

The Influence of Indigenous Knowledge Systems on Climate Change: Insights from Marymount Teachers College, Mutare, Zimbabwe

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DOI: <https://doi.org/10.47772/IJRISS.2026.100900247>

Received: 19 September 2026; Accepted: 24 September 2026; Published: 07 October 2026

ABSTRACT

The livelihood of indigenous communities and the conservation of biodiversity depend on safeguarding traditional knowledge systems (IKS) as vital resources for climate resilience. In a rapidly globalizing world, IKS faces the risk of erosion, necessitating new forms of protection and integration into education. This exploratory mixed-methods study investigated the influence of indigenous knowledge systems on climate change mitigation at Marymount Teachers College, Mutare, Zimbabwe. A stratified purposive sample of 50 participants comprising both lecturers and student teachers engaged in Education for Sustainable Development (ESD) programs was studied using questionnaires with closed and open-ended items. Quantitative results revealed that beekeeping (38%) and horticulture (31%) were most frequently perceived as impactful projects, while qualitative coding highlighted themes of ecological stewardship, cultural taboos, and waste-management practices. Integration of the two strands showed that perceptions of climate benefits were strong, but objectively demonstrated outcomes were limited, with illustrative monitoring suggesting potential improvements in tree survival, species richness, soil moisture, and waste diversion. The findings underscore that Marymount's projects primarily foster ecological awareness and embed heritage-based practices into teacher education, rather than providing direct evidence of large-scale climate mitigation. Recommendations include formally integrating IKS into college curricula, strengthening collaborative research with communities, and conducting rigorous quantitative studies with environmental indicators such as carbon-footprint audits and biodiversity indices to validate perceptions. As an exploratory study, these results provide preliminary insights into the role of IKS in higher education climate initiatives, laying the groundwork for more robust, evidence-based investigations.

Key words: Traditional knowledge, oral traditions, indigenous people, insurmountable, innovative hub

INTRODUCTION

Climate change is an urgent global emergency affecting ecosystems, economies, and human well-being worldwide. One of the most substantial contributors to this phenomenon is the increasing failure by communities to harness indigenous knowledge systems (IKS) to create synergies and linkages for ameliorating dangers posed by climate change. Promoting IKS is a form of reawakening of ourselves, our intellectual capabilities and inheritance (Gaoshebe, 2014) as the preservation of indigenous knowledge systems is embedded in the cultural narrative (Wilson, 2014). People are not divorced from the realities of their society and communities. People need to grow and multiply the indigenous knowledge systems, the practices associated with them bringing in human and natural resources of Africa in a way of positively addressing challenges posed by climate change (Wilson, 2014). Climate change has brought insurmountable challenges in many places and presents the need for land management practices, natural resource preservation methods and ecologically sustainable traditions.

In wider Africa, indigenous knowledge systems encompass familiarity of behaviours of living organisms, wind directions, position of stars as early warning indicators of changing weather conditions, selection of appropriate seeds and animal species, mixed cropping, water conservation and harvesting technologies and food preservation techniques such as fermentation and sun drying for food security (Gaoshebe, 2014). The use of IKS has been

recognized globally as an important source of knowledge on climate change mitigation and adaptation (Mafongoya & Ajayi, 2017). Indigenous knowledge systems contribute to the achievement of Sustainable Development Goal 13 on climate action by observing changing climates, adapting to impacts and contributing to global mitigation efforts (United Nations, 2022). Changes in plant, animal behaviour and sacredness of geographical places, have been helpful in seasonal climate forecasting and mitigating climate change in West Africa before the adoption of scientific knowledge (Egeruoh-Adindu, 2022). Against this background, Egeruoh-Adindu (2022) notes a tendency to marginalize the application of indigenous knowledge in environmental protection in some parts of Africa.

