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Original Article

Socio-Economic Effects of River Aggregates Quarrying in Masiu, Lanao del Sur: Community Perceptions and Policy Implications

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Abstract. River aggregate quarrying has expanded in many rural areas as a source of construction materials and local income. However, its socio-economic implications at the community level remain insufficiently documented, particularly in resource-dependent settings. This study assessed the socio-economic consequences of river aggregate quarrying in Masiu, Lanao del Sur, to establish a community-based baseline to inform policy development. Using a mixed-methods design, data were collected from 200 household respondents across six barangays through structured surveys and semi-structured interviews. Quantitative data were analyzed using descriptive statistics, while spatial patterns of perceived impacts and household willingness to engage in quarrying were examined using heatmaps and scatter plots; qualitative interview data were thematically analyzed to contextualize survey results. The findings indicate that quarrying generates short-term economic benefits, particularly employment opportunities for river-adjacent communities, but is also associated with increased household expenses, declining agricultural productivity, and infrastructure deterioration. Spatial analysis revealed that the intensity of livelihood impacts is strongly linked to proximity to quarrying sites, with communities closest to the river experiencing the most pronounced cumulative effects. Household willingness to engage in quarrying was primarily driven by economic necessity rather than positive valuation of quarrying as a sustainable livelihood. Hence, the study concludes that river aggregate quarrying in Masiu produces uneven socio-economic outcomes that warrant context-sensitive regulation, livelihood diversification, and community-based governance to balance economic needs with long-term household and community well-being.

Keywords: *Community perceptions; Livelihood impacts; Policy implications; Quarrying; Rural development.*

River aggregate quarrying has become an integral component of local development processes in many rural regions, supplying materials essential for infrastructure expansion while simultaneously reshaping socio-economic and environmental conditions. From an interdisciplinary perspective, quarrying represents not only an extractive economic activity but also a social and spatial phenomenon that intersects with livelihoods, governance, environmental change, and community well-being. Previous studies have shown that while quarrying can generate short-term employment and income, it often produces uneven socio-economic outcomes, particularly in communities where agriculture and river-based resources remain central to household survival (Vanclay, 2002; Gamu et al., 2015; Vanclay, 2020; Peša & Ross, 2021; Wen et al., 2023; Kitole et al., 2025).

Research across development studies, environmental sociology, and rural geography emphasizes that quarrying-related impacts are rarely confined to environmental degradation alone (Kondolf,2022). Instead, they manifest through interconnected pathways affecting household expenses, agricultural productivity, infrastructure conditions, and access to services (Le Billon, 2014; Bendixen et al., 2021; Mokoka & Malaza, 2025). Livelihood studies further suggest that participation in extractive activities is often shaped by economic constraints rather than by long-term livelihood strategies, particularly in settings with limited employment opportunities (Scoones, 2015; Bainton & Holcombe, 2018). Spatial factors such as proximity to extraction sites have been shown to mediate both exposure to negative impacts and household willingness to engage in quarrying, stressing the need for place-based analysis (Settele & Shupe, 2022; Ahmer & Ostendorf, 2025)

In Masiu, Lanao del Sur, river aggregate quarrying has expanded alongside persistent dependence on agriculture and natural resource-based livelihoods. Despite its growing presence, there has been limited empirical examination of how quarrying influences household welfare, livelihood decision-making, and community perceptions across space. Responding to this gap, the present study adopts an interdisciplinary, mixed-methods approach to assess the socio-economic consequences of river aggregate quarrying in selected barangays of Masiu. By integrating quantitative survey data, qualitative interview perceptions, and spatial visualizations, the study aims to generate a community-level evidence base that can inform local policy development while contributing to broader interdisciplinary discussions on sustainable resource governance and rural development.

Methodology

Research Design

This study employed a mixed-methods approach, specifically an explanatory sequential design, to examine the socioeconomic effects of river aggregate quarrying in Masiu, Lanao del Sur. In this design, quantitative data are collected and analyzed first, followed by qualitative data to explain and contextualize the initial results, consistent with established mixed-methods frameworks (Creswell & Plano Clark, 2018). The use of this design enabled the study to quantify community perceptions of quarrying-related impacts and to elicit deeper insights into lived experiences through qualitative analysis.

Study Area and Respondents

The study was conducted in the municipality of Masiu, Lanao del Sur, an area where river aggregate quarrying is actively practiced and where communities rely heavily on river resources for livelihoods and domestic use. Six barangays located at varying distances from quarrying sites were included to capture spatial variation in perceived socio-economic impacts. The primary respondents were household members who had resided in the area for several years and were presumed to have sufficient exposure to quarrying activities and their consequences.

