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Economic Impact of Water Scarcity in Thar – An empirical analysis with pragmatic measures

Jhaman Das Hirani

Researcher, Department of Economics, University of Sindh Jamshoro, Sindh, Pakistan

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Corresponding Author: jrhirani@yahoo.com

ABSTRACT

This paper examines the economic impact of water scarcity in Tharparkar. It is regarded as most water scare region in Pakistan for being semi-arid zone. Ground water is the only major water source in this region. However, only a few of studies cum research material can be found regarding water shortage problem with a particular focus on affecting economy of the area. The results reveal that women and school going children are responsible to fetch water which affects both productive working hours and education. Hence, economic impacts of water scarcity include water fetching direct cost, consumption of productive working hours, aggravating education status, provoking health issues, inciting food insecurity, depleting rain-fed agriculture and affecting livestock based economic activities. The Research suggests recommendation and pragmatic actions, based on its findings, useful for academia, implementers and policy makers.

Introduction

Water Shortage is a global challenge. Half of the world's population residing in these regions faces acute water shortage. Climate change further aggravates global water scarcity. Rainfall patterns are erratic which causes severe water shortage in arid zones and desert belts.

Thar Desert is 17th largest subtropical desert lies in Indian subcontinent, forming a natural boundary between Pakistan and India. It extends from Sutlej River, surrounded by the Aravalli Ranges on east, whilst on the south, salt marsh known as Great Rann of Kutch. The Indus River falls on its west. In Pakistan, this desert falls in Sindh and Punjab Province. Near Bahawalpur it joins the Cholistan Desert. However, Tharparkar district is a major part of this desert. The word Tharparkar originated from two words Thar and Parkar which means "desert" and "the other side" respectively. In terms of water availability and sanitation facilities, the district Tharparkar is ranked on bottom in PMDG (Pakistan Millennium Development Goals Report). The quality of water provided to people matters a lot when it comes to ground water compared to river water (Afzal, et. al., 2020; Bukhari et al., 2020).

According to ancient folk wisdom of Tharparkar it is constituted by 08 different ecological zones varying in geo-fabric, water tables, soil condition and topography etc. These zones are different from the seven administrative setups of the district. All the ecological zones have their own characteristics which are unique and well described in folklores. All the ecological zones have pastureland. However, below the earth there is a vast domain having different patches of water. Generally, all these zones vary from each other based on water quality, quantity, rainfall patterns, soil conditions and vegetation conditions.

These zones are locally called as Parker, Samroti, Kha`ur, Kantho, Vango, Muhrano, Dhat and Vat. Samroti lies in south-west of tehsil Mithi and in north of Diplo town. It has fertile soil, shallow wells and the small ecological zone of Tharparkar. In the west Samroti approaches Vango. The local inhabitants of this zone are benefitted from the available livestock fodder cum water, comparing other zones of Tharparkar. Hence, villagers of this zone seem to tender large flocks of goats and sheep. However, its northern portion has relatively less precipitation and meagre recharging rate. This portion is also termed Vango sometimes.

Tharparkar is water stress region in Pakistan. The open pit dug wells are the only source to abstract water for majority of rural villages in Tharparkar. Only a meagre population in some towns of Tharparkar are provided canal water with pipe water supply. Monsson rains are the only major source of fresh water in this desert belt which not only help to quench thirst of people but also helps agriculture and livestock in Tharparkar. However, the rainfall pattern has become too erratic. The area has witnessed frequent droughts since year 2013. The mean average rainfall has also decreased compared to past years. Although this desert belt has been facing severe water shortage for centuries which has exacerbated in recent years due to increased water demands and droughts.

The droughts in Tharparkar do have impacts on livelihood, agriculture productivity and ecosystem. Droughts are basically dry seasons or more accurately dryness is not only meagre rainfall but a complex phenomenon of miseries with acute water shortage. The constants drought might lead to famine like situations. They provoke further livestock (the major source of subsistence) death and mass migration from the area. Although drought history for Tharparkar desert is centuries old, its intensity has been elevated since 2013. The region has witnessed five consequents mild-to-severe droughts in the last six years. The Sindh Government, in 2018, has again declared Tharparkar region as drought-hit followed by recommendation of District Revenue Department which has reported extreme shortage of water, food and fodder. District Government Tharparkar has further portrayed a picture of helplessness of the people unable to live off the livestock which is turning into a serious situation. All seven tehsils of the district including Mithi, Islamkot, Chhachhro, Nagarparkar, Diplo, Dahli and Kaloi are severely affected due to prolong drought spell which need immediate relief response (Ali et al., 2017).

