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Sustainability of Subsistence Livelihoods of Agro-Pastoralists in Changing Socioeconomic Environment of Cholistan Desert-Pakistan

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Abstract

Subsistence livelihoods of agro-pastoralists are heavily dependent on vulnerable natural resources. These natural resources are exposed to a number of risks in the form of shocks, trends and seasonality. These risks are linked with environmental hazards. The Cholistan desert is divided into Greater and Lesser Cholistan. Based on 2016 population estimation, thirty settlements were selected with proportion of 30% and 70% from greater and lesser Cholistan, respectively. The socioeconomic changes and their impact on livelihood strategies were studied. Human practices (transhumance and nomadism), land uses, population & settlement growth and living standards are the key indicators of the socioeconomic changes. Modern technologies, policy and hazards brought transformations in the livelihoods patterns in the Cholistan desert. The sustainability of subsistence livelihoods of agro-pastoralists in Cholistan desert was analyzed through strength, weaknesses, opportunities and threats (SWOT) technique. In the lesser Cholistan, transformation in sustainability of livelihoods prevail in positive realm. However, in greater Cholistan which is the marginalized areas of Cholistan desert, this transformation both in socio-economic and physical set up are pushing the poor agro-pastoral communities towards vulnerability. The resilience of these subsistence livelihoods of agro-pastoralists can be enhanced through adaptation of innovative techniques and synchronization of land resettlement policy.

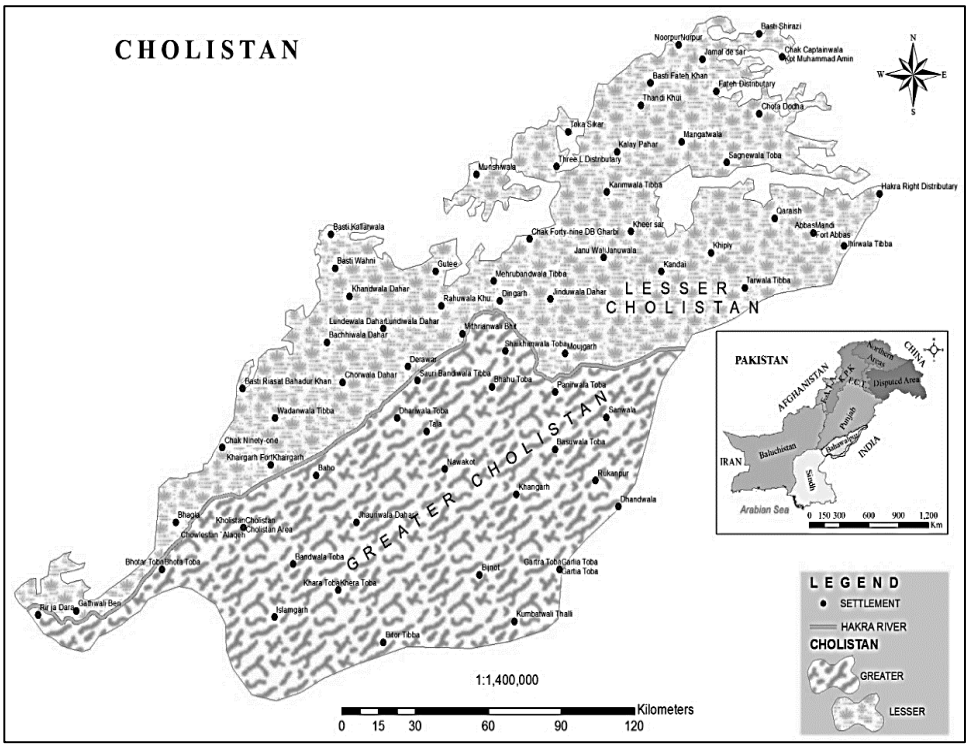
Keywords: productive and sustainable land management, sustainability, livelihoods, agro-pastoralists, Cholistan desert, SWOT analysis.

1. Introduction

Deserts cover more than one fifth of the Earth's land comprising almost 33.7 million square Kilometres are inhabited by over 1500 million people (National Geographic Society, 2014; Brown et al., 2008). The Cholistan Desert is located in southern Punjab Province, spreads over 26100 sq.km, presents a typical hot desert scenario and is one of the driest and hottest sandy deserts of Pakistan (Fig. 1) (Ahmad et al., 2012). Deserts are habitat of economically marginalized communities of the developing countries and having limited access to basic facilities including fresh water and face many environmental challenges (Alan & Macdonald, 2012; Manoli, et al., 2014). The inhabitants of Cholistan Desert are agro-pastoralists and livestock keeping and farming are their main economic activities (Ashraf, Chuadry, Farooq, & Mustafa, 2013). They are directly dependent on the available resources and exposed to many threats and challenges (Akbar et al., 1996; Middleton, 2009; Marie, 2006). With the passage of time, the innovation in technology; increasing frequency and intensity of natural hazards; population growth; and unprecedented changes in the traditional socioeconomic set up are seriously threatening the subsistence livelihoods (Akbar et al., 1996; Namgay et al., 2014).

This research is focused on three broad aspects of livelihoods i.e. structure of livelihoods; temporal changes in livelihoods; adaption and sustainability in livelihoods. The structure of livelihoods is studied through the interaction of man with the environment. The temporal changes in livelihoods is studied through the impacts of hazards; population growth; technology; modernization in agriculture; and policies on livelihoods. The analysis of strengths, weaknesses, threats and opportunities (SWOT) associated with livelihoods provide the basic answers of adaptation and sustainability. In Western Serengeti, the Kavana et al. (2017) studied the agro-pastoralism system with focusing the production and self-sufficiency of food of supported population (Kavana et al., 2017). The study of temporal changes and their climate change adaptation strategies of agro-pastoralists in northern China by Yu (2016) provide information of the diversification of livelihoods and use of modern technologies for storage and marketing ultimately affected the common property system (Yu, 2016). Climate and physiography are the basic components of the environment which has the major variables of temperature, precipitation, seasons, soil and water. For the studies of human interaction with the environment, the major variables of population distribution, human perception, and technologies is studied. The present status of these variables is fundamentally important for the study of man and environment interaction which is the base for livelihoods structure. The present human practices are the product of this interaction which is adapted in form of hamlet (*Toba*), villages, town, nomadic, common property management and transhumance. The associated livelihoods are animal husbandry (nomadic and commercial farming); agriculture (irrigated and rain-fed); wildlife; fuel wood; lumbering; herbs and shrubs for chemicals and medicine extraction; honey collection; and tourism etc. Drought, desertification, flash floods and epidemics have an adverse effect on these livelihoods. The Namgay et al., (2013 & 2014) studied the transhumant Agro-pastoralism in Bhutan with the major findings of highly stressed conditions of the associated livelihoods particularly of seasonal migration (Namgay et al., 2013; Namgay et al., 2014). With modified approach, the compound impacts of population growth, technology, farming, irrigation, machinery, commercial livestock and policies on

livelihoods is studied. The use of nearest neighborhood techniques provides collective information regarding population distribution, settlement size, pattern, growth and most importantly about transhumance pattern. The temporal data of these variables is collected from primary and secondary sources. In Cholistan Desert, with the passage of time, the people have adapted to the challenges through coping and creative adjustment strategies of livelihoods. SWOT analysis is the most common approach in ecological and climatic studies. Bull et al. (2016) and Demir et al. (2016) used SWOT techniques for the study of ecological framework and ecotourism. Similarly, Race (2016) studied the strengths and weaknesses of aboriginal communities living in central Australian desert with changing environmental, climatic and socioeconomic conditions (Race, 2016). In present study, the sustainability of these livelihoods is dependent on the mode of changes in these livelihoods which is studied through SWOT analysis with new technique of response normalization and combining the impacts of each component into singular modality.



Source: Field Data, 2015

Figure 1: Location Map of the Study Area

2. Literature Review and Conceptual Framework

Cholistan Desert is located between 27°42′00′′ to 29° 45′00′′ north latitude and 69°57′ 30″ to 72° 52′ 30″ east longitude. Geomorphologically, the Cholistan Desert has been divided into two natural regions named the Greater Cholistan and the Lesser Cholistan (United Nations Combat to Desertification [UNCD], 2011; Akbar et al., 1996). Geologically, Cholistan Desert past is linked with the earlier times of the Cambrian age and the Miocene age (Pithawala, 1978). Hakra River flowed through Cholistan region,

during 4th millennium B.C when it was very fertile, productive and well colonized, performing a central task in the Indus Valley Civilization. The remnant of Hakra River is the virtual boundary line between Greater and Lesser Cholistan. Mughal (1982) revealed that the Cholistan Desert has given a sample size of 414 sites 264 of that sites are related to Early, Mature and Late Harappan age of Indus Civilization, 99 sites are Hakra age 14 sites are directly related to Painted Grey wares of the first millennium B.C. These old sites are not only of archaeological importance but also for the study present settlement and transhumance pattern. Hakra River dried up around the beginning of first millennium B.C. Presently this area consists of broad open and levelled mud flats, to some extent enclosed with drift sand that has approached 20 to 90 Kms east ward from the actual boundaries of the Thar Desert (Mughal, 1982; Mumtaz, 1982).

The climate of Cholistan Desert is arid characterized by low sporadic rainfall, high summer temperature low relative humidity, high evaporation losses and strong summer winds. Bulk of the rainfall is received during monsoon (between July and September) but some rain also falls in winter spring (January to March). The annual rainfall varies between 100-200 mm (Akbar et al., 1996; Arshad & Rao, 1995). Soil of the Cholistan desert can be rated as poor, because it contains negligible amounts of organic matter. The Lesser Cholistan is characterized by large saline compacted areas with alluvial clay (Reddy et al., 1997; Arshad et al., 2008). The Greater Cholistan is comprised by large wind-shifting sandy dunes and ridges, interspaced with greatly reduced interdunal plains. Desertification in the Cholistan desert is due to wind erosion. Sand shifting is perennial and particularly intense during the monsoon season (Government of Pakistan [GOP], 2010). A wide range of nutritious and drought tolerant species of grasses, shrubs and trees occupy the entire territory. The Natural flora of Cholistan Desert is composed of 131 plant species of 89 genera and 24 families. Some of these species are of high economic value which support the subsistence economy of this desert region (Arshad et al., 2008; Hameed, et al., 2011; Ahmad et al., 2012). The animal species of Nilgai, Black Buck, Garacal Cat, Desert Fox and Sand Grouse are rarely found in the area (Baig, 1980; Akbar et al., 1996). Main source of drinking water for human and livestock is rainfall. Rainwater is collected in natural depression (*Toba*s) or manmade ponds (*Kunds*) from customized or treated vicinity. Most of the Cholistani people have adapted nomadic and agro-pastoral production system. The people involved in nomadic production system are generally landless and their entire activities are centred on rearing of livestock. Rangelands of the area serve principal source of animal feed, and the water requirements of livestock are meet either from *Toba*s or wells. They live semi-permanent houses locally called "*Gopas*" made of mud, branches and leaves of trees (Food and Agriculture Organization of the United Nations [FAO], 1989; (GOP, 1999 & 2010).

