

Natural, Structural or Man-made Impediments: What Triggers Vulnerability in a Disaster-Prone Rural Pakistan?

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Abstract: Natural catastrophic events are beyond human control; however, human interventions exacerbating natural disasters can be managed through appropriate policy measures. This study evaluates disaster vulnerability in the rural areas of district Badin, Sindh province, Pakistan, using a primary survey data collected through a multistage sampling design (301 households in 15 communities). The main objective is to identify the key natural, structural, and man-made impediments contributing to vulnerability. The research computes a household-level Vulnerability and Capacity Index (VCI) and use descriptive statistics and group comparisons to assess differences between Left Bank Outfall Drain (LBOD) and non-LBOD communities. Findings highlight that areas with significant human influence such as communities near the LBOD, are highly vulnerable. Environmental changes, including sea intrusion from the Arabian Sea intensified by upstream water mismanagement, have severely affected traditional livelihoods, groundwater quality, and arable land. These impacts extend to non-LBOD communities, further aggravating vulnerability. The study underscores the urgent need to rehabilitate and maintain critical man-made structures, ensure proper water management, and enhance local socio-economic conditions to reduce household-level vulnerability. Strengthening community networks, institutional support, and access to essential services can play a key role in building resilience in similar rural settings.

Keywords: Natural Disasters, Man-made Hazards, Sustainability, Capacity and Vulnerability Index, Rural, Pakistan

Introduction

The man-made interventions are generally perceived as human activities that also include industrialization and other technological and infrastructure developments in both urban and rural geographies. For any development activity which affects the lives of the local people, it is essential to include the local communities in decision making and planning (Barrios, 2008). Beside this, a thorough understanding of human ecosystems, biophysical environment, local natural resources and other economic, social and cultural factors is essential (SPDC, 2015).

‘Man-made disasters / events’ are used mostly in generic term. These man-made events or interventions initially tailed from scientific interventions such as nuclear and other technological, and chemical interventions (El-Sabh & Murty, 1988; Modica et al., 2018; Novelo-Casanova & Suárez, 2010), economic interventions that include economic and

financial crises, credit crunch, and other monetary and fiscal policy interventions etc. (Modica et al., 2018; Sawada et al., 2019), Physical Infrastructure interventions such as buildings, town planning etc. and other domestic and international political conflicts, civil wars and anthropogenic activities (Modica et al., 2018; Novelo-Casanova & Suárez, 2010; Warr & Aung, 2019).

Vulnerability is a phenomenon dependent more on context rather than the magnitude of natural catastrophic event (Mustafa, 2003; Mustafa et al., 2011, 2019). From the vulnerability perspective, there is a vast literature on the subject with variety of frameworks globally. However, in the context of Pakistan, there is a paucity of empirical work on vulnerability assessment in rural geographies and disaster-prone rural areas. Following the SPDC report, we define vulnerability not only as a biophysical condition but as susceptibility to suffer damage from extreme events and the relative inability to recover from that damage (SPDC, 2015).

The world is prone to several climate-induced natural catastrophic events, and the vulnerability to hazards has been augmented on account of different man-made interventions. There is a paucity of empirical works at global level that directly focus on human interventions in rural uplift and development for traditional rural economic activities that led to disasters. Thus, it is important to analyse the vulnerability to hazards with the inclusion of man-made interventions and their roles. It is recognized that the climate-induced factors are exogenous factors for disaster and considered beyond human control to some extent (Park, 2011). However, the human factors augmenting the effects of these disasters are considered as man-made and are found controllable with effective policy measures.

The LBOD is the world's largest public sector drainage project, built in Lower Indus Basin Plain in district Badin, Sindh Province, Pakistan (Mahessar et al., 2016; R et al., 1999). Badin, which has a high hazard risk rating (NCSW 2012), is at significant risk of submersion by the sea within the next 20 to 30 years (The News International, 2014). The LBOD was designed to drain the saline water from upper Sindh and Punjab provinces and manage rain flash and floodwater from the Indus River channelling it to the Arabian Sea. However, the district's natural conditions – such as declining Indus River flows due to climate change, and the powerful sea currents – combined with design flaws and maintenance neglect, have rendered the LBOD ineffective. The 1999 cyclone 2-A severely damaged LBOD structures and embankments near the Arabian Sea, which have not been repaired since. This damage has exacerbated sea water intrusion, leading to extensive waterlogging, salinity, and groundwater contamination. The coastal population now faces severe challenges, including unfit drinking water and soil degradation from rising salinity and the discharge of agricultural and industrial pollutants (Baloch et al., 2019).

The study area, District Badin, is situated in the south-eastern region of Sindh Province, bordered by the Arabian Sea to the south and southeast, forming part of Pakistan's international border with India. Badin's terrain consists predominantly of an alluvial plain shaped by the ancient Indus River, with a lower elevation near the Arabian Sea, making it highly vulnerable to sea intrusion and flooding. The district is one of the most climate-vulnerable areas in Pakistan, experiencing frequent cyclones, heavy rainfall, and floods due to its coastal location. Historical records highlight recurring disasters, including major cyclones in 1964, 1969, and 1999, and significant floods in 2010 and 2011, when Badin accounted for nearly one-fourth of all damages in Sindh Province. These natural calamities, compounded by high poverty levels—with estimates indicating poverty incidence ranging from 32.4% to 83.4%—make Badin a focal point for studying the social vulnerability of communities. The district's division into LBOD-affected and non-LBOD regions, exposing varying levels of risk to natural and man-made hazards, forms the basis for investigating social vulnerability and climate change impacts at household and community levels.

This research examines the social vulnerability of households and communities in District Badin, focusing on the impacts of climate change and disasters in LBOD-affected and non-LBOD regions. Using the Vulnerability and Capacity Index (detailed in Section 3.1), the study identifies the factors contributing to vulnerability and quantifying the extent of climate change impacts, this research contributes to developing evidence-based strategies for risk reduction, community resilience, and sustainable development. The findings aim to inform targeted policies for disaster risk reduction, infrastructure planning, and community resilience, addressing critical gaps in localized data and understanding.

The data used is taken from a primary survey of households in LBOD and non-LBOD communities (details are provided in section 3). The paper includes Introduction, followed by Data and sampling (section 2), and Methodological Framework (section 3). Section 4 entails the descriptive analysis and empirical results, followed by conclusion with policy recommendations arising from our analysis (section 5).

Data and Sampling

About Study Area

Pakistan is a disaster-prone country (Memon & Ahmed, 2022) and ranks among the most climate-vulnerable nations globally, positioned 16th on the vulnerability index (Kanwal et al., 2019; Memon et al., 2020). The study area, District Badin, is situated in the south-eastern and lower regions of Sindh province. Its southern and south-eastern coastal boundaries are bordered by the Arabian Sea, which also forms part of the international border with India.

The district's terrain is predominantly uniform and characterized by an alluvial plain formed by ancient streams of the Indus River. However, the southern region near the Arabian Sea has a relatively lower elevation compared to the northern part (Jamal & Lohano, 2008). The Left Bank Outfall Drain (LBOD), which traverses the district, poses a significant threat, especially during heavy rainfall, leading to flooding and sea intrusion.