Tharparkar is prone to droughts. It has been declared as a calamity-hit area more than dozens of times in the last four decades. There are around 2300 rural villages habituated by 1.5 million population in six different administrative talukas including Islamkot, Mithi, Nangarparkar, Chhachhro, Diplo and Dahli. The rainfall pattern in all these areas is not uniform, where some of them receive sufficient rainfall and some get below average rain-showers. This rainfall varies between 100 – 700 mm in desert belt of which monsoon season (July – September) accounts for 60% – 70% of annual rainfall (Pak Met Department). The reduced monsoon is the main cause of droughts (Khoso et al., 2015).

Literature Review

Memon et al., (2018) states that water shortage in Tharparkar has resulted in food insecurity and poor nutrition status in this desert belt. The relation of droughts since 2013 in Tharparkar can well be seen with nutrition through reviewing district health department reports of Tharparkar which intimate growing mother and child mortality in its rural villages. Water scarcity provoked by continuous droughts has aggravated malnutrition and food shortage in different rural villages of Tharparkar depending on rain-fed agriculture. This desert belt becomes very difficult during droughts. In the worst cases when crops completely fail to grow due to drought, the situation may aggravate famine in Tharparkar. The constant droughts have caused food insecurity. The unavailability of livelihood options in Tharparkar has coerced people to live in a state of hunger with almost no access to potable water and food. The research further found that in the span of three to four decades, an average household in Tharparkar experiences starvation about 11 times. However, the gender segregation data suggests that women do experience starvation twice comparing male community members

National Disaster Management Authority Pakistan (2018) estimated that water shortage caused recent major drought in 58 districts of the country which has rendered direct and indirect losses of USD 1.2 billion. Around three million people were affected with a cumulative loss of 2.5 million livestock. Tharparkar district is among the most drought prone districts of the country. From the year 2014 to 2018 Tharparkar has received below average rain-showers which have adversely affected the economy by crippling livestock and agriculture and sector (the main source of subsistence of the area). This vicious poverty cycle further affects the nutritional and health conditional of vulnerable groups including women and children in Tharparkar (pp.3-4).

Raza (2018) intimated that the omens of water shortage in Pakistan are obvious since many years including resources depletion and water contamination. This certainly accuses the leadership of the country for its inefficiency in management of available natural water resources. Consequently, Pakistan has become more vulnerable to extreme floods on one hand and long drought spells on the other. The country, at an alarming rate, is running out of its freshwater resources. The estimates seem more ironic since the country may suffer water scarcity up to 31 million acre-feet until 2025. Certainly, such huge shortage will produce much devastating results for a country having agriculture-based economy. Various studies and estimates suggest that more

than 70% of the total population in Pakistan is either directly or indirectly engaged in agriculture activities for its income generation. A total of 26% of the GDP's is constituted by the agriculture sector in the country (Thirsty Days Ahead, para. 1-3).

Ali et al., (2017) intimate that the current water supply in the country is not only limited but much erratic in nature. More importantly, the increasing population and climate change is increasing the risk for its further shortage. The demand for water is also rising due to rapid urbanization and population growth. Consequently, this imbalance is causing severe water shortage in the country. The major water sources of Pakistan are dependent on surface water (i-e Indus River and its tributaries), which itself is in vulnerable position due to continuous spat with India. The erratic water supply becomes more vulnerable to the variation in snow melting and rainfall trends. The country is witnessing high pressure on all renewable water sources, which results in inadequate access to water for the majority of its residents. It is further feared that this pressure on existing water sources will go on rising due to adverse climatic impacts, degradation of water quality, urbanization, industrial development and above all the population growth. Pakistan would have to face very high-level water stress by 2030, where she would be included in the list of 33 extreme water stressed countries (pp.93-94).

