PRINCIPLES AT THE FUNDAMENTAL LEVEL OF A SYSTEMS-BASED SUSTAINABILITY FRAMEWORK

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ABSTRACT

There are numerous sustainability frameworks and associated indicators cited in the literature for measuring sustainability. There is no shortage of possible indicators. The question is; how to choose the most appropriate number and types of indicators. Too many and it is overly complicated and time consuming, too few and not all the relevant issues are adequately covered.

This paper proposes a sustainability framework based on a row-column structure linking principles to indicators. In order to use the framework, agreement on the fundamental principles, based on systems thinking, is a vital step prior to the choice of indicators. This provides a structured, logical approach to choosing the most appropriate sustainability indicators.

The more fundamental level of principles is also shown to represent a possible commonality between the different 'worldviews' of 'western' and 'eastern' cultures, thus proposing another advantage for using principles at the fundamental level of sustainability.

INTRODUCTION

Numerous documents have been produced in New Zealand and internationally on the issue of measuring 'sustainability' and/or our 'quality of life'. The problem is not a shortage of indicators to measure sustainability issues, but how to choose the most appropriate indicators for a concise yet comprehensive coverage of all the relevant issues. Simply developing a long list of indicators with no overall structure or framework is not good enough.

Traditionally, the objective focussed engineering and science fields have focussed on quantitative measures as they have been considered to be the most 'accurate'. Qualitative measures have only been used if quantitative measures are too difficult, time consuming or expensive to measure. In the same light, principles have been seen to be too general, esoteric and difficult to use.

This paper explores the use of principles as the underlying fundamental laws that need to be agreed upon before choosing the specific quantitative and qualitative parameters for measuring our sustainability progress. By using agreed principles as part of the underlying sustainability framework, the number of indicators can be reduced to a manageable size yet still provide a comprehensive coverage of all the relevant issues.

It is also interesting to note that if sustainability is a global issue (which it must be if sustainability of the planet as a whole is our goal) then the use of principles as the basic building blocks of sustainability frameworks may also provide a possible commonality between the apparent different 'worldviews' of western and eastern cultures.

WHAT ARE PRINCIPLES?

Principles are fundamental laws or rules governing the behaviour of a system. In the context of sustainability, many writers have put forward a number of different sets of sustainability principles. Some examples of sustainability principles, or fundamental system qualities, are given below in Table 1.

Table 1: Example Sustainability Principles

Gibsons' Principles (Gibson 2001)	The seven system qualities (Luckman 2006)	Six Basic Orientors of self-organising systems (Bossel 1999)
Integrity	Nurturing	Existence
Sufficiency and Opportunity	Supportive	Effectiveness
Equity	Stable	Freedom of Action
Efficiency	Contributing	Security
Democracy and Civility	Responsive	Adaptability
Precaution	Directed	Coexistence
Immediate and Long Term Integration	Adaptive	

As can be seen from these examples, principles are more abstract and "vague" statements than quantitative parameters and often need further descriptions and examples to make them more meaningful and useful. Further descriptions of the Gibsons' principles are given below (Gibson 2001):

- **Integrity** – build human-ecological relations to maintain the integrity of biophysical systems in order to maintain the irreplaceable life support functions upon which human well-being depends
- **Sufficiency and opportunity** – ensure that everyone has enough for a decent life and that everyone has opportunity to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity
- **Equity** – ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, etc.) between rich and poor
- **Efficiency** – reduce overall material and energy demands and other stresses on socio-ecological systems
- **Democracy and civility** – build our capacity to apply sustainability principles through a better informed and better integrated package of administrative, market, customary and personal decision making practices
- **Precaution** – respect uncertainty, avoid even poorly understood risks of serious irreversible damage to the foundations for sustainability, design for surprise, and manage for adaptation

- **Immediate and long term integration** – apply all principles of sustainability at once, seeking mutually supportive benefits

Many of these basic 'principles' come from 'systems thinking'. Fritjof Capra, in his book 'The Web of Life' (1996) states that the main characteristics of systems thinking emerged simultaneously in the disciplines of biology, psychology, ecology and quantum physics during the first half of the 20th century, especially during the 1920s. In the systems view, the essential properties of a living system are properties of the whole, which none of the parts have on their own. They arise from the interactions and relationships between the parts. In essence, systems thinking is 'contextual', which is the opposite of analytical thinking. Capra sums up the difference between analytical thinking and systems thinking very distinctly in this statement:

> *"Analysis means taking something apart in order to understand it; systems thinking means putting it into the context of a larger whole"* (Capra 1996, p. 30)

He explains it thus:

> *"The great shock of twentieth-century science has been that systems cannot be understood by analysis. The properties of the parts are not intrinsic properties, but can be understood only within the context of the larger whole. Thus the relationship between the parts and the whole are reversed. In the systems approach, the properties of the parts can be understood only from the organisation of the whole. Accordingly, systems thinking does not concentrate on basic building blocks but rather on basic principles of organisation."* (Capra 1996, p.29)

Hence, principles tend to be more basic and generic in nature representing "qualities" of a systems interactions and functioning rather than specific individual measured quantities.