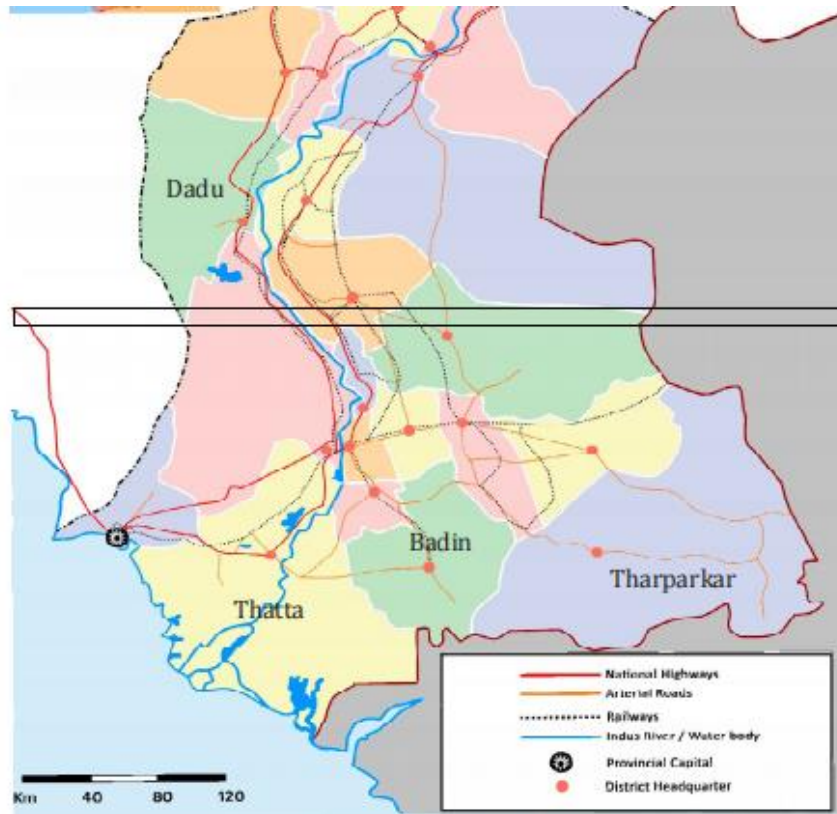


Figure 1. Map of District Badin (Source: SPDC, 2015).

Over the past 20 to 30 years climate change has caused extreme weather events particularly in the province of Sindh (Memon et al., 2018). Thus, the district having coastal areas associated with it, has a long history of being impacted by cyclones, heavy rainfall, floods, and droughts, with floods occurring particularly frequently. The area experienced severe tropical cyclones in 1964 and 1969, a storm in 1999, and floods in 1970, 1975, 1979, 1988, 1994, 2003, 2006, 2007, 2010, 2011, and 2012. Additionally, the district suffered from droughts in 1894, 1932, and 1965-1969, and earthquakes in 1958, 1960, 1963, 2001, and 2019 (DDMA, 2008; EM-DAT, 2020; GoP, 2012). In 2010, Government of Sindh, declared Badin district as disaster prone district (The Express Tribune, 2010). During the 2011 floods, District Badin was the hardest hit among the regions, accounting for approximately one-fourth (22.2%) of the total damages in the province. The majority of the destruction occurred in the housing sector (59.0%), followed by the agriculture sector (37.6%) (Authors calculation using PDMA, 2011). The district is also declared hazard prone by National and Provincial Disaster Management Authority, and categorized under high climate risk level and hazard score risk assessment (NCSW, 2012). The climate risk level and hazard score risk assessment for the district is considered high (see Table 1).

Table 1. Pakistan District Level Climate Risk and Hazard Risk Assessment Classification (Selected Districts)

DISTRICT BADIN	HAZARD RANKINGS
National Ranking	18/145
Provincial Ranking	7/23
Hazard Type	Hazard Score*
Overall Hazard Score**	5
Flood	4
Landslide	1
Earthquake	3
Tsunami	-
Cyclone	5
Drought	2
Avalanche	1
Glacial lake outburst flood (GLOF)	1

*Hazard Risk Score / Classification: 5: very high risk; 4: high risk, 3: medium risk; 2: low risk; 1: very low risk; - : no-hazard

** Overall Hazard Score is identified by Provincial Disaster Management Authority (PDMA)

Source: (ADB 2017)

From a socio-economic perspective, among the four disaster-prone districts in the Sindh province, this district ranks as the second most poverty-stricken (Memon, 2023). The poverty incidence or headcount in the district is 83.4 percent. According to the World Bank (Mansuri et al., 2018) the poverty headcount in Badin district ranges between 41 and 50 percent. Another district-level set of estimates by Jamal (2007) indicates that the rural poverty incidence in Badin district stands at 32.4 percent. These estimates are based on the national district-level secondary data from the Household Integrated Economic Survey (HIES) of 2004–05. The Poverty Gap Index (PGI) in Badin district is reported at 36.2 percent (Memon, 2023).

A primary data collection survey was conducted in the study area to identify the most severely affected regions by involving local stakeholders. The survey included several stages, such as stakeholder consultations, conducting the survey, focus group discussions (FGDs), and the dissemination of findings at the community level. These interventions started in early 2014 and concluded by mid-2015, with primary data collection taking place from August to September 2014. Due to the scarcity of micro-level data (at the district level) in Pakistan, this data holds considerable importance.

2.2 Sampling Details

Multistage sampling technique was adopted, initiated with the selection of province having high exposure and vulnerability to climate-induced disasters. This is followed by selection of disaster-prone districts, and district Badin is one of the four government declared disaster prone districts in the Sindh province. Finally, the identification of communities under LBOD influence and non-LBOD areas (total 15 communities) in the district and random selection of 20 households from each community.

From each household separate questionnaire were administered with senior male and female members, respectively. The table (Table 2) provides complete details of respondents and demographic coverages of household members.

Table 2. Sampling Details

DISTRICT →	BADIN			
Sample Distribution → / Geographic Division	Total Communities	Total no. of Households	Total Respondents*	Demographic Coverage
LBOD	7	140	135	797
Non-LBOD	8	161	147	1,174
Total	15	301	282	1,971

* Questionnaire were administered only with female head of household in female headed households where either no male member or the male member is minor.

Source: Authors calculation using raw data

Methodological Framework

The methodological framework steps up with the construction of vulnerability and capacity Index (VCI) at household level using VCI rural tool. The VCI is supported with the descriptive analysis of a household's economic, socio-economic and social characteristics. Lastly, the constructed VCI is correlated with the household characteristics not included in the VCI construct to identify other important explicit or implicit characteristics.

Vulnerability and Capacity Index

Vulnerability and Capacity Index (VCI) is used to assess the variance in household vulnerability in disaster or climate affected induced event regions (Mustafa et al., 2011). VCI is simple module, and can be easily compared with other tools. The tool is theoretically driven, thus have an advantage of theoretical interpretation through pressure and release (PAR) model (Wisner et al., 2003).

The VCI tool identified 12 key drivers of vulnerability, divided into three major components of material, institutional and attitudinal (Mustafa et al., 2019). These include: income source, education attainment, fungible assets, exposure to hazard, social networking, extra-kinship ties, infrastructure, warning systems, no. of earners, disadvantaged communities, sense of empowerment and knowledge about hazard. This tool follows the original formulation and classification of vulnerabilities and capacities matrix by Anderson and Woodrow (Anderson & Woodrow, 1989). The VCI tool can be used at household level and collectively at community level with some modifications. The current study uses the module of household vulnerability.

A short example for the construct of VCI indicators is as follows: As a simple illustration, consider the Warning Systems indicator: start value = 4; if a trusted warning system exists and is used by the household, we subtract 4 points (so the indicator score becomes 0). The full scoring tables and all indicator rules are provided in the supplementary file.

Descriptive Assessments & Empirical Tests

The descriptive assessments are assumed to support or give arguments with VCI scores and also support the comparative analysis across the sample with respect to aquifer depth. Pearson chi-square tests were employed to assess differences in categorical control variables (Franke et al., 2012; Frazier et al., 2012; Rana & Singhal, 2015). Additionally, an ANOVA (Analysis of Variance) F-test was used to compare means across multiple groups and variables (Green & Salkind, 2012; Kim, 2017; Venkatesh et al., 2013) ANOVA offers the advantage of better controlling Type I error (Green & Salkind, 2012).

Regression Analysis - VCI Correlates

The other implicit and explicit characteristics at household level are regressed with the VCI score to identify important variables not part of the VCI construct (Iqbal et al., 2017). Since the study focuses on man-made influence, interactions are performed with the influenced areas (LBOD) and non-influenced areas (non-LBOD) to see whether specific man-made influences have distinctions or not.

The suitable Ordinary least squares methodology is used for the current cross-sectional data. Equation 1 is considered as the base model for the important household characteristics:

$$VCI_i = \beta_0 + \beta_1 MMI_i + \beta_2 GHH_i + \beta_3 HoHAge_i + \beta_4 HoHEdu_i + \beta_5 \ln PCI_i + \beta_6 \ln IncDiv_i + \beta_7 OPF_i + \epsilon_i \text{ --- Equation (1)}$$

Where:

Dummy variable man-made influence (MMI) differentiating the two selected hazard categories man-made and natural, LBOD is represented by '0', and Non-LBOD represented by '1'.

