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Climate change vulnerabilities in Sindh, Pakistan

Investing in preparedness

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Abbreviations

CCI	Council of Common Interests
CCP	Sindh Climate Change Policy
CCT	Conditional Cash Transfer
DDMA	District Disaster Management Authority
DI	Decile Index
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization
FCDO	Foreign, Commonwealth & Development Office
GIS	Geographic Information System
GoS	Government of Sindh
HHS	Household Hunger Scale
IDPs	Internally Displaced People
IOM	International Organization for Migration
IRSA	Indus River System Authority
KII	Key Informant Interview
LBOD	Left Bank Outfall Drainage
NASA	National Aeronautics and Space Administration
NFICCP	National Framework for Implementation of Climate Change Policy
NGO	Non-Government Organization
PDMA	Provincial Disaster Management Authority
PDSI	Palmer Drought Severity Index
PMD	Pakistan Metrological Department
RBOD	Right Bank Outfall Drainage
RDMC	Regional Drought Monitoring Centre
RRR	Relief Rescue and Rehabilitation
SCDA	Sindh Coastal Development Authority
SDNA	Sindh Natural Disaster Consortium
SLR	Sea Level Rise
SPEI	Standardized Precipitation Evapotranspiration Index
SPI	Standardized Precipitation Index or Reconnaissance
SWAT	Sindh Water & Agricultural Transformation
UNCCD	United Nations Convention to Combat Desertification
UNFPA	United Nation Population Fund
WFP	World Food Programme
WHO	World Health Organization

1. Introduction

Pakistan has been subjected to multiple climate change related disasters in the recent past. Over the years, climate change related disasters have manifested themselves in a variety of forms across Pakistan. From glacial melts that cause riverine floods, to cloud bursts that result in flash floods and landslides, forest fires, heat waves, fog in the winter months, droughts and excessive rain related flooding, etc.

Recent climate related events have amply demonstrated the lack of preparedness of Federal and Provincial governments to mitigate the effect of these disasters. This is in spite t a plethora of legislations and policies that have been put in place for this purpose. The Climate Change Act (2010), subsequent provincial policies in Punjab, KP and Sindh as well as the Pakistan Climate Change Policy of 2022 are also additional instruments in place. However, what we see on the ground is that much of the effort is directed towards response along the RRR (rescue, relief and rehabilitation) spectrum. There is thus very little visible investment that has been made on the Disaster Risk Reduction (DRR) front.

The key elements of a DRR framework developed in other developing countries include effective planning and financing for investing in preparedness, developing human capacity at the institutional level as well as work with communities to create awareness of climate related vulnerabilities and integrating the plans with the functions of relevant departments such as health, irrigation, social protection, communication and works, etc.

This study explores the policy framework required and the institutional prerequisites for an effective DRR strategy with respect to four specific climate vulnerabilities in the Sindh province of Pakistan, identified by the PDMA Sindh (PDMA, 2016) and the ADB (2017). These are: i) heat waves, ii) droughts, iii) rain and riverine flooding and iv) sea water intrusion.

The report is structured as follows: Section 2 describes the methodology adopted for the report. Sections 3 to 6 provide a description of the vulnerability, its impact on the areas affected, the institutional responses and DRR strategies required for sea water intrusion, heat waves, floods and droughts respectively. Since the Provincial Disaster Management Authority (PDMA) of Sindh is the central organization for the formulation and execution of a DRR strategy, Section 7 provides an institutional assessment of the organization.

2. Methodology

The proposed study aims to address DRR issues in Sindh province through a review of existing research and analysis of available secondary data. Existing sources of statistical data on four climate disasters drought, flood, saltwater intrusion and heat waves were reviewed and analyzed. These secondary sources include publicly available data from the PDMA, Irrigation and metrological departments. The primary data was collected by using qualitative methodology.

For each climate hazard floods, drought, saltwater intrusion and heatwaves we have selected four Districts Jamshoro, Tharparkar, Thatta Delta and Karachi respectively. The study is of qualitative nature and Key Informant Interview (KII) was used as a research tool. We used two separate KII checklists for experts' and community level interviews. The study design and research tools were approved by internal Ethic Review Committee (ERC). The key informant interviews were conducted with women and men community leaders in all three rural Districts Jamshoro, Tharparkar, Thatta Delta and two urban districts South and Malir of Karachi division. Total number of community based KII is 20. 10 KIIs with geographers and climate change and climate action experts were conducted in person and remotely by using online e.g. zoom. The CSSR's core team (woman and man) conducted all experts' and community-based interviews. In community level KIIs local field research assistants were hired to help in translations from local languages/dialects to Urdu. Almost all community based KIIs were recorded with consent of participants.

In Thatta three KIIs were conducted with men groups in coastal villages and two women KII in diverse community groups. In Tharpakar three KII were conducted with a woman elected representative, journalist and an NGO activist. Two KIIs (men and women) were conducted in a village setting. In District Jamshoro four KIIs were conducted with men and women and in two village sites one riverine village and another village adjacent to the Manchhar lake and in Karachi division KIIs were conducted in South and Malir districts four KIIs men women in each site. Around 20 KIIs including district level experts and community level men and women leaders has participated in the research study and 10 KIIs were conducted with government official and experts.

3. Sea Water Intrusion

Sindh's climate hazard prone geography also includes sea water intrusion in the delta regions. The Indus Basin's freshwater flows have reduced on the one hand and on the other hand sea levels rise (SLR) have taken on the characteristic of a slow-on-set climate disaster. Lives and livelihoods of the inhabitants of the delta region have been historically tied to the ecology of the region. Fishing and perennial agriculture based on controlled freshwater flows have been the mainstay of livelihoods of the inhabitants of the delta regions. Both forms of livelihoods are consistently diminishing leading to economic and social distress in the region.

We first present the existing quantitative as well as qualitative information on sea water intrusion in the delta regions of the province in section 3.1. Section 3.2 assesses the extent and nature of vulnerability that this climate hazard creates. We then look into the prevalent institutional responses and identify their shortcomings in section 3.3. In section 3.4. we identify adaptation and mitigation strategies.

3.1. Existing Information on Sea Water Intrusion in the Delta Regions

Sindh's coastline stretches over 348 km with the low-lying tidal Indus Delta region covering 210 Km in four southern districts including Thatta, Sujawal, Malir and Badin. Agriculture is the main source of livelihood in all of these districts. All three districts are lower riparian downstream of Kotri Barrage with a large population most vulnerable to SLR due to climate change, mainly because of global warming. The global mean sea level rise is higher in the current century than the previous two centuries from 0.2 m to 3.7 mm/year, (Weeks, et al. 2023). According to a DRR gap assessment report by PDMA "Sea level is expected to rise by a further 60 centimeters by the end of this century and will most likely affect the low-lying coastal areas south of Karachi toward Keti Bander and the Indus River delta.

At the local level, SLR is measured through tide gauges. In Sindh, there are only two tide gauge stations at Karachi coast and Keti Bandar in District Thatta. The tide gauge is being used for early warnings on rough weather including tsunamis, high speed winds, storms and cyclones in the Arabian Sea. The salt water intrusion can be measured through tide gauge, local geology and slope surveys. The tide gauge annual data shows that the tide height level in 1925 was 700 mm and in 2000 it was 7200 mm. A small ocean island Kharo Chhan in district Thatta faces significant risk from rising sea levels because sea water often inundates low-lying land surfaces there.

The low-lying Indus Delta region of over 210 Kms is also vulnerable due to upstream water mismanagement, which has badly affected fresh water and sediment flows into the sea. Due to inconsistent fresh water flows over the year into the sea, saltwater intrusion is rapidly increasing. The lack of fresh water and sediment flowing into sea, the rate of aggradation remains insufficient to keep up with local sea-level rise.

National and international reports on saltwater intrusion in the Indus delta forecast that saltwater intrusion will increase due to reduced freshwater supplies to the delta. The Climate Change Profile of Pakistan by (ADB. 2017) says that Sindh's coastal zone is of tidal flat topography with higher population concentration than the Balochistan coast. The report mentions 176 miles of coastal erosion per year due to SLR and that the delta is shrinking due to sediment aggradation of 1mm per year. The population in the Indus Delta will be at high risk in the coming future.

