BI-ANNUAL RESEARCH JOURNAL "BALOCHISTAN REVIEW" ISSN 1810-2174
Balochistan Study Centre, UoB, Quetta (Pak) VOL. XXX, NO.1, 2014

# Resilience Framework for Earthquake Induced Disaster in Balochistan, Pakistan

`

**Geography**

**Syed Ainuddin**
Assistant Professor, Faculty of Earth and Environmental Sciences,
Geography, University of Baluchistan, Quetta, Pakistan
Syed.ainuddin77@gmail.com

**Dr kaleemUllah Breach**
Assistant Professor, History Department,
University of Balochistan, Quetta, Pakistan

## Abstract

*Resilience thinking is indeed acknowledged and applied in a variety of research perspective particularly community resilience is in dispensary in the field of hazard/disaster and global environmental change in the contemporary literature. However its measurement has been a challenge for researchers and practitioners both at the national and local levels especially in developing countries like Pakistan. This paper proposes a community resilience framework with measureable indicators at the local level and subsequently implemented in an earthquake prone community in Baluchistan in order to provide a rudimentary assessment of resilience at the community level.*

**Keywords:** *Community, Resilience Framework, Earthquake, Baluchistan*

## Introduction

The increased number of natural disasters over the years along with increasing order of their intensities and associated impacts, it is imperative to assess such vulnerabilities and risks to build safer and resilient communities. A paradigm shift is observed in the hazard/disaster literature from hazard assessment to vulnerability and resilience thinking. However their assessments are not linear. The assessment of vulnerability and resilience needs clear understanding of the very concepts in the right context to develop indicators for different levels. In fact the challenges become inevitable when their assessment is attempted at local levels. Disaster risk reduction is the current thrust in disaster management arena that has fundamental links with vulnerability and resilience. However, post disaster relief approach is still prevailing in many developed and developing countries (Gupta, 2006; Halvorson, 2007; Kulig, 2008; Sharma, 2001). At the same time selecting indicators for both the concepts is really a challenging task (W. N. Adger, Kelly, P.M., Winkles,A., Huy, L.Q., Locke, C., 2002; J. Birkmann, 2006a, 2007; J. Birkmann, Wisner, B., 2006b; L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008a; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; R. Davidson, 1997; Godschalk, 2002; USAID, 2006). Adger (2006) argues that "The challenges for vulnerability research are to develop robust and credible measures" while resilience approach does not have any standardized set of indicators and frameworks (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; M. A. Davidson, 2006; B. H. Morrow, 1999; Paton, 2001; Weichselgartuner, 2001). Therefore this paper takes the first step by providing a conceptual framework on community resilience drawn from hazard/disaster literature and proposes measurable indicators at the community level and finally examined and implemented in an earthquake prone community in Balochistan.

**Vulnerability and Resilience Discourse**

The term vulnerability is frequently employed in discussion of disasters (Hossain, 2002). The concept of vulnerability has been evolved out from Social Sciences (J. Birkmann, 2006a) and frequently used in the hazards and disasters literature (S. L. Cutter, 1996). Literature on vulnerability is filled with many notions and frameworks emanating from different points of view and different organizations but its assessment is rare in the literature (Leon, 2006). Its assessment is complex and varies from disaster to disaster and country to country depending on the education and awareness of the professionals engaged in disaster risk reduction and management. Therefore it needs holistic approach across the disciplines (McEntire, 2010). Many disagreements in the interpretation of vulnerability has arisen from various epistemological orientations: Political Ecology, Human Ecology, Physical Science, Spatial Analysis (W. N. Adger, 2006). Since 1980s, the dominancy of hazard oriented prediction strategies using advanced technologies for disaster has been intensively criticized and challenged by alternative paradigm of using vulnerability as the starting point of disaster risk management emerged. This approach combines the susceptibility of people and communities exposed with their social, economic and cultural abilities to cope with disasters (J. Birkmann, 2006a). Vulnerability has been found in relation to three major themes in literature and research (S. L. Cutter, 1996). Vulnerability as hazard/risk exposure explains the sources of biophysical or technological hazards and focuses on the occurrences of hazardous events and distribution of hazardous conditions (K. Hewitt, Burton, I., 1971). The second theme sees vulnerability as social response, examines the coping responses and societal resistance which is rooted in historical, cultural, social and economic processes (Wisner, 2004). The third one as vulnerability of places focuses on the combination of the elements of the first two directions but is more geographically centered taking both biophysical risk as social response in a particular geographic domain (S. L. Cutter, 1996). Above all vulnerable people and places are always deprived of access to power and resources (W.N. Adger, 2003; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; Pelling, 2003).

There is a common consensus of scholars that resilience has been introduced first in the field of ecology (L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008b; Fleischhauer, 2008; Folke, 2006; M. Janssen, Ostrom, E., 2006; Mayunga, 2007), particularly in Holling's influential paper "Resilience and stability of ecological system" (Holling, 1973). Resilience has variable characteristics over time and space. The term resilience is currently applicable to many disciplines and systems such as natural, social, economic and engineering. The application of the resilience concept to natural hazards is quite rational and suggests that resilience is the ability of a community to recover by means of its own available resources (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010). While Norris et al. (2008) argue that it is a set of adaptive capacities that can be fostered through intervention and policies. She defined resilience as process linking the adaptive capacities to responses and changes after adverse events. A different view of disaster resilience is put forwarded by Bruneau (2003) that emphasizes on infrastructures, buildings and critical facilities, using seismic risk as an example. He argues that the resilience framework developed by MCEER (Multidisciplinary Center for Earthquake Engineering Research) can be utilized for structural mitigation, especially applying the engineering concepts of robustness, redundancy, resourcefulness and rapidity.