Gender of household head (*GHH*) dummy variable records whether the head of the household is a male ('1') or a female ('0').

HoHAge represents age of the household head, while *HoHEdu* represents education of household head.

lnPCI is used for Per Capita Income (*lnPCI*), and *lnIncDiv* is used for diversification index. Natural logs are taken for both variables to account for outliers.

Income Diversification (*IncDiv*) is measured by applying the Herfindal Index. A total of four income sources i.e. agriculture, livestock, fishing and non-agriculture (off-farm) were used to construct the index.

$$Div = 1 / \sum_{i=1}^I s_i^2$$

Where s_i is the share of an income source (agriculture, livestock, fishing and non-agriculture) in total income.

The Share of Own Food Production (*OPF*) in the total food expenditure.

To capture the non-linear effects of specific man-made influenced areas in the base model i.e. equation 1, interactions with respective dummy variables (MMI) are used. Thus, the base model is expanded with an interaction with all other selected variables in the model. This means that 6 additional equations for each variable are interacted. Following is the example of expanded models of interaction with each dummy presented here for understanding:

$$VCI_i = \beta_0 + \beta_1 MMI_i + \beta_2 GHH_i + \beta_3 HoHAge_i + \beta_4 HoHEdu_i + \beta_5 lnPCI_i + \beta_6 lnIncDiv_i + \beta_7 OPF_i + \beta_8 MMI_i * GHH_i + \epsilon_i - -$$

– Equation (1a)

Equation 1a is the expansion of base model by interaction of dummy variable for man-made influences with the Gendered Headship ($\beta_8 MMI_i * GHH_i$). In the similar way, equation 1b (HoHAge), 1c (HoHEdu), 1d (lnPCI), 1e (lnIncDiv) and 1f (OPF) are constructed to see the interaction of MMI_i with the remaining variables in the base model.

A-prior to the multivariate regression analysis, a test multicollinearity is performed. Variance Inflation Factor (VIF) scores are also used in the analysis and are presented with the regression outcomes. To avoid the problem of heteroscedasticity, robust standard errors are used to interpret the significance of the coefficients.

Three significance levels (up to 10 percent level of confidence) were set for significance i. e. $P < 0.01^{***}$; $P < 0.05^{**}$; and $P < 0.1^*$.

Descriptive Analysis, Empirical Results and Discussion

Descriptive Analysis

Correlation matrix shows that most of the correlations are below 0.6, indicating no such income source. The sole dependence is found higher in LBOD influenced areas with multicollinearity bias in estimations (see **Errore. L'origine riferimento non è stata trovata.**). Variance Inflation Factor (VIF) scores suggest the same.

Average family size in the non-LBOD communities is higher at 7.29 vis-à-vis communities residing in LBOD influence areas (5.69). Overall literacy rates in the surveyed communities stood at 33.2 percent, better than the overall district literacy rates. However, far below provincial and national literacy rates of 40 percent and 46 percent, respectively (PSLM, 2016). Literacy rates are found higher at 35.1 percent in non-LBOD areas as compared to literacy rates of 30.1 percent in LBOD influenced areas. Agriculture is the major almost two-third (61.1 percent) of the income from agriculture (non-LBOD 44.9 percent). LBOD influenced areas are largely coastal communities, thus, the income share from fishing is reported at 6.1 percent (non-LBOD 0.7 percent). Despite high dependency ratio (105.5), the per capita income is found higher in LBOD communities at 18.69 thousand PKR, USD 1 179.71 (non-LBOD 17.72 thousand PKR, USD 169.56). This may be attributed to lower average family size vis-à-vis non-LBOD communities. However, the overall per capita income is considerably lower than provincial and national rural average per capita incomes i.e. 43.2 thousand PKR (USD 413.34) and 55.8 thousand PKR (USD 533.97), respectively (Pasha, 2019).

Discussion over VCI Scores

According to the VCI construct, difference in vulnerability can be observed between the man-made disaster areas of LBOD and non-LBOD. The figure (Figure 2) reveals that communities residing in LBOD influenced areas are comparatively more vulnerable vis-à-vis non-LBOD communities.

¹ based on 1 USD = 104.50 PKR in corresponding period

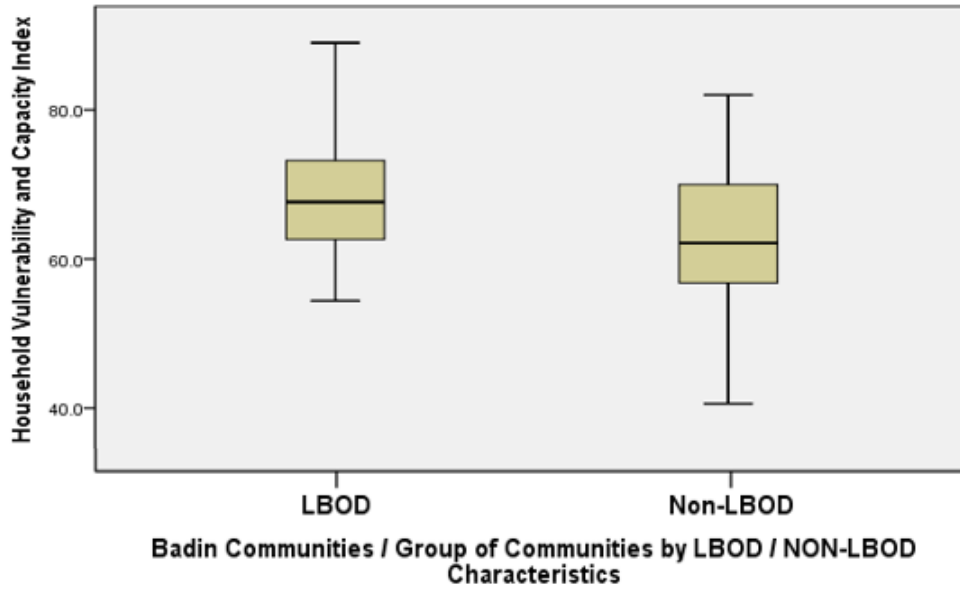


Figure 2. VCI Box Plot for LBOD and Non-LBOD Communities.

The table (Table 3) exhibits the detailed description of VCI scores. According to data, VCI scores of LBOD communities on average were reported at 68.03 as compared to average score of 62.45 for non-LBOD communities.

Table 3. VCI Score Descriptions

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES (N=140)				NON-LBOD COMMUNITIES (N=161)				ANOVA TEST	
	A ^{VG.}	M ^{IN}	M ^{AX}	SD	A ^{VG.}	M ^{IN}	M ^{AX}	SD	F- STATISTICS	P- VALUE
VCI Score	68.03	54.4	89.0	6.96	62.45	26.0	82.0	9.23	34.270	.000***

The difference in the VCI across influenced and non-influenced areas are mainly attributed to Material Vulnerability, followed by Institutional Vulnerability. The following figure (Figure 3) exhibits the variation across the sub-construct of the VCI.

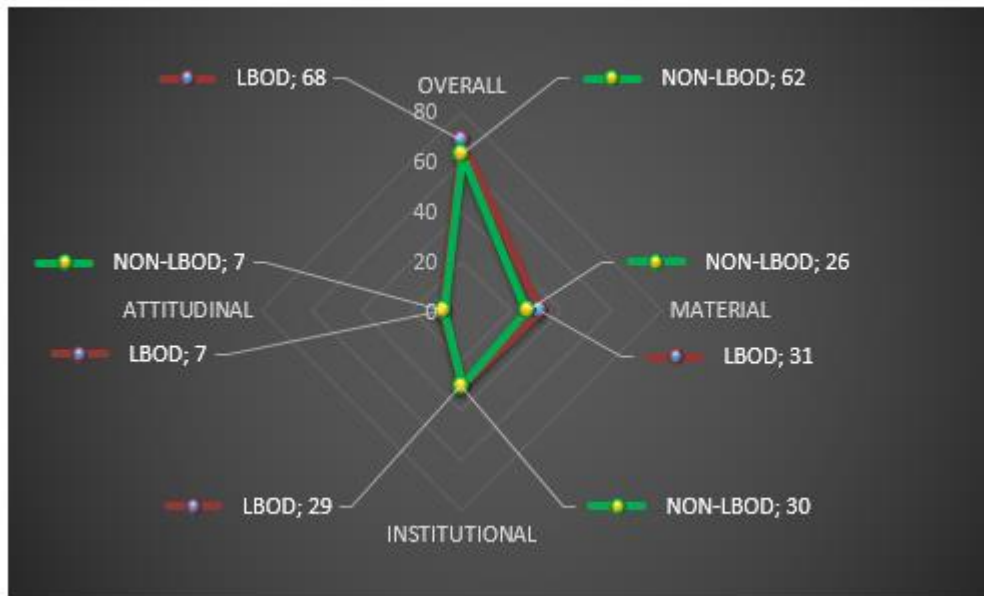


Figure 3. VCI Spider Diagram for Selected LBOD and NON-LBOD Communities.

