

Article

Spatial Distribution Analysis of Community Radio Stations as Means for Promoting Climate Change Adaptation Measures in Agriculture under COVID-19 Scenario, Southern Province, Zambia

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Abstract: Community Radio Stations (CRS) play an important role in information dissemination at local and context-specific levels. This study aimed to analyze the point data distribution of the CRS and their role in promoting climate change adaptation measures in agriculture in times of the Coronavirus Disease (COVID-19). The study's methodological approach included the geospatial mapping of point data of CRS in Arc GIS 10.3, surveys and interviews with thirty-nine (39) experts. In addition, the interview data were analyzed using SPSS 28.0 for frequency and descriptive analysis and excel for graphical outputs. The study found 19 operational CRS in 13 districts, and their radii completely cover the Southern Province of Zambia. Out of the time allocated to agricultural programs, an average of 47% is on climate change adaptation measures in local languages. However, the CRS have limited access to experts to provide information and program sponsorship. This study has established that CRS have the potential to disseminate climate change adaptation measures. Sixty-nine percent (69%) of the CRS noticed an increase in the demand for agricultural programs during the COVID-19 era, with the rapid growth of CRS. The study recommends stakeholders' collaboration to provide appropriate information to enhance the agricultural climate programmes on CRS and address the challenges of limited access to experts and associated costs.

Keywords: agriculture; climate adaptation; community radio stations; COVID-19; geospatial analysis; Zambia



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1. Introduction

The promotion of climate change adaptation measures in agriculture is vital in the Southern Province of Zambia because the area is negatively affected by climate change and weather variability [1]. Weather variability has significantly challenged agricultural production and productivity [1,2].

The dissemination of information on climate change adaptation measures is significant for small-scale farmers to adapt and build resilience. The channels for disseminating agricultural information for climate change adaptation are many, and one such approach is the use of radio broadcasts, especially in rural areas [3–6]. The surge in demand for CRS was also observed in India for broadcasting services on COVID-19, news, and health in a two-way communication approach [4]. Prahmana et al. [5] findings also reveal that CRS plays an essential role in ensuring blended learning models, especially in remote rural areas during the pandemic era. Similarly, in an armyworm pest radio campaign survey, radio listeners were more likely to adopt control practices than non-radio listeners [7]. However, limited studies have mapped the point data of CRS in Zambia and focused on agricultural information on climate change adaptation and sustainable agricultural

production during COVID-19 for enhanced social distancing [8], limited government extension services and declining budgetary allocation [8–10]. COVID-19 has been found to impact the provision of agricultural extension services [11]. Davis [8] highlights the need to change how agricultural extension services are provided in times of COVID-19 to ensure the safety of both the extension officers and the farmers. Potential solutions strategies are required to minimize the compound risks due to climate change hazards in the COVID-19 scenario [11,12]. Other studies have recognized the importance of radio services in agricultural extension and the adaptation to climate change [13–15].

In their review of adaptation processes by farmers in decision making, Robert et al. [16] propose continuous and sequential flexible planning based on the available new information towards anticipated changes to the environment. Thus, the adaptation process to climate change starts with access to information; therefore, CRS play a fundamental role [16,17].

For adaptation to occur, farmers need access to weather information for planning their agricultural season [16–18]. Farmers may also have information on appropriate crop varieties depending on the weather and climatic condition at the local level [15–17]. Access to smart climate agricultural information such as conservation agriculture (minimum tillage/crop residue retention, crop diversity/association and crop rotation) is also critical for adaptation in Zambia [19,20]. In addition, crop and livestock diversification information is key to climate change adaptation to ensure resilience to climate-related shocks [15–17].

Information dissemination of innovative approaches from research and extension must be managed and shared in simple and clear terms for small-scale farmers understanding through different platforms, including CRS, and will require stakeholder engagement and collaboration [18,19]. However, many processes in agricultural extension and food systems have been impacted by COVID-19. The impact of COVID-19 has been through the disruption of the food system due to the pandemic control measures, increasing numbers of confirmed cases and deaths at the global, regional and country levels. According to the World Health Organisation [21], more than 247.5 million confirmed cases of COVID-19 and above 5 million deaths occurred globally. In Africa, there were more than 6.2 million confirmed cases of COVID-19 and 150,825 deaths regionally, while in Zambia, there have been 209,760 confirmed cases of COVID-19 with 3611 deaths recorded. Therefore, in a COVID-19 scenario, agricultural extension and dissemination of climate change adaptation measures should be intensified through approaches that have a low-risk to COVID-19 but a broader impact on the public.

This study's overall objective was to assess CRS' potential effectiveness in promoting climate change adaptation measures under COVID-19 conditions. The specific objectives were: (i) to map out all the point data of CRS in the Southern Province of Zambia; (ii) to assess how much time is allocated to climate change and sustainable agricultural information dissemination out of the regular programming time; and (iii) to assess challenges in the dissemination of climate change adaptation and sustainable agricultural information on CRS. The authors hypothesize an increase in the use of CRS for agricultural information dissemination because of mass coverage and reduced contact with farmers due to COVID-19 under traditional extension services (farmer visits and meetings).

The study focused on CRS because access by households across the radio stations is the highest at 81.3% compared with 79.8% and 55.7% for public and commercial radio stations, respectively, according to Zambia Information and Communications Technology Authority (ZICTA) [22]. In addition, CRS have been critical for community engagement during the country lockdown [4]. For this study, community radio is defined as a radio station focusing on local coverage. Therefore, this study does not include all radio stations with national coverage and public radio stations.

This study examines all the 19 CRS, their coverage areas and the local languages used by all CRS in Zambia's Southern Province. Also mentioned are key gaps in enhancing the community radio station's role in climate change adaptation and sustainable agricultural information dissemination. This research is important for policy intervention in achieving

Sustainable Development Goals (SDGs) [22–24]. Specifically, it is by increasing agricultural information dissemination resulting in improving food production and productivity (SDG 2), good health (SDG 3), through good nutrition and reduced personal contact with extension staff and enhancing climate resilience among small-scale farmers (SDG 13).

