

Transforming ecological knowledge into collaborative action : lessons of environmental communication from the Balinese Community

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Abstract. Environmental communication is crucial for raising awareness, instilling a sense of urgency, and encouraging participation in conservation efforts. However, scientists and policymakers often face challenges in conveying complex ecological issues clearly and effectively, particularly to the general public and indigenous communities. This study aims to analyze and derive lessons from the Tukad Bindu Community, an environmental movement led by the indigenous Balinese community in Kesiman Village, which has managed to mobilize local communities and garnered support from partner organizations to collaborate in transforming the Bindu River from being a polluted area into both a community-based ecotourism destination and a hub for environmental dialogue among stakeholders. The research utilizes qualitative analysis of interviews with community leaders and local stakeholders, framed within the participatory environmental communication (PEC) approach, to illustrate the process by which the Balinese community integrates indigenous knowledge with scientific understanding in their environmental communication strategies. The study demonstrates how integrating scientific knowledge and strategic approach to local wisdom and a participatory approach can encourage collective action and build the community's problem-solving capacity.

1 Introduction

The pollution of rivers, worsened by the imminent threat of climate change, increasingly threatens the livelihoods of communities situated along riverbanks, presenting significant risks such as flooding [1], the proliferation of diseases and public health risks [2], economic losses and poverty [3], and potential displacement due to flood and eviction [4]. Indonesian rivers rank among the most polluted in the world with plastic waste, with certain waterways exhibiting plastic concentrations up to four times higher than those found in European rivers

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[5]. The significant presence of plastic pollution deteriorates water quality and poses severe threats to marine ecosystems, as these plastics are ultimately transported to the ocean [6]. The pervasive contamination of rivers by domestic, commercial, and industrial waste in Indonesia has resulted in many challenges, including deteriorating water quality, rendering it unsafe for consumption and the narrowing and sedimentation of river channels [7]. These risks need serious and immediate attention and solutions as they will likely cause severe public health, social, and economic issues.

The composition of urban waste in developing countries such as Indonesia is predominantly sourced from households, highlighting the critical need for waste and ecosystem management approaches that actively engage both individual and collective community participation as pivotal stakeholders in the solution [8]. However, the policy approach to environmental issues and ecosystem management globally has thus far failed to produce tangible action with the necessary level, scale, and depth to effectively address existing problems, as the ecological issues have traditionally been framed as external and technical challenges [9]. Breakthrough communication approaches and strategies that can translate technical information and scientific knowledge into easily understood and culturally relevant messages are needed to facilitate greater public comprehension and engagement in risk reduction and mitigation efforts [10].

Externally managed conservation efforts often fail and can cause social harm, such as displacing communities and abandoning local needs. The engagement of Indigenous people and local communities is crucial for effective conservation due to their knowledge of the environment [11]. Financial incentives may attract participation in conservation efforts, but they will not lead to more substantial commitment and sincere action because it is only effective for short-term behaviour change and often fails to produce long-term pro-environment behaviour [12]. Significant gaps remain in understanding the effective strategies to engage communities in sustainable development and conservation initiatives because the community decision-making process is often influenced by complex social and political dynamics [13].

Successful ecosystem management and conservation efforts rely on effective communication to enable the exchange of ideas and information, inspire behavioural shifts, and foster collaboration among stakeholders [14,15]. Participatory communication is needed to encourage genuine engagement, as it allows community members to exchange knowledge and perspectives [16,17]. Trust and reciprocity are fundamental in community engagement, so communication should be carefully adapted to the unique Indigenous knowledge system to ensure the message is understandable, culturally acceptable, and resonates with local values [18].

Environmental communication, as articulated by Pezzullo and Cox [19], encompasses the methods through which individuals or groups convey and interpret messages regarding the environment. The concept highlights the importance of context, power dynamics, and cultural influences in raising awareness, altering perceptions, and promoting action toward sustainability and environmental protection. The concept highlights the importance of context, power dynamics, and cultural influences in raising awareness, altering perceptions, and promoting action toward sustainability and environmental protection. This research's theoretical framework section will further explain the DNA (diversity, network, and agency) framework from the Participatory Environmental Communication Theory (PEC) by Harris [16,20] which will be utilized to analyze a community's environmental communication in encouraging collective action.

