

The Importance of Livelihood Diversification on Agroforestry Farmers in The Landslide Prone Area: A Case Study in Menoreh Hills Kulon Progo, Indonesia

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Abstract. Menoreh Hill in Kulon Progo is one of the most prone and vulnerable areas to natural disasters due to its location in an old volcanic complex, which can severely affect the livelihoods of agroforestry farmers. Diversification has become a livelihood improvement strategy in the landslide-prone area. This study specifically examines how and to what extent farmers diversify their livelihoods by comparing agroforestry farmers in high-risk areas (Samigaluh) and low-risk areas (Kalibawang). Primary data were collected from 54 farm households in Samigaluh and 51 farm households in Kalibawang districts using the census technique. The livelihood diversification index was calculated using the Simpson Diversification Index (SDI) and used an independent sample t-test to test whether groups of farmers would differ regarding livelihood diversification. The results showed that farmers in Samigaluh have a relatively higher diversification index (0.3994) than farmers in Kalibawang (0.3864). The results also show that diversification doesn't always bring higher income to farming households, but it is essential to survive in the landslide-prone area.

1 Introduction

Kulon Progo Regency is one of the regencies included in the category of high-risk areas affected by natural disasters, this is indicated by the disaster risk index score of Kulon Progo Regency, which is ranked the highest in DIY Province [1] and is one of the regencies in Java Island, which is included in the super priority category as an area vulnerable to natural disasters [2]. Looking at the data on disaster events, Kulon Progo Regency experienced an increase from 2018 to 2021 [3]. The highest total number of disasters occurred in 2021 with 297 disasters [4].

The dominant disaster in Kulon Progo Regency is a landslide. The results of [5] concluded that Kulon Progo Regency has the highest number of landslide risk points compared to other regencies located on the Menoreh Hills. Menoreh Hills is one of the areas in Java Island that has a high frequency of land mass movements. This is triggered by the diverse constituent content of the relief, which is an old volcanic mountainous area [6]. Based on the disaster data report of BPBD Kulon Progo Regency, the losses of households affected by landslides were estimated at 9,000,000 idr.

Considering the risk of landslides in Kulon Progo Regency, encourage agroforestry farmer households to pursue livelihood strategies through diversification. Income diversification refers to a continuous adaptive process whereby households add

new activities, maintain existing ones, or drop others, thereby maintaining diverse and changing livelihood portfolios. People may diversify their livelihood patterns by adopting a range of activities and income sources. Rural livelihood and diversification can be defined as the process by which rural households construct an increasingly diverse portfolio of activities and assets to survive and improve their standard of living [6] [7].

Livelihood strategies are a combination of activities and choices made to make ends meet. According to [9], livelihood strategies are the process by which farm households carry out various activities and obtain social support to fulfill and improve living standards. Livelihood strategies are created by two motivations, namely necessity and choice [9]. Livelihood diversification is the process of rural households undertaking diverse activities to survive and improve living standards. According to [10] there are two interpretations of livelihood diversification, the first being that diversification is a coping strategy or an involuntary response to a crisis. The second interpretation of diversification is that it is considered a decision by proactive households to reduce their risk by spreading their livelihoods. In the first sense, diversification is a survival strategy practiced by vulnerable households, while in the second sense, it is an accumulation strategy practiced by richer households. Diversification helps households deal with income instability, increases resilience, and reduces

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vulnerability. Broadly speaking, households will benefit from diversification.

Research by [11] shows that livelihood diversification is a strategy used by more than 62% of farmers in Burat, Kenya, in dealing with drought. The same thing was conveyed by [12] to overcome drought, farmers carry out various strategies, one of which is the diversification of livelihood sources. Implementing livelihood diversification allows farmers to have a lower risk of loss from the effects of natural disasters. Research by [13] stated that farmers have the ability to overcome the impact of losses and accelerate the recovery time in the face of disasters by diversifying. Diversification means that farmers get income from various sources so that they have higher adaptive capabilities than farmers with fewer sources of income. However, research by [14] explains that the implementation of farmer diversification is faced with several obstacles. The constraints faced are climate risk and uncertainty (23%), inadequate natural resources (17%), limited level of training (15%), lack of institutional support (12%), lack of credit facilities (11%), poor infrastructure (markets and roads) (16%), and lack of labor availability (4%).