2. Materials and Methods

2.1. Conceptual Framework

In order to address the objectives of this study, the authors proposed a modified integrated framework for analyzing pluralistic agricultural extension performance through the effectiveness of information sources [25,26] and perceptions [27–29] based on the innovation diffusion theory by Rogers [30]. Innovation diffusion theory is ideal for technology adoption, such as the use of CRS and climate change adaptation measures by farmers. The innovation-decision process, from knowledge (research and extension), persuasion (community radio operations), and decision (performance and farmer's characteristics) to implementation (impact through adoption), is critical for climate change adaptation by small-scale farmers [30]. In addition, the development of communication theories underscores the use of mass media such as CRS [5]. Understanding the geospatial distribution of point data for community radio infrastructure and coverage is critical for targeted effectiveness in information dissemination. Therefore, information dissemination is the core mandate of agricultural extension services, innovation diffusion, and knowledge acquisition through different platforms such as CRS [31,32] (Figure 1).

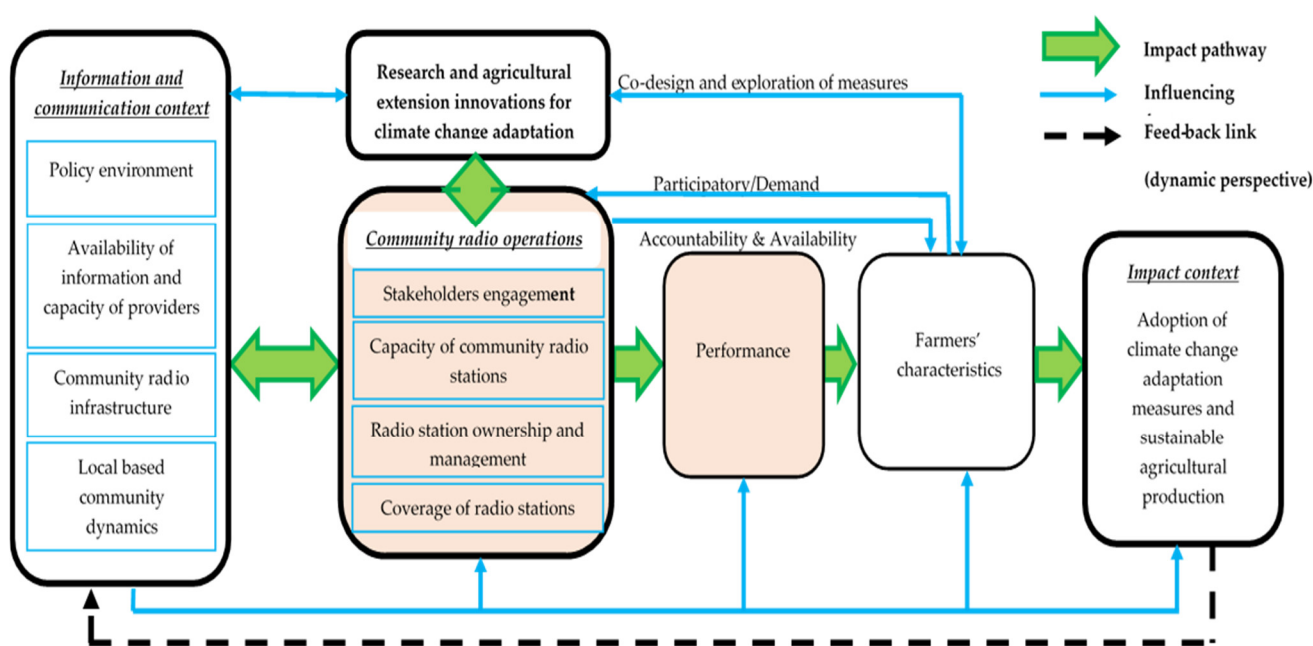


Figure 1. The conceptual framework for analyzing the potential effectiveness of CRS in disseminating climate change adaptation measures and sustainable agriculture. Modified from Birner et al. [26].

Policies, reliable information sources, infrastructure (point data and spatial distribution) and community socio-economic dynamics are the information and communication context that impact the operations of community radio operation's performance. The community radio operations that comprise stakeholder engagement, the capacity of the radio station, ownership and coverage of radio stations (radius) are also impacted by research and agricultural extension innovations.

Birner et al. [26] and Swanson et al. [32] define effectiveness as meeting the objective or target set to deliver quality agricultural services through a regular interaction with farmers, such as raising awareness, in this context through CRS. This paper focuses on community radio operations and the potential effectiveness in disseminating agricultural information

under the COVID-19 scenario (shaded area in Figure 1). The impact context measures the adoption of climate change and sustainable agricultural practices, such as adoption rate, production and productivity. The impact context is influenced and impacted by farmers characteristics, such as age, gender, education, farm size and other social-economic indicators.

CRS are accountable to the farmers and must be available to provide the necessary agricultural information on climate change and sustainable practices. In addition, farmers should be involved in co-creating knowledge through research and extension to encourage ownership and enhance adoption rates.

2.2. Methodological Framework

This study employed a three methodological approach. Steps 1 and 2 addressed objective 1 through Geographical Information System (GIS) functions for mapping and analyzing point data. Step 3 addresses objectives 2 and 3 through statistical evaluation of the questionnaires conducted to the contacts in the examined CRS and validation of the obtained information by feedback from the officers in the Ministry of Agriculture (Figure 2).

