used measuring the different types of land uses within the region. On the other hand, regional stakeholders only had one indicator 'land-use', which represented all land-use types within the region; therefore the priority of various land uses was not determined. Despite this, indicators for the present study were developed from this initial list of 92, therefore they are deemed appropriate for comparisons.

As previously discussed, in order to develop an index, indicators need to be standardised to a common scale before they can be aggregated into a composite. The process of standardisation of indicators completed for south-west Victorian sustainability indicators required developing a common scale at which indicators are measured. Sustainability is a complex, multi-disciplinary concept, and as such in order to accurately measure sustainability indicators need to be put in the context of sustainability.

The issue of standardisation is not addressed in this paper, although it should be noted that indicators used for this study were standardised to a common scale of sustainability. This is inherently a subjective process based on the need to establish thresholds for indicator values. In order to reduce some of this subjectivity, thresholds were established as objectively as possible based on a wide range of existing literature specific to different indicators, local knowledge, and through consideration of relationships between indicators. Indicators were individually assessed to develop thresholds for rating the range of indicator values on a 0 (unsustainable) to 8 (sustainable) sustainability ranking scale. This data was then used as a starting point for the reported study.

2. Methods

Figure 1 provides an outline and brief description of methods used to weight indicators based on underlying sustainability processes. Creating weightings for indicators that can be used as a basis of an index for measuring sustainability and incorporate system processes involved three steps. Firstly, Sustainability Impact Ratings (SIR) were calculated for indicators; secondly, using the Analytic Hierarchy Process (AHP) SIR were transformed into indicator priorities (known as AIRS priorities); and finally, the index was refined by eliminating indicators with little impact on the overall index.

As Figure 1 suggests, these three steps were completed for two different models of indicators, the balanced pillar model and the stand-alone indicators model. This enabled investigation into issues of balance between pillars representing sustainability to be conducted. Finally, comparisons were made between regional stakeholder priorities for south-west Victorian sustainability indicators (Wallis, 2002) and SIR and priorities determined using the two models. This comparison between subjectively and objectively weighted indicators helps to address underlying criticisms and confliction concerning sustainability and index development.

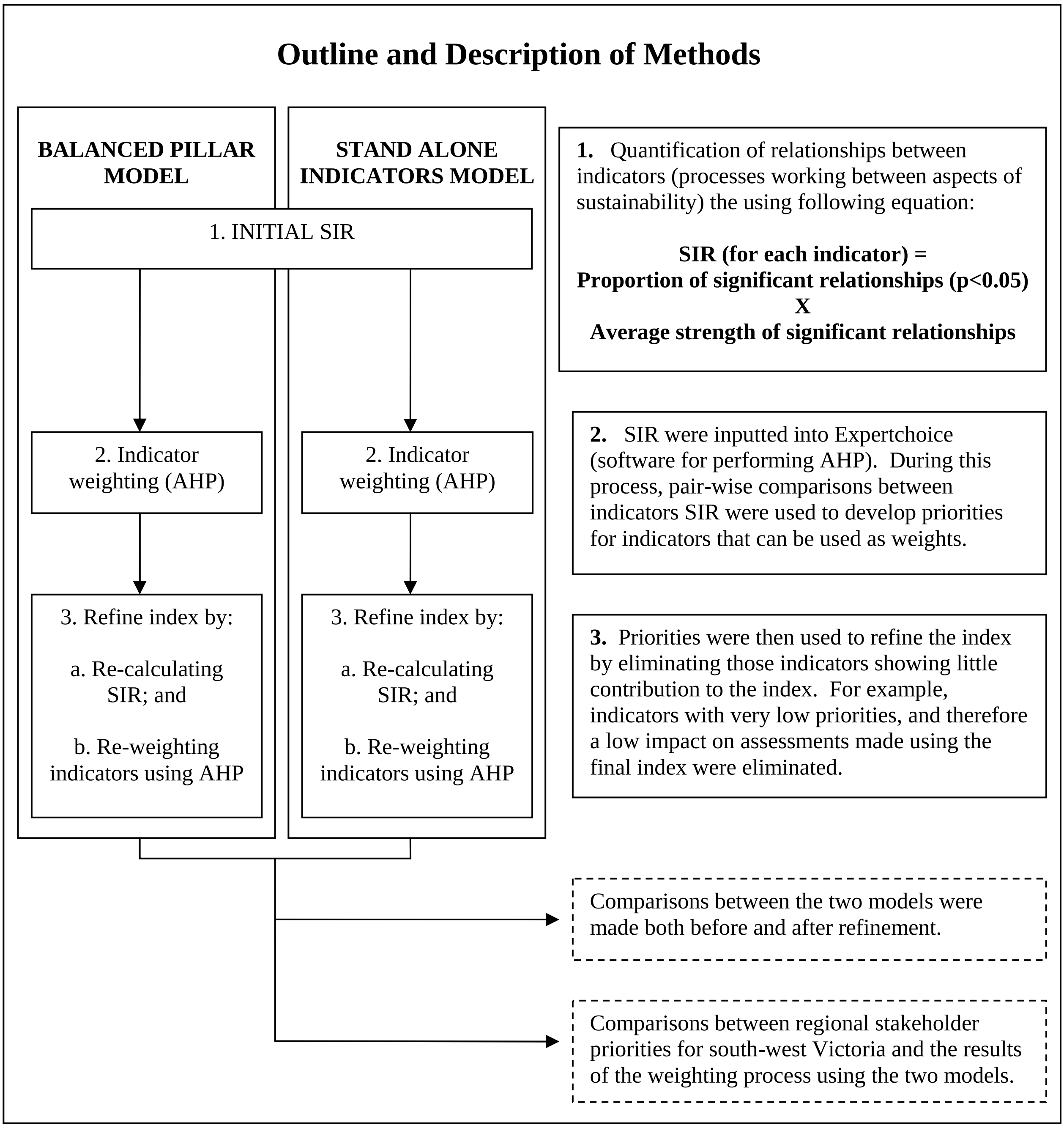

Figure 1: Model and description of methods used to complete the described study.

