



## ASSESSING COMMUNITY RESILIENCE TO CLIMATE CHANGE IMPACTS: A CASE OF SMALLHOLDER FARMERS OF PISHIN-LORA BASIN BALOCHISTAN, PAKISTAN

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### **Abstract**

*Vulnerability to climate change impacts is one of the biggest challenges faced by Pakistan in 21<sup>st</sup> century. Enhancing community-resilience is a widely used practice in dealing climatic shocks. This study aims to assess smallholder farmers' resilience to climate change impacts in Pishin-Lora basin of Balochistan, Pakistan. Resilience to climate change impacts was determined by selecting indicators of resilience through extensive literature review. Weightage was assigned to each indicator through expert-opinion. To collect primary data for the selected indicators of resilience, 264 small-holder farmers were interviewed through a structured questionnaire in two districts Pishin and Mastung of Pishin-Lora Basin. A resilience index was developed to calculate each component variable through a score ranging from 0-1. Resilience for each variable was calculated by dividing percent of obtained value from field survey upon weightage value. Later, resilience for each component was calculated by taking the average value of variables for each component. The results show that resilience of small-holder farmers for each component variable and overall composite resilience is low in both selected districts. The composite resilience index (CVI) of overall PLB is 0.38 while CRI of small-holder farmers in Pishin*



*and Mastung is 0.41 and 0.35 respectively. The study recommends for community-driven pragmatic measures to improve the socio-economic, physical and institutional components of resilience through consolidated mechanism of disaster risk management.*

**Key words:** smallholder, resilience, climate change, indicators, Pishin-Lora basin

## 1. Introduction

Climate change is one of the most significant phenomena of disasters established across the globe. It is a major environmental challenge faced by the world due to its impacts on different biophysical systems causing disturbance for major food and water sources through temperature surges, droughts and varying patterns of rainfall (Yamba et al. 2019; Bendell, 2018). Those segments of population around the world have been highly vulnerable to climate change impacts that are highly dependent on water related occupations such as agriculture, livestock and fishery. Community resilience has emerged as a significant concept to characterize and measure the capabilities of people to forecast, absorb, recover or accommodate from the impacts of hazards or disastrous events in an efficient and effective manner (Patel et al. 2017; Deeming et al. 2014). Understanding of resilience goes beyond social-ecological systems (Armitage et al. 2012), for example, by integrating social subjective aspects such as perceptions and beliefs along with the governance and institutional settings that outline the capabilities of people to enhance resilience (Ensor & Harvey, 2015).

Small-holder or small-scale farmers who operate farming on two or less hectares (4.9 acres) (Thapa, 2009) are the most vulnerable to water scarcity, climate variability and climate change (Speranza, 2010) because mostly they cultivate marginal areas, rely on rain-fed farming and have lack of access to financial and technical support to assist invest in climate resilient agriculture (Holland et al. 2017; Donatti et al. 2018). Small-scale food producers constitute the majority of food producers in the 37 countries surveyed, while in some countries, they account for up to 91 percent (UN, 2017). Climate change and water scarcity pose a critical risk to small-scale farmers and impend to weaken global steps for food security, poverty reduction and sustainable development (Vermeulen et al. 2012; Lipper et al. 2014). In 2016, it was estimated that there are 475 million small-scale farmers who farm 2 or less than 2 hectares of land (Lowder et al. 2016). Most of these small-scale farmers are poor, face food insecurity and dwell in very precarious situations (Cohn et al. 2017). The Resilience Alliance determined three different features of resilience, i.e., the capacity of a system to absorb change and continue with the same; the ability to have self-organization and capability to establish and improve the ability to learn and adapt (Desouza & Flanery, 2013). To assess how resilient and adaptive are farmers to climate change, it is pivotal to analyze major components of resilience i.e. social, economic, physical, human, institutional and environmental (Cutter et al. 2010; Ainuddin & Routray, 2012; Nasrullah et al.



2015; Haque et al, 2022; Qasim et al, 2016). Enhancing the resilience of households and communities has become a dominant segment in the agenda of bilateral and multilateral development organizations and donor agencies (USAID, 2012; UNDP, 2013; FAO, 2013).

Pakistan is one of the most severely affected and highly vulnerable country to climate change impacts and water scarcity (Naz et al, 2020; Schilling et al, 2013). Pakistan's vulnerability to the impacts of climate change is acknowledged and documented by well reputed organizations and institutes (GoP, 2012). As per Global Climate Risk Index (GCRI), Pakistan—with a CRI score of 31.50, has been ranked in the top ten countries that are heavily affected by climate change and extreme weather events (Eckstein, 2018) by facing loss of approximately 3989 million US dollars and suffer up to 141 extreme weather events (EWEs) during a period of 20 years (1994-2013) (Kreft, 2015).

Pishin-Lora basin is in the Balochistan province of Pakistan. Geographically, Balochistan is the largest province—located in the south-western region of the country. It has unique geo-political position having total area of 347,200 square kilometers. The rapid increase in the population and influx migration of refugees from Afghanistan has resulted in high demand for water and food in the province (Majeed and Qureshi, 2000). The province is the fruit basket of Pakistan—the largest contributor to the national production of apples (82 per cent), peaches (69 per cent), grapes (97.6 per cent), pomegranates (82 per cent), dates (64 per cent), almonds (93.5 per cent) and plums (49 per cent) (Zarai Taraqiati Bank Limited, Pakistan, 2016). The fruits were cultivated on an area of 660 km<sup>2</sup> in 1992-93 which has increased up to 2,310 km<sup>2</sup> in 2012-13 (Ali Shah, 2021). While, 2013 onward, the production of fruits has been decreased due to climate change, lack of rains and dryness. The province is most vulnerable to water scarcity and hydrological hazards because of its arid climate conditions (Jamro et al, 2019). Ashraf et al. (2014) claim that 85% population of the province has agriculture as its primary source of income. Groundwater and flood water are the only water sources available for agriculture, domestic and industrial use. However, due to regular and intensive spells of drought and extreme temperature, ground water resource is being over-exploited which has resulted in rapid decline in water table, drying of springs, *karez*<sup>1</sup> and abolishing fruit orchards (Ashraf & Sheikh, 2017). Groundwater is the smallest resource in terms of availability and interestingly, the largest one in terms of utilization as about 61 percent of this resource is exploited annually in Balochistan (ADB-PRM, 2006; IPD, 2006). Figure 1 shows the increasing trend of tube-wells installation in the province.

