Socio-Economic-Environmental Impacts of Climate Change: A Case Study of Nuh (Mewat), the Most Backward District of India

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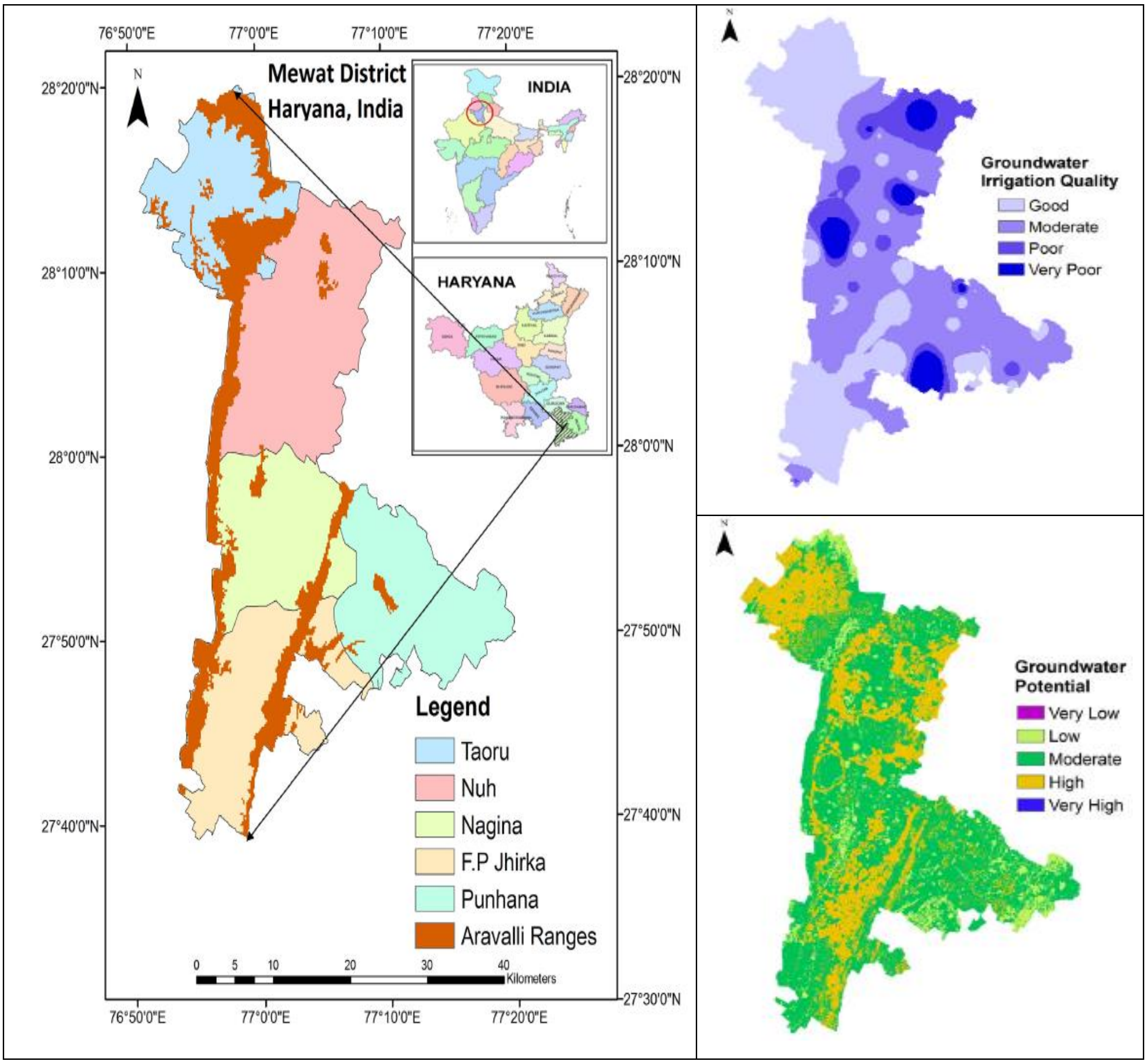
1. INTRODUCTION

Climate change associated risks have serious consequences on human wellbeing, particularly of those who are dependent on agriculture and natural resources. Poor people are more vulnerable due to their low adaptive capabilities. Global nature of the problem and local nature of the adaptive capabilities and practices calls for evidence-based rural/micro studies through engagement of local communities who are sufferers of the climate changes. Among 101 aspirational districts (i.e. most backward districts) in India, Nuh (Mewat) district holds the last position, despite its close proximity to the capital of the country, and stands in sharp contrast to the remaining parts of Haryana. Apart from the historical and socio-cultural factors, the impoverishment of the district to a large extent is due to climatic changes and natural resource degradation. The increasing groundwater salinity has become a major threat to the well-being of people in the region, as the majority of population is still engaged in agriculture. Within Nuh, there exists substantial intra-district diversity. The backward or highly deprived regions are saline-water zone, whereas comparatively developed regions are either sweet-water zone or have access to fresh water (Mehta 2015).

