

The Intersection of Human Rights and Disaster: Assessing Natural Resource-based Livelihoods in the Lapindo Mudflow Affected Area

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ABSTRACT

The right to natural resources is a fundamental prerequisite for human rights, yet it is largely neglected in disaster governance. This study examines the disproportionate access, management, ownership, and resource utilisation in the Lapindo mudflow-affected area in Sidoarjo, bridging the research gap that has focused predominantly on technical mitigation rather than the structural impact on the socioeconomic rights for victims. Employing a mixed-methods approach, our study integrates quantitative analysis through a 250-respondent survey alongside qualitative assessment based on semi structured interviews, focus group discussions, and policy reviews conducted in Tanggulangin, Porong, and Jabon. Results demonstrate that disparities in access to resources are not only driven by ecological degradation, but also by exclusive governance and bias towards investment interests. Tanggulangin has comparably better access but is restricted in utilisation, Jabon reflects legal ownership dominance lacking management effectiveness, while Porong experiences structural deprivation but establishes resource diversification-based adaptation stratagems. This exploration confirms that Lapindo's recovery tends to accommodate macroeconomic steadiness over affected community rights advocacy, exacerbating resource distribution disparity and social segregation. Therefore, this study recommends a more inclusive and evidence-based human rights-based governance approach, balancing economic interests, environmental sustainability and social justice to ascertain a comprehensive restoration.

1. Introduction:

Human rights are a fundamental cornerstone of international legal regimes and policies, serving as a powerful instrument to ensure individual freedom and dignity, including the right to a decent livelihood [1][2]. In an ecological disaster context, these values are frequently eroded due to the lack of sufficient access to natural resources as a basis for affected communities' livelihoods [3][4]. One of the clearest illustrations is the Lapindo Mud disaster in Sidoarjo, Indonesia since 2006, which created not only ecological disclosures, but systemically shattered the communities' economic and social landscape [5][6][7]. This disaster's intricate impact poses vital obstacles to basic rights fulfilment, requiring a comprehensive academic review of the intersection of natural resource governance and human rights in the post-disaster restoration setting.

Empirically, Lapindo not only inflicted massive environmental destruction [8][9] and deprived productive land on which the people's economy depended [10], but also exacerbated imbalances in access to livelihood-based natural resources [11][12]. Constraints on rights of ownership, access, utilisation, management of these assets trigger structural injustices leading to a deteriorating community welfare, reinforcing the systemic exclusion, widening social inequalities amongst vulnerable groups [13]. Furthermore, interaction dynamics between private and government entities in post-disaster recovery initiatives often indicate a proclivity to accommodate investment concerns over basic victims' rights, generating asymmetries in recovery aid distribution [14][15][16].

To respond to this challenge, a human rights-based approach offers an integral analytical framework for investigating whether post-disaster resource governance influences communities' rights to own, access, use, and manage natural resources in sustainable and equitable manner [17][18]. These resource rights not solely reflect economic aspects, but are also entangled with environmental sustainability and social justice, which are prerequisites towards inclusive recovery for afflicted communities [19]. Nevertheless, existing literature tends to focalise on practical aspects such as mitigation strategies and ecological impacts, without elaborating extensively on how disasters

diminish communities' rights to govern their own resources [20][21]. Therefore, this paper is essential to recognise the ways in which post-disaster constraints affect the affected communities' livelihood rights in perpetuity [22].

From an academic standpoint, it strives to make a considerable contribution to the literature on the intersection of disaster and human rights by shedding light on environmental justice, livelihood-based resource governance dynamics, socio-economic rights. [23][24]. In terms of policy, the findings are considered to provide a valuable basis for formulating post-disaster rehabilitation policies in a more evidence-based and inclusive manner, as well as strengthening the fulfilment and protection of affected communities' rights systematically [25][26]. This research also has immense potential to become a reference point in the creation of a disaster-prone zone governance model that promotes the principles of human rights, economic sustainability, and social justice for vulnerable groups [27][28][29].

2. Theoretical Background

Human rights are a fundamental principle in constructing a sustainable and just society, where entitlement to an appropriate livelihood includes ownership, access, managing and utilising natural resource-based livelihoods [30][31]. In the context of economic, social and cultural rights, maintaining a secure access to these assets is not simply an economic feature, but integral to inclusive environmental governance and social justice [32]. However, ecological catastrophe like Lapindo has destabilised this arrangement since 2006, inflicting a multidimensional crisis that hindered the fundamental rights realisation of the affected people [33][34].

This disaster extends beyond ecosystem degradation and subsequent disappearance of productive lands [35][36], but also engenders structural inequity dynamics caused by people's limited access to natural resources that support their subsistence [37]. Post-disaster governance's failure to incorporate a human rights lens aggravates economic and social injustice by compounding the systemic exclusion of the most fragile [38][39]. Further ramifications are apparent in limited access to agricultural land, sanitation, and water resources that were formerly the economic underpinnings of afflicted groups [40].

Normatively, the International Covenant on Economic, Social and Cultural Rights (ICESCR) recognised that each individual possesses the right to access the necessary resources for survival and decent living standard [41]. However, the fulfilment of these rights is inhibited in reality by interest conflicts among stakeholders engaged in post-disaster reconstruction, whether at the private sector, government, or local community level [42][43]. Interventions are largely prioritised towards capital interests rather than the basic rights of affected communities, resulting in a disproportionate impact on the rehabilitation mechanism [44].