Human settlements spatial distribution have a significant influence on land use and land cover and biodiversity. It is a basic link between human and environment. The analysis of spatial patterns of settlement gives information regarding land use changes, ecology and socio economic and cultural aspects and living standard of the dwellers (Yanga et al., 2016; Zhang et al., 2014). The Nearest Neighbour Index technique applied on human settlements to calculate the inter settlement distances and nearest neighbour analysis (Clark & Evans, 1954; Derracab et al., 2014; Khan & Ahmad, 2014).

A concept of sustainable livelihood was given in an advisory panel of the (World Commission on Environment and Development [WCED], 1987). Sustainable livelihood

aims to help poor people achieve lasting improvements against the indicators of poverty that they define (Dixon et al., 2013). The modern factors that have overwhelmed this complex system of risk management structures include: population growth in the face of limited land expansion potential; agricultural encroachment; national borders limiting migratory behaviours; and other modern stresses such as taxes; and the market economy. The hydro-metrological and natural hazards provide shocks and stress to the sustainability of livelihoods (Ostrom, 1999; Bonfiglioli & Watson, 1992). The same pattern is followed in Cholistan Desert, also. In such circumstances the indigenous creative adjustment strategies are under heavy pressure and undermining the sustainability issues (Chaiken, 2012; Dougill, et al., 2016; Wale & Dejenie, 2013). The indigenous knowledge and institutions for controlling and management of available natural resources have been undermined by new approaches, legislations and changes in resource ownerships (Scholtz, 2006; Dombrowski, 2007). The collective impacts of these challenges and transformation both in socio-economic and physical set up in the marginalized areas are pushing the poor agro-pastoral communities towards vulnerability. It is evident from literature review that there is a wide gap in understanding the traditional practices appraising their role in long term sustainability and highlighting the negative impacts of changes in the developing countries of the world. Therefore, there is need to carry out in-depth research to assess the risk and vulnerability situations of local inhabitants; and to understand the challenges and threats to sustainability (Figure 2).

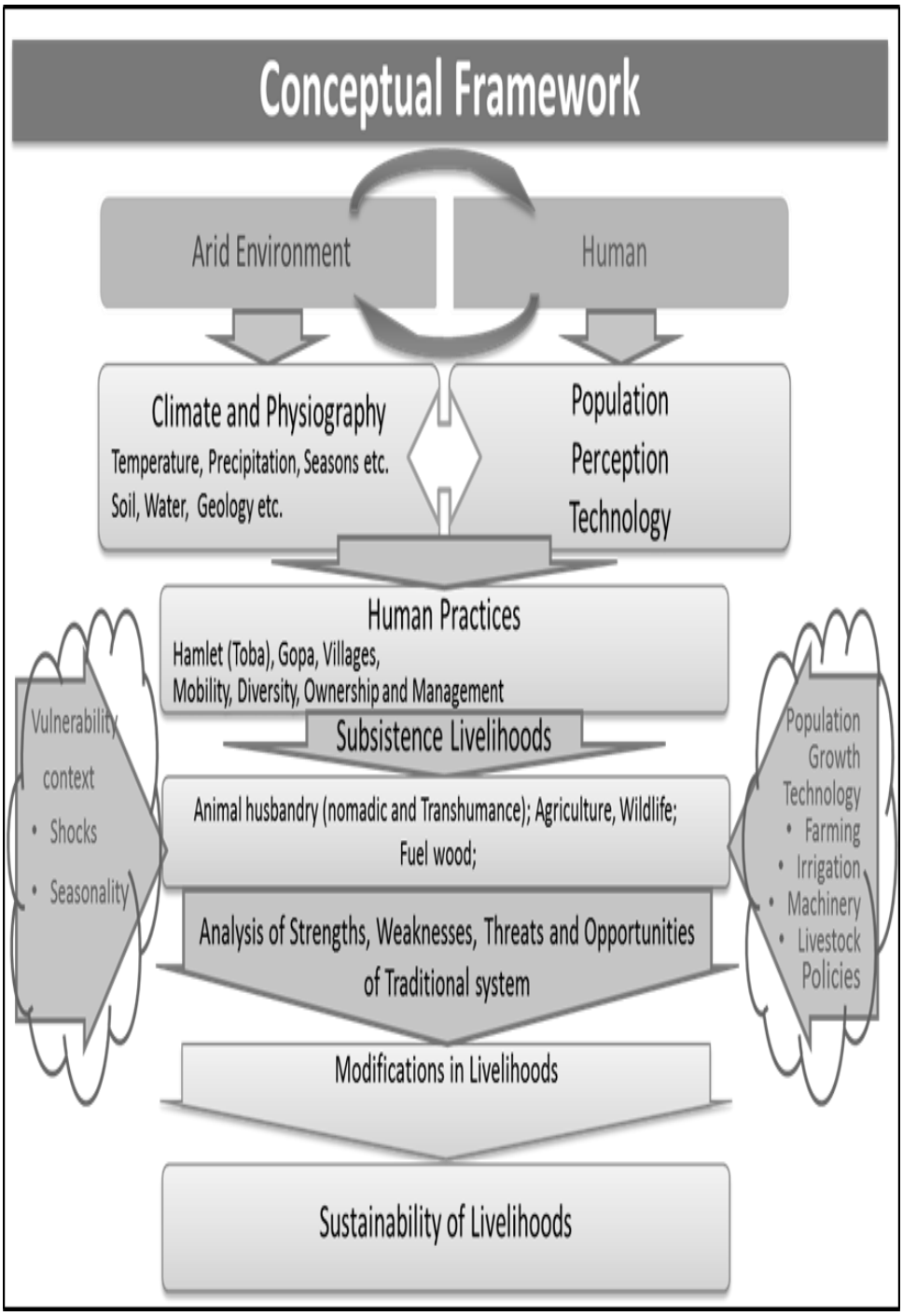


Figure 2: Conceptual Framework of the Study

3. Methodology

The Cholistan desert is spread over in three districts of Bahawalpur division, i.e. Rahim Yar Khan, Bahawalpur and Bahawal Nagar. According to the1998 Census, the total population of Cholistan Desert was 128019 persons with average annual growth rate 3.6, 19240 numbers of households and 6.65 average household sizes. The area comprises of 5, 8 and 1 *Qanoongo Halqa* with 38983, 81383 and 7653 population, respectively. Almost 70% of the total population is residing in the Lesser Cholistan area. The estimated population of the Cholistan Desert in 2015 is 229071 persons with 32140 numbers of households (Table 1). The primary data is collected through questionnaires; focus group discussions (FGDs); and field observations. Based on this estimation, a stratified sampling method was used for the household questionnaire survey. The total number of questionnaires are 1000, out of which 70% were collected from Lesser Cholistan while 30% of Greater Cholistan area. The district wise scheme of questionnaire survey was 290, 645 and 65 from Rahim Yar Khan, Bahawalpur and Bahawal Nagar, respectively. The sample size is 3% of the total households. 10 FGDs were conducted with local communities from Lesser Cholistan and Greater Cholistan. The main target of interviews was the elders of community, *numberdar*, councillors, clan heads and government officials. The primary data was collected through transect walks. The targets of these transect walks were: explaining and presenting the position and distribution of resources, physical features, landscape, land cover & land use, organization and perfection of spatial characteristics of a locality; gathering of observations and evaluation of ecological characteristics; observation of communal perception and assessment of resources; and calculation of GPS coordinates for mapping and GIS analysis. Moreover, transect walks are used to evaluate responses, feedbacks and discussion with different stakeholders like government departments, NGOs officials and public representatives for particular objective of confirmation of information and appraisal. The secondary data about these variables is collected from Pakistan Meteorological Department; Satellite Imageries; Geological Survey of Pakistan; Population Census Department; Agriculture Department; Irrigation Department; Cholistan Development Authority, etc.

Table 1: Population and Households Size of Sample settlements in Cholistan Desert

		Settlement	1981	1998	Estimated 2015	Household Number 2015	Questionnaire	Sample Size (%age)
Lesser Cholistan	1	92/1-L	1040	1666	2668	410	20	5
	2	144/5-R	373	803	1815	267	20	7
	3	Bhagla	230	420	816	122	15	12
	4	Derawar	1242	1840	2016	330	92	28
	5	Chanan pir	470	870	2803	529	87	16
	6	Dingarh	988	598	361	60	20	33
	7	Chapoo	344	577	1040	186	20	11
	8	Moujgarh	740	949	1217	217	69	32
	9	Janu wali	490	1098	2460	424	26	6
	10	Kheer Sar	254	336	444	79	30	38
	11	Kandai	281	300	390	72	20	28
	12	Khiply	230	300	391	78	20	26
	13	325/HR	413	823	1640	304	20	7
	14	Marrot	280	700	1023	176	63	36
	15	Kali Dhari	170	230	311	58	20	35
	16	Jam Sar	680	1020	1530	264	20	8
	17	Kalay Pahar	224	251	281	53	28	53
	18	Ladam Sar	1240	815	535	96	40	42
	19	Jogiat Pir	333	905	2459	424	20	5
	20	Thandi Khoi	300	540	972	174	30	17
	21	Jamal De Sar	610	800	1310	262	20	8
Greater Cholistan	22	Chota Ghania	101	73	41	8	5	62
	23	Islamgarh	340	456	595	106	49	46
	24	Majajywala	30	54	64	13	10	78
	25	Khairgarh	410	620	937	170	63	37
	26	Panjkot	18	55	112	20	9	44
	27	Bijnote	489	450	256	44	19	43
	28	Khangarh	100	250	625	114	33	29
	29	Nawankot	198	345	760	131	39	30
	30	Rukanpur	813	1020	1297	220	73	33

Source: GOP Census Reports 1981, and 1998

Socio-economic characteristics can influence the decision-making process of livestock keeping, pasture use and grazing patterns. These socioeconomic characteristics are indicators of welfare of different groups and periods of time or territories with reference to social wellbeing, also. Such socioeconomic profile is a situation by which one can assess financial and social condition of a community, tribe or a family. Important social

indicators to assess this situation are: income, wealth and employment; the living environment, including dwelling and neighbourhood; education, increasing attainment and quality; social order, involving personal and family problems. The temporal changes in land-use, land cover and natural resource distribution is analysed through satellite images and maps using Geographic Information System (GIS) & Remote Sensing (RS). Types, size, pattern, and spatial distribution are very important characteristics of the settlements to assess the socioeconomic conditions along with migration activities. Nearest Neighbour Index was calculated for spatial distribution of settlements in Cholistan desert (Equation 1).

$$Rn = 2\bar{d}\sqrt{\frac{n}{A}} \qquad \text{(Equation … 1)}$$

Where: (Rn = the description of the distribution; d = mean distance between nearest neighbours; n= number of settlements in the study area; A = the area under study (km^2)

The Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis technique was introduced by Albert Humphrey during a research project at the University of Stanford in 1960 and 1970s (Humphrey, 2005). This recognizing its strengths, weaknesses, opportunities, and threats, the organization is capable of making policies upon its strengths, eradicate its weaknesses, and utilize its opportunities or apply them to contradict the threats by internal and external factors. In present study, SWOT analysis was carried out of subsistence agro-pastoralists community regarding resilience in their livelihoods. To obtain standardized values, the field data was normalized using functional relationship formulas (Equation 2). The collected data and responses were normalized within range of 1 to 5.

$$X_{New} = \frac{x - \mu}{\sigma} \qquad \text{(Equation … 2)}$$

$$\text{Or} \qquad X_{New} = \frac{x - x_{Min.}}{x_{Max.} - x_{Min.}}$$

Where μ represents the mean value of the variable, σ is the standard deviation between different values of the variable, $x_{Min.}$ is the minimum value of the variable and $x_{Max.}$ is the maximum recorded value of the variable.