The National Framework for Implementation of Climate Change Policy (NFICCP) also clearly mentioned the increased intrusion of saline water in the Indus delta adversely affects coastal agriculture, mangroves and the breeding grounds of fish. The NFICCP also emphasized the threat to coastal areas due to projected sea level rise and increased cyclonic activity due to higher sea surface temperatures increases health risks and induced migration as well as enhance social and political conflict between upper riparian and lower riparian regions in relation to sharing of water resources (Climate Risk Profile ADB, 2021).

The irrigation and water management projects that regulate the flow of the river were based on the massive transformation that the economy and demography of the province, particularly the coastal and deltaic regions. These regions suffered due to projects such as Sukkur, Guddu and Kotri barrages. In the pre-Kotri barrage era, downstream flows were recorded at 71.6 MAF and 8.8 MAF in the Kharif-sowing season of summer crops and Rabi-sowing season of winter crop seasons respectively. After the construction of Kotri barrage, flows reduced to 56.4 MAF and 5.8 MAF in Kharif and Rabi seasons. The Tarbela Dam in 1976 further reduced flows of fresh water. Between 1976 and 2008, downstream Kotri flows were as low as 29.6 MAF in Kharif and 1.8 MAF in Rabi. WAPDA reports show that the annual variability of river flows downstream Kotri have been increasing day by day as are the number of days where the flow is 0 MAF in Rabi season. The recent water flows data called "Escapage below Korti" available at WAPDA's portal shows that there are almost low or no flows in Kharif 2023 in the month of August and during Rabi 2022-2023 in October and November there were regular but fluctuating flows and in other months there are no or very low flows (Brohi, S.2003).

One of our hydrology expert respondents said:

> "The policies and implementation processes are not human centric but infrastructure focused. The water and other disaster relevant authorities take sea intrusion and water flows downstream Indus Delta as a non-issue."

Further a hydro-geologist explained:

> "Seawater intrusion is like a seesaw: The place where freshwater and saltwater meet is the balance point between forces from land and forces from the sea. A push from the land side, such as heavy rainfall or high river flows, moves the

> balance point seaward. A push from the sea side – whether it's SLR, storm surge or high tides – moves the balance point landward" water level and allows seawater inland (Micheal. H. 2023)".

On the water politics and climate change disadvantages of dam construction (Gazdar, 2005) describes historical events and water accords. In 1991, the Council of Common Interests (CCI), which is a constitutional body for resolving issues between federal and provincial entities, engaged provincial and federal political governments to settle the water issue. The Indus Water Accord was signed and an autonomous body called Indus River System Authority (IRSA) was constituted to regulate and monitor Sindh's grievances on low flows in the Delta

3.2. Extent and Nature of Vulnerability due to Sea Water Intrusion

Hydrology experts are of the view that the Indus Delta is facing a human-made plight rather than a natural disaster. The Indus River basin has over 19 dams and 34 large canals. Therefore, fresh water flows into the sea and its sediments no longer replenish the delta. It is claimed by some agricultural experts that around 8,800 square kilometers of agricultural land have been lost to the sea (Bosshard, 2010).

The main crops in District Thatta during Rabbi season from mid-October to mid-April are wheat, barley, oil seeds and other grains. In the Kharif season, from mid-April to October, the main crops are rice, maize and millet. Other than main crops, fruits like date palm, coconut and banana are also grown in the delta. In 1988 total cultivable land was 116928 acres and in 2018 due to land degradation the cultivation was reduced to 48787 acres only. Three Taluka of Sujawal and three Taluka of Thatta have over 80 to 97 percent uncultivable land (Mahar and Zaighiam 2019).

The irrigation water distribution system is being controlled by big landlords and the lower riparian often face water shortages. Our respondent in Thatta reported:

> "We are small landholders in this area and on the tail of the water channel, water distributaries and watercourses. The upstream big landlords barricade water flows to us"

In the recent past the tropical cyclones Gonu-2007, Yemyin-2007 and Phet-2010 caused life and asset losses and recently Biporjoy-2023 with 2.5 m storm surge struck Karachi, Thatta, Sujawal and Badin. The PDMA reported that due to the threat of Biporjoy cyclone around 84,610 people were evacuated, around 2500 houses were damaged and 1800 livestock lost, and over 1000 acres of cropped land were damaged (Weeks, J. H.; et al. 2023).

A local social worker in Thatta explained sea intrusion and its relevance in irrigation water scarcity:

> “There are no proper irrigation water and drainage systems here. Therefore, during each monsoon, the habitants face inundation. We remember some 10 or 12 years ago; water flows deluged each and every thing because of breaches in the Indus River’s embankments. And then only one year later, there were torrential rains here. Almost all villagers had to move to various high elevation spaces and camps. Our villages are very near to the sea so all types of sea cyclones affect us in a cycle after almost three or four years. Some years ago, we were on high level threat of a cyclone and recently Biporjoy hit our villages. Majority of the population escaped on a self-help basis and the remaining were forcibly displaced by Rangers and Police.”

Sea intrusion being a slow onset disaster has caused voluntary and forcible displacement and the scale of migration is significant. For instance, Taluka Gharo Chan in District Thatta has 31 dehs. According to the Population Census 2017, in 5 out of 31 dehs in the Taluka, there are five dehs where the population in the 1981 census was 1,718 persons, this reduced to 1529 in the 1998 census and the 2017 census shows these dehs to have zero inhabitants (Mallah, 2013).

The economic impact of this slow onset disaster is also visible in decline in cropping patterns. Memon (2018) shows that the proportion of the labor force in livestock herding and rearing was 19.5% in 1990 and reduced to 0.8% percent in 2010 in the delta regions. Similarly, the labor force in rice cultivation has declined from 16.7% in 1994 to 4% in 2010.

3.3 Institutional Response

The Sindh Coastal Development Authority was created in 1994. In 2016, the Sindh government established the Environment, Climate Change & Coastal Development Department as an umbrella department to manage issues pertaining to the coastal region. The only contribution of note that these departments have achieved so far is regeneration of mangroves. The Forest Department has increased the mangroves cover to see tides over 160,000 hectares and envisages to cover 350,000 hectares of tidal river channels in the coast.

During our field work in Thatta, we witnessed the construction of embankments along the coast to protect villages from frequent inundation from high tides and cyclones. One respondent, who is a community leader, mentioned:

> “The development work is going fast after the BIPORJOY cyclone. During the cyclone, we had to leave our home and majority of the population went to camps where they were given ration, cooked food and clothing”.

3.4 Adaptation and Mitigation Strategies Required

As mentioned earlier, regeneration of mangroves and construction of embankments are the two mitigation strategies that have been adopted so far. While mangroves regeneration is a positive development, it will require resources to sustain the effort. The government has tapped into carbon credits for this purpose, which in turn has incentivized resource allocation for this purpose. Construction of embankments requires appropriate design so that it does not block freshwater flows into the sea.

Agriculture extension services need to be mobilized to demonstrate changes in cropping patterns that are appropriate for saline and waterlogged soil texture. Research has shown that for soils with up to 20 per cent salt patches are appropriate for crops such as cluster bean, wheat, maize, millet, turnip, sorghum and mash beans (Ashraf, M. et al. 2022).

Most importantly, adaptation and mitigation strategies need to incorporate the ‘lived experiences’ of individuals and communities who are vulnerable to sea-level rise (Kafle S.K, 2017). The World Bank has also emphasized the need to implement voices of most vulnerable communities and individuals in disaster risk planning, response, recovery and preparedness activities (World Bank, 2021).

4. Heatwaves

A heatwave is an extended period of exceptionally hot weather, often accompanied by high humidity, compared to typical seasonal conditions (WMO, 2023). Defined by the World Meteorological Organization as five consecutive days with temperatures exceeding the average maximum by 5°C, heatwaves are common in Pakistan, particularly in May and June (Babar, Tazyeen, and Khan, 2021). Characteristics such as duration, frequency, and peak temperatures help identify and understand these events (WMO, 2023).