## Linkage between Vulnerability and Resilience

The concept of vulnerability developed largely in social sciences addressing environmental risks and hazards (Kasperson, 2005; Wisner, 2004), while resilience emerged from ecological sciences to address change and persistence in the ecosystems (Carpenter, 2001; L. H. Gunderson, 2000). However, they have their own separate disciplinary histories and footings. For example, ecologists use the core concept of resilience to encompass the management of ecosystem of animals and plants. Vulnerability has its roots in geography, natural hazard and poverty literature, while adaptation has been the domain of anthropologists since the early 1990s. Vulnerability and resilience are dynamic processes. They may be defined differently, but for measurement purposes they are considered as static phenomena (M. A. Janssen, Ostrom, E.,, 2006; Olwig, 2012). Gallopin (2006) argues that these concepts are relevant in biophysical and social realm, and have some linkages. As these concepts are used in different disciplines and in different contexts, their linkage in terms of precise nature and their relationship becomes impossible, even though he has identified the conceptual linkages between these concepts using a generic system approach. Tobin (1999) explains that sustainability and resilience for comprehensive hazard management that is easy from a theoretical standpoint but difficult in implementation since the relationship between these two depends on many social, economic, political and physical factors, while, Tunner et al. (2010) argue that vulnerability and resilience constitute difference but also overlapping themes embraced by sustainability. To IPCC, the definition (McCarthy, 2001) of vulnerability is the degree to which a system is susceptible and is unable to cope with adverse effects of climate change. The point of convergence are more numerous and more fundamental than the points of divergence. Smit (2006) in the context of climate change adaptation argues that the concepts of adaptation, adoptive capacity, vulnerability, resilience, exposure and sensitivity are interrelated and have a wide application to global change science. Tunner (2003) explains vulnerability in his conceptual framework in a broader sense. The definition and analytical framework of vulnerability encompasses exposure, sensitivity and resilience. However, Jackson (2006) argues that resilience, adaptation and vulnerability are the key terms and they are linked in some ways to one another. (W. N. Adger, 2006; Bilham, 2006) argue that resilience is a part of adaptive capacity, while Smit (1999) considers adaptive capacity as component of vulnerability. To (Gallopin, 2006; Tunner, 2003) both resilience and adaptive capacity are parts of vulnerability. Resilience is an imbedded feature within vulnerability, when seen as process or outcome (Manyena, 2006) but for more cohesive learning and decisions, it is considered as process (Bruneau, 2003; Paton, 2001). (Miller, 2010) argue that despite having different approaches, linkages and complementarities can be explored to identify the areas of synergy between the concepts. In addition to that the linkages and possibilities of integration of the concepts are still in early stage; however the convergence of vulnerability and resilience can contribute on a common front, solving the real world problems. Above all despite diverse views and interpretations of these two important concepts; there are overlapping areas with linkages and also common areas of convergence.

**Community Resilience Models**

There are a number of models and frameworks developed in order to assess the resilience of community, region and system but there is no common framework or model to measure and monitor the community hazards resilience (J. Birkmann, 2007; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; S. L. Cutter, Emrich, C. T., 2006; R. Davidson, 1997; G. Tobin, 1999; Zhou, Wang, Wan, & Jia, 2010). However some of the notable models are briefly explained below. The Disaster Resilience of a Place Model (DROP), is developed by Cutter et al. (2008b). The current model is developed and created specifically to address the natural hazards however it can be adopted for the other onset hazards as well such as terrorism and technological hazards. In addition to that (G. Tobin, 1999; G. A. Tobin, Whiteford, L. M., 2002) adopted three separate models for the assessment of community resilience of Volcano hazard to create resilient communities. Those were mitigation model, recovery model and structural cognitive model. The model is a dynamic system and not necessarily to be balanced. Each model has a list of some of the important attributes that should be incorporated into the analysis. Norris et al (2008) have developed framework related to stress, resistance and resilience over time. In which resistance occurs when resources are robust, redundant to counteract the immediate effects. Bruneau et al. (2003) developed a conceptual framework for the seismic resilience of communities.

The framework includes quantitative measures of the ends of robustness and rapidity and the means of resourcefulness and redundancy, and integrates also those measures into the four dimensions of community resilience such as technical, organizational, social and economic. US, AID (2007) developed a framework to assess the resilience of the coastal community to different hazards. The framework highlights the strength and weaknesses and gaps in resilience that can be addressed by the community together with government agencies, nongovernmental organizations, private sectors and other stakeholders. It focuses largely on how to assess coastal community resilience as a first step in defining actions to reduce risk, accelerate recovery and adopt change. The process of CBDRM puts the community in understanding local level risk reduction measures as a central focus. Community takes responsibility for all stages of the program including both planning and implementation in the process. The adoption of the models focused at the community level seems to be difficult in developing countries including Pakistan due to limitation of explicit nature of indicators in many cases, coupled with the paucity of data. The previous section explains some of the community resilience frameworks proposed by a number of researchers. Those frameworks as suggested by different scholars focus on diverse aspects related to human and environmental interactions directly or indirectly related to disasters. The most prominent and cited framework of Cutter et al. (2008b) proposed disaster resilience of a place model (DROP), which provides measures at the national level. This type of assessment becomes cumbersome at the community level. Similarly Norris et al. (2008) have proposed a framework of resilience over time, which is broader and conceptual in nature. In addition to that Tobin et al (1999) proposed sustainability and community resilience framework in a general context of hazards planning and sustainability. Apart from that Paton et al (2001) provided a model of resilience to hazards effects that is based on the community perceived effects of hazard, where low risk perception results in poor mitigation and high risk perception contribute to Psychological resilience and preparedness. There are a number of issues that should be sorted out while implementing the framework at the community level in developing countries. DTOP framework is more generalized and broader in the context of natural hazards and has not explicitly elaborated how it can be implemented at the community level. The indicators selected are broad and applied at the national level. This framework has not followed the logical sequence of events in the course of achieving community resilience.

