Article

Strengthening Sustainable Pathways by Detecting Variability in a Community's Resilience at the Sub-Local Government Level Using the GCRM

Lila Singh-Peterson [1,2,*], Igor Popvic [3], Shamshad Karatela [2,4], Nawin Raj [5] and David Batt [6]

[1] Centre for Applied Climate Science, University of Southern Queensland, Toowoomba, QLD 4350, Australia
[2] School of Agriculture and Environmental Science, University of Southern Queensland, Toowoomba, QLD 4350, Australia
[3] UQ Spatial Epidemiology Laboratory, School of Veterinary Science, The University of Queensland, Gatton, QLD 4343, Australia
[4] School of Public Health and Preventive Medicine, Faculty of Medicine, Nursing and Health Sciences, Monash University, Melbourne, VIC 3004, Australia
[5] School of Mathematics, Physics and Computing, University of Southern Queensland, Toowoomba, QLD 4350, Australia
[6] Bundaberg Regional Council, Bundaberg, QLD 4670, Australia
* Correspondence: lila.singh-peterson@unisq.edu.au

Abstract: Enhancing community resilience has become increasingly important in preparing for, responding to, and recovering from disaster events. Determining how levels of community resilience vary across a local government area provides nuanced information from which targeted programs and initiatives can be developed, implemented, and evaluated. This study applies the Gympie Regional Community Resilience Metric (GCRM), developed with a local government organisation, and a community disaster sub-group in rural Queensland, Australia, and applies it to a larger, coastal region of Bundaberg, Queensland. Completed survey results returned by 696 households from across the region revealed that the Bundaberg community is generally well-prepared for disasters, with strong social networks and understanding of local risks. However, there are areas for improvement, such as increasing participation in local clubs and addressing the needs of those lacking confidence in obtaining help during disasters. Other findings indicate that the evidence of high levels of local knowledge and disaster experience within the community could provide opportunities to establish neighbourhood networks that aim to share local knowledge and experiences and enhance localised networks of support, particularly for more vulnerable and newer residents.

Keywords: community resilience; disaster management; policy initiatives; risk and resilience; climate change; local government; Australia; rural resilience

1. Introduction

In the twenty years between 2000 and 2019, there have been more than 7300 major disaster events reported worldwide, which have affected more than 4 billion people and resulted in 1.23 million deaths [1]. Although the number of disaster-related mortalities has decreased (by 49%) since 2005, the number of people affected by disasters has significantly increased by 71% [2]. There are many complex reasons why death rates have decreased whilst the numbers of those affected have increased. Some of the factors attributed to reduced mortality rates reflect success in improving levels of disaster resilience by addressing vulnerabilities in infrastructure, planning, and design, and enhancing the

adaptive capacity of local residents. However, undeniably, these trends also represent rapidly increasing numbers of displaced people moving away from climate-related dangers and vulnerabilities. Conservative estimates identify that, during 2023, about 26.4 million people, across 148 countries and territories, were internally displaced due to the cascading effects associated with climate-induced disaster events [2]. These numbers continue to increase each year, with around 7.7 million people in 2023 displaced due to climate change effects [2].

Within Australia, where this study is located, around 248,000 people were displaced due to climate-related disasters between 2008 and 2023. Of that number, almost 160,000 people were displaced in the last five years between 2018 and 2023, as climate-related impacts have made livelihoods in some areas unsustainable [2]. Over a longer time period, between 2008 and 2023, 149 climate related disaster events were reported in Australia. These disasters resulted in 96,000 people becoming displaced from their homes due to wildfire and 88,000 people displaced due to flooding, whilst 64,000 people were displaced due to storms [2]. Climate projection data and historical trend data indicate that Australia, as elsewhere, will continue to experience more intense bushfires and storms, prolonged droughts, and severe flooding, as well as devastating marine heatwaves, which will continue to produce significant ecological, economic, and social impacts across the continent [3,4].

Against this background, in order to drive future planning and development towards sustainable futures, the resilience concept continues to hold relevance and to be favoured as a central concept in government policy and programming [5], despite challenges in applying the resilience concept [6,7]. Resilience occurs when a community retains the capacity to absorb disturbances, such as climate change impacts or other environmental or social crises, while retaining the same basic structures, identification, and ways of functioning [8]. Criticisms of the resilience concept are often focused on the lack of recognition of power imbalances within communities, which render some members more vulnerable, with access to fewer resources and services than others in the community. For instance, Oliver-Smith (2016) posited that the ideals of sustainable resilience pathways may inadvertently reflect hegemonic, inequitable power structures that reproduce social vulnerabilities [9]. As modes of exchange and distribution are socially and culturally embedded, the process of building resilience itself is "culturally constructed, and socially enacted" [9] (p. 293). As Folke (2006) argued, resilience "is also about the opportunities that disturbance opens up in terms of the combination of evolved structures and processes, renewal of the system and emergence of new trajectories" [10] (p. 4). Accordingly, in empowering local communities to identify and co-develop equitable and sustainable future pathways that are cognizant of changing climate conditions, the resilience concept becomes a foundation from which planning and programs can be grounded. Community resilience, in this context, is then focused on the resilience of a diverse local community in a given location.

In Australia, the resilience concept is also embedded in national- and state-level policies and programs, which enable and support this localised process. In 2009, the Council of Australian Governments [11] first implemented a national resilience approach to disaster management that emphasises the importance of a cooperative and coordinated effort to enhance Australia's capacity to withstand and recover from emergencies and disasters. The National Strategy for Disaster Resilience outlined how the country could achieve this COAG vision, highlighting a whole-of-society approach to shaping a resilient future, and responding and preparing for disasters. Australia's National Disaster Risk Reduction Framework, released in 2019, further advanced these platform policy initiatives. Similarly, Australia's 2030 vision for disaster risk reduction, articulated in the Sendai Framework for Disaster Reduction 2015–2030, and the first and second National Action

Plans collectively act to align and direct Australia's resilience and risk reduction efforts into a coordinated approach [12].

Key to applying and operationalising the concept of resilience is being able to measure variability in levels of community resilience [13–18]. Measuring and monitoring the factors that contribute to a community's resilience allow for the identification of areas of concern where resilience is declining, or where targeted programs have been ineffective in addressing vulnerabilities. Even by identifying areas of weaknesses or vulnerability that affect overall levels of community resilience, and, conversely, by understanding areas of strengths, this information enables policy makers to identify where targeted policies and programs are needed, or their effectiveness and the trade-offs that may have resulted. Importantly, this also moves local governments beyond conceptual applications of resilience and towards more objective approaches that assess the potential contributions and benefits of resilience-enhancement initiatives [19]. In the last few years, there has been some progress in developing metrics capable of detecting levels of resilience. The Australian Natural Disaster Index progresses this objective by detecting differences between local government areas [20], which assist state-level and national-level government departments and first-responder organisations to direct and focus resources.

At a finer scale, at the sub-local government level, the Gympie Community Resilience Metric (GCRM) was developed to detect differences in resilience at multiple interconnected spatial scales, including at the household scale, at the community level, and across the local government area [17]. The GCRM was developed collaboratively with researchers, Gympie Regional Council, local community members, and resulted in part from several research activities with neighbouring local governments in Queensland, Australia.

