Atlas of Socioeconomic Deprivation in New Zealand NZDep2006

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Foreword

Reducing inequalities in health is central to New Zealand's health strategy. The New Zealand Deprivation Index 2006 (NZDep2006) is essential for measuring socioeconomic differences in population health. This atlas will make the NZDep2006 index more accessible by presenting the index as a series of maps. Mapping is a powerful communication tool that enables people to make sense of data by revealing otherwise hidden patterns and trends in the spatial distribution of the underlying data. The atlas therefore serves as a geographical user interface allowing us to explore the diverse landscape of NZDep2006.

The 21 District Health Boards (DHBs) are at the centre of the delivery of health care in New Zealand, and NZDep is a critical tool in their funding and planning decision making. For example, the index is used extensively for monitoring inequalities across a range of health indicators, including hospitalisations, morbidity and mortality, and for needs-adjusted capitation funding.

Like its predecessors, the atlas NZDep2006 atlas will appeal to many different users and organisations. However, for the first time, the atlas is explicitly based on the DHB and Territorial Authority (TA) structure. The 73 TAs are included because, increasingly, DHBs are considering wider environmental and social factors as key determinants in the health and disability landscape. The inclusion of the TA boundaries allows the pattern of deprivation within and between TAs to be compared to the patterns within and between DHBs. Another first for the atlas is the inclusion of a CD containing the index and ready-to-use NZDep2006 maps that will improve the index's accessibility and boost its usability.

We hope the atlas and the data CD will be useful to you, and serve to stimulate practical research that is targeted towards the goals of improving population health and reducing health inequalities.

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Contents

List of Figures

List of Tables

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Clare Salmond BSc (Hons), MSc retired from her position as a senior lecturer in biostatistics in the Department of Public Health at the University of Otago, Wellington, in 2004, but has maintained her active association with the New Zealand Deprivation Index (NZDep) project. Clare has 35 years' experience working as a biostatistician at the Wellington Hospital Epidemiology Unit and at the University of Otago (in Dunedin and Wellington). She has published extensively in epidemiology and medical research.

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The authors are grateful for the continued financial support of the Ministry of Health. In particular, the authors thank Barry Borman, without whom the atlas would not have been possible.

The original NZDep91 project, on which NZDep2006 is based, was funded by the Health Research Council of New Zealand. Statistics New Zealand supports the NZDep project by providing data, access to the Data Laboratory and technical assistance. Much of the data and all of the maps in this atlas have been based, partially or wholly, on the high-quality national data sets Statistics New Zealand collects and maintains. Statistics New Zealand provided access to the data in this study in accordance with 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.

We are grateful to the co-authors of the previous two editions of the atlas (*Degrees of Deprivation in New Zealand: An atlas of socioeconomic difference*. Crampton et al 2000b; and, 2nd edition, Crampton et al 2004), for their valuable assistance, and in particular to Russell Kirkpatrick, who so ably produced all the maps therein.

We are especially grateful to David Bateman Ltd for permission to re-use and update descriptive information published in the second edition of *Degrees of Deprivation in New Zealand* (Crampton et al 2004).

The conceptual approach to mapping NZDep2006, together with the mapping style and atlas layout has been completely rethought and redesigned for this atlas. This has required much discussion and attention to detail, so the authors would like to thank Dyfed Thomas in PHI for his helpful comments during the initial stages of the atlas design and also Kylie Mason, Saira Dayal, Erin Holmes and Faith Roberts in PHI for their time and invaluable map proofreading skills.

The contents of this book have benefited considerably from the assistance of the authors' colleagues, but the responsibility for the book remains solely with the authors.

Overview

Purpose of this atlas

The purpose of the *Atlas of Socioeconomic Deprivation in New Zealand NZDep2006* is to reveal the socioeconomic landscape generated by the New Zealand Index of Deprivation 2006 (NZDep2006). This atlas provides a mapped version of NZDep2006, and updates the first and second editions of the deprivation atlas (Crampton et al 2000b; Crampton et al 2004). The term 'NZDep' is used throughout the atlas as a generic term to refer to the indexes of socioeconomic deprivation for 1991, 1996, 2001 and 2006 (respectively, NZDep91, NZDep96, NZDep2001 and NZDep2006).

Content of this atlas

The NZDep2006 atlas has four components:

- important background information about how NZDep is created and how to use the index
- the NZDep2006 maps
- tabular lists of NZDep scores
- a CD containing the index with and NZDep2006 maps of the 21 DHBs that are ready to use.

The first section of the atlas provides background information on the theory of deprivation, details concerning NZDep2006, the methods used to create this atlas, a brief discussion of the problem of confusing NZDep with the underlying reality, a discussion of ethical issues related to mapping NZDep, information about how to carry out longitudinal analyses that compare NZDep scores across different censuses, and information to assist in the interpretation of the maps. The second section of the atlas contains NZDep2006 maps by District Health Board (DHB) and Territorial Authority (TA). The third section provides Census Area Unit average deprivation scores for 2006, a concordance list of Census Area Unit names and numbers, and lists of DHBs and TAs with their numerical codes.

Most sections in the first part of this atlas are similar to those in the second edition but have been updated using 2006 information and graphs. All remaining sections are new to this edition, including the section 'Mapping the New Zealand Index of Deprivation 2006', which describes how the maps are laid out and discusses the assumptions underpinning the mapping and cartographic visualisation of the index, including pitfalls that can trap unwary map users.

In addition, for the first time, the atlas includes a CD containing the NZDep2006 index and NZDep2006 maps of the 21 DHBs for you to use. The spreadsheet format of the data ensures the data are immediately available for analysis, and the inclusion of meshblock and Census Area Unit identifiers makes the data easy to use in a Geographical Information System (GIS).

Background to this atlas

This atlas follows a long tradition among social researchers and geographers of mapping socioeconomic conditions. For example, in the late 1800s Charles Booth made coloured maps of inner London, with the colour scheme corresponding to seven socioeconomic categories. Black areas, were labelled 'Lowest class. Vicious, semi-criminal'. At the other end of the socioeconomic spectrum, yellow areas were labelled 'Upper-middle and Upper classes. Wealthy' (Jones 1966, p 174). It is noteworthy that Booth described people's wealth and social position using his notion of their behaviour; people living in poor parts of town were not merely poor, but 'vicious'.

A contemporary of Booth, B Seebohm Rowntree, carried out an influential study of poverty in the city of York published as *Poverty, A study of town life* (Rowntree 2000). His book contained a map coloured according to the following four socioeconomic categories.

- **Dark green:** 'The poorest districts of the city, comprising the slum areas. Some of the main streets in these districts are, however, of a better class.'
- **Yellow:** 'Districts inhabited by the working classes, but comprising a few houses where servants are kept.'

- **Brown:** 'The main business streets, consisting of shops and offices. Between these principal streets are many old and narrow lanes and courts.'
- **Light green:** 'Districts inhabited by the servant-keeping class.'

Clearly, in Rowntree's mind, the keeping of servants was an important characteristic distinguishing the rich from the poor.

Recent social atlases have tended to use more statistically based and less overtly judgmental ascriptions in their socioeconomic categorisations. *A Social Health Atlas of Australia* (Glover et al 1999) for instance, maps a range of census-derived variables to convey information on socioeconomic conditions in Australia. These variables include the proportion of dwellings rented from state housing authorities, the proportion of dwellings with no car, and the Australian Bureau of Statistic's Index of Relative Socio-Economic Disadvantage. Friesen and colleagues (2000), similarly, use a variety of socioeconomic variables in their social atlas of Auckland, *Mapping Change and Difference: A social atlas of Auckland*.

Construction of the New Zealand Index of Deprivation 2006

Since the 1980s there have been major changes in the way New Zealand society is organised and in the ways in which we view our communities. A wealth of data is available from censuses, surveys and research that describe some of the effects of these changes. This atlas presents information relating to one summary measure derived from the Statistics New Zealand 2006 Census of Population and Dwellings, the New Zealand Index of Deprivation 2006 (NZDep2006).

The index is constructed from nine Census 2006 variables, and provides a summary deprivation score from 1 to 10 for small areas. A score of 1 is allocated to the least deprived 10 percent of areas, and 10 is allocated to the most deprived 10 percent of areas. The methodology behind the construction of NZDep2006 is detailed in the section on the NZDep2006 index of deprivation.

The maps in this atlas portray the NZDep2006 scores as quintiles. The deciles have been collapsed into quintiles for cartographic purposes which are explained in the section on mapping NZDep2006.

The potential social benefits, and possible harms, of social atlases are discussed in the section on ethics. Suffice to say here that the current atlas aims to provide an accessible and easy-to-interpret profile of socioeconomic deprivation in New Zealand communities as measured by NZDep2006.

Audience for the atlas

NZDep is used in a wide variety of contexts as a tool for needs assessment, resource allocation, research and advocacy. The maps and data in this atlas are provided to assist social service planners in the health sector, central and local government, community groups, researchers and students in the measurement and interpretation of socioeconomic status as an important facet of communities.

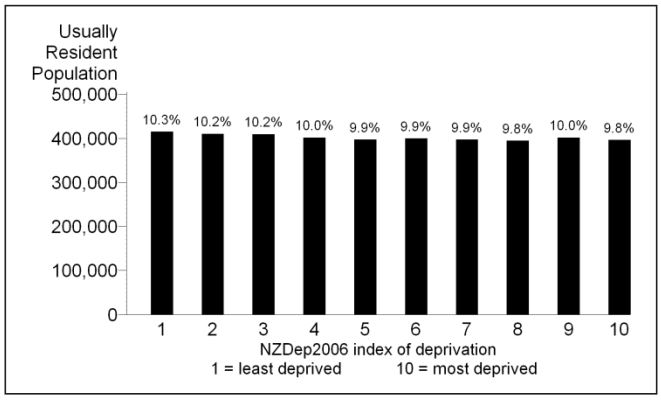
The atlas is not only a resource for those interested in the social geography of New Zealand communities, but it also aims to stimulate interest in the value and potential of social atlases. The concept of a social atlas, focusing on social, cultural and economic aspects of our society, is relatively undeveloped in New Zealand. As with its predecessors, the first and second editions of *Degrees of Deprivation in New Zealand* (Crampton et al 2000b; Crampton et al, 2004), and the *Contemporary Atlas New Zealand* (Kirkpatrick 1999) and *New Zealand Historical Atlas* (McKinnon et al 1997), this atlas takes a step towards providing such a resource. While this atlas describes socioeconomic deprivation, a need remains for a more comprehensive and in-depth social atlas that describes other facets of the social, cultural and economic fabric of New Zealand.

Visualising NZDep

Maps are a powerful means of conveying complex information in an easy-to-interpret manner. For example, the maps convey sociodemographic and geographical information in an integrated way, showing the interrelationships between NZDep, urban and rural divisions, population density, and so on.