Generally global climate change impacts the monsoon rainfall cycle which causes extreme heat waves. Rapid urbanization, industrialization, increase in heat trapping dense infrastructures, deforestation, land use changes, and rise in the number of vehicles, all contribute to increases in greenhouse gas emissions, which in turn lead to climate change induced extreme weather events such as heatwaves (Hassan, A. 2023).

Simultaneously atmospheric circulation patterns such as weather with high-pressure systems can also lead to stagnant air masses and reduce cloud cover and cause extreme heat waves. The atmospheric circulation patterns can be measured by using weather data, satellite imageries and various climate monitoring models. One common index to measure such occurrences is the Heat Index (HI). This combines air temperature and relative humidity to estimate how hot it feels to human body (Meehl, et al., 2004). Between 1983 and 2016, urban population exposure to extreme heat is reported to have increased by approximately 200%, globally and in the South Asian region three cities New Delhi, Karachi and Lahore experienced the largest increase (Tuholske et al 2021).

In the Sindh province, the northern districts including Jacobabad, Shaheed Benazir Abad, southern coastal districts including Karachi suffer from heatwaves every summer. Shaheed Benazir Abad district recorded the highest temperature of 50.2 °C in April 2018 (Arshad. A, et al 2022). Over the past six decades, the nighttime temperature has increased by 2.4ºC and daytime temperatures have increased by 1.6ºC (Anwar et al. 2022).

To understand the impact of heatwaves, Karachi Division was selected for this study. Karachi is a large coastal city with a population of 18 million, with a coastal belt spanning 90 kilometers. Karachi experienced a devastating heatwave in the summer of 2015.

4.1 Exposure to Heatwaves in Sindh

Karachi is in the region where mean annual rainfall is 5 to 10 inches and humidity averages 60% to 70% in the summer (Khan. S.U 2010). The consequences of heatwaves in Karachi are primarily due to elevated humidity, high temperature and minimal wind during the summer months. When combined with problems in the water

supply and frequent power outages, the impact on disadvantaged residents can be catastrophic (van der Linden, et al., 2019). In contrast, affluent areas of Karachi with backup generators experienced fewer casualties during heatwaves (PMD, 2017).

In 2015, the maximum temperature in Karachi was 44.8 °C and temperatures in this range continued for five successive days from the 19th to the 23rd of June (PMD, 2017). In regions with maritime climates such as Karachi, elevated temperatures combined with high levels of atmospheric water vapor result in heightened discomfort due to extreme heat sensations. On 20th June the Heat Index scaled up to 66 °C due to reduced winds and high levels of humidity. This was the highest temperature recorded for the month of June since the year 2000 (Hassan, A 2023).

Personal accounts from affected communities underscore the severity of the 2015 heatwave and the need for proactive measures. A community leader in a highly compact high-rise building in Lyari lamented, "There were boiling days and even nights during that fortnight of June 2015. There was no electricity supply for hours, and water vendors disappeared. There was no emergency support from government.

The elderly, women in homes and porters were prime targets of heatwaves. Similarly, a fisherfolk family in the Ibrahim Hydri locality of Karachi that had migrated from Thatta several decades ago due to livelihood issues, shared their experience:

> "My wife died during heatwaves because she couldn't tolerate the heat of the day. Our home is congested and there was no ventilation in the rooms and kitchen and the roof was made of tin. My daughter is mentally ill due to extreme heat and the trauma of her mother’s death."

4.2 Vulnerability of Low-Income Settlements

According to Gazdar and Mallah (2013), 44.1% of the city’s population lives in planned neighborhoods, while 35.9% resides in unplanned settlements and 19.1% live in informal residential settlements. The unplanned urban spaces, which are easily recognizable, are typically inhabited by poorer segments of the population and compared to planned settlements, often serve as habitats for historically marginalized and socially excluded communities (Gazdar and Mallah, 2013).

(Li.C. et al, (2023) explored geo-spatial data sets to measure land use and land cover in Karachi. According to this study, the formal built-up area in 2005 was 498.03 km2 and in 2020 and it had increased to 749.78 km2. Such rapid change in land use is symptomatic of an increase in population density, more use of concrete in the built area and consequently less vegetation. Similarly, the informal settlements also have dense and unplanned housing as well as limited or irregular access to water and electricity. (Li.C. et al, (2023)

Anwar, et al, 2022, have divided Karachi into specific geographies of heat vulnerabilities;

a) Homes: Informal or unplanned settlements, Katcha structures, shacks, rag made homes, shelterless in open land parcels,
b) Commuters: Pedestrians using semipublic transit like Rickshaws, Qingchis, cycle, carts and other public transport.
c) Work: Industrial and construction workers, all types of venders in streets, home based workers
d) Public Spaces: These include parks, road and pavements and street markets.

The high-rise, densely built infrastructure constructed predominantly of solid concrete tends to absorb and retain heat from the sun's rays, as well as from human activities such as the use and combustion of various fuels. In densely populated urban spaces, this phenomenon leads to more frequent and intense occurrences of heat waves and stress, commonly referred to as the "urban heat island effect (Anwar, et al 2022).

The building structures and roof types exacerbate the indoor temperature impact, particularly affecting individuals who spend prolonged periods indoors, such as women with limited mobility and elderly residents of unplanned informal settlements (Mariam et al., 2023). For instance, in these settlements, tin roofs are notorious for contributing to the urban heat island effect. Daily wage laborers, who toil outdoors amid exposure to sunlight, air pollution, and limited or untimely access to healthcare face heightened vulnerability during heatwaves (Mariam et al., 2023). Elderly people, especially laborers, women, and children, bear the brunt of heatwave episodes (Anwar, 2022).

4.3 Economic Impact of Heatwaves

Beyond human casualties, heatwaves detrimentally impact the economy by diminishing industrial output, reducing labor productivity, and constraining mobility (Hanif, 2017). Prolonged periods of high temperatures not only pose immediate health risks and disrupt livelihoods but also represent a slow-onset disaster with long-term repercussions on health, chronic disease incidence, work efficiency and labour productivity (Anwar, 2022).

4.4 Institutional Response to the 2015 Heatwave

The Provincial government decided to develop a heatwave management plan. The Commissioner’s office was given the responsibility to develop this plan. This plan, created between October 2016 and May 2017 with input from experts and stakeholders, was meant to outlines actions before, during, and after extreme heat events. The Terms of Reference had three main objectives.

b) Provide timely and specific information through a three-tier alert system, incorporating temperature forecasts from the Pakistan Meteorological Department. This also included installing weather monitoring stations, collecting data on heat-related morbidity and mortality.

b) A coordination setup was established. For this purpose, an Emergency Response Coordinator was appointed with the mandate to coordinate emergency heat response across government departments, utility companies as well as NGOs.

c) The plan also developed longer-term strategies, which included aligning with Karachi's Strategic Development Master Plan 2020 to adapt land use regulations by designating areas for high-rise development with adequate infrastructure and open spaces.

The plan also included developing urban heat islands in inner city areas during cycles of city renewal, incentivizing green urbanization through building and land use regulations, nurturing multiple city centers to reduce congestion, and investing in sustainable transport options are all essential components of the comprehensive approach to heat management in Karachi.

Eight years down the road, there has been little progress on the Plan. Data collection and prediction of heat waves has certainly improved. However, there appears to be nothing that has happened in terms of incorporating heat related specifications in building bye-laws and relevant changes in land use regulations. While there has been some regeneration of parks in the city, there has been no concerted effort at creating additional green spaces or to reduce congestion in the city either.

The central problem with the institutional response has been that it is bureaucratically driven, with no political ownership. Now that a local government structure is in place in the city, it will be appropriate if it is housed with the local government. The local government system can reach both lower tiers of government as well as the provincial government and is also better placed to draw on civil society expertise and resources to draw up an implementable risk reduction plan.

4.5 Lessons from Ahmedabad, Gujarat

Ahmedabad, a city in Gujarat, India, experienced a deadly heatwave in 2010. After the event, the Ahmedabad Municipality, in conjunction with the State government, civil society and the medical community to devise a heat management plan. After thorough consultations, the Plan was launched in 2013, with three important components: I) long duration forecasts to provide adequate time for mobilization, ii) Multi-lingual dissemination campaign through pamphlets and traditional as well as social media, and iii) Enhancing capacity of medical professionals to recognize and respond to heat related illnesses.