In this article, we present the results of the application of the GCRM to a larger, more urbanised local government area in Queensland, the Bundaberg Regional Council, and evaluate the effectiveness of the GCRM in providing useful information that can aid policymakers in their objectives of enhancing their community's resilience to disaster events. In this study, the GCRM's household survey was used to identify risks and responses to climate-related disasters. In total, 751 households responded to Bundaberg Council's request to undertake and return the survey, with 696 fully completed surveys utilised in the analysis of results described in this article. We argue that the application of the household survey of the GCRM has provided some great insights into levels of vulnerabilities and strengths for diverse cohorts residing within the Bundaberg regional population.

2. Methods

2.1. Case Study Location

Situated on the Burnett River, Bundaberg is a local government area with 99,125 inhabitants in the Wide-Bay Burnett region of Queensland, Australia (Figure 1) as of the time of the study. It is located approximately 360 km north of Brisbane, the capital of the state of Queensland [21]. Bundaberg faces several population inequalities relative to the rest of the state and nation, particularly its older demographic, which presents significant challenges for disaster management and community development services.

The median age of Bundaberg residents in 2021 was 47 years, which is higher than both the Queensland and Australian median age of 38.3 years [22]. Additionally, Bundaberg has a higher percentage of residents over 50 years old and a lower percentage of those under 50 years old in comparison with the Queensland average [22]. Moreover, a larger proportion of the population in Bundaberg (8.3%) requires assistance for core activities as compared to the Queensland (5.2%) and Australian (5.1%) populations. Consequently, a larger proportion of the population in Bundaberg provides unpaid assistance to a person

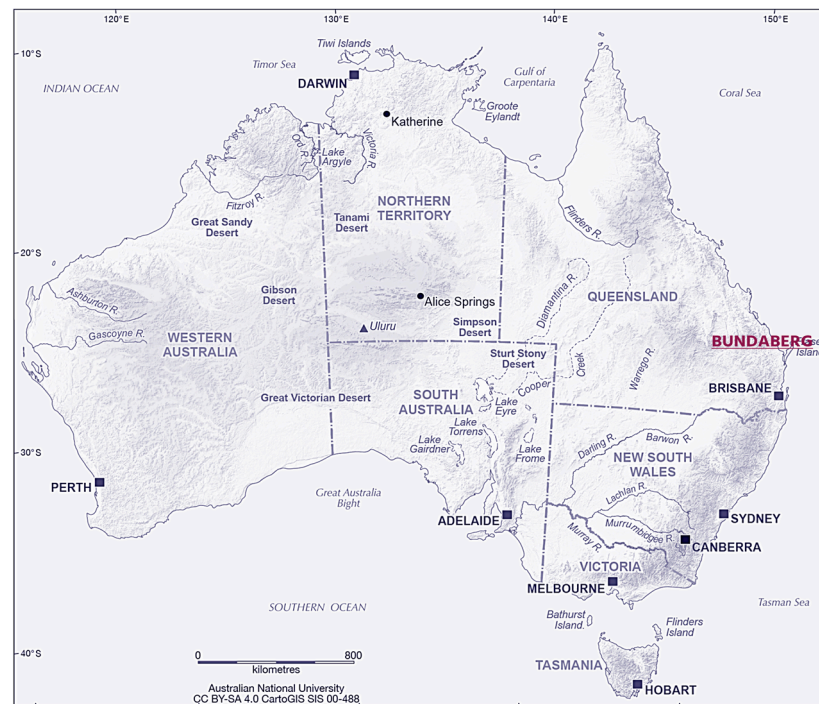with a disability (13.7%) as compared to the Queensland (11.5%) and Australian (11.9%) populations [22].

Figure 1. Bundaberg, Queensland, Australia (Source: Map reproduced with the permission of CartoGIS Services, Scholarly Information Services, The Australian National University).

Furthermore, a greater proportion of individuals in the Bundaberg local government area earn a median weekly income of less than AUD 650/week (28.1% of the population), in contrast to the Queensland (19.5%) and Australian (20%) populations [23]. Additionally, the unemployment rate in Bundaberg (6.8%) is also higher than the Australian unemployment rate of 5.1% [22].

2.2. The Gympie Community Resilience Metric (GCRM)

The GCRM was developed as a multi-scalar framework for measuring community resilience in the Gympie region, Queensland, Australia. At the time of development, the region of 7000 square kilometres was home to just fewer than 50,000 people [17]. Gympie also experiences regular flooding events and like Bundaberg, the Gympie population also experience higher rates of socioeconomic disadvantage compared to rural Queensland averages [17].

Following the evaluation of several community resilience metrics [7,17,24], the development of the GCRM involved two primary consultation groups: a Steering Committee established by Gympie Regional Council (14 members, predominantly senior local government officials) and the Cooloola Cove local disaster management sub-group (21 volunteers). The framework assessed resilience at three spatial scales: household, community, and at the Local Government (LGA) level. Household and LGA scales utilised quantitative indicators, while community-scale measurements employed qualitative indicators to additionally promote social knowledge sharing and network building. LGA-scale indicators were developed for a local government to broadly scan across the region and identify interactions with other actors (such as state governments and industry bodies) who have significant impact on local communities through initiatives like infrastructure provision and maintenance, the maintenance and planning of natural capital like National Parks, or the employment of significant numbers of local people. These interactions greatly impact local communities

but are often beyond the influence of local governments. The community-scale qualitative indicators were then developed to provide greater context for the development of policies and initiatives on areas identified through the application of the household scale metric referred to herein as the GCRM household survey.

The purpose of the household-scale metric was to provide a survey tool that local governments could regularly utilise to monitor diverse levels of community resilience between households and between towns within the local government area (LGA). Local governments, and local disaster management authorities (LDMAs, see [16]), were regularly engaged at this scale to address vulnerabilities and enhance resilience for local communities. For this reason, the Bundaberg study presented herein is concentrated only at the household scale and utilises the GCRM household survey.

The conceptual framework underpinning the development of the GCRM was based upon the three components of resilience: buffer capacity, capacity to learn, and capacity to self-organise [25]. The buffer capacity required by households and by communities considers capacities to prepare, cope, recover, and adapt to changes in climate and ongoing disaster events. These include both endowments, which are assets owned by individuals and the community, and entitlements, which relate to the community's access to resources. In the GCRM, these assets are organised around Bourdieu's capitals [26]. For example, they include human capital (skills, leadership, knowledge of the community), social capital (social networks, shared values), natural capital (access to fresh water, fertile soils), and infrastructure, amongst others. Capacity to learn, however, recognises that enhancing a community's resilience is a dynamic, incremental, or transformative adaptive process, based on prior experiences, new technologies, innovation, and new understandings. Learning is based on acquiring skills and knowledge and translating these into action, which occurs at the individual, community, and institutional (e.g., local government, community disaster sub-group) scale and is evident when behaviours change [27].

The third component, capacity for self-organisation, highlights how human agency, adaptive capacities, and social interactions shape socio-cultural structures that support a community to be self-reliant and self-directed. General or autonomous self-organisation can be thought of as the spontaneous emergence or reproduction of a society's dominant rules, values, and norms [25]. Pragmatically, the skills to create a new normal or new system equilibrium through incremental or transformative adaptation can be attributed in part to the capacity of a community for self-organisation and continual learning. In the GCRM, the inclusion of indicators around learning contexts and self-organisation capabilities responds to society's need to adapt and, where needed, transform [17]. The interconnectedness and capacity of individuals, embedded within local communities, to contribute to a community scale effort to enhance a community's resilience is also assessed in the GCRM, as are the needs within a community for assistance and support. Further information regarding the rationale for the selection of indicators, development, and initial evaluation of the GCRM have been presented in Singh-Peterson and Underhill (2017) [17]. A copy of the household-scale GCRM is attached as a Supplementary Material. Due to the size of the data generated by the GCRM, in this article, we focus on key areas of interest to the local government—these are preparedness, social cohesion, and capacity for self-organisation, which were assessed as capacity for learning, leadership, and creativity/innovation.