In pursuit of this challenge, our study offers detailed analyses of access changes and governance of livelihood-based resources for displaced people based on the human rights paradigm [45]. Furthermore, it explores the interaction dynamics across multiple stakeholders including local people, private sector and authorities in designing equitable and inclusive recovery strategies [46]. This also highlights the impact of post-disaster policies on affected communities' socio-economic structure and the ability of existing regulations to respect and protect basic needs [47].

The academic significance of this study lies in the integration of a human rights perspective in analysing disaster impacts on resource governance and affected people's livelihoods [48]. Based on a policy context, this outcome is envisioned to provide a benchmark in determining post-disaster restoration actions which are more evidence-based, inclusive, and ensure economic security and social welfare for those people [49]. Consequently, it enriches both the academic knowledge on the relevance of disaster and human rights, and provides practical solutions in developing a fairer and healthier resource governance towards disaster alleviation [50][51].

3. Methodology

1. Area Study

This study was conducted in the affected area of the Lapindo disaster covering 17 villages in three sub-districts, namely Jabon, Tanggulangin, and Porong [52]. **Figure 1** illustrates our site study for the primary data collected. This location was strategically selected considering it represents the epicentre of disaster impacts resulting in diminished access to livelihood-based natural resources, which forms the ultimate research objectives.

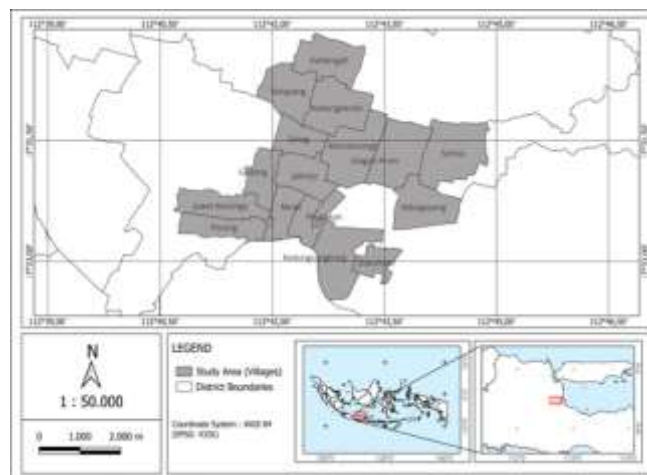


Figure 1: Area of study, Modified from source: (Sidoarjo Government, 2023)

Geographically, the zone experienced remarkable alterations following persistent mud sedimentation processes since 2006 [53]. The soil structure suffered extensive deterioration, prompting productive land to be replaced by unusable space, as well as elevated geotectonic hazards that aggravate people's socio-economic conditions. In economic outlook, the region had a resilient economic base in fisheries, agriculture, and small-medium enterprises [54], largely derived from natural resources in pre-disaster. However, the community's dependence on these resources suffered massive pressure afterwards, triggering a forced relocation, income reduction, growing social and economic precariousness [55].

The selection of this region as a research site has a strong justification. It is a prime representation of disaster victims [56], where thousands of families have lost access to their economic and environmental resources. In addition, this area is highly relevant in the context of human rights, as it allows for an accurate assessment of the four main rights, namely the right to own, use, manage and access resources. The socio-economic conditions of the people in this area have undergone structural changes that reflect how affected communities have had to adapt to loss of livelihoods, transformation of social structures, and recovery policies that are not always equity-based.

In addition, the region is subject to multiple international and government policy interventions [57], making it an appropriate setting to investigate a human rights-based recovery strategy's effectiveness. Consequently, it mapped beyond the immediate disaster impacts to determine the ways resource policies and management affect people's ability to maintain their livelihoods in perpetuity.

2. Research Methods

2.1. Data Collection

2.1.1. Qualitative

The quantitative data gathered through disseminating questionnaires to 250 respondents [58] determined based on the Yamane Taro equation, with a population of 61,651, generated 177 samples, but to achieve greater research validity and credibility, we rounded up to 250 participants. The survey was undertaken following inclusivity and proportionality protocols, considering region, gender, and a representative proportion of affected groups.

2.1.2. Quantitative

Qualitative data obtained through:

- a. Focus Group Discussions that were organised in three sub-districts involving 18 respondents (each sub-district consisted of 6 participants: 3 females, 3 males);
- b. Semi-structured Interviews with 30 respondents (10 interviewees from each sub-district involving 5 female and 5 male);
- c. Key Informant Interview with 2 local government officers to gain in-depth insights into socio-economic dynamics and post-disaster policies.

2.2. Data Analysis

2.2.1. Qualitative Analysis

A thematic analysis method was adopted to capture the affected communities' experiences and strategies in dealing with the human rights fulfilment challenges and socio-ecological transformation resulting from the catastrophe [59]. The process involved three distinct phases:

- a. Fragmentation and Open Coding: Data transcriptions in Indonesian and Javanese were translated into English in order to preserve meaning and relevance.
- b. Connecting main patterns emerged to recognise the interplay between ecosystem and human, particularly in socio-economic dynamics and socio-ecological adaptation of affected communities.
- c. Selective Coding: Integrating the core themes to produce a conceptual framework that illuminates social-ecological system transformation processes in a post-disaster human rights fulfilment setting.
- d. Triangulation of data was utilised by contrasting interviews with quantitative surveys, policy documents, and observations to strengthen the research authenticity.

2.2.2. Quantitative Analysis

A quantitative appraisal centred on analysing communities' perceptions of their rights to ownership access, use, and management of resources [60]. The statistical methods employed include:

- a. Descriptive Statistics: Designed to capture the respondents' gender, education, age, and income level characteristics along with the research variables' distribution. This enabled a greater understanding of the affected communities' socio-economic circumstances.
- b. Kruskal-Wallis Test: This non-parametric model was conducted to determine differences in community perceptions across the three sub-districts in relation to the predominant variables. Considering that data distribution is generally not normal, this measure accurately mapped variations in access to resources and community experience.

