

Indigenous Ecological Knowledge under Urban Pressure: A Cultural Capital Case Study of Disaster Mitigation in Kampung Cireundeu

JISPO
Jurnal Ilmu Sosial dan
Ilmu Politik
2026, Vol. 16, No. 1: 1-34
<https://journal.uinsgd.ac.id/index.php/jispo/index>
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ABSTRACT

Indonesia faces high disaster exposure compounded by environmental degradation, yet disaster-risk governance often gives limited attention to Indigenous ecological knowledge. Although such knowledge is increasingly recognized as relevant to resilience, less is known about how it is enacted, sustained, and challenged within rapidly urbanizing Indigenous communities. This study examines the forms, everyday implementation, and sustainability challenges of Indigenous ecological knowledge in the Cireundeu community, Cimahi, West Java. Using a qualitative case-study design, data were generated from 14 informants through semi-structured interviews, participant observation, repeated field visits, and documentation. The findings identify interconnected practices involving customary forest zoning, ecological values, ritual traditions, and the cassava-based *rasi* food system. These practices organize environmental responsibility, resource use, disaster memory, and food-related adaptation, while their continuity is challenged by land-use change, environmental pressure, urbanization, and uncertainty surrounding customary territorial authority. The study concludes that Cireundeu's ecological knowledge remains a locally grounded resource relevant to disaster mitigation, but its continuity depends on supportive social, environmental, and institutional conditions. It contributes to disaster-risk scholarship by explaining how Indigenous ecological

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knowledge is socially reproduced and mobilized as cultural capital in a peri-urban setting. It implies that disaster-risk governance should engage Indigenous knowledge through meaningful community participation while safeguarding the conditions necessary for its continued practice and intergenerational transmission.

Keywords

Indigenous ecological knowledge; disaster risk reduction; local wisdom; cultural capital; customary forest management; food resilience; community resilience.

INTRODUCTION

Indonesia faces exceptionally high disaster risk arising from the interaction of multiple hazards with exposure, vulnerability, environmental change, and uneven capacities for preparedness and response. The WorldRiskIndex continues to rank Indonesia among the countries with the highest disaster risk, while national records document substantial recurrent human and material losses (Bündnis Entwicklung Hilft and IFHV 2025; BNPB 2025). These impacts are shaped not only by tectonic and climatic hazards but also by land-use change, environmental degradation, settlement patterns, livelihood vulnerability, and institutional capacity. Disaster risk reduction (DRR) therefore requires more than monitoring, infrastructure, and emergency response. It also depends on how communities interpret environmental change, manage resources, organize collective action, transmit knowledge, and adapt livelihoods. This has increased attention to Traditional and Indigenous Knowledges as potential components of locally grounded and socially inclusive DRR (UNDRR 2022).

Research increasingly shows that Indigenous and local ecological knowledge can contribute to adaptation and resilience through environmental observation, resource-management rules, agricultural practices, food systems, customary norms, oral histories, and intergenerational learning. Reviews document its relevance to ecosystem management, climate adaptation, livelihood adjustment, and disaster preparedness across diverse settings (Nalau et al. 2018; Makondo and Thomas 2018; Petzold et al. 2020; Shaffril et al. 2020; Hadlos, Opdyke, and Hadigheh 2022; Filho et al. 2022; Dorji et al. 2024). This article uses Indigenous Ecological Knowledge (IEK) to refer to locally situated knowledge, values, practices,

and social arrangements governing relationships between people and their environments. The term *local wisdom* is retained where it reflects participants' language or Indonesian scholarship.

The value of IEK lies not simply in possessing hazard information but in how knowledge is enacted in everyday life. Studies show that Indigenous knowledge can guide environmental interpretation and preparedness in the Philippines (Cuaton and Su 2020), interact with scientific knowledge in community-based DRR in China (Wang et al. 2019), and inform locally developed flood management in Nigeria (Obi et al. 2021). Indonesian research similarly demonstrates the importance of collective memory, local interpretation, disaster learning, education, religious institutions, and community preparedness. The *Smong* narrative on Simeulue preserves tsunami knowledge across generations (Rahman, Sakurai, and Munadi 2018), while other studies examine earthquake resilience, disaster education, faith-based preparedness, and Indigenous environmental signs (Kurnio et al. 2021; Suarmika et al. 2022; Koopman 2023; Nopriyasman et al. 2024). These studies establish the relevance of locally grounded knowledge to DRR but also show that its forms and functions are highly context dependent.

Such context dependence requires caution against treating either “community” or “local knowledge” as homogeneous, static, or inherently resilient. Knowledge is reproduced through social relations, institutions, access to land and resources, cultural authority, and intergenerational learning (Räsänen et al. 2020; Choudhury et al. 2021). Co-production can improve risk communication when local experience and scientific expertise interact meaningfully rather than hierarchically (Lejano, Haque, and Berkes 2021), while traditional ecological knowledge can persist precisely because durable ethical principles coexist with flexible adaptation (Li and Han 2022). Local knowledge may therefore be preserved, modified, contested, selectively transmitted, or lost as social and environmental conditions change (Setten and Lein 2019). These dynamics are especially important in peri-urban settings, where customary practices coexist with land conversion, infrastructure expansion, market integration, demographic change, and institutional pressures.

