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RESILIENCE OF LOCAL COMMUNITIES TO CLIMATE CHANGE AROUND A RAMSAR SITE IN PAKISTAN

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ABSTRACT

The Taunsa Barrage controls water flow in the River Indus for irrigation and flood control purposes. The river ecology is sensitive to climate change due to the high portion of its flow derived glacial melt. To assess the socio-economic status of the rural communities living within the Taunsa Barrage Wildlife sanctuary, a questionnaire was developed based on the perception of local communities about their resilience capacity and climate change. Temperature and rainfall data over the period 1951 – 2010 were analysed and used as an indicator of climate change. 85 of the respondents (n =100) reported that there had been an increase extreme climatic events over the past 60 years. These communities have proved to be resilient (94% n = 100) to it by changing occupations and lifestyles. However at the same time they have increased the pressure on natural resource use and this is causing a serious problem in the management of the protected area

Keywords: Pakistan, Resilience, Climate Change, Taunsa Barrage, Wildlife Sanctuary, Rural Communities.

INTRODUCTION

According to the IPCC fifth assessment report '*Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased*' (IPCC, 2013). In the last century, an average annual increase in surface air temperature of about 2.9°C has been observed in boreal Asia. The Asiatic region seems to have more pronounced effect of climate change associated shifts like prolonged droughts and ever increasing sea level (Farooqi *et al.,* 2005).

Recent research has shown that many glaciers in the Himalayas may be expanding or stable (Scherler *et al*., 2010). However other reports mention that 5000 glaciers are in rapid retreat and that the rate of this retreat has gone up by 23% over the previous decade (Khan *et al*., 2011). The glaciers covering the Himalayan-Hindu Kush mountain range is the source of the nine largest rivers of Asia. Approximately 80% of the flow into the Indus River System can be attributed to snow and glacial melt. Glaciers in Pakistan cover approximately 15,000 sq. km. The increased rate of glacier melting in Himalayas has caused enormous lakes to develop, and if these lakes outburst, they can flood towns and villages. As the glaciers recede river flows will decrease. Freshwater availability is also projected to decrease which will lead to biodiversity loss and reduced availability of freshwater for the population. Any changes to rainfall and temperature will have a significant impact on the productivity of agriculture sector. Shakoor*et al*., (2011) estimated that a one percent increase in temperature would lead to loss of Rs. 4180 per farmer per annum.

Pakistan is highly vulnerable to climate change as its economy is heavily reliant on climate-sensitive sectors such as agriculture, fishing and forestry, and its low lying densely populated deltas are threatened by a potential risk of flooding. In Pakistan, the annual mean surface temperature has a consistent increasing trend since the beginning of 20th century with a rise in the mean temperature of 0.6-1.0°C in arid coastal areas, arid mountains and hyper arid plains. In addition a 10-15% decrease in both winter and summer rainfall in the coastal belt and hyper arid plains, 18-32% increase in rainfall in the monsoon zone has been observed. The core area of cyclogenesis exists over the northern Indian Ocean, which particularly affects Bangladesh, India, Pakistan and Sri Lanka. The frequency of depressions and cyclones has increased over the Bay of Bengal and the Arabian Sea during last 50 years. Moreover the intensity of systems has also increased during last quarter of the 20th century (Farooqi *et al.,* 2005). Pakistan, with an Environmental Vulnerability Index (EVI) score of 373, is rated as one of the extremely vulnerable countries of the world particularly in the areas of relief, soil cover, fishing, renewable water, sanitation, population growth, and conflicts (Kaly*et al.*, 2004).

Protected areas are a critical tool to conserve biodiversity and, at the same time, are often essential to assuring healthy communities. Globally protected areas serve as the achievement of the millennium goals and cover almost 12% of the total area of the world. Pakistan has a network of 236 protected areas comprising 25 national parks, 99 wildlife sanctuaries, 96 game reserves, and 16 unclassified. The total area covered by these categories is 9,170,121 ha which makes 10.4% of the total land area. Based on their global significance, 19 wetlands have been designated as Ramsar sites. Out of these sites 3 are found in the Punjab: Ucchali Wetlands Complex, Chashma Barrage Wildlife Sanctuary and Taunsa Barrage Wildlife Sanctuary. More than 25,000 people living in the villages on the banks of Taunsa Barrage are directly or indirectly dependent on this wetland. Fishing and working as labourers in agriculture is the main source of livelihood for the local communities. Some community members seek employment in construction work around the barrage. Mat-making and basket weaving is another significant source of income. Others are engaged in tourism but on irregular basis. Literacy in the area is very low. Due to a reduction in the fish population, due to unsustainable harvesting and lack of conservation measures, many have turned to labour work as an alternative source of livelihood.