For indirect functional relationship among the variables (negative domain), equation "2a" was used, while for variables having direct functional relationship (positive domain), equation "2b" was used.

$$r_{ij} = a + \frac{X_{ij} - \min\{X_{ij}\}}{Max\{X_{ij}\} - Min\{X_{ij}\}}(b - a) \qquad \text{(Equation … 2a)}$$

$$r_{ij} = a + \frac{\max\{X_{ij}\} - X_{ij}}{Max\{X_{ij}\} - Min\{X_{ij}\}}(b - a) \qquad \text{(Equation … 2b)}$$

Where r_{ij} is the normalized result of the object and (X_{ij}) is the actual object.

The normalized value was converted through Microsoft Excel logical function into very low; low; medium; high; and very high. The results were interpreted against resilience in livelihoods of agro-pastoralists of Cholistan desert.

4. Socio Economic Dimensions of Cholistan

The total human population of Cholistan Desert is 128021 persons according to 1998 Census and estimated population in 2015 is 229071 persons. These people of Cholistan Desert come from diverse tribes with dissimilar individuality, languages and traditions. They were migrated to this area since long ago from different areas of the sub-continent. Cholistan Development Authority (CDA) had allotted a piece of land measuring 12.5 acres to each Cholistani family in irrigated area adjacent to the desert-belt. Since these new allotments are situated at the tail and along the canals. Most common agriculture crops like guar millet; sorghum, rapeseed, cotton and wheat are cultivated on their farmland. Crop yield is low, due to low farm inputs and shortage of irrigation water. Split family system is observed in agro-pastoral production system, whereby women and children reside at farmlands, with one or two milking cows, while the adults with their livestock move to the rangelands of lesser or Greater Cholistan. Such movements and their destinations are pre-determined and properly decided. Generally, pastorals move towards area where their clans possess *"Tobas"* well or *"Kunds*". During these movements, one or two women (as case may be) also accompany to facilitate cooking and milking of cows during stay in the desert (Akhtar, Akhtar, & Maheen, 2013; GOP, 2010).

Largely the traditional institutions of the tribes or clan or sub-tribes or *biradaries* govern the social and political life of Cholistanies. They are all aware of larger tribes to which they belong. Marriages are mostly arranged within clans or *biradaries.* A *biradary* elder or *"Siana*" leads each Cholistan community. These elders *"Sianas*" have many responsibilities such as the settlement of *inter-briadaries* disputes, solving day-to-day interpersonal disputes and keeping record of exchange of gift during each marriage to assure that no household is neglected when its turn comes to hold a marriage etc. For more than a century the *numberdars* of the village / *wasoon* were the key link among *biradaries* and various Government Departments. These *numberdar* were also responsible for collecting *"trini*" (head tax on livestock) which is Rs.3 for sheep and goat, Rs.6 for cow/cattle, Rs.12 for Buffalo, and Rs.18 for camel annually and land revenue from arable lands (Akhtar, Akhtar, & Maheen, 2013; Arshad & Rao, 1995; Akram, 2012).

4.1 Level of Education, Family Size and Family Type

In the study area average family size was 5 persons per family in Lesser Cholistan and 5.6 persons per family in agro pastorals in Greater Cholistan but overall the family size was 6 persons per family. According to the farmers the larger the family size higher is the earning. Over all composition of the family were one old 2-3 adult and 3 children. Male and female ratio among the pastorals was 1.06 and 1.25 among the agro pastorals and overall 1.15. Adult children ratio is 1.21, 1.19 and 1.20 among pastorals, agro pastorals and overall. 38.35% of the families were nucleated 61.35% joint families over all. Maximum education level in the males was 6.04 years of the schooling while in female this figure was very small 0.64 years (Table 2).

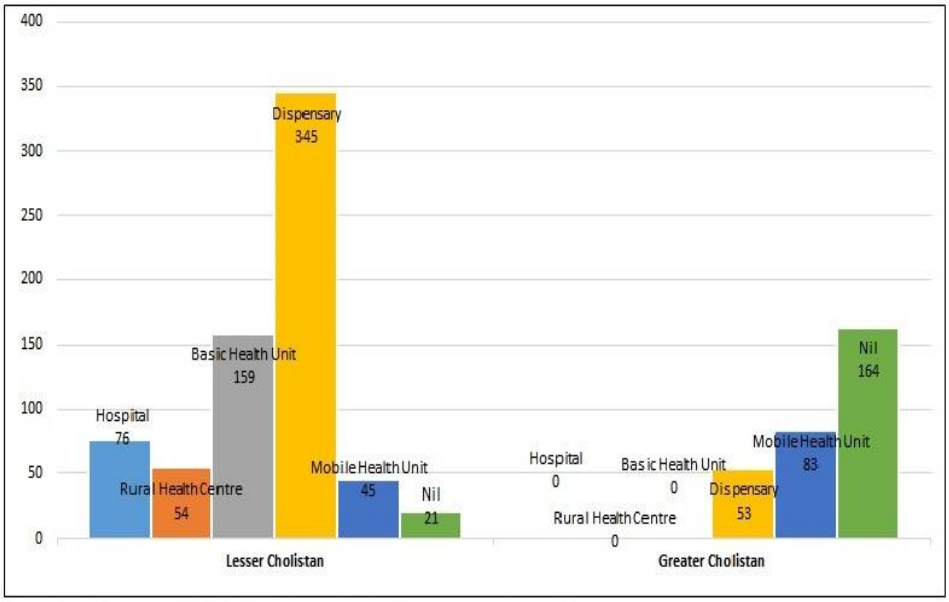
Table 0: Socioeconomic Characteristics of the Livestock Farmers

	Greater Cholistan	Lesser Cholistan	Total
Average Age (years)	55.20	48.80	52.00
Crop Husbandry Experience (years)	16.00	24.10	20.05
Livestock Husbandry by Experience (Years)	40.10	29.90	35.00
Formal education (years)	1.50	4.50	3.00
Percent attended school	10.00	25.30	17.15
Illiterate/No Formal education	18.00	8.00	13.00
- Able to read or write %	8.20	27.80	18.00
- Able to read Holy Quran%	33.80	50.20	42.00
- Totally ignorant %	40.00	14.00	27.00

Source: Field Survey, 2015

4.2 Civic Utilities and Services

Divisional Directorate of Health Bahawalpur is responsible for provision of health facilities in Cholistan Desert. Cholistan Desert health department has total annual budget of Rs.3889668, that is insufficient for a massive population of 344231 (estimated 2014) persons in Cholistan Desert. The health services are provided through eight Basic Health Units (BHU), two Rural Health Centre (RHU) three Zila Council Rural Dispensaries two mobile dispensaries of Zila council (Figure 3). Development is directly dependent on the accessibility to utilities and services. The areas lying in Greater Cholistan are very far from the facility centres as compared to Lesser Cholistan while, in lesser Cholistan, few settlements are closer to the facility centres to some extent. The distance in lesser Cholistan to the main facilities and services centers was within 8.03 km to 27km. In the Greater Cholistan, school for girls and boys, BHU/ Dispensary, medical stores for human and veterinary hospital and commercial Bank all these facilities were at the mean distance of 50 km.



Source: Field Data, 2015

Figure 3: Access to Various Health Facilities in Cholistan Desert

4.3 Source of Energy, Communications and Mass Media

The major source of energy for household are wood, dung cake, kerosene and mustard oil. Almost 70% of households use wood and dung for cooking purposes. In this age of development, the media plays a vital role. They must remain in touch with cattle markets, Grain markets and political situation. For the above purpose the mass media, the satellite telephone, T.V and news are the main sources. Communication among Cholistani family members those move into Greater Cholistan or lesser Cholistan with their livestock for grazing purpose is a need of the time. They remain in contact with other family members and share information about their livestock and other domestic and routine matters. In Lesser Cholistan 100% people have the communication facility and remained in contact while 50% of the residents of Greater Cholistan Desert have the communication facility (Table 3).

Table 3: Mass Media Used by the Livestock Farmers (%age of Method Used)

Type of Mass Media	Greater Cholistan	Lesser Cholistan	Total
None	21.20	38.80	30.00
Radio	66.00	50.20	58.10
Television	60.00	18.00	44.00
Discussion/Gossips	35.10	50.00	45.60
Others	12.10	3.00	7.00
More than one type	51.60	31.00	40.90

Source: Field Survey, 2015

4.4 Traditional Water Resources and Rang Lands

In Cholistan Desert, *Tobas* are the main source of water and only 1000 *Tobas* are functional out of 2000 (small and large *Tobas*). The remaining *Tobas* have been filled

with silt and sand up to the land surface (Pakistan Council Research in Water Resources [PCRWR], 2017). The water storage capacity of these *Tobas* ranges between 500 and 1000 cubic meter (0.1 and 0.2 million gallons with the average capacity of 0.5 million cubic meters (80 million gallon). The collected water hardly enough for maximum two to three months which is exhausted quickly due to infiltration and evaporation. 50% water losses due to seepage and evaporation. *Kund* is a structure mostly resembling to dug well used to store rainwater in the Cholistan, for drinking purpose in addition to ponds. *Kunds* are constructed by using pucca material (bricks, cement etc.) in the shape of well above the level of ground water depth to store rainwater for long period to be used for human drinking purpose whenever, there is no water in the *Tobas*. The numbers of *Kunds* in Cholistan Desert are round about 150. The ground water is mostly saline and brackish with very poor drinking qualities. Even then this water is used for drinking due to absence of other alternatives. The depth to water table of the most wells varies between 20 and 50 meters. In some regions, the earthen wells are plastered with locally available lime to keep the walls strong and to avoid its falling. The number of dug wells in Cholistan is about three hundred.

