Sustainable livelihood strategies: comparative cases at the aftermath of landslide at Ponorogo and Bantul, Indonesia

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Abstract. This study discusses the sustainable livelihood strategies of landslide impacted two different regions, namely: Banaran Village-Ponorogo Regency and Wukirsari village-Bantul Regency. Banaran landslide caused 28 houses to be buried, 28 people died, and 40 families directly affected. Wukirsari landslide caused 18 houses damaged, 4 people died, 2 people were injured, 15 families fled to different areas. Banaran Village is an Agrarian Village in rural area, and Wukirsari Village is an Industrial Village in urban area. These different types of villages affected the capacity of local people to cope with disasters. This research employed a spatial temporal statistical method with livelihood component to be evaluated. There are several indicators such as meeting the needs of life and utilizing the social-family-government network observed in each household. The more diverse the activities that are owned, the higher the income, so to increase the capacity of directly affected populations requires a variety of activities as a form of livelihood strategy. Meanwhile, they show different livelihood strategy in disasters: the rural people depending on government and family assistance, while the urban people rely more on various source of income and family assistance to survive.

1. Introduction

During 1981 – 2007, database showed that landslides has distributed unevenly between West Java (67 %), Central Java (29 %) and East Java (4 %). Slope failures were most abundant upon intensively weathered zone of old volcanic materials on slope angles of 30° – 40° [1]. This was also the case as depicted at Banaran Village, Ponorogo. which occurred 1st April 2017, caused 156 people killed, 168 people injured, 52,930 people displaced and suffered, and 7,000 more houses damaged by landslides [2]. Slightly similar cause shown in the case of landslide Wukirsari Village, Bantul. The Bantul landslide occurred due to slope failure, triggered by high rainfall at the afternoon of typhoon Savannah [3]. Wukirsari Village, to be exact the Pajimatan Kedung Buweng Hamlet is the most severe area due to the occurrence. It caused 18 houses damaged, 4 people died, 2 people were injured, 15 families (41 people) fled to neighboring areas [4].

The case studies were taken into consideration for two main underlying factors. First, the Ponorogo landslide expresses rural community which was at risk, while the Bantul landslide expresses rural community which was at risk, however, it has different support system which creates different capacities. Hence, this article argues, that during normal condition there is three importance factors, such as asset, access and activities which shape the modalities and capacities of an area. During the normal condition which then exposed to any threat, and disturbance occurred, such as disaster, there is a need to take a look at how these three fundamental factors existed before and after the occurrence. The aftermath of disaster occurrence, there will be varied embedded local resource which then shape local asset, access and activities to shape local resilience towards disaster. The rural capacity included asset as addressed into source of livelihood, activities, and access. The local assets defined as livelihood...
capital, such as human, financial, natural, social and political capital which will share local ability to cope with existing threat.

**Figure 1.** Resilience at the aftermath of disaster (Source: modified from DFID, 2011)

The social cognitive model focuses on the role of motivational factors on the decision to adopt preparedness actions, including awareness of the threat, anxiety, self-efficacy, and sense of community among others. Both models can help describe and understand the preparedness, however, for the purposes of the present study we incorporate elements of the Protective Action Decision Model, mainly in aspects related to the relation between sociodemographic factors and preparedness levels. This model also recognizes the role of experience that is relevant for this particular study considering that the communities that were studied had experienced both events [5]. Thus it is very important for local institutions to adopt a proactive approach and engage in preparedness activities and strengthen the existing governance system to manage disaster risks in Pakistan and policymakers should focus more on addressing challenges that could restrict effective preparedness to deal with disaster risks through relevant policy mechanism and consult with all other stakeholders been involved [6].

This research approach local capacity or local modality to confront post disaster occurrence using spatial temporal perspective. It is argued that local capacity is attached to spatial entities. It means local capacity in particular spatial unit surely different than those in different spatial unit. Those in particular spatial unit exposes to different scale of hazard, with off course different access, accessibility and activities [7,8].

