



## Livelihood changes in Banda Aceh, Indonesia after the 2004 Indian Ocean Tsunami



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### ABSTRACT

The 2004 Indian Ocean Tsunami disaster heavily affected Indonesia, particularly Aceh Province, leaving devastating impacts to people and their livelihoods. The tsunami wiped out coastal areas, causing permanent land loss and destroying aquaculture ponds and mangrove forests. This resulted in disruption in the community's sources of income, especially to those who rely on aquaculture activities as well as on gathering resources from the sea. This paper analyses households' livelihood changes in Pande Village, Banda Aceh City by assessing livelihood assets before, immediately after, and 12 years after the 2004 Indian Ocean Tsunami disaster in Indonesia. Data from 77 households were collected in a survey conducted in September 2016. This study tracked the changes in the human, financial, physical, natural, and social assets of the households to understand how these changes led to livelihood outcomes and eventually to disaster recovery. One of the findings is that the destruction of aquaculture ponds and mangroves significantly reduced the potential of reviving livelihoods that were mainly relying on coastal resources. As a consequence, households took up non-aquaculture livelihood activities, such as going into business, driving rickshaws, and providing manual labour, to support their family.

## 1. Introduction

### 1.1. Background

On December 26, 2004 a magnitude 9 earthquake hit the west coast of Sumatra Island in Indonesia causing powerful tsunami waves with speed up to 800 km per hour hitting the coasts of Indonesia, Sri Lanka, India, Thailand, Somalia, Myanmar, Maldives, Malaysia, and some other countries [44]. Indonesia was by far the worst affected country with an estimated total damage of USD 4.5 billion, 167,052 people killed, and 590,684 individuals further affected [21]. As for the public sector, 669 government buildings, 517 health facilities, and hundreds of education facilities became non-functional. Infrastructures were also gravely affected where over 3000 km of roads, 14 seaports, 11 airports, and 120 bridges were damaged [6,4]. Livelihood activities were impossible to continue due to the severe damages to transport vehicles and to roads. Additionally, the broken supply chain was unable to resume operations due to loss of lives of workers as well as survivors being occupied by efforts of ensuring the safety of their kin. The massive damage also disrupted telecommunications which made it harder to provide immediate assistance to affected villages in Aceh [30]. Around 78% of the destruction fell upon the private sector in Aceh where 139,195 homes were destroyed or severely damaged, 73,869 ha (ha) of

productive land were destroyed, 13,828 of fishing boats were lost, 27,593 ha of aquaculture ponds vanished, and 104,500 small and medium-sized enterprises (SMEs) were wiped out by the disaster [7]. For the environmental part, as much as 16,775 ha of coastal forests and mangroves as well as 29,175 ha of reefs were lost. The total estimated damage and loss is about 97% of Aceh Province's GDP [8]. Many of the livelihoods of the households were severely affected. Socio-economic activities were paralysed as thousands of hectares of land were swept away by the tsunami. The tsunami affected coastal communities that rely on natural resources for their livelihood [26,47]. The most impacted sector in terms of both number of deaths and capital destroyed was agriculture, particularly the fishery sector [40]. The Ministry of Marine Affairs and Fisheries confirmed the demise of about 55,000 fishermen and aquaculture workers and another 14,000 more were reported missing. The combined figure of workers in both categories made up half of the total fishermen population in Aceh. About 40–60% of the aquaculture ponds located along the coastal areas in Aceh were heavily damaged. Besides that, about 66–70% of small-scale fishing fleet and equipment were destroyed as well [14]. Due to the vast extent of devastation, the ability of households to continue their previous livelihood was reduced and resulted in forcing many households to change their livelihood.

The Government of Indonesia established a coordinating agency

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called Agency for the Rehabilitation and Reconstruction of Aceh and Nias (BRR), in April 2005 to restore livelihoods and to reconstruct the communities through community-driven reconstruction approach and development programs. The Earthquake and Tsunami Emergency Support Project (ETESP) by the Asian Development Bank (ADB) provided USD 290 million grant for the Asian Tsunami Fund for Indonesia's disaster management, reconstruction, and rehabilitation work. ETESP ran from 2005 to 2010 and covered multisectoral projects under five principal sector groupings: (a) restoring livelihoods, (b) social security provisions, (c) building community infrastructures (which included housing program, water, and sanitation), (d) building physical infrastructures, and (e) fiduciary governance [41]. Nazara and Resosudarmo [30] summarised that the rehabilitation of livelihood process first started with the restoration of the heavily damaged agriculture and fisheries sectors. Agricultural and plantation land were revitalised, ports were rebuilt, and fishing equipment was replaced. Financial assistance was provided in the form of microcredit for affected SMEs. Lastly, employment programs were launched through Cash-for-Work (CFW) and training programs [6].

The concept of livelihood is useful when investigating the impacts of a disaster because it helps to describe how people draw on different resources or assets and transform them into usable goods to respond to and cope with shocks [2]. In the 'Build Back Better' concept, livelihood is considered as one of the critical aspects aside from safety and security [24]. Jayasuriya and McCawley [23] also emphasised the importance of the economic rebuilding process immediately after a disaster which includes livelihood restoration. Many academic studies related to livelihoods took place in the tsunami-affected countries. Some discussed the impacts of the disaster on households' physical assets, social capital, and human capital [31,33] and on fishermen and aquaculture farmers [31,9]. Other research focused on the functionality of microfinance [35], on the vulnerability of coastal households [25], on assessing CFW programs [12], and on gender-related livelihood strategies [36]. In Aceh Province, the disaster recovery assistance prioritised and focused mainly on housing reconstruction while livelihood restoration was given lesser attention. The Fritz Institute [15] found out that the livelihood restoration programs did not get a high satisfaction score from the beneficiaries. The phenomenon could be attributed to insufficient fund allocation and to the lack of livelihood expertise [24,42]. The need for livelihood assistance is vital to ensure livelihood security in the aftermath of disasters [33,45].

