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Institutions' adaptability in reducing vulnerability: a study in the char lands of Assam

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Abstract
Institutions are crucial for shaping society and its values and behaviors, especially in the context of the global environmental crisis. Institutions can play a significant role in enhancing the adaptive capacity of society to climate change, as emphasized by the IPCC reports. Char is a land-form that is highly vulnerable to climate change and related events. Char is a land-form that is highly vulnerable to climate change and related events. According to the Human Development Report (Assam Human Development Report 2014. Government of Assam, 2014), char dwellers are the poorest and the most vulnerable communities in Assam. This paper aims to understand how the institutions of the char areas of Assam, including both formal and informal institutions can foster the adaptive capacity of the communities residing in these vulnerable locations. To achieve this goal, we apply the adaptive capacity wheel (ACW), a widely accepted approach to determine the quality of institutions in the literature of institutional economics. ACW is a normative economic study, based on value judgments, and we interviewed 49 stakeholders of a total of 16 char villages of Assam. Our study reveals the characteristics and challenges of institutions of the char areas in Assam. It emphasizes the fact that about certain dimensions, like the institutions' capacity to generate resources, support modifications to their structure and pattern, improve the ability to learn, and ensure fairness in the governance system, the char institutions of Assam's various regions require extra attention. These areas are crucial for the people's resilience to severe climate impacts. In addition to identifying regional variations in institutional quality, our research makes recommendations for institutional enhancements aimed at boosting societal adaptability. It is also argued that the study can be extended to other sensitive areas of the world with similar characteristics to char.

Keywords Normative economics · Adaptive capacity · Resilience · Community · Informal institution

1 Introduction

The idea of governance has gained popularity in policy studies as a way to overcome uncertainty in both natural and human systems (Pahl-Wostl 2009; IPCC 2021; Al-Malki and Durugbo 2023). The transition from a traditional government model to a new structure of decision-making that incorporates vertical and horizontal coordination, more participation, flexibility, and decentralization is a crucial component of governance processes (Biermann et al. 2010; Munaretto and Kolstermann 2011; Madni and Anwar 2020; Nguyen et al. 2021). Throughout human history, the social structure, also known as the institution, has evolved to meet various social challenges according to the prevailing culture and philosophy (Gupta and Dellapenna 2009; Fidelman 2019; Dau et al. 2022). The adaptability of a social system or an institution can lessen the possibility of being adversely affected by various extreme events and events caused because of climate change (Siders 2019; Moore 2010; Khan 2020). According to IPCC (2014, p. 1758), adaptive capacity can be defined as *the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences*. To achieve the reduction of possible losses from climate change and related catastrophes, it is imperative to comprehend how current institutions and social structures handle adaptation and mitigation to climate change (Saravade

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and Weber 2020). The lives and livelihoods of those who live in char[1] areas are unpredictable and unstable. The char region is harmed by erosion and this region is amongst the most flood-prone regions of Assam, a north-eastern state of India (HDR 2014). Since the char areas are some of the most vulnerable places in Assam, we looked into the char institutions' (a combination of both the formal and informal institutions) potential to lessen vulnerability there. We evaluated institutional quality using the adaptive capacity wheel (ACW) methodology, which was proposed by Gupta et al. (2010) and widely adopted and utilized by a number of studies. In terms of improving the community's ability to adapt to climate change, our study shows that the overall status of the quality of institutions currently in place in Assam's char areas is insufficient. But we have also discovered variations in the same among several char sites. The discussion of the fields where the current system must be carefully considered is included in the study. The study also reflects that the involvement of multiple actors and collaboration of different forms of institutions has the ability to improve the society's capacity for adaptation, hence lowering its vulnerability to climate change.

Davis and North (1970), who are known as the founders of institutional economics, defined the institution as *a set of fundamental political, social, and legal ground rules that govern economic and political activity (rules governing elections, property rights, and the rights of contract are examples of these ground rules)*. In economics, when we talk about the study of institutions, economists are particularly focused on the institutional arrangement (North and Thomas 1973; Yifu 1987). In this case, an institutional arrangements can be defined as a collection of behavioral norms that control a specific course of behavior and a system of relationships (Yifu 1987). Institutional arrangement can be formal[2] or informal[3] and are run by the government or voluntary organization (Yifu 1987; North and Thomas 1973). In our study, we consider these ideas of institution and institutional arrangement as bases for our institutional quality assessment.

Institutions have a significant impact on a region's long-term economic performance (Alonso et al. 2020). By encouraging change and innovation inside the system, institutions can improve society's capacity to deal with a variety of challenging conditions (North and Thomas 1973). Institutional reforms are frequently advocated to improve the relationship between the environment and humans in a society (Barker et al. 2003; Gupta et al. 2010; Laeni et al. 2020). But at the same time, they are also challenging to put into practice in a traditionally conservative society with its institutional structures (Gupta et al. 2010; Munaretto and Kolstermann 2011; Mandi 2019). Using panel data of 122 emerging economies for the years 1996 to 2020, Zhao and Madni (2021) discovered that economic and political reforms significantly contribute to conserving the environment in developing countries. Al-Saidi (2019) examined how interactions between institutions that are evolving quickly and slowly impact sustainable development. He recommended that reforms be adjusted to the regional and indigenous conditions of each nation. However, enhancing governance structures alone won't be enough to increase the ability to adapt to climate change; consideration of the power dynamics that both shape and are shaped by institutions is also vital (Fidelman 2019). A multi-level management model of institutional innovation was presented by Al-Malki and Durugbo (2023) after conducting a thorough assessment of the literature on institutional innovation. They claimed that institutional innovation develops shrewd institutions capable of surviving in a society marked by exponential change. According to Gupta et al. (2010), institutions must be more proactive and forward-thinking in the face of rapid environmental change, such as climate change. They contend that organizations must possess the capacity to adapt to the negative and irreversible effects of environmental change. While the process of natural adaptation may be sufficient for some cultures or institutions, it could not be enough for others. The existing institution or social structure should then be able to recognize the kind of support required, include it, and adjust to the new circumstance (Munaretto and Kolstermann 2011; Sethi et al. 2021). The capacity of social groups to adapt helps reduce the detrimental consequences of climate change as well as their susceptibility (Siders 2019). Thus, when climate change gets worse, it becomes more important to make different social systems like households, communities, and organizations more adaptable (Moore 2010; Fidelman 2021; Al-Malki and Durugbo 2023). This highlights the need for a deeper comprehension of how the current social structure and institutions respond to adaptation and mitigation of climate change (Saravade and Weber 2020). The impacts of institutional complexity affecting *adaptation* planning in European cities were investigated by Biesbroek et al. (2021). They discovered that institutional complexity might both facilitate and impede planning for adaptation by opening doors for cooperation and innovation but also posing difficulties for coordination and integration. In rural India, institutional variety and adaptive capacity were examined by Karpouzoglou et al. (2020). By giving people

[1] Chars are *the new riverine lands and islands created by the continual shifting of the rivers, and emerge from the deposition of sand and silt from upstream. Chars are found along all the major river systems, both lining the banks of rivers and as mid-river islands* (DFID 2000).

[2] The judicial and political norms, the economic rules, and the contracts are constraints or rules under formal institutions (North 1990).

[3] According to North (1990) and Yifu (1987), informal institutions are the unspoken laws or standards that govern behavior, such as morals, beliefs, codes of conduct, and traditions.

access to a variety of resources and knowledge, they demonstrated how institutional diversity can increase adaptive ability. However, it can also lead to conflicts and trade-offs between various actors and interests. A methodology for evaluating institutional adaptability in forest governance was put up by Ojha et al. (2023). They stated that learning, leadership, legitimacy, and leverage are the four characteristics that determine an institution's ability to change. They used case studies from Nepal and India to apply their framework and show how it may be used to determine the advantages and disadvantages of institutions for forest governance.

According to studies (Lebel et al. 2010; Vinke et al. 2017; Saikia and Mahanta, 2023b, e; Saikia and Das, 2024; Laeni et al. 2020), vulnerable populations are particularly susceptible to economic and social effects of hazardous occurrences caused by climate change. Climate and water-related challenges make Asia's coastal regions particularly susceptible (Pillai et al. 2010; PBL 2018). India and Bangladesh share about 54 trans-boundary rivers, which are vital for the livelihood of a large number of riverine communities. However, a number of causes, including climate change, have contributed to a decline in livelihood opportunities for and vulnerability status of these riverine communities throughout time (Sentinel 2022). Char areas are a special type of land-form found in Indian subcontinent in Ganga–Brhamaputra–Meghna (GBM) plains. Adjusting to the vulnerabilities induced by flood and soil erosion, managing a livelihood is not an easy task for the char dwellers who live with the river every day (Lahiri-Dutt 2014; Azam et al. 2019; Ahmed et al. 2021). The mouths of deltas, coastal regions, and wetlands are the closest geographical features to char environments, according to Lahiri-Dutt and Samanta (2013). However, they also note that char and other wetlands differ in several ways. In North-East India, char areas are spread across the Brahmaputra valley of Assam, covering four out of six agro-climatic zones[4] of the state (GOA 2002–2003). Due to the fact that char areas are among the most prone to flooding in Assam and are also affected by erosion, the lives and livelihoods of individuals who reside there are the most vulnerable and unpredictable (HDR 2014). Health, educational, and employment options are scarce in Assam's char regions, and their availability is also impacted by floods and other climate-related variables (Kumar and Das 2019; Saikia and Mahanta 2023a).