**Proposed theoretical framework**

The approach is mainly ecological focusing social, economic, institutional and physical aspects of the communities prone to hazards and disasters. These aspects are the key in achieving community resilience, once their assessments are carried out with the right kind of indicators and availability of the data at local levels. The framework has mainly four components explained as followed and shown in figure 1.

One of the components of the proposed community resilience framework is the social resilience which portrays the various social capacities of the community to handle the impacts of earthquake hazard. Socio-economic and demographic attributes such as educational level, age, health coverage, social capital and special needs for women, children and disable population indicates that higher educational level of the community, heath insurance, less people in old ages of their lives, people without physical and mental disability may have greater power to bounce back to their normal lives after the earthquake compared to those communities which do not have these characteristics. It also suggests that the community trust and networks during and after the disasters may enhances the community cohesiveness and can play a vital role in earthquake recovery period for better community disaster resilience. Economic resilience is the second component of the community resilience framework. Its contribution to the community resilience is essential in terms of economic capacities. Several variables presented such as housing capital, employment, health access, and multiple sources of income. The results of these variables will allow examining the local economic base and providing links whether they enhance the community resilience or decrease livelihood options particularly at the community level.

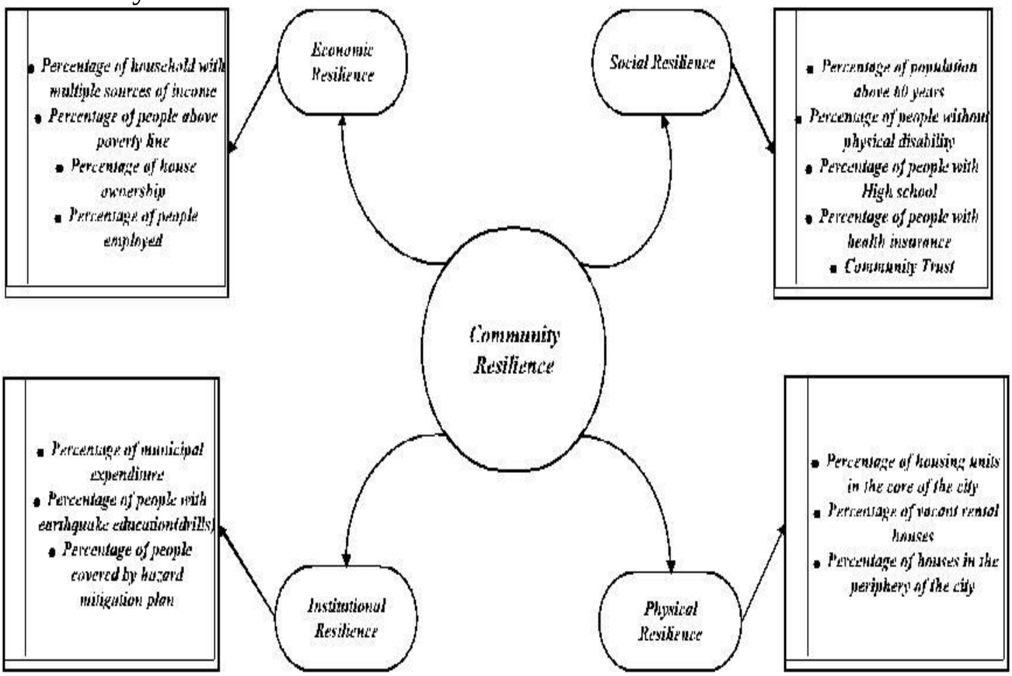


**Figure 1 Proposed Community Resilience Framework**

Community with diversified sources of income may absorb the impacts of earthquake and can play an important role in community rehabilitation and reconstruction and a community with less diversified sources of income may not recover easily from the earthquake impacts (W. N. Adger, 2000). These variables also suggest that a stable and growing community economy may generally enhance the community resilience while a poor and unhealthy community economy may indicate the increasing vulnerability of community to hazards (Buckle, 2001). The third component of community resilience is the institutional resilience that examines the capacities related to disaster planning, mitigation and public awareness. The indicators such as percentage of municipal expenditure, percentage of people with earthquake education (drills), percentage of people covered by hazard mitigation plan reflects that people at the community level should be involved in the disaster risk reduction strategies at local levels in order to cover and protect the social system (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010). Institutional resilience variables also highlight the institutional issues during the disaster emergency particularly in earthquake and other disaster. The last components of the community resilience framework constitute the physical resilience that portrays the community physical capacity specifically the location of housing units, vacant housing units, and housing age. These indicators provide the overall assessment that housing units located in the core area of the city due to density and congestion will be more vulnerable compared to those in the periphery. Housing units constructed before 1935 Earthquake, are relatively less resilient due to the absence of any kind of building regulation and building codes.

**Study Area and Methods**

Quetta is the provincial capital of Balochistan. It is located in the North Western part of the province. The district lies between 29˚ 48΄ and 30˚ 27΄ North latitudes and 66˚ 14΄ and 67˚ 18΄ East longitudes. The district is prominently mountainous. Most of the earthquakes on different scales occurred within the radius of 240 km from Quetta. At the same time historical seismic data also confirms that the district has been subjected to many earthquakes in the past particularly the major one in 1935, killing almost 35,000 people in Quetta City (PDMA, 2006). Based on collaborated study conducted by the NESPAK (National Engineering Services Pakistan) and QDA (Quetta Development Authority), the district has been divided into two seismic zones i. e. Zone A (Very High Seismic Risk) and Zone B (High Seismic Risk). The damages from the previous earthquakes in the city were observed more in Zone A compared to Zone B (QDA, 1985).

