

A Nationally Consistent Approach for Monitoring Land Fragmentation in New Zealand

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In New Zealand, productive land is under pressure from a range of competing uses. In particular, highly capability land is becoming increasingly fragmented, often as a result of rural subdivision. The impacts of land fragmentation vary depending on the context, but can include reduction of land available for primary production, generation of reverse sensitivity (where a newly introduced land use restricts or limits existing land uses), increased need for infrastructure and community service provision, increased demand for water or other resources, increased diversity of land uses and associated economic activities, and uncertain changes to habitat. Regional councils are increasingly aware of the potential impacts of land fragmentation, and many have introduced, or are introducing, policy to better manage further fragmentation of their land resources, primarily through better control of rural subdivision. Although land fragmentation has emerged as a relevant policy issue requiring attention, very few councils currently monitor or report on land fragmentation trends in their regions.

Introduction

As global, national and local population growth continues, competition for land and soil resources will also increase (Curran-Cournane et al. 2014; Godfray et al. 2010; RSNZ 2011; Smith et al. 2010). Some land uses impact on the future potential, versatility, or capacity of the land for certain uses. For example, urban development may preclude or limit future use for agricultural production either directly through reduction of area available or indirectly through the introduction of adjacent incompatible uses (i.e. reverse sensitivity) (Andrews & Dymond 2012). The restriction of future land-use options represents an opportunity cost that should be considered in policy, planning, and resource management decisions that affect the allocation of land use (e.g. zoning) (Salant 1995).

All classes of productive land in New Zealand are under pressure from competing uses. In particular, opportunities for productive use of that land decline as urban areas expand and rural land is subdivided into smaller parcels. Such trends are particularly evident for highly capable land. Just over 5% of the New Zealand's land area (about 1.39 million ha) is classified as having high capability land (Rutledge et al. 2010), defined as land with Land Use Capability classes I or II (Lynn et al. 2009; Stephens et al. 1996). LUC classes I and II have experienced the highest rates of conversion to urban uses as a percentage of original area (5.6% and 3.9% respectively) over the period 1985 to 2002 (Rutledge et al. 2010). Conversion of LUC class I and II land to urban uses raises concerns because of their comparatively high potential productive capability and their limited extent.

Many regional councils have existing policies to protect land with high land-use capability, including subdivision restrictions; however, land fragmentation continues to occur. Long-term and nationally consistent monitoring is required to assess the cumulative impacts of land fragmentation across national, regional, and local scales. Councils currently lack consistent monitoring methods and tools to track trends in land fragmentation and its associated effects to provide the evidence needed to gauge policy effectiveness.

The absence of standard guidelines, methods and indicators hampers councils' ability to monitor and report land fragmentation accurately and consistently. As a result, the communication of information regarding land fragmentation among councils (regional and local) by council staff and other land managers can be confused and inaccurate. Furthermore, the correlation of regional indicators for land fragmentation at the national level and the sharing of data between regions become difficult, given the current lack of a nationally consistent approach.

An Envirolink Tools Project *Guidelines for Monitoring Land Fragmentation* was developed as a collaborative project between Landcare Research and the Land Monitoring Forum, a special interest group representing the eleven regional authorities and five unitary authorities in New Zealand. The project is developing national guidelines and methodologies for monitoring land fragmentation trends and associated tools to assist councils with processing and analysing data to monitor and report on land fragmentation trends consistently. This paper presents the results of the first stage of the project, which had the following objectives: to summarise the state of knowledge and issues regarding land fragmentation from national and regional perspectives; to identify current and proposed regional policies, plans, and rules that address land fragmentation; and to assess current practices in monitoring and reporting land fragmentation.

