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Case Report

Sustainable Urban Development for Older Australians: Understanding the Formation of Naturally Occurring Retirement Communities in the Greater Brisbane Region

Jiaxuan E [1], Bo Xia [1,*], Laurie Buys [2] and Tan Yigitcanlar [1]

[1] Faculty of Engineering, School of Architecture and Built Environment, Queensland University of Technology, 2 George Street, Brisbane, QLD 4001, Australia; jiaxuan.e@hdr.qut.edu.au (J.E.); tan.yigitcanlar@qut.edu.au (T.Y.)
[2] Faculty of Health and Behavioural Sciences, The University of Queensland, St Lucia, QLD 4072, Australia; l.buys@uq.edu.au
* Correspondence: paul.xia@qut.edu.au

Abstract: As most older Australians prefer to age-in-place, providing sustainable and age-friendly communities poses a significant challenge to urban policymakers. The naturally occurring retirement communities (NORCs) have organically emerged as a collaborative model of care to support older adults to age-in-place, but neither academic research nor government policies recognise this housing option for older Australians. This paper aims to analyse the distributions and temporal patterns of NORCs in the Greater Brisbane Region, Australia, to understand the formation and development of NORCs. The geovisualisation method was employed to identify the distribution changes of NORCs between 2006 and 2016. The Global Moran's I and Local Moran's I measures were utilised to analyse the spatial correlation and the clusters of NORCs. The results show that NORCs increased significantly from 2006 to 2016, and their distribution was mainly clustered or co-located along the coastline and Brisbane River areas. The evolvement of NORCs reflected the change of aggregation pattern of older population between 2006 and 2016. Understanding the distribution trend of NORCs informs government policy and decisions in addressing issues of service delivery and community cooperation, and eventually leads to sustainable urban development and successful ageing in place for older Australians.

Keywords: age-in-place; ageing communities; naturally occurring retirement communities; sustainable urban development; age-friendly cities; older population; Brisbane; Australia

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1. Introduction

Most of the developed countries are ageing societies, and catering for this large proportion of the older population is becoming an important part of urban policy [1,2]. For most of the older people, ageing-in-place (remaining in their own home in the community as long as possible) is the preferred housing option, which has a positive impact on many aspects of daily life, such as feeling safe and comfortable, maintaining physical and mental wellbeing and receiving social support [3,4]. However, ageing-in-place can be challenging for older people due to various issues, such as reduced physical capabilities, the rising cost of long-term care, increased risk of social isolation, and an unprepared community environment [5]. As a result, many older Australians do not have a range of options other than to relocate into retirement villages or aged care facilities [6].

A retirement village is an older people-based community that provides a variety of accommodation, services and facilities to meet their unique requirements [7]. It is an institution and needs rules, regulations, programmes and staff to govern its residents' daily life [8]. An aged care is the health institution that provides services to meet the needs of help with day-to-day tasks or health care for older people in Australia. In some cases, the

best way to receive help and support can be by living in an aged care home (also known as nursing home) either on a permanent basis or for a short stay. However, although both of the options above provide protection for older people with respect to health and housing, more than 90% of older Australians wish to age-in-place and perceive the benefits of staying at home as a secure, familiar environment with the local community they know and love [9].

To support older people's ageing in place, urban planners and local governments need to provide an age-friendly urban environment, both in the community and city levels, so that older people's daily needs can be fully met [10]. The 'naturally occurring retirement communities' (NORCs), a concept originating from the US in the 1980s, has emerged as a collaborative living and care model to support older adults to age-in-place and avoid moving to more restrictive settings [11]. The concept of NORC was first proposed by Hunt and Gunter-Hunt [12], defining NORCs as neighbourhoods or building complexes that are not originally designed for older adults, in which 50% of the residents are 50 years or older and have aged in their homes. The criteria of NORCs varied over time. For instance, Hunt and Ross [13] identified a NORC with at least half of the residents aged 60 or older. Likewise, it is also defined as a housing community where at least 65% of residents are over 50 years old [14]. Moreover, the U.S. Congress Senate (2006) defined NORCs as communities in which at least 40% of the heads of households are older individuals.

Although the original purpose was not to help the older people to age in the community, NORCs have developed naturally and provide a way for older adults to live independently as long as possible. [15]. Because of the high density of the older population in the same geographical locations, communities can effectively serve older adults and support formal and informal collaborations between residents, communities, service providers and public sectors. Hunt and Gunter-Hunt [12] showed that neighbourhood services (which support older people's need and capabilities) were a major attraction to NORCs and increase the residents' satisfaction with such community-based housing.

