NZDep2013 Index of Deprivation

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Acknowledgements

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While the contents of this report have benefited considerably from the assistance of colleagues, the responsibility for this report remains solely with the authors.

Ethics and confidentiality

Ethical approval for the original NZDep91 project was obtained in May 1995 from the Central Regional Health Authority Wellington Ethics Committee.

Access to the data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the authors, not Statistics New Zealand.

Executive Summary

NZDep2013 is an updated version of the NZDep91, NZDep96, NZDep2001 and NZDep2006 indexes of socioeconomic deprivation. NZDep2013 combines nine variables from the 2013 census which reflect eight dimensions of deprivation. NZDep2013 provides a deprivation score for each meshblock in New Zealand. Meshblocks are geographical units defined by Statistics New Zealand, containing a median of approximately 81 people in 2013.

The NZDep2013 index of deprivation has two forms—an ordinal scale and a continuous score.

- The NZDep2013 index of deprivation ordinal scale ranges from 1 to 10, where 1 represents the areas with the least deprived scores and 10 the areas with the most deprived scores.

- The NZDep2013 index of deprivation interval variable is the first principal component score, which has been scaled to have mean 1000 index points and standard deviation 100 index points. The NZDep2013 10 point scale is derived from this interval variable.

The NZDep2013 scale of deprivation from 1 to 10 divides New Zealand into tenths of the distribution of the first principal component scores. For example, a value of 10 indicates that the meshblock is in the most deprived 10 percent of areas in New Zealand, according the NZDep2013 scores.

It should be noted that NZDep2013 deprivation scores apply to areas rather than individual people.

NZDep2013 combines the following census data (calculated as proportions for each small area):

Dimension of deprivation	Description of variable (in order of decreasing weight in the index)
Communication	People aged <65 with no access to the Internet at home
Income	People aged 18-64 receiving a means tested benefit
Income	People living in equivalised* households with income below an income threshold
Employment	People aged 18-64 unemployed
Qualifications	People aged 18-64 without any qualifications
Owned home	People not living in own home
Support	People aged <65 living in a single parent family
Living space	People living in equivalised* households below a bedroom occupancy threshold
Transport	People with no access to a car

*Equivalisation: methods used to control for household composition.

Introduction

This report describes the development of NZDep2013. The methods used in the creation of NZDep2013 are based on very similar methods used in the creation of NZDep91, NZDep96, NZDep2001 and NZDep2006. These are described in detail in *Research Report No.5 NZDep91 Index of Deprivation* (Crampton et al., 1997b), *Research Report No.8: NZDep96 Index of Deprivation* (Salmond et al., 1998a), *NZDep2001 Index of Deprivation* (Salmond & Crampton, 2002b), and *NZDep2006 Index of Deprivation* (Salmond et al., 2007a).

Minor changes only have been made to the methods used for NZDep2013. One very minor change is the result of changed income categories in the Census form. In addition, the telecommunications variable has been changed from access to a telephone, to access to the Internet for those less than 65 years of age. A description and explanation of these changes is given in the methods section. Work on NZDep2013 was carried out largely in the Statistics New Zealand Data Laboratory.

An overview of the theory and conceptualisation of socioeconomic deprivation can be found in the following two sources:

Salmond, C., King, P., Crampton, P. and Waldegrave, C. (2006). NZiDep: A New Zealand index of socioeconomic deprivation for individuals, *Social Science & Medicine*, 62, 1474-1485.

White, P., Gunston, J., Salmond, C., Atkinson, J., and Crampton, P. (2008), *Atlas of Socioeconomic Deprivation in New Zealand: NZDep2006*, Wellington, Ministry of Health.

Further information regarding NZDep and its various uses may be obtained in the following methodological papers, research reports, application papers, and atlases.

Methodological papers

Crampton, P., Salmond, C. and Sutton, F. (1997), NZDep91: a new index of deprivation, *Social Policy Journal of New Zealand*, 9, 186-193.

Crampton, P., Salmond, C. and Sutton, F. (1997*), The NZDep91 index of deprivation*, in Crampton, P. and Howden-Chapman, P. (eds.), *Socioeconomic Inequalities and Health - Proceedings of the Socioeconomic Inequalities and Health Conference, Wellington, December 9-10, 1996*, Wellington, Institute of Policy Studies, Victoria University of Wellington.

Salmond, C., Crampton, P. and Sutton, F. (1998), NZDep91: a new index of deprivation, *Australian and New Zealand Journal of Public Health*, 22, 95-97.

Crampton, P. and Davis, P. (1998), Measuring deprivation and socioeconomic status: why and how, *The New Zealand Public Health Report*, 5, 81-84.

Salmond, C. and Crampton, P. (2001), NZDep96 - What does it measure?, *Social Policy Journal of New Zealand*, 17, 82-100.

Salmond, C. and Crampton, P. (2002), Heterogeneity of deprivation within very small areas, *Journal of Epidemiology and Community Health*, 56, 669-670.

Salmond, C. E., and Crampton, P. (2012), Development of New Zealand's Deprivation Index (NZDep) and Its Uptake as a National Policy Tool, *Can J Public Health*, 103(Suppl. 2), S7-S11.

Salmond, C., and Crampton, P. (2012), Measuring socioeconomic position in New Zealand. *J Prim Health Care*, 4(4), 271-280.

NZDep research reports and most recent user manual

Crampton, P., Salmond, C. and Sutton, F. (1997), *Research Report No. 5: NZDep91 Index of Deprivation*, Wellington, Health Services Research Centre.

Salmond, C., Crampton, P. and Sutton, F. (1998), *Research Report No. 8, NZDep96 Index of Deprivation*, Wellington, Health Services Research Centre.

Salmond, C. and Crampton, P. (2002), *NZDep2001 Index of Deprivation*, Wellington, Department of Public Health, Wellington School of Medicine and Health Sciences, http://www.moh.govt.nz and http://www.otago.ac.nz/wellington.

Salmond, C., Crampton, P. and Atkinson, J. (2007), *NZDep2006 Index of Deprivation*, Wellington, Department of Public Health, University of Otago, Wellington, http://www.moh.govt.nz and http://www.otago.ac.nz/wellington.

Salmond, C. and Crampton, P. and Atkinson, J. (2007), *NZDep2006 Users' Manual*, Wellington, Department of Public Health, University of Otago, Wellington, http://www.moh.govt.nz and http://www.otago.ac.nz/wellington.

Research papers, chapters and reports illustrating applications of NZDep

Over the past fifteen years NZDep has been used in many academic papers, book chapters, social reports and advocacy documents -- far too numerous to be itemised here. Following are a few examples which illustrate some of the varied research uses of NZDep.

Salmond, C., Crampton, P., Hales, S., Lewis, S. and Pearce, N. (1999), Asthma prevalence and deprivation: a small area analysis, *Journal of Epidemiology and Community Health*, 53, 476-480.

Crampton, P., Salmond, C., Woodward, A. and Reid, P. (2000), Socioeconomic deprivation and ethnicity are both important for anti-tobacco health promotion, *Health Education and Behaviour*, 27, 317-327.

Mitchell, E., Stewart, A., Crampton, P. and Salmond, C. (2000), Deprivation and sudden infant death syndrome, *Social Science and Medicine*, 51, 147-150.

Salmond, C. and Crampton, P. (2000), *Deprivation and Health*, in Howden-Chapman, P. and Tobias, M. (eds.), *Social Inequalities in Health: New Zealand 1999*, Wellington, Ministry of Health.

Crampton, P. and Salmond, C. (2000), Socioeconomic deprivation and hospitalisation rates in New Zealand, *Australasian Epidemiologist*, 7, 20-24.

Love, T. and Crampton, P. (2001), Deprivation profiles in Wellington IPA practices, *New Zealand Family Physician*, 28, 327-332.

Tobias, M., Salmond, C., Crampton, P., Chan, M., Marmot, M. and Reid, P. (2001), *Life Expectancy and Small Area Deprivation in New Zealand,* Public Health Intelligence Occasional Bulletin No. 6, Wellington, Ministry of Health.

Abas, M., Vanderpyl, J., Robinson, E. and Crampton, P. (2003), More deprived areas need a greater number of psychiatric beds, *Australian and New Zealand Journal of Psychiatry*, 37, 437-444.

McFadden, K., McConnell, D., Salmond, C., Crampton, P. and Fraser, J. (2004), Socioeconomic deprivation and the incidence of cervical cancer in New Zealand: 1988-1998, *New Zealand Medical Journal*, 117, 1206.

Abas, M., Vanderpyl, J., Robinson, E., Leprou, T. and Crampton, P. (2006), Socio-economic deprivation and duration of hospital stay in severe mental disorder, *British Journal of Psychiatry*, 188, 581-582.

HURA Research Alliance, McLeod, D., Cormack, D., Love, T., Salmond, C., Robson, B., Dowell, A., Howard, M., Crampton, P. and Ramage, S. (2006), Ethnicity, socioeconomic deprivation and consultation rates in New Zealand general practice, *Journal of Health Services Research & Policy*, 11, 141-149.

McKenzie, F., Ellison-Loschmann, L. and Jeffreys, M. (2010), Investigating reasons for socioeconomic inequalities in breast cancer survival in New Zealand, *Cancer Epidemiology*, 34(6), 702-8.

Wall, R., Bell, A. and Theobald, J. (2011), Pertussis (whooping cough) epidemiology in Waikato, New Zealand: 2000-2009, *New Zealand Medical Journal*, 124(1332), 52-61.

Mehta, S., Wells, S., Riddell, T., Kerr, A., Pylypchuk, R., Marshall, R., Ameratunga, S., Chan, W C., Thornley, S., Crengle, S., Harrison, J., Drury, P., Elley, C R., Bell, F. and Jackson, R. (2011), Under-utilisation of preventive medication in patients with cardiovascular

disease is greatest in younger age groups (PREDICT-CVD 15), *Journal of Primary Health Care*, 3(2), 93-101.

Moodie, P., Jaine, R., Arnold, J., Bignall, M., Metcalfe, S. and Arroll, B. (2011), Usage and equity of access to isotretinoin in New Zealand by deprivation and ethnicity, *New Zealand Medical Journal*, 124(1346), 34-43.