2.2.3. Integration of Qualitative and Quantitative Results

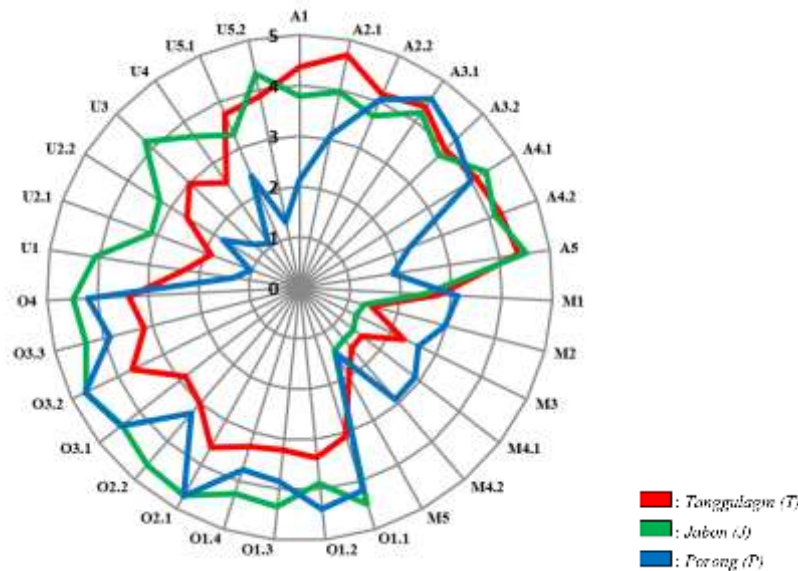
This mixed-methods design facilitates a comprehensive explanation of human rights terms in the Lapindo Mud affected area [61]. The combined outcome allowed this study to:

- a. Identify patterns of social-ecological adaptation of affected communities and the barriers they face in economic and social recovery.
- b. Verify qualitative findings through quantitative empirical data, strengthening the credibility of the research results.
- c. Explore the complex interactions between human rights and livelihood-based resources in a disaster context.

Consequently, this investigation offered an academic and practical premise for more evidence-based and inclusive policy-making in the disaster-affected communities' rehabilitation, incorporating the principles of human rights, economic sustainability and environmental justice.

4. Result

Drawing on human rights and resource-based livelihood assessments, this study attempts to identify the access, management, ownership, and utilisation dynamics of resources in affected Lapindo areas. Employing a multidimensional concept based on **Figure 2**, we probe the interactions between indicators to determine how economic, social and structural determinants shape the community's livelihood sustainability patterns.



Code	INDICATOR	T	J	P
A1	Accessibility of livelihood assets	4,36	3,80	2,13
A2.1	Balance of resource use and availability	4,71	3,95	3,08
A2.2	Diversity of livelihood resources in fulfilling needs	4,15	3,70	4,05
A3.1	Legal protection of access rights	4,36	4,22	4,55
A3.2	Suitability of rules on the right to access	3,96	3,81	4,27
A4.1	Freedom from livelihood assets	4,11	4,35	3,99
A4.2	People's safety in using resources	4,24	4,11	2,33
A5	Innovation and development in accessing resource	4,39	4,53	1,87
M1	Government interference with the right to manage	2,76	2,47	3,14
M2	Freedom to manage livelihood assets	1,46	1,33	2,98
M3	Ease of management	2,31	1,24	2,61
M4.1	Legal protection to manage	1,56	1,35	2,88
M4.2	Regulations on the right to organise	1,58	1,35	2,91
M5	Regulation of community rights in managing resources	2,01	1,42	1,48
O1.1	Clarity of rules on ownership rights	3,07	4,47	4,19
O1.2	Level of protection against possible removal and expropriation	3,36	3,88	4,39
O1.3	Livelihood Resource Protection	3,22	4,35	3,86
O1.4	Ownership rights protection	3,28	4,27	3,76
O2.1	Conflict resolution in ownership right	3,61	4,70	4,72
O2.2	Government involvement in ownership rights	3,02	4,61	3,27
O3.1	Discretion in ownership	2,86	4,43	4,45
O3.2	Livelihood asset ownership type	3,67	4,70	4,72
O3.3	Process of obtaining ownership rights	3,16	4,35	3,86
O4	Settlement of ownership conflicts	3,38	4,47	4,19
U1	Usability of livelihood resource	2,29	4,08	1,33
U2.1	Discretion in utilising	1,87	3,12	1,04
U2.2	Freedom in using various nature components	2,62	3,25	1,78

U3	Availability of replacement resources for needs	3,00	4,20	1,24
U4	Resource capacity to be used in the long term	2,53	3,64	1,07
U5.1	Fairness in utilising	3,74	3,30	2,41
U5.2	Protection to right of utilise	3,86	4,33	1,33

Figure 2. Sub-indicator multidimensionality in assessing the right to own, access, manage and use livelihood-based resources for Lapindo-affected area communities.

1. Analysis of Access Rights to Resources

Our results indicate that Tanggulangin achieves the greatest level of accessibility (A1: 4.36), seconded by Jabon (3.80), and Porong with the most limited accessibility (2.13). This pattern signify that despite Tanggulangin's higher access, the balance between resource use and availability (A2.1: 4.71) is not proportionate to resource diversity (A2.2: 4.15). This suggests some communities in Tanggulangin have broader access to resources, but remain constrained in diversifying their livelihood assets. As expressed by a Jabon SSI participant:

“Although access is actually possible on paper, we experience considerable difficulties in dealing with permits and accessing assistance that is required” (RA, Jabon SSI).