Kirby et al., (2017) while presenting the case of Pakistan stated that Pakistan is facing the issue of water scarcity despite having sufficient water sources few decades ago. In case of Pakistan, the physical water scarcity is caused due to human activity, such as excessive use of water resources. Hence, the country is considered as one among water stressed countries in spite of having the world's largest glaciers. The country needs paradigm shift in water policy, managing demand, curbing ground water excessive extraction and promoting water harvesting.

Hassan and Ahmad (2016) analyzed that there are different water availability sources in Pakistan including rainfall and snow (precipitation), surface water (rivers) flowing from melting of glacier and snow and watersheds causing runoff through winter and summer rain. Besides, these water flows recharge aquifers and increase storage of underground water. However, the rainfall pattern in Pakistan is very erratic. The mean rainfall in the northern areas (including Gilgit – Baltistan) may exceeds as high as 5000mm. While many parts of Balochistan and Sindh receive below 100mm. Therefore, water demand keeps on rising due to the increase in population and augmented requirement of various water users. Hence, areas lying on the lower riparian face water shortage. The management of water (for both quality and quantity) is a major issue in the country. Water availability based on storage is at minimum level i-e hardly 30-50 days (pp.1-7).

Rosegrant and Cai, (2016) examined that water shortage coupled with erratic and uncertain water supplies may causes decline in the gross domestic products (GDPs) by as high as up to 6% in next few decades, due to rise of population and increasing water cum food demands. Water is the lifeline for any society or country, since the majority of income contribution is secured with sufficient access to water improved

agricultural practices. All the countries and regions who are either water-stress or water scare would have to face critical water shortage leading to acute water scarcity due to population growth. This increased number of populations is exerting pressure on scare water means in a country.

Akber and Yasmeen, (2017) explained that drought in Tharparkar has seriously deteriorated food security and nutritional level for its inhabitants. Food shortage has provoked malnutrition among young children and women, who are more vulnerable to various diseases and death since last couple of years. Media headlines alarmed malnutrition issue in Tharparkar in 2014 when more than 120 children were reported died in just few months in civil hospitals of Tharparkar. This death toll cross 400 by the end of the year.

Material and Methods

This study assessed the economic impacts of water scarcity in Tharparkar and employed a descriptive survey design. A 2014 description by Creswell states that descriptive study is useful to present the situation as they prevail, where researcher can easily report what happened or is happening, along with discovering the causes of it. Descriptive research is effective for analyzing non-quantified topics and issues. Both qualitative and quantitative methods of data collection are integrated. (Tosun and Yasar, 2015)

According to the general census and as per record of district Government, Tharparkar has around 275000 households. These households reside in 07 different administrative setups (talukas) and 08 ecological zones of Tharparkar. Hence, under this study 02 villages from each ecological zone of Tharparkar were randomly selected to give equal representations to all zones of Tharparkar. The recommended descriptive statistics were used to get reliable results (Cooksey, 2020).

Therefore, random selected households' approach was used to collect data from households of 20% villages from all ecological zones of Tharparkar. Thus, primary data is collected through household census from 100 random selected households Simple random sampling was used to obtain a sample from a sampling frame of all the households in the study area. However, 16 FGDs and 16 KIIs were also conducted to double check household level data.

Primary data is collected at different tiers i-e from random selected households, focal group discussions, key informant interviews and personal observation from the 16 different rural villages of all eight ecological zones of Tharparkar. Secondary data is collected from various published and unpublished material, data collected by independent researchers, corporates / firms, NGOs, INGOs, UN Agencies and prevailing Government record. The similar nature other studies and reports were also reviewed which are ever conducted in various other similar regions of the world.

To collect primary information, different questionnaires were developed to collect necessary information over all parameters to assess water scarcity in Tharparkar

and its economic impact. The questionnaires consisted upon different questions to collect data to determine water sources, water needs, gaps, shortage of water, its impacts etc. Under this study three major questionnaires for the data collection from household level and village level were developed.

