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FACTORS ASSOCIATED TO FLOOD RESILIENCE MEASUREMENT IN NARAYANI RIVER BASIN, NEPAL

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ABSTRACT: *Resilience measurement is burning discourse these days for most of the international humanitarian and development works. Building resilience is important aspect for sustainability and ownership of a particular community for any development programing; and similarly measuring the resilience is crucial to showcase the evidence of change in the development works. There is growing need to invest in its measurement approach that enhance the resilience-especially related to the flood. The main objective of this research is to identify the factors, which contribute to the flood resilience measurement that explains community-level empirical evidence. Accordingly, research was done in two communities of Narayani river basins at Susta Rural Municipality, Nawalparashi-west, Nepal. The paper illustrates overall findings include factors contributing to the flood resilience measurement and how these factors are categorized and mapped out in the flood resilience measurement in general. The factors associated with livelihood capitals, resilience properties, and the DRR cycle have a great impact than others in community resilience. The paper also highlights comparative analysis on one community to another and one factor to another and presents process-oriented community actions and empirical evidence from the research findings that contribute to flood resilience measurement.*

KEYWORDS: flood, resilience, measurement, sustainable livelihoods framework, capitals

INTRODUCTION

Flood is the most frequently occurring and amongst the most devastating disasters. On an average, river flooding affects the lives of 21 million people, causes the reduction of US$ 521 billion in GDP (Luo, Tianyi, Robert Young, and Paul Reig, 2015), and inflicts internal displacement of several thousand people annually (Willner, S.N., Otto, C. & Levermann, A, 2018). Fflood-led disasters are increasing in frequencies and magnitudes together with more extreme events in recent decades as an impact of the rising global temperature (Satoshi Watanabe, Shinjiro Kanae, Shinta Seto, Pat J.-F. Yeh, Yukiko Hirabayashi, Taikan Oki, 2012) which is calling for an integrated approach that addresses social protection, DRR, and climate change adaptation (Lisa Schipper, Mark Pelling,

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2006). Floods affect more people globally than any other natural hazards; they can literally wash away the assets and resources overnight what communities have earned over the years as part of their income and livelihoods options (Szoenyi, Michael, Finn Laurien, and Adriana Keating, 2020).

In Nepal, floods are expected to affect 156,600 people every year (WRI, 2011). The annual flooding has led the affected communities and households with more poverty and marginalization (Myron B Fiering, 1982). The losses from the annual flooding in Nepal are considered a serious problem to the governments. Every year, it becomes a hotcake of the discussion to government, security persons, and victims. Agricultural land in the Terai region has been degraded in Nepal through floods.

Defining resilience

Resilience is the capacity that confirms shocks and stressors do not have consequences regarding long-lasting adverse development (Hoddinott, John, 2014). Household resilience is the household ability to adapt, mitigate and recover from the stresses and shocks. Resilience is an ability of a household or community to cope, withstands and recover or manage during and after the disaster. The resilience capacities are a set of attributes, skills and conditions that are known to permit households to achieve resilience in the face of shocks and stresses.

Community flood resilience

A community is considered as resilient to flood when it can function as well as withstand critical systems under flood stress which are caused by and acclimatized to the changes in the livelihood assets such as social, economic and physical environment; and be independent if external resources are cut off or limited." (Mueller, M., Spangler, T., & Alexander S., 2013). A flood community resilience defining feature is the extent to which communities can combine collective actions and social capital effectively in response to flood shocks and stresses. Social capital is viewed as one of the key capacities at the household level that have a direct bearing on resilience to flood. In a larger population, the interplay that take place between and within a larger population are dynamic and complex.