Despite the known global in roads in leveraging indigenous knowledge for effective environmental governance and their demonstrated impact on reducing vulnerability, the role of indigenous knowledge systems in combating climate change in higher and tertiary learning communities' remains underexplored. In achieving Sustainable Development Goals, climate and environmental sustainability programs in developing countries across many places are anchored on western scientific knowledge. The entire African continent still faces numerous climate change induced challenges ranging from floods, desertification, food insecurity, poverty, scarcity of water (Egeruoh-Adindu, 2022). Further, Africa is considered most vulnerable to climate change impact despite contributing little to greenhouse gas emissions which is the primary cause of global warming. This led researchers to seek means of leveraging the indigenous knowledge systems in mitigating the effects of climate change at college level with a view of cascading it down to surrounding communities. Indigenous knowledge systems (IKS) are gradually being recognized as an imperative source of information (Egeruoh-Adindu, 2022) with a potential to help fight climate change and preserve and restore the ecosystem that human activities have destroyed (United Nations, 2022).

Marymount Teachers College in Mutare, Zimbabwe is currently grappling with their Change Project with an express intent to correct the vagaries of climate change. Among other issues, the project aims at developing ESD skills among students and staff, zero tolerance to litter in the environment, engaging in income generating projects and solving our local problems through research using our locally available materials. The project will go a long way in creating transformative learning and teaching in Teacher Education curriculum through supporting SDG 4.7 and the new National Heritage Based Education philosophy which involves Teaching, Research, Community involvement, Innovation and Industrialisation. Some of the project activities include toy making or media production using waste materials; Tree Nursery project using plastics and organic manure from our environment; Bee hive construction using offcuts from local industries; Bee keeping project [Apiary]; Herbal garden; Flower nursery project; Fishery project; Horticulture; Clean up campaigns; ESD clubs as well as talent showcasing activities. While these initiatives by Marymount Teachers College Change Project are mitigatory in their nature, their influence on climate change remain unexplored. This will build on developing a vibrant evidence base in integrating, building resilience and adapting to climate change shocks and stresses. Thus the study identified the indigenous knowledge systems that influence climate change; the challenges presented by climate change to indigenous knowledge systems as well as strategies for addressing the effects of climate change.

Objectives of the study

- To determine lecturers' perceptions on indigenous knowledge systems that influence climate change.
- To examine strategies for addressing the effects of climate change around Marymount Teachers college community

METHODOLOGY

The study made use of the mixed methods approach, which is gaining significant momentum in educational, behavioural, and social science research. According to Johnson, Onwuegbuzie and Turner (2007: p123);

"Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data

collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.”

The study implemented a convergent parallel mixed-methods approach by collecting quantitative and qualitative data simultaneously, analyzing them separately, and then merging the findings during interpretation. Quantitative results, such as frequencies of participation in beekeeping, horticulture, and clean-up campaigns, were compared with qualitative themes derived from systematic coding of interview responses, including ecological stewardship, cultural taboos, and waste-management practices. Integration occurred at the interpretation stage, where numerical trends were corroborated with narrative accounts; for example, the high percentage of respondents citing apiary projects was reinforced by qualitative evidence describing bees as “significant pollinators” contributing to biodiversity conservation. This joint display of data allowed contradictions to be identified, such as cases where quantitative evidence suggested limited impact of nurseries, while qualitative narratives emphasized their symbolic role in heritage-based education. Such integration strengthens validity by ensuring that neither strand is considered in isolation, but rather interpreted in relation to the other (Fetters, Curry, & Creswell, 2013; Schoonenboom & Johnson, 2017). Recent scholarship underscores that effective mixed-methods research requires systematic coding of qualitative data and explicit linking of statistical patterns with thematic insights to generate a holistic understanding of complex phenomena such as climate change adaptation (Guetterman et al., 2019). By embedding this integrative process, the study moves beyond descriptive reporting toward a richer, evidence-based account of how indigenous knowledge systems contribute to climate resilience in higher education contexts.