2.3. Survey Rollout and Respondents

To operationalise the GCRM, the survey was printed and posted to residents registered on the property tax rates database by Bundaberg Regional Council. Within three weeks, 696 fully completed surveys were returned to the Council, providing a robust sample size for analysis. In total, 751 surveys were returned, but 55 surveys were excluded as they were

largely incomplete. De-identified data were then analysed utilising descriptive statistical analyses performed with R 4.2.0 and IBM SPSS v29 software.

The survey achieved a total response rate of 696 participants across the Bundaberg region, providing a robust sample size for statistical analysis. Gender distribution analysis revealed a relatively balanced representation, with 355 females (51.01%, CI 95% [47.3%, 54.7%]) and 293 males (42.10%, CI 95% [38.4%, 45.8%]), while 21 participants (3.02%) preferred not to specify their gender. These proportions broadly align with the regional demographic profile, although there was a slight overrepresentation of female respondents ($\chi^2 = 6.82$, $p < 0.05$).

Age distribution analysis revealed significant demographic skewing toward older residents, with 382 participants (54.89%) aged 61 years or older, representing a substantial overrepresentation compared to regional population statistics ($\chi^2 = 23.45$, $p < 0.001$). The middle-aged cohort (36–60 years) comprised 263 participants (37.79%), while only 31 participants (4.45%) fell within the 18–35 age bracket, indicating a significant underrepresentation of younger adults ($\chi^2 = 31.22$, $p < 0.001$). Ten participants (1.44%) did not specify their age category. This age distribution skew necessitates careful consideration when generalising findings to the broader population, particularly for younger demographic segments.

Geographical distribution analysis demonstrated a predominance of rural respondents, with 468 participants (67.24%) residing in rural locations compared to 192 (27.59%) in urban areas, while 18 participants (2.59%) did not specify their location. Chi-square analysis indicates that this distribution significantly differs from the regional population distribution ($\chi^2 = 18.93$, $p < 0.001$), with rural residents overrepresented in the sample. This skew, while presenting limitations for urban-focused analysis, provides robust data for examining rural community resilience patterns.

Cross-tabulation analysis revealed significant associations between age and location variables ($\chi^2 = 42.67$, $p < 0.001$), with older residents more likely to reside in rural areas. Specifically, among rural residents ($n = 468$), the majority of participants (53%) were aged 61+ years, and just over 40% were aged 36–60 years. Only 31 participants (6.6%) were aged 18–35 years. This distribution pattern suggests potential interactions between age and location factors in community resilience measures, warranting detailed examination in subsequent analyses.

3. Results

3.1. Evacuation Options and Plans

Almost all survey participants (87%) indicated that they had a good understanding of local natural hazards and potential consequences of living in their environment (see Table 1 and Figure 2). A large proportion of respondents (79%) reported having considered evacuation options and 627 participants (84%) felt confident in their ability to prepare for, and manage extreme weather events. Additionally, 83% of respondents had taken steps to minimise, or mitigate the risks and impacts to their households and livelihoods.

These results indicate that the vast majority of people were very aware of the risks to themselves, their families, and their communities from extreme weather events and further cascading impacts (see Table 1).

When cross-analysing these data with the people who lived in the urban centre of the local government area, ($n = 192$ of 696), it became apparent that the majority (85%) of the urban cohort were confident that they knew how to prepare and cope with most disaster events, and that most (79%) knew when to evacuate, whilst almost everyone knew what the natural signs (e.g., river heights) were to monitor. In addition, about 70% of urban residents had someone that they could call for assistance if needed, and had responded to someone's call for help. These results were consistent across the age groups.

Table 1. The proportion of responses to Question 1: Identifying Potential Risks and Understanding Impacts.

% Participants	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	No Response
1a. I understand the potential natural risks to my household and livelihood (e.g., bushfire, flooding).	49	38.5	5.5	3	1	3
1b. I am aware of what impact may arise from those risks (e.g., flooding may result in landslides etc.)	50	36	6	2	1.5	4.5
1c. I am confident that I know how to prepare for and cope with most events.	40	44	10	3	1	2
1d. I have taken actions to reduce risks to my property or livelihood, and potential impacts.	39	44	9.5	3.5	1	3
1e. I know when it is time to evacuate and have considered various evacuation options.	41	38	14	4	1	2
1f. Prepared to stay at home or go to an evacuation centre if my house is at risk.	52	35	5.5	3.5	1.5	2.5
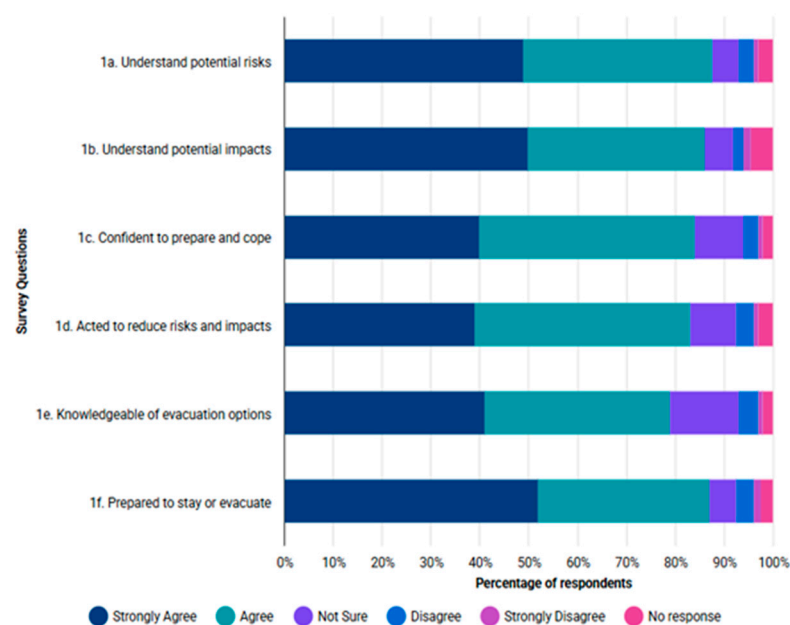
Figure 2. Varying levels of respondents' awareness of local risks, likely impacts, and preparedness.

More than 72% of the survey respondents lived in the rural parts of the LGA. Of these, 88 (13%) were uncertain about their evacuation plans, and 22 people (6%) were unsure about how to decide whether to stay or evacuate. Twenty-four participants (4%) had not considered evacuation options. Together, these comprise more than 25% of the rural cohort, which is concerning but understandable, as evacuation by road can become complex over longer distances. Over 80% of the rural cohort who were unsure about their evacuation choices were in the older age group (over 61 years). We note that it is unlikely that there is a one-size-fits-all plan for all rural residents who will need to navigate different landscape features that may be at risk during different types of disasters. The diverse experiences and knowledge of neighbours, particularly of those who have lived in the area for some time,

is therefore an important resource that could assist those who have yet to determine their evacuation plans.