Sampling Technique and Sample Size

A purposive sampling technique was used to select barangays based on their proximity to quarrying zones. Within each barangay, households were selected using systematic sampling to ensure adequate representation. A total of 200 household respondents participated in the survey, a sample size considered sufficient for descriptive and comparative statistical analysis. Distance from quarrying sites was also considered as an analytical variable to examine variations in perception and experience.

Data Collection Instruments and Procedure

Quantitative data were collected using a structured survey questionnaire designed to assess respondents' perceptions of the socio-economic effects of river aggregate quarrying. The questionnaire covered key domains including employment opportunities, livelihood impacts, household income and expenses, transportation and infrastructure conditions, and overall community well-being. Responses were measured using a Likert-type scale to capture levels of agreement. Following the quantitative phase, qualitative data were gathered through semi-structured interviews with selected respondents. The interviews aimed to elaborate on survey findings by exploring respondents' personal experiences, perceived benefits and challenges of quarrying, and observed changes in household and community conditions. This sequential process enabled the qualitative phase to explain the patterns identified in the quantitative results directly.

Data Analysis
Quantitative data were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to summarize respondent characteristics and perception scores. Inferential analysis, including nonparametric tests such as the Kruskal–Wallis test, was employed to assess differences in perceptions across groups defined by distance from quarrying sites and selected sociodemographic variables.

Qualitative interview data were analyzed thematically. Responses were transcribed, coded, and grouped into emerging themes related to livelihoods, economic opportunities, household challenges, and community-level impacts. Qualitative analysis was conducted after the quantitative phase to ensure alignment with the explanatory sequential design and to provide contextual interpretation of statistical results.

Ethical Considerations
Ethical considerations were observed throughout the study. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Respondents were assured of confidentiality and anonymity, and no personally identifiable information was included in the analysis or reporting of results.

Results and Discussion

Socio-Demographic Profile of Respondents
The socio-demographic profile of the 200 household respondents provides important context for understanding community perceptions of river aggregate quarrying in Masiu, Lanao del Sur. Respondents were predominantly male, reflecting the gendered nature of quarrying and farming, although a substantial proportion of women, primarily engaged in household management and small-scale trading, were also represented. Most respondents belonged to the economically productive age groups, particularly those aged 31–50 years, indicating that perceptions were primarily shaped by individuals directly engaged in livelihood activities. Educational attainment was generally at the secondary level, consistent with the municipality's rural setting. Farming emerged as the primary occupation, followed by quarry-related labor and other informal activities, underscoring a strong dependence on natural-resource-based livelihoods. The majority of respondents were long-term residents, having lived in the area for more than ten years, and many resided within one to three kilometers of active quarry sites, suggesting sustained and direct exposure to quarrying-related socio-economic and environmental impacts.

Table 1. *Socio-Demographic Profile of the Respondents*

Variable	Category	Frequency (*f*)	Percentage (%)
Sex	Male	118	59.0
	Female	82	41.0
Age Group	18–30 years	42	21.0
	31–40 years	58	29.0
	41–50 years	54	27.0
	51 years and above	46	23.0
Educational Attainment	Elementary Level	54	27.0
	Secondary Level	92	46.0
	Tertiary Level	54	27.0
Primary Occupation	Farming	86	43.0
	Quarry-Related Labor	48	24.0
	Small-Scale Trading	36	18.0
	Other Occupations	30	15.0
Years of Residence	Less than 5 years	28	14.0
	5–10 years	46	23.0
	More than 10 years	126	63.0
Distance from Quarry Site	Less than 1 km	62	31.0
	1–3 km	88	44.0
	More than 3 km	50	25.0

In Table 1, the socio-demographic profiles of the 200 household respondents provide important data on how community perceptions of river aggregate quarrying in Masiu, Lanao del Sur, are formed and sustained. Most male respondents reflect the gendered nature of quarrying and agricultural labor. In contrast, women's substantial participation is primarily in household management and small-scale trading, indicating broader household-level exposure to the impacts of quarrying. Based on the profiling, most respondents belonged to the economically productive age groups (31–50 years), implying that perceptions are primarily shaped by individuals actively engaged in livelihood activities and are therefore directly sensitive to fluctuations in income, farming productivity, and infrastructure conditions. Additionally, the generally moderate level of educational attainment suggests that

awareness of quarrying impacts is driven more by direct experience than by formal environmental knowledge, a pattern commonly observed in rural, resource-dependent communities (Pretty & Smith, 2004).

