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SIGNIFICANCE OF ENVIRONMENT IN THE ASSESSMENT OF SUSTAINABLE DEVELOPMENT: THE CASE FOR SOUTH WEST VICTORIA.

Abstract

The assessment of sustainable development is often based on the three pillars of sustainability model or triple bottom line using a set of indicators that evaluate the social, economic and environmental systems. It is thought that by measuring the performance of each system information can be gained about the sustainability of the whole system. However, this represents a disconnect between sustainability theory and the practice of sustainability evaluation as there is no attempt to evaluate if this assumption is true. During the development of a sustainability assessment framework for south west Victoria, Australia, it has become evident that this approach to sustainability assessment does not provide an accurate evaluation of system sustainability. Throughout this project, from stakeholder prioritisation of indicators to final multiple criteria analysis of sustainability, the environmental indicators were found to be the most important for the region's sustainability. As a consequence, the assessment produced shows that in south west Victoria, sustainability is largely determined by the condition of the environment. This finding highlights the current disconnection between theory and the reality of sustainability. Thus, we discuss a framework for sustainability assessment that attempts to re-connect theory to practice.

Keywords: *sustainability indicators, sustainable development evaluation, models of sustainability, ecosystem based models*

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1 Introduction

Since the release of Agenda 21 (United Nations, 1993) a significant effort has been employed at the global, national and local scale to select indicators and develop indices to assess progress toward sustainable development (Bossel, 2001; Wilson et al., 2007). This is demonstrated by over 800 sustainable indicator initiatives that are listed on the *Compendium of Sustainable Development Indicator Initiative* (IISD, 2008). This is because using indicators is seen not only as a means to collect and collate information about the sustainability of our social, economic and biophysical systems with the view to better inform decision making and policy formulation, but also as a means of communicating sustainability.

Although there is wide agreement that sustainability indicators are a useful tool for progressing sustainability (Bell and Morse, 1998; Gahin et al., 2003; Parris and Kates, 2003), there is still little agreement on which indicators to use and their broad nature and characteristics (Bell and Morse, 1998). Parris and Kates (p559) concluded in their assessment of sustainability indicators that ‘...there are no indicator sets that are universally accepted, backed by compelling theory, rigorous data collection and analysis and influential policy’. This is mainly because of the ambiguities in the definition of sustainability. This has led to a large amount of work devoted to indicator development producing very wide and varied systems of indicators and indices that are often characterised by poor or absent theoretical underpinning (Mitchell et al., 1995 p104). Thus, sustainability indicators are frequently simply social and economic indicators brought together with indicators derived from state of the environment reporting ‘selected from pre-existing lists with little to no modification, and are presented as ‘sustainability indicators’’ (Mitchell et al., 1995 p105).

Developing tools, be they sets of indicators or indices, for sustainability evaluation must have a theoretical underpinning to give them legitimacy (Parris and Kates, 2003). This is due in part to the sustainability paradigm and the emerging field of sustainability science being in its early days. However, a number of models of sustainability have been proposed (Liverman et al., 1988; Izac and Swift, 1994; Moffatt, 1994; Gilbert, 1996; Harger and Meyer, 1996; Pinfield, 1996; Rennings and Wiggering, 1997; Bell and Morse, 2001) and have been used as the basis for the development of assessment tools based on indicators. The most commonly used models are the three spheres, prism of sustainability (Valentin and Spangenberg, 2000) and pressure-state-response (OECD, 1993). These models generally involve

cataloguing indicators into pillars of sustainability (social, economic, environmental and institutional) or into two types: state indicators and driving force indicators or 'cause and effect' indicators (Bell and Morse, 2001). Once the data is collected for the indicators, then they are brought together in differing ways to give some assessment of sustainability. However, few, if any, of these models have been tested with data to see if they actually reflect the reality of sustainability. It is assumed that the model describes the sustainability of the system, and thus, the assessment produced using the model will assess the system's sustainability. In fact, evaluation of sustainability assessments is rare but increasingly important to improve the efficiency and effectiveness of sustainability assessment tools and to inform and progress the theory of sustainability (Wallis et al., 2007).

Thus, the aim of this paper is to contribute to the dialogue and thinking on sustainability assessment by evaluating the connection between the theory of sustainability and the practice of sustainability assessment. To do this the paper begins with a critical review of the literature on sustainability assessment, including the models that have been developed to conceptualise sustainability and how they have been applied to sustainability assessment. It goes on to use a sustainability assessment project undertaken in south west Victoria, Australia, to demonstrate that although attempts are made to base the assessment on the current models of sustainability the reality is that in practice this is a challenging process. A brief description of the south west region of Victoria, and an overview of the *Regional to Catchment Scale Indicators Project* that has been carried out there is provided. An evaluation of the project process then provides an insight into how the contextual nature of sustainability plays a role in determining the most appropriate model for a particular region. These findings have implications for the development of sustainability assessment methods to enable them to provide accurate information about local sustainability to help direct planning and management for sustainability achievement.

2 Background

2.1 The models of sustainability used to frame sustainability assessment methods

A plethora of conceptual models and principles of sustainability exist to help frame sustainability assessments. Examples include the pressure-state-response (PSR) framework used for state of the environment reporting (OECD, 1993), differing

versions of the three pillars of sustainability that form the basis of triple bottom line reporting, PICABUE framework of sustainability principles (Mitchell et al., 1995), Bellagio principles (Hardi and Zdan, 1997), basic orientors (Bossel, 1999), prism of sustainability (Valentin and Spangenberg, 2000) and the human-ecosystem linked system (Prescott-Allen, 2001). These models evolved from the Brundtland report's (1987) definition of sustainability and the Pressure-State-Response framework that had been used for environmental monitoring into the three pillars, spheres or domains, models to include social and economic indicators. As the theory of sustainability was debated, models diversified into three main streams. One being the four pillars stream which includes the 'prism of sustainability', a model with four interacting and interdependent dimensions. Another stream is the human-ecosystem linked models based on the carrying capacity concept where the human system has to be contained within the limits of the ecosystem, which includes the egg of wellbeing, the concentric rings model and the ecosystem – human system model used by Wackernagel (1996) for the ecological footprint. The third stream is an alternative means to frame sustainability assessment by using principles of sustainability, such as Bellagio principles (Hardi and Zdan, 1997), Haughton's (1999) futurity, equity, participation and biodiversity principles, or a more holistic systems model like Bossel's (1999) basic orientors. Using principles represents a move away from compartmentalising indicators and systems into separate pillars recognising that each system is interacting and interdependent. There has also been some moves away from theoretical frameworks to policy themes thought of as more 'practically orientated' (Lyytimäki and Rosenström, 2007). However this represents a disconnect between sustainability theory and practice, due to the lack of connection between sustainability and policy goals and will not be further discussed in this paper.