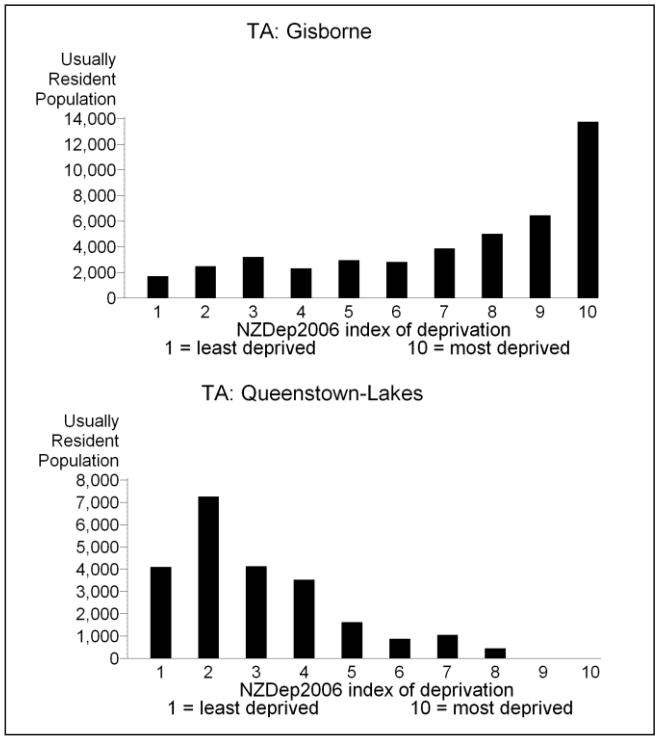
Mapping NZDep is, however, just one example of the index's use. Graphical depictions of deprivation are also a useful means of communicating otherwise complex information. For example, Figure 1 shows the NZDep profile for the usually resident population in New Zealand on census night in 2006. About 10 percent of the usually resident population lived in areas at each level of NZDep.

Figure 1: NZDep2006 profile of New Zealand



Not surprisingly, the deprivation profiles in different parts of New Zealand differ markedly from those shown in Figure 1. Figure 2 shows two contrasting deprivation profiles, one for the Gisborne District Territorial Authority and one for the Queenstown-Lakes District Territorial Authority.

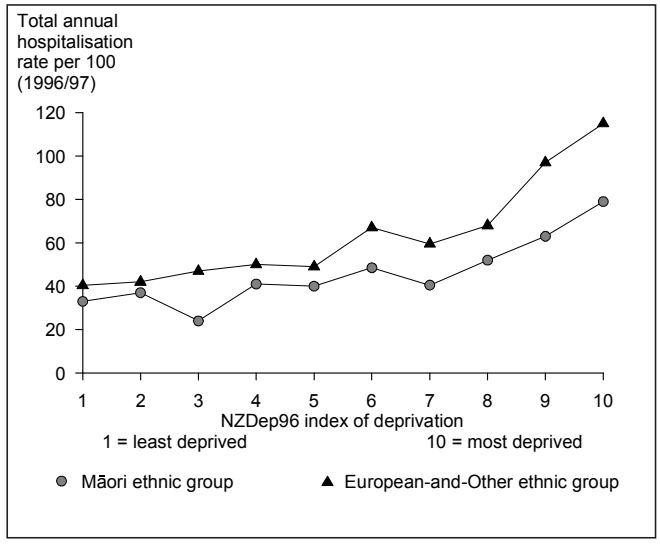
Figure 2: NZDep2006 profiles of the Gisborne District and Queenstown-Lakes District Territorial Authority districts



The Gisborne graph in Figure 2 illustrates a relatively socioeconomically deprived district, consisting predominantly of people who live in areas with low incomes and high unemployment. In contrast, the Queenstown-Lakes graph illustrates a relatively non-deprived district as measured by NZDep2006, populated by people who live mainly in areas with higher incomes and higher levels of employment than in Gisborne. Graphs such as these provide community groups, planners and researchers with valuable information about the composition and character of different areas.

The association between NZDep and other social factors can be illustrated by combining two variables in a graph. For example, Figure 3 shows the association between the rates of hospitalisation in public hospitals and the deprivation of the area of residence for male infants aged under one year, by ethnicity. This figure is based on NZDep96 and annualised hospitalisation data from 1996/97.

Figure 3: All-cause hospitalisations 1996/97 and NZDep96, males aged less than one year, by ethnicity

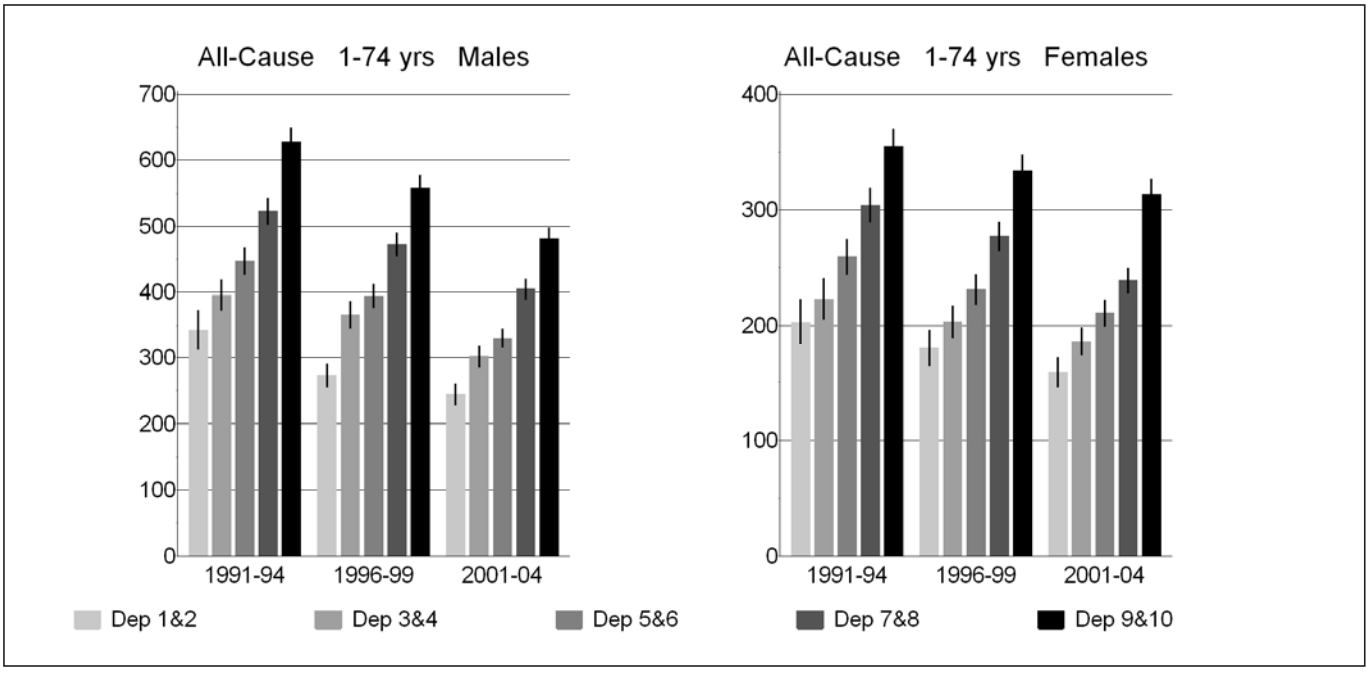


Source: Howden-Chapman and Tobias (2000).

Infancy (the period when a child is aged under one year) is a time of particular vulnerability. Figure 3 shows a strong, almost linear, relationship between NZDep and rates of all-cause hospitalisation for both the Māori and the European-and-Other ethnic groups.

In another example, national mortality rates show a strong and consistent increase as the deprivation of the area of residence increases (Figure 4). The data are taken from part of the New Zealand Census-Mortality Study (University of Otago 2007), and consist of three short duration cohort studies from the 1991, 1996, and 2001 census night populations aged 1–74 years, each followed up for mortality for three years. In each cohort, the probabilistic record linkage between the anonymous census data and administrative death data from the New Zealand Health Information Service was accomplished under secure conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975.

Figure 4: All-cause mortality rates per 100,000 (age and ethnicity-standardised), for 1–74-year-old males and females in three national cohorts, by NZDep91, NZDep96 or NZDep2001



Note: Dep = NZDep deciles, where 1 is least deprived and 10 is most deprived.

Source: The data are from the New Zealand Census-Mortality Study, see University of Otago (2007).

The data in Figure 4 are age and ethnicity-standardised to remove the known effects of these demographic variables from the associations. The 95 percent confidence intervals for each rate are shown as error bars in the graphs, and the NZDep2006 scale is presented in quintiles for clarity. For each cohort, the relationship between the relevant NZDep index – NZDep91, NZDep96 and NZDep2001 – and mortality in the following three years is striking, and points to a consistency in both the relationship and the indicator of deprivation.

Socioeconomic Deprivation

Socioeconomic deprivation provides one approach to conceptualising and measuring the broader construct of socioeconomic position. The term socioeconomic position is used here to mean 'the social and economic factors that influence what position(s) individuals and groups hold within the structure of society' (Lynch and Kaplan 2000, p 14). There are several theoretical and practical approaches to conceptualising and measuring socioeconomic position reflected in, for example, occupation-based and education-based socioeconomic measures.

Socioeconomic deprivation measures have been developed and used widely over the past four decades. While deprivation has to some extent underpinned conceptions of social class and socioeconomic status, area measures of deprivation represent a relatively new theoretical and practical approach to measuring the relative position of people in society (Townsend 1990). Compared with the large body of literature relating to practical and theoretical aspects of occupation-based measures of socioeconomic position, knowledge about deprivation is still expanding rapidly, and the theory relating to deprivation continues to be refined.

Two highly influential theoretical traditions are identified with respectively, Karl Marx and Max Weber. The former tradition, following Marx, focuses on structural features of capitalist economies, while the latter, Weberian, approach places more emphasis on individual characteristics and individual agency. The notion of socioeconomic deprivation may represent a move away from the Weberian emphasis on individual agency insofar as it marks a departure from measures of socioeconomic position based on a hierarchy of individual occupation, income or education. Socioeconomic deprivation places greater emphasis on two other important aspects of social stratification: material resources and, albeit to a lesser extent, structural features of society.

Socioeconomic deprivation reflects a 'neo-materialist' standpoint (emphasising relative rather than absolute material conditions). This takes the view that people have material, social, cultural and spiritual needs that are linked to the norms of their society and culture, and that it is possible to be deprived in one or more of these respects (although the separation of material and social factors is debated (eg, Muntaner 2004)).

Deprivation has been defined as 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). A distinction is drawn between material and social deprivation, where material deprivation involves the material apparatus, goods, services, resources, amenities and physical environment and location of life (Townsend 1987). Social deprivation involves the roles, relationships, functions, customs, rights and responsibilities of membership of society and its subgroups. While a primary distinction is made between material and social deprivation, subcategories of both concepts have also been distinguished (Townsend 1993, p 82). As a result, some people may be thought of as experiencing multiple deprivations and others as experiencing only a single form of deprivation.