The social resilience approach is a way of understanding dynamic systems of interaction between people and the environment (Folke, 2006). A resilience approach renders the fuller view of diversification and socio-ecological dimensions of communities. It has affinity to account the critical climatic shifts and related natural resource management decisions in particular to those coming up as a outcome of varying access to water resources.The social dimensions of climate change and the issues about resource dependency can be interpreted by resilience approach (Fenton *et al.*, 2007; Marshall *et al*., 2007).This perspective has potential to explicate the co-existence of communities and natural hazards (Paton and Johnston, 2006). The resilience approach identifies the resources and adaptive capacity that a community can utilize to overcome the problems that may result from change. This approach builds upon the inherent capacities of a community, rather than only relying on external interventions to overcome vulnerabilities.

In Pakistan no such study has been conducted to assess the resilience of the local communities against climate change, especially in the protected areas. Hence the present study was carried out to examine the awareness and response approaches to climate change within the communities in the Taunsa Barrage Wildlife Sanctuary (TBWS) with a view to identify sustainable intervention strategies, promote an understanding of resilience at the local level and enhance the skills of land-holders, community groups, industry and governments to contribute to sustainable management of natural resources.

METHODS

Study Area: The TBWS is located at 30º 30’ N, 70º 50’ E; 20 km northwest of KotAddu, in Muzaffargarh District, Province of Punjab, with an altitude of 137m. The aerial distance from Multan to Taunsa Barrage is 75 km (Figure-1). It is a large water storage reservoir constructed for irrigation purposes. Five embankments in the reservoir retain the shallow lagoons as the water level in the main river falls, the depth of water in the main channel varies from 5.0 - 11.5 m. Around the wildlife sanctuary are five main villages: Lomar Wali, Basti Allah Wali, Bait Qaim Wala, Jannu, and Fakeer Wali. The reservoir is state owned (Government of the Punjab), and controlled by the Irrigation Department; adjacent areas are privately owned.

The wetland was first declared as a Wildlife Sanctuary in 1972. It was re-notified in April 1983, July 1988 and subsequently in March 1993 with some reduction in size on demand of the people downstream of the barrage. It has been proposed to declare the wetland from Kalabagh to Guddu Barrage as a World Heritage Site for the Indus Blind Dolphin (*Platanista minor)*. Areas on both sides of the reservoir and 3 km wide area downstream of the barrage is proposed to be included in the sanctuary (Scott, 1989).

Climatic conditions: The region has a dry subtropical climate with an annual rainfall of 100-400 mm and a relative humidity ranging from 25 – 85 %. The average minimum temperature in January is 4.5º - 6.0º C, and the average maximum in June is 41.5º - 43º C.

Land use: Mostly the land area is used for fishing, water supply for irrigation, harvesting of reeds and recreation; agriculture, livestock, grazing and forestry in adjacent areas. Some of the land within the sanctuary is leased to farmers for cultivation during the dry season (Scott, 1989).

Disturbances and threats: Vegetation burning in the seepage lagoons and in lands within the protected area is one of the most concerning threats to the wetlands .Use of fishing net for illegal fishing activities and hunting by local community cause disturbance ,as number of reports on water fowls drowning in fishing nets has been accounted in recent years (Scott, 1989).