Methods

We undertook a literature review of land fragmentation both internationally and within New Zealand, reviewed relevant sections of operative and proposed regional policy statements (RPSs) and plans, and surveyed all 16 regional councils and unitary authorities. The survey was organised into three topics: a) issues, b) policies, plans, rules, and consents, and c) information, data, and monitoring. We prepared an initial set of questions and presented them for discussion at a Land Monitoring Forum workshop in February 2013. We modified the questions based on feedback received at the workshop. The survey ran from March through to June 2013. All regional councils and unitary authorities responded to the survey.

A direct survey of territorial authorities (city and district councils) was beyond the scope of the project. Regional councils were asked to distribute the survey to city and district councils within their regions and invite them to participate, which resulted in responses from three territorial authorities: Hamilton City Council, Matamata-Piako District Council, and South Waikato District Council. Unitary authorities, which combine the powers and responsibilities of both regional councils and territorial authorities, could respond from both perspectives.

Land Fragmentation Review Results

Definition

No common term or definition of land fragmentation is used across regional councils and unitary authorities. Four councils have formal definitions for land fragmentation (Table 1), while the remainder do not, or may use a number of other terms instead.

Councils that do define land fragmentation recognised rural subdivision as the key land fragmentation process occurring in their jurisdictions, which was reflected in the definitions. Rural subdivision occurs where a single parcel of rural land is divided into two or more parcels of land. The resulting smaller land parcels can often preclude the use of land for many types of primary production. Other fragmentation processes were not considered in definitions used by councils.

Table 1 Formal Definitions of Land Fragmentation

Council	Definition of Land Fragmentation
Auckland Council	<i>The on-going subdivision of rural land that leads to increasingly smaller land parcels</i>
Bay of Plenty Regional Council	<i>Development on land that is categorised as Land Use Capability (LUC) class I, II, or III</i>
Horizons Regional Council	<i>Subdivision on land categorised as LUC class I and II</i>
Tasman District Council	<i>Any increase over time in the number of separately developed properties in any area, through successive land subdivision to form new land parcels and associated land development activities such as buildings and roads</i>

Key issues and hotspots

Councils noted numerous issues associated with land fragmentation in New Zealand (Table 2). Loss of the productive capability of rural land was the key land fragmentation issue noted by councils. Loss of productive capability of land can occur through a number of processes, including: land-use change from productive to non-productive use (e.g. residential buildings); reverse sensitivity effects where some productive land uses become socially unacceptable in what has traditionally been a rural or

productive landscape; property values increasing so that productive land uses become unprofitable or unviable in the area; productive land uses becoming unprofitable or unviable because smaller property or lot sizes limit management options.

Also of key concern to councils is that low density, fragmented development can increase the costs of infrastructure provision and maintenance in comparison with new development that is consolidated into designated areas of higher density.

Table 2 Issues identified by councils related to land fragmentation

Issue	No. of Councils	Issue	No. of Councils
Loss of land (especially highly 'versatile' or 'high quality' soils)	14	Increased pressure on water quality (e.g. as a result of increasing septic tank numbers)	3
Reverse sensitivity effects	10	Land contamination problems (depending on the land use adopted at new sites)	3
Social and economic impacts of a changing rural landscape (both positive and negative impacts, e.g. loss of rural open space)	10	Increasing natural hazard risk (e.g. increased storm water pressures with increased impervious surface area)	3
Infrastructure provision (e.g. expense of servicing remote and very low density development)	9	Loss of access to regionally important resources (e.g. mineral extraction potential)	1
Decreasing options for productive land use (i.e. due to smaller title size and/or increasing property values in traditionally productive/rural land areas)	6	Degradation of soil ecosystem services	1
Increased water supply/allocation pressure	3	Inefficient development of rural land	1
Regional sustainability (i.e. unsustainable land uses, where cumulative effects of development put food production at risk)	3	Impacts on biodiversity	1

Councils also noted concern about negative social impacts associated with changing rural landscapes. Examples provided include: negative impacts for those who do not have access to social facilities because their property is isolated; undermining an existing rural centre's economic viability due to fragmented and disaggregated development; undermining rural economies by reducing options for productive land uses; and increasing reverse sensitivity that can impact negatively on rural livelihoods.