Material Vulnerability

Material vulnerability is the major differential across two selected influenced and non-influenced areas in district Badin, Sindh province. The material vulnerability score of LBOD communities recorded at 31.3 vis-à-vis 26.2 in non-LBOD communities. The variations amongst the two distinct areas are largely attributed to Exposure to hazards, followed by education attainments (see Table 4).

Table 4. VCI Score - Material Component

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES (N=140)				NON-LBOD COMMUNITIES (N=161)				ANOVA TEST	
	Avg.	M ^{IN}	M ^{AX}	SD	Avg.	M ^{IN}	M ^{AX}	SD	F- STATISTICS	P- VALUE
Material	31.3	24.0	35.0	2.79	26.2	10.0	31.0	3.8	170.620	.000***
Income Source	11.8	8	12	.875	11.5	0	12	1.53	4.089	.044**
Education Attainment	4.13	0	5	1.20	3.62	0	5	1.53	10.239	.002***
Assets	6.54	0	8	2.34	6.68	0	8	2.37	.268	.605
Exposure to Hazards	8.86	8	10	.993	4.26	0	10	1.32	1131.09	.000***

Hazard Exposure

Exposure to hazard is the major contributor of vulnerability and the triggering factor is man-made influence by LBOD. Due to sea-intrusion, land erosion and claims in the district (Kanwal et al., 2019; The News International, 2014) since the construction of LBOD, the communities affected by LBOD are largely considered as coastal communities. Thus, these are more prone to disasters as compared to non-LBOD communities.

Income Source

The economy of the Sindh is largely agriculture and allied (agriculture, livestock and fishing) (MFF Pakistan, 2016). District embraces rural outlook as three-fourth of the district

population resides in the rural settlements (GoP, 2017). Thus, the economy of the district is largely agriculture and allied. These are considered relatively highly unstable amidst man-made influences, augmenting the climate-induced and natural disasters. Thus, the triggering forces of natural, structural and man-made hazards altogether causes vulnerability and has uniform affect across district irrespective of LBOD and non-LBOD community characteristics. Almost three-fourth (72.5) of the population in the district is associated with agriculture and allied activities (agriculture 65.9 percent, livestock 1.9 percent and fishing 4.7 percent). The high reliance on traditional economic activities puts entire district’s population in a vulnerable state in the event of disasters (see Table 5).

Table 5. Major Livelihood Source of Population in Selected Districts (%)

GEOGRAPHY / DESCRIPTION →	AGRICULTURE			LIVESTOCK			FISHING			NON-AGRICULTURE		
	T	M	F	T	M	F	T	M	F	T	M	F
Overall	65.9	58.0	79.1	1.5	1.9	0.8	3.4	4.7	1.2	29.2	35.4	18.9
LBOD	70.7	64.7	80.2	1.0	1.6	0.0	7.0	9.8	2.6	21.3	23.9	19.0
NON-LBOD	62.2	52.9	78.3	1.9	2.1	1.4	0.5	0.8	0.0	35.4	44.2	20.3

* Population Working Age (15 to 65)

^a across geography: $X^2(3, N = 678) = 34.713, p < .01^{***} (= .000)$

between Male across district: $X^2(3, N = 424) = 32.355, p < .01^{***} (= .000)$

between Female across district: $X^2(3, N = 254) = 5.589, p > .1 (= .133)$

^b between Gender: $X^2(3, N = 678) = 32.699, p < .01^{***} (= .000)$

between Gender in LBOD: $X^2(3, N = 300) = 11.058, p < .01^{***} (= .01)$

between Gender in NON-LBOD: $X^2(3, N = 378) = 24.484, p < .01^{***} (= .000)$

Institutional Vulnerability

There are no such statistical differences amongst the communities residing in LBOD and non-LBOD areas. This explains the rural quandary of Pakistan, where the development is largely urban biased. The major variation is found in sub-component of infrastructure, besides some variation in hazard warning systems and disadvantaged community factors (see Table 6).

Table 6. VCI Score - Institutional Component

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES (N=140)				NON_LBOD COMMUNITIES (N=161)				ANOVA TEST	
	A ^{VG.}	M ^{IN}	M ^{AX}	SD	A ^{VG.}	M ^{IN}	M ^{AX}	SD	F- STATISTICS	P- VALUE
Institutional	29.3	20.0	46.0	4.89	28.9	16.0	41.0	5.34	0.316	.575
Social Network	10.0	10	10	.000	9.94	0	10	.79	0.869	.352
Extra Kinship Ties	4.20	3	5	.98	4.17	0	5	1.03	0.050	.823
Infrastructure	7.47	4	14	2.65	6.20	0	12	2.91	15.588	.000***
Warning Systems	2.13	0	4	1.86	2.63	0	4	1.82	5.636	.018**
No. of Earners	5.01	0	10	2.04	4.93	0	10	2.61	.077	.782
Disadvantaged Community	0.46	0	5	1.46	0.87	0	5	1.90	4.212	.041**

Infrastructure

Infrastructure shows significant differences between areas of the district influenced by human interventions and those unaffected. These distinctions are partly due to the destruction caused by frequent disasters over the past two decades, such as the 1999 cyclone, floods from 2003 to 2012, and the 2019 earthquake (DDMA, 2008; EM-DAT, 2020; GoP, 2012). Other contributing factors include sea intrusion, increased salinity, and land erosion (Baloch et al., 2019; Kanwal et al., 2019; The News International, 2014).

Access to safe drinking water, measured by the availability of taps inside or outside homes, remains uniformly low across the district, with only 15% of communities reporting access. This highlights the broader rural water access challenges in Pakistan. However, the selected communities show better access compared to the district average of 5.0% and the provincial average of 7.0% (PSLM, 2016).

Sanitation facilities are severely lacking, with nearly two-thirds (64.5%) of the sampled population without any, far exceeding the district (23%) and provincial (16%) averages (PSLM, 2016). Similarly, access to healthcare is inadequate, as only 26.7% of communities reported some basic health services, and a mere 6.7% had access to higher-level basic health facilities. The district has 39 basic health units (BHUs), serving an average of 42,000 people per unit—much higher than the national and provincial averages of 24,000 and 33,000 people per BHU, respectively (GoS, 2015, 2019; PES, 2018).

Disadvantaged Community

District Badin is one of the two districts where the population with lower caste, religious or ethnic minority is found relatively with higher proportions (Figure 4). This is mainly because of their geographic presence closer to neighboring district Tharparkar and the neighboring country India. According to the primary data collected, about 13.6 percent of household are religious minority (LBOD 9.3 percent; non-LBOD 17.4 percent). Being disadvantaged, this adds on to the vulnerability of respective households, and indirectly may have an impact on the communities as well.