Flood resilience measurement

Flood resilience measurement enables to assess and demonstrates the on-the-ground impact of improvements. To tackle with the resilience measurement related issues, different versions of disaster resilience indicators have been proposed by numerous national and international donor agencies, and also have developed a few regional disaster resilience indicators (Bakkensen, Laura A., et al., 2017). Indeed, there are several forms and type of resilience measurement framework as developed at local verses national level; and associated factors are also different substantially as per level of associated measurement frameworks. Since this paper focused on flood resilience at the community

level, and it explored many factors systematically and extensively which contribute to flooding resilience measurement associated factors with livelihood capitals, resilience properties, resilience themes, and the DRR cycle.

MATERIALS AND METHODS

Paklihawa and Kudiya communities of Susta Rural Municipality of Nawalparasi-west district under Lumbini Province, Nepal were purposively chosen to collect and examine empirical evidence of the factor associated with flood resilience measurements. Kudiya and Paklihawa are the most flood-prone communities in Nawalaparshi-west district and these communities are most vulnerable to monsoonal flooding almost every year. The communities regularly impacted and responding to flood events were considered the most suitable for the research work as it would provide community-based evidence in identifying the factors associated with the flood resilience measurements. The mixed research method was applied to collect both qualitative and quantitative data. Primary data was collected by administering household surveys within 402 households of the respective communities, which was supplemented by information gathered using 4 Key Informant Interviews (KII) and 4 Focus Group Discussions (FGD) in the two communities. The secondary data collection included a review of literature, articles, published and unpublished materials, and books.
The data analysis was done by calculating the indexing value. By taking the basis from other relevant references (Pandey, R., & Jha, S., 2012), a standardization approach of calculating Index was developed. This approach was chosen because it facilitates the indexing easily in comparison to the households and communities with the given indicators, and to the development of composite indices. With this method, a simple 0 – 1 index was calculated for each indicator using the following formula:

For household h and value of indicator i,

$$\text{Index}_{h,i} = \frac{i_h - i_{minimum}}{i_{maximum} - i_{minimum}}$$ (after Motsholapheko *et al.* 2011; Pandey and Jha 2012)

With this formula, every question had multiple options to choose a response, and each of these options had an associated score. Based on this score, each household was given a score for each question. Then the average score of all households was taken by study sites for all the relevant questions for a given attribute, e.g., when calculating a score for livelihoods capitals, all the score of all the households is averaged by livelihoods components, i.e. for social, human, physical, economic and natural capitals. Likewise, index scores for all flood resilience attributes like 4R (Robustness, Rapidity, Redundancy and Resourcefulness), Disaster Risk Reduction (DRR) cycle, etc. were calculated accordingly.

RESULTS AND DISCUSSION

Demographic characteristics of respondents

Out of 402 respondents, about three fourth of them were female compared to about two fifth male. Higher respondent's age groups (n=286, 71%) fall under 26-50 years categories (Table 1)

Table 1: Age distribution of respondents in Kudia and Paklihawa

Age Group (years)	Female	Male	Total
15-25	16 (7.05 %)	13 (7.43 %)	29 (7.21 %)
26 -50	168 (74.01 %)	118 (67.43 %)	286 (71.14 %)
Over 50	43 (18.94 %)	44 (25.14 %)	87 (21.64 %)
Total	227 (100 %)	175 (100 %)	402 (100 %)

Source: Field Survey, 2019

There were different age groups of participants from age of 15 to over 50 years. 227 women and 175 males (total 402) participated in the survey, where 76 % women and 67% male participants were in the 26-50 age group.

Table 2: Ethnic composition of the respondent in Kudia and Paklihawa

Ethnic group	Kudiya(n)	Paklihawa(n)	Grand Total(n)
Chaudhary	69	19	88
Kanu/Kalawar/sah	30	15	45
Majhi	7	19	26
Mushar/Dalit	7	54	61
Muslim	22	34	56
Other	15	6	21
Pahadi	40	14	54
Yadav	12	39	51
Grand Total	**202**	**200**	**402**

Source: Field Survey, 2019

Table (2) presents the ethnic composition of respondents who participated in the survey from of Kudiya and Paklihawa communities. Chaudhari, Pahadi, Kannu/Kalawar were