There are studies available at the national and international levels that explore the function and potential of

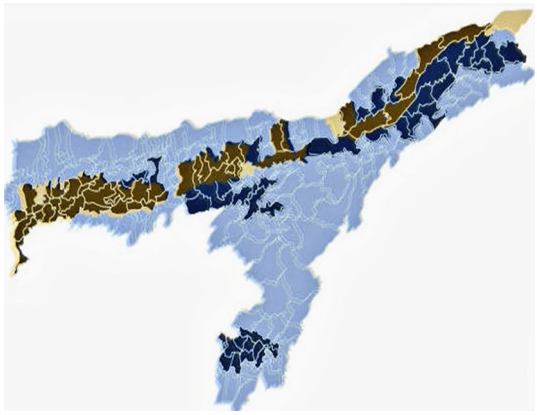


Fig. 1 Char and flood dominated blocks of Assam. *Source* HDR (2014) (re-constructed)

institutions in lowering community susceptibility to climate threats (Gupta and Dellapenna 2009; Gupta et al. 2010; Munaretto and Kolstermann 2011; Fidelman 2019; Siders 2019; Fernández and Peek 2020; Saravade and Weber 2020; Khan et al. 2020; Laeni et al. 2020; Nguyen et al. 2021; Al-Malki and Durugbo 2023; Huddleston et al. 2023). To the best of our knowledge, there aren't many studies focused on char institutions and their capacity to raise the adaptability and, consequently, social standing of the society residing in char areas, despite the fact that the char lands are vulnerable and the communities residing there are underdeveloped with few opportunities. The same holds true for the char regions of Assam. Therefore the respective study aims to pave a direction on this least explored but essential aspect of the studies on char areas.

The entire article is divided into four sections. Part two of the paper provides a detailed overview of the technique, while Section Three presents the findings and related comments. The paper's conclusion summarizes the key points and suggests future directions for this field of study.

2 Materials and methods

2.1 Study area and sampling design

The island char and riverside char are the first and second categories, respectively, of char areas, according to the Government of Assam (GOA 1983) (Fig. 2). These areas are frequently impacted by a variety of climate-driven natural disasters, with flood being the most prominent one (Lahiri-Dutt and Samanta 2013; Saikia and Mahanta 2023a, c, d, 2024a, b). Flooding has badly devastated nearly all of Assam's char-dominated blocks (Fig. 1) (HDR 2014). In Fig. 1, the flood-affected blocks are shown in dark blue, whereas the Assamese char-dominated blocks are shown in light yellow.

[4] Geographically the entire state of Assam is divided into six agro-climatic zones. These six zones are: Upper Brahmaputra Valley, North Bank Plain Zone, Middle Brahmaputra Valley, Lower Brahmaputra Valley, Hill Zone and Barak Valley Zone. Out of these, the first four zones are covered by the Brahmaputra Valley and char areas are found across these four zones.

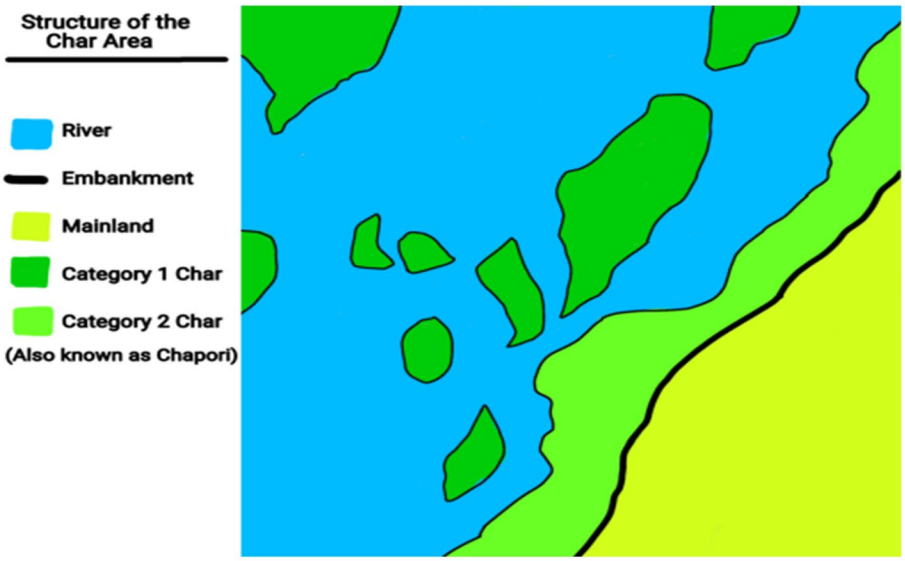


Fig. 2 Char areas and mainland. *Source* Authors' own drawing

Since the dark brown area shows the combination of the two, it is obvious that the water has had a significant impact on the charred areas. Figure 2 depicts how char regions are structured.

According to the Assam's char residents' demographic breakdown, Mishing people, a small number of Nepalis, Muslims from Na-Asomia, Rajbanshi caste members, and a few other indigenous groups all live in this area (Khandakar 2016; Hazarika 2018). Due to their lack of access to basic services like healthcare, education, and other facilities, char dwellers are one of Assam's poorest ethnic groups (GOA 2002–2003; HDR 2014).

To understand the adaptability of Assam's char institutions and their distinct characteristics across different char regions of Assam, we have considered one district with char areas from each of the four Agro-Climatic Zones of Assam where char lands are available. The district with the greatest concentration of char population is chosen for the study from each zone. As a result, the North Bank Plain Zone's North-Lakhimpur district, the Middle-Brahmaputra Valley's Morigaon district, the Upper-Brahmaputra Valley's Tinsukia district, and the Lower-Brahmaputra Valley's Dhubri district are taken into consideration. One revenue circle or the development block including char villages is randomly chosen from each chosen district, and four char villages are chosen for the study from each revenue circle. The study is primarily based on the stakeholders' perception of the institutional quality. Interviews are conducted with different stakeholders from the selected study areas. This includes social actors, such as government representatives and regional leaders of the village, and common villagers (the villagers that may not be holding any such specific position), in each community. For the study, interviews were conducted with two to four stakeholders from each community and a total of 49 stakeholders were interviewed. The study area's location maps are shown in Fig. 3. The Geographic Information Science (GIS) method is used to create the maps. The study locations are indicated on the maps by the red-colored area that is highlighted. Furthermore, by enlarging the map layers, the surveyed villages from each revenue circle in the corresponding districts have been made clearer to see. The readers may easily identify the sandy riverine regions through these magnified figures.

2.2 Method

The application of indicator-based approaches is supported by various studies because it converts theoretical ideas into a set of variables or indicators that operate as an operational depiction of a system's attributes (Birkmann 2006; Khan et al. 2020). The indicators-based index technique often necessitates the following: a framework; a study's nature, objective, and context; the selection of variables and sub-indicators under each component; data collecting; and result aggregation (Binder et al. 2010; Asare-Kyei et al. 2015). The various dimensions of adaptive ability are represented by indices, which are created by combining the coded and combined indicators into a comparable range of values (Khan et al. 2020). To comprehend the adaptable nature of the institutions in the various char regions of Assam, the present study employs an indicator-based case-study research approach. Case-study research is a type of analytical inquiry that enables the contemporary phenomena of an object to be explored in the context of real-world experience (Yin 2014). As an analytical framework under this case-study research design, we have used the framework Adaptive Capacity Wheel (ACW) developed by Gupta et al. (2010). Scholars of institutional studies have used different approaches to