2 Theoretical framework

2.1 Participatory environmental communication (PEC)

The increasing complexity of environmental issues, alongside the growing threat and impact of the climate crisis and disasters, has led to the convergence of environmental communication studies with risk communication [10]. Once dominated by strategic, one-way dissemination models focused on behaviour change, risk communication approaches have shifted toward a more participatory and dialogical model, enabled by advancements in information and communication technologies that facilitate dynamic, multi-directional interactions [16]. This shift has also encouraged a change in the goals of environmental communication to prioritize building the capacity and resilience of the community in dealing with environmental challenges. Harris argues that strategic and dialogical approaches play crucial roles in environmental communications. The strategic approach (vertical communication) is practical for disseminating information widely, quickly, and efficiently.

In contrast, the dialogical approach (horizontal communication) fosters discourse, debate, and the dynamic exchange of opinions on environmental issues, effectively helping identify local solutions. The goals of environmental communication have broadened, now emphasizing community empowerment, understanding, and resilience-building to address environmental challenges. Resilience, in this context, aligns with disaster risk reduction (DRR), which integrates traditional local knowledge, fosters solidarity and networks, and leverages community expertise and technology [16].

Harris [16,20] introduced Participatory Environmental Communication (PEC), a framework aimed at promoting dialogue, empowering marginalized communities, and supporting a praxis-oriented cycle of action-reflection to drive sustainable social change. Participatory environmental communication engages the public by utilizing any available medium (digital, conventional, or even traditional) for activities such as broadcasting, advocacy on environmental issues, Early Warning Systems (EWS), information exchange, and community initiatives. PEC stresses the system of community engagement with various stakeholders—the general public, scientists, practitioners, and government agencies—on the issues of dialogue and problem-solving. This theory conceptualizes a system with three interconnected elements: diversity, networks, and agency.

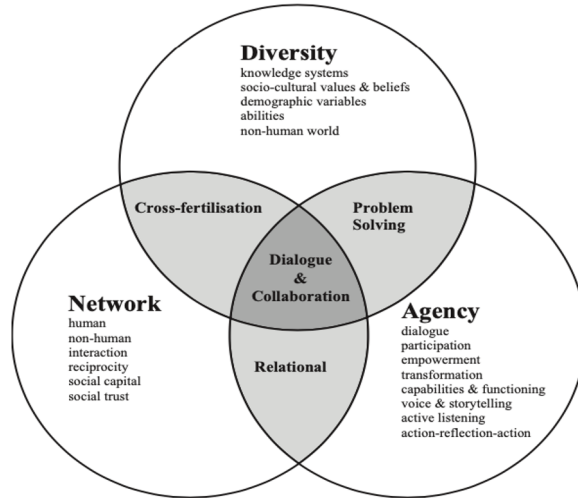


Fig. 1. DNA Framework of participatory environmental communication [16].

The three elements integrated into the DNA framework are rooted in Harris' [20] core idea that effective environmental-social movements require the engagement of ordinary citizens grounded in deep ecological concern. Therefore, effective environmental communication must cultivate critical awareness through dialogue and bottom-up approaches. A fundamental assumption within the DNA framework is that ordinary communities, including indigenous groups and marginalized populations, inherently possess valuable knowledge and methods for addressing local environmental issues. Environmental communication should involve and integrate this knowledge and wisdom into broader discourse and decision-making processes [20]. Below is a further explanation of DNA Framework by Harris:

Table 1. Interpretation of DNA elements [16].

Diversity (D)	This element is characterized by the diversity of various aspects within a community, such as demographic variables, skills, professions, educational background, and socio-cultural values. This element can produce innovative and transformative ideas.
Network (N)	This element is based on the awareness that humans are an inseparable part of the environment so that all ideas and actions carried out by humans can be influenced and influence non-human reality. This awareness is the core of the praxis (action-reflection-action cycle) of participatory environmental communication (PEC).
Agency (A)	An element that develops from awareness of human potential in creating change through dialogical interaction. In essence, agency is the ability of individuals or communities to carry out actions or deeds that can impact or create change.
Cross-fertilization (D+N)	A process of exchange and sharing ideas, knowledge, values, methods, and resources between stakeholders such as local residents, scientists and academics, field practitioners, and policymakers. Such processes enhance the potential for cooperation and collaboration in addressing environmental issues.
Relational (N+A)	This element refers to the interconnectedness and partnerships among groups and individuals based on mutual understanding and trust. This process creates spaces for egalitarian and authentic dialogue while enhancing solidarity in addressing environmental issues.

