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Environmental Stress and Migration Dynamics in the Girana-Godavari Basin in Nashik District, Maharashtra

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Abstract

This paper examines the impacts of environmental stress on the migration patterns of tribal households in Girana-Godavari basin, Maharashtra specifically, in relation to climate variations and water scarcity. The region has witnessed a tremendous reduction of rainfall (about 22 percent) and severe droughts over the past 20 years, which have aggravated livelihood insecurities. According to field data of 120 tribal households in 12 villages of Nashik, Jalgaon and Ahmednagar districts, 41 percent of households are currently involved in seasonal migration caused by failed crops, ground water, and local joblessness. Women are particularly disadvantaged as 74 percent of them walk more than 1.5 km a day to collect water in dry months. The results point to the interplay between the ecological stress, socio-economic marginalization and institutional neglect being rather complex. The paper holds the argument that migration is not necessarily an economic reaction; it is a socially instilled adjustment to environmental insecurity. Community-based water governance, gender responsive adaptation and livelihood diversification are needed to ensure that forced migration is minimized and resilience of tribal people is improved.

Keywords: Climate variability, Water scarcity, Tribal migration, Hydro-social vulnerability, Livelihood adaptation, Maharashtra, Gendered impacts.

Introduction

Climate change has been causing environmental stress, which is gradually changing the livelihood and hydro-logical systems of semi-arid India. An example of this interaction of the ecological decline and human susceptibility is the Girana-Godavari basin in northern Maharashtra. The communities that reside in this basin are mainly tribal communities including Bhil, Koli and Pawara who rely on rain-fed agriculture, forest industries and wage employment. These subsistence systems have been compromised in the last few decades by threats of declining rainfall, increased temperature variability, and groundwater depletion (Gadgil and Guha, 1995; Kulkarni et al., 2020).

Although migration has been a long existing survival tactic in peripheral agrarian areas, new environmental alterations have escalated the magnitude and rate. It has now become an influential push factor where the rural families are pushed to find hazardous work in the urban centres like Nashik, Aurangabad and Pune due to droughts, crop failure and lack of water (Deshingkar and Start, 2003; Srivastava, 2011). Migration decisions are, however, not entirely economic, they are still in hydro-social settings influenced by unequal resource access, gender division of labor, and institutional inequality (Zwarteveen and Boelens, 2014; Mehta, 2013).

The current paper discusses the effect of environmental stress on tribal migration patterns in the Girana-godavari basin among tribal households. It takes a hydro-social approach, which analyzes how water shortage, social inequality, and livelihood adjustment co-evolve. Through a mixture of fieldwork in a community setting, participatory mapping and qualitative interviews, the study will reflect on the lived experiences of people who live in environmental uncertainty.

The shifts in river and water regimes in India are occurring as a result of climate change and this directly impacts farming and rural livelihoods, particularly in tribal India. The tribe groups in the Girana-Godavari basin of Maharashtra are experiencing an increasingly erratic weather pattern, including irregular precipitation, increasing dry seasons, and decreased groundwater levels (Gadgil and Guha, 1995; Kulkarni et al., 2020). These developments have rendered traditional farming and forest based working more cumbersome.

Among the most affected tribes are the Bhil, Koli as well as the Pawara. They primarily rely on rain-fed agriculture and lack access to large irrigation systems, or government water irrigation plants (Gaikwad et al., 2011).

Over the last decade, rainfall shortages have hit the region (particularly rain-shadow areas of Nashik, Jalgaon, and Ahmednagar) by up to 2025% and make crop cultivation and the subsequent stable income more difficult (IMD, 2022). This has meant that seasonal migration of tribal families to cities is being influenced in search of employment (Deshingkar and Start, 2003).

Study Area and Methodology

1. Study Area Description

These villages were specifically selected according to three major criteria (i) a high percentage (>60) of Scheduled Tribe (ST) as a population, (ii) existing seasonal migration history, and (iii) previous exposure to drought or water stress within the past years. Table 4 indicates that in 12 of the villages the population of these STs is at least 60 and in several of the villages like Hattigaon (74.6) and Pimpaldara (72.5) the population of tribal residents is even more. This justifies the research interests in tribal dominated settlements within Nashik, Jalgaon and Ahmednagar districts.