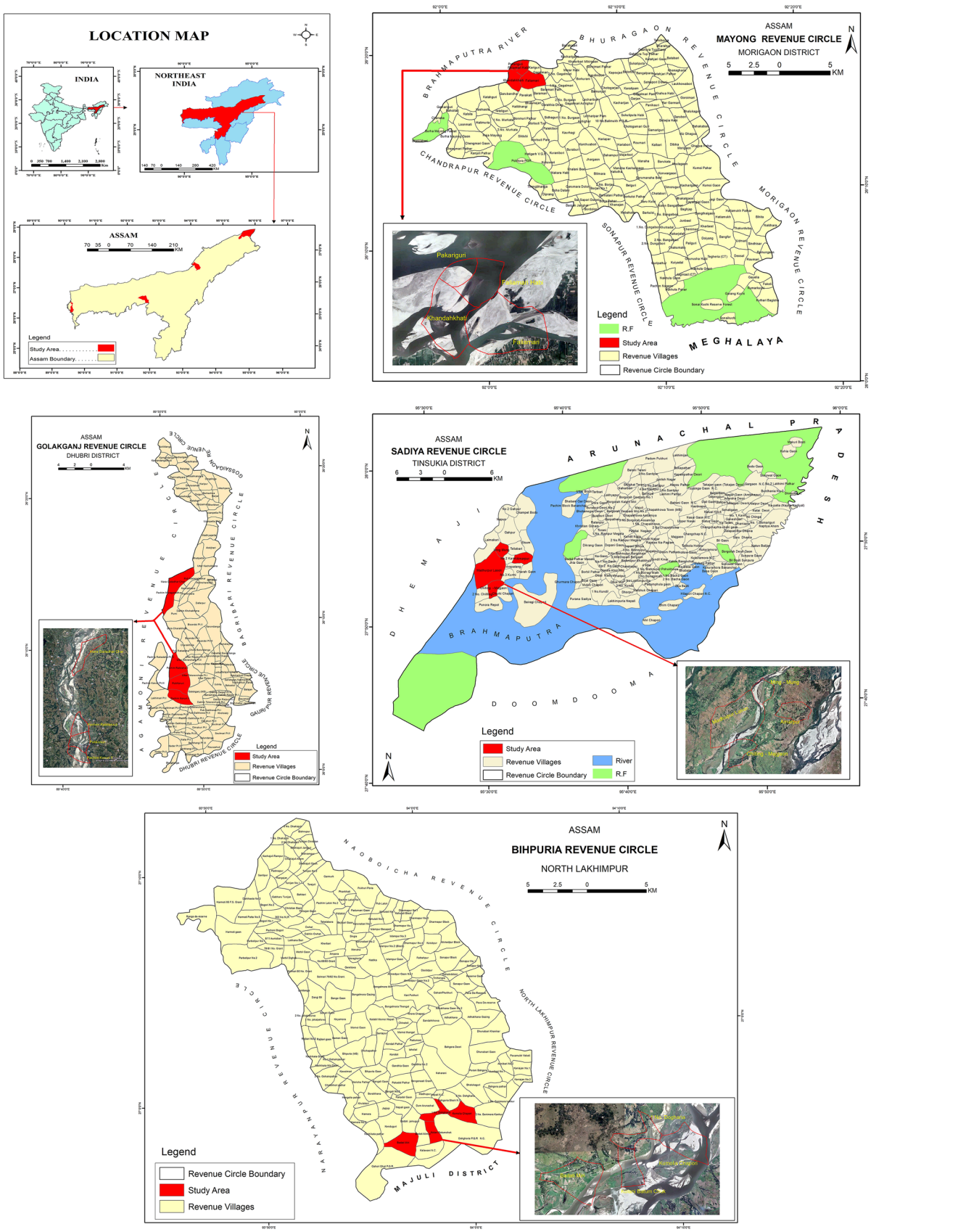


Fig. 3 Maps of the study area. *Source* Developed through the use of GIS

study the resiliency and adaptive capacity of institutions to climate extremes. These approaches are such as "Adaptive Capacity Wheel (ACW)" (Gupta et al. 2010), "Adaptation in Collaborative Governance Regimes" (Emerson and Gerlak 2015), "Adaptive Governance and Resilience" (Djalante et al. 2011), "Examining Adaptational Readiness" (Ford and King 2015), "Disaster Resilient Hotel Indicators" (Brown et al. 2018). However, amongst all these methods, the ACW is a widely cited index for measuring institutional adaptive capacity, as shown by Sider (2019) in his systematic review of the literature. In the words of Munaretto and Kolstermann (2011), *The adaptive capacity of institutions to climate change is a phenomenon that is very dependent on social and physical contexts. … By comparing multiple case studies, important lessons may be learnt to the benefit of both the cases under study and other regions.* Even though ACW was first created to assess institutional capacity for mitigating climate change, it has since been adopted and adjusted in a number of other studies, including those that assess resilient transport (Essex 2015), the hotel sector (Nguyen et al. 2021), water catchment (Grecksch 2015), water governance (Grecksch 2013), and the wine industry (Pickering et al. 2015). We have employed the ACW methodology to investigate institutional quality in boosting society's ability to adapt to climate change due to the broad acceptance of the strategy, criteria, and methodology employed as well as its relevance to our proposed research.

2.2.1 Conceptual idea on adaptive capacity wheel (ACW)

Considering the social-ecological dimension, the concept of adaptive capacity of the institutions is crucial in order to reduce the society's extent and degree of vulnerability to climatic extremities (IPCC 2001, 2021). According to Gupta et al. (2010), an institution's adaptive capacity results from the institution's inherent nature, which has the capacity to empower social actors for responding to both short- and long-term impacts by encouraging and allowing the society's creative responses both ex ante and ex post or through some planned measures. The adaptive capacity of institution encompasses: (1) the form of institutions, which may be formal or informal; values, customs, and laws; that permit society, including people, groups, and networks, to adapt to climate change and (2) how much actors[5] of the institutions are permitted and encouraged to alter their institutional behavior in order to adapt and deal with changing environmental conditions by the institutions.

The index-based method has a number of benefits for evaluating an institution's ability to adapt. First, it enables the identification of various institutional adaptation determinants based on a variety of sources, including the experience of the authors, the topic of interest, expert opinions, or literature reviews (Notenbaert et al. 2012; Bryan et al. 2015). It also makes it possible to utilize indicators to measure the chosen aspects qualitatively or quantitatively. Third, it makes it easier to aggregate the results of the determinants to determine the institution's overall quality (Siders 2019). This paper applies the adaptive capacity wheel (ACW) to examine the adaptability of institutions to climate change and their role in reducing social vulnerability. According to Klostermann et al. (2010) and Munaretto and Kolstermann (2011), the ACW is a normative economic tool that assesses an institution's capacity to adapt to climate change. According to Gupta et al, (2010), *The fundamental story line is that institutions that promote adaptive capacity are those institutions that (1) encourage the involvement of a variety of perspectives, actors and solutions; (2) enable social actors to continuously learn and improve their institutions; (3) allow and motivate social actors to adjust their behavior; (4) can mobilize leadership qualities; (5) can mobilize resources for implementing adaptation measures; and (6) support principles of fair governance.* Therefore, the wheel is based on six dimensions: variety, room for autonomous change, learning capacity, resources, leadership and fair governance. Amongst these dimensions, variety, room for autonomous change and learning capacity can represent the institution's potential inherent flexibility. On the other hand, other three dimensions resources, leadership and fair governance are classically accepted dimensions for effective governance process. Improvements to the institution's variety dimension may allow it to respond to many predicted and unforeseen effects of climate change (Nooteboom 2006; Madni 2019). An institution is supposed to be flexible in handling various issues and providing suitable solutions for a variety of difficulties in order to effectively reduce the vulnerability of its people and enhance their adaptive nature (Gupta et al. 2010; Huddleston et al. 2023). Therefore, diversity within the institutions is crucial to accommodate a range of difficulties. This will let the organization handle a variety of issues according to the institutional actors' areas of expertise at various levels and in various sectors (Huq 2016; Fidelman 2017; Khan et al. 2020). Another feature of a good adaptable institution is redundancy. Possessing a backup plan in place in the event that an earlier endeavor fails can improve the institution's capacity to handle unfavorable circumstances (Shakya et al. 2018; Huddleston et al. 2023). Learning capacity is necessary in order to create new responses to climate change impacts. According to Argyris (1990), Gunderson and Holling (2002), Pahl-Wostl et al. (2007), Zhao et al. (2021) and other authors, this involves an

[5] The idea of actor in institutional economics is as an/any entity, which is endowed with agency (Voronov and Weber 2020). For the identification of actor, researchers use the idea of organizations, people and other collective constructions like state or nation (Lok 2018; Meyer 2010).