In the U.S., most of the NORCs occur throughout the southern third of the country (Sun Belt) and some of the denser cities, such as New York and Boston, because of their ample public transportation links and amenities. Canada is considered to have an ageing environment similar to that in the U.S, and thus NORCs can be identified in some of the densely populated areas, such as the Ontario province [16]. In some other countries of the world, the term NORC is not applied, but communities sharing similar features are still recognised, which facilitate independent living for the older residents. AARP International reported on piloting various housing solutions for the ageing population in Europe, and Japan is widely regarded as a hospitable ageing country [17].

In response to the NORC demographic cluster, NORC supportive service programmes (NORC-SSPs) were developed to serve their senior residents by providing social and health care services tailored to their specific needs. The first NORC programme was established in 1986 at Penn South Houses, in New York City. Since then, the NORC programme model has been broadly replicated in more than 25 states across the U.S. Masotti, Fick [18] proposed the idea of healthy NORCs—that some NORC environments are healthier or more attractive than others for seniors, so that older people are intentionally moving together and the health benefits within healthy NORCs are higher where physical and social environments facilitate greater activity and promote feelings of well-being. The NORC is, therefore, considered a positive model for ageing-in-place to promote the health and mental well-being of older individuals [19,20].

Although NORCs are well recognised in the U.S., they are much less so in Australia. Currently, only two 'virtual retirement communities' (one in Sydney and another in Perth) claimed to be inspired by the NORC movement in the U.S., where online local networks are provided to support older people living independently in their own homes and with access to local services [20]. Meanwhile, though, this pattern of ageing is happening naturally in Australia, given that an increasing number of communities in Australia have more than 40% of residents over 65 years old. For example, 40.6% of the residents of Queensland's Bribie

Island are 65+ years old [21]. It is thus clear that NORCs are an existing but unnoticed social phenomenon in Australia. In other words, we have already witnessed an Australian version of NORCs, but neither academic research nor government policies recognise this housing option for older Australians. Currently, there is very limited, if any, knowledge about the formation and development of NORCs.

This paper, hence, aims to understand the formation and development of NORCs in the Greater Brisbane Region (a geographical area with a much higher ageing rate than the national average of 15%), mainly in terms of their spatial and temporal changes over a 10-year period, from 2006 to 2016. The study is innovative in its spatial analysis of Australian NORCs, enabling various stakeholders, especially policymakers, to identify the formation trend of NORCs, with the ultimate purpose of developing age-friendly communities and cities to support older Australians' ageing-in-place.

2. Materials and Methods

A spatial and temporal data analysis, including a spatial autocorrelation analysis, a cluster and outlier analysis and a hotspot/coldspot analysis, upon a geographic information system (GIS), were applied to identify the distribution pattern of older population and NORCs on the basis of geographical boundary and census characteristics in Australia. The census statistics of the residential areas of the households with different characteristics can reflect the geographical patterns that naturally form with the development of time.

2.1. Data

The Australian Bureau of Statistics (ABS) Census data of 2006, 2011 and 2016, which include the distribution of usual residents in the households by different ages, were used. Given that regions with a rapid population growth, such as the Greater Brisbane Region, are especially sensitive to population ageing, which will necessarily involve substantial increases in public expenditure on health and aged care, the Greater Brisbane Region was chosen as the case locality for the data analysis. In particular, this region has become the popular retirement destination for older Australians [21], with some areas such as the Bribie Island with the oldest median age (60.6 years) in the capital city region. The Greater Brisbane Region comprises eight local government areas and covers a total area of around 15,800 square kilometres, or 1% of Queensland's total area, but was home to 2.27 million people, almost half of Queensland's population, which is about 4.7 million [22].

2.2. Unit of Analysis

An appropriate unit of analysis is critical in geography-based analyses. Every five years, ABS counts every person and home in Australia, in the Census of Population and Housing. For the 2011 and 2016 Census, Statistical Area Level 1 (SA1) was designed for a detailed spatial analysis of the Census data. This research used these areas to examine how Census characteristics vary at a neighbourhood scale within larger areas [23]. For the 2006 Census, the Census Collection District (CD) was designed as the smallest unit for data collection and processing—including about 200 dwellings. CD was the basis of output for most data and served as the basic building block in the Australian Standard Geographical Classification (ASGC) [24].