Ellis, C., Pryce, A., Macleod, G. and Gamble, G. (2012), The most deprived Auckland City Hospital patients (2005-2009) are 10 years younger and have a 50% increased mortality following discharge from a cardiac or vascular admission when compared to the least deprived patients, *New Zealand Medical Journal*, 125(1357), 15-35.

Wilson, D., Harding, S. A., Melton, I., Lever, N. A., Stiles, M. K., Boddington, D., Heald, S. and Larsen, P D. (2012), Geographic, ethnic and socioeconomic factors influencing access to implantable cardioverter defibrillators (ICDs) in New Zealand, *Heart, Lung & Circulation*, 21(9), 576-81.

Atlases

Crampton, P., Salmond, C., Kirkpatrick, R., Scarborough, R. and Skelly, C. (2000), *Degrees of Deprivation in New Zealand: An atlas of socioeconomic difference*, Auckland, David Bateman Ltd.

Crampton, P., Salmond, C. and Kirkpatrick, R. (2004), *Degrees of Deprivation in New Zealand: An atlas of socioeconomic difference. 2nd Edition*, Auckland, David Bateman Ltd.

White, P., Gunston, J., Salmond, C., Atkinson, J., and Crampton, P. (2008), *Atlas of Socioeconomic Deprivation in New Zealand NZDep2006*. Wellington, Ministry of Health.

Aim

The aim of the NZDep research programme is to develop small area indexes of socioeconomic deprivation for New Zealand.

Purpose of indexes

NZDep91, NZDep96, NZDep2001, NZDep2006 and NZDep2013 have been developed with three principal purposes in mind: resource allocation, research, and advocacy.

1. Indexes of deprivation have application in funding formulas. For example, indexes of deprivation have a long history of being used in capitation funding formulas for primary health care services, the population-based funding formula for District Health Boards, and in funding formulas for social services in other sectors.

2. Indexes of deprivation have application in research in a variety of settings such as health and other social services. For example, in the health sector, many researchers use small area indexes to describe the relationship between socioeconomic deprivation and health outcomes; increasing levels of deprivation are associated with higher mortality rates, and higher rates of many diseases.

3. Indexes of deprivation are used by community groups and community-based service providers to describe the populations they serve, and to advocate for extra resources for community-based services.

Cautions

A number of potential problems arise in using measures of socioeconomic position. The following are of particular importance for NZDep.

The indicator becomes the reality

The problem of confusing the indicator with the underlying phenomenon is discussed by Carr-Hill and Chalmers-Dixon (2002):

> A common problem is to confuse the index with the phenomenon it purports to measure and, as a result, forget that *an index is only a proxy or partial measure*. (Emphasis added)

This common problem is referred to as reification. It is crucial that users of any measure of socioeconomic position recognise this problem and scrutinise both the theoretical basis for, and the construction of, the specific index. Carr-Hill and Chalmers-Dixon (2002) give the following UK-based example:

> The tendency is not unknown with measures of deprivation where it is more common to use phrases such as the ten most deprived local authorities, rather than "the authorities with the top ten scores on the DETR2000 index".

Users of NZDep indexes should refer to 'areas that have the most deprived NZDep scores' rather than 'the most deprived areas'.

Area versus individual measures

Please note that NZDep is a small-area measure of deprivation. Caution must be used if the index is applied to individuals. This issue is discussed in greater detail in *NZDep - What does it measure?* (Salmond & Crampton, 2001), in *Heterogeneity of deprivation within very small areas* (Salmond & Crampton,

2002a), and in *NZiDep: A New Zealand index of socioeconomic deprivation for individuals* (Salmond et al., 2006).

Relative versus absolute deprivation

A view is sometimes expressed in reference to NZDep that 'it is disgraceful that still 10% of areas are most deprived'. Please note that 10% of areas will *always* fall into the most deprived decile of NZDep scores—NZDep is designed to measure *relative* socioeconomic deprivation, not *absolute* socioeconomic deprivation.

Apparent simplicity

The NZDep scales (from 1 to 10) have been constructed so that they can be readily used in a variety of contexts. They are easily presented graphically. This simplicity should not be allowed to obscure the underlying complexity of construction, the limitation to components available from the Census, and the underlying theoretical assumptions (discussed in the *Atlas of Socioeconomic Deprivation in New Zealand: NZDep2006* (White et al., 2008) and in *Development of New Zealand's Deprivation Index (NZDep) and Its Uptake as a National Policy Tool* (Salmond & Crampton, 2012b).

Longitudinal comparisons

Difficulties arise in making comparisons between different NZDep indexes (NZDep91, NZDep96, NZDep2001, NZDep2006 and NZDep2013). These difficulties are discussed in detail in Appendix five.

Constructing the index

Overview

Creation of a small area index of deprivation requires:

1. A source of data.
2. A definition for the small area.
3. Choice of, and definitions for, the variables included in the index.
4. A method for using the variables to create the index.
5. Internal and external validation of the index.

Data sources

NZDep2013 was created from data from the 2013 Census of Population and Dwellings. The variables included in NZDep2013 are all age and sex standardised proportions of people in a small area with an attribute.

Information was maximised by obtaining files from two sources:

1) All individual census forms of persons usually resident in New Zealand whose meshblock of usual residence can be ascribed, whether present in their usual residence on census night or not (4.24 million).

2) Dwelling forms from private dwellings (4.13 million records); that is one record for each person usually resident in a private dwelling.

More details concerning the source populations are given in Appendix one.

Defining small areas

The NZDep small areas used to create the base index of deprivation are unique to this deprivation project (NZDep2013 small areas). The building blocks for these small areas are standard Statistics New Zealand meshblocks. Where necessary, meshblocks have been agglomerated to create NZDep2013 small areas with a population of at least 100 persons usually resident, where possible. Agglomeration occurred only within primary sampling unit (PSU) boundaries so that the resulting small areas were geographically connected. (PSUs are areas used internally by Statistics New Zealand for their labour force and other surveys.) It should be noted that connectivity does not necessarily imply consecutively numbered meshblocks. In general, the NZDep2013 small areas consist of one or two meshblocks. Details of the agglomeration are included in Appendix five (Comparing areas over time, section 2a).

In addition to the desire to have at least 100 persons in each NZDep2013 small area, it was important to check that individual proportions in an area did not have very small denominators because of small numbers of individuals and/or missing data. We therefore identified those NZDep2013 small areas with any proportion denominator less than 20. These proportions occurred in 107 small areas. The agglomeration steps were therefore repeated, further agglomerating these small areas up to their respective primary sampling unit boundaries (where possible). The final number of NZDep2013 small areas was 23,751. Ultimately, the values for 82 NZDep2013 small areas, involving 112 meshblocks, have been withheld from the index because two or more of the nine denominators were less than 20, or (in four small areas) when one denominator was less than 4. In these cases the index value was considered unreliable.

The following meshblocks, mostly on the fringes of more populated areas (see Mapping below), have had their deprivation values withheld:

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0053404, 0061802, 0133411, 0133412, 0133428, 0171911, 0172807, 0173120,
0176414, 0178511, 0178607, 0180870, 0180871, 0180873, 0180875, 0290800,
0304300, 0364601, 0393702, 0394000, 0466104, 0468802, 0496102, 0589205,
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0625400, 0681209, 0681210, 0681319, 0687001, 0711743, 0759514, 0767812,
0769040, 0812304, 0825105, 0896002, 0952121, 1053600, 1161903, 1179608,
1183203, 1183204, 1183205, 1192226, 1192229, 1192233, 1193215, 1204924,
1204925, 1254505, 1288100, 1288900, 1289102, 1371300, 1371400, 1402503,
1419100, 1556312, 1707100, 1744901, 1814302, 1867008, 1883804, 1943701,
1944702, 1944703, 1944705, 1997104, 1999732, 1999733, 1999734, 1999735,
1999736, 1999737, 1999740, 2003505, 2004104, 2004106, 2004108, 2004110,
2036303, 2052300, 2052900, 2053000, 2053105, 2053106, 2056617, 2056618,
2056619, 2126000, 2127500, 2159801, 2171005, 2171300, 2178801, 2304505,
2343701, 2346702, 2359718, 2365504, 2365710, 2448604, 2454200, 2485709,
2654600, 2654802, 2784801, 2965805, 2965807, 2965808, 2978200, 3138802.
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Choice of variables for inclusion in NZDep2013

The NZDep2013 index of deprivation reflects eight dimensions of material and social deprivation. These dimensions reflect lacks of income, employment, communication, transport, support, qualifications, owned home and living space. A list of the variables used in NZDep2013 is given in Table 1.

Table 1: Variables included in NZDep2013

Variable (proportions in small areas) in order of decreasing weight in the index
People aged < 65 with no access to the Internet at home
People aged 18 - 64 receiving a means tested benefit
People living in equivalised* households with income below an income threshold
People aged 18 - 64 unemployed
People aged 18 - 64 without any qualifications
People not living in own home
People aged < 65 living in a single parent family
People living in equivalised* households below a bedroom occupancy threshold
People with no access to a car

*Equivalisation: methods used to control for household composition.

The telecommunication variable used in previous versions of NZDep – no access to any phone at home – has been dropped in 2013, after careful investigation, and has been replaced by another telecommunication variable – no access to the

Internet at home. Another variable – household income – has been very slightly modified as a result of changed categories in the Census. A description of this change is given below. For convenience, a short description of each of the unchanged variables -- means-tested benefits, access to a car, unemployment, single parent family, no qualifications, occupancy, and dwellings not owner occupied – have been extracted from *NZDep2006 Index of Deprivation* (Salmond et al., 2007a) and placed in Appendix two.

Household income

The setting of the household equivalised income threshold was based on two principles:

1. The proportion of the population identified as being socioeconomically deprived by the threshold should be broadly consistent with the other variables in the index (i.e., the threshold should be neither too inclusive nor too restrictive).