Farming emerged as the dominant livelihood among the surveyed respondents, indicating the community's dependence on land and river systems and explaining heightened concern about quarrying-related disruptions. The high proportion of long-term residents, many of whom have lived in the area for more than a decade, further strengthens the reliability of their perceptions, as these respondents can compare conditions before and after the intensification of quarrying. Moreover, the concentration of households within one to three kilometers of quarry sites intensifies direct exposure to dust, noise, road degradation, and altered river conditions, reinforcing negative socio-economic perceptions. Consistent with studies on extractive industries in rural settings, these findings propose that location, livelihood, and duration of exposure serve a central role in shaping community assessments of quarrying that often lead residents to adapt short-term economic gains as insufficient compensation for longer-term risks to livelihood security and well-being (Hilson, 2002; Wen et al., 2023; Le Billon, 2014; Peša & Ross, 2021; Vanclay, 2020; Vanclay, 2002; Bendixen et al., 2021).

Measured Economic Contributions of River Aggregate Quarrying

As shown in Table 2 below, respondents generally agreed that river aggregate quarrying contributes to local economic activity, particularly through employment generation (WM = 3.62), local income circulation (WM = 3.41), and household participation in quarry-related work (WM = 3.58). These quantitative findings are reinforced by interview narratives, which reveal that quarrying serves as an important, though often precarious, source of income for many households in Masiu.

Table 2. *Measured Economic Contributions of River Aggregate Quarrying (n = 200)*

Indicator	Weighted Mean	Interpretation
Quarrying provides employment opportunities.	3.62	Agree
Quarrying increases local income circulation.	3.41	Agree
Quarrying contributes to short-term economic activity.	3.53	Agree
Households have members engaged in quarry-related work.	3.58	Agree

Scale: 1.00–1.75 (Strongly Disagree); 1.76–2.50 (Disagree); 2.51–3.25 (Neutral); 3.26–4.00 (Agree)

Several interview participants described quarrying as a means of sustaining immediate household needs, especially in the absence of alternative employment opportunities. For some families, income from quarrying has supported basic expenses such as food, schooling, and minor household improvements. One participant shared that earnings from quarrying enabled a family member to continue secondary education. However, concerns were raised about the physically demanding nature of the work and its potential to interfere with schooling.

"Yes, actually. In fact, one of my children, who is still a high school student, has continued his studies with support from earnings from river aggregate quarrying. However, I am still afraid he might get tired and stop going to school due to the load of work from quarrying, since it needs a lot of body work and consumes time…"

This echoes the general pattern observed in rural extractive communities, where quarrying income is often used to meet short-term needs rather than to build long-term economic security (Hilson, 2002; Peša & Ross, 2021). Household participation in quarry labor also appeared to be necessary to reinforce livelihoods, particularly among respondents with limited formal education. As one participant explained, quarrying became a default option due to a lack of educational qualifications and employment alternatives.

"Sort of. Originally, since we are not educated or we did not finish studying, my family had no choice but to rely on this quarrying…"

This finding supports the existing literature, which shows that river extraction activities frequently involve labor excluded from formal employment markets, reinforcing dependency rather than upward mobility (Wen et al., 2023). Interview responses further illuminate the uneven distribution of economic benefits, which helps explain the moderate weighted means reported in Table 2. While truck operators and those directly involved in hauling aggregates reported relatively higher financial gains, residents living farther from quarrying sites indicated minimal economic benefit, aside from access to cheaper construction materials. This disparity supports previous findings that the benefits of quarrying tend to concentrate among specific actors within the value chain, whereas broader community-level gains remain limited (Vanclay, 2020; Vanclay, 2002; Bendixen et al., 2021).

Notably, the interviews also reveal that even those who benefit economically express contradiction and uncertainty regarding the sustainability of quarrying as a livelihood. Several participants acknowledged that while quarrying currently provides income, it is perceived as physically exhausting, environmentally damaging, and unlikely to persist in the long term. This uncertainty mirrors findings from studies indicating that extractive livelihoods often provide immediate financial relief at the expense of long-term economic vulnerability (Settele & Shupe, 2022; Le Billon, 2014).