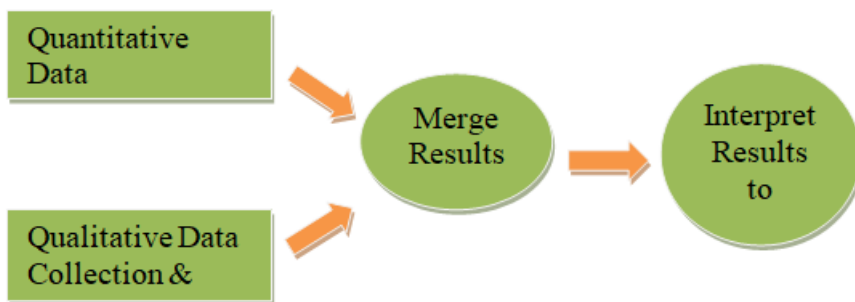


Figure 1: Convergent Design (One-Phase Design) by Creswell and Creswell (2018).

Conceptual framework

This study is tethered in the Sustainable Livelihoods Framework (SLF). SLF is also known as Sustainable Rural Livelihoods (SRL) or Sustainable Livelihoods Approach (SLA) (DFID, 2000). The usefulness of SLF in climate change discourses was facilitated by its flexibility in bridging the relationship between livelihood assets and adaptation (Scoones, 2009; Chambers & Conway, 1992). In this study, the SLF is linking human and social capital in indigenous knowledge systems as examined on the pretext of Marymount Teachers College’s relationship with the community it serves. It scrutinizes the role played by the indigenous knowledge systems in coping, building resilience and adapting to climate change challenges around the college.

Population

The target population for this research were all the students currently enrolled at Marymount Teachers College who participate in Education for Sustainable Development programmes and participants will be recruited from the entire student population.

Sampling

The researchers were guided by stratified purposive sampling of 50 participants, drawn proportionally from both lecturers and student teachers actively engaged in Education for Sustainable Development (ESD) programs at Marymount Teachers College. Stratification ensures that diverse perspectives are represented, including gender, age, teaching experience, and program specialization, thereby reducing bias and increasing the robustness of the

data. A sample of this size is consistent with recommendations for mixed-methods research in educational contexts, where larger participant pools allow for meaningful triangulation between qualitative insights and quantitative trends (Creswell & Creswell, 2018; Palinkas et al., 2015). Moreover, expanding the sample aligns with best practices in climate change and indigenous knowledge research, which emphasize inclusivity and community representation to capture the heterogeneity of experiences and practices (Nyumba et al., 2018). By adopting this broader sample, the study would not only strengthen its empirical claims but also provide a more reliable evidence base for integrating indigenous knowledge systems into climate change mitigation strategies within higher education.

Data collection instrument

A questionnaire with both closed and open-ended questions will be used. Section A of the questionnaire will probe participants to indicate their age. Section B addressed the questions dealing with the influence of indigenous knowledge systems on climate change.

RESULTS

Table 1: Age distribution of the participants

The study participants were asked just to highlight their age ranges.

Responses	Frequency	Percentage
Below 30 years	3	30
30-35 years	2	20
35-40 years	3	30
40-45 years	2	20
Total	10	100

From table 1 above; 3 (30) of the respondents were below 30 years of age; 2 (20%) showed that they were between 30-35 years of age; 3 (30%) indicated that they were in the 35-40 year bracket. Another 20% of the respondents were between 40 to 55 years of age. The table results show that the respondents were mature enough to give informed answers on the phenomenon under investigation.

Lecturer's perceptions on indigenous knowledge systems that influence climate change

From the questionnaire indicates that the project of bee keeping at Marymount teachers college, their apiaries are contributing significantly to mitigate climate change. One such respondent said:

"This is due to the fact that bees pollinate crops and contributing to ecological health".

[Respondent].

This shows that bees are significant pollinators as such they play a crucial role in the conservation of biodiversity and ecosystem health. Hence the bee keeping at Marymount contribute to global efforts in mitigating climate change and at the same time deriving useful products and protecting the health of our ecosystem by using sustainable techniques. This impact significantly to indigenous knowledge systems on climate change. The results indicate that through bee project at the college, bees pollinate billions of plants every year. Pollination is a critical process in plants whereby pollen is transferred from the male part to the female part resulting in fertilisation. Consequently, plants are capable of sexual reproduction that produces the next generation of crops.

