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RESEARCH ARTICLE

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An applied framework for assessing the relative deprivation of dam-affected communities

Ruilian Zhang[1] | John R. Owen[1] | Deanna Kemp[1] | Guoqing Shi[2]

[1]Centre for Social Responsibility in Mining, Sustainable Minerals Institute, University of Queensland, Brisbane, Australia

[2]National Research Centre for Resettlement, Hohai University, Nanjing, China

Correspondence
Ruilian Zhang, Centre for Social Responsibility in Mining, Sustainable Minerals Institute, University of Queensland, Brisbane 4072, Australia.
Email: ruilian.zhang@uq.edu.au

Abstract

Over the past half century, hydropower dams have displaced 40–80 million people around the world. In the development literature, the outcome of these shocks is represented in the form of "absolute deprivation." The policy norms surrounding development-induced displacement and resettlement, across all industries, prioritize compensation as the primary means through which to address any short-term deprivation caused by the shock of displacement. One dimension that has been overlooked is the force and effect of "relative deprivation (RD)." To demonstrate the merits of the RD approach, we develop a novel framework to assess the poverty conditions of affected communities across different resettlement schemes in Qinghai Province, China. A review of the case literature shows the scope and depth of deprivations experienced by those directly impacted by project-induced displacement. Our findings offer two important insights. First, that restorative schemes that most closely resemble like-for-like appear to have the least negative impact in RD terms. Second, that the involuntary acquisition of land in hosting communities should be accounted for in the same way as the acquisition of land for the project. The impacts of "indirect" displacement can be significantly greater, particularly when the responsibility for managing or mitigating these impacts falls outside the formal scope of the project.

KEYWORDS

displacement, livelihoods, resettlement, resilience, China

1 | INTRODUCTION

Hydropower dams have become a remarkable source of clean energy over the past half century, but they have also displaced 40–80 million people around the world (World Commission on Dams, WCD, 2000). In 2018, Shi (2018) estimated that over 20 million people were displaced by 95,000 dams during 1950–2015 in China alone. The construction of these dams before 1980s has created a social phenomenon summarized by Chinese resettlement scholar as "advanced projects, less developed reservoir areas, and poor people affected" (Shi et al., 2015; Shi et al., 2021). Dam construction introduces an external shock to the people in the affected areas through displacement and relocation. Academic institutions (Cernea, 2003), international financial institutions (World Bank, 1996), and non-government organizations (International Rivers, 2012) have focused on understanding the impact of such external shocks (Scudder, 2019). The negative impacts of these projects on affected communities include reduced access to natural resources and ecological services (Wilmsen et al., 2011), decreased household incomes (Tilt et al., 2009), routine and dissonant culture (Downing & Downing, 2008), widening interhousehold and intercommunity economic disparities (Wang et al., 2013), and diminished mental health and wellbeing (Xi & Hwang, 2011). In the development literature, the outcome of these shocks is typically measured in the form of "absolute deprivations (ADs)," which is concerned with whether people possess or have access to certain universal goods (land, food, water, education, and health care). Where resettlement cannot be avoided, the policy norms surrounding development-induced displacement, across all industries (Bainton & Banks, 2018; Nordensvard et al., 2015; Schapper et al., 2020), prioritize compensation as the primary means through which to address short-term, AD caused by the displacement process. This includes providing replacement land and housing, together with a bundle of cash or in-kind services aimed at off-setting the immediate effects of such wide ranging loss. The logic is to identify possible areas of material deprivation and to design a program of restoration that addresses them.

One dimension that we believe has been overlooked is the force and effect of "relative deprivation (RD)." Stouffer et al. (1949) described RD as a condition where a person holds an inferior position relative to a certain standard or reference. We argue that RD can be used to explain the medium- and long-term impoverishment effects caused by displacement. Moreover, there is ample evidence to suggest that displacement scholars should pay closer attention to the knock-on effects experienced by host communities, who themselves are not directly displaced by projects, but feel the very real pressure of involuntary land acquisitions. Where AD is concerned with universal access to basic goods, RD focuses on the relationship between socio-economic status and the experience of poverty. Simply stated, the status of a person's resources and attributes relative to that of the society around them has a pronounced and determining impact on their long-term prospects. The interplay between household resources and the context of displacement and resettlement requires much greater attention (Owen et al., 2021).

In 2014, Nombre (2014) claimed that hydropower projects have provided "irrigation water to feed 800 million people," and the positive social impacts of dams can induce multiple indirect positive impacts, from improved nutrition to enhanced incomes, flood protection, water storage for irrigation, additional employment opportunities, and accelerated economic growth (Cernea, 2003). The greatest negative social impact of large-scale infrastructure projects (such as dams and hydropower facilities) may be the long-term impact of involuntary resettlement. Dam resettlement is a complicated process, with far-reaching effects (Wilmsen & Wang, 2015), requiring multiple and diverse technical inputs (Gong et al., 2020; Shi et al., 2015). According to Cernea (2000), the impoverishment landscape covers several interconnected domains, such as loss of land, unemployment, loss of homes, marginalization, increased morbidity and mortality, food insecurity, loss of public rights and interests, and disintegration of their social organizations. These aspects have been well documented and debated in the literature; however, we argue that too much emphasis has been placed on the value of countering AD in the short term. There are two aspects of this that need further explanation. First, developers almost never fully combat the short-term effects of AD, and the residual shortfall of these efforts undermines the prospects of displaced people in ways that are not sufficiently recognized (Owen & Kemp, 2016; Owen et al., 2020). Second, the value of people's capabilities and material holdings changes considerably depending on where people are relocated. For instance, a household may be compensated at full-market value for a remote land holding, and then relocated to a more densely populated area where property prices are manifestly higher (Wang et al., 2020). This "relative" dimension extends to education and other life skills where household members may have much lower status compared to the people around them. These relativities make "resettling" in that new context all the more difficult.

In China, there are two policies that directly affect the livelihoods of dam affected communities: (1) the *State Council Decree No. 471* (2006) on large- and medium-scale hydraulic and hydropower projects' land acquisition and resettlement compensation rules, and (2) the *Suggestions of the State Council No. 17* (2006) on the improvement of follow-on support to people affected by large- and medium-scale reservoirs. In these policies, the "development-oriented" resettlement model provides preliminary compensation combined with subsidies and follow-on support, in order to improve resettlers' chances of earning a livelihood. The *Decree No. 17* established a 20-year compensation scheme of 600 yuan per person/year for qualified resettlers (Articles 4–6).