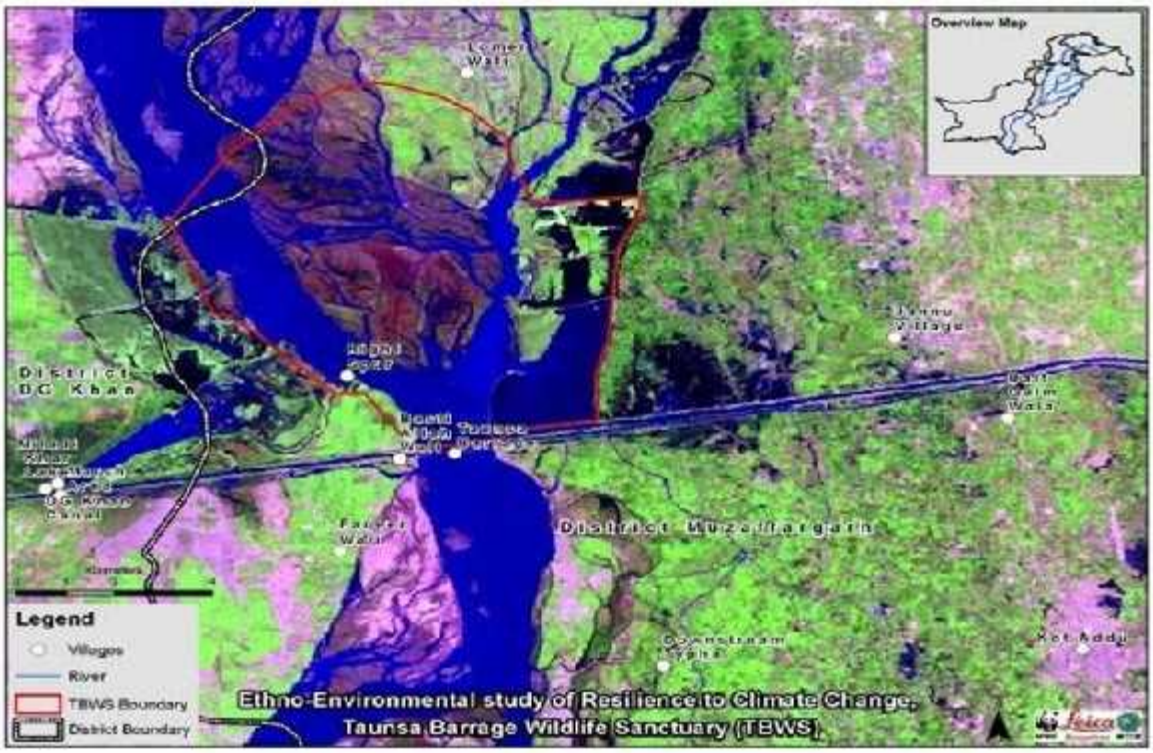

Figure 1: Map of Taunsa Barrage Wildlife Sanctuary

Data collection and Analysis: A questionnaire was developed to assess the changes in demography, socio economics, land use, livelihood systems, natural resource use, family systems, lifestyles, household fuel consumption, and awareness regarding climate change and their response over the period of 60 years (1951 - 2010). The questionnaire was administrated at community level and 393 persons were interviewed from the total population of 25,200. The questionnaire included questions additionally; information was also gathered through published or secondary data by visiting different government, non-government organizations and departments. Temperature and rainfall data for the site over the period 1951 – 2010 were gathered from government meteorological department. Data for the Indus River Water Discharge from 1958-2010 was also taken. Temperature and rainfall data was analysed and used as an indicator of climate change.

RESULTS

Population Structure: The population of district Muzaffargarh has increased by 76.1% from 1991 to 1998 with an average annual growth rate of 3.4% (District Census Report 2000). This trend has continued todate and roughly 48% of the population are in the age range 6-25years. Hence there is huge potential workforce available (Table 1).

Table 1. Age structure of rural populations, Tehsil Kot Addu

TEHSIL KOT ADDU, AGE STRUCTURE:RURAL POPULATION			
AGE GROUPS	MALE	FEMALE	TOTAL
0-5 YEARS	74,072 (51.0%)	70,986 (48.9%)	145,058(21.0%)
6-25 YEARS	169,957 (51.4%)	160,291 (48.5%)	330,248(47.94%)
26-50 YEARS	7, 9950 (51.9%)	73,816 (44.9%)	153,766(22.3%)
50 ABOVE	32,856 (55.0%)	26,843(48.0%)	59,699(8.66%)
TOTAL	356,835 (51.8%)	331,936 (48.2%)	688,771

The entire population of the area is divided into different tribes: Khar, Gurmani, Quereshi, Jatoi, Dasti, Qalandri, Hinjra, Langrials, Sheikh, Tarrangar, Pirhar, Goapung, Bukhari, Gillani, Rajput, Jat, Arain and some migrant families including Shairwani, Rajput and Qureshi.

Health Status: The health status of the population highlighted that malaria was the most prevalent in both males and females. Tuberculosis was mainly observed in females this could be due to the constant exposure to smoke during cooking. Veterinary health is important as the sanctuary is treated as free grazing land for livestock and cattle. The poultry industry was also flourishing and a number of diseases were present (Table 2).

Livelihoods structure: The five villages around the TBWS comprise of 3500 households with an average number of 7.2 people per household. Hence the immediate population around the area was approximately 25,200 people. It wasnoted that the major family system in the community was joint (72%) which means that few children move out of the house to build their own homes and their parents land is divided amongst all the male children. Mostly they live in mud (42%), concrete (30%) and thatched (28%) houses.