From a structural perspective, individual characteristics such as education and income are determined by broader social factors that in turn provide the primary route for social policy interventions. The Weberian tradition has exerted a strong influence in the social sciences and epidemiology, expressed through the widespread use of individual characteristics such as occupation and income as measures of socioeconomic position. One of the effects of this emphasis on individual characteristics may be the implication that the solution to social inequalities is to be found in individuals' behaviour rather than in addressing – in Marxian terms – exploitative economic and social relations structurally embedded in society. This difference in emphasis is

important insofar as structurally mediated solutions to social inequalities are generally, and inherently, more radical than individually mediated solutions that tend to focus on incremental alterations to the status quo.

Area-based measures of deprivation, although mainly aggregates of individual characteristics, move towards reflecting structural elements related to area and community – that is, they are more likely to reflect aspects of the physical and social infrastructure of communities than are single variable individual measures such as income. However, area-based measures of deprivation clearly fall short of including the more fundamental structural features of society that determine social position, such as exploitative economic and social relations.

Lynch and Kaplan (2000, p 20) describe a hybrid Marxian–Weberian view that serves as a useful theoretical starting point for understanding the concept of socioeconomic deprivation.

The social and structural relations between groups in any particular society have a broadly defined material basis that is determined by a group's access to productivity in relationship to the economy. This relationship is characterised by the group's effective control of resources. Exercise of this control exploits, dominates, alienates, and excludes other less advantaged groups.

The above theoretical statement emphasises the material basis for defining and describing the social and structural relations between groups in society – it is this material basis that the concept of socioeconomic deprivation most clearly taps into. The statement then links this material basis with an individual's or group's relations to the means of production; that is, in Marxist terms, material resources are determined (in part at least) by one's access to the productive economy (via capital or labour).

Area Measures of Deprivation

Although studies of socioeconomic deprivation were commonplace in the 19th century, much of the modern scientific and statistical work on area measures of deprivation was first carried out during the 1970s, 1980s and 1990s, for the purposes of research, planning and resource allocation (Liberatos et al 1988; Townsend 1993).

Area-based classifications have been developed largely in order to make summary measures available in circumstances where information is otherwise hard to collect or unavailable. Area-based measures of deprivation have been developed in the United Kingdom and United States (Carstairs 1995; Krieger et al 1997; Kunst and Mackenbach 1995; Liberatos et al 1988; Morris and Carstairs 1991). Area-based indices have also been developed in Australia and New Zealand (Castles 1994; Crampton et al 1997a; McLennan 1990; Reinken et al 1985).

Measures of material and social deprivation

Most area measures of deprivation have focused on measuring material deprivation, mainly because of the existence of suitable variables in routine data sets. United Kingdom area measures of deprivation have generally not included direct measures of income, due to its non-availability in census data sets (Rose and O'Reilly 1997, p 117). However, it is increasingly recognised that social aspects of deprivation are just as influential in relation to health status as are material aspects of deprivation (Macintyre et al 2002; Morris and Carstairs 1991).

Variables included in area measures of deprivation can be further classified into two groups: demographic and deprivation variables (Crampton et al 1997b). Demographic variables such as age, sex and ethnicity are not directly amenable to change or influence, but may be associated with increased risk of deprivation. Deprivation variables are more direct markers of deprivation, for example, income, housing occupancy and access to a telephone. Several researchers have argued that demographic variables should be excluded from area measures of deprivation as they are not direct markers of deprivation (Crampton et al 1997b; Morris and Carstairs 1991; Townsend 1990). Demographic variables are not included in the NZDep index of deprivation.

Associations between socioeconomic deprivation and outcomes

The use of area measures of deprivation assumes associations between socioeconomic deprivation and outcomes at various levels (eg, individual, family and neighbourhood) and allows different levels of association to be explored (Macintyre et al 2002). For example, at the area level, deprived neighbourhoods may adversely affect health outcomes for individuals living in those neighbourhoods and, at the individual level, deprived individuals are more likely to suffer poor health outcomes than are less deprived individuals. An increasing number of studies are examining these multiple levels of association (see, for example, Anderson et al (1997), Duncan et al (1999), Kleinschmidt et al (1995), Reijneveld (1998), Shouls et al (1996), and Davey Smith (1998)).

Weaknesses of area measures of deprivation

Possible weaknesses of area measures of deprivation include their complexity, vulnerability to the selection of census variables, inconsistent statistical methods, measurement error when applied to individuals, ecological fallacy problems, spatial autocorrelation when used in ecological studies (Lorant et al, 2001), statistical limitations of small area aggregate data, and the interval between censuses (Crampton and Laugesen 1995). Possible weaknesses of particular relevance are described below.

Complexity

Whereas area measures of deprivation may be easy to understand (usually as ordinal scales such as lowest to highest), the methods used to derive them can be complex. Similarly, the selection of variables for inclusion

in area measures, and the statistical techniques for their transformation, vary considerably between different measures (Carr-Hill 1988; Crampton and Laugesen 1995; Morris and Carstairs 1991), and so may lead to confusion regarding the choice of measure.

Measurement error

Measurement error inevitably occurs when area-based measures of socioeconomic position are applied to individuals, because not all people in deprived areas are deprived, and not all socioeconomically deprived people live in deprived areas (Blakely and Pearce 2002; McLoone 2001). For example, NZDep96 has been shown to be only weakly correlated with an individual deprivation index (Salmond and Crampton 2001; Salmond and Crampton 2002). The effect of this measurement error generally reduces the strength of observed associations between socioeconomic position and health outcomes. However, researchers have found that the use of small spatial areas, such as meshblocks, diminishes the extent of measurement error (Crayford et al 1995; Hyndman et al 1995).

Small area census data

Concerns have been raised about the use of census data from small areas (Morphet 1992). First, small denominators may lead to spurious high proportions. Secondly, random variation between small areas may limit the representativeness of small-area data. Clearly, care must be taken in the interpretation of studies using small area measures of deprivation; strength and consistency of associations are important in confirming the validity of results.

Summary

In summary, deprivation of area of residence is increasingly recognised as a salient predictor of life chances (Krieger 1992; Krieger et al 1997; Macintyre et al 1993). Although there has been much debate concerning the choice of variables and their weighting, and the selection of statistical techniques, there is general agreement that area measures of deprivation provide powerful means of measuring variations in health status (Curtis 1990; Gilthorpe 1995; Gordon 1995; Lynch and Kaplan 2000, p 28; Morris and Carstairs 1991; Reading et al 1994; Townsend 1993).

NZDep2006 Index of Deprivation

Description of the index

NZDep2006 describes the deprivation experienced by groups of people in small areas. Its methodology is based on its predecessors, NZDep91, NZDep96 and NZDep2001, and was created from data from the Statistics New Zealand 2006 Census of Population and Dwellings.

The small areas used to create the index were unique to the deprivation project (NZDep2006 small areas). The building blocks for these small areas are standard Statistics New Zealand meshblocks. In a city, these are roughly a block in size. Where necessary and possible, geographically connected meshblocks within slightly larger Statistics New Zealand boundaries were pooled to create NZDep2006 small areas, each with a usually resident population of at least 100 people.

There are 23,786 NZDep2006 small areas compared with 41,376 meshblocks. The impact this aggregation has with respect to mapping NZDep2006 is discussed in the section on mapping NZDep2006.

Variables used to construct the index

The index is constructed from nine variables, reflecting eight types of deprivation. All are similar to the variables used in the three previous indexes. The variables, in decreasing importance in NZDep2006, are summarised in Table 1.

Calculating NZDep

The NZDep2006 continuous score is a weighted sum of the nine variables created using a principal components analysis. This statistical method identifies weighted sums of variables that progressively account for the overall variation in the data.

The NZDep2006 index is the first principal component scaled to have a mean of 1000 index points and standard deviation of 100 index points. The index is the weighted sum of the variables that accounts for the most variation. Each variable in the sum is a proportion of people in a small area. Each proportion is standardised in eight age–gender groups (0–17 years, 18–39 years,

Table 1: Description of the nine variables, in decreasing importance, used to construct the New Zealand Index of Deprivation 2006

Deprivation domain	Census variables
Income	aged 18–64[a] years receiving a means-tested benefit
Income	living in households with equivalised[b] income below an income threshold
Owned home	not living in own home
Support	aged under 65 years living in a single-parent family
Employment	aged 18–64 years and unemployed
Qualifications	aged 18–64 years and without any qualifications
Living space	living in households below an equivalised[b] bedroom occupancy threshold
Communication	with no access to a telephone
Transport	with no access to a car

Notes

a The upper age boundary of 65 years was increased from the earlier value of 60 years, where relevant, to better reflect societal norms in 2006 (and after extensive evaluation of the minor differences this change caused).

b Equivalisation is a method to control for household composition. In this way, for example, the standard of living of a single person with an income of $40,000 can be compared with the standard of living of a household consisting of two adults and three children on an income of $40,000. The census income groups vary between censuses, therefore the income thresholds for each index also vary.

40–64 years, 65 years and over, for each gender) to the New Zealand population structure. This equivalises the small areas, so that some areas cannot be considered more deprived than others simply because their populations have different age structures. For example, a small area with a high proportion of young families is likely to have a low number living in their own home simply because the parents are young, whereas another area with a high proportion of older adults is likely to have a greater proportion living in their own home. This distinction between the areas is, therefore, partly attributable to their different age structures.

The NZDep2006 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 small area is in the most deprived 10 percent of small areas in New Zealand as measured by the index. Each meshblock in a small area is given the NZDep2006 value of the small area.

In this atlas, the 10-point NZDep2006 scale has been reduced to a five-point scale (quintiles). That is, NZDep2006 values 1 and 2 are combined into the first quintile, which indicates the least deprived 20 percent of small areas, and so on, until the NZDep2006 values 9 and 10 are combined into the fifth quintile, or the most deprived 20 percent of small areas.

Validation of NZDep, does it measure small area deprivation?