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the major ethnic groups in the Kudiya, while Mushar/Dalit, Muslim, and Yadav were major ethnic groups in Paklihawa (Table 2)

Livelihoods capitals

The trend of capability of livelihoods capitals in Kudiya and Paklihawa in terms of flood resilience was similar (Figure 1). We found that financial and physical capitals are poor, but social and human capitals are stronger in both the communities. However, human and natural capital's index score is less in Kudiya than in Paklihawa. Due to the variation in the capital's index score, flood vulnerability is high in Kudiya compared to Paklihawa. Low economic values result in low community resilience (Said Qasim, Mohammad Qasim, Rajendra Prasad Shrestha, Amir Nawaz Khan, Kyawt Tun, Muhammad Ashraf, 2016). From the FGDs, it was also known that Paklihawa has Community Disaster Management Committee (CDMC) and more trained community people on the flood early warning, communication, and response mechanism, while Kudiya did not have such trained community human resources. Similarly, natural resources like plantation, water reservoir, landscape planning, are significantly less in Kudiya. The analysis of the capitals correlates the fact that the stronger the social capital of the community, the more resilient is the community (Sarita Panday, Simon Rushton, Jiban Karki, Julie Balen, Amy Barnes, 2021). Indeed, rural communities have their own local resources and assets which can be categorized into five capitals that include social, physical, human, economic, and natural (Chambers, Robert, and Gordon Conway, 1992). These properties help them to cope with the situation at the time of disasters. The richness in such capitals means the communities are more capable to mitigate, prepare, respond, and recover from the disaster.

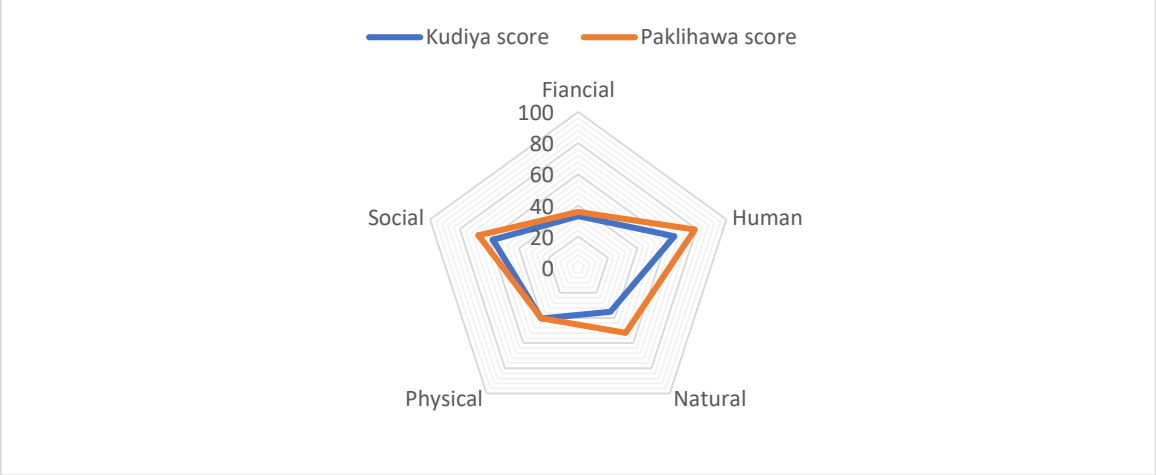

Figure 1: Scenario of livelihoods capitals in Kudiya and Paklihawa (n=402)
Source: Field Survey 2019

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Resilience properties

Considering the flood resilience (figure 2) it was well revealed that rapidity and redundancy are weak while resourcefulness and robustness are good in both the communities. However, Kudiya is weaker in all four resilience properties based on 4R compared to the Paklihawa. From the KI and FGD as well it was known that due to poor economic capital, natural capitals, and physical capitals the rapidity and redundancy in both communities are weaker.