1.2. Objective

The objective of the paper is to examine the household's livelihood changes by assessing livelihood assets after the 2004 Indian Ocean Tsunami (IOT) disaster in Banda Aceh, Indonesia. An in-depth study on livelihood changes of disaster-affected households, particularly looking at their assets, has not yet been conducted. It is important to know how a household's livelihood progresses after a disaster and the various livelihood schemes that influence the beneficiaries of livelihood

assistance to retain or change their livelihood [45]. The assets owned by a household are used as the means of living and to build a satisfactory living environment in the context of interacting with vulnerability [38]. Households rely on their own available assets or on the assets of the community when dealing with vulnerabilities [13]. The combination of personal and community assets can also improve household's resilience to disasters [22]. Two important questions were tackled in the study:

1. How did the 2004 Indian Ocean Tsunami disaster impact the livelihood of households, particularly their assets (human, financial, physical, natural, and social)?
2. What is the households' livelihood situation 12 years after the tsunami disaster?

1.3. Structure of paper

This paper is organised as follows. Section 1 gives a brief overview of the impacts of the 2004 IOT disaster in Aceh Province, Indonesia. Section 2 describes the conceptual framework used in the study. The methodology is outlined in the Section 3 with details of the study area, field research, and analysis. Section 4 shows the findings which are split into three time periods: before the disaster, immediately after the disaster, and 12 years after the disaster. The discussion and the limitations of the study are in Section 5. Conclusions are presented in the final section.

2. Conceptual framework

The 2004 IOT wiped away shorelines, aquaculture ponds, estuaries, and coastal vegetation, such as mangroves, which protected the village from erosion, strong winds, and waves. These changes had directly impacted on the households' assets, forcing households to abandon their previous livelihood activities as part of their coping strategies. With the permanent loss of aquaculture land and mangroves, households had to change or diversify their livelihood assets and opt for new livelihood activities. As illustrated in Fig. 1, the disaster's impacts on the household's livelihood assets during the transition period (immediately after and current condition) included changes in the human assets (household size and age of the members, education, and health), financial assets (occupation, total household income, and other financial resources), physical assets (house, other household assets, and public facilities), natural assets (aquaculture ponds and mangrove), and social assets (local community participation, relationship with village leader, local government and local community, and trust among neighbours). The current condition of the household represents the livelihood outcome achieved by the households based on the livelihood assets created from the processes. In this study, the primary focus is on the disaster impacts on the households' livelihood and on the changes in household livelihood assets.

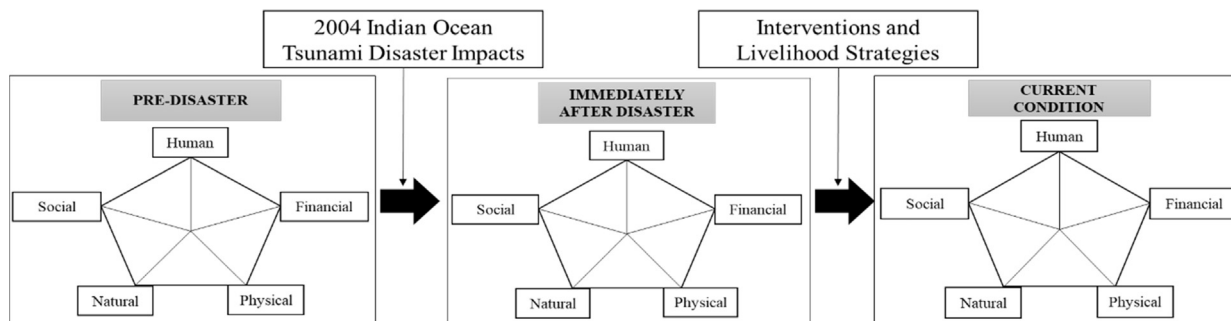


Fig. 1. Framework for monitoring post-disaster livelihood asset changes.

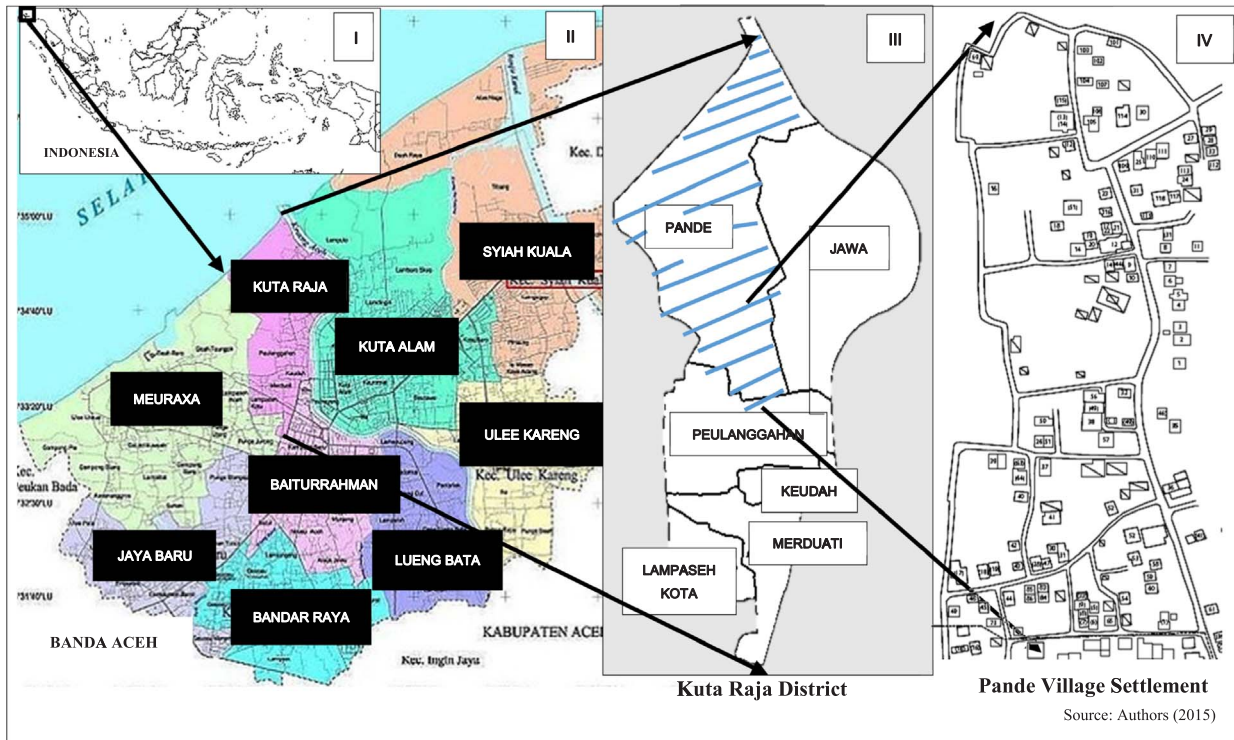


Fig. 2. Location of Pande Village.

