

Frameworks for sustainability in the urban environment

I. K. G. Boothroyd^{1,2,#}, M. J. Drury³

¹Kingett Mitchell Ltd., P.O. Box 33849, Takapuna, Auckland, New Zealand;

²School of Geography and Environmental Science, University of Auckland, Private Bag 92019, Auckland, New Zealand; and

³EnviroVentures Ltd., P.O. Box 23A, Puhoi, Auckland, New Zealand

#Corresponding author; Phone: ++64 9 4868068; Fax: ++64 9 486 8072; E-mail: iboothroyd@kma.co.nz.

Running title: *Frameworks for sustainability*

Abstract

The majority of New Zealanders live in urban environments, and national and regional community surveys have shown that improving the state of our urban waterways and environment are high priorities. In this paper we discuss the real and perceived driving forces and pressures contributing to the sustainability of the natural resources of urban (including peri-urban) environments and the real and perceived human, social and economic contexts that will lead to an advancement of sustainability. A key component of this dynamic is the ability to develop a conceptual framework that captures this human-ecosystem relationship; it is through this relationship, and modified responses by humans, that sustainability will be achieved. We review models of sustainability applied to urban environments that aim to achieve sustainability, and discuss the limitations of these frameworks as they are currently formulated for use in New Zealand, and what attributes are likely to contribute to frameworks that will further advance sustainability in urban environments. Where these contemporary frameworks comprise environmental resources, processes and outcomes there is a need to consider social and cultural, and economic resources, processes and outcomes alongside their environmental counterparts.

Introduction

More than 85% of New Zealanders live in urban areas and nearly 72% live in the 16 largest urban environments (Statistics NZ 2006) with over one million people (>30% of New Zealand's population) living in Auckland (< 2% of New Zealand's land area). Increasing urbanisation of our landscape through housing, commercial and roading intensification within towns and cities, and growing demand for lifestyle living in areas surrounding urban centres (i.e., peri-urban development), places increasing pressure on the existing, and often already limited or highly-modified natural resources; while at the same time demanding increasing service from these ecosystems (i.e., for stormwater runoff or wastewater disposal). National and regional community surveys have shown that while on average New Zealanders consider our environment to be moderate to good, improving the state of our urban waterways and environment can be high priorities for urban dwellers.

Urban sustainability involves creating better places to live, work and play, while solving problems caused in and by our settlements (MFE 2003). Sustainable development is the context by which achieving such progress can be managed and measured. However, there is a need for suitable and practical frameworks or models by which sustainable development can be applied. Conceptual frameworks and models of sustainability have been developed and applied at a range of scales and definition, varying from international to domestic to local resources. The need to assess the performance of constituent parts of conceptual models has led to the development of indicators or performance measures (Hodge 1997). In the 2002 report on sustainable development, PCE (2002) recognised that *New Zealand's urban areas have not received the attention they need to promote sustainable urban environments and infrastructures*. In this paper we discuss the real and perceived driving forces and pressures contributing to the sustainability of the natural resources of urban (including peri-urban) environments and the real and perceived human, social and economic contexts that will lead to an advancement of sustainability. A key component of this dynamic is the ability to develop a conceptual framework that captures this human-ecosystem relationship and to understand how sustainability will be achieved by this relationship.

Driving Forces

Several factors are behind the thinking and practice towards sustainable development and environmental sustainability. In urban areas, community well-being is at the heart of sustainability initiatives. For example, the overarching principle of the Greater Christchurch Urban Development Strategy is **sustainable prosperity** and requires an understanding of the systems that support life in the community (see Box 1). Similarly, the Auckland Regional Growth Strategy aims (amongst four key goals) to sustain **strong and supportive communities**. Similar themes are evident in most Council strategies.

Several themes are evident amongst statements of sustainable urban living and strategic initiatives, including social, economic, environmental, and in some cases, health. While the common themes amongst these driving forces include protection, prevention and enhancement, an alternative, process-orientated thematic viewpoint to key drivers has been developed by the Auckland Regional Council that support their 'Long-term sustainability framework':

- The need to build resilience and better cope with changes that will impact on the sustainability of the Auckland region.
- Improving alignment and efficiencies in regionally significant decisions, strategies and activities.

- The need to prioritise major decisions coming up in the region, such as long-term infrastructure investments, and the desirability of working collaboratively across the region to find enduring solutions.
- Legislative drivers.

