Analyzing Resilience and Food Insecurity of Drought Prone Communities of Tharparkar Desert, Pakistan

LAILA Shahzad (lailashahzad@gcu.edu.pk)  
Government College University, Lahore  
https://orcid.org/0000-0001-8629-7586

ASMA YASIN  
Government College University Lahore

ammar liaqat  
Government College University Lahore

ASMA mansoor  
Government College University Lahore

faiza sharif  
Government College University Lahore

umair raiz  
Soil and Water Research Institute

Research Article

Keywords: Resilience, drought, adaptive capacity, climate change, Pakistan

DOI: https://doi.org/10.21203/rs.3.rs-472894/v1

License: ©  This work is licensed under a Creative Commons Attribution 4.0 International License.  Read Full License
Abstract

The resilience of the rural household to food insecurity has been assessed in two districts of Tharparkar desert, Sindh-Pakistan. The main aim of the study was to assess the prospects of the local community to cope with droughts. Drought has been the most threatening risk for the study area due to its severe effects on the food, income, health, adaptability of the people, and survival of livestock. The resilience of locals to the serious dry conditions was estimated by using a Resilience Index. The household resilience index from ten latent variables: income and food access, agricultural assets, non-agricultural asset, access to basic services, social safety nets, sensitivity, adaptive capacity, climate change, agricultural practices and technology and enabling institutional environment were calculated. Principal Component Analysis (PCA) was conducted for checking the appropriateness of data as a whole and along with ten components of resilience index. Data samples were measured by the KMO Test of Sampling Adequacy (0.512) which indicates that the components used for PCA were relevant as the standard value was greater than equal to 0.5. The results state that overall Tharparkar region was vulnerable due to having more livelihood from natural resource dependency. The availability of the water resources by any community aided their survival even in the worst conditions. Nagarparkar being close to the openly accessible water was comparatively more resilient then Islamkot which had no water in close proximity. Evitable attention is needed by the policy makers to tackle food insecurity of local community.

Introduction

Drought is a complex and slowly invading natural hazard with significant and pervasive socio-economic and environmental influences, is identified to cause more deaths and displace more people than any other natural disaster (Khiari and Jauffret, 2019). Among the dryland ecosystems, desert almost covers 35% of the world and is often defined by lower rainfall, higher temperatures, lower humidity, and shortage vegetation cover. It is reported that 16% of the world's deserts are semi-arid, 15% arid, and 4% hyper-arid (Nanzad et al., 2019; Sun et al., 2018; Tchakerian, 2015). Drought conditions in desert areas turn out to be the main culprit to worsen food insecurity in these regions. The sensitivity of dryland desert to drought is difficult to measure because of problems related to drought quantification, the variable response of vegetation types and changing climate-vegetation dynamics (Jha et al., 2019; Wei et al., 2019). Droughts as an outcome of climate change causes food insecurity not only at global scale, where it effects the production of traded grains, but also at local scale by effecting local yields. One in every eight people are affected by food insecurity worldwide and two-third of them are the locals of Sub-Saharan Africa, India and China (FAO, 2013). There are numerous factors which cause food insecurity and adversely affect the production and supply of food, and its prices. Increasing pressure for food, climate change, availability of natural resources, production of biofuel, and lack of research and development in the agriculture sector are the main seeds of global food insecurity (Fyles and Madramootoo, 2016).

Although, drought can become more drastic in the semi-arid countries like Pakistan where the agriculture sector contributes around 20% to the GDP and absorbs nearly 42.3% of the country’s labor force (Chandio et al., 2019). Livestock, a sub-sector of Pakistan's agriculture approximately accounts for 56% of value addition in agriculture and nearly 11% to the gross domestic product (GDP) (Imran et al., 2020). Almost 68% of the entire population makes their living from the agriculture sector. The livestock sector contributes about 28% while the crop sector gives 24% to the rural household (National Food Security Policy, 2017; Kafle, 2017). Recent studies conducted by Pakistan Meteorology Department (PMD) at National Drought Monitoring Centre (NMDC) claimed that Pakistan had experienced a large spell of severe droughts which have often led to famine and greater disruption of socio-economic well-being in history mostly confined to Sindh and Baluchistan provinces (Ashraf and Routray, 2015; Din, 2018). Consistently, Pakistan's agriculture sector is facing a severe crisis, as the growth is decreased by 3.3% over the last decade. To feed a population in millions, Pakistan requires to harness the food and agriculture system efficiently and mold it to achieve sustainable agricultural development. Over half of a decade, most affected Sindh province has witnessed severe drought in desert areas of Tharparkar, Umerkot, Thatta, Dadu, Sanghar and Kambar Shahdadkot which have been declared as calamity-affected. The area encompasses approximately 315 villages, but estimates of the affected population are not yet available (OCHA, 2018). Ongoing drought
conditions in Sindh is rapidly developing into one of the worst disasters in Pakistan leading to higher child mortality in the region (IFRC, 2019).

