The Geographic Classification for Health

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Methodology and classification report, May 2021

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Purpose

This report, *The Geographic Classification for Health – Methodology and classification report,* describes the methodology used to create the Geographic Classification for Health (GCH).

The GCH has been designed as a 'fit-for-purpose' rural-urban geographic classification that can be used to accurately monitor rural-urban variations in health outcomes.

The GCH therefore classifies all areas of Aotearoa New Zealand as rural or urban according to their proximity to larger urban areas with respect to health. The approach used has been specifically chosen to:

- Be clear and transparent
- Be based on a framework
- Use high quality data
- Be robust, but also easily maintained over time
- Produce results that are valid on the ground

The GCH consistently classifies all areas of New Zealand as either rural or urban based on population and drive time to urban centres.

It is important to be clear that the GCH is ***not*** a formula for the allocation of healthcare resources, and that the GCH is ***not*** a healthcare accessibility index.

Executive Summary

The GCH is based on population and drive time data that was used in the development of the Urban Accessibility (UA) classification (Statistics New Zealand, 2020). The UA is in turn based on the Statistical Standard for Geographic Areas 2018 (SSGA18) which includes the urban rural 2018 (UR2018) classification (Statistics New Zealand, 2018). The authors of this report have applied a framework to the UA classification that considers a health services discourse to determine appropriate population and drive time thresholds. We have tested both the quantitative and 'on-the-ground' validity of the GCH, in partnership with the Ministry of Health's National Rural Health Advisory Group (NRHAG).

The GCH is comprised of five categories, two urban and three rural, that reflect degrees of reducing urban influence and increasing rurality. The GCH applies these categories to all of New Zealand's Statistical Area 1s (SA1s, small statistical areas which are the output geography for population data) on a scale from 'Urban 1' to 'Urban 2' based on population size, and from "Rural 1' to 'Rural 3' based on drive time to their closest major, large, medium, and small[1] urban areas. Like the UA, the GCH is based on population size and density, with drive time used to indicate increasing rurality. Unlike the UA, which is a generic classification, the population and drive time thresholds used in the GCH have been developed from a health perspective, in consultation with more than 300 individuals from 20 organisations. The nature of the functional relationships between urban areas and rural surrounds have also been considered through a health lens.

In this paper we discuss concepts and issues with previous 'generic' urban-rural classifications being used in health research in Aotearoa New Zealand. We also describe the GCH methodology and classification, discuss limitations, and illustrate the GCH with maps.

[1] As defined in the Statistical Standard for Geographic Areas 2018 (Statistics New Zealand, 2018)

Background

What is rural?

The short answer is that it depends. The definition of rurality has long been contested (Halfacree, 1993). In many ways, rurality is defined by the approach that is used to describe it. The two main ways of conceptualising and defining rurality that are outlined in the geographic literature are: (1) a discourse driven approach; and (2) a descriptive, data driven approach (Woods, 2011). The discourse approach focuses on the "imagined" rural. It uses 'social representation' to consider how people construct themselves as *being* rural, recognising that rurality is 'a state of mind'. Rurality is in the eye of the beholder (Woods, 2011). The descriptive approach is a purely technical, quantitative approach that relies on empirically describing the socio-spatial characteristics of places. Spaces are classified as rural if they meet a set of pre-defined criteria (Woods, 2011). The development of a meaningful classification of rurality needs to effectively balance both of these approaches so that the classifications produced both make sense on the ground, and are the result of a clear, transparent, and replicable process. An additional important consideration is that what is meant by "rural", and thus how it is defined, also depends on what questions are being asked, and what purpose rurality is being defined for (Ricketts & Johnson-Webb, 1997).

Internationally, a wide range of approaches to describing areas as urban or rural have been taken by both researchers and government departments. According to Hall et al. (2006), in the United States of America, there are five key measures of rurality that can be used for epidemiological studies: (1) population density; (2) the US census definition, based on population density and size; (3) the Metropolitan Areas and Core-Based Statistical Areas classification, based on population size; (4) Urban Influence Codes and Rural-Urban Continuum Codes, based on population size and distance to metropolitan counties; and (5) Rural-Urban Commuting Area Codes, based on population size, density and commuting patterns. Likewise, in Canada there are at least four different rurality classifications based on a combination of population size, density, and distance (Muula, 2007).

While exact thresholds cannot be universally applied internationally (for instance populations of >300 are considered urban in Iceland but areas with <30,000 people are considered rural in Japan (Woods, 2011)), it is clear that the factors of population size, density, and distance are key considerations in any geographic classification of rurality. One example of this is the Modified Monash Model (MMM) which was developed in Australia as a framework for distributing rural health workforce recruitment and retention funding (Humphreys & Wakerman, 2018). Although six indicators of rural and remote workforce retention were examined, population size and distance to metropolitan centre were found to be more sensitive indicators of the need for recruitment and retention incentives (Humphreys & Wakerman, 2018).

In order to determine appropriate thresholds and develop a fit-for-purpose geographic classification of rurality in Aotearoa New Zealand, we used several key criteria outlined in the international literature (Hart et al., 2005; Humphreys, 1998; McGrail & Humphreys, 2009; Mueller et al., 2020). These are outlined in more detail later in this document.

In this report, we describe the approach we have taken to classifying areas of Aotearoa New Zealand as urban or rural within a health discourse. This discourse is developed through consultation and engagement with rural health stakeholders including rural health professionals and rural communities. Our approach is an attempt to improve generic typologies of rurality that often misclassify borderline regions. Woods (2009) argues that the task of classifying spaces as urban or rural are most challenging and complex in peri-urban areas, the rural-urban fringe, and small towns in rural regions where rural and urban identities become entangled. To address these challenges, our approach therefore relies on applying both a 'descriptive' definition of rurality - which is nested in the use of transparent frameworks and data – and an attentive lens to the health discourse surrounding rurality and how this affects the social representation of rural.