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<sup>1</sup> *Karez* is a method of underground tunnels that are constructed to gather subsoil water, through gravitational pull, the foot of hills. This water is then either taken to the field through vertical shafts which are sunk underground, or it is drawn out at the foot of hill where it has been gathered.



Water scarcity for more than two decades destroyed almost 80% of the fruit production and orchards in the province (Ashraf and Routray, 2015). It caused shrank for all types of crops in general and rain fed crops in particular, in addition to, killing around two million animals (Jairath, 2008). Heat waves caused by climate change resulted deteriorating situation in the region—putting life of farming communities at high risks. Climate changes considerably effected the hydrological cycle in the province. It has probably disrupted the typical seasons resulting in longer and intense summers and shorter winters (IPCC, 2014). Shortage of water due to climate variability

and extreme weather events in the region led to significant water table declines in many parts of the province (Shahid et al, 2014). The province is already suffering from water scarcity, further; climate change will worsen the situation in future. Due to rise in temperature, the agriculture sector will be in need of more water during summers (Report No. ACS2258 v2, 2013).

To this very deteriorating situation of water scarcity and climate variability, the local small-scale farmers deal with and adapt coping mechanism in different ways. They either engage in seeking non-agricultural sources of livelihood and selling out their agricultural assets; establish new farms in other parts of the region or keep farming continued in the same area by pumping water from even deeper depth under different patterns of farming (Steenbergen et al, 2014). It has been established that water scarcity and climate change will worsen the situation in future and cause more threats to the livelihood of people who are still dependent on farming. The most important factor that can help farmers handle and live with this hazardous situation is their strong resilience and adaptive capacity.

In Balochistan, there is no evident systematic indicator-based resilience assessment of smallholder farmers to climate change impacts. Therefore, the objective of this study is to assess the resilience of smallholder farmers to the impacts of climate change in Pishin-Lora basin of Pakistan.

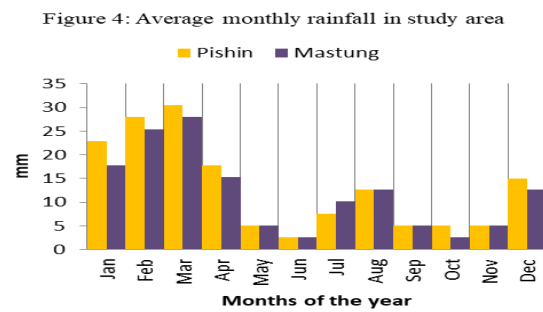
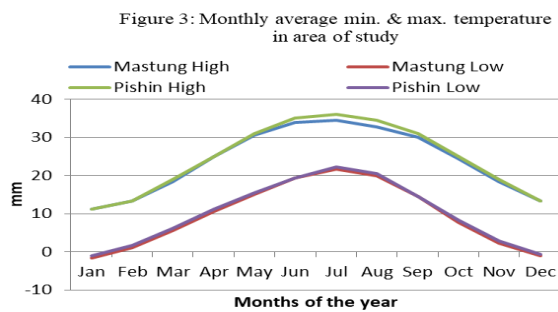
## 2. Area of study and selection criteria

The area of study for this research study is Pishin-Lora basin located in the Balochistan province of Pakistan. Out of eighteen river basins, PLB is the most water exhausted (Halcrow, 2007; Ashraf et al, 2016). The basin is spread into five districts namely Killa Aabdullah, Pishin, Quetta, Mastung and Kalat. Quetta is an urban and capital city of the province. Killa Abdullah and Kalat districts are partially water by PLB, therefore, for the purpose of field survey, Pishin and Mastung districts were selected. Agriculture is a dominant source of livelihood in both selected districts and small-



scale farming has a dominant stake in the agricultural production. Both districts have been suffering from water scarcity and impacts of hydro-climate change for more than two decades.

The total area of Pishin and Mastung is 6,218 km<sup>2</sup> and 3,308 km<sup>2</sup> respectively. According 2017 census report of Pakistan, the population of Pishin and Mastung is 736,903 and 265,676 with 3.59% and 3.05% annual growth respectively. 80.56% population of Pishin and 86.82% population



of Mastung district live in rural areas. The average household size of Pishin and Mastung is 5.81 and 6.84 respectively. Literacy rate is 52.97 (67.18 for male and 33.95 for female) in Pishin and 39.66 (49.69 for male and 28.92) in Mastung district. Data shows that there is significant variation of literacy rate between rural and urban population in the selected districts.

The climate of study area is arid, mostly very hot in summers and very cold in winters. Average annual minimum and maximum temperature in Pishin is 17.37 °C and 28.59 °C while that of Mastung district is 17.55 °C and 28.89 °C. The coldest months are January and December while June and July are the hottest in both districts. Due to geographical location of the districts and changing climate conditions, the precipitation rate has decreased to alarming position during the last two decades. The annual rainfall in Pishin is 12.68mm with only 24.82 (6.8%) days with rainfall ( $\geq 1.0$ mm) and 340.18 (93.2%) days without rain.