Pakistan's adaptive capacity have been considerably reduced as the country's vulnerability to climate change is increasing. Climate-related stresses has kept the country under-pressure. (Robert B. Zoellick, 2009). Drought events in parts of Baluchistan and interior Sindh along with the rising temperature have often lead to famine and greater disruption of socio-economic well-being. Abnormal rainfall patterns are affecting the ecology, enhancing social disparities among communities. For instance, Keti Bunder, a coastal area in Pakistan have faced frequent and severe tropical storms in the recent years due to erratic rainfall pattern (Salman, 2014); on other side KPK and Punjab provinces had severe floods (Shahzad et al, 2019a; Shahzad et al, 2021).

Keeping in view the current status, local communities in affected areas are in dire need to build up resilience to livelihood based on agriculture along with the risks associated with climate change. Resilience as described by United Nations Office for Disaster Risk Reduction is the ability of a system or a community to absorb a shock, accommodate and recover from the effects of a hazard (UNISDR, 2009). Owning to basic definition, Resilience is a multifaceted term but in context of climate based resilience, local communities are influenced by three important dimensions as explained in figure-1. Psychological capacities of individuals or a person can determine its level of coping a disaster, whereas social dimensions are from the society ones live in and economic dimensions involves diversification and financial choices (Khatibi et al., 2019). Effective implementation of the risk reduction plan is essentially an important factor for saving lives and livelihoods of numerous people across Pakistan who are vulnerable. Therefore, better preparedness is an extremely crucial step. (Usamah, 2017).

The study was conducted with the aim to identify the key factors of resilience in drought prone communities’ of Tharparkar Desert, Sindh Pakistan. The study tries to analyze the variation in resilience of two communities; Nagarparkar and Islamkot of Tharparkar desert under various natural resources and socio-economic conditions. It also identified the adaptations of local communities towards managing droughts in extreme environmental condition.

**Methodology**

**Study Area**

The study area, Tharparkar is symptomatic of its land conditions i.e., Thar and Parkar. Thar implies *desert* and Parkar implies *rough and sloping*. The Thar Desert of Sindh Province is extended to Rajasthan India in west and other side reaches up to Cholistan Desert of Punjab, Pakistan (Rustogi and Amir, 2018). Ninety five percent of the entire population of Tharparkar relies on development and dairy cattle while remaining five percent are in employment through private companies like shop keeping and assembling handcrafted floor coverings. An enormous territory of this area is desert. There is just a single harvest which additionally relies upon rain (NDMA, 2009). Human Development Index of Tharparkar communities was designated as low (Jamal and Khan 2007). A sixty years long analysis states, different intensities of droughts have been experienced by our country. Thar is designated to be the only desert in world where the livelihood is from agriculture and livestock rearing. Therefore rain is crucial for household food security (Rustogi and Amir, 2018). While due to lesser then average rainfall and expected water shortage, major setbacks could be observed. According to an assessment by the UN in the beginning of 2014, 67 adults and 99 children died in Thar because of chronic malnutrition and other drought related waterborne diseases. The number of deaths of children under the age of five was recorded at 326, 398, and 476 in 2014, 2015, and 2016 respectively (Shaw, 2015). In 2016 the district of Thar faced 100 per cent water scarcity as it faced drought for the fourth consecutive year. There was also a drastic reduction in crop harvest of up to 53 per cent, while livestock had reduced to 48 per cent; this background of the study area provided a rational to assess what are the current piracies of local communities to cope with future disasters (Kohli, 2014).
Islamkot and Nagarparkar regions of the Tharparkar desert in Sindh were selected as the prime locations to conduct a household based research. The selection of the site was based upon the geographical location, availability of food during droughts, resources available at crucial times of the year, drought frequencies, livelihood of the community, food security, and coping strategies of locals. The map of the study area is shown as figure 2.

**Study design and data collection**

A sample size of hundred households in Islamkot and Nagarparkar of Tharparkar were approached randomly to gather the data. Questionnaire based survey was conducted in the selected sites. The designed questionnaire was used to get the data via all possible means available, including individual interviews, door-to-door data collection method and focused group discussions. Most of the respondents were farmers and shepherds. The questionnaire derived the data on the basic information of respondents regarding their demography, income, impacts of the droughts, livestock rearing, agricultural practices, food storage and the strategies they use to combat the menace of drought related problems.

After gathering all the field data, RIMA II (Resilience Index Measurement and Analysis) Model was used which has a functional equation as follow:

\[
R_i = f (IFA, AA, ABS_i, SSN_i, SI, AC, CC, APT_i, EIE_i)
\]

Whereas, \( R \) = resilience; \( IFA \) = income and food access; \( AA \) = agricultural assets; \( NAA \) = non-agricultural assets; \( ABS \) = access to basic services; \( SSN \) = social safety nets; \( S \) = sensitivity; \( AC \) = adaptive capacity. \( CC \) = climate change; \( APT \) = agricultural practice and technology; and \( EIE \) = enabling institutional environment.

**Study tool**

The type of questions which filled this section included the number and type of animals they owned, the storage of food in the worst drought times, their adaptability and terms to improve their conditions through education and advanced technology. Moreover, production from animals and farms during drought conditions was asked so that the scenario could be built. Frequency of drought in the study area shows their adaptive capacity as they could plan more greatly before any risk appear to happens.

The description of each of these latent variables of the equation 1 are given in Table 1.