Problem-solving (A+D)	This element involves developing or implementing innovative solutions resulting from dialogue and deliberation among diverse stakeholders. This problem-solving process integrates knowledge, expertise, and resources from various groups, particularly local communities, into decision-making.
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Based on these three elements, Harris [16] defines DNA as a framework that emphasizes various methods for acquiring knowledge and fostering change while utilizing social networks to empower ordinary citizens and enable them to engage in collective action.

Harris [20] proposes the DNA framework as an alternative to answering the need for an inclusive conceptual framework for environmental communication that respects diversity and can build resilience in grassroots communities. The three interrelated concepts in DNA aim to attract participation from society as a whole (not only elites) in interactions as equal partners so that they can encourage better decision-making in dealing with current environmental issues, most of which threaten the grassroots and vulnerable people.

2.2 Case: Environmental movement of the Balinese Community

Water and river ecosystems are significant aspects of Balinese culture, regarded not merely as a physical resource but as a sacred element that plays a crucial role in religious rituals and ceremonies, rather than simply serving as a physical resource. Water symbolizes purity and is employed in numerous rites for the cleansing and purifying of individuals and their surroundings [21]. However, renowned worldwide for its natural beauty and tourism appeal, Bali ranks as the eighth-largest waste-producing province in Indonesia, generating a total of 1.027.433 tons of waste in 2023 annually, with Denpasar City contributing the highest amount of waste among cities and regencies, totaling 357.984 tons annually, which followed by Gianyar Regency (196.698 tons) and Buleleng Regency (150.652 tons) [22]. River pollution in Bali is also affected by factors such as waste, population density, and land use changes [23]. These issues threaten aquatic ecosystems and have hindered economic development by impacting critical sectors like tourism and agriculture, thus underscoring the need for effective local policies [3].

However, amidst these challenges, a social-environmental movement initiated by the Tukad Bindu Community in Kesiman Village, East Denpasar, has successfully implemented community-based waste management and river conservation practices.



Fig. 2. Bindu River after rehabilitation by Tukad Bindu Community

Tukad Bindu is a river or canal (*tukad*) that flows across four *banjars* (traditional Balinese villages): Banjar Dukuh, Banjar Ujung, Banjar Abinangka Kelod, and Banjar Abinangka Kaja. Since the initiation of the Tukad Bindu Community in 2010, which was later established as a foundation in 2017, this community has transformed the environment of the Bindu River, previously characterized by its slum conditions and littered with waste; the riverbanks have been converted into a clean and attractive ecotourism destination through effective environmental communication and collaboration. Knowledge diversity, networking, and agency within this community are crucial in fostering dialogue and effective collaboration [24,25].

One unique aspect of the Tukad Bindu environmental movement is raising awareness through discourse framed by Balinese cultural values and local wisdom, specifically the *Tri Hita Karana* and *Tri Kaya Parisudha* philosophy. This cultural foundation is the basis for community initiatives and participation in the Tukad Bindu movement [24]. Apart from environmental communication integrated with indigenous knowledge and local wisdom, Tukad Bindu Community members also use audio-visual content to spread news and messages about the environment through digital and conventional media to the public.

3 Method

This research uses a qualitative research design in order to explore the participatory environmental communication practices of the Tukad Bindu Community in Kesiman Village. It aims to understand the landscape of the Balinese community's environmental communication and collaboration dynamics in waste management and river conservation efforts. Using a case study approach referring to Creswell and Creswell [26], this research aims to capture the nuances of how indigenous knowledge, local culture, spirituality, and community dynamics influence environmental communication and action. Data collection involves in-depth interviews with key community leaders and local stakeholders, focus group discussions (FGD) with local residents, and periodic field observations from June to September 2024 to document community activities.

