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Climate change-induced relocation dilemma between preserving cultural heritage and embracing modern infrastructure: insights from Fijian coastal villages

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Abstract
The Pacific Island nation of Fiji, renowned for its cultural heritage, is facing unprecedented challenges due to climate change. Rising sea levels and extreme weather events are threatening Fiji's cultural heritage. Despite the profound significance of cultural heritage in Fiji, both international and national discussions on climate change-induced losses and damages tend to focus predominantly on economic aspects, often neglecting the cultural and social dimensions. To understand how local communities balance cultural heritage preservation and other socio-economic benefits, we employed the choice experiment technique combined with face- to-face interviews. Conducted in ten coastal villages, the research engaged 100 participants who evaluated 16 hypothetical relocation scenarios and rated the importance of different dimensions of cultural heritage. The findings revealed that cultural heritage emerged as a critical dimension of community life, with churches, fishing grounds, community ties, and place attachments being highly valued. The choice experiment results uncovered that there was a significant heterogeneity in participants' views, especially concerning the relocation of burial grounds. Improvement in infrastructure, particularly road connectivity, was consistently favoured, while the proximity of new villages to the old locations (i.e., place attachment) played a crucial role in relocation scenario selection. Participants were willing to accept relocation to distant locations if the relocation scenarios involve quality roads and/or a kindergarten. Intriguingly, participants demonstrated a willingness to contribute more labour under favourable relocation scenarios, which deviates from the conventional economic theory that postulates labour contributions create disutility. The willingness to contribute more labour in our experiment is likely driven by cultural norms and values surrounding communal labour and a strong desire for ownership of the newly established village. These insights underscore the need for holistic climate change adaptation strategies that are not only resilient but also culturally sensitive and community centric.

Keywords Climate change · Adaptation · Relocation · Choice experiment · Cultural heritage · Fiji · Pacific region

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1 Introduction

Since the industrial revolution, the Earth's climate has undergone significant changes, with temperature and sea level persistently rising. As of 2023, our planet has warmed by approximately 1.1 degrees Celsius compared to the average of 1900–2000 temperature (NASA, 2023) and global sea levels have risen by an average of 210–240 mm since 1880 (Church et al. 2013; Church and White 2011). The sea-level rise in the Pacific region has been notably higher compared to the global average (World Meteorological Organization (WMO), 2023), making the region one of the most vulnerable regions to climate change in the world (Mycoo et al. 2022). Communities in the Pacific region, including Fiji, have been facing the brunt of climate change, despite their minimal contribution to global warming (Khalfan et al. 2023; Mishra 2023).

Climate change affects every aspect of life, causing damages and losses to all sectors in the Pacific region and beyond. Nevertheless, most existing estimates of climate change-induced losses and damages have focused on economic impacts (Brabec and Chilton 2015; McNamara et al. 2021), while the true impacts are far broader (Dembedza et al. 2022). There is a notable gap in the literature regarding the effects of climate change on cultural heritage, particularly those intangible aspects (Fatorić and Seekamp 2017; Orr et al. 2021; Sesana et al. 2021), which are deeply embedded in the identities of Pacific communities (McNamara et al. 2021).

For Fijian communities, cultural heritage is an invaluable treasure that transcends mere economic value (McNamara et al. 2021; Yee et al. 2022). It is a living connection that ties together the past, present, and future, serving as the foundation of community identity and continuity (Steadman et al. 2022; Dembedza et al. 2022). This heritage encompasses not only physical sites and artifacts but also the traditions, customs, practices, and ceremonies that have been passed down through generations.

However, climate change is posing a grave threat to both the tangible and intangible aspects of cultural heritage. As sea levels rise and extreme weather events intensify, not only are physical sites such as ancestral burial grounds, sacred places, and historical buildings at risk, but also the very practices and traditions that define Fijian culture are in danger of being lost. Their erosion would leave deep and lasting scars on the collective memory and identity of these communities.

Fiji has experienced a series of severe cyclones and climate change-related hazards in recent years, highlighting the nation's vulnerability to extreme weather events (Fiji Meteorological Service 2020). Notable cyclones include Cyclone Winston in 2016, which was the strongest recorded cyclone to make landfall in Fiji, causing widespread devastation, significant loss of life, and extensive damage to infrastructure and homes (Mansur et al. 2017). More recently, Cyclone Harold and Cyclone Yasa in 2020 brought substantial destruction, impacting many communities (Fiji Meteorological Service 2020). Furthermore, rising sea levels and increased coastal erosion are ongoing threats, exacerbating the vulnerability of coastal villages.

As part of its climate change adaptation strategies, Fiji has implemented climate change-induced relocation programs aimed at moving communities from low-lying, vulnerable coastal areas to safer, higher areas (Office of the Prime Minister 2023). To date Fiji has relocated 6 villages, with 50 villages earmarked for potential future relocation (Fiji Climate Change Portal 2024). Relocation is viewed by the Fijian government as the last resort after

other adaptation attempts have failed or are not feasible (Office of the Prime Minister 2023). Various factors such as the distance between the new and old villages, preservation of cultural heritage, and provision of basic services play a critical role in the relocation process.

In this study, to understand the preferences of local communities and the trade-offs they make regarding the different aspects of relocation programs, we used a choice experiment focusing on economic (e.g. infrastructure) and cultural heritage-based attributes (e.g. burial grounds, connectedness to community and place).

Our choice experiment was designed based on Fiji's relocation program. Participants in our study were given scenarios involving different relocation alternatives, each with varying attribute levels related to economic benefits and cultural heritage preservation. These attributes included the distance between new and old villages, quality of roads connecting the new village with the nearest town/city, and the preservation of cultural sites (e.g. relocation of burial grounds). Our study assesses the trade-offs local communities make between provision of socioeconomic benefits and preservation of cultural heritage.

2 Methods

2.1 Study sites and data sources

Fiji is situated in the Pacific region and had a population size of 935,974 in 2023 (The World Factbook 2014). Economically, Fiji relies on the service sector, which contributed 55.1% to the country's GDP in 2023 (World Bank 2025c), largely driven by tourism. The service sector also employed 58% of Fiji's labour force (World bank 2025b). In 2023, the agricultural sector employed 28% of total employment (World bank 2025a) and contributed 11.75% to the GDP (World Bank 2025c). The industrial sector, while contributing 14.2% to GDP (World Bank 2025c), employed 14% of the labour force (World Bank 2025d). Administratively, Fiji is divided into four divisions which are further divided into 14 provinces, containing 195 districts and 1193 villages (Fiji Budget Vacation 2023) (see Fig. 1). The data for this study was collected from 10 coastal villages located in 6 districts (see Fig. 1).