In an actual sense, rapidity, redundancy, resourcefulness, and robustness (4R) are the basic properties of resilience measurement (Szoenyi, Michael, Finn Laurien, and Adriana Keating, 2020). These are the community ability to cope, withstand and recover from the disaster. These properties are measured especially after the impact of disasters to know their ability to withstand and recover from the disasters.

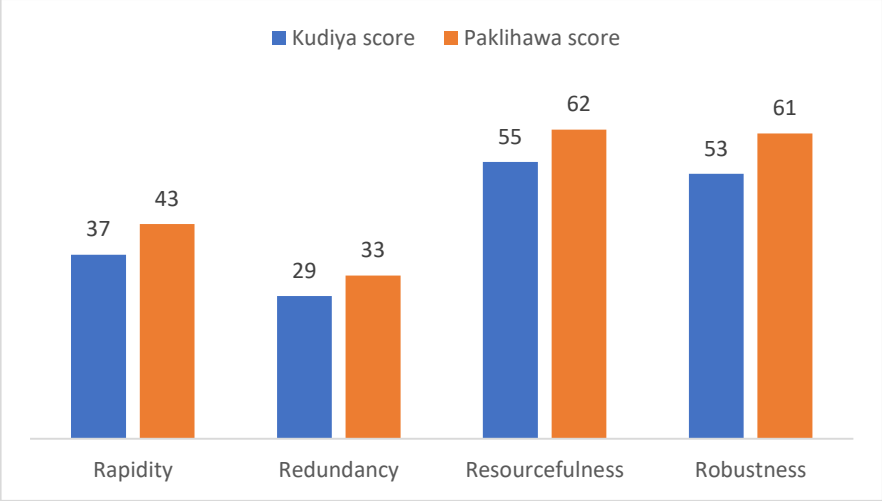

Figure 2: Resilience properties of Kudiya and Paklihawa (n=402)
Source: Field Survey 2019

Disaster risk reduction and management cycle

Mitigation, preparedness, response, and recovery are the capacities of the community especially considered during disaster risk management (Figure 3). These are also commonly used as different phases of the disaster risk management cycle (DRM cycle) and these are helpful to know the community's capacity to cope, withstand and recover from the disasters.

Figure 3: DRR cycle used commonly in risk management
Source: DIMERSAR, 1995

Considering the flood resilience, mitigation and preparedness capacities are in better condition while response and recovery capacities are below the average index value in both the communities of Kudiya and Paklihawa. Paklihawa is better with index values 76 and 64 compared to 60 and 55 respectively in mitigation and preparedness capacities of Kudiya (Figure 4). The capacity in response and recovery of both communities is the same with an index value ***hi*** 46, which is considered below the average value. During the KII and FGD, community people informed that both the communities are inundated by yearly monsoonal floods in the Narayani river, however, the level of flood impact is different in both communities. There are few permanent and semi-permanent structures supported by the government of India for flood mitigation and control whereas people are also aware to carry out some preparedness for coping with the flood, but they do not have adequate plans and resources to prepare, respond, and recovery-perhaps it is beyond their capacity. The key informants' who were representatives from the local government highlighted that they did not have sufficient financial and technical resources at the community level, which is a major reason for the response and recovery capacities of the communities to be below the average indexing score.

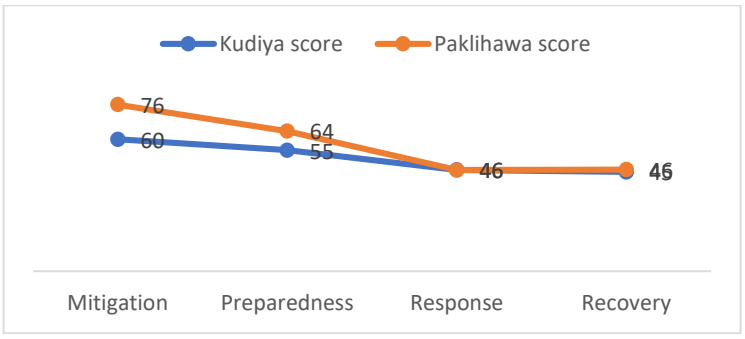

Figure 4: Resilience capacities of Kudiya and Paklihawa in Disaster Risk Reduction and Management cycle (n= 402)
Source: Field Survey 2019