**Table 1 Resilience dimensions and the Components used**
| Capacity Dimensions | Resilience Dimensions | Description                                                                                                                                                                                                 | Components                                                                 | Effect |
|---------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------|
| Income and Food Access (IFA) | Resilience Dimensions | These includes various aspects of livelihood of an area/region which basically indicates the capacity of a household to earn its living and sustain. Mostly, caloric intake, Total expenditure on food and average income are the major indicators. | Income, Food availability, Crops grown                                     | + ve   |
| Agricultural Assets (AA) |                     | For an agricultural region, agrarian assets are the important sources of revenue. Assets make a way for the household to be independent. It employs livestock, Pasteur land present and other durables. | Agricultural land owned, Livestock owned, Kinds of livestock               | + ve   |
| Agricultural Assets (AA) |                     | For an agricultural region, agrarian assets are the important sources of revenue. Assets make a way for the household to be independent. It employs livestock, Pasteur land present and other durables. | Agricultural land owned, Livestock owned, Kinds of livestock               | + ve   |
| Non-agricultural Assets (NAA) |                     | The assets owned by the people aside from agricultural products also make up the livelihood of a household. From rural as well as urban aspect, owning something tradable and other assets to employ is sufficiently involved in this definition. | Livestock productivity, House ownership, Education level               | + ve   |
| Access to Basic Services (ABS) |                     | A household's capacity to depend upon the effective infrastructural settings fully explains the concept of having admittance to the basic services. Indicators include healthcare facilities, educational institutions, daily household gears such as markets, hospitals, toilet, electricity, water etc. | Presence of washrooms in every house, Sources of information, Water availability, Schools | + ve   |
| Social Safety Nets (SSN) |                     | In order to mitigate any shock or crisis faced by the community, social safety nets are the most critical part. This involves help from agencies either local or international, furthermore the assistance from different organizations working in the region, or support from relatives or friends are also helpful in this aspect. | Help from NGOs/government, Cope up with droughts                          | + ve   |
| Climate Change (CC) |                     | The abrupt change in the climate is least helpful in building up the household capacity to make their living. The major indicators are: the soil type of the region, the degradation of land area etc. | Complexities of drought, Land degradation due to drought conditions, Plants diseases, Economic loss | - ve   |
| Agricultural Practices and Technology (APT) |                     | Advancing technological use in the field of farming in entrapped in this dimension. Various adopted practices for the storage of food, use of pesticides, fertilizers etc. | Practices involved to store food, Water usage during stress conditions, Milk production | + ve   |
Enabling Institutional Environment (EIE)

For the household to retain in the area and become resilient, the strong support from central as well as local authorities plays their vital role.

- Quality of water deterioration
- Land affected from the drought condition

Physical Dimensions

**Sensitivity (S)**

Sensitivity effectively defines the extent to which a community or a household is affected by the natural hazard in the recent times or previously. It includes Total occurrences of any event calculated, the fatalities it’s causing due to the frequency of incidences. This concept also incorporates a household’s enhancing compassion and its capability to react to and cope with the shock faced.

- Drought frequency
- Livestock mortality

**Adaptive Capacity (AC)**

It includes the ability of a community/household to resist the effects of any shock and to bounce back to the original condition or adapt to the available new situation. The concept revolves around the principle of adaptability.

- What measures are adopted to cope with such conditions?
- Other sources of income (livestock, migration for search of alternative job, or selling of livestock)

The table 1 shows the various dimensions and components of resilience sorted inconsideration of the dimensions of the resilience index given. If the income and food access or resource availability are more of an area then their adaptive capacity to resist any change would be more as compared to the area having a lesser capability to fight with the drought and its effects therefore it has a positive effect on community resilience. Having greater assets (whether agricultural of non-agricultural) enhances the ability of any community to combat the risk or emergency situations. Having a positive effect means having direct proportionality of variables to the community resilience. In the prevailing drought conditions or during disastrous dry situations, foreign or local support functions as pillars aiding the community to repel or withstand such circumstances. However, abruptly changing climatic conditions can badly affect the crop reducing its production that were to be stored for later use. Moreover, unalarmed flooding and droughts could impact the living states of people over there. Thus, having a negative impact on the resilience of community. Modernize agricultural practices and advanced technology ensures good and excess of crop production, creating a positive impact on the community resilience. Sensitivity has been a serious negative impact on the household as well as community resilience of an area. The more a community or household is prone to a natural hazard less likely it is to resist the harmful effects of that risk. The greater the sensitivity of a community towards the risk factors the lesser it would have such capability to adapt. Thus, adaptive capacity of the area largely depends upon the people's attitude to acclimatize themselves with such natural calamities.

Data Analysis

A combination of primary and secondary sources of data was utilized in our research. Primary data was collected from the rural households of the selected site, focused groups and certain key informants. However, the secondary sources of data were various journals, NGO reports working in the specific area etc. Purely quantitative nature of data was gathered.

Prior to the data analysis, the gathered info was prepared. The dataset was checkered for any misplaced/omitted data or outliers. The data obtained from the survey questionnaires are analyzed on various aspects by using SPSS 24. Later on, in order to calculate the resilience of the area “Factor Analysis” was performed majorly. However, several other descriptive analysis were performed in order to obtain the substandard values of chi-square of each indicator, mean and standard deviation values of all the variables exclusively for both the regions. The extracted values were then computed in the RIMA
equation to measure resilience of Tharparkar as a whole and a comparison of the adaptive capacities of each selected area marked by their output resilience capabilities to withstand disastrous drought conditions.