In the first step, processes working between indicators representing various sub-systems were used to develop weights for indicators that provide the basis of an index for measuring sustainability. The choice of weighting technique used in creating the index was based on fact that the aim of the research is to incorporate indicator relationships into a tool for assessing system sustainability. The idea behind this incorporation is that indicator relationships between indicators represent system processes, and therefore the driving forces of sustainability. An indicator that demonstrates significant relationships with a high proportion of other sustainability indicators reflects one with a greater impact on sustainability, and therefore should receive a higher weighting within the index.

Calculating indicator impacts onto sustainability required the determination of the number and strength of significant relationships each indicator shared with all other indicators within the indicator set. This relationship identification was performed on indicators both within and across the three pillars of sustainability represented, and relationships were determined using Spearman's correlation coefficients using SPSS® 12.0 software.

Relationships between indicators were used to determine the impact each indicator had on the condition of other indicators within the set. This was achieved by using a simple calculation based on the Spearman correlation coefficients shared between every pair of indicators. Firstly, for every indicator the proportion of significant correlations with other indicators and the average strength of these significant correlations were calculated. To calculate the 'average strength of correlations' only significant correlations were used ($p<0.05$), and the negative and positive signs were disregarded because regardless of whether the impact is positive or negative it is still influencing sustainability. The proportion of significant relationships and the average strength of these were then multiplied by one another in order to calculate an 'impact rating' on sustainability (SIR) for all indicators within the set.

The process of calculating SIR provides a ranking of indicators based on their influence on the sustainability of other indicators, the most highly ranked being the one that most influences sustainability and the lowest with least impact on sustainability. However, this does not provide an index of weighted indicators, and so represents an incomplete tool for measuring sustainability. Therefore, in order to develop an index from these SIR, weightings are necessary.

In the second step, these SIR were then used to develop weights for indicators. Pair-wise comparisons between SIR calculated for all indicators were analysed using AHP (utilising Expert Choice software). This enabled indicators to be weighted according to their determined impacts on regional sustainability (SIR), which were quantitatively determined.

The third step involved the refinement of the indicators making up the index by eliminating those indicators contributing little to the index in terms of their weighting. In order to identify the indicators to be eliminated guidelines were set out in the form of two rules.

> Rule 1: Each pillar must be represented by at least three indicators.
> Rule 2: Indicators with an AIRS priority of <0.10 (for the balanced pillar model) and <0.05 (for the stand-alone indicators model) are to be eliminated from the index.

The first rule ensured that all pillars, regardless of how indicators were weighted, are represented in the final index. This is based on the regionally agreed definition of sustainability, which identifies the social, economic, environmental and institutional domains as the four pillars of sustainability (South West Sustainability Partnership, 2001; Wallis and Barrot, 2005). No regional data was available for institutional indicators; therefore, the pillar was not included in this research.

The second rule means that those indicators contributing very little to the index (demonstrated by low AIRS priorities) were eliminated. The elimination of redundant indicators ensures the final index is as concise and informative as possible, and is void of repetition.

Once those indicators for elimination were identified and excluded, SIR and AIRS priorities for indicators were re-calculated based on the reduced number of indicators. Therefore, steps one and two described above were completed again, producing a final set of AIRS priorities that can be used as a basis for assessing sustainability in south-west Victoria.

In order to address the issue of balance between pillars representing sustainability, the three steps undertaken to prioritise indicators were completed for two models, a balanced pillar model and a stand-alone indicators model. The first of the models, the balanced pillar model, separates indicators into their respective pillars in order to weight them. This implies that pillars were each treated equally, and ensures that the number of indicators representing each of the pillars did not influence the results. For example, the environmental pillar is represented by three to four times the number of indicators than either the social or economic pillars, by weighting indicators within their own pillars this imbalance in the numbers of indicators will not result the environmental pillar being viewed as three to four times more important than social or economic pillars.

Despite being separated into pillars for weightings, all SIR calculated for various indicators take into account across pillar interactions. Therefore, although when using the balanced pillar model priorities for indicators within each pillar were calculated based on pair-wise comparisons among themselves, these comparisons were of SIR that take into account processes occurring across the three pillars.

The second model uses indicators as direct measures of sustainability, without classifying them into their respective pillars. Therefore, throughout the process of prioritising, indicators were viewed as direct measures of sustainability and so the number of indicators representing each of the pillars was not balanced. Using this approach means that pillars were weighted based more on the regional definition than on the need to seek a balance between the pillars. For example, if the community chose twice as many environmental indicators than social or economic ones, this is taken as a reflection of how the importance of the environmental pillar is placed higher than that of the social and economic pillars.

In order to investigate the issue of balance between pillars of sustainability, comparisons between the results of analysis performed on the two different models were made at various stages during index development. These included comparisons between the methods after initial indicator prioritisation, after re-calculation of indicator SIR, and after final priorities were determined.

Finally, comparisons were also made between indicator priorities (PI) determine by regional stakeholders, and those determined based on processes driving system sustainability. This comparison represents an opportunity to determine how qualitative and quantitative methods differ and how they may influence the design of an index of sustainability and consequently results of sustainability assessments.

3. Results

Results are described in a similar format to that shown in the methods outline with the initial SIR being presented first in section 3.1. The balanced model will then be addressed in section 3.2, with descriptions of all results, from initial prioritisation to refinement of the index. The stand-alone indicators model is presented in the following section 3.3, which similarly describes results from all prioritisation and refinements completed. Comparisons between the two models are then presented in section 3.4, which compares results from the models both before and after refinements were completed. Throughout these descriptions, comparisons are also made between the results of the reported study with priorities obtained through a process of stakeholder consultation of south-west Victorian sustainability indicators.

3.1 Initial Sustainability Impact Ratings

As shown in the outline of methods (Figure 1), the first step was to calculate SIR for each of the indicators based on the number of significant relationships it shared with all other indicators, and the strength of these significant relationships. Table 1 lists SIR for all indicators; it also lists the corresponding priority given to each indicator by regional stakeholders within south-west Victoria (PI) for comparison. Regional stakeholder priorities were based on a set of 92 indicators, covering social, economic, environmental and institutional pillars of sustainability.