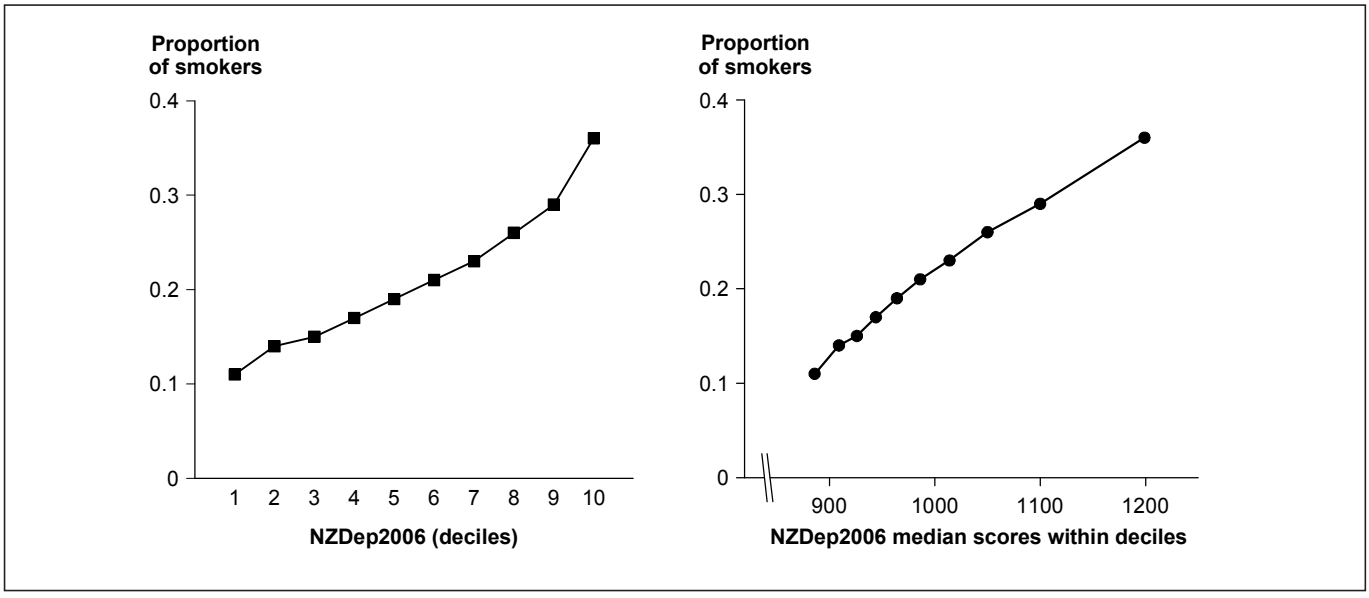
Health variables

The first two NZDep indexes, for 1991 and 1996, were extensively validated to confirm their usefulness. Validation answers the question: does the index accurately describe levels of deprivation in small areas? Scores were explored in several areas for which local knowledge was readily available, and no anomalies were detected. The indexes were then correlated with key health variables as a measure of criterion validity, since NZDep itself does not contain health information, and many researchers have found that socioeconomic deprivation, as measured by area-based composite indices, correlates with measures of health status (Crampton et al 1997a; Eames et al 1993; McLoone and Boddy 1994; Morris and Carstairs 1991).

The first index, NZDep91, was validated using mortality data, lung cancer registrations and hospital admission rates (Crampton et al 1997a). The similar NZDep96 index was validated using smoking data from the 1996 census, since smoking was known to be strongly correlated with socioeconomic factors (Benzeval et al, 1995; Marmot et al, 1991; Statistics New Zealand and Ministry of Health, 1993). More recent work shows that the strong relationship continues (Blakely and Wilson, 2005). As expected, the relationship between the proportion of people smoking in an area and the NZDep96 area ranking was striking: the more deprived the area, the larger the proportion of people who smoked (Crampton et al 2000c; Salmond et al 1998b).

The most recent census, in 2006, also included a question on smoking, so the opportunity was taken to validate NZDep2006 against smoking. As expected, there was a very strong relationship (Figure 5). The left-hand graph shows a slightly non-linear relationship between the proportion of smokers in areas defined by

Figure 5: Relationship between NZDep2006 and smoking



their NZDep2006 deciles, and increasing deprivation of those areas (as measured by NZDep2006). The right-hand graph shows an almost linear relationship when the median underlying NZDep2006 scores within each decile are plotted instead. This illustrates the slight loss in information that occurs when the NZDep2006 continuous scores are categorised into more convenient ordinal scales, such as deciles (the NZDep2006 index) or quintiles (mapped herein).

New Zealand research evidence demonstrates a strong association between NZDep and other health outcomes. Increasing NZDep scores are associated with increased total mortality, injury-related mortality, asthma prevalence in adults, sudden infant death syndrome, domestic fire deaths, and mortality due to causes amenable to medical treatment, including lung cancer, diabetes, rheumatic fever, ischaemic heart disease, pneumonia, chronic obstructive respiratory disease, asthma, peptic ulcer, alcoholic liver damage, complications of pregnancy and perinatal causes (Blakely et al 2002; Duncanson et al 2002; Jackson et al 1998; Ministry of Health 2008, 2004; Mitchell et al 2000; Salmond and Crampton 2000; Salmond et al 1999a; Salmond et al 1998a).

Environmental and lifestyle factors

In New Zealand, environmental factors, the quality of the water supply, aspects of lifestyle and disease risk factors are also patterned according to the level of NZDep. People living in areas with high NZDep scores are more likely to have their house close to a contaminated waste site (Salmond et al 1999b) and are more likely to have a risky drinking water supply (Hales et al 2002).

Analyses of the 1996/97 New Zealand Health Survey demonstrated increasing NZDep scores to be associated with increased smoking, high blood pressure, cardiovascular risk factors and diabetes (Ministry of Health 1999). Results from the 1997 National Nutrition Survey indicate that the greatest risk of inadequate intakes of vitamin A, riboflavin and folate are among those living in areas ranked as the most deprived by NZDep (Russell et al 1999). People living in those areas were also the most likely to express concern about 'household food security' – the ready availability of nutritionally adequate and safe foods, and the assured ability to acquire personally acceptable foods in a socially acceptable way (Parnell et al 2001).

Use of hospital services

There is strong New Zealand evidence related to the association between measures of area deprivation and the use of hospital services (Crampton et al 1997a; Hoskins 1990; Jackson et al 1998; Kydd et al 1991; Salmond and Crampton 2000). Increasing NZDep scores are associated with increasing total hospitalisations (Salmond and Crampton 2000), hospitalisations due to heart failure (Westbrooke et al 2001) and hospitalisations avoidable through good primary care or outpatient care, including hospitalisations for pneumonia, asthma, cellulitis, kidney infections, ruptured appendix, congestive heart failure, immunisable infections and diabetes (Jackson et al 1998).

Use of primary health care services

There is less published research related to area deprivation and use of primary health care services. However, while there is evidence that preventive services such as immunisation are not taken up as much by people in areas of high deprivation compared to those in low deprivation areas (Salmond et al 1998a), frequent use of general practitioner services is higher in the more deprived areas (Ministry of Health 1999).

Organisational aspects of primary health care, such as ownership and business arrangements (for example, for-profit or non-profit) and setting of patient fees, have also been found to be strongly influenced by the NZDep ranking of the area (Barnett 2000; Crampton et al 2000a).

Use of the index in local government planning

While NZDep has been used extensively in planning and health needs assessment (see, for example, Mitchell et al (2001a, 2001b, 2001c)), published deprivation research has not been confined to health matters. Local government planners have compared local districts at various geographical scales (see, for example, Rotorua District Council (1998), Hutt City Council (The Family Centre Social Policy Research Unit 1998), and Manukau City Council (1999)).

Interpretation of NZDep2006

It is important to remember that NZDep describes general socioeconomic deprivation in an area. It does not describe the deprivation of an individual. It is also a relative measure, essentially ranking all small areas of New Zealand from least deprived to most deprived.

This ranking is most obvious when considering the NZDep scale from 1 (the least deprived 10 percent of small areas) to 10 (the most deprived 10 percent of small areas). The ranked values from 1 to 10 divide the distribution of the underlying scores on the basis of the percentage of the small areas, as illustrated for NZDep2006 in Figure 6. Note that the distribution is skewed.

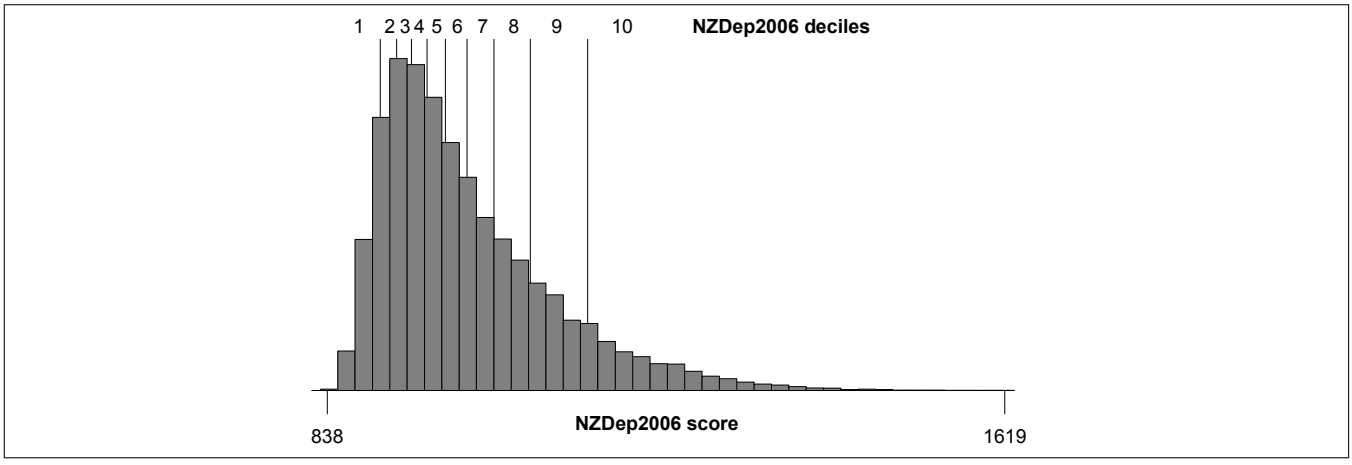
The NZDep value derived for any small area is assigned to each meshblock in that area. There may be one or two constituent meshblocks in small areas in densely populated areas, but several sparsely populated ones in rural areas. Therefore, a small group of meshblocks with, say, scores of 10, in a neighbourhood of interest may simply reflect a sparsely populated region, which has been pooled into one NZDep small area, that scored 10.

Note also that the size of a meshblock on a map is relative to geographical size, not population size. For example, large areas of dark orange with a single meshblock boundary indicate sparse populations; they do not indicate large numbers of people living in areas with high NZDep scores. These visual distortions are discussed in more detail in the mapping sections further on.

There are 493 meshblocks, mainly coastal or estuary, which in total contain very few people and were excluded from the derivation of the NZDep2006 index. For technical reasons these meshblocks could not be pooled with others to make small areas of sufficient population size. Additionally, in a few instances there was too little information from a small area to provide reliable values for input into the NZDep2006 index (more than one of the nine proportions was based on fewer than 20 people). These small areas contained 40 meshblocks. Their NZDep2006 values have, therefore, been withheld, and are shown as white areas on the maps.

Meshblocks can be combined into any desired area of interest, such as a city council area or a school catchment area. However, since the small geographical areas used in the construction and dissemination of the NZDep2006 index – NZDep2006 small areas and Statistics New Zealand meshblocks – vary in population size, deprivation information for the larger area should be a population-weighted average of the deprivation values of the constituent areas. This averaging should be done using the NZDep2006 score, not the 10-point scale. In this way, the full underlying information about deprivation in an area is used.