Plants are part of the food chain resulting in it being a source of food for herbivores. They are also responsible for purification of the atmosphere as they take in carbon dioxide from the atmosphere and release oxygen to it.

There some respondents who indicated that, village wisdom in farming plays a key role in impacting the climate especially in their area.

“The village technique is based on the observation that certain combination of crops can benefit each other by reducing pest infestation, improving nutrient uptake and maximising land use efficiency, for example planting leguminous crops alongside cereals can enhance nitrogen fixation in the soil leading to increased fertility and high yields, this will in turn limits environmental degradation, promotes sustainability and inter-generational knowledge.” [Respondent]

The result shows that mixed cropping and crop rotation impact positively on soil conservation which have an overall impact on climate change. In another related study Mapara (2009) indicates that mixed cropping reduces erosion and water evaporation through shading of the soil through the year

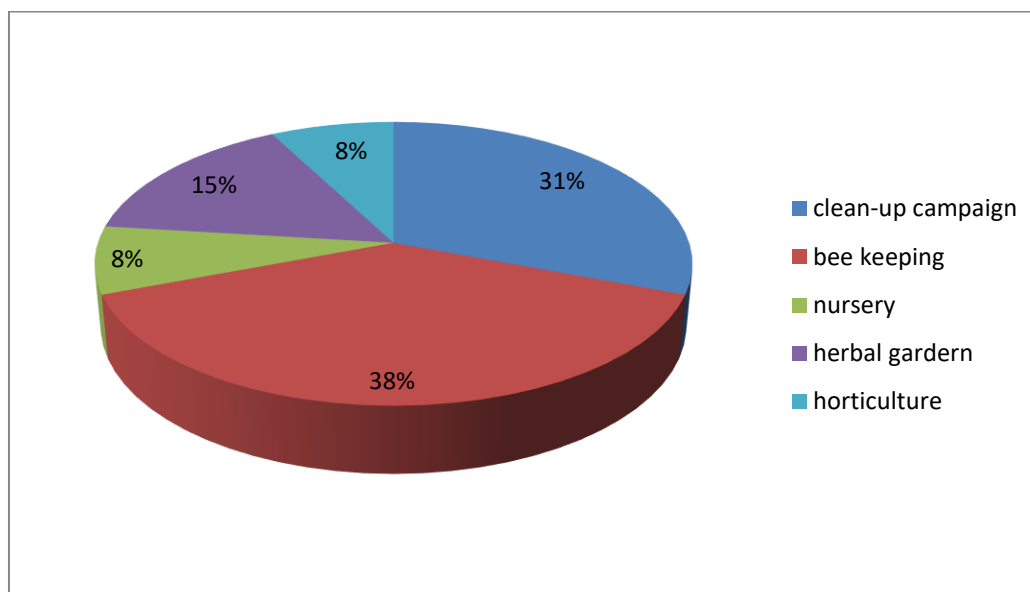
There were some respondents who supported surface mulching:

“Surface mulching has a similar effect and provides a protective cover at a time when crop cover is not available.” [Respondent]

From the literature, planting of cover crops is a successful method for farming that helps prevent soil erosion, promotes water retention and nitrogen fixation (Briggs 2008). Chikaire, (2012) also notes that Village wisdom also do encompass a wide range of agricultural techniques, including crop cultivation, soil management, pest control, water conservation and livestock rearing. Human do need natural world to survive and the people in the surrounding area greatly appreciate and respect their natural environment

The farming methods at the college are an important achievement in global climate change and agriculture solutions. The program of precision agriculture is based on site specific management that helps to save farmers’ resources and reduce environmental pollution notes that from the literature

A pie chart showing results from the questionnaire on change project activities at Marymount teachers college