In contrast, Porong reported the most lack of access but greater resource diversity compared to Jabon (A2.2: 4.05 vs. 3.70). This demonstrates the fact that despite inferior access, Porong residents possess adaptive strategies centred on resource diversification relative to Jabon. An FGD attendee in Porong remarked:

“We depend mostly on community solidarity because formal access to resources is extremely difficult and frequently only accessible to a privileged group” (YS, Porong FGD).

The interaction of access level and utilisation became apparent with the Kruskal-Wallis experiment presented in **Table 1** ($H = 88.072$, $p < 0.001$), highlighting that expanded access does not inevitably imply optimised utilisation. In some cases, strict regulations or patchy distribution hindered communities from accessing the necessary resources they required for survival.

Rights	Mean \pm SD			H-TEST		
	T	J	P	H Value	df	P Value
Access	4.28 \pm 0.813	4.04 \pm 1.05	3.28 \pm 1.201	88.072	2	0.000
Own	3.26 \pm 1.185	4.42 \pm 0.813	4.14 \pm 0.918	52.763	2	0.003
Manage	1.94 \pm 0.964	1.52 \pm 0.636	2.66 \pm 1.388	11.945	2	0.000
Use	2.84 \pm 1.389	3.7 \pm 1.477	1.45 \pm 0.616	121.719	2	0.000

Table 1. Kruskal-Wallis test results on human rights indicators related to natural resource-based livelihoods in Lapindo-affected areas. (The result of primary data processing).

2. Analysis of Property Rights to Resources

In regard to ownership, Jabon posted the most tenure (O2.1: 4.70), closely followed by Porong (4.14) and Tanggulangin (3.07). This suggests that communities have clearer legal assertiveness in claiming their resources. However, this is not invariably complemented by effective resource governance (M3: 1.24), reflecting the gap between on-the-ground management and legal entitlement. As declared by an SSI from Tanggulangin:

“We currently have valid land certificates, but realisation is complicated. People still struggle with multiple levels of bureaucracy. ” (MJ, Tanggulangin SSI)

In contrast, Porong is less endowed but with potentially stronger legal protections over Jabon (O1.2: 4.39 vs. 4.22). This signals that despite ownership rights being tighter, there is improved legal protection towards resource rights, possibly diminishing the exploitation risk by external entities. Another FGD participant added:

"Property rights are frequently disputable since not all affected people share equally in the protection." (BZ, Jabon FGD)

Table 1 ($H = 52.763$, $p = 0.003$) illustrates that stronger ownership does not always guarantee greater control in resources. In some locations with relatively minor ownership, regulations are robust enough to safeguard people from forfeiting their resource rights.

3. Analysis of Management Rights to Resources

Porong scored the steepest level of government intervention in managing resources (M1: 3.14), which is contradictory to the community's freedom in managing resources (M2: 2.98). This represents that more structured stewardship by the government may compromise communities' flexibility in deciding on their own assets. Meanwhile, Jabon logged the weakest level of management (M3: 1.24), denoting continued challenges in governance capabilities despite higher ownership. Indeed, a KII delegate said:

"We have existing resource management regulations, yet implementation is notoriously problematic. Many laws remain to be reexamined for better responsiveness to people's demands." (BW, KII)

Another Porong SSI representative continued:

"We are unable to participate in the management because everything has to be conducted through the government intervention, although we are aware of the condition on the field." (AA, Porong SSI)

Kruskal-Wallis test findings ($H = 11.945$, $p < 0.001$) revealed improved governance structurally does not consistently equate to easier and more efficient control at the community level. The discrepancy between formal rules and the community's concrete needs becomes a persistent impediment to the resource management implementation.

4. Analysis of Resource Utilisation Rights

Concerning resource utilisation, Jabon achieves the sharpest utilisation index (U1: 3.12), meaning that people in this locality appear overly complacent in resources utilisation. However, the latitude in using an environmental resource in Jabon (U2.2: 3.25) is more pronounced as opposed to Porong and Tanggulangin, potentially entailing greater expropriation. One FGD interviewee emphasised:

"We managed to use the land for agriculture, but the soil quality degraded drastically post-disaster, and it inhibited our productivity." (LM, Jabon FGD participant)

Contrastingly, Porong logged the weakest utilisation rate (U2.1: 1.04), correlating with poor access to resources. This illustrated that low access implies significant barriers to resource utilisation. Similarly, a Porong SSI respondent shared:

"We have resource potential, but due to insufficient infrastructure and assistance, it is difficult for us to properly utilise it." (MS, Porong SSI).

The Kruskal-Wallis analysis ($H = 9.587$, $p < 0.001$) confirms that better utilisation is associated with greater resource extraction, reaffirming the complex dynamics between environmental policy, accessibility, and affected communities' economic priorities.

In aggregate, **Figure 3** embodies a multipronged configuration of resource rights reflecting structural discrepancies between disaster-affected sub-districts. The distribution scheme indicates asymmetry in resource utilization and control, with each site exhibiting particular characteristics in owning, managing, accessing, and utilising livelihood-based assets.

Tanggulangin exhibits relative equilibrium in its four rights distribution, indicating that despite policy instruments providing access, there are bottlenecks in optimising governance. Jabon, prominent in the ownership feature, exposes intricate dynamics in utilisation and management, demonstrating that legal certitude is not invariably directly proportional to the community's adaptability to environmental and economic constraints.