Table 1: Climatic data of study area

District	Mean rainfall			Mean annual Temperature		EWEs Occurrence
	Annual rainfall	Days with rainfall ( $\geq 1.0$ mm)	Days with no rain	Min.	Max.	
Pishin	12.68 mm (0.5in)	24.82 days (6.8%)	340.18 days (93.2%)	17.37°C (63.27°F)	28.59°C (83.46°F)	Frequent & recurrent spells of



						moderate level drought, wind and hail storms in winter & early spring, torrential rains, high temperature in summers,
<b>Mastung</b>	12.81 mm (0.5in)	25.08 days (6.87%)	339.92 days (93.13%)	17.55°C (63.59°F)	28.89°C (84.0°F)	

*Source: Pakistan Meteorological Department; Global Historical Weather and Climate Data; Weather Spark*

The climate of Mastung district is not very different. The annual rainfall in Mastung is 12.81mm with only 25.08 (6.87%) days with rainfall ( $\geq 1.0\text{mm}$ ) and 339.92 (93.13%) days with no rain. Impacts of climate change and occurrence of Extreme Weather Events include frequent and recurrent drought spells, wind and hail storms in winter and early spring, torrential rains and high temperature in summers. Flood is not a common phenomenon in the study area. For the purpose of field survey twelve Union Councils were selected from each district. (Table 1 illustrates detailed climatic data of the study area)

### 3. Materials and methods

#### 3.1 Sample size, sampling procedure and data collection

Primarily, two districts (Pishin and Mastung) among the five catchment districts of Pishin-Lora Basin were selected on the basis of previous records of climate change impacts and EWEs. There are 4 Tehsils and 52 UCs in Pishin and 3 Tehsils and 20 UCs in Mastung. 12 UCs from each District were purposively selected for field survey by implying cluster sampling technique. Each selected UC has been considered as a separate cluster in the study. Later, for field survey, 11 households of small-scale farmers from each UC were selected using UNICEF pencil-spin selection method (Haque et al. 2022; Ogbu & Guha-Sapir, 2021). All selected UCs were from rural areas of both districts as the selected UCs have small-scale farming as a dominant source of income and extensive record of water scarcity, EWEs, and hydro-climatic hazards based on reconnaissance survey and secondary records (Ashraf et al, 2016).

According to Agriculture Census, 2011, the number of small-scale farmers in Pishin and Mastung is 23806, 1989 respectively (GoP, 2011). To determine sample size for field survey, the Arkin and Colton (1963) formula (**Eq: 1**) was used. Based on total number of small-scale farmers ( $N=25795$ ),



the total sample size (n=264) was selected for both districts. Due to huge variation in the No. of small-scale farmers in the selected strata—the districts, disproportionate stratified sampling technique was implied and equal number of elements i.e. 132 households were selected from each district. The disproportionate allocation of sample size helped for a more balanced comparative analysis across the districts (Khan N. et al. 2020; Nayeem & Huma, 2017).

**Eq:1**

$$n = \frac{Nz^2 p (1-p)}{Nd^2 + z^2 p (1-p)}$$

where: n = sample size; N = total population (25795); z = confidence level (at 95% level, z = 1.96); p = estimated population proportion (0.5); and d = error limit of 6% (0.06)

By putting values, the total sample size (**n**) for the study is = **264**.

The study method is a mix of quantitative and qualitative techniques. Quantitative data was mustered from field survey through a structured questionnaire. Already selected components, variables and indicators were inserted into questionnaire to gauge resilience of farming households. To ensure reliability and validity of questionnaire, 10% HHs of the total sample size were surveyed for pre-testing. On the basis of pilot-test of questionnaire, the weaknesses were removed and additional corrections were incorporated to standardize data-tool. The field data was collected during May-July 2021, which is a peak time for farmers to be present in the fields. Qualitative data was collected to get in-depth perception and understanding of potential stakeholders. For this purpose, two Focus Group Discussions (FGD) – one in each district, 4 In-depth Interviews (IDI)—3 in each district and six Key Informant Interviews (KII) – 3 in each district were conducted. FGDs were carried out with small-scale farmers severely affected by hydro-climatic hazards, IDIs were conducted with officials from line departments, public representatives, Regional Meteorological Department, and Provincial/District Disaster Management Authorities (PDMA and DDMA), while KII were conducted with representatives of farmers' associations, unions, tribal leaders and social activists. Both qualitative and quantitative data was used to finalize resilience components, variables, indicators and to assess small-scale farmers' resilience to climate change and water scarcity in Pishin-Lora basin.

Secondary data for the study was obtained from different sources such as research publications, government and NGOs reports, journals, newspapers, documentaries, district profiles (reflected in reference section). Comprehensive review of secondary data assisted in getting information about study area specific information such as area, demographic figures, literacy rate, rainfall,



temperature, climatic trends, climatic history, frequency and occurrence of EWEs, etc. (Table No.1). Review of secondary sources also assisted in assessment of resilience components, variables, and indicators to incorporate in questionnaire and finalization of overall Resilience Assessment Index. Data cleaning and corrective measure were strictly considered to ensure quality check. Data analysis and graphical illustration of data was carried out using Statistical Package for Social Science (SPSS) version 21, and MS Excel respectively.

### **3.2 Selection of resilience components, variables and indicators**

Resilience assessment and measurement is complex in nature. Firstly, there is no universal definition and criteria of resilience and its assessment. Based on review of literature, for the purpose of this study, it was sought to assess resilience on the basis of social, economic, human, physical and institutional components (Cutter et al, 2010; Ainuddin & Routray, 2012; Qasim et al. 2016, Haque et al, 2022). Secondly, due to lack of standardized variables and indicators of resilience components (Cutter et al. 2010), specific component associated variables & indicators were selected on the basis of findings from KII, IDI, and review of literature (Table 2). To avoid complexity, results of each selected variable from field data was observed in the form of percentage.

The indicators of social component of resilience include; formal education, religious belief, social capital, source of information for updates of climate change and hazards, social networking/linkages with civil society organizations and gender balance. All the selected indicators have significant impact on resilience of small-scale farmers either positive or negative. For example, farmers with formal education, are more likely to understand climatic hazards, get scientific information, and adapt to climate change which result in positive impact on resilience (Ainuddin & Routray, 2012). Nonetheless, farmers who believe that climate change is caused by sins of human beings and not obeying Allah, are less likely to adapt to climate change, thus, having negative impacts on resilience (Qasim et al, 2016).