The selection of interviewees and FGD participants is based on several criteria with the following details:

Table 2. Selection criteria of interviewees and participants

Technique	Categories	Criteria
In-depth interview	Community leaders	<ul style="list-style-type: none"> Having experience as an organizational leader or division head of the Tukad Bindu Community. Take part in educational activities and dialogue related to the environment. Understand the history, vision, missions, functions, and work programs of the Tukad Bindu Community. <p>(2 informants)</p>
In-depth interview	Local stakeholders (Community members)	<ul style="list-style-type: none"> Tukad Bindu Community officers, members, or volunteers. Have participated in educational and environmental conservation activities in Tukad Bindu.

		(4 informants)
In-depth interview	Local stakeholders (Traditional leaders)	<ul style="list-style-type: none"> Religious leaders or traditional sub-village leaders (<i>kelian banjar adat</i>) or local spiritual gurus. Have a deep understanding of Balinese customs, culture, and local wisdom. Have collaborated or been directly involved in meetings, environmental education, and conservation activities with the Tukad Bindu Community. (4 informants)
In-depth interview	Local stakeholders (Formal leaders)	<ul style="list-style-type: none"> Village head (<i>perbekel</i>), or village head, or kelian banjar department in Kesiman Petilan Village. Knowing the history, cases, regulations, rules, and institutional roles related to environmental issues. Have collaborated or been directly involved in meetings or educational and environmental conservation activities with the Tukad Bindu Community. (6 informants)
In-depth interview	Local stakeholders (Partner organizations)	<ul style="list-style-type: none"> Leaders or officers of non-profit organizations, donor companies, or CSR in Bali. Have an understanding of environmental issues and activism. Have collaborated or been directly involved in meetings or educational and environmental conservation activities with the Tukad Bindu Community. (2 informants)
FGD	Local residents (Kesiman Village)	<ul style="list-style-type: none"> Residents living in Kesiman Village, especially around Tukad Bindu (Banjar Ujung, Banjar Dukuh, Banjar Abinangka Kelod, Banjar Abinangka Kaja). Have been directly involved or participated in activities held at Tukad Bindu.

Based on the mentioned data collection techniques and source selection criteria above, this research has triangulated data collection techniques (interviews, FGDs, field observations, and document studies), triangulated data sources (community, stakeholders, residents, etc.), and triangulated research time (June, July, August, September 2024). This triangulation is expected to ensure the validity and reliability of the findings by confirming that the data obtained from various techniques, sources, and timeframes corroborate each other. Any discrepancies could be analyzed further to understand the complexity of the phenomenon.

Utilizing thematic analysis as outlined by Saldaña [27], this research incorporates manually coding the collected data to identify significant themes and patterns. This approach allows for an interpretation of how the elements of the Tukad Bindu community's DNA (diversity, networks, and agency) interact and contribute to their environmental communication practices, influencing local engagement and collaborative actions in waste management and river conservation.

4 Results and discussions

4.1 DNA in Tukad Bindu Community's Environmental Communication

4.1.1 Diversity

Diversity of perspectives, such as those between formal actors (Government agencies) and traditional actors (cultural leaders), enriches the community's approach to understanding and addressing environmental issues. Perspectives from Government agencies and local authorities provide insights related to policies and regulations. In contrast, traditional leaders' perspectives can provide insights based on local cultural and spiritual values, which are aligned with environmental conservation narratives based on the values and philosophy of Balinese indigenous communities such as *Tri Hita Karana* and *Tri Kaya Parisudha* which is closely related to the heart and daily life of the Balinese community. One of the initiators of the Tukad Bindu Community explained that although he often uses technical and strategic narratives when interacting with formal institutions, narratives rooted in Balinese local wisdom are more effective as a basis for communication with traditional communities and institutions.

"Our culture really values harmony or balance between humans with God, humans with humans, and humans with nature. This is what we call 'Tri Hita Karana'. We also have 'Tri Kaya Parisudha', which means we must think well, speak well, and behave well. This means that our thoughts must be positive. Then, we have to communicate and perform those thoughts as well positively. That's what I always tell the public so they want to take action,"

-Informant 2, Initiator of Tukad Bindu Community.