**Results And Discussions**

A total of 100 households were interviewed in both the districts of Tharparkar. The basic information was collected which included questions regarding their age, literacy level, availability of the basic services, income per annum, sources of income etc. The second phase of the questionnaire was narrowed down specifically for extracting the variables on which their resilience was based. The indicators/components of the index used was formulated in light of the income earned by each household, access to food and basic services, assets (either agricultural or non-agricultural), adaptive capacity of the community to bounce back from the shock, sensitivity of each household which collectively becomes the sensitive factor of the household based community, social safety nets, climate change and different practices with or without the use of modern technology are involved.

**Calculating Resilience Index**

For each dimensions, there were associated components, which are explained in column 1 and 3 respectively. Resilience for Nagarparkar and Islamkot were estimated by converting the values into means and standard deviation as shown in Table 2. Adding into equation 1, the resilience index for both sites were calculated. The outcomes made it clear that the presence of openly-accessible water resource close to Nagarparkar makes it more resilient then Islamkot district. Other factors (income, food access, basic services, adaptive capacity, and technology) also played their part indeed.

**Table 2 Comparative Analysis of the Study Site**

| Factors/Dimensions                  | Islamkot     | Nagarparkar |
|-------------------------------------|--------------|-------------|
|                                     | Mean         | Standard Deviation | Mean | Standard Deviation |
| Income and Food Access (IFA)        | 2.22         | 0.6276      | 1.82 | 0.5583 |
| Agricultural Assets (AA)            | 2.03         | 0.5571      | 2.41 | 0.5020 |
| Non-agricultural Assets (NAA)       | 1.35         | 0.4130      | 1.47 | 0.4071 |
| Access to Basic Services (ABS)      | 2.1          | 0.6451      | 2.59 | 0.4489 |
| Social Safety Nets (SSN)            | 2.16         | 1.1690      | 3.38 | 0.9452 |
| Sensitivity(S)                      | 3.04         | 0.5807      | 3.59 | 0.3258 |
| Adaptive Capacity(AC)               | 1.73         | 0.7478      | 1.66 | 0.6403 |
| Climate Change(CC)                  | 2.29         | 0.5158      | 2.00 | 0.9047 |
| Agricultural Practices and Technology(APT) | 1.72 | 0.4500      | 2.36 | 0.6418 |
| Enabling Institutional Environment(EIE) | 2.9 | 0.8894      | 2.97 | 0.6545 |
| Resilience of study sites \( R_i \) | 0.0009       | 0.0038      |

Explaining each component of resilience as below:

**Income and Food Access (IFA)**

The resilience value calculated from equation 1 is 0.8022 for IFA individually. Income is basically the most important indicator when it comes to measuring resilience of any community or a particular household. Both the study areas, Islamkot
and Nagarparkar have certain differences in the average annual income of the people over there. When taken an overall view of the data, it turned out that majority of the households have an income range of about 5000-10,000 making a total of 43% while only 15% people have income ranging above 20,000. The average annual income of the study site, Tharparkar, was defined. Discrete analysis of each study site shows a huge gap between them, clearly stating Nagarparkar a step higher in terms of income then Islamkot. The access to food during drought conditions was seriously impacted, about 41% of the total households in Tharparkar claimed that they didn't get enough 3 course meal during drought conditions. Furthermore, the storage capacity was for just one month as claimed by 67% of the questioners, which becomes the prime concern when considering any catastrophic event. A lot of crops were grown in normal conditions, but during dry conditions the major crops which are impacted are “Millet and Gawarah”

**Agricultural Assets (AA)/ Non-Agricultural Assets (NAA)**

The R value of AA/NAA was calculated to be 0.4429/ 0.9243 respectively. How much a region is resilient to any shock can also be predicted by the presence of agricultural and non-agricultural assets they possess. About 60% of the people had the profession of farming, 30% livestock, 2% handicraft and 8% had other professions. About 97% people had their own houses while remaining 3% didn't have their own. About 59% of the families had only one bread earner, while remaining 22 and 19 percent had 2 and 3 bread earners respectively. When asked about kinds of livestock owned, 35% responded that they had sheep, 24% responded with cows/buffaloes and 41% opted other. About number of livestock owned, majority have more than 5 livestock. Having an agriculture land of their own could help them suffice after being hurt from certain shock factor. Both the sites have similar conditions, but Nagarparkar having the freely available water reserve had a better chance in such aspect. Non-agricultural aspects include the level of education which could be helpful in developing a stable earning or in terms of migration. Most of the people of both districts had qualification up to primary level which was about 66% of the people. 19% of the population never went to the school, 12% had secondary and 3% had higher qualification.

**Access to Basic Services (ABS)**

R value of ABS estimated individually was 0.6976. For any community to be resilient against any shock or risk factor, the residents must have quality resources and access to basic services including access to water for drinking and irrigation, enough food to sustain themselves as well as their livestock, availability of daily news, access to reliable education, markets, hospitals, and washroom facility at least in each house. However, the research showed us the different face of it. About 45% of the respondents informed that there are two schools in the area while 38% of them responded that there is only one school in the area. About 24% of the respondents informed that they get updated about drought from radio, 23% of them from newspaper and majority of them from other sources. When asked about the washroom availability, the answer was same for both the areas that no household own a separate washroom. The level of education delivered can be seen by the number of schools present in a locality.