Resilience theme

The trend of resilience themes in Kudiya and Paklihawa communities are the same (Figure 5). Considering flood resilience, Paklihwas has better themes in life and health and social norms with an indexing value of 75. Life and health are the protection of human life in supporting human physical health and resources which is considered good in Paklihawa, but lifelines and livelihoods themes are below the average (with indexing value 33 and 27 respectively). Lifelines are essential systems or critical infrastructures that provide the resources or services for meeting the community's needs. On the other hand, lifelines and livelihood opportunities in Paklihawa are less, which has a negative effect on the community to cope, withstand and recover from the floods. Four flood resilience themes are below average in Kudiya, which makes it more vulnerable to flooding compared to Paklihawa. Findings of the FGD and KII also revealed the fact that community people lack the basic health infrastructures such as health posts, hospitals, and health equipment. Access to those facilities is difficult in the flood situation when the roads are wash away and sometimes even the health facilities are inundated. Due to being marginalized and poor, people in the community do not have better livelihoods option or diversification, which cause further vulnerability for above resilience themes. The regular flood affects the cultivable land, crops, and livestock and disrupts local markets and supply moving them into further poverty.

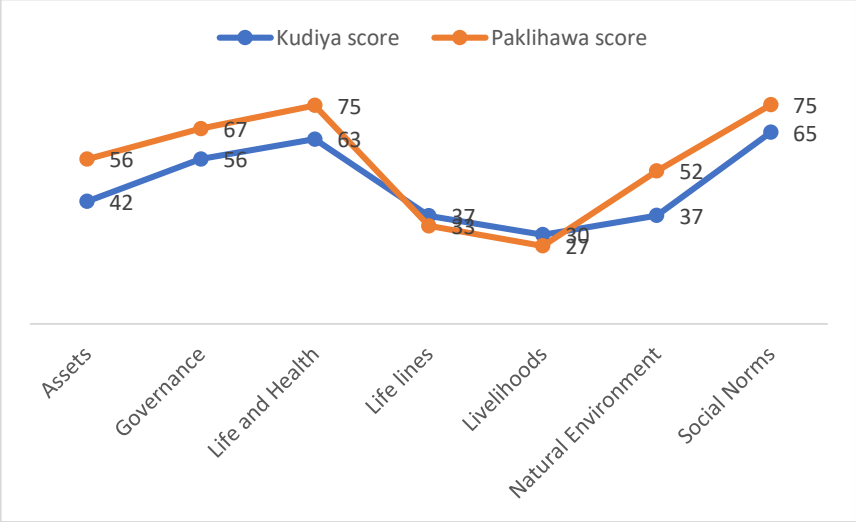

Figure 5: Condition of resilience themes in Kudiya and Paklihawa (N=402)
Source: Field Survey 2019

Resilience sources

For the flood resilience and considering the local context of Nepal, 35 resilience sources were customized from the survey questionnaires, which were important and relevant to measure the flood resilience in the two communities, whereas there is different resilience source applied by different institutions for resilience measurement (Bulti, D.T., Girma,

B. & Megento, 2019)Considering the community actions for flood resilience, the condition and trend of resilience sources in Kudiya and Paklihawa are the same (Figure 6)It was well demonstrated that out of 35 resilience sources, only 8 sources have index value above 80, which is considered a stronger resilience source, but 13 out of 35 sources are below the average index value (less than 40) in both communities which are considered poor resilience scores. Comparatively, Kudiya has a poor index value in most of the resilience sources, which indicates more vulnerability to flooding. Key informant interview conducted with municipality representative of Susta Rural Municipality reported that they lack the knowledge to manage disaster risk reduction in a holistic approach. They are newly elected, need to learn more in DRRM, and will require external technical support to prepare a long-term plan addressing the issues of the flood-prone communities.