Defining rural in Aotearoa New Zealand health research

There are currently multiple rural-urban classifications being used in Aotearoa New Zealand health research. Researchers investigating rural-urban disparities must choose between

using Statistics New Zealand definitions which were not specifically designed to be used for health research, or to use an alternative definition. In the last 20 years, 31 different approaches to classifying rurality have been applied to health research in Aotearoa New Zealand (Farrell & Fearnley, 2021). These include the 1992 Statistics New Zealand rural-urban classification system based on population size, 10 other ways of using Statistics New Zealand classifications, as well as a range of other ad-hoc approaches. These different approaches to defining rurality inevitably classify different populations as rural, therefore making comparisons across studies impossible. The most frequently used geographic classification in the Aotearoa New Zealand health literature is the Statistics NZ Urban Rural Experimental Profile 2004 (UREP). The UREP consists of three categories of urban (Main urban area, Satellite urban community, Independent urban community), and four categories of rural (Rural area with high urban influence, Rural area with moderate urban influence, Rural area with low urban influence, Highly rural/remote area). The UREP is a generic classification that is problematic when used for health analyses (Fearnley et al., 2016). The UREP classifies as 'independent urban communities' numerous areas that are, in a health discourse, invariably considered rural. Independent urban communities are often rural towns with a considerably smaller population than metropolitan centres. They do not have a significant functional relationship with main urban areas. Examples of independent urban communities include Tokoroa and Wairoa in the North Island, and Westport in the South Island. Independent urban communities have, on average, the highest levels of socioeconomic deprivation, oldest age structure and highest proportion residents reporting Māori (the Indigenous population of Aotearoa New Zealand) ethnicity of any of the UREP categories. Furthermore, the UREP category 'Rural areas with high urban influence' is also problematic. The places assigned this category are, generally, Aotearoa New Zealand's most affluent areas, with 'a significant proportion' of residents working in an adjacent 'Main urban area' (Statistics New Zealand, n.d.). Although 22% of the UREP's 'rural' population are in this category, the health outcomes of those living in these peri-urban areas (currently classified as rural) systematically differ from those who live and work in more 'rural' areas. The inclusion of the population classed as 'rural area with high urban influence' into the rural category is likely to bias 'rural' health outcomes. Likewise, the inclusion of 'independent urban communities' into the urban category is likely to bias 'urban' health

outcomes. The combination of these two misclassifications is therefore likely to mask rural-urban health inequities.

Current Statistics New Zealand urban-rural classifications

Statistical Standard for Geographies Review 2018

In 2018 Statistics New Zealand released its Statistical Standard for Geographic Areas (SSGA18), built on Statistical Area 1s (SA1s) instead of smaller meshblocks used in the past. SA1s are the smallest geographic units that Statistics New Zealand releases census data for, with a usually resident population typically between 100 and 200 people, and form the 'building blocks' of larger geographic areas such as Statistical Area 2s (SA2s) and Territorial Authorities.

The SSGA18 also included the urban rural 2018 (UR2018) classification. The UR2018 classifies urban areas according to population size and density. It is a 'form classification' that reflects 'what things look like on the ground'. It describes the immediate environment in which a population is domiciled, but not the way in which their lives are organised. Urban areas and rural settlements are named in the UR2018 classification. The UR2018 categories are presented in Table 1 and additional information about the SSGA18 and UR2018 is available from Statistics New Zealand (2018).

Table 1: Categories in the UR2018 classification

Statistical Standard for Geographic Areas 2018 Urban Rural Indicators	
UR2018 category	Population size
Urban	
Major urban area	100,000 or more
Large urban area	30,000 – 99,999
Medium urban area	10,000 – 29,999
Small urban area	1,000 – 9,999
Rural	
Rural settlement	Represents a reasonably compact area with an estimated resident population 200-1,000 or at least 40 residential dwellings and containing at least one community building.
Other rural	Areas not otherwise categorised
Water	Bodies of water including inland water, inlets and oceanic

Urban Accessibility classification

The Statistics New Zealand Urban Accessibility (UA) classification was released in 2020. In contrast to the UR2018, the UA is a 'functional' classification that reflects the way in which populations have access to employment opportunities and services. It classifies populations according to their geographic accessibility to larger urban areas which are likely to be service centres. Detailed information on the development of the UA has been outlined by Statistics New Zealand (2020). To briefly summarise the key points, the UA has been developed using the population weighted centroid of SA1s, and classifies each SA1 as belonging to one of seven gradations of urbanicity within a rural-urban binary categorisation. Towns and cities with a population of 10,000 or more are classed as Major, Large or Medium urban areas depending on their size (see Table 2) and these centres make up the 'urban core'. Small urban areas (population 1,000 – 9,999) and all other SA1s are assigned a level of urban accessibility depending on the travel time from each SA1 to the edge of an urban core. SA1s that are 25 minutes or less from a Large or Major centre, as well as SA1s within 15 minutes of a Medium centre are considered part of the 'peri-urban area'. Those SA1s which are more than 25 minutes from Major or Large centres, or more than 15 minutes from a Medium centre fall outside the peri-urban area and are classified with varying degrees of rurality as indicated in Table 2.

Table 2: The travel time thresholds used in the Statistics New Zealand UA

	The Urban Accessibility Classification				
UR2018 Category	High Urban Accessibility	Medium Urban Accessibility	Low Urban Accessibility	Remote	Very Remote
Major Urban (Population≥100,000)	0-15 min	16-25 min	26-60 min	61-120 min	>120min
Large Urban (30,000 – 99,999)		0-25 min	26-60 min	61-120 min	>120min
Medium Urban (10,000-29,999)		0-15 min	16-60 min	61-120 min	>120min

The measure of geographic accessibility used in the UA is travel time by road. The rationale for this measure is outlined in the full UA methods (Statistics New Zealand, 2020). Travel time is used to categorise individual SA1s. The 'origin point' of the calculated travel time is

the address weighted centroid of the SA1 (see Statistics New Zealand (2020) for further information). The 'destination' is the edge of a nearby urban area. When an SA1 centroid falls within the duration thresholds for multiple urban areas (as is often the case), the higher urban accessibility category is assigned. For example, if an SA1 centroid was 5 minutes from medium urban area, and 10 minutes from a major urban area, the class of high urban accessibility from proximity to the major urban area would be assigned to the SA1. SA1s within small urban areas and rural settlements are assigned to a single urban accessibility category. In cases where a small urban area or rural settlement has SA1s with different urban accessibility categories, the category of the majority of SA1s is applied to the whole small urban area or rural settlement. Islands in the UA are classified as remote or very remote (with the exception of the western urban areas on Waiheke Island and the rural settlement of Oban at Stewart Island, which can be reached within 60 minutes by regularly scheduled flights and ferries, and are therefore classified as having low urban accessibility).