Figure 6: Distribution of NZDep2006 scores, with the NZDep2006 decile scale superimposed

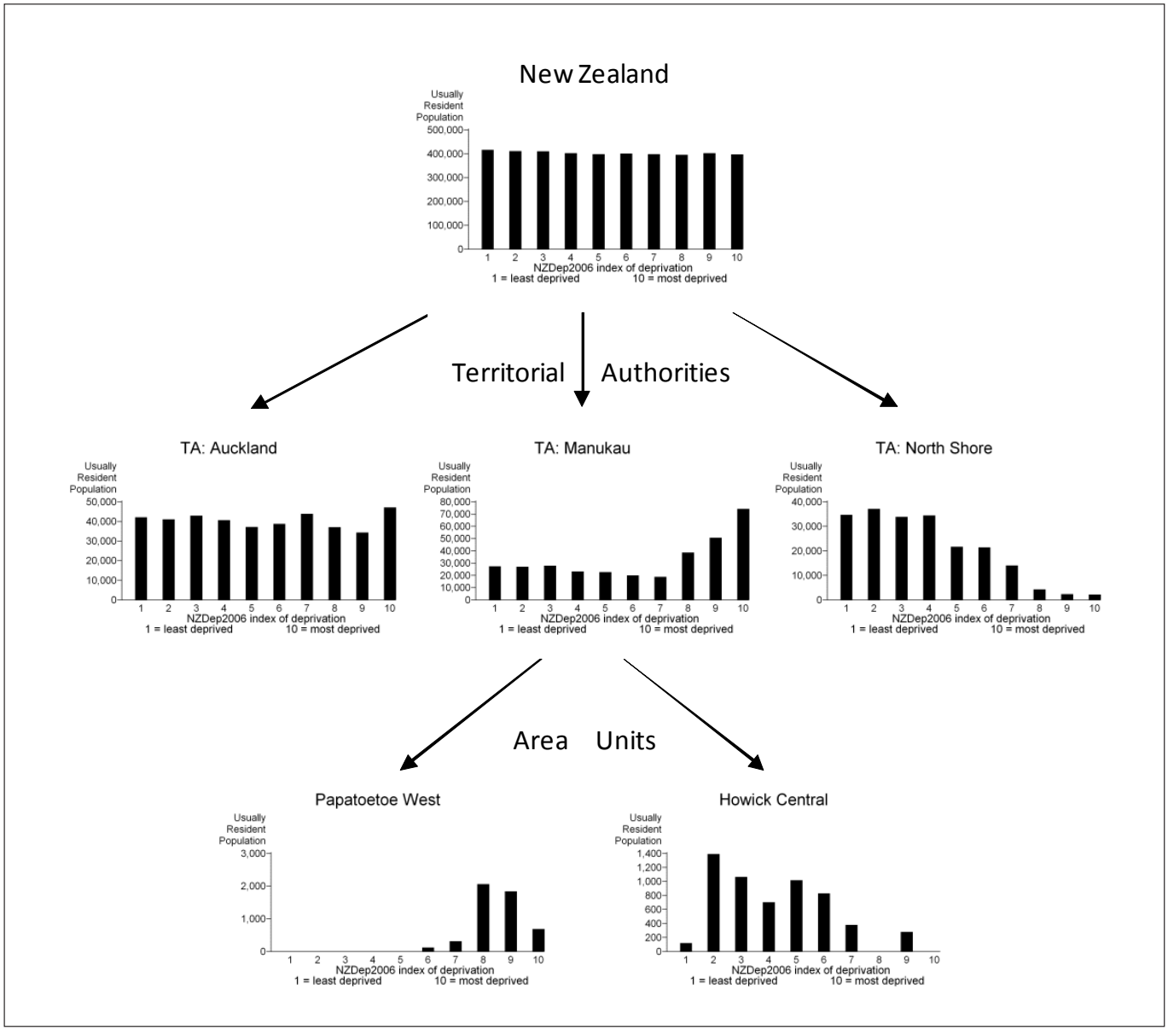


Social Variation within New Zealand Communities

It is important to note that 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 (TA) boundary is used for creating an NZDep profile, there may be relatively deprived and relatively non-deprived pockets within that TA. This point is illustrated in Figure 7, starting with the New Zealand population and then focusing on successively smaller areas.

As can be seen in the New Zealand NZDep profile at the top of Figure 7, there are approximately equal numbers of people in each NZDep category. When three territorial authorities in the Auckland area are compared, marked differences in their NZDep profiles are observed. Again, when two different area units from Manukau City are compared, there are clear differences in their NZDep profiles.

Figure 7: Variation in NZDep2006 profiles



Mapping NZDep2006

The majority of the atlas is taken up with the maps of NZDep2006. This section describes how the maps are laid out and discusses some of the pitfalls that can trap unwary map users.

Why map NZDep2006?

The aim of this atlas is to make NZDep2006 accessible. Mapping is a powerful communication tool. It helps us to make sense of data by allowing otherwise hidden patterns and trends in the spatial distribution of the underlying data to be revealed. These patterns and trends are seldom apparent in more traditional forms of graphical output such as graphs and tables. This is important because geography matters, and our health and our health care systems are driven by complex interactions with our environment. As a result, the geographical perspective has been a longstanding area of interdisciplinary health and social research (Curtis and Taket 1996, Gatrell 2002, Meade and Earickson 2000), providing insight and explanation, and also, through mapping, opening up data for others to interpret (Koch 2005). This atlas, therefore, serves as a geographical user interface to NZDep2006.

In creating the 2006 atlas, we have resisted the temptation to interpret the spatial patterns of NZDep2006. This is for you to do. Our job in producing this atlas has been to provide an objective, descriptive picture. What this picture means, is for you to decide. This is because, as the above sections outline, NZDep is a sophisticated model that aims to capture dimensions of the complex socioeconomic environment that shape our health and wellbeing. Elements contributing to the various landscapes of deprivation include demography, history and ethnicity. Consequently, it is simply beyond the scope of this atlas to interpret and explain what these patterns mean. Were we to do so, we would inevitably be providing an interpretation that is just one of many competing views of a complex landscape. Therefore, it is the purpose of this atlas to help stimulate debate by unravelling the spatial picture of deprivation across New Zealand, rather than by attempting to explain it.

Who is the NZDep2006 atlas for?

The NZDep2006 atlas will, like its predecessors, have wide appeal. Indeed, the geography of deprivation could be portrayed in many ways to meet the demands of the many different people and organisations that will use the index and find value in the atlas. However, unlike the first two editions of the atlas, this third edition has adopted the District Health Board (DHB) structure of New Zealand as the primary frame of reference for the maps. This is because the health sector will be one of the key users of NZDep2006. The 21 DHBs are at the centre of health care delivery in New Zealand, and NZDep is a critical tool in funding and planning decision-making. For example, every three years DHBs are required to undertake a health needs assessment. NZDep is used extensively in this assessment for monitoring inequalities across a range of health indicators, including hospitalisations, morbidity and mortality, and for needs-adjusted capitation funding.

Increasingly, DHBs are including wider environmental and social factors as key determinants of the health and disability landscape. Factors such as housing and land use are the responsibility of district councils, so the DHB maps in the atlas also includes Territorial Authority (TA) boundaries. Seventy of the 73 TAs (at the 2006 census) form a coterminous relationship with the DHBs. The three exceptions are Queenstown-Lakes District (in both Southland and Otago DHBs), Kapiti Coast District (in both Capital & Coast and MidCentral DHBs) and Ruapehu District (in both Waikato and MidCentral DHBs). The inclusion of the TA boundaries allows the pattern of deprivation within and between the 73 TAs to be compared in relation to the DHBs.

Visualising the population distribution across New Zealand

New Zealand had a population of 4,027,947 at the time of the 2006 census (usually resident population: Statistics New Zealand), with a low population density of 15 people per square kilometre. This compares to the United

Kingdom average population density of 244 people per square kilometre in a country of roughly similar size.

The New Zealand population is more than 85 percent urban (Statistics New Zealand). Consequently, most land in New Zealand is uninhabited and comprises large mountainous regions, lakes and rivers, areas of forestry, agricultural land, and national parks. This has important visual impacts when mapping population-based phenomena such as NZDep. Therefore, the first maps in the atlas aim to introduce the sparse population geography of New Zealand to provide important context within which to interpret the NZDep maps.

The first two maps provide a physical relief of New Zealand depicting the variations in height and the geographical distribution of physical features that are defining hall marks of New Zealand. Clearly evident in these maps are the Southern Alps forming the main divide running the length of the South Island. Across the Cook Strait, the mountains continue, extending from the southern tip of Wellington through the Central Plateau that dominates much of the central North Island, reaching to the west in Taranaki and extending northeast towards East Cape.

On the adjoining pages are maps of population density. The first population density maps are conventional choropleth maps, created by dividing the population within a meshblock by the meshblock land area. By dividing the total number of meshblocks into fifths (or quintiles) based on the population density, the distribution of the population is immediately apparent. Most of the map appears white, especially in the central North Island and nearly all of the South Island, representing the lowest level of population density in these mountainous and forested regions. It is only by zooming in to the relatively small populated areas, predominantly around the coast, that a higher degree of population density becomes apparent. A better reflection of population density is perceived in the following cartogram map.

Cartograms, or value-by-area maps (Dent 1999), resize the units used to create the map to reflect the magnitude of the data represented by the map (Dorling 1996). Consequently, the mapping units with high population density are made larger, and the areas with low population density are much smaller. These maps present a grossly distorted image and are challenging to interpret at first. However, the apparent difference in the geographic distribution of the population when compared to the choropleth maps becomes clear, with the main population centres more discernable.

The visual distortions in the cartograms arise from the units used to map NZDep2006. As with the previous editions of the atlas, NZDep2006 is created from aggregated census data and released at the small area census geography level, comprising meshblocks with a population of approximately 100 individuals and the larger Census Area Units (CAUs) of about 1,500 people. These two census geographies are continuous across New Zealand. Meshblocks (41,384 at the 2006 census) group together to form CAUs (1,919 at the 2006 census), that then group together to form TAs (73), DHBs (21) and public health services (PHS) (12). In most, but importantly not all instances, TAs form DHBs and DHBs form PHS.

The visual distortion due to population density appears in the cartograms described above because all meshblocks, and all CAUs are created to be approximately population equal. In urban areas with high population density the census mapping units are small, whereas in rural areas with much lower population density, the units are much larger. It is important, therefore, to bear in mind the physical and population density maps when viewing and interpreting the NZDep2006 maps.

NZDep2006 thematic map design

Maps are documents and have a language similar to structured text (MacEachren 1994; Robinson et al 1995; Kraak and Ormeling 1996). The message the map is delivering should be clear and not mislead or confuse. The map layout in the atlas has been designed to be as clear as possible, with the spatial distribution of NZDep2006 as the central focus. Equally, careful consideration has been given to the use of colour, font, symbols and composition in the contextual data that is included to help interpret the deprivation maps.