Despite growing recognition of Indigenous knowledge, important gaps remain. First, systematic reviews show that calls to integrate local and scientific knowledge are more common than detailed accounts of how integration occurs or how its outcomes are assessed (Vasileiou, Barnett, and Stanton Fraser 2022; Hermans et al. 2022). Second, external organizations may recognize local knowledge rhetorically while continuing to privilege expert-defined categories and priorities, and community-based DRR may fail when participation is superficial (Trogrlić et al. 2021, 2022). Third, integration is neither politically nor epistemologically neutral: decisions about which knowledge is credible, who represents a community, and how knowledge enters policy can reproduce power inequalities (Bwambale et al. 2020). Indigenous DRR strategies may also remain adaptive while becoming increasingly vulnerable to social, institutional, and environmental change (Bwambale et al. 2022). Recent policy analysis similarly finds that formal recognition of traditional and local knowledge does not necessarily produce effective participation or operational pathways within DRR systems (Paudel et al. 2024).

The resulting research need is therefore not simply to document that Indigenous communities possess *local wisdom*. Rather, research needs to explain how different forms of ecological knowledge are connected, how they are enacted in everyday environmental and social practices, what risk-related functions communities attribute to them, and what conditions sustain or constrain their reproduction. This gap is particularly relevant in Indonesia, where much prominent research has focused on specific hazards or mechanisms, including tsunami memory, earthquake learning, disaster education, and environmental indicators (Rahman, Sakurai, and Munadi 2018; Kurnio et al. 2021; Suarmika et al. 2022; Nopriyasman et al. 2024), leaving less attention to how ecological values, resource-management practices, food strategies, customary norms, and cultural practices operate together within rapidly changing peri-urban environments.

Cireundeu in Cimahi City, West Java, provides a relevant case for examining this problem. Recent research describes Cireundeu as a traditional peri-urban Sundanese community whose ecological knowledge is expressed through cassava cultivation, ethnobotanical knowledge,

and the *rasi* food system (Irawan et al. 2024). That work establishes the importance of cassava-related knowledge but does not examine Cireundeu's ecological practices as an interconnected repertoire related to disaster mitigation. The present study therefore analyzes how forest-use practices, environmental ethics, ritual traditions, food strategies, and customary norms are enacted in relation to environmental risk and how their continuity is affected by socio-environmental change. These practices are not assumed to be inherently or measurably effective mitigation measures; rather, their meanings, implementation, perceived risk-related functions, and sustainability are examined empirically.

To interpret these processes, the study draws on Bourdieu's concept of cultural capital (Bourdieu 1986). Rather than treating Indigenous knowledge as an inventory of traditions, cultural capital directs attention to how ecological knowledge and dispositions are learned, embodied, transmitted, legitimized, and mobilized as social resources. The framework is used cautiously: it does not itself explain ecological resilience, but helps analyze the social reproduction of ecological competencies and the conditions under which they may support collective action or lose influence.

Accordingly, the study asks: (1) What forms of Indigenous ecological knowledge and customary practice in Cireundeu are relevant to disaster mitigation? (2) How are they enacted through everyday environmental, livelihood, cultural, and social practices in relation to disaster risk? and (3) What socio-environmental and institutional pressures affect their continuity and potential contribution to mitigation? The study makes three contributions. Empirically, it extends Cireundeu research beyond cassava and ethnobotany by examining ecological practices as an interconnected peri-urban repertoire. Conceptually, it brings cultural-capital analysis into dialogue with IEK and community-based DRR to explain how ecological knowledge is reproduced and mobilized rather than treated as static inheritance. Practically, it clarifies how locally grounded knowledge may complement formal DRR without assuming that it can be extracted, standardized, or incorporated into policy independently of community authority, environmental context, and meaningful participation.

METHODS

Research Design and Case Selection

This study used a qualitative single-case study design to examine the forms, enactment, and sustainability challenges of Indigenous ecological knowledge in relation to disaster mitigation in the Cireundeu community. This design was appropriate because the research questions focus on how ecological knowledge and customary practices are understood, practiced, and maintained within their social, cultural, and environmental contexts rather than on measuring prevalence or causal effects.

The study was conducted in the Cireundeu Indigenous Community, Leuwigajah Village, South Cimahi District, Cimahi City, West Java, Indonesia. Cireundeu was selected purposively because it continues to maintain customary ecological and livelihood practices, including forest-use arrangements, ritual traditions, environmental values, and a cassava-based food system, while being situated within a rapidly urbanizing area. This combination makes Cireundeu an analytically relevant case for examining the continuity and adaptation of Indigenous ecological knowledge under changing socio-environmental conditions. The study sought contextual depth rather than statistical generalization.

Participants and Recruitment

Fourteen informants participated: two customary elders, five Indigenous community members, three Indigenous youth, three environmental activists associated with a WALHI West Java discussion on environmental issues, and one academic expert. Participants were recruited through purposive and snowball sampling. Purposive sampling identified individuals with knowledge or experience relevant to Cireundeu's customary practices, ecological conditions, and disaster-related issues, while snowball sampling was used to identify additional informants through participant referrals.