3.2. Household Preparedness

The majority of respondents reported that they were prepared for a disaster event, as depicted in Figure 3 and Table 2. Specifically, 94% of respondents had 3 days of food on hand, whilst more than 93% of respondents had 3 days of water. Additionally, most respondents had access to non-electrical lighting (92%), key documents (93%), and medicine (92%). Table 2 presents the proportion of participants who responded positively and negatively to these questions.
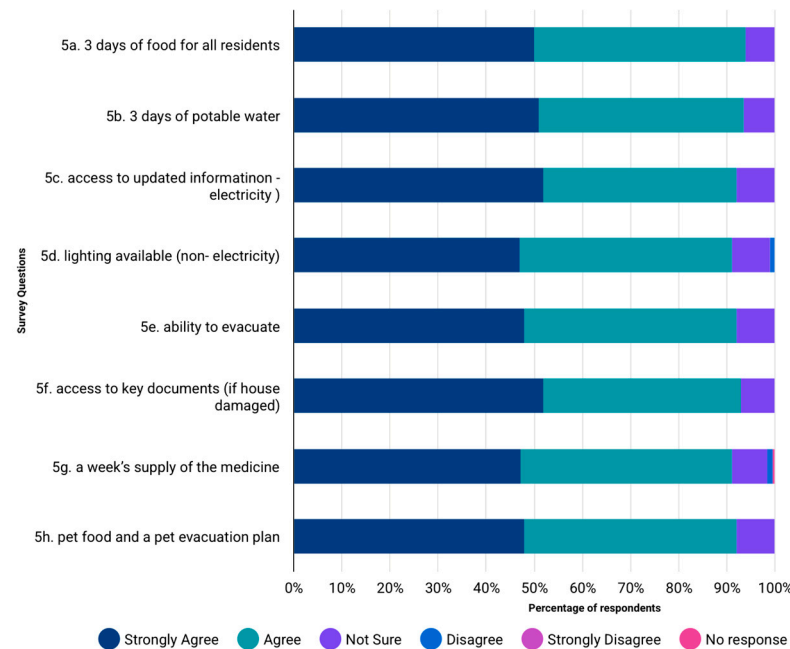

Figure 3. Respondents' self-reported level of household preparedness.

Table 2. The proportion of responses to Question 5: Preparedness.

% Participants	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
5a. At least 3 days of food available for all residents?	50	44	6	0	0
5b. At least 3 days of potable water available?	51	42.5	6.5	0	0
5c. Access to updated information which is not dependent upon electricity (e.g., radio)?	52	40	8	0	0
5d. Lighting available which is also not dependent upon electricity.	47.5	44.5	8	1	0
5e. The ability to evacuate if need be.	48	44	8	0	0
5f. Access to key documents should something happen to your house.	52	41	7	0	0
5g. A week's supply of the medicine that our household currently needs.	47.5	44	8	1	0
5h. Enough pet food and a pet evacuation plan.	48	44	8	0	0

These results are consistent with general preparedness recommendations from government and first-responder organisations, which typically suggest that households should have 3 days of provisions. However, it is worth noting that participants from a study in the nearby region of Gympie [17] suggested that 10 days of supplies was needed following extreme flooding events. It is suggested that, for rural communities, particularly those likely to be flood-affected, that the preparedness indicator may need to be revised to suit local conditions for Bundaberg rural residents in the future.

These results were equally distributed across gender and age categories. The lack of preparedness was not associated with a particular gender or age group, nor was it more prevalent among urban residents. It was also noted that 15 respondents who had lived in rural areas previously did not have 3 days' worth of food at the time of the survey. This result may be indicative of a household's financial stress leading to a lack of preparedness, rather than a lack of awareness.

3.3. Demographic Features of Those Well-Prepared and Knowledgeable About Local Conditions and Evacuation Options

To identify the cohort who displayed confidence in planning and implementing their own preparedness strategies, as well as those who understood local conditions and evacuation options, we analysed the cohort who responded positively (agreed or strongly agreed) to questions 1a–1f, 2c, 3a–3c, 3e, 5a–5h (see survey attached in Supplementary Materials).

There were 187 people in this cohort who displayed a range of demographic features, which could cautiously be considered as predictors of preparedness. Of this cohort, rural residents demonstrated significantly higher preparedness levels (86.47%) compared to urban residents (78.18% of urban residents). This substantial difference persisted after controlling for age and gender variables in multivariate analysis (adjusted OR = 3.62, 95% CI [2.48, 5.28], $p < 0.001$). Noticeable preparedness indicators showed that varying rural–urban disparities included the knowledge of evacuation routes (rural (89.2%), urban (72.4%), $\chi^2 = 18.45$, $p < 0.001$), emergency supplies (rural (84.6%), urban (68.8%), $\chi^2 = 15.82$, $p < 0.001$), and difference in non-electricity forms of communication plans (rural (78.9%), urban (65.2%), $\chi^2 = 12.93$, $p < 0.001$).

Age also emerged as a significant predictor of preparedness levels, with older adults showing higher preparedness scores across multiple measures. The age distribution of well-prepared respondents showed clear relationships, with about 49% of respondents being 61+ years of age, 43% between 36 and 60 years and 25% of the 31 respondents aged between 18 and 35 years included in this cohort. Multiple regression analysis revealed significant interaction effects between age and location (F = 8.92, $p < 0.001$), suggesting that age-related preparedness patterns differ between rural and urban contexts.

There was not a great distinction between genders, with a slightly higher proportion of females (52%) in comparison to males (42%) identifying as well-prepared and retaining good local knowledge of climate-related risks and evacuation options.

3.4. Willingness to Offer Support or Accept Help

Questions 17 and 18 of the survey enquired if individuals were willing to offer support to others or if they had accepted help during a past disaster event. Table 3 presents how survey participants responded to these questions.

Just under half of the survey participants claimed that they did not know anyone they could help, whilst 44% of the cohort answered that they did not know anyone who could offer them aid. A further 38% of respondents simply responded that they would not need assistance. This is a significant proportion of survey respondents who could not identify someone who would help them in a disaster event, and an equally large number of

potentially willing respondents who did not know someone that they could assist during an emergency. Also depicted in Figure 4, more than 40% of respondents said that they do check on others and 20–25% have assisted others during an emergency, either informally or formally through their profession or status. These results indicate potentially effective local networks of those willing to offer assistance and those seeking support which indicates an opportunity for greater connection between households and their immediate community.