Considering the constraints faced by farmers in implementing livelihood diversification [15], [16]. The studies compared farmers' livelihood diversification in several disaster-prone locations. The results showed that locations that are most prone to natural disasters tend to have low diversification levels. Research by [15] explains that there is a strong negative relationship between the shock effect of natural disasters and livelihood diversification. Locations in the post-disaster period will experience a decline in welfare due to the loss of income from livelihood diversification. Research by [16] explains that the majority of households in disaster-prone locations depend on the utilization of natural resources, so their ability to diversify their livelihoods is low because their income comes from agricultural activities.

This study assesses the pattern of income sources and measures diversification by comparing agroforestry farming households at different levels of landslide-prone areas. Overall, this study will give significant attention to the income diversification portfolio by finding the conditions of appropriate livelihood strategies undertaken by farmer households. Thus, this study aims to analyse income diversification and the decisions taken by farmer households in landslide-prone areas.

2 Material and Method

2.1 Study Location

The study was carried out in the Samigaluh district and Kalibawang district, which were purposely chosen because they are the highest and lowest landslide-prone areas in the Menoreh Hills, Kulon Progo regency. The

research was conducted in two locations. Samigaluh is located between latitudes 7039'50.18"-7039'01.17" S and longitude 110011'36.50"-110011'47.45" E, which are at the top of Menoreh hills. Based on data from the Regional Disaster Management Agency (Badan Penanggulangan Bencana Daerah, BPBD), there was an increase in disaster events from 2018-2022, with the peak in 2022 six times more than 2021. Then the second location in Kalibawang was located between longitude 7°42'53.4"-7°43'20.9"S and latitude 110°11'17.9"-110°12'00.3"E, which is at the foothills. The village of Sidoharjo represents the location with the highest landslides prone-areas, while the village of Banjararum represents the location with the lowest prone areas. These two areas have implemented an agroforestry system in Kulon Progo regency.

2.2 Data Collection

The data were collected through a census of farmer households, with a total of 105 respondents consisting of farmer households in Samigaluh (n=54) and Kalibawang (n=51). The census method and questionnaire were used to explore the demographic characteristics of the village and the respondents. Meanwhile, observations and in-depth interviews were conducted to obtain detailed socio-economic dynamics and household demographic information. Each interview was preceded by an explanation of the research objectives to obtain informed consent. Data were collected from January to February 2023.

2.3 Data Analysis

Livelihood diversification was measured using the Simpson Diversification Index (SDI). The Simpson index is most widely used because of its simple calculation method and broad adequacy [17]. The equation of the index is shown below:

$$SDI = 1 - \sum_{i=1}^n P_i^2$$

where n is the total number of livelihood income sources and P_i is the proportion of income from the i-th livelihood source. To measure livelihood diversification, it can be done through employment diversification and income diversification [18]. In this study, livelihood diversification is calculated based on income sources. Income sources come from different activities such as agroforestry income (AI), non-agroforestry income (NAI), livestock income (LI), off-farm income (OI), and non-farm income (NI), so the model is SDI:

$$SDI = 1 - \left\{ \left(\frac{AI}{THI} \right)^2 + \left(\frac{NAI}{THI} \right)^2 + \left(\frac{LI}{THI} \right)^2 + \left(\frac{FI}{THI} \right)^2 + \left(\frac{OI}{THI} \right)^2 + \left(\frac{NI}{THI} \right)^2 \right\}$$

The SDI value is between 0 and 1. Households with the most diversified income sources have the highest SDI values and are close to 1. Meanwhile, households that do not diversify or specialize have an SDI value close to 0. The number of income sources and the distribution of income from various sources of activity both affect the value of the Simpson index. Basically, based on the SDI value, we also tested the difference between two locations : high-risk areas (Samigaluh) and low-risk areas (Kalibawang) using the Mann-Whitney statistical test [17]. In addition to analysing the SDI, the level of livelihood diversification has been defined as [2]: limited (≤ 0.01), low (0.01-0.25), medium (0.26-0.50), high (0.51-0.75), and very high (≥ 0.75) (Khatun and Roy 2012; Datta and Sing 2011). To assess the relationship between income and livelihood diversification, we relied more on descriptive analysis.