Under economic component, household income, income diversification, saving, remittances/pension and social funds/grants were selected as study indicators. Small-scale farmers with income above poverty line (Middle Income Class Poverty Line @ 3.20 USD) are more resilient to climate change impacts as compared to those whose income is lesser. For example, farming families with multiple and diverse sources of income will have adequate income to meet household expenses during crop failure – thus more resilient they will be (Nasrullah et al, 2015, Haque et al, 2022).



The third component is the human aspect of community resilience. The variables of human resilience included are; literacy rate of community, disability and chronic diseases, interest in seeking scientific knowledge of climate change, human skills and trainings. These components have both positive and negative impacts on resilience of farmers, for example; besides indigenous knowledge, scientific and updated knowledge of climate change, EWEs, and adaptation is significant to deal with recurrent droughts and floods. Farmers who are not interested in seeking updated scientific knowledge of climatic change and adaptations are more vulnerable and less resilient.

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Table 2: Indicators used to assess resilience

Resilience components, variable and source	Explanation	Optimum weightage	Impact
<b><u>Social Resilience</u></b>			
<i>Formal education</i> (UNDP-CoBRA, 2017; Cutter et al. 2010)	Percent of farmers with formal education.	90	+
<i>Religious belief of climate change</i> (Qasim et al, 2016; Yousuf & Nasir, 2016)	Percent of farmers who think that climatic hazards are merely due to human fate and sins	85	-
<i>Social capital</i> (Ainuddin & Routray, 2012; Nasrullah et al, 2015)	Percent of communities where relationship of trust and cooperation exist during hydro-climatic stresses/disasters.	65	+
<i>Sources of information for updates of climate changes and hazards.</i> (Cutter et al., 2010; Owusu, et al. 2016)	Percent of households who have multiple sources of information for family to get updates about climate changes and hazards.	85	+
Social networking / linkages with CSOs (Nasrullah & Ainuddin, 2019)	Percent of farmers who have social networking / linkages with CSOs	65	+
<i>Gender balance</i> (UNDP-CoBRA, 2017)	Percent of families where household decisions are made by involving both male and female family members.	75	+
<b><u>Economic Resilience</u></b>			
<i>HH income above poverty line</i> (Nasrullah & Ainuddin, 2019) Edgemon et al. 2018)	Percent of HHs with income above poverty line (Middle Income Class Poverty Line @ 3.20 USD)	50	+
<i>Income diversification</i> (UNDP-CoBRA, 2017; Nasrullah et al, 2015)	% of families having multiple or diverse sources of income.	65	+



<i>Saving</i> (UNDP-CoBRA, 2017; Nasrullah & Ainuddin, 2019)	% of families having saving scheme	80	+
<i>Investment</i> (Berke & Campanella, 2006; Adger, 2000)	% of families who have invested money other than agriculture.	70	+
<i>Remittances/pension</i> (Sato et al. 2022; Nasrullah & Ainuddin, 2019)	% of households who receive remittance/pension	40	+
<i>Social funds/grants</i> (Nasrullah & Ainuddin, 2019)	% of farmers who believe that social funds/grants of any type are given in their community.	75	+
<b><u>Human Resilience</u></b>			
<i>Literacy</i> (Ainuddin & Routray, 2012; Cutter et al., 2010)	Literacy rate in district (10+population) *Census 2017	90	+
<i>Disability and chronic diseases</i> (Ainuddin & Routray, 2012; Edgemon et al. 2018)	% of population and families with disability/chronic disease	55	-
<i>Interest in Scientific knowledge of climate change</i>	% of farmers who do not have interest in getting updates and scientific knowledge of climate change.	85	-
<i>Skills to enhance resilience to climate change</i>	% of farmers/HH members having skills to improve their resilience to climate change	85	+
<i>Training of climatic threats and adaptations</i>	Percent of farmers/HH members who have got trainings regarding climatic threats and adaptations (during last five years)	80	+
<b>Physical Resilience</b>			



<i>Household assets</i> (Nasrullah & Ainuddin, 2019)	Percent of household with multiple household assets including vehicles, agriculture machinery, communication tools.	90	+
<i>Access to communication services</i> (UNDP-CoBRA, 2017; Cutter et al. 2010)	% of household who have access to communication services ( landline, internet, mobile(2G/3G/4G)	65	+
<i>Household location</i> (Ainuddin et al., 2015; Haque et al. 2022; Qasim et al. 2016)	% of farmers who live in houses that are located at disaster vulnerable locations (> than 1 km of water source for drought and < than 1 km radius of flood radios)	95	+
<i>Water channels for irrigation</i>	Percent of smallholder farmers who have paved/piped water channels for irrigation	95	+
<i>Access to safe drinking water</i>	% of household who have fair/easy access to safe drinking water.	98	+
<i>Water and fodder for livestock</i>	% of small-scale farmers who have suitable daily water and fodder for livestock.	85	+
<b>Institutional Resilience</b>			
<i>Institutional support for DRM</i> (Nasrullah & Ainuddin, 2019; Cutter et al. 2010)	% of small-scale farmers who have been helped by government organizations for DRM (in the last 5 years)	80	+
<i>Access to extension services</i> (UNDP-CoBRA, 2017; Cutter et al. 2010)	Percent of farmers who have easy access to extension services of GOs.	90	+
<i>Early warning system</i> (Cutter et al. 2010; UNDP-CoBRA, 2017)	% of communities with effective early warning system regarding climatic risks.	95	+
<i>Existence of civic and social organizations</i> (Ainuddin & Routray, 2012; Edgemon et al. 2018)	Percent of communities with existence of civic and social organizations for effective support to deal with climatic hazards.	95	+