Table 3. The proportion of responses to Question 17 and 18: Social support who agreed with each statement.

| % Participants	Agreed (%)
17a. I do not know of anyone to offer my assistance.	47.6
17b. I am normally the person who checks in on others to see if they need assistance.	38.7
17c. I traditionally have a role to play during an emergency or disaster.	21.3
17d. I am a member of an emergency response or community welfare group active during an emergency.	24.5
18a. No, I do not really know anyone here, but I would accept assistance if required.	43.9
18b. I know that there are people in my community that will check on me to see if I am okay, so I will accept this assistance when needed.	51.5
18c. No, I cannot think of a situation where I would need to accept assistance.	37.8
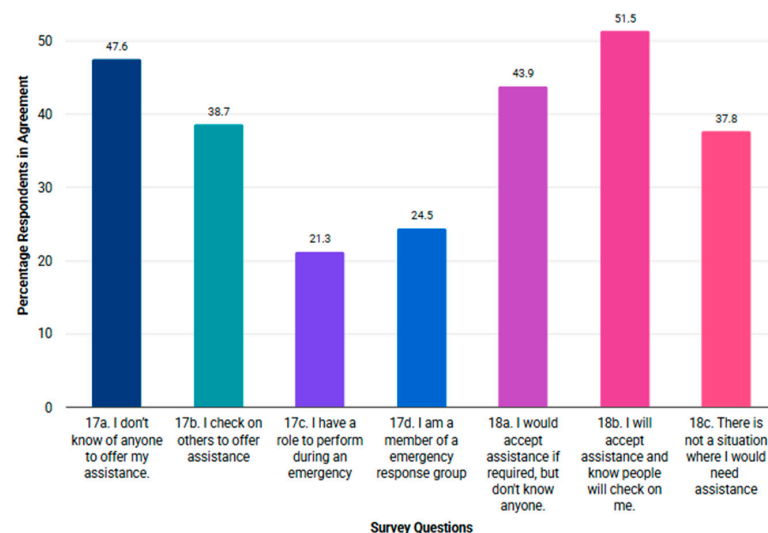
Figure 4. Proportion of survey respondents who would offer or accept assistance.

3.5. Community Members' Understanding of Localised Risks and Impacts

The survey revealed that 609 individuals (87.5%) reported actively monitoring environmental changes around them, and were aware of the warning signs such as river heights and weather patterns that may produce disasters in their region. Additionally, 603 individuals (87%) felt informed about potential disasters through social networks or media. However, 125 respondents (18%) felt that they were not alerted promptly about possible disasters such as flooding or extreme weather events. This finding provides another potential policy or programming inception point, where emergency responders and communication experts could provide further assistance.

Identifiable data generated from the survey could be used by the local government to determine whether these respondents comprise clusters of people who live within a particular area, where for instance, cell phone coverage is lacking. Alternatively, by

reviewing demographic data generated by the survey, Bundaberg local government may be able to identify an association of people who had difficulty receiving warnings with age, levels of digital literacy, or language preferences. Once identified, programs could be initiated to support this cohort within the community.

3.6. Challenges for Assessing Information and Age-Based Preferences of Media Formats

Overall, the survey respondents exhibited relatively high levels of personal resilience. More than 84% of the 696 survey respondents reported having an emergency plan with which all household members were familiar. Regarding previous emergency events, 518 respondents (74%) had shared and received resources and information with others, while 229 people (33%) received assistance. It is worth noting that fewer than 70% of the respondent's expressed confidence in their ability to access information if there was no power. Specifically, 88 people (13%) reported that they could not access information if there was not power to operate the internet, television, or the radio and if roads were blocked. Table 4 presents the survey respondents' preferred sources of information.

Table 4. Information sources that respondents relied upon.

% Participants	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
10a. Internet—general	25	45.5	8.9	10	10.4
10b. Social media	23.6	38.7	8.9	15	15
10c. Community newsletters	24.5	39.6	10.1	13.2	12.7
10d. Friends and family	23.6	39.4	8.9	15	13.24
10e. Conferences and workshops	22.6	39.6	9.6	13.8	14.5
10f. Newspaper	26.5	38.7	8.9	13.8	12.2
10g. Television	24	39.4	8.9	14.5	13.2
10h. Radio	26.5	36.3	9.6	13.8	13.8

Previous research conducted in the Gympie and Sunshine Coast regions determined that accessing information during disaster events was an important issue for several rural communities [17]. Information provided by the internet was utilised by more than 70% of the respondents, followed by the newspaper (65%), community newsletters (64%), the television (63.4%), and radio (62.8%). Some of the most popular sources of information among the survey respondents are presented in Table 4, but it is important to note that the survey sample cohort heavily skewed towards the older age categories. Social media and workshops/conferences were the least popular sources of information. The survey results also indicate that residents in rural areas do not necessarily have different information preferences than urban residents, but consideration of the practical limitations in accessing information in areas where telephone and internet coverage is lacking is warranted. These findings also suggest that urgent information communicated only via the internet or social media may not reach a significant portion of survey respondents (older demographics).

3.7. Tensions Between Agency and Social Cohesion During Disaster Events

In times of crisis, responding to instruction from unknown people can be an immensely stressful task, particularly in rural environment where the person issuing the directions is not familiar with local conditions, nor are they a member of the local community. Earlier research identified that a number of participants at forums conducted in Gympie shared their grievances about the absence of agency and control they had in determining their own response to a prior disaster event [7]. As a result, indicators pertaining to leadership

were devised for the GCRM, such as confidence in leaders, the capability to comply with instructions, and the availability of local leaders and decision-making mechanisms. These indicators relate to the shared responsibility mandate of disaster management. However, in reality, particularly in rural localities where resources are relatively sparse, communities need to be able to support one another during and following disaster events. These indicators reiterate that there is local knowledge and there are leaders within the community who are willing to be called upon to assist other local people.

A total of 185 respondents (27%) reported that they were not connected to any school or community networks. Of this sub-cohort, 72% (57 people) were not involved in any clubs or school communities. Despite this, the majority of respondents reported having contact with the local government officers, and most had confidence, or were unsure, that local government officers would listen and respond to their concerns. Additionally, most respondents expressed confidence in their elected local government representatives, with about 20% of the cohort responding that they did not have confidence in their representatives. However, 201 (30%) respondents knew of more than three individuals whom they would describe as local leaders.

3.8. Capacity to Recover and to Support Adaptation and Transformation Activities

The ability to lead and follow others can be critically important during disaster events especially in rural communities where external assistance by first responders may not be immediately available. In the final section of the survey, respondents reported on their level of confidence to lead and direct their families and others, as well as their confidence to follow other leaders. Figure 5 illustrates the results of this section; 29% of respondents had experience coordinating community-scale responses, and an additional 48.7% were confident in their skills and knowledge to make innovative decisions to cope and respond during emergencies. Among the respondents, 48.7% also lacked confidence in taking charge.
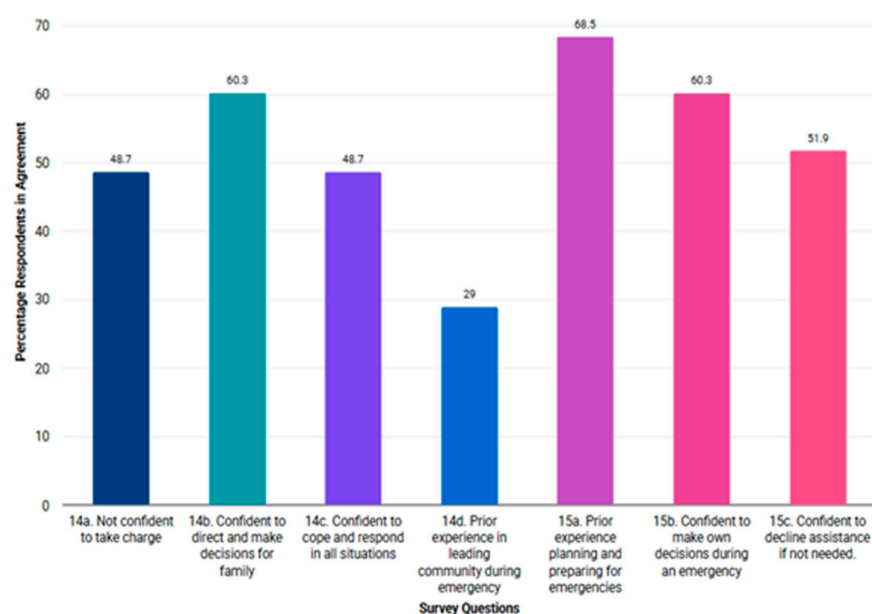

Figure 5. Experience and ability to lead or follow instructions.