Five years later, a survey was conducted which demonstrated that “many lives have likely been saved, local health professionals’ awareness of predicted heat waves and capacity to care for patients with heat-related illnesses have increased, and overall, Ahmedabad is now much better prepared for heat wave.” (AMC, 2018). Based on Ahmedabad’s success, another 10 cities in India have replicated the model.

The underlying reason for success was that it was the elected municipality that took the initiative. This created the requisite political ownership that enabled the Municipal Corporation to provide resources and enlist support from the medical community and the meteorological authorities.

In recent years, heightened attention to vulnerability and impact assessment of extreme heat, alongside the recognition of comprehensive planning needs and collaborative efforts against heatwaves in South Asia is developing. Due to limited technical knowledge, financial constraints, and low-income levels, South Asian countries are particularly vulnerable to heatwaves.

In recent years, there has been a shift in focus towards vulnerability and impact assessment of extreme heat, considering various intricate, interrelated parameters. Given the extensive impact of heatwaves on lives and livelihoods, the scientific community is working on developing indices to estimate the magnitude, duration, and intensity of heat stress. Despite the existence of policies, noticeable disparities exist in their ground-level implementation and initiation.

Given the similarities in urbanization, climate, and socio-economic conditions among South Asian nations, collaborative efforts and shared knowledge through multi-disciplinary research endeavors are imperative for effective mitigation and adaptation strategies against extreme heat (Kotharkar and Ghosh, 2021).

4.6 Regional Collaboration

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5. Floods

The River Indus, spanning approximately 3,000 kilometres, is a vital watercourse in Asia with a catchment area of around one million km^2 (Panhwar, 2002). Predominantly flowing through Pakistan, it constitutes 65% of the Indus Basin and covers 75% of the country's land, with approximately 930 km of its course winding through the Sindh province (Panhwar, op.cit). River Indus, adopts a meandering course in Sindh, forming an 'S' shaped curve with major outer and inner curvatures near the cities of Dadu and Hyderabad respectively. The riverine floodplain in Sindh, crucial for agriculture and livelihoods, is confined between protective levees, constructed to manage the common occurrence of river discharge exceeding 300,000 cusec during floods (Panhwar, op.cit).

The climate in Sindh varies across three distinct zones, each contributing to the province's ecological diversity. Additionally, historical disputes over water usage and dam construction persist between India and Pakistan, which led to the signing of the Indus Waters Treaty in 1960 (Kazi, 2010). Intra-state disagreements within each country further complicate water management issues. The complex interplay of geographical, climatic, and geopolitical factors pose significant challenges to the sustainable development of the River Indus region, especially since it is also prone to extreme flooding events that are being aggravated not only by climate change but inefficient river basin management (Kazi, 2013).

Between 1950 and 2011, Pakistan witnessed an average of one flood every three years, totaling approximately 21 severe floods within this timeframe. These calamitous occurrences resulted in substantial human casualties, with 8887 lives lost, and left a lasting economic imprint, reaching $19 billion (Ali et al., 2022). Notably, 2010 stands out as a catastrophic milestone, marked by super floods that claimed 1985 lives, inflicted a tangible economic setback of $9.7 billion, and directly or indirectly affected 200 million people (Shah et al., 2019).

In 2022, the monsoon floods exacted a grim toll on Pakistan, claiming the lives of at least 1500 individuals and affecting 33 million people (United Nations, 2022). The aftermath witnessed 5.4 million people displaced, 72 districts officially declared as 'calamity hit,' and extensive devastation, including the destruction of 2 million acres of crops and orchards, along with 2 million homes (United Nations, 2022). Between June and August 2022, Pakistan grappled with unprecedented floods and heavy rains, a consequence of extreme precipitation, and glacial melt, intensified by climate change (UNOCHA, 2023). Impacting one-third of the country, the disaster led to widespread flooding, landslides, and extensive damage to lives, property, and infrastructure (UNOCHA, 2023). Of the 33 million people affected, 20.6 million required urgent assistance, leading to the displacement of 7.9 million individuals, including 664,000 seeking refuge in camps (UNOCHA, 2023). The floods devastated 1.7 million hectares of crops, and caused the loss of

more than 800,000 livestock, pushing over 8 million people into poverty (PDMA, 2023). The disaster damaged 30,000 schools and 2,000 health facilities, exacerbating challenges in accessing essential services. Climate-induced floods have created a distressing cycle of displacement for communities, imposing a severe human and socio-economic cost, particularly on vulnerable groups (UNOCHA, 2023). Urgent measures are imperative to enhance resilience and adaptation in the face of escalating climate threats. Sindh bore the economic brunt, accounting for 70 percent of the country's losses, while other provinces also experienced a substantial losses (UNOCHA, 2023).

5.1. Extent of Damage and geography of vulnerability

The rainfall in July of 2022 exceeded the average by more than 307% and in August, it was 726% higher than the usual monthly average (GOS, 2022). Khairpur witnessed the highest number of casualties, while Sanghar faced the greatest impact in terms of affected families and populations (PDMA, 2023). Larkana recorded the highest number of injuries, signaling a significant health crisis in the region (PDMA, 2023). Furthermore, Khairpur stood out with the highest proportion of damaged roads among districts (PDMA, 2023). In contrast, Hyderabad experienced the highest number of Union Councils affected, highlighting the widespread geographic reach of the disaster across these districts (PDMA, 2023). As per UNOCHA, flood waters persisted in districts like Dadu, Jacobabad, Kambar, Shahdad Kot, Khairpur, Mirpur Khas, Jamshoro, Sanghar, Umer Kot, Badin, Shaheed Benazir Abad, and Naushahro Feroze, causing a prolonged humanitarian crisis (UNOCHA, 2023). As of January 2, 2023, the Provincial Disaster Management Authority of Sindh reports over 89,000 people still displaced, with Dadu having the highest number of internally displaced persons (IDPs) at 41,742(UNOCHA, 2023). 24 out of 30 districts were declared as calamity hit. These vulnerable communities faced added challenges during winter, especially in mountainous and high-altitude areas (UNOCHA, 2023).

5.2. Causes of Vulnerability: The role of the Left and Right Bank Outfall Drains

There is a consensus amongst locals and experts in Sindh on the manner in which the two drainage projects called the Left Bank Outfall Drain (LBOD), and the Right Bank Outfall Drain (RBOD), have impacted Sindh’s natural drainage system, and exacerbated the impact of monsoon floods and consequently enhanced vulnerability of the districts in immediate contact with it (Kazi, 2014).

The Left Bank Outfall Drain (LBOD) was conceived to address waterlogging and salinity issues in Sindh, particularly in lower Sindh (Kazi, 2014). It aimed to protect fields irrigated by various canals, notably the rice canal diverted at Sukkur Barrage (Kazi, 2014). LBOD received substantial funding from the Asian Development Bank (ADB), with the expectation that it would effectively manage excess irrigated water and prevent waterlogging and salinity problems (Kazi, 2014). However, the canal's flawed design and inadequate drainage structure have contributed to severe flooding issues and ecological destruction in the region (Kazi, 2014). LBOD is designed adjacent to districts Nawabshah, Sanghar, Mirpur Khas, and Badin (Kazi, 2014). The canal exhibits design flaws that hinder the large natural drainage system of lower Sindh, formed by both the Indus River and the Sarasvati-Hakro River (Engineer Sevan (09/09/2023). The obstruction of drainage channels has been a primary reason why water hadn't drained from the Badin district for more than half a year after the floods (Kazi, 2014). LBOD's inadequacies have proven detrimental during massive rain events, exacerbating flooding problems in the region (Nawaz, 2022).