Table 2. *Livelihood structure of rural populations of TBWS

	Mean	**Minimum**	**Maximum**	**SD**	
Age (Years)	45	18	95	17.38	
Number of Children	4.2	0	13	2.96	
Gender	**Male**	**Female**			
	80%	20%			
Housing type	**Thatched**	**Mud Houses**	**Concrete**		
	28%	42%	30%		
Family System	**Combined**	**Separate**			
	72%	28%			
Source of earning	**Yes**	**No**			
	62%	38%			
Professions	**Agriculture**	**Fishing / Basket making**	**Government service**	**Factory workers**	**Others**
	43%	27%	6%	13%	11%
Husband help in cooking	**Yes**	**No**			
	32%	68%			
Education	**None**	**Primary**	**Middle**	**Secondary**	**Graduate**
	64.6%	20.2%	9.7%	4.2%	1.3%
Health (Male)	**Malaria**	**Scabies,**	**Worm infestations**	**Depression**	**Others**
	37%	23%	9%	17%	14%
Health (Female)	**Malaria,**	**Scabies,**	**Tuberculosis**	**Hepatitis**	**Others**
	29%	27%	11%	12%	21%
Health (Veterinary)	**Mastitis,**	**Fever,**	**Worm infestations**	**Diarrhea,**	**Others**
	13%	21%	27%	26%	13%
Health (Poultry)	**Newcastle disease,**	**infectious bronchitis,**	**infectious coryza,**	**avian tuberculosis**	**Others**
	6%	27%	15%	17%	35%
Means of Transportation	**Animal Driven Cart**	**Cycle**	**Tractor/Trolley**	**Public Transport**	**Others**
	25%	20%	20%%	15%	20%

*Data has been collected from 393 participants (298 male + 95 female) out of total population of 25,200 around TBWS.

The major occupations of the communities for males were fishing, agriculture, teaching, labouring, factory worker, cobbler, barber, carpenter, poultry industry, basket making, saf (mat) making and goldsmith. For women the major occupations included basket making, cotton picking, sesame collection, saf making, wheat collection and livestock rearing. The source of income for the household from jobs and labour is around 62% whereas the remaining community depends on the sanctuary area completely. The major profession in the area being agriculture (42%) followed by fishing and basket making (27%). The remaining community falls into the labour force and government servant category. Men, being the bread earners of the family, usually do not participate in house chores like cooking and cleaning.

The level of education is low with 64.6% being uneducated (Table-2).

For the agricultural community livestock holding is treated as an additional profession and a significant income resource. The labour force has been mainly employed in industries such as four thermal power stations using furnace oil as fuel, sugar mills (3), ginning factories (70), rice processing plants (6) and flour mills (10).

The poultry industry has flourished at the district level to such an extent to fulfil the needs of the area as well as servicing the markets in Quetta, Loralai, and Sibi. Livestock, poultry and camels have been used over the decades in households as a meagre source of income generation as well as for domestic use. An average of two to three animals for livestock and cattle were observed. In the past this number would have been higher but as people changed their professions the numbershave fallen. The number of poultry kept in homes has stayed constant with an average of 10 -20 chickens per household. These are kept by women for domestic use to fulfil the protein requirement. Camels were noted to have decreased overthe past decades since the means of transportation has improved.

The rural community has about 200-300 boats in the area surrounding the TBWS. The majority of the fish caught are the Indian and Chinese carps. These are sold at Rs. 30-50/kg depending on the quality of the fish by the local fishermen to the contractor. The contractor then sells the fish to the general public in the villages and the surrounding cities for almost triple the price. Some people who commonly sell fried fish along the barrage area earn around Rs.400/kg for Rohu (*Labeorohita),* which constitutes the major part of the sales. The cottage industry is one of the minor sources of income mainly run by the local women and includes making of "Saf mats" from *Typha (Typhaagustata),* baskets from *Tamarix (Tamarixdioca)* and "Rali" made from small size cloth pieces sewn together and sold in markets.

Natural resource Use: Timber from the TBWS is used for making furniture and fuel wood is also extracted from the area, hakims (Ayurveda practitioner) use the herbs and shrubs for the treatment of people. The agriculture community in the area constitute around 500 households, with 84% using the land to cultivate for cash crop production.

Water and Wetland product use: Wetland products (e.g. fruit of lotus (koldoda)) are used by hakims for medicinal purposes and around 40% of the people use the roots of the plant as a source of food. *Typha (Typhaagustata)* and *Tamarix (Tamarixdioca)* are used by the cottage industries.

Wildlife Use: Wild animals, such as migratory birds are caught by nets and baskets for eating. The hog deer (*Axis porcinus)* is hunted by the locals for its meat and also as a sport. Some birds (Black partridge (*Francolinusfrancolinus*), grey partridge (*Francolinus.pondicerianus*) and chukor partridge (*Alectorischukar*)) are kept as pets. Dolphins and turtles are trapped for their body fat which is removed and used by hakims in medicines. Over the past decades the animal sacrifice for religious reasons has come to an end after the communities converted from Hinduism to Islam. Turtles are also caught for export to countries like China. Snakes are caught by the local people for selling to snake charmers and for export. Wild boars (*Sus scrofa*) are hunted as a sport; they are also caught by the local people for fights with dogs at their annual get together (mela). Owing to the above use to the wildlife resources turtles, migratory birds and large snakes have gradually decreased in number. Almost no wildlife is observed in the area when people from Loralai and Baluchistan visit to the TBWS area as rangelands for sheep herds after the cotton harvesting season has ended.