The most commonly used definition of sustainability is that presented by Brundtland (1987 #274), which defines sustainability as three dimensions, environmental, social and economic. This has led to the development of the three spheres, pillars, domains, and the triple bottom line models (Figure 1). These models describe sustainability as three equal systems or parts, either completely separate, as in the triple bottom line (Figure 1a) and pillars (Figure 1b) models, or with some interaction, as in the spheres model (Figure 1c). The sustainability assessment methods developed using these models are often just sets of economic, social and environmental indicators assessed in isolation to each other. As such Hardi and Zdan (1997, p12) advocate the use of the Bellagio Principles to guide the development of the indicator set, since they state that the assessment should consider the well-being of

the social, ecological and economic sub-systems and the interaction between the parts, thus advocating the three interacting spheres model.

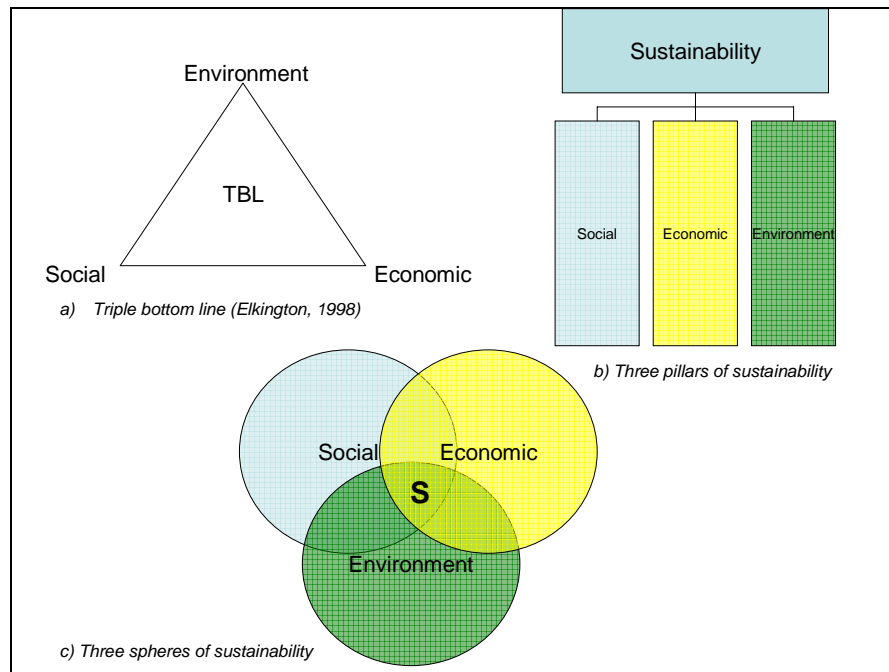


Figure 1: The three dimensions of sustainability models: a) triple bottom line {Elkington, 1998 #3320}; b) three pillars of sustainability; and c) three interacting spheres of sustainability.

Valentin and Spangenberg (2000) developed the prism of sustainability (Figure 2a) as a model for developing community indicators with broad community participation to define goals for sustainability, indicators and targets. This model describes sustainability as equal to the sustainability of each of the four interacting dimensions (social, economic, environmental and institutional), as well as sustainability of the interactions between these dimensions. The prism of sustainability has been taken further by O'Connor (2006) where he describes it as the 'four spheres' model (Figure 2b), with three self-organising spheres and a system regulation of political governance sphere that acts like a referee of the system. Using this model, sustainability can be analysed by focusing attention on the interfaces, interactions and interdependencies between the three spheres, the performance and quality of the spheres. Thus, this model provides a way to think of a system as being made up of interacting, interdependent parts giving a holistic approach to sustainability assessment. In this way, a system can only be deemed sustainable if the relationships between the spheres and the spheres themselves are sustainable (Peet, 2006).

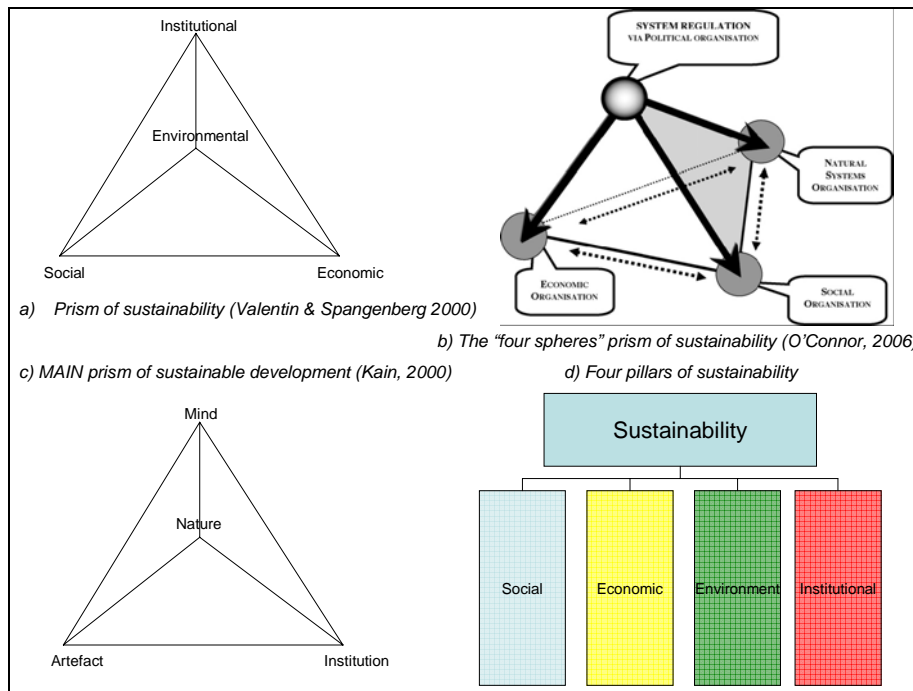


Figure 2: The four dimensions of sustainability models: a) prism of sustainability (Valentin and Spangenberg, 2000); b) 'four spheres' prism of sustainability (O'Connor, 2006); c) MAIN prism of sustainable development (Kain, 2000); and d) four pillars of sustainability.

However, Kain (2000) argues that the economic dimension of the prism of sustainability tends to include assets of the other dimensions and this leads to confusion (cited in Keiner, 2005). Thus, he developed a MAIN prism of sustainable development with four interacting dimensions, mind (social dimension awareness of individual), artefact (economic for all man-made material), institution (organisation of society and relation between people) and nature (environment all natural capital) (Kain, 2000) (Figure 2c).