The purpose of the family's livelihood strategy is to obtain livelihood security, a condition that indicates the sustainability and adequacy of the family towards access to meet basic needs for food security and improved family health status. Family capital such as financial, human, natural, social, and physical capital will affect the success of family livelihood strategies in the form of food security and improvement of family status. The strategies most often carried out by example families both upstream and downstream in the dry season, rain, disaster, and high economic pressures [9].
2. Theoretical background

This sustainable livelihood approach not only discusses income (income poverty) and jobs (jobs) but more thoroughly. Livelihood strategy or livelihood strategy is an effort made by the family in order to meet the needs of his life [10]. Any increase in one female economic contribution will be able to lower the family welfare score. The livelihood strategy in the regression test in this study is the number of livelihood strategies implemented and carried out by families in various seasons namely the dry season, the rainy season, during a disaster, and when the family is experiencing high economic pressure. The results also show that livelihood strategies have no significant effect on family welfare. The many or fewer livelihood strategies employed by the family will neither increase nor decrease the family welfare score [11]. For each community, there are potentially different asset conditions and, consequently, varied livelihood strategies. Moreover, assets in normal condition are likely to change in the face of disasters. If properly selected, asset utilization strategies can help affected livelihoods to bounce back to and even become stronger than their normal condition [5].

Theoretically, community livelihood is somewhat relevant within the work of disaster management. As depicted in the following Figure 2.

![Figure 2. livelihood strategy in the context of disaster risk resilience [13]](image)

There has been considerable academic discussion concerning the need to develop disaster management emergency plans for specific hazards rather than for all hazards. Some researchers believe that different types of disasters warrant different types of plans, while others believe that the similarities between any two disasters are sufficient to allow for generic plans. A generic, or all-hazard, plan would be one that could be used for any hazard, regardless of its cause or effect [12], [13]. To add, vulnerability has been related so much with resilience due to its relevant indicators. The existing given hazard may induce vulnerable elements to come up with risk. In order to minimize risk, when hazard is given, thus the remaining variable to be modified is vulnerability. Such a mathematical logic then relates to the fourth key words, which is resilience [14].

Commonly, within the literature debate, to modify vulnerability, it is essential to increase resilience. In the practical assessment, vulnerability and resilience has been enormously essential due to its relevant indicators. Here, the research focus to identify the stakeholder community strategy at the aftermath of disaster occurrence which in the framework of disaster management it is included in the resilience [13].
Into details, the household studies were situated under the broader umbrella of household economics, where emphasis was on land allocation and income strategies. Subsequent studies, on the contrary, - survival studies - and were more socially than economically induced, with special focus on understanding how poor people cope and survive in the face of different kinds of crises. The latter revealed that poor households are excluded from the benefits of economic growth, precipitated a new form of household studies, which sought to approach households from livelihood perspectives. Largely, the latter studies emerged as a result of the disappointing outcomes of the former approaches in devising effective poverty alleviation strategies [15].

People develop complex portfolio of livelihood activities [16]. Livelihood strategies can be defined as increased well-being, reduced vulnerability, improved food security and more sustainable use of natural resources base. It largely depends on the availability of livelihood assets/capitals – natural capital, human capital, financial capital, physical capital and social capital. Vulnerability context – shocks, trends and seasonality; and institutional and policy context are the other aspects of livelihood strategies. A sustainable livelihood is a situation, where all these aspects are controlled and they have great potential to future livelihood sustainability [17], and it has been argued that understanding such complexities and dynamism, especially in the local context, is critical in building participatory approaches to livelihood enquiry [15].

A descriptive analysis portrays a complex web of activities and interactions that emphasises the diversity of ways people make a living. This may cut across the boundaries of more conventional approaches to looking at rural development which focus on defined activities: agriculture, wage employment, farm labour, small-scale enterprise and so on. But in reality people combine different activities in a complex bricolage or portfolio of activities. Outcomes of course vary, and how different strategies affect livelihood pathways or trajectories is an important concern for livelihoods analysis. This dynamic, longitudinal analysis emphasises such terms as coping, adaptation, improvement, diversification and transformation. Analyses at the individual level can in turn aggregate up to complex livelihood strategies and pathways at household, village or even district levels. [15]. These, to a large extent, explain why the livelihood approach continues to be the central focus of contemporary rural and development studies [18].

3. Method
The research selects respondent and informan to collect primary data. They are the head of the family who directly affected by landslide. 40 household in Banaran and 18 Household in Wukirsari. The Type of analysis is qualitative. Determination of informants using purposive sampling techniques by collecting data using observation and interview methods. Informants in this study were 58 households represented by the head of the family, consisting of 40 families of Banaran and 18 families of Wukirsari. The criteria in this study are:

a) Local residents whose houses are directly affected by landslides 
b) The head of the family

Data validity test is done by using triangulation techniques. Furthermore, the process of data analysis is by collecting all data, sorting data, interpreting data with theory, presenting data and drawing conclusions.
4. Results and discussion

There are 1917 households at Banaran Village, while the population used in this study were households that were directly affected by landslides in Banaran Village with total population 1917 (female 946, male 971) and households that were directly affected by landslide in Wukirsari village with total population 15,947 (female 8,016, male 7,661). The sampling technique used is total sampling, which is a number of 40 families (Banaran Village) and 18 Household (Wukirsari Village) that each household is represented by one person who act as the head of the family. The research method indicated two spatial entities with different number of impacted communities between Banaran and Wukirsari.