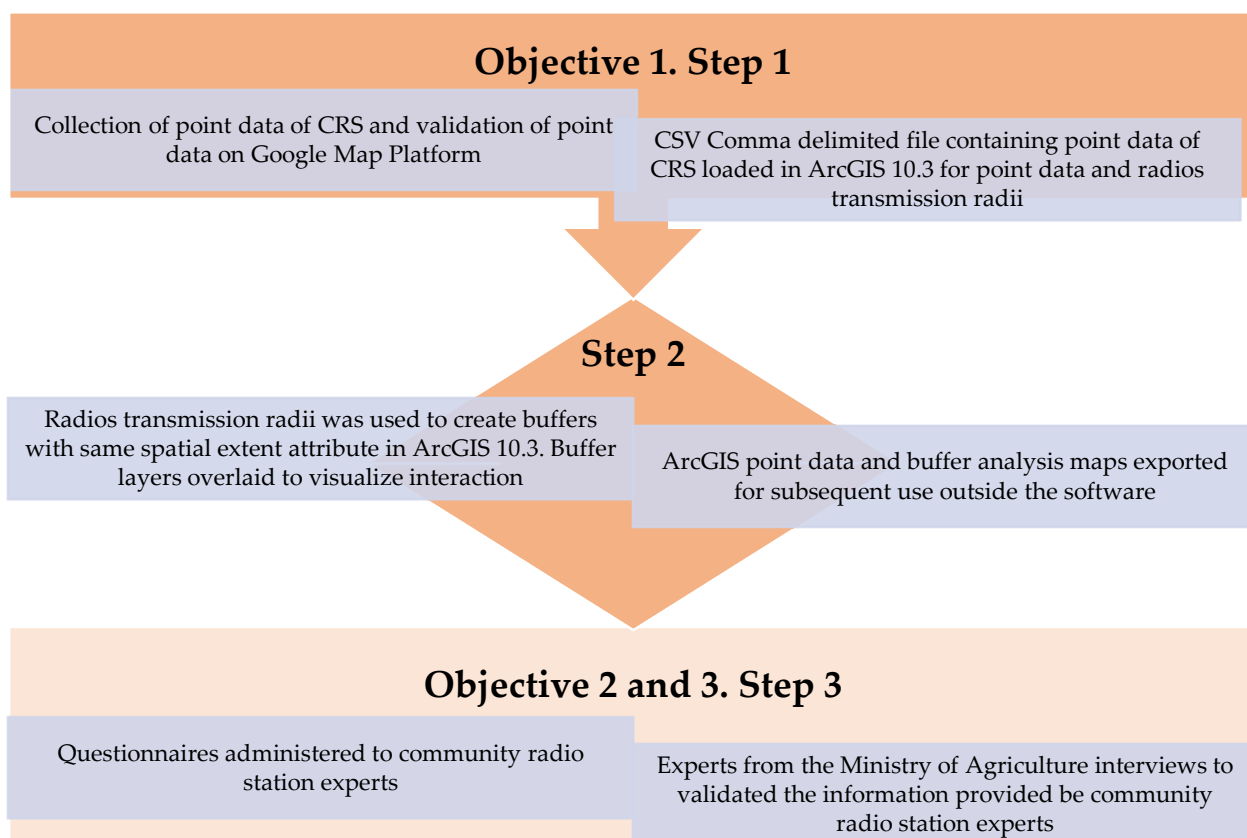


Figure 2. Methodological framework. Source: Authors.

2.3. Study Area and Sample Size

This study was conducted in the Southern Province of Zambia. The study area was selected because it is prone to the impacts of climate change, especially the agricultural sector [1]. The province has 13 districts in which all the 19 CRS available were included in the study (Figure 3).

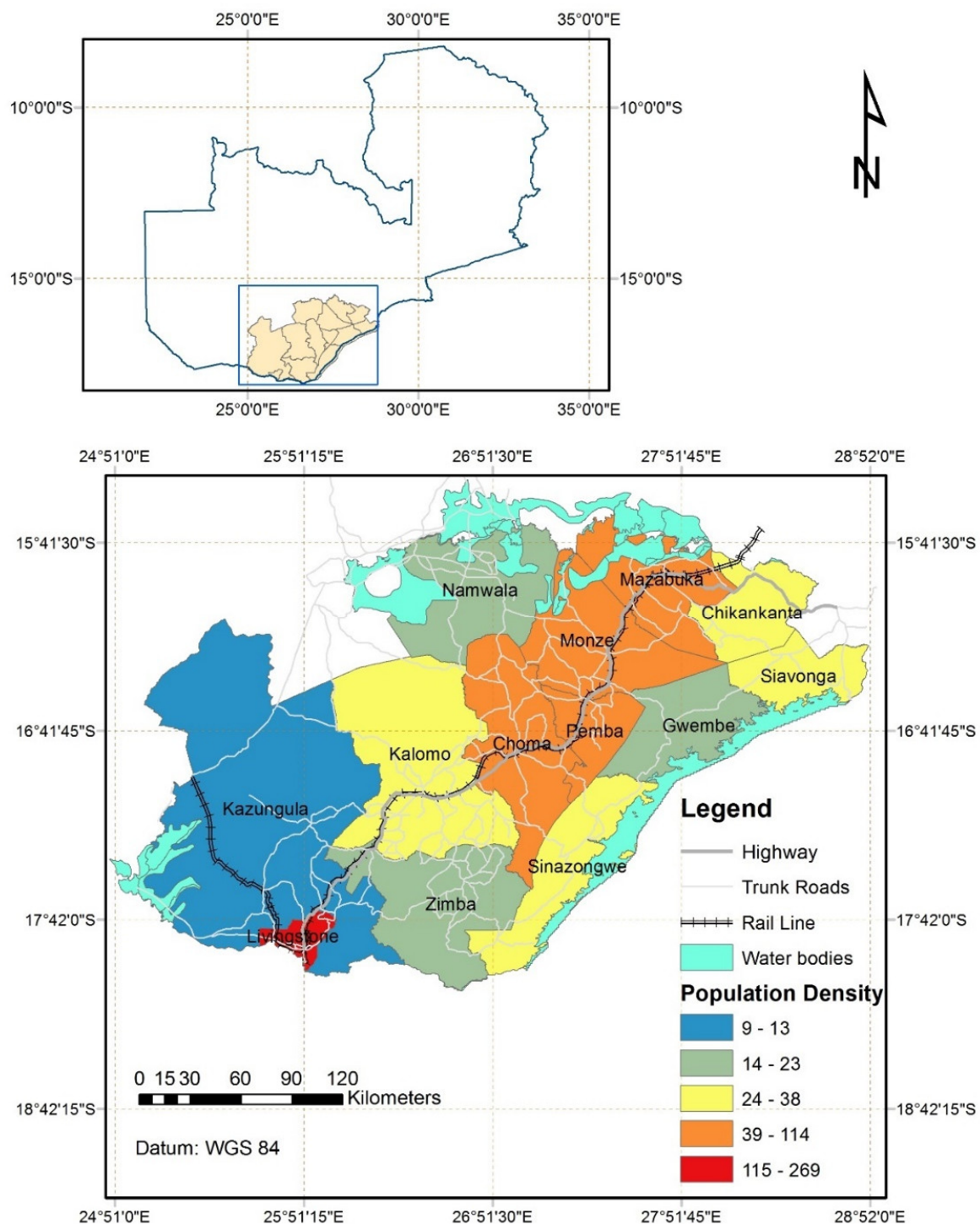


Figure 3. The Southern Province of Zambia. Authors' illustration. Data sources: DIVA-GIS (<https://www.diva-gis.org/>).