Results and Discussion

Water shortage is major problem of Thar region in Pakistan. This examines the impact of water scarcity on the economy of Tharparkar. Therefore, primary data is collected for this paper on various parameters including if the available water sufficient for drinking and other household consumptions, what is direct cost involved on collection of necessary water and how much time including productive working hours are spent over collection of daily needed water. For the efficacy of data, the primary data was directly collected at three different tiers i-e at household level through household assessment tool, at village level through FGDs and from key informants through KII. All the data collection tools used indicators to collect data regarding how dearth of water is affecting human health, food availability, livestock health and fodder and current education practices in rural setups of Tharparkar. Besides, personal observations were undertaken, and available secondary information was also reviewed.

The overall feedback from primary data summaries that 98% people assume water shortage affects economy in various ways including direct cost involved on water fetching, consumption of productive working hours, aggravating educational status, water scarcity provoking health issues, water shortage causing food insecurity, water scarcity depleting agriculture activities and water scarcity affecting livestock based economic activities etc, in Tharparkar.

Water fetching responsibility in Tharparkar is a dilemma. Household level data collection intimates for 71% households, only women and young girls are responsible to fetch water from distance dug wells. This water collection exercise on average consumes 06 to 08 working hours per day per household which could otherwise have been used for more productive activities. 65% households have their women engaged one way or other in income generation activities including embroidery, sewing, tailoring, small enterprise and livestock rearing.

The time consumed on water collection of their non-formal working women affects both social and economic dimension in rural setups of Tharparkar. Women estimate they could earn 50% more of their current average earning (PKR 2200 per household) if doorstep water access is ensured.

This proves that research hypothesis no. 2 "Time consumption of water fetching effects production working hours, otherwise might be used on income generation" stands true in light of above data analysis. The rest of 29% household shared that either male members from their houses or school going children are responsible to collect water from distant water points (village wells).

Water safety is another major challenge for the people of Tharparkar. Secondary data analysis suggest that ground water obtained in Tharparkar is chemically contaminated having the range of TDS (Total Dissolved Salts) as high as 2500 – 7500 ppm which is never feasible for human consumption as per WHO water testing standards i-e below 1000 TDS (WSP Tharparkar, 2016). Water testing reports conducted by PCRWR (Pakistan Council of Research in Water Resources) also suggested that ground water of Tharparkar is contaminated having high TDS, presence of arsenic and other hazardous chemical components. Hence, from all available water samples it is obvious that available underground water is not safe to drink.

The findings of primary data collection are very ironic since 73% of people in general consume very brackish to saline underground water of Tharparkar, having TDS ranging from 3500 ppm to 7500 ppm as per WSP Tharparkar 2016 report. Only 17% have access to improved water services provided by the Government of Sindh after installation of RO plants. However, according to Jhaman and Asif, (Assessment of ROs in Tharparkar, 2017), 53% ROs are non-functional. Of these non-functional RO plants, 35% are temporarily closed due to the failure of membrane and other technical faults, while the remaining (65%) appear to be permanently closed. Hence, overall, 47% (70 RO plants) are found functional. The water testing results show that out of 97 water samples of functional ROs depict that 47% were found unsafe due to presence of TDS content beyond the maximum permissible limit (1000 mg/l), the highest concentration for TDS was measured 4100mg/l. 47% unsafe samples with high TDS also include objectionable taste and due to presence of fluoride content beyond the maximum permissible limit recommended for safe drinking water.

The lab reports suggested 53% of water samples as safe to drink. Water testing further intimated that 29% samples are unsafe for human consumption due to bacteriological contamination i.e. presence of E. Coli. Hence, the goal of "zero bacteria environment" behind these RO plants is in vain. Pathetically, 33% FGD participants also reported the test of water is not satisfactory, whilst a similar number of respondents said that the quality of water is not satisfactory. Additionally, 30% intimated that they are not satisfied with the quantity of water because it does not fulfill the overall water needs of their villages.

The data collected through households' assessment also ensures that 95% of people don't feel the available water is safe for drinking. However, no water treatment or proper filtration is not practiced. Research also found that at present no water boiling practices are opted to make sure that drinkable water is safe before consumption.

However, only 30% shared that they filter water through cloth before using it, 70% don't do any sort of filtration or water treatment. Although, 43% were aware of the importance of safe drinking water against 57% who did not know about it. This unawareness may be blamed for the concurrent water borne diseases among children in Tharparkar which also cause child mortality in worst cases. Unsafe water has crippled the overall economy by incurring additional expenses to treat water borne diseases. 94%

of people in Tharparkar usually spend up to 2000 pkr per month over medical expenses due to unavailability of safe water. Even 06% spend more than 3000pkr per month.