### 3. Methodology

#### 3.1. Study area

For this study, the researchers purposively selected a village called Pande (Fig. 2) in Banda Aceh, which is located on the coastal tip of Sumatra Island adjacent to the Indian Ocean. This location is prone to tsunami because of its proximity to the zone where the Indo-Australian and Euroasia plates collide. Pande was heavily devastated by the 2004 IOT disaster (Fig. 3). The disaster killed 70% of Pande's total population and made geographical changes which had drastically changed the livelihood of the villagers.

The population of Pande as of August 2016 is 860 people, of which 450 are males and 410 are females [18]. There are about 251 households in Pande's four hamlets. The population density in Pande is 85 person per km<sup>2</sup>. Pande is situated 2.2 m above sea-level. Three-quarters of the residents are non-original residents who came to the village through marriage or house rental after the reconstruction period ended.

From the 251 households in Pande, there are 101 poor households, of which 29 are extremely poor households earning IDR (Indonesia Rupiah) 450,000 (USD 33) and 73 are poor households earning between IDR 450,000 and IDR 900,000 (USD 67) monthly [18]. As of 2016, only 3.5% of Pande's population is unemployed [18].

#### 3.2. Data collection

Our study investigated the households' livelihood changes through the administered questionnaire survey based on the list of component factors of the livelihood assets in Table 1. The fieldwork was carried out four times between September 2015 and March 2017. During this period, 100 households were selected using convenience sampling and 77 valid responses were obtained. As the survey took place during working hours on weekdays as well as during Eid Adha, a Muslim holiday, data were collected from households who were available to participate in the study.

The research is mainly a cross-sectional study employing mixed



Fig. 3. Changes in Pande Village seen from satellite imagery taken before and after the 2004 Indian Ocean Tsunami Disaster (Source: JICA and Development Planning Agency of Banda Aceh, 2016).



**Table 1**  
Component factors of the livelihood assets, as used in this study.  
Source: Compiled by the authors

Capital	Factor	Explanation	Reference
Human	Household size and age of members	Number of family members	[17]
		Percentage of adults in household	[32]
	Education	The age of the household head	DFID [48]
		Percentage of adults with or without education	
Health	Percentage of population having illness	[27]	
		DFID [48]	
Financial	Occupation	Farm/non-farm type	DFID [48]
	Total household monthly income	Monthly income generated from all activities	DFID [48]
	Other available financial resources	Microcredit existence	DFID [48]
			[27]
Physical	House	Ownership of house	DFID [48]
			[29]
	Other household assets	Assets that can improve livelihood	DFID [48]
			[29]
Public facilities	Availability and condition of infrastructure to conduct livelihood activities	[46]	
		[16]	
Natural	Aquaculture ponds	The size and style of productive ponds that support livelihood activities	[1]
	Mangroves	Mangrove area size and functionality	DFID [48]
Social	Participation in local community activities	Involvement and relationship among villagers	[20][29]
	Relationship with higher authorities	Relationship with village leader, local government, and community	[20][27]
	Trust among neighbours	Letting their children to be watched over and taken care of by the neighbours should there be any emergency	DFID [48]
			[20][28]
			[11]

\*For relationship with higher authorities, scale used is '1' for very dissatisfied, '2' for dissatisfied, '3' for satisfied, and '4' for very satisfied.

\*For trust, scale used is '1' for not at all, '2' for not so much, '3' for fairly yes, and '4' very much.

methods to collect quantitative and qualitative data. Apart from the survey, the researchers also conducted five in-depth case studies, one informal group discussion, and a series of 15 semi-structured interviews which included the key informant, the elderly, village leaders, livelihood beneficiaries, and an archaeologist to understand the livelihood recovery experience of disaster-affected households thoroughly. Data were collected until information was saturated. Our study also adopted participatory observation to study the housing condition, natural environment, and village life to add more information to the dataset. Secondary data related to livelihood such as those from literature reviews, Pande Village Medium Term Development Plan (GPMDP), journals, reports from the international and local organisations, statistical data, and books from relevant sources were also collected. For the convenience and correct understanding of the survey respondents and interviewees, questions were prepared in Bahasa Indonesia. The first author conducted the face-to-face surveys and interviews in the field with the assistance of trained local university students.

Quantitative data were subjected to descriptive statistical analyses while qualitative data were later processed using Microsoft Excel. The interviews which were recorded through written notes and audio recordings were transcribed, coded, assigned to different themes, and summarised.

## 4. Research findings

### 4.1. Human capital

#### 4.1.1. Pre-tsunami

The pre-tsunami population of Pande was 1199, of which 689 were males and 510 were females (Kecamatan Kuta Raja Dalam Angka 2005, 2005). Due to the data loss caused by the disaster, the researchers were not able to obtain other socio-demographic data (e.g., education and health) of Pande's households before the disaster.

#### 4.1.2. Immediately after the tsunami (relief period)

The Gampong Pande Plan List after the Tsunami (2005) stated that the number of Pande residents who survived the tsunami was at 254 (175 males, 81 females). 74% of the male residents and 84% of the female residents perished from the tsunami and 79% of Pande's total population were killed. Schools were among the facilities destroyed by the disaster. Children returned to school within two months after the disaster. Classes took place in tents. Some children attended schools in a different area.

#### 4.1.3. Current condition (12 years after the 2004 IOT disaster)

From our survey of 77 households, 31% have a family size of up to three members, 48% have 4–5 family members, and 21% have more than six family members. The average family size in Pande is four, with two adults and two children per household. 79% of the households surveyed stated that they had experienced at least one or more deaths in the family due to the 2004 IOT disaster. The reduced household size decreased the number of available labour which consequently reduced the number of livelihood activities the household engaged in. The present study reveals that majority of the respondents were women (65%). Most of the respondents (96.1%) were in the productive age group which ranges from 15 to 65 years. The average age of the household head was 41 years old.