Measured Impacts on Livelihood and Agricultural Activities

The results presented in Table 3 show a strong consensus among respondents that river aggregate quarrying has adversely affected livelihoods and agricultural activities in Masiu. The highest level of agreement was observed for the statement *"Farming activities have been negatively affected by quarrying"* (WM = 3.89), reflecting the central role of agriculture in the local economy and the vulnerability of farming systems to environmental disturbance. Survey findings are strongly reinforced by interview narratives, particularly from respondents directly engaged in farming. Several farmers reported a sharp decline in crop yield and soil quality following the intensification of quarrying activities.

Table 3. *Measured Impacts on Livelihood and Agricultural Activities (n = 200)*

Indicator	Weighted Mean	Interpretation
Farming activities have been negatively affected by quarrying.	3.89	Agree
Quarrying has reduced agricultural productivity.	3.76	Agree
Dust and sediment from quarrying affect crops and soil quality.	3.83	Agree
Quarrying disrupts access to irrigation and river water.	3.71	Agree

Scale: 1.00–1.75 (Strongly Disagree); 1.76–2.50 (Disagree); 2.51–3.25 (Neutral); 3.26–4.00 (Agree)

One interviewee explained that crops planted near the river now "*do not grow as well as before*," and "*Our farmland near the shore is getting destroyed or sinking due to this quarrying. This needs to stop, or at least be regulated by the government,"* attributing this change to the increased dust and soil disturbance. Such observations are consistent with established studies showing that quarrying-induced sediment disruption and dust deposition reduce soil fertility and impair crop productivity (Mokoka & Malaza, 2025; Kondolf, 1997; Bendixen et al., 2021). The perception that quarrying has reduced agricultural productivity (WM = 3.76) is further supported by accounts of altered river behavior. Interview participants reported changes in water clarity, depth, and flow that affected their ability to irrigate farms, particularly during dry months. One farmer described,

"…The river is not the river we once knew anymore. I think it is dead; it has stopped flowing. We are also afraid to drink since it seems non-potable anymore…"

This remark makes irrigation more difficult than in previous years. These experiences support hydrological studies demonstrating that instream aggregate extraction can disrupt sediment balance and river morphology, thereby affecting downstream water availability for agriculture (Kondolf et al., 2002; Bendixen et al., 2021; Wen et al., 2023). Thus, the impacts of dust and sediment on crops and soil (WM = 3.83) were vividly described in interviews. Respondents observed that fine particles from quarry operations settled on crop leaves and farmland, increasing plant stress and reducing harvest quality. Similar effects have been documented in adjacent mining agricultural communities, where airborne particulates interfere with photosynthesis and accelerate soil degradation (Mokoka & Malaza, 2025). In communities that depend heavily on resources such as Masiu, where agricultural harvests are limited, such impacts can significantly undermine household income and food security (Ogundana & Afolalu, 2024).

Disruptions to irrigation and river access (WM = 3.71) appeared as a recurring theme in both survey and interview data. Several respondents expressed concern that continued quarrying would further compromise access to water, particularly for downstream farms. One participant emphasized that "*the river used to be reliable for farming, but now it is difficult to predict*," stressing growing uncertainty among agricultural households. This concern reflects broader findings that extractive activities often intensify competition over water resources, particularly in rural and agrarian contexts (Peša & Ross, 2021; Vanclay, 2020; Vanclay, 2002). Thus, this trade-off mirrors patterns observed in other communities, where immediate economic benefits are offset by longer-term declines in livelihood sustainability and food security (Settele & Shupe, 2022; Le Billon, 2014). In Masiu, the strong dependence on farming amplifies the socio-economic consequences of quarrying-related environmental change,

reinforcing community concerns about the long-term viability of their livelihoods.

Measured Effects on Household Expenses, Transportation, and Infrastructure

As shown in Table 4, respondents strongly agreed that river aggregate quarrying has increased household expenses and placed significant pressure on local transportation and infrastructure systems. The highest agreement was recorded for the statement *"Quarry trucks have damaged local roads"* (WM = 3.86), indicating that road degradation is one of the most visible and immediate socio-economic consequences of quarrying in Masiu. Interview narratives vibrantly support this finding. Several participants described how the constant movement of heavily loaded quarry trucks has accelerated road deterioration, particularly on barangay roads not designed for heavy industrial traffic. One resident noted that roads which were previously passable year-round have become "*rough and muddy, especially during the rainy season*," making daily travel more difficult. Similar infrastructure impacts have been widely documented in quarrying and mining communities, where transport traffic contributes disproportionately to rural road damage (Ashraf et al., 2011; Hilson, 2002).