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<i>Frequency of activities regarding climate hazards</i> (Owusu, et al. 2016; Nasrullah & Ainuddin, 2019)	No. of climate related activities carried by organization (in last 5 years)	5	+
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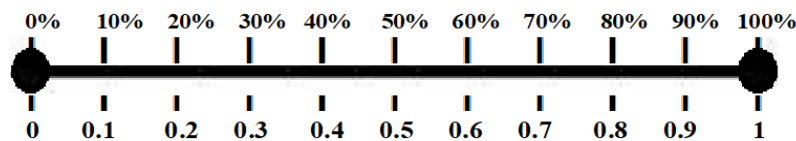
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Another significant dimension of resilience is the physical component. To assess and measure physical resilience of small-scale farmers, a number of indicators were included in the index. The indicators included household assets, access to communication services, household location, pattern of water channels for irrigation, access to safe drinking water and availability of water and fodder for livestock animals. Taking example of HH location – farmers who live in houses that are located at disaster vulnerable locations (> than 1 km radius of water source in case of drought and < than 1 km radius of flood radii). Location of house at water scarce location makes it very difficult for family to arrange water for domestic use which consequently compel family members especially women and children to fetch water from remote areas. House location at disaster vulnerable location decreases the resilience of family to cope with climatic hazards. Indicators selected for institutional components include institutional support for disaster risk management (DRM), access to extension services, early warning system, existence of civic & social organizations and frequency of activities regarding climatic hazards

### 2.3 Assigning weightage to indicators and their aggregation

As mentioned above, the resilience of small-scale farmers is consisted of five main components. Each component of resilience has a number of variables (Table 2). To produce a resilience indices, variables and indicators within each within each components were assigned in percentage. It is evident from literature that weights can be assigned to the variables and indicator in subjective or empirical method. For the purpose of this study, subjective approach of assigning weightage to variable or indicators was used as used by (Cutter et al. 2010; Shah et al. 2018; Haque et al, 2022). Assignment of weightage values to each variable/indicator was guided by previous researches of community disaster resilience assessment mostly carried out in South-Asian countries (Ainuddin & Routray, 2012; Nasrullah et al, 2015; Qasim et al, 2016; Raheem, et al. 2018; Haque et al. 2022). Additionally, to validate weightage of each variable/indicator (as listed in Table 2) guidance was acquired from experts of resilience and researchers in the field of disaster risk management. The weightage of variables was acquired in the form of percent. Later, percent value of each variable was converted into score that ranged from 0—1 (as shown in figure below).



To obtain variable resilience index (VRI) for each single variable, the percent value of variable of the sample households was divided by the optimum weightage value already obtained from



literature and experts (as in **Eq. 2**). As show in Table 2, each variable has either positive or negative impact on resilience of small-scale farmers. In case variable has positive impact on resilience, the more the score of VRI is near to 0, the lower resilient is the variable and the more the score of VRI is near to 1, the higher the resilience will be, however, in case of negative impact on resilience, the VRI should be dealt with in the reverse manner by flipping the scale of measurement from 1—0. For example, religious belief of climate change has negative impact on resilience of small-scale farmers, as farmers who think that climate change, climatic hazards, water scarcity and EWEs are merely the result of human sins, such farmers are less likely to accept scientific reasoning of climatic hazards and, consequently, are less prepared for adaptations. In this case, the resilience score is measured from 1—0, where VRI nearer to 1 is less resilient as compared to VRI nearer to 0. **Eq.2** represents the formula to calculate Variable Resilience Index (Ainuddin & Rotray, 2012; Qasim et al, 2016; Haque et al, 2022).

**Eq: 2**

$$i = o/w$$

Where:

$i$  = variable resilience index (VRI)

$o$  = obtained percent of value from field survey

$w$  = Weightage of optimum value

By applying equation 2, variable resilience index (VRI) of all variables in the five components of resilience i.e., Social, Economic, Human, Physical and Institutional for each selected districts were calculated. Then, Social Resilience Index (SRI) for each district and overall study area was calculated by taking the average of all six VRIs in the Social Resilience. Similarly, the VRI scores for each component and ERI, HRI, PRI and IRI were calculated. Finally, the overall resilience i.e. Composite Resilience Index (CRI) for each selected district was calculated by taking the average index values of all components i.e. SRI, ERI, HRI, PRI and IRI. Composite Resilience Index (CRI) for each district separately and overall study was calculated (Table 9). The overall score of CRI reflects the resilience level of both districts and entire study area i.e. PLB.

The scores of resilience index of various variables and components are further analyzed by assigning resilience levels to resilience scores (Table 3). A total of five levels of resilience levels have been developed on the basis of equal distribution of scores (Haque et al. 2022).

*Table 3: levels of resilience (r) on the basis of resilience index scores*

<b>r score</b>	<b>r level</b>
≥ 0.20	Very poor level of resilience
0.21—0.40	Poor resilience



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0.41—0.60	Medium level of resilience
0.61—0.80	Good resilience
0.81—1.0	Very good level of resilience

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#### **4. Results and discussion**

##### **4.1 Descriptive statistics of respondents' profile**

As per data of field survey, the mean age of small-scale farmers is 48.18 years with standard deviation 7.2. A high majority of respondents i.e. 56.1% farmers are illiterate. The rate of illiteracy among farmers is higher in Mastung (67.4%) as compared to Pishin (44.7%). Only 21.2% farmers have primary level of education, and 2.7% with high secondary education. The rate of religious education is higher in Pishin (18.2%) as compared to Mastung 5.3%. The average family size in study area is 10.59 with minimum 6 and maximum 18 members in the family. Farming families mostly tend to live in joint families therefore, the average family size is greater as compared to overall family size in both district. The economic conditions of farming families in PLB is poor as field data show that mean per capita income per day is PKR 457.5.

The mean farm size is 4.3 acres. It is to be considered that small-scale farmers are those who have less than 5 acres farm land (Thapa, 2009). It was noticed during field survey that small-scale farming is more common in district Pishin as compared to district Mastung. Irrigated orchards (42.8%) and irrigated annual crops/vegetable (41.7%) are more common types of major agriculture in target districts with very little varying between the districts. Rain-fed/flood-fed agriculture has decreased to only 11% due to lack of rainfall. Farmers have been trying to convert to tunnel farming (7.6% in Pishin & 1.5% in Mastung), however, due poor affordability of small-scale farmers, the trend of tunnel farming is very slow, especially, in Mastung district. 58% farmers are owners of the farms, 37.5% are tenants while only 3% are agriculture laborers. Experience of farmers also has a considerable value in resilience, the average experience of farmers in agriculture sector is 19.3 years with standard deviation 5.306.