2. The threshold should be broadly consistent with other measures of income poverty.

The poverty-line work of Stephens and Waldegrave (2001) was used as a guide for setting the NZDep2001 and NZDep2006 household equivalised income thresholds as close as possible to 15% of people (*NZDep2001 Index of Deprivation*, (Salmond & Crampton, 2002b), *NZDep2006 Index of Deprivation*, (Salmond et al., 2007a)). This threshold is maintained for NZDep2013. Table 2 gives an abbreviated distribution of equivalised income.

Table 2: Jensen equivalised household income distribution (abbreviated)

Equivalised-income*			Cumulative percent of *people*	
under	15,172		4.8	
..	to	23,742	10.0	
..	to	26,307	12.0	Deprived
..	to	26,714	14.9	
..	to	26,837	14.9989	
	26,843		15.0002	2013 threshold cuts off 15.00 percent of people with household income information
..	to	28,413	15.9	
..	to	33,170	20.0	Not deprived
..	to	41,127	30.0	
	etc.		etc.	

* Note that because the source information is in income bands, there are only a limited number of values for 'equivalised' income.

Possible new candidate variables available in the 2013 census

The 2013 Census was examined in detail for possible new candidate variables for NZDep2013. To be considered for inclusion in the index, variables needed to be consistent with the theoretical approach adopted for NZDep (see *Research Report No. 5* (Crampton et al., 1997b). Only one potential variable was identified—access to the Internet at home.

Access to the Internet is becoming very common and it was necessary to check whether a variable 'no access to the Internet' could be used in the index of deprivation. There are two issues. First, is lack of such access theoretically a deprivation characteristic in 2013? And second, is the variable closely related, statistically, to the known deprivation characteristics used in the previous NZDep indexes?

The Internet is now a fundamental aspect of our structures of opportunity, both socially and in the market; our structures of communication; and our structures for enabling choices. These aspects are not restricted to luxury items but include day-to-day goods, such as buying cheaper clothing and accessing health care

(Logan, 2013; Moffatt & Eley, 2011; Sarkar et al., 2010; Hong, 2008; Wilson et al., 2008), and ongoing activities such as social networking and instant messaging (Rice et al., 2012). That is, Internet access is as much an integral part of day-to-day living in 2013 as the telephone was considered to be in 1996, the first time such communication information was available from the census dwelling forms. The Internet variable is currently restricted to those aged <65 because of the strong age-related (cohort) effect (which will diminish rapidly over coming years).

The lack of access to the Internet is strongly correlated with the other variables in the index with correlations varying from 0.50 (no access to a car or other means of transport) to 0.76 (no qualifications), where the unit of analysis is a small area (23,751). (The smallest correlation among all the variables is that between no qualifications and no access to a car, 0.33.) A factor analysis of the variables in the index does not isolate the Internet variable in any way, and its loading on the first principal component is marginally greater than those for being on a means-tested benefit and those living below an equivalised income threshold, these three variables having the highest loadings (0.372, 0.364 and 0.356 respectively).

Thus lack of access to the Internet at home has both face validity and statistical validity as a deprivation characteristic in 2013.

Investigation showed that an index including the Internet access variable performed better than one including both the Internet access and the telephone access variables, probably because the lack of access to any form of phone is nowadays relatively rare.

Creating the index

Principal components analysis was used, as previously, to create the index. Principal components analysis is a multivariate method that identifies linear combinations of variables that progressively account for the overall variation in the data. The first principal component accounts for the most variation, the

second accounts for as much of the remaining variation as possible, and so on. Further information is contained in *Research Report No. 5* (Crampton et al., 1997b).

NZDep2013 is the first principal component of nine variables. Each variable is a proportion of persons in a small area. The index was created, as before, using standardised proportions, where each small area proportion was standardised in eight age/sex groups (0-17, 18-39, 40-64, 65 and over, for each sex) to the New Zealand population structure. Proportions were calculated both standardised and unstandardised as a way of checking the effect of standardisation. A description of the standardisation process used in creating NZDep2013 is given in Appendix three.

Technical difficulties, encountered occasionally when an NZDep2013 small area had no one in certain age/sex groups, were overcome, as before, by *defining* such proportions to be zero. The explanation given in *Research Report No. 5* is repeated in Appendix four (Structural zeros). Other technical difficulties involving 'not specified' codes were treated as before and are also described in Appendix four (Not specified).

Validation

Validation for the earlier indexes is discussed in *Research Reports No. 5* and *No. 8* (Crampton et al., 1997b; Salmond et al., 1998a) as well as in the web-based research reports for the 2001 and 2006 indexes (*NZDep2001 Index of Deprivation* (Salmond & Crampton, 2002b) and *NZDep2006 Index of Deprivation* (Salmond et al., 2007a)).

As in 1996 and 2006, we were able to validate the NZDep2013 index against individual smoking data contained in the 2013 census.

Results

Defining small areas

Meshblocks varied in size from zero to more than 300 persons usually resident. Small meshblocks were agglomerated within primary sampling units (2013 version) [as well as within the Great Barrier, Matakana, Stewart and Chatham Islands] to form NZDep2013 small areas with, as far as possible, at least 100 persons usually resident (Table 3). Primary sampling units are used internally by Statistics New Zealand for non-census sampling purposes.

Table 3: Distribution of population in NZDep2013 agglomerated small areas

Usually resident population	Number of NZDep2013 small areas*	Cumulative percent
1 - 30	14	0.06
31 - 60	48	0.26
61 - 75	58	0.50
76 - 90	120	1.00
91 - 99	147	1.62
100 - 120	2897	13.82
121 - 150	4612	33.24
151 - 200	9115	71.62
201 - 300	6083	97.23
>300	657	100.00
	total = 23,751	

* The target size for NZDep2013 small areas was a minimum of 100 persons usually resident, where possible. Percentages above are based on populations randomly rounded to base 3.

The distribution of the number of meshblocks incorporated in each NZDep2013 small area is shown in Table 4.

Table 4: Number of meshblocks per NZDep2013 small area

Number of meshblocks	Proportion of small areas (%)
1	50.0
2	30.4
3	11.3
4	4.5
5	2.0
6 or more	1.8
total	100.0 (N = 23,751)

NZDep2013 scores

We used principal components analysis to create the index from the nine variables listed in Table 1. The first principal component explained 60.7% of the overall variance (even better than the NZDep2001 figure of 57.7% and the NZDep2006 figure of 55.4%). The first principal component yields the NZDep2013 score.

A number of empty meshblocks, mainly sea or estuary, have been omitted from the index. Deprivation values have been withheld for a further 112 meshblocks because more than one of the nine proportions within a small area have denominators less than 20. These 112 meshblocks could not be agglomerated with any other small area within a PSU. The 112 meshblocks are listed in *Constructing the index, Defining small areas*.

The weights for each of the nine variables in the first principal component, which is the basis of NZDep2013, are shown in the last column of Table 5. The equivalent weights for NZDep2006 are also shown in the table, which is ordered by decreasing 2013 weight.

Table 5: Weights on the first principal components for 2013 and 2006

	Weight	
Proportion of persons (with a lack of something)	**2006**	**2013**
People aged < 65 with no access to the Internet at home	-	**0.372**
People aged 18-64 receiving a means tested benefit	0.371	**0.364**
People living in households with equivalised* income below an income threshold	0.356	**0.356**
People aged 18-64 unemployed	0.332	**0.338**
People aged 18-64 without any qualifications	0.326	**0.332**
People not living in own home	0.334	**0.322**
People aged < 65 living in a single parent family	0.333	**0.317**
People living in households below an equivalised* bedroom occupancy threshold	0.318	**0.303**
People with no access to a car	0.311	**0.286**
People with no access to any phone at home	0.314	-
Percentage of variance explained	55.4%	**60.7%**

* Equivalisation: methods used to control for household composition.

Comparison of NZDep2013 scores and NZDep2006 scores

The table above shows that the changes in weights between 2006 and 2013 are small. The changes are similar to those seen between comparable indexes in 2001 and 2006, where the maximum change was 0.022 (Salmond et al., 2007a). The largest change in weights between 2006 and 2013 was for people without access to a car (decrease of 0.025). This is offset by the relative importance of the new variable – access to the Internet at home – which has the highest loading of all in 2013 (0.372), stronger than the loading for the alternative communication variable, lack of access to any phone, in NZDep2006 (0.314).

Part of the small differences observed may be a result of differing levels of missing information.

Part, of course, is likely to be due to changing social circumstances. For example, the high loading for 'lack of access to the Internet at home for those less than 65' reflects the ever-increasing importance of the Internet for buying and selling goods, connecting with friends, looking for work, doing homework, and so on.

Furthermore, the combination of cell-phones and land-line telephones means that lack of access to one or the other is increasingly relatively rare.

The more than five percentage-point improvement in the proportion of the variance of all the variables explained by the NZDep2013 scores, and the similarity of their loadings, shows how consistent the variables are in describing the underlying concept of deprivation.

The NZDep2013 Index of deprivation

An NZDep2013 scale of deprivation has been produced from the distribution of the NZDep2013 scores. This scale from 1 to 10 divides New Zealand into tenths of the distribution of the first principal component scores, where, for example, a value of 10 indicates that the area is in the most deprived 10% of NZDep2013 small areas in New Zealand.

Figure 1 shows the relationship between the NZDep2013 scores and the NZDep2013 scale from 1 to 10. The skewed distribution illustrates clearly that NZDep2013 reflects a continuum from 'least deprivation' to 'most deprivation', rather than from 'affluence' to 'deprivation'. This was intended, as all the variables in NZDep2013 reflect a lack of something.