In addition to mapping, the point data of CRS [33,34] and nineteen (19) radio station staff were interviewed, and 20 agricultural officers validated the community radio station information (Table 1).

Table 1. Experts from community radio stations and the Ministry of Agriculture.

Position	Frequency	Percent	Male	Female
Station Manager	8	21	7	1
Programs Manager	7	18	5	2
Marketing Manager	3	8	2	1
Reporter	1	3	1	0
District Agricultural Information Officer	12	31	6	6
Provincial Agricultural Information Officer	1	3	1	0
Senior Agricultural Officer	5	13	5	0
Agricultural Officer	1	3	0	1
Program Officer (Agricultural Research)	1	3	1	0
Total	39	100.0	28	11
Source: Survey				

Purposive sampling was employed for the experts [32,35–38], while a snowball technique was applied for agricultural officers [36,37,39–41]. Purposive sampling was important for gathering CRS information from experts with the knowledge of their operation in line with climate change adaptation. On the other hand, the snowball technique ensured that local experts were captured through a local referral system among the respondents.

2.4. Study Instruments, Data Collection and Analysis

To achieve objective 1, the authors applied GIS mapping of all CRS and their coverage areas to create a heatmap [33,34]. Heatmaps are important in showing the geospatial concentration of Point data for community CRS in the southern province of Zambia. The focus was on CRS because of its unique setting compared with national broadcasting stations. Climate change adaptation measures and sustainable agricultural production are easily adopted when scaled down and contextualized to the local situation. Furthermore, most CRS understand the local context, social and cultural norms, and language, making them ideal for information dissemination of climate adaptation [42,43]. The mapping was applied using the GPS and ArcGIS version 10.3 and geospatial analysis of the point data of the available radio stations [33,34]. This study used the World Geodetic System (WGS84) as its reference coordinate system [44]. Zambia uses geodetic datums, ARC 1950, referenced to Clark 1880 reference ellipsoid, a horizontal datum. This Zambian physical infrastructure is vital for the precision and proliferation of the Global Navigation Satellite System and Global Information System for consistency with the International Terrestrial Reference Frame.

The study used the android GPS test application to collect point data for all the radio stations in Southern Province. The point data were validated using Google Maps [45,46] by ensuring that the point data aligned with the radio station buildings. To address objectives 2 and 3, the authors used survey questionnaires on experts from CRS and validated by experts from the Ministry of Agriculture in Southern Province, Zambia. Data from questionnaires were analyzed using the available Statistical Package for the Social Sciences (SPSS) version 21 to the researchers. The results of this study are presented using maps, heatmaps, descriptive and frequency statistics.

3. Results

3.1. CRS Geospatial Mapping

The results demonstrate that the minimum radius coverage for the community radio station is 70 km (Chikuni radio and Power FM) and a maximum of 350 km (SKY FM), as shown in Figure 4.