institution's capacity for learning to do things better (single-loop-learning) and learning about the processes by which the institution may do better things (double-loop-learning). To facilitate learning capacity in the economy, the institutions need to enhance the mutual trust amongst the different actors (Rydén Sonesson et al. 2021). Simultaneously, it is imperative that an adaptable institution create enough room for its actors as well as the community to voice their worries (Dau et al. 2022). By navigating changes and potential regions of viewpoint adjustments, maintaining records and information about past occurrences helps institutions improve their capacity for learning (Nguyen et al. 2021). In a similar vein, institutional autonomy is crucial since top-down initiatives can appear ineffective due to lengthy processes and a lack of local knowledge (Polsky et al. 2007; Folke et al. 2005; Pelling and High 2005; Zhao and Madni 2021). Consequently, it is required that institutional actors operating at the regional level possess comprehensive knowledge and understanding of the current system (Huddleston et al. 2023). With the autonomy in decision makings and complete information and knowledge about the social system, the institutional actors can more effectively improvise the society's adaptive capability in response to environmental changes (Hurlbert and Gupta 2019; Haddad 2005; Walker et al. 2013). Nonetheless, institutions and institutional actors need to work with a defined plan of action and adhere to it (Shakya et al. 2018; Brown 2013; Gupta et al. 2010; Huq 2016). Resources Mandi and Anwar (2020) and Khan et al. (2020) and leadership (Batukova et al. 2019; Li et al. 2020; Xie and Yang 2021; Huddleston et al 2023) are crucial elements in any institutional change process, even when adjustments are needed to address climate change (Mandi and Anwar 2020). Institutions play a vital role in the creation and development of resources to support society with reduced vulnerability and by increasing society's adaptive capacity to climate change (Gupta et al. 2010; Mostofi Camare and Lane 2015; Mandi and Anwar 2020). Human resource development can boost labor productivity, skill, and knowledge generation, and intern increase people's potential for adaptation (Morshedlou et al. 2018; Walker et al. 2013). Another key component that contributes significantly to the institutions' growing ability to adapt is access to technology and other financial resources for the construction of infrastructure, such as roads and communications, health care, and education (Salas and Yepes 2020; O'Donnell et al. 2018). More political and legal support from higher authorities is also vital for the various institutions and institutional actors in order to have more human and financial resources (FAO 2018; Huq 2016; Fidelman et al. 2017; Khan et al. 2020; Huddleston et al. 2023). Enhancing an institution's resilience and adaptability requires strong leadership. In a crisis, it is the leaders' duty to act promptly and appropriately (Szpak 2022). As a result, the institution's management needs to have a plan for improving local development and residents' quality of life (Hulbert and Gupta 2017, 2019). Accordingly, institutional leaders of intra- and interregional institutions can improve their institutions' ability to adapt through cooperation and co-management (Nursey-Bray et al. 2018; Sarmah and Mahanta 2023). A transparent and equitable process is followed by the institution (Gupta et al. 2010; Moser et al. 2015; Hurlbert and Gupta 2019). Legitimate policymaking has distinct accountabilities and is sensitive to the society that the institution serves (Barton 2013; Alessa et al. 2016). In addition, the idea of "good governance[6]" with specific attributes can be illustrated by fair governance (Gupta et al. 2010; Kolstermann et al. 2010; Munaretto and Kolstermann 2011; Fernández and Peek 2020; Dau et al. 2022). In light of the need for institutions to balance efficacy and efficiency in the face of climate change, Gupta et al. (2010) made the conscious decision to embrace "fair governance" as compared to "good governance" (Huddleston et al. 2023). Fair governance guarantees that innovation is not subordinated to efficiency (Hurlbert and Gupta 2019; Grothmann et al. 2013a, b). Table 1 lists the dimensions of ACW, along with the corresponding criteria and definitions for each.

2.2.2 Calculation procedure and presentation

The authors used a mixed methods technique, or what Creswell (2021) refers to as a "Exploratory Sequential Design," to gather data that could be entered into the adaptive capacity wheel. This procedure is divided into two stages: gathering qualitative data in the first phase, and translating that data into quantitative form in the second phase to further sharpen and highlight the findings of the qualitative phase. For each criterion, information is gathered. Data can be gathered in a variety of methods, including through interviews and observations. Interviews, for instance, could be used to gather information about obstacles associated with implementation as well as informal regulations like norms and values. Creating a list of inquiries can aid in gathering data regarding the criteria. The questionnaire's questions are essentially separated into six categories, one for each dimension. The opening question is followed by the closing question. To elucidate the specifics of the responses, especially in relation to the definitions of the criteria mentioned in Table 1, open-ended questions with the possibility of follow-up questions are utilized. The opening and closing questions sought to identify any crucial elements that may have been overlooked during the debate as well as any overlapping or opposing concepts and forces that may exist

[6] Good governance is a principle, covering the ideas of decentralization, rule of law, democracy, discretion into it (Botchway 2001).

Table 1 Description on dimensions and criterions of ACW

Dimension	Criterion under the dimensions	Definition and justification for the dimension and criterion used	Prime concern in framing the questions for respective criterion	Values to assign when nothing in place (Kolstermann et al. 2010)	Literature supporting the views
Variety		An institution needs to use a range of instruments, precautions, and proactive strategies in order to adapt to both predicted and unforeseen future effects of climate change			Nooteboom (2006), Madni (2019), Gupta et al (2010), Huddleston et al (2023), Huq (2016), Fidelman (2017), Khan et al (2020), Gupta et al (2010), Khan et al (2020), Shakya et al (2018), Huddleston et al (2023)
	Variety of problem frames	If institutions can accommodate a range of issues and have access to references and different points of view for solutions, then it is believed that they will be more effective in reducing vulnerability	Different environmental and social issues and how the institution addresses them	Neutral (0)	Gupta et al (2010), Huddleston et al (2023)
	Multi-actor, multi-level, multi-sector	Institutions must allow for multi-level (different levels), multi-actor (diversity of players), and multi-sector (many stakeholders) as they are planning for a solution	The presence of different actors from formal and informal institutions. Also if the NGOs are having any involvements in the locations	Neutral (0)	Huq (2016), Fidelman (2017), Khan et al (2020)
	Diversity of solutions	To address a problem, a large range of different policy solutions must be accessible	How different actors are involved in framing the solution to the various issues	Neutral (0)	Gupta et al (2010), Khan et al (2020)
	Redundancy	To ensure long-term advantage, the organization must have a backup system and overlapping safety measures in the near future	The measures taken by the institutions and institutional actors and their ability for long-term effectiveness	Neutral (0)	Shakya et al (2018), Huddleston et al (2023)

Table 1 (continued)

Dimension	Criterion under the dimensions	Definition and justification for the dimension and criterion used	Prime concern in framing the questions for respective criterion	Values to assign when nothing in place (Kolstermann et al. 2010)	Literature supporting the views
Learning capacity		An adaptive organization must provide social actors with the freedom to question social norms, deeply embedded assumptions, claims, frames, and regulations in order to resolve problems and facilitate learning			Gupta et al (2010), Rydén Sonesson et al (2021), Argyris (1990), Gunderson and Holling (2002), Pahl-Wostl et al. (2007), Zhao et al. (2021), Dau et al (2022), Nguyen et al (2021)
	Trust	Institutions need to promote mutual respect and trust amongst their diverse actors	Mutual trust, communication, and ability to work together to bring a solution. Society's trust towards the actors	Neutral (0)	Rydén Sonesson et al (2021)
	Single loop learning	The institutional pattern needs to allow for and possess the ability for learning from the past in order to improve for the future	Techniques and steps used and reformed based on previous experiences	Negative (− 1)	Argyris (1990), Gunderson and Holling (2002), Pahl-Wostl et al. (2007), Zhao et al. (2021)
	Double loop learning	A substantial correction of the institutional framework through modifications to norms and presumptions is necessary to equip society to withstand and adjust to extreme circumstances	Structural changes made by the institutions for the betterment of the society, nature of changes, and effectiveness	Neutral (0)	Argyris (1990), Gunderson and Holling (2002), Pahl-Wostl et al. (2007), Zhao et al. (2021)
	Discuss doubts	Being receptive to ambiguity and doubt promotes institutional improvement	Space for discussion on various issues	Neutral (0)	Dau et al. (2022)
	Institutional memory	Strong institutions can evaluate and monitor their activities	Accessibility and availability of present and past information	Negative (− 1)	Nguyen et al. (2021)

Table 1 (continued)

Dimension	Criterion under the dimensions	Definition and justification for the dimension and criterion used	Prime concern in framing the questions for respective criterion	Values to assign when nothing in place (Kolstermann et al. 2010)	Literature supporting the views
Room for autonomous change		Social actors in society require autonomy from the institutional structure in order for them to adapt their behavioral patterns in response to changes in their surroundings			Polsky et al. (2007), Folke et al. (2005), Pelling and High (2005), Zhao and Madni (2021), Huddleston et al. (2023), Hurlbert and Gupta (2019), Haddad (2005), Walker et al. (2013), Shakya et al. (2018), Brown (2013), Gupta et al. (2010), Huq (2016)
	Continuous access to information	The institution must be able to retrieve data stored in its memory and give people early warning systems	Provision for providing information on disaster resiliency, adaptation techniques, and early warning	Negative (− 1)	Huddleston et al. (2023)
	Act according to plan	An institution's adaptability is enhanced when it can empower people to take action, especially in times of catastrophe by providing action plans and scripts	Plans towards disaster mitigation and the institutions' commitment towards it	Negative (− 1)	Shakya et al. (2018), Brown (2013), Gupta et al. (2010), Huq (2016)
	Capacity to improvise	People's ability to organize and increase their social capital depends heavily on institutions	Institutions' contribution towards the improvement of people's and societies' adaptive capacity, nature of contribution, and its success	Neutral (0)	Hurlbert and Gupta (2019), Haddad (2005), Walker et al. (2013)

Table 1 (continued)