3 Result and Discussion

3.1 Source of Household Income and Percentage Shares

The finding in this study is consistent with the research conducted by [19] that households located in natural disaster-prone areas have low incomes and are vulnerable to poverty. Natural disasters are the main driving factor in the risk of unpredictable uncertainty and their impact on economic losses. Table 1 shows that farmer households in the highest landslide-prone areas have lower incomes than households in the lowest landslide prone areas. This encourage farming households to combine livelihood sources from on-farm, off-farm, and non-farm activities.

Table 1 shows the contribution and distribution of each source of income for the respondents. Households in the highest landslide-prone areas (Sidoharjo Village) have the largest contribution from on-farm income (69%), followed by non-farm activities (27%). When compared to farmer households in the lowest landslide-prone area (Banjararum Village), the largest contribution comes from non-farm income (48%), and the second from on-farm income (44%). From both research locations, the contribution of off-farm income does not dominate. This is because the majority of agricultural activities are carried out by labor within the family, so off-farm income in both locations is low. According to [20] the low contribution of off-farm income is due to the view that off-farm activities can reduce the availability of family labor.

The difference in income from on-farm activities in the two research locations is quite significantly different, with the income of farmer households in the highest landslide prone areas being greater. Farmer households located in the highest landslide prone areas are identified to manage their natural resources better. This is identified by the land management system and the types of crops cultivated. Farmers in landslide-prone areas are highly engaged in agroforestry land management through mixed farming systems with more economically

valuable crop commodities, including chili, cardamom, coffee, and sengon. In addition, farmers integrate resources from agroforestry land with livestock businesses as a new source of livelihood. The results of interviews found that agroforestry land management activities are a form of adaptive capacity for farmers in the face of landslides [21]. Meanwhile, farmers in the lowest landslide-prone areas are not managing agroforestry land properly, this is indicated by the outpouring of labor in agroforestry land management carried out only during planting and harvesting.

Non-farm livelihoods contribute significantly to the income of farm households in the lowest landslide prone area. This is due to the existence of a location that supports farmer households to run livelihood sources outside of agroforestry land. This is in line with research [22] that low or high intensity of land management at the foot of the slope has no impact on landslides. In addition, the availability of access and facilities, as well as the nature of non-farm income that can be accessed throughout the year, support farmer households in landslide-prone areas to source livelihoods from non-farm activities. According to [23] [24], non-farm income sources can improve the livelihood of farmer households.

Table 1. Source of Household Income and Percentage Shares

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Sources of Income	Kalibawang		Samigaluh	
	Amount	Percentage (%)	Amount	Percentage (%)
On-Farm				
Agroforestry	4,706,016	13	11,019,855	34
Paddy field	2,675,604	7	26,574	0.08
Livestock	8,927,902	24	11,307,259	35
Fisheries	97,451	0.26	2,890	0.01
Off-Farm				
Agriculture labour	3,042,549	8	1,055,926	3
Post-harvest	-	0	133,333	0.41
Non-Farm				
Non-agriculture wage labour	1,031,373	3	2,256,481	7
Service and salaried job	7,759,175	21	5,412,963	17
Small business	9,403,922	25	1,038,889	3
Total	37,643,991	100	32,254,171	100

Sources : Primary data analysis (2023)

3.2 Livelihood Diversification

This study measured diversification using the Simpson diversification index method. The results showed that agroforestry farmer households in the highest landslide-prone areas practiced higher diversification than farmers in the lowest landslide-prone areas. Livelihood diversification activities are carried out by farmer households with a drive to fulfill their needs and survive the risk of landslides (diversification for survival). This study underscores that diversification is not limited to undertaking several livelihood activities but is a combination of several activities with equal income from each livelihood source.