Note that the decile cut-points of the NZDep2013 scale are not equally spaced, so that, for example, the difference between deciles 2 and 5 is not huge, unlike the difference between deciles 7 and 10. Other scales can be created from the NZDep2013 scores. For example, fortieths have been used to explore national five-year mortality rates, and quintiles have been used to explore National Health Survey data. The choice of division for the scale should be made bearing in mind the skewed nature of the distribution of the underlying NZDep2013 scores. Divisions based on unequal sub-sample sizes should be used with caution, as the precision of any resulting statistics will vary by division category.
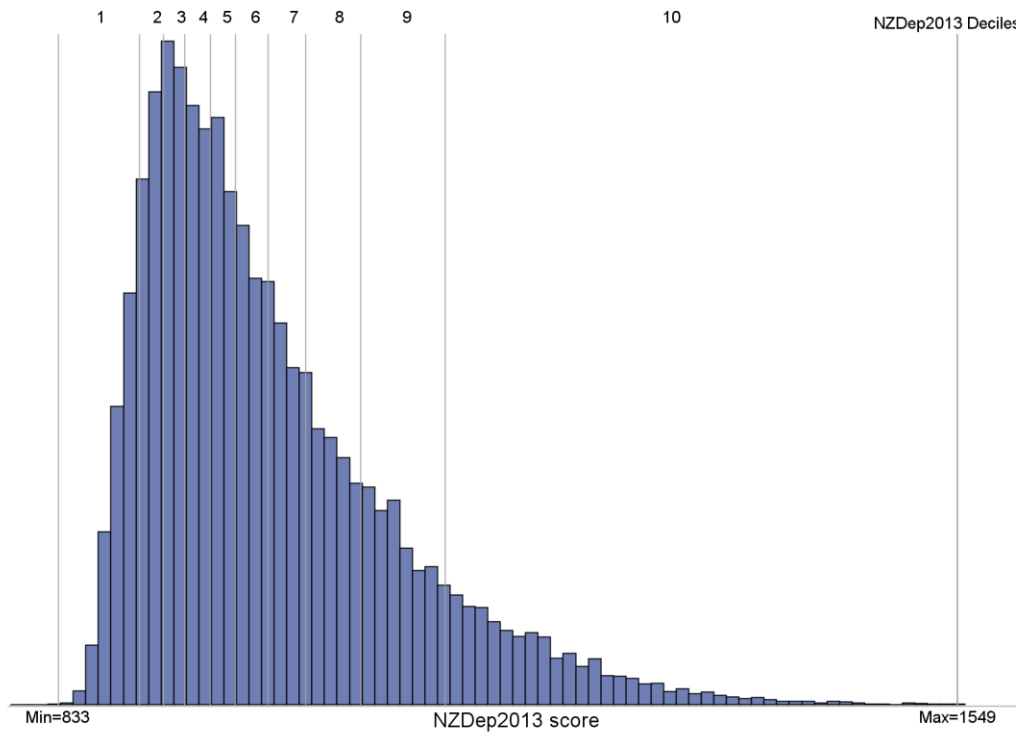
Figure 1: Distribution of NZDep2013 scores, with the NZDep2013 decile scale superimposed

Variation within communities

There is frequently a considerable amount of variation between neighbourhoods or small areas within any given larger geographical area. For example, if a Territorial Authority boundary is used for creating an NZDep profile there may be pockets of relatively deprived areas and relatively non-deprived areas within the territorial authority. This point is illustrated in Figure 2, which starts with the New Zealand population and then focuses on successively smaller areas.

As can be seen in the New Zealand profile at the top of the figure, there are approximately equal numbers of people in each NZDep2013 category. They are not exactly equal because the index is created from a distribution based on small areas, not on people. When three Territorial Authorities (TA) are compared,

marked differences in their NZDep2013 profiles are observed. Again, when two different census Area Units (AU) in Auckland are compared, there are clear differences in their NZDep2013 profiles.
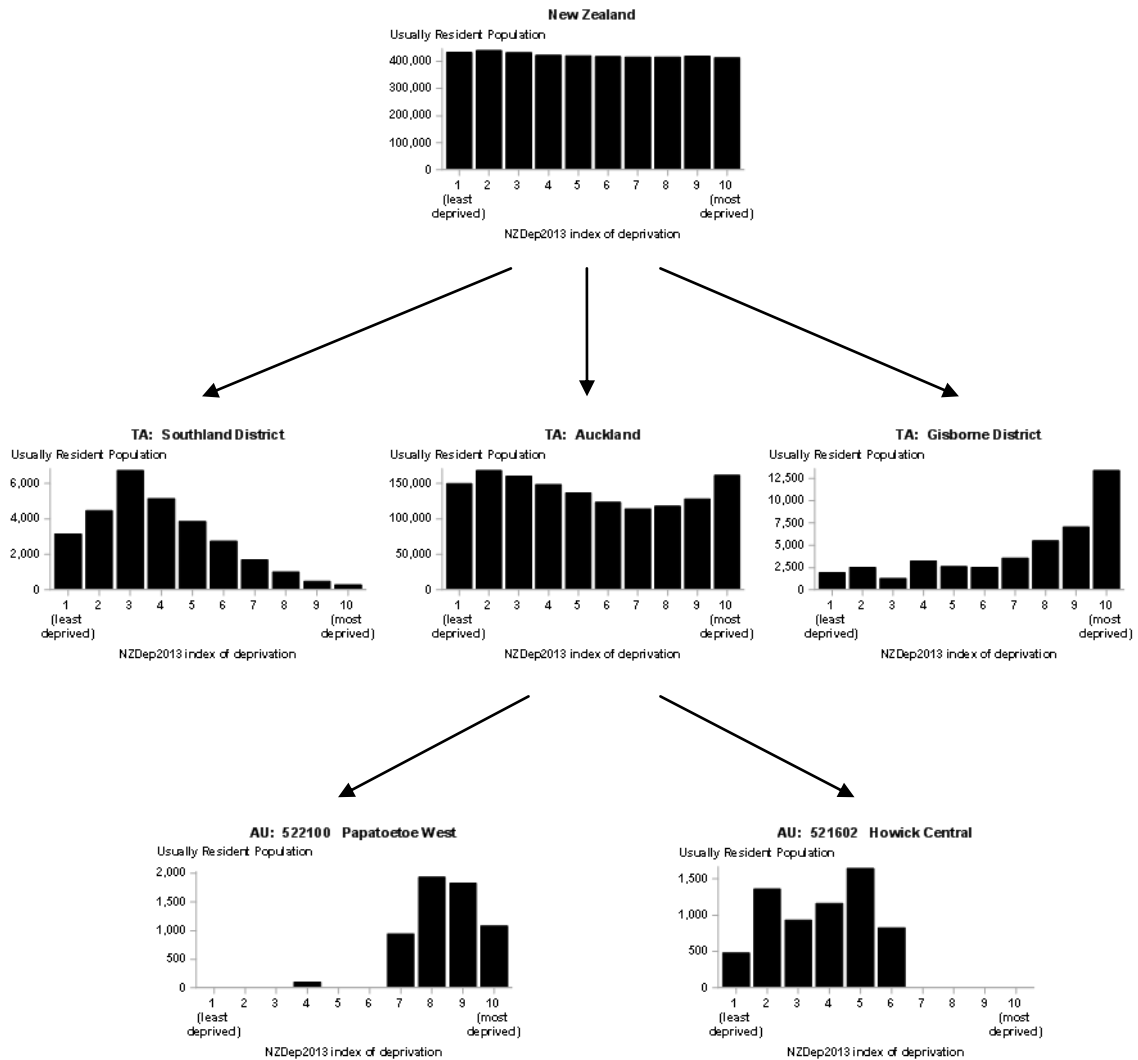

Figure 2: Variation in NZDep2013 profiles.

Standardisation

Standardisation of the input variables made a small but appreciable difference to the overall performance of the index. An illustration of the difference was provided for NZDep96 in *Research Report No. 8* (Salmond et al., 1998a). Further details about the standardisation procedure are contained in Appendix three.

Validation

The objective of validation is to confirm the usefulness of the indices. Validation asks the question: do the indices accurately measure what they purport to measure, levels of socioeconomic deprivation in small areas? Validation of the index, in the absence of a gold standard, has consisted of checking for construct validity and criterion validity.

Construct validity seeks agreement between a theoretical concept, socioeconomic deprivation in this instance, and the measuring device. We explored construct validity at the time of the development of NZDep91 with investigations of technical aspects of the index and exploration of scores in sentinel areas (Crampton et al., 1997b).

Criterion validity checks how well the measure predicts other variables known to be associated with the underlying construct, socioeconomic deprivation. The first two NZDep indexes (NZDep91 and NZDep96) were validated against a number of health outcome and health behaviour variables (Crampton et al., 1997b; Salmond et al., 1998a). In the 2006 Census there was a further opportunity to validate the NZDep index of deprivation by using the smoking information provided by adults aged 15 years and over. This is again possible from the smoking data contained in the 2013 Census.

There is good evidence in the literature that smoking patterns are strongly correlated with socioeconomic status (Wilson et al., 2006). Therefore, if

NZDep2013 is a good indicator of area deprivation, we would expect the proportions of regular smokers to increase across the deprivation deciles from least deprived to most deprived.

The percentage of smokers was calculated using only those individuals who provided information on their census forms. The strong relationship between smoking and the NZDep2013 index of deprivation is shown in Figure 3.
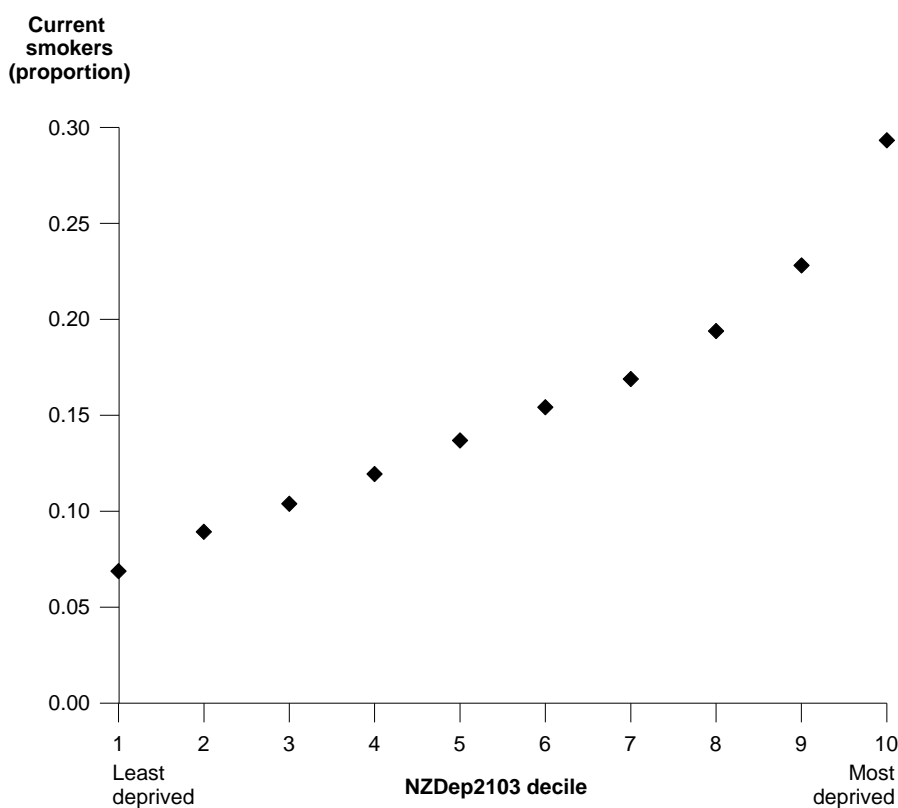
Figure 3: Current smoking in 2013 by NZDep2013