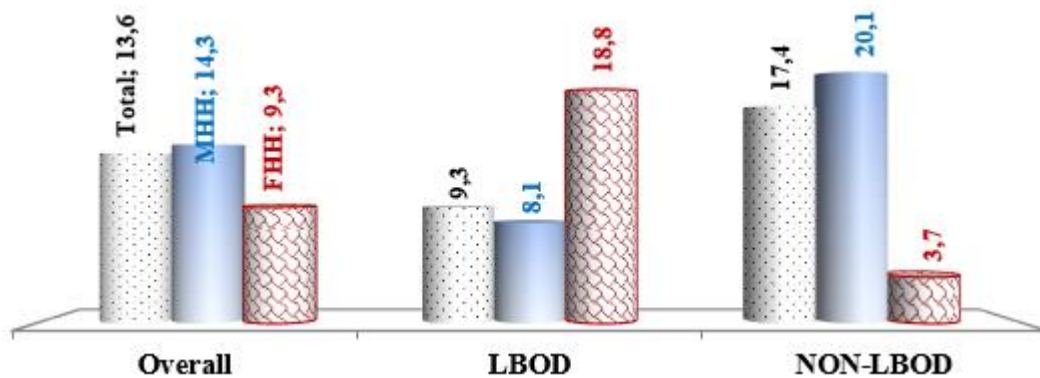


Figure 4. Disadvantaged Communities (%)

^a across geography: $X^2(1, N = 301) = 4.172, p < .05^{**} (= .041)$

^a Between Gender Headship: $X^2(1, N = 301) = 1.745, p > .1 (= .187)$

Attitudinal Vulnerability

The existence of feudal system in Pakistan, has impact on lower confidence in population, beside restrictions on accessibility and political affiliations at district, provincial and national level. The average scores of attitudinal vulnerabilities are led by

sense of self-empowerment in the rural areas of Pakistan. Thus, there is no such statistical difference across the selected geographies and is found insignificant. The table (Table 7) exhibits the relevant vulnerability scores.

Table 7. VCI Score Descriptions for Material Component

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES (N=140)				NON-LBOD COMMUNITIES (N=161)				ANOVA TEST	
	A ^{VG.}	M ^{IN}	M ^{AX}	SD	A ^{VG.}	M ^{IN}	M ^{AX}	SD	F- STATISTICS	P- VALUE
Attitudinal	7.43	0	10	2.84	7.27	0	15	2.95	0.232	.631
Self-Empowerment	7.43	0	10	2.84	7.17	0	10	2.95	0.578	.448
Hazard Knowledge	.00	0	0	.000	.03	0	5	.39	0.869	.352

The table (Table 8) reveals the sense of empowerment (self-community leader), and accessibility to leaderships at community, district, provincial and national level. Interestingly, there is no such difference across the communities in the district. Beside this, the accessibility declines with the higher level of community and political leadership at district, regional and national level. Gender wise differential may also be noted which, however, reflects the cultural and traditional norms of the rural communities in Pakistan.

Table 8. Self-Empowerment & Accessibility to Leaderships by Households in Selected Districts

DESCRIPTION / DISTRICTS →	SELF- LEADER	ACCESS TO COMMUNITY LEADERSHIP	ACCESS TO DISTRICT LEVEL LEADERSHIP	ACCESS TO REGIONAL LEADERSHIP	ACCESS TO NATIONAL LEADERSHIP	
Overall	T	13.29	39.2	2.66	3.65	1
	M ^{HH}	15.5	43.41	3.1	4.26	1.16
	F ^{HH}	0.0	13.95	0.0	0.0	0.0
LBOD	T	10.71	37.14	2.86	3.57	0.71
	M ^{HH}	12.1	37.9	3.23	4.03	0.81
	F ^{HH}	0.0	31.25	0.0	0.0	0.0
NON- LBOD	T	15.53	40.99	2.48	3.73	1.24
	M ^{HH}	20.16	52.42	3.23	4.84	1.61
	F ^{HH}	0.0	3.7	0.0	0.0	0.0
Across Geography	X ² (3, N = 602)	=1.506, p > .1 (= .220)	=0.466, p > .1 (= .495)	=0.040, p > .1 (= .841)	=0.005, p > .1 (= .943)	=.212, p > .1 (= .646)
Gender Headship	X ² (3, N = 602)	=7.688, p < .01*** (= .006)	=13.419, p < .01*** (= .000)	=1.370, p > .1 (= .242)	=1.903, p > .1 (= .168)	=0.505, p > .1 (= .477)

Regression Analysis - VCI Correlates

The results of multi-variate regression are furnished in table (Table 9). The analysis reveals that all selected variables are found explaining the VCI score with expected signs, except for income diversification being insignificant. The variables are significant at 1 percent level except for per capita income and share of own foods, which are significant at 5 percent and 10 percent.

Table 9. Regression Results - VCI Correlates

	EQ (1)	EQ (2)	EQ (3)	EQ (4)	EQ (5)	EQ (6)	EQ (7)
	-	-	-	-	-	-	-
Man-made Influence (MMI)	5.259* ** (0.831)	4.236* (2.22)	12.24* ** (2.752)	4.723* ** (0.969)	32.85* (18.97)	4.807* ** (1.024)	5.825* ** (1.022)
Gender of Household Head (GHH)	8.657* ** (1.247)	7.928* ** (1.926)	9.068* ** (1.244)	8.641* ** (1.247)	8.785* ** (1.242)	8.641* ** (1.248)	8.718* ** (1.249)
Age of Household Head (HoHAge)	0.124* ** (0.030 1)	0.122* ** (0.030 5)	0.226* ** (0.048 5)	0.125* ** (0.030 1)	0.118* ** (0.030 1)	0.124* ** (0.030 1)	0.126* ** (0.030 2)
Education of Household Head (HoHEdu)	0.795* ** (0.118)	0.792* ** (0.118)	0.776* ** (0.117)	0.638* ** (0.188)	0.783* ** (0.117)	0.797* ** (0.118)	0.795* ** (0.118)
Log of Per Capita Income (lnpci)	10.06* * (4.316)	10.22* * (4.333)	11.17* ** (4.291)	10.37* * (4.324)	-2.552 (5.689)	9.907* * (4.324)	10.03* * (4.316)
Income Diversification (Log Inverse Herfindahl Index - incdiv)	-0.747 (1.583)	-0.739 (1.585)	-0.745 (1.567)	-0.762 (1.583)	-0.536 (1.578)	0.43 (2.222)	-0.759 (1.584)
Share of Own Produced Food (opf)	0.0415 * (0.021 5)	0.0419 * (0.021 5)	0.0419 * (0.021 3)	0.0414 * (0.021 5)	0.0414 * (0.021 4)	0.0416 * (0.021 5)	0.0585 ** (0.028)
Interaction of Variable with Man-made Influences (MMIs)							
Gender of Household Head (ghh)		-1.193 (2.399)					
Age of Household Head			0.161* ** (0.060 5)				
Education of Household Head				-0.246 (0.229)			
Log of Per Capita Income					16.96* * (8.432)		
Income Diversification						-2.389 (3.161)	
Share of Own Produced Food							0.0404 (0.042 4)
Constants	105.7* ** (9.652)	105.3* ** (9.696)	112.6* ** (9.904)	106.0* ** (9.656)	88.57* ** (12.83)	105.1* ** (9.694)	106.0* ** (9.662)
Observations	293	293	293	293	293	293	293
R-squared	0.43	0.43	0.443	0.432	0.438	0.431	0.431
Adjusted R-squared	0.416	0.414	0.428	0.416	0.422	0.415	0.415
Mean VIF	1.11	3.19	4.72	1.65	1.48	1.48	1.41

Standard errors in parenthesis / * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The significance of man-made influence variable entails that households residing in non-LBOD areas are less vulnerable vis-à-vis LBOD communities. The negative sign with per capita income explains the inverse relationship with the associated vulnerabilities. Further, age and education of household head, the former entails the more experience, and the latter entails higher the schooling, leads to lower the associated vulnerabilities.

The insignificance of the income diversification may be attributed to absence of appropriate multisectoral activities in the district Badin. Beside this, high illiteracy rates and low education attainment in higher and technical education, hinders the access to economic opportunities in the urban centers. Thus, the rural population is largely engaged in menial, dead-end and non-technical jobs. The wage and work load (standard working hours etc.) exploitation in menial jobs are found common in unregulated sectors and particularly in the rural economies. Another reason of high supply of unskilled labour may be attributed to such exploitations.

Specific to location of non-LBOD, the age of household head and the per capita incomes are the variables which are more pronounced in the non-LBOD regions vis-à-vis LBOD communities. While the rest explains the vulnerability, however, there is no specific impact exclusive to locations.

