



Local Wisdom and Traditional Knowledge for Tsunami Disaster Resilience in the Coastal Areas of North Bengkulu and Mukomuko, Indonesia

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ABSTRACT

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local wisdom, traditional knowledge, tsunami resilience, exploratory Geographic Information System, WebGIS, North Bengkulu, Mukomuko

Local wisdom and traditional knowledge can strengthen community preparedness when they are documented carefully and integrated with appropriate disaster-risk information. This study identifies local practices related to tsunami resilience in 15 coastal villages in North Bengkulu and Mukomuko Regencies, Indonesia, and documents community-identified evacuation points through exploratory Geographic Information System (GIS) mapping. A descriptive qualitative design was used, combining observation, in-depth interviews, documentation, secondary data review, and spatial field records. The findings identify Tolak Bala, Kenduri Pantai, coastal conservation practices, and the local term “Beno” as important cultural and ecological resources. “Beno” describes an abnormal marine condition recognised through a sudden rise in sea level, unusually large waves, a distinctive humming sound, or, in some accounts, a major wave following a strong earthquake. Field coordinates, reported route distances, settlement context, and community-identified safe locations were organised in a GIS and displayed through a WebGIS research prototype. The spatial component is exploratory and does not constitute an optimised evacuation model because elevation, slope, tsunami inundation, walking time, road capacity, population exposure, and least-cost analysis were not assessed. The study shows that local knowledge can support culturally grounded preparedness, but formal hazard modelling, participatory validation, and intergenerational evaluation are required before the mapped routes or WebGIS are used operationally.

1. INTRODUCTION

Indonesia is highly susceptible to earthquakes and tsunamis because it lies near the active convergence of the Australian, Eurasian, and Pacific plates. The northward subduction of the Australian Plate beneath the Eurasian Plate forms a major seismic belt along Sumatra, Java, Bali, Nusa Tenggara, the Maluku Islands, and Sulawesi. This tectonic setting makes many Indonesian coastal regions, including Bengkulu Province, vulnerable to earthquake and tsunami hazards [1-3].

Tsunamis can cause severe loss of life, infrastructure damage, and long-term social disruption. Because the arrival time of a locally generated tsunami may be short, preparedness measures must combine scientific warning systems with knowledge that can be recognized and acted upon immediately by coastal communities [4, 5]. Historical records describe destructive earthquakes and tsunamis affecting Bengkulu in 1818 and 1833. The 1833 earthquake was estimated at magnitude 8.8 Mw and caused extensive damage across the region [6]. More recently, the 2007 Bengkulu earthquake, centered near Mukomuko Regency, caused fatalities, damaged public facilities, and generated a tsunami of approximately 40-100 cm along parts of the Mukomuko coast.

Local wisdom refers to values, knowledge, and practices developed through the long term experience of a community [7, 8]. Coastal communities may preserve environmental signs, oral narratives, land use practices, social rituals, and evacuation memories that support disaster preparedness. The well-known “smong” tradition of Simeulue, Aceh, shows how oral knowledge about strong earthquakes and receding seawater can encourage immediate evacuation to higher ground [9, 10]. Territorial knowledge and community memory can therefore complement scientific risk reduction measures [11].

Research increasingly emphasizes the integration of local and scientific knowledge in disaster risk reduction [12-15]. Such integration can make preparedness programmes more culturally meaningful and easier for communities to accept. However, local knowledge should not be romanticized or treated as a substitute for hazard assessment. Its meaning, transmission, current public understanding, and practical limitations must be examined transparently.

This study focuses specifically on 15 coastal villages in North Bengkulu and Mukomuko Regencies, rather than the entire coastline of Bengkulu Province. It has two objectives: (1) to identify forms of local wisdom and traditional

knowledge associated with tsunami preparedness; and (2) to document community-identified evacuation points and reported routes through exploratory Geographic Information System (GIS) mapping and a WebGIS research prototype. The spatial work is intended to organize and visualize field information. It is not presented as a fully optimized or operational evacuation route model.

This focus clarifies the contribution of the study: it documents how local cultural practices, oral terminology, environmental stewardship, and spatial memory may support disaster-risk communication, while also identifying the scientific and participatory validation required before operational use.

2. METHODOLOGY

The study used a descriptive qualitative design to document cultural practices, environmental knowledge, community narratives, and locally recognized evacuation locations. Observation, in-depth interviews, documentation, secondary

data review, and exploratory spatial mapping were combined to examine how coastal communities understand and respond to tsunami risk [14].