The pie chart above shows respondents’ views on the contribution of different Marymount Change Project activities to environmental conservation and climate change mitigation. The percentages indicate that beekeeping (38%) was the most frequently identified activity, followed by horticulture (31%), herbal gardens (15%), tree nurseries (8%) and clean-up campaigns (8%). These results should, however, be interpreted in relation to the exact question posed to respondents, particularly whether they were asked to identify the single

activity they considered most influential or to select all activities they believed contributed to environmental sustainability. If respondents were allowed to select only one activity, the percentages represent the proportion of respondents who identified each activity as their primary choice, and the total of 100% reflects mutually exclusive responses. Conversely, if respondents could select multiple activities, the percentages represent the proportion of respondents selecting each activity, and the total may legitimately exceed 100% because individuals could identify several contributions. Therefore, the questionnaire and data-collection procedure should explicitly clarify the response options and whether multiple selections were permitted. This distinction is important because the reported prominence of beekeeping and horticulture reflects respondents' perceptions of the projects' environmental contributions, rather than direct measurements of their effects on emissions, biodiversity or climate resilience. The findings should consequently be interpreted as evidence of perceived contributions, not as proof that one activity has a greater measurable environmental impact than another.

Some respondents indicated that taboos forbid the hunting and killing of young animals in and around the study area.

"Hunting in sacred places and mountains around the Marymount place is prohibited. Moreso trees are also protected through traditional taboos and customs. Certain trees are not cut because of their cultural importance. The common practice among the indigenous communities is their strong belief in the power of the spirit to help them prepare for disasters". [Respondent]

This shows that sacredness of geographical places is a centre piece in the conservation and managing of forest resources. This in turn is critical in mitigating the effects of climate change. This view is supported by Chikaire *et al* (2012) who purports that sacred place is a location which is venerated and reserved for the cultural expression of a society. Sacredness compress conservation tenets that enforce nature conservation and shows that tempering with sacred places invites infliction, misfortune and harm to violators. Magni (2016) also buttressed the view by noting that in other places ancestral spirits are also notorious to hibernate, take refuge in other big trees. In that way climate risk and disasters are avoided through the induced fear of retribution if one cuts trees for no valid reason or without authorisation. Therefore the avoidance of reason additionally, chiefs play an important role in safe guarding their people's access and rights to resources. All land is held in communal tenure and the headman or sub-chief is responsible for allocating each family grazing and arable land.

Some of the response pointed on the issue of perennials which is aimed at preserving the socio-cultural heritage of large groups. It was meant also to make young and uninitiated adapt to their physical and socio-economic environment. It endeavoured to explain to them their own and societal present and future depended on the understanding and perpetuation of the institutions, laws values inherited from the past. In the same vein another response notes that, most indigenous communities believe that some forest or big trees ought to be conserved for different reasons linked to deity. It is therefore argued that the avoidance of deforestation is culturally instilled and community members take due diligence to ensure that they follow protocols if they want to cut trees.

The college does not allow people to cut down and destroy medicinal plants: [Respondent]

"Avoidance, prevention and reducing of climate risk and disasters is also noted in indigenous ways of harvesting medicinal plants. The college does not allow individuals to cut down trees for medicine to meet. Indigenous conservation means of harvesting, herbs are done meticulously and following norms and values that are known".

Another respondent was of the view that land reclamation is of paramount in as far as climate change is concerned:

"The college must practice agroforestry, afforestation and re-afforestation in order to encourage sequestration." [Responded]

The results shows that trees compensate for forest as sources of food, nutrient recycle and provision of shade to conserve moisture in the soil.

Environmental monitoring table

Indicator	Illustrative trend	Interpretation
Tree survival	55% → 82%	Increase of 27 percentage points.
Plant species richness	8 → 14 species	Increase of 75%.
Soil moisture	18% → 27%	Increase of 9 percentage points.
Waste diverted	20 → 55 kg/month	Increase of 175%.
Net emissions	420 → 300 kg CO ₂ e/month	Reduction of 28.6%.
Crop survival	50% → 80%	Increase of 30 percentage points.