According to Mehta (2015), Taoru is the most developed block, and Punhana is the least developed one. There seems to be a direct correlation between groundwater availability and its quality, and development of blocks. Taoru and F.P. Jhirka are the two blocks which have high potential of good quality ground water (Figure 1). Interestingly, according to the report, Nuh is the second best developed block just after Taoru, despite of its low potential and low quality of groundwater. This is because of the availability of canal water in Nuh block. In Taoru and Nuh blocks, farmers are able to produce high value crops like onion and tomato due to availability of fresh water, and meet the demand from the national Capital and surrounding rich neighbourhood. This is not possible in Punhana and other blocks where high salinity has resulted in lower crop yield.

Figure 1: Mewat district and its groundwater irrigation quality and potential



Source: Mehra et al 2017

In this background, this study brings out the socio-economic-environmental impacts of climate change for the most backward district of India. The specific objectives of the study are to:

a) Capture the trend of meteorological data in this particular region
b) Explore loss of soil moisture (through evapotranspiration) and groundwater depletion
c) Analyse the socio-economic consequences of the salinity problem arising as a result of these changes
d) Identify the adaptive measures taken to combat climate change and groundwater salinity; and resulting impacts on people's wellbeing

2. METHODOLOGY

The study uses both quantitative and qualitative data collected through primary and secondary sources. Particular to first objective, Mann-Kendall[1] trend analysis of long term rainfall and temperature data has been used to capture climatic vulnerability. Potential Evapotranspiration (PET) was calculated using Thornthwaite method[2] to capture the dryness of the region. Geographical Information System (GIS) is used to explore ground water availability over the period of time.

The socio-economic consequences as a result of climate change and ground water salinity have been explored through both secondary sources and primary information based on interviews and focus group discussions (FGDs).

The adaptive measures taken in the context of climate change and groundwater salinity have been identified on the ground, and its impact on people's wellbeing has been captured through case study method.

3. FINDINGS

3.1. Environmental Variability and Vulnerability

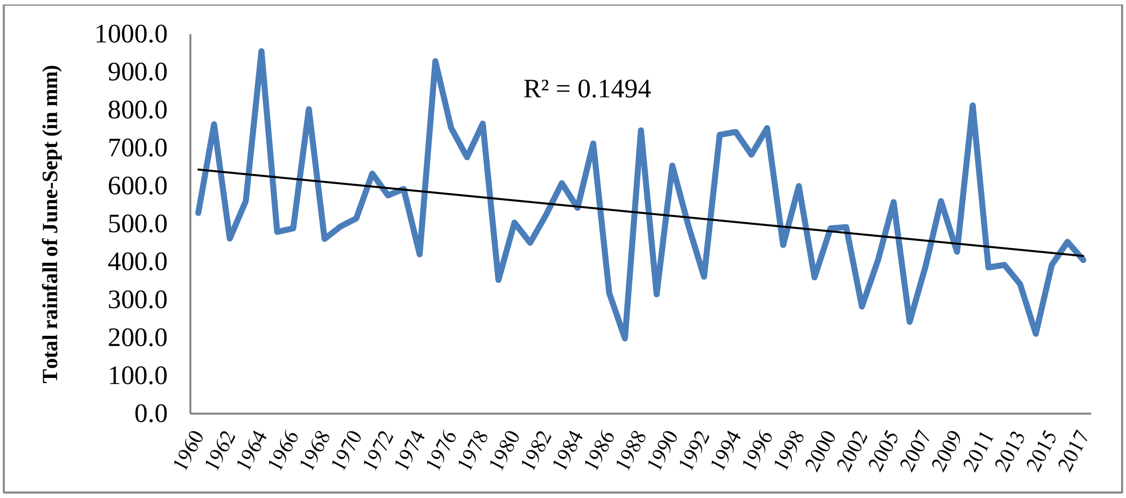
Climate change is generally referred to environmental changes for a period of at least 30 years. Since Mewat district was separated from Gurgaon district recently in 2005, we have analysed the rainfall of entire Gurgaon region based on secondary data collected from Indian meteorological department (IMD).

Figure 2 shows a mild downward trend (R^2=0.1494) of monsoon rainfall (i.e. total rainfall of 4 months from June to September) from 1960 through 2017. The statistical significance of this downward trend is established by Man-Kendall test (Table 1), which shows negative trend (Kendall's tau: -0.265, and Sen's slope: -3.920) to be statistically significant at 1 per cent level (p-value: 0.004).

[1] According to this test, the null hypothesis H_0 assumes that there is no trend (i.e. the data is independent and randomly ordered) and this is tested against the alternative hypothesis H_1, which assumes that there is a trend.

[2] For details of the method please see Stephens, J. C., & Stewart, E. H. (1963). A comparison of procedures for computing evaporation and evapotranspiration. Publication, 62, 123-133.