Whereas themes such as protection, prevention and enhancement have been translated into many outcome statements, policies and actions, less consideration is given to leadership, institutional structures, and other mechanisms that influence the application of sustainable development (PCE 2002). Although the government consider that governance for sustainable development is about ensuring the processes and institutions are in place to embed sustainable development approaches into decision-making, there is often little integration across institutions responsible for sustainable development; indeed there may be conflict in its place. However there is cause for some optimism as there has been a move towards greater inter-agency agreement on issues and strategy in recent years as evidenced by the ARC Long-term sustainability framework'.

Box 1: Generic issues identified for sustainable urban living

(adapted from Greater Christchurch Urban Development Strategy and Auckland Regional Growth Strategy)

- Drawing a defined boundary between urban and rural areas.
- Maintaining the character of communities.
- Preserving, creating and linking urban and rural open space including parks and recreational areas.
- Protecting outstanding landscapes.
- Protecting the quality and quantity of groundwater and surface water resources.
- Protecting and enhancing ecological systems.
- Reducing and preventing air, land and water pollution.
- Maintaining a secure and productive resource base, including minimizing the loss of productive land.
- Provision of more transport options, including walking, cycling and public transport.
- Moving goods and people efficiently, making effective use of transportation and service corridors.
- Ensuring good stewardship of land, sites and structures with cultural heritage value.
- Ensuring adequate, affordable and appropriate housing.

But how real and effective are these driving forces? In surveys of quality of life, most New Zealand urban residents describe their quality of life positively with 88% rating it as good (60%) or extremely good (28%) (Gravitas 2005). Hughey et al. (2004) found that, on average, New Zealanders consider the state of their environment to be adequate to good. Even when focused on the built environment, most residents (>70%) stated that air, water and noise pollution had not been an issue over the previous 12 months (Gravitas 2005). In surveys within a single urban catchment (Project Twin Streams, Waitakere City), two-thirds

of the respondents (n = 305) rate the streams as passable or better for water quality (only 8% regard it as clean) with only a minority rating cleanliness highly.

Such surveys of quality of life are usually derived from questionnaires of residents and not from empirical studies of inter-relationships with the environment, and, of course, are influenced by other factors such as wealth and health. However, it is well established that natural and built features of the environment affect behaviour, interpersonal relationships and even actual mental states (Frumkin 2005). Pretty et al. (2006) consider that exposure to nature can make positive contributions to health, help people recover from pre-existing stresses or problems and help people concentrate or think more clearly. Studies on 'green exercise' (exercise in green areas vs built urban areas) shows clear improvements in health, with implications for economic benefits, productivity and well-being in urban areas.

However, human health and well-being are omitted, or given low status, in most frameworks of sustainability. Pretty et al. (2006) go on to state that there remains a distinct tension between the (environmentally sustainable) drivers for human health and the drivers of economic development in urban (and rural) regions. Yet these responses and perceptions differ greatly from the results of scientific studies of environmental condition. For example, monitoring of air quality in the Auckland region has shown regular breaches of national air quality standards. Similarly, water quality surveys throughout the major urban centres in New Zealand show degradation of water quality and loss of ecosystem condition (Suren et al. 2006, Boothroyd et al. 2003, EVA 2004). These findings occur alongside human perceptions of a positive quality of life.

Although Hughey et al. (2004) suggested that relying on trends among biophysical indicators alone for state of the environment monitoring may be problematic and that people's perceptions of the state of the environment are also important, few commentators have provided solutions to a reality-perception divide. Hughey et al. (2004) conclude that 'differences in opinion between the public, scientists, policy makers and politicians signal the need to identify the reasons for people holding different views, and to work on bridging gaps in perceptions to allow action to be taken in cases of critical environmental concern'.

Tellingly, as part of their perceptions of state of New Zealand's environment, Hughey et al. (2004) reported that almost all respondents wanted greatly increased government expenditure in the areas of health, education and law enforcement, reinforcing the view that community well-being needs to be at the heart of sustainability initiatives.

Pressure-State-Response framework

The pressure-state-response (PSR) model, and variations of the PSR are based on the concept of causality; human activities exert pressures on the environment, altering the quality and quantity of environmental resources that lead to responses in human behaviour (Hughey et al. 2004). In this way, the framework integrates environmental and development issues (i.e. pressure and state) to enable better informed policy decisions and behavioural changes (i.e. social response) to be implemented at appropriate levels to achieve sustainability. In particular, the PSR model provides a means for selecting and organising data and indicators in a manner useful for decision makers and the public, and ensuring that important considerations are not overlooked. The PSR is in wide use in New Zealand as a framework for state of the environment monitoring programmes (e.g., Hutt City Council, Environment Canterbury, Waitakere City Council have all adopted the PSR framework), but has rarely been applied to questions of sustainability.