In terms of education level, we also found out that 54% of the total population in Pande either did not attend school at all or did not complete elementary school or high school while 37% had finished at least high school. Additionally, the labour quality in Pande is good as most of the villagers are healthy and able to work. From the secondary data, only 0.3% of the residents suffer from contagious illnesses. Households in Pande have access to healthcare in their village as there is a healthcare centre which conducts health-related activities for the well-being of the villagers.

### 4.2. Financial capital

#### 4.2.1. Pre-tsunami

From our interviews, the main livelihood of majority of the residents of Pande was aquaculture farming. Villagers also depended on natural resources, particularly mangrove for traditional cigarette production, and conducted fishing activities [according to respondent 1 (R1) and respondent 9 (R9)]. We also found out that before the disaster, 8% of the households were earning less than IDR 500,000 (USD 37), 17% were earning between IDR 500,001 and IDR 1000,000 (USD 37 to USD 74), 42% were earning in the range of IDR 1000,001 to IDR 3000,000 (USD 74 to USD 223), and 6% were earning more than IDR 3000,001 (USD 223) (Fig. 4). Our group discussions revealed that villagers drew on informal credit from better-off local villagers who were intensive pond proprietors with working capital and an established market. The availability of financial resources such as credit at the local level and bank facilities was infeasible before the tsunami as the villagers did not require such services previously.

#### 4.2.2. Immediately after the tsunami (relief period)

Due to the loss of aquaculture pond land and mangroves, employment opportunities were significantly reduced. The loss of aquaculture

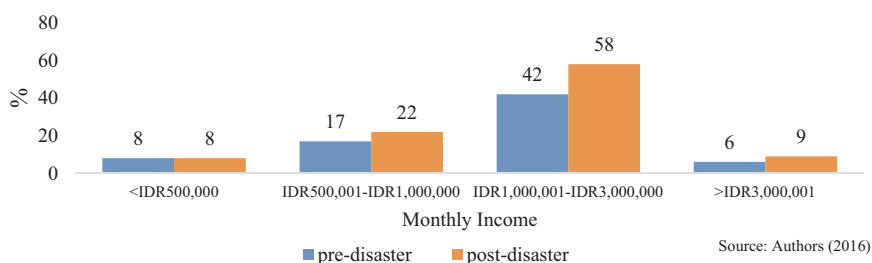


Fig. 4. Monthly household income in Pande before and 12 years after the disaster (N=77).

resources also reduced the percentage of people with an income. Livelihood activities were disrupted as supply chains were interrupted and networks were broken off due to the high number of deaths in the fisheries sector. Those who were working in the government resumed their work immediately after the disaster and their financial situation was secured. However, households depending on agriculture activities and other side jobs lost their income completely. Donors from many countries stepped in and enormous aid came in covering from cash to basic daily necessity. Some residents mentioned that they do not even need to work as everything was being provided by the donors. [R9] recalled that the food aid lasted from 2005 till to 2008 and people were having an easy life as the food supply was abundant and constantly available. The food aid supported household's livelihood and their assets such as children's education and roads condition.

According to our survey results and in-depth interviews [with R9, R10, and R11], Pande residents participated in the temporary CFW program sponsored by a relief organisation to clean up their village. The program provided the residents with a regular income for about two to three months after the disaster. There were also residents who could go fishing in the sea by borrowing or sharing fishing gears or by scouting for smaller fish, crab, and prawn in the remaining ponds, canals, and mangrove areas. The CFW program offered a minimum daily wage of IDR 50,000 which was equivalent to USD 5 at that time. Cash was preferred over food immediately after the disaster and the average monthly household income in Banda Aceh was USD 297 with 93% of it coming from CFW programs [12]. The amount of wage paid depended on the type of work, the skills required to accomplish the work, and the number of working hours. Tasks included removing and burying corpses, clearing debris, cleaning houses and public facilities such as roads and drains, constructing temporary shelters, etc. CFW was an important source of income for the disaster-affected households. People were back to work within a year after the disaster happened. However, household income did not necessarily return to their pre-disaster level. We also found out that the informal financial resource in Pande was weakened due to the deaths of the proprietors and loss of existing capital. Households had barely enough to cover their daily expenditure to enable them to save. Hence, microcredit was offered by the NGOs to reduce poverty and vulnerabilities to disasters by providing a quick relief while simultaneously supporting livelihood recovery.

#### 4.2.3. Current condition (12 years after the 2004 IOT disaster)

After the restoration period ended in 2010, Pande residents started to look for jobs that could offer them stability in the longer term. They also began to take up additional jobs and spent lesser time in the ponds or the sea. Our survey revealed that there were 14 different jobs during pre-tsunami period, eight different jobs immediately after the tsunami, and 20 different jobs in the post-tsunami period among the 77 households surveyed. The most common jobs post-tsunami were trading (11.5%), fishmongering (9.8%), and civil service (8.1%). Our survey also found out that there was a decrease in the number of brackish shrimp aquaculture farmers from 3% to 1% and fishermen from 6% to 3% (Fig. 5). Pond owners who suffered a total loss of their aquaculture pond diversified their livelihood by securing themselves a new type of job. Others intensified their strategies by buying over other people's

aquaculture pond and working on the pond themselves. Some of the aquaculture farmers decided to work on their aquaculture pond on a part-time basis and took up another job such as becoming a *becak* driver, casual labourer for aquaculture pond, or crab seller or taking care of other people's livestock. Household members improved their livelihood with the skills and training they received during the reconstruction period. With their own savings they were able to establish small businesses. Additionally, households also relied on their gold stocks and properties such as pieces of land outside Banda Aceh. They would put land on lease for some years during desperate times. In the worst scenario, they would sell land to generate income.

Former fishermen also mentioned that the amount of catch is less now compared to before the tsunami. Due to more frequent bad weather, fishermen are unable to fish and there is less available fish stock in the sea. The expense incurred in going out to the sea has also sharply risen. Fishing expenses such as for renting boat, engine, and nets would require a substantial capital. However, they could not fork out the initial amount.