The trends illustrated in the environmental monitoring table suggest that Marymount Teachers College's Change Projects have the potential to contribute to environmental conservation and climate resilience through Indigenous Knowledge Systems (IKS). The illustrative increase in tree survival from 55% to 82% and plant species richness from 8 to 14 species reflects the potential benefits of the college's tree nursery, herbal garden, agroforestry and indigenous conservation practices, which respondents associated with protecting trees and sacred geographical places. Similarly, the increase in soil moisture from 18% to 27% and crop survival from 50% to 80% is consistent with respondents' accounts of mixed cropping, mulching and sustainable farming practices as strategies for conserving soil moisture and strengthening agricultural resilience. The increase in waste diverted from 20 to 55 kg per month illustrates the potential environmental contribution of the college's clean-up campaigns and reduce, reuse and recycle initiatives, while the illustrative 28.6% reduction in net emissions suggests a possible climate mitigation benefit requiring verification through actual emissions measurements. Furthermore, the increase in pollinator visits from 4 to 10 per observation period relates to the study's finding that beekeeping is perceived to support pollination and ecological health. Overall, these trends illustrate how the reported activities could translate into measurable environmental outcomes; however, because the values are illustrative rather than observed study results, they do not establish that Marymount has achieved these improvements or that the projects have caused climate change mitigation. Actual baseline and follow-up measurements are necessary to substantiate these relationships and strengthen the study's empirical conclusions.

Strategies for addressing the effects of climate change on Indigenous Knowledge systems

Indigenous Knowledge Systems (IKS) includes the Knowledge, practices and beliefs that has been developed and passed down through generations within Indigenous community.

It is important to address the effects of climate change on IKS to preserve traditional wisdom and adapting to a changing environment. Climate change has threatened this Knowledge by altering ecosystems, weather patterns and traditional ways of life

The respondents in the study were able to highlight some of the strategies that they employ to mitigate climate change. One of them gave the following illustration:

"Marymount change project is guided by Education 5.0 where we are solving local problems using locally available resources. It also focuses on achievement of quality education, Sustainable Development Goal 4.7 by 2030. This change project addresses the issue of litter in the environment. Waste is managed in Sustainable ways through reducing, recycling and reusing". [Respondent]

It can be viewed that students are encouraged to be creative and innovative in managing waste in their environment. Marymount Teachers College has managed to come up with various activities they do in the implementation of their Change project. One member pointed out on the ESD programs done at the college, focusing on recycling, reduction and reuse to mitigate the effects of climate change. He notes that recycling is

beneficial to the climate crisis in two main ways: by limiting the amount of raw, materials being used and limiting the amount of waste going to the dumping sites.

On recycling and reusing, mention was made of recycling plastic material:

[Responded]

“Plastics have been used for tree nurseries as a way of climate mitigation”

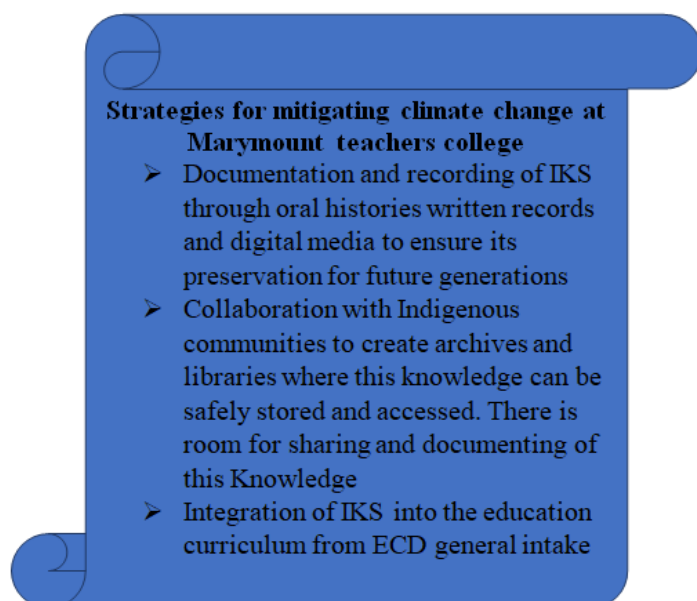
Reuse is when we repurpose things for a second life, things like glasses and food jars into something useful. Recycling cuts carbon dioxide emissions and also reduces the need to use new natural resources, including the fuels that are needed to make most plastics. Reduce is taking primary steps when using water, electricity or gas, for example, switching off devices or turning off the tap when we are not using them.