Above all the Earthquake Zonation Map of Pakistan in Figure 1 indicates that Quetta lies in high Seismic zone. The city is frequently visited by a number of damaging earthquakes in the past and currently impacted by earthquake of 2008. The sample size was derived on the basis of the population size (total households) in two zones following the formula of sample size calculation by (Yamane, 1967) as mentioned below.

Totally, 200 samples were collected and further distributed proportionally in Zone A (80 households) and Zone B (120 households) respectively. A simple random sampling method was used for two zones almost covering all Union Councils (lowest unit of administration). A structured questionnaire was used for data collection and has several components such as socio-economic profile of the respondents, social resilience, economic resilience, physical resilience and institutional resilience with direct relevance to measure the vulnerability as well as resilience. Mostly the head of the households and in some cases senior and elderly person of the household in the absence of the head were interviewed. The research is based on both the primary and secondary data sets collected through key informant interviews, focus group discussions, and household questionnaire survey. Descriptive and inferential statistics are used for the analysis of the data. Throughout the survey, most of the respondents were male due to the cultural and traditional norms of the community, as women in Islamic societies do not come to the forefront.

The average age of the respondents are 46 and 40 respectively in Zone A and zone B. In terms of educational attainment, comparatively Zone B has a better status than Zone A in all categories (For example, Illiterate: Zone A with 40% and 22%, in zone B, Grade 1-5: Zone A with 19% and 24% in Zone B, High School: Zone A with 11% and 14% in Zone B, College or above: Zone A with 30% and 40% in Zone B). The most dominant primary occupation is business, followed by employment and wage labor. Business has 27% workers in Zone A and 34% in Zone B. Employment in formal sectors shares 36% and 16% in Zones A and B respectively. Wage labors constitute 26 % in Zone A and 24% in Zone B. Other common occupations are small trade, petty business and services. The average household size is about 10 persons in both the zones. As revealed from the survey, the average annual household income is 741 US dollars. However, a majority of the households (158) are below the urban poverty line (101 US dollar per house hold). This illustrates a big disparity between the rich and the poor. Average annual household incomes of Zone A and Zone B are 300 US dollars and 441 US dollars respectively. Regarding the housing condition, the data reveal that 50 % of the housing stock is adobe houses1 while, 35 percent with unreinforced concrete, 17 percent concrete and 2 % are with booboo and wooden materials.

The adobe type of house is very unsafe because it can easily be collapsed during earthquake. Zone A has more housing stock of adobe type. It has been experienced during Baluchistan earthquake in 2008 and Kashmir Earthquake in 2005 about the impacts on adobe houses, which were destroyed and collapsed easily than other types. The methodology adopted and the indicators chosen in such a way that some of them can address the generic issues of resilience and others are more specific to Baluchistan. The parameter values for specific indicators are drawn from western countries empirically, however the procedures followed and results can be comparable with countries under identical situations of Baluchistan. The parameter value of specific indicators may be revised and re-worked out for application to other countries without any alteration to methodology and procedure. It is

indeed true that resilience cannot be measured absolutely however, the paper has tried to use the proxy of resilience in terms of indicators to get the acceptable results. And some of the resilience indicators are purely social which are always difficult to measure absolutely.
1 Adobe: A type of Dwellings made of stone, clay and mud.

**Selection of Indicators**

Within the research community that resilience is a multifaceted concept, which includes social, economic, institutional, infrastructural, ecological, and community elements (Bruneau, 2003; L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008a, 2008b; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; L. Gunderson, 2009; Norris, 2008; NRC, 2010). Based on these findings, our index comprises these sub-components such as Social. Economic, Institutional and Physical. Each one of them has different sets of indicators based on the extensive literature search on resilience particularly related to natural hazards. It is not easy to measure the community resilience absolutely and there is no single method or a set of standardized indicators for resilience measurement (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010), however the indicators employed in the study are proxies for community resilience as used by (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010). The selection of indicators was done carefully on the basis of literature and its significance to community resilience, and the availability of both primary and secondary data. All the values of the raw data were taken into percentages to avoid problems related to different units of measurements. Table 2 presents the selected indicators for community resilience.

**Table 2. Variables Selected for Constructing Community Resilience Index**

| Category | Variable | Justification | Effect on Resilience |
|---|---|---|---|
| **Social Resilience** | | | |
| Educational level | Percentage of people with high school and above education. | Higher the education level, greater is the understanding and | Positive |

| | | | |
|---|---|---|---|
| | | interpreting early warning & evacuation decision. | |
| | Percentage of people without any education. (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; B. Morrow, 2008; Norris, 2008). | | Negative |
| Age | Percentage of population > 60 years, Percentage of population < 15 years.(L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008a; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; B. Morrow, 2008; G. Tobin, 1999). | Constraints of mobility during earthquake and evacuation. | Negative |
| Health coverage | Percentage of population with health insurance.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Heinz, 2002). | Health insurance can Facilitate treatment and reduce the impacts during secondary Disasters following an earthquake such as spread of epidemic diseases. | Positive |
| Special needs for old/pregnant women, children and disable population | Percentage of people without physical or mental disability. (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Heinz, 2002). | Population with disability Will increase the household Finance during earthquake recovery and mobility problems During emergency evacuation. | Positive |