Table 4. *Measured Effects of River Aggregate Quarrying on Household Expenses, Transportation, and Infrastructure (n = 200)*

Indicator	Weighted Mean	Interpretation
Quarrying has increased transportation costs.	3.74	Agree
Quarry trucks have damaged local roads.	3.86	Agree
Household expenses have increased due to quarrying.	3.58	Agree
Access to markets and services has become more difficult.	3.52	Agree

Scale: *1.00–1.75 (Strongly Disagree); 1.76–2.50 (Disagree); 2.51–3.25 (Neutral); 3.26–4.00 (Agree)*

The increase in transportation costs (WM = 3.74) further reflects the indirect economic burden borne by households. Interviewees reported rising tricycle fares, increased fuel consumption, and more frequent vehicle repairs due to poor road conditions. A transport operator explained that maintenance costs have increased because vehicles are "*The elf trucks seem to suffer a lot from a damaged path road from quarrying sites to the national road*". Such costs are often passed on to passengers, thereby compounding household expenses. This pattern aligns with studies showing that infrastructure degradation from extractive activities creates hidden costs that disproportionately affect non-beneficiary households (Vanclay, 2020; Vanclay, 2002; Bendixen et al., 2021).

Respondents also agreed that household expenses have increased (WM = 3.58), a perception echoed in interviews, in which residents attribute higher transportation costs to rising prices of basic goods. One participant explained that market goods now cost more because vendors account for higher transport costs. In rural economies where income margins are already narrow, even modest increases in daily expenses can significantly affect household welfare. These costs are externalized mainly to the broader community, reinforcing perceptions of inequality and economic strain. Consistent with international findings, the Masiu case illustrates how unregulated or weakly regulated quarrying can undermine rural infrastructure and household economic stability, even as it generates localized economic activity (Settele & Shupe, 2022; Le Billon, 2014).

Spatial Patterns of Household Willingness to Engage in Quarrying under Existing Challenges

Figure 1 below presents the heatmap of household willingness to engage in river aggregate quarrying across six selected barangays in Masiu, despite the socio-economic and environmental challenges identified in earlier sections. The distribution reveals apparent spatial and livelihood-related differences in willingness levels, which are closely associated with proximity to quarrying sites and access to quarry-related income opportunities.

Barangays located closer to the river: Gondarangin, Asa Adigao, A. Datimbang, Balindong, and Paino exhibit higher concentrations of households within the *moderate* to *moderate-high* willingness categories. In Gondarangin, Asa Adigao, the largest number of respondents clustered in the moderate-willingness category (42 households), followed by the moderate-high category (32 households). A similar pattern is evident in A. Datimbang, Balindong, and Paino, where moderate willingness consistently exceeds both low and high extremes. This implies that households in these barangays recognize quarrying as a readily accessible source of income, yet remain cautious due to its associated risks. In contrast, barangays situated farther from the river, particularly Buadi Amaloy, Apa Mimbalay, and Magayo Bago a Ingud, show a noticeable shift toward *low* and *moderate-low* willingness categories. Magayo Bago a Ingud, the farthest barangay from the quarrying sites, reports the lowest overall willingness, with only three households expressing high willingness and the majority falling within the low-to-moderate range. This pattern reflects limited direct economic benefits from quarrying, coupled with continued exposure to indirect costs, such as increased transportation expenses and higher market prices, as discussed in previous sections.