Research conducted within 5 years of massive Three Gorges Dam displacement in China found that over time household incomes generally declined, livelihoods were dismantled, and permanent employment was progressively replaced by temporary work (Xu et al., 2013; Peng et al., 2019; Wilmsen, 2016; Wilmsen et al., 2011). This is despite a program of compensation and coordination aimed at mitigating the serious effects of displacement. Studies found that moving to an urban destination was strongly associated with a decline in wellbeing, as was moving far from established networks of family and friends (Randell, 2016). Although the institutional context is important, culture, physical location, and individual and household characteristics are also important and add to the explanation of risk exposure in the period after people have relocated and received their short-term entitlements. Most of the reported changes had a negative trend, and a high number of these trends were statistically significant (Hwang et al., 2011).

Our objective in this article is to demonstrate the importance of RD for understanding the long-term development prospects of displaced people and the communities that are required, under the same involuntary displacement process, to accommodate them. Our work confirms that resettlement remains synonymous with impoverishment (Koranteng & Shi, 2018; Wilmsen et al., 2019), and that the burdens often fall disparately on already disadvantaged individuals and communities (Cooke et al., 2017; Wang et al., 2019; Xu et al., 2020; Shi & Shang, 2020).

To demonstrate the merits of the RD approach, we assess the poverty conditions of affected communities across different resettlement schemes. For the purposes of our study, the term "affected communities" includes host communities. Our research contributes to current policy debates by (1) connecting the theory of RD to dam-affected communities and (2) considering the development capability of affected communities from the perspective of a social-ecological system. Following Section 1, the article is presented in four subsequent sections. Section 2 discusses the conceptual framework related to development capability and RD. Section 3 explains the data collection process and methodology. Section 4 presents the results, and in Section 5, we conclude with a critical discussion emphasizing key policy and safeguard gaps.

2 | CONCEPTUAL FRAMEWORK: DEVELOPMENT CAPABILITY, RD, AND THE SOCIAL-ECOLOGICAL SYSTEM

The framework presented here connects three novel conceptual ideas to address the challenge of assessing the RD of dam-affected communities to determine the social and environmental impacts produced by resource development. Using the framework to guide the analytical focus, this research engages with these issues using three conceptual devices: (1) development capability, (2) RD, and (3) social-ecological system.

2.1 | Development capability and RD

In 1987, the Brundtland Report, *Our Common Future*, formally articulated the concept of sustainable development (WCED, 1987). The premise is that development efforts to meet the needs of the present must occur without compromising the ability of future generations to meet their own needs (Holden & Linnerud, 2007). It requires fairness between generations and carries two basic presuppositions: (1) the notion that development capabilities and opportunities should not come at the expense of others, and that (2) we must have sufficient foresight to recognize the practical consequences and potential effects of the development we desire (Redclift, 2005). However, a "zero-sum game" underpins a typical market based system, meaning that increasing one person's share (or living standard) often implies reducing another person's share (or living standard).

We are interested in how development capabilities are promoted, exchanged, and diminished in large-scale capital projects. Development-induced displacement highlights a central problem in our historical thinking about human progress; that a larger societal unit's development capabilities can be advanced at the direct cost of a smaller unit. The idea does not meet the criteria of "no sacrifice," but these large nation building projects are frequently championed for their foresight, and the long-range, broad-scale benefits they provide. This is precisely the context in which "RD" occurs—and the issue to which policy makers should be carefully attuned. Renewable resources, such as hydropower, provide benefits at national scale and across generations. However, the construction of these large capital projects bring into play those base, non-renewable, and scarce resources that are central to these endeavors. It is the extraction or dispossession of these other resources that drives deprivation risk and creates a two-tier "capability" economy. These challenges occur both intergenerationally and intragenerationally; in that the creation and destruction of development capability happen within and across generations. The long-run consequences of climate change, for example, are often described in terms of intergenerational equity, because decisions taken by the current generation will directly determine the opportunity conditions of future generations. It is difficult to solve such problems for quite simple reasons: (1) deferring opportunity will have consequences for people who miss out, whether it is now or in the future, and (2) the allocation of resources is not optimally coordinated, meaning that immediate or proximate demand will usually prevail.

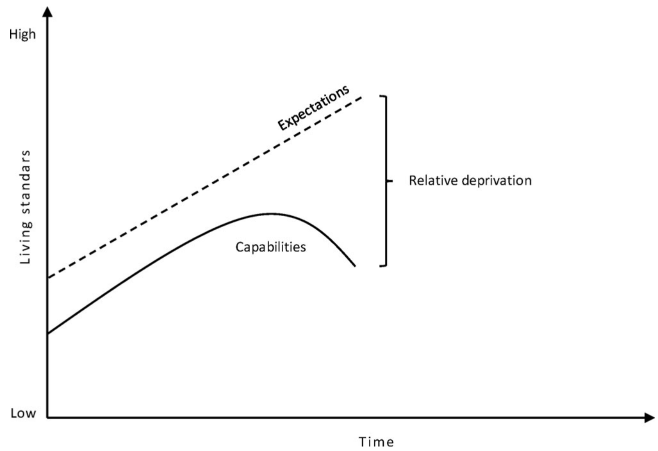

FIGURE 1 RD of affected persons based on their expected standard of living

In a general sense, we are using the term "RD" to account for those people whose current and future opportunities have been diminished as part of a larger scheme of development (Walker & Pettigrew, 1984). For different groups and generations, this reflects the dilemma between depriving and being deprived of development capability. Early uses of RD stressed the importance of individual judgment about how much a person had lost or gained compared to others. In the comparison, others or other groups are used as the reference, and individuals or groups compare their gains and losses to the reference points. If they think that they have gained less than the reference, they will feel that their situation is unfair and that they have not received what they should have (Merton, 1949).

Gurr (1970) suggested that RD is formed when people cannot reconcile the difference between what they would like to have and what they are able to obtain using the skills and resources available to them (see Figure 1). Our construct varies in that we are concerned with the material dimensions of deprivation and the social processes that have placed people into contexts where comparisons with other groups reflect real and measurable forms of inequality.

2.2 | Resilience, adaptability, and transformability

Dam-induced displacement is characterized by its significant external impact or shock. The intervention of the state and other proponents leads to relocation, causing immediate changes to household and village level production, livelihood recovery, and long-term sustainability (Yan et al., 2017; Yan et al., 2018). For dam-affected communities, changes in development capability can be understood using three concepts: resilience, adaptability, and transformability.