It should be noted that although CD in 2006 and SA1 in 2011 and 2016 were the basic census units of the same level for the data analysis in this study, the number of census units for SA1 were higher than that of CD because of the increase of population and immigrants. Nevertheless, as the purpose of this study is to understand the formation trend of NORCs over time, which focused on the population changes and the distribution features of the older population (65+), the slight differences in the number and scale between SA1 and CD units do not affect the overall result.

2.3. Analysis

The definition of NORC varies in different places and different periods. In the place of origin, the US Federal Government, through Title IV of the Older Americans Act, recognised NORCs as 'communities in which at least 40% of the heads of households are older individuals' [25]. According to prior studies, 'resident', 'head of household', 'old adult' and 'house owners and renters' are the most frequently used concepts (and their datasets) in identifying NORCs [13,14,26]. The most widely cited definition of NORCs is 'communities in which at least 40% of the heads of households are older individuals'. In Australian statistical data, older people are defined as people aged 65 years or more [27]; however, the concept of 'head of household' was not applied in the 2006, 2011 and 2016 ABS Census data. Alternatively, this research employed the concept and dataset of all household members who usually reside in the private dwellings rather than the head of household to define NORCs. It also excluded older residents living in nursing homes or aged care facilities. Therefore, this study adopted the combined circumscription of NORC as the community with 40% or more members of households aged 65 years and older, which has excluded holiday visitors and persons who have moved to nursing homes.

Four approaches of spatial analyses were conducted to identify the formation and development of NORCs. These were: (i) geovisualisation, (ii) spatial autocorrelation (global Moran's I), (iii) cluster and outlier analysis (local Moran's I), and (iv) hotspot and coldspot analysis (Getis-Ord Gi *). These are among the frequently applied spatial analysis techniques in the age and healthcare studies [28]. The software of ESRI ArcMap Version 10.8.1 was applied for data analysis.

A geovisualisation was conducted to identify the distribution of NORCs in 2006, 2011 and 2016. When working with spatially referenced data, geovisualisation is helpful to recognise patterns across large geographical regions [29,30]. Choropleth maps, in this study, are used to display different classes of proportion of older people in each census unit and recognise the possible NORCs that meet the criteria.

Global Moran's I was used to measure the spatial autocorrelation of NORCs based on both locations and the proportion of older population simultaneously. Given a set of features such as location, areas and population, it evaluated whether the distribution pattern of NORCs was clustered, dispersed or random. Global Moran's I supports geovisualisation by statistically distinguishing the level of the spatial structure, which qualitatively improves the reliability of the interpreted geovisualised information [31]. In this research, global Moran's I statistic for the proportion of household members in the greater Brisbane region aged 65 years and over in each census unit has value ranges from -1 to 1. A negative value reveals that farther census units are more related than closer ones, a positive value of I reveals that the closer census units are more connected than farther ones, and 0 informs no spatial autocorrelation between them. [32]. A *Z*-score and *p*-value were used for the statistical significance test to verify the result: when *z*-score < -1.65 or $>+1.65$ associated with *p*-value < 0.10, the confidence level is 90%; when z-score < -1.96 or $>+1.96$ associated with *p*-value < 0.05, the confidence level is 95%; when z-score < -2.58 or $>+2.58$ associated with *p*-value < 0.01, the confidence level is 99%.

Local Moran's I, 'a local spatial autocorrelation statistic' [33], was employed to identify local clusters or outliers of NORCs to understand their contribution to the 'global' cluster statistic. It assesses each feature of census units within the context of neighbouring features and compares the local circumstance to the overall situation. Local Moran's I could be utilised to detect the clusters of census units with 40% or more of the members of a household aged 65 years and over among nearby census units in the greater Brisbane region.

Getis-Ord Gi * (Gi *) was used to verify a statistically significant spatial cluster of high values (hotspots) or low values (coldspots) of proportion of older household members within a distance [34]. A Gi * analysis was employed to reveal whether a high or low proportion of older household members is concentrated over the greater Brisbane region at the different statistically significant levels, which means that to be a statistically significant hotspot, a census unit will have a high value and be surrounded by other census units with

high values as well. The visualisation of hotspots and coldspots of older population is the enhanced tool of cluster statistic in Local Moran's I, where hotspot identification not only describes the state of aggregation of older population at the moment but also predicts a trend of cluster for some neighbourhoods with low proportions of older population located in the contexts of high values. Meanwhile, coldspot areas are indicated as the aggregation of suburbs with a low proportion of older population, with the neighbours co-locating with low values as well. This research focused on finding hotspots of highly proportioned older household members including NORCs.