Functional Urban Areas classification

The most recently released Statistics New Zealand urban-rural classification is the Functional Urban Areas (FUA) classification (Statistics New Zealand, 2021). The FUA uses census data on commuter patterns to create functional zones around major, large, medium, and some small urban areas. These FUAs include SA1s that are likely to have strong economic, social, and cultural ties with a larger 'core' urban area, as indicated by high rates of commuting. While the FUA classification is likely to be useful for a range of non-health purposes, it is subject to many of the limitations of the UA classification. Specifically, it considers all medium urban areas, as well as some small urban areas, and surrounding regions with high levels of commuting, to be urban. Furthermore, since the FUA classification is based on commuting data, it does not directly measure travel patterns for other purposes such as for education, shopping, recreation, or the use of health facilities. In some cases, this produces unusual results, such as where there are SA1s very close to the core of an urban area that, due to low commuting rates, are outside the FUA, whereas other SA1s much further away are included. When the FUA boundaries are overlaid on the UA, these anomalies become clear. Statistics New Zealand have identified these anomalies and therefore advised us to

base the GCH on the UA, which considers the *potential* of people living in each SA1 to travel to urban areas for a range of amenities and services.

Methodology

Key criteria

Rurality is a subjective concept, and landing upon a clear and concise definition has proved elusive internationally. Statistics New Zealand (2020) have highlighted that a range of approaches are used internationally by governing bodies, and that there is no clear 'gold standard'. Our review of the international rural health literature also emphasised that there is no 'one-size-fits-all' definition of rurality. However, we did identify several key concepts and criteria that should be adhered to when developing rurality classifications (Hart et al., 2005; Humphreys, 1998; McGrail & Humphreys, 2009; Mueller et al., 2020). These criteria, and how they were addressed in the development of the GCH, are outlined in Table 3.

Key steps

Once the key criteria for developing a rurality classification were outlined, four key steps were taken in the development, testing, and initial utilisation of the GCH (see Figure 1).