| | | | |
|---|---|---|---|
| | | | |
| Social capital | Community trust during disaster. (Norris et al. 2008, Cutter et al. 2010, Cutter et al. 2008, Adger 2000). | It facilitates coordination And cooperation during Emergency and facilitates access To community resources. | Positive |
| **Economic Resilience** | | | |
| Housing Capital | Percentage of house ownership.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; Norris, 2008). | Higher the ownership of The housing units is better will be the quality and maintenance of the houses. Most of the public buildings by the government got collapsed during the Kashmir Earthquake and also in Sichuan Earthquake China. | Positive |
| Employment | Percentage of people employed.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Tierney, 2001). | Increases economic capacity of the community. It also improves the well being in reducing poverty and vulnerability. | Positive |
| Single and multiple Sources of income (remittance is not taken explicitly for assessment) | Percentage of households with multiple sources of income.(W. N. Adger, 2000; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; Norris, 2008). | Diversified sources Provide alternatives and help better in community rehabilitation And recovery from earthquakes impacts. | Positive |
| Income | Percentage of population above poverty line.(S. L. Cutter, Mitchell, J. T., Scoot, M.S., 2000; K. Hewitt, 1997). | People with above urban poverty line may be impacted less than those below especially in the recovery period from earthquake | Positive |

| | | | |
|---|---|---|---|
| | | hazards. | |
| **Institutional Resilience** | | | |
| Mitigation | Percentage of population covered by hazard mitigation plan.(L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008a; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Godschalk, 2007). | Increase community safety And facilitate to develop And implement disaster Risk reduction strategy at community level. Reduces high Probability of losses from disasters. | Positive |
| Municipal services | Percentage of municipal expenditures for fire and emergency management system and medical services.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Sylves, 2007). | Strongly supports during search and rescue and Emergency situation following An earthquake emergency. | Positive |
| Awareness building | Percentage of people with earthquake education ( mok drills, programs)(Paton, 2001). | Increases knowledge, awareness and skills of the community for safety measures, preventive issues and life saving information. | Positive |
| **Physical (shelter) Resilience** | | | |
| Shelter capacity | Percentage of vacant rental houses.(Tiemey 2009; Cutter 2010) | Vacant rental housing helps in the aftermath of earthquake where victims can be provided with shelter facility. | Positive |
| House age | Percentage of housing | Building codes were introduced | Positive |

| | | | |
|---|---|---|---|
| | units following the building rules of 1938.(Cutter 2010). | first time after 1935 earthquake in Pakistan. Housing units constructed before 1938 may be less resilient to earthquake shocks. | |
| location | Percentage of housing units located in core of the city. | In terms of Density of houses/population reflects the potential losses and effects on recover if strikes by earthquakes. | Negative |
| | Percentage of housing units in periphery of the city.(Taubenbock, 2008). | Less density provide more vacant places around. | Positive |

Source: (Ainuddin & Routray, 2012)

**Weighting and Aggregation of Indicators**

The community resilience is based on the idea of four major components such as social, economic, physical and institutional as discussed in the previous section, where each one has its own contribution to the overall community resilience. Each component is an independent domain that is measured through different indicators. The values of all indicators are expressed in percentage which requires no normalization process of the indicators; therefore the normalization step is exempted. Once the indicators are selected, the step after normalization is to attach weights to the indicators and components. Attaching weights to different indicators have been extensively discussed in the literature that how one can determine that which component or indicator is important than other (Mayunga, 2007). The best weights for community resilience are those that accurately represent the relative contribution of corresponding indicators to the overall resilience. There are two methods of determining weights to indicators that weights derived through empirical testing or weights determined by subjective assessments (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; M. A. Davidson, 2006; Esty, 2005; Noble, 2006); however the literature does not provide any evidence that which method is the best to use, because it depends on situations where they are applied. This study did not use empirically derived weighting system because our data is not large enough to run the

Principle Component Analysis for weights. Therefore we have used subjective assessment to attach weights to selected indicators. To do that we have developed a percentage weighting scale ranging from 0 to 1 as shown below in Figure 2.

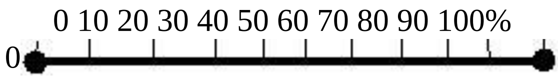


Figure 2. Percentage Weighting Scale of Resilience

To make this clear, the values of the variables and indices can be interpreted as, higher the value of the indicator, higher is the weight and index value, and finally higher is the resilience of that particular variable within a domain/component or zone. The resilience factor index of any selected indicator used under any component is worked out as:

*Resilience Factor Index (RFI) of ith indicator = (% Value of the ith indicator (actual) / %Value taken as the level of the resilience of the ith indicator)*

Less value or those around or close to zero should be considered less resilient, and high values towards to 1 should be considered more resilient. For some indicators in which high values reflect low level of resilience, precaution has been taken to make them comparable in the same way (higher the value of a variable, higher is the resilience) by reversing the calculation of resilience factor index as mentioned below.

*Resilience Factor Index (RFI) of ith indicator = (% value taken as the level of resilience of the ith indicator / % value of the ith indicator (actual).*

For each indictor it has been tried to assign a particular percentage value for the optimum level of community resilience especially in the context of earthquake hazards in Baluchistan. This optimum level has been developed after reviewing extensive literature, and following field observations as shown in Table 3. Data of United States of America (specifically California), Japan and Pakistan were studied intensively for making decision about resilience level for each of the indicator.

Resilience factor index of any component is computed as the mean value of resilience index of all variables under that component. Mathematically it is expressed as:

Component Resilience Index (CRI) =

Where, n = is the number of indicators of that component.
Similarly, the aggregate resilience index is calculated as the mean value of all components. It is expressed as:
Aggregate Resilience Index (ARI) for zones =
Where, N = is the total number of components

**Results and discussion**

The community Resilience index shows variation between the zones and among the components but the difference is not statistically significant. And the overall picture of both the zones with overall community resilience index with mean and expected mean is shown in Figure 6. This explains that the there is difference between the zones in most of the indicators that signifies that Zone A is less resilient compared to zone B. Based on the results and expected mean index value of all indicators, it can be inferred that the area is still less resilient to earthquake hazards, therefore institutional and physical components are crucial to be taken into account along with economic and social components to avoid future earthquake impacts. In terms of physical components, more focus should be given to structural design and materials used for housing construction. Local based indigenous materials are to be used following the Building Regulations Act of 1938. To improve the institutional resilience component of the community, city planning By-laws are to be implemented with proper risk assessment models and risk monitoring and land use zoning to avoid the population and development from risk areas. Earthquake education and awareness about preparedness is required to be implement at each level of education, media etc.