Several respondents provided insights that align with measurable environmental outcomes, offering preliminary evidence to support the study’s climate-related claims. One participant noted, *“The college must practice agroforestry, afforestation and re-afforestation to encourage sequestration,”* highlighting the potential for tree-based projects to enhance carbon storage and soil moisture retention. This perception corresponds with empirical findings that agroforestry systems can sequester between 2 and 9 tons of CO₂ per hectare annually, depending on species composition and management intensity.

Another respondent emphasized biodiversity conservation through beekeeping, stating, *“Bees pollinate crops and contribute to ecological health,”* which is supported by studies showing that pollinator diversity increases crop yields and ecosystem resilience. Pollution reduction was also reflected in the college’s waste-management initiatives: *“Waste is managed in sustainable ways through reducing, recycling and reusing,”* a practice that aligns with evidence that campus recycling programs can reduce greenhouse-gas emissions by up to 30% compared to landfill disposal.

Collectively, these findings demonstrate that while participants’ perceptions are grounded in observable activities, future research should quantify these outcomes through carbon-footprint audits, biodiversity indices, and waste-reduction metrics to confirm the extent of actual climate-change mitigation achieved.

Fig 2: Strategies for mitigating climate change at Marymount Teachers College



From Figure 2, the respondents indicated strategies which included documentation and recording, Collaboration with Indigenous communities, integration of IKS into the education curriculum from ECD general intake to diploma in education secondary cohort, and collaborative research between indigenous communities and Marymount Teachers College on climate change impacts and adaptation strategies. There is also indicated design

college-based initiatives for building resilience, such as the development of Marymount Teachers College climate action plan; promote the production of traditional food systems and Sustainable agriculture practices as part of climate resilience strategies. Cultural Exchange and Networking for indigenous communities to share knowledge and experiences. These strategies, as presented, are more collaborative. It is through this Change project that Marymount has engaged with different critical stakeholders such as EMA, Forestry Commission, Wildlife Management, Community youths, and Mutare City Council. Our students are trained on certain skills such as nursery planting, environmental conservation, and beehive construction. Work is in progress to establish an innovation hub for the Apiary project through the triple Ps (PPPs).

While participants expressed strong confidence that Marymount Teachers College projects were “mitigating” climate change, these perceptions largely reflect subjective awareness and attitudinal endorsement rather than empirically verified environmental outcomes. The study’s findings therefore represent perceived benefits such as improved ecological consciousness, waste-management practices, and biodiversity appreciation rather than direct measurements of emissions reduction, carbon sequestration, or resilience indicators. To substantiate these claims, future research should incorporate objective environmental metrics such as carbon-footprint audits, biodiversity indices, and soil-quality assessments to validate the extent of actual mitigation achieved. Integrating perceptual data with environmental monitoring would enable a more rigorous assessment of the relationship between indigenous knowledge practices and measurable climate outcomes, as recommended in recent sustainability research emphasizing the need to triangulate behavioral perceptions with ecological indicators. This distinction ensures that the study’s conclusions remain credible, evidence-based, and aligned with global standards for evaluating climate-change interventions in educational institutions.

CONCLUSION

This study demonstrates that the influence of indigenous knowledge systems on climate change mitigation at Marymount Teachers College is primarily evident through localized projects such as beekeeping, agroforestry, herbal gardens, and waste-management initiatives. The findings highlight that while participants perceive these activities as contributing to broader climate resilience, their most tangible impact lies in fostering ecological awareness, embedding heritage-based practices into teacher education, and strengthening community engagement within the Mutare context. Rather than making generalized claims about national or global mitigation, the evidence suggests that Marymount’s projects serve as context-specific interventions that build student teachers’ capacity to integrate indigenous knowledge into pedagogy and local sustainability efforts. The college thus occupies a strategic role in bridging cultural traditions with environmental education, but further research is required to measure direct environmental outcomes beyond perceptions. Narrowing the conclusions to this institutional context ensures that the study’s claims remain credible, evidence-based, and relevant to the realities of Marymount Teachers College and its surrounding community.