Types of occupation directly affected communities at Banaran Village are less varied than communities directly affected by Wukirsari Village. In Banaran Village there was a slight change in the type of occupation at the aftermath of landslide, while in Wukirsari Village there was no change in the type of occupation. The type of occupation can be seen in the following Table 1, 2 and 3 as follow:

| Table 1. Type of occupation directly affected communities of Banaran village before landslide |
|-----------------------------------------------|---------------|----------|---------------|---------------|
| Type of Occupation | Frequency | Percentage | Frequency | |
|---------------------|------------|------------|------------|------------|
| Farmer              | 28         | 70%        | 22         | 6          |
| Laborer             | 3          | 7.5%       | 1          | 2          |
| Entrepreneur        | 1          | 2.5%       | 1          | 0          |
| Village Apparatus   | 3          | 7.5%       | 0          | 3          |
| Indonesian Workers  | 1          | 2.5%       | 1          | 0          |
| Abroad              | 2          | 5%         | 1          | 1          |
| Jobless             | 3          | 7.5%       | 1          | 2          |

| Table 2. Type of occupation directly affected communities of Banaran village after landslide |
|-----------------------------------------------|---------------|----------|---------------|---------------|
| Type of Occupation | Frequency | Percentage | Frequency | |
|---------------------|------------|------------|------------|------------|
| Farmer              | 28         | 70%        | 22         | 6          |
| Laborer             | 3          | 7.5%       | 1          | 2          |
| Entrepreneur        | 1          | 2.5%       | 1          | 0          |
| Village Apparatus   | 3          | 7.5%       | 0          | 3          |
| Indonesian Workers  | 1          | 2.5%       | 1          | 0          |
| Abroad              | 2          | 5%         | 1          | 1          |
| Jobless             | 3          | 7.5%       | 1          | 2          |
Type of Occupation   | Frequency | Percentage | Frequency Tanggal Hamlet | Frequency Krajan Hamlet
---|---|---|---|---
Farmer | 28 | 70% | 22 | 6
Laborer | 2 | 7.14% | 0 | 2
Entrepreneur | 1 | 2.5% | 1 | 0
Village Apparatus | 3 | 10.71% | 0 | 3
Indonesian Workers Abroad | 3 | 10.71% | 2 | 1
Jobless | 3 | 10.71% | 1 | 2

There are differences in livelihood changes after landslides. In Banaran there was a slight change in the livelihoods of the people directly affected. Whereas in Wukirsari there was no change in livelihoods at all.

**Table 3.** Type of occupation directly affected communities of Wukirsari village before and after landslide

| Main Occupation Type | Side Job | Frequency | Percentage (%) |
|---|---|---|---|
| Teacher | Wedang Uwuh maker and seller | 2 | 11.11% |
| Farmers | Batik craftsmen | 1 | 5.55% |
| Local entrepreneur | The trader | 8 | 4.44% |
| Civil Servants | Seller, artist | 6 | 33.33% |
| Student | Freelancer | 1 | 5.55% |
| Total | | 18 | 100% |

In rural areas that have high kinship relations, the assistance of relatives, neighbors and friends can be relied on during an economic crisis, such as a landslide. A part from relying on assistance from the Government and social organizations, involvement in the form of providing financial assistance is the most common form of network utilization. Community involvement in mutual cooperation actions, such as land equity, building houses, repairing roads, and cleaning irrigation canals are examples of involvement in the form of power that is also commonly found. Those families were directly affected whose landslides were funded to receive funding for the construction of permanent housing and temporary direct assistance funds for six months of living expenses.