THE AUTHOR'S PRINCIPLE BASED FRAMEWORK

In order to give a structured approach to the selection and use of sustainability indicators the author has developed a sustainability framework based on a hierarchical system of principles and indicators (Kettle 2006). The framework has been based on Karl-Henrick Robert's basic outline of how principles, activities and ways to monitor a process are interrelated in any system (Robert 2000). Robert proposes five hierarchical system levels (Robert 2000):

> Level 1: Principles that describe the system, these are *constitutional* principles
> Level 2: Principles that determine favourable *outcomes* in a system
> Level 3: Principles that describe *how* to reach a favourable outcome in a system
> Level 4: Various activities that must be aligned with those principles
> Level 5: Ways of measuring and monitoring those activities

The author's interpretation of these five levels to be used in the proposed principle based sustainability framework is summarised below in Table 2.

Table 2: The Five Hierarchical System Levels

Robert's five hierarchical system-levels for sustainable development (Robert 200)	**Author's interpretation and proposed terminology for the author's sustainability framework**
1. Principles for the ***constitution*** of the system (e.g. ecological and social principles)	1. **The overarching issues and 'world view'** of the system. The overarching issue is sustainability and the make up of the system is the 6 elements of sustainability of cultural, social, institutional, financial, natural and built environment.
2. Principles for a favourable ***outcome*** of planning within the system (e.g. ***principles for sustainability***)	2. These are **the general principles for sustainability** related to the 6 elements of sustainability in Level 1 (e.g. intergenerational equity, integrating of immediate and long-term concerns and biodiversity).
3. Principles for the ***process*** to reach this outcome (e.g. to meet ***principles for sustainable development***)	3. These are **discipline specific principles.** These discipline specific principles are related to the Level 2 general principles (e.g. catchment approach, water cycle and nutrient cycle for the specific discipline of water services infrastructure). For this level, the author's interpretation of 'principles for the process' refers to the specific discipline rather than the more general overall decision making process.
4. ***Actions, i.e. concrete measures*** that comply with the principles for the process to reach a favourable outcome in the system (e.g. recycling and switching to renewable energy)	4. These are the **'comparison sustainability indicators'** for comparing different development scenarios (e.g. contaminant loadings, impact on amenities, financial costs)
5. Tools to ***monitor*** and ***audit***	5. These are the **'progress sustainability indicators'** for monitoring and auditing the progress towards more sustainable outcomes.

These five levels are then used as five rows in the author's principle based framework given below in Figure 1. The three columns in Figure 1 are titled People, Processes and Places. The derivation of these three columns and accompanying six elements of sustainability of cultural, social, institutional, economic, natural and built environment have been given previously by the author (Kettle 2004). In this three column arrangement:

- The '**People**' combines both the cultural and social aspects.
- The '**Processes**' includes both the institutional and financial aspects, which are the vital **processes** by which the **people** interact and link with the **places**, or environment.
- The '**Places**' includes both the natural (ecological) and built (buildings and infrastructure) environment.