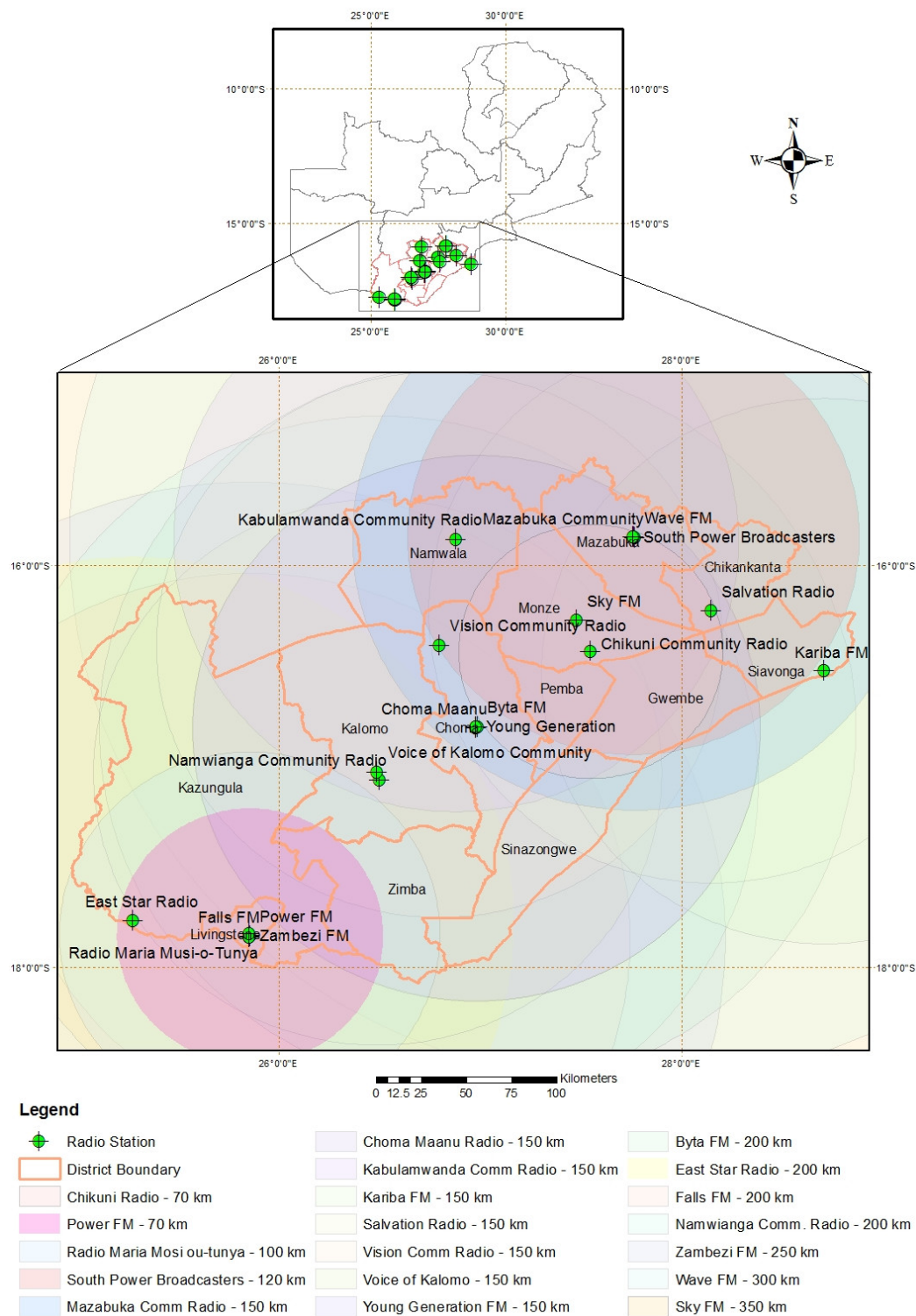


Figure 4. The mapped point data of CRS and their transmitter radius coverage. Source: Survey.

The average radius of the CRS in Southern Province is 170.58 km. The Sky FM in Monze district has the highest coverage area among the CRS and has an estimated 3,000,000 listeners, and the Kabulamwanda community radio station has the least number of 2000 listeners (Figure 5). In addition, the average audience for all the operational nineteen (19) CRS in Southern Province is estimated at 648,389.

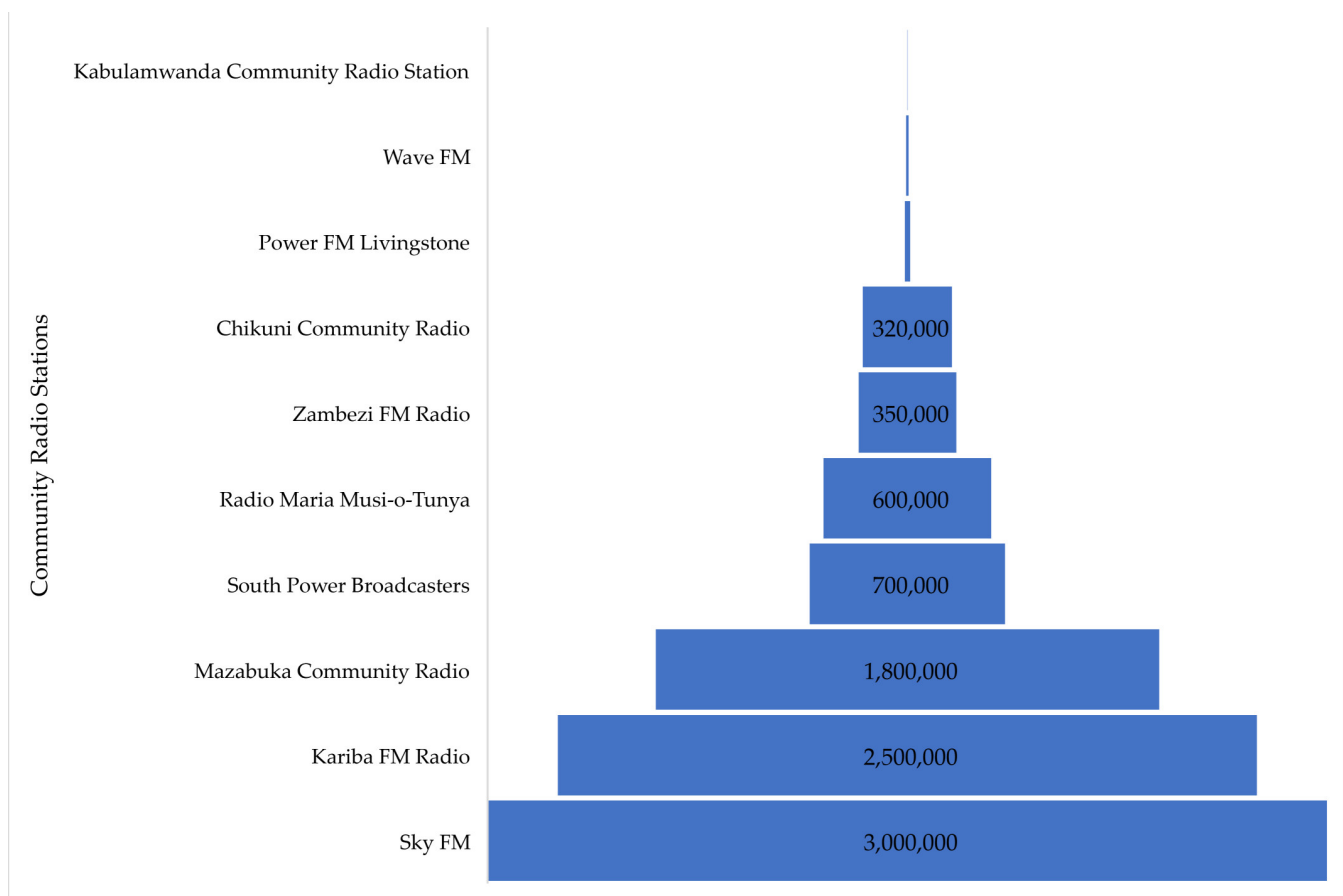


Figure 5. The estimated community radio station listenership (n = 10). Source: Survey.

The majority (78.9%) of the radio stations are privately managed, while faith-based organizations manage 21.1%. Four of the thirteen districts have no community radio station (Gwembe, Pemba, Sinazongwe and Zimba). Choma and Livingstone districts have four community radio stations each, the highest number per district. An analysis of the heatmap for the point data of the CRS demonstrates that they are more on the eastern half of the province than the western side of the Southern Province (Figure 6).

3.2. Allocated Time to Climate Adaptation Measures Programs on CRS

When experts were asked how the demand for agricultural broadcasting services was during the COVID-19 pandemic, they were asked, if it increased, remained the same or decreased based on the average weekly estimated time (%) allocated for agricultural programs out of the normal programming hours? The results demonstrate that, given the COVID-19 period, the demand for broadcasting agricultural-related programs increased in the majority of the CRS (69%), as shown in Figure 7.