Dimension	Criterion under the dimensions	Definition and justification for the dimension and criterion used	Prime concern in framing the questions for respective criterion	Values to assign when nothing in place (Kolstermann et al. 2010)	Literature supporting the views
Leadership		Robust leadership is essential for an institution to succeed. This is necessary in order to undertake lengthy, challenging tasks			Gupta et al. (2010), Batukova et al. (2019), Li et al. (2020), Xie and Yang (2021), Huddleston et al (2023), Mandi and Anwar (2020), Szpak (2022), Hulbert and Gupta (2017, 2019), Nursey-Bray et al. (2018), Sarmah and Mahanta (2023)
	Visionary	When the leadership has intellectual, reformist, and rule-following qualities, the institution is stronger	Nature and quality of institutional leaders, their vision towards the improvement of society, and people's trust in these institutional actors' ability	Neutral (0)	Szpak (2022), Hulbert and Gupta (2017, 2019)
	Collaborative	Leaders must be provided enough room to promote cooperation among many actors and support adaptive co-management	Collaboration and scope for collaboration amongst the different institutions, institutional actors, and non-governmental organizations	Neutral (0)	Nursey-Bray et al (2018), Sarmah and Mahanta (2023)

Table 1 (continued)

Dimension	Criterion under the dimensions	Definition and justification for the dimension and criterion used	Prime concern in framing the questions for respective criterion	Values to assign when nothing in place (Kolstermann et al. 2010)	Literature supporting the views
Resources		In order for an institution to function well, it must be able to produce enough resources for the society			Gupta et al (2010), Mandi and Anwar (2020), Khan et al (2020), Mostofi Camare and Lane (2015), Morshedlou et al. (2018), Walker et al. (2013), Salas and Yepes (2020), O'Donnell et al. (2018), FAO (2018), Huq (2016) Fidelman et al. (2017), Khan et al. (2020), Huddleston et al. (2023)
	Authority	Political and legal power must be supported by the institution. Respecting certain constitutional laws is beneficial	Presence and successful practice of law and orders by the institutions	Negative (− 1)	FAO (2018), Huq (2016) Fidelman et al. (2017), Khan et al. (2020), Huddleston et al. (2023)
	Human resources	An adaptable institution can encourage the creation of labor, subject-matter experts, and information resources	Steps towards the creation of human resources, and training programs for the improvement of adaptive capacity of people	Negative (− 1)	Morshedlou et al. (2018), Walker et al. (2013)
	Financial resources	In order to maintain different policies and financial incentives, an institution needs to have the financial resources required	Provision for providing financial support for enhancing people's adaptive capacity	Negative (− 1)	Salas and Yepes (2020), O'Donnell et al. (2018)

Table 1 (continued)

Dimension	Criterion under the dimensions	Definition and justification for the dimension and criterion used	Prime concern in framing the questions for respective criterion	Values to assign when nothing in place (Kolstermann et al. 2010)	Literature supporting the views
Fair governance		To enable the institution's effective adaptive capacity, the governance process must be fair. Additionally, the institutions strongly support finding a balance between efficacy and efficiency in the critical process of innovation			Gupta et al (2010), Kolstermann et al. (2010), Munaretto and Kolstermann (2011), Fernández and Peek (2020), Dau et al (2022), Hurlbert and Gupta (2019), Barton (2013), Alessa et al (2016), Moser et al (2015)
	Legitimacy	The people at large support and accept a good institution and the judgments it makes	Transparency, democratic and public acceptance of institutional policy	Negative (− 1)	Barton (2013), Alessa et al (2016)
	Equity	A competent organization takes into account all social divisions and unjust situations while developing policies	Practice of equality in institutional policies and activities	Neutral (0)	Gupta et al (2010), Moser et al (2015), Hurlbert and Gupta (2019)
	Responsiveness	A fair institution takes a very transparent approach to addressing many societal issues	Responsiveness of institutions towards various environmental and climatic issues in the region	Neutral (0)	Fernández and Peek (2020), Dau et al (2022)
	Accountability	The assignment of specific duties to distinct actors with unambiguous accountability is a sign of a good institution	Maintenance of clear accounts, and continuous monitoring of ongoing actions and activities	Negative (− 1)	Hurlbert and Gupta (2019)

Source Authors' preparation

Table 2 color schemes of the ACW

Color	Green	Lime	Light yellow	Light orange	Red
Effects	Positive effect	Slightly positive effect	Neutral or no effect	Slightly negative effect	Negative effect
Description	The potential of institutional structure to enhance adaptability	The structure exists but is not yet fully applied to adaptation	Neither positive nor negative effect can be expected	Gaps needed to be filled to counteract negative effect on adaptive capacity	Institutional structure obstructs adaptive capacity for adaptation
Scores	Score 2	Score1	Score 0	Score − 1	Score − 2
Aggregate scores for dimensions and ACW as a whole	1.01 to 2	0.01 to 1	0	− 0.01 to − 1	− 1.01 to − 2

Source Gupta et al, (2010)

inside the institutional framework in a given situation. Similar methods were applied to observations, but the researcher made sure that all pertinent aspects were covered by the dimensions. The questions posed weren't very complicated, and they were written so that anyone could understand them. The questionnaire was prepared in English language but during the interview, the questions were asked in the regional language Assamese. However, some of the respondents (those from other castes or communities) were unable to understand or speak Assamese at some points in the survey. In order to facilitate communication between the two sides in such a scenario, the authors employed a translator, who clarified the inquiries and responses. Without any further interpretation, the stakeholder's responses and observations are recorded in a formal background document. It was taking enough time to carefully record the responses. In order to improve the accuracy and dependability of the data, the responding stakeholder double-checks the recorded replies, which were descriptive in nature, once the survey is finished. The survey with one stakeholder took between one and a half and two hours, with an average of one hour and forty-three minutes.

Furthermore for the data analysis, it is essential that various researchers independently score the background information before discussing any differences in opinion on a particular criterion. This contributes to ensuring both transparency and reliable outcomes (Gupta et al. 2010). As a result, both researchers examined the data, assessed the criteria separately, and then talked about their scores. Through their debate, a final score for the criteria was established. For our study, we consider a total of 21 criterions under the six dimensions of ACW. To reach the second stage of the mixed method technique, that is to quantify the qualitative information, the study uses a five-point Likert scale technique. Following Gupta et al. (2010), each criterion are scored between − 2 to 2. The meaning of the scores and the respective colour to represent the quality is described in Table 2. We have utilized the Cronbach's alpha reliability test to increase the confidence and overall robustness of the study because the reliability of the Likert scale analysis of qualitative data is frequently questioned. Cronbach's alpha is potentially the most frequently utilized estimator of reliability (Forero 2014). All the statistical analysis are done in the STATA 14 software.

According to Gupta et al. (2010), an equal weighting process can be used to determine the institution's overall value or quality while also allowing for the measurement of each dimension's and each criterion's quality. The value of the criterion for the specific region is measured using the average following a thorough analysis and understanding of the responses against each of the criteria. After determining the value of each criterion associated with a dimension, the dimension value is calculated by averaging the criterion values. By averaging the values of each dimension, the wheel's total value may be calculated. Mathematically it can be shown as follows:

The criterion value is measure using the following formula:

$$X_{uw} = \frac{\sum_{v=1}^{n} Y_{vw}}{n} \tag{1}$$

where, X_{uv} is the average value of the uth criterion of the wth location.

Y_{vw} is the value of uth criterion accessed from the responses by vth respondent from the wth location.

n is the total number of respondent of the respective location.

Once the value of each criterion under the dimensions is measured, the dimension value is measured using the following formula:

$$Z_{aw} = \frac{\sum_{i=1}^{m} X_{iw}}{m} \tag{2}$$

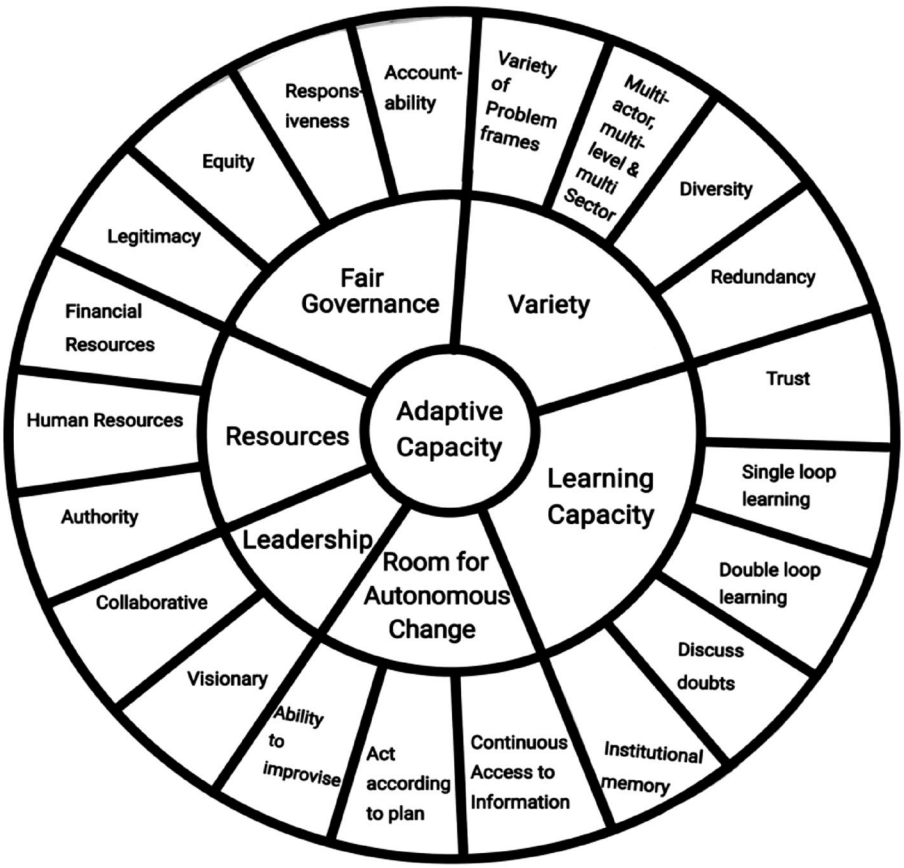


Fig. 4 Adaptive capacity wheel (ACW). *Source* Gupta et al. (2010)

Here, Z_{aw} is the dimension value of ath dimension of the wth location.