Meanwhile, Porong presents tighter constraints in nearly all instances, reflecting the prolonged impact of poorly inclusive mitigation schemes and limited mechanisms that enables people to partake in their own resource governance. This imagery reinforces the finding that discrepancies in resource rights distribution are not only driven by geographical and physical constraints, but rather by the policy frameworks and governance mechanisms that establish power relations in resource welfare within affected territories.

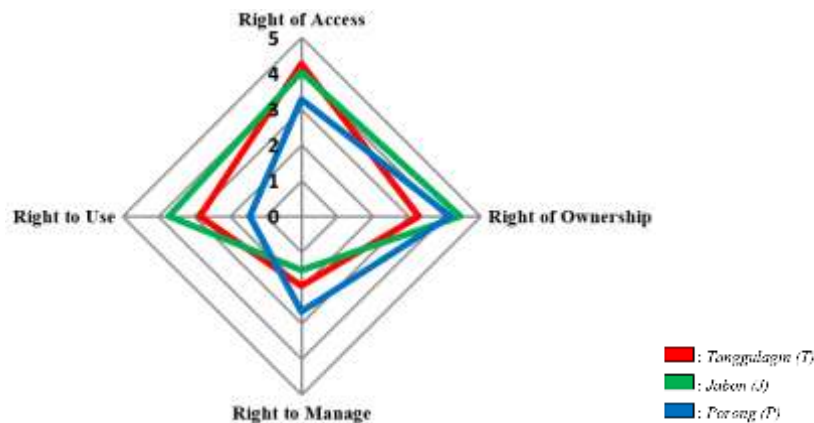


Figure 3: Assessment of access, utilise, manage and own rights to livelihood-based resources in three Lapindo-affected sub-districts. (The result of primary data processing)

5. Quality Dynamics of Natural Capital and Environment in the Lapindo Affected Zone

The environmental quality and natural assets progress in the Lapindo affected area from 2006 to 2023 indicated in **Figure 4** exhibits a considerable enhancement trend, as denoted by Kendall's tau of 0.882 which highlights a consistent growth pattern within environmental parameters. Sen's slope of 1.2 affirms that environmental quotient is progressing steadily over time, regardless of fluctuations in policy dynamics, socio-economic influences, regulatory interventions on natural resource management.

A p-value of <0.0001 reinforces the statistical significance of this trend, revealing no random fluctuation, but rather a consequence of implemented strategic policies in resource and environmental stewardship. In 2006-2011, the environmental quality index entered a precarious phase representing the immediate disaster consequences on natural resource and ecosystems sustainability. The government initiated remediation efforts through Presidential Regulation No. 14/2007 setting up the Sidoarjo Mudflow Management Agency (BPLS) and Government Regulation No. 48/2008 launching a compensation mechanism for victims.

However, this approach was largely concerned with socio-economic concerns rather than environmental conservation, leading to a piecemeal recovery of the ecosystem. Considering people's rights to resources, this era exposed shortcomings in management and access rights, with communities struggling to customise and manage damaged land independently.

Heading into the 2012-2018 horizon, environmental restoration is commencing to be enforced, including ex-silt land revitalisation projects for community-based green infrastructure and ecotourism. Rules governing affected land use started to emerge, offering space for people to participate in more efficient resource utilisation. This contributed to advancements in resource management and ownership rights where displaced groups start to obtain improved access to post-disaster decisions on land usage. While environmental justice indicators were upgraded, these rights continued to be unfairly allocated to districts, generating disparities in policy execution.

The culmination of environmental performance occurs in 2019-2021 fuelled by environmental regulation strengthening based on mud hazard mitigation coupled with investments in ecological infrastructure. However, it is sobering to notice that there was a hiatus in regulation between 2019 and

2021 due to a shift in the authorities' priorities towards tackling the COVID-19 outbreak. The dearth of new initiatives in environmental recovery throughout this time suggests that the recovery policy is prone to changing social and economic dynamics. From a resource rights standpoint, this chapter affirms a frustration in concession rights and strengthening ownership, with formerly community-empowerment-orientated regulations inactive amidst new constraints on interventions.

Post-2021, a slight deceleration in the environmental value index occurred, signifying that sustainability issues are remaining a core determinant in maintaining policy effectiveness in the long term. The diminution in government involvement during the post-pandemic era along with barriers to community-based rehabilitation movements are leading to volatile patterns in this quarter. Structurally, these matters also impinge on access and utilisation rights to resources, with some local people unable to operate a sustainable natural resource-based livelihood amidst regulatory reforms that do not align closely with impacted groups' objectives.

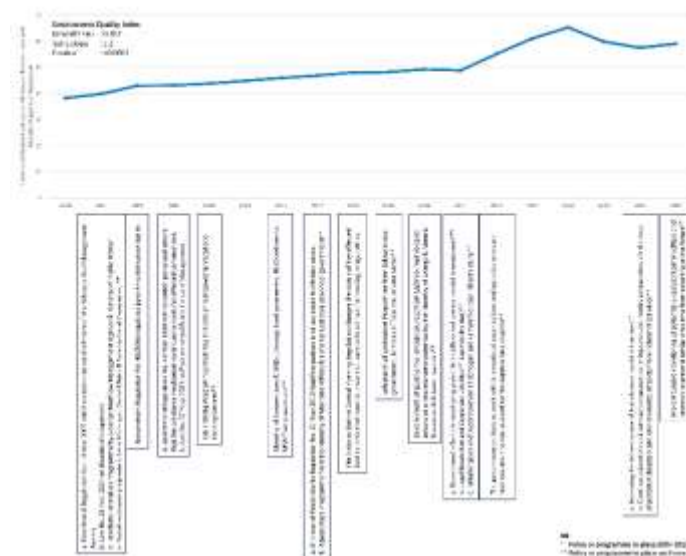


Figure 4: Time series and trend analysis findings on resource-based livelihood and environmental quality in Lapindo disaster affected zone and relevant policies/programmes.