Table 1: Comparison of SIR for indicators with indicator priorities determined by regional stakeholders. (Ec = Economic; Soc = Social; Env = Environment)

		Sustainability Impact Rating (SIR)		Regional Stakeholders Priorities (PI)	
Pillar	**Indicator**	**SIR**	**Overall ranking of indicator SIR**	**Stakeholder PIs**	**Overall ranking of stakeholder PIs**
Ec	Employment diversity	0.092	11	4.05	5
	Unemployment rate	0.085	12	3.88	14
	Weekly household income	0	17	3.72	24
Soc	Age structure diversity	0.093	10	3.79	19
	Students completing year 12	0.074	13	3.6	32
	Population growth rate (1996-2001)	0.069	15	4.04	7
	Growth in number of qualified people (1991-2001)	0.023	16	3.3	56
Env	Risk of dryland salinity	0.279	1	4.33	1
	Remnant vegetation	0.275	2	3.67	30
	Dryland pasture land-use	0.269	3	3.67	30
	Susceptibility to wind erosion	0.268	4	3.84	16
	Susceptibility to water erosion	0.203	5	3.84	16
	Risk of soil structure decline	0.184	6	3.53	38
	Pine plantations	0.168	7	3.67	30
	Water quality	0.127	8	4.11	3
	Index of stream condition	0.099	9	3.89	13
	Loss of wetland area	0.071	14	4	8
	Blue gum plantations	0	18	3.67	30
	Cropland/hay and silage land-use	0	19	3.67	30

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The most obvious feature from Table 1 is that of the three pillars the environmental indicators showed the biggest impact on the health of the other indicators, and overall sustainability. This reflects the local definition of sustainability for south-west Victoria established through the identification of values and indicators of sustainability for the region by stakeholders. These local values demonstrated the importance of the environmental pillar by identifying over twice the number of indicators for the environmental than the social or economic pillars (Wallis and Barrot, 2005).

The three most important indicators were dryland salinity, the area of remnant vegetation, and the area of land used for dryland pasture. Rating dryland salinity as having the most impact out of all indicators reflects regional issues and values identify dryland salinity as a threat to the health of the region (Glenelg-Hopkins Catchment Management Authority, 2003). Dryland pasture is one of the more dominate land-uses within the region, suggesting it has a greater potential to impact on regional values, and this is reflected by its SIR.

For the economic pillar the most important indicators was employment diversity. This reflects the importance of a diverse employment base that is capable of adapting to change and presents a wide range of opportunities to the community (Sustainable Seattle, 1998; Wallis and Barrot, 2005). Finally, of the social indicators the most important was age structure diversity. This supports already established concerns regarding the aging of the population within regional areas of Victoria, and Australia (Australian Bureau of Statistics, 2006; Glenelg-Hopkins Catchment Management Authority, 2003).

Weekly household income, blue gum plantations and cropland/hay and silage land-use all showed SIR of 0.0. This can be explained by their lack of interactions with other indicators representing the three pillars of sustainability. This is understandable for blue gum plantations and cropland/hay and silage land-uses as both are rather insignificant in the area of land they utilise within the region, therefore their potential for affecting the health of other indicators is low. It is not quite as clear, however, why income was rated as zero.

Table 1 also includes priorities given to indicators by regional stakeholders within south-west Victoria. In comparison to SIR calculated for indicators, regional stakeholders also prioritised dryland salinity as the most important indicator of regional sustainability, again supporting the importance of this indicator to regional sustainability (Glenelg-Hopkins Catchment Management Authority, 2003). The main difference seen between SIR and regional stakeholder priorities within the environmental pillar was the prioritisation of the water quality indicator. According to regional stakeholders, water quality was ranked third out of 92 indicators and the second most highly ranked environmental indicator, which reflects regional concern over the condition of waterways (Commonwealth of Australia, 2004; Glenelg-Hopkins Catchment Management Authority, 2003; Wallis and Barrot, 2005). This could indicate that the importance of waterway health to sustainability across the whole region is difficult to quantify, and that impacts may not be evident at such a large scale and are more locally focused around the waterway itself.

Indicators representing the economic pillar were prioritised by stakeholders in the same order as indicator SIR. This suggests that SIR for economic indicators agree with the regional definition of sustainability, despite the low value for weekly income. On the other hand, within the social pillar, rankings were not the same between the reported study and stakeholder priorities. For example, population growth was ranked as the seventh most important indicator (out of 92) as far as stakeholders were concerned, but this was not reflected by SIR that rank it as the fifteenth out of only nineteen indicators. Again, this comes down to a lack of relationships shared between population growth and other indicators.

When comparing regional stakeholder priorities with indicator SIR, ten indicators were found to be common between the two sets of priorities. For example, of the 19 most highly ranked indicators according to regional stakeholders (out of 92 indicators) 10 were found to be represented within the 19 indicators for which SIR were calculated. Of the 10 common indicators those that demonstrated a significant difference between rankings of SIR and regional stakeholder priorities included employment diversity, population growth, water quality, and all of the land-use indicators, which were all ranked as less important by SIR than by regional stakeholders. These differences highlight the difference in the approaches used to rank indicators according to their impact on regional sustainability.

3.2 Balanced Pillar Model

This section represents results of index development using a balanced pillar model of sustainability. Therefore, priorities and reductions for indicators representing each of the three pillars were determined separately. Despite this separation, across pillar interactions were still incorporated into the calculation of priorities using indicator SIR, which were calculated without consideration for the pillar each indicator represents.

Indicator weighting

Once SIR for indicators were calculated, they were used to develop indicator weightings through a process of pair-wise comparisons using AHP. Using Expertchoice software AHP produces a set of priorities for indicators, which can in turn be used to weight indicators within an overall index. A list of these AHP determined priorities (AIRS priorities) is shown in Table 2. As AIRS priorities for indicators were determined separately for the three pillars, some re-scaling was necessary to make priorities comparable across the three pillars. Along with AIRS priorities, Table 2 lists the corresponding SIR and stakeholder priorities for comparison.