X_{iw} represents the value of the ith criterion belonging to ath dimension of wth location.

m is the number of criterion under the dimension a.

After the calculation of the dimension values, the value of ACW of a location w is measured using the simple average of the dimension values.

$$\mathrm{ACW_w} = \frac{V_w + LC_w + RAC_w + L_w + R_w + F_w}{6} \quad (3)$$

$\mathrm{ACW_w}$ is the value of Adaptive Capacity Wheel of wth location. V_w, $\mathrm{LC_w}$, $\mathrm{RAC_w}$, L_w, R_w and F_w are the derived dimension values of variety, learning capacity, room for autonomous change, leadership, resources and fair governance of wth location respectively.

The Wheel is presented with the aid of the color provided by Gupta et al. (2010) after the derivation of the values of each criterion and the associated dimension. The accompanying Fig. 4 and Table 2 display the wheel and color that must be filled in relation to the range of values. The value of the wheel is represented by the inner circle. The six conditions of the institution's adaptive quality are represented by the central circle of the wheel, and the relevant criteria are shown in the outer circle.

3 Results and discussion

The results of Cronbach's alpha reliability test are presented in Table 3. According to Nunnally and Bernstein (1994), a reliability coefficient value higher than 0.7 is generally acceptable. In our study, the Scale reliability coefficient value is 0.8334, which is sufficiently high to consider the coding process and the analysis as reliable. Figure 8 in the appendix section provides a snap of result screen of the reliability test performed in STATA 14. In the appendix section's Table 5, the values measured for each dimension and the criteria for each dimension are displayed. Here, we give the

Table 3 Results of Cronbach's alpha reliability test

Test scale = mean(unstandardized items)	
Average interitem covariance:	0.160194
Number of items in the scale:	21
Scale reliability coefficient:	0.8334

Source Authors' own calculation

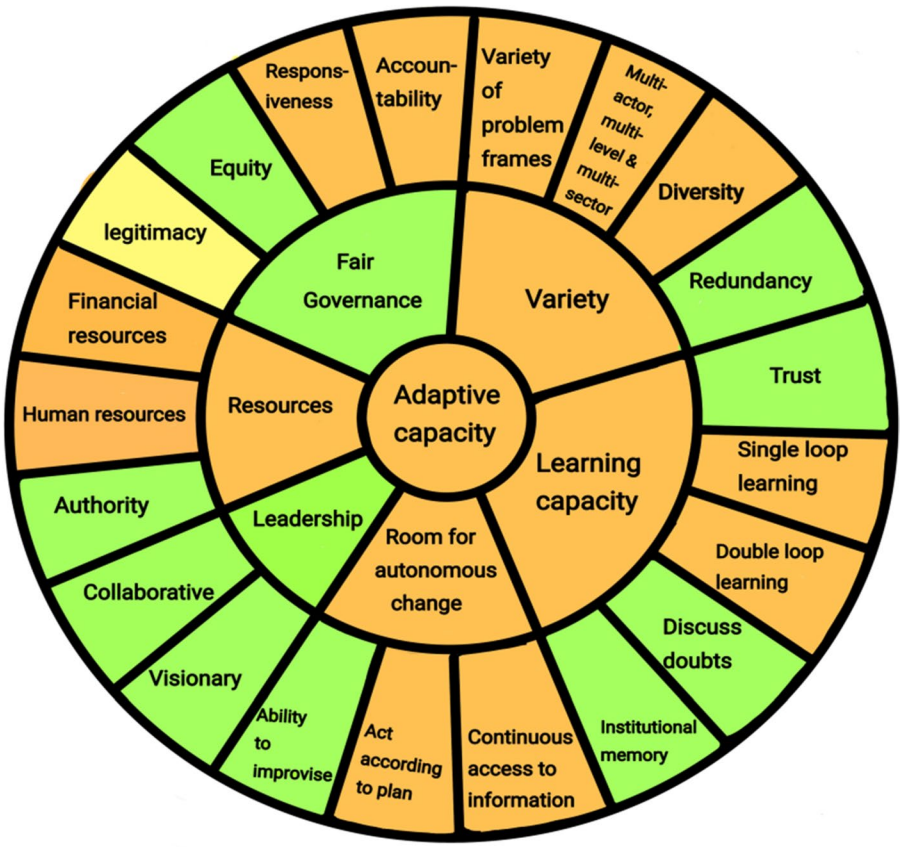


Fig. 5 ACW of the institutional arrangement of char areas of Assam. *Source* Author's own analysis

ACW value's overall average, which is calculated by averaging the ACW values across all districts. Additionally, we have shown the ACW value for each sample district that was taken into consideration. In accordance with the presentation process, the adaptive capacity of the institutional setup existent in Assam's char regions can be depicted by using the proper hue in various dimensions and ACW criteria. The methodology section includes a discussion of the color fill technique. The adaptive capacity of char institutions of Assam as a whole is presented in Fig. 5 through the ACW methodology.

From the color fill, it is evident that the overall adaptive capacity of the char areas of Assam represents a slightly negative effect. The key findings are summarized in the Table 4. At the same time, it is worth mentioning that the char areas in various parts of Assam are inhabited by members of various communities and differ from one another in terms of their topographical makeup. As a result, it's possible that the ACW composite number does not accurately depict institutional capacity in Assam's various districts. Therefore we have presented the district-wise institutional quality through the ACW approach in Fig. 6. Moreover, for an in-depth understanding of the extent of institutional quality in enhancing the char dwellers' adaptive capacity across different locations of the state, Fig. 7 may be taken into consideration.

Figure 7 displays the institutional arrangements' criterion-wise scores and its power to improve the adaptability of several sample districts. The graph shows that practically every institutions' criterion has to be improved. Most of the criteria give the lowest marks to the Dhubri district, which is followed by the Morigaon district. A better situation at their char institutions is shown by the slightly higher scores in the North-Lakhimpur and Tinsukia districts. It should be emphasized that some of the criteria in all areas need to be seriously improved in order to increase the ability of the char institutions to adapt. Criteria including diversity of solutions, the institution's capacity for single and double loop learning, the provision for providing information to the residents, acting in accordance with the plan, and the provision for providing financial help to the char inhabitants during times of emergency brought on by hazards, all are in need of special treatment in the char institutions of all the regions. The positive attributes the institution has earned in the criteria, such as trust, visionary, equity, and authority, show that people have faith in the prevailing institution and that they support the institutional structure.