The second stream of sustainability models used in the development of sustainability assessment methods is the ecosystem based models of sustainability where the human system is dependent on the environment (Figure 3). These models are based on the carrying capacity concept, which states that there is a limit to how much activity an ecosystem can support. Thus, the human system can not exceed the abilities of the ecosystem to provide resources and other life support services such as assimilating wastes. The egg of wellbeing (Figure 3a) and the human-ecosystem linked (Figure 3b) models have both been the basis of the commonly used sustainability assessment methods the Wellbeing Assessment (Prescott-Allen, 2001) and the Ecological Footprint (Wackernagel and Rees, 1996) respectively. The concentric rings model of sustainability (Figure 3c), shows that the human system,

which is broken up into social and economic systems, must stay within the capacity of the ecosystem for the system to be sustainability. Also, the economy has to remain within the capacity of the social system for sustainability to be achieved.

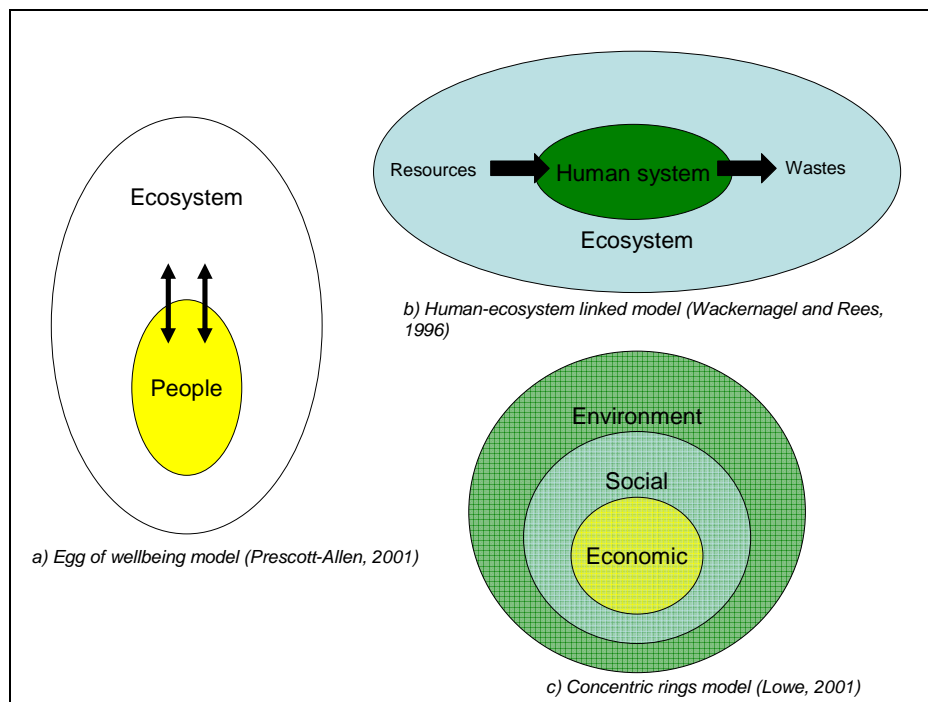


Figure 3: Ecosystem based models of sustainability: a) egg of wellbeing (Prescott-Allen, 2001); b) human-ecosystem linked (Wackernagel and Rees, 1996); and c) concentric rings (Lowe, 2001).

The third stream of models proposed as a framework for sustainability evaluation is the principles of sustainability (Figure 4). This approach concentrates on the elements necessary for sustainability to be achieved. This removes the separation of social, economic and environmental issues which can lead to issues of trade-offs between the pillars during decision making (Gibson, 2001; Giddings et al., 2002). Haughton's (1999) principles of sustainability (Figure 4a) argue that for sustainability to be achieved, each of the following has to be met: a) futurity (intergenerational equity); b) social justice (intragenerational equity); c) trans-frontier responsibility (geographical equity); d) procedural equity (participation in decision making and people treated fair and openly); and e) inter-species equity (importance of biodiversity). This focus was also used by Cooper's (1995; cited in Palmer et al., 1997) principles of futurity, environment, equity and public participation (Figure 4b). Bossel's (1999) basic orientors framework (Figure 4c) takes a systems based approach whereby selecting indicators that assess each orientor – existence,

effectiveness, freedom of action, security, adaptability, co-existence, psychological needs – the viability and performance of the human, support systems and environment can be evaluated. This provides a systematic approach to indicator development as a sustainable system needs to have each of these properties met. Thus, each of these frameworks could be used to guide the selection of sustainability indicators to assess the achievement of each principle or orientor.

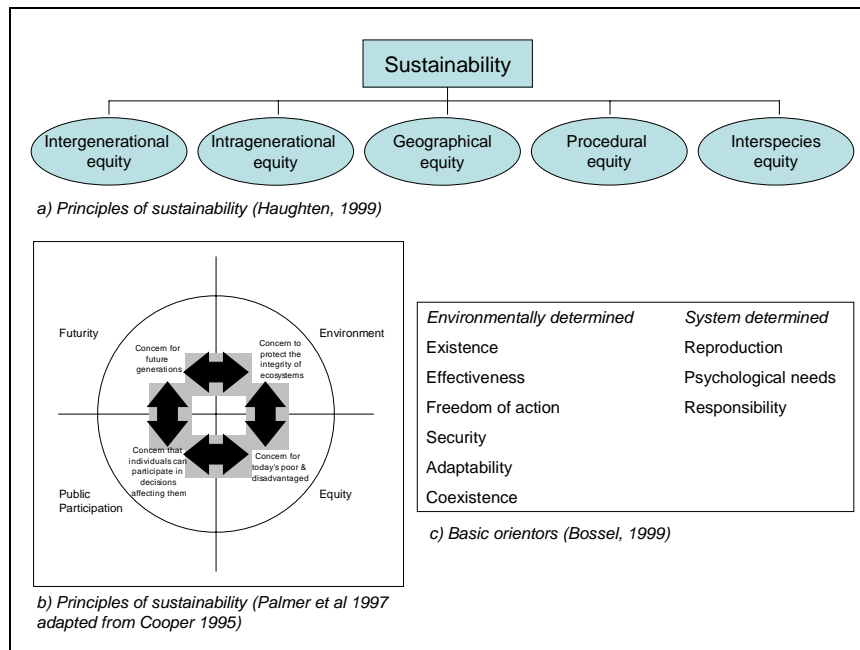


Figure 4: Systems models of sustainability. a) Haughton's principles of sustainability (Haughton, 1999); b) Cooper's principles of sustainability (Cooper, 1995; Palmer et al., 1997); and c) basic orientors (Bossel, 1999).