From each village, we selected 10 households ($n = 100$), which was greater than the threshold sample size required for the design of our choice experiment (de Bekker-Grob et al. 2015). Our survey focus was coastal villages prone to the climate change impacts through sea-level rise and/or coastal erosion.

Participant recruitment was through village chiefs and village headmen. Prior to data collection, the research team visited village chiefs/headmen to gain formal permission to conduct the survey in their village and to identify households to participate in our survey. The households identified were asked at the beginning of the survey for their consent to participate. Depending on the willingness and availability of the household heads, they were asked to do the choice experiment and answer survey questions during a face-to-face interview. In our survey, even though most household heads were men, we asked their wives to fill in the questionnaire to produce a gender-balanced sample. Female participants represented 39% of our sample. The questionnaire, including the choice experiment, was translated into the Fijian language and in all the cases the Fijian version was used to conduct the survey. The research was conducted with social ethics approval (NK29/2/2024) from Manaaki Whenua-Landcare Research, New Zealand.

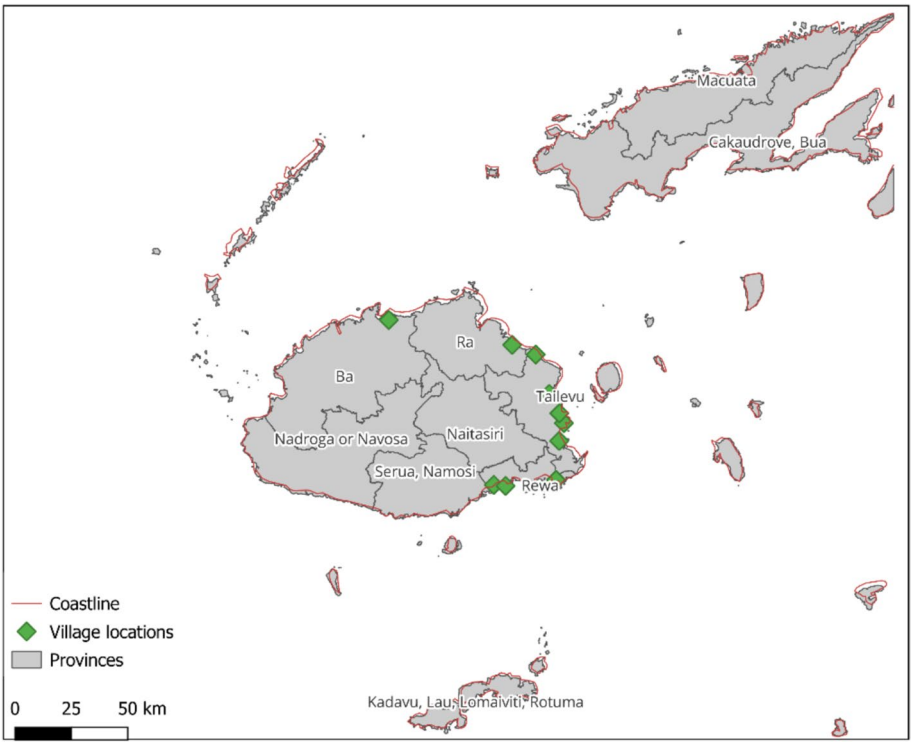

Fig. 1 Map of the study sites

2.2 Data collection methods

We used two data collection methods: (1) structured face-to-face interviews to determine the importance of different aspects of cultural heritage and the perceived severity of the threats of climate change, and (2) a choice experiment to assess the preferences of local communities to different scenarios of climate change-induced relocation programs.

2.2.1 Structured interviews

Structured interview questions with a Likert scale were used to elicit how participants ranked (1) the importance of different aspects of cultural heritage, (2) the threat of different extreme weather events, (3) the threat of climate change impacts on different aspects of cultural heritage, and (4) the connections a participant perceived they had to different dimensions of cultural heritage. These questions were used to provide context on community perceptions and to help interpret the choice experiment results.

2.2.2 Choice experiment

We used the choice experiment to analyse the preferences of local communities to different dimensions of cultural heritage (such as burial grounds and connectedness to one's com-

munity and place) compared to the provision of some socioeconomic services (e.g. roads, kindergarten).

Design and implementation We presented participants with hypothetical scenarios simulating real world situations. Participants were asked to state their preferences among alternative scenarios for relocation, each associated with varying attribute levels.

Our choice experiment was designed based on Fiji's relocation program for coastal communities severely threatened by climate change. The relocation procedure is often initiated by the villagers (Office of the Prime Minister 2023). Then, the government assesses the feasibility and urgency for relocation. In the relocation process, communities are expected to contribute towards the relocation, which may include building materials (e.g. timber) for houses and village hall, labour (skilled/unskilled), fundraising for community infrastructure (e.g. church, kindergarten), accommodation for workers (Office of the Prime Minister 2023; Bertana 2020). The government supports the relocation by constructing houses and providing basic services (e.g. electricity, clean water, roads).

Central to our analysis is preserving cultural heritage. This encompasses the important question of relocation of burial grounds, how far away are communities willing to be relocated from their original villages, and then what trade-offs are they willing to make around the provision of basic services in the new village (e.g. roads, kindergarten). The willingness of communities to navigate the relocation process while safeguarding their cultural heritage underscores the importance communities attach to cultural heritage. Our choice experiment assesses the preferences of local communities to different aspects of a relocation program and trade-offs they are willing to make between socioeconomic benefits and cultural preservation (e.g. attachment to one's place of origin).

Attributes and their levels Each attribute and its associated levels (Table 1) were based on a review of literature/documents related to relocation programs and pre-design discussions with communities vulnerable to the effects of climate change. The attributes and levels in our experiment reflect the multifaceted nature of the relocation process in Fiji and beyond.

Burial grounds This attribute represented the possibility of exhuming and relocating ancestral remains (relocation of burial grounds), covering one dimension of cultural heritage. The

Table 1 Attributes and their levels

Attributes	Levels			
Burial ground relocation	YES	NO		
Whole community relocation	YES	NO, Partial		
Kindergarten	YES	NO		
Type of road connecting the new village with the nearest town	No road	Dirt/ muddy road	Gravel road	Asphalt or tar seal road
Distance from the current village to the new village	1 KM	5 KM	10 KM	15 KM
Labour contribution to the construction work (hours per week)	0 Hrs	5 Hrs	10 Hrs	15 Hrs

two levels of this attribute were relocation of burial grounds or no relocation, while recognizing this is a deeply personal and emotional decision. The trade-offs communities make imply the preferences of communities for the difficult decision of relocating burial grounds compared to other attributes. This attribute was based on previous experiences in Fiji of relocating burial grounds (e.g., in Vunidogoloa village) (Charan et al. 2017; Borsa 2020).