Although many of the issues related to land fragmentation via rural-residential subdivision were negative, councils also noted several potential positive impacts including: improved water quality when intensive farming practices are reduced; improved environmental outcomes on lifestyle blocks when changed from traditional farming practices (depending on the activity and management approach on the lifestyle block, among other things); increased protection of indigenous biodiversity on private property (e.g. Rodney District 'bushlot' covenants¹); revitalisation of rural towns via increased population and economic activity; and growth in rural schools.

Demand for lifestyle block living is considered a key driver of land fragmentation, as are the financial gains for property developers and permissive district plan provisions regarding rural residential subdivision.

The relative importance of land fragmentation as a regional issue was found to vary widely. Four regional councils and three unitary authorities identified land fragmentation as an important issue in their RPSs. However, almost *all* regions have 'hotspots' where land fragmentation is an important local issue. Councils identified local hotspots for land fragmentation (Fig. 1).

¹ Rodney District Council rule that enables new rural subdivision where an area of indigenous biodiversity (e.g. bush or wetland) is covenanted by the owner. Areas to be covenanted must meet certain criteria to be eligible for the development right.

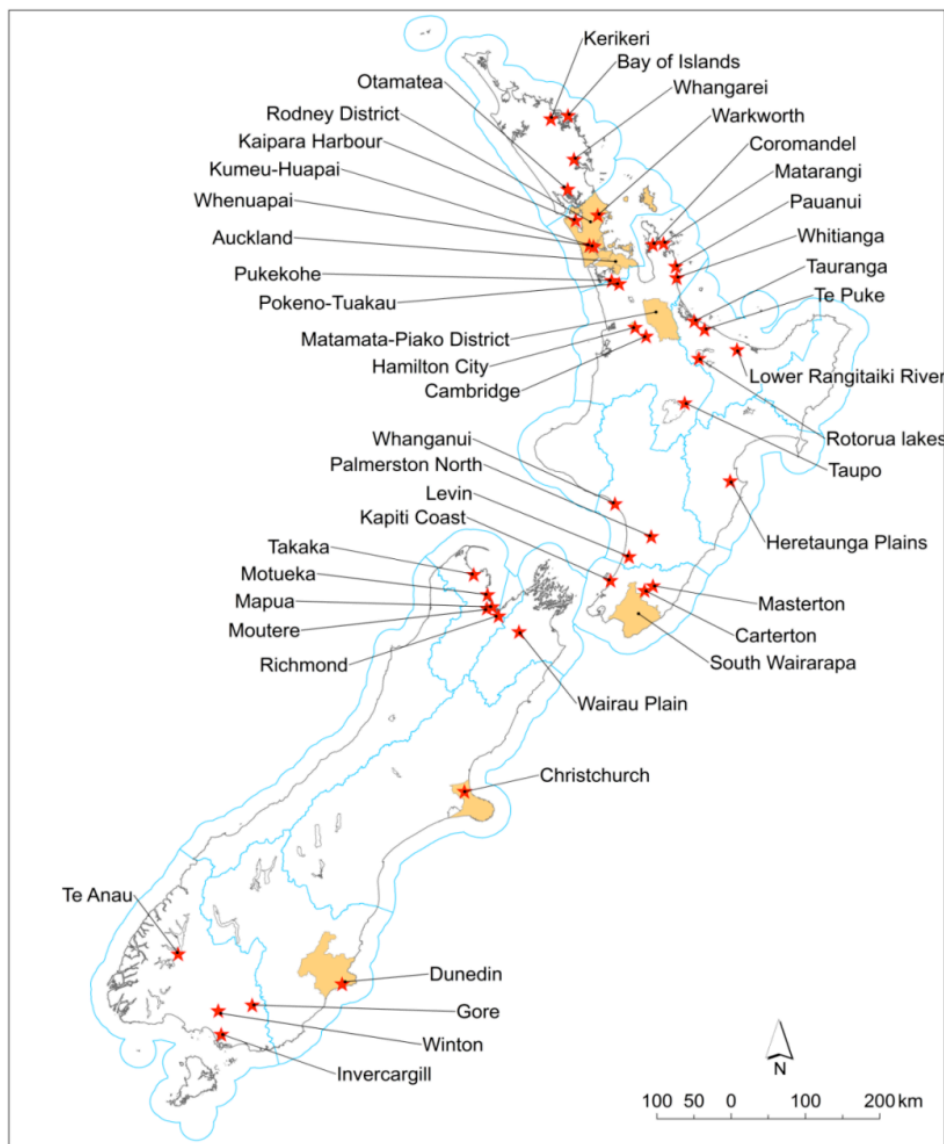


Figure 1 Land fragmentation hotspots identified by councils.

Land Fragmentation Policy

Thirteen councils have provisions in their operative or proposed RPSs that address land fragmentation: Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawke's Bay, Manawatu-Whanganui, Wellington, Marlborough, Tasman, Canterbury, Otago, and Southland. Taranaki, Nelson, and West Coast do not address land fragmentation in their RPSs or other planning documents.

While the importance of land fragmentation currently varies regionally, policy trends indicated that most councils expect land fragmentation to increase in importance. Several councils have introduced policies to address land fragmentation in their second generation RPSs, reflecting broader expectations for increasing competition for land in New Zealand (e.g. Mackay et al. 2011). Several councils have already had land fragmentation policies in place, even though land fragmentation was not considered a regionally important issue. Such cases suggest a more proactive and preventative policy approach designed to prevent land fragmentation from becoming an issue in the first place.