Following cartographic best practice for visual clarity and objectivity, the NZDep2006 atlas has broken with the style of the first two editions in two notable ways: First, by using a quintile thematic grouping, and secondly, by using a sequential monochromatic light-to-dark colour scheme. While NZDep2006 has been operationalised into deciles of meshblocks and CAUs, for mapping purposes a thematic range of 10 classes is beyond what is considered readily discernable by the human eye (MacEachren 1994). The principle aim of a map is visualisation so optimising visual acuity should be a central aim in designing the map

layout. A cartographic norm recommended for thematic maps is a minimum of four classes (Dent 1999) and no more than eight classes (Robinson et al 1995; Kraak and Ormeling 1996). Therefore, the original NZDep2006 decile score has been collapsed into quintiles, with each quintile created by adding the two sequential deciles together, so deciles 1 and 2 form quintile 1, deciles 3 and 4 form quintile 2, and so on. Similarly, the divergent red-green colour ranges of the first two editions of the atlas have been replaced with a sequential monochromatic orange scheme (from light for quintile 1 (least deprived) to dark for quintile 5 (most deprived)). This colour scheme more effectively shows the magnitude change and spatial variation of NZDep2006 across the quintiles (Robinson et al 1995; Bygott 1969). In addition, the sequential, monochromatic colour scheme is also suitable for viewers with colour-impaired vision (Brewer 2006).

Map layouts in the atlas

The mapped sections of the atlas are divided into the 21 DHBs, with each section laid out similarly. The title page for each section provides a quick reference map showing where in New Zealand the DHB is. In addition, the title page has some summary information including the DHB's population (the Statistics New Zealand census 2006 usually resident DHB population), the proportion of the population in urban areas (the Statistics New Zealand census 2006 usually resident meshblock population) and the population change between the census years 2001 to 2006 (again the Statistics New Zealand census 2006 usually resident meshblock population[1]). For ease of use each DHB mapped section in the atlas can be easily identified by the blue title page with the DHB name on the right-hand page margin.

Following the DHB title page map, the next section is a double-page spread. The left-hand page has charts showing the population in each of the five NZDep2006 quintiles. The top chart is for the DHB, with the charts below of the TAs within the DHB (where a TA crosses a DHB boundary, only that proportion of the TA population in the DHB is included). The right-hand page is a thematic map of NZDep2006 for the entire DHB. This map includes the names of the main population centres and TAs (with the TA boundaries in black, or black on grey where the TA boundary is also the DHB boundary). The DHB map also includes blue outlined boxes that indicate areas shown in greater detail on the succeeding pages. These maps form the bulk of the NZDep maps in the atlas. The areas mapped in detail represent the main population centres such as the cities and towns but also rural population settlements, and were selected where the detail of these areas cannot be easily seen on the main DHB map. As these maps vary in size from a large city to a smaller rural town they include state highways and other contextual information as a useful reference to orientate readers unfamiliar with the DHB. Each double page set of maps contains a map legend that shows the colour for each of the NZDep quintiles. For further information on reading the maps and the charts refer to the map symbology and the keys to interpreting the charts and maps that are on the pages immediately before the first DHB maps.

The detail maps also include the meshblock boundaries. However, it is important to note that these are for contextual reference only. The NZDep2006 index is created from aggregations of meshblocks; therefore the meshblock boundaries shown on the maps are not necessarily the NZDep2006 small areas used to calculate the index. Consequently, any apparent patterns of meshblocks of a similar NZDep quintile should be interpreted with caution, as they do not necessarily infer clustering. This is explained further below.

NZDep2006 data CD

For the first time, the atlas includes a CD containing data and NZDep2006 maps of the 21 DHBs ready for you to use. The data includes spreadsheets of both the meshblock and CAU NZDep2006 indices. The spreadsheet format ensures the data are immediately available for analysis. The inclusion of meshblock and CAU identifiers makes the data ready and easy to use in a Geographical Information System (GIS). Therefore, to encourage your own GIS exploration of NZDep2006 the corresponding meshblock and CAU digital boundary data are also included. These boundary files are in the propriety ESRI Shape file format for use with the ArcGIS suite of analytical and mapping tools.

Using NZDep2006 with GIS

Unlocking the spatial dimension of data has become more commonplace through the use of GIS to integrate geographically referenced data for mapping and analysis. Across the health sector, GIS are increasingly being used as they enable disease and health services data to be mapped and spatially analysed together with explanatory socioeconomic and environmental data. Using NZDep2006 geographically in this way will help to

1 Rounding causes a difference between the meshblock aggregated population total for a DHB and the total DHB population provided by Statistics New Zealand.

unmask hidden detail, enabling otherwise obscured relationships and explanatory potential hypotheses to be considered (White 2005).

The data contained on the CD when used within a GIS environment will allow users to exploit the rich potential of NZDep2006 more fully than is possible just with the atlas DHB maps. The inherent flexibility of GIS affords huge opportunities to create user-defined visualisations. These custom-made maps will enable users to explore the spatial landscape of NZDep2006 to meet their own needs. In this sense, the atlas is a starting point for users. Hopefully, it will stimulate ideas and encourage spatial thinking about the varying geographies of deprivation in New Zealand.

Reading the maps: Analytical errors inherent to mapping

As with all analytical techniques, important assumptions underpin the spatial aspects of NZDep relating to the census geography used to map, visualise and therefore interpret the index. These assumptions are compounded through the use of GIS (Murray and Shyy 2000). The availability of geocoded indices such as NZDep, and the ease of use of GIS are advantageous in terms of empowering a wider and more diverse range of users to undertake valuable health research. However, whilst the use of mapping and GIS in health is now commonplace, atlases such as this together with easy-to-use GIS have made potential errors arising from the age old geographic concerns of the ecological fallacy and the modifiable areal unit problem (MAUP) easier to make (White 2005).

The ecological fallacy

The ecological fallacy derives from ascribing to individuals the characteristics of a group (Green 1994). With respect to NZDep, this means inferring the meshblock and CAU index value to all individuals within that meshblock and CAU. This is similar to the problem of a statistical mean attempting to adequately describe the full variation of a range of data (White 2005). A large variation in a range of census data tends to exhibit extremes of census values that can result in misleading mapped visualisations (Dorling 1993).

The ecological fallacy can be demonstrated by considering a typical neighbourhood meshblock. Each neighbourhood will include people of varying occupations and levels of income that each represents different degrees of deprivation on the NZDep scale, for example quintiles 1 and 3. However, that meshblock can have only one NZDep score overall, and could therefore be classified as quintile 2, reflecting the average census data from all the people (who returned census forms) in that meshblock. In this case, neither of the individuals in quintiles 1 and 3 is accurately represented at the individual level. Therefore, it is important to remember that NZDep is a population indicator and not an individual-level indicator, with the meshblock NZDep value and quintile reflecting the population as a whole generally and not individuals specifically.

The problem at the core of the ecological fallacy is heterogeneity: the larger the aggregations of data, the more dissimilar in characteristics are the people represented. For example, 140 people in a meshblock are more likely to be similar in characteristics than are 1500 people in a CAU. However, dissimilarity occurs even at the meshblock level, and indeed at every level of aggregation.

In addition to size, administrative spatial units are vulnerable to the ecological fallacy, in this instance relating to the visual interpretations arising from the shape of the units. Shape has noticeable impacts on people's perception of census unit mapped data such as NZDep (Robinson et al 1995), although, as Openshaw and Rao (1995) observe, this is much less understood compared to the problem of areal unit size. As meshblocks are constructed for census administrative use, they are arbitrary in shape insofar as the current configuration is one realisation of many alternative forms (Morphet 1993). Meshblocks can, therefore, exhibit strange shapes that arise from the convenience of census enumeration.

The two problems of size and shape interact and can lead to visual distortions when mapping census unit data. Census units encompass residential and non-residential areas such as industrial or recreational land. These predominantly non-residential units will contain the smallest population counts, and it follows that these populations will also comprise very small areas of the unit. The resulting census unit is geographically large in comparison to its neighbours in an attempt to keep the population approximately equal. However when mapped, these large and irregularly shaped units have undue influence on perception by drawing the viewer to these least populated areas (Monmonier 1996; MacEachren 1994; Kraak and Ormeling 1996). This means that census unit maps are not visually equal as the least populated rural areas have greater visual dominance compared to the most populated urban areas.

The modifiable areal unit problem

The severity of the problem posed by ecological fallacy is, as Martin (1996a) notes, dependent on the way in which data are aggregated into different areal units for analysis. This leads to the second problem encountered in the spatial analysis of ecological data, the modifiable areal unit problem (MAUP). The MAUP relates to the way in which geographical space is partitioned for analysis, and in particular the size and shape of the areal partitions (Openshaw 1977, 1984).

Size or scale effects result from the differences in data patterns that become apparent as many smaller units of analysis are combined to form fewer but larger units of analysis, for example, meshblocks aggregated to form CAUs. This impacts NZDep. A CAU of, for example, 20 meshblocks representing a range of NZDep scores has to take a single quintile value, and so cannot represent the variability of NZDep across all 20 meshblocks. This is similar to the ecological fallacy problem of heterogeneity. However, unlike striving to solve the ecological fallacy by using smaller units to maximise homogeneity, the problem with the ever-changing patterns of the MAUP is understanding which size units are correct.

The second aspect of the MAUP, termed shape or zonation effects, results from the way in which the areal units are created. Differences in the patterns result as the areal unit boundaries are altered (Openshaw 1977; Green 1994; Flowerdew and Green 1994; Amrhein 1995). The overall distribution of data remains the same. However, localised distributions alter as local boundaries move, changing the shape of the individual zones within the study area. For example, a single meshblock of a neighbourhood experiencing population growth could, at the next census, become sufficiently large to need to be split into two meshblocks (in order to maintain the population threshold of approximately 140 people). The split to form the two new meshblocks could be made in several ways, with a particular street ending up in either one of the new meshblocks, according to how the boundary between the two is drawn.

The two aspects of the MAUP are similar to those discussed with regard to the ecological fallacy. However, unlike the data interpretation errors that were the concern of the ecological fallacy, here the problems of areal unit size and shape affect data counting. In the example above, the two new meshblocks are unlikely to have exactly the same size populations or population characteristics, with the variation between them dependent on the placement of the boundary. This could result in the NZDep value of the two meshblocks changing according to where the boundary bisects the neighbourhood. Unfortunately, even though the problems of inappropriate areal units for geographical analysis are well recognised, there are no clearly defined answers (Morphet 1993; Openshaw and Rao 1995; Martin and Higgs 1997).

The ecological fallacy and the modifiable areal unit problem in practice

The ecological fallacy and the MAUP directly affect interpretation of choropleth maps such as those illustrating NZDep2006. The visual assumption is made that all of a meshblock or CAU is uniformly populated (Robinson et al 1995; Kraak and Ormeling 1996), when in reality the distribution of the population is inconsistent and highly variable, accommodating industrial, agricultural, recreational as well as residential areas. However, the NZDep2006 maps do not show the varying population distribution, and instead suggest that a given meshblock is homogeneous. This leads to a further inherent assumption that, for example, the meshblock NZDep2006 quintile value changes abruptly at the boundary of the areal unit (Rase 2001). In practice, given that the boundary locations of meshblocks and CAUs are just one of many alternatives, such changes will not always occur.