Figure 2: Declining trend of monsoon rainfall of (Mewat belonging) Gurgaon region



Source: prepared by authors based on IMD data

Table 1: Man-Kendall trend analysis of monsoon rainfall of Gurgaon region

Mann-Kendall trend test value	Observations	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
528.712	56	56	198.108	955.016	529.260	176.196
Kendall's tau	**p-value**	**Sen's slope**				
-0.265	**0.004**	**-3.920**				

Source: Authors' calculation based on IMD data

Although average temperature was available for recent years, maximum and minimum temperature was accessible only upto year 2000. Therefore Table 2 shows decadal trend of max-min temperature from 1965 through 2000. It reveals that though monthly maximum temperature remained more or less same over the four decades, the monthly minimum temperature has increased over the time.

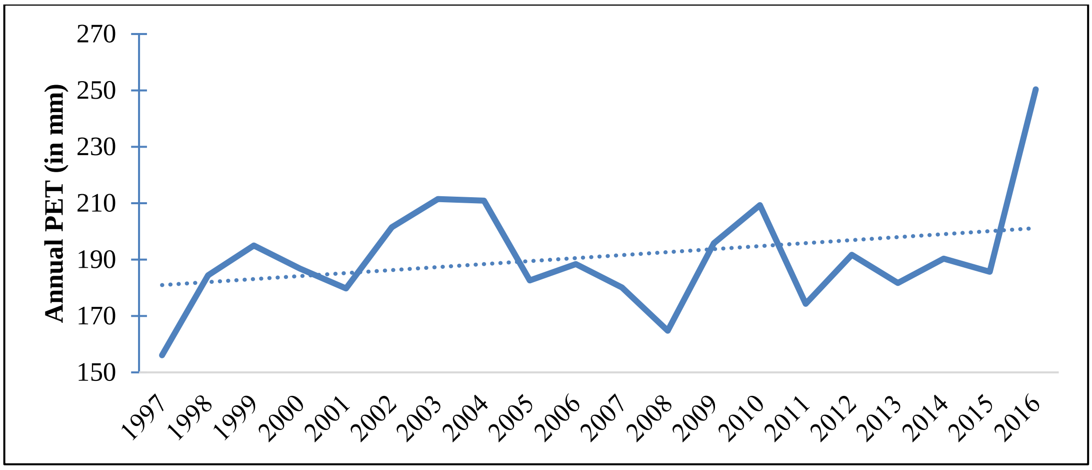
Table 2: Decadal max-min temperature of Gurgaon region

	1965-75		**1975-85**		**1985-95**		**1996-2000**	
	Monthly max	**Monthly min**	**Monthly max**	**Monthly min**	**Monthly max**	**Monthly min**	**Monthly max**	**Monthly min**
mean	31.8	16.7	31.6	17.0	32.2	18.1	31.2	18.9
st dev	6.31	8.30	6.29	7.79	6.70	7.68	6.51	7.58

Source: Authors' calculation based on IMD data

Rainfall and temperature affect crop yield both directly and indirectly through change in Potential Evapotranspiration (PET) and soil moisture. Soil moisture content (SMC) is a soil status condition, directly connected with the process of evapotranspiration (ET) – a process whereby water is transferred from the soil compartment and/or vegetation layer to the atmosphere (Verstraeten et al 2008). Based on the average monthly rainfall and temperature data (calculated on the basis of sub-daily data collected from https://www.wunderground.com/) PET was calculated using Thornthwaite method. Figure 3 shows an increasing trend of PET which indicates loss of soil moisture and rising dryness in the region.