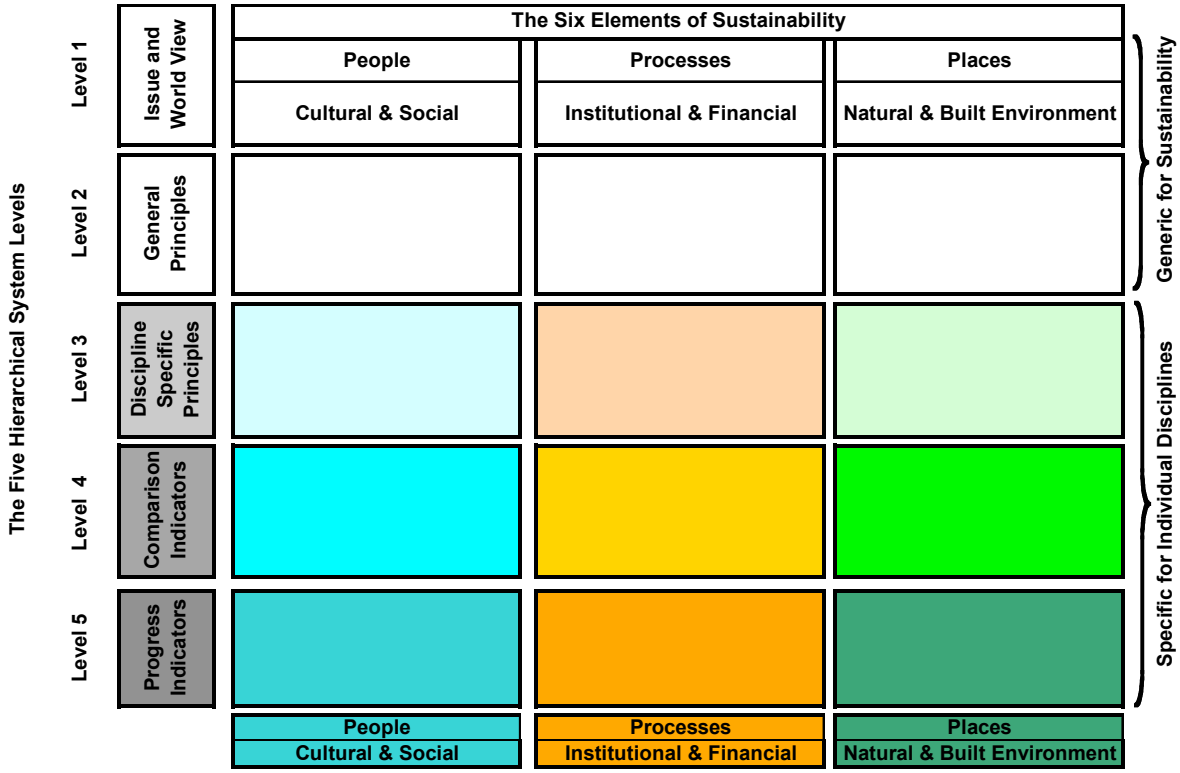

Figure 1: The Author's Principle Based Framework

As noted in Figure 1, the first two levels are generic for all disciplines and levels 3 to 5 are chosen for specific individual disciplines (such as water services, energy, transport etc.). To provide overall consistency between different disciplines the first two levels (Level 1 and 2) are kept the same while the flexibility to include different disciplines is provided by choosing different discipline specific parameters for levels 3 to 5.

Further elaborations on these five levels are:

Level 1 - Issue and World View: These are the basic elements, or themes of sustainability. The author has used the basic four quadruple bottom line themes of cultural, social, financial and environmental, with the additional two elements of institutional (legal and regulatory considerations) and the built environment (the built environment of pipes and buildings have been separated out from the natural environment aspects of air, land and water). These six basic themes are then paired into the three columns of People, Processes and Places.

Level 2 – General Principles: These are general principles that can be applied to any discipline, not only water services infrastructure. This level provides the common link between different disciplines such as transport, energy and water services, so that the subsequent underlying discipline-specific principles and indicators are derived from a common source.

Level 3: Discipline Specific Principles: These principles are discipline specific, in this case, specific to water services infrastructure, although some of these principles could also be applicable to other disciplines as well. Some of these level 3 discipline

specific principles may also be the same as for the general level 2 principles, such as community consultation. Consultation is an important general and discipline specific principle. These discipline-specific principles are derived from, and linked to the Level 2 general principles.

Level 4: Comparison Indicators: These indicators are used for comparing different options; in this case, different water services infrastructure options. These Level 4 indicators follow on from and are linked to the Level 3, Discipline Specific Principles.

Level 5 – Progress Indicators: Level 5 indicators are used for monitoring progress towards sustainability. Hence some of these indicators may be very similar to Level 4, or may be more of an 'existing state' indicator rather than a 'design comparison' indicator. For instance, in the natural environment element of sustainability, a good Level 5 progress indicator of stream health is a measure of the level of macroinvertebrates, or the biodiversity of actual living organisms. This would give a true picture of the health of the stream; however, this would have limited use as a Level 4 indicator where you can only really measure the levels of contaminants (such as lead and zinc) and not necessarily their impact on the living organisms. While there have been correlations derived between say zinc levels and stream health, there are also numerous other factors which impact on the living organisms in the stream, and thus determine the ultimate stream health. These Level 5 indicators also follow on from and are linked to the Level 3 – Discipline Specific Principles.

Examples of parameters for each of the five levels and three columns for the specific discipline of water services infrastructure are given below in Figure 2.