These boundary impacts are directly relevant to mapping NZDep2006. To reach confidentiality thresholds, NZDep2006 is created from 23,786 NZDep2006 small areas. These small areas are aggregations of the 41,376 individual meshblocks for which census data are available. However, NZDep2006 is mapped by individual meshblocks and not by the NZDep2006 small areas. Given that the small areas are created from groups of meshblocks, with each constituent meshblock of a small area assigned the same NZDep2006 value, the resulting mapped pattern of meshblocks could appear clustered purely from this aggregation process. These apparent clusters are, of course, different from any 'real' clusters that may occur in areas where there are local concentrations of neighbourhoods (meshblocks) of similar NZDep values.

Consequently, it is prudent to exclude the meshblock boundaries in the NZDep2006 maps because including them can give an impression of clustering where none exists. In addition the meshblock boundaries implicitly describes a spatial framework (the 41,376 meshblocks) that does not reflect the actual framework used in

the creation of the index (the 23,786 NZDep2006 small areas). However, the meshblock boundaries do provide useful contextual information to help interpret the maps; for example, meshblock boundaries often follow geographical features such as roads and rivers, and provide some sense of the population distribution. Therefore the meshblock boundaries are included on the detail NZDep2006 maps that focus on populated areas, but are excluded from the DHB level maps.

Nevertheless, as the NZDep2006 mapping data is included on the CD accompanying the atlas, GIS users are encouraged to consider alternative mapping options. Population mapping frameworks such as the meshblocks used here that fail to identify or delineate non-populated from residential regions provide a false impression and are considered fundamentally flawed by some researchers (Martin 1989; Dorling 1993; White 2005). As a result there are compelling arguments to not use mapping units that strongly influence the visual interpretation of data (Martin 1996a). Equally compelling are arguments advocating alternative mapping formats for census unit data, including:

- population density cartograms (Dorling 1993, 1996)
- frame free or surface maps (Bracken 1994; Martin 1996b; Openshaw and Alvanides 2001)
- population delineation or Dasymetric mapping (Langford and Unwin 1994; Kraak and Ormeling 1996; Dent 1999; Martin et al 2000; Eicher and Brewer 2001)
- combinations of surface and Dasymetric methods (Bracken and Martin 1989; White 2005).

The aim of using these, perhaps less familiar, methods is to challenge our understanding of how we visualise geographic distributions, encourage critical thinking of mapped information, and through the increasing awareness of alternative forms of cartographic portrayal, understand more about the population data we are analysing. Combined, these methods are opening up new opportunities in the analysis, communication and understanding of health information by improving the visual acuity of the population data the maps are showing. As a result GIS users of NZDep2006 are encouraged to explore these alternative formats.

The problems posed by changing patterns and rates associated with the use of census administrative boundaries are endemic to all spatially aggregated data (Openshaw and Alvanides 2001). Ignoring the problem perpetuates the potential for misinterpretation of analytical results. Thus, the effects of areal unit size and shape cannot be ignored, with the impact of differing areal units as important as a potential source of error to interpreting mapped data as confounding and bias are to epidemiological studies (White et al 2008). As a result, anyone using mapped data such as NZDep2006 should explicitly consider the underlying spatial framework used to describe the spatial distribution. Therefore, it is important that users of the atlas read the enclosed maps critically. Remember, what you see is one version of many alternatives and is a product of the meshblock census framework used to create the maps.

Where to next with mapping NZDep?

Increasingly, digital formats are replacing traditional paper-based products. This is demonstrated to some extent by the inclusion of the CD with this atlas. Digital media such as the internet are far more cost-effective, more flexible in output, and reach a far wider audience than do traditional formats. This is important for an index such as NZDep2006 that is not confined to the DHB or even TA geography that this atlas implies. Increasingly, New Zealand's health sector is evolving to accommodate changes in health care delivery. This is demonstrated through the creation of Primary Health Organisations (PHOs) across New Zealand. The majority of health dollars are spent in primary health care; therefore as PHOs become more established, it is feasible that the focus for future editions of the NZDep atlas (from a health perspective) may shift from DHBs to PHOs. Alternatively, as there are many 'geographies' of deprivation in New Zealand, reflecting both the complex diversity underlying NZDep and the wide user base, it is equally possible that future editions of the atlas may require several different spatial realisations. Such competing needs can only readily be accommodated through the flexibility of digital media.

The interactive nature of internet mapping and GIS technologies affords opportunities to create user-defined visualisations. These custom made maps will open up NZDep by enabling users to explore the spatial landscape of NZDep to meet their own needs. Therefore, to remove the constraints of conventional paper-based mapping and meet the NZDep mapping needs of tomorrow, it is likely that future editions of the atlas will be digital and available online.

Cautions

The indicator becomes the reality (reification)

The potential problem of confusing the indicator, or measure, with the underlying phenomenon arises with all measures of socioeconomic position. The problem has its basis in the inability of any one socioeconomic indicator to capture all aspects of the complex social variable that it attempts to measure. Carr-Hill and Chalmers-Dixon (2002) discuss this:

> 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 they are using. Carr-Hill and Chalmers-Dixon (2002) give the following United Kingdom based example in relation to the DETR2000 index of socioeconomic deprivation:

> 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'.

Apparent simplicity

The NZDep deciles (ie, groups from 1 to 10) have been constructed, so they can be readily used in a variety of contexts. This simplicity should not be allowed to obscure the underlying complexity of construction, the limitation of components available from the census, and the underlying theoretical assumptions.

Ethical Issues

For centuries, maps have been used as a tool of colonisation and as a means of asserting power and control over others (Harley 1988). It is, therefore, not surprising that ethical issues arise when mapping a social characteristic such as socioeconomic deprivation that is emotionally and politically charged. Indeed, the term 'deprivation' itself is not without its problems – it can be interpreted as a stigmatising label. Two important ethical issues are discussed briefly here: the pseudo-scientific verity and 'objectivity' of the deprivation maps, and the risks of harming communities by visibly portraying them as 'deprived'.

The section ends with our justification for producing the maps. We hope, of course, that the maps result in positive social change, and benefit those communities that have suffered as a result of two decades of social and economic upheaval, or, in the case of Māori, over 160 years of social and economic upheaval. Nevertheless, it is also up to users of the maps to consider the ethical issues that are inherent in their use, and to satisfy themselves that the likely benefits outweigh the possible harms.

Ethical interpretation of maps: pseudo-scientific verity and objectivity

By pseudo-scientific verity, we mean that NZDep maps, through their use of national statistics, and by imposing on the landscape rigid boundaries and colours, convey a sense of objectivity and certainty that may be misleading. For example, as the mapping sections discuss, the maps suggest more homogeneity and clearer boundary definitions than exist in reality.

More importantly, the atlas presents socioeconomic information about areas, towns and cities in a seemingly value-neutral format. This 'objective' style is adopted in other contemporary social atlases, for example, *A Social Health Atlas of Australia (Glover et al 1999), Contemporary Atlas New Zealand* (Kirkpatrick 1999), and *Mapping Change and Difference: A social atlas of Auckland* (Frieson et al 2000). This (more recent) style represents a marked departure from the earlier approach taken by, for example, Booth and Rowntree (Rowntree 2000), who were unabashed in their use of frequently pejorative labels for the poor – in the late 1800s Booth referred to people living in the poorest areas of inner London as 'vicious and semi-criminal' (Jones 1966, p 174).

More recent social atlases, including this one, ostensibly present a more 'objective' picture of the socioeconomic landscape. Nevertheless, it is important to remember that any attempt to portray socioeconomic conditions is coloured by the preconceptions, judgements and particular worldview of the researchers and authors. As the previous section on mapping makes clear, the apparent 'objectivity' potentially sets a trap if the worldviews and judgements of the map-makers are not made explicit.

In this respect, atlases may be particularly vulnerable to uncritical interpretation if readers look only at the maps and not the accompanying text. For example, some earlier NZDep maps raised the charge of 'emotive cartography' – using colours for their emotive impact rather than the clear communication of data (they used divergent red and green to colour the deprivation scale, with red for the most deprived areas and green for the least). These colours created the perception, in some minds at least, that the maps inferred red is bad and green is good. This concern has been addressed in this version of the atlas through the use of a monochromatic, sequential, thematic shading scheme.

Risk of harming communities by portraying them as 'deprived'

The second ethical problem relates to the direct harms that might occur as a result of the maps highlighting the poor socioeconomic circumstances of communities. Individual communities may feel marginalised or stigmatised as a direct consequence of the labelling

effect of the maps. For example, 'dark orange areas are bad areas' could be a message derived from the maps. This message may inadvertently lead to further disinvestment or reluctance by businesses to move to, or invest in, these communities. People and communities may be marginalised in so many senses: in terms of their access to work and their means to earn an income; in terms of gender discrimination; in of terms racism; or because of where they live, and so on. The ethical problem posed here is that maps in this atlas may serve as a further means of marginalising communities.

Justification for creating the deprivation indexes and maps

Due to the ethical concerns discussed previously, it is necessary to state once again the purposes of creating both NZDep and the deprivation maps. These purposes, and the subsequent use of the indexes and maps, serve as our justification – we hope that the benefits more than compensate for the potential harms caused by the maps. The NZDep projects are, of course, not value-neutral. NZDep is informed by a public health action philosophy, incorporating, among other things, a commitment to a fair distribution of society's benefits and wealth and community mobilisation as a means of achieving social change. NZDep was created by health researchers with three specific purposes in mind: for use in resource allocation formulas; as a tool for community groups to advocate on behalf of their constituencies; and as a research tool. In short, it was created as a tool for public health action. It is in this respect that this edition of the atlas adopts DHBs as the mapping framework, but by including the data CD we implicitly recognise there is more than 'one deprivation landscape', so empowering users to explore alternative deprivation geographies.

An important, and perhaps more covert, aim of the maps was to introduce into policy and planning an easy way for people to see inequalities – to make more visible the socioeconomic divisions that characterise our society. Insofar as the maps have the capacity to shape people's understanding of our social fabric, they are intended to challenge policy makers and planners to see afresh the divisions in our socioeconomic landscape, and to 'de-normalise' our sometimes uncritical acceptance of these divisions. The most important inequalities have, in many respects, become so familiar to us that they are invisible. They have become normal features of our social landscape, and as such often fail to register. Our social radar screens are attuned to picking up abnormalities. However, as is clearly illustrated in publications such as *Hauora: Māori Standards of Health IV* (Robson and Harris 2007), inequalities are not abnormal in New Zealand; rather they are an aspect of the national landscape that we live with and, for the most part, tolerate.