Looking from a governance and resource policy outlook, the favourable progress trend evident in the data is testament to the extent to which interventions over the previous two decades have produced a meaningful outcome towards environmental regeneration and natural capital security. However, progress must be nurtured through policies oriented beyond immediate relief, to guarantee that rights of access, management, ownership, and utilisation of resources are inclusively and consistently exercised by distressed populations. In this sense, the time series analysis suggested that environmental welfare gains resulted not exclusively from ecological recoveries, but rather policy synergies regulating human rights to resources, communities' capacity to adapt, environmental governance to post-disaster difficulties in a self-reliant and supportive manner.

6. Stakeholder Analysis in Lapindo Mud Disaster Recovery and Countermeasure

Referring to **Figure 5**, Multiple stakeholders have intertwined contributions to the mitigation and rehabilitation of the Lapindo catastrophe, which are expanded at length in **Appendix 1**. The Indonesian President (1A-1E) has the ultimate oversight in moulding macro policy and compliance, including the inception of the Sidoarjo Mud Management Agency and the corporate liabilities machinery of PT Lapindo Brantas. This aligned with the Ministry of Finance and the Ministry of Public Works (2A-2B) in regulating land purchase measures and the reconfiguration of the damaged sites.



Figure 5: Stakeholder analysis diagram on the livelihood rights enforcement for Lapindo's affected zone. (The author's findings and analysis)

The Sidoarjo Mudflow Management Agency (3A-3D) serves as the technical actor involved in the compensation programme planning, alternative settlement provision and subsequent disaster risk monitoring. Close engagement with the Indonesian parliament (4A-4B) ensures oversight of disaster victims' rights and social impact resolution. Meanwhile, local governments (5A-5C) take responsibility for assisting economically as well as zoning the affected region as a non-industrial area and residential.

In the private segment, the role of PT Lapindo Brantas (9A-9D) includes compensating victims through property and land acquisition as well as corporate social responsibility. The Ministry of Energy and Tourism (Codes 8A-9C) also participated in ecotourism promotion and geothermal energy exploration to productively utilise the disrupted area. The government also brings in the Ministry of Manpower (10A-10B) to facilitate access to occupational skills training for residents who are forced to abandon their livelihoods.

This stakeholder interaction reflects a multi-sectoral perspective in Lapindo mud-affected recovery. Despite progress in economic and environmental remediation, key obstacles still revolve around coordinating effectiveness among actors and policy consistency in the future. Accordingly, stronger collaborative governance-based efforts are warranted to enshrine social and environmental reforms in an inclusive and durable format.

DISCUSSION

1. Structural Injustice in Access to Post-Disaster Resources: Critique of Post-Disaster Inclusionary Development Frameworks

This study illustrates that disparities in access to natural resources in Lapindo mud-affected areas reflect both patchy remediation strategies and geographical features. Tanggulangin possesses better access than Porong and Jabon, but this accessibility does not inherently contribute to local community economic sustainability. Theoretically, access to resources should not merely be considered in the physical affordability and ownership context, but also in the wider political economy setting as stipulated in the Justice and Resource Distribution theory [62] and the Environmental Justice approach [63]. However, in the Lapindo scenario, the environmental justice approach which is oriented towards inclusive recuperation failed completely.

The recovery prioritised legal-formal matters over substantive justice concerns that accommodate vulnerable groups [64]. This is consistent with the criticism that post-disaster recovery favours bureaucratic elitism, where resource access is readily obtained by stronger social and economic capital players [65]. Accordingly, our findings validate existing evidence that post-disaster development

efforts often generate new stratification in afflicted societies [66] In contrast, our study also challenges the Post-Disaster Resilience Framework [67], which argues that disaster-affected communities achieve resilience through local-based adaptation.

Regarding the Lapindo phenomenon, despite the Porong residents being more deprived in access, they displayed a resource diversification pattern considered quite innovative compared to the Jabon inhabitants. This is contrary to the hypothesis that groups with greater access will be better resilient in the long duration [68]

2. The Property Rights and Resource Governance Paradox: The Contradiction between Social Reality and Property Law

Our discovery unveiled a paradox between legitimate land ownership and efficient resource stewardship in the impoverished settlements. Jabon claimed stronger land tenancy, but less effective management compared to Porong and Tanggulangin. Conceptually, this contradicts the Property Rights Theory [69], which contends ownership certainty will empower communities to steward resources sustainably. However, this investigation lends credence to criticisms of the Access Theory [70], asserting formal ownership is not the only factor determining genuine access to resources.

Bureaucracy, political factors, and socio-economic power also determine who can actually utilise and manage resources. These findings correspond with other research evidence that demonstrate legal ownership does not guarantee sovereignty in management due to corporate interests and government intervention [71]. Conversely, data from Porong suggests that despite inferior land ownership, resource protection legitimacy is strengthened compared to Jabon.

This underscores that tightening regulations on property rights provides a potential tool for mitigating injustices over resource apportionment [72]. The Social-Ecological Resilience theory garners empirical validation in this instance, where stricter statutory regulations afford protection against external exploiters [73]

3. Asymmetry in Resource Utilisation Rights: Social-Ecological Adaptation Model Deconstruction

Following our assessment, the affected residents of Porong showed a better adaptation level in resource utilisation compared to Jabon. This counteracts the Vulnerability-Resilience Nexus model [74]'s assumption stating that communities with restricted access are more exposed and incapable of adaptation. Vice versa, our data suggests that communities with constrained access develop community-based adaptation schemes and social cohesion to surmount their limitations [75]. However, these insights further argue that Porong residents' socio-ecological adaptation is predominantly reactive rather than long-term proactive. This is against the concept of Adaptive Capacity [76], which postulates that effective adaptation requires strong institutional preparedness and proactive behaviours.