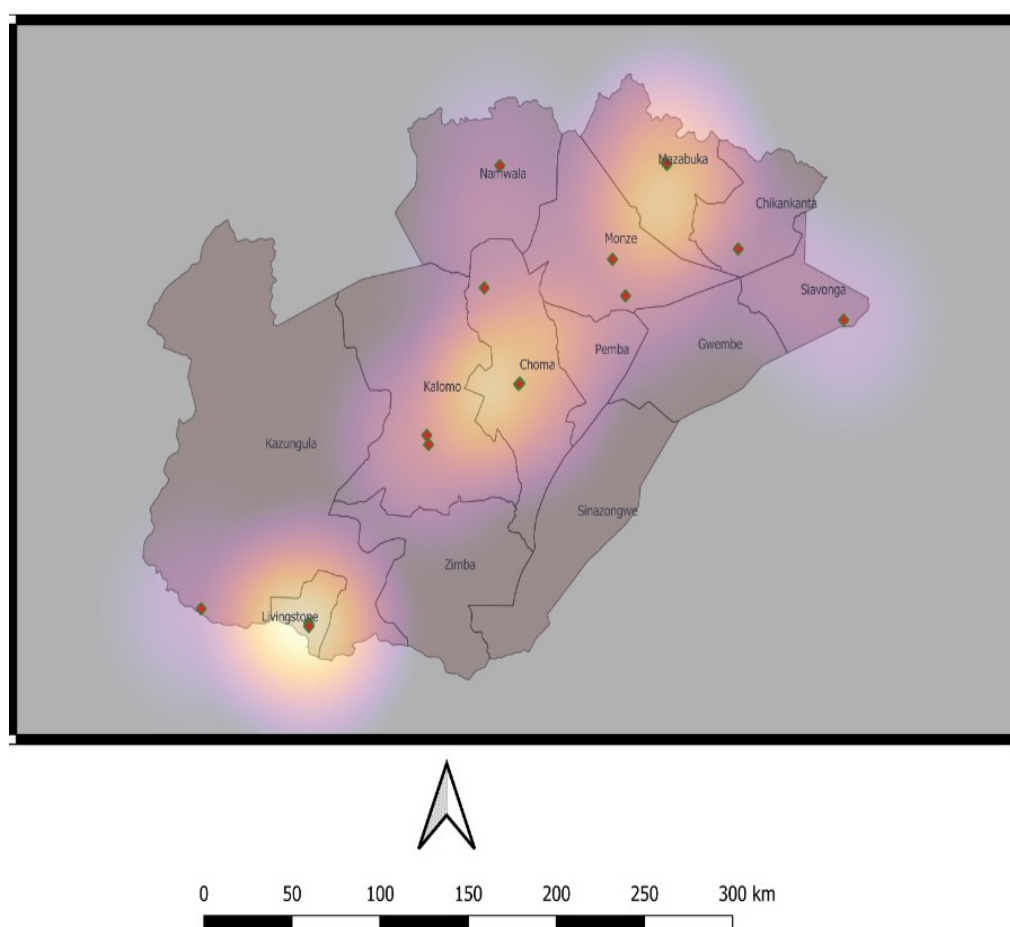


Figure 6. The heatmap based on point data of CRS in Southern Province of Zambia. Source: Survey.

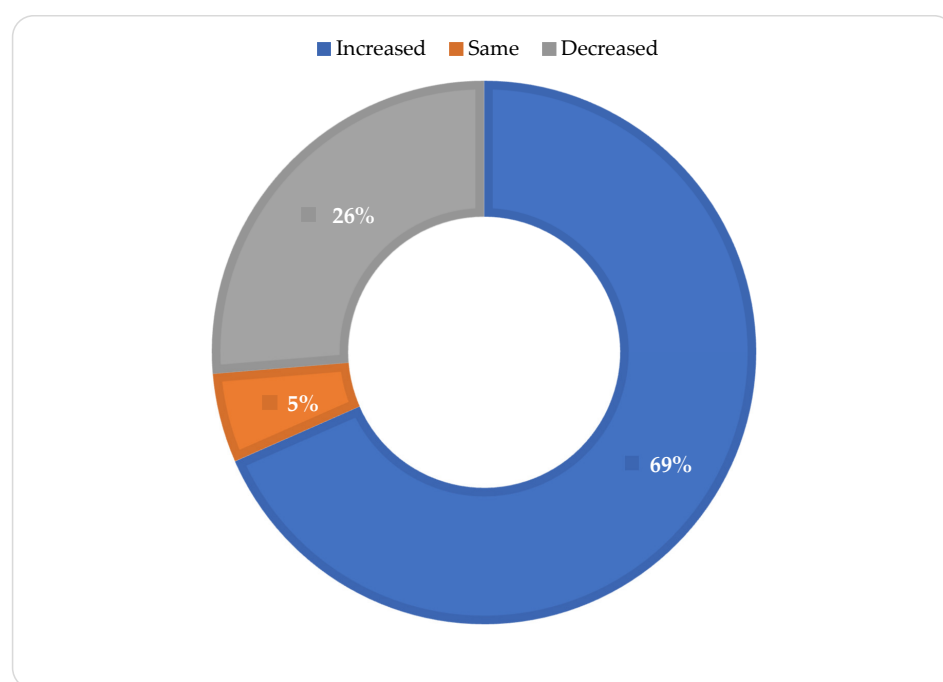


Figure 7. Demand for agricultural programs during the COVID-19 period (n = 19) Source: Survey.

The average weekly estimated time (%) allocated for agricultural programs out of the normal programming hours is 16.65%. In comparison, the average estimated time (%) allocated for climate adaptation programs out of the time allocated to agricultural programming is 47.32% (Table 2).

Table 2. The estimated weekly time allocated to agricultural programs on CRS.

Time Allocation	N	Minimum	Maximum	Mean	Std. Deviation
Estimated time (%) allocated for agricultural programs	19	1	60	16.65	18.830
Estimated time (%) allocated for climate adaptation measures on agricultural	19	0	100	47.32	33.771
Source: Survey					

In all the 19 operational CRS surveyed, the common languages used are English and Tonga (39.9%), while the least used languages are Illa, Goba and Bemba (1.8%) (Table 3). The most combination of languages used by 13 CRS is Tonga, Lozi and English, accounting for 68.4%.