Figure 3: Increasing trend of annual PET of Mewat belonging Gurgaon region



Source: authors' calculation

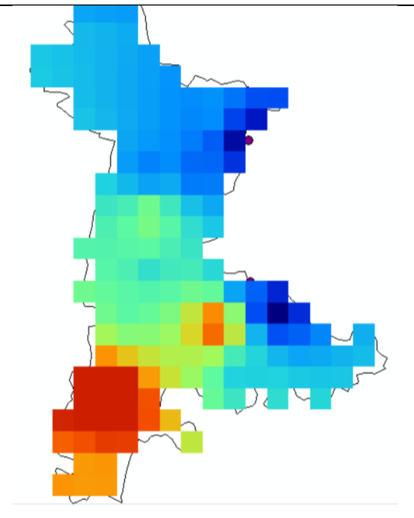
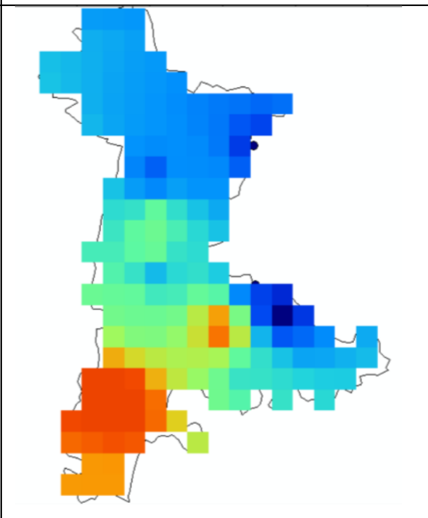
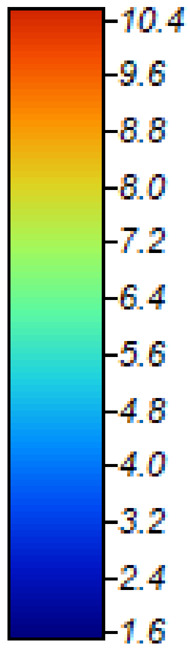
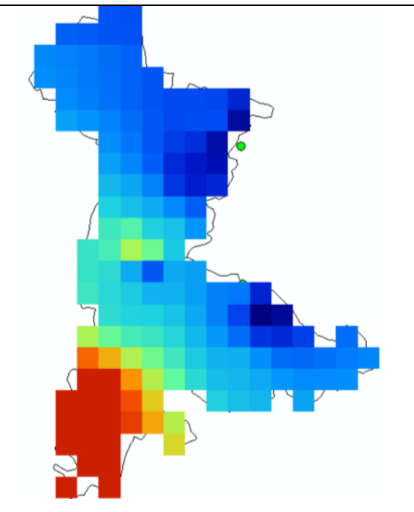
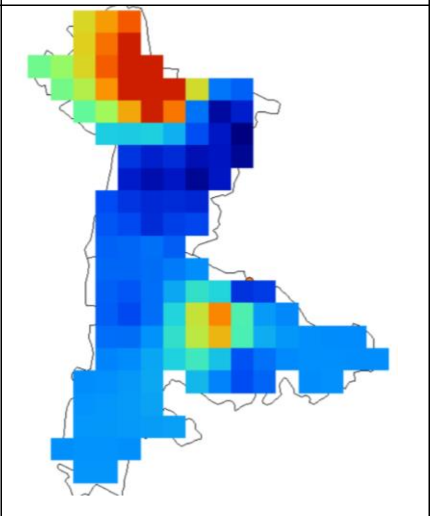
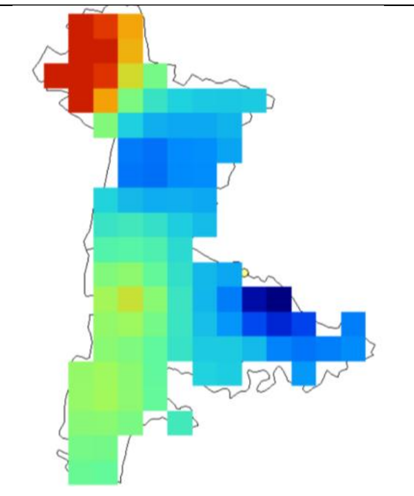
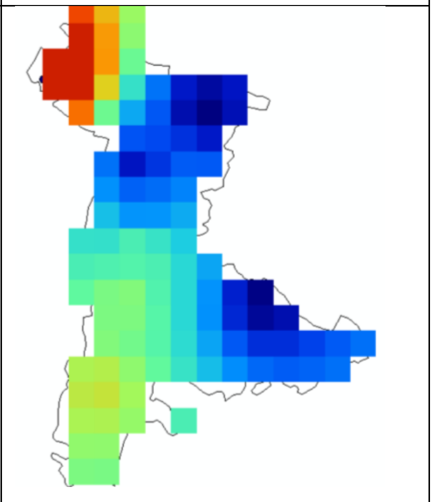
Mewat district is presently facing two challenges related to ground water. Firstly, extreme salinity of ground water in three blocks particularly centrally situated Nuh and Nagina blocks between the Aravalli ranges, and Punhana block at extreme right. Secondly, over extraction of the limited availability of fresh groundwater in few the pockets of Taoru and F.P.Jhirka blocks.

We did a time series analysis of availability of ground water in GIS, based on data collected from Central Ground Water Board through India Water Portal site. The time series information was mapped through inverse weighting interpolation, and point to raster conversion.

Figure 4 shows that where ground water has already become saline and difficult to use for irrigation or drinking purpose, the water level has increased over time. In some of the pockets the ground water level has increased to such an extent that it often leads to water logging problem. On the other hand, fresh water pockets in Taoru blocks is depleting continuously over the last decade. The colour legend of Figure 4 has captured this drastic shift (from blue to red). The other fresh water pocket of F.P. Jhirka got recharged due to good rainfall in

2011, but once again moved towards rapid depletion in the next 5 years between 2011 and 2016.

Figure 4: Decadal trend of groundwater level in Mewat

	Pre-Monsoon	Post Monsoon	Colour legends
2006			Red implies higher values, i.e. low ground water level, and blue implies lower values, i.e. high ground water level. The scale towards Red thus signifies ground water depletion. 
2011			
2016			

Source: Prepared by authors based on data collected from Central Ground Water Board

3.2.The Socio-Economic Consequences

The economic losses caused due to climatic variability can be in the forms of short-term crop failures or long-term reduction in productivity, crop diversification, and even loss of indigenous crop varieties in the district (Sood and Mehta 2015). We have identified following types of socio-economic consequences of ground water salinity:

Decline in productivity

An important outcome of lack of freshwater for irrigation is the decline in productivity of the crops grown in that region. According to the farmers, in earlier times when rainfall was abundant, there was no need for irrigation at all. In the late nineties three consecutive drought year led to substantial rise in groundwater extraction, and soon after the fresh water at the uppermost level got extracted, saline water started coming out. Presently if there is delay or inadequacy in the rainfall, farmers apply saline groundwater knowing fully well that the productivity will be comparatively less. If there is sufficient rainfall in the following year, the accumulated salt in the soil gets washed away and the productivity is not further affected. However, if there is low rainfall in the next year also, productivity gets further down. In some of the fields, with repeated use of saline water farmers have witnessed even zero productivity.