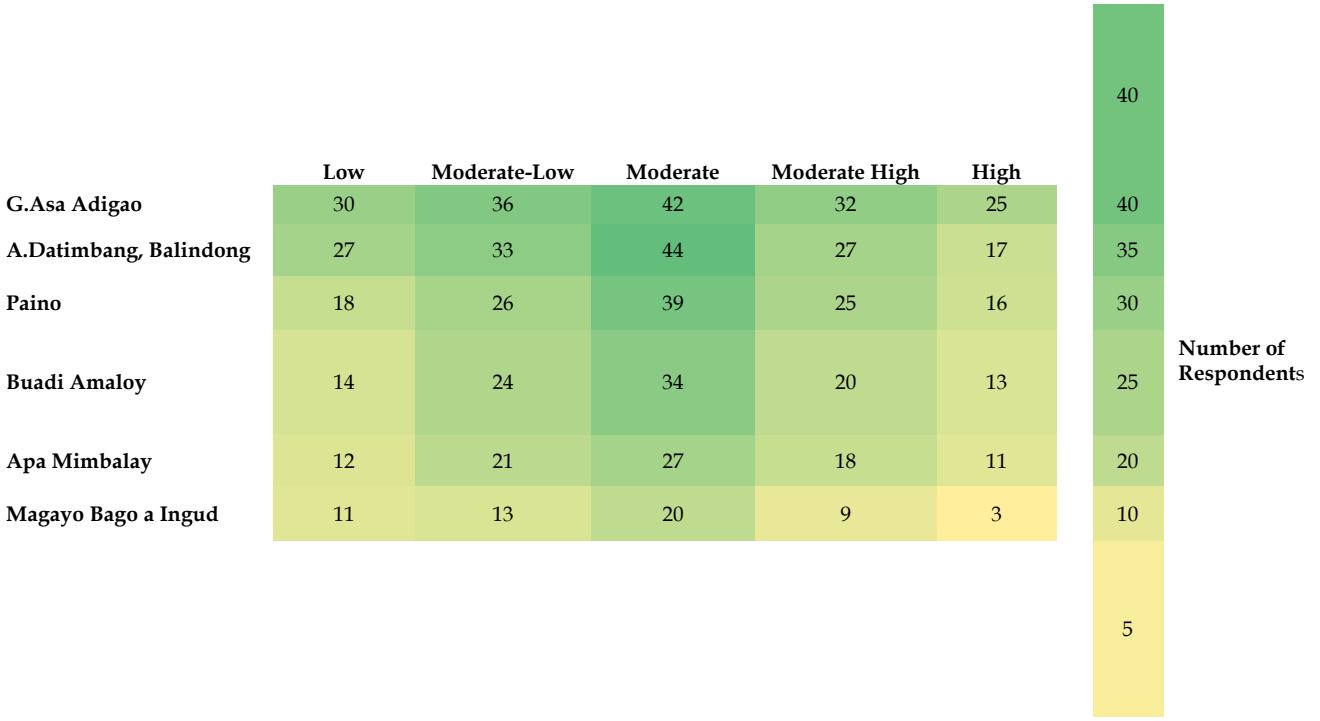

Figure 1. *Heatmap showing household willingness to engage in river aggregate quarrying across selected barangays in Masiu, Lanao del Sur. Color intensity indicates the concentration of households within each willingness category – source: Field data.*

Significantly, the heatmap indicates that high willingness levels remain relatively low across all barangays, including those closest to the river. This indicates that willingness to engage in quarrying is largely conditional rather than enthusiastic, driven more by economic necessity than by positive valuation of quarrying as a sustainable livelihood. Interview narratives reinforce this interpretation, as several respondents emphasized that quarrying is considered only when alternative income sources are unavailable, reflecting constrained choice rather than preference. These spatial patterns are consistent with findings from aggregate extraction studies, which show that location settings increase the probability of participation but do not eliminate concerns about livelihood sustainability and environmental degradation (Hilson, 2002; Vanclay, 2020; Peša & Ross, 2021). Communities closest to extraction sites tend to experience both the highest dependence on quarrying income and the greatest exposure to its negative externalities, creating a persistent tension between short-term survival and long-term well-being.

Distribution of Quarrying Impacts on Household Livelihoods

Figure 2 illustrates the distribution and intensity of perceived quarrying impacts on household livelihoods across selected barangays in Masiu, Lanao del Sur. The scatter plot reveals an apparent spatial clustering of barangays by location relative to quarrying sites and by the degree of livelihood dependence on river-based resources, reinforcing the role of geographic exposure in shaping socio-economic vulnerability. Barangays located nearest to active quarrying zones, particularly Gondarangin, Asa Adigao, A. Datimbang, Balindong, and Paino, are positioned in the upper-right portion of the plot, indicating both higher composite impact scores and a greater number of livelihood impact dimensions. This pattern suggests that households in these barangays face overlapping pressures, including declining agricultural productivity, rising household expenditures, and greater difficulty accessing markets and services. Similar cumulative livelihood effects have been documented in rural extractive communities, where environmental disruption interacts with economic precarity to intensify household vulnerability (Peša & Ross, 2021; Scoones, 2015).

The clustering of high-impact barangays further supports earlier survey and interview findings that quarrying-related benefits are often accompanied by livelihood risks rather than long-term economic security. Studies on quarrying and small-scale mining have shown that while extractive activities may provide short-term income, they frequently undermine traditional livelihoods such as farming and fishing, leading to livelihood fragmentation rather than diversification (Kafu-Quvane & Mlaba,2024; Le Billon, 2014). Barangays with moderate

levels of impact, namely Buadi Amaloy and Apa Mimbalay, exhibit intermediate exposure to quarrying-related stressors. Although these communities are less directly affected by extraction activities, households still report indirect impacts such as increased transportation costs and higher prices of basic goods. This spatial spillover effect is consistent with findings from rural infrastructure and extractive governance studies, which emphasize that economic externalities of quarrying often extend beyond immediate extraction sites (Vanclay, 2020; Bendixen et al., 2021).