The statement above shows that Balinese values, philosophy, and local wisdom are still believed and held firmly in people's daily lives, so communication that integrates cultural perspectives and participatory approaches will be more effective in encouraging action and participation. These approaches are further enhanced through educational activities often conducted in collaboration with environmental NGOs, academic institutions, and researchers employing scientific methodologies. The integration of these three approaches (cultural, institutional, and scientific) enables the Tukad Bindu Community to develop a rich selection of narratives for environmental communication which includes narratives centered on policy and regulation, cultural and spiritual values, and modern scientific knowledge, all of which can be flexibly employed according to the community's or stakeholders' needs.

"Basically, I'm not an environmental activist. But after joining Tukad Bindu in 2010, I learned a lot. Since the establishment of the Foundation (Tukad Bindu), I have been learning a lot. This means studying with friends in Bali. There are mentors from academics, from the government, and also NGOs. Yesterday, people from Warmadewa (University), Udayana (University), just came here to share knowledge, about indigenous law, about environmental engineering. Almost all campuses already know Tukad Bindu. Academics from PAUD to universities have all been here,"

-Informant 1, Officer at Tukad Bindu Foundation.

4.1.2 Network

The extensive and solid network of the Tukad Bindu Community is driven by the understanding that environmental issues, particularly regarding river ecosystems (*tukad*) in

Bali, cannot be addressed by a single *banjar* or village alone. Cross-regional and cross-sectoral cooperation is needed to tackle the complexities of ecological challenges. One of the informants explained the Tukad Bindu Community's initiative to build synergy between traditional institutions and government agencies as follows:

"There is a synergy between the government agencies and local traditional institutions. For example, when we want to organize a river clean-up activity, the agenda will first be discussed at a 'pesangkepan' (traditional subvillage meeting). If the traditional stakeholders approve, then the local government will support it. In initiating these activities, we really appreciate the Foundation (Tukad Bindu) as the leading sector,"

-Informant 3, Subvillage Leader.

Collaborative experiences with local governments, cultural leaders, educational institutions, NGOs, and other social-environmental movements have opened access to critical human resources, policies, funding, knowledge, and technical, moral, and cultural-spiritual support necessary for the preservation of river ecosystems and the management of Tukad Bindu's ecotourism efforts. This network also plays a vital role in building trust among the local community and partner institutions regarding the capabilities and credibility of the Tukad Bindu movement. The reciprocal relationships between the Tukad Bindu Community and Government agencies, cultural leaders, educational institutions, NGOs or social movements, local media, and particularly local communities enhance local capacity and roles while also broadening the impact and serving as an inspiration for similar movements in other areas of Denpasar and Bali Province.

4.1.3 Agency

The agency demonstrated by the Tukad Bindu Community reflects the community's capacity to initiate small-scale efforts to address local environmental issues independently, without reliance on external parties. One of the informants explained the Tukad Bindu Community's ability to make changes as follows:

"We, and the Tukad Bindu Community, respect each other. In my opinion, the Tukad Bindu Community is driven by sincere and brave people. This was visible because they dared to take the initiative to clean the river without any orders or payment from anyone. This sincerity can also be seen in their communication style, which is very touching to the public. That's why I always enjoy stopping by and learning at Tukad Bindu,"

-Informant 4, NGO Officer

The above testimonies show that the Tukad Bindu Community has the capacity to act and initiate change independently. Initiatives began with river clean-up activities, organizing riverbanks, and conducting educational programs in the four nearby *banjars*: Banjar Ujung, Banjar Dukuh, Banjar Abinangka Kelod, and Banjar Abinangka Kaja, involving local actors. These initiatives have strengthened the image and credibility of the Tukad Bindu Community in the eyes of the local community in Kesiman Village. This initially small positive track record has grown alongside expanding networks and reciprocal relationships with external stakeholders, motivating the Tukad Bindu Community to continuously learn new concepts such as identifying local ecotourism potential, establishing waste banks, managing plastic waste, utilizing green open spaces, and implementing various programs which bring social and ecological benefits.

4.1.4 Collaboration

The collaboration between Tukad Bindu Community for the sustainable ecotourism and river ecosystem conservation efforts in Denpasar City results from integrating diverse

perspectives, inter-village and multi-sectoral networks, and the community's capacity to initiate change so by integrating these three DNA elements—diversity, network, and agency—a strong and sustainable synergy in environmental conservation initiatives is created. The involvement of actors from varied backgrounds enhances communication capabilities and fosters an environmental narrative that is inclusive, emancipatory, versatile, and relevant to both the Kesiman Village community and external stakeholders at the municipal and provincial levels. Within this social domain, communication is essential in engaging the local community and facilitating effective collaboration among stakeholders across four or more different *banjars*. Thus, the initiatives of the Tukad Bindu Community extend beyond merely addressing river issues; they transform riverbanks, once used by residents to dispose of their household waste, into a sustainable ecotourism destination.