46% of people suggest that unsafe food is a major cause of diarrhea in all zones of Tharparkar. 38% assume unsafe water is major cause behind rampant diarrhea disease in Tharparkar, and 05% think unhygienic conditions incite diarrhea in study area. Whereas 11% don't know the cause of diarrhea. On probing the prevention for diarrhea 43% feel that safe food may help to prevent it. 17% were of the idea that safe water is safe and 21% assume that better hygiene may curb diarrhea. There were also 19% respondent who did not know how one can avoid diarrhea. People's awareness about the danger of diarrhea suggests that 65% consider vomiting and fever with diarrhea as dangerous to consult with doctor and 15% think that blood with stool is sign of danger. 83% of people assume that water shortage in general and unavailability of safe water in particular do cause water borne diseases in Tharparkar. Hence, it is proved that water scarcity in general and unsafe quality of available water in particular are rendering economic impact in Tharparkar. The sufficient safe water provision could have saved 30% of the earnings of an average household in Tharparkar.

The primary data collection through household census, village level FGDs and key informant interviews pointed out that water shortage is contributing to exacerbate further the current educational status in rural villages of Tharparkar. Since, availability of water is major problem and Tharparkar. Therefore, all the family members including school going children (both girls and boys) are assigned to fetch water necessary for survival (drinking and cooking etc). These children must go with their elder family members in the early morning to distant village wells and other water sources to fetch the needful water. Water scarcity in the village and its excessive demand by thirsty dwellers usually causes delay in getting their water-turn (opportunity to get water). Hence, timely reaching at schools gets comprised. Continuous practices compel school children to remain frequently absent and finally drop out.

Primary data collection summarizes that after drinking water needs what they need most is sufficient supply of food items. Tharparkar is regarded as one of the main areas yielding organic food by rain-fed agriculture. Surveyed communities shared that in past when they were having sufficient rainfall to produce rain-fed Thari food, the crops including millet, cluster bean, mung bean, moth bean, watermelons, cow peas, sesame etc which were not only sufficient to meet food needs for various months of a year, but they also helped to cater nutritional requirements and promote healthy life in Tharparkar.

People in Tharparkar used to generate income by selling organic food products including cluster beans, mung beans, sesame and millet at large scale. This research study found that low rainfall and water shortage in Tharparkar have severally dilapidated organic food products in Tharparkar. The data analysis for however food production is compromised by dearth of water intimated that around 65% households have lost their food production by more than double in last decade. One quarter of the surveyed households suggested that they are fully food insecure now, since they lost

almost all of their previous productions cum food stocks due to dearth of water and non-availability of local food produces.

Table 01
Status of Prevailing Food Stocks (Survey Data Findings)

#	Food stock status	%age of Hhs
1	Lost half of their food stocks	65%
2	Lost three quarters of their food stocks	09%
3	Lost their food stocks	25%
4	Food stocks are available	01%

Through the primary data collection 97% of households have confirmed that either they or their household members are engaged in rain-fed agriculture. However, all of them intimated that available water sources are not sufficient for agriculture activities. Whereas, other than rain-fed agriculture only 02% of people practice kitchen gardening. People also shared that water shortage in Tharparkar is affecting agriculture activities which in long term impacts on minimizing overall household income up to 30% for around 70% households of Tharparkar.

60% people estimate that if additional water is ensured for agriculture than each household could have an additional 5000 income monthly. 37% of people estimate additional income of up to 10000 and 03% even assume that more than 10000 per month per family could have earned if additional water was available for agriculture activities. In other words, PKR 5000 monthly is being lost by 60% households due to water shortage. 37% households bear a financial loss of PKR 10000 per month due to dearth of water and 03% households exceed in monthly loss in their household income by more than PKR 10000 due to non-availability of sufficient water.