4. Multi-Stakeholder Collaboration and Policy Complexity: Evaluating Post-Disaster Collaborative Governance Models

The study also concluded that the post-disaster reconstruction policy in Lapindo continues to exhibit a gap between implementation and regulations on the terrain. Although the authorities have launched various reconstruction initiatives, many of these appear to be top-down and insufficiently consider community participation [77]. This is incongruent with the theory of Collaborative Governance [78], which stipulates that post-disaster reconstruction success is entirely dependent on multi-stakeholder coordination and inclusivity.

Furthermore, this study bolsters criticisms of post-disaster policy execution, which argues that numerous post-disaster policies aggravate social exclusion by privileging macroeconomic stabilisation over community-based regeneration [79]. Empirical evidence thus suggests that, in the presence of socially exclusionary regimes, reconstruction policies reproduce inequality [80].

5. Theoretical Reflection and Contribution to the Human Rights Discourse in the Disasters Context

Ideologically, our findings challenge traditional models in disaster and human rights literature that overlook the natural capital aspect of affected people's fundamental rights [81]. By highlighting a critical indicator of socioeconomic rights attainment, we expand the human rights and disaster field's discourse [82]. Furthermore, this argument reaffirms that post-disaster regeneration that does not consider environmental justice and resource distribution carries the potential to create significant social devastation [83]. As such, Disaster Capitalism theory is substantiated by our conclusion, which claims disasters are commonly instrumentalised to restructure economies by sacrificing those affected [84].

5. Conclusion

This study highlights human rights complex dynamics in ecological disasters, particularly related to the rights of utilisation, management, access, and ownership of livelihood-based resources in Lapindo mud-affected territories. Empirical findings indicate significant structural disparities in the rights enforcement across Tanggulangin, Jabon, and Porong sub-districts. This inequality is not only influenced by geographical and ecological circumstances, but also by governance policies that are frequently exclusive, elitist and non-inclusive of the affected groups.

Conceptually, our investigation confirms that the right to resources involves more than just legal-formal procedures; it is a decisive instrument in establishing social and environmental justice. Nevertheless, the post-disaster recovery effort in the Lapindo area has tended to accommodate investment interests over basic rights protection for victims. This is mirrored in the gap between legal ownership and resource management practices, where Jabon has extensive land ownership but suffers from management deficiencies, unlike Porong, which has endured severe ecosystem deterioration despite relatively greater property rights protection.

Our data further unpacks post-disaster governance paradoxes demonstrating that broader access to resources does not mechanically increase optimal utilisation. Instead, complex regulations and tendencies towards regulatory centralisation constrain the flexibility of communities to design locally-driven adaptation solutions. Thus, a recovery programme that merely aims to stabilise the macro-economy disregarding social justice considerations risks perpetuating structural exclusion and inequality for the most disadvantaged groups.

From a theoretical framework, it contributes decisively to human rights discourse in disaster scenarios, by shedding light on natural resource rights as a vital component of post-disaster resilience. This study moreover challenges assumptions in post-disaster resilience literature, which has long portrayed accessibility as the ultimate determinant of social-ecological preparedness. Instead, we argue that community-based adaptation strategies offer greater potential for long-term resilience, even in limited access situations.

In the policy-making sphere, these facts underline human rights-based strategies for more equitable and holistic post-disaster management. Reforms are necessary to ensure that post-disaster resource models guarantee the ecosystem's sustainability and public welfare, rather than just mitigating economic repercussions. In the future, we envisage our findings contributing to the development of a just, evidence-based and responsive disaster risk governance framework that promotes the fundamental rights of vulnerable communities.

6. Recommendation

Judging from our empirical findings, reforming the post-disaster resource stewardship paradigm is urgently imperative. This should be accomplished through a social justice-based methodology for inclusion and human rights preservation. Consequently, post-disaster rehabilitation strategies require human rights-oriented mechanisms that place affected groups at planning and execution centre stage. The essential regulatory reform entails decentralising post-disaster governance to diminish the top-down approach's ascendancy, ensuring social and environmental justice as the policy's bedrock. This

must be geared towards macroeconomic stability and equitable asset distribution. In addition, accountability and transparency in aid distribution and compensation monitoring systems ought to be tightened to counteract the distortion caused by prioritising investment interests above the affected communities' basic rights.

In terms of resource management and ownership, this investigation discovered a paradox between real control and resource legal entitlement. Strengthening legal instruments for ownership rights through regulatory amendments is vital to providing land and property protection for affected communities. Beyond that, the resource redistribution programme must incorporate monetary and non-monetary incentives to affected residents, such as access to arable land and designated economic zones. The government needs to promote a collaborative governance regime, involving the civil society, the private sector, and the government, to achieve equitable, sustainable resource management based on community engagement.

In addition, community-based socio-ecological adaptation efforts must be supplemented by resilient adaptation infrastructure, including upgraded water drainage systems, disaster-resistant agricultural equipment, and environmental mitigation measures based on ecosystem conservation. Local economic empowerment initiatives also need further elaboration through ecotourism projects, livelihood diversification, and eco-friendly farming initiatives to minimise people's dependence on degraded resources. Socio-ecological capacity building and awareness remain paramount to empower victims in developing effective and autonomous long-term solutions.