The fieldwork covered 15 coastal villages: six in North Bengkulu Regency and nine in Mukomuko Regency (Figure 1). Villages were selected through a preliminary survey using the following criteria:

1. Coastal proximity: The village directly borders the coastline or contains settlements exposed to coastal hazards.

2. Hazard relevance: Documented or locally reported exposure to the 2007 Bengkulu earthquake and tsunami, or location within a tsunami-prone coastal setting. References to a separate tsunami event in 2000 were removed because an authoritative supporting source was not available in the research records reviewed for this revision.

Remote sensing imagery and field observations were used to describe settlement proximity to the coast, coastal vegetation, open spaces, and the physical context of community-identified routes and assembly points. Figures 2-5 are descriptive spatial illustrations rather than outputs of a formal tsunami-inundation, network, or least-cost path model.

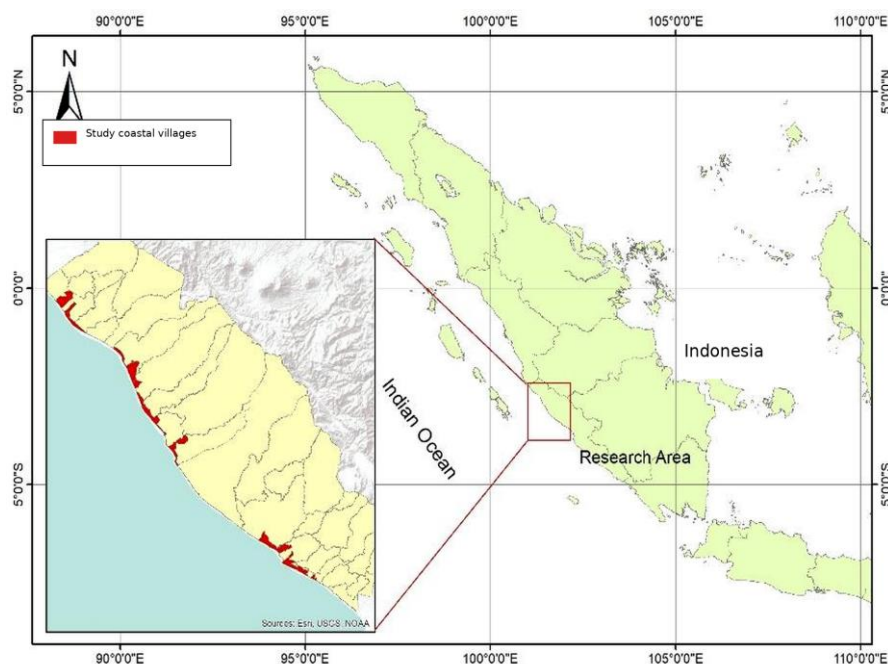


Figure 1. Study area in North Bengkulu and Mukomuko Regencies, Bengkulu Province, Indonesia

Source: Authors' compilation from the study's field coordinates and spatial basemap (Esri, USGS, and NOAA). The north arrow and geographic graticule provide orientation; the red coastal areas indicate the study villages.

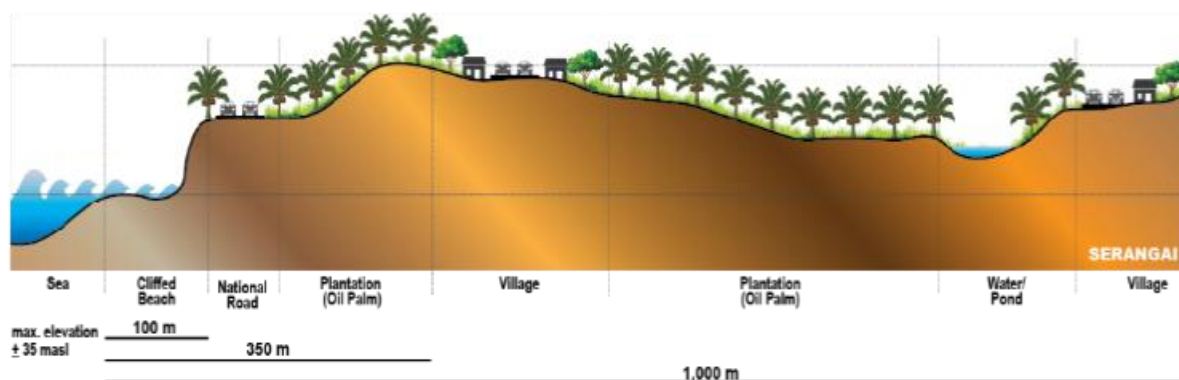


Figure 2. Schematic coastal profile of Serangai Village

Source: Authors' interpretation of satellite imagery and field observations. Horizontal distances are reported in meters.