Including participants from different social positions enabled the study to capture multiple perspectives on the forms, transmission, implementation, and continuity of ecological knowledge. The sample was intended to provide information-rich qualitative accounts rather than numerical representativeness.

Data Collection

Fieldwork was conducted from February to May 2025 through eight visits to the study site, including one three-day, two-night stay within the community. Data were generated through participant observation, semi-structured interviews, field documentation, and participation in discussions concerning Indigenous and environmental issues.

Participant observation focused on how ecological values and customary practices were enacted in everyday settings. Observed activities and locations included the *Ngarekes* ritual, *rasi* or cassava-rice processing, visits to *leuweung tutupan* and *leuweung baladahan*, customary discussions, conservation activities around the former Leuwigajah landfill, and areas affected by housing development and forest conversion. Repeated visits and the residential stay provided opportunities to examine these practices within their social and environmental contexts rather than relying solely on retrospective accounts.

Semi-structured interviews were conducted with all 14 informants in Sundanese, Indonesian, or a combination of both, according to participant preference and interview context. Interviews lasted approximately one hour on average, were audio-recorded with consent, and transcribed verbatim. The semi-structured format allowed participants to describe their knowledge, experiences, and interpretations while enabling further exploration of issues relevant to the research questions. Field documentation complemented interview and observational data by recording relevant activities, locations, environmental conditions, and customary practices encountered during fieldwork.

Data Analysis

Data were analysed thematically through an iterative process informed by Miles, Huberman, and Saldaña's (2014) interactive model of qualitative data analysis, particularly data condensation, data display, and conclusion drawing and verification. Interview transcripts, field notes, observational records, and documentation were reviewed and manually coded.

Coding focused on recurring patterns related to the research questions, including forms of Indigenous ecological knowledge, customary

environmental practices, their everyday enactment, perceived relationships with environmental and disaster risks, knowledge transmission, and pressures affecting continuity. Related codes were compared across data sources and grouped into broader thematic categories. Emerging interpretations were repeatedly checked against the underlying interview, observational, and documentary evidence.

Bourdieu's concept of cultural capital was applied at the interpretive stage to examine how ecological knowledge, values, dispositions, and customary practices function as culturally embedded resources within the community (Bourdieu 1986). Cultural capital was used as an analytical lens for understanding the transmission and mobilization of ecological knowledge, rather than as a predetermined coding framework or evidence that customary practices necessarily produce measurable disaster resilience.

Trustworthiness

Credibility was strengthened through source and method triangulation. Accounts from customary elders, community members, youth, environmental actors, and the academic informant were compared with one another and, where relevant, with participant observation, field documentation, and secondary materials. This process was used to identify convergence, differences, and contextual variation across the evidence.

Method triangulation was particularly important because several practices discussed in interviews, including food preparation, customary activities, environmental management, and landscape change, could also be observed directly during fieldwork. Repeated site visits and participation in selected activities further strengthened contextual understanding. Triangulation was not treated as objective verification of all participant claims, but as a means of reducing dependence on any single account and increasing the transparency and credibility of interpretation.

Ethical Considerations

Participants were informed about the purpose of the study, and verbal consent was obtained before participation and audio recording. Permission

to conduct research and participate in activities within the customary area was obtained from Indigenous community leaders. Participation was voluntary, and customary protocols were respected throughout fieldwork. Because the study concerns Indigenous ecological knowledge and customary practices, interpretations were kept within the limits of the evidence generated and did not assume that culturally significant practices necessarily produce objectively measurable disaster-mitigation effects.

Methodological Scope

As an intensive qualitative study of a single Indigenous community, the research was not designed for statistical generalization. Instead, it provides contextually grounded evidence on how ecological knowledge, customary practices, livelihood strategies, and socio-environmental pressures interact within Cireundeu. The description of the case, participants, data sources, and analytical procedures is intended to enable readers to assess the credibility and potential transferability of the findings to comparable contexts.

RESULTS

Forms of Indigenous Ecological Knowledge in Cireundeu

The first research question examined the forms of Indigenous ecological knowledge maintained within the Cireundeu community. The field material identified three closely related domains: ethical principles governing relationships between humans and nature, customary arrangements for managing environmental space, and cultural practices through which ecological knowledge is enacted and transmitted. These domains were expressed particularly through *Tata Lampah*, *Tata Wayah*, and *Tata Wilayah*, as well as through forest-use practices, ritual traditions, and the cassava-based *rasi* food system. Table 1 summarizes the principal ecological values identified in the field material and the ways participants related them to environmental responsibility and risk.

Ecological Ethics: Tata Lampah, Tata Wayah, and Tata Wilayah

Participants described *Tata Lampah* as a principle regulating individual conduct through moral restraint and responsibility. In this understanding, appropriate conduct requires people to avoid greed, envy, cruelty, and actions that cause harm to other people or to the environment. Community members connected environmental degradation with failures of human restraint and awareness. During fieldwork, these values were also encountered in customary discussions and ritual activities through which elders and other community members communicated appropriate ways of relating to the surrounding environment.

Tata Wayah refers to an awareness of time, natural rhythms, and the limits of human control over environmental processes. Participants associated this principle with adapting activities to seasonal and environmental conditions rather than imposing human preferences on nature. In their accounts, patience, humility, and attentiveness to environmental change formed part of appropriate ecological conduct. The significance of *Tata Wayah* therefore lay less in a specific technical mitigation practice than in the disposition it encouraged toward uncertainty and changing natural conditions.