Community perspective of changes in land area, occupations: Communities living around the Taunsa Barrage were living more traditional ways before construction of the barrage; 50% of the communities were involved in agricultural practices and the varieties of crops and their rotations were different from those in use today (Table-3).

The crops grown included wheat (*Triticum. aestivum*), maize (*Zea mays*), cotton (Gossypium*spp*), green fodder and orchards:mangoes (*Mangniferaindica*) oranges (*Citrus sinensis*), guava (*Psidiumguajava*) and date palms (*Pheonixdactylifera*). Other communities were mostly involved (35%) in Typha *(Typhaagustata)* and Lotus (*Nelumbiumnuciferum)* harvesting.

Other professions accounted for less than 15% while those involved in fishing was below 2%. River natural products like Typha *(Typhaagustata)* were mostly used in house roof-tops, storage of agricultural products and mats. Figure 2 shows the cultivated area before the construction of the barrage with Typha and Lotus harvesting area and fishery practices along the river belt with the natural flow of the river.

Communities around the TBWS changed their lifestyle after its construction. They stated that most of the cultivated crop area was merged with the barrage whereas rest of the area changed to saline marshes. Hence the majority of the community had to shift their occupations or relocate away from the area. The marsh area around the barrage flourished with Typha *(Typhaagustata)* and Lotus (*Nelumbiumnuciferum),* so it was noted that there was increase in the use of the river products, a large number of professionals of the Typha using communities and fishermen, moved to the area and gradually the rural communities around the TBWS were seen to be involved in fisheries, basket making, and mat making (Figure 3).

On any remaining available land, rice, wheat, cotton and sugarcane were cultivated but this was dependent upon water availability.

Table 3. Community perception and resilience to climate change

Climate Change	Yes	No
Change in the water table	95%	5%
Change in the quality of water in the last 50 years	83%	17%
Change in forest products use	78%	22%
Change in wetlands product use	66%	44%
Change in wildlife use (Hunting / Poaching)	73%	27%
Change in population of mammals / reptiles / amphibians in the region	44 %	66%
Change in fish catch	98%	2 %
Change in fish variety	86%	14%
Change in cottage Industry (basket making)	71%	29%
Are summers getting warmer	89%	11%
Are summers getting cooler	14%	86%
Are the winters getting warmer	79%	21%
Are the winters getting cooler	13%	87%
Has there been any change in the incident of extreme climatic events	85%	15%
Have you noticed any unusual pattern in the climate? (Unusual rainfall, change in wind pattern),	93%	7%
Has there been any change in the incidence of floods	52%	48%
In the communities perception, is there any link between increased floods and agricultural land quality	68%	32%
Can you relate any traditional practice that was handed down to you from your forefathers to deal with turmoil caused by floods	37%	63%
Do you think there is any benefit of floods in the area	86%	14%
Do you think flood is an indicator of climate change	45%	55%
Resilience		
Community adapted to this change	89%	11%
Coping mechanism practiced by communities	76%	24%