The Right Bank Outfall Drain (RBOD) is another structure that forms the water resource management of Indus river, particularly for Lake Manchar (Mahessart et al., 2019). Originally, a natural drainage system supplied water to the lake from the Indus River via Hamal during the monsoon season, but it was disrupted by road construction and land conversion(Mahessart et al., 2019). Implemented to address drainage needs, RBOD comprises RBOD-III, RBOD-I/MNVD, and RBOD-II (Mahessart et al., 2019). RBOD-III manages wastewater from Baluchistan and Sindh, connecting with RBOD-I at Mirokhan and Shahdadkot drains. RBOD-I/MNVD links to RBOD-II at the Indus Link, flowing parallel to the Indus River and discharging into the Arabian Sea (Mahessart et al., 2019). Presently, RBOD-I/MNVD receives around 4500 cusecs of wastewater, posing challenges to Lake Manchar (Mahessart et al., 2019). The ongoing construction of RBOD-II aims to curb pollution, but concerns persist about potential lake volume reduction and ecosystem impact due to decreased water supply (Mahessart et al., 2019). The RBOD-II is yet to be completed despite a 2019 deadline (Dawn, 2021).

The breach of the Main Nara Valley Drain (MNV Drain)/RBOD-I contributed to the overflowing of Lake Manchar, resulting in the formation of a colossal 100km lake (NASA, 2022). During the devastating floods in early September 2022, Lake Manchar experienced both natural and artificial breaches . Officials, attempting to prevent a catastrophic overflow into densely populated areas, had artificially created breaches to manage the water levels (NASA, 2022). However, these breaches placed several hundred villages and over 100,000 residents in the direct path of floodwaters, exacerbating the impact of the extreme monsoon rains (Community Interview: 09/09/2023; NASA, 2022). The breached MNV Drain and the subsequent overflow of Lake Manchar exemplify the challenges faced in managing water resources and preventing widespread flooding in the region (NASA, 2022).

5.3. Institutional Response

The Sindh Government, in coordination with the Federal Government, International Development Partners, NGOs, and other stakeholders, actively participated in rescue and relief operations to provide essential aid in areas affected by floods (GOS, 2023). Simultaneously, the government emphasized rehabilitation efforts with a 'build-back-better' strategy to bolster resilience against future disasters. The 'Post-Disaster Needs Assessment' report of October 2022, carried out by international experts from the World Bank, Asian Development Bank, European Union, and UNDP, sought to assess damages, losses, and needs with preliminary estimates (GOS, 2022).

Immediately after the flood, in collaboration with the Urban Unit, the Government of Sindh initiated a Joint Flood Damage Assessment Survey in flood-affected areas (GOS, 2022). The objective was to evaluate the damage and losses caused by the floods, employing an android application for digital surveys and a monitoring dashboard (GOS, 2022). The joint survey team, consisting of representatives from District Administration, Local Government, PDMA, NDMA, and the Pakistan Army, received training on utilizing the android application before conducting surveys in 24 calamity-hit districts (GOS, 2022). The survey covered 2.1 million households, revealing that 31% of houses were partially damaged and 69% were fully damaged, with 79% being Kacha and 21% Pakka houses (GOS, 2022).

The Sindh government, in collaboration with the World Bank, Asian Development Bank, and other partners, is actively addressing flood-related challenges. The World Bank has committed significant support, approximately $500 million each, for crucial initiatives like the 'Sindh Flood

Emergency Rehabilitation Project,' focusing on infrastructure, livelihoods, and rescue services, and the 'Flood Response Emergency Housing Project,' centered on low-cost housing reconstruction (GOS, 2022). Additionally, the 'Sindh Water & Agricultural Transformation (SWAT)' project, initially aimed at modernizing agriculture, has been restructured to provide subsidies for winter crops (GOS, 2022). The World Bank is also backing projects targeting healthcare services, social protection, and the 'First 1000 Days' for Pregnant and Lactating Women across Sindh (GOS, 2022). The provincial government is strategically aligning resources to address extensive rehabilitation needs, recognizing the pivotal role of international assistance, particularly from the World Bank, in supporting these critical initiatives (GOS, 2022).

At community level, our field interviews in Sewan, at Karampur and Manchar Lake revealed that response was make-shift and mostly aided by NGOs. Manchar Lake had to be completely evacuated; water levels were as high as the Basic Health Unit located in the highest area near to the lake. In Karampur, the communities themselves had to come up with plans to protect their village from being flooded. They used make-shift sacks full of soil or mud to raise the heights of embankments. Help from the governments arrived a few days later but it was NGOs that were mostly involved in rescue efforts (Community Interview: 09/09/2023).

5.4. Medium and Long-term Response

The Key pillars required to create an appropriate medium and long term response for disaster risk reduction are presented in section 5.5.1. In Section 5.5.2, we present suggestions that our field respondents made.

5.5.1. Rectifying Systemic Issues:

Drainage of the Indus River in Sindh is an outcome of historical developments. The colonial government started manipulating the river morphology to maximize agricultural output. This altered the natural drains for flood water to flow. The colonial legacy carried on post-partition also.[1] The strategic policy in response to the 2022 floods developed by the Government of Sindh acknowledges this issue and aims to rectify it (GOS, 2022). This will also require that excessive focus on the safety of large infrastructure – barrages and dams – for irrigation but also prioritize people and their livelihoods as part of mitigation strategy on floods. The GoS flood strategic policy does address these issues.

5.5.2. Adaptation Perspectives from the Community

In Sindh, the drainage challenges leading to severe flooding are multifaceted. Natural waterways for stormwater drainage, known as dhoras, particularly on the left bank of the River Indus, face blockages due to chocking and encroachments, accommodating around five million people (Kazi, 2014). The construction of embankments aimed at preventing river overflow has inadvertently resulted in settlements on both sides, and the lack of maintenance has led to embankment failures, causing widespread floods impacting life, property, infrastructure, and agriculture (Kazi,

[1] Perspective of a respondent who is a geographer with extensive work on Pakistan.

2014). Ineffectiveness in surveillance and protection of embankments, coupled with unauthorized diversions of floodwaters, exacerbates the situation (Kazi, 2014). Dams and barrages, including Guddu, Sukkur, and Kotri, have altered river flow dynamics, diminishing the return period of riverine floods, with existing structures deemed under-designed (Kazi, 2014). Encroachments on natural drainage areas, coupled with the higher elevation of the River Indus in Sindh, hinder the return of floodwater to the river, necessitating pumping or evaporation (Kazi, 2014). The implementation of the Indus Waters Treaty has significantly reduced the annual river flow to Pakistan, impacting the intensity and frequency of riverine floods (USIP, 2017; Kazi, 2010). Furthermore, floods are intensified by the synchronization of heavy rainfall with riverine flow during abnormal rainfall years, emphasizing the need for holistic flood management strategies tailored to Sindh's complex drainage issues (Kazi, 2014).

It was revealed during community interviews that a major lake in Sindh, Manchar lake, has suffered over the decades, its water quality degraded and the communities that once derived their livelihoods from it left destitute and afflicted by health issues. One of our field accounts with a Lady Health Worker mentioned how skin disease had slowly made its way into the community owing to the degrading water quality of Manchar lake.

During the 2022 floods, the community of Karampur in the face of the rising water levels, built makeshift embankments using sacks of mud. As help from the government or NGOs was yet to come, the community relied on available resources to protect their village. Such behaviors can be supported and brough to scale for the rest of the province to strengthen disaster preparedness initiatives. Local capacity can be enhanced for self-rescue and immediate response by empowering communities and leveraging their indigenous knowledge (Amin, 2023). This can lead to an integrated resilience approach, combining technology, local wisdom, and insurance to fortify community resilience against floods (Amin, 2023).

From community interviews, it was realized that most communities were still reliant on a single source of livelihood, such as fishing or agriculture. Implementing comprehensive programs aimed at diversifying livelihoods for communities, ensuring sustainable income sources (Shah, A.A., Gong, Z., Khan *et al*, 2021). These initiatives not only reduce dependency on fishing but also address the impacts of declining fish populations (Shah, *et al*, 2021). Livelihood diversification, illustrated in a study in Khyber Pakhtunkhwa Province, is vital for small-scale farmers, offering a solution to low agricultural productivity (Shah, *et al*, 2021). By adopting off-farm and on-farm strategies, small farmers can reduce climate-related risks, alleviate hunger, and improve overall well-being, emphasizing the need for supportive government policies and climate adaptation initiatives (Shah, A.A., Gong, Z., Khan *et al*, 2021).