Tata Wilayah was described in both internal and external terms. Internally, it concerns regulation of one's thoughts, speech, and actions. Externally, it concerns the organization and use of environmental space. The latter dimension was particularly visible in participants' descriptions of the customary distinction among *leuweung larangan* (forbidden forest), *leuweung tutupan* (protected forest), and *leuweung baladahan* (cultivated forest). Community members understood these categories as setting different limits on human access and resource use.

These principles were reinforced by customary expressions emphasizing restraint and responsibility in the use of natural resources. One expression recorded in the field material was *mipit kudu amit, ngala kudu bebeja*, which conveys an obligation to seek permission and show respect before taking from nature. Another expression, "*Gusti nu asih, alam nu ngasah, urang nu ngasuh*," articulates a relationship in which

divine provision, nature, and human responsibility are understood as interconnected. Within the field material, such expressions were not presented simply as abstract beliefs. Participants connected them to expectations regarding forest use, cultivation, settlement practices, and the protection of water and vegetation.

Table 1. Ecological principles and their implementation in the Cireundeu community

Principle	Meaning in the field material	Reported or observed implementation	Risk-related significance identified by participants
<i>Tata Lampah</i>	Regulation of human conduct according to moral and ethical principles	Avoiding greed, destructive behaviour, and unnecessary harm to living beings and the environment	Encourages restraint in the use of natural resources and personal responsibility toward the environment
<i>Tata Wayah</i>	Awareness of time, natural processes, and the limits of human control	Adjusting activities to seasonal conditions and avoiding excessive intervention in nature	Encourages attentiveness and adaptation to changing environmental conditions
<i>Tata Wilayah, internal</i>	Regulation of thoughts, speech, and conduct	Exercising self-restraint so that actions do not harm other people or the environment	Links personal conduct with ecological responsibility
<i>Tata Wilayah, external</i>	Organization and regulation of environmental space	Differentiating forest areas according to customary restrictions and permitted uses; protecting vegetation and water sources	Provides customary rules for limiting resource use and protecting environmentally sensitive areas

The evidence therefore shows that Cireundeu’s ecological knowledge comprises both normative and practical elements. Ethical principles establish expectations regarding appropriate relationships with nature, while customary spatial arrangements and livelihood practices translate those expectations into everyday forms of resource use.

Enactment of Indigenous Ecological Knowledge in Relation to Environmental and Disaster Risk

The second research question concerned how Indigenous ecological knowledge is implemented in everyday life in relation to environmental and disaster risk. Three areas were particularly prominent in the field material: customary forest management, ecological restoration and disaster remembrance, and the cassava-based food system.

Customary forest zoning and environmental management

Participants described customary forest management through three categories: *leuweung larangan*, *leuweung tutupan*, and *leuweung baladahan*. Each category was associated with different rules of access and use.

Leuweung larangan was described by participants as the most restricted forest category. According to their accounts, cultivation and extraction are prohibited in this zone, and human intervention is kept to a minimum. Participants associated these restrictions with the protection of steep and environmentally sensitive terrain. Because the Methods section does not document direct researcher access inside *leuweung larangan*, the findings concerning its internal ecological condition are based primarily on participant accounts rather than systematic observation within the restricted area. Figure 2 documents the location identified as *leuweung larangan* during the field study.



Figure 2. *Leuweung larangan* in the Cireundeu customary area
Source: Field documentation, 2025.

The second category, *leuweung tutupan*, was directly visited during fieldwork. Participants described this area as a protected zone associated particularly with vegetation and water conservation. One important feature identified during the field visit was the spring known locally as *Nyi Mas Ende*. Community members associated the spring with household, agricultural, and ritual needs and described customary restrictions intended to protect the surrounding area. During the visit, the researcher also observed that visitors were asked to remove their footwear before entering parts of the customary forest. Participants explained this practice as an expression of respect for the sacred character of the area. Its environmental significance lies primarily in the behavioral restrictions and collective attention that accompany the practice, rather than in the symbolic act itself.

Leuweung baladahan differs from the more restricted forest zones because agricultural and productive activities are permitted. Field observation documented cassava cultivation and other plants used for household and community purposes. Participants described use of this area as subject to customary expectations concerning restraint and collective responsibility. The zone therefore illustrates how environmental use in Cireundeu is not based on complete exclusion from nature, but on differentiated rules governing where and how resources may be used. Figure 3 shows the *leuweung baladahan* area observed during fieldwork.



Figure 3. *Leuweung baladahan* in the Cireundeu customary area.

Source: Field documentation, 2025.

Taken together, the three categories indicate that customary environmental management in Cireundeu operates through differentiated access rather than a uniform prohibition on resource use. Protected areas are subject to stronger restrictions, whereas cultivated areas permit livelihood activities within customary expectations. Participants linked this spatial differentiation to the protection of vegetation, slopes, and water sources. The present qualitative evidence establishes these customary rules and community interpretations, but it does not independently measure their hydrological or geotechnical effects.