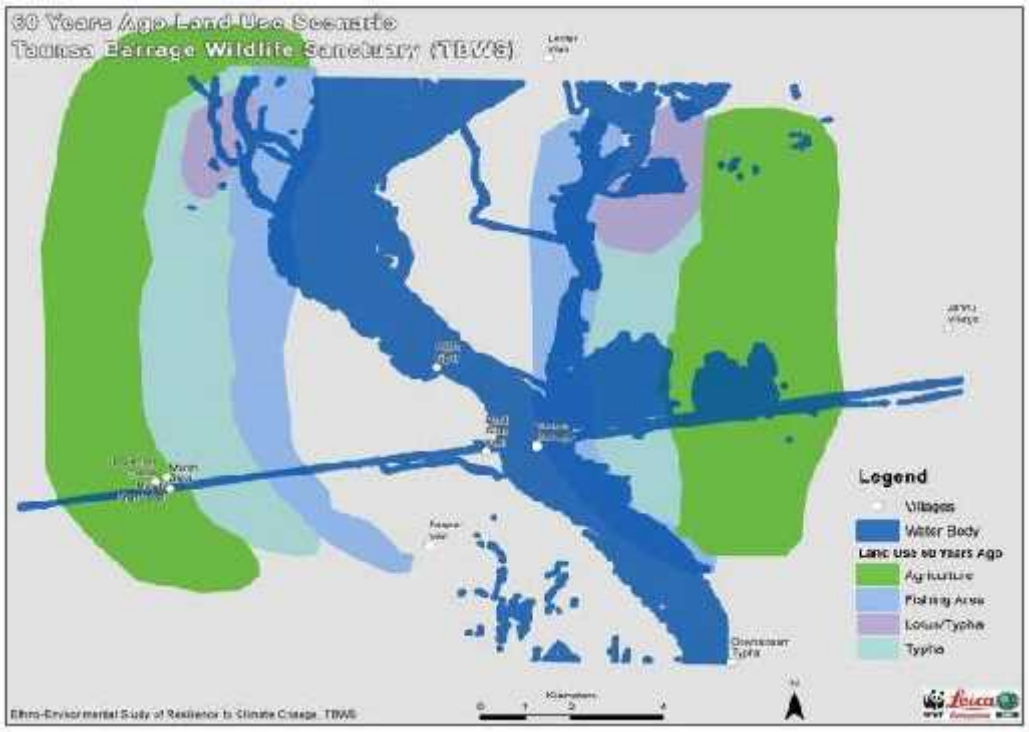

Figure 2 Map of TBWS 60 years ago

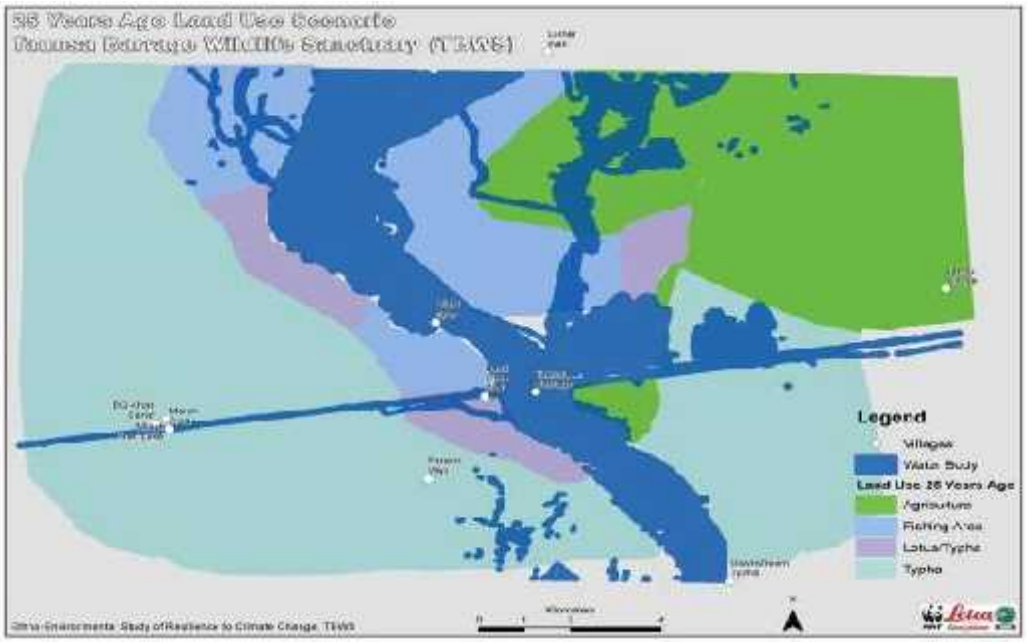

Figure 3: Map of TBWS, 25 years ago.

In the present scenario the local communities have encroached on the TBWS area for cultivation. They increased the land cultivated area by drying the saline marshes by constructing barriers or by digging water channels. The local communities who encroached upon or reclaimed the areas for cultivation were happier to shift to their traditional practices. After significantly reducing the natural Typha *(Typhaagustata)* growing areas and a reduction in the number of fish caught, those communities were deprived of their income and most likely changed into other professions e.g. becoming labourers for the industrial sector. Figure 4 shows the present scenario of cultivation, fishing and the Typha *(Typhaagustata)* activity area around the TBWS.