2.1 Observation and in-depth interviews

The qualitative component involved 46 informants from the 15 study villages. Participants were aged 34-74 years and comprised 15 (32.6%) women and 31 (67.4%) men. Interviews were conducted between 8 August and 22 September 2025.

Initial informants were village heads or village officials. Snowball sampling was then used to identify customary leaders, community figures, fishers, and other residents with

knowledge of coastal traditions, tsunami experiences, environmental signs, and evacuation practices. The interview guide covered experiences of earthquakes and high waves; meanings and practices associated with Tolak Bala and Kenduri Pantai; the meaning and transmission of “Beno”; natural warning signs; coastal conservation; community responses during the 2007 event; traditional routes and safe points; and expectations for digital mapping.



Figure 3. Descriptive spatial illustration of Serangai Village

Source: Authors’ analysis of satellite imagery and field observations. White arrows and annotations show routes and distances documented during the field inventory.

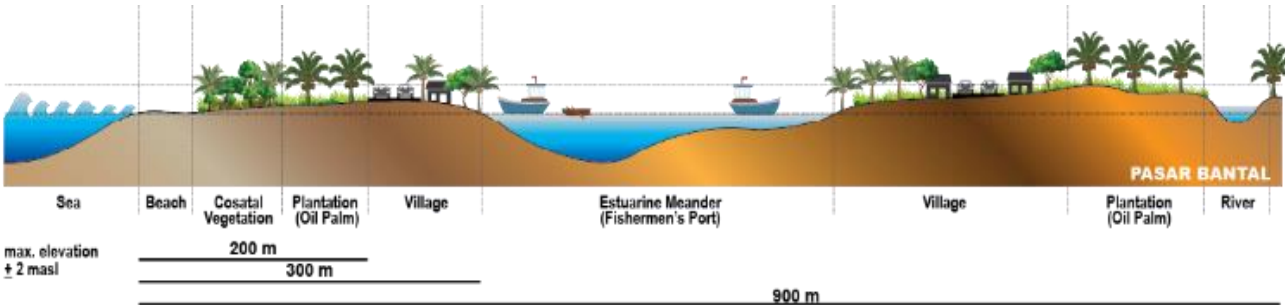


Figure 4. Schematic coastal profile of Pasar Bantal Village

Source: Authors’ interpretation of satellite imagery and field observations. Horizontal distances are reported in meters.



Figure 5. Descriptive spatial illustration of Pasar Bantal Village

Source: Authors’ analysis of satellite imagery and field observations. Labels identify the settlement, open area, vegetation, and reported distances.

Interview notes, recordings where available, photographs, and observation records were organized by village. The analysis combined deductive codes derived from the research objectives with inductive codes emerging from the interviews. Initial categories included ritual practices, ecological conservation, natural warning signs, local terminology, knowledge transmission, evacuation routes, assembly points, and institutional interaction. Related codes were compared across villages and grouped into the themes reported in Section 3.

Coding was conducted manually using a structure coding matrix in Microsoft Excel. Coding was conducted by one researcher. A second author reviewed the codebook and thematic summaries. Differences in interpretation were discussed until consensus was reached, ambiguous excerpts were re-examined and re-coded, and the codebook was revised where necessary. These details must reflect the actual analysis undertaken.

Triangulation was undertaken by comparing interview accounts with direct observation, village documents, agency records, photographs, coordinates, and reported route distances. Agreements and differences among villages were retained rather than forcing all accounts into a single interpretation. Data collection was considered sufficient when additional interviews no longer produced new categories concerning traditions, natural signs, ecological practices, or evacuation locations.

Before participation, the study purpose, voluntary nature of participation, use of quotations and photographs, and right to decline or withdraw were explained to each informant. Verbal informed consent was obtained before each interview and documented the field notes. Separate permission was obtained for audio recording, direct quotation, photography, and identification by name or official role. At the time of data collection, formal committee review was not required for this minimal-risk, non-interventional study under the applicable institutional procedure. The study nevertheless followed voluntary participation, informed consent, confidentiality, and the right to withdraw. Names and official roles are reported only where explicit permission to identify the participant was obtained.