The National Disaster Management Authority reports that 2,000 health facilities, constituting 10% of the country's total, are damaged or destroyed, leaving eight million people in urgent need of health assistance (WHO, 2023). Stagnant water in Sindh posed a substantial health threat, hindering access to facilities for over 50% of those in need. The province faces a high risk of disease outbreaks, including malaria and dengue, while rising Severe Acute Malnutrition cases add to the existing concerns (WHO, 2023). Disruptions in immunization campaigns, tuberculosis

and HIV treatment, and the polio vaccination campaign exacerbated the health crisis (WHO, 2023). COVID-19 transmission added another layer of risk, especially for displaced individuals. Low stocks of essential medicines, damaged transport infrastructure, and compromised disease surveillance further contribute to the challenges (WHO, 2023). Urgent, coordinated responses are essential to address Sindh's heightened health risks and healthcare disruptions (UNOCHA, 2023).

While on field, it was revealed that the Basic Health Units in Dadu and Sevan, particularly close to Manchar Lake, were all under water. It is not only imperative to increase healthcare capacity but also focus on the provision of healthcare in a crisis setting. The capacity of which Sindh does not have (Field Account: 09/09/2023).

It is common for those impacted by disasters to lose earnings and assets, particularly in vulnerable settings of Sindh, as it is the worst afflicted region of Pakistan to flooding. Financial tools play a pivotal role in disaster risk management, mitigating economic impacts by addressing direct losses and supply chain disruptions (Pillay, K., Ballabh, H., Pillay, S., 2023). These tools, supporting climate adaptation, help integrate resilient measures into community infrastructure, enhancing overall vulnerability reduction. Additionally, financial solutions contribute to bolstering economic resilience, aiding communities in bouncing back from geophysical hazards (Pillay, K., Ballabh, H., Pillay, S., 2023). By combining financial instruments with risk reduction measures, a comprehensive disaster risk management strategy is achieved, utilizing diverse finance sources, both public and private, for a multifaceted approach to building resilience (Pillay, K., Ballabh, H., Pillay, S., 2023).

6. Drought

The United Nations Convention to Combat Desertification (UNCCD) defines drought as "the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems" (Memon, M. H et al. 2018)

The Sindh province has irrigated plains including arid and semi-arid zones such as desert and mountain ecosystems. The arid desert zones cover over approximately an area of 68,000 km sq. The livelihood of the majority population in deserts depends on cattle raising and dairy production including grain cultivation after monsoon rainfall. In normalize climate conditions the economic potential of the habitants in those ecoregions is limited as compared to other low-lying regions with perennial or even non- perennial irrigation systems. The desert zones have no timely and sufficient rainfall causing low humidity, high temperatures, dusty storms, high evaporation rates and abnormal aridity that leads to moderate, severe and extreme droughts. The long moderate and short or long severe drought spells badly impact livelihoods.

Firstly, the rainfall below the average or unevenly distributed rainfall in monsoon or summer seasons is the main cause of hydrological drought and secondly meteorological drought is there due to a rise in temperatures, dryness, thirdly because of low moisture due to low precipitation. The fourth factor is shortages of water in the Indus due to low ice melt and disputed water distribution to Sindh particularly in lower riparian semi-arid districts. These climate change hazards can be measured through various gauges, weather stations, various remote sensing techniques and satellite data. Other than those four main causes of drought we can include the deforestation and changes in land use as supplementary causes of droughts. Forestation and green spaces in both semi-arid and arid districts reduce rapid impacts of droughts.

But the core factor is climate change including global warming, sea temperatures and sea-level rise. For climate hazard assessment the hydrologists and meteorologists often use various indices for example to assess drought conditions, anomalies, periods and vulnerable locations the Decile Index (DI), Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI) or Reconnaissance Drought Index [RDI]), Standardized Precipitation Evapotranspiration Index (SPEI)[2].

[2] There are four categories of droughts, D0-abnormal dry, D1-moderate drought, D2-severe, D-3 extreme and D4-exceptional drought. The percentile ranges and Standard Precipitation Index (SPT) and Standardized Precipitation and Evapotranspiration Index (SPEI) for normal or wet conditions, SPT is 30.01 or above SPEI -0.49 or above. The SPT for D-1 20.01 to 30.00 and SPEI -0.5 to -0.79, for D-2, 5.01 to 10.00, and -1.3 to -1.59 for D-3, 2.01 to 5.00 and -1.6 to -1.99 and for D-4, 0.00 to 2.00 and -2.0 or less

6.1. Frequency and Impact

Out of 30 districts in Sindh there are 8 districts including our site Tharparkar faced the worst drought situation historically in 1871, 1881, 1899, 1931, 1942, 1999, 2003, and the drought hazard continued in recent past years 2020,2021, and 2022. According to a PDMA report in recent decades a long spell of drought was of four years between 1999 to 2002. Out of the total arid desert area over 68,000 km sq of Sindh province the district Tharparkar covers more than 30 percent. according to poverty indices 28.4 percent of the rural population of the district is below the poverty line (Adnan. et al, 2018).

Ahmed. M. et al (2023) mentioned in the latest natural hazard research that the Thar zone had the longest drought duration of 15 months (September 2001—November 2002) in the 3-month SPEI. In the 12-month SPEI, Thar had the longest drought duration of 25 months (June 1986—June 1988). The latest 2001-2002 longest spell of drought affected 1.4 million population, crops on 12.5 million acres were damaged including 5.6 million cattle head due to hunger and increase in disease epidemics. The drought caused undernutrition including stunting and wasting in children and anemia in women. The droughts also pushed thousands of families and individuals to force for both temporary and permanent migration. In continuity of droughts during years 2020 and 2021 Sindh faced drought like situation due to blew the normal rainfalls. The rainfall from October to May was below normal -36.1 percent in overall Pakistan and it was -64.5 percent in Sindh so in the moderate drought situation leaned toward severe particularly in southern districts of Sindh province (Hina. H & Saleem. F, 2019).

The PDMA report estimated losses due to severe and moderate droughts in between 1999 and 2002. The report mentioned that 1.8 million were expected to suffer acute food insecurity and hunger due to high food and fuel prices and also the impacts of dual hazard the COVID-19 pandemic. Not only prolonged drought spells but even short spells drought can damage and harm the local economy (PDMA, 2022)[3].

PDMA conducted a household sample survey in 2018 in collaboration of national and international organizations (SDNA, 2019). Sindh Drought Needs Assessment was conducted in 8 drought vulnerable districts of Sindh. This household survey's analysis shows high reduction in produce of traditional desert crops in for example cluster bean highest reduction 92 per cent, millet 84 percent, pulses/lentils 95 percent, sesame 100 percent in Tharparkar. Also, the Household Hunger Scale (HHS) in SDNA recorded the highest 47 percent in Tharparkar,

[3]See drought details available at PDM website : https://pdma.gos.pk/drought/#:~:text=The%20Sindh%20province%20is%20historically,persisted%20till%20the%20year%202002.

illnesses or deaths of breadwinner 36 percent and livestock disease outbreak was also highest. PDMA's survey report also mentioned that the percentage of indebted households in Tharparkar highest 40 per cent (SDNA, 2019).

6.2.Institutional Response

In Sindh province we have a Regional Drought Monitoring Centre (RDMC) at Karachi[4]. The center has been functional since 2006 with 159 drought measurement stations by collecting rain data from all drought stations as well as from other relevant departments such as the agricultural department. Sindh government's Climate Change Policy (CCP-2022) emphasized on "Regeneration of Desert Ecosystem" and outlined the strategic objectives and responsibilities of lead departments for example: to improve and develop water availability to manage the limited water sources is the responsibility of Irrigation department, PHED, Local government, directorate of Climate Change ECC&CDD and P&D. The CCP has given responsibilities and mandate to enhance the use of advanced irrigation technologies, increase vegetation, reduce degradation, deforestation to various relevant departments and NGOs and other partner service providers (SCCP, 2022).