**Social Safety Nets (SSN)**

R value of SSN estimated individually was 1.2214. In dry conditions, several complexities are faced by the locals and need immediate support from the government or the local, national or international foundations working over there to aid the people living over there to fight and combat the menace of drought. But the social safety nets for the protection of people from such risks seems extremely weak. The locals responded about the complexities faced by them as 65% people responded that they face water shortage and 29% of them face food shortage and 6% face lack of facilities. When asked about government or NGO help, respondents had different opinions. Some responded that they help very less, some said they provide wheat and some informed that they don't help at all. So the condition in such dry areas was not even closed to satisfaction.

**Sensitivity (S) towards drought and other natural hazards**
R value of S estimated individually was 0.8374. Dry areas are usually very much prone to the risks of repeated drought situations. The locals about, 50% of the population, told that drought occur three times in five years in Tharpakar, 31% people believed that drought occur more than four times in five years and remaining 17 and 2 percent said that drought occur once in a year and one time in two years respectively. These conditions have a serious negative impact on the livestock over there. The livestock mortality rate was 'Very high', around 80% of the population responded. This is the straight-forward effect of the rapidly changing climate over there.

**Adaptive Capacity (AC) of local community**

R value of AC estimated individually was 0.8779. The adaptive capacity of an area actually measures the resilience of the community or the household. About 36% of the respondents informed that they migrate to find jobs in order to cope with the drought conditions and 34% of them sell livestock. When they were asked about migration during drought, about 38% responded that they don't migrate, 37% migrate sometimes, 22% migrate very frequently and 3% of the people migrate less frequently. In both the districts, migration has been evidently enhanced during such conditions. The adaptability of Nagarparkar is comparatively more than Islamkot making it more resilient.

**Climate Change (CC)**

R value of CC estimated individually was 0.6829. Abrupt change in the climate could possibly have the negative impact on the productivity of crops, other soil and water conditions of the area. When asked about the productivity during drought conditions, majority of the respondents informed that up to six months the productivity of crops was decreased drastically. Due to this dramatic reduction in the crop production the loss of economy at that period was high; 63% respondents informed that they face economic loss in lacs, 28% responded in thousands and 9% went with more than lac option. Climate change also have serious diseases in plants. Almost 78% majority of the farmers told that plants die, wither and become unproductive mostly in this condition and 19% claimed that it happens sometimes with their crops and not every single time. The conditions calculated were similar in both the districts.

**Agricultural Practices and Technology (APT)**

R value of APT estimated individually was 0.6535. Traditional methods for the cultivation are still used in our study sites. Newer technologies are not yet introduced due to lack of resources. Lack of technologies could be a barrier as food cannot be preserved for longer plus the milk production is also lesser in dry conditions in desert areas. When asked about reduced milk production, majority of the people responded with 'Very less'. About livestock mortality rate, 80% responded with 'Very high'. About livestock mortality rate, 80% responded with 'Very high' option.

**Enabling Institutional Environment (EIE)**

R value of EIE estimated individually was 0.7853. About drought resilient farms, opinions were different from respondents. Majority i.e, 70% of the respondents said that ‘Nothing’ is done. When asked about water conservation techniques, 98% of the respondents said ‘No’ such technique is used and 2% responded with ‘No resource available’. So this also became a hurdle in finding resilience in areas such as Islamkot and Nagarparkar. Figure 3 shows the comparative means and resilience by using a radar chart.

**Resilience Index Valuation**

At certain point, household resilience can only be assumed depending upon the options accessible which makes the household enable to function and suffice using the income it generates through activities. The estimation of resilience index is accomplished using a two stage factor analysis. In the very first step, each component is estimated individually utilizing the principal factor technique of the variables that were selected previously. While in the later stage, resilience index
is calculated using factor analysis while taking into account the components that were effectively interacting with each other in the first stage. The index used is the weighted sum of the factors that were created by using Bartlett’s (1937) scoring method. Variance of each was fully explained by each factor.

Table 3 Component Correlation Matrix and Factor Loading Values

| Component | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    |
|-----------|------|------|------|------|------|------|------|------|------|
| IFA       | 1.000| -.016| -.095| -.201| .145 | -.121| .056 | .051 | .266 |
| AA        | -.016| 1.000| .032 | .126 | .043 | .093 | .074 | -.106| .003 |
| NAA       | -.095| .032 | 1.000| .027 | -.002| .054 | -.228| -.107| -.031|
| ABS       | -.201| .126 | .027 | 1.000| .033 | .096 | .078 | .043 | -.070|
| SSN       | .145 | .043 | -.002| .033 | 1.000| .004 | .063 | -.067| .027 |
| S         | -.121| .093 | .054 | .096 | .004 | 1.000| .059 | -.109| -.099|
| AC        | .056 | .074 | -.228| .078 | .063 | .059 | 1.000| .069 | .025 |
| CC        | .051 | -.106| -.107| .043 | -.067| -.109| .069 | 1.000| .033 |
| APT       | .266 | .003 | -.031| -.070| .027 | -.099| .025 | .033 | 1.000|

It is known through policy implications that greater the value of factor loading more important it is, in addition it demands greater attention. More a factor is correlated to the variable, greater it owns its percentage in estimation of a community resilience. The factor loadings and correlation coefficients of all the variables is different as expected. The negative values shows lesser of a correlation with the variables. However, AC has almost all the factors positively correlated, indicating that it hold prime importance in the measurement of resilience of a community. Although, all of the factors are important but negative correlation shows less importance in terms of resilience index identifications. The highlighted values in the Table 3 shows “factor loading” extracted from factor analysis. The factor loadings express the relationship between the variables and the factor underlying. Every component have its distinct value.