Farmer households in landslide-prone areas are highly engaged in several activities to earn a higher income in even or balanced proportions. Farmer households practice diversification with no tendency to focus on one source of livelihood. This indicates that farmer households try to spread the risk of disaster by diversifying their livelihoods. Diversifying livelihoods allows farmers to have a lower risk of losses caused by natural disasters. This research is in line with [13] that by diversifying farmer household, they have the ability to cope with the impact of losses and accelerate recovery time when facing disasters. Diversification is a risk minimization strategy that is effectively applied by rural farmer households to meet their needs [25].

Farmer households in the lowest landslide-prone areas have lower diversification scores or tend to practice livelihood specialization. Being located in a low

landslide risk area causes farmers to focus on one source of livelihood that contributes significantly to household income. Table 1 shows that the household income of farmers in the very low landslide risk area is dominated by income from non-farm activities. According to [26] that non-farm income allows households to do work and earn income throughout the year.

Based on the results of the Mann-Whitney test, it shows that the diversification values in the two research locations are not statistically different. However, this does not mean that there is no difference between the two locations. Table 2 shows that households in the highest landslide-prone areas have a higher diversification value but a lower average income than households in the lowest landslide prone areas. This shows that households in the very high landslide risk area carry out livelihood diversification to avoid the risk of failure from the threat of landslides. Meanwhile, households in low-risk areas tend not to need livelihood diversification (specialization) but have a higher average income. Thus, this study emphasizes that the livelihood strategies of agroforestry farming households are influenced by the level of disaster risk.

3.3 The Importance of Livelihood Diversification on Agroforestry Farmers

Table 3 shows the distribution of diversification index values in both research locations. The results of the categorization of farmer households in the highest landslide-prone area are very high, which is classified as high diversification (22%), moderate (52%), and low (26%). Meanwhile, farmer households in lowest

Table 2 Simpson Diversification Index

SDI	Kalibawang	Samigaluh	Mann-Whitney Test
Mean	0.3864	0.3994	Z= -0.141, p>.05
Min	0.0000	0.0678	
Max	0.7197	0.6838	

Sources : Primary data analysis (2023)

landslide prone areas, which are classified as high (33%), medium (37%), low (27%), and very low (2%) diversification. Both research locations have an even distribution in the low, medium, and high diversification categories.

The research found that the higher value of diversification is not consistent with an increase in household income (Table 3). This is evidenced by the value of SDI and the average household income in both research locations. The higher the value of SDI, it does not show an increase in the household income of agroforestry farmers in the lowest landslide prone areas. However, agroforestry farmers in very high landslide disaster risk areas showed higher SDI values and higher income. This is in line with the results of research conducted [27] that diversification cannot be concluded to be consistent with increased income.

The results of the study prove that farmers who are in a very high landslide-prone area need to carry out livelihood diversification to meet their needs, or diversification for survival. This is indicated by the average household income of farmers, whose income has increased by diversifying their livelihoods. Meanwhile, for farmers in the lowest landslide-prone area, livelihood specialization is a good strategy to increase income. The low level of disaster vulnerability makes it easier for farmers to focus on and maximize one source of livelihood.

4 Conclusion

This study found that agroforestry farmers in very high landslide-prone areas practiced higher diversification than farmers in very low landslide-prone areas, but the higher value of livelihood diversification was not consistent with higher household income. This study found that livelihood diversification is necessary for agroforestry farmers in very high landslide-prone areas to spread the risk of failure and make ends meet. Meanwhile, in very low landslide prone areas specialization or not diversifying is a good strategy to increase income. The findings of this study suggest that the livelihood strategies of farmer households are strongly related to the level of disaster vulnerability.