This strong validation is in line with the 1996 validation of the smoking information contained in the 1996 Census (*Research report No. 8;* Salmond & Crampton, 1998a) and with the similar validation in 2006 (Salmond et al., 2007a). The relationship between area deprivation and smoking behaviour among various age groups, both sexes, and across ethnic groups has been explored in detail in *Deprivation and Health* (Salmond & Crampton, 2000); in *Socioeconomic deprivation and ethnicity are both important for anti-tobacco*

health promotion (Crampton et al., 2000b); and, most recently, in *A decade of tobacco control efforts in New Zealand (1996-2006): impacts on inequalities in census-derived smoking prevalence* (Salmond et al., 2012a).

Mapping

The authors are not GIS experts. Nevertheless tools are available within SAS to enable us to map the NZDep index as a simplified illustration of the visualisation possibilities. Details of the mapping procedures used for the *Atlas of Socioeconomic Deprivation in New Zealand: NZdep2006* (White et al., 2008) are given therein. For coloured mapping purposes, quintiles of NZDep2013 are shown instead of deciles.

Three maps are shown on the following pages. The first two show the quintiles for the North and South Islands in five shades of orange. The white areas, for which there are no NZDep2013 data, consist of (a) waterways, estuaries, lakes, and so on, plus 109 empty meshblocks; and (b) 112 meshblocks having NZDep data withheld. In the third map below these areas are shown more explicitly where the former white areas are coloured cyan if (a) applies, and purple where (b) is relevant.

The total population of the 221 inhabited meshblocks for which there are no NZDep2013 data, or for which the data are withheld, is 1,059 (random rounded).

NZDep2013 Quintiles

quintile 1 (least deprived)
quintile 2
quintile 3
quintile 4
quintile 5 (most deprived)
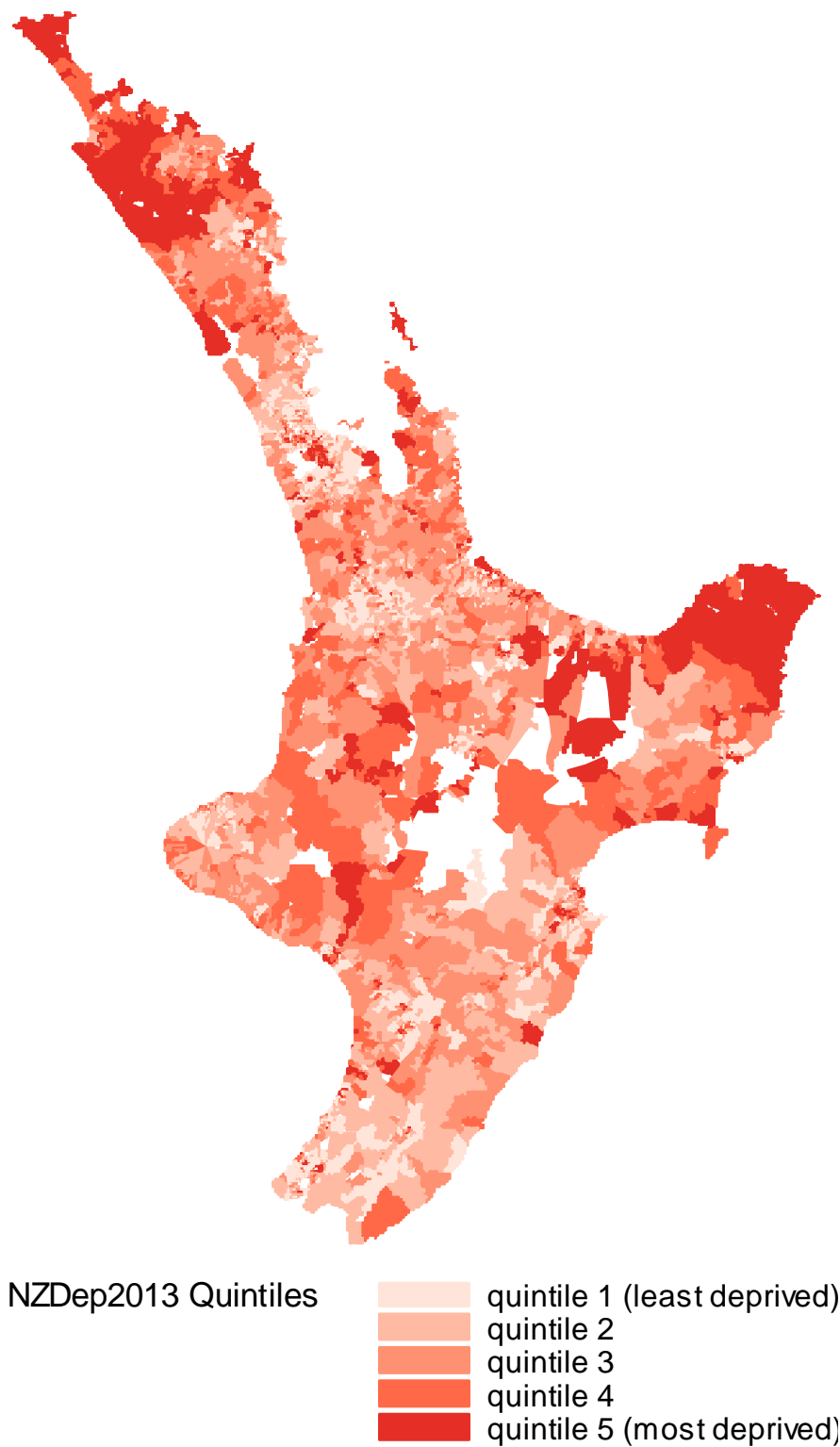
Figure 4: NZDep2013 distribution in the North Island of New Zealand

NZDep2013 Quintiles

- quintile 1 (least deprived)
- quintile 2
- quintile 3
- quintile 4
- quintile 5 (most deprived)
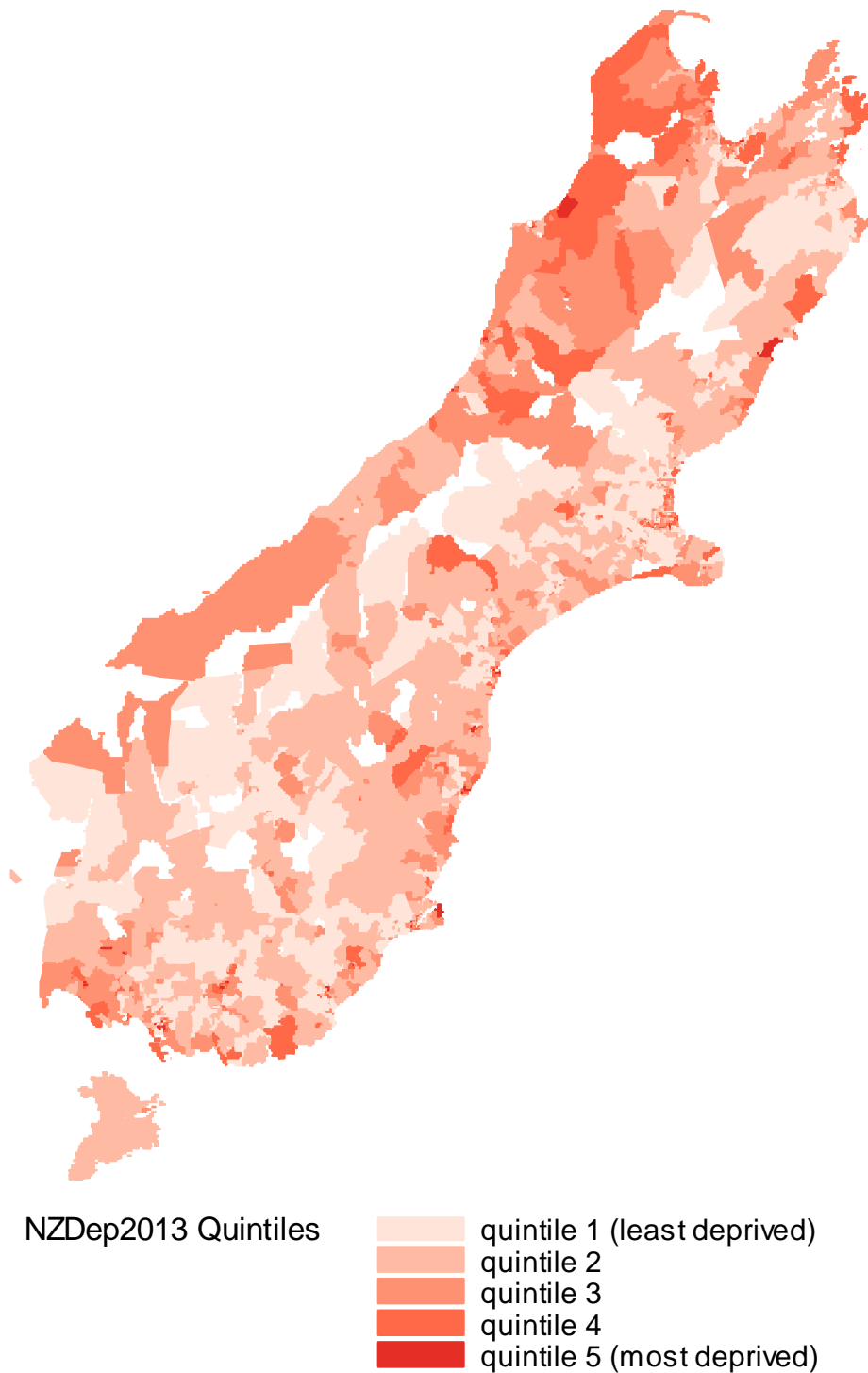
Figure 5: NZDep2013 distribution in the South Island of New Zealand

NZDep presence by MB

☐ NZDep2013 Value Produced
☐ NZDep2013 Value Withheld
☐ No Usual Resident Population

Figure 6: Areas of New Zealand for which there is no NZDep2013 information

Notes:

1. Meshblocks close to a shore line extend out into the 200-mile economic zone (approximately 320 kilometres). Generally, they have no usual residents.