**Table 1. Results of Community Resilience**

| Category | Variable | Justification | Effect on Resilience |
|---|---|---|---|
| **Social Resilience** | | | |
| Educational level | Percentage of people with high school and above education. | Higher the education level, greater is the understanding and interpreting early warning & evacuation decision. | Positive |
| | Percentage of people without | | Negative |

| | | | |
|---|---|---|---|
| | any education. (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; B. Morrow, 2008; Norris, 2008). | | |
| Age | Percentage of population > 60 years, Percentage of population < 15 years.(L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008a; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; B. Morrow, 2008; G. Tobin, 1999). | Constraints of mobility during earthquake and evacuation. | Negative |
| Health coverage | Percentage of population with health insurance.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Heinz, 2002). | Health insurance can facilitate treatment and reduce the impacts during secondary disasters following an earthquake such as spread of epidemic diseases. | Positive |
| Special needs for old/pregnant women, children and disable population | Percentage of people without physical or mental disability. (L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Heinz, 2002). | Population with disability will increase the household finance during earthquake recovery and mobility problems during emergency evacuation. | Positive |
| Social capital | Community trust during | It facilitates coordination and | Positive |

| | | | |
|---|---|---|---|
| | disaster. (Norris et al. 2008, Cutter et al. 2010, Cutter et al. 2008, Adger 2000). | cooperation during emergency and facilitates access to community resources. | |
| **Economic Resilience** | | | |
| Housing Capital | Percentage of house ownership.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; Norris, 2008). | Higher the ownership of the housing units is better will be the quality and maintenance of the houses. Most of the public buildings by the government got collapsed during the Kashmir Earthquake and also in Sichuan Earthquake China. | Positive |
| Employment | Percentage of people employed.(L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Tierney, 2001). | Increases economic capacity of the community. It also improves the well being in reducing poverty and vulnerability. | Positive |
| Single and multiple Sources of income (remittance is not taken explicitly for assessment) | Percentage of households with multiple sources of income.(W. N. Adger, 2000; S. L. Cutter, Boruff, B. J., Shirley, W. L., 2003a; Norris, 2008). | Diversified sources provide alternatives and help better in community rehabilitation and recovery from earthquakes impacts. | Positive |
| Income | Percentage of population above poverty line.(S. L. Cutter, Mitchell, J. T., Scoot, M.S., 2000; K. Hewitt, 1997). | People with above urban poverty line may be impacted less than those below especially in the recovery period from earthquake hazards. | Positive |

| | | | |
|---|---|---|---|
| **Institutional Resilience** | | | |
| Mitigation | Percentage of population covered by hazard mitigation plan.(L. S. Cutter, Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J., 2008a; L. S. Cutter, Burton, G. C., Emrich, T. C., 2010; Godschalk, 2007). | Increase community safety and facilitate to develop and implement disaster risk reduction strategy at community level. Reduces high probability of losses from disasters. | Positive |
| Municipal services | Percentage of municipal expenditures for fire and emergency management system and medical services.(L. S Cutter, Burton, G. C., Emrich, T. C., 2010; Sylves, 2007). | Strongly supports during search and rescue and emergency situation following an earthquake emergency. | Positive |
| Awareness building | Percentage of people with earthquake education ( mok drills, programs)(Paton, 2001). | Increases knowledge, awareness and skills of the community for safety measures, preventive issues and life saving information. | Positive |
| **Physical (shelter) Resilience** | | | |
| Shelter capacity | Percentage of vacant rental houses.(Tiemey 2009; Cutter 2010) | Vacant rental housing helps in the aftermath of earthquake where victims can be provided with shelter facility. | Positive |

| | | | |
|---|---|---|---|
| House age | Percentage of housing units following the building rules of 1938.(Cutter 2010). | Building codes were introduced first time after 1935 earthquake in Pakistan. Housing units constructed before 1938 may be less resilient to earthquake shocks. | Positive |
| location | Percentage of housing units located in core of the city. | In terms of Density of houses/population Reflects the potential losses and effects on recover if strikes by earthquakes. | Negative |
| | Percentage of housing units in periphery of the city.(Taubenbock, 2008). | Less density provide more vacant places around. | Positive |

**Conclusion**

The paper has reviewed literature on community resilience frameworks and analyzed some the most well cited and prominent frameworks on community resilience in disaster literature. The analysis revealed that most of the frameworks were found generic and broader in the context of environmental hazards and disasters. More specifically the variables and attributes of those frameworks were very broad and often not workable at the community level for measurement purposes. The idea of resilience, its conceptual models and assessment is still new in the contemporary literature on disasters. Despite having shortcomings, indices still provide constructive feedback to the policy makers and emergency planners. The composite community resilience index (aggregate index) provides the overall picture of the community resilience and the sub indices of components provide the opportunity to compare among the components, and individual indicator's contribution to the overall community resilience. The results of the proposed framework and indicators clearly indicate that the hazard planning along with other socio-economic situation of the community needs to be improved. Particularly the social, institutional and physical components by raising the awareness and preparedness of people regarding earthquakes, implementing building codes as provided in 1938's Building Regulation Act for Quetta city. However, need arises to revisit the existing Building Codes and bring necessary modifications with strict implementation. This is very basic in order to reduce risk of people in earthquake prone areas. Therefore the proposed community resilience framework can be used for the community level assessment of resilience.