In rural communities, where the population may be spread across a large area, local leaders are important in supporting and guiding their neighbours during disaster events. Local government could refer to identifiable survey respondents' postcodes to determine where people were located in relation to those who answered that they did not know of a

local leader or where those who were unsupported were grouped. These results potentially indicate that a mentoring or civil leadership group could be established to assist other community members to establish evacuation and preparedness plans that align with the work of local government and first-responder agencies.

3.9. Capacity for Learning and Innovation

For a community to adapt to ongoing disasters, such as extreme weather events, the ability to learn and self-organise is crucial. This capacity allows for the creation of new technologies, new understandings, and the reproduction of social rules and norms underpinned by established social values. Questions 9, 11, 12, and 14 in the survey assess an individual's ability to learn, teach, and create, and their confidence in applying these skills. When examining the learning and teaching context, most respondents considered themselves to be lifelong learners. However, 316 respondents (45.4%) who identified as lifelong learners also answered that they had no time to pursue their own interests at the time of the survey. Additionally, 192 respondents stated that they had no interests other than family, friends, and work. We acknowledge that, for many people, work activities can provide many opportunities for learning and growth, which this indicator does not consider. A future development of the GCRM could consider refining these indicators to better capture the act or result of ongoing formal and informal learning.

Question 12 presents a scenario of independent learning, where learners are required to follow instructions from a webpage and asks whether they have the ability and confidence to share their learning activity and newly acquired knowledge. Out of the 696 respondents who answered this question, just over half chose one of the positive options when asked to instruct others, which suggests that, for the remaining cohort, there was a lack of confidence or interest. Table 5 presents the percentage of respondents who agreed with the various statements regarding learning/teaching and creativity. However, the ability to learn, apply, and share knowledge is an important indicator of the capacity to innovate, adapt, and transform, which we consider is not adequately captured in the current survey and has been identified as an area for future improvement. Similarly, the survey assessed the capacity for creativity and innovation by asking whether people are currently engaged in creative pursuits. Of the respondents, more than 50% were involved in creative activities, and half of the participants stated that they often created something and embraced creativity. Furthermore, about 40% of respondents were current owners of businesses that sold products that they had built, designed, or created. These results indicate that within the community there are innovators and creative thinkers who could assist with preparing or responding to disaster events, and the development of strategies to adapt to ongoing climate-related disaster events within the local community.

Table 5. The proportion of responses to Questions 12 and 13: Learning/Teaching and Creativity.

% Participants	Agreed
12a. Happy to instruct others	51.2
12b. Confident instructing others, but only after I have perfected this skill a few more times	50.5
12c. I would rather refer people to my website and other information sources, in case I have misinterpreted an instruction	44.3
13a. I do not really have time to think about being creative and innovative	46.8
13b. Somewhat, I do enjoy working with my hands and have produced something creative.	53.7
13c. Yes, I embrace creativity—you just have to see the many creations in my house	50.5
13d. Yes, as part of a business, I sell products that I have built, designed, or created	40.7

3.10. Demographic Features of Those Indicating Confidence to Learn, Innovate, Lead, and Teach Others

To identify the cohort of respondents who were confident to learn, innovate, lead and teach others, we grouped people who answered agree or strongly agree to specific survey questions. These were: 3c, 5e, 9a or 9b, 11a or 11c, 12a or 12b, 13b or 13c or 13d, 14b or 14c or 14d, 16b, 17b or 17c or 17d. Overall, there were 106 participants (15.2%) who expressed confidence in their ability to learn, innovate, lead, and teach others. This cohort was relatively balanced in terms of gender, with 52% males and 43.4% females. The age distribution showed a majority of people aged 36–60 years (54%), followed by those aged 61+ years (40%), and a small fraction aged 18–35 years (5%). In this younger age group, there were five respondents in this cohort, which accounts for 17% of those (in this age range) who participated in the survey. The majority of this cohort resided in rural areas (69.81%), compared to 26.42% in urban locations. Specific demographic trends indicated that middle-aged females (36–60 years) residing in rural areas (20.75%)

These findings suggest that rural residents may have more opportunities or feel more confident in their abilities to learn, innovate, lead, and teach others. These results may also reflect rural cultures and traditions of self-reliance and solidarity, although the study does not examine this topic. The underrepresentation of younger individuals (18–35 years) indicates a need for targeted programs to build confidence and leadership skills in this age group. Additionally, the experience, confidence and leadership qualities identified in rural communities could be co-ordinated, and leveraged to further enhance community resilience and development by local government and first responder agencies.

3.11. Demographic Features of Those Without Support

The analysis in this section focused on negative responses to the survey question "I have someone close by who will help me out in times of crisis". Overall, 120 people (17.2% of respondents) answered that they either disagreed or strongly disagreed with this statement. Demographic features of this cohort indicated that more men (56%) than women (43%) were grouped in this cohort, and a significant portion of the cohort was aged 61+ years (45.00%) and 36–60 years (44.17%). A smaller percentage was aged 18–35 years (10.83%), which comprised 13 of the 31 (42%) people in this age range who participated in the survey. Of this group, only one person identified as female, and all respondents resided in rural locations. When considering the underrepresentation of this younger age group in the sample, this result is quite alarming.

Overall, the majority of the cohort lives in rural locations (65.00%), while a smaller percentage lives in urban locations (35.00%). This suggests that people in rural areas are more likely to feel unsupported and isolated in comparison to those in urban areas, although further work is required to examine the complexities that combine to form feelings of being isolated, and unsupported.

4. Discussion and Evaluation of GCRM

The survey results from the Bundaberg region indicate a generally high level of awareness and preparedness among residents regarding potential hazards and consequences. A significant majority of the survey sample demonstrated a good understanding of local risks, and the GCRM was effective at determining differences in survey responses based on location, gender, and age. Furthermore, the vast majority of respondents have a strong understanding of the potential environmental risks and associated impacts on their households and livelihoods. More than 80% of respondents had considered evacuation options and felt confident in managing extreme weather events, whilst most had already taken steps to minimise risks to their households and livelihoods. However, the survey also

highlights disparities in preparedness levels between urban and rural areas. While urban residents displayed confidence in preparing for and coping with disasters, a significant portion (over 25%) of the rural cohort expressed uncertainty about evacuation plans. This concern is understandable, given the complexities of rural evacuations over longer distances and diverse landscape features. Specifically, more than 80% of the rural residents who were unsure about evacuation choices were in the older age group. This suggests a need for targeted interventions that address the unique challenges faced by older rural residents in developing effective evacuation strategies, particularly if they struggle with disabilities. The diverse experiences and knowledge of neighbours, particularly those with long-term local experience and those who have enacted their own adaptation and evacuation strategies, could serve as valuable resources for those still determining their emergency response plans.

These encouraging findings are in keeping with other studies that found that people who had experienced a flood before were more likely to take preventive measures in the future, such as installing flood barriers or elevating their homes [28,29] or creating an emergency kit and developing a family communication plan [30].