Table 3. The number of languages and combinations used in information dissemination by the CRS.

Languages	Number of CRS	Percent	Percent of Cases
English	19	33.9	100.0
Tonga	19	33.9	100.0
Lozi	13	23.2	68.4
Illa	1	1.8	5.3
Goba	1	1.8	5.3
Bemba	1	1.8	5.3
Nyanja	2	3.6	10.5
Total		100.0	294.7
Combination of Languages	Number of CRS	Percent	Valid Percent
Tonga and English	3	15.8	15.8
Tonga, Lozi and English	13	68.4	68.4
Tonga, Lozi Nyanja, Bemba and English	1	5.3	5.3
Tonga, Goba, Nyanja and English	1	5.3	5.3
Tonga, Illa and English	1	5.3	5.3
Total	19	100.0	100.0
Source: Survey			

3.3. Challenges and Opportunities for CRS in Promoting Climate Adaptation Measures

The major challenge faced by CRS (42.1%) is the limited access to agricultural experts that would continuously feature and disseminate climate-smart agricultural information and techniques. However, the significant opportunity that CRS (36.8%) in Southern Province have is a proximity to farmers at the local level (Figure 8).

The high response (36.8%) from CRS on being closer to farmers as an opportunity is also reflected in the distribution of CRS in 9 out of the 13 districts. In addition, an analysis of the trends in the registered and operating radio stations shows that there has been a steady increase in the number of radio stations, from two (2) to nineteen (19) from 2000 to 2021, respectively (Figure 9). The increase in the number of CRS also shows the effectiveness potential through coverage and diversity in information dissemination in most districts of Southern Province.

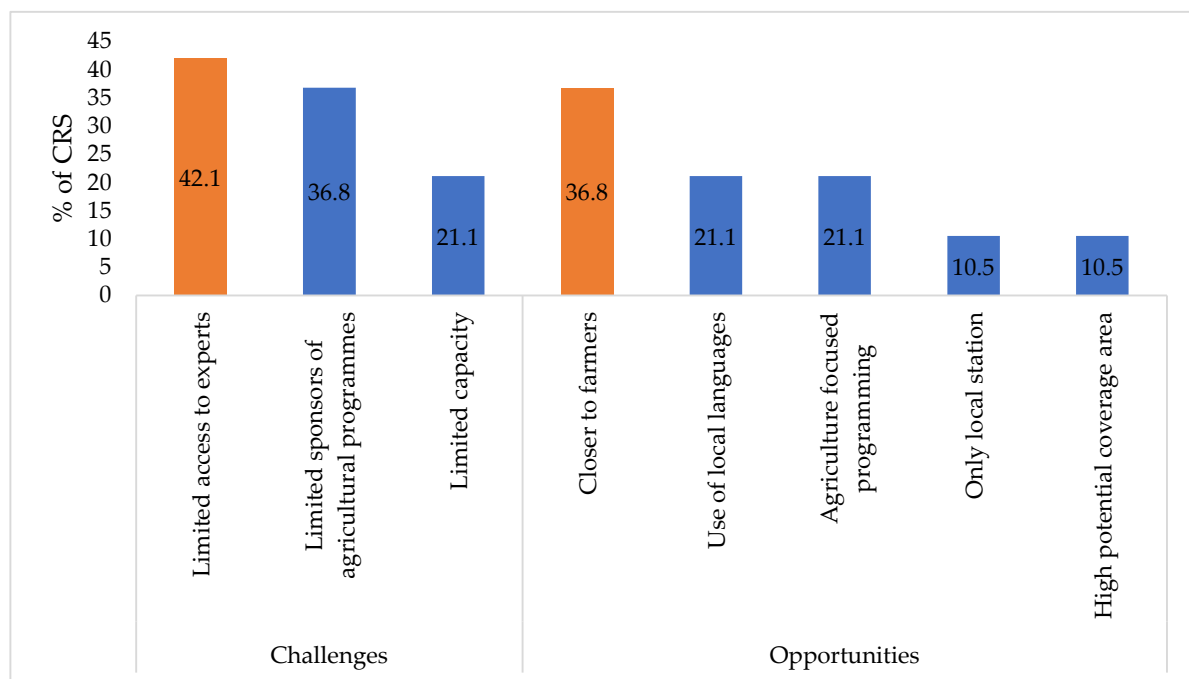


Figure 8. The challenges and opportunities for the CRS in disseminating climate adaptation measures. Source: Survey.