Whole or partial village relocation This attribute represents the connection of individuals to their communities and is chosen based on the previous relocation programs in Fiji (McMichael et al. 2019, 2021; Piggott-McKellar and Vella 2023; Office of the Prime Minister 2023). In some villages, all households were relocated (e.g. Vunidogoloa) while in others only some households were relocated (e.g. Narikoso). In Narikoso, only seven households identified to be in high-risk areas for sea-level rise were relocated to higher ground. This attribute had two levels: all households of a village would be relocated or only some households would be relocated.

Road connecting the new village to the nearest urban centre or town Roads are essential for connectivity and access to resources, services and markets (McMichael and Powell 2021). This attribute evaluates the priority participants place on transportation links to the nearest urban centre/town.

Improved transportation infrastructure can profoundly impact the daily lives of community members. Better road connectivity can stimulate economic opportunities, facilitate the transportation of goods to and from the village, and potentially boost local businesses and other income-generating activities. Improved access to markets can increase the value of agricultural and other products produced by the villagers. This attribute has four levels: No road, Earthen (or dirt) road, Gravel road, Asphalt (or tar seal) road.

Kindergarten This attribute represents the possibility of the presence of a kindergarten in the new village, and it has two levels: new village would have a kindergarten, or it would not have a kindergarten. Participants express their preferences for constructing a kindergarten in the new village compared to having other attributes. In our experiment, 9 out of 10 sample villages currently do not have a kindergarten.

Distance between the current and new village This attribute measures the distance between the old and new village and aims to capture the cultural ties of Fijian communities to their land, place and sea (McMichael et al. 2021). This attribute has four levels: 1 km, 5 km, 10 km and 15 km. The levels were to reflect the diverse needs and preferences of different communities given their local context. For example, some communities may prioritize proximity to the sea and ancestral land and other cultural practices, while others may prioritize safety from climate change impacts. Previous relocation programs in Fiji saw seven households from Narikosa village being relocated 200 m further from the coast, while in Vunidogoloa all households were moved 2 km inland (Rubeli 2015). In our experiment, we use the distance attribute as a price/cost attribute to assess the trade-offs respondents make in terms of willingness to accept to be relocated further away from their old village in response to getting different attributes.

Contribution of labour for construction work (in hours per week) Community contribution to relocation is one of the requirements of Fiji's relocation programs, and this attribute represents this requirement. There were four levels: 0, 5, 10, 15 labour hours per week. In our experiment, this contribution of labour would continue until the construction work is completed for the new village.

Most rural communities are largely subsistence-based economies where households earn or produce just enough for their own consumption/needs. Thus, the role of money may be limited. The value of labour, however, is tangible and vital for daily sustenance. In such contexts using money as a mechanism of contribution or payment, may underestimate the willingness of the local communities to contribute to the relocation program. By using labour contribution, we acknowledge the economic reality of these communities, where non-monetary contributions are fundamental to their way of life.

Our choice experiment is designed to capture the complex decision-making process that climate-induced relocation involves. It allows a participant to weigh the importance of cultural heritage, community unity, connectedness to the place, obtaining socioeconomic services (e.g. infrastructure, kindergarten) and their labour contributions to the relocation efforts. By offering various levels within each attribute, the experiment provides a comprehensive view of the trade-offs and preferences involved in this critical decision.

Design of the choice sets Our experiment has six attributes (three attributes with two levels and three attributes with four levels (see Table 1)), giving 648 (2^3*3^4) possible choice sets. As it was not feasible to present all the 648 choice sets to the same participant, we used efficient designs to represent the complete choice sets (Hanley et al. 2006; Lancsar et al. 2007; Hanley and Barbier 2009; Lancsar et al. 2013; Lancsar et al. 2017). We used the Bayesian D-efficient (DB-efficient) design (with priors from a normal distribution) to select 16 choice sets from the 648 possible choice sets using the "idefix" R package (Traets et al. 2020). Bayesian efficient designs are more robust and less sensitive to prior misspecifications (Bliemer et al. 2009; Walker et al. 2018; Traets et al. 2020).

Each participant was presented with 16 choice sets. In each choice set, participants were asked to choose the best option in two rounds. In the first round, they were asked to choose the most preferred option from three alternatives (i.e. two relocation scenarios or none of the two scenarios). In the second round, the alternative chosen in the first round was removed and, the participants were asked to choose the better option from the remaining two options (see Table 2). Combining the choices over the two rounds, we created an implied complete preference ranking per choice set. The 16 choice sets were presented in the same order to all participants.

To reduce the hypothetical bias in our survey, the enumerator read written instructions to each participant at the beginning of the experiment, explicitly emphasizing the real-life relevance of their choices. We highlighted their responses could potentially influence decisions that directly impact their well-being and that of their families. This framing was intended to enhance the perceived consequentiality of our experiments (see also Catalogue of Bias Collaboration 2020). We directly asked participants to make their choices based on what mattered most to them and their families' well-being. This approach was to link the hypo-

Table 2 Sample choice card

Card 1/16	Scenario A	Scenario B
Burial ground relocation 	YES	NO
Whole community relocation 	YES	NO, Partial
Kindergarten 	NO	YES
Type of road connecting new village with the nearest town 	Dirt/muddy road	No road
Distance from the current village to the new village.  	15 KM	1 KM
Labour contribution to construction work (hours per week) 	5 Hrs	15 Hrs

Which relocation program would you prefer?

○ A ○ B ○ None of the two scenarios

From the remaining two options, which one do you prefer? (option chosen in the first round would be removed)

○ A ○ B ○ None of the two scenarios

thetical scenarios in the experiment to their actual preferences and real-world trade-offs, encouraging realistic behaviour.

Analytical framework Choice experiments are survey-based stated preference valuation methods used to examine the preferences of respondents to different market and non-market goods (Hanley and Barbier 2009). They are based on the principles of Lancasterian consumer theory of utility maximization (Lancaster 1966), which states that consumption decisions are determined by the utility derived from the attributes (or characteristics) of the goods consumed rather than the goods themselves. Random utility theory provides the behavioural framework for the econometric analysis of the data obtained from choice exper-

iments (McFadden 1973). Random utility theory postulates individuals, as rational decision makers, choose alternatives that maximize their personal utility subject to constraints they face.