A high-level consortium the Natural Disaster Consortium (NDS) was established in 2015 by the government of Sindh in coordination with the PDMA to climate action response to droughts through multidimensional interventions. The ultimate goal of the NDS was to "assist at-risk and affected communities to prepare for, respond to and recover from natural disasters". The consortium has conducted (SDNA, 2019) surveys in 8 drought vulnerable districts including Tharparkar. The consortium is comprised on FAO, UNICEF, HANDS, ACTED and led by IOM[5]. The international organization WFP, WHO, OCHA[6], and UNFPA had provided technical support to complete this assessment and the FCDO provided financial support for SDNA (Government of Sindh, 2019).

A male respondent informed that:

> The district's relief division is very active here, they often declare drought calamity if rain falls below the crop requirement till mid-August. For example, 2017 to 2019 or you may include 2020 Tharparkar was declared as a 'calamity hit' district.

[4] See RDMC's drought map https://ndmc.pmd.gov.pk/new/outlooks.php
[5]See IOM Website on NDS https://www.iom.int/news/iom-led-consortium-provides-emergency-aid-flood-affected-families-pakistans-sindh-province
[6] OCHA support government of Pakistnan in publishing Drought Bulletin (quarterly) https://reliefweb.int/report/pakistan/drought-bulletin-pakistan-july-september-2023

In 2018 the Sindh government approved distribution of 100 kg wheat among 287,000 families and drought affected areas.[7]

(FICCP 2014- 2030) recommends integrated conservation approaches for adaptation to climate change which can prevent and reduce the widespread land degradation and desertification processes, such as droughts. That can be possible alternative land use and conservation management plans and strategies. The policy framework also recognizes most vulnerable the marginalized people who face food insecurity due to failing of crops, loss of livestock and relocation of dwellings due to water and energy resource stress[8].

The Federal Government of Pakistan had launched the Benazir Income Support Programme (BISP) in 2008. This unconditional cash transfer programme, a women centric social transfer programme was implemented to reduce or mitigate food prices and vulnerability to hunger as idiosyncratic shocks. Currently BISP has 153,077 women beneficiaries in all 7 Tehsils of Tharparkar and an amount PKR, 1,288,505,500 has been transferred to accounts of those beneficiaries[9].

Recently in 2022 the Government of Sindh has constituted the Sindh Social Protection Authority (SSPA) to develop a comprehensive social protection strategy and implement social transfer programmes. SSPA, Mother and Child Support Programme (MCSP) component is investing on the first 1,000 mother and child health through Conditional Cash Transfer (CCT). The pilot phase was initiated in Tharparkar district. The five-year programme will be scaled up further in 15 districts of the province[10].

6.3. Adaptation and Mitigation Strategies Required

Our field research site for this study is Tharparkar in Thar region of Sindh which is stretched over 20,000 km. Where agriculture and livestock and dairy products are primary sources of income. In the desert region of Sindh, the average rainfall in wet years mainly in monsoons ranges 200 to 250 mm. In case of regular rainfall and runoff in wet year Guar, Millet are only cash crops and also growth of range of vegetations, weeds, fodder for animals which add in animals feed and dairy produces. In case of no or untimely rainfall the population of Thar desert

[7] See detail on drought ration support in Tharparkar: https://www.thenews.com.pk/latest/293207-murad-approves-distribution-of-free-of-cost-wheat-in-thar

[8] http://www.gcisc.org.pk/Framework%20for%20Implementation%20of%20CC%20Policy.pdf

[9] Authors' calculation: Source BISP dashboard: https://uctdashboard.bisp.gov.pk/

[10] Sea the SSPA website for more details: https://sspa.gos.pk/our-initiatives/mother-child-support-program-mcsp-ssdps/

region tend to migrate towards plain irrigated zones to seek labour work (Shahid. A et al, 2004 and Ansir, et al. 2022).

On migration due to droughts or no frequent rainfall a community leader described well what localized mitigation strategies are being adopted by the people of Tharparkar.

> "The people of this region are very resilient to drought hazards because they have been experiencing it for centuries. In Tharparkar- Mithi district we have seven diverse zones three of those including Morano, Dhat and Samsoli zones are extreme drought prone. The population of Tharparkar is diverse from ethnic, religious and caste point of view. Majority upper caste Hindus unlike low-caste Hindus often don't prefer family migration for agriculture work in canal irrigated fertile zones of Sindh. While low or scheduled castes groups always migrate for agricultural labour along with their family members including women and children during dry spells each year."

Another political activist added that:

> "The poor and marginalized families who are forced to migrate due to no rainfall in monsoon are often trapped as bonded labor. Because in case of crop failure due to various reasons at their work destination they could not return advance money so they need to stay and work there until they could repay the debt".

(Hasan. A,. 1988) gives historical context of "Tharis-residents of desert region" that in the 1950s the Ghulam Mohammad Barrage's construction had colonized Badin's land. That large parcel of grazing land was available for open grazing where Tharis worked in farmland and graze their animals. After the barrage the lands were allocated to non-local Punjabi migrants from India. So the patronage relationships between Tharis and non-local landlords was changed and an advance cash payment module was inducted and that led to bonded labor[11].

The climate-smart desert food crops and plants production for example Sorghum or Juwar is a grain crop that uses water more efficiently than other grains crops. Grasses, grains and legume including tree legumes for long-lasting forage sources for domestic and wild animals can be a potential source of food security risk management and drought tolerance (Carter, P. R. et al. 1989).

A 60 year old male respondent said:

[11] Sea the article available on Author's website: http://arifhasan.org/articles/tharparkar-a-man-made-disaster

> "This year we have sown seeds and as it had rained a month earlier but now our cropped lands are dry now and if no rains all sown crops will be ruined. We have experienced 6 to 8 year long droughts. We have shrubs and bushes for cattle but no fodder or vegetation for small animals like goats and sheep. A number of households have moved to rice harvesting, cotton picking in plain fertile areas in Sindh. People have consumed all procured grains and now it is time for hungry days".

Memon et al (2018) also corroborate our findings from the field research in Tharparkar that the practice of storing food as a coping mechanism has increased substantially from 33 percent to about 48 percent of households. The authors' findings show the quantity of food available for storage was lower due to decrease in yield and an increased frequency of disasters.

In Key Informant Interviews (KIIs) with local women and men community leaders described that:

> Around a decade before 10 we used to collect drinking water from water ponds in leather baskets by walk or donkeys and the ponds can hold rainwater for two to three months. But now we have Chingci, motorbikes and plastic containers and tanks for water storage alternatives of pond water and our men with motorbikes collect water from RO plants near the Mithi city.

The PDMA' Capacity Enhancement Plan (CEP-2017-18) developed by National Support Organization (NSO) suggests that disaster management plans, contingency plans, Early Warning Systems (EWS) should be developed by District Disaster Management Authorities (DDMA) each year. For preparedness pre-drought relief packages should be provided to DDMAs. The CEP in Tharparkar District chapter has a number of suggestions in general like above but no specific suggestion aligned with drought hazard (NSO-PDMA 2018).

To cope with droughts and food insecurity in desert zones, mainly in the Rajasthan state of India, which borders with Sindh's desert, the Indian government provide irrigation water through barrage, canal and distributaries. Other than wells and tubewells the canal irrigation is second major source in desert parts of Rajasthan. Around 30 percent of the total irrigated area is being cultivated by canal irrigation (Payal. P & Poonam, 2020). While the government of Sindh is investing in through Sindh Irrigation Department using available irrigation networks such as LBOD, mainly to generate power and energy for Thar Coal project in Tharparkar [12].

With the effort of the Sindh government and various stakeholders the SCCP 2022 has been transferred to a mutually agreed climate action plan and implementation framework for the province. The Regeneration of Desert Ecosystem (RDE) proposed some strategic points for example to adopt sustainable agriculture practices, technologies for sustainable production systems and to meet food security. Reduce food loss and waste and ensure quality nutrition,

[12] https://irrigation.sindh.gov.pk/pub_thar.aspx

Increase and ensure protection and preservation of prime agricultural land and combat desertification and drought. For implementation of those strategies the Ministry of Food Security, EPA, Agriculture departments, irrigation departments are given responsibilities to measure, report and take action[13].