2.2 Secondary data and literature review

Secondary data from relevant government agencies and village records were used to describe the research setting, identify tsunami-prone coastal villages, and support interpretation of the field findings. Previous studies were reviewed to provide conceptual and historical context for local wisdom, tsunami mitigation, and the integration of local and scientific knowledge. This component was a targeted literature and secondary-data review; it was not a PRISMA-based systematic review and did not involve formal database screening or quality appraisal.

2.3 Data extraction and qualitative analysis

Secondary records were reviewed first to identify the 15 coastal villages and to prepare the field instruments. Primary information from interviews, observations, and documentation was then summarized by village. The analysis focused on identifying recurring practices and differences in terminology, ritual timing, ecological rules, evacuation experience, and recognized safe locations.

Findings were interpreted descriptively and compared across North Bengkulu and Mukomuko. The qualitative themes were linked with the spatial inventory to examine how community knowledge is expressed through traditions, natural warning signs, assembly points, and reported evacuation paths.

2.4 Geographic Information System and WebGIS development

The spatial component documented locations identified by residents and village officials rather than calculating an optimal evacuation network. Inputs consisted of field coordinates, names and types of assembly points, reported route distances, observed or described paths, village and regency identifiers, photographs, settlement and coastline context, and notes from the interviews. Coordinates were checked for plausible placement against the satellite and topographic basemaps used in the study.

Each WebGIS point record contains a unique identifier, village, regency, latitude, longitude, assembly-point name or type, reported distance, descriptive notes, and a linked photograph where available. Point and route layers are displayed separately from the basemap. Routes are shown as polylines based on field observations and community descriptions; they are not generated through least-cost, network, or walking-time algorithms. Pop-up windows and a village list allow users to inspect each location and its attributes.

The prototype was developed using HTML, CSS, JavaScript, and Leaflet.js. OpenStreetMap was used as the primary basemap, with Esri Satellite, OpenTopoMap, and CartoDB available as alternative layers. Nominatim supported reverse geocoding. GitHub was used for version control and Vercel for deployment. Functional checks were conducted in Chrome, Firefox, and Edge to confirm that markers, pop-ups, layer switching, route display, and navigation controls loaded correctly.

No formal positional accuracy assessment, structured usability test, or participatory evaluation with residents or Regional Disaster Management Agency (BPBD) officers was conducted. The prototype should therefore be treated as a research and communication tool. Operational application requires validation with users and agencies, updated authoritative hazard data, and analyses of elevation, slope, tsunami inundation, road conditions, walking time, population exposure, route capacity, service areas, and least-cost paths.

3. RESULTS AND DISCUSSION

The 15 villages contain diverse traditions, ecological practices, oral histories, and evacuation memories. These forms of knowledge are not identical across locations, but they share an emphasis on social solidarity, environmental awareness, collective prayer, recognition of unusual marine conditions, and movement toward locally recognized safe places.

The villages included in the study are presented in Table 1. The historical impact field now refers only to the documented 2007 event; unsupported references to a separate 2000 tsunami have been removed.

3.1 Local wisdom and traditional knowledge of coastal communities

3.1.1 Tolak Bala and related coastal prayer traditions

Tolak Bala, Doa Pantai, Doa Muaro, and Tolak Bumi are locally used names for communal rituals intended to request protection, express gratitude, restore harmony, and strengthen social ties. Residents prepare the ritual site, organize offerings or communal meals, and conduct collective prayers. The process reinforces gotong royong, intergenerational participation, and awareness of the relationship between people and the coastal environment.

Table 1. Coastal villages included in the study

No.	Village	Regency	Coastline	Tsunami
1	Pasar Lais	North Bengkulu	3.01	-
2	Dusun Raja	North Bengkulu	2.65	-
3	Air Padang	North Bengkulu	2.44	2007
4	Bintunan	North Bengkulu	1.94	2007
5	Serangai	North Bengkulu	3.86	2007
6	Urai	North Bengkulu	7.87	2007
7	Air Rami	Mukomuko	6.36	2007
8	Air Buluh	Mukomuko	2.81	2007
9	Pasar Ipuh	Mukomuko	4.9	2007
10	Retak Hilir	Mukomuko	9.74	2007
11	Sinar Laut	Mukomuko	6.54	-
12	Pasar Bantal	Mukomuko	5.98	2007
13	Teramang Jaya	Mukomuko	6.89	2007
14	Koto Jaya	Mukomuko	12.99	2007
15	Bandar Ratu	Mukomuko	4.71	2007

In Serangai Village, the ritual is conducted on the first day of Muharram and supported by the village budget and community contributions. In Pasar Bantal, Doa Muaro was historically associated with a three-day customary prohibition on fishing and maritime activity. In Bandar Ratu, Doa Pantai is conducted after a disaster and functions partly as psychological and spiritual recovery. Air Rami, Teramang Jaya, and Koto Jaya maintain related practices under locally specific names.