Conclusion and Policy Implications

This study improves understanding of how natural, structural, and human-made factors increase disaster risk in rural parts of District Badin. Using household survey data and a household-level Vulnerability and Capacity Index (VCI), we identify the main weaknesses that make families and communities more vulnerable. The most important are: (1) damaged or poorly maintained man-made infrastructure, (2) weak local institutions and services, and (3) limited economic options that leave households dependent on risky livelihoods.

Our evidence shows that communities near the Left Bank Outfall Drain (LBOD) face higher vulnerability than non-LBOD communities. Sea water intrusion — intensified by upstream water mismanagement and infrastructure failure — has reduced groundwater quality, eroded land, and destroyed traditional livelihoods. These environmental changes, together with weak institutions and limited access to basic services, increase the risk that households will fall into or remain in poverty.

Practical and Policy Implications

The findings provide significant insights into the vulnerabilities faced by communities in LBOD and non-LBOD areas. The higher VCI scores for LBOD communities highlight the greater material and institutional vulnerabilities, particularly due to exposure to hazards and limited infrastructure. These insights underscore the need for targeted policy interventions to enhance resilience in high-risk areas. Policies should prioritize hazard mitigation measures, improve education access, and strengthen rural infrastructure. Additionally, addressing disparities in material vulnerability through income diversification and enhanced institutional support can promote equitable development and improve overall community well-being.

Limitations and Future Research Directions

This study has limitations. First, it is based on primary data collected in 2015, nearly a decade ago. During this period, numerous disasters have occurred, potentially altering the vulnerability status of both LBOD and non-LBOD communities. Future research should

consider converting this cross-sectional dataset into a longitudinal survey to assess whether vulnerabilities have further aggravated or improved. This would provide deeper insights into the evolving nature of these challenges.

Second, the study relied on a cross-sectional dataset, which limits the analysis to correlation rather than causation. Incorporating longitudinal data would enable researchers to explore causal relationships and understand the dynamics of vulnerability over time. Finally, while the study applied methodologies deemed appropriate for the available data, alternative frameworks and methodologies could be explored for comparative analysis in future studies. Employing updated data, if available, would also provide a more comprehensive understanding of the region's vulnerabilities in the context of disasters and climate-induced events.

References

- Anderson, M. B., & Woodrow, P. J. (1989). *Rising from the ashes: Development strategies in times of disaster*. Westview Press. <https://agris.fao.org/agris-search/search.do?recordID=US9101558>
- Baloch, S., Chang, F. K., Mangio, H.-R., Sana, M., & Kumbhar, M. I. (2019). Deterioration of Ground Water Quality through Seawater Intrusion in Coastal Area of District Badin Sindh Pakistan. *International Journal of Environmental Sciences & Natural Resources*, 20(5), 148–157.
- Barrios, E. B. (2008). Infrastructure and rural development: Household perceptions on rural development. *Progress in Planning*, 70(1), 1–44. <https://doi.org/10.1016/j.progress.2008.04.001>
- DDMA. (2008). *Disaster Risk Management Plan: District Badin* (District Disaster Risk Management Plan, p. 100). District Disaster Management Authority, Government of Sindh. <http://www.ndma.gov.pk/plans/Disaster%20Risk%20Management%20Plan%20Badin.pdf>
- El-Sabh, M. I., & Murty, T. S. (Eds.). (1988). *Natural and Man-Made Hazards*. Springer Netherlands. <https://doi.org/10.1007/978-94-009-1433-9>
- EM-DAT. (2020, April 15). *EM-DAT | The International Disasters Database*. Centre for Research on the Epidemiology of Disasters. <https://www.emdat.be/>
- Franke, T., Ho, T., & Christie, C. (2012). The Chi-Square Test Often Used and More Often Misinterpreted. *American Journal of Evaluation*, 33, 448–458. <https://doi.org/10.1177/1098214011426594>
- Frazier, L., Yu, E., Sanner, J., Liu, F., Udtha, M., Cron, S., Coulter, S., & Bogae, R. C. (2012, March 26). *Gender Differences in Self-Reported Symptoms of Depression among Patients with Acute Coronary Syndrome* [Research Article]. Nursing Research and Practice; Hindawi. <https://doi.org/10.1155/2012/109251>
- GoP. (2012). *Annual Flood Report 2012* (p. 99) [Annual Flood Report]. Ministry of Water and Power, Government of Pakistan. <http://mowr.gov.pk/wp-content/uploads/2018/06/Annual-Flood-Report-2012.pdf>
- GoP. (2017). *Census Report 2017* [Census]. Pakistan Bureau of Statistics, Statistics Division, Government of Pakistan.
- GoS. (2015). *Development Statistics of Sindh 2014* (No. 44th; Development Statistics of Sindh, p. 327). Bureau of Statistics, Government of Sindh. <http://sindhbos.gov.pk/wp-content/uploads/2014/09/DS-2014.pdf>
- GoS. (2019). *Development Statistics of Sindh 2018* (No. 48th; Development Statistics of Sindh, p. 345). Bureau of Statistics, Government of Sindh.

<http://sindhbos.gov.pk/wp-content/uploads/2019/09/Development-Statistics-of-Sindh-2018.pdf>

- Green, S. B., & Salkind, N. J. (2012). *Using SPSS for Windows and Macintosh: Analyzing and Understanding Data*. Pearson/Prentice Hall.
- Iqbal, M. A., Jamal, H., & Memon, M. H. (2017). *Vulnerability and Capacity Assessment with regard to Social Protection: A Study of districts Lower Dir, Nowshera, Rahim Yar Khan and Sargodha* (p. 68) [Case Study]. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Social Policy and Development Centre, Karachi. <https://socialprotection.org/discover/publications/vulnerability-and-capacity-assessment-regard-social-protection>
- Jamal, H. (2007). *Income Poverty at District Level: An Application of Small Area Estimation Technique* (Research Report No. 70; p. 21). Social Policy and Development Centre.
- Jamal, H., & Lohano, H. R. (2008). *Understanding Rural Poverty Dynamics: The Case of The Poorest District of Sindh Pakistan* (Research Report No. 78; p. 29). Social Policy and Development Centre.
- Kanwal, S., Ding, X., Sajjad, M., & Abbas, S. (2019). Three Decades of Coastal Changes in Sindh, Pakistan (1989-2018): A Geospatial Assessment. *Remote Sensing*, 12, 2020. <https://doi.org/10.3390/rs12010008>
- Kim, T. K. (2017). Understanding one-way ANOVA using conceptual figures. *Korean Journal of Anesthesiology*, 70(1), 22–26. <https://doi.org/10.4097/kjae.2017.70.1.22>
- Mahessar, A., Mukwana, K., Qureshi, A., Ehsan, M., Leghari, H., & Manganhar, A. (2016). ASSESSMENT OF WATER QUALITY OF LBOD SYSTEM AND ENVIRONMENTAL CONCERNS. *QUAID-E-AWAM UNIVERSITY RESEARCH JOURNAL OF ENGINEERING, SCIENCE & TECHNOLOGY*, 15, 32–39.
- Mansuri, G., Sami, M. F., Ali, M., Doan, H. T. T., Javed, B., & Pandey, P. (2018). *When Water Becomes a Hazard: A Diagnostic Report on The State of Water Supply, Sanitation and Poverty in Pakistan and Its Impact on Child Stunting* (No. 131860; pp. 1–151). The World Bank. <http://documents.worldbank.org/curated/en/649341541535842288/When-Water-Becomes-a-Hazard-A-Diagnostic-Report-on-The-State-of-Water-Supply-Sanitation-and-Poverty-in-Pakistan-and-Its-Impact-on-Child-Stunting>
- Memon, M. H. (2023). Poverty, Gap and Severity Estimates for Disaster Prone Rural Areas of Pakistan. *Social Indicators Research*, 166(3), 645–663. <https://doi.org/10.1007/s11205-023-03082-0>
- Memon, M. H., Aamir, N., & Ahmed, N. (2018). Climate Change and Drought: Impact of Food Insecurity on Gender Based Vulnerability in District Tharparkar. *The Pakistan Development Review*, 57(3), 307–321.
- Memon, M. H., & Ahmed, R. (2022). Multi-topographical landscape: Comparative vulnerability of climate-induced disaster-prone rural area of Pakistan. *Natural Hazards*. <https://doi.org/10.1007/s11069-021-05107-8>
- Memon, M. H., Ali, M., & Khalil, S. (2020). Determinants of income diversification in flood-prone rural Pakistan. *International Journal of Disaster Risk Reduction*, 50, 101914. <https://doi.org/10.1016/j.ijdrr.2020.101914>
- MFJ Pakistan. (2016). *A Handbook on Pakistan's Coastal and Marine Resources* (Mangroves for the Future, Pakistan, p. 78). Mangroves for the Future, Pakistan. https://www.iucn.org/sites/dev/files/pk_coastal_resources_handbook.pdf
- Modica, M., Reggiani, A., & Nijkamp, P. (2018). Vulnerability, resilience and exposure: Methodological aspects and an empirical applications to shocks. In *SEEDS Working*