The net water storage available for human and livestock drinking purpose is about 0.150 million cubic meters (33 million gallons). The human and livestock population in the Cholistan desert is about 0.10 million and 2.0 million respectively. The minimum drinking water requirement for this population is about 7.0 million cubic meters (1700 million gallons) annually. These small *Tobas* do not meet drinking water requirement and after three to four months people migrate along with their livestock toward irrigated areas and stay there till the next seasonal rainfall. During the last fifteen years some tube wells have been installed by the CDA where useable ground water is available. Tube wells installed by (CDA) are on the canal banks (perennial/seasonal). PCRWR installed tube wells for drinking as well as for few experimental based fodder crops and few species of wild fruit plants and for some shadow trees.

The rangelands of Cholistan Desert constitute an area of about 2.6 million hectares. The livestock population in the study area is 134798. The animal unit is considered as an adult cow weighing 350 kg (400 kg at international level) and consuming 7 kg dry-matter forage per day in Cholistan condition. The total annual dry-matter forage demand in Cholistan is 344, 409 tons while the available dry matter forage is 117 896 Tons. Thus, there is annual shortage of 226513 tons of dry-matter forage. It has been noticed that, at the moment, some 88 655 Animal units are in excess of the present carrying capacity (Akbar & Arshad, 1999). Consequently, the increased livestock population the rangelands of Cholistan are under severe threat of degradation. The desirable species of vegetation are vanishing at an alarming rate and relatively unpalatable species have started possessing the landscape due to continuous grazing.

5. Ownership and Management of Resources

Livestock farming is the main stay of economy in the Cholistan Desert. Agro-pastoralists are heavily dependent on limited natural resources i.e. crop production, livestock, aquaculture and forestry. Animal husbandry is an integral part of rural economy in the desert region, livestock produces milk, meat, wool, hair, energy and by product (skins, bones, slaughter house waste, manure etc.). Common Property Resources are fundamental features of the social and institutional provision to meet the everyday necessities of the rural communities in Cholistan (Buch, 1991). Cholistan Desert has

limited reserves of natural resources and few tracts of fertile landmass for agriculture. Sustainable resources management of land, water, forest and animal genetic resources are of prime significance. People of Cholistan Desert are using a large piece of land 312440 acres called "*Shikargah*" which is a private land of Late Ameer of Bahawalpur, within a radius of 16 km from Derawar Fort as common property. Furthermore, 72 *Tobas* are declared as common property by PCRWR and few Tube wells and Turbines by CDA.

5.1 Population and Settlement Growth

Population growth, infrastructural development, socioeconomic conditions and historical factors contributed in the diffusion, expansion and growth of settlements in the study area. In the Lesser Cholistan, population of old settlements increased through natural increase condition resulted because of political change. In the Greater Cholistan, there has been a little possibility for the extension in the area of the settlement because of ecological condition. This natural condition resulted in the establishment of the temporary or seasonal settlement in the periphery of the permanently occupied settlement. The newly founded settlements were used seasonal for few months during drought period. Further increase in population caused more pressure on the available natural resources. To reduce the pressure on the available resources and additional demand of food and fodder these seasonal settlements were occupied permanently in Lesser Cholistan. Each settlement, irrespective of its size, location and site perform certain functions. It is the function, which has its impact on each and every aspect of settlement from its origin to further growth. Functions are of dynamic nature and change temporally. Change in functional characteristics changes the whole settlement pattern of the region. Nearest neighbour index is applied to understand the problems of location of settlements and human interaction with environment (Table 4). The value of 1.282 shows the random distribution of settlements.

$$Rn = 2x19.43\sqrt{30/26100} = 1.282$$

Whereis Rn=0.0 is Linear Clustering (Nucleated); Rn=1.0 Random (Tendency towards Clustering); and Rn=2.15 Regluar-uniform (Tendency towards Regularirty).

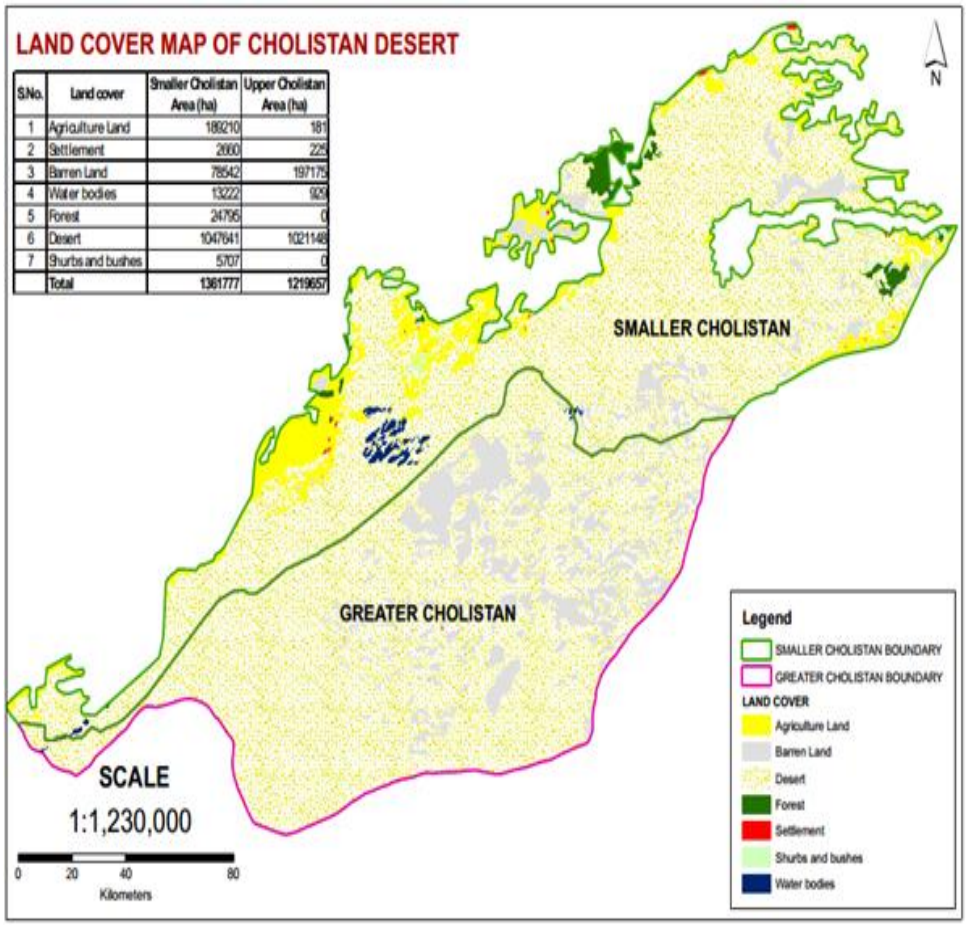
Table 4: Nearest Neighborhood Analysis of Cholistan Desert

Serial No	Settlement	Nearest settlement	Distance (KM)
1	92/1-L	2	15
2	144/5-R	1	15
3	Chota Ghania	4	21
4	Bhagla	3	21
5	Islamgarh	3	23
6	Majajywala	7	18
7	Khairgarh	6	18
8	Panjkot	9	15
9	Bijnote	8	15
10	Khangarh	12	31
11	Nawankot	10	31
12	Rukanpur	10	38
13	Derawar	14	32
14	Chanan pir	15	21
15	Dingarh	16	18
16	Chapoo	17	30
17	Moujgarh	18	18
18	Janu wali	21	15
19	Kheer Sar	18	15
20	Kandai	20	22
21	Khiply	19	22
22	325/HR	23	10
23	Marrot	22	10
24	Toba Kali Dhari	25	13
25	Jam Sar	24	13
26	Kalay Pahar	27	22
27	Ladam Sar	28	7
28	Jogiat Pir	27	7
29	Thandi Khoi	28	17
30	Jamal De Sar	29	30

Source: Author 2015

5.2 Land Cover

In Cholistan, more than three fourths of the land consist on desert area. The agriculture land is mainly concentrated in the marginal canal irrigated areas near Yazman and Ahmed pur towns. As compare to Lesser Cholistan the proportion of the agri land cover is only 0.01% which is very trivial due to the harsh environment and unavailability of water resources. Forest area consists on slightly less than 2% in Lesser Cholistan and it is mainly found in Ladam Sar kanongoi and Lal Sohanera. Settlements have covered area almost 0.19%. Water bodies are distributed on less than one percent in the Lesser Cholistan and very trivial proportion in the Greater Cholistan (Figure 4).



Source: Field Data 2015

Figure 4: Land use and Land Cover of Cholistan Desert

5.3 Agriculture: Land's Ownership, Irrigation System, Cropping Pattern and Production

Overall 60% of the total area of Lesser Cholistan is cultivable. The share of land ownership with people was about 85% and the rest of the remaining land was shared and rented. Majority of the farms were irrigated by canal water (73.87%) while some of the farms were supplemented by the tube wells. The major sources of powers were animals and the Tractors. Bullocks and the camels were mainly used to draught water from the wells and *Kunds*. Animals were engaged in subsistence agricultural activity while the tractors were mainly used in commercial agriculture system. There were two cropping patterns in Cholistan i.e. *Kharief* and *Rabi* season. Cholistan is an arid area having high temperature. Canal water is very limited. Cotton and green fodder the main *Kharief* dominant crops while wheat and oil seeds are dominant *Rabi* season crops (Table 5). The average production is very low which is 13 *mounds* (37.324 kg) of cotton per acre and wheat is17 *mounds* and oil seeds 6.3 mounds per acre.