These gatherings can provide culturally accepted opportunities for preparedness education, including recognition of natural warning signs, the location of assembly points, and immediate self-evacuation. However, ritual participation alone should not be interpreted as evidence of technical preparedness.

3.1.2 Kenduri Pantai tradition

Kenduri Pantai, also known as Kenduri Nelayan, is conducted as an expression of gratitude for marine livelihoods and safety. The practice involves communal prayer, food preparation, beach activities, and participation across social groups. It strengthens solidarity and can support environmental awareness through collective beach cleaning and the protection of coastal vegetation [16].

Air Buluh and Pasar Ipuh in Mukomuko, and Air Padang and Bintunan in North Bengkulu, maintain forms of this tradition. The Head of Bintunan Village, Amiril Mukminin

(70), explained that the event is generally held annually in July and includes communal prayer, the sacrifice of three chickens, and a shared meal. Preparedness messages may be incorporated into such established gatherings without replacing their cultural and religious meaning. Field photos taken by the author, documenting research interviews, are presented in Figures 6 and 7 below.



Figure 6. Field interviews used to document local traditions and tsunami-related knowledge
Source: Authors' field documentation.



Figure 7. Interview activity with coastal community representatives to explore the local tsunami term "Beno"
Source: Authors' field documentation.

3.1.3 Local tsunami terminology ("Beno")

"Beno" emerged as a locally meaningful but variably understood term associated with unusual marine conditions and large waves. The evidence comes mainly from village leaders and older community figures; the study did not measure how widely the term is understood among younger residents or across all households. It should therefore be treated as an important emerging finding rather than a uniform community-wide warning system. Nurdin, Head of Teramang Jaya Village, explained:

"Beno itu cerito dari jaman dulu. Kalau dulu itu, dak diandalkan dari gempo ajo, dari air pasang jugo. Itulah pasang beno. Kalau itu ado, itulah tando-tando pasang lebih besak dari sebelumnya. Biasonyo ombak 2 meter kini 4 meter, itulah beno suaronyo bedengung."

Translation: "Beno is a story from the past. Previously, people did not rely only on an earthquake but also on an unusual tide called pasang beno. It indicates a tide larger than usual. Waves that are normally about two meters may reach four meters, accompanied by a distinctive humming sound."

Munzilin, Head of Pasar Bantal Village, emphasized the sudden and unusual rise in sea level:

"Beno tuh air laut mendadak naik, dulu tuh ado cerito berkembang terkait beno. Air lautnya naik tapi dakdo ganas,

cumo air pasang tuh mendadak naik ajo."

Translation: "Beno is a sudden rise in seawater. Stories about beno have circulated for a long time. The water rises, although it is not always violent; the important feature is that the rise occurs suddenly."

Putra Andeka, Head of Retak Hilir Village, stated that "Beno" or "Geno" may also be used for a tsunami following a major earthquake. Across the three villages, the term is distinguished from an ordinary high tide by its sudden onset, abnormal magnitude, unusual sound, and, in some accounts, association with a strong earthquake. Ordinary tides are understood as regular and expected coastal fluctuations, whereas beno is described as exceptional and potentially dangerous.

Oral narratives from Teramang Jaya link the origin of beno knowledge to stories transmitted since the 1883 Krakatau

eruption. This historical association was not independently verified through archival evidence and is therefore reported as community oral history. The comparison with "smong" in Simeulue is useful because both terms transform disaster memory into communicable warnings, but their specific signs, social transmission, and current levels of understanding differ [10]. Intergenerational interviews are required to determine how widely beno is understood today.

The findings indicate that local wisdom in North Bengkulu and Mukomuko is expressed through ritual, oral terminology, environmental stewardship, social organization, and spatial memory. Data regarding the types of local wisdom in the 15 research villages are presented in Table 2. These forms of knowledge vary among villages and should be interpreted as context-specific resources rather than as uniform warning systems.