2. The large purple area to the north and east of Auckland also includes this economic zone extension. It is very sparsely populated.

Glossary of terms and abbreviations

Agglomeration   Combining areas that are geographically connected.

CAU   Census Area Units are administrative areas defined by Statistics New Zealand. They are also called Area Units.

Deprivation   Deprivation is a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs (Townsend, 1987).
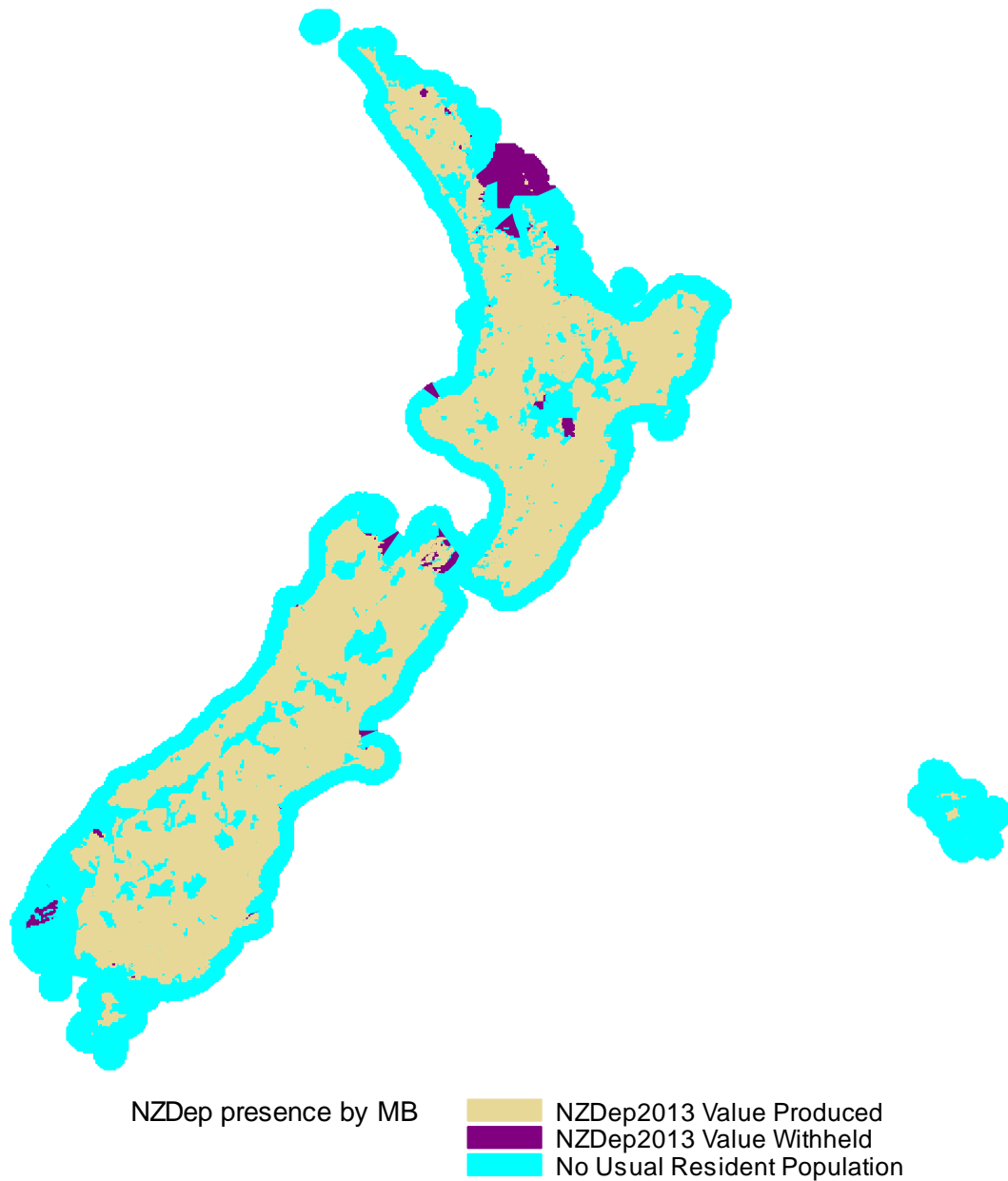
Townsend distinguishes between material and social deprivation. Material refers to material apparatus, goods, services, resources, amenities and physical environment and location of life. Social refers to the roles, relationships, functions, customs, rights and responsibilities of membership of society and its subgroups.

Meshblock   Meshblocks are the smallest administrative areas used by Statistics New Zealand. Meshblocks had a median population of approximately 81 persons in 2013.

NZDep2013 scale   A ten category ordinal scale from 1 (assigned to the 10% of NZDep2013 small areas with the least deprived NZDep2013 scores) to 10 (assigned to the 10% of NZDep2013 small areas with the most deprived NZDep2013 scores). (Note the wording to avoid 'reification'—see *Cautions, The indicator becomes the reality*.)

NZDep2013 score   The value for a small area is the score for the area on the first principal component. The distribution has mean 1000 and standard deviation 100. The distribution is skewed.

Ordinal scale	A measurement scale having a natural ordering, such as 'most' to 'least' deprived.
Principal components analysis	Principal components analysis is a method of multivariate analysis that is used to find a few combinations of variables, called components, that adequately explain the overall observed variation, and thus reduce the complexity of the data (Kirkwood, 1988).
PSU	Primary Sampling Units are small areas defined by Statistics New Zealand to be approximately 70 households.
SAS	SAS refers here to a statistical software suite used in the production of NZDep2013. The suite is a product of SAS Institute.
SNZ	Statistics New Zealand
Socioeconomic position	Socioeconomic position is a descriptive term for a person's position in society, which may be expressed on an ordinal scale using criteria such as income, educational level obtained, occupation, value of dwelling place, deprivation of area of residence, etc.
TA	Territorial Authorities are larger administrative areas defined by Statistics New Zealand.

Appendix one: Source populations

Data for NZDep are extracted from either individual forms or dwelling forms of the Census.

Individual form data

Eligible people are those usually resident in New Zealand, even if they are temporarily absent from their usual residence, but are elsewhere in New Zealand. Such 'visitors' will have on their individual forms two meshblock identifiers, 1) meshblock of residence on census night, and 2) meshblock of usual residence. Using the meshblock of usual residence as the identifier ensures that the entire usually resident population of New Zealand is included in the calculation of the following three variables: qualifications, unemployment, and income support.

Dwelling form data

Eligible people are all those living in private dwellings. This excludes people permanently or temporarily living in hospitals, nursing homes, prisons, retirement homes, welfare education or relief institutions, defence establishments, hotels, motels, guest houses, boarding houses, motor camps, construction camps, youth camps, staff quarters (e.g. nursing home, seasonal fruit pickers), vessels (except the navy), communes, marae, and others. Data for people living in non-private dwellings are not necessarily relevant; for example, housing tenure and occupancy are not salient characteristics for people in retirement homes. Also excluded are visitors to private dwellings.

In 2013, 0.6 percent of all occupied dwellings were non-private. Their residents account for the difference between denominators based on information in the individual and dwelling forms.

The six dwelling form variables are: household income, crowding, communication, vehicle, tenure and family type. The denominators for the proportions using these variables are people living in private dwellings.

Why do we use two different source populations?

The rationale for choosing the source populations was to maximise the amount of information incorporated into NZDep. Another option would have been to develop the index restricting both individual form data and dwelling form data to the usually resident population in private dwellings. This approach would have omitted information (related to the three non-dwelling variables) from individual forms from people living in non-private dwellings.

The denominator for rate calculations using NZDep could appropriately be the usually resident population, or the usually resident population in private dwellings. We recommend the former; in practice there will be very little difference.

Appendix two: Description of variables used in NZDep

Nine deprivation-related variables have been used to create NZDep2013. Seven are described below. The remaining two have already been described.

Access to the Internet; Household income

Access to the Internet at home, and being below a household income threshold are described under *Constructing the index*.

Unemployed

In the 2013 Census, taken on 5 March, unemployment is defined for all people aged 15 years and over who, during the week ended 3 March 2013, were without a paid job, were available for work, and had actively sought work in the past four weeks. For NZDep2013, the unemployed variable refers only to the 18 to 64 year age group.

Single parent families

The following are abbreviated versions of Statistics New Zealand definitions.

- A family consists of a couple (legal or de facto marriage) with or without children, or one parent with children (i.e. a brother and a sister is not a family).
- A household is a group of people who live together whether related or not.
- A dwelling is the physical structure occupied by a household.

If a three-generation family lives in a dwelling, Statistics New Zealand creates two families, *but each person is only counted once*.

Therefore:

- there may be more than one family per household (and therefore per dwelling); and

- the sum of occupants of households equals the sum of all people in families and all people not in families.

Our definition of the *proportion of single parent families* variable is: *people less than 65 in a single parent family with dependent children as a proportion of all people under 65.*

The denominator includes everyone aged less than 65 years (i.e. those considered to be at risk of being in a single parent family). This variable is restricted to those aged less than 65 years in order to avoid inflation of the denominator by large numbers of elderly people who are less likely to be in a single parent family.

No qualifications

The no qualifications variable refers only to the 18 to 64 year age group. No qualification indicates that no qualification has been obtained from a completed course of at least three months of full time study.