Table 5: Cropping Patterns and Farm Size of Cultivated Area (% age)

Farm Size Categories	**Small**	**Medium**	**Large**	**Total**
***Kharief* Season**				
Cotton	60	70.94	75	68.33
Sugarcane	3	2.5	3	2.83
Maize	0.5	0.5	1	0.67
Fodders	15	15.2	15	15
Jwar	15	10.2	5.3	10.16
Bajra	5	1	-	2
Other Kharief Fodder	1.5	0.6	2.7	1
***Rabi* Season**				
Wheat	70.2	79.1	70	79.76
Gram	-	0.2	-	0.07
Oil seeds	12.8	12	15	13.27
Fodders	7.3	10.2	8.5	8.67
Berseem	9.7	7	6.5	7.73
Vegetables	0.05	0.3	0.1	0.15
Other Rabi fodder	0.5	1	0.2	0.53

Source: Field Survey, 2015

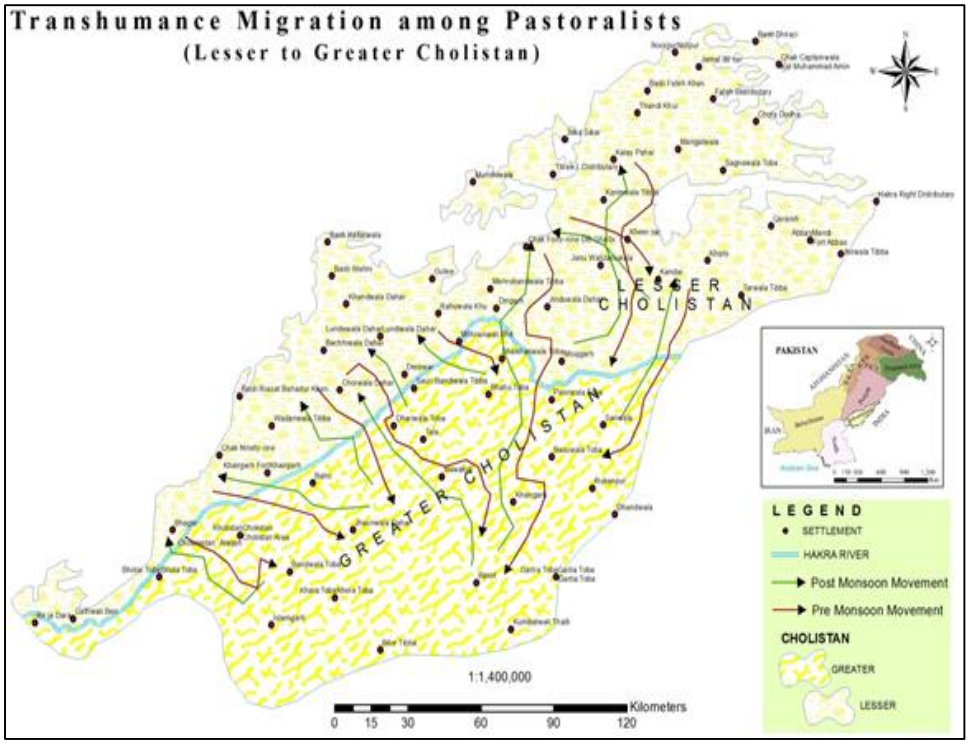
5.4 Nomadism and Transhumance

People of Cholistan exploit the ecologically contrasting potentials of the land through a high frequency of moves in short and medium range. The transhumance can permit greater livelihood flexibility in the form of resource diversification. Many pastoralists are depending upon a transhumant movement pattern, and practice verities of subsistence livelihoods and income generation activities outside of livestock husbandry. The pastoralists in the Cholistan Desert take the advantage of religious and cultural events along their migratory routes and they participate in the fairs to sell their animals and milk and their products. Movement is from the irrigated and riverine areas to traditionally owned tobas in Lesser or Greater Cholistan. Transhumance system, being heavily dependent on the timing and quantity of rainfall, can be severely disrupted by drought. For example, during a prolonged drought over the last 8 to 10 years preceding this study, most of the herders barely moved south, some staying only a few days or for a few months before being compelled to return (Table 6 and Figure 5).

Table 6: Movement schedule and activities of Herders between Lesser and Greater Cholistan

Months	Location/movement and livestock production activities
January-February	Movement towards *Tobas* and *Kunds* in water hunt and foliage continues with slow withdrawal towards lesser Cholistan
March-April	Come back to irrigated periphery of Lesser Cholistan as crop harvesting period comes nearer.
May-June	Settle in hamlets and impermanent flocks on fellow lands. Cattle are fed by ranches and stall-feeding of purchased or self-grown fodder.
July-August	Movement from Lesser Cholistan canal irrigated patches and nearby areas of Satluj banks to the '*Tobas*'. Animals usually graze on the foliage in the vicinity of tobas.
September-October	Relying on the range of tobas and availability of water commonly, journey towards transitory camping as tobas and wells on track. Cattle graze fairly lonely places from *Tobas* and *Kunds*.
November-December	Journey towards tobas and *Kunds* in water hunt and foliage continues. Cattle graze moderately at very far-flung places about *Tobas*/*Kunds*.

Source: Modified after FAO (1993) & Field Survey (2015).



Source: Field Data, 2015

Figure 5: Transhumance Migration among Pastoralists of Cholistan Desert

5.5 Common Property Systems

In Cholistan Desert a vast tract of state land which is lying vacant as unallotted and unleased. The most common types of common property resources are: *Tobas,* wells, pasture land and hunting land. Desert dwellers are using as pasture and woodland. Everyone can use the *Toba* water as per his requirements. The tribes or families generally own water pools or tobas within the desert. Some of them are periodically excavated to increase their water reserve capacity. Normally other herders will not use them without the owner's prior permission without which it is considered an offence attracting some minor penalty. Water points, being vital hubs of activity, indirectly intensify desertification. When the *Tobas* are exhausted or silted then all the people living in the vicinity of that *Toba* they collectively desilt and renovate it. Particularly, 72 tobas are lined by PCRWR. The people are using as common property but the responsibility of desilting and repair of these tobas are on the PCRWR and ownership rights are in favour of that Department. Few water pools and water turbines are installed by CDA are left for communal use along with management rights. Most of the residents are using 2-3 types of common properties daily and there is very high dependency in Greater Cholistan on common properties.

6. Traditional Occupations and Transformation of Livelihoods Resources

People in arid areas of Pakistan are mostly living under very difficult conditions. To make both ends meet their main occupations are rearing the cattle and cultivation of few patches of land near oasis and marginal areas of the desert. Their option of a specific "livelihood approach" even it is possibly essential rather than preference which shapes these strategies. The major occupations in Cholistan are: agriculture (70%), herding (16%), services (8%), businesses (6%), and remaining (< 1%).

6.1 Agriculture (Pastoralism)

Agro-pastoralists are commonly found having livestock as the chief source of livelihood, which is improved and standardized by cropping and harvesting. Poor pastorals earn food grains by working on the farms of landlords and farmers by harvesting the wheat. Young males look after the livestock while male and female adults do labour on farm. Harvesting of wheat is the total activity of a month but these days are crucial because farmers do not afford any delay in harvesting. Though wages for wheat harvesting are customary a harvest share which is $1/15^{th}$ of the crop or kind of cash per day or moth may be. With average family size of six persons, confine their subsistence for their households and other needs of the family i.e. food, cloth, shelter etc. However, in present scenario of farm mechanization, job opportunities at farm are decreased and human labour is being replaced by the harvesting machinery. Therefore, it is becoming very difficult to earn the wheat grains and corns for a year.

6.2 Animal Husbandry (Herding)

Animal husbandry is primary and prime economic resource for many meagre families, their subsistence is totally dependent on animal husbandry. The poor people of the study area to cope with the shortage of income take livestock on share keeping from the wealthy landlord, relatives, farmers, or neighbors etc. Generally, the terms and the condition of such rearing are as if a goat is taken on share keeping, and give birth to two kids, which are divided between owner and share keeper. When the share keeper has enough goats to run his small livestock herd, the original goat is returned. Livestock

furnish products are: manure, milk, meat, wool and hair. Wool and hair are locally sppined on hand made *Dhaira* a wooden cross which used rope spinning by male members and *Charkha* by women folk for embroidery and winter garments. Leather is made into sacks for storing grain and flour, and rough working gloves. Nowadays a special kind of footwear *Mauezee* a kind of inner-shoe for the winter season is made by the local people.

6.3 Business and Services

Services are concerned with collecting resources to cover the minimum standard of living of the public/private servants or working in different organizations. Many people have adopted business locally called the *Beopaar*. These *Beoparies* have their own few cattle and purchase the cattle in harsh and sever seasons when food and fodder is scarce at low costs. They feed these cattle on stall keep them in marginal irrigated areas. They sell them in big cities of Pakistan at the eve of Eid ul Azha on higher rates and earn sufficient amount to meet their requirements. There is an also a local cattle marketing system exists which operates seasonally, monthly, and weekly at various levels depending on the availability of animals for sale. Near the Derawar Fort, shop keeping is another major business activity.

6.4 Secondary Occupations

In Cholistan desert, along with animal herding and subsistence agriculture, these agro-pastoralists indulge themselves in labored work, cottage and home industries, agricultural activities like grinding of corn, extracting of oil from seeds and other wage services. These activities give them a safe way from the challenges; fears and calamities (environment, climate, commerce and trade) linked with agriculture and provide an approach to strengthen their economic conditions around all weathers. The most common secondary occupations are: Labor, Woodcutting, Khar Harvesting, Jeep Rally, Honey bee, Handicraft, Wild Hunting, Wool Collection, Tourism, Wild Plants Collection, Poultry Farming, Natural Fruit Collection, Wood Crafting, Aquaculture, Zakwat/Charities and Beggary etc. (Table 7).

Table 7: Secondary Occupations of Agro-Pastoralists in Cholistan Desert

	Frequency	Percent	Cumulative Percent
Labour	239	23.9	23.8
Woodcutting	213	21.3	45.2
Khar Harvesting	123	12.3	57.5
Jeep Rally	78	7.8	65.3
Honey bee	70	7	72.3
Handicraft	70	7	79.3
Wild Hunting	58	5.8	85.1
Wool Collection	50	5.0	90.1
Tourism	37	3.7	93.8
Wild Plants Collection	20	2.0	95.8
Poultry Farming	14	1.4	96.2
Natural Fruit Collection	7	0.7	97.4
Wood Crafting	7	0.7	98.4
Aquaculture	7	0.7	99.8
Other	7	0.7	100
Total	**1000**	**100**	

Source: Field Survey, 2015

6.5 Women Help in the Household Subsistence

The women folk in the sample area play a vital role in the subsistence survival of household but, unluckily, this is not appreciated by the male heads of the households in rural areas of Pakistan. The women of the desert play a hidden role in the household in the time of economic crisis; working as housekeeper, child/livestock caring and participation in the household economy to achieve subsistence standard of living. Mostly women folk of the poor households are hardworking and energetic; they do not take rest or sit lazy. Especially in long summer day women folk after serving lunch to their families mostly busy in making crafts, small garments, wallets, purses, embroideries and other artificial jewellery. They sell their products to the tourists and nearby towns.