##### **4.2 Resilience scores**

The variable resilience index (VRI), component resilience index (SRI, ERI, HRI, PRI & IRI) and composite variable index (CRI) for both district and over all study area has been calculated and presented in tables 4, 5, 6, 7, 8 & 9. Beside variable scores, the tables also present percent values (% value) and optimum weightage of each variable in the form of % value and resilience index (RI). The resilience index of each component is discussed as follows;



#### 4.2.1 Social resilience

Social resilience is concerned with access and participation in education, understanding, social capital, formal and informal institutions, relationship of trust, social networking, governance issues and participation of both genders (DFID, 1999). It indicates the social abilities and strengths of community to deal with climatic stressors (Haque et al. 2022). The results of field survey (Table 4) reveals that the social resilience (SRI) of PLB is lower middle (0.47). The SRI of Pishin district (0.52) is comparatively better than that of Mastung district (0.42). Similar study carried out in Noshki district of Balochistan reveals lower resilience and higher vulnerability of community to climatic hazards (Nasrullah et al. 2014). The VRI score for formal education is 0.49, while the resilience score for farmers' perception that climatic hazards occur due to human sins or fate (religious belief) is 0.43 which has negative impacts on resilience. The highest resilience score (0.73) is for relationship of trust and cooperation/social capital with dominant score in district Mastung (0.79). The lowest resilience score is for social networking / linkages with CSOs (0.22) and gender balance (0.30). Only 14.35% farmers have linkages with civil society organization in the study area. Similarly, only 22.75% farming households have participation of male and female members in the decision making process particularly regarding household matters. The score for gender balance in Mastung district is very much low (0.17). Stronger tribal links increase spirit of cooperation and weaken women participation in the study area.

Table 4: Score of social component/variables resilience index

Component and Indicator	Pishin		Mastung		Over all study area		Optimum weightage	
	%	VR I	%	VR I	%	VRI	%	RI
Formal education	55.3	0.6 1	32.6	0.3 6	43.95	0.49	90	1
Farmers' perception that climatic hazards are due to human fate/sins	40.9	0.4 8	32.6	0.3 8	36.75	0.43	85	1
Relationship of trust and cooperation (Social capital)	43.9	0.6 8	51.5	0.7 9	47.7	0.73	65	1



Multiple sources of information for updates of climate changes and hazards.	53.8	0.6	54	0.6	53.9	0.63	85	1
		3		4				
Social networking / linkages with CSOs	18.9	0.2	9.8	0.1	14.35	0.22	65	1
		9		5				
Gender balance	32.6	0.4	12.9	0.1	22.75	0.30	75	1
		3		7				
<b>SRI (Social Resilience Index)</b>		<b>0.5</b>		<b>0.4</b>		<b>0.47</b>		<b>1</b>
		<b>2</b>		<b>2</b>				

Source: Field survey

#### 4.2.2 Economic resilience

Economic resilience is related to abilities of community to adapt various strategies for livelihood. It can be in the form of income, sources of income, saving, investment, social funds, remittances/pensions, etc. (DFID, 1999) that enhance community's capacity to recover from disasters (Haque et al, 2022). The economic resilience scores of Pishin, Mastung and overall ERI (Table 5). The ERI of Pishin and Mastung is 0.38 and 0.24 respectively. While the overall economic component resilience index score is 0.31. This denotes that the level of economic resilience of the small-scale farmers in PLB is low. Similar findings were sought in another study in Balochistan (Nasrullah et al, 2015). The VRI score for multiple/diverse sources of income is 0.54 with 0.63 in Pishin and 0.45 in Mastung. It is observed that people of Pishin district make their livelihood other than agriculture in other parts of the country, especially, in hotel industry. The score for HH income above poverty line (Middle Income Class Poverty Line @ 3.20 USD) is 0.42 where Pishin is 0.47 and Mastung is 0.37. Remittances/pension and saving schemes for households of small-scale farmers are both very low VRIs with score of 0.15 and 0.18 respectively. The findings of ERI show that economic resilience of small-scale farmers is not satisfactory. Only 23 percent farmers have access to social funds/grants. The resilience variable score in Mastung (0.17) is lower than Pishin (0.28).

Table 5: Score of economic component/variables resilience index



Component and Indicator	Pishin		Mastung		Over all study area		Optimum weightage	
	%	VR I	%	VR I	%	VRI	%	R I
HH income above poverty line (Middle Income Class Poverty Line @ 3.20 USD)	35.6	0.4 7	28	0.3 7	31.8	0.42	75	1
Multiple or diverse sources of income	47	0.6 3	34.1	0.4 5	40.55	0.54	65	1
Saving scheme of family	19.7	0.2 5	9.8	0.1 2	14.75	0.18	80	1
Investment other than agriculture	28.8	0.4 1	16.7	0.2 4	22.75	0.33	70	1
Remittances/pension	9.1	0.2 3	3	0.0 8	6.05	0.15	40	1
Social funds/grants	21.2	0.2 8	12.9	0.1 7	17.05	0.23	75	1
<b>ERI (Economic Resilience Index)</b>		<b>0.3 8</b>		<b>0.2 4</b>		<b>0.31</b>		<b>1</b>

Source: Field survey

#### 4.2.3 Human resilience

Human resilience refers to skills, knowledge, good health and trainings of people that enhance their abilities to pursue variety of strategies for livelihood and make income (DFID 1999).