Disaster memory, the Ngarekes ritual, and ecological restoration

The 2005 Leuwigajah landfill disaster remains an important reference point in community narratives about environmental responsibility. During fieldwork, the researcher participated directly in the annual *Ngarekes* ritual while staying in the community for three days and two nights. The observed activities included collective prayer, communal gatherings, and traditional music performed using *karinding* instruments. Figure 4 documents the musical instruments used during the ritual.



Figure 4. *Karinding* musical instruments used during the *Ngarekes* ritual
Source: Field documentation, 2025.

Participants described *Ngarekes* as both an act of remembrance and an occasion for reflecting on the relationship between human activity and environmental degradation. Community accounts connected the ritual to the former Leuwigajah landfill and to efforts to restore the surrounding landscape. Within these narratives, the disaster was remembered not only as a past tragedy but also as a warning concerning the consequences of environmentally damaging practices.

Participants further described efforts to revegetate parts of the former landfill area and expressed an intention to restore bamboo vegetation, locally referred to as *leuweung awi*. Bamboo was valued by participants because they associated its root structure with soil and water retention. During field visits, the researcher observed vegetation growing in parts of the former landfill landscape and identified small water sources that community members described as having reappeared during the recovery of the area.

Figures 5 and 6 provide visual documentation of the former landfill at two different points in time. The images illustrate changes in the visible landscape, particularly the presence of vegetation in the more recent field photograph. They should not, however, be interpreted as demonstrating that community reforestation alone caused the observed environmental change because the study did not undertake longitudinal ecological measurement.



Figure 5. Leuwigajah landfill landscape.

Source: Pikiran Rakyat, 2020.



Figure 6. Former Leuwigajah landfill landscape during fieldwork.

Source: Field documentation, 2025.

The relationship between *Ngarekes* and environmental restoration is therefore both material and cultural in the field material. Restoration activities concern the physical landscape, whereas the ritual keeps the history of the disaster present within community life. The evidence supports interpreting *Ngarekes* as a mechanism through which disaster memory and environmental responsibility are communicated collectively. It does not establish that the ritual itself reduces the physical probability of future disasters.

Rasi and food-related adaptation

The cassava-based food system represents another important component of ecological knowledge in Cireundeu. Community oral histories recorded during the study traced the shift toward cassava consumption to the early twentieth century. Participants associated this shift with periods of difficulty in obtaining rice and described cassava as better suited to local environmental conditions. Community narratives identified Nyai Asanah as an important figure in the early adoption of cassava as a staple and referred to 1924 as an important point in the establishment of the practice through customary agreement. These dates and historical details are reported here as community narratives; the present study did not independently verify them through archival research.

Field observation documented the continuing preparation and consumption of *rasi*, or cassava rice. The processing sequence described by

participants included *ngalacag*, *ngarajang*, *nyeupan*, *ngapung*, *ngarajih*, *ngagiling*, and *nyangray*. Some stages continue to be performed using customary techniques, whereas modern equipment has been introduced for parts of the process. Participants did not regard the adoption of such equipment as necessarily abandoning the cultural significance of *rasi*.

Community members described cassava as less dependent on the environmental requirements associated with paddy rice and therefore as an important source of food security. They also reported that local cassava production was sufficient to meet community consumption needs and, according to their estimates, could exceed annual household demand. Because the study did not collect agricultural production and consumption statistics, this finding should be understood as a community assessment rather than a quantified estimate of food self-sufficiency.

The significance of *rasi* in the findings therefore extends beyond its role as a food product. It connects livelihood practice, ecological knowledge, historical memory, and cultural identity. Within participants' accounts, maintaining cassava as a staple reduces dependence on a single food source and provides continuity with practices developed in response to earlier periods of scarcity. The study supports this interpretation at the level of community practice and experience, although it does not quantify the extent to which the food system reduces vulnerability during contemporary disasters.

Challenges to the Continuity of Indigenous Ecological Knowledge

The third research question examined the pressures affecting the continuity of Cireundeu's ecological knowledge and customary practices. Three interconnected challenges emerged from interviews, observation, and environmental discussions: land-use and environmental change, uncertainty surrounding customary territorial authority, and changing patterns of intergenerational transmission.

Land-use pressure and perceived environmental change

Participants repeatedly identified land conversion around the customary area as a major concern. They referred particularly to housing development

and stone-extraction activities on or near forested slopes. Some participants specifically identified a nearby development as the Mandalika Residence project and described certain stone-extraction activities as illegal. These statements represent participant accounts; the study did not undertake an independent regulatory investigation to determine the legal status of the activities concerned.

Field observation confirmed visible differences in land cover between some forested and developed areas around the study site, including locations where vegetation had been cleared or substantially reduced. These observations establish the presence of landscape transformation but do not, by themselves, demonstrate who was responsible for particular changes or establish a direct causal relationship between specific developments and environmental hazards.

Participants and environmental activists also associated land conversion with changes in local water availability. Several reported that springs formerly used by the community had diminished as surrounding land use changed. Environmental activists participating in the WALHI West Java discussion further expressed concern that increased built-up areas could contribute to greater surface runoff during heavy rainfall. No hydrological measurements were undertaken as part of this study. These findings therefore document locally perceived environmental change and risk rather than measured changes in runoff, groundwater recharge, or watershed behavior.