3. Results

As shown in Figure 1, the proportion of older Australians increased obviously across the census units in the greater Brisbane region from 2006 to 2011 to 2016. The total number of household members aged 65 and over in the greater Brisbane region were 185,490, 215,149 and 267,281 in 2006, 2011 and 2016, respectively. Meanwhile, the proportion of older household members (aged 65+) increased from 10.68% in 2006 to 11.15% in 2011 to 12.76% in 2016 in the greater Brisbane region. This indicated a significant growth rate (44.1%) of older household members (65+), much higher than the growth rate of the total household members (20.6%) in the greater Brisbane region from 2006 to 2016. In addition, in 2006, 57.9% of the census units had less than 10% of older household members (those with 65+ years old), while in 2016 it dropped to 48.9%. By contrast, in 2006, only 7.6% of the census units had an older population of more than 20%, and this number increased to 10.7% in 2016.

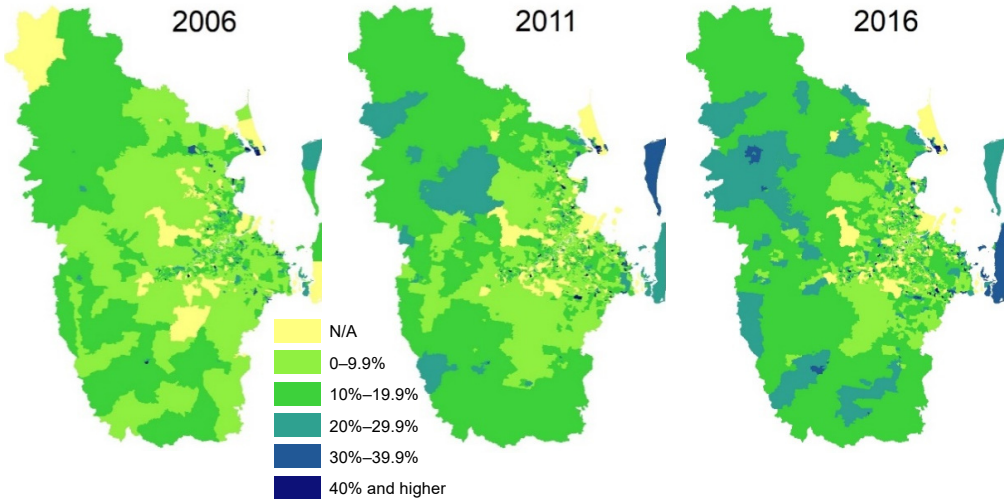

Figure 1. Map of census units with the percentage of older household members (age 65+) in the Greater Brisbane Region in 2006, 2011 and 2016. The colours are classified by N/A, 0–9.9%, 10–19.9%, 20–29.9%, 30–39.9%, 40% and higher.

Figure 2 shows the locations of NORCs in 2006, 2011 and 2016. In 2006, 25 (0.8%) out of 3236 census units were identified as NORCs (with the proportion of 65+ years old more than 40%) in the greater Brisbane region. These numbers increased to 65 (1.3%) out of 5164 census units in 2011 and 92 (1.7%) out of 5373 census units in 2016, which indicated a rapid growth of NORCs over the 10-year span. In addition, the older household members (65+) living in NORCs accounted for 3.4% of the total older household members in 2006, and it increased to 6.1% in 2011 and 7.2% in 2016. According to Figure 2, NORCs were distributed mostly along the coastline and Brisbane River. Especially on the Bribie Island, there already existed four NORCs accommodating 886 older household members (65+) in 2006, and this number increased rapidly to 10 NORCs with 1961 older household members (65+) in 2011 and 15 NORCs with 2963 older household members (65+) in 2011. Currently, the Bribie Island has the oldest median ages (60.6 years) in Queensland.