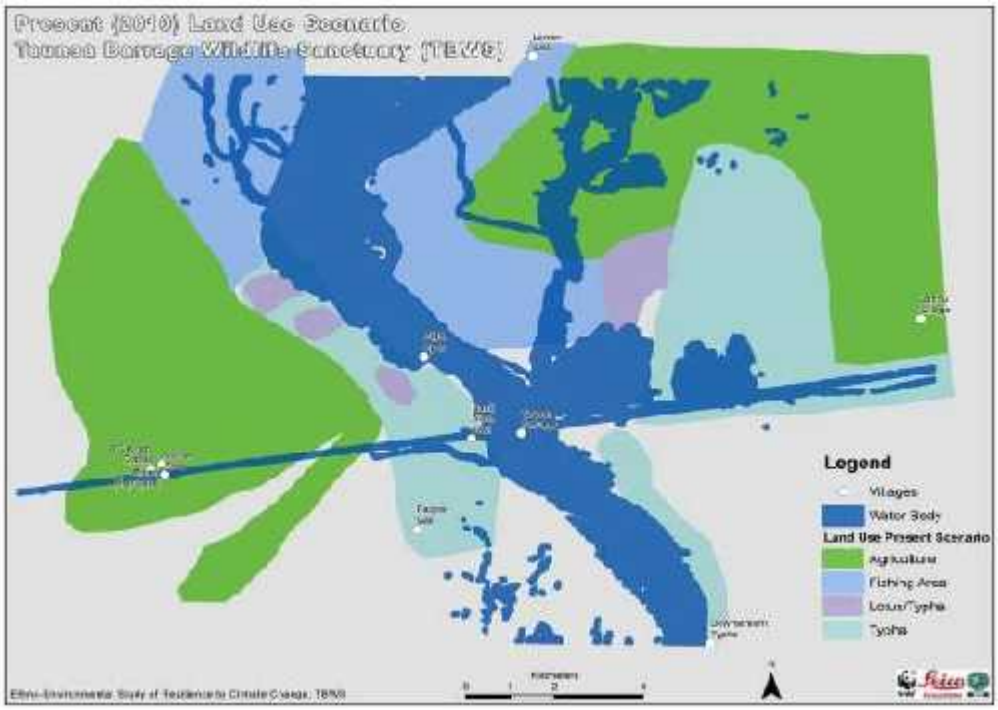

Figure 4: Map of TBWS, in the present scenario

Climate Change and Resilience of Communities: Over the last six decades there have been some significant changes in temperature and rainfall.. Some of the months are becoming warmer (January, February and March; October, November and December) while others (June, July and August) are getting comparatively cooler over the period from 1951-2010. Similarly rainfall is increasing in some months (August, September and October) but decreasing in others (November and December).

These climatic variations were also recorded from the data of Indus River Water Discharge from 1958-2010. It was observed that high and very high flooding had increased in the last two decades. The most significant floods were observed in 1958, 1976, 1992, 2004, 2006 and 2010. Periods of drought occurred from 1967-1972, 1979-1982 and a severe drought 1994-2004. The questionnaires analysis shows that 85% respondents were of the view that there had been an increase in extreme climatic events over the past 60 years. The community observed the summers (89%) and winters getting warmer (79%), major floods and extreme climatic changes have been observed in the last five decades.Few (37%) traditions handed down by the forefathers are applicable now. The flood in area is beneficial (86%) as it increases the fertility of the soil. The majority of the community (89%) has adapted to the change by developing resilience to this climate change in the area as shown in table-3 resulting the coping mechanisms have also increased.

The majority (95%) of the community's perception was that the water table had decreased in the last six decades (1951-2010) whereas 83% agreed that water quality has also changed. There was increase in the forest product use (78%). Hunting and poaching of wild animals increased (73%) and as a result the population of wild animals in the area had decreased. The fish catch (98%) and variety (86%) have been highly effected in last fifty years.

Technology has affected the farming practices to a great extent, people have moved from using animal driven carts to tractors and harvesters and much advanced machinery with added fertilizer to the soil for increased productivity. On the other hand about 20% of the people have left farming and shifted to private and government jobs and new flourishing industries. 9% of the farmers have shifted to education sectors and left farming for good. The division of land with holding has also made 43% of the people to shift to other means of living. The fishing community reported an increase in the quantity fish in 2010; many hatchery ponds located near the river banks were flooded introducing the hatchery fish into the mainstream river.

The aquaculture and river fishing industry on the other hand has flourished after the barrage was built with the fishing community increasing from 250 to about 900 households in the last five decades. The fish that were caught by baskets, nets and hands for subsistence living and small scale industry were exploited largely by the introduction of the contract system in the last twenty five years, different size nets with very small mesh size have been used with the addition of poisonous substances to catch both fish and turtles for trade. This poison is known to affect the biological and physical aspects of the river. The use of poisons and nets over the long period of time has also decreased the quantity of fish caught from large sized fish and a catch of more than 1200 kg/month fifty years ago to around 300-500kg/month medium sized fish in the present scenario. Hardly any large size fish are now caught. Around 40% of the community has left fishing practices.

In the fish breeding season when fishing is banned by the government the fishing community shifts to jobs in the major cities and also turn to basket and mat making. Turtle capture and trade has initially flourished in the area due to their huge demand as a Chinese delicacy. It was recorded that the local community has observed an increased in river pollution with an associated decrease in turtle numbers. During the last six decades after the barrage was built the water table depth has increased from 20 ft to 35ft

DISCUSSION

Resilience in communities mainly refers to the capacity of a system to absorb the changes occurring due to climate change and other factors to retain the same structure and function while maintaining the options for better development. In the community's perspective the weather is extremely hot in summer and cold in winter, but in the last six decades both the summer and winter weather and thus the climate of the area on the whole is getting warmer. There have been long periods of drought followed by heavy rain spells. With an increasing incidence of floods in the last 25 years; five major floods spells occurred after the barrage structure was built. That which occurred in 2010 has proved to be the worst flood with maximum life and economic loss. The resultant water quality was unfit for human and animal consumption.