From our survey, households reported earning an average of IDR 1515,065 (USD 112) per month, with the lowest income at IDR 500,000 (USD 37) and the highest at IDR 4000,000 (USD 295). 67% of the households in Pande earned slightly lower than the 2016 Aceh Province's minimum wage, IDR 2118,500 (USD 157) [10]. Households of poor category and below receives a support payment of IDR450,000 (USD 34) for one child's school expenses once in every two years. Almost half of the surveyed households stated that there was no change in their financial situation after the disaster. Households reported that their expenditure also went up with additional family members and with increased prices of commodities. Expenditures for children's education, food, and bills were regarded the highest priority. From the survey, some of the households were found to have also conducted extra livelihood activities such as running an online business (e.g., selling baby clothes, dresses, *mukenah* (female praying garments), and shawl).

After the reconstruction period had ended, financial assistance for livelihood such as supporting business start-ups was introduced in Pande. However, we found out that the support stopped when funds ran out after a few years. The projects were not sustained partly due to lack of monitoring and evaluation conducted by the donors. Below is an insight from one of the recipients who mentioned that the support was unsustainable due to clashes among the business start-up group members.

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The *kue* (snack) group did not last long and failed. There were many problems. Some of the members who received the funds were dishonest. The women were eventually worn out and lost interest. There were too many opinions, too many differences among them which raised conflicts and led to the disbandment of the group [R10, R11].

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Problems also surfaced because there was lack of assessment and background check by the donors on the interest of the beneficiaries. Our survey found out that households participated in the financial support

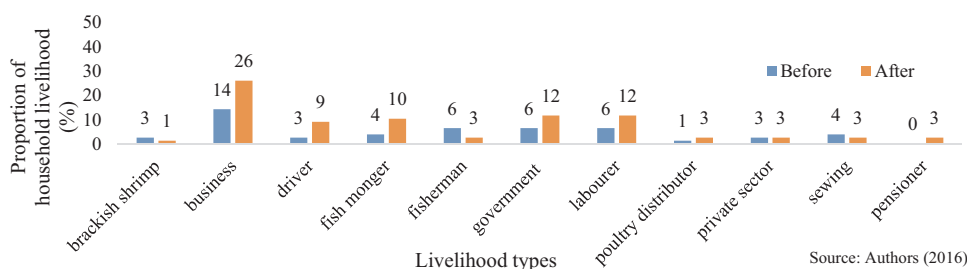


Fig. 5. Changes in livelihood in Pande after the 2004 tsunami disaster (N=77).

**Table 2**  
Aid received by residents of Pande.  
Source: BRR and GTZ, 2007 [5]

Types of Aid	Donor
1 Village mapping	Centre for Local Government Innovation
2 Village planning	USAID/PT Wastuwidyawan (local partner)
3 Spatial planning	GTZ-SLGSR
4 Housing (153 units)	ADB ETESP Housing
5 Supervision of reconstruction works	Transparency International Indonesia
6 Construction of health centre	Merlin (UK-based NGO)
7 Clean water supply and groceries	World Vision
8 Aquaculture	ADB ETESP <sup>a</sup> Fisheries
<ul style="list-style-type: none"> <li>● pond rehabilitation</li> <li>● agro-input (milkfish)</li> </ul>	
9 Business start-up support – young livestock; goat	Department of Agriculture
10 Women’s group/female-headed household economic empowerment	Betaco Family Group
11 Scholarship for children education	Purchasing Managers Index Irlandia

<sup>a</sup> Earthquake and Tsunami Emergency Support Project.

programs due to the influence of neighbours or relatives. The programs were also the most readily available sources of income at that time. It was a common trend to set up a business after the tsunami disaster despite not having an interest in carrying out business-related activities. Some households also participated in the programs but the participation was half-hearted, just for the purpose of earning a ‘side income’ as they were still going to the ponds or doing other jobs. From our interviews and observations, there were informal financial services in the village as of 2015: Independent Savings and Loan Group (*Simpan Pinjam Bergulir Mandiri*, PNPM) and a Women Household Head’s Productive Economy Group (*Pemberdayaan Perempuan Kepala Keluarga*, PEKKA) as well as *arisan* (local rotating savings and credit group without interest) group in Pande which only converge during certain festivities such as Eid Adha, where people pool their money to buy a goat or a cow for the event. However, follow-up interviews in March 2017 revealed that PNPM and PEKKA were not doing well. PNPM was halted as the repayments were late and payments were not always made in full. On the other hand, PEKKA faced challenges in the development of product marketing. [R12] also mentioned that there was no more microcredit support for the fishermen and that the Fisherman Credit Group in Pande has been closed down due to the small number of fishermen in Pande.

### 4.3. Physical capital

#### 4.3.1. Pre-tsunami

Our survey found out that 81% of the respondents owned a house before the disaster. Their previous house had a cement floor and the size was about 150–199 m<sup>2</sup>. Most houses used a pump or well to access water. Toilets were equipped with a septic tank. The basic living

condition of the households was met.

Pande is strategically located in Banda Aceh. The distance from Pande to the sub-district government office is about 500 m and to the city centre of Banda Aceh is about 2 km. There was an elementary school within the vicinity of Pande. Children could go to school on their own. If accompanied by the parents, the time spent bringing children to school was not much. We found out that the residents of Pande relied on the minibus (*labi-labi*) as the main transportation to go anywhere as many households did not have their own means of transportation. The number of minibuses severely dropped after the tsunami disaster as the owners suffered losses due to the fuel price hike.

#### 4.3.2. Immediately after the tsunami (relief period)

The tsunami disaster swept the entire village, destroying not just facilities and infrastructures but also houses. The house was regarded by the survey respondents as the most valuable asset that they had lost. 76% of the respondents reported that their house suffered heavy damage from the tsunami. Respondents mentioned that they stayed in the temporary barracks for almost two years before moving into their new permanent house. Most of the other assets of the households were also swept away by the tsunami, leaving them with nothing. Our interviews and discussions revealed that livelihood restoration was conducted by ADB and the government through pond restoration. Additionally, those who lost their livelihood from the aquaculture ponds were also given boat and fishing equipment to be shared among a group of four [R13]. Goat and poultry livestock rearing activities were among the start-up initiatives targeting some of the villagers. Secondary data prepared in 2007 by the city government of Banda Aceh with assistance from the German Technical Cooperation project ‘Support for Local Governance and Sustainable Reconstruction’ (GTZ-SLGSR) contains records of organisations and the types of assistance they provided to Pande after the disaster (Table 2).