To analyse our data, we follow two approaches. The first approach focuses on the first best alternative chosen by participants across all 16 choice sets. In the second approach, we obtain the implied rank of alternatives combining the two stages of questions for each choice set.

In the first approach, we assume individual n chooses the relocation scenario j over the relocation scenario i if, and only if, the perceived utility associated with j is greater than the utility associated with i, i.e.,

$$U\left(j\right) > U\left(i\right) \forall j \neq i \tag{1}$$

where $U(j)$ and $U(i)$ are utilities derived from alternatives j and i respectively. The random utility theory assumes that utility derived from an alternative (e.g., relocation scenario) is composed of deterministic (V_{nj}) and stochastic (ε_{nj}) components.

$$U_{nj} = V_{nj} + \varepsilon_{nj}, \forall j \tag{1a}$$

where V_{nj} is a function of the observed m attributes $(X_1, X_2, X_3, \ldots, X_m)$ of the relocation scenario and ε_{nj} represents the unobservable characteristics of the relocation scenario and individual level variations in preferences, and is assumed to be independently and identically distributed with Type I extreme-value (Gumbel) distribution (Steckel and Vanhonacker 1988). The deterministic component is often assumed to be additive and linear in fixed marginal utility parameters (McFadden 1973) and is given as:

$$V_{nj} = \alpha_j + \sum\nolimits_{m=1}^{M} \beta_m X_m \tag{2}$$

Substituting Eq. 2 into Eq. 1a, we obtain:

$$U_{nj} = \alpha_j + \sum\nolimits_{m=1}^{M} \beta_m X_m + \varepsilon_{nj} \tag{2a}$$

The probability that individual n chooses a relocation scenario j, in a given choice set, is given by (McFadden 1973):

$$P_n\left(j\right) = P(U_{nj} > U_{ni}) \tag{3}$$

$$P_n\left(j\right) = P(V_{nj} + \varepsilon_{nj} > V_{ni} + \varepsilon_{ni}) \tag{3a}$$

$$P_n\left(j\right) = P\left\{(V_{nj} - V_{ni}) > (\varepsilon_{ni} - \varepsilon_{nj})\right\} \tag{3b}$$

For conditional logit specification, Eq. 3b can be written as:

$$P_n(j) = \frac{\exp(\mu V_{nj})}{\sum_{j=1}^{J} \exp(\mu V_{nj})} \tag{4}$$

In Eq. 4, μ, which is a scale parameter, is inversely proportional to the standard deviation of the distribution of the error term and is usually assumed to be one. This specification makes a strong assumption that selection in any choice set must obey the Independence of Irrelevant Alternatives (IIA) property, which implies that the relative probabilities of two options being selected are unaffected by the introduction or removal of other alternatives. This is because according to this assumption, the preference between any two alternatives i and j only depends on the individual's preferences to i or j and not on an individual's preference for one over the other. The IIA property follows from the independence of the Gumbel error terms across the different options/alternatives contained in the choice set.

Maximum likelihood procedures can be used to estimate Eq. 4, with respective log-likelihood functions given as:

$$logL = \sum_{n=1}^{N} \sum_{j=1}^{J} d_{nj} \left\{ \frac{\exp(\mu V_{nj})}{\sum_{j=1}^{J} \exp(\mu V_{nj})} \right\}$$

where d_{nj} is a dummy variable taking a value of one if respondent *n* chooses option *j* and zero otherwise, and V_{nj} is as defined in Eq. 2.

These models usually assume participants to be homogeneous according to their preferences towards the attributes and have homogenous utility functions. Consequently, the coefficients of the attributes are assumed to be constant across individuals (i.e., the effect of the attributes to be the same across the participants), which might not be realistic. To account for the heterogeneity in the preferences of individual participants, in this study we used random parameter (mixed) logit models. Random parameter logit models account for variations across individuals by assuming a specific distribution (usually normal distribution) for coefficients of the attributes across individuals. These models relax the strong assumption of IIA of the homogenous models. In this study, to estimate the random parameter logit models, we used the Rchoice package in R (Sarrias 2016). In these models, the cost attribute is treated as fixed to provide a stable reference point for estimating trade-offs (see Giergiczny et al. 2012; Morrissey et al. 2018). In our study we used distance as a price/cost attribute and the models were estimated assuming the distance attribute to be fixed (see Table 3).

In the second approach, which uses the implied rankings of the alternatives, we combined the choice of the alternatives by participants over the two stages in each choice set and obtained the implied ranking of alternatives per choice set. In our experiment, as given in Table 2, we asked participants to make their choices in two stages for each choice set. The probability of choosing i as the first best, and j as the second best can be modelled using rank ordered logit model following Lancsar et al. (2013) as follows:

$$\mathrm{P(i > j > k)} = \frac{\exp(V_{ni})}{\sum_{w=i,j,k} \exp(V_{nw})} * \frac{\exp(V_{nj})}{\sum_{w=j,k} \exp(V_{nw})} \tag{5}$$

Rank ordered logit models estimate the probability of a particular ranking of alternatives as the product of multinomial logit models for choice of alternatives in a particular order

Table 3 Random parameter and Rank ordered logit regression results

	Model 1: Random parameter logit (fist best alternative)	Model 2: Rank ordered logit (rank from the two stages)
ASC	-2.413***	-0.990***
	(0.163)	(0.116)
Distance between old and new villages (in km)	-0.032***	-0.022***
	(0.007)	(0.006)
Burial grounds	-0.547***	-0.660***
	(0.115)	(0.111)
Burial grounds x Gender (Male)	0.100	0.216
	(0.184)	(0.131)
Whole village relocation	-0.156	-0.113
	(0.168)	(0.111)
Whole village relocation x Gender (Male)	0.149	0.024
	(0.209)	(0.133)
Kindergarten	0.370***	0.393***
	(0.085)	(0.077)
Road (Dirt)	0.790***	0.684***
	(0.110)	(0.099)
Road (Gravel)	0.683***	0.694***
	(0.112)	(0.103)
Road (Asphalt)	1.250***	1.175***
	(0.132)	(0.098)
Reference: No road		
Labour Contribution	0.013*	0.018***
	(0.007)	(0.007)
N	4800	4800

Standard errors are given in parentheses; Significance: *** =$p < 0.001$; ** =$p < 0.01$; *=$p <$ 0.05

(Lancsar at al. 2013). For example, we have three alternatives with possible ranking of scenarios $i > j > k$. Hence, the probability of a particular ranking of $i > j > k$ is modelled as the product of the multinomial logit probability of choosing scenario i as best among the scenarios $i, j, \ and \ k$ times the probability of choosing scenario j as better from the remaining scenarios j and k.