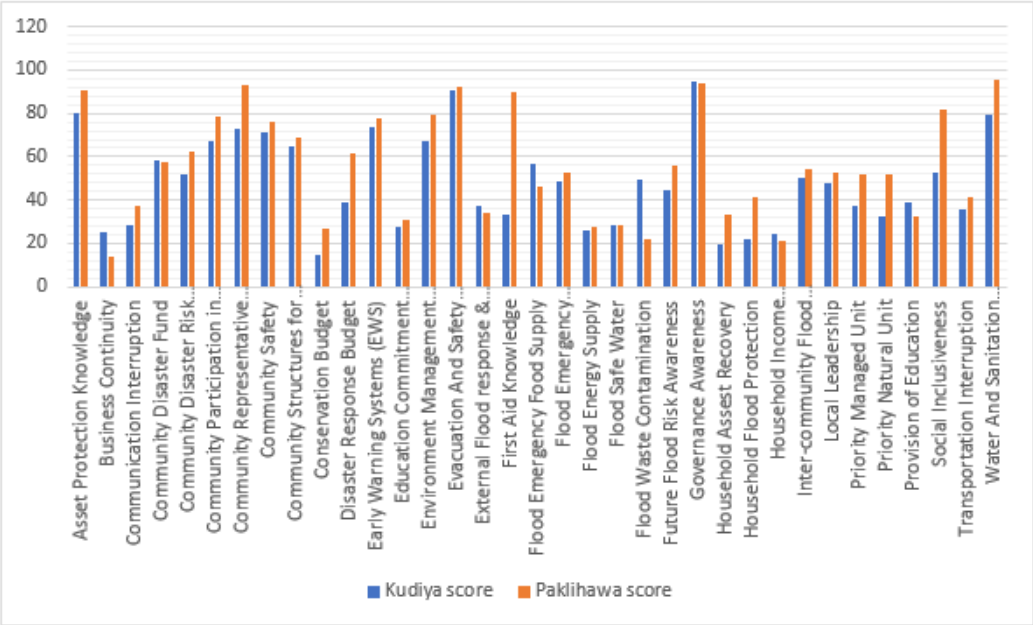

Figure 6: Resilience source influencing flood measurement in Kudiya and Paklihawa(n=402)
Source: Field Survey 2019

The resilience as argued by (Birkmann, Jörn, 2006) can be interpreted through the positive movement or improvement of asset, process, and institution categories as, understood and measured through the Sustainable Livelihood Framework (SLF). Similarly, a positive increase in the score on ability to learn and self-organized among the communities also suggests a greater ability to adapt and transform in the community flood resilience. Increase in flood resilience of these communities can be defined through the

net positive change in their various factor categories along with an increase in the indexing scores.

CONCLUSION

It is important to identify the communities whose resilience is being addressed for measurement including their needs to be resilient to cope and withstand in order to reduce the impacts of those floods. The factors contributing to flood resilience measurements were found more associated with different resilience sources and capacities of the particular community. Indeed, it was well demonstrated that status of physical resources, capacities, systems, governance, and engagement of the community could make a significant difference in the flood resilience for mitigation, preparedness, response, and recovery from the floods. The impact trends of floods in both Kudiya and Paklihawa were similar but the flood impact level in the communities was different due to community actions, resources, and capacities available, which suggest that the factors analyzed in our study are quite relevant and useful to measure the resilience under rural flood-prone context of Nepal. The factors associated with the flood resilience measurements include livelihoods capitals, resilience properties, resilience themes, DRR cycle, and resilience sources. These research findings show that the lower scores coincide with the higher impact of flood in Kudiya than Paklihawa and have significance.

Likewise, the factors contributing to community resilience were found dynamic and correlated to natural, social, political, economic, physical, and human capital. The resilience 35 sources which were chosen at the community level are to be pursued more effectively by community-level actions in flood resilience measurement.

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