**Table 4.** Type of assistance received by direct affected communities Banaran village

| Indicator | Yes | No |
|---|---|---|
| | Frequency | Percentage (%) | Frequency | Percentage (%) |
| Insurance | 0 | 0 | 40 | 100.00 |
| BLTSM (Temporary cash aid) | 40 | 100.00 | 0 | 0 |
Funds for equitable distribution of land for permanent residential development

Whereas 18 households were directly affected by the landslide of Wukirsari until now still have not received land compensation assistance or assistance to build houses. The village government offers assistance of Rp.25,000,000 per household from the central government to buy building materials. The process of compensation for land for communities around the tombs of the kings who have certificates of ownership until now has not received certainty. In addition, the Village Government also offers village land for rent at a tax of Rp.400,000 per year. Most communities directly affected by landslides have not agreed to the agreement. The different types of villages have an effect on the survival of the inhabitants. In general, the communities of Wukirsari Village have stronger economic power due to more diverse sources of income, the location of the Village which is on the outskirts of the city also makes it easier to access assistance after a disaster.

Table 5. Type of Assistance received by direct affected communities in Wukirsari village

| Type of Assistance                  | Frequency | Percentage (%) |
|-------------------------------------|-----------|----------------|
| 5 Million Rupiah for Pass away resident | 2         | 11,11%         |
| Food, flip bed, secondhand clothes  | 18        | 100%           |
| **Total**                           | **18**    | **100%**       |

The behavior of urban and rural directly affected victim are different. Many rural people rely on government assistance to survive, whereas communities directly affected landslide at urban areas are not dependent on government assistance for survival. The access they have is different so that the type of assistance received is different. The following table 4 and 5 described type of assistance program to the research area. The Banaran Village assistance program has so much concerned with cash fund program, while in the Wukirsari Village, the assistance program has related so much in functional use of a tools that can help households and industrial sectors.

In Wukirsari, there are mechanism to strengthen local strategies. At the aftermath of landslindde, many craftsmen (as seen in The Table 6) were still able to access their building, which are essential to continue production process, institutional and marketing, supply facilities to market and inter-group consolidation. That is the reason why the construction of the gazebo is supported by various parties. Village government as a land provider, and IRE (Institute for Research and Empowerment) responsible for providing material. Gazebo development and local government assisted each other to complete other infrastructure such as toilets and roads. The Wukirsari exhibitions which was held every year, managed to absorb thousands of visitors and traders who are present to see and buy their handicraft products. The public functions were also subjected to many assistance program from the government since the area has been receiving so many visitors (Table 7).

Table 6. Type of livelihood strategy in Wukirsari village

| No  | Type Of Craft   | Number of craftsmen | Location (Hamlet) | Information       |
|-----|-----------------|----------------------|-------------------|-------------------|
| 1   | Shadow Puppet Craft | 750 peoples       | Pucung            |                   |
| 2   | Batik Craft     | 465 peoples         | Giriloyo          |                   |
| 3   | Bamboo Craft    | 333 peoples         | Karangtalun dan Jatirejo |               |
Vulnerability Livelihood strategies provide more sustainable results for some people than for others. People who have many different choices about how they can live (a strategy they can use) are usually less vulnerable compared to people who have limited choices. The sustainable livelihoods approach is all about dealing with this problem. Ideally an effective sustainable livelihoods approach should generate greater income, improve well-being, reduce vulnerability, increase food availability, and result in a more sustainable use of natural resources for its users. [19].

| Table 7. Type of public facilities in Wukirsari village |
|--------------------------------------------------------|
| Facilities and infrastructure | Wukirsari Village | Banaran Village |
|-------------------------------|-------------------|-----------------|
| Health                        |                   |                 |
| Puskesmas (Community Health Center) | 1                | 0               |
| Puskesdes                      | 1                 | 0               |
| UKBM (Posyandu / Polindes)     | 18                | 0               |
| Education                     |                   |                 |
| Library                        | 1                 | 0               |
| Early Childhood Education      | 1                 | 1               |
| Programs                       |                   |                 |
| Kindergarten                   | 7                 | 1               |
| Primary School                 | 6                 | 1               |
| Junior High School             | 1                 | 0               |
| High School                    | 2                 | 0               |
| Religion                       |                   |                 |
| Mosque                         | 35                | 3               |
| Mushola                        | 106               | 15              |
| Church                         | 2                 | 0               |
| Public Facilities              |                   |                 |
| Sport                          | 3                 | 0               |
| Art/Culture                    | 55                | 0               |
| Meeting Hall                   | 8                 | 1               |
| Village Well / Wellspring      | 3                 | 3               |
| Village Market                 | 1                 | 0               |
| Pos Kamling (Security Pos)     | 98                | 28              |

In temporal manner, Wukirsari Village presented quick recovery process compared to Banaran Village. Spatially, Banaran Village has less access to other areas, thus it has less time to recover (see Figure 4). In terms of access to urban areas, and many other political access and facilities access, yes in deed, Wukirsari has better access to it as seen in the Figure 5.
Figure 4. Map of administrative boundary of Banaran Village, Ponorogo Regency.