PICABUE (Mitchell et al., 1995), a methodological framework for the development of indicators of sustainable development, uses similar sustainability principles in a participatory process of indicator development that involves the selection of indicators to assess equity and ecological integrity. Mitchell (1995) argues by using the principles of sustainability as the framework for the evaluation it prevents the indicators from being contentious unless the underlying principles of sustainability are in dispute. This point highlights the importance of grounding sustainability evaluations in sustainability theory as this gives the indicators legitimacy and credibility, helping them be accepted and used by managers and the wider community.

A quick look at each of these models of sustainability shows that sustainability assessments developed using different models could produce quite a different assessment of sustainability. This was demonstrated by Wilson et al. (2007) who used six sustainability assessment methods to assess a number of countries and found a large variability in results for each country. This is caused by differences in the model of sustainability used to base each method. So with a variety of models to choose from and no general agreement on how the concept of sustainability should be translated into practice, how do we know which model will really assess the sustainability of the system we are interested in? This problem has led to many people redefining sustainability to suit their own political agendas, rather than using sustainability as an influential basis for policy development (Andrews, 1997; Jabareen, 2006). Thus, sustainability assessments, and the model used to build them, often reveal more about the social and political ideologies that shaped them and the purpose of the assessment than about sustainability (O'Riordan and Voisey 1998 cited in McAlpine and Birnie, 2006).

Furthermore, Coelho et al. (2006) in their review of the processes used to develop sustainability assessment indicators found that over half didn't use any framework to develop their assessment. Those that did were dominated by PSR, driving forces-pressure-state-impact-response (DPSIR) model and three pillars model, often in combination, and sometimes including an additional pillar (eg. institutional). Our review of 54 sustainability assessment methods (Table 1), had a similar result with 57% of the methods reviewed using the three pillars, the four pillars or PSR frameworks producing lists of indicators developed to assess each of the pillars in isolation from each other. This is because many sustainability indicator sets have sprung from environmental monitoring programs to become expanded indicator sets with social and economic indicators included, and thus, taking the three pillar approach (Lyytimäki and Rosenström, 2007).

Table 1: The sustainability models used for sustainability assessment development with the assessments that used stakeholder participation and involved integration of indicators.

Model used	Number of assessments using model	Stakeholder selected indicators	Integration of indicators	References
PSR/DPSIR	7 (2 incorporating 3 spheres model)	2	1	(Hardi and Zdan, 1997; Barrera-Roldán and Saldivar-Valdés, 2002; Kelly and Moles, 2002; MCSD, 2002; Eckerberg and Minuer, 2003; Coelho et al., 2006; Ness et al., 2007)
Three spheres/pillars and Triple-bottom-line	15	5	1	(Hardi and Zdan, 1997; AtKisson, 1999; Cartwright, 2000; GAPDL, 2001; Herrera-Ulloa et al., 2003; Parris and Kates, 2003; Schlossberg and Zimmerman, 2003; Swisher et al., 2003; Clerici et al., 2004; Wiek and Binder, 2005; Coelho et al., 2006; Van Cauwenbergh et al., 2007; Global Reporting Initiative, 2008; Melbourne City Council, 2008)
Prism of sustainability or four pillars	9 (4 th pillar was wellbeing (1), natural resources (1), democracy (1), cultural (1))	5	2	(IWGSDI, 1998; Gustavson et al., 1999; Valentin and Spangenberg, 2000; UNCSD, 2001; Buselich, 2002; Eckerberg and Minuer, 2003; Parris and Kates, 2003; Luckman, 2006; McAlpine and Birnie, 2006; Peet, 2006; Lee and Huang, 2007; Ness et al., 2007; ARUP, 2008; NIE & NISGI, n.d.)
Human-ecosystem linked	2	1	3	(Wackernagel and Rees, 1996; Prescott-Allen, 2001; Fraser et al., 2006)
Basic orientors	4	1	0	(Bossel, 1999)
Principles of sustainability	2	1	0	(Mitchell et al., 1995; Keirstead and Leach, 2007)
Systems analysis	2	1	0	(Lopez-Ridaura et al., 2005; Bagheri and Hjorth, 2007)
Stakeholder defined	6	6	0	(Hardi and Zdan, 1997; The Australia Institute, 2000; The Boston Indicators Project, 2000; Parris and Kates, 2003; Bell and Morse, 2004; Fraser et al., 2006)
issue/goal based	5	3	1	(Henderson et al., 2000; Eckerberg and Minuer, 2003; Mederly et al., 2003; Hezri and Hasan, 2004; Boulder County Civic Forum, 2005; Coelho et al., 2006)
Issue/goal based	5	3	1	(Henderson et al., 2000; Eckerberg and Minuer, 2003; Mederly et al., 2003; Hezri and Hasan, 2004; Boulder County Civic Forum, 2005; Coelho et al., 2006)
Policy themes	2	1	0	(DEFRA, 2004; Office of Urban Management, 2005)

Very few of the sustainability assessments reviewed attempted to integrate the pillars and/or indicators (only eight), however, they usually treated the indicators and pillars as if they were of equal importance to sustainability (eg. Herrera-Ulloa et al., 2003; Lee and Huang, 2007). In fact, only Gustavson *et al.* (1999) investigated the relationships between the indicators, but they did not look at variations in the indicators impact on sustainability. Furthermore, they did not review their assumption that the model they used to select the indicators was able to describe the sustainability of the system. This lack of investigation into the relationships between the indicators and sustainability means that none of the assessments reviewed made any attempt to determine if the model of sustainability they based the assessment on correctly described the sustainability of the area being evaluated. However, to be able to guide managers to progress sustainability, the sustainability assessment needs to be able to produce accurate information about the sustainability of the system. But without this investigation or any other evaluation of the model used this cannot be known. Thus, the lack of evaluation of the process of sustainability assessment may lead to a disconnection between sustainability theory and the practice of sustainability assessment.

Table 1 also clearly demonstrates the small number of assessment methods that used stakeholder participation to determine the definition of sustainability and choose relevant indicators. Only 6 of the 53 methods reviewed use a stakeholder definition of sustainability, and only 48% used stakeholders to help select the indicators. The rest relied on experts, researchers or the managers themselves to choose the indicators. Of the 14 methods using the three pillars model, only four used stakeholder participation to select the indicators. This shows that stakeholder participation in sustainability assessments is still not the normal procedure, even though it is essential to ensure the assessment is locally relevant and taken up by the local community (Bell and Morse, 2004; Coelho et al., 2006; Fraser et al., 2006 and others). This is because stakeholders often feel the context in which they are living with great passion (Bell and Morse, 2004), and they have invaluable local knowledge that will help inform the assessment process. Therefore, by allowing the stakeholders values to inform the definition of sustainability it is more likely to produce a sustainability assessment able to assess the sustainability of the system of interest. Furthermore, if the assessment development includes wide community engagement and participation throughout the process it is more likely to produce an assessment that the community and decision makers accept and use (Coelho et al., 2006).