Figure 1: Key steps in developing, testing, and using the GCH

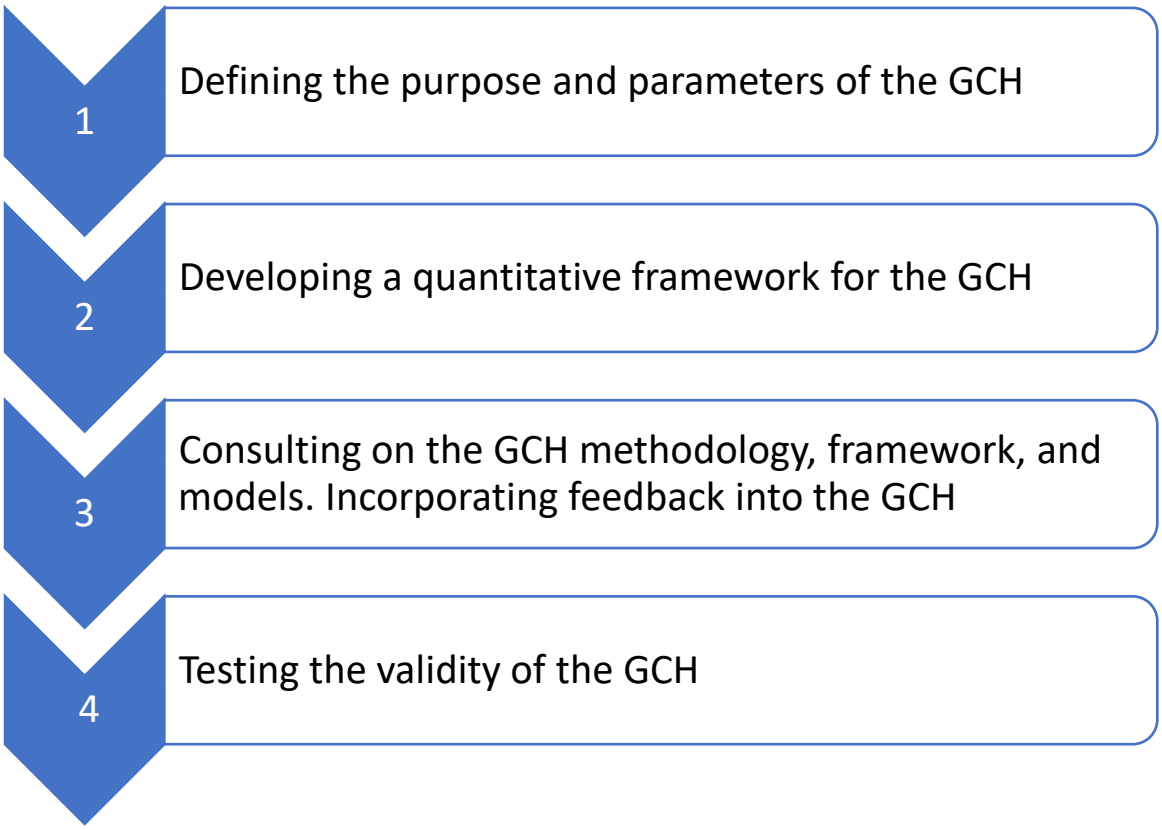

Table 3: Key concepts and criteria for developing rurality classifications

Concept	Key criteria. The GCH should:	Action or consideration in GCH
Objectives & Purpose	1) Have clear objectives and purpose 2) Measure something explicit and meaningful	The GCH is intended to be a 'fit-for-purpose' urban-rural classification for Aotearoa New Zealand health research and policy that accurately monitors rural-urban variations in health outcomes.
Framework Indicators & Data	3) Be based on a framework or formula relevant to the purpose 4) Use appropriate algorithms, criteria, and cut-off points 5) Be based on simplicity including indicators that are as parsimonious as possible 6) Derived from high quality data 7) Be based on a replicable process 8) Stable over time but ability to adjust for changes	Quality population data, stability, and an ability to update in response to 5 yearly census data is derived from the underlying Statistics New Zealand classifications and geographic building blocks used to create the GCH. A co-design process involving those with an understanding of Aotearoa New Zealand's rural population and health services determined appropriate criteria and cut-off points for the GCH categories. Reasoning for the criteria, cut-off points and any special cases are outlined. In line with the UA the input variables are limited to population size, density, and travel time.
Spatial unit	Be based on a spatial unit that: 9) Is consistent with data availability 10) Enables confidential examination of small area differences 11) Ensures comprehensive coverage and allows for aggregation into broader regions	Statistical Area 1s (SA1s) are the smallest geographic unit for the reporting of Statistics New Zealand population data, and the building blocks of the UA. SA1s are designed for examination of spatial variation while maintaining confidentiality and anonymity. The GCH classifies every SA1 in NZ as rural or urban, and broader regions of interest can be developed from SA1s.
Validity	12) Have categories that maximise internal homogeneity and external heterogeneity 13) Has on-the-ground validity and aligns closely with a heuristic sense of what is and is not rural	The internal homogeneity and external heterogeneity of categories with respect to health were quantitatively validated using Primary Health Organisation enrolment data. Extensive consultation with key stakeholders has ensured that the GCH reflects 'common-sense' understandings of what is and is not rural.

1) Defining the purpose and parameters of the GCH

This step is arguably the most important part of developing the GCH. We received strong guidance from our international advisory group that any geographic classification must be developed with a specific purpose in mind, and that it should be used for that purpose.

The GCH has been designed as a rural-urban geographic classification that can be used to accurately monitor rural-urban variations in health outcomes.

We hope that the GCH will be used to analyse health outcome data, and the results of these analyses will inform a more equitable and efficient allocation of healthcare resources. However, the GCH in itself has not been designed as a formula for distributing health resources or funding. Furthermore, the GCH has not been designed as an index of healthcare accessibility or workforce shortage. Although these are important areas of future rural health research, these issues would require a different approach and indicator framework.

We therefore strongly advise that the GCH should *not* be used as a substitution for resource allocation formulae, or as a proxy measure of health service accessibility.

2) Developing a quantitative framework for the GCH

The second key step in developing a geographic classification was to develop a transparent quantitative framework based on high quality data and clear criteria. Although the UA is a generic classification that is not specifically designed for use in health research, we have based the GCH upon the same building blocks – SA1s, population size, and drive time – for the following reasons:

1. Both the Ministry of Health and Statistics New Zealand, have expressed a preference for the GCH to be based on the SSGA18 and the UA to ensure consistency across sectors. The support of these agencies was considered crucial to ensuring the future uptake of the GCH.
2. The Statistics New Zealand Statistical Geographies Review (2018) followed international best practice, has been detailed, was robust, and involved rigorous testing.

3. Using the SSGA18 and UA building blocks will allow the GCH to be maintained and updated regularly as new population data from each census becomes available.
4. Using SA1 building blocks will mean that additional census-based data, such as ethnicity or area-level socioeconomic deprivation, can be used with the GCH, allowing researchers to examine the impact of combinations of rurality, ethnicity and socioeconomic deprivation on health outcomes.
5. Statistics New Zealand reviewed our research proposal and provided feedback which will contribute to a consistent approach to the future reporting of rural-urban differences in health.

Framework, indicators, and data

Population size, population density and drive time as measured in the UR2018 and UA also form the basis of the GCH. However, with the GCH important modifications have been made to the population size and distance thresholds used in the 'generic' UA. These thresholds have been determined by listening to and applying a rural health discourse identified through co-design workshops with the Ministry of Health's National Rural Health Advisory Group (NRHAG), and consultation with stakeholders (see appendix Table 7). At the same time, wherever possible, the UR2018 and drive time thresholds between UA categories have been retained. The methodology used to develop the UA has also been applied to the GCH. This includes the techniques used to calculate travel time and to deal with areas that contain SA1s with different classifications. Major and large urban areas retain their UR2018 classification. However, the GCH contains two urban categories in order to differentiate between populations living in and around major metropolitan centres (U1) compared to provincial cities (U2). U1 corresponds with the UR2018 major urban category, plus its surrounding peri-urban area. U2 corresponds with the UR2018 large urban category plus its surrounding peri-urban area. The GCH drive time thresholds were applied to all remaining SA1s, including medium urban areas, small urban areas, rural settlements, and other rural areas. The drive time thresholds used to create the GCH are outlined in Table 4. In selecting these thresholds particular consideration was paid to the Aotearoa New Zealand health context, including principles such as the 'Golden Hour' (Lilley et al., 2019) and the back-to-back agreement between the Ministry of Health and Primary Health Organisations (PHOs) for 24-hour primary care (Ministry of Health, 2018).

Table 4: Travel time thresholds used in the GCH

UR2018 Category	**Geographic Classification for Health**				
	Urban		Rural		
	Urban 1 (U1)	Urban 2 (U2)	Rural 1 (R1)	Rural 2 (R2)	Rural 3 (R3)
Major urban (Population ≥100,000)	≤25 min		>25 to ≤60 min	>60 to ≤90 min	>90 min
Large Urban (30,000 – 99,999)		≤20 min	>20 to ≤50 min	>50 to ≤80 min	>80 min
Medium Urban (10,000-29,999)			≤25 min	>25 to ≤60 min	>60 min
Small Urban (1,000 – 9,999)				≤25 min	>25 min

The typology for the GCH is shown in Table 5. SA1s are grouped according to their degree of remoteness from major and large urban areas. The number of categories in the GCH has been minimised to ensure simplicity. Furthermore, this approach maximises the difference between categories while including the minimum number of categories to facilitate homogeneity within each of them. There are two urban categories (U1 and U2) and three rural categories (R1 to R3) in the GCH taxonomy. For comparison, the UA has three rural plus five urban categories. The GCH can also be used as a binary urban/rural classification.