It was revealed during FGD in Sounk village of Nuh block that in early nineties with sole dependency on rainwater, per acre productivity of Mustard (the main crop of Mewat) was around 12 quintal. With the use of saline ground water the yield came down to 8 quintal per acre late nineties onwards. However, in the last five years, with the availability of canal water, the productivity has doubled, approximately 16 quintal per acre. According to the farmers, the productivity of canal water is reportedly even higher than the rainwater. According to farmers perception the deposited latrine wastes in the canal water works as natural fertiliser and increases the productivity. However, they believe that chemical wastes should not be allowed to be deposited in these canals as it might be harmful for the crops as well as the end users.

Loss of indigenous varieties

Apart from a decline in the yield, salinity has also impacted in a substantial loss of crop varieties. Before the salinity problem, mustard, gram, wheat, jawar, bajra, and vegetables were being cultivated in Mewat. While other crops remained the same, due to increased salinity farmers do not cultivate vegetables now. Since salt tolerance level is high for tomatoes, only tomatoes are cultivated in limited parts of the land.

However, farmers stated that the size of the tomatoes has reduced due to salinity, and therefore they do not fetch commensurate selling prices. Earlier big tomatoes produced by them used to get sold at Rs 450-500 per crate[3]. Now the small tomatoes get sold at Rs. 150 per crate.

Increase in cost of cultivation

Earlier rain water was the prime source of irrigation. Now farming practices in Mewat has changed drastically. The local seeds have been substituted by hybrid seed. The use of organic manure like cow dung has been substituted by chemical fertilizers like Urea, Potash, DAP, Boron and Zink etc. With canal water now farmers apply 50 Kilograms of chemical fertilizer per acre. The year when canal water is not available, they have to apply as much as 150 kilograms of chemical fertilizer per acre (with combination of rain water and saline ground water). The changing agricultural practices have raised the cost of input in farming especially the irrigation cost. Farmers of Sounk village in Nuh block informed that per acre cost of cultivation for wheat has increased by INR 13000, from an average of INR 2,000 in the early nineties to INR 15,000 at present. Likewise, per acreage cost of input for Jowar and Mustard was approximately INR 1,000 in early nineties, which has increased to INR 7,000 to 10,000. According to many farmers hybrid seeds and chemical fertilizers have affected the taste of the food negatively.

Increase in cost and time to arrange fresh drinking water

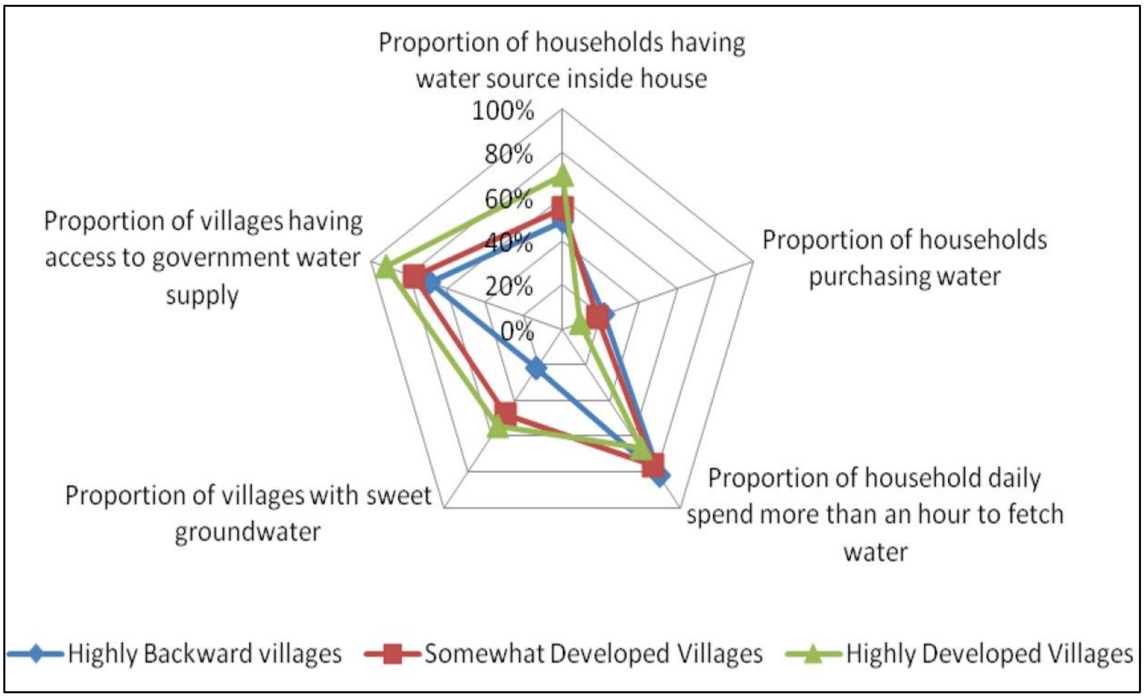
In terms of drinking water availability, increased groundwater salinity in Mewat has triggered the community to shift their source of water from local wells to distant water storage units. The storage units draw water from limited sweet groundwater pockets located in the foothills of Aravallis. Drinking water is supplied to some of the nearby villages by the government through underground pipes. In the absence of this provision, buying water through local water merchants is the only option. The water price is INR 900 to 1000 per tank. For an average family size of 6 to 7 people this amount is sufficient for 15 days. Therefore an average family spends INR 1800 to 2000 only on drinking water.