Thus, to ensure that the sustainability assessment method is able to provide accurate information about the sustainability of the area it needs to bring together sustainability theory with stakeholders values in an integrated assessment of system sustainability. This would provide the link between theory, practice and stakeholder values that is currently missing. For a large number of sustainability assessment methods to date there has been little link between theory and practice and widely differing levels of stakeholder participation from none to full participation. Thus, we argue that to advance the theory and practice of sustainability assessment there is a need to fully understand the underlying model on which an assessment is based, the influence of stakeholder participation and the relationships between the indicators used and how each of these influence the assessment outcome. This will ground the indicators in theory and give them legitimacy (as they are respectful of stakeholders values and beliefs and are unbiased and fair), credibility (embedded in theory and sound scientific analysis) and salience (relevant to the local system and its community) which will make them more widely accepted and used (Parris and Kates, 2003). Therefore, in the rest of the paper, the link between theory and practice is explored using the case of south west Victoria's sustainability assessment development. This will reveal the model which most closely describes the systems sustainability and thus, how the indicators should be integrated to produce an accurate sustainability assessment tool.

3 South West Victoria - a case study sustainability assessment

The south west region of Victoria, Australia, covers an area of 26,000 square kilometres representing approximately 11% of the state of Victoria (Glenelg Hopkins CMA, 2003). The regional boundary as defined in this study is based on the natural spaces of three river basins and is therefore a biophysical region rather than a region based on institutional or infrastructural boundaries. The three river basins are the Glenelg, Hopkins and Portland Coast and between them there are 32 sub-catchments (Figure 5). The region has a population of 103,000 people mostly located in the urban centres of Portland, Warrnambool and Hamilton.

Traditionally the region has depended largely on agriculture with approximately 81% of the land area having been developed for agricultural purposes (Glenelg Hopkins CMA, 2003). As a result of high levels of agricultural production the region's natural resource base is being degraded by native vegetation clearing, increasing salinity levels in soils, pest plant and animal invasions and both wind and water erosion.

There are also some social and economic issues mainly caused by population decline in rural towns.

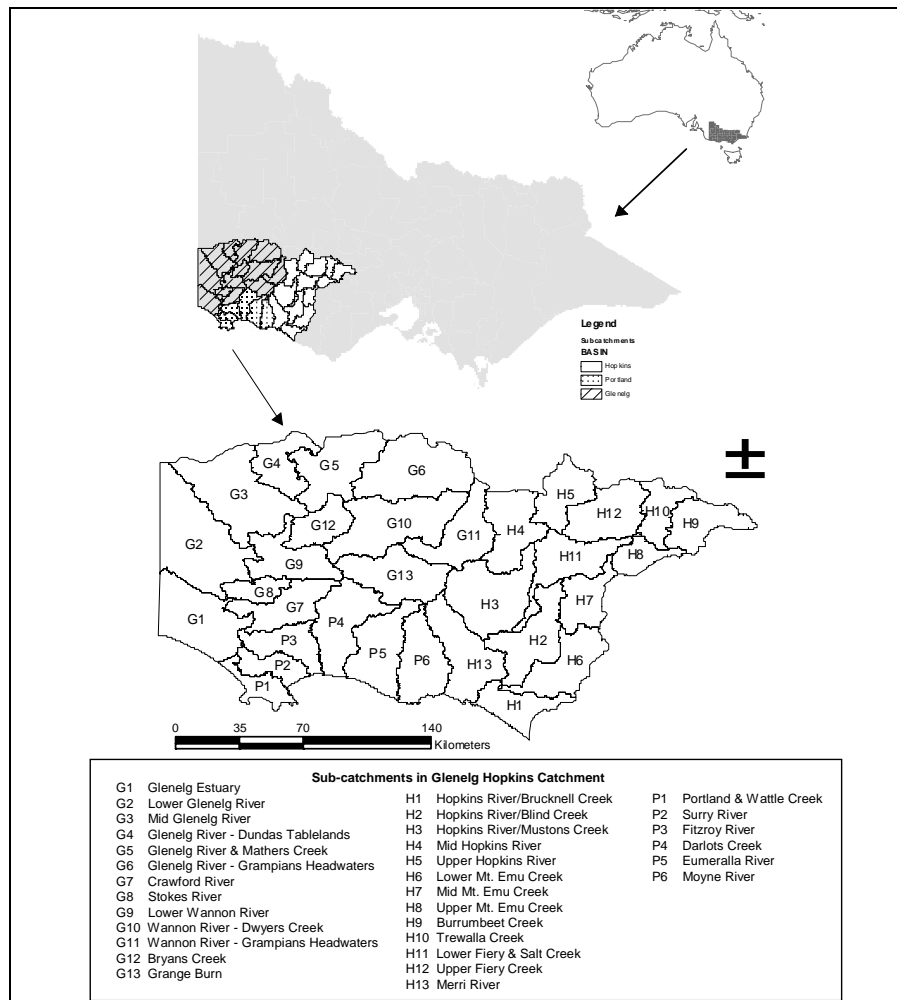


Figure 5: South west Victoria, Australia.

3.1 Regional to Catchment scale indicators project.

In 2002, the South West Sustainability Partnership, a group comprised of 16 public sector organisations, local government bodies and tertiary education institutions, proposed a set of regional sustainability indicators be developed for the region. Such an indicator set was seen as a means to provide an assessment of sustainability and a means to track progress toward a sustainable future. The approach taken was to identify indicators that could assess four pillars of sustainability, representing the goals of sustainability within the region as defined in the South West Sustainability Blueprint (South West Sustainability Partnership, 2001):

- **Social** – building capacity for regional action;

- **Economic** – creating greater prosperity through sustainability as a competitive advantage;
- **Environmental** – conserving and enhancing the natural resources base; and
- **Institutional** – requirements for implementation and monitoring.

Thus, the prism of sustainability (Figure 2a) was used as the underlining framework for developing the indicator set. This process began by having stakeholders identify priority indicators appropriate to the south west region. Given that stakeholders demonstrated consensus on the indicators selected (Wallis, 2006) the 44 priority indicators were taken to the community for affirmation of their appropriateness. This allowed the stakeholders and community to define what sustainability means for the region. Once it became apparent that there was community support for the indicators selected, trend and condition data was collected and collated for as many of the indicators as possible. The information was published as a series of report cards (Wallis and Barrot, 2005) at both the regional, catchment and sub-catchment scales. This provided a descriptive assessment of sustainability based on 19 indicators from the social, economic and environmental pillars. By this point it became apparent that due to difficulties with data access and availability that an assessment using the prism of sustainability or even the four pillars model (Figure 2d) with no interaction between the pillars could not be applied in the region. Instead, an assessment based on the independent three pillars model (Figure 1b) was carried out. This, according to the principles of sustainability, was inadequate as the pillars are not isolated systems.