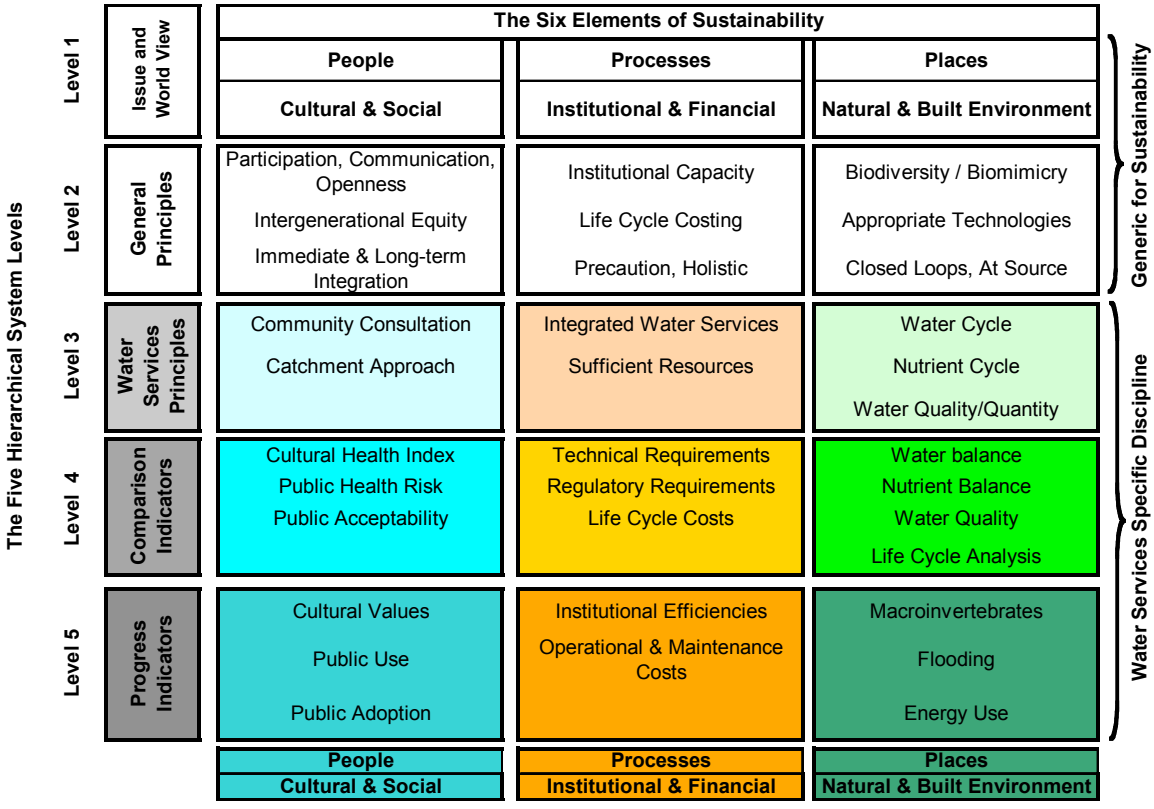

Figure 2: Example Parameters for the Proposed Sustainability Framework for the discipline of Water Services Infrastructure.

The benefits of the proposed row-column structured principles framework are:

- The design of a sustainability framework based on 'systems thinking' that provides a foundation where the whole is more than the sum of the parts.
- The ability to portray the framework and associated principles and indicators in a structured one-page easy to read format.
- The ability to select the most appropriate indicators from the vast field of sustainability indicators by working through the five levels of the sustainability framework (working from level 1 to level 5) to ensure a comprehensive yet compact set of indicators covering all relevant aspects.
- The framework includes both sustainability principles (Levels 2 and 3) and sustainability indicators (Levels 4 and 5) and shows how the indicators are derived from and linked to the 'higher level' principles.
- The terminology used for the principles has been chosen to be readily understood without being too esoteric and generalised (e.g. Immediate & Long-term Integration, Life Cycle Costing and Closed Loops).
- A range of indicators have been selected which are both quantitative (Water Balance) and qualitative (Public Acceptability).
- Different types of indicators have been selected representing four general ways of 'measuring', that is; scientific measurement (Water Quality); simplified visual assessment (Public Use); Maori cultural indicators (Cultural Health Index); public questionnaires (Public Adoption).

The disadvantages of the proposed sustainability framework are:

- Yet another sustainability framework to add to the array of alternatives within the existing literature.
- The apparent complexity of expanding the established triple (social, economic, and environmental) or quadruple (adding the fourth cultural element) bottom line 'well-beings' with an additional two areas of institutional and built environment.