Similar caution applies to reported biodiversity changes. Community members stated that some medicinal plants and other vegetation had become more difficult to find and that birds and pollinating insects appeared less abundant than in the past. These observations are important because they reveal how environmental change is experienced locally, but the study did not conduct a biodiversity inventory or longitudinal ecological survey. They should therefore be interpreted as participant perceptions rather than quantified evidence of species decline.

Customary territory and participation in environmental governance

A second challenge concerned the community's relationship with formal land administration and development decision-making. Participants described uncertainty regarding their ability to protect areas they regard as customary territory. According to community accounts, historical changes in land administration had weakened collective control over some areas and increased their exposure to private ownership and development.

Participants also stated that development decisions affecting areas of customary importance did not always involve meaningful consultation with the Cireundeu community. These accounts indicate a perceived mismatch between customary understandings of territory and formal systems of land-use decision-making.

The present study did not include a systematic review of cadastral records, court decisions, municipal spatial plans, or legal instruments governing recognition of customary land. It therefore cannot independently determine the precise legal status of Cireundeu's territorial claims. The finding is more narrowly that participants experience uncertainty over territorial authority and perceive limited influence over some development decisions affecting environmentally and culturally important areas.

This uncertainty matters for the continuity of ecological practices because customary restrictions depend partly on the community's practical capacity to regulate access to land, vegetation, and water sources. Where control over environmentally important areas is reduced, the community's ability to maintain customary spatial practices may also become more difficult.

Intergenerational continuity under changing social conditions

Participants also identified changing lifestyles and economic aspirations as potential challenges to the transmission of customary knowledge. Older community members expressed concern that urban influences, digital media, and changing livelihood preferences could alter younger people's relationship with customary practices.

Field observations, however, did not support a simple narrative of cultural abandonment. Young community members were present in ritual activities, environmental discussions, and conservation-related activities observed during fieldwork. Their participation indicates that intergenerational transmission remains active, even while its social context is changing.

The findings therefore point to adaptation rather than straightforward disappearance. Cireundeu's ecological knowledge continues to be reproduced through ritual participation, everyday food practices, customary discussions, and involvement in environmental activities, but this transmission occurs within an increasingly urban and socially changing environment. The central challenge is consequently not only whether younger generations retain particular traditions, but also how those traditions are interpreted and practiced as the surrounding ecological, economic, and institutional conditions change.

Across the three research questions, the findings show that Indigenous ecological knowledge in Cireundeu is expressed through an interconnected set of ethical principles, spatial practices, ritual traditions, environmental activities, and food-related knowledge. *Tata Lampah*, *Tata Wayah*, and *Tata Wilayah* provide normative principles for human-environment relations; customary forest categories regulate different forms of access and use; *Ngarekes* maintains collective memory of environmental disaster; restoration activities connect that memory with landscape management; and *rasi* represents a continuing food practice that participants associate with adaptation and reduced dependence on rice.

These practices are not static. They are maintained amid land-use change, perceived ecological degradation, uncertainty over customary territorial authority, and changing intergenerational conditions. The evidence demonstrates how community members understand and enact these practices in relation to environmental responsibility and risk. It does not, however, establish quantitatively that individual customary practices prevent floods, landslides, drought, biodiversity loss, or food insecurity. Those broader causal and theoretical implications are considered in the Discussion.

DISCUSSION

The findings show that Indigenous ecological knowledge in Cireundeu is relevant to disaster mitigation not as a discrete set of traditional techniques, but as an interconnected system of values, practices, memory, livelihood strategies, and spatial rules that shape environmental responsibility. This supports scholarship that treats Indigenous knowledge as socially embedded and place-based rather than as isolated information about hazards (Setten and Lein 2019; Kurnio et al. 2021; Hadlos, Opdyke, and Hadigheh 2022). The Cireundeu case extends this literature by showing how such knowledge is maintained in a peri-urban setting where customary practices coexist with urban development, changing livelihoods, and growing pressure on environmentally important spaces.

Indigenous Ecological Knowledge as Everyday Environmental Governance

Tata Lampah, *Tata Wayah*, and *Tata Wilayah* demonstrate that ecological knowledge in Cireundeu operates through normative principles as well as environmental practices. These principles connect restraint, adaptation, responsibility, and spatial use with culturally defined expectations about appropriate human relationships with nature. The distinction among *leuweung larangan*, *leuweung tutupan*, and *leuweung baladahan* further translates these values into differentiated rules of access and resource use.

This finding confirms research showing that Indigenous ecological knowledge combines environmental understanding with social institutions, values, and livelihood practices (Hadlos, Opdyke, and Hadigheh 2022). It also suggests that Cireundeu's customary arrangements constitute a form of everyday environmental governance by establishing culturally legitimate limits on the use of environmentally valued areas. Their significance for disaster risk reduction lies primarily in shaping risk-relevant behavior and environmental responsibility before formal emergency interventions become necessary (Lejano, Haque, and Berkes 2021; Vasileiou, Barnett, and Stanton Fraser 2022).

The evidence, however, does not establish that these customary practices measurably reduce floods, landslides, or drought. No hydrological or geotechnical assessment was conducted. Their contribution is demonstrated at the level of knowledge, behavior, resource-use norms, and community practice rather than through measured reductions in physical hazard.