Table 6: Score of human component/variables resilience index

Component and Indicator	Pishin		Mastung		Over all study area		Optimum weightage	
	%	VR I	%	VR I	%	VRI	%	R I
Literacy rate in community (10+population) *Census 2017	52.97	0.5 9	39.66	0.4 4	46.31	0.51	90	1
Disability and chronic diseases	21.2	0.3 9	23.5	0.4 3	22.35	0.41	55	1
Interest in Scientific knowledge of climate change	33.3	0.3 9	53.8	0.6 3	43.55	0.51	85	1



Skills to enhance resilience to climate change	33.6	0.4	0	30.3	6	0.3	31.95	0.38	85	1
Training of climatic threats and adaptations	18.2	0.2	3	5.3	7	0.0	11.75	0.15	80	1
<b>HRI (Human Resilience Index)</b>		<b>0.4</b>	<b>0</b>		<b>0.3</b>	<b>8</b>		<b>0.39</b>		<b>1</b>

Source: Field survey

The human resilience index of study area falls under low category, where the overall VRI score is 0.39. Literacy rate (both male and female) as per statistics of Government of Pakistan (Census Report, 2017) in community reflects medium level resilience score (0.51), however, district Pishin (0.59) has better resilience in literacy as compared to Mastung (0.44). The prevalence of disability is not common in study area, however, people with chronic diseases are in good number in both districts. The resilience score for disability and chronic diseases in 0.41. This variable has negative effect on resilience of farmers as such people need special care and investment on treatment and rehabilitation. More farmers in Mastung (53.3%) have interest in scientific knowledge of climate change and water management as compared to farmers in Pishin (33.3%). Major reason behind this is prevalence of strong attachment to religious belief (Ashraf et al. 2014). The score for skills to enhance resilience to climate change is low (0.38). Skills that were inquired of farmers include climate smart adaptations, budgeting, leadership, forecasting the climate trends etc. The lowest resilience score is for training of farmers regarding climatic threats and adaptation skills (0.15). This reflects lack of interest of farmers and poor role of institutions to develop the skills of farming households to deal with climate hazards at grass-root level (Nasrullah & Ainuddin, 2014).

#### 4.2.4 Physical resilience

Physical resilience is concerned with basic infrastructure (roads, bridges, water supply, communication services, etc.) in a community that is used by community to have productive functioning (DFID, 1999).

Table 7: Score of physical component/variables resilience index

Component and Indicator	Pishin		Mastung		Over all study area		Optimum weightage	
	% Value	VR I	% Value	VR I	% Value	VRI	% Value	R I
Multiple household assets	36.98	0.4	32.56	0.3	34.77	0.39	90	1



Access to multiple communication services	45.5	0.5	4	42.22	0	43.86	0.52	85	1
Vulnerability of household location	45.5	0.4	8	53.8	7	49.65	0.52	95	1
Paved water channels for irrigation	28.8	0.3	0	24.2	5	0.26	0.28	95	1
Access to safe drinking water	47.7	0.4	9	40.1	1	43.9	0.45	98	1
Water and fodder for livestock	31.1	0.3	7	18.9	2	25	0.29	85	1
<b>PRI (Physical Resilience Index)</b>		<b>0.4</b>	<b>3</b>		<b>0.3</b>		<b>0.41</b>		<b>1</b>

Source: Field survey

The physical resilience indices (Table. &) for Pishin and Mastung are 50 and 48 while the overall component variable index is 49. Contrary to another study (Nasrullah et al. 2014) which was conducted in Noshki district of Balochistan, the component variable index is improved in Pishin and Mastung. The score for paved water channels for irrigation is low level of resilience (0.28) which has negative impact on resilience level. The variable score for vulnerability of household location in a radius of less than 1 km of water source is 0.52 which fall in medium level of resilience, similarly, VRI for access to multiple communication services is 0.52. The communication services include mobile signals, internet, landline etc. 0.39 is VRI score for household assets such as bike/motorbike, agriculture machinery, tractor, vehicle, radio/TV etc. Medium level resilience (VRI: 0.45) is also for access to safe drinking water for domestic use, however, water and fodder for livestock is challenging as its resilience score is 0.29. People usually buy water for domestic use but cannot afford to for livestock. Since, the overall PRI is just above low level of resilience, therefore, farmers in Pishin-Lora basin have been suffering from impacts of climate change and water scarcity. Their ability to recover from EWEs is not satisfactory.

#### 4.2.5 Institutional resilience

Institutional resilience is related to the framework that enables people to prepare for and mitigate risk and impacts of disaster (Qasim, et al, 2016; Shah et al, 2018, Haque et al, 2022).

Table 8: Score of institutional component/variables resilience index

Component and Indicator	Pishin	Mastung	Over all study area	Optimum weightage
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	%	VR I	%	VR I	%	VRI	%	R I
Institutional support for DRM	12.1	0.1 5	14.4	0.1 8	13.25	0.17	80	1
Access to extension services	33.3	0.3 7	18.9	0.2 1	26.1	0.29	90	1
Early warning system	13.6	0.1 4	9.1	0.1 0	11.35	0.12	95	1
Existence of civic and social organizations	12.88	0.1 4	13.04	0.1 4	12.96	0.14	95	1
Frequency of activities regarding climate hazards	0.69	0.1 4	0.56	0.1 1	0.625	0.13	5	1
<b>IRI (Institutional Resilience Index)</b>		<b>0.1 9</b>		<b>0.1 5</b>		<b>0.17</b>		<b>1</b>

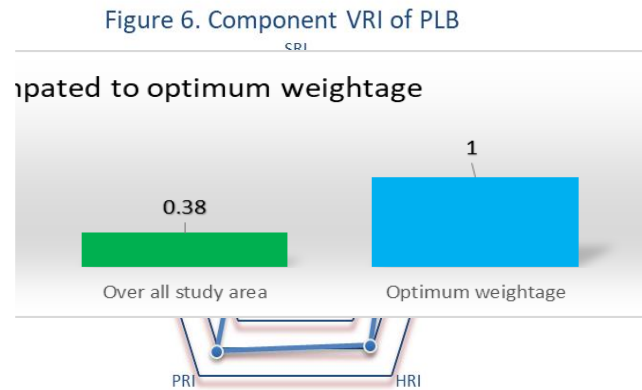
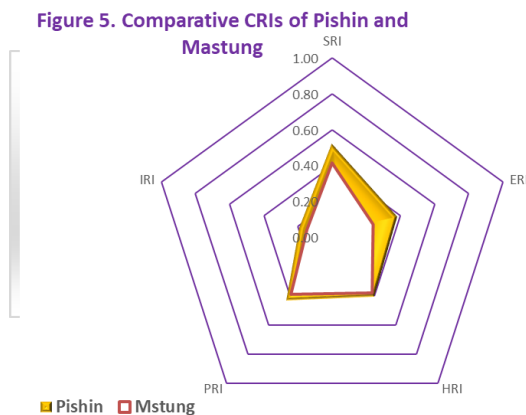
Source: Field survey