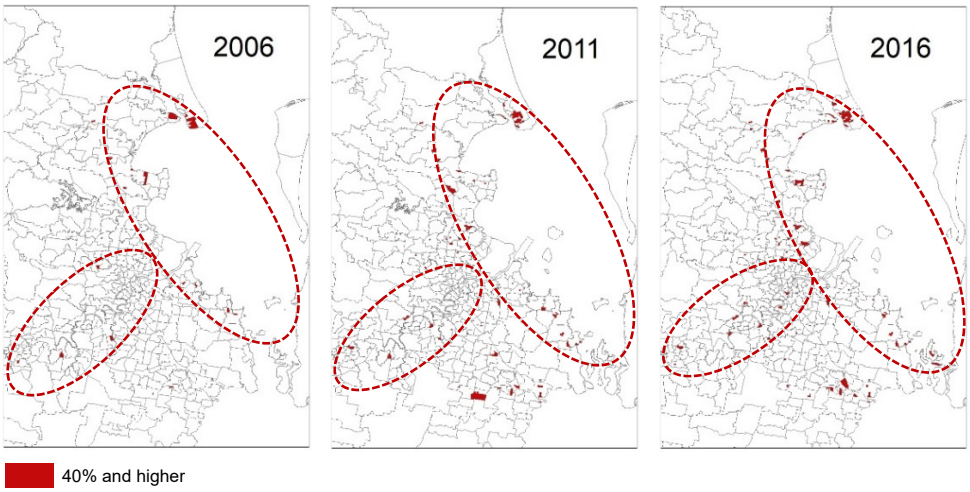

Figure 2. Map of naturally occurring retirement communities (NORCs) with suburb boundaries in the Greater Brisbane Region in 2006, 2011 and 2016. The distributions along the Brisbane River and coastal areas are marked out. Bribie Island has the greatest number of NORCs and oldest median ages.

As indicated by the NORCs' distribution pattern, Global Moran's I was 0.352423 (z = 33.740511) in 2006, 0.252765 (z = 30.630196) in 2011 and 0.282963 (z = 35.100097) in 2016. For the Global Moran's I statistic, the null hypothesis states that the NORCs are randomly distributed in the study area. This result indicated that the distributions of NORCs were spatially autocorrelated or considered as not randomly distributed (rejecting the null hypothesis), which means that the NORCs or census units with a high proportion of older household members (65+) tended to get close to similar ones. Similarly, census units with low proportions of older household members were close to similar ones as well. Given the z-score of 33.74, 30.63 and 35.10, there was less than 1% likelihood that this clustered pattern could be the result of random chance.

Local Moran's I was used to detect the clusters, outliers and hotspots of NORCs. Figure 3 shows that the high-high clusters of census units (i.e., the census units with high proportions of older household members were co-located or clustered together, with a red colour in the red dot-line circle in Figure 3) were located in some specific areas, such as the Bribie Island, Cleveland and Victoria Point, most of which were distributed along the coastal line and expanded their cluster areas rapidly from 2006 to 2011 and 2016. By contrast, the low-low cluster (where census units with a low proportion of older household members (65+) were co-located together) were mainly located in the mountainous areas. Especially those blue areas in the black dot-line circle were disappearing from 2006 to 2011 and 2016 primarily due to the increase of the older population. For high-low and low-high outliers, no obvious patterns exist in this study.

Figure 4 shows the optimised hotspot and coldspot living areas of older household members in 2006, 2011 and 2016. The optimised hotspot map shows that the statistically significant hotspot suburbs (with high proportions of older household members) are distributed along the coastline, and these areas were expanding rapidly from 2006 to 2016. The total number of older household members (65+) living in those optimised hotspot areas were 69,326, 60,341 and 69,595 in 2006, 2011 and 2016, respectively, accounting for 37.4%, 28.0% and 26.0% of the total older household members (65+). Meanwhile, some of the inland regions became hotspots as well, although the number of older household members (65+) was small. Take the Laidley, for example. Only 493 (18.9% of its total household members), 516 (16.1% of its total household members) and 619 (18.9% of its Total household members) older household members (65+) were living there in 2006, 2011 and 2016, respectively. By contrast, the coldspots (with low proportions of older

household members) in the inner-city areas and urban suburbs were increasing along with the decrease of the hotspots in these areas during the 10-year period.