Resilience is the capability of a system to absorb disturbances and reorganize when undergoing change to retain essentially the same function, structure, identity, and feedback. Applied to development-induced displacement, we define resilience as the capability of affected communities to cope with internal changes and external shocks and to maintain their main structure and function in the event

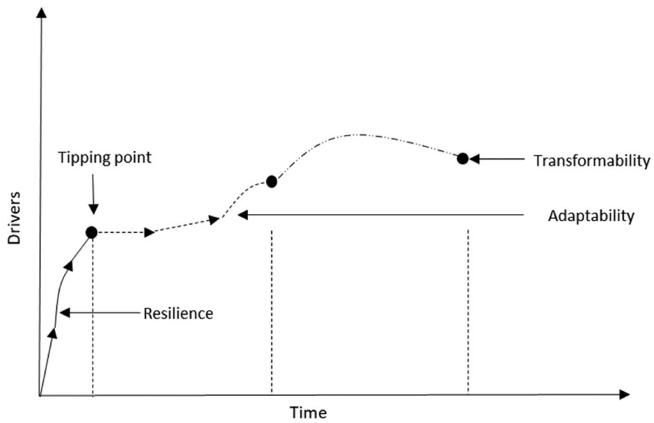

FIGURE 2 Development capability of affected communities over time. Source: Adapted from Patil et al., 2018

of a crisis. When resilience is relatively high, even in the face of internal changes or external shocks, people can continue to seize opportunities and make use of the resources available to them. By contrast, when resilience is low, the vulnerability of the system to smaller changes will increase, and the system may collapse under additional strain.

Adaptability is the capability of actors in the system to influence resilience settings and outcomes. In the context of development-induced displacement, we define adaptability as the capability of households to adjust their resilience settings. This involves balancing the relationship between the internal elements of the system, the relationship between internal elements and the system itself, and the relationship between the system and the external environment.

Finally, transformability is the capability to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable for individuals and groups (Holling, 1973; Walker et al., 2004). We define transformability as the capability of affected communities to create a fundamentally new system when the external social, political, and economic environment makes it impossible to maintain the existing system.

For the purposes of this paper, we are interested in tracking the resilience, adaptability, and transformability of affected communities, and the influence of these factors that has on development outcomes over time (Walker et al., 2004; Figure 2).

3 | MATERIAL AND METHODS

3.1 | Case introduction

The Heihe River is a large inland river system in the arid zone of northwest China, and it is located in the central section of the Hexi Corridor Region, Gansu Province, between 98° and 101°30′E and 38° and 42°N. It covers an area of approximately 130,000 km^2. The source of its upper reaches is located in the boundary area of Gansu and Qinghai, and its lower reaches end in the desert in the western part of Inner Mongolia. Construction of the Huangzangsi water conservancy project on the Heihe River displaced 1076 persons in from 2016 to 2021, of whom 1046 were affected by reservoir inundation and 30 held land that is now occupied by hubs. The flooding of the reservoir involved the relocation of 76 households representing 274 people (Figure 3). Our sample includes households from Huangzangsi village, which comprise the "host community," whose land was acquired as part of the resettlement program.

3.2 | Data source

The data were collected via a survey questionnaire with four parts: (1) demographic profile (gender, age, educational level, health status, occupation, and family labor status), (2) community resilience (social resilience [SOR], economic resilience, and ecological resilience [ECOR]), (3) adaptability (based on the sustainable livelihood [SL] five capitals model), and (4) transformability (based on market connectivity [MKC], social diversity [SOD], and ecological factors).

Surveys were administered in two counties (Qilian County and Sunan County), two towns, and four villages in the research area. The fieldwork was undertaken between August and November 2018. The following three types of research objects are finally determined: (1) resettled and hosting communities, (2) rural and urban resettlement communities, and (3) agricultural resettlement and non-agricultural resettlement communities. Each site was taken as the basis for testing the performance of different resettlement schemes. For example, Dipanzicun Village in Qilian County was selected to investigate the agricultural resettlement and non-agricultural resettlement of the Huangzangsi Dam. Baopinghecun and Baopinghe farm in Qilian County were chosen as examples of rural and urban resettlement. Huangzangsicun in Sunan County was used in the research design to depict conditions among hosting communities. A total of 420 questionnaires were distributed in Qilian and Sunan Counties (including 350 resettled persons and 70 persons in the hosting community), 390 questionnaires were recovered, and the valid response rate was 93.58%. Of the 365 valid questionnaires, 310 were from the resettled group, for an effective recovery rate of 88.6%, and 55 questionnaires from the hosting community were valid, for an effective recovery rate of 78.6% (Table 1).

3.3 | Method

The steps to in applying the Alkire–Foster (A–F) model included: (1) developing the A–F model (suitability description), (2) determination of dimensions and indicators, (3) setting the cut-offs, and (4) determining the index weight.

3.3.1 | A–F model suitability description

The A–F model (the A–F dual cut-off method) is a multidimensional poverty measurement method that was developed in 2007 by Sabina