It is well documented that integration of the pillars of sustainability is essential for an accurate assessment to be made (Gustavson et al., 1999; Morse et al., 2001; Dovers, 2005). Thus the next step, based on the 'three spheres of sustainability' model, was to determine the relationships between the indicators both within and between the pillars using Spearman's Correlation and Principle Component Analysis. This process highlighted indicators that were highly correlated with other indicators and allowed Sustainability Impact Ratings to be developed. Using the Analytical Hierarchy Process (AHP) (Saaty, 1980) in Expert ChoiceTM, pairwise comparisons of the indicator's Sustainability Impact Ratings were made to determine indicator weightings. Redundant indicators, those that contributed little to the overall sub-catchment sustainability assessment, were then eliminated resulting in a reduced set of 13 indicators. These indicators formed the index called An Index of Regional

Sustainability (AIRS), which takes a multiple criteria approach using weighted summation to integrate the standardised indicator data into a sustainability index for each sub-catchment. The weightings for these 13 indicators were determined using AHP (Table 2) (Richards et al., 2007). This was then integrated into GIS software to enable the assessment to produce maps of sub-catchment sustainability (Graymore et al., 2007). This forms a GIS based decision support system utilising multiple criteria analysis, which is able to reduce the complexity of environment, social and economic pillar interactions, based on the three spheres model, into a tool that is easy to use and understand without losing important information about sustainability. This could be a useful tool for regional managers in south west Victoria, as it provides information about sub-catchment sustainability to aid in their decision making regarding strategies to progress the region's sustainability.

Table 2: AIRS indicators and their weights.

Pillar	Indicator	Weighting
Environmental	Dryland pasture	0.124
	Dryland salinity	0.118
	Remnant vegetation	0.113
	Wind erosion	0.108
	Pine plantations	0.103
	Soil structure Decline	0.097
	Water erosion	0.093
Social	Age structure	0.043
	Population growth	0.029
	People completed Year 12	0.028
Economic	Medium household income	0.061
	Unemployment rate	0.046
	Employment diversity	0.039

Source: Graymore et al. (2007 #1612).

During the development of AIRS it became apparent that the tool was dominated by biophysical indicators and hence the assessment produced placed emphasis on the environmental pillar. Such an emphasis on one pillar does not fit the three spheres model as this model assumes equal emphasis should be given to each of the sub-systems, a balanced approach to sustainability. It was therefore deemed necessary to review the research process to better understand this outcome. Thus, document analysis and review of the AIRS tool development process from the beginning of the

project was undertaken to determine the emphasis given to the environment pillar in comparison to the social and economic pillars.

Three stages of the index development process were identified. Stage 1 was the selection of indicators by stakeholders and the community, in Stage 2 the indicators with reliable data were collated into report cards, and stage 3 was the development of the AIRS metric. For each stage the number of indicators pertaining to each pillar was tabulated to provide a comparison between pillars. Table 3 provides a comparison of the percentage contribution of indicators from the three pillars through steps 1 to 3. The results illustrate a clear emphasis on the environmental pillar throughout the project. Running parallel with the development of AIRS O'Toole et al. (2006) conducted a telephone survey to determine how members of the south west community defined sustainability. A total of 535 people responded to the survey and of these 35% (188) linked sustainability to a pillar or combination of pillars. Of these 61% (115) linked it either singly or in combination with the environmental pillar (Table 4). The emphasis on the environmental pillar was becoming apparent as the pillar that drives sustainability in south west Victoria. This clearly demonstrates that any assessment using this tool will give an emphasis to environmental sustainability. Hence, it appears that the model of sustainability that best characterises sustainability in this region is not a balanced one.

Table 3: A comparison of how the pillars of sustainability are represented by indicators at various stages in the development of AIRS.

Project stage	Sustainability Dimensions				TOTAL
	Environmental	Social	Economic	Institutional	
	% (n)	% (n)	% (n)	% (n)	
1. Indicators selected – based on 4 Dimensions as defined by SWSP* (South West Sustainability Partnership, 2001)	55% (24)	16% (7)	18% (8)	11% (5)	100% (44)
2. Data collection and collation – Sustainability report cards	58% (11)	26% (5)	16% (3)	0% (0)	100%(19)
3. AIRS metric	54% (7)	23% (3)	23% (3)		100% (13)

*South West Sustainability Partnership

Table 4: The number and percent of respondents who defined sustainability as either linked to a pillar or a combination of pillars.

Domains	Frequency	Percentage
Environmental	59	31
Social	29	15
Economic	27	15
Social + Environmental	17	9
Social + Economic	17	9
Environmental + Economic	29	15
Environmental + Social + Economic	10	6

Source: Adapted from O'Toole et al. (2006)

During the development of AIRS this lack of balance was analysed by testing two models of sustainability, the three spheres balanced model and the stand alone indicators model. This analysis of the models underlying the assessment was carried out to ensure the model that most accurately described sustainability in the region was used and that those indicators shown to have the greatest impact on sustainability were included in the index. A comparison of the weightings for the balanced model indicators with those of the stand alone indicators (Table 5) shows that the balanced model weights the indicators evenly across the pillars compared to the stand alone model. The stand alone model consistently weights environmental indicators as significantly more important than social or economic indicators. In fact, if the ranking of the indicators is considered, all the environmental indicators are the most highly ranked indicators followed by the economic and then social indicators for this model. This is a similar pattern to the Sustainability Impact Ratings that were determined for all 19 indicators, where all the environmental indicators had higher impact ratings than the social or economic indicators. This pattern was also supported by the original south west Victorian set of sustainability indicators chosen by the stakeholders where over twice as many environmental indicators were highly prioritised compared to the social and economic indicators combined (Wallis and Barrot, 2005).

Considering the Sustainability Impact Ratings showed that the environmental indicators have a larger impact on sustainability, forcing the indicators into balanced model compared to the more holistic stand alone model appears to cause important information about the region's sustainability to be lost. This was evidenced by the elimination from this indicator set of a number of environmental indicators that had high Sustainability Impact Ratings. This suggests that the balanced model gives a misleading view of the importance of various indicators to sustainability and therefore does not accurately describe the sustainability of the region. As such, the three spheres model of sustainability, on which the balanced model is

based, is not appropriate for the region. The stand alone model however, is more suitable as it provides a more accurate picture of the sustainability of the region's sub-catchments.