[3] One crate has the capacity of 25 to 30 kilograms approximately

The price charged by private tankers varies depending on the availability of water and distance travelled to deliver water. During summers, price increases due to high demand, and even delays in the delivery system is frequent due to inconsistent supply of electricity at storage unit.

The economically weaker households (mainly landless labourers and marginal farmers) use saline water from village pond for daily ablutions uses and young girls and women spend enormous time to fetch fresh water from far off sources for drinking. This has significant repercussions for girls' education and overall development of women in this region. Mehta (2015) found that highly backward villages significantly lack in terms of availability of sweet groundwater, government water supply, and in house water sources compared to highly developed villages (Figure 5).

Figure 5: Highly backward villages of Mewat lack in terms of fresh water availability



Source: Mehta (2015)

Sood and Mehta (2015) mentioned about few far reaching consequences. Firstly, consumption of limited available sweet groundwater is occurring at an unprecedented rate and is bound to decrease water level. Secondly, discrimination based on social identity in the distribution of water is taking place in some of the villages. In Karehri village an exclusive water tank called *Balmiki* tank was constructed in 2013 for the poor and lower caste minority called *Balmiki*, through Panchayat funds. Prior to the construction of this tank, they were not allowed to fetch water from the common village storage tank. The report mentioned that the discriminatory practice still continues, and though there seem to be no conflict until now, with increasing water scarcity, the emergence of conflicts over resources may arise in near future.

Reduction in livestock

Among other reasons, salinity has also resulted into a decline in the number of livestock. In earlier times every household used to have 5 to 15 cattle on an average. Now the number has reduced drastically. *'Paani aur Chhaya'* (water and shade) are the two crucial items for cattle rearing, which became scarce. As pointed out by some of the villagers in Sultanpur of Nagina block *'apne parivar ke liye hi paani kharidna parta hai, to pashuyon ke liye paani kahan se laye?'* (We have to purchase water for our own family, where can we arrange water for the cattle?). Moreover, the amount of common pasture/grazing land has reduced, and hence, villagers are forced to use residue obtained from crops for animals. The remaining fodder requirement is met through buying fodder from the market. Due to water scarcity problem the scope of mixed farming of food crops and fodder crops has also got restricted.

3.3 Adaptive Measures Increasing Welfare

Different parts of the world suffering from salinity problem like Western Australia, Central Asia (e.g. Pakistan), the Middle East (e.g. Israel), and Northern Africa (e.g. Tunisia), often practice soil reclamation or other coping mechanisms like cultivating halophytic species, Eucalyptus, P.juliflora, and other salt-tolerant plants (known as saltbushes) (Ladeiro, 2012, Shah et al 2005, Hollington et al 2001). According to Davidson (2000) soil reclamation practices are rare in developing counties, firstly because, of limited knowledge about these practices, secondly, small size of landholdings which restrains farmers for adopting new technologies, and thirdly, small landholders frequently lack the necessary capital to invest in these technologies. On the other hands, shift in crops have other benefits also. Cultivating halophytic species and salt-tolerant plants can also be used as livestock feed. P.juliflora can be used to make biofuel. Eucalyptus has huge medicinal value.

Acknowledging soil salinity to be one of the major land degradation problems in Indian agriculture, Central Soil Salinity Research Institute estimated the yield and monetary losses from various crops across 240 salt-affected districts in India. The report by Sharma et al. (2015) established significant production and monetary losses, and emphasised on soil reclamation by suitable location specific techniques. However, these techniques often being costly become infeasible for small farmers (Tomar and Minhas 1998). In that situation use of salt tolerant varieties and/or putting the land to alternative uses are suggested, which includes – afforestation program, medical and aromatic crops, bio-fuel crops, fodder crops, fruits and vegetables trees, coconut plantation, prawn/shrimp cultivation, and integrated farming of crop and fish (Selvamurugan et al 2017, Tomar and Minhas 1998, Singh and Dagar 1998, Kumar 1998, Patra and Singh 1998).