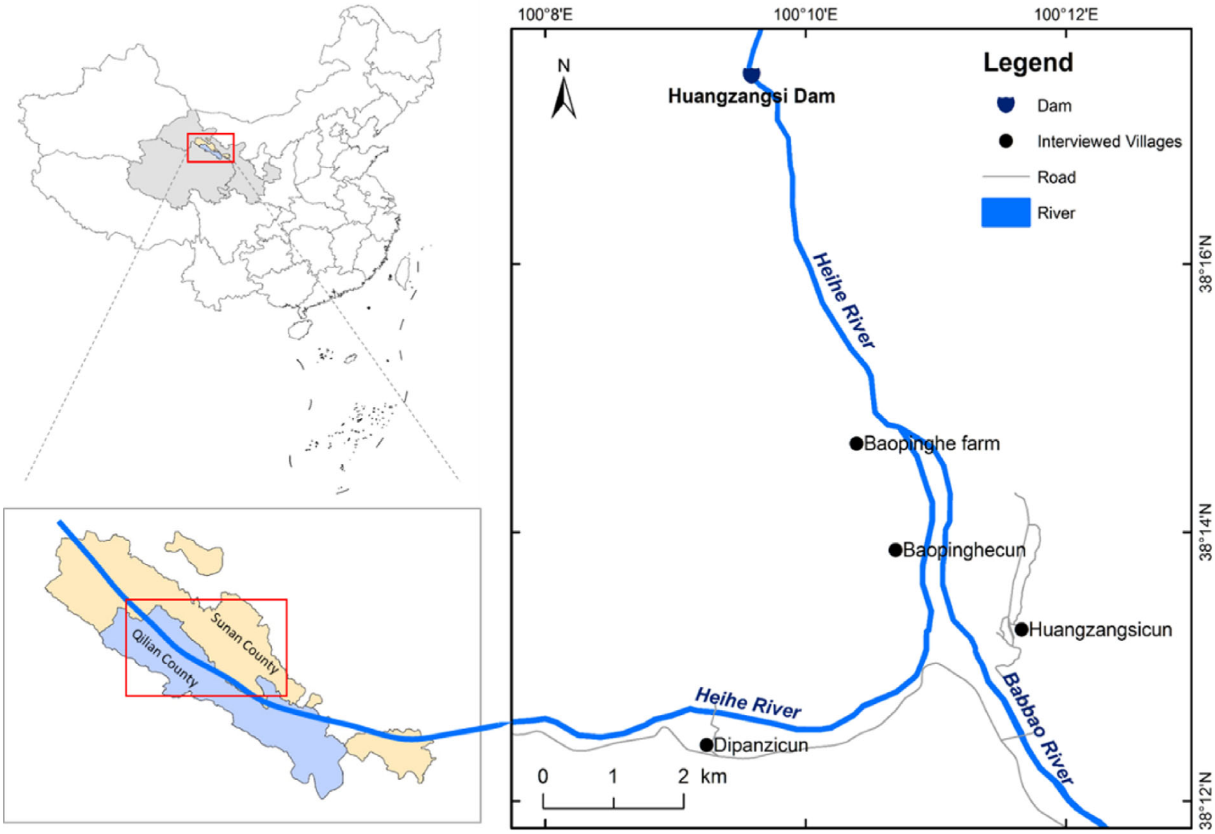

FIGURE 3 Location of the Huangzangsi Dam and affected villages [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Distribution of data sources

Sample characteristics	County	Community	Number	Percentage (%)
Non-agricultural resettlement	Qilian	Dipanzicun	$N = 78$	21.37
Agricultural resettlement	Qilian	Dipanzicun	$N = 63$	17.26
Rural resettlement	Qilian	Baopinghecun	$N = 86$	23.56
Urban resettlement	Qilian	Baopinghe farm	$N = 83$	22.74
Hosting communities	Sunan	Huangzangsicun	$N = 55$	15.07
Total			365	100

Alkire and James Foster of the Oxford Poverty and Human Development Initiative. The advantage of the A–F model is that it can simultaneously incorporate discrete qualitative data and continuous quantitative data into the test model for measurement. Key decisions are left for researchers, including the selection of dimensions, the setting of the cut-offs, and the weights of each dimension. People have some basic practical capabilities in any development process, including the ability to avoid hardship, disease, and hunger. The logic of the model is that if people are deprived of these basic practical capabilities, they will be at greater risk of impoverishment. Therefore, the purpose of multidimensional measurement is to identify which communities are deprived and which practical capabilities they are deprived of.

To measure deprivation across dam-affected communities, we focus on three standard elements: (1) deprivation rate, (2) deprivation share, and the (3) deprivation index. These are defined as follows:

(1) Deprivation rate (incidence): the deprivation rate in each indicator, which includes all people who are deprived, regardless of whether they are multidimensionally poor or not. (2) Deprivation share (intensity): this measures the proportion of people who are multidimensionally poor and the proportion of persons deprived for each of the indicators. (3) The deprivation index reflects both the deprivation incidence and the deprivation intensity. The deprivation index is calculated by multiplying the incidence of deprivation by the average intensity across the affected communities.

As stated above, our assessment includes the deprivation rate, deprivation share, and deprivation index and uses the following calculation steps:

1. Setting of the matrix $X = [x_{ij}]$, where $X = [x_{ij}]$ is an $n \times d$-dimensional matrix; x_{ij} represents the actual value of research object i in the jth dimension; $Z_j (Z_j > 0)$ is set to represent the deprivation

cut-off of research object i in the jth dimension; and Z is the row vector of the cut-off of the specific dimension.

2. One-dimensional identification of development capability deprivation. The deprivation function is as follows:

$$g_{ij}^{\alpha}=\begin{cases}\left(\frac{z_j-x_{ij}}{z_j}\right) \text{When } x_{ij}<z_j.\\ 0,\text{others}\end{cases} \quad (1)$$

3. Multidimensional (k) identification of development capability deprivation.

$$\rho_k(x_i;Z)=\begin{cases}1,c_i>k,i:\text{unsustainable individus}\\ 0,c_i<k,i:\text{sustainable individus}\end{cases}. \quad (2)$$

4. Sum of development capability deprivation. After identifying deprivation, the problem consists of summing the different dimensions.

$$M_0(y;z)=\mu\left(g^0(k)\right),M_0=\mu\left(g^0(k)\right)=HA, \quad (3)$$

where M_0 is the deprivation index, H is the deprivation rate, and A is the average deprivation proportion.

5. Decomposition of development capability deprivation.

$$M(d_j,k)=\frac{\sum_{i=1}^{n}C_{ij}(k)}{nd}=\sum_{j=1}^{d}\left(\sum_{i=1}^{n}g_{ij}/nd\right), \quad (4)$$

where $\sum_{i=1}^{n}g_{ij}/nd$ is the deprivation index of dimension j, j =1, 2, …, d.