Field data (Table 8) reveals that the Institutional Resilience Index (IRI) is very poor in both selected districts of Pishin-Lora basin. The component resilience score of Pishin is 0.19 and Mastung is only 0.15. The overall component resilience index for both district is 0.17 which shows very poor level of resilience. Score for access to extension services is 0.29 that falls in the level of poor resilience. Whereas, other variables of the component show very poor resilience i.e. institutional support for Disaster Risk Management (DRM) (0.17); existence of civic and social organizations (0.14); frequency of activities regarding climatic hazards (0.13) and early warning system (0.12). The resilience level of small-scale farmers in Mastung is even worse than that of farmers in Pishin. Farmers are not satisfied with the role of government organization in terms of prevention, mitigation and preparedness for climatic hazards and extreme weather events. In some communities platforms for organizational support do exist such as farmers' associations, community/volunteer groups, community based organization, tribal organizations such as *Jirga/Merh*<sup>2</sup> and religious organization. However, the role of these organization is very poor in assisting communities with climatic stressors. Farmers in PLB area claim that activities such as awareness raising, capacity building, technical support and research are very much lacking in communities. However, physical infrastructure and emergency response is existing in some communities to some extent.

#### 4.2.6 Composite Resilience Index (CRI)

<sup>2</sup> Local tribal informal organizations

Composite Resilience Index (CRI) is the average of all five Component Resilience Indices i.e. SRI, ERI, HRI, PRI and IRI. CRI has been calculated both for Pishin & Mastung district and overall study area. As shown in elaborated in Figure 7, the CRI score of overall study area is 0.38 that fall under low resilience level (Table. 3). Institutional resilience (0.17) is the lowest followed by economic (0.31), human (0.39), physical (0.41) and social (0.47) as shown in Figure 6. The CRI of Pishin is (0.41) is better than Mastung (0.35) as shown in Figure 5 & 7.



#### 4. Conclusion and recommendations

Pishin-Lora Basin in Balochistan is the most water stressed basin due to hydro-climatic shocks for the last two decades in which the life and livelihood of small-scale farmers has been at high level risk. The purpose of this study was to assess the resilience of small-scale farmers through a model of component resilience index (CRI) in Pishin and Mastung districts. The study tried to determine components, variables & indicators of resilience for each district and compare the component variable-index of selected districts. Components of resilience assessed and compared included social, economic, human, physical and institutional, whereas, the overall resilience of study area was determined through composite resilience indices. The results determined that both districts of PLB have low resilience, thus, highly vulnerable to climate change impacts and water scarcity. However, the resilience of small-scale farmers in Mastung district is lower as compared to Pishin. By comparing component wise resilience of study area, institutional resilience is the lowest followed by economic, human, physical and social resilience. It is, therefore, needful that indicator-wise focus and consideration be established for improving the resilience of small-scale farmers in overall Pishin-Lora basin with special attention on role of institutions and improving the economic



status of populace. The study recommends measures on the basis of each component and indicators of resilience.

In social component, majority farmers relate disasters to religion—having perception that climatic hazard occur when people do not obey the orders of Allah, therefore, less prepared for disaster mitigation and adaptations. This can be addressed through an integrated approach by involving religious scholars and institutions in a series of seminars, training workshops and conferences to give them leading role in bring change in the attitude of farmers for better adaptations and mitigations of climatic hazards. Social linkages with civil society organizations is an important variable that should be address by supporting community organizations such as CBOs, CCBs and local tribal organizations to get organized and focus climate change as major theme of intervention. Women participation, empowerment and leadership is a neglected segment in tribal society of Balochistan. It is highly recommended that gender equality need to be integrated as a cross-cutting theme in every development program particularly in DRM. Special programs of literacy for faming household should be devised with special focus on climate change as major component of syllabi.

In economic component, farming households should be given with appropriate vocational trainings and opportunities to opt for income sources other than agriculture and encourage investment in diverse fields. Farmer-oriented projects with focus on social grants, creation of jobs, micro-credit and financial aids need to be initiated both by GOs and NGOs. Moreover, subsidized climate resilient varieties of trees and seeds should be given to small-scale farmers. It will enable farming communities to improve income, better deal with climatic stressors and eventually, come up with enhanced economic resilience.

On part of human resilience, the interest of farmers in seeking scientific knowledge and skills can be increased by involving environmental specialists, social workers, media persons and tribal key persons in awareness raising activities, trainings and workshops to assist farmers in understanding scientific factors of climate change and adapt accordingly. Physical resilience can be enhanced by motivating farmers for climate-smart water management measures such as drip irrigation and tunnel farming in a subsidized scheme. To remain updated in regard with climate trends and forecasts, access to multiple and effective communication services need to be enhanced particularly via programs in local languages such as Pashto and Brahvi. The lowest component of resilience is institutional. To enhance the role of climate change and disaster management institutions, transparency and accountability of duty bearers of relevant agencies should be ensured along with capacity building of employees. Farmers at local level should be provided with access to extension services and support for DRM. Besides government agencies, other formal and informal



institutional platforms need to be encouraged to effectively take part in addressing issues related to climate change impacts and resilience of communities through a well-coordinated mechanism in accordance with the components and indicators highlighted in this paper. This study was limited to PLB, based on components and indicators of resilience, similar studies need to be conducted in other river-basins of the province to highlight community resilience to climate change impacts.

### **Declaration of competing interest**

The authors have no conflict of interest or known competing financial interests.

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