A key finding resulting from the survey was to highlight a clear need for the installation of locally recognised leaders and inclusive social networks to aid in disaster preparedness and response. While a substantial proportion of respondents expressed willingness to assist others during emergencies, a significant number (48%) did not know anyone whom they could help. About 30% of respondents were not connected to any school, sporting, or recreational networks, and 17% of the 696 people who responded to the survey answered that they did not have anyone nearby to assist them during a crisis. A demographic analysis of this cohort indicated that it comprised more men (56%) than women (43%), with a significant portion aged 61+ years (45%) and 36–60 years (44.17%). A smaller percentage was aged 18–35 years (10.83%) but. considering the small sample size of this age group, the survey found that 13 of the 31 people in this age range (over 40%) who participated in the survey identified as this cohort. This further highlights a need for greater connection between households and within immediate communities, particularly for young rural people.

Despite these gaps in social connectedness, about a third of respondents identified more than three individuals whom they considered to be local leaders. These individuals can play a critical role in supporting and guiding their neighbours during disaster events, especially in rural communities where external assistance may be delayed. The local government could utilise survey data, such as postcodes, to identify areas where residents lack knowledge of local leaders or feel unsupported. This information could inform the establishment of mentoring, knowledge sharing, or civil leadership groups to assist community members in developing preparedness and evacuation plans aligned with local government and first-responder agencies. The survey identified more than 100 people with diverse demographic features who held the knowledge and expertise to be effective in this role.

Within the current study, most respondents (80–90%) had sufficient supplies of food, water, medicine, and copies of important documents readily available during the survey period. More than 90% of respondents also had access to a source of lighting and information that did not rely on electricity. A small number of respondents (four) reported that, during a previous flooding event, they were directed to websites for information that they could not access due to a lack of electricity. These provide policy inception points where targeted programming can support people to ensure that they are connected to information sources that are not vulnerable to power and internet outages.

There are several studies that have focused on access to basic necessities and information during disasters. One study conducted in New Orleans following Hurricane Katrina found that households with higher incomes and education levels were more likely to have access to resources such as transportation, cash, and adequate supplies of food and water. Additionally, households with children, elderly members, or individuals with disabilities faced challenges in accessing resources [31]. Another study conducted in the aftermath of Hurricane Harvey in Houston found that access to resources varied, with socioeconomically deprived residents less likely to have access to basic necessities such as food, water, and medical supplies [32]. Similarly, a study conducted in Puerto Rico following Hurricane Maria found that access to basic necessities such as water, food, and medical supplies was significantly impacted across the population, with those in rural areas and lower-income households facing particular challenges [33]. Overall, while access to basic necessities and information during disasters is a critical factor in disaster preparedness and response, it is important to consider the specific demographic and geographic factors that may impact access to these critical resources for different households. Connecting support services to these households would be an important aspect of enhancing their resilience.

Approximately 90% of the surveyed individuals monitored natural systems such as river heights and weather patterns as potential indicators of impending disasters in their region. Despite 27% of respondents having no prior experience of living in a non-urban area, the aforementioned results are consistent with a rural community context, where self-reliance is expected and necessary. However, it should be noted that individuals who are concerned with disaster resilience may be more likely to complete and return the survey, leading to overly positive results.

Another important result highlighted by the survey, were the proportion of respondents (52%) who displayed some level of caution in accepting advice and instructions from others. This finding points to experiences where informed local community members have disagreed with the advice of externally based first responders who were brought in to cope with a disaster event. Local government could act as mediators in these interactions by acknowledging and communicating this aspect of local knowledge of residents to external first responders. Again, this finding could lead to the establishment of a local mentoring program, which would reduce the opportunities for local residents to be confronted with external advisors. It would also lead to the establishment of an informal network of community leaders that could inform and be guided by local first responders and disaster management experts.

The findings presented above are all examples of the information generated by the survey that could be useful to local government when seeking to enhance their community's level of community resilience. Although this is only one level of the GCRM, an analysis of these survey results in relation to the postcode level of respondents would assist to develop focused and strategic investments in programs to address any vulnerabilities detected by the metric.

In this study, our application of the GCRM did also detect some limitations that could be considered in future developments. Although a great deal of varied and specific information was garnered through the use of the survey, there are several areas for improvement. Overall, the indicators adopted to assess the capacity within the community for innovation, creativity, and learning required rethinking, as they were developed for different local cultural contexts that may not be relevant to the sample group. For instance, better indicators of one's capacity for self-organisation, including creativity and innovation, might enquire into whether new skills have been learnt, hobbies were practiced, or educational activities pursued. We also note that there was a significant underrepresentation of the 18–35 age group (only 4.8% of survey respondents), which accounts for 22.6% of the regional popu-

lation, and overrepresentation of the retiree population. To be engaged with the younger population, the distribution method of the survey could be considered. In this study, the Council had requested that respondents return the survey via post. Replicating the GCRM as an online survey or accepting the survey return via email might encourage younger people to complete the survey. There are many ways that the Council currently engages with different cohorts of their community; participation in the GCRM could be attached to these activities and monitored bi-annually to detect whether programs and initiatives have produced the desired results.

5. Conclusions

As Bundaberg's population continues to grow as city-dwellers seek a tree change or sea change, it will remain important for community members to retain their high levels of community resilience, self-reliance, and local agency to aid disaster management and community development goals. We found that the GCRM was useful in identifying which factors that underpin a community's resilience could be strengthened and where strategic programs could be located. The GCRM was also effective in drawing attention to areas of strength.

The application of the GCRM in the Bundaberg region highlights the need to focus on communication strategies and to enhance social networks and cohesion. However, the GCRM also reveals many strengths, such as the significant proportion of respondents who report having a good understanding of environmental risks and impacts, planning, and preparedness, as well as those who report taking action to minimise and mitigate these risks and who possess the ability to lead local response and recovery efforts. Overall, policies and programs that build from these strengths and are cognizant of the resource capacities of local governments and first responders in rural localities can be strategically placed. We propose that a neighbourhood mentoring or knowledge sharing program could be established that would aid new community members, or those who are older or less confident, to develop effective response strategies that would enhance their resilience. This would also assist in connecting those who may need assistance with those willing to support and assist others. This is but one suggestion produced from the findings of the survey, and the Council is likely to identify many more. The GCRM could then be deployed every two years in isolated areas or across the region to determine whether programs and initiatives have been successful, or whether circumstances or local environments have shifted to produce or counter new vulnerabilities. In closing, the GCRM is an effective tool that enables local governments to identify potential vulnerabilities and identify strengths across their local government area.

References

1. Internal Displacement Monitoring Centre (IDMC). Global Report on Internal Displacement. 2024. Available online: https://api.internal-displacement.org/sites/default/files/publications/documents/IDMC-GRID-2024-Global-Report-on-Internal-Displacement.pdf (accessed on 17 December 2024).

2. United Nations Disaster Risk Reduction (UNDRR). Snapshot of the Sendai Framework Monitoring as of March 2024. 2024. Available online: https://www.preventionweb.net/media/97771/download?startDownload=20241217 (accessed on 17 December 2024).

3. Australian Bureau of Meterology; CSIRO. State of the Climate 2018. 2018. Available online: https://www.csiro.au/en/research/environmental-impacts/climate-change/State-of-the-Climate/Previous/State-of-the-Climate-2018/Report-at-a-glance (accessed on 17 December 2024).