When using AHP, priorities for all indicators included in the analysis are a proportion of one, therefore as there were differing numbers of indicators representing each of the pillars, priorities for indicators representing different pillars were not comparable in their current form. For example, there are 12 indicators representing the environmental pillar and only three representing the economic pillar. To make these priorities comparable across the three pillars, they were all re-scaled to a factor of 12, ensuring values are directly comparable across all indicators.

Table 2 shows that environmental indicators were not quiet as dominate when ranking indicator AIRS priorities than was seen from results of indicator SIR. According to indicator priorities, the most highly prioritised indicator was a social indicator, age structure diversity. Age structure was ranked only 10 overall by SIR, although remained the most highly ranked social indicator. Employment diversity, population and year 12 completion were also ranked in the top 10 indicators by AIRS priorities, but were outside the top 10 according to SIR rankings of indicators. Dryland salinity was still highly ranked by AIRS priorities, at two, again demonstrating its importance to the sustainability of the region.

Table 2: Comparison of AIRS priorities and rankings with regional stakeholder priorities and ranks. Indicators are sorted based on their overall AIRS priority.

		SIR		AIRS Priorities				Regional Stakeholders Priorities (PI)	
Pillar	Indicator	SIR	Overall SIR indicator ranking	AIRS priority	Method of re-scaling	Re-scaled priorities	Overall ranking of AIRS priorities	Stakeholder PI	Overall ranking of stakeholder PIs
Economic	Employment diversity	0.092	11	0.359	Divided by 4	0.09	8	4.05	5
	Unemployment rate	0.085	12	0.326		0.082	11	3.88	14
	Weekly Household income	0.000	17	0.315		0.079	12	3.72	24
Social	Age structure diversity	0.093	10	0.377	Divided by 3	0.126	1	3.79	19
	Population growth rate (1996-2001)	0.069	15	0.271		0.09	6	4.04	7
	Year 12 completion	0.074	13	0.266		0.089	9	3.6	32
	Growth in number of qualified people (1991-2001)	0.023	16	0.085		0.028	19	3.3	56
Environment	Dryland salinity	0.279	1	0.119	None	0.119	2	4.33	1
	Remnant vegetation	0.275	2	0.117		0.117	3	3.67	30
	Dryland pasture land-use	0.269	3	0.115		0.115	4	3.67	30
	Wind soil erosion	0.268	4	0.114		0.114	5	3.84	16
	Water soil erosion	0.203	5	0.09		0.09	7	3.84	16
	Soil structure decline	0.184	6	0.082		0.082	10	3.53	38
	Pine plantations	0.168	7	0.076		0.076	13	3.67	30
	Blue gum plantations	0.000	18	0.069		0.069	14	3.67	30
	Cropland/hay and silage land-use	0.000	19	0.069		0.069	15	3.67	30
	Water quality	0.127	8	0.06		0.06	16	4.11	3
	Index of stream condition	0.099	9	0.05		0.05	17	3.89	13
	Wetland loss	0.071	14	0.039		0.039	18	4	8

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These examples highlight the changes between rankings of indicator SIR and priorities. Once re-scaled to enable comparability across pillars, social and economic indicators show higher importance than demonstrated through ranking of indicators using SIR. This shows that splitting indicators into pillars influences how their importance as measures of sustainability is weighed. Despite the differences seen between indicator SIR and priorities, it is clear that some indicators contribute more strongly than others do, and that the environmental pillar can be very influential.

In comparison to regional stakeholder priorities, AIRS priorities mainly differed in their ranking of the age structure, water quality and wetland loss indicators. Age structure was ranked much lower by regional stakeholders than it was by AIRS priorities that ranked it as the most important of all indicators. With age structure as an exception, all of the other social and economic indicators showed the same order when ranking indicators based on the AIRS and regional stakeholder priorities, demonstrating agreement between the two different approaches. This was further demonstrated with strong similarities between regional stakeholders and AIRS priorities found for both the employment and qualifications indicators.

Unlike age structure, water quality and wetland loss were ranked much higher by regional stakeholders than by AIRS priorities. Regional stakeholder priorities indicate that both these environmental indicators measure issues that are recognised as regionally significant, and this is supported by other regional documentation (Commonwealth of Australia, 2004; Glenelg-Hopkins Catchment Management Authority, 2003; Wallis and Barrot, 2005). Despite this, AIRS priorities do not reflect the regional importance of these indicators, which for water quality was discussed in section 3.1 when describing indicator SIR. With regards to wetland loss, similar to water quality, it may be that the impacts of the loss of regional wetlands may be more locally focused and difficult to quantify over the whole region.

Index refinement

The next step after prioritising indicators was to refine the index by eliminating indicators having little contribution to the overall index. Table 3 highlights those indicators eliminated from the index based on two rules:

Rule 1: Each pillar must be represented by at least three indicators.
Rule 2: Eliminate indicators with <0.10 AIRS priority.

Table 3: Table of indicators and their priorities compared to regional stakeholder PIs, table highlights indicators that are eliminated from the tool developed based on a balanced model of pillars when addressing sustainability assessment.

		AIRS Priority - before reduction			Regional Stakeholders Priority (PI)	
Pillar	Indicator	AIRS priority	Re-scaled priorities	Overall ranking of re-scaled AIRS priorities	Stakeholder PI	Overall ranking of stakeholder PIs
Soc	Age structure diversity	0.377	0.126	1	3.79	19
Env	Dryland salinity	0.119	0.119	2	4.33	1
Env	Remnant vegetation	0.117	0.117	3	3.67	30
Env	Dryland pasture land-use	0.115	0.115	4	3.67	30
Env	Wind soil erosion	0.114	0.114	5	3.84	16
Soc	Population growth rate (1996-2001)	0.271	0.090	6	4.04	7
Env	Water soil erosion	0.09	0.090	7	3.84	16
Ec	Employment diversity	0.359	0.090	8	4.05	5
Soc	Year 12 completion	0.266	0.089	9	3.6	32
Env	Soil structure decline	0.082	0.082	10	3.53	38
Ec	Unemployment rate	0.326	0.082	11	3.88	14
Ec	Household weekly income	0.315	0.079	12	3.72	24
Env	Pine plantations	0.076	0.076	13	3.67	30
Env	Blue gum plantations	0.069	0.069	14	3.67	30
Env	Cropland/hay and silage land-use	0.069	0.069	15	3.67	30
Env	Water quality	0.06	0.060	16	4.11	3
Env	Index of stream condition	0.05	0.050	17	3.89	13
Env	Wetland loss	0.039	0.039	18	4	8
Soc	Growth in number of qualified people (1991-2001)	0.085	0.028	19	3.3	56