Figure 5. Map of landslide area of Wukirsari Village, Bantul Regency.
The following Table 8, the research argue that Wukirsari promoted active participation from economic and cultural activities, while Banaran promoted active participation from collective groups.

**Table 8. Variable assets in Wukirsari and Banaran Village**

| Variable assets | Wukirsari Village | Banaran Village |
|-----------------|-------------------|-----------------|
| **Social**      |                   |                 |
| Participation in the organization, RT Event, Village event and religion event. | More actively participate in economic and cultural activities | More actively participate in RT and religious activities |
| Trust to Government | Trust in government but not active in political activities | Trust in government but not active in political activities |
| **Physical**    |                   |                 |
| Vehicle ownership | Every house has a motorcycle or bicycle | Every house has a motorcycle or bicycle |
| Agriculture land ownership | Not all households have agricultural land | All households have agricultural land |
| **Variable assets** | **Wukirsari Village** | **Banaran Village** |
| **Economy**     |                   |                 |
| Ownership of Livestock | 14 out of 40 households have livestock | 5 out of 18 households have livestock |
| Business Ownership | 6 dari 40 Rumah Tangga memiliki usaha kecil | Semua Rumah Tangga memiliki usaha kecil |
| **Human**       |                   |                 |
| Level of Education of Family Head | Most of them are graduated from High School | High school and undergraduate degree alumni are equal |
| Age of the head of the family | 30-80 y.o | 35 – 75 y.o |
| Natural Capital |                   |                 |
| Natural tourism | 0 | 8 |

The main livelihood strategy in Wukirsari were not mainly at agriculture, but it focused in small industrial, while Banaran were mainly focused at agriculture. Both areas presented very strong social and cultural activities (Table 9 and Table 10).

**Table 9. Cultural activities in Wukirsari Village**

| No | Activities       | Time            | Location               |
|----|------------------|-----------------|------------------------|
| 1  | Tirakatan Night | Suro Night      | RT                     |
| 2  | Tirakatan Night | Independence Anniversary | Village/RT/Hamlet |
| 3  | Independence Anniversary | August 17th       | Village/RT/Hamlet |
| 4  | Kartini Day      | April 21th      | Village/RT/Hamlet |
| 5  | Youth Pledge Day | October 28th    | Village/RT/Hamlet |
| 6  | Beading crafts  | 144 Peoples     | Sindet, Nogosari I, Nogosari II |
In Wukirsari, RT (Neighborhood Association) group has sufficient activities stand out in the development both in terms of workmanship and aspects financing.

Table 10. Cultural heritage in Wukirsari Village

| No | Type of Activities          | Time                        | Location  | Information            |
|----|-----------------------------|------------------------------|-----------|------------------------|
| 1  | Majemukan Perti Dusun (Cleaning the Village) | After the great harvest, every year | Hamlet    | Shadow puppets, Carnaval, prayer together |
| 2  | Nguras Guji/Kong Suro       | Month (Friday/Tuesday Kliwon) | The tombs of the mataram kings | Carnaval |
| 3  | Suran                       | Every 9 suro                 | Hamlet    | Feast (kenduri)        |
| 4  | Selikuran                   | 12 Ramadhan                 | Hamlet    | Feast (kenduri)        |
| 5  | Sadranan                    | Ahead of Ramadan             | Hamlet    | prayer together         |
| 6  | Rejeban                     | Every Rejeb month            | Hamlet    | prayer together         |
| 7  | Mauludan                    | Every Maulud month           | Hamlet    | prayer together         |

5. Conclusion
The conditions of people in urban and rural areas, as seen from their activities, have similarities and differences. The similarity lies in how both research areas have high spiritual cooperation called “gotong royong”. Meanwhile, they show different livelihood strategy in disasters: the rural people depending on government assistance, while the urban people rely more on various sources of income and family assistance to survive. Their main strategies presented at Wukirsari is to strengthen industrial livelihood at the aftermath of disaster, while at Banaran, people get engaged in agriculture, for those with no impact to agriculture. As for the community with impact to agriculture due to landslide, they focused on other main source of activities, such as pastoral husbandry and other service activities. The post disaster recovery in both research area requires different period. The urban areas, represented by Wukirsari presented faster recovery, while rural areas, represented by Banaran, has slower recovery. The access, asset and activities at urban areas are abundant and dynamic, while the access, asset and activities at rural areas are equally abundant and less dynamic and less access to other source of disaster assistance.