Table 5: GCH typology

Urban		Rural		
Urban 1 (U1)	Urban 2 (U2)	Rural 1 (R1)	Rural 2 (R2)	Rural 3 (R3)

Population thresholds

Table 4 highlights one of the key differences between the UA and GCH – that medium urban areas are not considered to be part of the 'urban core' in the GCH. Furthermore, medium and small urban areas are given a GCH classification based on their proximity to major and large urban areas, *and* are also used to classify smaller areas. These population thresholds were modified based on feedback from NRHAG and stakeholders that strongly suggested communities living in medium urban areas were very different from those living in

metropolitan centres (major urban areas) and provincial cities (large urban areas). Feedback also suggested that the range of services and amenities in medium urban areas is likely to be substantially different from major and large urban areas. Furthermore, it was argued that the importance of small urban areas in a remote setting was missing from the UA, and that including this population threshold in the GCH would provide a more nuanced classification of remote Aotearoa New Zealand. The size of small urban populations is generally large enough to support some level of local health services, and therefore, from a health discourse, proximity to a small urban area is relevant in a geographic health classification. Conversely, it is understandable that proximity to small urban areas is not considered significant in the generic UA, since many small towns do not have a significant level of wider services or amenities such as larger supermarkets, shopping centres or a range of financial or business services.

Drive time thresholds

Another key difference between the UA and GCH is that under the UA the urban core (major, large, and medium urban areas) have different classifications to their corresponding peri-urban areas. This produces similar key limitations to the UR2018 in that it is implied that the experiences of living in the urban core and peri-urban areas are significantly different. In reality, much of the population living in the peri-urban zone have significant interactions with the services and amenities available in the adjacent cities. One aspect of this is highlighted in the Statistics New Zealand (2021) Functional Urban Areas (FUA) classification, which highlights commuter patterns around the urban core, and suggests that a high proportion of peri-urban residents commute into the city for work and other purposes. For this reason, the GCH classifies major and large urban areas plus their respective peri-urban zones into U1 and U2 categories respectively. This is a subtle but important distinction between the two classifications.

The GCH also makes the following modifications to the drive time thresholds presented in the UA.

1. Although the 25-minute drive time for the peri-urban zone around major urban areas is unmodified, the 'high urban accessibility' and 'medium urban accessibility' categories were collapsed into the single U1 category.
2. The R2 / R3 threshold (which roughly corresponds to very rural / remote in the UA) was reduced to 90 minutes.
3. The drive time threshold around large urban areas is reduced to 20 minutes to reflect the steeper urban-rural gradient that exists around provincial cities and is reflected in commuter data in the FUA.
4. The drive time thresholds for the R1, R2, and R3 categories around large urban areas were also reduced to reflect this steeper urban-rural gradient.
5. Medium urban areas outside the U1 or U2 peri-urban zone were classified as R1, as are all SA1s within 25 minutes drive time of a medium urban area
6. The R1 / R2 threshold for medium urban areas was reduced to 25 minutes, while the R2 / R3 threshold was reduced to 60 minutes. This recognises that medium urban areas (outside the U1/U2 peri-urban zone) are often large rural towns, and that surrounding areas are often very rural or remote.
7. The GCH adds a drive time threshold of 25 minutes around small urban areas that do not fall into any of the above categories, and would otherwise be classified as R3. This recognises an additional nuance that, within a health discourse, the experience of living in or around a small town, which often contain some health services, is different to living in more isolated areas. Therefore, SA1s within 25 minutes of a small urban area are classified as R2.

Hierarchy

A hierarchy was developed in order to deal with these new population and travel time thresholds. Firstly, SA1s were classified as U1 based on UR2018 major urban areas and their peri-urban zone. Next, SA1s were classified as U2 based on UR2018 large urban areas (that had not been included in a U1 area) and their peri-urban zones. SA1s that were under UR2018 as 'medium urban areas', including their peri-urban zones, that had not already been included in U1 or U2 areas, were classified as GCH R1. SA1s that were classified under UR2018 'small urban areas' and their peri-urban travel time zone were classified as GCH R2.

Remaining SA1s that fulfilled all of the criteria of being located more than 90mins from a major urban area, more than 80mins from a large urban area, more than 60mins from a medium urban area, and more than 25mins from a small urban area were classified as R3. At each stage, where a SA1 could fit within more than one category, the most urban/least rural classification was applied.

Spatial unit - SA1s

SA1s were selected as the spatial unit of the GCH because they form the building blocks of all other Statistics New Zealand geographical areas, and are an output geography, designed for the release of population data. Furthermore, the Ministry of Health are likely to release health outcome data at the SA1 level in the future, replacing the current Domicile Codes that align to Census Areas Units. Using SA1s as the geographic unit for the GCH will 'future-proof' the classification, allowing it to be readily updated in the future as new population data becomes available with each census. Furthermore, SA1s are the geographic unit of other key datasets such as the New Zealand Index of Socioeconomic Deprivation (University of Otago, 2021). This will allow information to be overlaid on the GCH, and the influence of combinations of rurality, ethnicity, and socioeconomic deprivation on health outcomes to be examined.

It is important to note that very sparsely populated SA1s cover large geographic areas. On occasions one boundary of a SA1 may be much more rural or remote than other parts of the SA1. This generates apparent anomalies when viewing maps of rural classifications built with SA1s. Since the boundaries of SA1s are fixed by Statistics New Zealand, this is unavoidable. As the methodology considers the address weighted centroid of the SA1 the actual number of individuals affected will be very small.

Border issues and additional considerations

Modifications and special cases outside of the changes to the population and drive time thresholds outlined above have been avoided as much as possible. However, one important challenge has been that, inside a health discourse, the most meaningful population threshold likely sits *within* the medium urban areas category. Communities at the upper end

of the population threshold (close to 30,000 residents) tend to be more urban in nature than towns at the smaller end of the scale (closer to 10,000 residents). To maintain consistency with the SSGA18 and UA we have avoided splitting the medium urban areas category. However, we identified four communities - Timaru, Blenheim, Whakatāne, and Masterton – which are classified in the UR2018 as medium urban areas, but have larger populations than other medium urban areas. Furthermore, these centres, for historic reasons, also have substantially different health services to most other medium urban areas, setting these places apart as special cases. On this basis Timaru, Blenheim, Whakatāne, and Masterton have been included in the U2 category in the GCH. Furthermore, despite being classified as a small urban area in the UR2018, Greymouth has many of the characteristics of a medium urban area, and is treated like a medium urban area in the UA. Therefore, we have also classified Greymouth as a medium urban area in the GCH. Finally, the rural settlement of Te Poi in the Matamata-Piako region was originally classified as U2 due to its travel time to the edge of Tauranga City. However, we received strong feedback during the consultation process that this U2 was inappropriate. The Kaimai ranges present a significant geographic barrier, and commuter data from the Statistics New Zealand (2021) Functional Urban Areas classification indicates that the Te Poi area is not a functional part of Tauranga City. Consistent feedback received from NRHAG and stakeholders was that all of these additional considerations and modifications (see Table 6) were appropriate changes and produced a better reflection of the 'on-the-ground' reality.