Cultural Capital and the Reproduction of Ecological Knowledge

Bourdieu's concept of cultural capital helps explain how Cireundeu's ecological knowledge is reproduced. The findings most clearly reflect embodied cultural capital because ecological dispositions and practical competencies are acquired through participation, socialization, ritual, cultivation, food preparation, and interaction with culturally meaningful landscapes. Knowledge of forest rules, *rasi* processing, customary expressions, and appropriate environmental conduct persists because it is repeatedly enacted rather than merely remembered (Bourdieu 1986).

The findings also reveal an important distinction between cultural legitimacy and institutional authority. Ecological knowledge may hold considerable authority within the community without being equally influential in formal land-use and environmental decision-making. Participants' concerns regarding customary territorial authority illustrate this asymmetry. The study therefore contributes theoretically by showing that ecological knowledge may function as embodied cultural capital without necessarily being converted into political or institutional power.

This interpretation is consistent with DRR research showing that formal recognition of local knowledge does not automatically produce meaningful influence in governance (Troglić et al. 2021, 2022; Vasileiou, Barnett, and Stanton Fraser 2022). In Cireundeu, sustaining ecological knowledge internally may therefore be insufficient if access to the landscapes through which it is practiced becomes increasingly constrained by external land-use decisions.

Disaster Memory, *Ngarekes*, and Social Learning

The *Ngarekes* ritual illustrates how ecological knowledge is reproduced through collective memory. Its significance lies not in functioning as a direct warning or hazard-reduction mechanism, but in keeping the Leuwigajah landfill disaster present within community life and linking that memory to environmental responsibility.

This finding complements Indonesian studies showing how culturally transmitted memory can sustain disaster awareness and learning (Rahman, Sakurai, and Munadi 2018; Kurnio et al. 2021; Suarmika et al. 2022). The Cireundeu case, however, differs from traditions such as *Smong*, which transmit explicit hazard warnings and response instructions. *Ngarekes* operates primarily through remembrance, reflection, spirituality, and environmental ethics.

This distinction is analytically important because Indigenous knowledge contributes to disaster risk reduction through different pathways. Some practices transmit warning signs, others regulate resource use, while others sustain memory, learning, and responsibility. In Cireundeu, *Ngarekes* is best understood as a mechanism of social learning and ecological memory rather than as a direct mitigation intervention.

Community members also connected the ritual with revegetation and recovery around the former landfill. The study cannot attribute observed landscape changes to community restoration alone because natural regeneration, interventions by other actors, and broader land-management changes may also have contributed. The evidence instead shows how ecological recovery is culturally interpreted through disaster memory and environmental responsibility.

***Rasi*, Food Knowledge, and Adaptive Continuity**

The *rasi* food system provides another example of ecological knowledge embedded in everyday practice. Previous research has already documented cassava cultivation, processing, and ethnobotanical knowledge in Cireundeu (Irawan et al. 2024). The contribution of this study is therefore not the identification of *rasi* itself, but its interpretation as part of a broader

repertoire of ecological knowledge relevant to environmental risk and livelihood adaptation.

Community narratives connect cassava with historical experiences of rice scarcity and drought, while contemporary participants continue to value it as an alternative staple suited to local conditions. This suggests that a livelihood strategy associated with past scarcity can become culturally institutionalized and persist beyond its original context.

The coexistence of customary processing knowledge with newer equipment further indicates that continuity does not require technological immobility. This supports research showing that Indigenous knowledge can remain socially meaningful while adapting to changing conditions (Setten and Lein 2019; Bwambale et al. 2022). What persists is not necessarily an unchanged technique, but the relationship among knowledge, practice, identity, and environmental experience.

The resilience implications of *rasi* nevertheless remain bounded by the available evidence. The study did not measure agricultural yields, household consumption, nutritional outcomes, market dependency, or food availability during disasters. It therefore supports interpreting cassava-based food knowledge as a locally valued resource that may reduce dependence on rice, but not as evidence of quantitatively demonstrated food security or reduced disaster losses.

Urbanization, Environmental Pressure, and the Limits of Local Knowledge

The findings also qualify narratives that portray Indigenous knowledge as inherently resilient. Participants reported land conversion, development pressure, extractive activities, changing water availability, and perceived biodiversity decline. These concerns suggest that the continuity and practical relevance of ecological knowledge depend partly on continued access to the landscapes and resources through which it is enacted.

This supports research showing that Indigenous DRR strategies can remain adaptive while becoming increasingly vulnerable to social, environmental, and institutional change (Bwambale et al. 2022). Knowledge

about forests, water sources, or cultivation has limited practical reach if communities lose access to the places where that knowledge applies. Resilience should therefore not be understood as an intrinsic cultural property independent of external conditions.

The Cireundeu case thus cautions against romanticizing local wisdom. Cultural continuity cannot by itself compensate for landscape transformation, constrained territorial authority, or environmental degradation. Nor should the persistence of Indigenous knowledge shift responsibility for disaster mitigation from public institutions to communities. Resilience is relational and depends on interactions among community capacities, institutions, land-use decisions, political authority, and environmental resources (Choudhury et al. 2021).