Table 4 Discussion on the results of ACW

Dimension	Criterion	Description of the findings
Variety	Variety of problem frames	Although there are several issues, there are only a few, insufficient sources to address them
	Multi-actor, multi-level, multi-sector	The presence of social players at various levels and in various sectors varies in some regions. Once more, it is absent in certain places. Although their restricted availability is a problem, the issue of their unavailability is more serious
	Diversity of solution	The social actors that are active in the area are not allowed enough room to frame solutions in accordance with their plans
	Redundancy	To improve people's ability to adapt and lessen their vulnerability during catastrophes, a few short-term measures are implemented. There is still room for improvement of the status quo
Learning capacity	Trust	People have modestly optimistic expectations about the social actors' potential to advance society in the future
	Single loop learning	In some of the locations, certain actions are done to address the issues. However, the beneficial effect is rarely seen
	Double loop learning	In certain regions, the introduction of new laws, regulations, or institutional reforms is hardly ever seen, while in other areas, it is unclear to the social actors involved
	Discuss doubts	The issues can be discussed with formal and informal authorities. However, the reviews and recommendations still need to be implemented correctly with the aid of the resources at hand
	Institutional memory	Positive records are maintained on the events, finances, and expenditures of the same. However, it is not sufficiently clear that these are published or accessible to the broader public
Room for autonomous change	Continuous access to information	Access to information about natural hazards and related remedies is very poor. In some district the situation is even worse
	Act according plan	The regional institutional process lacks ambition and is inappropriate for developing plans to mitigate the issues that have already arisen. As a result, it is uncommon to witness institutional activity geared toward resolving societal issues. The formal institutional system and its actors tend to confine themselves to the tasks that have been delegated to them by the center and are not observed to take initiative for a wider goal
	Capacity to improvise	The majority of comments are neutral and doubtful of the institution's ability to change the problem. However, due to the district of North Lakhimpur's improved institutional capability, the combination of several locations produces a marginally good effect
Leadership	Visionary	The char dwellers provide complete assistance for the institutional actors at this level. The regular gatherings and talks about potential solutions strengthen residents' faith in the institution's ability to see the future. Additionally, it is necessary to prepare for the implementation of new policies for the benefit of society
	Collaborative	The institutional structure of the char regions is benefiting from the cooperation of various social actors. However, North-Lakhimpur and Tinsukia districts show the most evidence of other institutional players' engagement and attention in the developmental process, while the char regions of the other two districts have not yet seen this level of institutional collaboration

Table 4 (continued)

Dimension	Criterion	Description of the findings
Resources	Authority	Although the cooperation of various authorities in preserving constitutional laws, legal rights, and political authority is positive, there is still room for improvement. In the case of the char areas of the Tinsukia district, the demand for the same is greater
	Human resources	The potential and scope for the institution to develop human resources represents a range of outcomes in the caliber of institutional arrangements of the areas belonging to various districts. However, the wheel presents a generally weak picture of the role that the charitable institution plays in the production of human resources
	Financial resources	Char institution are found to be weak in terms of providing financial assistance to the hazard prone char dwellers for improving their adaptive capacity
Fair governance	Legitimacy	The average value presents neutrality in the legitimacy in the adaptive capacity of char institution of Assam
	Equity	The establishment of char areas in Assam is showing a somewhat favorable effect, suggesting the potential for providing for the entire population of the region and people
	Responsiveness	The char institution presents weak responsiveness capacity against the situation when needed. This is found in almost all the locations. Providing reliefs during the hazard emergencies is not the only responsibility of the institutions
	Accountability	Weak accountability procedure in almost all the char areas of Assam

Source Authors' own observation

Different districts show variations in the criteria under each dimension of the char institutions. A number of social actors and their involvement have been seen in some of the char locations. The institutional actors from the formal institutions, however, are allowed the least amount of liberty to behave in a way that will help them accomplish the intended results practically everywhere in the char areas.

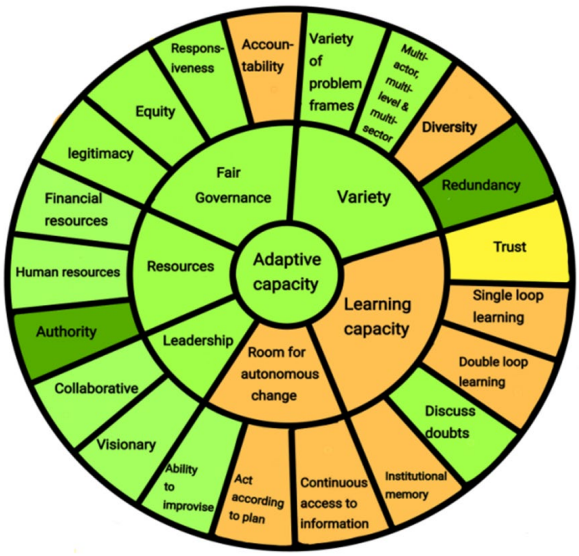
> *We make an effort to address problems in our community. There are numerous problems in this area, ranging from the environment to infrastructure and development. We constantly work hard to find solutions. We also do our own planning. But we aren't getting full support from the government to accomplish those aims,* said the Gaon Burha, the village leader of a village of Tinsukia district that was under survey. Another village stakeholder who is an active villager rather than an institutional actor said that *our leaders are constantly with us and they always attempt to solve the problems to the best of their abilities. They do, however, receive the least amount of government assistance, which prevented them from completing all of their plans. Both formal and informal entities cooperate in some situations to achieve better results, such as assisting flood-affected homes, resolving disputes and debates, and allocating newly developed char lands to the needy char residents.*

Though they are not receiving the necessary support from the government, the statement previously offered provides an indication of the institutional actors' intention to improve the status of the char regions. The latter comment demonstrates how locals have faith in their social actors. It also shows how cooperative the institutions in the relevant field are. Collaboration between various formal and informal organizations, social actors, and groups is essential for any civilization to advance. Sarvade and Weber (2020) and Dau et al. (2022) claimed in their recent research that strong collaboration can result in a better adaptation in society and an improvement in the status of those who live there.

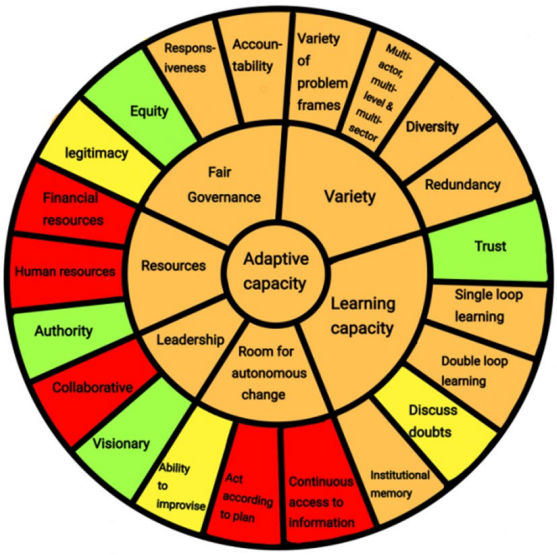
The institutions of the char regions of the North-Lakhimpur and Tinsukia districts are more diverse than the institutions of the other two in terms of collaboration and the engagement of many social actors in the institutional arrangements and formal and informal institutions. The *Mishing Autonomous Council* (MAC)[7] (formal) and *Takam Mishing Porin Kebang* (TMPK)[8] (informal) are the regional communal organizations that work with the char inhabitants of these two villages, in addition to other social actors. This may have enhanced these two districts' char institutions' capacity for enhancing adaptation. Additionally, it is

[7] MAC is an autonomous governing body of Assam.

[8] TMPK is a Mishing students' union and known as the father organization of MAC.



6.1: ACW of North Lakhimpur



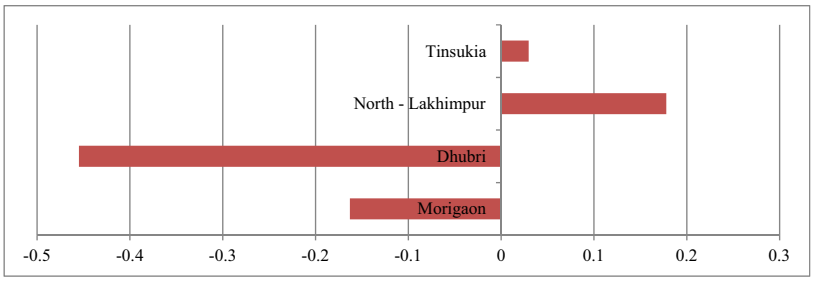
6.2: ACW of Dhubri

6.3: ACW of Morigaon

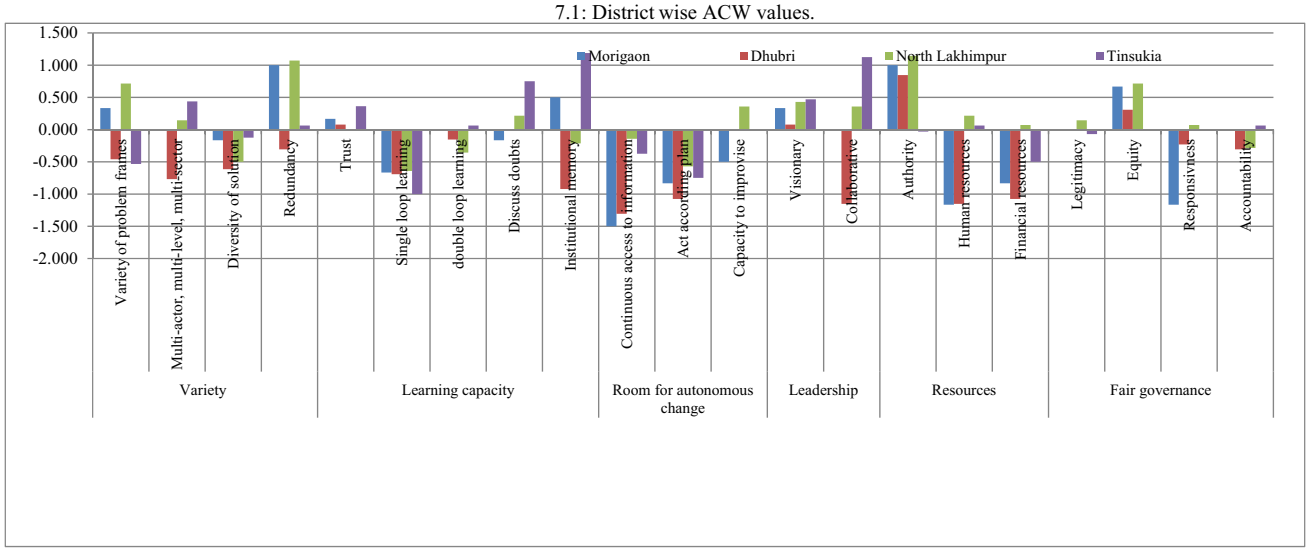
6.4: ACW of Tinsukia

Fig. 6 ACW of selected districts. 1: ACW of North Lakhimpur. 2: ACW of Dhubri. 3: ACW of Morigaon. 4: ACW of Tinsukia

discovered that the Mishing community in the two districts has a strong informal institutional pattern. It is therefore plausible to assume that the informal institutional pattern has complemented the formal one to improve these study areas' ability for adaptation. In the district of Morigaon, the informal institution is weak. There is absolutely no informal



7.1: District wise ACW values.