The PSR model has been applied to Auckland urban streams (EVA 2003) and most comprehensively to Project Twin Streams in the Waitakere City Council, Auckland. The outcomes clearly show a relationship between increasing urbanization and a loss of sustainability, as measured by various water, sediment and ecological quality indices (KML 2006). However, key social, economic, cultural and historical attributes have been omitted from the model. Previous measures of social indicators for Project Twin Streams found that two-thirds of the respondents living within the catchment area rate the streams as passable or better for water quality. This highlights the difficulty of measurement and interpreting the inter-relationships between various pressure and state of the environment attributes.

Some commentators observe that the PSR logic that is often used to assess and frame environmental policy is reactive and remedial, focusing on 'alleviating' pressures, protecting environmental 'states' and 'mitigating' impacts (Hindmarch et al. 2006). These authors go on to suggest that a more appropriate framework is to include environmental and ecosystems thinking into high-level policy thus rendering many interventions redundant, as causal factors are addressed.

Inherent to the PSR framework is that appropriate environmental measures have been chosen, and that there is causality between environmental pressures and current state. However, these two assumptions may not always be met, due to the complexity of natural systems, and the subjectivity in identifying indicators of environmental pressures, states, and potential management responses. As currently formulated, the PSR (and other frameworks for sustainability) are focused on state measurements of pressure and environment (or social

and economic) attributes. In other words, a single, often static, snapshot of the amount or condition of these attributes is all that contributes to measurement of sustainability. Largely overlooked has been the question of function or functionality. Environmental, social or economic systems are dynamic, that is, they are formed by multiple complex interactions.

Human-ecosystem-economic relationships

The advancement of sustainability requires a conceptual framework that captures the dynamics of the human-ecosystem relationship and to understand how sustainability is modified by changes to this relationship. A number of studies have shown the connection between resilience, diversity and sustainability of social-ecological ecosystems (Berkes et al. (1998). Folke et al. (2002) recognised two key areas of concern: assumptions that ecosystem uses to human uses are linear, predictable and controllable, and an assumption that human and natural systems can be treated independently. Human-ecosystem-economic systems are constantly changing, and whole regime shifts (known for many ecosystems, e.g., lake ecosystem crashes) can be difficult to predict in advance and are difficult, expensive or sometimes impossible to reverse (Scheffer et al. 2001).

Folke et al. (2002) suggested three general policy recommendations that can be used as a framework for sustainable social-ecosystem planning: policy that strengthens the perception of humanity and nature as inter-dependent and enhances resilience in social-ecological systems, policy frameworks for building adaptive capacity and social-ecological sustainability, and policy to encourage monitoring of key ecosystem attributes.

Environment Waikato have recently been awarded funds to develop tools and knowledge support for integrated planning and decision-making including linking environmental planning to economic and social decision-making, identifying conflicting issues and trade-offs, plugging into future issues and set priorities for action; all with the aim of making more informed choices (<http://www.ew.govt.nz>; <http://www.choosingfutures.co.nz>).

Resilience

The concept of resilience is widely used in ecology (the characteristic of ecosystems to maintain themselves in the face of disturbance) but has been rarely applied to sustainable social and economic concepts. What is not clear is whether resilient ecosystems enable resilient communities or economies. Adger (2000) suggests that resilience in natural systems provides capacity to cope with surprises and large-scale changes, allowing innovation, coping with change and social learning in social institutions. Few frameworks for urban sustainability consider resilience except as 'maintenance of communities' type of

approach; paradoxically, management that uses rigid control mechanisms (e.g., rules and protocols) to maintain the condition of social-ecological systems can erode resilience and promote collapse (Folke et al. 2002). A notable exception is the ARC who explicitly includes resilience (building systems to support our day-to-day living which can deal with uncertainty and cope with the shifts and shocks that we will face in the future through adaptability, robustness and diversity) as one of four common goals of their Long-Term Sustainability programme (Box 2). Management that builds resilience can sustain social-ecological systems in the face of surprise, unpredictability and complexity that can range from sudden events such as volcanic eruptions, flooding events to pandemics.