#### 4.3.3. Current condition (12 years after the 2004 IOT disaster)

From our survey, as many as 44% of the disaster-affected households in Pande received ADB-built houses. Another 45% reported to have received aid in the form of cash or house construction materials. 11% were reported to have been provided with leasing services. Slightly more than a fifth of the respondents (22%) stated that they became house-owners after the disaster. This perhaps might be because they were designated as the caretaker of the house whose rightful owner was either still under-aged or was still studying.

The ADB-built house had two sleeping rooms, a living room, and a bathroom. It had a concrete floor, zinc roof, and brick walls. The housing design followed the policy which granted a 36 m<sup>2</sup> standard housing unit with BRR’s anti-seismic construction standards for households which were affected by the disaster regardless of their previous housing status. The houses were installed with electricity and clean water connection. However the houses did not have a kitchen. The survey found out that 88% of the households extended their house by building a kitchen, adding another bedroom, toilet, bathroom, garage, and shop space. For the most part, although owners participated minimally in the reconstruction of the house, the majority of the

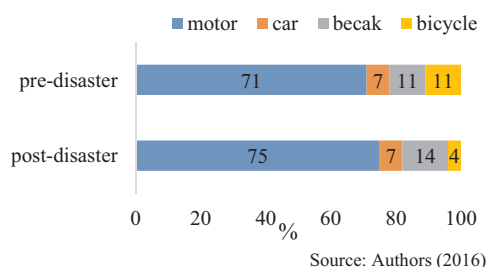


Fig. 6. Vehicle ownership (N=77).

owners were satisfied with the ready-built house.

Out of the 77 households surveyed, there was an increase in the ownership of transport vehicles, especially motorcycle (71–75%) and becak (11–14%) (Fig. 6). Motorcycles and becak were found to be the common vehicles possessed by majority of the residents as access to public transportation was not available in the village. In addition, the availability of becak services made it easy for people to go to work, school, or the market. Becak services increased access to livelihood opportunities outside of the village. Many households prefer to own a motorcycle rather than taking the labi-labi. Our survey also observed an increase from 3 to 7 households involved in goat rearing and a decrease from 25 to 5 households engaged in poultry business.

We found out that 74% of the households were satisfied with the length of their commuting time and the distance from their house to their workplace (Fig. 7). Two-thirds of the respondents were satisfied with the available facilities and infrastructure in the village, such as water, electricity, roads, and garbage collection. Based on our observation, the public facilities and infrastructure constructed by ADB in Pande such as tar roads, drainage system, and slaughterhouse were in good condition. There was a healthcare centre within the village as well as a few sundry shops and a grocery shop that catered to the villagers' daily necessities.

#### 4.4. Natural capital

##### 4.4.1. Pre-tsunami

Among all the villages in Kuta Raja District, Pande had the largest aquaculture pond area at 200 ha (Kuta Raja District, 2015). The vast wetland served as the main source of livelihood for the villagers engaged in aquaculture farming and fishing activities. Most of the owners were living in the village and mostly had worked on their pond themselves with help from other villagers.

Pande is located near the sea and had natural mangrove before the tsunami. The total pre-disaster mangrove area was 66.25 ha. According to our informants, mangroves contributed to the villagers' livelihood by serving as a breeding site for aquatic creatures such as shellfish, shrimp, and crab. The mangrove area also supplied Nipah palm leaves used in traditional cigarette production, wood for building enclosures around the aquaculture ponds, and wood barks for dyeing fishing nets.

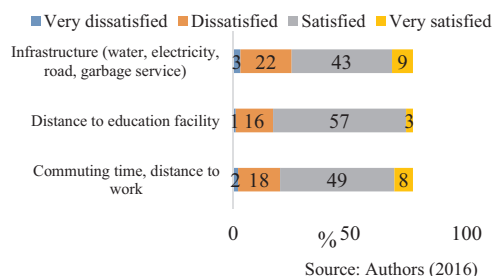


Fig. 7. Access to public facilities (N=77).

Table 3

Land use in Pande.

Sources: Aceh Government and GTZ- SLGSR (2007), [18]

Land usage	2007	2015
Aquaculture ponds	220.69 ha	200 ha
Settlements	17.53 ha	32 ha
Public facilities	0.33 ha	–
Others	11.50 ha	24 ha
<b>Total</b>	<b>250.05 ha</b>	<b>256 ha</b>

Table 4

Size of useable aquaculture land in Pande.

Sources: [19], Aceh Government and GTZ- SLGSR (2007), [18]

	Before 2004	Immediately after disaster	2007	2015
Aquaculture pond land	167 ha	14 ha	22.50 ha	17.5 ha

##### 4.4.2. Immediately after the tsunami (relief period)

The tsunami inundated Pande's land to about 0.5 m. From our observation, traces of heavy erosion could be found along the coastal area. Erosion led to land loss. The research of Daly et al. (2017) corroborates our observations on the conditions in Pande. Table 3 shows the land use in Pande during the reconstruction period in 2007 and the land use in 2015.

The size of the aquaculture ponds in Pande changed considerably after the 2004 IOT disaster. The ponds were reduced by 91% from 167 ha to only 14 ha [19] (Table 4). The pond rehabilitation efforts focused mainly on physical restoration only. According to [R9, R12, and R13], the poorly built seawall allowed the massive leak of sea water into the pond, creating an acidic environment which harmed the shrimp, leading to loss of breeding efficiency. The pond repair cost was too high and unbearable for the farmers [R10, R12 and R13].

Additionally, the mangrove areas were reduced to 47.9 ha by the tsunami [37]. After the tsunami, one of the rehabilitation efforts done by ADB in Pande was mangrove replantation. BRR (2006) also reported that ADB expanded some other efforts in Pande such as the conservation and protection of the coastal zones through land utilization in the coastal area. The on-going tidal embankment construction is meant to perform economic, leisure, and esthetic functions along the outer perimeter of the coastal village. ADB also put an effort in the re-development of the aquaculture pond area by planting mangroves which can create a buffer zone and act as a shield against tidal fluctuation while forming a natural conservation habitat.

##### 4.4.3. Current condition (12 years after the 2004 IOT disaster)

The number of settlements increased in Pande in 2015 (Table 3). The location of the village provides livelihood opportunities for outsiders to rent and stay in the village. On the other hand, the seawall is still not entirely fixed as of this time. [R9, R10, R12 and R13], who are aquaculture farmers as well as former aquaculture farmers, voiced out their concern about the low quality of the restoration work done on the seawall which caused failures in aquaculture farming. The pond's living environment has a standard ratio for seawater and freshwater depending on the aquatic creatures cultivated. The farmers also mentioned that the seawall plays a vital role in ensuring the minimal mixing of seawater and pond water.