(Chaudhry Q. Z, 2015) recommends three level relevance rationale for disaster risk reduction, mitigation and adaptation. High level relevance rationale, low level relevance rationale and marginal level relevance rationale. Some climate change and climate actions experts are of the view and propose that the cash assistance modality can help in immediate support for climate change affected individuals and families. Timely cash injection can improve food availability, access and consumption by communities vulnerable to short or long spell drought hazards. Cash transfers can be implemented for provision of fodder during drought periods. The authors also mentioned BISP support and of the view to add conditional cash-based interventions focusing food security, undernutrition and livelihoods in those droughts hit regions (Hina, S., & Saleem, F. 2019.)

[13] See national and international stakeholder recommendation is details: https://csccc.org.pk/attachments/news-bulletin/Sindh%20Implementation%20Framework.pdf

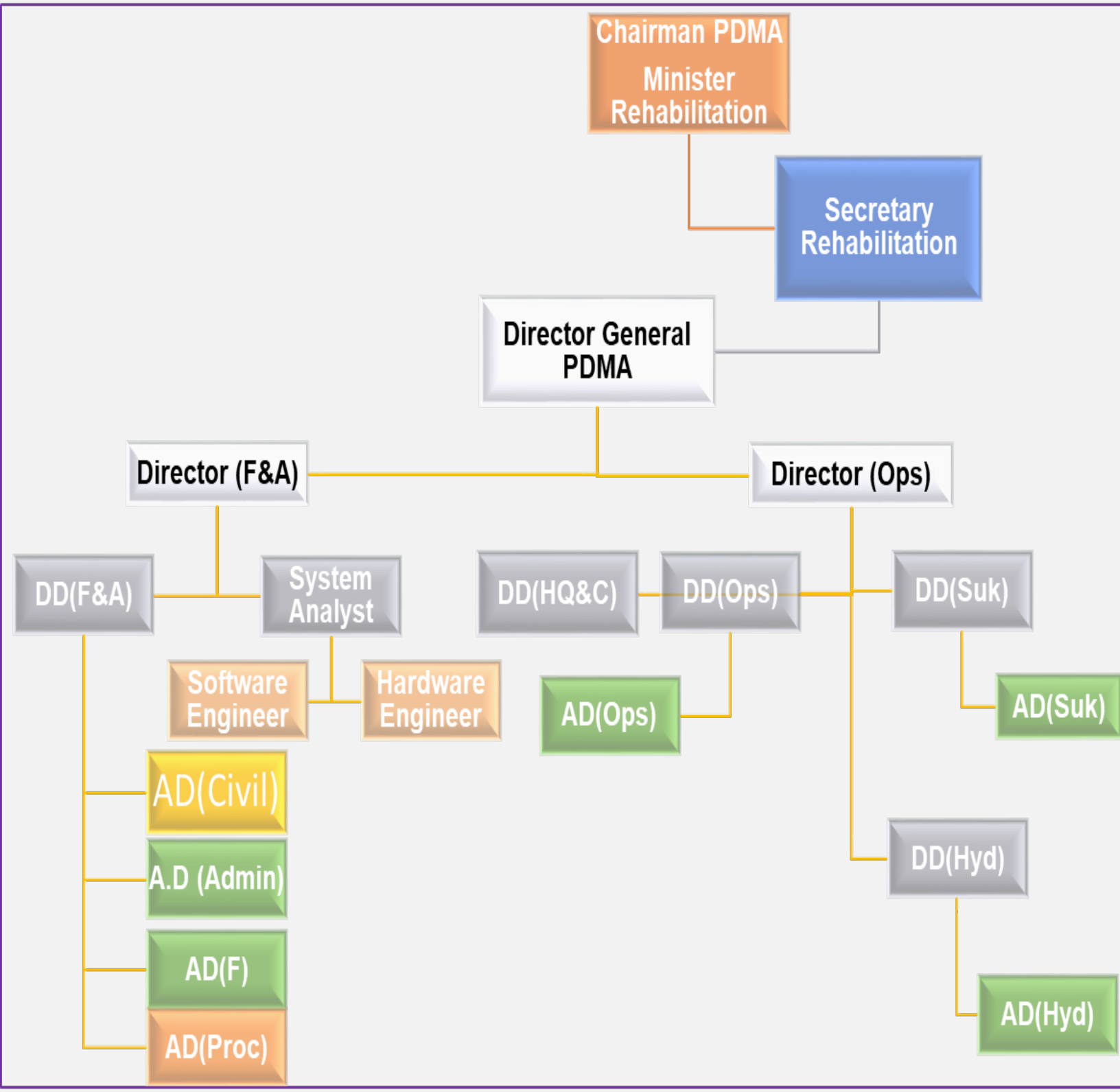
7. Institutional Analysis of the Provincial Disaster Management Authority (PDMA)

For a DRR policy framework to be effective in terms of execution, it is necessary that the appropriate institutional structure exists. The organization that is responsible for the formulation, execution and upgrading of a proposed DRR policy is the PDMA, Sindh. Below we discuss the organizational structure of PDMA and assess its suitability for the purpose. We then move on to suggest institutional reforms in the PDMA that equips the entity to execute an effective, evidence-based DRR framework for the Sindh province.

7.1 Organizational Structure of PDMA

The PDMA is headquartered in Karachi and has two other offices in Hyderabad and Sukkur respectively. PDMA is structured around two main wings: Operations and Finance & Administration (see Figure 1). The Operations Wing is responsible for coordination with other departments at the provincial level and with the line departments and responsible bureaucrats, such as the deputy commissioners and assistant commissioners at the district level and below. In addition, PDMA has three warehouses – in Karachi, Hyderabad and Sukkur where procurements for disaster response – such as excavators, tents, moving equipment, etc. are procured and stored to respond in time to disasters. It is salient to note that the PDMA organizational structure is purely response oriented and has no capacity for technical analysis, research or Monitoring & Evaluation.

Figure 1: ORGANOGRAM
(PROVINCIAL DISASTER MANAGEMENT AUTHORITY)



Our key informants also highlighted that another institutional disjuncture they encounter is the role of the District Disaster Management Authorities (DDMA). These authorities were also established under the National Disaster Management Act, 2010 and they are autonomous entities. As such, the PDMA cannot create its own institutional structure at the sub-provincial level and is dependent on the provincial bureaucracy and line departments to implement its directives.

PDMA is also severely constrained for financial resources. The Annual budget for PDMA for the financial year 2022-23 was PKR 150 million. According to our key informants roughly 85% of the budget goes into salaries of staff and the rest of the 15% into overheads of their office premises and warehouses. There is also a contingency fund of PKR 1 billion created each year that can be drawn upon if a disaster occurs.

7.2 Institutional Assessment of PDMA

The main take away based on the organizational structure of PDMA in Sindh is that it is solely designed for disaster response. The key informants we interviewed have suggested that in order to provide comprehensive disaster management, especially in the context of climate change, Disaster Risk Reduction (DRR), research and analysis as well as monitoring and evaluation wings need to be added to the organizational structure of PDMA. They went on to suggest that their ability to effectively respond to disasters is also hampered without adequate DRR and analysis on climate disasters.

Whether there should be different wings for DRR, research and M&E or should all three be subsumed in one wing is a moot point. Our tentative view is that research and analysis are crucial inputs for DRR and therefore research & analysis should be subsumed in the DRR wing. This wing will draw in expertise in relevant streams, such as climate change, DRR, hydrological flows, epidemiology, GIS mapping, etc. into the organization.

There are two inter-related hurdles at the policy level that will have to be overcome. First, the existing budget of PDMA will have to be enhanced significantly. Our initial assessment suggests that it will have to be increased four times of what it presently is. Second, the higher-level policy makers of the provincial government will have to be convinced that a well-functioning DRR strategy is worth investing in. This will require a shift in allocative priorities of the government. Consistent with the evidence-based policy formulation approach, this will require demonstrating that effective DRR reduces the cost of disaster response for the government.

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