Table 3 shows that of those indicators retained, five of them fell below the 0.10 AIRS priority cut-off that was set out by the second rule but were kept as representatives of their respective pillars according to the first rule. Two of these were social, and three economic indicators. Age structure, being the most highly prioritised, was the only non-environmental indicator to be above the 0.10 AIRS priority cut-off. This again demonstrates the dominance of the environmental over the social and economic indicators, and the dominance of the age structure indicator over other social indicators as a measure of sustainability.

In comparison to stakeholder values, of those indicators eliminated, water quality and wetland loss were the most significant, being prioritised as third and eighth highest respectively out of a possible 92 indicators. This suggests that despite the known importance of the water quality of rivers and streams to the health of south-west Victoria (Glenelg-Hopkins Catchment Management Authority, 2003), quantifying its influences across the whole region does not reflect this.

The next step in refining the index once indicators were eliminated was to re-calculate indicator SIR and AIRS priorities. Table 4 outlines both the newly calculated SIR and AIRS priorities for the remaining indicators. AIRS priorities were again re-scaled to enable comparisons across pillars to be made.

Similar to before elimination of indicators, age structure was the most highly prioritised indicator (according to AIRS priorities), although again this was not reflected in SIR values which were dominated by environmental indicators. Despite newly calculated SIR showing a similar pattern as before reduction by rating the four environmental indicators as the most important overall, AIRS priorities changed this significantly. In comparison to SIR, AIRS priorities ranked social and economic indicators as the top four most important indicators. This change in dominance of the environmental pillar between SIR and AIRS was also noted between AIRS priorities determined before and after refinement. For example, after refinement no environmental indicators remained in the top five most highly prioritised indicators, whereas before reduction four of the top five highest prioritised indicators were in fact environmental.

Compared to stakeholder priorities the main difference to AIRS priority ranking was seen with the ranking of dryland salinity, which has also been reduced from the first to second most important environmental indicator behind dryland pasture. Otherwise similarities were found between the rankings of the year 12 completion indicator, which has consistently shown to be of lesser importance than the other indicators; and employment diversity, ranked as one of the more important economic indicators. It can also be noted that there are now two strong measures representing the economic pillar, which has previously been represented by indicators of comparatively lesser importance.

These indicators and their final priorities now represent the basis of an index for assessing system sustainability within south-west Victoria. To enable to the issue of balance to be investigated the next section outlines results of the same prioritisation and refinement process applied in this section although using a stand-alone model of indicators.

Table 4: SIR and priorities for refined set of indicators (priorities are re-scaled by a factor of 12 to enable comparisons across pillars) based on the balanced pillar model, table also contains regional stakeholder PIs and rankings for comparison.

		SIR		AIRS Priority				Regional Stakeholder Priorities (PI)	
Pillar	**Indicator**	**SIR**	**Overall ranking of indicator SIR**	**AIRS priority**	**Method of re-scaling**	**Re-scaled to a factor of 12**	**Overall ranking of AIRS priority**	**Stakeholder PI**	**Overall ranking of stakeholder PIs**
Ec	Unemployment rate	0.165	5	0.374	Multiply by 4	1.496	2	3.88	14
	Employment diversity	0.136	7	0.325		1.300	3	4.05	5
	Weekly household income	0	10	0.302		1.208	5	3.72	24
Soc	Age structure diversity	0.153	6	0.511	Multiply by 4	2.044	1	3.79	19
	Population growth rate (1996-2001)	0.096	8	0.319		1.276	4	4.04	7
	Year 12 completion	0.051	9	0.17		0.680	9	3.6	32
Env	Dryland pasture land-use	0.296	1	0.268	Multiply by 3	1.072	6	3.67	30
	Dryland salinity	0.276	2	0.249		0.996	7	4.33	1
	Remnant vegetation	0.267	3	0.242		0.968	8	3.67	30
	Wind soil erosion	0.267	4	0.242		0.968	8	3.84	16

3.3 Stand-Alone Indicators Model

The results presented in this section represent an attempt to develop an index based on indicators that were not categorised into pillars for the purposes of analysis. Therefore, indicators were viewed as direct measures of sustainability and weighted accordingly. Indicator weighting and index refinement were completed using the same method as was used for the balanced pillar model in section 3.2, and SIR for indicators listed in Table 1 were used to develop the initial weightings.

Indicator weighting

Initial indicator SIR were used to determine indicator priorities using AHP. Unlike the balanced model, all indicators were analysed together and not split into pillars for pair-wise comparisons. Table 5 outlines AIRS priorities for indicators and compares them to both indicator SIR and regional stakeholder priorities.

Table 5: Comparison of AIRS priorities and rankings with regional stakeholder priorities and ranks.