To estimate Eq. 5, based on the ranks obtained from the two rounds per choice set, we estimated the rank order logit model using the ROlogit R package (Tan and Yilin 2022) and Rchoice package in R (Sarrias 2016). In all the models, standard errors were clustered at the participant level.

In our models, we accounted for different contextual factors, including:

- Demographic factors, such as having children under the age of five years (see SOM Table S4).
- Environmental factors, such as proximity to the coastline (see SOM Table S5).
- Socioeconomic factors, such as unemployment status (see SOM Table S11).
- Perceptions of future displacement (see SOM Table S8).
- Perceived importance attached to burial grounds (SOM Table S6).

- Tribal composition of the villages (SOM Table S7).
- Presence of kindergarten in a village (SOM Table S9)

3 Results and discussions

3.1 Descriptive statistics

Thirty nine percent of the participants in our sample were women and 61% were men. Almost one in four participants had primary education, more than half had high school education and one in five had a diploma or certificate, and only one participant had a bachelor's degree. Most participants (65%) were older than 45 years of age (SOM Figure S3).

The majority of participants were engaged in farming, fishing, and/or hired labour in agricultural and domestic work. Almost 54% of participants relied on farming as their primary source of income, highlighting the central role agriculture plays in sustaining household livelihoods within these communities. The second most significant livelihood activity was fishing. Almost 30% of participants reported fishing as important for their livelihood, in addition to farming and other activities such as hired labour. A smaller but notable proportion of participants reported being engaged in hired labour (domestic or farming tasks for other households) and skilled work, mostly in addition to farming and fishing. One in ten participants reported they were unemployed.

3.2 Structured interviews

3.2.1 Community perspectives on cultural heritage and threats from climate change

Our results revealed that churches hold the highest significance among the dimensions of cultural heritage we assessed. An overwhelming 99% of participants rating them as very important or extremely important (Fig. 2), reflecting the central role religious institutions play in the social and cultural lives of communities. Fishing grounds are also highly valued, with 96% of participants rating them as very important or extremely important. This underscores the integral role fishing grounds have in the daily livelihoods, cultural practices, and food security of coastal communities. The reliance on fishing for sustenance and economic activities makes fishing grounds critical to these communities'way of life. Notably, the significance attached to fishing grounds likely stems from their combined importance for cultural heritage and as a source of livelihood. Coupled with the significant importance of connectedness to the sea (79%) (see Fig. 2), it can be argued that the cultural aspect of fishing grounds holds substantial significance.

Connectedness to one's community emerges as another crucial dimension, with 95% of participants considering it as very important or extremely important. This highlights the deep bonds and social networks essential for mutual support, collective identity, and cultural continuity within the community. Cultural identity was rated by 94% of participants as very important or extremely important (Fig. 2).

Totems were rated as very important or extremely important by 89% of participants, symbolizing the spiritual and ancestral connections fundamental to the community's belief systems and cultural expressions. These symbols often represent lineage, clan identity,

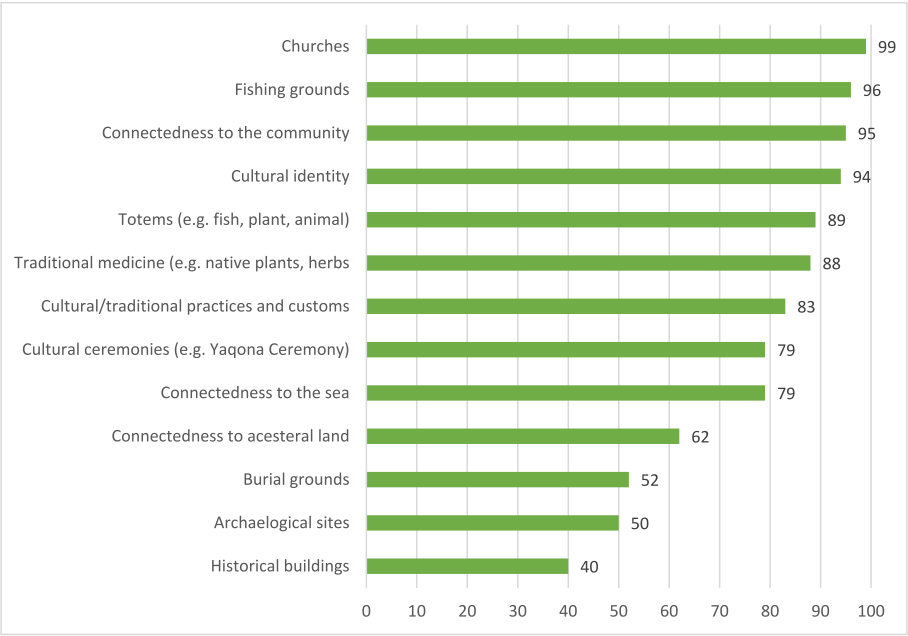

Fig. 2 Percentage of participants rating different dimensions of cultural heritage as very important or extremely important

and the continuity of traditions passed down through generations. Traditional medicine is also highly valued, with 88% of participants recognizing its high importance (Fig. 2). This reflects the community's reliance on indigenous knowledge and practices for health and well-being, and how it is deeply intertwined with cultural heritage and identity.

In contrast, burial grounds, historical buildings, and archaeological sites were considered relatively less important (Fig. 2). While these elements still represent important dimensions of cultural heritage, they do not hold the same level of significance as churches, fishing grounds, connectedness to one's community and cultural identity.

Overall, the results highlight a clear hierarchy of different dimensions of cultural heritage within communities, emphasizing the prominent role of religious, economic, social, and traditional health practices in their daily lives and cultural identity.

Our data also revealed that, from the perspective of communities, fishing grounds are the most affected dimension of cultural heritage by climate change-induced hazards (see Fig. 3). A large percentage (83%) of participants reported that the threat from climate change to fishing grounds is high or very high.

In addition to fishing grounds, cultural identity and connectedness to communities are also highly threatened by climate change. About 55% of participants indicated that these two dimensions face significant threats from climate change-induced hazards in their villages (Fig. 3). Traditional practices and cultural ceremonies are similarly at risk, with around 45% of participants reporting these aspects of their cultural heritage are highly threatened by climate change. We found that three of the five most important dimensions of cultural heritage in our study villages are highly threatened by climate change.