Dwellings not owner occupied

The housing tenure variable is: proportion of people in dwellings not owner occupied. Two categories of 'dwelling not owned by usual resident(s)' were used to capture not owner occupied. The third category, 'dwelling not owned by usual resident, who do not make rent payments', was treated as not specified since it was not possible to determine whether this represents an advantage or a disadvantage (for example, both a farm labourer and a multinational company executive could have accommodation provided rent free). In 2006, three further categories involving housing provided by Trusts were introduced as answer

options on the census form. For the purposes of NZDep it was considered that people living in such Trust accommodation are not deprived.

Access to car

This variable measures the proportion of people (children and adults) with no access to a car. Access to transport (cars) has relevance to children as well as adults.

Occupancy

Occupancy describes the relationship between housing space available and persons usually resident in the house. For deprivation purposes, the extreme of an occupancy scale is used. It is usually called overcrowding.

For NZDep2001 and NZDep2006 the Canadian National Occupancy Standard formula for calculating occupancy was used. This formula was considered to be a more precise way of capturing occupancy than the OECD formula used previously. The Canadian National Occupancy Standard sets the bedroom requirements of a household according to the following composition criteria (Statistics New Zealand, 1998, p.79):

- there should be no more than two people per bedroom;
- parents or couples share a bedroom;
- children under five years, either of the same or the opposite sex, may reasonably share a bedroom;
- children under 18 years of the same sex may reasonably share a bedroom;
- a child aged five to 17 years should not share a bedroom with one under five of the opposite sex;
- single adults 18 years and over and any unpaired children require a separate bedroom.

We have continued to use this definition in 2013. The data for 2013 are shown in Table 6.

Table 6: Crowding index

'Spare' bedrooms*	Percent (people)	Cumulative percent	
-10 to - 3	1.13	1.13	
- 2	2.15	3.28	*Deprived*
- 1	6.85	10.13	
....			
0	24.50	34.63	
+ 1	32.50	67.13	*Not deprived*
+ 2	23.88	91.01	
+3 to +13	8.99	100.00	

* Number of bedrooms under or over those required by the Canadian National Occupancy Standard.

Means tested benefit status

This variable is obtained for those people aged 18 to 64. Means tested benefits included in the NZDep2013 version of this variable are the same as in 2006: Sickness Benefit; Domestic Purposes Benefit; and Invalid's Benefit.

Most, but not all, government benefits are income-tested to some extent (personal communication, Ministry of Social Development, March 2002; re-confirmed 2006).

The New Zealand Superannuation or Veterans Pension category is not included in the NZDep means-tested benefit variable because New Zealand Superannuation is not income tested (apart for the relatively small number of people on Superannuation who have an 'underage' spouse), it does not reflect standard of living in the way the other means tested benefits do, and its strong correlation with age would influence results unduly.

The proportion of people on the Unemployment Benefit is not used, even though it is an income tested benefit, because unemployment is picked up in the unemployment variable.

The Student Allowance Benefit is income tested, but is not included in the means-tested benefit variable because it was considered that the majority of people on this benefit were probably not disadvantaged or socioeconomically deprived in the same way as those on the other means tested benefits.

The final group of benefits – other government benefits, government income support payments, war pensions, or paid parental leave – presented a new problem in 2006. The war pensions benefit is not income tested and applies to a relatively small number of people. The government benefit of paid parental leave, introduced in 2002, is also not income tested.

As for NZDep2006, the errors likely to be introduced by including income from the above 'other' benefits group into the means-tested benefit variable would be much the same as would be produced by excluding them. Since we do not wish to label people 'deprived' unnecessarily we excluded the 'other' benefits group from the list of means-tested benefits used in the production of NZDep2013.

Appendix three: Standardisation

Age and sex

All variables are related to age and sex to some extent. Therefore it was important to standardise for both age and sex, and compare the standardised indexes with non-age/sex standardised indexes. The resulting comparisons allowed investigation of the effect of age/sex standardisation on the ranking of small areas.

The options available for controlling for age and sex confounding were: age/sex standardisation; stratification; and, restriction. Age/sex standardisation was used with each variable.

Age/sex standardisation in five year age bands was not possible because of the problem of small numbers (small areas of about 100-200 people will not allow full age/sex standardisation). Therefore indirect standardisation was carried out using four age bands: 0-17; 18-39; 40-64; 65+. The youngest age group, 0-17, reflects non-voting status and, in general, dependency. The oldest age group, 65 and over, reflects the 2013 entitlement to state retirement income, and vulnerability to changing living arrangements, income levels, employment status, and health status. The remaining adults have been split into two groups of roughly equal size: 18-39 and 40-64.

Indirect standardisation

The purpose of standardisation is to remove the effects of age and sex, as far as possible, from our deprivation variables within each small area. Indirect standardisation of proportions was used, with the New Zealand population as the standard population. Indirect standardisation for age and sex was chosen due to

the small denominators in each small area observation (see Borman (1992) for further discussion of indirect standardisation).

The following formula was used as the basis for indirect standardisation of the variables.

$$\text{Standardised ratio} \quad = \quad \frac{\sum_{i=1}^{8} n_i}{\sum_{i=1}^{8} p_i R_i}$$

where: the subscript i refers to the age/sex member of the array

n is the number of people in the small area with the desired characteristic

p is the population 'at risk' in the small area

R is the rate of the characteristic in the standard (New Zealand) population

The result of the above calculation was multiplied by the overall New Zealand rate to create an age/sex adjusted proportion.

Non-responses were those records in which the value was recorded as 'not-specified'. The number of 'not-specifieds' was removed from the p and R denominators (and was automatically not included in the numerators). Thus the population at risk in any age/sex category (p_i) was the sum of those with, and those without, the characteristic.

The effect of standardisation is illustrated by the analysis of data in 2001, which showed that, overall, 11.1% of small areas at that time changed their decile rank by ± 1 when comparing indirectly standardised and raw deciles, with a further two small areas changing by 2, and one small area changing by 3.

Ethnicity

Ideally proportions should have been standardised by ethnicity (European, Maori, Pacific Island, other) as well as by age and sex. However, small numbers per ethnic group in NZDep small areas preclude standardising for this variable on top of age and sex. This is of no concern in funding formula applications since they treat ethnicity explicitly along with age and sex. Similarly, ethnicity can be included explicitly in any research application.

Appendix four: Methodological issues

Equivalisation

Equivalence scales are "measures of the relative incomes needed by different types of families to attain the same material standard of living" (Whiteford, 1983). Equivalised household income was used for calculating the income variable so that, for example, the standard of living of a household consisting of a single person with an income of $40,000 could be compared to that of a household consisting of two adults and six children on an income of $40,000.

The revised Jensen scale was chosen for use in the equivalised measures of income (Jensen, 1978; Jensen, 1988). A two adult family is used (arbitrarily) as the 'reference household' (expenditure = 1.0), and figures are given for different family configurations (up to six children). Hence, for example, to obtain an equivalent standard of living as a two adult family, a family comprised of two adults and two children would require 1.41 times the income of the two adult family.

Structural zeros

The research considered the implications of meshblocks with no one in certain age/sex groups.

Taking a meshblock with no one aged 65 or over in it as an example then proportions of those aged 65 or over with certain characteristics are mathematically not defined. In a SAS programme the proportion would be given a missing value. This, in turn, means that no principal component score could be calculated for this meshblock.

Conceptually, if there is no one in a meshblock aged 65 or over then the *meshblock* is not deprived from the point of view of, say, elderly people not living in their own home. Thus the proportion in the meshblock deprived in this way was *defined* to be zero. This allowed the meshblock to be allocated a meaningful principal component score.

Not specified

'Not specified' refers to census questions for which there was no response. Values for 'not specified' were not included in denominators for the input variables for the principal components analysis.

A simple modelling exercise carried out for the 1991 Census dataset indicated that there would be little to choose between including the 'not-specifieds' and excluding them. The bias when 'not-specifieds' are included is always negative, whereas the sign of the bias can vary when the 'not-specifieds' are left out.

Appendix five: Longitudinal analyses

Introduction

The NZDep2013 index of deprivation is the fifth census-based NZDep index to be produced (the earlier ones were NZDep91, NZDep96, NZDep2001 and NZDep2006). The first two were created one year apart in calendar time, and the second, NZDep96, was improved in two ways. First, we dropped two variables for theoretical reasons. Second we were able to include another deprivation variable into NZDep96 from a new question in the 1996 Census relating to whether people had access to a telephone or not. These changes—from ten variables in the 1991 version to nine variables in the 1996 version, eight of which were common to both indexes—mean that these indexes should be compared with caution. There are, in addition, technical reasons to be cautious (see below).

There are fewer obvious differences between the 1996 and 2001 versions of NZDep, or between the 2001 and 2006 versions. As noted earlier, however, the difference in 2013 is that the communication variable has been changed from access to a phone of any kind at home to access to the Internet at home.

We are aware that many researchers would like to use the index to inform longitudinal studies. We can distinguish two types of longitudinal study—those comparing areas over time, and those looking for changes in the relationship between deprivation and some other variable (e.g. mortality) over time.

Our conclusions are that:

1. **COMPARISONS OF AREAS as small as single meshblocks across time may not be meaningful. Comparisons of areas at a higher aggregation, such as Territorial Authorities, or Area Units, should be reasonable, although we advise caution in interpreting small changes over time as being practically meaningful.** See *Comparing areas over time* below.

2. **Comparing RELATIONSHIPS between deprivation and another variable, over time, is reasonable.** See *Comparing relationships with deprivation over time* below.

Note that each NZDep index of relative deprivation (NZDep91, NZDep96, NZDep2001, NZDep2006 and NZDep2013) divides the country into 10, where the highest value indicates the 10% of NZDep[*year*] small areas with the most deprived NZDep[*year*] scores. It is important to remember that *by definition 10% of small areas will always fall into the most deprived group*—irrespective of the absolute deprivation in those areas at that time, or the overall wealth of the country.

Comparing areas over time

Meshblocks can change deprivation values between any two censuses for both substantive and technical reasons.