In Mewat, various coping mechanisms are being practised presently. These include: a) shifting from saline ground water to surface water due to proximity of the canal, b) purchasing water for irrigation, c) using computerised land levelling, d) using water saving technology of drip/sprinkler irrigation, f) distress migration and livelihood diversification. In this section some of the case studies of coping mechanisms have been discussed along with their impacts on farmers.

Combating water scarcity through laser levelling

Mahavir of Mundaka Village in F. P. Jhirka block owns four acres of land, and farming is his primary source of income. He has witnessed water scarcity problem in his village after the devastating drought of 1996. He recalled that water was abundantly available in the village before the drought. Agriculture was primarily rain fed and approximately 30 per cent of the lands were irrigated through water extracted by diesel pumps from open well, since groundwater was available at 15 to 20 feet only. Since the drought, almost all the village lands get irrigated through bore wells which run either through diesel or electric pump. It has resulted in overexploitation of groundwater, and presently groundwater is available at 70 to 80 feet. With the decreasing water level, the quality of water also changed from sweet to saline. As per Mahavir, there have been many unfavorable agriculture outcomes, especially increase the irrigation cost.

Realizing the fact that cost of irrigation is directly linked to unevenness of the land, Mahavir adopted the method of digital levelling in 2 acres of his land during 2015. Within this time period he has witnessed numbers of economic benefits. Alongside decline in water requirement, 3 to 4 hours per irrigation has also been saved due to laser levelling. As a result, there has been a reduction the electricity bill. It has come down from INR 1000-1500 (cumulative bill of two months) to INR 250-300. The adoption of laser levelling has raised the yield of the crop also. A net increase of one quintal per acre in mustard, 2 quintals per acre in wheat, bajra and cotton has been observed by him.

Mahavir informed that due to the constant failure of electricity during the day time, all the farmers in his village who irrigate the land through the electric pump prefer to do that at night. Describing the benefits of laser levelling, Mahavir told us that before laser levelling, he had to spend the whole night in the field. In winters he had to sit in front of the fire for the entire night, in order to change the pipe from one place to another since water did not used to spread over all the farmland equally due to the unevenness. After installing laser levelling, he goes to field twice in the night to shift the location of pipe from one place to another so that water automatically spreads to the entire land. He can now have peaceful sleep rest of the night.

Efficient water use through adoption of sprinkler

Iqbal, a resident of the Sounk village in Nuh block, witnessed the devastating drought back in 1996. According to him it had badly affected the groundwater and the farming practices of villagers. Iqbal said that the groundwater level of his village declined sharply from 30 to 35 feet in early nineties up to 80 to 85 feet at present. At the same time the taste of the water has also changed from sweet to saline, which had impacted the household consumption pattern and agricultural practices drastically. Iqbal along with other villagers often depend on purchased water for drinking as well as farming purposes.

Describing the past days, Iqbal said that before the drought, agriculture was mostly rain-fed and some of the lands were irrigating through bore wells. The average time of irrigation per acre was 6 to 7 hours which has increased up to 10 to 12 hours at present. According to him, the adoption of hybrid seeds and application of a number of chemical fertilizers has raised the cost of input in farming, especially the cost of irrigation. As a solution to check the irrigation cost and to check the inefficient groundwater use, he has adopted sprinkler irrigation system.

Iqbal installed the sprinkler in his land at a subsidized rate from a private company in 2018. Within this short time period he realized that the installation of sprinkler proved beneficial for him in many aspects, e.g. saving water, cost of irrigation, physical drudgery, time taken for irrigation, and increasing yields.

Canal irrigation helped Haji Israel to spend money on children's education

Haji Israel, a resident of Sultanpur village in Nagina block is a beneficiary of canal water. Interestingly the canal is situated in Umra village, which is at a distance of 3 kilometres from their village. Comparatively economically better-off farmers of Sultanpur village (including

Haji Israel) arranged funds to bring water to their village from the nearest canal in Umra village through pipelines during 2014-15. He recalled that rainfall was very regular upto seventies, and due to good rain the soil had better moisture. Therefore none of the villagers felt the requirement of irrigation. However, rainfall gradually reduced upto mid-nineties, and decline and variability became serious after late-nineties. The crops were continuously affected due to the scarcity of water in the village. Before the canal irrigation, villagers were dependent on other nearby villages like Sangel, Umra, Ujaina for purchasing food grains, but now to some extent, villagers became self-sufficient in terms of food production.

However, according to Haji Israel, the canal water covers nearly 30 per cent of the total land in the village, where cultivation is possible twice a year for both Khariff and Rabi seasons. The rest of the villagers depend on rainfall only and cultivate once in a year. If rainfall is inadequate they helplessly use saline water, knowing fully well that it will affect productivity. Haji finds himself one of the blessed residents in the village whose entire 2.5 acres of land is irrigated through canal water. His per acreage yield has increased significantly – on an average 800 kilograms for wheat, and 400 kilograms for Mustard. Moreover, with canal water, he even started growing cotton which fetches him good income which he can spend on children's education and save for their future as well.