Alternative explanations must also be acknowledged. Participants associated development with declining springs, erosion, and ecological deterioration, but the study did not measure groundwater, runoff, slope stability, vegetation change, or biodiversity longitudinally. Climatic variability, infrastructure development, and other urban processes may also contribute to these changes. Likewise, because no systematic cadastral or legal analysis was conducted, the study cannot determine the formal status of all customary territorial claims. The findings therefore document community perceptions, observed landscape change, and perceived constraints rather than establishing direct environmental or legal causation.

From Knowledge Integration to Knowledge Partnership

The findings also contribute to debates about incorporating Indigenous knowledge into formal disaster governance. Although the literature frequently advocates integrating local and scientific knowledge, such integration can remain superficial when Indigenous knowledge is treated as supplementary information to be extracted and fitted into expert-designed systems (Hermans et al. 2022; Vasileiou, Barnett, and Stanton Fraser 2022).

The Cireundeu case supports a more cautious notion of knowledge partnership. Its ecological knowledge is inseparable from cultural authority, social relations, environmental practices, and particular landscapes. Meaningful engagement therefore requires attention not only

to what communities know, but also to who holds that knowledge, how it is transmitted, and whether knowledge holders can participate in decisions affecting the environments on which those practices depend.

This interpretation aligns with research emphasizing knowledge co-production and meaningful participation rather than one-directional incorporation (Lejano, Haque, and Berkes 2021; Trogrlić et al. 2021, 2022; Paudel et al. 2024). The policy implication is not that customary practices should replace scientific risk assessment, engineering, spatial planning, or formal disaster institutions. Rather, locally grounded knowledge can complement scientific and technical evidence where communities participate meaningfully and where the environmental effectiveness, legal context, and applicability of particular practices are appropriately assessed.

Contributions and Limitations

The study makes three main contributions. Empirically, it extends research on Cireundeu beyond the well-documented cassava tradition by examining food knowledge together with ecological ethics, customary spatial practices, disaster memory, ritual, environmental restoration, and peri-urban pressures. Theoretically, it shows how ecological knowledge can function as embodied cultural capital within a community without necessarily translating into equivalent authority in formal environmental governance. Conceptually, it identifies multiple pathways through which Indigenous knowledge may become relevant to disaster risk reduction, including environmental regulation, spatial differentiation, disaster memory, ecological learning, and livelihood diversification.

These contributions remain bounded by the study's qualitative single-case design. The research involved 14 informants recruited purposively and through snowball sampling, which may have favored participants already engaged with customary and environmental issues. Eight field visits and one short residential stay provided contextual depth but could not capture long-term or seasonal change. The study also lacked hydrological, ecological, geotechnical, agricultural, cadastral, and longitudinal measurements needed to test many reported environmental effects.

Future research could combine qualitative inquiry with longitudinal ecological monitoring, spatial analysis, hydrological assessment, household food-security data, and legal analysis of land-use and customary territorial arrangements. Comparative studies involving other peri-urban *adat* communities would also help determine which dynamics observed in Cireundeu are context specific and which may be transferable.

Within these limits, the Cireundeu case shows that Indigenous ecological knowledge matters to disaster research because it connects environmental responsibility, livelihood practice, memory, spatial regulation, and cultural transmission. Its continuity, however, depends not on tradition alone but on the interaction among community agency, environmental conditions, access to land and resources, and institutional arrangements.

CONCLUSION

This study shows that Indigenous ecological knowledge in the Cireundeu community is expressed through interconnected ethical principles, customary spatial practices, ritual traditions, and food-related knowledge that shape how community members understand and respond to environmental risk. *Tata Lampah*, *Tata Wayah*, and *Tata Wilayah* guide conduct, adaptation, and the use of environmental space; customary forest categories regulate access to and use of ecologically valued areas; *Ngarekes* sustains collective memory of environmental disaster; and the *rasi* food system maintains locally embedded knowledge of livelihood adaptation and reduced dependence on rice. At the same time, these practices face pressures associated with land-use change, environmental transformation, uncertainty over customary territorial authority, and changing patterns of intergenerational transmission. The principal contribution of the study is therefore to show that Cireundeu's ecological knowledge is not a static body of tradition, but a socially reproduced repertoire of values and practices that is mobilized in relation to environmental responsibility and risk. Viewed through Bourdieu's concept of cultural capital, the findings further highlight how such knowledge can retain strong cultural legitimacy within the community even when its influence within formal environmental governance remains limited.

These findings suggest that disaster risk reduction and environmental governance may benefit from more meaningful engagement with Indigenous ecological knowledge, not as a substitute for scientific assessment or formal planning, but as a complementary source of locally grounded knowledge and practice. Such engagement should also recognize that the continuity of Indigenous knowledge depends on the social and environmental conditions that allow it to be practiced and transmitted. The conclusions remain bounded by the study's qualitative, single-case design, its relatively small purposive sample, and the absence of hydrological, ecological, geotechnical, agricultural, and legal measurements that could independently test the reported environmental effects of particular practices. Future research should therefore combine qualitative inquiry with longitudinal, spatial, ecological, and household-level data to examine the measurable effects of customary land management and food practices, clarify changes in land use and territorial authority, and compare Cireundeu with other *adat* communities facing different forms of environmental and urban pressure.

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