Table 5: Original Sustainability Impact Ratings and the weightings for the balanced and stand alone models. Note: where there is a '-' this indicator was not included in the set.

Pillar	Indicator	Sustainability Impact Rating		Equal three pillars model		Stand alone indicators model	
		SIR	Rank	Weight	Rank	Weight	Rank
Economic	Employment diversity	0.092	9	0.374	2	0.039	11
	Unemployment rate	0.085	10	0.325	3	0.046	9
	Weekly household income	0	13	0.302	5	0.061	8
<i>Total economic pillar weight</i>		<i>0.177</i>		<i>1.001</i>		<i>0.146</i>	
Social	Age structure diversity	0.093	8	0.511	1	0.043	10
	Students completing year 12	0.074	11	0.170	10	0.029	12
	Population growth rate	0.069	12	0.319	4	0.028	13
<i>Total social pillar weight</i>		<i>0.236</i>		<i>1.000</i>		<i>0.090</i>	
Environment	Risk of dryland salinity	0.279	1	0.249	7	0.118	2
	Remnant vegetation	0.275	2	0.242	8	0.113	3
	Dryland pasture	0.269	3	0.268	6	0.124	1
	Susceptibility to wind erosion	0.268	4	0.242	8	0.108	4
	Susceptibility to water erosion	0.203	5	-	-	0.093	7
	Soil structure decline	0.184	6	-	-	0.097	6
	Pine plantations	0.168	7	-	-	0.103	5
<i>Total environmental pillar weight</i>		<i>1.646</i>		<i>1.001</i>		<i>0.756</i>	

Source: Adapted from Richards et al. (2007 #1610).

Furthermore, the fact that the stakeholder prioritisation of indicators contained 24 environmental indicators out of the 44 indicators tell us that the region's stakeholders feel that the environment is extremely important to the region's sustainability. This strong link between stakeholder prioritisation of indicators and the stand alone model's prioritisation of indicators demonstrates the importance of local stakeholder knowledge in defining sustainability, providing further evidence for the need for stakeholder participation in sustainability assessment development. It also lends further weight to the point that the stand alone model describes local sustainability more accurately than the balanced model.

So what do these results suggest about the type of model that should be used to describe the sustainability of south west Victoria? Because the environmental indicators are found to

be more important to the sustainability assessment, it suggests that an ecosystem dependent sustainability model, such as the egg of wellbeing, the human-ecosystem linked, or concentric rings models (Figure 3), is the most appropriate for describing and assessing the sustainability of south west Victoria. Thus, demonstrating that for this region, the link between theory and practice of sustainability assessment is gained through understanding that the region's sustainability relies on the capacity of the environment to continue to support the human system and thus, this capacity has to be assessed to accurately evaluate the region's sustainability.

4 Discussion

To date there is no single agreed upon method for undertaking sustainability assessments (Hamblin, 2001) yet a vast number of attempts have been made to assess progress toward sustainability (for example: Wackernagel and Rees, 1996; Gustavson et al., 1999; Prescott-Allen, 2001). By reviewing the current models of sustainability and the sustainability assessment process carried out in south west Victoria, it has become evident that connecting the current theory of sustainability and the practice of sustainability assessment is not a straight forward process. Difficulties faced included selecting a theoretical model that was relevant to the system and implementing the assessment process to reflect the model chosen. Through this process it was evident that the model used to base the assessment has to be reviewed and adapted to reflect the system and that a balanced approach to each of the dimensions as required by the sustainable development paradigm is not always applicable.

In line with current approaches to measuring sustainability and with the South West Sustainability Partnership's view of sustainability in mind, the prism of sustainability was used as the framework for selecting the indicators for the southwest sustainability assessment. Local stakeholders and the community participated in choosing the most appropriate indicators. As such the assessment process began with what was believed to be a solid theoretical background and a view of the region's 'sustainability' reflecting the values and understandings of the people who live in the region ensuring a local context.

In contrast, the process most commonly used in other studies (such as Prescott-Allen, 2001; Mickwitz et al., 2005; Coelho et al., 2006; McAlpine and Birnie, 2006) is one where indicator sets are developed based on the model of sustainability chosen at the start of the process by the developers with or without stakeholder input. For the rest of the development process, it is assumed that this model accurately describes the sustainability of the system of interest and the assessment is based on this assumption. The evaluation of the south west process

however, demonstrates for a number of reasons that such an assumption is misleading. Firstly, once indicators were selected it was apparent that they represented a four pillar model rather than the prism of sustainability. Secondly, due to difficulties (such as finding quality data for all the indicators selected) in implementing the assessment based on the original model, in the subsequent stages of the assessment's development different models were substituted as the underlying theoretical basis for the assessment.

The majority of sustainability assessment methods (for example: AtKisson, 1999; Schlossberg and Zimmerman, 2003; Global Reporting Initiative, 2008; Melbourne City Council, 2008) are developed using the three pillars models or the triple bottom line approach, where each pillar is separate but equally important to sustainability and can be treated more-or-less independently (Peet, 2006). However, the applicability of this model to the system's sustainability is doubtful because systems theory tells us that sustainability is dependent on the whole system's viability. This involves complex interactions between social, economic and biophysical systems, with the human system dependent on the environmental support systems for its viability and functioning (Bossel, 2001). Thus, there is small likelihood that each pillar is equally important to sustainability, and treating them as such means that the linkages and interdependencies of the systems are ignored (Pope et al., 2004). This would mean that any assessment produced using this model would be unlikely to provide an accurate picture of the system's sustainability. Hence, as AIRS was developed a fourth model, the interacting spheres, became the underlying theoretical basis for the assessment. The three sphere model demonstrates the interrelationships that exist between the social, economic and environmental dimensions of sustainability and by investigating the relationships and producing AIRS a more integrated approach to sustainability assessment was developed.

What was found however, when applying the AIRS metric, was that in south west Victoria the environmental indicators were both the most important indicators to the stakeholders and the most important in terms of their contribution to the sustainability of region. This means that the environmental condition is largely influencing the sustainability of sub-catchments in the region, changing the theoretical model underpinning the assessment again. Figure 6 shows how over the period of the project the theoretical basis changed. Therefore, it is suggested that the ecosystem based model where system sustainability is dependent on the sustainability of the environmental system, such as the concentric rings model, best underpins regional sustainability in this context. Hence, this model should be used as a basis for the assessment of sustainability, and for helping managers understand the sustainability of the system.