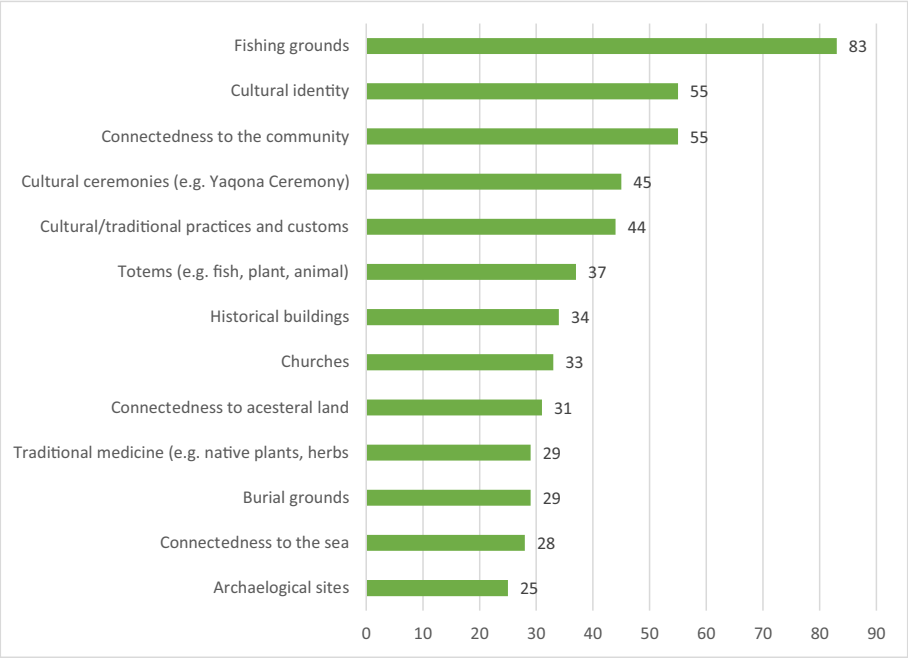

Fig. 3 Percentage of participants rating the severity of threats posed by climate change to different dimensions of cultural heritage as high or very high

3.2.2 Community perceptions of climate change-induced hazards

Our results indicate that severe storms and cyclones, along with coastal erosion, are the primary climate change-related hazards threatening the cultural heritage in the villages surveyed (SOM Figure S4). A substantial proportion of participants (72%) reported severe storms and cyclones pose a high or very high threat to their cultural heritage. Similarly, 69% of participants highlighted coastal erosion as a significant climate change-related threat. Sea-level rise and floods were identified as other significant climate change-related hazards, with 53% and 49% of participants, respectively, reporting the severity of these threats as high or very high. In contrast, the severity of threats posed by droughts, heatwaves, and landslides was reported to be relatively low.

3.3 Choice experiment

3.3.1 Preferences of local communities and considerations in relocation scenarios

We analysed the choice experiment data at two levels to understand how participants'preferences were influenced by various attributes of relocation scenarios. First, we analysed only the first best option selected by participants using random parameter logit models. Second, by combining the two rounds of questions per choice set, we analysed the implied ranking of preferences using rank ordered logit models. The preference results

obtained using the two methods were very similar (see Table 3), which is consistent with other studies in the literature (Lancsar et al. 2013).

The results using the random parameter logit models, revealed the existence of considerable heterogeneities among participants in their consideration of specific attributes (see SOM Table S1). Notably, the results show that there were significant heterogeneities among participants in terms of burial grounds and connectedness to one's community, as suggested by the significant standard deviations of the coefficients of these attributes (see SOM Table S1).

On average participants viewed the relocation of burial grounds negatively (see Table 3). Men had a greater positive inclination towards relocating burial grounds compared to women, although the difference was not statistically significant. In general, only 18% of participants expressed a positive inclination towards relocating the burial grounds (see SOM Figure S1). When we accounted for the distance between the participants house (or village hall) to the coastline, the statistical significance of the burial grounds attribute became weaker as households located away from the coastline were relatively less likely to favour relocation scenarios involving burial grounds being moved (see SOM Table S5). Moreover, participants who perceived burial grounds as an important or extremely important dimension of cultural heritage show a higher preference to relocate burial grounds to the new village site, but still the coefficient of the burial grounds relocation attribute remains negative and statistically significant (see SOM Table S6). Nonetheless, this may not mean that our participants have attached less value to burial grounds. As shown in Fig. 2, 43% of participants indicated that burial grounds are very important dimensions of cultural heritage. During focus group discussions participants revealed that they need more investment to protect the burial grounds in-situ (e.g., by erecting seawall) as opposed to relocating them.

Our results show that, on average, participants were indifferent between partial and whole village relocation. The possibility of relocating the whole village had a statistically insignificant effect on the probability of the relocation scenario being chosen (Table 3). However, there was a significant heterogeneity in responses, where 57% of participants preferred relocating the whole village and 43% of participants preferred the partial relocation of villages. We found that around 12% of participants had statistically significant positive estimates, while 18% had statistically significant negative estimates. The remaining participants had insignificant estimates, with both positive and negative point estimates (see SOM Figure S2). The significant heterogeneity among participants (as suggested by statistically significant standard deviation of the community attribute) might have led to the insignificance of the coefficient for the whole village relocation attribute. In addition, our results suggest that, relatively, men tend to prefer scenarios with whole community relocation compared to women, though the difference was not statistically significant (Table 3).

The inclusion of infrastructure-related attributes (roads) showed a clear preference among participants for scenarios offering road connectivity and accessibility. The road attribute was positively and significantly associated with the probability of a relocation scenario being selected as compared to scenarios with no road access. The provision of roads, as expected, emerged as a significant factor, with participants favouring scenarios with road access. Similarly, the possibility of having a kindergarten in the new village increases the probability of the relocation scenario being chosen. Our results also show participants with young children (i.e. children under five years of age) were more likely to favour scenarios with a kindergarten, though the coefficient for this interaction was not statistically signifi-

Table 4 Trade-offs between proximity to the original village and infrastructure and social services

Attributes	WTA (in terms of distance to be relocated farther away from the original village in KM)
Dirt road	25
Gravel road	22
Asphalt or tar seal road	42
Kindergarten	12

cant (see SOM Table S4). We have checked the robustness of these results for how the actual presence of kindergarten in a village was coded. The results show that the potential noise introduced by our coding of the kindergarten attribute as 1 when the relocation scenario involves a kindergarten and zero otherwise (for all participants) (Table 3) is minimal and does not significantly affect our findings (see SOM Table S9).