3.3.2 | Determination of dimensions and indicators

According to the conceptual framework stated above, 11 dimensions are selected to reflect the development capability of affected communities. These are presented in Table 2. Social, economic, and ecological elements are proposed as constituting three dimensions of resilience. A clear link exists between social and ECOR, particularly for social groups or communities that depend on ecological and environmental resources for their livelihoods (Adger, 2000). As Adger notes, SOR is defined at the community level rather than being a phenomenon pertaining to individuals (Adger, 2000). One key factor in the economic aspects of resilience is the nature of economic growth and the stability and distribution of income among populations. Livelihood capital plays

TABLE 2 Indicators and sources of development capability assessment

Dimensions	Indicators	Contents	Range	Sources
Resilience	Social resilience	Cultural level, self-organizing ability, ability to learn from experience, social network integration, ability to perceive risk	(1, 7)	Adger (2000), Tilt and Gerkey (2016), Martin (2012), and Adger (2000)
	Economic resilience	Labor skill, livelihood diversity, grain crop yield, income level, equity of distribution	(1, 7)	
	Ecological resilience	Vegetation coverage, resource availability, environmental quality	(1, 7)	
Adaptability	Natural capital adaptability (NCA)	Types of available resources, per capita arable land area, cultivated land quality, substitution of cultivated land	(1, 7)	Sabir et al. (2017), and Tilt et al. (2009)
	Physical capital adaptability (PCA)	Housing area, housing quality, household assets, transport infrastructure, medical facilities	(1, 7)	
	Financial capital adaptability (FCA)	Household income, access to funds, ability to repay	(1, 7)	
	Social capital adaptability (SCA)	Social network, power resources, interpersonal trust	(1, 7)	
	Human capital adaptability	Available labor force, average educational level, reception of skills training, health awareness, the most distant footprint of the household head	(1, 7)	
Transformability	Market connectivity	Distance from towns, distance from the market, acceptance of cash crops	(1, 7)	Wilson et al. (2013), Walker et al. (2009), and Tilt and Gerkey (2016)
	Social diversity	Size of the resettlement area, food self-determination, diversity acceptance	(1, 7)	
	Ecological potential (ECP)	Resource types, land cover change, environmental policy, natural resource management capability, ability to cope with natural disasters	(1, 7)	

an important role in the restoration and reconstruction of affected persons' production and living systems. It is the basis of realizing SLs and restoration. The most widely used SL framework involves analysis based on the dimensions of natural capital, material capital, financial capital, social capital, and human capital. Therefore, adaptability is presented based on these five aspects (Lin & Chang, 2013). MKC, SOD, and ecological potential are selected to indicate transformability (Walker et al., 2004; Walker et al., 2009).

3.3.3 | Setting the cut-offs

The first step consists of setting cut-offs for each indicator. Here, we give an example: if the average education level of family members in the dimension of human capital adaptability (HCA) is middle school or below (i.e., approximately 9 years of schooling), the index of the average educational level is defined as deprivation in terms of development capability. If this is the case, the index of the average educational level of family members takes the value of 1 and 0 otherwise.

The second step consists of setting the cut-offs (k) of the dimensions. There is still no firm consensus on cut-off k. However, the United Nations Human Development Report defines $k \geq 1/3$ as multidimensional poverty. The assignment of k must be an integer. Therefore, we use the k value standard of poverty assessment as our reference using $k = 4$ as the cutoff for development capability (across 11 dimensions). That is, when at least four of the multiple functional and capability dimensions are missing, this is regarded as constituting development capability deprivation.

Since the variables in the influencing factor model cannot be directly measured, multidimensional observation variables should be established to estimate them. To ensure reliability and validity, the variables in this study were adapted from the existing literature. The item design of the questionnaire draws lessons from typical scales in the relevant literature and makes corresponding revisions based on the specific situation of affected communities. The questionnaire uses seven-point Likert scales. Table 2 presents the indicators and references of development capability assessment.

3.3.4 | Determining the index weight

Setting the weight of each indicator and dimension is a key issue. At present, there are many methods for determining indicator weight, such as principal component analysis (Wold et al., 1987), the expert scoring method (Kwong et al., 2002), and the analytic hierarchy process (Saaty, 1987). The size or adjustment of the weight will greatly affect the size of the index. Based on farmers' preferences for practical abilities or weight selections in areas characterized by poverty, we hold that the influence of the weight on the deprivation index of development capability is not stable.

Additionally, the limitations of the equal weight method and the data-based weight confirmation method are irreconcilable: although the equal weight method is convenient to operate, it does not reflect the true importance of each index, and the results reflected by the equal weight method sometimes challenge known facts (Chowdhury & Squire, 2006). However, at present, the application of non-equal weight methods such as principal component analysis and the decision-making trial and evaluation laboratory (DEMATEL) entropy method ignores or has difficulty reflecting the complex relationships, such as the randomness and nonlinearity, between indexes.

The authors chose the artificial neural network (ANN) method to determine the weight for each index. This method was considered preferable to the expert scoring method (Kuo et al., 2002), and the analytic hierarchy process given that the method requires few additional external inputs and relies largely on the integrity of the data itself. In the process of weight calculation, the method has a strong learning ability, can approach any distribution function with precision, and has unique advantages such as high robustness. The specific calculation formula is as follows:

$$\mathrm{F}(\mathrm{Y}_i) = \sum_{i=1}^{T} \beta_t \varphi(\gamma_t \cdot \mathrm{y}_i + \vartheta_t), \tag{5}$$

$$r_{js} = \frac{\sum_{t=1}^{L} \gamma_{tj} (1 - e^{-\chi})}{(1 + e^{-\chi})}, \chi = \beta_{ts}, \tag{6}$$

$$R_{js} = \frac{|(1 - e^{-z})}{(1 + e^{-z})|}, z = r_{js}, \tag{7}$$

$$w_j = \frac{R_{js}}{\sum_{j=1}^{Z} R_{js}}, \tag{8}$$

where Y_i is the relevant index value of affected families or affected families in a hosting community, and $\gamma_t, y_{i,}$ and ϑ_t are the network input weight, output weight, and offset value, respectively. Z is the number of nodes in the input layer, where $j = 1, 2, \cdots Z$; S is the number of output layer nodes, where $s = 1, 2, \cdots S$; T represents the number of nodes in the hidden layer, where $t = 1, 2, \cdots T$; γ_{tj} is the weight between the input layer and the hidden layer; and β_{ts} is the weight between the output layer and the hidden layer.

4 | RESULTS

To understand the impacts of socio-economic status on development capability, we conducted principal component analysis and logistical regression with the derived indexes (see TABLE A1, A2, A3 & A4 in Appendix A). We found that age and education are correlating to RD of development capability. In detail, the affected people aged between 17 and 60 are less likely to be deprived comparing with affected people aged 7–16. The affected people with the education background of primary school are less likely be deprived comparing with uneducated people. We used exploratory factor analysis to test the sample correlation and convergent validity of the dimensions and indicators (see TABLE B1 in Appendix B). The results show that the sample passed the reliability and the validity test. Using the data and formulas (5)–(8), the indicator weights are calculated and presented in TABLE C1 in Appendix C.

The key findings in this study relate to the domains in which directly affected communities report experiencing deprivation against host communities who similarly experience involuntary land acquisition, but without the short-term programmatic support available to those who are resettled. These findings are important for both policymakers and development proponents given that displaced and hosting communities typically share common underlying economic risks. In this case, the host community in Huangzangsi village was already poor relative to national income measures.