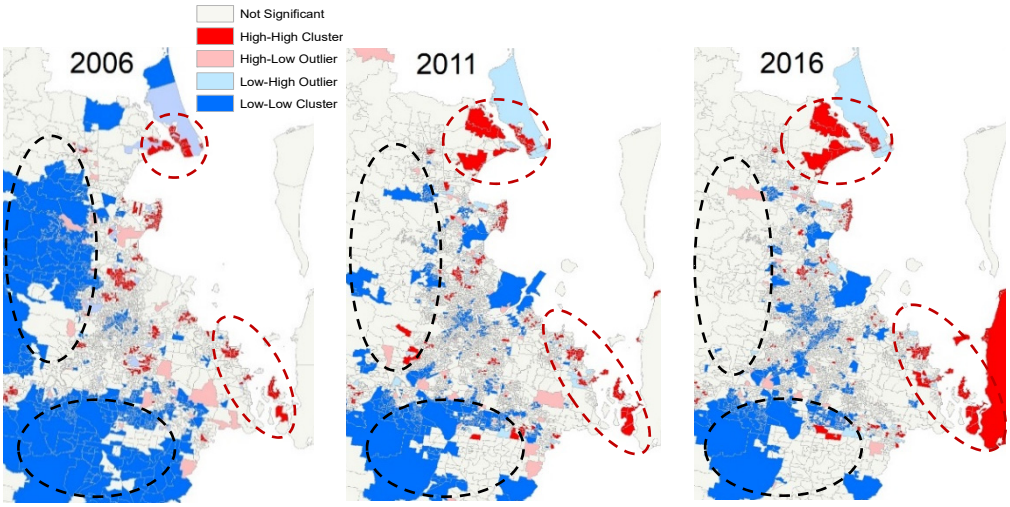

Figure 3. Cluster and outlier analysis of census units with a proportion of older household members (age 65+) in the Greater Brisbane Region in 2006, 2011 and 2016. Different colours indicate different meanings, including not significant, high-high cluster, low-low cluster, high-low outlier and low-high outlier. Significant high-high clusters and low-low clusters are marked out.

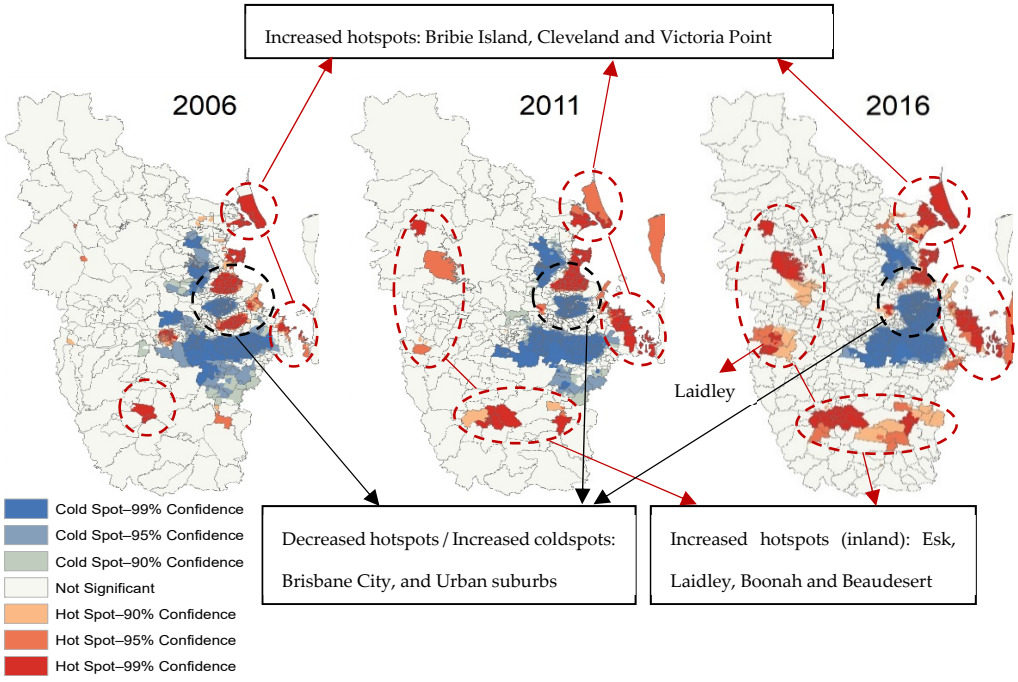

Figure 4. Optimised hotspot analysis of census units with the proportion of older household members (age 65+) in the Greater Brisbane Region in 2006, 2011 and 2016. Different colours indicate 90%, 95% and 99% confidence of hotspots and coldspots. The red circles mark out the increased hotspot areas from 2006 to 2011 to 2016, and the black circles indicate the increased coldspot and decreased hotspot areas from 2006 to 2011 to 2016.