- Papers* (No. 1318; SEEDS Working Papers). SEEDS, Sustainability Environmental Economics and Dynamics Studies. <https://ideas.repec.org/p/srt/wpaper/1318.html>
- Mustafa, D. (2003). Reinforcing vulnerability? Disaster relief, recovery, and response to the 2001 flood in Rawalpindi, Pakistan. *Global Environmental Change Part B: Environmental Hazards*, 5(3–4), 71–82. <https://doi.org/10.1016/j.hazards.2004.05.001>
- Mustafa, D., Ahmed, S., Saroch, E., & Bell, H. (2011). Pinning down vulnerability: From narratives to numbers. *Disasters*, 35(1), 62–86. <https://doi.org/10.1111/j.1467-7717.2010.01193.x>
- Mustafa, D., Gioli, G., Memon, M., Noshirwani, M., Idris, I., & Ahmed, N. (2019). Pinning down social vulnerability in Sindh Province, Pakistan: From narratives to numbers, and back again. *Disasters*, 43(2), 311–335. <https://doi.org/10.1111/disa.12315>
- NCSW. (2012). *Assessment of Disaster Management Institutions: An Investigated Study [An Investigated Study]*. National Commission for Status of Women.
- Novelo-Casanova, D. A., & Suárez, G. (2010). Natural and man-made hazards in the Cayman Islands. *Natural Hazards*, 55(2), 441–466. <https://doi.org/10.1007/s11069-010-9539-0>
- Park, H. (2011). Man-made disasters: A cross-national analysis. *International Business Review*, 20(4), 466–476. <https://doi.org/10.1016/j.ibusrev.2010.08.004>
- Pasha, H. A. (2019). *Growth and Inequality in Pakistan: Vol. I (First)*. Friedrich Ebert Stiftung. <http://library.fes.de/pdf-files/bueros/pakistan/15252-20190411.pdf>
- PDMA. (2011). *Disaster Need Assessment: Sindh 2011*. Provincial Disaster Management Authority, Government of Sindh.
- PES. (2018). *Pakistan Economic Survey 2017-18* (Annual Report Nos. 2017–18; Pakistan Economic Survey). Ministry of Finance, Government of Pakistan. http://finance.gov.pk/survey_1718.html
- PSLM. (2016). *Pakistan Social and Living Measurement Survey 2014-15 (National / Provincial / District)* (No. 10th; Pakistan Social and Living Measurement Survey, p. 489). Pakistan Bureau of Statistics, Statistics Division, Government of Pakistan. <http://www.pbs.gov.pk/content/pakistan-social-and-living-standards-measurement-survey-pslm-2014-15-provincial-district>
- R, B., N, M., M.i, A., G, R., A, H., T, S., A, H., M, T., & K, Y. (1999). *Waterlogging and salinity management in the Sindh Province. Volume one - Supplement 1-D: Drainage in the LBOD project: impact assessment*. <https://agris.fao.org/agris-search/search.do?recordID=QL19990086658>
- Rana, R., & Singhal, R. (2015). *Chi-square test and its application in hypothesis testing*. 1(1), 69–71. <https://doi.org/DOI:%252010.4103/2395-5414.157577>
- Sawada, Y., Bhattacharyay, M., & Kotera, T. (2019). Aggregate Impacts of Natural and Man-made Disasters: A Quantitative Comparison. *International Journal of Development and Conflict*, 9(1), 43–73.
- SPDC. (2015). *Gender and Social Vulnerability to Climate Change: A study of Disaster Prone Areas in Sindh* (p. 144). Social Policy and Development Centre. <https://spdc.org.pk/publications/gender-and-social-vulnerability-to-climate-change-a-study-of-disaster-prone-areas-in-sindh>
- The Express Tribune. (2010, June 30). Four Sindh districts declared to be disaster-prone. *The Express Tribune*. <https://tribune.com.pk/story/24664/four-sindh-districts-declared-to-be-disaster-prone/>
- The News International. (2014, June 6). ‘The sea may swallow Thatta, Badin, Sujawal in 30 years.’ <https://www.thenews.com.pk/archive/print/506793-‘the-sea-may-swallow-thatta-badin-sujawal-in-30-years’>

- Venkatesh, V., Brown, S., & Bala, H. (2013). Bridging the Qualitative–Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems. *Management Information Systems Quarterly*, 37(1), 21–54.
- Warr, P., & Aung, L. L. (2019). Poverty and inequality impact of a natural disaster: Myanmar’s 2008 cyclone Nargis. *World Development*, 122(C), 446–461.
- Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2003). *At Risk: Natural Hazards, People’s Vulnerability and Disasters* (2nd edition). Routledge.

Appendices

Table 1. Correlation Matrix

S.#	DESCRIPTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Man-made Influenne (LBOD / Non-LBOD)	1																		
2	Gender Headship	0.1	1																	
3	Family Size	0.2	0.3	1																
4	Dependency Ratio	0.0	0.1	0.2	1															
5	Earning Members (excluding unpaid)	0.1	0.1	0.5	0.2	1														
6	Age of Household Head	0.3	0.1	0.2	0.2	0.2	1													
7	Education of Household Head	0.0	0.1	0.0	0.0	0.0	0.0	1												
8	Share of Own Produce Food	0.3	0.1	0.0	0.0	0.0	0.0	0.1	1											
9	Log of Per Capita Income	0.0	0.3	0.1	0.2	0.2	0.1	0.0	0.0	1										
10	Livelihood Index	0.3	0.0	0.1	0.0	0.1	0.0	0.0	0.5	0.1	1									
11	Income of Household Head	0.0	0.2	0.2	0.0	0.0	0.1	0.1	0.0	0.4	0.1	1								
12	Income from Agriculture	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.5	1							
13	Income from Livestock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.0	1						
14	Income from Fishing	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.0	1					
15	Income from Non-Agriculture	0.2	0.1	0.3	0.1	0.3	0.1	0.1	0.0	0.3	0.0	0.5	0.0	0.0	0.1	1				
16	Total Assets (Basic + Earning)	0.0	0.1	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.2	0.2	0.1	0.1	0.2	1			
17	Total Household Basic Assets	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.5	1		
18	Total Household Livestock Asset	0.0	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.2	0.2	0.1	0.1	0.1	0.5	0.2	1	
19	Land Holding (Acres)	0.4	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	1