4.1 | Statistical analysis

Table 3 displays the mean characteristics of the survey sample ($N = 365$). There were 365 respondents, 251 of whom were men, accounting for 68.77% of the total number of respondents, while 114 of whom were women, accounting for 31.23%. The majority of people, 243, were aged 17–60, accounting for 66.58% of the total; 34 people were aged 7–16, accounting for 9.32%, and 88 people were over 60, accounting for 24.11%. The educational level of the surveyed resettled households was mainly concentrated in the levels of primary school, middle school, and high school. Eighty-nine respondents had a primary school educational level, accounting for 24.38%; 117 had a middle school educational level, accounting for 32.05%; 103 had a high school educational level, accounting for 28.22%; and only 12 had a junior college educational level or above, accounting for 3.29%. The educational level of the research objects was generally at the normal level. Regarding occupation, the respondents were mainly farmers and migrant workers, accounting for 36.14% and 31.78% of the total, respectively; the number of village head and teachers/doctors was relatively small, at only four and eight, respectively.

TABLE 3 Mean characteristics of the respondents ($N = 365$)

Category		Number	Percentage (%)
Gender	Male	251	68.77
	Female	114	31.23
Age	7–16	34	9.32
	17–60	243	66.58
	>60	88	24.11
Educational level	Illiterate	44	12.05
	Primary school	89	24.38
	Middle school	117	32.05
	High school	103	28.22
	University	12	3.29
Occupation	Farmer	132	36.14
	Migrant worker	116	31.78
	Businessperson	64	17.53
	Village head	4	1.09
	Student	41	11.23
	Teacher or doctor	8	2.19

TABLE 4 Development capability deprivation of resettled and hosting communities

Dimensions	Resettled community	Hosting community
SOR	.6935	.6727
ECNR	.6161	.3636
ECOR	.5097	.6364
NCA	.1129	.3455
PCA	.1000	.6182
FCA	.1290	.5818
SCA	.1355	.5818
HCA	.2806	.6909
MKC	.6774	.2909
SOD	.1355	.3636
ECP	.6258	.6000

4.2 | Assessment of resettled and hosting communities

The deprivation rate, deprivation share, and deprivation index were calculated using formulas (1)–(4). Table 4 shows that there are obvious differences in the deprivation experienced by the resettled and hosting community considering the various indicators of development capability; these differences play a fundamental role in understanding the degree to which deprivation is driven by individual and combinations of individual indicators.

It is necessary to perform a comprehensive analysis of development capability deprivation across the resettled and hosting communities. This analysis highlights the specific drivers of deprivation across resettled and hosting communities. Figure 4 indicates that hosting communities suffer greater deprivation than resettled communities and confirms a major gap in terms of existing policy safeguards.

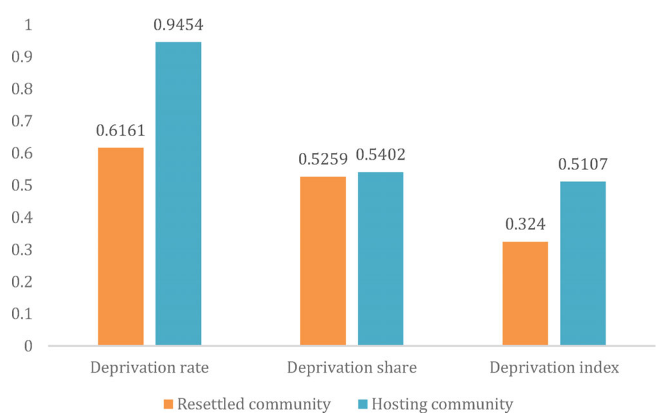

FIGURE 4 Development capability deprivation of resettled and hosting groups ($k = 4$) [Colour figure can be viewed at wileyonlinelibrary.com]

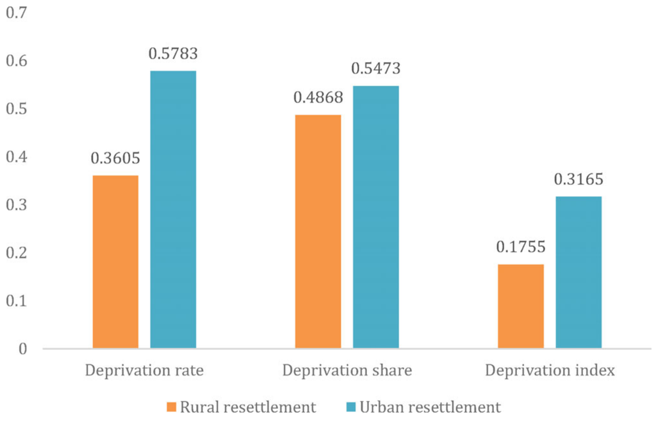

FIGURE 5 Comparison of development capability deprivation between rural and urban resettlement ($k = 4$) [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE 6 Development capability deprivation between agricultural and non-agricultural resettlement ($k = 4$) [Colour figure can be viewed at wileyonlinelibrary.com]

4.3 | Assessment of rural and urban resettlement communities

Figure 5 shows the extent to which resettled groups that rely on rural and urban resettlement are deprived of development capability. As illustrated in Figure 5, the deprivation rate and deprivation index for the development capability of the Huangzangsi Dam-affected community that relocated to urban areas are higher than those of the affected community that relocated to rural areas. When $k = 4$, the deprivation rate and deprivation index for sustainable development under rural resettlement are .3605 and .1755, respectively, and those under urban resettlement are .5783 and .3165, respectively. The deprivation share for development capability, which represents the degree of sustainable development capability deprivation, gradually increases with an increase in the defined value. When $k = 4$, the deprivation shares for development capability under rural resettlement and urban resettlement are .4868 and .5473, respectively.

FIGURE 7 Contribution of different indicators to development capability deprivation in different resettlement schemes ($k = 4$) [Colour figure can be viewed at wileyonlinelibrary.com]

4.4 | Assessment of agricultural and non-agricultural resettlement communities

As shown in Figure 6, the deprivation rate and deprivation index for the development capability of the Huangzangsi Dam-affected community who underwent non-agricultural resettlement were higher than those of the Huangzangsi Dam-affected community who underwent agricultural resettlement. When $k = 4$, the deprivation rate and deprivation index for the development capability under agricultural resettlement are .6508 and .3348, respectively, while the results under non-agricultural resettlement are .9103 and .4872, respectively. However, the difference in the deprivation share for development capability, which represents the depth of development capability deprivation, is not obvious when $k = 4$ (.5144 < .5352).