SUSTAINABILITY AS A GLOBAL ISSUE

It is also interesting to note that if sustainability is a global issue (which it must be if sustainability of the planet as a whole is our goal) then the use of principles as the basic building blocks of sustainability frameworks may also provide a commonality between the apparent different 'worldviews' of western and eastern cultures.

For discussion purposes the author has used Gibsons' principles (Gibson 2001) as a representation of western cultures (see similarities between Gibson and others in Table 1 above) and example fundamental qualities of nature as expressed in Vedic literature as an example of eastern cultures. Vedic literature is an ancient tradition of India. For simplicity Table 3 below lists Gibsons' seven principles versus seven qualities of nature's intelligence as given in Vedic Literature to show likely similarities, although Vedic Literature states that a total of forty different qualities are required to fully describe all the qualities of nature's intelligence (Maharishi Mahesh Yogi 1997). The alignment of the vedic quality and Gibsons' principles are also for

demonstration purposes only and are not necessarily meant to be representing the same quality of nature or the system. A much more detailed analysis, beyond the scope of this paper, would be required to determine more categorical linkages between the western and eastern terminology for the fundamental principles of nature and sustainability.

Table 3: Vedic Literature vs Gibsons' Principles

Vedic Literature (examples of seven of the total number of forty vedic qualities of natures intelligence)		
Vedic Literature Terminology	**English terminology for equivalent vedic term**	**Gibsons' Principles (Gibson 2001)**
Rk Veda	Holistic	Integrity
Nirukt	Self-referral	Sufficiency and Opportunity
Yoga	Unifying	Equity
Karma Mimamsa	Analysing	Efficiency
Vagbhatt Samhita	Communication and Eloquence	Democracy and Civility
Madhav Nidan Samhita	Diagnosing	Precaution
Charak Samhita	Balancing – Holding Together and Supporting	Immediate and Long Term Integration

The above table indicates a possible similarity at the level of fundamental principles between eastern (represented by the Vedic literature) and western (represented by Gibsons' principles) world views and has been presented to show another possible advantage for using principles at the fundamental level of sustainability.

CONCLUSIONS

A sustainability framework is proposed based on a row-column structure linking principles to indicators. The three columns are based on the pairing of the proposed six fundamental elements of sustainability of cultural, social, institutional, financial, natural and built environment. The five rows are based on Roberts five hierarchical system levels (Robert 2000).

The basic fundamental to using the framework is to agree on the relevant 'principles' (Level 2 and 3 general and discipline specific principles) prior to the choice of indicators (Level 4 and 5 comparison and progress indicators). This structured approach allows the user to select the minimum number of indicators while still providing a comprehensive coverage of all relevant aspects of sustainability. Simply developing a long list of indicators with no overall structure or framework is not good enough.

The more fundamental level of principles has also been shown to represent a possible commonality between the different 'worldviews' of 'western' and 'eastern' cultures.

REFERENCES

Bossel, H. (1999). *Indicators for Sustainable Development: Theory, Method, Applications.* A report to the Balaton Group, Published by the International Institute for Sustainable Development, Winnipeg, Manitoba, Canada.

Capra, F. (1996). *The Web of Life – A New Synthesis of Mind and Matter,* HarperCollins*Publishers*, 77-85 Fulham Palace Road, Hammersmith, London W6 8Jb, UK.

Gibson, R. B. (2001). *Specification of sustainability-based environmental assessment decision criteria and implications for determining "significance" in environmental assessment.* Associate Professor, Department of Environment and Resource Studies, University of Waterloo; and Research Affiliate, Sustainable Development Research Institute, University of British Columbia.

Kettle, D. A. (2004). *A Sustainability Action Planning Tool*. International Conference on Sustainability Engineering and Science, 6-9 July 2004, Auckland, NZ.

Kettle, D. A. (2006). *'An Urban 3-Waters Infrastructure Sustainability Decision-Making Process'*. A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Architecture and Planning, October 2006. School of Architecture and Planning, National Institute of Creative Arts and Industries, The University of Auckland, Auckland, New Zealand.

Luckman, P. G. (2006). *KiwiGrow^{TM} – a universal, ecosystem-based framework for sustainable development.* 12th Annual International Sustainable Development Research Conference, Hong Kong, 6-8 April, 2006.

Maharishi Mahesh Yogi (1997) *Celebrating Perfection in Education, Dawn of Total Knowledge*. Maharishi Vedic University Press, Iowa, USA.

Robert, K.-H. (2000). *"Tools and concepts for sustainable development, how do they relate to a general framework for sustainable development, and to each other?"* Journal of Cleaner Production 8: 243-254.