		SIR		AIRS priority		Regional Stakeholders Priorities (PI)	
Pillar	**Indicator**	**SIR**	**Overall indicator SIR ranking**	**AIRS priority**	**Overall ranking of AIRS priority**	**Stakeholder PI**	**Overall ranking of stakeholder PIs**
Env	Dryland salinity	0.279	1	0.096	1	4.33	1
Env	Remnant vegetation	0.275	2	0.095	2	3.67	30
Env	Dryland pasture land-use	0.269	3	0.093	3	3.67	30
Env	Wind erosion	0.268	4	0.092	4	3.84	16
Env	Water erosion	0.203	5	0.072	5	3.84	16
Env	Soil structure decline	0.184	6	0.066	6	3.53	38
Env	Pine plantations	0.168	7	0.061	7	3.67	30
Env	Water quality	0.127	8	0.048	8	4.11	3
Ec	Weekly household income	0	17	0.043	9	3.72	24
Env	Blue gum plantations	0	18	0.043	10	3.67	30
Env	Cropland/hay and silage land-use	0	19	0.043	11	3.67	30
Env	Index of stream condition	0.099	9	0.039	12	3.89	13
Soc	Age structure diversity	0.093	10	0.038	13	3.79	19
Ec	Employment diversity	0.092	11	0.037	14	4.05	5
Ec	Unemployment rate	0.085	12	0.033	15	3.88	14
Soc	Population growth rate (1996-2001)	0.069	15	0.029	16	4.04	7
Env	Wetland loss	0.071	14	0.029	17	4	8
Soc	Year 12 completions	0.074	13	0.028	18	3.6	32
Soc	Growth in number of qualified people (1991-2001)	0.023	16	0.014	19	3.3	56

out of 92

Table 5 shows environmental indicators having the most influence, with the eight most highly rated according to SIR and prioritisation being environmental indicators. Dryland salinity was again rated and prioritised the highest of all indicators, and remnant vegetation the second highest. The high rating of remnant vegetation may be a reflection of the impact of continuing clearing for agricultural purposes, which has been extensive within the region since settlement, and as a result is a good indicator of the extent of land use within particular areas.

Of the economic indicators, weekly household income was prioritised the highest, as was age structure for the social pillar. This is extremely unusual, as weekly household income has consistently shown a sustainability impact rating of 0.0, although this is obviously not reflected by AIRS priorities. Age structure was the highest prioritised social indicator, and this was consistent across both SIR and AIRS priorities.

Compared to regional stakeholder priorities, dryland salinity was still the most highly prioritised according to both AIRS and regional stakeholder priorities. The main differences found between the two rankings were the ranking of employment diversity, population and wetland loss indicators. These three indicators were ranked in the bottom five indicators according to AIRS, although regional stakeholders rank all three in the top five most important indicators out of 92.

The unusual prioritisation of the household weekly income indicator as the most important economic indicators was also found to be inconsistent with regional stakeholder priorities. Stakeholders prioritise income as less important than the other two economic indicators and this was reflected by SIR, but not by AIRS priorities.

Index refinement

AIRS priorities were used to refine the index by eliminating indicators demonstrating little contribution to the overall index. Guidelines were set in place to facilitate the identification of indicators to be eliminated and they are similar rules were used for the refinement of the balanced model already described.

Rule 1: Each pillar must be represented by at least three indicators

Rule 2: Eliminate indicators with <0.05 AIRS priority

The second rule has been altered to reflect the lower values of AIRS priorities. These lower values are a result of the larger number of indicators used in the analysis compared to analysis carried out on pillars separately as priorities for all indicators sum to 1. Table 6 highlights those indicators to be eliminated based on the above rules.

The most obvious feature of those indicators that fall below the 0.05 AIRS priority cut-off was that they consist of all social and economic indicators, with only environmental indicators found above the cut-off. Therefore, although the top three indicators for each of the social and economic pillars were retained, they were by far outweighed by environmental indicators. This supports the original south-west Victorian set of sustainability indicators that identifies over twice the number of indicators to represent the environmental pillar, than those identified to represent the social and economic pillars (Wallis and Barrot, 2005)

Table 6: List of indicators and their AIRS priorities for the stand-alone model of indicators in comparison to regional stakeholder PIs, table highlights those indicators that are to be eliminated form the set.

		AIRS Priority - before reduction			Regional Stakeholder Priorities (PI)	
Pillar	Indicator	AIRS priority	Overall ranking of AIRS priorities	Within pillar ranking of AIRS priorities	Stakeholder PI	Overall ranking of stakeholder PIs
Env	Dryland salinity	0.096	1	1	4.33	1
Env	Remnant vegetation	0.095	2	2	3.67	30
Env	Dryland pasture land-use	0.093	3	3	3.67	30
Env	Wind soil erosion	0.092	4	4	3.84	16
Env	Water soil erosion	0.072	5	5	3.84	16
Env	Soil structure decline	0.066	6	6	3.53	38
Env	Pine plantations	0.061	7	7	3.67	30
Env	Water quality	0.048	8	8	4.11	3
Ec	Weekly household income	0.043	9	1	3.72	24
Env	Blue gum plantations	0.043	10	9	3.67	30
Env	Cropland/hay and silage land-use	0.043	11	10	3.67	30
Env	Index of stream condition	0.039	12	11	3.89	13
Soc	Age structure diversity	0.038	13	1	3.79	19
Ec	Employment diversity	0.037	14	2	4.05	5
Ec	Unemployment	0.033	15	3	3.88	14
Soc	Population growth rate (1996-2001)	0.029	16	2	4.04	7
Env	Wetland loss	0.029	17	12	4	8
Soc	Year 12 completions	0.028	18	3	3.6	32
Soc	Growth in numbers of qualified people (1991-2001)	0.014	19	4	3.3	56

Water quality was eliminated from the tool despite being prioritised as third highest of all indicators by regional stakeholders, and despite soil structure decline and some land uses being retained, which were very lowly prioritised in comparison by regional stakeholders. This was also the case for index of stream condition and the wetland loss indicator, which were both eliminated despite less important other indicators (according to regional stakeholders) being retained.

Once eliminated, SIR and priorities for the remaining indicators were re-calculated and results are presented in Table 7. Table 7 also contains regional stakeholder priorities for comparison.

All the remaining environmental indicators were prioritised higher than any of the social or economic indicators. Below these seven environmental indicators, the next two highly ranked were both economic indicators, weekly household income and unemployment. The latter of these would be expected in any region and reflects its corresponding SIR, in contrast the household weekly income prioritisation cannot be explained.

Table 7: SIR and AIRS priorities for refined set of indicators (stand-alone model of indicators), table also contains regional stakeholder PIs for comparison. Ec = Economic, Soc = Social, Env = Environment.