7. Livelihoods and Sustainability

Cholistan Desert is exposed to changing bio-physical and anthropogenic dimensions. A severe climate, highly amplified precipitation instability, and natural phenomena such as drought and dry spells upshot the land, wealth and economy, human and livestock population expansion, development and affect human prosperity and well-being. These factors produce environmental and livelihood vigorous threats and challenges for the habitants of that area. The subsistence livelihoods are strained by hazard events and they are vulnerable and susceptible by these episodes. The adaptation and resilience are outlined by the landscape and herders' capability to alleviate risks. Nomadism and transhumance are common modes of life in drought affected areas of Pakistan. Especially in the Cholistan Desert, herders conventionally graze their livestock on desert flora and interdunal gaps and few patches of irrigated lands on the marginal areas are their major crop fields.

7.1 Natural and Anthropogenic Hazards

Natural hazards in the paired forms of drought and flooding have traditionally occurred commonly in the desert environments. The most severe and intense spell of drought was 1999 to 2002. This drought led to 120 deaths and affected 2,200,000 people (Middleton, 2009; GOP, 2010). The migration calendar of farmers is settled to the condition of weather and the provision of water and forage in the Desert. Cholistan Desert is exposed to disproportionate heat freights and an insufficient and inconsistent pattern of precipitation. In Cholistan desert, flash flood causes loss of human life as well as harm to assets and property, and opens corridor for the transmission of fatal diseases e.g. malaria, dengue fever, and cholera (Table 8). Animal husbandry is consistent on three major components of health; feed, water and disease in Cholistan Desert. Sometimes Available fodder at *ToIba* level is of substandard and drinking water is brackish and infectious causes many problems related to animal health. Very few poorly equipped veterinary health small units are available in peripheral cities. Some traditional homemade herbal preparations are used to treat sick animals. The mortality rate is very high and drought conditions increase stress due to malnutrition and lack of water causing various diseases (Schmidt & Doerre, 2011; Khan & Ali, 2015; Ahmad, et al., 2004).

Table 8: Natural Hazards in Cholistan Desert

	Lesser Cholistan	Greater Cholistan	Total
Incidence of Natural Hazards			
Drought	257	181	438
Famine	166	56	222
Flash flood	3	1	4
a & b	150	58	208
a & c	9	2	11
b & c	3	1	4
All three	109	1	110
Other	3	0	3
Total	**700**	**300**	**1000**
Occurrence of Droughts			
Frequent	598	250	848
Occasionally	101	50	151
Never	1	0	1
Total	**700**	**300**	**1000**
Frequency of Drought			
Don't know	6	2	8
Once in decade	3	1	4
Once in five years	40	12	52
Less than five years	102	54	156
Once a year	435	130	565
Two times in a year	114	101	215
Total	**700**	**300**	**1000**
Most Disastrous Drought in your Locality			
Earlier	98	28	126
1970	101	21	122
1999	497	248	745
Not Known	4	3	7
Total	700	300	1000
Intensity of Drought			
Not Known	4	3	7
Decreased	123	66	189
Increased	432	198	630
Constant	141	33	174
Total	**700**	**300**	**1000**

Source: Field Survey 2015

7.2 Policies

The nomads have lived a largely self-contained existence with strict observance of traditional rights and obligations. The development and management of livestock production continues to be followed through reliance on "opportunistic" stock movements. In Cholistan desert, policy and program interventions are needed to help pastoral nomads overcome a number of emerging concerns that have made effective and efficient (in the economic sense) livestock management more difficult for them. These concerns include: the rapid increase in human populations in pastoral communities; a

more sedentary life on the pasturelands; the increasing need for technology to deal with emerging problems; and changing political, economic and social conditions. These concerns are not static. CDA and Revenue Board of Punjab sets the rules and regulation to allot and lease out the land to the peasants of *Rohi* (Cholistan). There is no specific chunk of land that is spared or declared as common property but a sizeable piece of land which is "Shikargah". For the last 50 years, since the death of Ameer of Bahawalpur; this chunk of land is being used as pastureland as common property. The people of Cholistan Desert have no *de jure* rights but are using as *de facto* rights.

The CDA has allotted the cultivable land by the order and under the guidance of government of Punjab among the Cholistanies in different schemes and in different times (1950 to date). Bona fide residents of Cholistan were determined inter-alia on the basis of CNIC, existence of his name in the voter list of last election, produce copy of *Trini* (cattle head tax) along family history of *Trini Guzari* prior to 1980 and a proof of his residence in the Cholistan area (GOP, CDA Act 2010). Beyond the above legal criteria of allotment/lease of land; groups of outsider investors are grabbing the land from poor pastoralists in terms of different corporate farming schemes (Table 9). In Cholistan Desert, it was revealed in FGDs and interviews that most of the pastoralists across the entire Cholistan have been grieved that major part of the fertile land in lesser/ irrigated area of Cholistan has been allotted/occupied by the close and affiliated people to the politicians and high officials from the different areas of Punjab for corporate farming (Cholistan Development Authority [CDA], 2017).

Table 9: Land Allotment Policy in Cholistan Dessert

Name of Scheme	**No. of Allottees**	**Area Allotted in Acres**
1. Shahi Muzarian Scheme (1950-51)	170	8500
2. Grow More Scheme (1959-60)	2091	31041
3. 20-years temporary Cultivation Scheme (1970-71)	2038	25475
4. 15-year temporary Cultivation Scheme (1977-78)	11598	144112
5. 5-year temporary Cultivation Scheme (2000)	4556	57075
6. Allotment Balloting 1983 ordered in (2005)	245	3063
7. Area reserved for Army Welfare Scheme (Kargal)	133	2390
8. Agri Graduate Scheme (2010)	05	100
Total	**20846**	**271461**

Source: Cholistan Development Authority, 2015

7.3 Mechanization and Transformation of Livelihoods

Agriculture revolution and innovation in technologies are obviously labor-displacing. In Cholistan Desert, few major types of agro-pastoral farming are generally experienced and each of them has definitely a couple of its ecological impacts on the environment the area. The main problems associated with the mechanized agriculture are traced in the deficiency of arrangement and development of agro-pastoral sector throughout past half

century. Newly introduced mechanized agricultural activities have an impact in terms of widespread cultivation with a variety of machines, mechanical equipment, utilizing the land resources up to its maximum level of exhaustion. As a result, the environment observes the terrible upshot of socio-economic activities; loss of vegetation cover; formal and primitive agricultural farming system; weathering and erosion of soil by flash floods; and damaging of soil productivity.

Poverty is widespread among the people of Cholistan Desert. In Lesser Cholistan Desert, the transformation in livelihood is taking place very rapidly and sharply but not in a systematic way. For agricultural purpose land is available but water and other sources are very scarce and limited so the outsiders and land mafia are grabbing the land from the poor Cholistani people. The pasture lands are shrinking. By the introduction of technology and machinery, labor and wages opportunities are decreasing day by day. Therefore, their subsistence is at high risk In Greater Cholistan, the pace of transformation is very slow. The people are more static for changing life style and socioeconomic system.

7.4 SWOT Analysis

Natural hazards like droughts and epidemics are very common phenomena in desert environment of Cholistan. However, Cholistan desert has been gifted a lot of resources by the Nature. Most of *Rohillas* (Cholistani people) own fertile land in irrigated (Lesser Cholistan Desert) capable of cereal and cash crops, orchards and vegetables but land holdings are very small. Where canal water is available for agricultural purposes, people of Lesser Cholistan take benefit of both cropping seasons *Rabi* and *Kharif*. Livestock is the major strength of Cholistan Desert, most of the population derives her livelihood from livestock. Livestock is a main source of food and cash for Cholistanies. In Greater Cholistan, a lot of fertile land with virgin soil is lying fallow and uncultivated. It was found that they have plenty of water *Tobas* which need desilting and maintenance.

Non-availability of drinking water for both human and livestock is a major weakness of the area. The main resource of economy is livestock and it has been confined to subsistence only. Non-availability of improved and good quality seeds; high costs of fertilizers and pesticides; lack of agro-forestry & pastureland management; poor road networks, connectivity & remoteness; low literacy rate; unawareness about the use of resources; extinction of local/indigenous knowledge; lack of coordination among the community and government institutions are the other main weakness and obstacle against the progress and prosperity of Cholistan Desert.

Livestock is a chief source of income and a great opportunity if the farmers are encouraged and facilitated by micro-financing and credits during the droughts and natural calamities. The rain water (monsoon season) harvesting; canals from Islam Headwork and Head Punjnad; milk and dairy products the “white gold” of Cholistan; tourism, archaeological and cultural heritages are the other potential opportunities of the area. Most importantly, the allotment of Cholistan land to the deserving people on merit would be a fortune for the people of Cholistan Desert.

Encroachment and illegal allotment of land is the major threat for Cholistani people. The other major threats are: the exploitation water resources by the farmers up to optimum level; the bigger herd of animal is the sign of proud but is dangerous and cause of over exploitation of pastureland resources; the local and indigenous knowledge is diminishing

rapidly; the hybrid and improved seeds and different varieties of cotton are at high risks of pests; the innovation, modern technology and mechanization causes unemployment; fertilizers and pesticides kills also friendly insects and worms which are helpful for reinstating the fertility and enrichment of soils; and consecutive & frequent droughts. The results of SWOT analysis can be summarized as follows:

Table 10: SWOT Analysis

Resources	Strengths	Weakness	Opportunities	Threats
Rain water	Water resources are sufficient for drinking of both human and livestock	Lack of interest in harvesting of rain water and use of water resources by local population/ Community or organizations	By the effective utilization of harvested water there is a potential for growing vegetables and fruits for domestic use	Siltation and evaporation in tobas will loss the moisture and water resources
Ground water	Drinkable ground water is available along the old and dry bed of Hakra	Brackish and saline water is dominant across the Desert and water table is very deep	Installation of tube wells and turbine can increase the agricultural production	Loss of water can affect the ecological environment
Livestock	Majority of the Cholistanies have number of cattle. agricultural output and is a major component of the sector	Cattle are only meant for subsistence level	Livestock sector can improve the standard of living and provision of dairy products	Vulnerable to droughts and hazards
Land Resources	Fertile land is available for multiple cropping	Existing leasing and holding/ ownership of land constraint to productive agriculture	Vast uncultivated lands that can be brought under organized system of agriculture	Environmental degradation due to unsafe land management practices
Forest Resources	A vast woodland is available	Lack of awareness to use explore forest resources for livelihood	Efficient use of plants and trees for fuel and subsistence purposes	Deforestation for agricultural land