In the GPMDP, Pande included resolutions for both rehabilitated and yet-to-be-rehabilitated ponds. Funds from the National Annual Budget and the Village Fund Allocation will cover the four-year rehabilitation projects [18]. However, our survey found out that not all the ponds in Pande can undergo rehabilitation. Some of the aquaculture sites in Pande are off-limits due to the buried cultural artefacts and



tombs beneath the ponds. According to [R19 and R20], archaeologists who worked in Pande, the tomb areas were once on flat land. Due to geographical changes such as sediment piles and erosion as well as the tsunami, ponds have been formed on top of what used to be cemeteries. The boom of aquaculture business in 1960s–1970s also contributed to the structural alteration of the area. [R12, R13, R19 and R20] also mentioned that the location of the ocean used to be miles away from the current location.

Our survey found out that out of the 17.5 ha of restored aquaculture ponds in Pande, only 15 ha are functional. From the in-depth interview, [R9] mentioned that the BRR had restored about 15 ha of ponds after the tsunami. However, 5 ha were damaged again as excessive saltwater was found in the ponds. There were so many aquaculture ponds that required rehabilitation but due to the high cost ponds were rehabilitated selectively [R12 and R13]. The survey found out that the functional ponds are further categorised into productive type (whether productive or nonproductive) and breeding style (whether intensive or natural breeding). Non-productive ponds are ponds that are identified to be unworkable due to bad soil quality, less harvest amount, or the existence of artefacts. Productive ponds can be operated in either intensive or natural breeding style depending on the available capital of the pond owners. The majority of productive ponds in Pande employ natural breeding.

From our interviews, the villagers regarded the mangroves to have a role in providing protection from strong wind, waves, and future tsunami. Despite this, we observed that the present mangroves are still young and cannot offer protection and resources like they used to. In 2012, the Forestry and Plantation Office of Aceh had allocated about 450,000 mangrove seedlings to be planted throughout the coastal villages located in Banda Aceh, including areas in Pande. However, it was found out that only 95,857 mangrove seedlings were planted throughout Banda Aceh, of which 29,800 mangrove seedlings were in Pande [43]. This kind of anomaly affected the coastal households' livelihood.

#### 4.5. Social capital

##### 4.5.1. Pre-tsunami

From our interviews and discussions, informants mentioned that the relationship among the villagers was close before the tsunami disaster.

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There was no one in the village that we did not recognise. We knew everyone. Some of our neighbours were actually our relatives. Everyone in the village had their extended families or relatives living nearby [R10, R11, R14 and R17].

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##### 4.5.2. Immediately after the tsunami (relief period)

According to the ex-village head of Pande, the remaining survivors were busy looking for their family members during this period and were occupied with CFW or involved in programs such as livelihood training or mental health care.

##### 4.5.3. Current condition (12 years after the 2004 IOT disaster)

Our survey found out that 45% of the households have been living in the village for more than 20 years and that they participated in local community activities such as community meetings, *gotong-royong*, mosque activities, and local festivals. From our observations in 2016, villagers usually gathered at the mosque to perform prayers together and attend religious class or Quran reciting class. However, we also found out that the renters participated lesser in local events. This somewhat affected the *gotong-royong* spirit in the village where relationships are built among the people as they make acquaintances while carrying out an activity together. Villagers who sit outside and hang around the shops are usually the non-renters. Renters do not

mingle with Pande residents as they have the 'outsider' feeling. According to [R9], renters will usually participate in the local events or respond to invitations only when they are personally invited. Some veteran renters had already integrated themselves into the community after staying there from around 2010 or 2011 [R1 and R9]. They even bought the house where they stayed from the local Pande owner. They also purchased another house for income-generation by renting it to others.

Our survey found out that 69% of the households reported that they were satisfied with their relationship with the community. Additionally, 58% of the households stated that they were also satisfied with their relationship with the local government and 56% were satisfied with their relationship with the village leader. The current village head is seen as an influential individual. He was the village leader from 2008 until 2014 and was re-elected for another term which started in 2015. This shows that the people in Pande acknowledge, trust, and believe in his leadership

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The current leader is good. We elected him again after his term ended. We trust him to take care of and develop our village [R3, R10, R14, and R17].

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We also found out that 81% of the households fairly trusted their neighbours, with only 2% saying that they did not trust the neighbours at all. Around 6% said that they did not trust neighbours so much while another 6% said that they do trust neighbours very much. Households put trust in their neighbours on matters such as letting their children to be watched over and taken care of by the neighbours during emergencies. Additionally, households mentioned that they would help their neighbours when a disaster happens. However, when it comes to financial matters, the majority (44%) of the households do 'not at all' borrow from their neighbours and only 1% would 'very much' lend money to their neighbours. Households also mentioned that they do 'not at all' know about personal matters of their neighbours such as financial situation (57%) or family affairs (49%).

## 5. Discussion

The framework in Fig. 1 provides a simple and clear way of distinguishing the changes of the livelihood assets in three different time periods. The five livelihood assets (human, financial, physical, natural, and social) went through significant changes after the tsunami. The change in the household's livelihood influences the accumulated assets. Different types of assets, such as pond land, skills, credit, and labour, were positioned differently depending on which were the most relevant to the type of livelihood the households were engaged in. After the tsunami, in some cases, households with limited assets such as those who had lost their aquaculture ponds and fishing equipment built up their assets by leasing their ponds or offering labour to other pond owners. Households forewent some assets in order to build up other assets. Additionally, factors such as economic processes, institutional change, livelihood interventions, and population growth were also among the factors that could have affected the assets, as observed in previous disasters [3].