Box 2: Auckland Regional Council Long-Term Sustainability programme

The vision of a sustainable Auckland region is underpinned by four goals. Achieving these goals will contribute to a sustainable Auckland.

1. **Liveability:** making sure that the Auckland region into the future is a place where people find it easy and enjoyable to live.
2. **Resilience:** building systems to support our day-to-day living which can deal with uncertainty and cope with the shifts and shocks that we will face in the future.
3. **Prosperity:** being rich in the things we need to be happy and content.
4. **Ecology / Living with nature:** taking more care of the living systems which support us, and passing them on to future generations in better shape.

Implementation

Implementation of urban sustainability frameworks that recognise human-economic and environment relationships must be practical and have realistic goals and objectives. For example, managers of urban waterways are presented with a near-impossible task of raising environmental conditions to some high or better condition, with the threshold criteria too extreme to meet and existing ecosystem management frameworks unsuitable for urban environments. The application of many initiatives to improve urban sustainability has led to little improvement despite developments at the human-ecosystem interface (e.g., community-based environmental initiatives); or responses occur to perceived rather than realised and quantified pressures. In cases where a change in state of the environment might be measured there is often no real understanding of what shift in pressures or responses led to modifications.

Reasons for this are complex but Hodge (1997) identified that any conceptual framework would need to build from fundamentals that both underpinned and bridged many existing discipline-specific approaches. Furthermore, Hughey et al. (2004) suggested that relying on

trends among biophysical indicators alone for assessing environments (e.g., using PSR) may be problematic and that people's perceptions of the state of the environment are also important. Our experience (EVA 2003a,b, EVA 2005) of implementing the existing PSR framework to urban and peri-urban environments suggests that further examination of pressures is required, and existing uses of PSR models are unlikely to lead to the degree of response and change anticipated, especially to improve sustainability (e.g., reduce habitat and biodiversity loss) in these environments. Furthermore, the existing measurement of social drivers (largely through interviews and questionnaires) limits the establishment of empirical relationships and predictive models of outcomes of sustainable development. This is not helped by the fact that local councils have generally not collected suitable data over regular time periods, or over periods that match data on social, economic or environmental at the same scale or within the same geographic area. For example, stormwater management units tend to form the basis of catchment plans and environmental assessments, pressure data is generally available as a district-wide reference or specific to a particular area of interest, and information on quality of life is generally a city-wide phenomenon.

Complexity of the PSR model is illustrated by comparing biodiversity PSR models for urban and peri-urban (i.e., the urban fringe) environments. In the urban environment, pressures on biodiversity (e.g., lack of habitat) are actual and apparent; however responses to degraded biodiversity are costly and constrained by the ability to change the built environment. In contrast, in the peri-urban environment, pressures are actual (e.g., diffuse pollution from agriculture), but also potential (i.e., urban sprawl causing further habitat decline). Therefore, there may be significantly greater opportunities for management responses to improve sustainability in the peri-urban environment.

Despite a sustainable development approach being adopted throughout New Zealand, questions still remain over how urban sustainability can be achieved: how to achieve continual growth and yet remain sustainable? How to integrate technology and stakeholders to develop an approach that is appropriate to New Zealand's needs? Robertson & Hull (2003) argue for public ecology; an approach to environmental enquiry and decision-making that does not expect complete scientific knowledge but rather a collaboration with all stakeholders to construct a body of knowledge that reflects the pluralistic and pragmatic context of its use while maintaining the rigour that earns scientific knowledge its respect. The sustainable development approach also encourages participation and partnership, as everyone must contribute to make it viable. However, it is notable that results from the 2005 Public Life Values study indicated that the vast majority of respondents considered that it

should be central government's role to make industry do less damage to the environment (SHORE 2005).

The Government's present approach to sustainable development is highlighted by a range of activities across the government sector but lacks a common framework for implementation. In a report on urban sustainability (NSF 2000), it was argued that the greatest barriers to defining and achieving urban sustainability are political, and that changes in the structure of governance are a prerequisite for moving towards sustainability.