Table 6: Additional considerations in the GCH

Place name	UR2018 category	Unmodified GCH category	Final GCH category
Timaru	Medium urban	R1	U2
Blenheim	Medium urban	R1	U2
Whakatāne	Medium urban	R1	U2
Masterton	Medium urban	R1	U2
Greymouth	Small urban	R2	R1
Te Poi	Rural other	U2	R1

3) Co-design and consultation process

The key co-design partners in developing the GCH were the Ministry of Health National Rural Health Advisory Group (NRHAG), whose members include representatives of the Ministry of Health, the New Zealand Rural General Practice Network Rural Health Alliance (RHANZ), Primary Health Organisations (PHOs), District Health Boards (DHBs), the Royal NZ College of General Practitioners (RNZCGP) and rural Māori healthcare providers. NRHAG supported our application for funding for the development of the GCH, and were closely involved in the development process. NRHAG directly contributed to several key decisions, including:

1. Defining the intended purpose and scope of the GCH
2. The decision to base the GCH on the building blocks and methodology of the UA
3. Determining appropriate population and drive time thresholds in a health context
4. Providing feedback on test models of the GCH
5. Approving the final agreed-upon GCH framework and model

In addition to working with NRHAG to co-design the GCH, we have also extensively consulted with key stakeholders. This involved both face-to-face and virtual seminars and workshops with more than 20 organisations and over 300 individuals from a range of sectors (additional details provided in the Appendix Table 7). This included health researchers and policymakers, representatives of rural communities, organisations involved in the delivery of health services such as DHBs and PHOs, and a range of health professional groups. Seminars and workshops involved an explanation of the GCH's purpose, the methodology and framework used to develop it, and a presentation of various developmental versions of the classification (GCH version 1, version 2, version 3, version 4, and the Statistics New Zealand UA). Initially GCH versions 1 & 2 were presented alongside the Statistics New Zealand UA and workshop attendees were asked to examine their local area in detail and provide feedback on each of the models presented. Attendees were also asked to provide feedback on the framework and methodology used to develop the GCH. A blog site was made available for individuals to access more information about the GCH, download and examine maps, and provide additional feedback.

Overwhelmingly, workshop and seminar participants stated that the GCH was a significant improvement on the generic UA, and that version 2 was the most appropriate classification for their region. This feedback was remarkably consistent irrespective of the geographic location of participants. However, another area of consistent feedback was that, under version 1 and 2 of the GCH, the peri-urban zone surrounding large urban areas (i.e. U2) was too large, and did not accurately reflect the steeper urban-rural gradient around these provincial cities. We used the boundaries of the FUA classification to test this feedback and examine the functional relationship around large urban areas. We found that, typically, the FUA zone around large urban areas was smaller than the FUA zone around major urban areas, suggesting that participants were justified in arguing that large urban areas had a smaller 'influence' on surrounding areas. These findings were used to further refine the GCH and led to the development of GCH versions 3 and 4. In subsequent seminars and workshops all four developmental versions of the GCH were presented for consultation alongside the UA.

4) Testing the validity of the GCH

The validity of the GCH was ascertained in two ways. The first was through qualitative feedback from workshop and seminar participants who confirmed that the classification made sense on the ground in their local area. Version 4 of the GCH was overwhelmingly confirmed as the preferred classification, with stakeholders agreeing that it provided the 'best fit' and was a realistic representation of rurality in Aotearoa New Zealand. The GCH was also tested quantitatively. Following an unsuccessful attempt by the Ministry of Health to develop an acceptable national formula to replace the Rural Ranking Scale (RRS), it devolved responsibility for allocating rural primary care funding to local Rural Service Alliance Teams. Based on criteria laid out in the RRS and using local knowledge, rural Service Level Alliance Teams (SLATs) were asked to develop a local (DHB level) formula for the allocation of rural funding. This process involved considerable consultation with the affected practices and was required to have the agreement of more than 75% of practices (who represented more than 75% of the DHB's enrolled rural patients) in order to be adopted. This process was extensive and robust. Two PHOs (Mahitahi Hauora and WellSouth) that

had successfully completed this process were approached and agreed to provide enrolment data. This included a list of all practices in their region, and whether they had been classified as urban or rural for funding purposes. They also provided an anonymised list of enrolled patients. This was used to determine whether patients enrolled in rural practices were living in rural locations. Although recent research suggests that travel for primary healthcare is complex and often involves bypass behaviours (Whitehead et al., 2019), it can be assumed that most patients living in urban areas enrol with urban general practitioner (GP) practices, while most patients living in rural areas likewise enrol with rural clinics. We then compared how accurately the UREP, UA, and developmental versions of the GCH classified patients based on their enrolment patterns. The UREP correctly classified rural enrolees to rural residences and urban enrolees to urban residences in 66% to 70% of all cases. The UA improved this to 81%, while the GCH classified patients as urban or rural with an accuracy of between 93% to 95%.

Limitations

Usage

The GCH has been designed as a 'fit-for-purpose' rural-urban geographic classification that can be used to accurately monitor rural-urban variations in health outcomes. The purpose of the GCH is to classify all areas of Aotearoa New Zealand as rural or urban according to their proximity to larger urban areas employing population and drive time that are meaningful with respect to health. The GCH is ***not*** a formula for the allocation of healthcare resources, and that the GCH is ***not*** a healthcare accessibility index.

Methodological limitations

The GCH has similar methodological limitations to the UA classification. The drive time for each SA1 is an average for the area, and not all addresses will necessarily fall within the drive time threshold. Since address-weighted centroids are used, the distribution of addresses within SA1s can influence results. For instance, some rural SA1s may have two clusters of addresses, one close to an urban area, and one further away. In these cases, the entire SA1 may receive a lower drive time if the cluster of addresses close to an urban area is larger than the cluster further away.