The housing reconstruction program is linked to employment and human resource development, as well as to economic and business development [41]. Being able to fulfil the basic needs, receiving a house allows the households to focus more on their livelihood activities. The renovations and extensions made were an indirect pull factor for the house owner to improve their livelihood and, at the same time, diversifying their livelihood options. This shows that households were trying to improve not just their home but also their living condition. The aid households received previously during the relief period, particularly the skill-based trainings, had motivated some household to open their own business. The availability of cash has led to changes in the



house space and to the strong desire of the people to start their own business. Households built additional spaces for their home-based business. Sewing, weaving, making snacks, drying fish, or opening a sundry shop right in front of their house are some of the home-based businesses in Pande. A specific area or room in the house had been allocated for conducting livelihood activities such as making *kue* (traditional snacks/cakes), rearing livestock, or storing some business-related equipment.

A shop which is mainly managed by a female household member is set-up either within the house compound or in the extension in front of the house. House ownership adds an advantage especially to the women as owning a house lowers the possibility of falling into poverty [34]. Previously, the women in the village were actively involved in the production of traditional cigarette using Nipah mangrove leaves. However, the activity has decreased tremendously due to the loss of local knowledge on traditional cigarette making. The replanted Nipah mangroves are also still young and deemed unsuitable to provide raw materials for cigarettes as they still cannot provide a large amount of young leaf sprout. The younger generation of Pande residents are also not interested in continuing the production of traditional cigarette due to the tedious work involved, from collecting the Nipah leaves to the drying process.

The livelihood interventions as well as the aid and support received by the households reduced the unemployment rate in Pande throughout the years since the tsunami. Households opted for a more secure livelihood. This was prompted by the high variability in the income from aquaculture farming and fishing. Since many of the households are now working outside of the village, most of them own a motorcycle to go to work and also to send their children to school in the neighbouring village. This takes some portion of their working time. Nevertheless, the investment made for the children's education is with hopes and expectation that the children will be better educated and thus able to access better employment and wage in the future. Access to education and training can increase the chances of households to develop and expand their human capital [27].

The remaining aquaculture ponds are mostly owned either by the residents of Pande or by former residents who are now living in a bigger city like Jakarta or Medan. Owners living outside of Pande appoint local residents to manage their pond. Some local owners with insufficient funds opted to lease their ponds to reduce the probability of income failure as aquaculture farming business result is unforeseeable. The price of fuel also has an impact on the fishing activity. Higher fuel charges mean shorter travel distance from the shore, which might result in limited types of catch and smaller catch quantity. Besides that, the price of the catch sold to the *Toke Ikan* (middleman) might not be significantly higher than the initial expense, resulting in no profit. The earnings from diversification provide the households with cash resources which can lead to more options for the households. This in return reduces the vulnerability of the households, especially those which depend on seasonal income. Households looked for a more secure income after the disaster as they realised the importance of having a steady monthly income. Moser and Felton [29] mentioned that having a job can secure households by using their labour as a potential asset. The most secure jobs were permanent jobs such as working in the government, followed by people with stable employment in the private

sector. Households are spending lesser time in the sea or at the ponds as they are occupied with other jobs.

### 5.1. Limitations of study

One limitation of our study is the unavailability of data for the period before the 2004 IOT disaster and also for the reconstruction period at the village level. Evidence and data were non-existent and our research had to rely more on the recollection of the survivors and on the experience of NGOs that had worked or are working in Pande. After the disaster, the local government started to keep the data from 2005 onwards, building slowly with the available records and preserved disaster-related data as much as possible. To arrive at a comprehensive conclusion, this study could have taken all related agency such as BRR, BPBD, Agricultural Department, Fisheries and Marine Department, Tourism Department and policy makers into account.

## 6. Conclusion

Due to the severity of the disaster impacts, the livelihood of Pande residents was drastically changed. The tsunami disrupted livelihood mainly by taking away vast amount of human labour in aquaculture farming as well as the local knowledge of the mangroves that served the households in terms of providing free food supply. The majority of households in Pande had to change their livelihood in order to adapt to the post-disaster condition. Households either took up new livelihood activity or added a side activity that could generate income to support the household's expenses. The great loss of local expertise on and knowledge of aquaculture farming and mangroves can be curbed by providing training and education to the new farmers to enhance their product quality and work activities.

Households started their livelihood from scratch with assistance from both the external organisations and their own savings. The skills and trainings provided by the donors during the reconstruction period benefited the households in the long run. However, microcredit did not work well in the case of Pande. The aid received played a vital role in helping the households to pick up and revive their livelihood. Pande households took up various strategies to attain their current income by conducting various income-generating activities. Despite the monthly income returning to pre-disaster level, households had to conduct more livelihood activities to meet higher expenditures, such as on food and on children's education. Additionally, assets such as political and cultural assets can be included in similar studies in the future to increase understanding on the different assets households rely on in the long term.

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### Appendix. Respondents of the structured interviews

Code	Gender	Interview type	Occupation	Date conducted
R1	Male	Key Informant	Ex-village Leader	November 12th, 2015 July 20th, 2016 March 11th, 2017
R2	Male	Livelihood Benefactor Key Informant	Banda Aceh Red Cross Director (NGO) Ex-World Vision Officer	March 11th, 2017

R3	Female	Livelihood Beneficiary	Housewife	March 12th, 2017
R4	Female	Livelihood Key Informant	Housewife	March 12th, 2017
R5	Female	Livelihood Beneficiary	Housewife	March 12th, 2017
R6	Female	Livelihood Beneficiary	Housewife	March 12th, 2017
R7	Female	Livelihood Key Informant	Housewife	March 10th, 2017
R8	Male	Livelihood Key Informant	Not working	March 12th, 2017
R9	Male	Key Informant	Village Leader	November 12th, 2015
				July 22nd, 2016
				March 11th, 2017
R10	Female	Livelihood Key Informant	Clerk at Village Leader Office	March 13th, 2017
R11	Female	Livelihood Key Informant	Clerk at Village Leader Office	March 13th, 2017
R12	Male	Livelihood Key Informant	Aquaculture farmer	March 13th, 2017
R13	Male	Livelihood Key Informant	Aquaculture farmer	March 12th, 2017
R14	Female	Group interview	Shop owner	September 3rd, 2016
R15	Female	Group interview	Housewife	September 3rd, 2016
R16	Female	Group interview	Housewife	September 3rd, 2016
R17	Female	Group interview	Housewife	September 3rd, 2016
R18	Female	Group interview	Housewife	September 3rd, 2016
R19	Male	Key Informant	Archaeologist	March 13th, 2017
R20	Female	Key Informant	Archaeologist	March 13th, 2017

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