Other frameworks for urban sustainability

Other frameworks exist and are currently in use by organisations and regulatory authorities for both general and specific sustainability programmes. Most involve application at specific scales: regional, city, catchment or location, although NSF (2000) suggested a move away from traditional concepts of locality to a concept of sustainable lives and livelihoods through localities that rejects the idea of universal solutions to local problems. Across New Zealand at present there is considerable public and private investment in integrated approaches to catchment management, where well-defined protocols exist (e.g., ARC 2004) with the aim of improving the long-term management of natural resources within a 'whole-system' approach (ACT 2000). However, implementing the concept in practice has proved more difficult and there has been little demonstration the success of these ICM programmes in urban areas. Furthermore, ICM programmes are largely based on the management of biophysical attributes and have little or no regard to social and cultural perceptions of the catchment.

The Natural Step Framework is a methodology for successful organisational planning. It is based on systems thinking, recognizing that what happens in one part of a system affects every other part. A practical set of design criteria that can be used to direct social, environmental and economic actions, developing effective, durable solutions to environmental, social and economic issues. From a business perspective, The Natural Step framework is used as a planning tool to enable corporations to profitably integrate environmental and social considerations into strategic business decisions and daily operations.

Although case studies of the use of the natural step are available in New Zealand (www.naturalstep.org.nz), no case studies incorporate urban sustainability. The city of Santa Monica in California adopted the natural step as a unifying framework for the conservation element of the Sustainable City Program and has provided unity to a complex program.

The ARC's Long-Term Sustainable Framework is based on the Vancouver Cities^{PLUS} model (PLUS stands for planning for long-term urban sustainability) and builds on an Adaptive Management framework to develop an urban planning system that will be responsive and resilient to change. Kettle (2005) suggested a 'Sustainability Action Tool' for evaluating sustainable urban 3-waters (stormwater, wastewater and potable water) infrastructure systems. In this tool, six elements of sustainability (cultural, social, institutional, economic, natural and built environments) are re-defined into three groups (people, processes and places), all stages of a development can be included, and site-specific themes (e.g., water quantity, water quality) can be evaluated in terms of the six elements of sustainability. Boyle (2005) takes a long-term future view and focuses her attention on the 1,000 year (many human generations) perspective of sustainable development. For this Boyle (2005) makes certain assumptions regarding the persistence of humans, cities, food availability, energy and materials demand, as well as basic human needs.

Key trends and barriers

The requirement for regional and local Councils to develop Long-term (10 year) Community Plans (LTCCPs) is a positive trend that forces Councils to consider sustainable development in line with community expectations. Mostly these plans are framed as global statements and action points and in reality do not provide for integrated sustainable development. In part, this is due to a lack of partnership between central, local and regional government as well as industry, energy, social and transport sectors of society. Whilst the significance of the quality of life to New Zealanders is also reflected in such policies, legislation, and actions at all levels of government (e.g., Resource Management Act 1991, Local Government Act 2002, Sustainable Development Programme of Action), there is a large gap between implementing a sustainable approach that incorporates a dynamic human-ecosystem concept.

In urban areas the ability to quantify the key attributes to assess sustainability is a potential barrier to the implementation of sustainability frameworks. For example, local councils have generally not collected social, economic or pressure-type data over regular time periods, or over times that match data on the state of the environment, or over the same geographic area. Government and regulatory authorities may also collect different information to represent a component of sustainability, with little thought given to information sharing. A new initiative in the Waikato region may show how information sharing can lead to better environmental decision-making.

Hindmarch et al. (2006) suggest that as long as legislation deals with outcomes, it is likely to be uncoordinated and difficult to manage, late to respond and ineffective when it does; yet a cornerstone of policy development in New Zealand is to link environmental policy to anticipated outcomes (e.g., Regional Policy Statements). Hindmarch et al. (2006) also suggested that commitments to sustainable development are often muddled, vague and largely unenforceable, and perpetuate easily-obtainable short-term goals at the expense of long-term sustainability objectives. Further, despite many state of the environment monitoring programmes in place throughout New Zealand, in many cases it is not been possible to measure how well these outcomes have been met (MFE 1997). Many factors are likely to be responsible but a lack of integrative socio-economic-environmental frameworks and information gathering protocols will have limited this ability. Hindmarch et al. (2006) also go on to suggest that the more responsive or reactive approach is probably a 'comfortable place' to be for most operators, and avoids implementing measures that may restrict markets, disrupt social conventions or disengage political lobby-groups.