		SIR - after reduction		AIRS Priority - after reduction		Regional Stakeholder Priorities (PI)
Pillar	**Indicator**	**SIR**	**Overall ranking of SIR**	**AIRS priority**	**Overall ranking of AIRS priorities**	**Overall ranking of stakeholder PIs**
Ec	Weekly household income	0	13	0.061	8	24
	Unemployment rate	0.124	8	0.046	9	14
	Employment diversity	0.102	10	0.039	11	5
Soc	Age structure diversity	0.115	9	0.043	10	19
	Population growth rate (1996-2001)	0.072	11	0.029	12	7
	Year 12 completion	0.069	12	0.028	13	23
Env	Dryland pasture land-use	0.357	1	0.124	1	30
	Dryland salinity	0.339	2	0.118	2	1
	Remnant vegetation	0.326	3	0.113	3	30
	Wind soil erosion	0.309	4	0.108	4	16
	Pine plantations	0.293	5	0.103	5	30
	Soil structure decline	0.276	6	0.097	6	38
	Water soil erosion	0.265	7	0.093	7	16

Out of 92

Age structure was found to be the most important social indicator, and reflects concerns about the age diversity of communities living within the region (Glenelg-Hopkins Catchment Management Authority, 2003). Dryland pasture land-use was ranked as the highest priority indicator overall and this rank, along with the ranking of the rest of the environmental indicators, was the same as was found in the ranking of SIR.

Indicator rankings based on SIR differed only slightly from those based on AIRS priorities and only affected economic indicators. This difference involved weekly household income, which has a SIR of 0.0, yet is prioritised as the most important economic indicator. This was unexpected as both employment diversity and unemployment had much higher SIR and may need further investigation.

In comparison to regional stakeholder priorities, the most obvious difference with AIRS priorities was shown by dryland pasture land-use. Although this indicator was classified as the most important indicator using the AIRS method, it was only prioritised by regional stakeholders as 30 out of a possible 92 indicators. This may be a reflection of the reduction in the extent of dryland pasture across the region in recent years (Institute for Land and Food Resources, 2000), possible leading to a reduced amount of stakeholder concern.

The order of AIRS priority ranking for economic indicators was the opposite to that of regional stakeholder priorities for the same indicators. Differences included regional stakeholders viewing weekly household income as the least important of the three economic indicators, which in turn was ranked highest by AIRS priorities. The other most obvious difference between rankings involved employment diversity, which was ranked 5 out 92 indicators by regional stakeholders, and the most important of the three economic indicators. In comparison, employment diversity does not even make it into the top 10 indicators ranked using SIR and AIRS priorities, and was the lowest ranked economic indicator according to AIRS priorities.

These final priorities now represent the basis for an index of south-west Victorian sustainability, similar to those presented in section 3.2. The next section goes on to compare the results of prioritisation and refinement completed using the two different models, allowing the investigation into the issue of balance and how pillars representing sustainability can be integrated.

3.4 Comparisons between the Models

Comparisons between the results of the two different models of indicators were then undertaken both before and after each of the indices was refined. This comparison helped to identify the differences between the two approaches, and the impact they have on the overall index, and may therefore have on the assessments it produces. Table 8 presents a comparison between initial AIRS priorities calculated using the two models.

Results of the balanced pillar model showed age structure to be the most highly prioritised indicator, although this differed significantly from the stand-alone indicators model that ranked it thirteenth out of 19 indicators and ranked dryland salinity as the most important. Despite the difference in the age structure rankings, the balanced pillar model also highly ranked dryland salinity, as the second most important.

Table 8: Comparison of AIRS priorities determined for the balanced model of pillars with those determined for the stand-alone indicators model, to aid in investigations into the issue of balance between pillars within the index.

		Balanced Model of Pillars			Stand-Alone Indicators Model	
Pillar	Indicator	AIRS priority	Re-scaled priorities	Overall ranking of AIRS priorities	AIRS priority	Overall ranking of AIRS priorities
Ec	Unemployment rate	0.326	0.082	11	0.033	15
	Employment diversity	0.359	0.090	8	0.037	14
	Household weekly income	0.315	0.079	12	0.043	9
Soc	Population growth rate (1996-2001)	0.271	0.090	6	0.029	16
	Age structure diversity	0.377	0.126	1	0.038	13
	Year 12 completion	0.266	0.089	9	0.028	18
	Growth in numbers of qualified people (1991-2001)	0.085	0.028	19	0.014	19
Env	Blue gum plantations	0.069	0.069	14	0.043	10
	Cropland/hay and silage land-use	0.069	0.069	15	0.043	11
	Dryland pasture land-use	0.115	0.115	4	0.093	3
	Pine plantations	0.076	0.076	13	0.061	7
	Remnant vegetation	0.117	0.117	3	0.095	2
	Dryland salinity	0.119	0.119	2	0.096	1
	Water soil erosion	0.09	0.090	7	0.072	5
	Wind soil erosion	0.114	0.114	5	0.092	4
	Soil structure decline	0.082	0.082	10	0.066	6
	Water quality	0.06	0.060	16	0.048	8
	Index of stream condition	0.05	0.050	17	0.039	12
	Wetland loss	0.039	0.039	18	0.029	17

The stand-alone indicators model prioritised all eight environmental indicators as the eight most important indicators overall. In comparison, the balanced model prioritised age structure as the most important, with three of the top eight indicators representing a pillar other than the environmental one. This demonstrated that the balanced model, as expected, shares the importance of indicators more evenly across the three pillars unlike in the stand-alone indicators model.

Overall, there are considerable differences between priorities determined using the two models, and not only with regards to the integration of pillars. Of the top 10 prioritised indicators, only five of these are common between the two models, and of those that were common, their ordering was not consistent. These changes were further investigated by comparing the two models after refinements were made in Table 9.

Table 9 compares the results for the two models after refinement. Dashes next to an indicator imply that it has been eliminated from that particular model, but remains in the table as it was not eliminated from the other model. For this study, it was only the stand-alone indicators model that retained any indicators that were eliminated from the balanced pillar model. Those indicators found in only the stand-alone indicators model were all environmental indicators and were the lowest ranked environmental indicator according to both models.