Agriculture	Subsistence agriculture leading to mechanized system of agriculture	Lack of resources; water seeds and credit	A vast fallow land can be brought under cultivation and yield appreciable amount of food grains	Harsh climate and land mafia are major constraints
Fertilizers	Fertilizers are frequently used in lesser Cholistan Desert irrigated areas	Prices are high and affordability is very low	Availability of fertilizers on controlled and subsidized rates will enhance the crop yielding	Frequent use without quality check and soil analysis will lead to soil degradation
Improved seeds	Most of the peasants of Lesser Cholistan use improved seeds	Improved and high yielding seed varieties are inaccessible and costly	Improved and good quality seeds will increase the production	Hybrid and improved seeds are mostly vulnerable to insect and pests
Herbal and medicinal plants	Considering the possible potential for export to earn lot of exchange	Lack of marketing facility and disinterest of Government	Worthwhile opportunities for making efficient and organized marketing system	Ignorance and lack of knowledge about the use of herbal medicines
Land holdings	Most of the Cholistanies (small holdings) up to 25 acres	Illegal allotments And few patches in irrigated lesser Cholistan are available	Legal and proper land allotment	Due to population pressure irrigated land is reducing
Institutions	Accessible subsidy and competent Staff	Special program in line with the scheme of the donner	Extensive fields programmes for development cooperation with GOs, NGOs and CBOs	Policies constraint to broad level execution of plans for sustainability
Govt. Financing	financial products for small and medium scale extend financial services	Deficient in financial assistance right to sponsorship for various purposes	With the ability to come into partnership with different organizations to diffuse risk	Rivalry with different stake holders and organizations

Market	Exposed to the open marketing of products	Fragile to local and export market	Tourists and visitors are main clients of domestic market	Competition with local modern handicrafts and supply of cheaper and quality products
Machinery	Most of the Cholistanies have Tractor, plough. thresher and other essential tools of machinery for agriculture	Day by day raising prices of petroleum products and machinery	Mechanized agriculture is the guarantee of progress and development	Unemployment and surplus of human resources and natural ecosystem will be disturbed

7.5 Sustainability of Livelihoods

Nomadic and transhumance pastoral production systems have been the most effective and efficient system for the rangelands of the Cholistan Desert. These pastoralists are well equipped with a specific and traditional knowledge, skills and experience by which they can derive the highest benefits from the available natural resources. Subsistence agricultural activity was started in the seasonal settlements on a limited scale. Before land settlement policy, the people of Cholistan desert practiced transhumance production system. Today after land settlement policy, they have their permanents houses and become permanent residents of the Lesser Cholistan. They move back to Greater Cholistan in monsoon season when then rainfall is sufficient and water reservoirs *Tobas and Kunds* are bank full and vegetation is plentiful. The placement of this social infrastructure changed the functional structure of the settlements. The change in the means of transportation and new road building affected the traditional functional structure of the habitations which leads to the transformation of livelihood system.

The study of resilience in change of developmental process shows that Lesser and Greater Cholistan had totally different responses. In Lesser Cholistan, the local community have adapted with the population growth, change in technology, new policy intervention natural hazards. The development of physical infrastructure, mechanization of agriculture, expansion of settlement size, change in land uses, access to modern technologies, innovation in agriculture practices including livestock and poultry farming are yardsticks which indicate resilience in the transformation of livelihoods in Lesser Cholistan. In Greater Cholistan, the adaption process is setback by natural hazards, lacking of specific policy, and attraction of Lesser Cholistan. As a result, the sustainability of subsistence livelihoods of agro-pastoralist in Greater Cholistan is at great risk. The data is normalized with negative and positive attributes regarding resilience in overall developmental process which is reflected in socio-economic conditions of the residents. The combined characteristics of development shows that the people of Lesser Cholistan enjoy the prosperity and development while the residents of Greater Cholistan face the serious challenge of their socioeconomic existence (Table 11).

Table 11: Analysis of Sustainability in Livelihoods

Town/Village	Negative		Positive		Negative		Positive	
1. 92/1-L	4	3	2	3	Low	Medium	High	Medium
2. 144/5-R	4	3	2	3	Low	Medium	High	Medium
3. Bhagla	4	4	2	3	Low	Low	High	Medium
4. Derawar	4	3	2	3	Low	Medium	High	Medium
5. Chanan pir	4	3	2	3	Low	Medium	High	Medium
6. Dingarh	4	3	2	3	Low	Medium	High	Medium
7. Chapoo	4	3	2	3	Low	Medium	High	Medium
8. Moujgarh	4	3	2	3	Low	Medium	High	Medium
9. Janu wali	4	4	2	3	Low	Low	High	Medium
10. Kheer Sar	4	3	2	3	Low	Medium	High	Medium
11. Kandai	4	3	2	3	Low	Medium	High	Medium
12. Khiply	4	3	2	3	Low	Medium	High	Medium
13. 325/HR	4	3	2	3	Low	Medium	High	Medium
14. Marrot	4	3	2	3	Low	Medium	High	Medium
15. Kali Dhari	4	3	2	3	Low	Medium	High	Medium
16. Jam Sar	4	4	2	3	Low	Low	High	Medium
17. Kalay Pahar	4	3	2	3	Low	Medium	High	Medium
18. Ladam Sar	4	3	2	3	Low	Medium	High	Medium
19. Jogiat Pir	4	3	2	3	Low	Medium	High	Medium
20. Thandi Khoi	4	3	2	3	Low	Medium	High	Medium
21. Jamal De Sar	4	3	2	3	Low	Medium	High	Medium
Lesser Cholistan	**4**	**3**	**2**	**3**	**Low**	**Medium**	**High**	**Medium**
22. Chota Ghania	2	3	4	3	High	Medium	Low	Medium
23. Islamgarh	2	2	4	3	High	High	Low	Medium
24. Majajywala	3	2	4	3	Medium	High	Low	Medium
25. Khairgarh	2	2	4	3	High	High	Low	Medium
26. Panjkot	3	2	4	3	Medium	High	Low	Medium
27. Bijnote	2	2	4	3	High	High	Low	Medium
28. Khangarh	2	2	4	3	High	High	Low	Medium
29. Nawankot	2	2	4	3	High	High	Low	Medium
30. Rukanpur	2	2	4	3	High	High	Low	Medium
Greater Cholistan	**2**	**2**	**4**	**3**	**High**	**High**	**Low**	**Medium**
Total	**3**	**3**	**3**	**3**	**Medium**	**Medium**	**Medium**	**Medium**

8. Conclusion

Cholistan Desert is the one of the most backward and under-developed region of Pakistan. The people are living on limited and scarce availability of natural resources. They obtain their livelihoods from the utilization of ordinary widespread natural resources besides taking care of preservation and maintenance trial and procedures to gain their subsistence. They are utilizing the common natural resources of Cholistan Desert up to maximum capacity Consequent upon their exploitation, the sustainability is undergoing to the vulnerable stage. Lands and settlement are the basic elements in the environmental management to establish the rights and access to the natural resources. The capacity and ability of pastoral system which has been under threat not only by economic and social change i.e. population explosion, technology, mechanized

agriculture and commercialization but it is also by the undeserved policies of the authority. The increasing population and scarcity of food and fodder people are not static in Greater Cholistan they can't stay permanently therefore no any specific settlement pattern exists except few old and famous sites. The land and natural resource rights are susceptible issues, both ethnically and politically in combination with other changeable indicators of livelihood. Management of natural resources and especially common property management are very poor in the study area. A blazing issue of encroachment and land grabbing mafia is not highlighted and no any policy and illegal solution of this problem is sorted out.

In Lesser Cholistan, the sustainable livelihood approach is associated with the realistic improvement and enforcement of policies. CDA is responsible to regulate functions those have a significant posture on the environment i.e. execution and enforcement of land policy. Land tenure policy and common property resource management became complex issues. In Greater Cholistan, the sustainability of subsistence livelihoods of agro-pastoralist is at risk and their socioeconomic conditions are deteriorating with the passage of time. The increasing burdens on food resources are accelerating the depletion of natural resources and ecosystems. It has a significant impact on food supply and income of the poor agro-pastoralists. These circumstances often increase their vulnerability and create a brutal succession of poverty, further deprivation and starvation. The future of the agro-pastoralists community is vulnerable without sound management of natural resources and the environment. The resilience in subsistence livelihoods of agro-pastoralists can be achieved through proper policy interventions, sustainable common property resources management, innovative technologies, and environmental adaptive livestock management.

8.1 Contribution of the Study

The present study provides a new platform for understanding of sustainability of subsistence livelihoods of agro-pastoralists in changing socioeconomic environment of Cholistan Desert, Pakistan. The livelihoods as a product of Man and environment was studied with new dimension of settlement pattern, land use and major socioeconomic characteristics analysis. Common Property, transhumance and land management systems were analyzed in the perspective of agro-pastoralists of subsistence socio-economic system. Most importantly, the study summarized the results of SWOT analysis in more accurate and simple method which is a base for future studies, also.

8.2 Limitations and Future Study Directions

Cholistan Desert is a vast area where human settlements (*Tobas*) and scare natural resources like water and vegetation are fundamental important for their subsistence livelihoods and survival. However, these scare resources are very difficult to find and analyzed through modern technologies of remote sensing (Satellite Images) because of spatial and spectral resolutions problems. The upper boundary line of Cholistan desert is in constant flux due to development and illegal land allotment. This dynamic boundary line can affect the results of data analysis. This study provides a base for future studies e.g. the contrast change in socioeconomic conditions of Lesser and Greater Cholistan can be correlated with temporal changes in land use, settlement growth and natural resources; the impacts of policy intervention on agro- pastoralists with their socioeconomic growth;

using the present methodology of SWOT analysis the sustainable human development in Greater Cholistan can be assessed.

REFERENCES

Abrams, M., Jacobson, P., Jacobson, K., & Seely, M. (1997). Survey of Soil Chemical Properties Across a Landscape in the Namib Desert. *Journal of Arid Environment, 35*(1). 29-35.

Ahmad, M., Ghafoor, N., & Aamir, N. M. (2012, Sep-Oct). Antibacterial Activity of Mother Tinctures of Cholistan Desert Plants in Pakistan. *Indian Journal of Pharmaceutical Sciences, 74*(5), 465–468.

Ahmad, S., Hussain, Z., Qureshi, A. S., Majeed, R., & Saleem, M. (2004). *Drought Mitigation in Pakistan: Current Status and Options for Future Strategies.* Pakistan Agricultural Research Council (PARC), Islamabad, Pakistan. Colombo: IWMI.

Akbar, G., Khan, T. N., & Arshad, M. (1996). Cholistan Desert, Pakistan. *Rangelands, 18*(15), 124-128.

Akhtar, S., Akhtar, N., & Maheen, F. (2013). A Study of Nomads In District Faisalabad. *Pakistan Journal Agriculture Sciences, 50*(3), 511-516.

Akram, M. (2012). *Management of Surface and Groundwater Resources in Cholistan Desert of Pakistan for Drinking and Farm Production.* Islamabad: Pakistan Council of Research in Water Resources (PCRWR). [ONLINE] Available at: https://pecongress.org.pk/images/upload/books/12-82-90Desertication%20Muhammad%20Akram.pdf (September 10th, 2017).