A way forward

It is evident that a way forward to sustainable development requires a greater integration of policy within a dynamic and integrative framework. As stated above, there is cause for optimism, as forward-thinking strategies are being developed that bring together major economic (e.g., transport, energy), social (e.g., housing) and environmental (e.g., ecosystem enhancement) drivers along with concepts of resilience, adaptability and diversity. As sustainable development initiatives shift focus from the responsive and corrective approach to a more causal approach (i.e., internalizing externalities), there is likely to be more integration of resources and planning for sustainable development.

Acknowledgements

We thank Annabel Barnden and Roland Payne for assistance with the collation of literature and search of websites for additional material on urban sustainability.

References

- Adger, W.N. 2000: Social and ecological resilience: are they related? *Progress in Human Geography* 24: 347-364.
- ARC 2004: Auckland Regional Stormwater Action Plan. Auckland Regional Council
- Berkes, F., Folke, C. (eds.) 1998: Linking social and ecological systems. Management practices and social mechanisms for building resilience. Cambridge University Press, Cambridge.
- Boothroyd, I.K.G., Fowler, R., Symmans, W. 2003: Urban stream management framework: Classification and management objectives for urban streams, North Shore, Auckland.

- Proceedings of the 3rd South Pacific Conference on Stormwater and Aquatic Resource Protection, New Zealand Water and Wastes Association, Auckland.
- Boyle, C. 2005: Achieving Sustainability. Proceedings of the 1st New Zealand Conference for Sustainability Engineering and Science, Auckland.
- EVA 2003a: Auckland urban streams: pressure-state-response. Prepared for Ministry for the Environment by Enviro-Ventures & Associates, Diffuse Sources Ltd and Kingett Mitchell Ltd. May 2003.
- EVA 2003b: Twin Streams PSR Report. Report prepared by EnviroVentures & Associates, Diffuse Sources Ltd & Kingett Mitchell Ltd. for EcoWater Solutions, June 2003.
- EVA 2005: Twin Streams ecological monitoring: summer 2003-2004. Report prepared by Kingett Mitchell Ltd for EcoWater Solutions, September 2004.
- Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C., Walker, B. 2002: Resilience and sustainable development: Building adaptive capacity in a world of transformations. *Ambio* 31: 437-440.
- Frumkin, H. (ed.) 2005: Environmental Health. From Global to Local. Jossey Bass, San Francisco.
- Gravitas 2005: Quality of Life in New Zealand's Largest Cities – Resident's Survey. Report prepared for the Quality of Life Project Team and Ministry of Social Development, Wellington, New Zealand.
- Hindmarch, C.; Harris, J.; Morris, J. 2006: Growth and sustainability: integrating ecosystem services into economics. *Biologist* 53: 135-142.
- Hodge, T. 1997: Toward a conceptual framework for assessing progress toward sustainability. *Social Indicators Research* 40: 5-98.
- Hughey, K. F. D., Cullen, R., Kerr, G. N., Cook, A. J. 2004: Application of the pressure-state-response framework to perceptions reporting of the state of the New Zealand environment. *Journal of Environmental Management* 70: 85-93.
- Kettle, D. 2005: A sustainability action planning tool. Proceedings of the 1st New Zealand Conference for Sustainability Engineering and Science, Auckland.
- MFE 1997: The state of New Zealand's Environment. Ministry of the Environment, Wellington, New Zealand.
- MFE 2003: Urban Sustainability in New Zealand: An Information Resource for Urban Practitioners. Ministry for the Environment, Wellington, New Zealand.
- NSF 2000: Towards a comprehensive geographical perspective on urban sustainability. Final report of the Workshop on urban sustainability, National Science Foundation.
- PCE 2002: Creating Our Future: Sustainable development for New Zealand. Parliamentary Commissioner for the Environment, Wellington, New Zealand.
- Pretty, J.; Hine, R.; Peacock, J. 2006: Green exercise: the benefits of activities in green places. *Biologist* 143-148.
- Robertson, D.P.; Hull, R.B. 2003: Public ecology: an environmental science and policy for global society. *Environmental Science and Policy* 6: 399-410.
- SHORE 2005: Public Life Values: A report from the New Zealand Values Study 2005. Centre for Social and Health Outcomes Research and Evaluation & Te Ropu Whariki, Massey University, Palmerston North.
- Statistics NZ 2006: New Zealand in profile. Statistics New Zealand, Wellington, New Zealand.
- Suren A. M. 2000: Effects of urbanisation. In: Collier K. J.; Winterbourn M. J. eds. *New Zealand stream invertebrates: ecology and implications for management*, pp. 260-288. New Zealand Limnological Society, Christchurch.