In governance sense, reforms are vital in multi-stakeholder governance frameworks which are more evidence-based, multi-actor and structured towards tackling fragmented policies and interest conflicts in post-disaster recuperation. A key priority is the setting up of a Post-Disaster Oversight Council, an independent body comprising government, academia, civil society and affected communities to ensure that policies are responsive, inclusive and oriented towards social justice. In addition, the harmonisation of regulations and incentive structures also deserves greater attention so that post-disaster reconstruction policies dovetail with regional development initiatives, incentivising projects promoting environmental restoration, social empowerment and green economic advancement. The authorities must also enforce the principle of transparency in the decision-making process, for example through open data-based information technology, which facilitates real-time public access to data on compensation allocation and recovery programme milestones.

Reform of the policy model for sustainable ecosystems must be a core priority in maintaining the balance. Post-disaster land revitalisation must be approached with nature-based solutions, such as reforestation, improved land cultivation for long-term agriculture, and aquatic ecosystem restoration. In addition, a circular economy approach to recovery must be embedded, where disaster-affected material can be reused to offset carbon emissions and strengthen the local livelihoods. This cannot be achieved without the government cracking down on environmental exploitation, with strict supervision and sanctions against industrial operations that aggravate ecosystem depletion in devastated sites.

The academic and research institutions play an indispensable role as part of the endeavour to construct evidence-based policy. Multi-disciplinary research collaboration is essential to avoid a narrow focus on technical dimensions and encompass economic, social and environmental concerns. The government must push for knowledge hub development on post-disaster governance, a data and research platform accessible to affected communities and policy setters. Research results must be integrated into regulations through collaborative mechanisms between stakeholders to legitimise evidence-based policies and maintain systematic recovery.

Consequently, our recommendation affirms that recovery from the Lapindo disaster must be oriented towards environmental sustainability, social justice, and inclusivity in resource management. The current recovery model is still characterised inequality in access and benefits, which potentially prolongs the socioeconomic consequences for affected communities. Therefore, a multi-stakeholder,

evidence-based approach that prioritises human rights is warranted, so that the produced policies are equipped to overcome structural disparities, improve social-ecological resilience, and guarantee just and long-lasting recovery.

Copyright Contribution Statement:

Arie E. Baskhoro: Manuscript drafting, critical review & editing, Validation, Methodology, Formal analysis, Conceptualisation.

Thi Phuoc Lai Nguyen: Manuscript compilation, critical review & editing, Validation, Supervision, Project administration, Methodology, Formalisation.

Declaration of Conflict of Interest

The authors hereby declare that they have no conflict of interest, either in the form of financial or personal affiliations, which could be considered to potentially influence the research objectivity and scientific integrity presented in this publication.

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APPENDIX 1:

Name	Code	Content of Programme/Policy
President of Indonesia	1A	Establishment of Sidoarjo Mud Management Agency & Sidoarjo Mud Control Centre
	1B	Mud Flow to Porong River
	1C	Emergency Programme for Lapindo Mudflow Victims
	1D	Work with international organisations and agencies to secure technical and financial support for the Lapindo Mud disaster
Ministry of Finance & Ministry of Public Works	1E	Legal Resolution and Corporate Liability (PT Lapindo Brantas)
	2A	Regulate government intervention in land purchase and assistance for affected victims
	2B	Re-zone land use in the affected area and permanently prohibit land ownership in mud-affected areas.
	3A	Continue the compensation policy and ensure that the assistance mechanism continues to work for affected communities.
Sidoarjo mudflow management agency and Sidoarjo Mudflow Control Centre	3B	Provision of land and alternative settlements for affected residents with re-regulated land ownership rights
	3C	More intensive monitoring of potential disasters from mudflow and research to prevent similar problems from occurring in the future
	3D	Continue education and outreach programmes to improve community preparedness in the face of potential disasters and environmental impacts from industrial activities.
	4A	Regulate the rights of disaster victims to gain access to recovery, including rights to land and economic resources.
The house of representatives of the republic of indonesia	4B	Require Lapindo Brantas to participate in environmental rehabilitation and conduct a social impact assessment on the community.
	5A	Assistance and mentoring for small businesses, including crafts and home industries for affected residents
	5B	Regulates the spatial planning of East Java Province, including Sidoarjo District.
	5C	Change the status of the affected land to industrial zones or areas that cannot be utilised for settlement or agriculture.
Sidoarjo district government and east java provincial government	5D	Set out the details of spatial planning and zoning in Sidoarjo Regency, which serves as a reference in the post-Lapindo Mudflow disaster spatial planning.
	6A	Rehabilitation and reconstruction of damaged and unmet facilities and infrastructure
	6B	Contributing to the education and social sectors for disaster victims.
	6C	Cash and non-cash assistance for affected families who have lost their livelihoods.
Minister of Infrastructure and Regional Development and Minister of Social Affairs	7A	Development of ponds and fisheries in areas that have been permanently inundated with mud as a new source of livelihood.
Ministry of Maritime Affairs	8A	Development of the affected area as a tourist attraction to create jobs for the community
	8B	Improving the infrastructure of Lapindo mud tourist attractions
	9A	PT Lapindo Brantas Corporate Social Responsibility programme which includes various social activities to help affected communities.
	9B	Clean Water Aid for Gempolsari Village
Ministry of Energy & Mineral Resources & Private Investors	9C	Development of geothermal energy sources from Lapindo mud volcanic activity as a new economic potential.
	9D	PT Lapindo Brantas' programme to purchase land and buildings owned by affected communities in accordance with the Affected Area Map.
	10A	Organise competency certification tests to support work
	10B	Training for former farmers and small business owners who lost their land and businesses

*The author's analysis results are based on secondary data sources.