4.5 | Contribution of different indicators to deprivation

Figure 7 illustrates the degree to which each dimension and indicator contributes to development capability deprivation under different resettlement schemes. We find that for different resettlement schemes, the contribution to development capability deprivation is mainly from resilience and transformability dimensions. Livelihood capital (adaptability) is not the critical factor contributing to development capability deprivation. It illustrates that communities are impacted by AD in similar ways; however, the RD is greater across the different resettlement schemes, because there are incompatibilities between development capabilities that restoration policies do not account for.

5 | DISCUSSION AND CONCLUSION

The social assessment of dam projects differs significantly depending on whether one belongs to the resettled or the hosting community.

Displaced people view the dam project more negatively than people who do not have to move (Wiejaczka et al., 2020), but at the same time, the effects on hosting communities are less rigorously tested or supported by international or national safeguard policies. Our results show that the resettlement caused by dam development not only has a significant impact on displaced people but also contributes to deprivation among hosting communities. Therefore, paying attention to the development capabilities of hosting communities is essential.

The livelihood impacts of land acquisition, displacement, and resettlement are typically adverse (Wilmsen, 2016). The literature documents the negative effects of dams on rural people, including fewer options for economic activities (Kura et al., 2017), land scarcity, lower land quality, changes in the control over resources (Dao, 2016), high levels of unemployment, enduring poverty (Aiken & Leigh, 2015), and forced sharecropping due to land unaffordability. Our results show that the transition from rural to urban settings had a pronounced negative effect on resettled households. This "urbanization resettlement method" promoted in the *State Council Decree No. 471* (2006) on large- and medium-scale hydraulic and hydropower projects has gradually come to replace the traditional land-based resettlement approach. When rural households relocate to urban regions, the impacts are reflected in the loss of accumulated skills in animal husbandry, farming, field management, harvest, and sales. Likewise, changes in housing and living environments disrupt daily life habits. Given the change in living and physical spaces, the urban resettlers are "disconnected" from their original sense of place (Lu et al.,). This has far reaching consequences when considering the function of land, kinship, accumulated knowledge, and the security that inter-generational social networks provide. In terms of RD, these conditions become pronounced as households integrate into the local society. This typically occurs through processes of disadvantage and marginalization, whereby the resettling household is deficient in education, financial capital, or social capital, such that they are incorporated into the societal structure on lesser terms. The long run effect is that households face barriers in navigating life-course decisions, such as property purchases, schooling opportunities, social network, or peer-network building, among others. These effects transfer across generations but are not factored into the programming logic of resettlement schemes. In China, the current official urbanization policies are to bring people to development by constructing high-density resettlement sites in small towns and peri-urban areas. According to Rogers et al. (2020), up to 16 million people have been resettled in this way between 2016 and 2020.

The results show that for land-based rural schemes, the deprivation rate generally deepens. Resettled households indicated that the shock of losing assets such as land and existing sources of income (often coming from agriculture) was profound. These shocks were exacerbated when the rate of financial compensation was insufficient to replace assets at a similar standing or cover other losses to household earning capacity (Zou et al., 2020). The differences between agricultural and non-agricultural schemes are the pronounced negative effect on resettled households. Overcoming the challenges associated with transferring knowledge and skills into unfamiliar work contexts is fundamental to livelihood restoration in the short term, and as these cases indicate, when these short-term policy objectives are not met, households are exposed to long term and even intergenerational disadvantage. The historic differences between rural and urban populations in terms of their education and general labor mobility are central to understanding the drivers of RD within and across these resettlement schemes. These effects are prominent across the case literature, but are not represented in the international guidance, or the planning documentation attached to individual resettlement schemes (such as Resettlement Action Plans [RAPs]).

Finally, the study highlights a pressing gap in the practice and policy literatures in terms of the attention given to host communities. The underlying poverty status of households in Huangzangsi village was amplified through the involuntary acquisition of land, the influx of "cashed up" but still poor resettling households, and the dilution of already scarce services and employment opportunities. Hosting communities in poor rural and mountainous areas are especially vulnerable to the impost of resettlement schemes, and given the considerable impost on land, labor, and other livelihood resources, there is cause for re-thinking how they are classified in the various national and international policy frameworks on land acquisition and involuntary resettlement. Policy and planning changes are needed to ensure that the interests and needs of receiving communities are not sacrificed for the sake of incomers, or to make the task of creating a "right of way" for the project less difficult or less expensive. The gap we highlight is routinely overlooked in resettlement reporting, further obscuring the issue. Current reporting sees the socio-economic status of *receiving* communities used as a benchmark for measuring the recovery of *resettling* households. Diminished conditions at the host location have the potential to create perverse reporting outcomes. In these instances, the RD of one community can be skewed to suggest some relative advantage or improvement in another.

As countries move toward progressively decarbonizing their national energy supply, hydropower dams could play an increasingly significant role. The boom in hydropower dam development over the last half century has already led to the displacement of millions of people. A review of the existing case literature shows the scope and depth of deprivations experienced by those directly impacted by project-induced displacement events. Our research confirms these findings and adds two important dimensions that are critical to the design, financing, and implementation of resettlement schemes. First, use of the theory of RD can show how changes in both asset and social profiles affect settlement outcomes across different scheme types. The findings in our research show that conditions that most closely resemble like-for-like appear to have the least negative impact in RD terms. A deeper understanding of the needs and capabilities of those affected and their involvement in the earliest stages of project decision-making is one improvement that could be incorporated into project development strategies. Likewise, a more comprehensive set of checks and balances in decision-making and resourcing throughout the resettlement lifecycle would be advantageous. This aligns with the recent conclusion by Zhao et al. (2020) that failures in meaningful consultation, participation, and negotiation are leading to substantive and procedural injustices in the sector. These dimensions are materially relevant for considering how long-term relative forms of deprivation might be avoided or reduced in future. Second, that the involuntary acquisition of land to accommodate settlers should be accounted for in the same way as the acquisition of land for the project. According to our research findings, the impacts of "indirect" displacement can be significantly greater, particularly when the responsibility for managing or mitigating these impacts falls outside of the formal scope of the project.