The final computation of the level of household resilience by utilizing the resilience index was done through Principal Component Analysis (PCA) using the previously mentioned ten indicators of resilience. According to Kaiser’s rule, if the eigenvalues of any components obtained from the results of PCA are greater than 1, then they are retained. The appropriateness of data sampling as measured by the KMO Test of Sampling Adequacy was 0.512 which indicates that the variables or components used for PCA were relevant as the standard value should be greater than equal to 0.5. Furthermore, the Bartlett’s Test of Sphericity which shows that the original correlation matrix that was find out is in fact the identity matrix in which all the coefficients of the R-matrix would be zero (Field, 2005). Scree plot was formulated to graphically represent if all the components are related to each other. Usually values of significance level smaller than 0.5 are generally categorized as insignificant and recommended as an identity matrix. Our results indicates that the tests conducted are significant as p=0.000 and Chi-square= 1049.566. The results suggests that the PCA conducted was fitting appropriately with the data used in the study (Table 4).

Table 4 Principal Component Factor lodging and Eigenvalue of the Correlation Matrix
This study of drought induced food insecurity and people responses to drought in Tharparkar corroborates many literatures, such as from South-western Uganda (Twongyirwe et al., 2019), Bangladesh (Ahmed et al., 2018), South Africa (Bahta et al., 2016) and Nigeria (Hassan et al., 2019). FAO’s (Food and Agricultural Organization) Resilience Index Measurement and Analysis (RIMA) has been utilized for the sake of measuring resilience of drought-prone district, Tharparkar. The results suggest that Tharparkar to fall in the category of moderately resilient basically depending upon the access to food, water, and other basic services. The calculated resilience of both the study sites (Islamkot and Nagarparkar) indicates one to be more resilient than the other. The reserve of water plays an advantageous role for the households situated in Nagarparkar. It allows them to bounce back at a greater degree than that of Islamkot district which is lacking such prestige. The lower level of average income per household in Islamkot explains their lower level of adaptive capacity, and hence their vulnerability to catastrophic events. Thus comparatively greater recovery time is required by Islamkot to fall back to its original state after fighting the menace of drought then that of Nagarparkar.

Extreme drought events may influence the Sindh region’s resilience, vulnerability, and exposure (Veettil et al., 2018; Guo et al., 2018). Though, community resilience is a concept that incorporates various factors; it can be described as “the ability of groups, such as communities and cities, to withstand hazards or to recover from such disruptions as natural disasters”. It is anticipated that Pakistan will have severe drought-like conditions that emerged with an expectation for further deterioration.
over the next 4 years due to El Nino events and a reduction in the rainy days (UNCT, 2019). Risks associated with droughts are less visible as compared to those of floods and tropical cyclones; therefore, it remained less understood. There are several drivers of droughts including rural vulnerability, poverty, and an increase in the water demand majorly for enhancing agribusiness, industrialization, urbanization and climate variability. Such drivers interpret drought hazards into extreme risk for the people (Global Assessment Report on Disaster Risk Reduction, 2011). A comprehensive assessment of resilience to the drought hazard in several communities and identifying the main factors that affect resilience are crucial to coping with the hazard and promoting resilience for future land use and adaptation.

The significant value (Table 4) very well documents the hypothesis that the household which holds more amount of assets are indeed at higher level of resilience as the owned resources buffer shocks (Aboubakr et al., 2016). Compared to coping strategies and dealing with the complexities of drought by Tharparkar, there was an extreme decline in the Tunisian livestock densities which was accounted for the changes that were introduced in the traditional agricultural practices and animal breeds which were more resource demanding. Still, this does not fully explain their rapid livestock decrease. Tunisian farmers, on the other hand, considered disturbances in press and pulse to be the sole reason for the lowering livestock numbers. The most important and effective strategy referred as a “coping mechanism” during drought periods is selling of livestock forming the main income source during that time. A reduced adaptive potential and lowered shock resistance is basically a reflectance of incompetence of farmers to refill the stocks after being hit by a catastrophe (Twongyirwe et al., 2019).

Despite our study, the disaster resilience of urban regions of Tehran was compared with its rural districts. The results were mapped clearly highlighting the regions as they fall among the three levels of resilience (high, medium, low). Among 22 states of Tehran, about 5-7 regions were categorized as least resilient while 3 urban districts were highly resilient. All the remaining were considered as moderately resilient. According to the study, urban areas are more resilient then the rural regions with clear demarcation of better services and other parameters with might be lacking on the other extreme (Twongyirwe et al., 2019; Shahzad et al., 2019b).