Table 2. Forms of local wisdom documented in the study villages

No.	Village	Local Wisdom
1	Pasar Lais	Tradition of visiting ancestral graves (<i>makam puyang</i>)
2	Dusun Raja	<i>Gandai</i> Dance and <i>Berarak Petang</i>
3	Air Padang	Coastal preservation (maintaining coastal vegetation)
4	Bintunan	<i>Kenduri Pantai</i> Tradition
5	Serangai	<i>Kenduri Pantai</i> Tradition
6	Urai	Coastal preservation (maintaining coastal vegetation)
7	Air Rami	<i>Sedekah Tolak Bala</i> Tradition
8	Air Buluh	Coastal preservation (maintaining vegetation and prohibition on cutting coastal trees)
9	Pasar Ipuh	<i>Doa Pantai</i> Tradition
10	Retak Hilir	<i>Kenduri Nelayan</i> Tradition
11	Sinar Laut	<i>Kenduri Pantai</i> Tradition
12	Pasar Bantal	<i>Sedekah Tolak Bala</i> Tradition
13	Teramang Jaya	Nature Conservation (Turtle Conservation)
14	Koto Jaya	<i>Doa Muaro</i> Tradition (<i>Tolak Bala</i>)
15	Bandar Ratu	<i>Sedekah Tolak Bumi</i> Tradition (<i>Tolak Bala</i>)
		Coastal preservation (maintaining vegetation and prohibition on cutting or damaging coastal trees)
		<i>Sedekah Doa Pantai</i> Tradition (<i>Tolak Bala</i>)
		<i>Sedekah Doa Pantai</i> Tradition (<i>Tolak Bala</i>)

3.2 Community-identified evacuation points and exploratory route mapping

Residents and village officials identified locations regarded as safer during strong earthquakes, high waves, or tsunami warnings. These locations include fields, plantations, schools, public offices, cemeteries, hills, and road junctions. Some points have also been recognized or adapted by government agencies. Their value lies in familiarity and community acceptance, but their safety cannot be confirmed from local knowledge alone.

Table 3 records coordinates, place names, and route distances collected during the field inventory. Distances are descriptive values reported in the original manuscript and are

not walking-time estimates. The mapped lines show observed or described paths; they do not represent optimal routes generated from a road network, digital elevation model, inundation surface, or least-cost algorithm.

The coordinate and distance inventory is useful for documenting community knowledge and identifying locations for further assessment. Before any point is formally designated as safe, it should be evaluated against authoritative inundation maps, elevation and slope data, route condition, accessibility for children, older adults and persons with disabilities, travel time, expected population demand, and the capacity of the destination. This need for route-specific spatial assessment is consistent with previous tsunami evacuation-route research [17-20].

Table 3. Community-identified assembly points and reported route distances

Village Name	Traditional Assembly Point		Distance from Village (km)	Location Photo
	Coordinates	Name		
Pasar Lais	3°31'44"S 102°02'57"E	Field Area (<i>Lapangan</i>)	0.831	
Dusun Raja	3°31'26"S 102°02'20"E	Plantation Area (<i>Perkebunan</i>)	Route 1 (0.930)	
			Route 2 (0.840)	
			Route 3 (0.996)	

Air Padang	3°30'12"S 102°00'05"E	Evacuation Shelter (PRM)	0.842 km	
Bintunan	3°29'28"S 101°58'54"E 3°28'26"S 101°56'50"E	PT. Agro Perak Air Lakok	1.747 km 4.847 km	   
Serangai	3°25'15"S 101°53'47"E 3°25'06"S 101°53'46"E	Rubber Plantation Public Cemetery (TPU)	0.820 km 1.821 km	   
Urai	3°24'19"S 101°51'55"E 3°23'29"S 101°51'20"E 3°23'05"S 101°50'44"E	Simpang Satu Lubuk Balam Bukit Tarikan	1.893 km 0.103 km 0.096 km	   
Air Rami	3°06'43"S 101°31'58"E 3°06'24"S 101°32'22"E 3°05'27"S 101°32'01"E	SMP N 20 Mukomuko Bukit Mulya Village Hall Hill near Cemetery	0.851 km 1.855 km 1.014 km	   
Air Buluh	3°03'35"S 101°30'52"E 3°03'03"S 101°30'17"E	Ex-Transmigration Land Bedeng Bata	0.802 km 2.201 km	  
Pasar Ipuh	2°59'13"S 101°29'39"E	SMAN 02 Mukomuko	3.597 km	
Retak Hilir	2°57'47"S 101°27'53"E	Plantation (<i>Kebun</i>)	2.138 km	
Sinar Laut	2°51'52"S 101°23'31"E 2°52'07"S 101°26'07"E 2°53'31"S 101°26'53"E	Air Hitam PT. GGS 1F (Mekar Sari)	2.150 km 9.816 km 12.940 km	