4. Discussion

Our analysis results reveal that NORCs have developed rapidly over the 10-year period in the greater Brisbane region. The cluster of older population may generate both positive and negative impacts on active ageing. Firstly, in NORCs, service providers

and multilevel collaborations may serve the older people more efficiently because of the spatially proximate locations for NORC residents living within a reachable range. It is a great opportunity for the government to provide home and community care in NORCs where the older people can enjoy professional care with comparatively low cost due to the economies of scale.

According to the Queensland Department of Communities, Housing and Digital Economy [35], the distribution of retirement villages in the greater Brisbane area is highly consistent with the distribution of older people, where the areas with high density of older residents have one or more retirement villages located around them. This implies that the retirement village developers have realised the advantage of the economic scales brought by the concentration of the older population. Similarly, one or more nursing homes can also be found in these popular areas with older people. NORC supportive service programmes as the solution of ageing-in-place provide the older people with another choice of ageing, which is different from the retirement village or nursing home, and the NORC participants can enjoy some of the services that the institutional care system could not provide, such as exercise and dance classes, trips and cultural events [36]. For the government, NORC programmes play a positive role in reducing the pressure of resource scarcity in the healthcare system [37]. However, it must be clarified that NORCs are different from NORC Service Support Programmes where multilevel collaborations, services and supports are provided to those NORCs with a high proportion of older people. Governments should provide NORC service support programmes to existing NORCs, with the ultimate purpose of providing an age-friendly urban environment to facilitate older Australians' ageing-in-place.

Nevertheless, neither academic research nor government policies recognise this housing option for older Australians. Although the Advisory Taskforce on Residential Transition for Ageing Queenslanders [38] recommended that the Queensland Government and the local governments provide incentives for the development of NORCs as one of the diverse age-friendly housing solutions, no relevant initiatives are available to date, most likely as NORCs do not fit the definition of a retirement community. However, NORCs present a huge opportunity for governments because supporting ageing-in-place can ultimately result in significant public expenditure savings, particularly given the fiscal demands of institutional aged care and healthcare.

In addition, a high density of older population may lead to diverse social networks in later life, which are related to more positive outcomes, including better cognitive functioning [39], lower levels of depressive symptomatology [40], better outcomes in serious physical illnesses [41], reduced likelihood of loneliness and anxiety and increased likelihood of happiness [42]. Studies have found that in maintaining a positive attitude and preventing depression, the existence of a network of friends is as important as, or even more important than, the existence of family members [43]. The Robert Woods Johnson Foundation also emphasises that communities that provide social services and material support have a positive impact on the health of their residents [44]. Moreover, Cornwell, Laumann [45] found that an older adult's larger socialisation network of friends and the frequency of that socialisation positively impact their longevity. However, it should also be noted that while ageing-in-place and ageing-in-community may have the advantages of familiarity and maintaining one's connections, it may also set older adults up for social isolation, particularly if they have limited mobility or access to other people. Social isolation and loneliness have been shown to have negative effects on health and well-being [46].

The temporal distribution of NORCs shows that the formation of NORCs closely aligns with spatial distributions of older population, which could be caused by the in-migration (move into a certain area for permanent living inside or outside the state), out-migration (move out of a certain area to a more suitable place for permanent living) and ageing of existing populations [47]. The increase of high-high clusters and hotspots along the coastal areas, where most of the NORCs are located, might be very likely due to the in-migration of older household members (65+), given that many Australians would like to live in an

environment with seaside scenery, convenient seacoast facilities for activities and extending social networks. These people are known colloquially as 'sea-changers' [48].

Likewise, some of the rural residential suburbs and their neighbouring suburbs, such as Esk, Laidley, Boonah and Beaudesert, became ageing hotspots after a 10-year change of demographic mainly because of the out-migration of youth and tree-change in-migration of older people. The proportion of local young generations leaving their rural homelands was high—more than half of the cohort population in some cases [49]. Meanwhile, tree-change as a relatively nascent migration trend of urban residents moving towards inland regional areas of Australia becomes another option for some older people [50]. Clearly, NORCs in rural areas have the great potential to accommodate 'tree-changers', even though current facilities and services can be sparsely located/provided in these areas.

Compared with the increase of the above-mentioned hotspots for older people, the increase of coldspots in the inner city areas are mainly due to young people moving in for job opportunities, along with older people choosing out-migration for retirement [51]. On the contrary, the decrease of low-low clusters in inland areas, caused by the increasing proportion of older population, is mainly due to the natural ageing and younger generations moving out for job opportunities in capital cities or regional centres. Currently, how to better support older people who prefer to remain at home and independent in inland areas can be a challenge for the Australian society.