4. Queensland Reconstruction Authority. The State of Queensland, Queensland Reconstruction Authority Annual Report 2023–2024. 2024. Available online: https://www.qra.qld.gov.au/sites/default/files/2024-09/QRA_Annual_Report_2023_2024.PDF (accessed on 17 December 2024).

5. Aldunce, P.; Beilin, R.; Howden, M.; Handmer, J. Resilience for disaster risk management in a changing climate: Practitioners' frames and practices. *Glob. Environ. Chang.* **2015**, *30*, 1–11. [CrossRef]

6. Davoudi, S.; Shaw, K.; Haider, L.J.; Quinlan, A.E.; Peterson, G.D.; Wilkinson, C.; Fünfgeld, H.; McEvoy, D.; Porter, L.; Davoudi, S. Resilience: A bridging concept or a dead end? *Plan. Theory Pract.* **2012**, *13*, 299–333. [CrossRef]

7. Southwick, S.M.; Bonanno, G.A.; Masten, A.S.; Panter-Brick, C.; Yehuda, R. Resilience definitions, theory, and challenges: Interdisciplinary perspectives. *Eur. J. Psychotraumatol.* **2014**, *5*, 25338. [CrossRef] [PubMed]

8. Walker, B.W.; Holling, C.S.; Carpenter, S.R.; Kinzig, A. Resilience, Adaptability and Transformability in Social–ecological Systems. *Ecol. Soc.* **2004**, *9*, 5. [CrossRef]

9. Oliver-Smith, A. Adaptation, vulnerability, and resilience: Contested concepts in the anthropology of climate change. In *Routledge Handbook of Environmental Anthropology*; Routledge: London, UK, 2016; ISBN 9781315768946.

10. Folke, C. Resilience: The emergence of a perspective for social–ecological systems analyses. *Glob. Environ. Chang.* **2006**, *16*, 253–267. [CrossRef]

11. Council of Australian Governments. National Strategy for Disaster Resilience. 2011. Available online: https://www.homeaffairs.gov.au/emergency/files/national-strategy-disaster-resilience.pdf (accessed on 15 December 2024).

12. Australian Government. National Emergency Management Agency. Disaster Risk Reduction. 2024. Available online: https://www.nema.gov.au/about-us/governance-and-reporting/strategies-and-frameworks/disaster-risk-reduction (accessed on 15 December 2024).

13. Burton, C.G. The Development of Metrics for Community Resilience to Natural Disasters. Doctoral Dissertation, University of South Carolina, Columbia, SC, USA, 2012. Available online: https://scholarcommons.sc.edu/etd/1275/ (accessed on 10 December 2023).

14. Cutter, S.L.; Burton, C.G.; Emrich, C.T. Disaster Resilience Indicators for Benchmarking Baseline Conditions. *J. Homel. Secur. Emerg. Manag.* **2010**, *7*. [CrossRef]

15. Cutter, S.L.; Ash, K.D.; Emrich, C.T. The geographies of community disaster resilience. *Glob. Environ. Chang.* **2014**, *29*, 65–77. [CrossRef]

16. Singh-Peterson, L.; Salmon, P.; Goode, N.; Gallina, J. Translation and evaluation of the Baseline Resilience Indicators for Communities on the Sunshine Coast, Queensland Australia. *Int. J. Disaster Risk Reduct.* **2014**, *10*, 116–126. [CrossRef]

17. Singh-Peterson, L.; Underhill, S.J. A multi-scalar, mixed methods framework for assessing rural communities' capacity for resilience, adaptation, and transformation. *Community Dev.* **2017**, *48*, 124–140. [CrossRef]

18. Zautra, A.; Hall, J.; Murray, K. Community Development and Community Resilience: An Integrative Approach. *Community Dev.* **2008**, *39*, 130–147. [CrossRef]

19. Cutter, S.L. The landscape of disaster resilience indicators in the USA. *Nat. Hazards* **2016**, *80*, 741–758. [CrossRef]

20. Parsons, M.; Reeve, I.; McGregor, J.; Marshall, G.; Stayner, R.; McNeill, J.; Hastings, P.; Glavac, S. The Australian Natural Disaster Resilience Index: A System for Assessing the Resilience of Australian Communities to Natural Hazards—Final Project Report. 2020. Available online: https://www.researchgate.net/publication/308026039_The_Australian_Natural_Disaster_Resilience_Index (accessed on 6 December 2023).

21. Bundaberg Regional Council. ID Community Profile. 2025. Available online: https://profile.id.com.au/bundaberg/ (accessed on 12 November 2024).

22. Australian Bureau of Statistics. Bundaberg 2021 Census All Persons QuickStats. 2021. Available online: https://www.abs.gov.au/census/find-census-data/quickstats/2021/LGA31820 (accessed on 12 November 2024).

23. Australian Bureau of Statistics. 2016 Census QuickStats: Bundaberg (LGA). 2017. Available online: https://www.abs.gov.au/census/find-census-data/quickstats/2016/UCL311001 (accessed on 10 November 2024).

24. Singh-Peterson, L.; Salmon, P.M.; Goode, N.; Gallina, J. An assessment of community disaster resilience for small, high-risk communities on the Sunshine Coast, Qld. *Aust. J. Emerg. Manag.* **2015**, *30*, 35–40.

25. Speranza, I.C.; Wiesmann, U.; Rist, S. An indicator framework for assessing livelihood resilience in the context of social–ecological dynamics. *Glob. Environ. Chang.* **2014**, *28*, 109–119. [CrossRef]

26. Bourdieu, P. The forms of capital. In *Handbook of Theory and Research for the Sociology of Education*; Greenwood Press: Westport, CT, USA, 1986; pp. 241–258.

27. Argyris, C.; Schön, D.A. *Organizational Learning: A Theory of Action Perspective*; Addison-Wesley Pub. Co.: Albuquerque, NM, USA, 1987; pp. 8–29.

28. Bubeck, P.; Botzen, W.J.; Aerts, J.C. A review of risk perceptions and other factors that influence flood mitigation behavior. *Risk Anal.* **2012**, *32*, 1481–1495. [CrossRef] [PubMed]

29. Paton, D. Disaster risk reduction: Psychological perspectives on preparedness. *Aust. J. Psychol.* **2019**, *71*, 327–341. [CrossRef]

30. Lindel, M.; Perry, W. Communicating Environmental Risk in Multiethnic Communities. 2003. Available online: https://api.semanticscholar.org/CorpusID:152301283 (accessed on 22 November 2024).

31. Kates, R.W.; Colten, C.E.; Laska, S.; Leatherman, S.P. Reconstruction of New Orleans after Hurricane Katrina: A research perspective. *Proc. Natl. Acad. Sci. USA* **2006**, *103*, 14653–14660. [CrossRef] [PubMed]

32. Chakraborty, J.; Collins, T.W.; Grineski, S.E. Exploring the Environmental Justice Implications of Hurricane Harvey Flooding in Greater Houston, Texas. *Am. J. Public Health* **2019**, *109*, 244–250. [CrossRef] [PubMed]

33. Kishore, N.; Marqués, D.; Mahmud, A.; Kiang, M.V.; Rodriguez, I.; Fuller, A.; Ebner, P.; Sorensen, C.; Racy, F.; Lemery, J.; et al. Mortality in Puerto Rico after Hurricane Maria. *N. Engl. J. Med.* **2018**, *379*, 162–170. [CrossRef] [PubMed]