Pasar Bantal	2°45'39"S 101°20'24"E 2°43'53"S 101°21'54"E	Mandi Angin PT. Agro Muko Bunga Tanjung Estate	1.436 km 5.895 km
Teramang Jaya	2°46'31"S 101°23'40"E 2°45'39"S 101°20'24"E	Air Bikuk Mandi Angin	7.296 km 3.897 km
Koto Jaya	2°35'24"S 101°07'36"E	Koto Jaya Sub-district Office	1.701 km
Bandar Ratu	2°33'11"S 101°06'13"E	Mukomuko Regent's Office	2.722 km

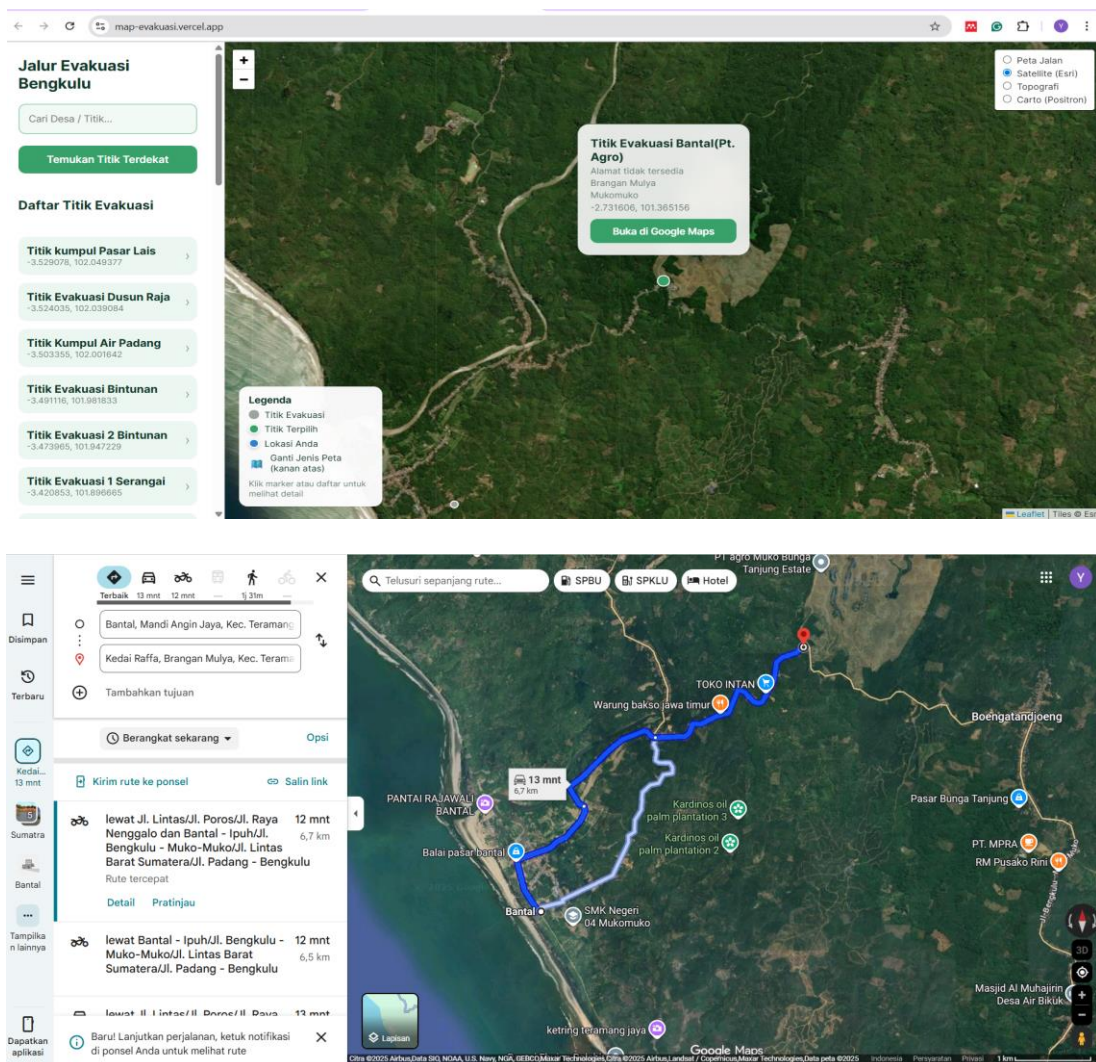


Figure 8. WebGIS prototype showing mapped assembly points, attribute pop-ups, and a displayed route
Source: Authors' WebGIS prototype. Route lines visualize field-documented paths and are not least-cost or walking-time solutions.