If there are any significant gaps in address data, then the accuracy of address-weighted centroids will be affected, and this could in turn affect the classification that an SA1 is given. As in the UA classification, addresses are used to position centroids, not the number of people living in those addresses. For instance, a large number of small vacant buildings will have a disproportionately larger influence on the location of an address-weighted centroid than would a large building with many residents living at a single address.

The methodology in the UA, and therefore the GCH, only considers drive time by car, and assumes ideal driving conditions. With the exception of Waiheke Island and Oban, Stewart Island, other modes of travel such as ferry, bus, air, or rail are not considered. Calculated drive times are based on the OpenStreetMap road network data and routing service and therefore the completeness and accuracy of this dataset will be reflected in the results.

Maintenance

Now that the population and drive time thresholds to create the GCH have been confirmed, the methodology used to produce the GCH is readily replicable and therefore it will be relatively straightforward to update the classification as needed.

Statistics New Zealand (2020) have indicated that the UA classification will be reviewed every five years, before each census. While the timely availability of accurate census population information may be a limiting factor, it is our intention to also correspondingly update the GCH every 5 years, after each census. Other changes that may affect future GCH classifications include potential modifications to SA1 and urban boundaries that will reflect changes in population distribution and the expansion of urban areas. Furthermore, the road network may change due to the addition of new motorways, road upgrades, which may reduce travel times. Reviewing and updating the GCH every 5 years will ensure that while the classification remains relatively stable, it will continue to reflect

Results

Version 4 of the GCH has been approved and adopted as the Geographic Classification for Health 2018 (GCH-2018). Figures 2 and 3 below display the GCH categories of each SA1 in Te Ika-ā-Maui and Te Waipounamu.