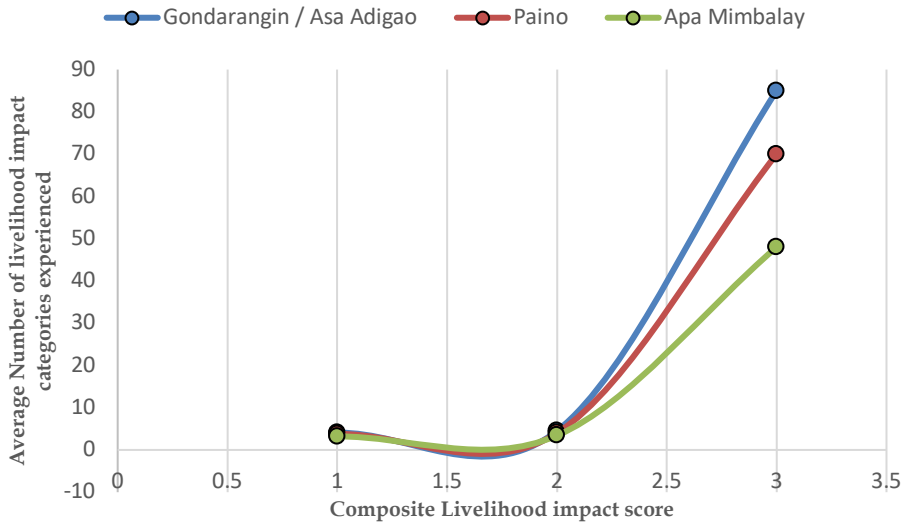

Figure 2. *Scatter-bubble plot illustrating the distribution and intensity of perceived quarrying impacts on household livelihoods across selected barangays in Masiu, Lanao del Sur.*

Magayo Bago a Ingud, the barangay farthest from the river, occupies the lower-left portion of the scatter plot, reflecting comparatively lower impact scores and fewer livelihood disruptions. This supports the argument that distance moderates the exposure and intensity of quarrying impacts. However, the presence of non-zero impact scores even in this barangay indicates that quarrying effects are not spatially isolated, but instead embedded within broader local economic systems. Similar distance-related gradients have been observed in extractive landscapes, where indirect effects such as market price shifts and mobility constraints affect communities beyond extraction zones (Settele & Shupe, 2022).

Thus, the scatter plot complements the heatmap and tabular analyses by visually demonstrating that livelihood impacts are unevenly distributed and intensify with proximity and livelihood dependence, rather than being uniformly experienced across communities. The absence of barangays exhibiting low impact intensity alongside high livelihood engagement further suggests that quarrying does not function as a sustainable livelihood pathway for most households. Instead, it reinforces patterns of economic necessity participation, a phenomenon widely documented in extractive economies characterized by limited alternative livelihood options (Bainton & Holcombe, 2018; Ahmer & Ostendorf, 2025).

Contribution to the Knowledge Advancement

This study contributes to the growing body of research on river aggregate quarrying by providing empirical, community-level evidence from a rural Philippine context that remains underrepresented in existing research. Although previous studies have documented the socioeconomic impacts of quarrying primarily in urban or large-scale extractive settings, the present findings address a critical gap by demonstrating how small-scale, localized quarrying activities influence livelihoods, household expenses, infrastructure conditions, and community well-being in a resource-dependent municipality. By focusing on household perceptions across varying distances from quarry sites, the study adds spatial specificity to discussions of the impacts of quarrying, which are often treated uniformly in prior research.

The integration of quantitative survey data with qualitative interview narratives further extends current

knowledge by illustrating how measured patterns of socio-economic change are experienced and interpreted by affected communities. Rather than treating community perceptions as supplementary, this study positions them as a central analytical component that enriches understanding of quarrying-related impacts. This approach responds to recent calls to bridge statistical analysis with lived experience, particularly in environmental and development studies where local knowledge plays a crucial role in shaping adaptive responses and policy relevance.