4.1.5 Tukad Bindu Community PEC model

Based on the DNA typology explanations above, the following is an illustration of the participatory environmental communication practices of the Tukad Bindu Community:

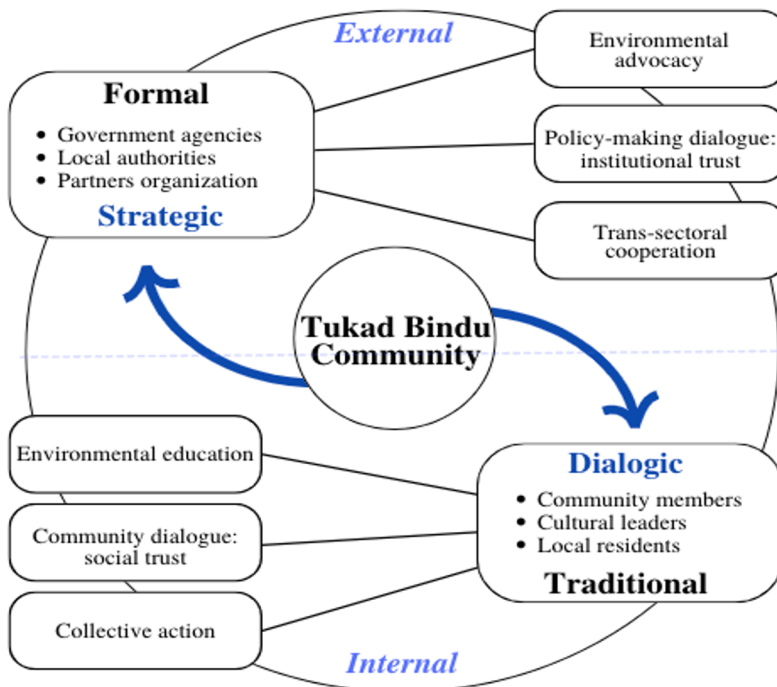


Fig. 3. Mode of participatory environmental communication of Tukad Bindu Community
Reference: Author's analysis (2024)

The figure above describes how the DNA elements within the Tukad Bindu Community facilitate engagement in communication across two distinct public domains within Balinese society: external-formal and internal-traditional. The external sphere encompasses interactions with stakeholders such as Government agencies, local authorities, universities and academic institutions, funding organizations, and media. Environmental communication within this domain typically happens in formal or semi-formal contexts, with strategic objectives to sustain and enhance the community movement's capacity. This type of strategic communication utilizes formal narratives and discourses grounded in scientific and

institutional approaches. In this capacity, the Tukad Bindu Community seeks to establish robust relationships and institutional trust to secure policy support, funding, and access to essential resources. In contrast, the internal sphere concentrates on interactions with local village stakeholders, including community members, cultural leaders, and local residents. Communication in this sphere focuses more on providing space for the informal but dialogical exchange of expression and knowledge about the environment by using local indigenous knowledge to build mutual trust, understanding, support, and a sense of ownership regarding the ideas and initiatives for environmental conservation.

These communication spheres or domains (internal and external) complement each other in addressing actual environmental challenges by engaging local residents and gaining support from multiple stakeholders to sustain and develop the movement.

5 Conclusion

This research seeks to present the lessons learned from a community that is finding ways of addressing its ecological challenges through participatory communication that integrates scientific knowledge with local Indigenous knowledge to raise environmental awareness and encourage collective action. The DNA elements are reflected in the Tukad Bindu Community's ability to exchange ideas from diverse perspectives (scientific, institutional, and cultural) through dialogue, developing networks of partners on the basis of mutual trust, and building credibility upon the capacity to create changes through impactful initiatives. These capacities to strike a balance between the formal and traditional, as well as strategic and participatory approaches of environmental communication also play an important role in finding, advocating, and implementing solutions to ecological problems through multi-stakeholder collaborations.

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