Measuring resilience via resilience index analysis is crucially important in its own aspect. Analysis to find vulnerability of a community or a household is not an alternative to resilience. They both complement each other. Susceptibility of people as they are wide-open for any shock or hazard and damage created by those incidents is greatly shown by the vulnerability analysis. But it accompanies certain limitations: as it has its major focus on a single target variable and is only effective for cross-sectional type of surveys. This over-simplified format of analysis is then enhanced by involving all the factors which may be short term or long term with a systematic approach (Bakkensen et al., 2016).

**Conclusion**

Drought is the main problem in the desert areas which affects the productivity of crops due to water shortage that also has indirect effect to the livelihood of farmers and livestock. Although meteorological information from ground stations has good accuracy and is popular worldwide for drought forecasting, however Pakistan needs to establish such meteorological stations to provide better picture and therefore planning at farmers level. Although the shocks and threats faced by the area were huge but the increasing adaptive capacity and enhancing knowledge about the advanced technologies and food storage helped them to become resilient. Water availability functions as a key factor in aiding a community to become resilient as depicted by our results. Nagarparkar having readily useable water resource is comparatively more resilient then Islamkot. Thus, income, food access, water and presence of other basic services are the major components helping a household to be lesser prone to any hazard. The dependency on agriculture and water resources were the factors which aided in various aspects to the households of Tharparkar as a whole. Storing food for a longer time in case of prevailing drought was the most accommodating factor in gaining resistance for any upcoming disastrous situations. For the mitigation of drought, there is dire need to adapt to the climatic changes. There is necessity to aware the local community about the drought management techniques therefore they can face and mitigate it more systematically. The government
should come forward to help farmers by providing them with drought resilient farms and seeds. Water problem can only be sorted out by building wells so that the precious water can be saved well before drought season.

Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Availability of data and materials: All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Competing interests: The authors declare that they have no competing interests

Funding: Not applicable

Authors’ contributions

Asma Yasin and Ammar Liaqat: conducted the field visits, and written initial manuscript

Laila Shahzad conceived the original idea and improved manuscript

Faiza Sharif statistical analysis

Asma Mansoor did the language and grammatical edits/ proofread manuscript

Umair Riaz provided technical help in field work

References

Abubakr, G.B., Diaw, A. & Wunscher T (2016). Factors affecting rural households’ resilience to food insecurity in Niger. Sustainability: 2-10

Ahmed B, Kelman I, Kamruzzaman M, et al (2018) Indigenous people’s response to drought in northwestern Bangladesh. Environmental Development: 2-12

Ashraf M and Routray J (2015) Spatio-temporal characteristics of precipitation and drought in Balochistan Province, Pakistan. Natural Hazards: Journal of the International Society for the Prevention and Mitigation of Natural Hazards, Springer 77: 229-254

Bahta YT, Jordaan AJ, and Muyambo F (2016) Communal farmers’ perception of drought in South Africa: Policy implications of drought risk reduction. JAMBA, Journal of disaster risk studies 9: 326-340

Bakkensen LA, Lent CF, Laura K et al, (2016), Validating Resilience and Vulnerability Indices in the Context of Natural Disasters. Society of Risk Analysis: 2-10

Chandio AA, Jiang Y, Gessesse AT et al, (2019) The Nexus of Agricultural Credit, Farm Size and Technical Efficiency in Sindh, Pakistan: A Stochastic Production Frontier Approach. Journal of Saudi Society of Agricultural Sciences 18: 348-354

DeCoster J, (1998) Overview of Factor Analysis. Retrieved on May 21st, 2019 from http://www.stat-help.com/notes.htm

Eskandari H, Borji M, khosravi H et al, (2016) Desertification of forest, range and desert in Tehran province, affected by climate change. Solid Earth, 7: 905-915
FAO (2013) UN Food and Agriculture Organization. Retrieved from: http://www.fao.org/statistics/en/

Fyles H and Madramootoo C (2016) Key drivers of food insecurity. In Emerging technologies for promoting food security: Overcoming the world food crisis (ed). Elsevier, pp 1-19

Global Assessment Report on Disaster Risk Reduction (2011) United Nations Office for Disaster Risk Reduction. Retrieved from PreventionWeb.net: https://www.preventionweb.net/english/hyogo/gar/2011/en/what/drought.html

Guo H, Bao A, Liu T et al, (2018) Spatial and temporal characteristics of droughts in Central Asia during 1966–2015. Science of the total environment 624: 1523-1538

Hassan AG, Fullenb MA, and Oloke D (2019) Problems of drought and its management in Yobe State, Nigeria. Weather and Climate Extremes: 2-8

IFRC (2019) International Food Research Conference, the Everly Putrajaya, Malaysia. Retrieved from: http://www.ifrc2019.com/

Ikram Ud din (2018) Impacts of climate change on agriculture sector: Evidence from Pakistan 2000-15. Journal of Economics Info: 1-4

Imran M, Shrestha RP, Datta A (2020) Comparing farmers’ perceptions of climate change with meteorological data in three irrigated cropping zones of Punjab, Pakistan. Environment, Development and Sustainability 22: 2121-2140

Jha S, Das J, Sharma A et al, (2019) Probabilistic evaluation of vegetation drought likelihood and its implications to resilience across India. Global and Planetary Change 176: 23-35