The distance between the new and old villages significantly reduced the probability of a relocation scenario being chosen. Participants prefer relocation scenarios where the new village is located a short distance from the old village. The negative relationship between the distance separating old and new villages and the probability of a relocation scenario being chosen emphasizes the importance of connectedness to one's place. We also found participants from villages with one clan tended to give priority to relocation scenarios with closer proximity to the original village, though the impact of clan composition as a mediating factor on the importance of proximity was not statistically significant (see SOM Table S7). In addition, we also estimated models where we allowed for the interaction between the whole village relocation and the distance attributes. The results showed participants who preferred scenarios with whole village relocations had slightly more tolerance to a longer distance between the old and new villages (see SOM Table S2).

Perhaps one of the most intriguing findings of our experiment pertained to labour contributions. Contrary to conventional economic theory positing labour contributions as a source of disutility, participants displayed a willingness to contribute more labour under favourable relocation scenarios. This unexpected finding may be attributed to the cultural norms surrounding communal labour contributions in Fijian villages, where such contributions are integral to community life and cohesion. We also estimated models with interactions between the labour contribution attribute and a dummy variable for unemployment and found that the unemployed participants were more willing to contribute labour compared to employed participants, though the effect was only marginally significant (at 10%) (see SOM Table S11). However, the coefficient of the labour attribute was still positive and statistically significant, suggesting that the positive coefficient of the labour attribute in our study may be more because of cultural norms than the unemployment status of the participants. Group discussions with community members revealed that contributing more labour creates the sense of ownership for the newly established village, and hence participants are happy to contribute more labour.

Based on the estimates of the parameters of the attributes in Model 1 (Table 3), we estimated the additional distance participants were willing to be relocated in response to having different attributes in the relocation scenarios (see Table 4). These estimates are obtained using the *"effect"* function from *"Rchoice"* package in R (Sarrias 2016), which follows the common logic of estimating the marginal willingness to pay (or accept) from the regression results using $-\beta\ (x)/\beta\ (price\ attribute)$. In our case, distance between the old and

new villages is considered to be the price attribute. Our results show that participants were more willing to move farther from their original villages when essential infrastructure and services were available in their new settlements (see Table 4). Road access significantly impacted relocation preferences. In the absence of roads, participants strongly preferred to remain near their original village. However, the presence of gravel or dirt roads increased their willingness to relocate to sites up to 22–25 km from their original village. The impact was even more pronounced for asphalt roads, which raised the acceptable relocation distance to up to 42 km away. This underscores the crucial role of road infrastructure in shaping community acceptance of how far away from their original village they would be willing to be relocated.

Similarly, access to a kindergarten increased participants' willingness to accept relocation sites up to 12 km from their original villages, highlighting the high value placed on social services such as kindergartens. We note that in Fiji, any relocation is likely to follow communal land ownership structures, and with any relocation occurring within *mataqali* (clan) land (as much as possible) (Yee et al. 2024).

Our results underline that while participants exhibited strong place attachment, they also demonstrated a willingness to make trade-offs, opting for more distant relocation sites in exchange for improved infrastructure and essential services.

4 Discussion

Climate change poses an existential threat to many coastal communities around the world, particularly in small island nations like Fiji. Rising sea levels, severe storms, coastal erosion, inundation and intrusion of salt water onto land and into freshwater systems necessitate discussions around the relocation of communities from low-lying coastal areas to higher grounds. However, relocation is not merely a logistical challenge; it also affects the cultural, emotional, and social fabric of the affected communities. Our study, conducted in ten coastal villages in Fiji, explored these complexities, revealing a significant heterogeneity in the attitude of communities toward different components of relocation scenarios. We also found communities attach critical importance to road access, maintaining proximity to one's current village, and have high willingness to contribute labour to the relocation process.

4.1 Heterogeneity in relocation scenario preferences

One of the key findings of our study was that while infrastructure improvements, such as better road connectivity and the inclusion of a kindergarten in the relocation program were consistently favoured, there were notable heterogeneities in how the participants viewed the relocation of burial grounds, and whole versus partial village relocation. This divide is indicative of the broader dilemma at individual level to balance the needs for better infrastructure and the deep cultural and emotional ties that communities have to their communities, ancestral land, traditions and customs.

For many Fijians, burial grounds are sacred sites that represent a connection to their ancestors and the continuity of their cultural heritage (Chand 2023). The reluctance to relocate these sites, as expressed by a significant portion of participants, reflects a broader concern about the potential trauma, grief and sense of loss caused by disturbance to sacred

places (Chand 2023). The opposition to the relocation of burial grounds also reflects the deep respect and reverence Fijian communities have for their ancestorial burial grounds. Insights from group discussions further revealed that many community members prefer investing in protective measures, such as constructing seawalls whenever it's feasible, to safeguard burial sites in their current locations rather than relocating them.

These findings highlight certain dimensions of cultural heritage, such as burial grounds, may not be compatible with relocation as a climate change adaptation strategy. Consequently, discussions surrounding climate change-induced losses and damage, as well as associated compensation mechanisms, must recognize the existence of irreversible losses. For instance, the inundation of burial grounds represents a form of loss that cannot be fully compensated, underscoring the need for tailored approaches that prioritize cultural preservation wherever and whenever possible.

4.2 The importance of proximity to the place of origin

The distance between the new and old villages emerged as a critical factor in participants' attitudes towards relocation. The preference for proximity underscores the importance of maintaining an attachment to one's place, which serves as a physical, cultural, and emotional anchor for Fijian communities. In Fijian culture, the concept of *vanua* captures the idea that the land, the ocean, the people, their customs, and their spirituality are all interconnected (Tuwere 2002; Yee et al. 2022). The land, beyond being a resource, is a repository of memories, traditions, and a sense of belonging integral to a community's identity (Tuwere 2002).

Relocation, particularly to a place far away from the current village site is often perceived as a severing of the bonds that define a community's sense of self and attachment to a place (McMichael et al. 2021). The preference for being closer to the old village underscores the importance of maintaining attachment to one's original place (McNamara et al. 2021; Yee et al. 2022).

Nonetheless, our results also show that well-planned relocation programs involving infrastructure and essential services can help overcome resistance to relocation sites that are far away from original villages. Despite strong place attachment, participants in our study demonstrated a clear trade-off: they were willing to accept greater relocation distances in exchange for improved infrastructure and services. These findings have important policy implications for relocation planning. Governments and development organizations should recognize the cultural significance of place attachment in the planning of climate change-induced relocation programs.