3.3 WebGIS research prototype

The WebGIS prototype translates the field inventory into an interactive map that displays villages, community-identified assembly points, descriptive attributes, photographs, and route lines. Users can select a village, inspect a point, switch basemaps, and view the route representation. The interface supports documentation and communication of local knowledge, but it does not provide real-time hazard forecasting or automatic emergency navigation.

The spatial data are organized into point, route, and basemap layers. Each point contains the village name, coordinates, assembly point description, reported distance, notes, and a photograph where available [21]. Route lines visualize field-observed or community-described paths and are not generated by a least-cost or walking time algorithm. The results of the evacuation route mapping at one of the study sites are presented in Figure 8.

Browser-based functional checks confirmed that markers, pop-ups, village selection, layer switching, route display, and navigation controls loaded as intended in Chrome, Firefox, and Edge. However, no structured user testing was undertaken with residents, vulnerable groups, or BPBD officers, and no formal positional-accuracy assessment was conducted. Participatory validation is therefore required before operational use.

3.4 Synthesis: Local wisdom as a dynamic but context-specific resource

The findings show that local wisdom in North Bengkulu and Mukomuko is expressed through ritual, oral terminology, environmental stewardship, social organization, and spatial memory. These elements can strengthen preparedness because they are embedded in familiar community practices. Integrating them with scientific information can improve communication and local acceptance [15].

At the same time, the evidence does not support treating all traditions as direct early warning mechanisms or all community-identified points as technically safe. The most appropriate role of local knowledge is as a context-specific source of meaning, memory, and practical experience that should be examined together with hazard modelling, infrastructure assessment, inclusive evacuation planning, and agency coordination.

3.5 Study limitations

First, the informants were mainly village leaders, customary figures, and community representatives. The study did not systematically compare understanding across age groups, genders, occupations, or household types. The intergenerational reach of “Beno” and other traditions therefore remains uncertain. Second, the historical connection between beno and the 1883 Krakatau eruption is based on oral history and was not independently verified through archival research. Third, the spatial analysis is exploratory and excludes Digital Elevation Model (DEM) elevation, slope, modelled inundation, road-network analysis, walking time, population exposure, route capacity, service areas, and least-cost paths. Fourth, the WebGIS has not undergone formal positional accuracy assessment or structured evaluation by residents and BPBD officers. These limitations restrict the

operational interpretation of the results and define priorities for future research.

4. CONCLUSIONS

This study documented local wisdom and traditional knowledge in 15 coastal villages in North Bengkulu and Mukomuko Regencies. Tolak Bala, Kenduri Pantai, environmental conservation practices, and the local term “Beno” contribute to social cohesion, environmental awareness, disaster memory, and recognition of unusual marine conditions. Their meaning and continuity vary among villages and should not be assumed to be uniform across generations.

Community-identified assembly points and reported routes were organized through exploratory GIS mapping and a WebGIS research prototype. These outputs preserve and communicate local spatial knowledge, but they are not validated operational evacuation plans. Safe and inclusive route designation requires integration with tsunami inundation modelling, elevation, slope, road and walking time analysis, population demand, destination capacity, and participatory validation with communities and BPBD.

Local wisdom is therefore best understood as a dynamic, context-specific foundation for dialogue between communities, scientists, and disaster management institutions. Its value lies not in replacing scientific assessment, but in making preparedness more culturally grounded, socially accepted, and responsive to local experience.

ETHICS STATEMENT

The final submission must report the verified consent and ethics procedure: Under the institutional procedure applicable at the time of data collection, this minimal-risk, non-interventional study did not require formal committee review. Participation was voluntary, verbal informed consent was obtained, and identifiable quotations and photographs were used only with explicit permission.

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DATA AVAILABILITY

The identified qualitative summaries and spatial records may be made available subject to participant consent and institutional requirements. The qualitative data are not publicly available because the consent obtained from participants did not include open data sharing. Aggregated and the identified information may be provided by the corresponding author where ethically and institutionally permissible.

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