**References**

Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography, 24* (3), 347-364.

Adger, W. N. (2003). Social capital, collective action and adaptation to climate change.

*Economic Geography*, *79*, 387-404.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change, 16*, 268-281.Adger, W. N., Kelly, P.M., Winkles,A., Huy, L.Q., Locke, C. (2002). Nested and

teleconnected vulnerabilities to environmental change. *Frontiers in Ecology and the Environment, 31* (4), 358-366.

Ainuddin, S., & Routray, J. (2012). Earthquake hazards and community resilience in Baluchistan. *Natural Hazards*, 1-29.

Bilham, R., Hough, S. (2006). Future Earthquakes on the Indian Subcontinent: Inevitable Hazard, Preventable Risk *South Asian Journal*, *12*, 1-9.

Birkmann, J. (2006a). Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies. *Tokto: United Nations University Press*.

Birkmann, J. (2007). Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications. *Environmental Hazards, 7*, 20-31.

Birkmann, J., Wisner, B. (2006b). Measuring the Un-Measurable The Challenge of Vulnerability. *United Nations University, 5*, 1-58.

Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., Rourke, T. D., Reinhorn, A. M. et al. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra, 19* (4), 733-752.

Buckle, P., Marsh, G., Smale, S. (2001). Assessing resilience and vulnerability: Principles, strategies and actions. Victorian Governament Publishing services.

Carpenter, S. R., Walker, B., Anderies, J.M., Abel, N.,. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems, 4*, 765–781.

Cutter, L. S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J. (2008a). Community and Regional Resilience to Natural Disasters: Perspective from Hazards, Disasters and Emergency Management, CARRI Research Report 1. Oak ridge: Community and Regional Resilience Institute.

Cutter, L. S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J. (2008b). Aplace-based model for understanding community resilience to natural disasters.

*Global Environmental Change*, *18*, 598-606.

Cutter, L. S., Burton, G. C., Emrich, T. C. (2010). Disaster Resilience Indicators for benchmarking Baseline Conditions. *Journal of Homeland Security and Emergency Management*, *7* (1), 1-22.

Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in Human Geography*, *20*(4), 529-539.

Cutter, S. L., Boruff, B. J., Shirley, W. L. (2003a). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*, *84* (2), 242-261.

Cutter, S. L., Emrich, C. T. (2006). Moral Hazard, Social catastrophe: Face of Vulnerability along the Hurricane Coasts. *Annals of the American Academy*, 102-112.

Cutter, S. L., Mitchell, J. T., Scoot, M.S. (2000). Revealing the Vulnerability of People and Places: A Case Study of Georgetown Country, South Carolina. *Annals of the Association of American Geographers*, *90* (4), 713-737.

Davidson, M. A. (2006). Designing for Disasters. Massachusetts coastal hazards commission, NOAA coastal service center.

Davidson, R. (1997). An Urban Earthquake Disaster Risk Index. In. The John A. Blume Earthquake. Engineering Center, report no. 121. Stanford, California: Blume Center.

Esty, D. C., Levy, T., Srebotnjak, Sherbinin, A. (2005). Environmental Sustainability Index: Benchmarking National Environmental Stewardship. New Haven: Yale Center for Environmental Law and Policy.

Fleischhauer, M. I. (2008). The Role of Spatial Planning in Strengthing Urban Resilience.

*Resilience of Cities to Terrorist and other Threats*, 273-298.

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological system analysis. *Global Environmental Change*, *16*, 253-267.

Gallopin, G. (2006). Linkage between vulnerability, resilience and adaptative capacity.

*Global Environmental Change*, *16*, 293-303.
Godschalk, D. R. (2002). Urban hazard mitigation: Creating resilient cities. Plenary paper presented at the Urban Hazard Forum, john Jay College, University of New York.
Godschalk, D. R. (2007). Functions and Phases of emergency Management. In Emergency Management: Principles and Practice for Local Government, Washington : International City Manager Association.
Gunderson, L. (2009). Comparing Ecological and Human Community Resilience. CARRI Research Report 5. Oak Ridge. Community and Regional Resilience Institute.
Gunderson, L. H. (2000). Ecological resilience: in theory and application. *Annual Review of Ecological Systems*, *31* ( ), 425-439.
Heinz, J. H. (2002). Human links to Coastal Disasters. H. John Heniz Center for Science Economics and Environment. Washington D.C.
Hewitt, K. (1997). Regions of Risk: A Geographical Introduction to Disasters, Essex, UK. Hewitt, K., Burton, I. (1971). The Hazarness of a Place: A Regional Ecology of Damaging
Events. *University of Toranto, Department of Geography, 6*.
Holling, C. S. (1973). Resilience and Stability of Ecological System. *Annual Review of Ecology and Systematics 4*,1-23.
Hossain, M. S. (2002). Vulnerability due to Natural Hazards in South Asia: A GIS aided Characterization of Arsenic Contamination in Bangladesh (Master Thesis). *Agricultural University Norway*.
Jackson, J. (2006). Fatal attraction: living with earthquakes, the growth of villages into mega cities, and earthquake vulnerability in modern world. *The royal Society, 364*, 1911- 1925.

Janssen, M., Ostrom, E. (2006). Resilience, Vulnerability, and Adaptation: A cross-cuttingtheme of International Human Dimension Programme on global Environmental Change.*Global Environmental Change, 16*, 237-239.
Janssen, M. A., Ostrom, E.,. (2006). Resilience, vulnerability, and adaptation: A cross-cuttingtheme of the International Human Dimensions Programme on Global Environmental Change.*Global Environmental Change, 16*, 237–239.
Kasperson, J. X., Kasperson, R.E., Turner II, B.L., Schiller, A., Hsieh, W.-H.,. (2005). Vulnerability of global environmental change. In: Kasperson, J.X., Kasperson, 472–485.R.E. (Eds.), Social Contours of Risk. Earthscan, London,. pp. 245–285.