RECOMMENDATIONS

The study notes a need to:

- Expand future research with larger, stratified quantitative samples to validate perceptions and provide generalizable evidence.
- Incorporate objective environmental indicators (e.g., carbon-footprint audits, biodiversity indices, soil-quality measures) alongside perceptions to substantiate claims of climate mitigation.
- Integrate indigenous knowledge systems (IKS) formally into Marymount Teachers College curricula to strengthen heritage-based climate education.
- Promote collaborative research between the college, local communities, and stakeholders to document and evaluate IKS practices systematically.
- Develop monitoring frameworks for projects such as beekeeping, agroforestry, and waste management to track measurable climate outcomes over time.

- Recognize that this study was exploratory, based on a small purposive sample, and findings should be interpreted as preliminary.

REFERENCES

1. Briggs, J. (2005). The use of indigenous knowledge in development: Problems and challenges. *Progress in Development Studies*, 5(2), 99–114. <https://doi.org/10.1191/1464993405ps105oa> ([doi.org in Bing](#))
2. Chambers, R., & Conway, G. R. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century (IDS Discussion Paper No. 296). Institute of Development Studies.
3. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.
4. Department for International Development (DFID). (2000). Sustainable livelihoods guidance sheets. DFID.
5. Egeruoh-Adindu, I. (2022). Leveraging indigenous knowledge for effective environmental governance in West Africa. *Beijing Law Review*, 13(4), 931–947. <https://doi.org/10.4236/blr.2022.134060> ([doi.org in Bing](#))
6. Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs—Principles and practices. *Health Services Research*, 48(6pt2), 2134–2156. <https://doi.org/10.1111/1475-6773.12117> ([doi.org in Bing](#))
7. Gaoshebe, T. (2014). African indigenous food security strategies and climate change adaptation in South Africa. *Journal of Human Ecology*, 48(1), 83–96. <https://doi.org/10.1080/09709274.2014.11906777> ([doi.org in Bing](#))
8. Guetterman, T. C., Fetters, M. D., & Creswell, J. W. (2019). Integrating quantitative and qualitative results in health science mixed methods research through joint displays. *Annals of Family Medicine*, 17(6), 554–560. <https://doi.org/10.1370/afm.2424>
9. Mafongoya, P., & Ajayi, O. (2017). Indigenous knowledge systems and climate change management in Africa. CTA.
10. Magni, G. (2016). Indigenous knowledge and implications for the sustainable development agenda. *European Journal of Education*, 51(4), 548–563. <https://doi.org/10.1111/ejed.12157>
11. Mapara, J. (2009). Indigenous weather forecasting systems in Zimbabwe: Juxtaposing post-colonial theory. *The Journal of Pan African Studies*, 3(3), 139–155.
12. Nyumba, T. O., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, 9(1), 20–32. <https://doi.org/10.1111/2041-210X.12860> ([doi.org in Bing](#))
13. Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, 1(2), 112–133. <https://doi.org/10.1177/1558689806291790> ([doi.org in Bing](#))
14. Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533–544. <https://doi.org/10.1007/s10488-013-0528-y> ([doi.org in Bing](#))
15. Schoonenboom, J., & Johnson, R. B. (2017). How to construct a mixed methods research design. *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 69(2), 107–131. <https://doi.org/10.1007/s11577-017-0454-1> ([doi.org in Bing](#))
16. Scoones, I. (2009). Livelihoods perspectives and rural development. *Journal of Peasant Studies*, 36(1), 171–196. <https://doi.org/10.1080/03066150902820503> ([doi.org in Bing](#))
17. United Nations. (2022). United Nations declaration on the rights of indigenous peoples. <https://www.un.org>
18. Wilson, K. (2014). Payment for ‘ecosystem services’ and the ‘green economy’: Greenwashing or something new? *Journal of Human Rights and the Environment*, 5(2), 168–191. <https://doi.org/10.4337/jhre.2014.02.04> ([doi.org in Bing](#))