Of the 13 councils with land fragmentation policies: 4 have operative policies from a first generation RPS (Gisborne, Marlborough, Tasman, and Otago); 3 have operative policies from a second generation RPS (Hawke's Bay, Wellington, and Canterbury); 6 have policies undergoing transition

from the first to second generation RPS (Northland, Auckland, Waikato, Bay of Plenty, Manawatu-Whanganui, Southland).

Regional policies to address land fragmentation are focussed primarily on limiting unplanned rural subdivision. Some councils use plan zoning to introduce defined rural-residential development zones close to existing urban centres to minimise loss of high capability rural land, provide infrastructure more efficiently, avoid potential negative social and cultural impacts, and take advantage of positive impacts. For example, enabling rural-residential development can increase population in rural areas, which can have subsequent flow-on effects in the community (e.g. school enrolment numbers) and local economy (e.g. increased income). In terms of managing development across the landscape, regional and district councils generally aim to meet the demands of their residents for this style of living while avoiding negative impacts and creating positive impacts for the region or district.

Second generation RPSs show substantial development of land fragmentation policy and implementation methods in comparison to first generation RPSs, particularly in regions where land fragmentation is becoming a more pressing issue (e.g. Northland, Auckland, Waikato, and Canterbury). In second-generation RPSs regional councils are much more involved in managing regional 'rural form' and subdivision (i.e. land use). Broadly speaking, second-generation RPSs contain more detailed and prescriptive policies and methods. Regional councils are consistently focussed on retaining and protecting the productive capability of rural areas, on ensuring that development is planned to avoid conflict with other land uses, on minimising environmental effects, and on enabling efficient infrastructure provision.

District Plans and their implementation are seen as key factors in RPS policy effectiveness or ineffectiveness. In some cases regional councils and district and city councils work together effectively to address land fragmentation by coordinating regional and city/district planning to give effect to regional objectives and policies. Unitary authorities reported easier and better internal relationships and coordination on regional and district matters than did regional councils that must coordinate with multiple district councils.