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Table 3 The Interaction between Livelihood Diversification and Income Household

SDI	Category SDI	Kalibawang			Samigaluh		
		Amount	Percentage (%)	Avg. Income	Amount	Percentage (%)	Avg. Income
≤ 0.01	Limited	1	2	3,501,000	0	0	-
0.011-0.250	Low	14	27	43,142,452	14	26	18,804,507
0.251-0.50	Medium	19	37	41,730,200	28	52	34,186,775
0.51 – 0.75	High	17	33	30,557,269	12	22	43,436,208
≥ 0.751	Very high	0	0	-	0	0	-

Source: Primary data analysis (2023)

References

- [1] A. W. Adi *et al.*, “Indeks risiko bencana Indonesia tahun 2021,” pp. 11–3, 2022.
- [2] P. Mahyastuti *et al.*, “Daftar lokasi & aksi ketahanan iklim,” 2021.
- [3] Badan Pusat Statistik, “Banyaknya desa/kelurahan yang mengalami bencana alam dalam tiga tahun terakhir,” 2022. <https://yogyakarta.bps.go.id/indicator/152/244/1/banyaknya-desa-kelurahan-yang-mengalami-bencana-alam-dalam-tiga-tahun-terakhir.html>
- [4] Badan Penanggulangan Bencana Daerah, “Rekapitulasi Data Kejadian Bencana Kab. Kulon Progo,” 2022. <https://bpbdkulonprogokab.go.id/detil/497/rekapitulasi-data-kejadian-bencana-alam-bpbdkulon-progo-tahun-2021>
- [5] K. R. Fairuz, “Pemetaan Risiko Bencana Longsor Perbukitan Menoreh,” Universitas Gadjah Mada, 2017.
- [6] R. Purwaningsih, J. Sartohadi, and M. Anggri, “Trees and crops arrangement in the agroforestry system based on slope units to control landslide reactivation on volcanic foot slopes in Java, Indonesia,” *Land*, vol. 9, no. 9, 2020, doi: 10.3390/LAND9090327.
- [7] D. Narayan and P. Petesch, “Crying Out,” no. January 2000, 2015.
- [8] S. Schwarze and M. Zeller, “Income diversification of rural households in Central Sulawesi, Indonesia,” *Q. J. Int. Agric.*, vol. 44, no. 1, pp. 61–73, 2005.
- [9] F. Ellis, “Rural Livelihood Diversity in Developing Countries,” *Oxford Univ. Press*, no. 40, pp. 1–10, 2000.
- [10] C. Be’ne’, K. Mindjimba, E. Belal, T. Jolley, and A. Neiland, “Inland fisheries, tenure systems and livelihood diversification in Africa: The case of the Yae’re’ floodplains in Lake Chad Basin,” *Afr. Stud.*, vol. 62, no. 2, pp. 187–212, 2003, doi: 10.1080/0002018032000148759.
- [11] A. Quandt, “Coping with drought: Narratives from smallholder farmers in semi-arid Kenya,” *Int. J. Disaster Risk Reduct.*, vol. 57, p. 102168, 2021, doi: 10.1016/j.ijdrr.2021.102168.
- [12] F. Opiyo, O. Wasonga, M. Nyangito, J. Schilling, and R. Munang, “Drought Adaptation and Coping Strategies Among the Turkana Pastoralists of Northern Kenya,” *Int. J. Disaster Risk Sci.*, vol. 6, no. 3, pp. 295–309, 2015, doi: 10.1007/s13753-015-0063-4.
- [13] N. T. T. Pham, D. Nong, A. Raghavan Sathyan, and M. Garschagen, “Vulnerability assessment of households to flash floods and landslides in the poor upland regions of Vietnam,” *Clim. Risk Manag.*, vol. 28, no. January, p. 100215, 2020, doi: 10.1016/j.crm.2020.100215.
- [14] A. A. Shah, Z. Gong, and N. A. Khan, “Livelihood diversification in managing catastrophic risks : evidence from flood-disaster regions of Khyber Pakhtunkhwa Province of Pakistan,” pp. 40844–40857, 2021.