Alan, K., & Macdonald, D. (2012). *Indigenous People, Poverty and Developement.* (G. H. Hall, & H. A. Patrions, Eds.) Newyork, USA: Cambridge Uinversity Press.

Arshad, M., & Rao, A. (1995). The Past, Present and Future of Desert,. *International Scientific Conference on the Takliakan Desert, Arid Zone Research* (pp. 156-162). Semica, China: Xinjiang Institute of Biology, Pedology and Desert Research, Academic.

Arshad, M., Hussan, A. U., Ashraf, M. Y., Noureen, S., & Moazzam, M. (2008). Edaphic Factors and Distribution of Vegetation in The Cholistan Desert, Pakistan. *Pakistan Journal of Botany, 40*(5), 1923-1931.

Ashraf, S., Chuadry, H. R., Farooq, U., & Mustafa, Y. (2013). Prospective Of Dairy Farming in Cholistan. *Science International, 25*(2), 345-346.

Baig, M. A. (1980). Evaluation of anticancer activity of Cleome gynandra on Ehrlich's Ascites Carcinoma treated mice. *Pakistan Journal of Forestry, 129*(1), 131-134.

Bonfiglioli, A., & Watson, C. (1992). *Pastoralists at a Crossroads: Survival and Development Issues in African Pastoralism.* Nairobi ,Kenya: UNICEF/UNESCO NOPA Project for Nomadic Pastoralists in Africa.

Brown, D., Taylor, J., & Bell, M. (2008). The demography of desert Australia. *The Rangeland Journal, 30*(1), 29-43.

Bull, J. W., Jobstvogt, N., Henrichs, A. B., Mascarenhas, A., Sitas, N., Baulcomb, C., & Koss, R. (2016). Strengths, Weaknesses, Opportunities and Threats: A SWOT analysis of the ecosystem services framework. *Ecosystem Services, 17*(2), 99-111.

Chaiken, M. D. (2012). *Food Security and Safety Nets:NGOs in Northern Mozambique. In: Zerbe, N., Dowd-Uribe, B., Scarnecchia, T., Limb, P.* ACAS Bulletin 88.

Cholistan Development Authority [CDA]. (2017). *Cholistan Development Authority* . [ONLINE] Available at: http://www.cholistan.gov.pk/docs/CDAAct.pdf (May 11th, 2017).

Clark, P. J., & Evans, F. C. (1954). Distance to Nearest Neighbor as a Measure of Spatial Relationships in Populations. *Ecology, 35*(4), 445-453.

Demir, S., Esbah, H., & Akgun, A. A. (2016). Quantitative SWOT analysis for prioritizing ecotourism-planning decisions in protected areas: Igneada case. *International Journal of Sustainable Development & World Ecology, 23*(5), 456-468.

Derracab, J., Garcíac, S., & Herrera, F. (2014). Fuzzy nearest neighbor algorithms: Taxonomy, experimental analysis and prospects. *Information Sciences, 260*, 98-119.

Dixon, J. A., James, D. E., & Sherman, P. B. (2013). *Economics of Dryland Management.* Abingdon, UK: Routledge.

Dombrowski, K. (2007). Subsistence livelihood, native identity and internal differentiation in Southeast Alaska. *Anthropologica, 49*(2), 211-229.

Dougill, A. J., Akanyang, L., Perkins, J. S., Eckardt, F. D., Stringer, L. C., Favretto, N., . . . Mulale, K. (2016). Land use, rangeland degradation and ecological changes in the southern Kalahari, Botswana. *African Journal of Ecology, 54*(1), 59-67.

Food and Agriculture Organization of the United Nations [FAO]. (1989). *Arid zone forestry: A guide for field technicians.* Paris, Rome, Italy: Forest Department. [ONLINE] Available at: http://www.fao.org/docrep/t0122e/t0122e00.htm (Feburary 3rd, 2014).

Government of Pakistan [GOP]. (1999). *District Census Report of Bahawulpur*. Islamabad, Pakistan: Statistic Division Population Census Organization, Printing Press, Islamabad, Pakistan.

Government of Pakistan [GOP]. (2010). *Federal Drought Emergency Relief Assistance (DERA) Unit.* [ONLINE] Available at: http://www.planningcommission.gov.pk/organization/sections/dera.pdf (June 15th, 2014).

Hameed, M., Ashraf, M., Quriany, F. A., Nawaz, T., Ahmad, M. S., Younis, A., & Naz, N. (2011). Medicinal Flora of the Cholistan Desert: A Review. *Pakistan Journal of Botany, 43*(Special Issue), 39-50.

Humphrey, A. (2005, December 15). *SWOT Analysis for Management Consulting.* [ONLINE] Available at: http://www.sri.com/sites/default/files/brochures/dec-05.pdf(June 9th, 2014).

Kavana, P. Y., Fyumagwa, R. D., Hassan, S. N., Ntalwila, J., Sangeda, A. Z., Mtengeti, E. J., & Ilomo, O. (2017). Panorama of agro-pastoralism in western Serengeti: A review and synthesis. *Livestock Research for Rural Development, 29(*10), Published 3 October 2017.

Khan, A. N., & Ali, A. (2015). Drought Risk Reducion Approches in Pakistan. In A. U. Rehman, A. N. Khan, & R. Shaw, *Disaster Risk Reducion Approches in Pakistan* (pp. 71-90). Tokyo: Springer.

Khan, S., & Ahmad, A. (2014). Organization of Settlements in Aligarh District using Nearest Neighbour Analysis. *International Journal of Advanced Research, 2*(2), 756-759.

Manoli, C., Ancey, V., Corniaux, C., Ickowicz, A., Dedieu, B., & Moulin, C. H. (2014). How do pastoral families combine livestock herds with other livelihood security means to survive? The case of the Ferlo area in Senegal. *Research, Policy and Practice*, 4(3), 1-11.

Marie, M. (2006). Ethics: The New Challenge for Animal Agriculture. *Livestock Science, 103*(3), 203-207.

Middleton, N. (2009). *Deserts: A Very Short Introduction.* New York: Oxford University Press.

Mughal, M. R. (1982). Recent Archaeological Research in the Cholistan Desert. In G. L. Possehl, *Harappan Civilization: A Contemporary Perspective* (pp. 84-104). New Delhi: Oxford & IBH Publishing.

Mumtaz, K. K. (1982). Habitat and Desert, The Case of Cholistan. In B. B. Taylor (Ed.), *Essay in The Changing Rural Habitat; Volume I: Case Studies, proceedings of Seminar Six in the series Architectural Transformations in the Islamic World.* (pp. 17-28). Beijing: Concept Media/Aga Khan Award for Architecture.

Namgay, K., Millar, J. E., Black, R. S., & Samdup, T. (2014). Changes in Transhumant Agro-pastoralism in Bhutan: A Disappearing Livelihood? *Human Ecology, 42*(5), 779–792.

Namgay, K., Miller, J., Black, R., & Samdup, T. (2013). Transhumant agro-pastoralism in Bhutan: Exploring contemporary practices and socio-cultural traditions. *Pastoralism: Research, Policy and Practice, 3*(13), 26-40.

National Geographic Society. (2014). *National Geographic*. [ONLINE] Available at: http://www.nationalgeographic.com/environment/habitats/deserts/ (September 2nd, 2017).

National Museum of Australia. (2005). *National Museum of Australia.*[ONLINE]Available at: http://www.nma.gov.au/__data/assets/pdf_file/0017/19421/Extremes_desert_science.pdf (June 15th, 2014).

Ostrom, E. B. (1999). Revisiting the Commons: Local Lessons, Global Challenges. *Science*, 284, 278-282.

Pakistan Council Research in Water Resources [PCRWR]. (2017). *Desertification and Rainwater Harvesting*. [ONLINE] Available at: http://www.pcrwr.gov.pk/research.php?view_desertification (June 15th, 2017).

Pérez, A. A., & Gatti, R. C. (2011). *Building Resilience to Climate Change: Ecosystem-Based Adaptation and Lessons from the Field (Ecosystem Management).* New York: International Union for the Conservation of Nature (IUCN).

Pithawala, M. (1978). *Historical Geography of Sindh.* Jamshoro: University of Sindh.

Pratt, D. J., Gall, F. L., & Haan, C. d. (1997). *Investing in Pastoralism: Sustainable Natural Resource Use in Arid Africa and the Middle East (World Bank Technical Paper).* Washington DC: World Bank.

Race, D. (2016, 12). Understanding climate adaptation investments for communities living in desert Australia: experiences of indigenous communities. *Climatic Change, 139*(3-4), 461-475.

Reddy, K. N., Locke, M. A., & Za, R. M. (1997). Soil Type and Tillage Effects on Sorption of Cyanazine and Degradation Products. *Weed Science, 45*(5), 727-732.

Schmidt, M., & Doerre, A. (2011). Changing meanings of Kyrgyzstan's nut forests from colonial to post-Soviet times. *Area, 43*(3), 288–296.

Scholtz, M. M. (2006). A developing country perspective on recent Developments in animal breeders and intellectual property rights. *South African Journal of Animal Science, 36*(5), 22-25.

Spedding, C. R. (1988). Pastoral Nomadism. In C. R. Spedding, *An Introduction to Agricultural Systems* (pp. 120-124). Dordrecht: Springer.

United Nations Combat to Desertification [UNCD]. (2011). *Global Drylands.* (Y. Hori, C. Stuhlberg, & O. Simonett, Eds.) Bresson: Zoi Environment Network.

United Nations Decade for Deserts and Fight aginst Desrtification [UNDDD]. (2014). *UNDDD.* [ONLINE] Available at: http://www.un.org/en/events/desertification_decade/value.shtml (June 15th, 2014).

Wale, H. A., & Dejenie, T. (2013). Dryland Ecosystems: Their Features, Constraints, Potentials and Managements. *Research Journal of Agricultural and Environmental Management, 2*(10), 277-288.

World Commission on Environment and Development [WCED]. (1987). *Report of the World Commission on Environment and.* New York: Oxford University Press.

Yanga, R., Xua, Q., & Long, H. (2016). Spatial distribution characteristics and optimized reconstruction analysis of China's rural settlements during the process of rapid urbanization. *Journal of Rural Studies, 47*(2), 413-424.

Yu, L. (2016). Agro-pastoralism under climate change: Institutions and local climateadaptations in northern China. *Land use Policy, 58*, 173-182.

Zhang, Z., Xiao, R., & Shortridge, A. (2014). Spatial Point Pattern Analysis of Human Settlements and Geographical Associations in Eastern Coastal China - A Case Study. *International Journal Environmental Research in Public Health, 11*(3), 2818-2833.