We note two limitations in the approach. First, the indicators for what we are calling "RD" could be developed more comprehensively based on local affected communities inputs and valuations. Second, historic spatial assessments could be developed to determine the long-term impacts of dam-induced displacement and resettlement (Lechner et al., 2019). These offer opportunities for further research.

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ORCID

Ruilian Zhang https://orcid.org/0000-0001-5064-1226
John R. Owen https://orcid.org/0000-0002-5952-0479
Deanna Kemp https://orcid.org/0000-0002-1435-2694
Guoqing Shi https://orcid.org/0000-0002-5060-3630

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APPENDIX A

TABLE A1 Variable definition

Variable category	Variable name	Variable assignment
Dependent variable	Development capability	Not deprived = 0, Deprived = 1
Independent variables	Gender	Female = 0, Male = 1
	Age	7–16 = 1, 17–60 = 2, >60 = 3
	Educational level	Illiterate = 1, Primary school = 2, Middle school = 3, High school = 4, University = 5
	Occupation	Farmer = 1, Migrant worker = 2, Business person = 3, Village head = 4, Student = 5, Teacher or doctor = 6

TABLE A2 Model summary

Step	−2 log likelihood	Cox and Snell R square	Nagelkerke R square
1	403.759	.244	.326

TABLE A3 Classification table[a]

		Predicted		
		Development capability		
	Observed	.00	1.00	Percentage correct
Step 1	Development capability .00	91	93	49.5
	1.00	32	149	82.3
	Overall percentage			65.8

[a]The cut value is .500.

TABLE A4 Variables in the equation

	Variable	B	Sig.	Exp (B)
Step 1[a]	Gender(1)	.608	1.000	1.837
	Age		.015	
	Age(1)	2.434*	.028	11.400
	Age(2)	1.378	.267	3.967
	Educational level		.243	
	Educational level(1)	−2.197*	.041	.111
	Educational level(2)	19.596	1.000	3.240E8
	Educational level(3)	.000	1.000	1.000
	Occupation		1.000	
	Occupation(1)	−21.203	1.000	.000
	Occupation(2)	−.590	1.000	.554
	Occupation(3)	−21.736	1.000	.000
	Occupation(4)	−21.736	1.000	.000
	Occupation(5)	−21.736	1.000	.000
	Constant	−.845	1.000	.430

Notes: In the analysis process, we take female = 0; age = 1; educational level = 1; occupation = 1 as the reference group. It is found that age (.028) and education (.041) are correlating with RD of development capability. In detail, the affected people aged between 17 and 60 are less likely to be deprived comparing with affected people aged 7–16. The affected people with the education background of primary school are less likely be deprived comparing with uneducated people.
[a]Variable(s) entered in step 1: age, gender, educational level, and occupation.
* < .05.

APPENDIX B

TABLE B1 Sample correlation and convergent validity test results

Model parameter estimate							Convergent validity				
Indicators		Dimensions	NSTD	S.E.	C.R. (*t*-value)	P	STD.	SMC	1-SMC	C.R.	AVE
SOR1	←	SOR	1				.841	.707	.293	.798	.503
SOR2	←	SOR	.699	.063	11.178	***	.634	.402	.598		
SOR3	←	SOR	.604	.061	9.893	***	.569	.324	.676		
SOR4	←	SOR	.882	.064	13.7	***	.76	.578	.422		
ECNR1	←	ECNR	1				.751	.564	.436	.819	.603
ECNR2	←	ECNR	1.128	.08	14.023	***	.869	.755	.245		
ECNR3	←	ECNR	.843	.072	11.776	***	.701	.491	.509		
ECOR1	←	ECOR	1				.715	.511	.489	.741	.497
ECOR2	←	ECOR	1.004	.101	9.949	***	.839	.704	.296		
ECOR3	←	ECOR	.646	.081	8.003	***	.525	.276	.724		
NCA1	←	NCA	1				.801	.642	.358	.823	.54
NCA2	←	NCA	1.011	.071	14.327	***	.781	.61	.39		
NCA3	←	NCA	.756	.067	11.23	***	.634	.402	.598		
NCA4	←	NCA	.871	.068	12.857	***	.712	.507	.493		
PCA1	←	PCA	1				.685	.469	.531	.832	.50
PCA2	←	PCA	1.05	.091	11.6	***	.772	.596	.404		
PCA3	←	PCA	1.045	.099	10.506	***	.685	.469	.531		
PCA4	←	PCA	.972	.093	10.454	***	.681	.464	.536		
PCA5	←	PCA	.984	.091	10.774	***	.705	.497	.503		
FCA1	←	FCA	1				.894	.799	.201	.865	.683
FCA2	←	FCA	.926	.047	19.548	***	.851	.724	.276		
FCA3	←	FCA	.822	.054	15.135	***	.726	.527	.473		
SCA1	←	SCA	1				.658	.433	.567	.749	.501
SCA2	←	SCA	1.015	.101	10.001	***	.652	.425	.575		
SCA3	←	SCA	1.312	.111	11.831	***	.803	.645	.355		
HCA1	←	HCA	1				.684	.468	.532	.823	.484
HCA2	←	HCA	.97	.1	9.656	***	.629	.396	.604		
HCA3	←	HCA	1.245	.107	11.626	***	.789	.623	.377		
HCA4	←	HCA	1.13	.105	10.712	***	.709	.503	.497		
HCA5	←	HCA	1.115	.112	9.992	***	.654	.428	.572		
MKT1	←	MKT	1				.757	.573	.427	/	/
MKT2	←	MKT	1.224	.087	14.018	***	.894	.799	.201		
SOT1	←	SOT	1				.74	.548	.452	.777	.55
SOT2	←	SOT	.705	.083	8.536	***	.513	.263	.737		
SOT3	←	SOT	1.175	.098	11.965	***	.916	.839	.161		
ECP1	←	ECP	1				.592	.35	.65	.805	.512
ECP2	←	ECP	1.597	.15	10.627	***	.824	.679	.321		
ECP3	←	ECP	1.256	.131	9.589	***	.699	.489	.511		
ECP4	←	ECP	1.319	.134	9.856	***	.728	.53	.47		

***$p < .01$.

APPENDIX C

TABLE C1 Weight of each indicator

Dimensions	Indicators	Weight
Resilience	SOR	.1007
	ECNR	.0885
	ECOR	.0912
Adaptability	NCA	.1124
	PCA	.0835
	FCA	.0726
	SCA	.1000
	HCA	.0870
Transformability	MKC	.0910
	SOD	.0900
	ECP	.0831