Wetland ecosystems support countless forms of biodiversity such as fish, amphibians, reptiles, birds, mammals and invertebrates. Wetlands also maintain terrestrial forest ecosystems, recharge ground water and help in flood control, shore protection and climate stabilization (Parikh and Datye, 2003). Wetlands serve as life support systems for millions of people in Pakistan. They help maintain ecological balance among water, vegetation and fauna in addition to supplying fuel, fodder, fish, herbs, medicines and other non-timber forest produce. The gradual loss of wetlands is of great concern

to many people of the country especially when their very survival directly depends on it.

Natural resources are the backbone of every country's economy and are a major component in using and transforming resources, asset building adding to the wealth of present and future generations. Unsustainable resource use can cause serious damage to the environment and contributes significantly to climate change.

The inter-relationship between the human communities and the protected areas plays a life sustaining role in maintaining the integrity of protected area and biological diversity. The command and control approach for the management of wetlands, where manipulation and control by humans result in less resilient ecosystems is described as the pathology of natural resource management (Holling and Meffe, 1996).

These climatic variations have been well perceived by the rural communities around TBWS and 96% of the community is of the view that climate change has been there in the shape of prolonged summers and less cold winters and rainfall unpredictability. In the meantime the local population has increased at the rate of 3.4% in the area and almost doubled in the last two decades. It was observed that the communities have opted for different professions as the opportunities changed. Before the construction of the barrage most of the people were involved in agriculture.

After the construction of the barrage agriculture lands were acquired by the government and converted into the pond areas. Natural salinity and water logging increased in the adjacent areas and compelled people to reduce agricultural farming. A significant decline of orchards of guavas, oranges, and mangoes was observed in the area but at the same time Typha and Tamarix proliferated. Similarly the fish catch increased from the ponds and that attracted the fishing communities from Sindh and other areas of Pakistan which increased the total number of fishermen from about 250 to 900 households over the last three decades.

The community is not well educated as local education is unstructured with a lack of trained teachers. Health care facilities are poor with just one hospital, with only 20 doctors and 15 nurses, to cater for a population of 240,000. New industries including e thermal power plants, sugar mills, ginning industry, flour mills have been introduced into the area in the last three decades and these provide n additional income source.

Advancement in agriculture has increased the income of the farmers with the use of better varieties of crops, use of insecticides, pesticides etc. Canal water availability has increased the agricultural products, although some of the farmers use tubewells. The local communities wish to live a sustainable livelihood but the majority of them are below the poverty line. With a lack of awareness and education they are compelled to use the natural resources in an unsustainable manner.

Occupational diversification in an economy is usually considered to be positive phenomenon, as it constitutes an important component of the growth process (Koppel *et al*., 1994; Unni, 1996).Formulation of economic and social strategies in accordance to climatic change makes resilient communities capable of retrieving from adverse situation .With substantial socio-economic networks they can call upon myriad of resources in hard times to tackle the situation and improve the health of community. Even being well aware of climate change and proving to be resilient to the changes caused by it the community is unable to decrease the impact on natural resources of the area as of having almost no other means of livelihood.

Conclusions and future directions: This paper observes the livelihood diversification in approaches to rural development at TBWS to consider the interactions among diversification resilience and natural resource management that could lead to advance the policy understanding of diverse rural livelihoods (Ellis, 2000). As the rural livelihoods framework (Ellis and Freeman, 2004)suggest that different livelihood activities by the rural population and the consequent outcomes are the influenced assets (natural, human, physical, financial and socio capital) so the agrestic community can understand the vulnerability baffled by the seasonal shifts andperilsfaced by rural community in conducting livelihood activities. Following recommendations could lead to enhance adaptive capacity of local people at TBWS.

- The emphasis must be on promoting awareness of both tangible and usefulness of the protected area to the rural community in the area and at the country level as well.
- Issues like the herd size and the composition of cattle and livestock, veterinary health care and alternative fodder availability should be looked into.
- The concerned government department should consider developing a buffer area in the sanctuary.
- Large scale use of variable renewable energy technologies that are economically viable.
- Use of new methods of cultivations. And new breed of cattle which are more productive in terms of meat and milk.
- Intensive efforts on afforestation and reforestation.
- Local rain harvesting.
- Development of capacity of deal with disasters like floods
- Participatory approach and use of traditional knowledge in management of natural resources.
- Develop and elaborate appropriate integrated plans for adaptations to the impact of climate change

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