Table 02
Mouzas reporting sources of irrigation

Administrative Units		Rural Populated Mauzas	Number of Mauzas Reporting Source of Irrigation					
			Canal	River	Tubewell/Well	Ravine	Spring/ Stream/	Arid/Barani
Tharparkar District	No.	163	7	-	64	2	-	158
	%	100	4		39	1		97
Nagarparkar Taluka	No.	37	-	-	25	1	-	37
	%	100			68	3		100
Chachro Taluka	No.	40	-	-	26	-	-	40
	%	100			65			100
Mithi Taluka	No.	44	2	-	7	1	-	44
	%	100	5		16	2		100
Diplo Taluka	No.	42	5	-	6	-	-	37
	%	100	12		14	2		88

Source:GOS. 2008. *Mauza statistics of Sindh.* Agriculture Census of Pakistan.

Data collected from various zones of Tharparkar depicts that every household owns livestock in Tharparkar. Livelihood for more than 70% of people directly depend on livestock in Tharparkar. 83% people shared that they don't have sufficient water to

meet livestock watering needs. Thus, insufficient water causes weight loss and malnutrition in animals. Insufficient water creates fodder shortage for livestock in Tharparkar. Data estimates that more than 30% of local villagers along with at least 50% of livestock do nearby districts (barrage areas) which also affects economy of the region.

Even those who don't migrate from the area also have to bear heavy economic losses. 47% of people shared that they are bearing an economic up to 10000 per annum due to water shortage affecting livestock. 33% bear loss up to 5000 and 17% bear above 10000 loss affecting livestock due to water shortage. Only 03% shared they don't face any loss due to water shortage which could have affected livestock.

Table 03
Mean Annual rainfall in Tharparkar

No.	Location	Mean Annual Rainfall	Probability of Annual Rainfall	
			50% Probability	75% Probability
1	Mithi	230	161	60
2	Chachro	264	245	173
3	Chhor (district Umerkot)	162	145	94
4	Diplo	261	243	171
5	Nagarparkar	358	337	248

Source:Sukkar Foundation 2018

Conclusion

This study "Economic Impact of Water Scarcity in Tharparkar and Suggestive Measures" employed descriptive research method under which both the primary and secondary data was collected through structured questionnaires and desk review of available information. The results conclude that water scarcity is a major problem of the Thar region which affects its economic conditions. Firstly, the time spent fetching water affects productive working hours. Besides, the dearth of water availability in Tharparkar has incited food insecurity which in the worst cases leads to Malnutrition. It has also depleted agricultural activities and livestock rearing, which are the major economic sources in Tharparkar.

The whole analysis and interpretation culminated in the following pragmatic recommendations/suggestive measures. These recommendations may be considered and opted by concerned stakeholders cum policy makers to address water scarcity problem of Tharparkar and to revamp its rain-fed agriculture economy. For convenience these suggestive measures are provided in two phases as immediate actions and long-term actions.

Immediate Required Measures

- Rehabilitation of existing RO plants to make them all functional so that one third of the population of Tharparkar may have improved access to water necessary for drinking, cooking, sanitation, hygiene, livestock rearing etc.
- Provision of hand pumps and Solar powered submersible pumps in the areas having ground water quality acceptable including Vango, Vat and Samroti Zones.
- Promotion of rainwater harvesting practices to collect and store additional fresh water sources in Tharparkar. Some NGOs have implemented some pilot projects which could be replicated further at larger scale.
- Introducing the income generation activities in the areas having ensure improved water services provision, to engage both men and women to untap additional economic growth options.
- Introduction of pilot-based kitchen gardening activities in the areas having installed RO plants and other water schemes.
- Promoting water awareness at different tiers in Tharparkar through undertaking schools, villages, UC, tehsils and district level campaigns.

Long Term Required Measures:

- Need to formulate rainwater harvesting and ground water management policies for Tharparkar to untap and safeguard additional water available for Tharparkar.
- Increased the supply of pipe water / barrage water supply from 6% of current coverage to at least 30% population
- Introduce ground water recharge initiatives including introduction of sand dams and artificial rainwater injection in low lying areas having good water catchment area.
- Introduction of social entrepreneurship model in Tharparkar for water management and other crafts to promote income generation.
- Promotion of agriculture in Tharparkar through introduction of drought and saline water resilient crops for cultivation
- Promotion of efficient livestock management initiatives to revamp livelihood and economy in Tharparkar.

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