Monitoring land fragmentation

Currently, one regional council (Waikato) and two unitary authorities (Auckland, Marlborough) monitor and report on land fragmentation. Horizons and Greater Wellington regional councils indicated that they undertake periodic, ad hoc reporting of land fragmentation. The remaining 11 regional councils and unitary authorities do not currently monitor and report on land fragmentation. Among the city and district councils responding, both South Waikato and Matamata-Piako district councils monitor land fragmentation but do not formally report on it except in RMA Section 32 analyses.

Among the councils that monitor and report trends in land fragmentation, the indicators and data sources utilised vary (Table 3). Despite the variation, the methods broadly aim to capture the process of land fragmentation by monitoring changes in the number, size, and location of land parcels or titles. Increasing numbers and decreasing sizes of titles and parcels indicate areas where certain land-use activities may become constrained or unfeasible due to size threshold effects or, in the case of the urban-rural interface, generation of future conflicts through reverse sensitivity.

Among the six councils undertaking land fragmentation monitoring, Matamata-Piako District Council (MPDC) appears to have the most comprehensive approach. They collect data for six inter-related indicators across two thematic areas of 'residential growth' and 'rural area development.' Together the six indicators provide a comprehensive picture of trends across the gradient of rural, rural-residential, and residential zones. As a result, MPDC can monitor and report both broad and localised land fragmentation trends. Most interestingly, they also track the number of consents declined on LUC Class I, II or III land, which provides evidence to help track effectiveness of policies and plans designed to manage land fragmentation within the district. Finally, MPDC can track all these indicators because they record the details of all land-use and subdivision consents in their 'state of environment' database.

Auckland Council is developing formal methods for the systematic monitoring of land fragmentation. They are considering various options, including:

- using LINZ cadastral database information to determine the change in number of land parcels, for example between 1998 and 2008. Cadastral information is available regionally and at yearly intervals, which can be classified into parcel-size categories to gain more detail about rural fragmentation
- using LINZ database of titles. This option will allow the assessment of average title size in an area of interest. However, until 2013 this information would provide data only of the latest subdivision of a title but did not capture re-subdivision. This approach can now be calculated and will be undertaken at annual intervals by the Land Use Built Environment Team in the Research Investigations and Monitoring Unit (RIMU) at Auckland Council.

Both options of land-fragmentation monitoring could be used in conjunction with the Land Resource Inventory database to provide information on the type of land (e.g. LUC class I, II, or III) that may be affected.

Table 3 Existing council indicators and data sources used to monitor land fragmentation

Council	Indicator	Data Sources
Auckland Council	Change in the number of titles	LINZ Cadastral Database
	Change in the number of vacant titles outside the existing Rural-Urban Boundary	LINZ Cadastral Database
Hamilton City Council	Number of new titles issued	Not specified
Marlborough District Council	Change in parcel size and number	Council consents database (geo-referenced)
Matamata-Piako District Council	Number of residential lots created as a result of subdivision	Council state of environment indicators database
	Number of lots between 2500 m ² and 10 000 m ² in the residential, rural residential, and rural zones	Council state of environment indicators database
	Applications received/granted to subdivide LUC Class I, II, and III land in lots < 8 hectares of size	Council state of environment indicators database
	Area of LUC class I, II and III land removed from the Rural zone through District Plan changes	Council state of environment indicators database
	Average lot size for rural subdivision on class I, II and III land	Council state of environment indicators database
	Number of consent applications declined for subdivision on Class I, II and III land	Council state of environment indicators database
South Waikato District Council	Number of new lots approved for development	Not specified
Waikato Regional Council	Amount and type of low-density rural land subdivided into smaller blocks (Low density = land with 1 or fewer houses per 4 hectares)	Statistics New Zealand Census of Population and Dwellings Meshblock Database Land Resource Inventory

Conclusions

This paper summarises land fragmentation in New Zealand, including: issues, policies, and monitoring based on a review and analysis of regional policy statements; and the results of a land-fragmentation survey of all regional councils, unitary authorities and three district/city councils, as well as subsequent discussions with council staff.