Moreover, the findings offer new insights into the complex trade-offs associated with river aggregate quarrying in rural settings. While respondents acknowledged short-term economic benefits, such as employment opportunities and income circulation, these were often offset by longer-term challenges, including livelihood sustainability, rising household costs, and deteriorating infrastructure. By explicitly documenting these tensions, the study advances a more balanced and context-sensitive understanding of quarrying impacts, providing evidence to inform more inclusive and responsive policy interventions.

Policy Recommendation

The findings of this study demonstrate that river aggregate quarrying in Masiu generates uneven socio-economic outcomes, characterized by short-term livelihood opportunities alongside persistent household-level and community-wide costs. In response, policy interventions should move beyond general regulation and adopt a context-sensitive, evidence-based approach grounded in local realities.

a) First, strengthened barangay-level quarry governance is essential. Given that livelihood impacts are most pronounced in communities closest to quarrying sites, local government units (LGUs) should institutionalize spatially differentiated extraction limits, designate quarry-free buffer zones near agricultural lands, and enforce time-bound hauling schedules. These measures can reduce cumulative livelihood disruption while allowing controlled economic activity.
b) Second, livelihood transition and diversification support should be prioritized in high-impact barangays. The scatter plot and heatmap findings indicate that household willingness to engage in quarrying is primarily driven by economic necessity rather than long-term preference. Skills development programs, agricultural input support, and small-enterprise financing can reduce dependency on quarrying as a fallback livelihood and enhance household resilience.
c) Third, mandatory infrastructure responsibility mechanisms, such as river control, should be established for quarry operators. The documented increase in household expenses and transportation challenges highlights the need to internalize quarrying-related external costs. Policies requiring operators to contribute to road maintenance, drainage systems, and transport safety through impact fees or maintenance agreements can mitigate infrastructure deterioration and prevent cost transfers to households.
d) Fourth, community-based monitoring and participation frameworks should be formalized. Residents possess long-term experiential knowledge of livelihood and environmental changes and should be engaged as partners in monitoring quarry impacts. Barangay-level monitoring committees can enhance accountability, improve compliance, and facilitate transparent communication between communities, operators, and regulators.
e) Finally, integrated livelihood and environmental planning should guide future quarry policy decisions. The spatial distribution of impacts emphasizes the need to align quarry permits with land-use planning, agricultural protection, and rural development objectives. Policies that balance economic extraction with livelihood sustainability can prevent the entrenchment of extractive dependency and promote more equitable development outcomes.

Hence, these recommendations emphasize that effective quarry governance in Masiu requires not only regulating extraction activities but also proactively investing in alternative livelihoods, infrastructure protection, and participatory decision-making. Such an approach can help reconcile immediate economic needs with long-term community well-being and policy sustainability.

Conclusion

This study demonstrates that river aggregate quarrying in Masiu, Lanao del Sur, generates both perceived economic benefits and substantial socio-economic challenges for local communities. Although quarrying activities were associated with short-term employment opportunities and localized income circulation, these benefits were frequently offset by adverse effects on household livelihoods, rising living expenses, and deteriorating

transportation and infrastructure conditions, particularly among households closer to quarrying sites. The findings emphasize the uneven distribution of the costs and benefits of quarrying and underscore the importance of incorporating community perspectives into local development planning and environmental governance.

From a practical and policy standpoint, the results suggest the need for targeted interventions to enhance community preparedness and mitigate quarrying-related impacts. Local government units may consider strengthening monitoring and regulation of quarrying operations, particularly with respect to transport routes, infrastructure maintenance, and safety measures in affected barangays. Community-based programs, such as livelihood diversification initiatives, skills training for non-quarry employment, and participatory planning mechanisms, can help reduce household vulnerability and enhance resilience. Clear policy guidelines on quarrying operations, coupled with regular community consultation, may also promote more equitable sharing of economic benefits while minimizing social disruption.

Several limitations of this study should be acknowledged. The reliance on self-reported perception data may introduce response bias, and the cross-sectional design limits the ability to capture long-term socio-economic changes. Although the sample size was adequate for descriptive and comparative analyses within the study area, caution should be exercised when generalizing the findings to other communities with different socioeconomic or regulatory contexts. Future research may build on this work by employing longitudinal designs, incorporating objective economic indicators, and comparing multiple quarrying-affected communities to better understand long-term impacts and policy effectiveness. Such studies would further strengthen evidence-based decision-making in resource-dependent settings.

Contributions of Authors

Author 1: supervision, management, and analysis
Author 2: data gathering and tabulations
Author 3: data gathering and tabulations
Author 4: data gathering and tabulations
Author 5: manuscript writing, analysis, and management

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Conflict of Interests

The authors declare no conflict of interest.

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