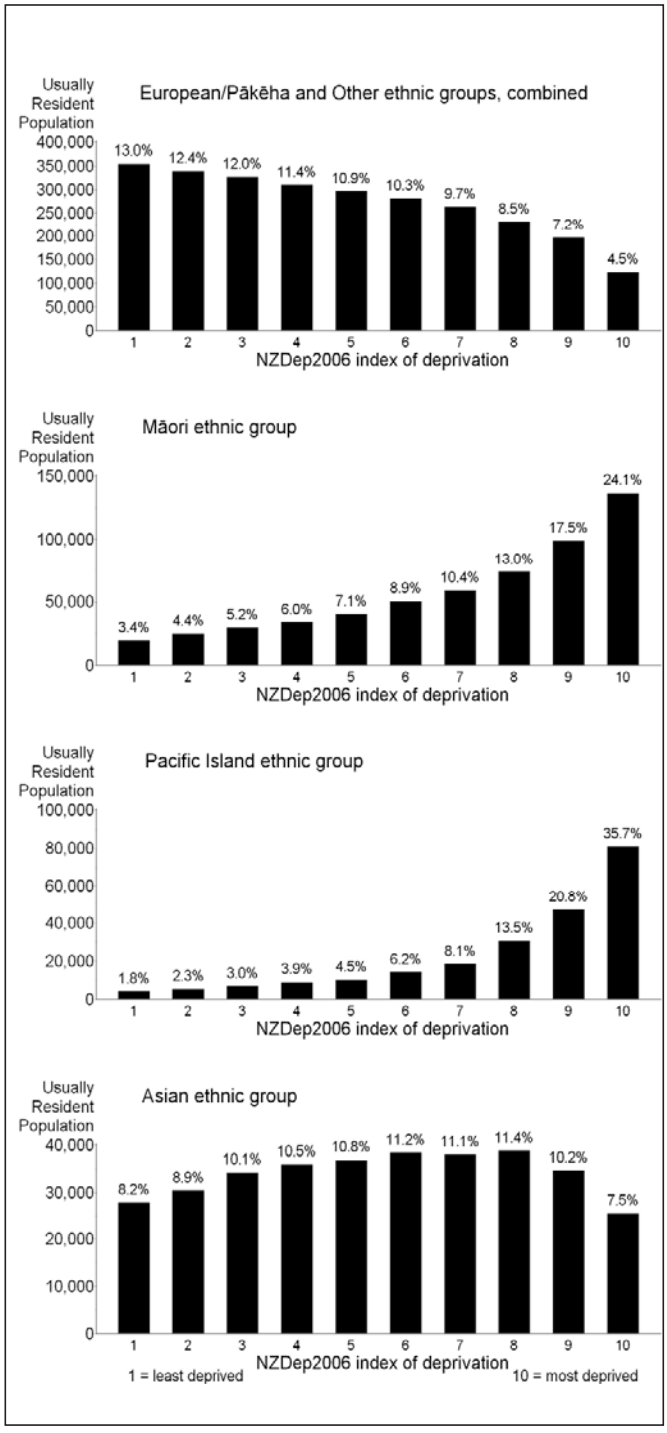
We hope that by putting marginalised communities at the centre of our frame of reference we can assist community mobilisation, the formulation of equity-promoting social policies and public health action. Indeed, we hope that the eyes of planners and policy makers are drawn to the 'dark orange areas' so that they become the focus of their attention. We hope also that the maps might succeed in challenging dominant ways of thinking and dominant discourses and power structures, and help to 'de-normalise' inequalities.

Deprivation and ethnicity

The New Zealand population consists of several ethnic groups. The distribution of NZDep2006 scores is not the same across these groups (see Figure 8). The NZDep2006 profiles of Māori and Pacific peoples are very different from the profiles of the overall New Zealand population, Asian people, and the combined European/Pākehā and (relatively small) Other ethnic groups.

Māori and Pacific peoples are disproportionately represented in the more deprived areas of the country (high NZDep2006 values). This highly unequal distribution of material and social resources across different ethnic groups has roots in New Zealand's colonial history and in its contemporary social structures. Some of the profound health and social consequences arising from the disparate resource base of Māori and Pākehā are described and discussed further by Pomare and others (1995), Durie (1998), Reid (2000), and Robson and Harris (2007).

Figure 8: NZDep2006 profile of New Zealand ethnic groups



Source: Census of Population and Dwellings 2006.

The data in Figure 8 are taken from the 2006 Census of Population and Dwellings. 'Ethnicity' refers to the self-identified ethnic group or groups that a person specified in their answer to the question 'Which ethnic group do you belong to? Mark the space or spaces which apply to you'. Using the hierarchical method of assigning ethnicity, each person was allocated to one of four ethnic groups on the basis of a priority order. The prioritised groups in Figure 8 were defined as follows.

1. The Māori ethnic group includes any person who indicated Māori as their only ethnic group or one of their ethnic groups (14.0 percent of the total New Zealand population in 2006).
2. The Pacific ethnic group includes any person who indicated a Pacific ethnic group as their only ethnic group or one of their ethnic groups. People who self-identified as both Māori and Pacific ethnicity were prioritised to the Māori ethnic group. The prioritised Pacific ethnic group comprised 5.6 percent of the total New Zealand population in 2006.
3. The Asian ethnic group includes any person who indicated an Asian ethnic group as their only ethnic group or one of their ethnic groups. People who self-identified as both Māori and Asian ethnicity were prioritised to the Māori ethnic group, while people who self-identified as both Pacific and Asian ethnicity were prioritised to the Pacific ethnic group. The prioritised Asian ethnic group comprised 8.5 percent of the total New Zealand population in 2006.
4. The European/Pākehā ethnic group is combined in Figure 8 with the smaller Other ethnic group. These composite groups include everyone who answered the ethnicity question who had not already been assigned to the Māori, Pacific, or Asian ethnic groups (67.7 percent of the total New Zealand population in 2006). The majority of this combined group self-identified as either 'European' or 'New Zealander'.

(The percentages above do not add to 100 percent as not everyone answered the ethnicity question.)

Longitudinal Analyses and Comparisons of Deprivation Profiles, 1991–2006

Introduction

NZDep2006 is the fourth census-based NZDep index to be produced (the earlier ones were NZDep91, NZDep96 and NZDep2001). The first two indexes were created one calendar year apart, with the second, NZDep96, improved in two ways. First, we dropped two variables for theoretical reasons. Secondly, 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 10 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. Additional technical reasons to be cautious are outlined below.

There are fewer obvious differences between NZDep96 and NZDep2001 or between NZDep2001 and NZDep2006. 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 (eg, mortality) over time.

Our conclusions are as follows:

- *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 Census Area Units should be reasonable, although we advise caution in interpreting small changes over time as being practically meaningful. See the following section 'Comparing areas over time'.
- *Comparisons of relationships* between deprivation and another variable, over time, are reasonable. See the section 'Comparing relationships with deprivation over time'.

Note that each NZDep index of relative deprivation (NZDep91, NZDep96, NZDep2001 and NZDep2006) divides the country into 10, where the highest value indicates the 10 percent of NZDep[year] small areas with the most deprived NZDep[year] scores. It is important to remember that *by definition 10 percent 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 substantive and technical reasons.

Substantive reasons

The NZDep value of a meshblock may change between any two censuses for two substantive reasons.

- The local neighbourhood changes 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.
- The local neighbourhood changes in characteristics as a result of changes in house ownership.

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

- The size of the usually resident population in the meshblock changes somewhat, and the meshblock boundary remains unchanged.
- The size of the usually resident population 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 ends 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.

Technical reasons

The NZDep value of a meshblock may change between any two censuses for four technical reasons.

- Small area definitions are not always identical from one census to the next.
- NZDep distributions may not be identical from one census to the next.
- At least one of the nine component variables – the proportion below a household income threshold – is inevitably not identical from one census to another.
- The crowding variable was deliberately changed between the 1996 and 2001 censuses, but remained consistent from 2001 to 2006.

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 boundaries, if this is possible. Primary sampling units 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 or areas, if this is possible within the primary sampling unit boundary. Thus, the resulting census–time-specific small areas have the least number of constituent meshblocks consistent with the dual requirements of at least 100 people usually resident and boundaries within a single primary sampling unit. The result (in 2006) is more than 23,000 small areas constructed from more than 40,000 meshblocks (this is the reason that when mapping NZDep by meshblock any apparent NZDep clusters are likely to be a product of the agglomeration process and not necessarily a true reflection of NZDep for a group of neighbourhoods).

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.

NZDep is conducted 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

Table 2: Comparison of NZDep96, NZDep2001 and NZDep2006 distributions

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

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. This is the modifiable areal unit problem discussed in the mapping section. Aside from analytical distortions, this can also lead to erroneous visual interpretations. Therefore, it is important to remember when analysing and mapping NZDep that the meshblock boundaries are for context only and are not necessarily the small areas used to calculate the index.

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. Table 2 shows close agreement on the form of the NZDep96, NZDep2001 and NZDep2006 distributions. Each has been derived with a mean of 1000 and a standard deviation of 100.

The NZDep variable 'proportion below a household income threshold' is not identical from one census to another.

Changes to the income categories in the census due to changes in dollar values give rise to changes in the household income variable. This household variable assumes the relevant median income within each income category (obtained in 2006 from Statistics New Zealand's Survey of Family, Income and Employment) as the value to use for adding up incomes over family members. This gives rise to a finite number of possible family incomes, depending on the number of earners in the family and how much 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 because, 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 threshold cut off decision was made from a household file). The change between 2001 and 2006 is, however, slight, as the threshold in 2006 cuts off 14.96 percent of people.

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

The crowding variable changed between the 1996 and 2001 censuses but has remained consistent from 2001 to 2006

The definition of 'crowding' used in the NZDep96 calculations was the definition from the Organisation for Economic Co-operation and Development (OECD), which counted the number of people and the number of bedrooms available in a household (see Urlich et al 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 2006 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. 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), and again in close alignment with the other weights (range 0.311–0.371).

As a result of the change in the definition of crowding, the information added to the composite NZDep96 and NZDep2001 indexes was slightly different, however, the information between the last two indexes, NZDep2001 and NZDep2006, was unchanged.

Conclusion:
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 (9 or 10) 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. In that sense, the four versions of the NZDep index 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 four 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 a change in the 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 2–8, and not 1, or 9 and 10).

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 Census 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, and so on. The hypothetical data in Figure 9 illustrate how such comparisons might be undertaken graphically. Each of the bars represents people living in areas that 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 9: Comparing deprivation deciles over time (hypothetical outcome data), NZDep91, NZDep96, NZDep2001 and NZDep2006

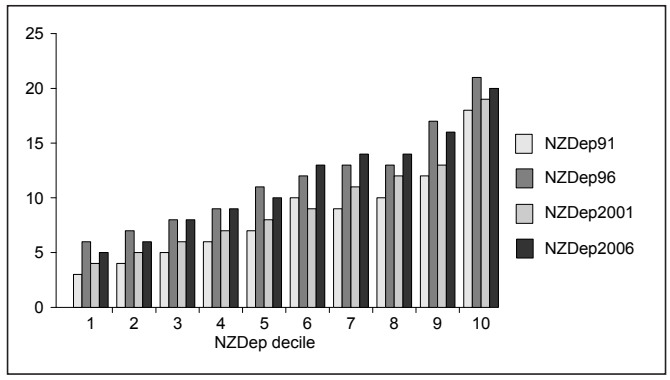


Figure 4 (page 4) shows a real example involving quintiles. The bar chart indicates changes over time in all-cause mortality rates by time-relevant quintiles of NZDep, that is, by using quintiles of NZDep91, NZDep96 and NZDep2001.

We conclude:

> *Comparisons of relationships* between deprivation and another variable, over time, is reasonable.