Khatibi S.A. Golkarian A. Mosaedi A. Qeidari SA. (2019): Assessment of Resilience to Drought of Rural Communities in Iran, Journal of Social Service Research, DOI: 10.1080/01488376.2018.1479342

Khalid Z (2015) Pakistan’s resilience continues to defy the odds. Retrieved from Pakistan Insider: http://insider.pk/national/pakistans-resilience-continues-to-defy-theodds/

Khiari H and Jauffret S (2019) Land Degradation Neutrality Transformative Projects and Programmes: Operational Guidance for Country Support. Bonn, Germany. Global Mechanism of UNCCD: pp 2-100

Kolhi C (2014) Drought and migration, a brief story of Tharparkar. The Daily Times. http://dailytimes.com.pk/105392/drought-and-migration-a-brief-story-of-tharparkar/. Accessed 30 Nov 2018

National Disaster Management Authority (2009) District disaster risk management plan. District Tharparkar, Pakistan. Accessed from: http://www.ndma.gov.pk

National Food Security Policy (2017) Government of Pakistan Ministry of National Food Security and Research Islamabad. Retrieved from: http://www.mnfsr.gov.pk/mnfsr/userfiles1/file/12%20Revised%20Food%20Security%20Policy%2002%20June%202017.pdf

Nanzad L, Zhang J, Tuvdendori B et al, (2019) NDVI anomaly for drought monitoring and its correlation with climate factors over Mongolia 2000-2016. Journal of arid environment 164: 69-77

OCHA (2019) UN Office for Coordination of Humanitarian Affairs annual report 2019. Retrieved from: http://www.unocha.org/publication/ocha-annual-report/ocha-annual-report-2018.
Rustogi P, Amir J.K. 2018. Integrated Water Resource Management Practices to Alleviate Poverty – A Model of Desert Development in Tharparkar. Pakistan Water Partnership (PWP)- GLOBAL water partnership.

Salman A (2014) Mainstreaming Community-Based Climate change adaptations in Pakistan. Climate Leadership for Effective Adaptation and Resilience. LEAD Pakistan

Sen Z (2015) Climate change drought and water resources. Applied drought modeling, prediction and mitigation: 321-391

Shahzad L, Tahir A, Sharif F, Hayyat MU, Ghani N, Farhan M, Dogar SS (2019a) Does livelihood vulnerability index justify the socioeconomic status of mountainous community? A case study of post-earthquake ecological adaptation of Balakot population. Appl Ecol Environ Res 17(3):6605–6624

Shahzad L, Tahir A, Sharif F, Khan WUD, Farooq MA, Abbas A, Saqib ZA (2019b) Vulnerability, wellbeing and livelihood adaptation under changing environmental conditions: a case from mountainous region of Pakistan. Environ Sci Pollut Res. https://doi.org/10.1007/s11356-019-05880-x

Shahzad L, Shah M, Shah M, Mansoor A, Sharif F, Tahir A, Hayyat MU, Farhan M, Ghafoor GZ. 2021. Livelihood vulnerability index: a pragmatic assessment of climatic changes in flood affected community of Jhok Reserve Forest, Punjab, Pakistan. Environmental Earth Sciences (2021) 80:252. https://doi.org/10.1007/s12665-021-09562-1

Shaw AR (2015) Disaster Resilience: Generic overview and Pakistan Context. Disaster Risk Reduction, Springer, Tokyo: 53-75

Sun L, Yang L, Chen L et al, (2018) Hydraulic redistribution and its contribution to water retention during short-term drought in the summer rainy season in a humid area. Journal of hydrology 566: 377-385

Tchakerian VP (2015) Hydrology, Floods and Droughts: Deserts and desertification. In Encyclopedia of atmospheric sciences (2nd Edition, Volume 3). Elsevier Ltd, pp 185-191

Twongyirwe R, Mtumukiza R, Barasa D et al.(2019) Perceived effects of drought on household food security in Southwestern Uganda: Coping responses and determinants. Weather and climate extremes: 1-11

UNCT (2019) Pakistan: Drought response plan- Pakistan (n.d.). Retrieved from: http://reliefweb.int/report/pakistan/Pakistan-drought-response-plan-jan-dec-2019

UNISDR (2009). United Nations Office for Disaster Risk Reduction Terminology on disaster risk reduction. Geneva: UNISDR.

Veettil AV, Konapala G, Mishra AK et al, (2018) Sensitivity of drought resilience, vulnerability exposure to hydrologic ratios in contiguous United States. Journal of Hydrology 564: 294-306

Wei W, Li H, Wang B et al, (2019) Rain-and water-use efficiencies of a shrub ecosystem and its resilience to drought in the Central Asia region during 2000–2014. Global ecology and conservation 17: 5-95

Zoellick RB (2009) World Bank Annual Report. The World Bank. Retrieved from: http://www.worldbank.org/world-bank-annual-report-2009/

**Figures**
Figure 1

Dimensions of Community Resilience
**Figure 2**

Map of Tharparkar District, Sindh, Pakistan. The marked points indicate the study sites.
Figure 3

Radar diagrams showing means and resilience of the study areas along with their comparison

Figure 4

Values of factor loading for community is shown as e1 to e10. (DeCoster, 1998)