7.2: Criterion wise scores of ACW across four sample districts.

Fig. 7 Criterion and district-wise adaptive capacity of institutions to climate change. 1: District wise ACW values. 2: Criterion wise scores of ACW across four sample districts. *Source* Authors' own analysis

institutional organization in the Dhubri district. Only one social actor serves as the formal institution's representative in the villages of Dhubri. *All those elderly person in our village who used to participate in various decision-making processes and holding the structure of our informal institution are now dead*, a stakeholder from a village in the Dhurbri district stated. He further stated that *as of right now, our village lacks any informal administration. Only one Gaon Pnchayat (GP) member is available to us, and we only contact him or her when necessary*. Interestingly, unlike the other three districts, Dhubri does not have a government-appointed village head person (Gaon Burha), hence the member of the GP is the only official representative of the char regions in that particular place. *Being the only representative, it is challenging for me to handle all of the village's difficulties. Additionally, the government does not provide us with enough room or money to carry out development projects in the hamlet. Our responsibilities are limited to starting the aid distribution during emergencies and distributing the schemes to the recipients*—remarked a GP participant from a Dhubri district's survey village. Therefore, it is a question of how a few representations can result in a higher level of adaptability in the dominant institution.

In terms of generating resources for enhanced adaptation, char institutions are incredibly deficient. From the survey, it has been observed that the training sessions on disaster preparedness and livestock management were held in the char areas of the Tinsukia and North-Lakhimpur districts. The MAC usually collaborates with TMPK to organize these training sessions. However, no equivalent activities or arrangements are present in the other two districts. It is crucial for the institutions to plan such a training program in this area to improve the char dwellers' capacity for adapting.

Studies and reports like Rani and Maheswari (2015) and CCA RAI (2014, 2023) have supported the training program for increasing the society's and the local population's adaptive capacity to combat the negative effects of climate change. The institutions in every char regions of Assam are also clearly in need of significant attention for aspects like room for autonomous change and learning ability to have institutional reform for boosting char dwellers' adaptive capacity.

4 Conclusion

In this paper, one of the state's most hazardous locations, the char regions of Assam, we have attempted to assess the institutional setup's capacity for adaptation. We highlight the intrinsic qualities of institutions that can enhance society's ability to adapt to climate change and its associated risks using the adaptive capacity wheel (ACW), a normative economic approach. Char areas are the most severely impacted by the climate, and this makes people most vulnerable. Society must become more resilient in order to lessen this susceptibility, and institutions both formal and informal are crucial in boosting a community's potential for adaptation. We may grade the many institutional dimensions and the criteria that fall under each of these categories using ACW. We can determine the areas that require attentive monitoring and policy changes for improvement because it gives us a clear picture of their performance or capacity.

It is crucial to realize that only one type of institution can't carry out all the tasks and produce development on its own. Collaboration with other institutions or the local institution serving the community is essential. Including various social actor types in the decision-making process can increase an institution's diversity (Munaretto and Kolstermann 2011). It is evident from the study that institutions, their configuration, and their effectiveness in reducing vulnerability vary among different geographic sites. Communities living in this area might also have a different impact on it. Even though top-down techniques are frequently seen to be less effective, institutions must have the ability to organize themselves through local groups in order to have the freedom to make decisions based on their in-depth local knowledge (Munaretto and Kolstermann 2011). As a result, it has also suggested a potential area for additional investigation. Additionally, all of the char regions' institutional arrangements need to be improved in specific dimensions and criteria in order to boost the society's potential for adaptation. To increase the adaptability of the char institutions in Assam, a distinct approach to the institutions of various regions with diverse communities may be advised.

4.1 Scope for the further research

The study is limited to the char areas of only four districts as a representation of the entire char areas of the state. Capturing more of the char regions may provide more insightful and diverse outcomes in compliance to the present study. The paper also offers a wide range of opportunities for additional study about the critical assessment of formal and informal institutions' contributions to the growth of the char community. Our research also demonstrates the potential for investigating the relationship between the community's informal institutional structure and the institution's overall capacity for adaptation in a given place. Additionally, a broad scope has been reflected for a thorough examination into the relationship between the caliber of these institutions and how it has been able to lessen the vulnerability status of the residents of these particular regions of Assam. Char areas share similar characteristics with river deltas, wetlands, and other coastal regions worldwide that are vulnerable to floods and other climate-related natural hazards (Lahiri-Dutt and Samanta 2013; Lahiri-Dutt 2014). Consequently, the present study's approach can also be applied in these regions to comprehend the institutional adaptability

Table 5 Values of dimensions and criterion of ACW

Dimension	Criterions under each respective dimension	Over all	Morigaon	Dhubri	North Lakhimpur	Tinsukia
Variety		− 0.097	0.292	− 0.538	0.357	− 0.281
	Variety of problem frames	− 0.367	0.33	− 0.46	0.71	− 0.53
	Multi-actor, multi-level, multi-sector	− 0.02	0	− 0.769	0.14	0.438
	Diversity of solution	− 0.367	− 0.167	− 0.615	− 0.5	− 0.125
	Redundancy	0.367	1	− 0.308	1.07	0.06
Learning capacity		− 0.057	− 0.03	− 0.338	− 0.2	0.288
	Trust	0.184	0.167	0.077	0	0.36
	Single loop learning	− 0.776	− 0.667	− 0.692	− 0.643	− 1
	double loop learning	− 0.12	0	− 0.154	− 0.357	0.063
	Discuss doubts	0.286	− 0.167	0	0.214	0.75
	Institutional memory	0.143	0.5	− 0.92	− 0.214	1.188
Room for autonomous change		− 0.483	− 0.944	− 0.795	− 0.119	− 0.375
	Continuous access to information	− 0.694	− 1.5	− 1.308	− 0.14	− 0.375
	Act according plan	− 0.796	− 0.83	− 1.077	− 0.57	− 0.75
	Capacity to improvise	0.04	− 0.5	0	0.357	0
Leadership		0.214	0.167	− 0.538	0.39	0.688
	Visionary	0.265	0.33	0.077	0.429	0.469
	Collaborative	0.16	0	− 1.154	0.357	1.125
Resources		− 0.068	− 0.33	− 0.46	0.476	− 0.125
	Authority	0.694	1	0.846	1.14	− 0.03
	Human resources	− 0.367	− 1.167	− 1.154	0.214	0.06
	Financial resources	− 0.53	− 0.83	− 1.077	0.07	− 0.5
Fair governance		0.01	− 0.125	− 0.058	0.16	− 0.016
	Legitimacy	0	0	0	0.14	− 0.07
	Equity	0.367	0.667	0.308	0.714	0
	Responsiveness	− 0.184	− 1.167	− 0.23	0.07	0
	Accountability	− 0.14	0	− 0.308	− 0.286	0.06
Average ACW value		− 0.0801	− 0.1629	− 0.4549	0.1779	0.0296

Source Authors' own calculation

```
. alpha Varietyofproblemframes Multiactormultilevelmulti Diversityofsolution Redundancy Trust Singlelooplearning
>  doublelooplearning Discussdoubts Institutionalmemory Continuousaccesstoinformation Actaccordingplan Capacityt
> oimprovise Visionary Collaborative Authority Humanresources Financialresources Legitimacy Equity Responsivness
>  Accountability

Test scale = mean(unstandardized items)
Reversed item:  Authority

Average interitem covariance:      .160194
Number of items in the scale:           21
Scale reliability coefficient:      0.8334
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Fig. 8 Snap of Cronbach's Alpha reliability test results in STATA 14

of those regions to construct a community that is climate resilient and to shape policy perceptions.

Appendix

See Table 5, Fig. 8.

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Declarations

Conflict of interest The authors have no conflict of interest.

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