1. Substantive reasons

    a) The local neighbourhood has changed in population size and/or characteristics through housing development—such as new subdivisions, or inner-city apartments created in disused office or warehouse space, or housing demolition.

    b) The local neighbourhood has changed in characteristics through changes in house ownership.

These changes may give rise to either or both of two consequences:

    a) the usually resident population size in the meshblock changes somewhat and the meshblock boundary remains unchanged; and/or

    b) the usually resident population size increases substantially and Statistics New Zealand splits the original meshblock into two (or more) new meshblocks. In this case the original seven-digit meshblock number is discontinued and new ones are created with the same first five digits. Thus the original meshblock number would end with the two digits '00'. If necessary, it is then split into (say) two meshblocks with the same first five digits and the endings '01' and '02', while the '00' number is discontinued. If, later, the '02' meshblock needs to be split, the '02' number is discontinued and (if it is again split in two) the numbers '03' and '04' are used.

These substantive changes can thus give rise to new meshblocks that are not readily comparable to old ones as well as to meshblocks that have 'legitimately' changed NZDep values through changes in population composition.

2. Technical reasons

   a) Small area definitions are not always identical from one Census to the next.

   Small areas are defined on the basis of the current usually resident population count, where meshblocks with usually resident populations under 100 are agglomerated (pooled) within Statistics New Zealand's internal Primary Sampling Unit (PSU) boundaries, if this is possible. PSUs usually contain one or two meshblocks, but may contain more (often with very small population counts).

   Our agglomeration algorithm creates small areas by pooling small meshblocks, if necessary, as they increase in population count, until the pooled group contains at least 100 people, if that is possible. On a second pass, working from smallest to largest small area, any remaining too-small areas are agglomerated with the next smallest area(s), again if this is possible within the PSU boundary. The resulting census-time-specific small-areas thus have the least number of constituent meshblocks consistent with the dual requirements of at least 100 people usually resident and boundaries within a single PSU. The result (in 2013) is over 23,000 small areas constructed from over 40,000 meshblocks.

   Thus the agglomeration procedure applied to different censuses inevitably changes the composition of some of the small-areas as a result of changes in the size of the New Zealand population and changes in the occupiers of individual homes.

   The NZDep index is created from proportions created for each small-area. Changed small-area boundaries may give rise to somewhat different constituent populations from which proportions are derived. This may result in changes in the final NZDep value for the constituent meshblocks for the small-area (which are each given the small-area NZDep value).

Such a change, therefore, may have more to do with the boundary changes for the small-area than any changed circumstances among the residents.

b) NZDep distributions may not be identical from one census to the next.

The base NZDep values are the scores on the first principal component of the correlation matrix of the nine component adjusted proportions. The following table, however, shows close agreement on the form of the 1996, 2001, 2006 and 2013 distributions. Each has been derived with a *mean* of 1000 and a *standard deviation* of 100.

Table 7: Comparison of the NZDep96, NZDep2001, NZDep2006 and NZDep2013 score distributions

Quantile *	NZDep96 score	NZDep2001 score	NZDep2006 score	NZDep2013 score
100% (most deprived)	1528	1521	1619	1549
99%	1315	1307	1320	1314
95%	1202	1199	1203	1203
90%	1140	1141	1138	1141
80%	1073	1075	1072	1074
70%	1032	1034	1030	1030
60%	1000	1002	999	1000
50% (median)	975	976	974	974
40%	954	953	953	954
30%	936	934	935	934
20%	917	916	918	917
10%	897	895	899	898
0% (least deprived)	830	834	838	833

 * The unit of analysis is the year-specific NZDep small area.

c) At least one of the nine component variables—the proportion below a household income threshold—is inevitably not identical from one Census to another.

Changes to the income categories in Census forms, due to changes in dollar values, give rise to changes in the household income variable, as this assumes the estimated median of the category as the income for the purpose of adding up incomes over family members. Household Economic Survey data for the year ending June 2011 have been used to estimate the medians. This gives rise to a finite number of possible family incomes, depending on the number of earners in the family and what each of them is estimated to earn. In turn, this yields a finite number of equivalised household incomes (that is, incomes adjusted to take account of the size and composition of the household). From the distribution of people within these categories we have to decide which of these finite values will be the threshold below which we will define a household, or people, to have a 'low' equivalised household income. The threshold of equivalised household income used in 1996 was 17,100 'equivalised dollars', which cut off 13.9 percent of *households*; in 2001 it was 17,700 'equivalised dollars', which cut off 15.0 percent of *people*. (The change from household to people is due to the fact that, in 2001, Statistics New Zealand staff provided the information in the raw data set of individuals, whereas, in 1996, the information was calculated in the data laboratory and the decision was made from a household file.) The change between 2001 and 2006 was slight as the threshold in 2006 cut off 14.96% of people. For 2013 the threshold cuts off 15.00% of people.

As a result of the inevitable changed proportions of individuals living in households below the equivalised income threshold, there has been a slight difference in information being added to the composite NZDep index, though this is very small in the last three indexes – and will have been swamped by changes in the underlying monetary value.

d) One further variable—crowding—was deliberately changed between the 1996 and 2001 censuses, but has remained consistent from 2001 to 2013.

The crowding definition used in the 1996 NZDep calculations was the OECD definition which counted the number of people in a household and the number of bedrooms available to it (see Urlich Cloher & Murphy, 1994). A ratio of more than one 'equivalent' person per bedroom was defined to be 'crowded' for the purposes of establishing the proportion of people in a small area living in 'crowded' accommodation. A person-equivalent was defined following Morrison (1994): children aged 10 years and over are equivalent to one adult; children aged under 10 years are equivalent to half an adult.

In the 2001 and subsequent indexes we have improved our indicator of crowding by using the Canadian definition (Statistics New Zealand, 1998, p.79) which allows couples and certain small children (on the basis of their ages and sexes) to share a bedroom (see *Occupancy* in *Appendix two*). This has resulted in a better performance for the indicator in the principal component analysis. Whereas the OECD-defined variable in 1996 had a weight of 0.228, which was the lowest of all the weights (range 0.228 – 0.363), the Canadian-defined variable in 2001 had a weight of 0.309, again the lowest, but in closer alignment with the other eight coefficients (range 0.312 – 0.361). In 2006, the weight was similar to 2001 (0.318), in close alignment with the other weights (range 0.311 – 0.371). In 2013, the weight is 0.303, again in close alignment with the other weights (range 0.286 – 0.372).

As a result of the change in crowding definition, there is a slight difference in information being added to the composite NZDep96 and NZDep2001 indexes, but not between the last three indexes, NZDep2001, NZDep2006 and NZDep2013.

Despite the above technical changes, it must be remembered that the purpose of pooling information from nine deprivation-related characteristics is to describe an underlying, but not directly measurable, axis identified as 'area deprivation'. We use the best information available

from each Census to define this axis. By using a reasonable number (nine or ten) of inter-related and measurable theoretical deprivation variables in a standard analytic procedure, we have attempted to define the *same* not-directly-measurable axis at each census-time. In that sense, the several NZDep indexes are comparable.

The index created along the small-area deprivation axis at a particular time is a relative one, separating one small-area from another relative to the overall distribution of deprivation at that time. In that sense, the several NZDep indexes are again comparable. However, not much weight should be given to a meshblock's small change in relative position over time. In practice the small change might easily be one decile point simply because the change in underlying score, although very small, crosses a decile boundary. Even changes of two decile points may not indicate a large change in underlying deprivation score if they are not at the extremes of the decile distribution (say, if they are within deciles 2, 3, 4, 5, 6, 7 and 8).

As a result of all of the above, we conclude:

COMPARISONS OF AREAS **as small as single meshblocks across time may not be meaningful. Comparisons of areas at a higher aggregation, such as Territorial Authorities, or Area Units, should be reasonable, although we advise caution in interpreting small changes over time as being practically meaningful.**

Comparing relationships with deprivation over time

It is reasonable to compare relationships between deprivation deciles and a given outcome over time, for the same aggregated area, using graphical approaches,

time series regressions, etc. The hypothetical data in the figure below illustrate how such comparisons might be undertaken graphically. Each of the bars represents people living in areas which are in nationally-defined deprivation deciles, and the nationally-defined deprivation deciles have a nearly consistent meaning, on a relative scale, regardless of time.
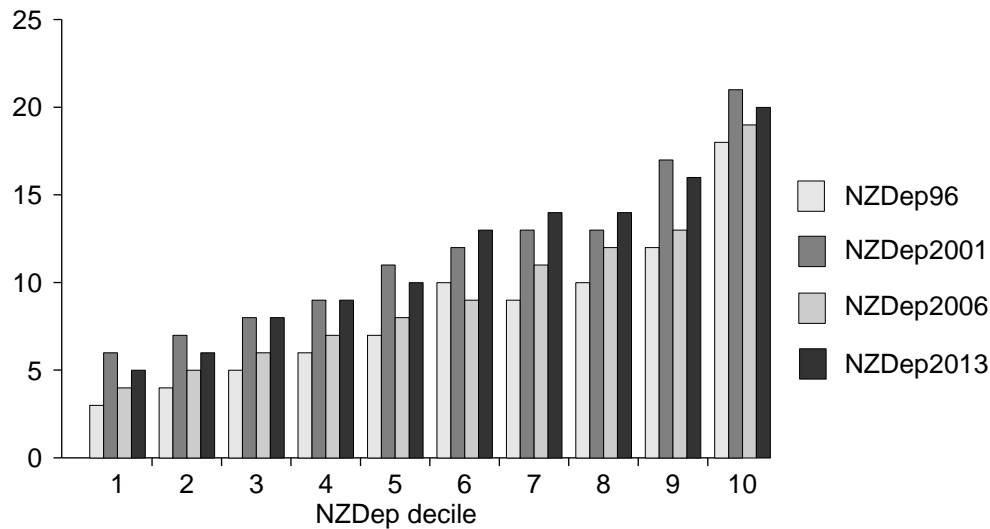

Figure 7: Comparing deprivation deciles over time using hypothetical outcome data

We conclude:

> **Comparing RELATIONSHIPS between deprivation and another variable, over time, is reasonable.**

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