Coping up with migration and livelihood diversification

70 years old Khanaya of Patan Udaypuri village in F. P. Jhirka block observed an alarming rate of depletion in groundwater level in his village from 200 to 300 feet to 1100 feet, and eventual change of the ground water from sweet to saline. He narrated *"pahele goan me pani meeta tha ab pure gaon ka pani karwa ho gaya hai"* (In earlier time the water of our village used to sweet, now it has become saline). The depletion of ground water has forced Khanaya and many villagers to depend on purchase water for drinking and irrigation. In order to cope up with increasing cost of cultivation Khanaya has to migrate more often. Earlier he was migrating once in a year, but now he migrates twice a year. Khanaya said that earlier due to water availability he used to produce wheat and mustard in his small patch of land, but due to water scarcity, presently he produces only mustard, and hence he migrates during the wheat cutting season as well.

He generally migrates to Hanumangarh (Rajasthan), Punjab and Gujarat for cotton plucking, and Bilaspur and Rewari for wheat harvesting. The main incentive behind migrating so far is to receive cash payment, since in the local areas people pay him in kind. With the additional income, he has bought an electrical *chaak* with INR 5000 to make earthen pots for selling. The electrical *chaak* is able to make 70 to 80 pots per day whereas manually he used to make only 3 to 5 pots per day. He sells these pots in the local market and earn around INR 40 to 50 per pot.

4. CONCLUSIONS AND RECOMMENDATIONS

The impoverishment of the most backward district of India viz. Nuh is directly related to climatic changes and natural resource degradation, as the backward or highly deprived regions are saline-water zone, whereas comparatively developed regions are either sweet-water zone or have access to fresh water. This area specific, evident-based study brings out the socio-economic impacts of both climate change induced ground water salinity problem and various coping mechanisms. As per meteorological data analysis rainfall has declined in the last six decades. Increase in minimum temperature is more than the maximum temperature. Calculated potential evapotranspiration shows an increasing trend over last 20 years, which imply more dryness in the soil/region. The ground water of limited freshwater pockets is depleting fast, whereas unusable saline water level is increasing. An important outcome of lack of freshwater for irrigation has been the decline in productivity of the crops grown in that region. According to the farmers, in earlier times when rainfall was abundant, there was no need for irrigation at all. In the late nineties when there were three consecutive droughts, suddenly extraction of the groundwater became intense, and soon after the fresh water at the uppermost level got extracted, saline water started coming out.

The major socio-economic impacts are found to be: a) decline in crop productivity, b) loss of indigenous crop varieties, c) increase in cost of cultivation, particularly irrigation, d) increase in cost and time to arrange fresh drinking water, and e) reduction in livestock. Various coping mechanisms are practised in the region. These include: a) shifting from saline ground water to surface water due to proximity of the canal, b) purchasing water for irrigation, c) using computerised land levelling, d) using water saving technology of drip/sprinkler irrigation, and f) distress migration (mainly as truck drivers) and livelihood diversification. The case studies provided in the paper throws light on their impacts on farmers' wellbeing.

It has been found that lack of knowledge of the farmers, support and absence of public institutions has restricted planned adaptive measures to address long-term climate change phenomena. Demonstration effect has been found to be present in the region. For example, villagers of Sultanpur arranged for canal water on their own initiative and expenditure, after witnessing the benefits of canal water in Umra village, situated 3 kilometres away. These villagers also saw land levelling taking place in Umra village, so they also started land levelling. However, as revealed in villages of other blocks, sprinkler irrigation is also helpful in reducing water requirement and increasing yield, but the villagers of Sultanpur have neither seen that, nor tried that.

Recommendations

In Nuh district, options of livelihood are sparse due to multiple factors such as poor education indices, lack of vocational skills, absence of any rail network, poor road connectivity etc. Resultantly, majority population in the region are either employed in agriculture or are opting for migration (mostly circular) to meet their daily ends. Increase incidents of drought in the past and higher spread of salinity in the region has jeopardised the livelihood of the people by limiting crop choices and low crop yield. As scarcity of resources limits avenues of industries in the region, coupled with low agricultural growth and nearly 55 per cent area being saline, investment on agriculture technology should receive attention. New saline resistant crop varieties introduced, recently, in several countries can also be introduced in Nuh. High investment in water infrastructure for drinking and farming purposes should be utmost priority in the region as it has adversely affected rural development such as living standard, agriculture, gender etc. Furthermore, around three fourth area of Nuh district fall in critical groundwater level and increased incidence of temperature rise and decline in rainfall puts further burden on the same. In this regard, rainwater harvesting could be one of the viable options that could be utilised. Artificial recharge is feasible in major parts of the district and the major source of water for recharge is rainfall. The type of recharge structures suitable in the terrain of Mewat are recharge trenches with injection well, and gabion check dams (Government of India, 2018). Also, as case studies suggested that some of the new and innovative technologies like laser levelling, drip irrigation is found to be successful in saving water and increasing revenues from farming, such technologies should be up scaled through means of various agriculture extension services by the government. As water salinity is spreading in the region, alternative livelihood in terms of small scale fishing can also be tested. Also, plantation of eucalyptus trees can be encouraged which can lower the water table through rapid transpiration.

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