- [15] S. S. Ibrahim, H. Ozdeser, and B. Cavusoglu, “Vulnerability to recurrent shocks and disparities in gendered livelihood diversification in remote areas of Nigeria,” *Environ. Sci. Pollut. Res.*, vol. 26, no. 3, pp. 2939–2949, 2019, doi: 10.1007/s11356-018-3854-5.
- [16] N. T. T. Thao, D. N. Khoi, T. T. Xuan, and B. Tychon, “Assessment of Livelihood Vulnerability to Drought: A Case Study in Dak Nong Province, Vietnam,” *Int. J. Disaster Risk Sci.*, vol. 10, no. 4, pp. 604–615, 2019, doi: 10.1007/s13753-019-00230-4.
- [17] N. Habib, P. Rankin, M. Alauddin, and R. Cramb, “Determinants of livelihood diversification in rural rain - fed region of Pakistan : evidence from fractional multinomial logit (FMLOGIT) estimation,” *Environ. Sci. Pollut. Res.*, no. 0123456789, 2022, doi: 10.1007/s11356-022-23040-6.
- [18] R. O. Babatunde and M. Qaim, “Patterns of income diversification in rural Nigeria: Determinants and impacts,” *Q. J. Int. Agric.*, vol. 48, no. 4, pp. 305–320, 2009.
- [19] R. B. Bista, “Does Disaster Change Income and Wealth Distribution Toward Extremity of Inequality and Poverty? Analysis of Flood and Landslides in the Vulnerable Locations of Nepal,” *Forum Soc. Econ.*, vol. 51, no. 4, pp. 1–15, 2020, doi: 10.1080/07360932.2020.1715810.
- [20] L. Pfeiffer, A. López-Feldman, and J. E. Taylor, “Is off-farm income reforming the farm? Evidence from Mexico,” *Agric. Econ.*, vol. 40, no. 2, pp. 125–138, 2009, doi: 10.1111/j.1574-0862.2009.00365.x.
- [21] J. Tan, L. Peng, and S. Guo, “Measuring Household Resilience in Hazard-Prone Mountain Areas: A Capacity-Based Approach,” *Soc. Indic. Res.*, vol. 152, no. 3, pp. 1153–1176, 2020, doi: 10.1007/s11205-020-02479-5.
- [22] N. Muddarisna, E. Yuniwati, H. Masrurroh, and A. O., “Local Agroforestry as Landslide Mitigation in the Gede Catchment in Malang Regency,” 2020, doi: 10.4108/eai.18-7-2019.2290363.
- [23] G. W. Gebru, H. E. Ichoku, and P. O. Phil-Eze, “Determinants of livelihood diversification strategies in Eastern Tigray Region of Ethiopia,” *Agric. Food Secur.*, vol. 7, no. 1, pp. 1–9, 2018, doi: 10.1186/s40066-018-0214-0.
- [24] M. A. Iqbal *et al.*, “A quest for livelihood sustainability? Patterns, motives and determinants of non-farm income diversification among agricultural households in punjab, pakistan,” *Sustain.*, vol. 13, no. 16, pp. 1–14, 2021, doi: 10.3390/su13169084.
- [25] T. B. Shan and J. U. Ahmed, “Determinants of Livelihood Diversification of Rural Households in Sylhet,” vol. 38, no. 11, pp. 97–104, 2020, doi: 10.9734/AJAEES/2020/v38i1130457.
- [26] G. Danso-Abbeam, G. Dagunga, and D. S.

Ehiakpor, “Rural non-farm income diversification: implications on smallholder farmers’ welfare and agricultural technology adoption in Ghana,” *Heliyon*, vol. 6, no. 11, p. e05393, 2020, doi: 10.1016/j.heliyon.2020.e05393.

- [27] K. Hussein and J. Nelson, “Sustainable Livelihoods and Livelihood Diversification,” 1998. [Online]. Available: <http://www.ids.ac.uk/ids/research/env/index.html>