Leon, D., Villagran, J. C. (2006). Vulnerability A Conceptual and Methodological Review institute of Environment and Human security. *United Nations University- EHS.*

Manyena, S. B. (2006). The concept of resilience revisited. *Disasters, 30* (4), 433-450.

Mayunga, J. S. (2007). Understanding and Applying the Concept of Community Disaster Resilience: A capital-based approach. *A draft working paper prepared for social vulnerability and resilience building, Munich, Germnay,* 1-16.

McCarthy, J. J., Canziani, O. F., Leary, N. A., Dokken, D. J., White, K. S. (2001). Climate Change 2001: Impacts, Adaptation and Vulnerability, in Adger, W., Vulnerability

*Global Environmental Change, 16,* 268-281.

McEntire, D. (2010). Addressing vulnerability through an integrated approach. *International journal of Disaster Resilience in the Built Environment, 1* (1), 50-64.

Miller, F., H. Osbahr, E. Boyd, F. Thomalla, S. Bharwani, G. Ziervogel, B. Walker, J. Birkmann, S. Van der Leeuw, J. Rockström, J. Hinkel, T. Downing, C. Folke,. (2010). Resilience and Vulnerability: Complementary or Conflicting Concepts? .

*Ecology and Society, 15* (3), 1-11.

Morrow, B. (2008). Community Resilience: A Societal Justice Perspective, CARRI Research Report 4. Oak Ridge.

Morrow, B. H. (1999). Identifying and Mapping Vulnerability. *Disasters, 23* (1), 1-18. Noble, M., Babita, M., Barnes, H., Dibben, C., Magasela, W., Noble, S., Ntshongwana, P.,

Phillips, H., Raman, S., Roberts, B., Wright, G., Zungu, S. (2006). The Principle indices of Multiple deprivations for South Africa 2001, Oxford, UK.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., Pfefferbaum, R. L. (2008). Community Resilience as a Metaphor, Theory, Set of Capacities and Strategy for Disaster Readiness. *Community Psychology, 41,* 127-150.

NRC. (2010). Private-Public Sector Collaboration to Enhance Community Disaster Resilience: A Workshop Report, Washington, D.C, National Research Council.

Olwig, F. M. (2012). Multi-sited resilience: The mutual construction of “local” and “global” understandings and practices of adaptation and innovation. *Applied Geography, 33,*112-118.

Paton, D., Fohnston, D. (2001). Disasters and communities: vulnerability, resilience and preparedness. *Disaster Prevention and Management, 10* (4), 270-277.

PDMA. (2006). Provincial Disaster Management Plan for Balochistan, Quetta, Pakistan.

*Provincial Disaster Management Authority*.

Pelling, M. (2003). The Vulnerability of Cities: Natural Disasters and Social Resilience.

*Earthscan, London.*

QDA. (1985). Quetta Urban Plan, Quetta Development Authority in Collaboration with National Engineering Services Pakistan In. QDA, NESPAK.

Smit, B., Burton, I., Klein, R.J.T, Street, R. (1999). The science of adaptation: a framework for assessment. *Mitigation and Adaptation Strategies for Global Change, 4*, 199-213.

Smit, B., Wandal, J. (2006). Adaptation, adaptative capacity and vulnerability. *Global Change Research Institute, 16*, 282-292.

Sylves, R. (2007). Budgeting for Local Emergency Management and Homeland Security, In Emergency Management: Principles and Practice for Local Government, Washington. International City Manager Association

Taubenbock, H., Post, J., Roth, A., Zosseder, K., Strunz, G. and Dech, S. (2008). A conceptual vulnerability and risk framework as outline to identify capabilities of remote sensing. *Natural Hazards and Earth System Science* (8), 409-420.

Tierney, K. J., Lindell, M.K., Perry, R.W. (2001). Facing the Unexpected: Disaster Preparedness and Response in the United States, Natural Hazards and Disasters, Washington.

Tobin, G. (1999). Sustainability and community resilience: the holy grail of hazard planning?

*Environmental Hazards, 1*, 13-25.

Tobin, G. A., Whiteford, L. M. (2002). Community Resilience and Volcano Hazard: The Eruption of Tungurahua and Evacuation of the Faldas in Ecuador. *Disasters, 26* (1),28-48.

Tunner, B., Kasperson, R., Maston, P., McMarthy, J., Coreel, R., Christensen, L. et al. (2003). A Framwork for Vulnerability analysis in sustainability science. *Retrieved on September 9, 2009 from www.psas.org.*

Turner, B. L., IIa, B., . (2010). Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change, Article in Press, G Model JGEC-789;* , 1-7.

USAID. (2006). Concepts and Practices of "Resilience": A compilation form various secondary sources. *United States Agency for International Development*.

USAID. (2007). How Resilient is your coastal ccommunity: a guide for evaluating Coastal community Resilience to Tsunami and other Hazards. *United States Agency for International Development*.

Weichselgartuner, J. (2001). Disaster mitigation: the concept of vulnerability revisited.

*Disaster Prevention and Mangement, 10* (2), 85-94.

Wisner, B., P. Blaikie, T. Cannon, and I. Davis. . (2004). At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd ed.). *Routledge, London, UK.*

Yamane, T. (1967). *Statistics, an Introductory Analysis* (2nd ed.). Harper and Row, New York.

Zhou, H., Wang, J. a., Wan, J., & Jia, H. (2010). Resilience to natural hazards: a geographic perspective. *Natural Hazards, 53* (1), 21-41.