We suggest that to get further insights into the preferences of communities, future research could explore the trade-offs between proximity to one's place of origin as compared to proximity to social services (e.g. hospitals, schools).

4.3 Infrastructure improvements: balancing practical needs with cultural preservation

Despite the strong attachment to their current village location (i.e. place attachment), participants consistently favoured certain infrastructure improvements, such as better road connectivity and having a kindergarten. These improvements are seen as essential for enhancing

the quality of life in the new location, providing practical benefits that are difficult to ignore. Improved road connectivity, for instance, offers better access to markets, healthcare, and education, which are crucial for the long-term sustainability of the relocated community (McMichael and Powell 2021).

However, the preference for these infrastructure improvements does not diminish the importance of cultural heritage. Instead, it highlights the need for a balanced approach that considers both the practical needs of local communities for better infrastructure as well as preserving cultural heritage. The challenge for policymakers and planners is to design relocation strategies that provide the necessary infrastructure improvements while also preserving the cultural and emotional ties that bind communities to their land, traditions and customs.

4.4 Willingness of local communities to contribute labour: a reflection of cultural norms and values

One of the most intriguing findings of our study was the participants'willingness to contribute more labour under favourable relocation scenarios, contrary to the conventional economic theory that views labour contributions as a source of disutility (Rätzel 2012). This willingness is deeply rooted in the communal way of life in Fijian villages, where communal labour is a key aspect of social cohesion and community building (Ratuva 2014). In these communities, labour contributions are not only about getting work done, but also about fostering a sense of ownership and responsibility for community's well-being.

This cultural norm of communal labour, known as *solesolevaki* in Fijian, reflects the deep-rooted belief in the importance of working together for the common good (Movono and Becken 2018; Ratuva 2014). The willingness of participants to contribute labour to the construction of the new village is not just a practical response to the need for infrastructure but also a cultural statement of their commitment to maintaining social cohesion, network and a sense of ownership over the new village. Thus, the use of labour contribution as a payment vehicle (see Gibson et al. 2016) instead of the customary monetary approach makes our experiment more culturally relevant to the local context of Fijian communities.

However, we acknowledge that in our study, while labour was culturally relevant, some participants may not have perceived labour contributions as negatively as money, likely due to strong community-based norms and collective action traditions. These contextual differences could potentially influence how labour operates as a trade-off measure. This is reflected in our findings, where the coefficient for the labour attribute was positive, making it unsuitable for use as a price variable in marginal trade-off estimations. Hence, we suggest that future research should explore hybrid approaches or supplementary methods to better capture the trade-offs in such contexts.

5 Conclusions

We used a choice experiment to assess the relocation dilemma that communities face in Fiji and to understand the trade-offs they make between preserving cultural heritage and access to better socioeconomic services. We found that there were significant heterogeneities among households in their preferences for different relocation attributes, particularly the

relocation of burial grounds and partial versus whole community relocation. There is more homogeneity among participants for their preferences for access to better roads, kindergarten and distance from their current village. Our findings underscore the need for a holistic approach to climate-induced relocation that integrates cultural sensitivity with practical needs. While infrastructure improvements are essential for the sustainability of relocated communities, they cannot fully compensate for the loss of identity and cultural heritage that can result from climate change-induced relocation. We also found that proximity to current villages is crucial, as it allows communities to maintain their connection to their ancestral land, sacred sites, burial grounds and cultural practices.

The willingness of communities to contribute labour to the relocation process highlights the importance of involving them in the planning and execution of relocation strategies. Their involvement ensures the relocation process is culturally appropriate and fosters a sense of ownership and responsibility among the community members, which is critical for the long-term success of the relocation programs.

5.1 Policy insight: a culturally sensitive and inclusive approach to climate-induced relocation

As climate change continues to threaten the lives and livelihoods of coastal communities in Fiji and beyond, the need for relocations will likely become more pressing. However, relocation must be approached with sensitivity for the affected communities' cultural heritage and socioeconomic needs.

In our study, while infrastructure improvements, such as better road access and the inclusion of amenities like a kindergarten, were consistently favoured by affected communities, these practical needs must not overshadow the cultural and emotional ties to ancestral land and sacred sites. Proximity to current village sites emerged as a critical factor in ensuring cultural continuity. Policymakers should design relocation sites, as much as possible, that maintain this proximity to preserve the strong connection between communities and their *vanua* (land and culture). Nonetheless, whenever this is not possible our findings suggest that investments in road infrastructure and social services can encourage greater flexibility in relocation decisions.

The significant heterogeneity in preferences regarding relocation attributes, such as whole versus partial village relocation and the relocation of burial grounds, reflects a diverse range of attitudes within communities, and should be explored and discussed at the community level during any relocation process. Thus, policymakers should adopt participatory planning processes that capture this diversity by engaging with all community members to co-develop relocation plans. Tailoring relocation options to align with these preferences, rather than adopting a one-size-fits-all approach, is essential for ensuring both acceptance and long-term success of the relocation programs.

Proximity to the current village, preserving burial grounds where they currently are (if possible), and the retention of cultural identity must be central to relocation strategies, along with the attempts to meet the needs of local communities for quality infrastructure and socioeconomic development. Policymakers need to recognize that physical relocation alone cannot address the trauma and sense of loss communities experience. Successful relocation requires a holistic approach that combines recognition and respect to the cultural heritage, ensuring access to essential infrastructure (e.g. roads, healthcare, education, and access

to markets), and engaging local communities in the decision-making and implementation processes.

5.2 Study limitations and future research directions

While our use of Bayesian efficient design with normally distributed priors follows best practice and is generally robust to prior misspecifications, the efficiency of the design still depends on the accuracy of the specified priors. Although we validated our design by assessing choice probabilities of alternatives in each choice set, potential prior misspecification remains a limitation. Future research could mitigate this limitation by conducting a pilot study or using previous studies (whenever possible) and leveraging expert elicitation to refine prior estimates.

Another limitation of our study could be the lack of a follow-up question to assess hypothetical bias in respondents' stated willingness to contribute labour. While our findings offer valuable insights, incorporating validation mechanisms could enhance understanding of how stated and actual behaviour align. Therefore, we recommend that future studies using labour contributions as a payment vehicle in similar contexts should include a follow-up question to assess the extent of hypothetical bias.

Finally, our coding of the status quo for the kindergarten attribute as zero for all participants likely introduced minimal noise in parameter estimates as only 10% of participants were from villages with a kindergarten during our study. However, had this percentage been higher, the noise in the parameter estimates may have been higher. Thus, future studies should explore alternative coding strategies and robustness checks.

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Declarations

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