Bossel (2001) and others (such as Rapport, 2000; Bagheri and Hjorth, 2007) have argued that for a system to be sustainable, the elements of the system that keep it functioning have to be healthy and working. For south west Victoria, the system has been primarily based on agriculture, and as such, the land quality indicators are the most important indicators for explaining the region's sustainability. Thus, to maintain its economic and social capacity, it is imperative that the biophysical capacity of the region is maintained. This requires the protection of soils, which impacts directly on agricultural production, and the protection of remnant vegetation, waterways and biodiversity. This finding is support by Walker et al. (2006) whose work demonstrated the importance of similar environmental indicators in assessing catchment condition in Australia at the national scale. The south west Victorian case study therefore supports Bossel's (2001) argument, suggesting that the primary function of sustainability assessment must be to assess the health and functioning of the supporting elements of the system. These results indicate that all sustainability assessments should have an environmental emphasis, particularly for those systems were the viability of the system is highly dependent on the environment for survival, such as agricultural or other natural resource based systems. However, this requires further investigation.

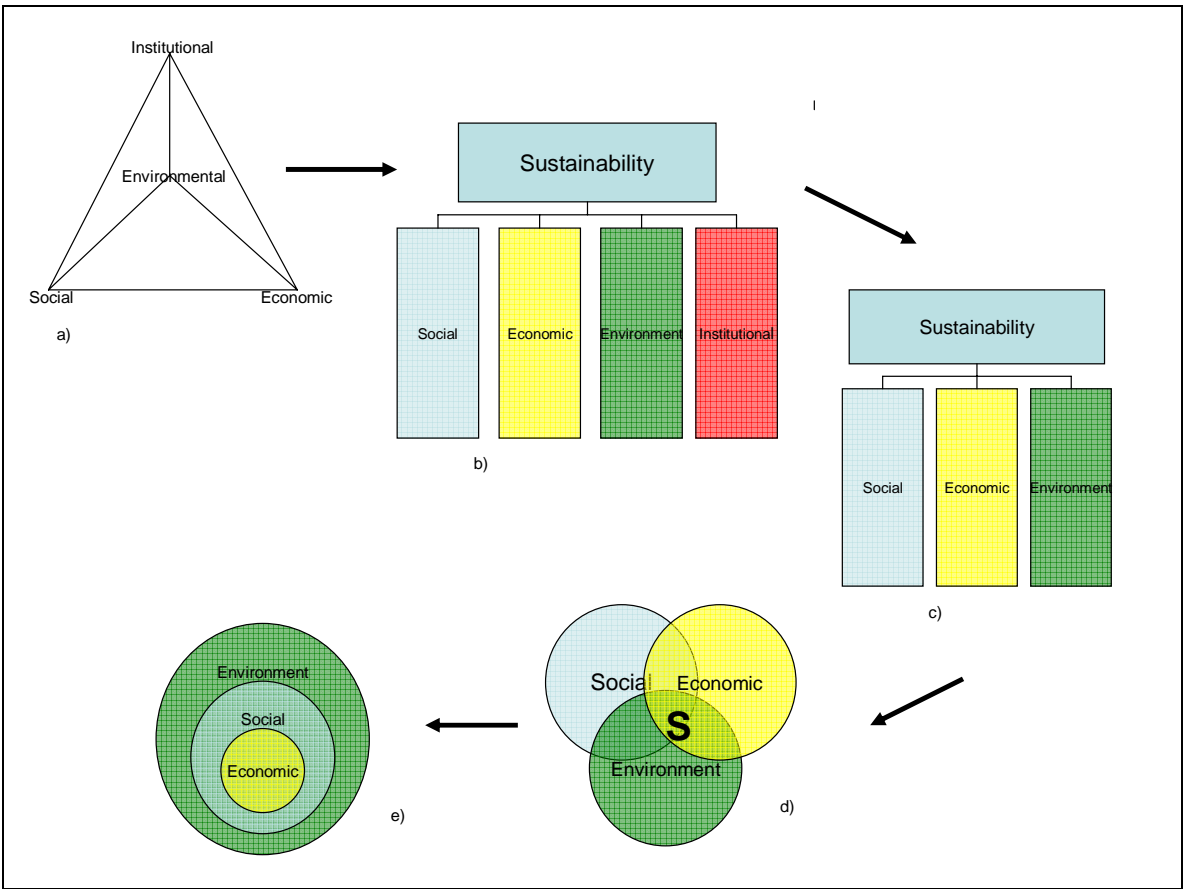


Figure 6: The evolving nature of the theoretical models on which the south west sustainability assessment was based. a) in the project design stage; b) after indicators selection; c) after data collection and collation; d) during AIRS development; e) after the evaluation process.

It is not unusual to find indices used to assess sustainability differ in their emphasis on the different pillars (Wilson et al., 2007). The contextual nature of sustainability means that what is appropriate to be measured in one location may not be appropriate at another and this is reflected in the greater emphasis placed on the environmental pillar in south west Victoria. Therefore, the outcome of the assessment will be influenced by location, scale, the choice of indicators, who selects the indicators and how they are presented. Wilson et al. (2007) demonstrated this by assessing the sustainability of a number of countries using differing indices. They showed that each index produced different and sometimes conflicting results. This is not surprising given the lack of clear definition, the multitude of model types and the current practice of using assessment tools that are a long way from reflecting sustainability in an integrated and holistic manner. While this is the case, the context in which the assessment is undertaken must be clearly articulated along with the models and methods used. Indicators should be chosen specifically for the system with stakeholder participation and integration based on the quantified relationships between the indicators and their impact on sustainability. And finally, evaluation of the assessment process and outcomes should be an integral part of sustainability practice.

5 Conclusion

This study has made it clear that the sustainability of sub-catchments in south west Victoria is dependent on sustainability of the environment. Hence, for managers to progress sustainability in the region with a well founded theoretical underpinning, they have to think of the region's sustainability in terms of the ecosystem dependent models. That is, they must recognise that for sustainability to be achieved development must be constrained within the ecological carrying capacity of the region (Moran et al., 2008). To ensure a connection between the theory and practice of sustainability it is recommended that managers in the region concentrate their efforts on the protection of environmental health to ensure that the biophysical capacity required to support the human system is maintained.

The evolving nature of sustainability science requires that the process of sustainability assessments along with the assessment outcomes be evaluated so that the theory and practice can be demonstrated to be well connected. In these early days, when there is still a lot to learn about measuring sustainability, indicators and indices should be used within the context for which they are designed and the practice of sustainability assessment must be informed by evaluation of the methods and processes used to undertake these assessments. In order to be useful to planners and decision makers, the information provided by the assessments needs to be based on a model that adequately reflects current sustainability thinking, as well as the local context of sustainability, using a method that is transparent with

an open declaration of subjective judgements made in index. Only further exploration and evaluation of sustainability assessment will allow experience in sustainability practice to grow.

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