Understanding the distribution of hot and coldspots associated with NORCs may be useful in guiding governments in resource allocation and optimising investment to promote financial efficiency. As NORCs are clustered in the same hotspot areas, collaborations between industry and local governments across different NORCs, such as sharing the existing infrastructure and services (e.g., transportation and healthcare), will have the great potential to maximise their value to older people due to the increased economic scale. Since NORCs are based on the existing resources of the community, they may become a supplementary part of the local service delivery system. NORCs have become an opportunity to develop and/or strengthen community partnerships to improve how the community responds to the changing needs of residents as they age-in-place [11].

The growth of NORCs in the greater Brisbane region aligns with the phenomenon of population ageing not only in Australia but also in all developed countries. Today, more than 530 cities and communities from 37 countries are participating in the WHO's Global Network of Age-Friendly Cities and Communities; however, government structures are often isolated and lack flexibility to formulate and implement effective age-friendly programmes covering multiple disciplines. Working with local NGOs, citizen groups, service providers and other private sector entities, NORC supportive service programmes will enable local governments to integrate the vision of the age-friendly programme with the interests of older people, coordinate stakeholder priorities and leverage existing resources. With the identification of NORCs and their formation patterns, researchers, communities and local governments can collaborate to understand the local history, economic activities and experience of older residents in those NORCs to enrich policy planning. As the most popular interstate destination for people aged 65+ years (with 31% of interstate arrivals in 2015) [52], Queensland has launched the programme Queensland: An Age-friendly Community since 2016, aiming to ensure older people are free from age-related barriers that prevent community participation. The findings of this study provide a valuable data support this programme.

5. Conclusions

To support older Australians' preference for ageing-in-place, it is essential to provide a smart, sustainable and age-friendly urban environment [53,54].This study aimed to understand the distribution and formation of NORCs with temporal changes for the first time in Australia. As emerging age-friendly communisis, NORCs evolved rapidly in the greater Brisbane region, accommodating 7.2% of the older members of households, although accounting only for 1.7% (92) of the total census units in 2016. In addition, NORCs

were not developed randomly, but are mainly clustered or co-located along the Brisbane River and the coastline areas, which attract an increasing number of older people moving into these areas for retirement living.

This study provides both knowledge and practical implications for NORCs and urban development. First, the spatial analytic approach made the geographical reference data more accessible and comprehensive. It visualised and described the distribution patterns, temporal trends and geographic locations of NORCs at the city level. Second, a multilevel cooperation among local governments, industries and agencies can be developed to provide better services and urban environment for the older population in these areas. Finally, this research offers an approach to data visualisation to interpret the temporal and spatial distribution of NORCs.

This study has some limitations. First, although the geographical factors affect the clusters or outliers of NORCs, the development of NORCs may be driven by multiple factors, such as built environment, natural scenery, walkability, accessibility and health and social services, the information of which was not available in the Census data. The second limitation in the spatial analysis is the mutative unit, which was modified from CD in 2006 to SA1 in 2011 and 2016. Different units of analysis may change the findings, even though the changing may follow the life pattern of the local population. Thirdly, the distribution of nursing homes and aged care facilities may likely affect the growth and development of NORCs, whose pattern of influence needs to be explored in future studies. Fourthly, among the census units with a high proportion of older household members (65+), some of them (accounting for less than 0.5% of the total census units, and many located in national parks or remote usual areas) have a small number of total household members (less than 200). As a result, the proportion of senior residents in these census units can be easily affected by the relocations of older people, even in a very small number. Therefore, whether these census units can be identified as NORCs needs to be further investigated according to the actual living environment and neighbourhood relationship.

The occurrence mechanisms of NORCs requires further investigation in the future. An ageing policy and related services regarding NORCs may be promoted to provide better ageing-in-place for older Australians.

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Informed Consent Statement: Patient consent was waived due to no specific patient information was used in this study because the data set this search using was from the Australian Bureau of Statistics Census Data which is the open resources database can be visited publicly.

Data Availability Statement: Data are available in a publicly accessible repository that does not issue DOIs. Publicly available datasets were analysed in this study. These data can be found here: [www.abs.gov.au] accessed on 5 July 2021, Census TableBuilder, 2006, 2011 and 2016 Census-Counting Persons, Place of Usual Residence.

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