Although land fragmentation is occurring around New Zealand, it is not occurring uniformly within or across regions. Six regions identified land fragmentation as a regionally important issue; in remaining regions it was only of medium or low importance (Table 4). While varying in importance at a regional level, most regions reported some localities or hotspots where land fragmentation has become an important issue (e.g. the Wairau Plains in Marlborough). In those cases, hotspots include areas where subdivision for rural-residential development (e.g. lifestyle block) is occurring close to urban centres on land with relatively high productive capability.

While land fragmentation is commonly an issue regionally or locally, the understanding of it and associated issues varies across councils. The lack of shared understanding stems partly from a lack of consistent terminology or definitions to help characterise, measure, monitor, and report land fragmentation trends, and many councils indicated a desire to develop more consistent terminology and definitions for land fragmentation. New Zealand is not alone in that regard. Based on a literature

review, numerous definitions or conceptions of land fragmentation are used internationally, such as: the number and size of land uses and/or land parcels in the rural landscape; the number of parcels that make up an individual farm; and the spatial distribution of multiple parcels that make up a single farm.

Rural residential development is not seen as a negative process in its own right, but scattered, un-managed, and un-planned rural residential development can be expensive for councils as well as having potential financial and social impacts on local communities. Policy makers have favoured introducing rural zones to limit and delineate rural subdivision and development, as well as introducing policy and methods to implement transferable development rights, title amalgamation, and development guidelines.

Table 4 Summary of land fragmentation importance, policies, rules and monitoring by region

Region	Regional Importance	Existing Policies		Plan Rules	Monitoring
		1st Generation RPS	2nd Generation RPS		
Northland	High	Yes Operative RPS 1999	Yes Proposed RPS 2013	No	No
Auckland	High	Yes Operative RPS 1999	Yes Proposed Unitary Plan 2013	Operative RPS 1999: No Proposed Unitary Plan 2013: Yes Rural Zones	Yes
Waikato	High	No Operative RPS 2000	Yes Proposed RPS 2013	No	Yes
Bay of Plenty	High	Yes Operative RPS 1999	Yes Proposed RPS 2010	No	No
Gisborne	High	Yes Operative RPS 2002	-	No	No
Hawke's Bay	Locally important – Heretaunga Plains	No Operative RPS 1995	Yes Operative RPS 2006 (RPS Change 4 2011)	No	No
Taranaki	Low	No Operative RPS 1994	No Operative RPS 2009	No	No
Manawatu-Whanganui (Horizons)	Low	Yes Operative RPS 1998	Yes Proposed One Plan 2010	No	Ad hoc reporting
Wellington	Low	Yes Operative RPS 1995	Yes Operative RPS 2013	No	Ad hoc reporting
Nelson	Low	No Operative RPS 1995	-	No	No
Marlborough	Locally important – Wairau Plain	Yes Operative RPS 1995	-	Yes Rural Zones	Yes
West Coast	Low	No Operative RPS 2000	-	No	No
Tasman	High	Yes Operative RPS 2001	-	Yes Rural Zones	No
Canterbury	Low	Yes Operative RPS 1998	Yes Operative RPS 2013	No	No
Otago	Medium	No Operative RPS 1998	-	No	No
Southland	Low	No Operative RPS 1997	Yes Proposed RPS 2012	No	No

Few regional plans included rules targeting land fragmentation, except for plans prepared by unitary authorities (Table 4). Such a result is not surprising, given that unitary authorities combine the functions, powers and responsibilities of both regional councils and territorial authorities. The lack of rules from regional councils (not unitary authorities) suggests they may be challenged under current governance arrangements to implement rules to manage land fragmentation effectively. In those cases, a regional council must work effectively with city and district councils to ensure city and district plans contain rules and provisions that help meet regional objectives and policies.