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References
[1] Hadmoko D S, Lavigne F, Sartohadi J, Gomez C and Daryono 2017 Spatio-temporal distribution of landslides in java and the triggering factors Forum Geografi 31
[2] Badan Nasional Penanggulangan Bencana 2017 2.341 kejadian bencana, 377 tewas dan 3,5 juta jiwa mengungsi dan menderita akibat bencana tahun 2017 [Internet]. BNPB [cited 20 January 2019]. Available from: https://www.bnpb.go.id/
[3] BMKG 2019 Topan Savannah Pemicu Cuaca Ekstrem Penyebab Longsor Di Yogya,” MSN, 2019 [Online]. Retrieved from: https://www.msn.com/id/Id-News/other/bmkg-topan-savannah-pemicu-cuaca-ekstrem-penyebab-longisor-di-yogya/ar-BBUUZVJ?ocid=ob-fb-idid-705 [on July 10, 2019]
[4] Village Government 2017 Document of Wukirsari landslide Bantul
[5] Bronfman C N, Cisternas C P, Repetto P B, Castaneda J V 2019 Natural disaster preparedness in a multi-hazard environment: Characterizing the sociodemographic profile of those better (worse) prepared (https://doi.org/10.1371/journal.pone.0214249)
[6] Shah A A, Shaw R, Jingzhoung Ye, Abid M, Amir S M, Pervez A K M K, Naz S 2018 Current Capacities, Preparedness and Needs of Local Institutions in dealing with Disaster Risk
Reduction in Khyber Pakhtunkhwa, Pakistan. *International Journal Disaster Risk Science*

[7] Rampengan M M, Boedihartono A K, Law L, Gaillard J and Sayer J 2014 Capacities in facing natural hazards: a small island perspective. *International Journal disaster risk science* 5 (DOI 10.1007/s13757-014-0031-4) 247-264

[8] Hizbaron 2018 *Study the capacity of the community, government agencies, and the private sector in disaster risk reduction efforts in Yogyakarta* (Yogyakarta: Gadjah Mada Press)

[9] Kamaruddin R and Samsudin S 2014 The sustainable livelihoods index: a tool to assess the ability and preparedness of the rural poor in receiving entrepreneurial project *Journal of social economics* 1 108-107

[10] Widiyanto, Setyowati R and Suwarto 2010 The dynamics of a farmer's household income Sustainable livelihoods (SLA) approach *Agritext journal*

[11] Muzakkiyah F and Hartoyo 2017 Woman Economic Contribution, Livelihood Strategies, and Family Well-being of Farmer Families in Cimanuk Watershed *Journal of family sciences* 2 42-58

[12] Islam R and Chamhuri S 2012 Characterization of Hazard, Vulnerability, and Risk of disaster management *Advances in Environmental Biology* 6 955-966

[13] Hizbaron D, Hadmoko D, Mei E, Murti S, Laksani M, Tiyansyah A E and Tampubolon, I 2018 Towards measurable resilience: Mapping the vulnerability of at-risk community at Kelud Volcano, Indonesia *Applied geography* 98 212-227

[14] UNISDR 2017 *Worlds into Action Guidelines: National Disaster Risk Assessment (4. Flood Hazard and Risk Assessment)* UNISDR

[15] Scoones I 2009 Livelihood perspectives and rural development *Journal of Peasant Studies* 36 171 – 196

[16] Marschke J M and Berkes F 2006 Exploring Strategies that Build Livelihood Resilience: a Case from Cambodia *Ecology and Society* 11

[17] Sati V P 2014 *Sustainable Livelihood and Options: A case study of the Upper Minjiang River Basin, Sichuan Province, China* (Germany: LAP Lambert Academic Publishing)

[18] Baffoe G and Matsuda Hirotaka Moving Beyond the Sustainable Livelihood Rhetoric: A Conceptual Model of Rural Livelihood Sustainability *Developing country studies* 7

[19] Scale Up 2011 Conflict over natural resources and sustainable livelihoods. Scale Up Bulletin, II, 1-4 Retrieved from http://www.forestpeoples.org/sites/fpp/files/news/2012/02/WebBulletinFord_02_2011.pdf.