Table 2. Data Descriptive & Empirical Results

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES							NON-LBOD COMMUNITIES							ANOVA / CHI-SQUARE TEST	
	%	A ^{VG.}	M ^{IN}	M ^{AX}	SD	N	SUM	%	A ^{VG.}	M ^{IN}	M ^{AX}	SD	N	SUM	F / χ^2 STATISTICS	P- VALUE
Family Size	-	5.69	1	20	3.57	140	797	-	7.29	1	25	4.518	161	1174	F: 11.375	.001***
Male (Adult)	-	1.80	0	7	1.37	140	252	-	2.45	0	8	1.79	161	395	F: 12.283	.001***
Boys	-	0.99	0	4	1.08	140	138	-	1.19	0	6	1.28	161	191	F: 2.124	.146
Female (Adult)	-	1.87	1	7	1.21	140	262	-	2.50	1	10	1.61	161	403	F: 14.60	.000***
Girls	-	1.04	0	6	1.26	140	145	-	1.15	0	6	1.35	161	185	F: 0.563	.454
No. of Dependents	-	2.73	0	11	2.41	140	382	-	3.24	0	12	2.631	161	522	F: 3.088	.080*
No. of Independents	-	2.96	0	9	1.78	140	415	-	4.06	0	15	2.764	161	653	F: 16.041	.000***
Dependency Ratio	-	105.5	0	1000	113.65	139	-	-	99.2	0	700	108.2	159	-	F: 0.241	.624
Gendered Headship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	χ^2 : 1.745	.187
MHH	88.6	-	-	-	-	-	-	83.2	-	-	-	-	-	-	-	-
FHH	11.4	-	-	-	-	-	-	16.8	-	-	-	-	-	-	-	-
Age of Household Head	-	41.04	21	75	12.51	140	-	-	48.2	21	95	14.78	161	-	F: 20.194	.000***
Cumulative Education Years of Household Members (all ages)	-	6.90	0	47	9.66	140	-	-	12.93	0	105	18.30	161	-	F: 12.237	.001***
Average Education Years of Household Members (all ages)	-	1.08	0	6	1.375	140	-	-	1.5	0	7	1.67	161	-	F: 5.618	.018**
No. of Earning Members (excluding unpaid and family helpers)	-	2.02	-	10	1.283	140	283	-	2.20	-	12	1.722	161	355	F: 1.073	.301
No. of Earning Members (including unpaid and family helpers)	-	2.36	-	10	1.499	140	331	-	2.60	-	12	2.087	161	418	F: 1.194	.275
Total Household Income (Yearly, '000)	-	95.88	-	896.0	116.22	140	13,423.5	-	121.36	-	692.3	113.52	161	19,539.6	F: 3.691	.056*

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES							NON-LBOD COMMUNITIES							ANOVA / CHI-SQUARE TEST	
	%	A ^{VG.}	M ^{IN}	M ^{AX}	SD	N	SUM	%	A ^{VG.}	M ^{IN}	M ^{AX}	SD	N	SUM	F / χ^2 STATISTICS	P- VALUE
Income of HoH (Yearly, '000)	-	72.75	-	760.0	84.25	140	10,185.2	-	74.3	-	500.0	88.11	161	11,964.4	F: 0.025	.876
Average Contribution by HoH (%)	-	79.04	-	100	29.79	140	-	-	64.0	-	100	38.93	161	-	F: 13.809	.000***
Average Contribution by Male Members (%)	-	86.31	-	100	25.4	140	-	-	82.9	-	100	32.23	161	-	F: 0.988	.321
Average Contribution by Female Members (%)	-	12.42	-	100	12.97	140	-	-	14.67	-	100	29.48	161	-	F: 0.526	.469
Per Capita Income (PKR, '000)	-	18.69	-	140.5	19.60	140	-	-	17.72	-	157.5	17.33	161	-	F: 0.207	.649
No. of Income Sources	-	1.45	-	3	.567	140	-	-	1.37	-	3	.557	161	-	F: 1.420	.234
Agriculture Income (PKR, '000)	<i>61.1</i>	<i>58.57</i>	-	<i>764.0</i>	<i>90.67</i>	<i>140</i>	<i>8,199.7</i>	<i>44.9</i>	<i>54.6</i>	-	<i>499.8</i>	<i>73.5</i>	<i>161</i>	<i>8,784.9</i>	F: 0.179	.673
Income from Livestock (PKR, '000)	<i>1.2</i>	<i>1.14</i>	-	<i>61.5</i>	<i>7.40</i>	<i>140</i>	<i>159.5</i>	<i>0.7</i>	<i>0.85</i>	-	<i>80.0</i>	<i>6.74</i>	<i>161</i>	<i>137.0</i>	F: 0.125	.724
Income from Fishing (PKR, '000)	<i>6.1</i>	<i>5.89</i>	-	<i>150.0</i>	<i>20.58</i>	<i>140</i>	<i>824.46</i>	<i>0.7</i>	<i>0.78</i>	-	<i>96.0</i>	<i>7.91</i>	<i>161</i>	<i>126.0</i>	F: 8.475	.004***
Non-Agriculture Income (PKR, '000)	<i>31.6</i>	<i>30.29</i>	-	<i>760.0</i>	<i>75.29</i>	<i>140</i>	<i>4,239.8</i>	<i>53.7</i>	<i>65.17</i>	-	<i>692.3</i>	<i>103.27</i>	<i>161</i>	<i>10,491.6</i>	F: 10.921	.001***
Total Household Assets (Basic Plus Earning, PKR, '000)	-	72.74	-	1,010.6	133.88	140	10,183.3	-	73.55	-	614.0	110.65	161	11,842.3	F: 0.003	.954
Total Household Assets (Basic, PKR)	-	12.86	-	242.5	25.79	140	1,800.5	-	16.02	-	405.6	429.45	161	2,579.5	F: 0.577	.448
Male Member Basic Assets (PKR)	-	4.7	-	22.5	20.5	140	654.5	-	5.7	-	400	32.3	161	919.2	F: 0.106	.745
Female Member Basic Assets (PKR)	-	3.3	-	60.7	8.8	140	456.5	-	2.9	-	103	11.5	161	473.5	F: 0.072	.789
Combine Assets (Furniture & Utility Fixture)	-	4.9	-	74.0	8.4	140	689.5	-	7.4	-	181.5	18.1	161	1,186.8	F: 2.173	.142
Total Household Assets (Livelihood, PKR)	-	59.87	-	796.5	116.44	140	8382.8	-	57.5	-	548.0	91.8	161	9,262.8	F: 0.038	.845

GEOGRAPHY → DESCRIPTION & PARTICULARS → VARIABLES	LBOD COMMUNITIES							NON-LBOD COMMUNITIES							ANOVA / CHI-SQUARE TEST	
	%	A ^{vg.}	M ^{IN}	M ^{AX}	SD	N	SUM	%	A ^{vg.}	M ^{IN}	M ^{AX}	SD	N	SUM	F / χ^2 STATISTICS	P- VALUE
Livestock (PKR)	-	37.24	-	216.0	58.68	140	5,213.9	-	31.9	0	446.0	66.7	161	5,141.4	F: 0.530	.467
Agriculture Land (PKR)	-	22.63	-	596.5	799.4	140	3,168.9	-	25.6	-	335.3	64.3	161	4,121.4	F: 0.127	.722
Other Earning Assets	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3. Literacy Rates a by Gender by District (%)

BY GENDER →	POPULATION AGE 10 YEARS OR OLDER ^{A, B, C,} D			POPULATION AGE 15 YEARS OR OLDER ^{E, F, G,} H		
	OVERALL	MALE	FEMALE	OVERALL	MALE	FEMALE
Overall	33.2 (437)	51.2 (332)	15.7 (105)	30.4 (341)	49.8 (276)	11.4 (65)
LBOD	30.1 (155)	47.6 (120)	13.3 (35)	27.5 (119)	47.0 (102)	7.9 (17)
NON-LBOD	35.1 (282)	53.5 (212)	17.2 (70)	32.2 (222)	51.6 (174)	13.6 (48)

Figures in parenthesis are absolute literate population numbers

^a across Geography: $\chi^2 (1, N = 1318) = 3.569, p < .1^* (= .059)$

^b across Gender: $\chi^2 (1, N = 1318) = 187.976, p < .01^{***} (= .000)$

^c across Gender in LBOD: $\chi^2 (1, N = 515) = 72.011, p < .01^{***} (= .000)$

^d across Gender in NON-LBOD: $\chi^2 (1, N = 803) = 116.306, p < .01^{***} (= .000)$

^e across Geography: $\chi^2 (1, N = 1122) = 2.821, p < .1 (= .093)$

^f across Gender: $\chi^2 (1, N = 1122) = 195.237, p < .01^{***} (= .000)$

^g across Gender in LBOD: $\chi^2 (1, N = 433) = 83.184, p < .01^{***} (= .000)$

^h across Gender in NON-LBOD: $\chi^2 (1, N = 689) = 113.813, p < .01^{***} (= .000)$