Nationally, regional and district coordination regarding land fragmentation issues was mixed. Some relationships were considered strong and effective. The Future Proof strategy in the Waikato and the Heretaunga Plans strategy in Hawke's Bay were good examples cited of effective collaborative efforts between regional councils, territorial authorities, and iwi to develop and agree coordinated plans to manage sub-regional growth over long time horizons. Several other successful cases were cited where district plan provisions effectively manage rural residential subdivision on land with high productive capability.

Other relationships were considered dysfunctional or non-existent, thus creating fundamental barriers to achieving policy goals. Lack of district plan provisions regarding rural subdivision, and/or weak implementation of district plan provisions were noted several times as contributing to land fragmentation issues. Therefore a key component in achieving successful management of land fragmentation requires effective coordination among regional policy statements, regional plans, district/city plans and district/city council implementation of the district plan provisions.

While land fragmentation is an increasingly important issue, few councils currently monitor land fragmentation. Those councils that undertake monitoring do not use consistent methods or indicators for measuring and reporting. The lack of consistency prevents comparison among regional trends and, at a higher level, aggregation of results to support reporting at the national level.

In summary, the current study demonstrates a compelling need to develop effective guidelines to help councils monitor and report trends in land fragmentation. The next steps of the project are informed by the results of this review and will involve working with regional councils and unitary authorities to develop guidelines for monitoring and reporting trends in land fragmentation, including: (1) suitable definition of key terms, such as, land fragmentation, versatile land, high-class soils, etc., (2) consistent methods for monitoring trends in land fragmentation, (3) an indicator or set of indicators for reporting on land fragmentation trends, (4) reporting content and format, and (5) developing, testing, and implementing a tool to support monitoring and reporting of land fragmentation by regional councils.

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References

- Andrews R, Dymond J 2012. Expansion of lifestyle blocks and urban areas into high-class land: an update for planning and policy. *Journal of the Royal Society of New Zealand*
DOI:10.1080/03036758.2012.736392.
- Curran-Cournane F, Vaughan M, Memon A, Fredrickson C 2014. Trade-offs between high class land and development: recent and future pressures on Auckland's valuable soil resources. *Land Use Policy* (accepted).
- Godfray HCJ, Beddington JR, Crute IR, Haddad L, Lawrence D, Muir JF, Pretty J, Robinson S, Thomas SM, Toulmin C 2010. Food security: The challenge of feeding 9 billion people. *Science* 327: 812–818.
- Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF 2009. *Land Use Capability Survey handbook – a New Zealand handbook for the classification of land*. 3rd edn. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163 p.
- Mackay AD, Stokes S, Penrose M, Clothier BE, Goldson SL, Rowarth JS 2011. Land: competition for future use. *New Zealand Science Review* 68(2): 68–72.
- Miranowski J, Cochrane M 1993. Economics of land in agriculture. In: Carlson G, Zilberman D, Mirankowski J eds *Agricultural and environmental resource economics*. Oxford University Press.
- RSNZ 2011. *Competition for land use in New Zealand*. Wellington, Royal Society of New Zealand. 6 p.

- Rutledge DT, Price R, Ross C, Hewitt A, Webb T, Briggs C 2010. Thought for food: impacts of urbanisation trends on soil resource availability in New Zealand. *Proceedings of the New Zealand Grasslands Association* 72: 241–246.
- Salant S 1995. The economics of natural resource extraction: a primer for development economists. *The World Bank Research Observer* 10(1): 93–111.
- Smith P, Gregory PJ, van Vuuren D, Obersteiner M, Havlik P, Rounsevell M, Woods J, Stehfest E, Bellarby J 2010. Competition for land. *Philosophical Transactions of the Royal Society B* 365: 2941–2957.
- Stephens P, Jessen M, Newsome P 1996. Land indicators for national environmental monitoring – Part 1A: New Zealand Land Resource Inventory. Landcare Research Report LC9697/105 prepared for the Ministry for the Environment. 12 p.