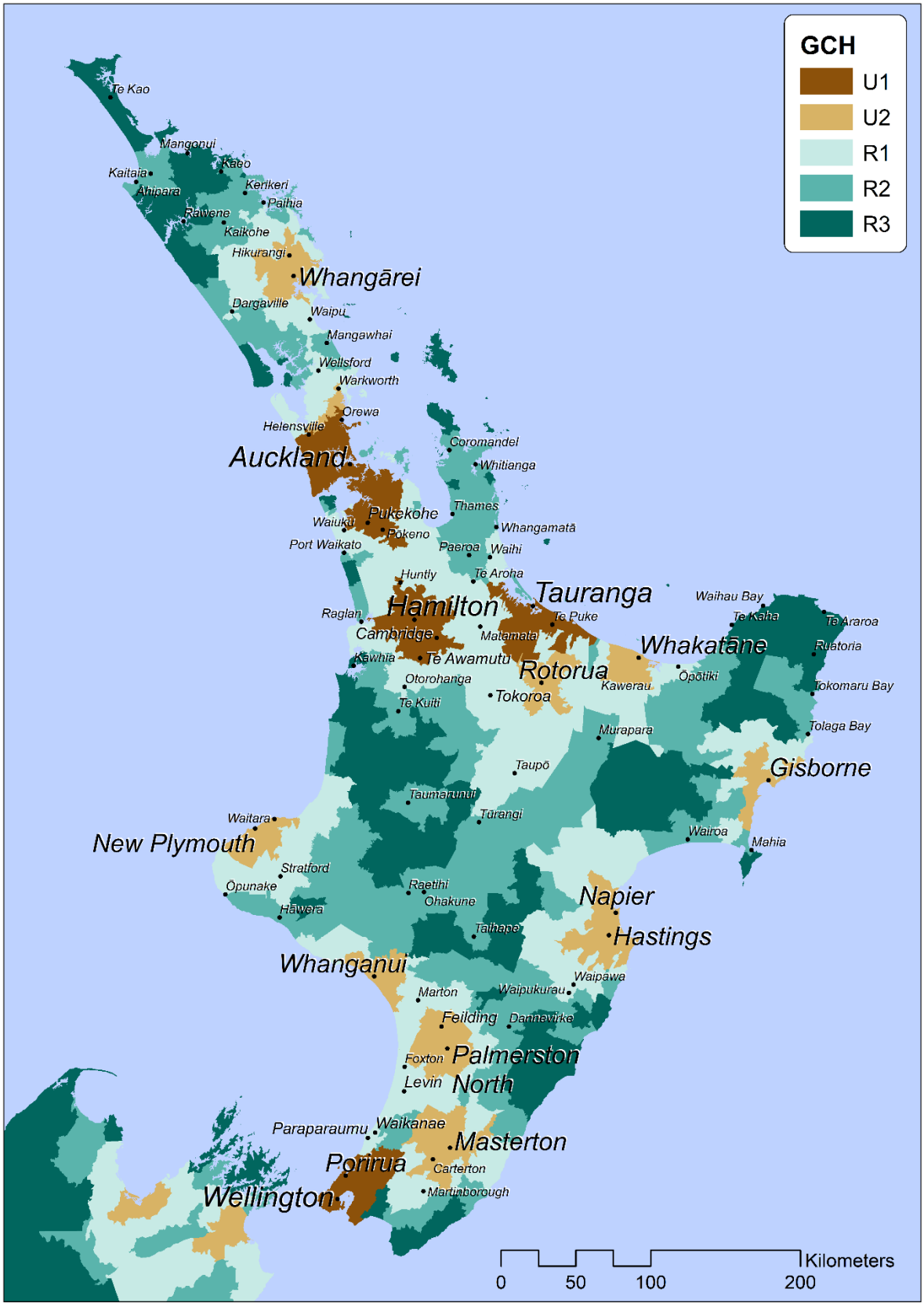

Figure 2: The GCH categories of SA1s in Te Ika-a-Māui / North Island

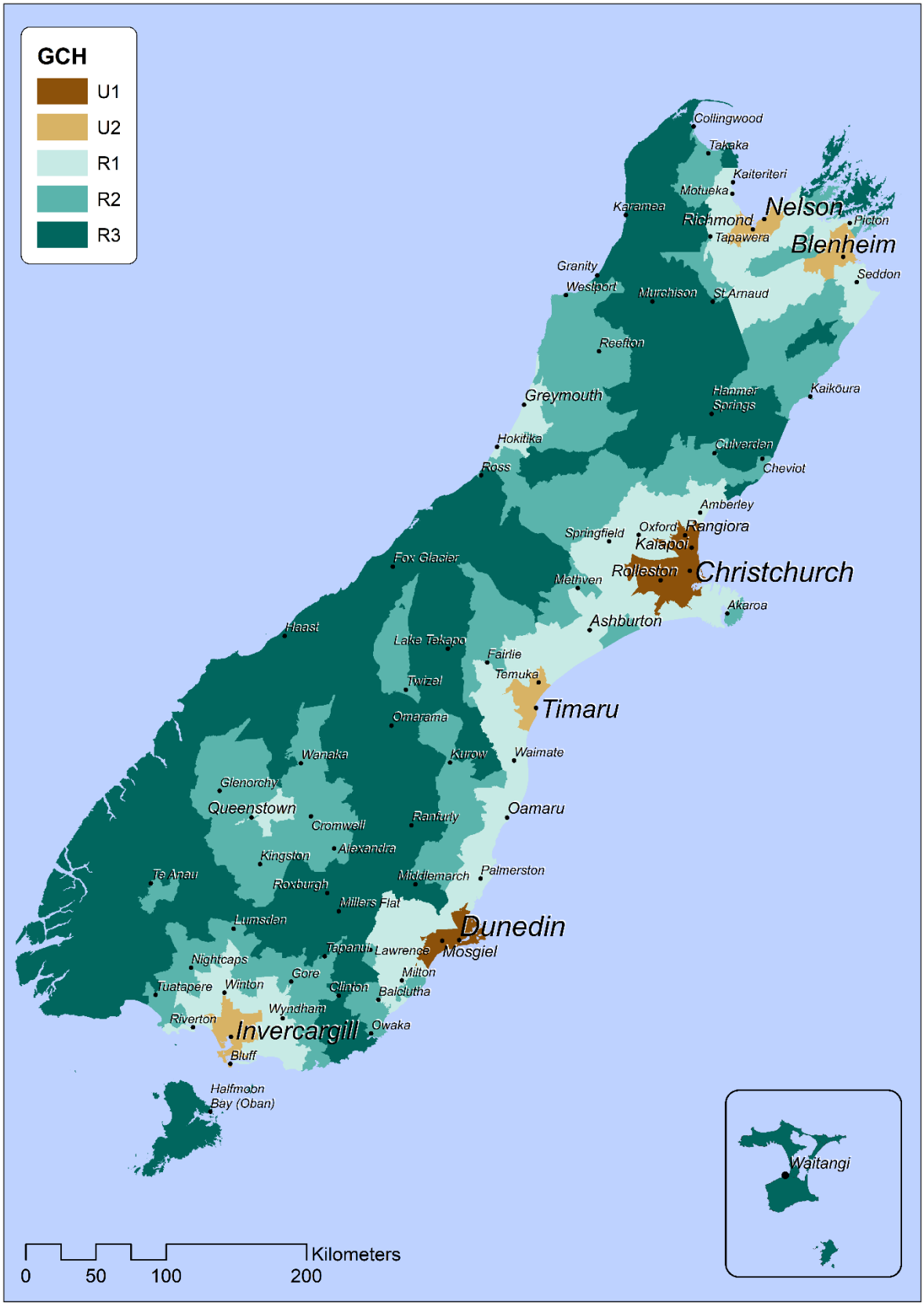

Figure 3: GCH categories for SA1s in Te Waipounamu / South Island

Conclusion

Developing the GCH-2018 is the first phase in our wider research project. To be useful, this classification needs to be applied and used.

The next phase of our research will involve applying the GCH-2018 to routinely collected data from the Ministry of Health. This will enable us to examine current inequities in health outcomes between rural and urban areas. This will include examining ethnic specific rural-urban inequities as well as ethnic inequities in outcomes within each GCH-2018 category. We will also examine whether the GCH-2018 'unmasks' health outcome inequities that previous classification systems, such as the UREP and UA, fail to identify. We also encourage other researchers to consider using the GCH-2018 as a valid and meaningful rurality classification for health research.

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Abbreviations

DHB – District Health Board

FUA – Functional Urban Areas

GCH – Geographic Classification for Health

GP – General practitioner

MMM – Modified Monash Model

NRHAG – National Rural Health Advisory Group

PHO – Primary Health Organisation

R1 – Rural 1

R2 – Rural 2

R3 – Rural 3

RNZCGP – Royal New Zealand College of General Practitioners

RRS – Rural Ranking Scale

SA1 – Statistical Area 1

SA2 – Statistical Area 2

SLAT – Service Level Alliance Team

SSGA18 – Statistical Standard for Geographical Areas 2018

U1 – Urban 1

U2 – Urban 2

UA – Urban Accessibility

UR2018 – Urban Rural 2018

UREP – Urban Rural Experimental Profile 2004

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Appendix

Consultation information

Table 7: Organisations consulted with during the development of the GCH

Date	Organisation	Attendees	Format
March, July & November 2020	National Rural Health Advisory Group (NRHAG)	35-40	Face-to-face and Zoom
August 2020	Waikato University and Waikato DHB	70	Zoom
August 2020	Otago University	30	Zoom
August 2020	Mahitahi Hauora PHO	10	Zoom
September 2020	Pinnacle PHO Rural SLAT	1	Face-to-face
September 2020	Rural Hospital Network	31	Face-to-face
September 2020	Health Workforce NZ Board (HWFNZ)	8	Zoom
October 2020	Southern DHB	2	Face-to-face
November 2020	Royal New Zealand College of GPs (RNZCGP)	2	Zoom
November 2020	WellSouth PHO	3	Face-to-face
November 2020	Rural research evening: Otago University	43	Zoom
November 2020	Maori Advisory Group	3	Zoom
November 2020	Statistics New Zealand	1	Face-to-face
November 2020	Ministry of Health: HWFNZ Analytics	2	Face-to-face
December 2020	Academic Advisors	3	Zoom
December 2020	Auckland University	11	Face-to-face and Zoom
February 2021	NZ College of Midwives	70	Zoom
February 2021	Rural Women NZ	2	Zoom
April, December 2020, February 2021	International Academic Advisors	2	Zoom
February 2021	Canterbury Rural Workforce stream	6	Email
February 2021	Medical Council of New Zealand	1	Email