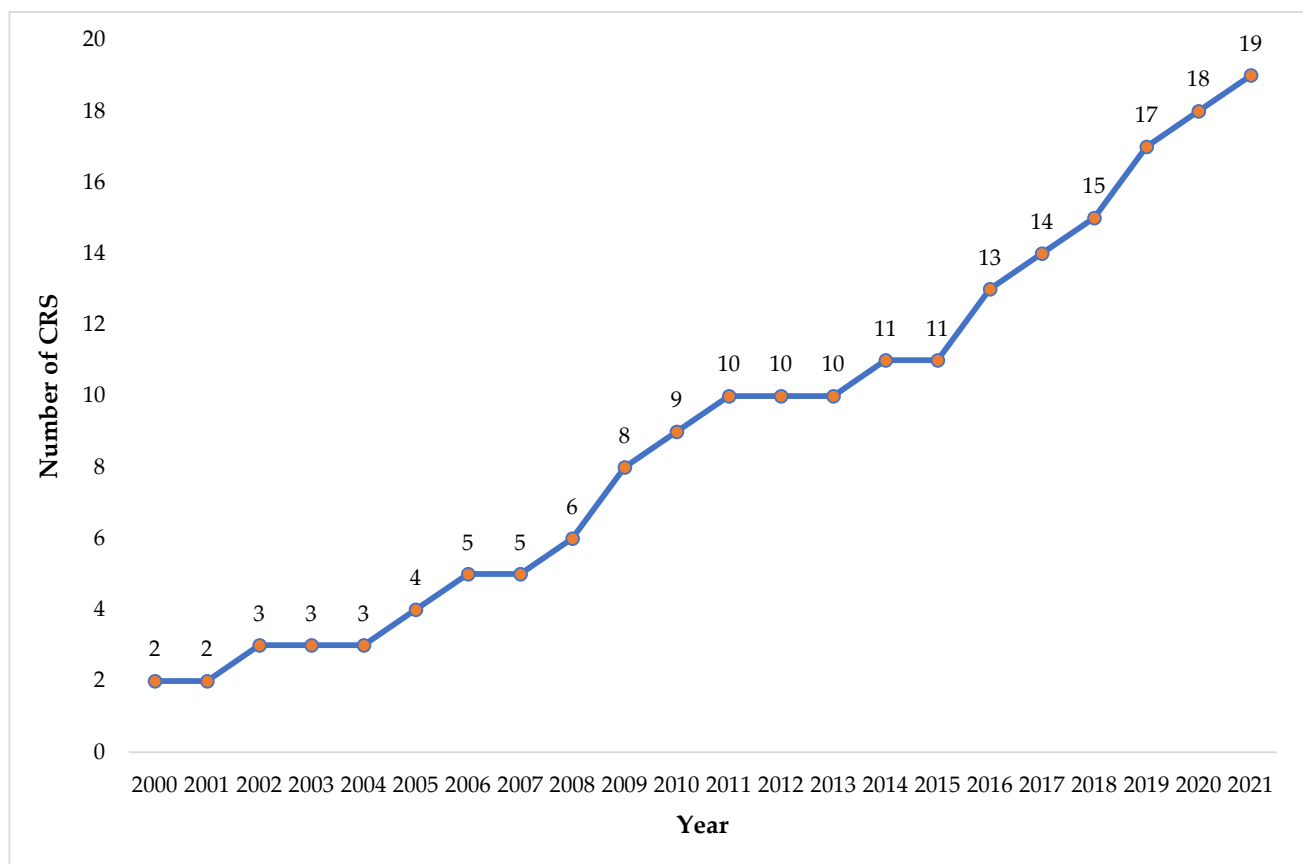


Figure 9. Cumulative registered radio stations (n = 19). Source: Survey.

4. Discussion

The community radio station mapping results suggest that the entire Southern Province is covered, as evidenced by the buffer radius transmission coverage. This corroborates well with findings from the survey conducted in 2018, which demonstrated that 83.1% of the households that own radio sets have access to the CRS in the country [22]. The point data heatmap has also revealed that CRS are more concentrated on the eastern than the western side of Southern Province. The concentration of CRS on the eastern side of the province could be attributed to population distribution, fairly developed infrastructure and terrain shown in Figure 3.

The demand for agricultural programs from agricultural organizations and companies increased for 69% of the CRS during the COVID-19 period, indicating that there is a prospective effective information dissemination of agricultural information, including climate change adaptation measures in agriculture (SDG 2 and 13). In Southern Province of Zambia, the confirmed COVID-19 cases are 2900 and 116 deaths, as of 3 November 2021 [47]. The vaccination rate for COVID-19 is still low in Africa (0.6%) [48]. In contrast, in Zambia only 538,310 (2.9% of the population) were fully vaccinated as of 1 November 2021 [21], and CRS will continue to be essential in this COVID-19 scenario [4,5]. This approach is also essential in achieving good health and well-being (SDG 3) for extension experts and farmers in general [49].

Although the demand for agricultural programs on CRS has increased during the COVID-19, there are still challenges. The major challenge identified in this study faced by the CRS is the limited access to specialized experts to be available continuously throughout the year. During the interviews, it was also revealed that experts on climate adaptation measures are only available for a short period of time during the rainy season, where in some cases it is too costly for CRS. Similarly, Abdulai et al. [50] have demonstrated that community engagement is essential for climate change knowledge transfer (SDG 13). Although these challenges exist, there are opportunities that can be maximized to enhance the CRS dissemination of climate adaptation measures. This study identifies that proximity to farmers at the local level not only increases accessibility to climate adaptation information but also entails local ownership, participation, culture, and values that are context-specific for the local adaptation to climate change in a COVID-19 scenario. Similar key drivers are appropriate for the local-led adaptation initiatives suggested by Westoby et al. [42].

This study demonstrated that the geospatial analysis point data of CRS can methodologically contribute to the visual understanding of the potential effectiveness in disseminating climate change adaptation measures. Furthermore, the study has proposed a new conceptual framework for analyzing CRS and has made it known that the engagement of CRS in information dissemination has the potential to contribute to achieving the SDGs.

5. Conclusions

This study has established that community radio stations have a potential effectiveness in disseminating climate change adaptation measures in agriculture (SDG 2 and 13), as demonstrated through the transmission coverage in Southern Province of Zambia. Sixty-nine percent (69%) of the CRS noticed an increase in the demand for agricultural programs during the COVID-19 era. On average, it is also estimated that 47% of agricultural programming is allocated to climate change adaptation. Furthermore, all radio stations broadcast programs in local languages, which is critical for local context adaptation. The increase in CRS from two (2) in 2000 to nineteen (19) in 2021 is also a clear indication of the growth and potential in information dissemination and coverage (SDG9).

The study recommends that the Ministries of Agriculture (extension and research wings), Fisheries and Livestock and Green Economy and Environment should provide appropriate information on climate-smart agriculture to CRS to enhance the climate-smart agricultural radio programmes. Further, close partnerships with agricultural stakeholders and other corporate bodies to sponsor climate-smart agricultural radio programs are

required, which is key to SDG 17. It is imperative to promote CRS in Gwembe, Pemba, Sinazongwe and Zimba districts for stakeholders willing to set up radio stations through the provision of radio licenses in these districts by ZICTA. Lastly, studies that include the farmer's perception of CRS in the COVID-19 scenario through a mixed-methods approach and fully test the proposed theoretical framework can be conducted.

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Informed Consent Statement: Authors obtained informed consent from each participant in the survey through a Yes/No before beginning the interview. All participants were informed about the context of the study and the anonymous nature of the survey. Permission was sought from each respondent, and they openly and freely answered the questions asked.

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Conflicts of Interest: The article's authors declare that they have no conflict of interest. The sponsors did not play any role in the study's design, execution, interpretation, or writing.

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