Table 9: Comparison of SIR and Priorities determined using the two models after refinement

		AIRS Priorities for Balanced Pillars Model			AIRS Priorities for Stand-Alone Indicators Model	
Pillar	Indicator	AIRS Priority	Re-scaled to a factor of 12	Overall ranking of SIR	AIRS Priority	Overall ranking of AIRS priorities
Ec	Unemployment rate	0.374	1.496	2	0.046	9
	Employment diversity	0.325	1.300	3	0.039	11
	Weekly household income	0.302	1.208	5	0.061	8
Soc	Population growth rate (1996-2001)	0.319	1.276	4	0.029	12
	Age structure	0.511	2.044	1	0.043	10
	Students completing year 12	0.17	0.680	9	0.028	13
Env	Dryland pasture land-use	0.268	1.072	6	0.124	1
	Pine plantations	-	-	-	0.103	5
	Remnant vegetation	0.242	0.968	8	0.113	3
	Dryland salinity	0.249	0.996	7	0.118	2
	Water soil erosion	-	-	-	0.093	7
	Wind soil erosion	0.242	0.968	8	0.108	4
	Soil structure decline	-	-	-	0.097	6

The elimination of indicators from one model and not the other, along with the fact that the top seven highest prioritised indicators for the stand-alone indicators model were once again environmental, demonstrated that priorities were more evenly spread across the pillars when using the balanced model. This was further highlighted by the overall ranking of social and economic indicators when compared across the two models. For example, the three economic indicators ranked in the top five most important indicators overall, yet in the stand-alone indicators model only two were ranked in the top ten indicators.

4. Discussion

This paper addresses the complex issue of sustainability, and our ability to accurately assess the current state of regional sustainability to improve decision-making and inform strategies across a system. The main criticisms of tools currently available for assessing sustainability relate to the incorporation of the inherent complexity within a system, and issues regarding the process of index creation. The first of these criticisms concerns the incorporation of underlying system processes that are driving sustainability, as well as the method of integrating the different pillars representing sustainability. Issues relating to index creation revolve around the subjectivity involved in the choice of indicators and the methods used to standardise, weight and combine them. Both of these issues were investigated in part through the development of an index of regional sustainability (AIRS) using a set of indicators collated as measures of sustainability for south-west Victoria (Wallis and Barrot, 2005).

The method developed in this paper demonstrates that it is in fact possible to incorporate system processes underlying sustainability into an index, a need that has been highlighted by previous studies (Bossel, 2001; Duff *et al.*, 2000; Sustainable Seattle, 1998; Wallis, 2002). This integration is achieved through a process of quantitatively weighting indicators based on the relationships they share with one another, and therefore the impact they have on system sustainability. This enables the method to overcome the limitations of previous tools concerning their lack of integration of system processes, and ensures weightings reflect the actual impacts of various indicators, and not their perceived importance.

The weighting method employed eliminates the need for subjective judgements to be made during the weighting of indicators, while also increasing the amount of complexity working within a system that the tool takes into consideration. Although this overcomes the subjective nature of the weighting process within index development, subjectivity can never be completely eradicated from any assessment of sustainability (Bell and Morse, 2003; Lélé and Norgaard, 1996; Morse *et al.*, 2001). To some point, subjectivity is essential as sustainability is contextual, so the definition of sustainability used for assessing regional sustainability has to be based on stakeholder values and the indicators must reflect this to effectively assess sustainability. However, assessing sustainability must be objective from a researcher's point of view to ensure the local definition of sustainability is retained, and not altered by outside judgements.

The two different models of sustainability for which indices were developed demonstrate that the approach taken to the integration of pillars has a substantial impact of the form of the final index, including the number of indicators used and their weightings. In particular, the ranking of indicators across pillars alters dramatically between the two models. The balanced pillar model weighs indicators fairly evenly across pillars in comparison to the stand-alone indicators model, which consistently weights environmental indicators as significantly more important than social or economic indicators. This suggests that separating indicators into pillars gives a misleading view of the importance of various indicators to the assessment of sustainability.

The increased focus on environmental indicators in the stand-alone indicators model is further highlighted by the retention of three extra environmental indicators in this model that were eliminated from the balanced pillar model. The elimination of indicators making little contribution to the index enables the development of very clear and concise tool enabling the clear communication of sustainability progress to decision makers and the public. The retention of indicators with larger priorities means that the index comprises of more integrated set of indicators, providing the most information regarding system processes driving sustainability.

This strong link between regional stakeholder priorities and those determined through relationship incorporation (AIRS) demonstrates the importance of local stakeholder knowledge in defining sustainability, confirming the need for stakeholders to be involved in indicator development. Many of the indicators that were highly prioritised by regional stakeholders (Wallis, 2002) remained as part of the final index despite the number of steps undertaken between stakeholder prioritisation and index development. However, the similarities with stakeholder rankings were more evident for the stand-alone indicators model, where it was not only the indicators themselves, but also their priorities that strongly reflected those determined by regional stakeholders. This point again enforces the importance of local values to the accurate definition and measurement of regional sustainability, and demonstrates that the final index is a good representation of that definition.

5. Conclusion

The approach to sustainability index development used in this paper provides a valid method for incorporating system processes underlying sustainability into a tool for measuring sustainability. It achieves this by reducing the subjectivity involved in the creation of the index by providing a quantitative method for weighting indicators. This weighting process is not only void of subjective judgements, but it also adds to the complexity within the system that the tool accounts for.

Investigation of differences in the final index when changing the way pillars were integrated demonstrated that the method chosen for pillar integration is critical to what indicators are included in any assessment and how they are weighted. From this investigation it was concluded that the extended research with focus on the use of the stand-alone indicators model of sustainability, which more accurately reflects the local definition of sustainability, and takes a more holistic approach to sustainability assessment. The similarities with regional stakeholder priorities demonstrated the importance of local values to creating an appropriate definition and indicators, and the need for them to be involved in index development.

The final set of priorities provides the foundation for a truly holistic and integrated index of regional sustainability in south-west Victoria. It also satisfies a number of criticisms of sustainability assessment and index use, and allows the assessment and prioritisation of different areas across the region, informing current and future decisions and strategies undertaken in the process of sustainable development.

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