Table 1: Percentage of Scheduled Tribe (ST) Population in Sample Villages

Village Name	Taluka	District	Total Population	ST Population	% ST Population
Hattigaon	Surgana	Nashik	1,133	845	74.6%
Peint	Peint	Nashik	1,569	1,082	68.9%
Kalwan	Kalwan	Nashik	1,236	822	66.5%
Nimgul	Chopda	Jalgaon	1,675	1,110	66.2%
Amalgaon	Yawal	Jalgaon	2,134	1,410	66.1%
Akulkhede	Raver	Jalgaon	1,254	800	63.8%
Kolwadi	Akole	Ahmednagar	1,312	812	61.9%
Ranjani	Sangamner	Ahmednagar	1,075	698	64.9%
Kumshet	Akole	Ahmednagar	1,124	743	66.1%
Pimpaldara	Peint	Nashik	1,011	733	72.5%
Pardevi	Igatpuri	Nashik	1,213	848	69.9%
Wadi	Akole	Ahmednagar	1,298	841	64.8%

All the 12 chosen villages have more than 60 percent population of Scheduled Tribe according to Census 2011. STs comprise more than 70% of the population in such villages as Hattigaon and Pimpaldara (Nashik). The ST share is above 60% even in less remote regions such as Ranjani and Kolwadi in the Ahmednagar district. This proves that the sample actually represents the settlements which are dominated by tribes and it is worth studying the Scheduled Tribe communities which are most susceptible to climate effects.

2. Data Collection and Research Design

The qualitative research design was used to investigate the complicated relationships between climate variability, water access and tribal migration. The research was done by gathering a lot of fieldwork involving surveys, interviews and participatory approaches in the selected tribal villages.

Sampling and Respondents

There were 12 tribal villages picked in the three districts.

A survey was conducted with 120 households (10 households were in each village) which was conducted through semi-structured interview, both male and female members of the household were surveyed.

Some of the key informants that were used included: village elders, local NGO workers, forest guards, as well as gram panchayat representatives.

Instruments and Methods of Data Collection

- Semi-structured Interviews:** The interviews were based on the perception of climate change, water access, livelihood patterns, and migration choices.
- Focus Group Discussions (FGDs):** Men and women were interviewed separately and this was done to get gendered experience of water scarcity and migration.
- Participatory Rural Appraisal (PRA) techniques:
 - Rainfall, crop cycles, and times of migration calendar
 - Mapping of local water resource
 - History of the significant droughts over the past two decades
- On-site Observation: Observations of water infrastructure (e.g., wells, tanks), deteriorated lands, and socio-ecological states.

3. Data Analysis

The data were collected and analyzed through manual transcription and analysis using the thematic approach. An iterative coding scheme was worked out to distinguish common responses to such main themes as:

- Climatic change perceptions
- Reasons and the effects of migration
- Water access and usage

- Community coping and adaptation practices

Matrices were themed to make comparisons between districts and gender groups. Quantitative frequencies (e.g. percentage of households reporting migration, or water related crop loss) have been collected too in order to verify the qualitative results.

The informed consent of all participants provided ethical clearance and full confidentiality was obtained.

Results

Climate Variability and Cherished Environmental Change

Out of the 12 villages sampled, 87 percent of the sampled respondents indicated that there has been a change in climatic patterns in the last 10-15 years in the 12 villages sampled. The main changes that were perceived were:

- Unpredictable rainfall: 72% have been found to report a late monsoon onset and premature withdrawal.
- Extended dry periods: 65% had at least 20-30 days of dry consecutive days in the crucial crop periods.
- Sinking ground water: 58 percent of households reported that wells and boreholes dry up sooner than in the past, even by mid-February.

It was also emphasized by older respondents that previously, the period of water availability extended up to April-May, but currently, the availability reaches at most up to March.

The well used to fill even during summer but is now drying up by Shivratri, said a 68-year old farmer at Nandgaon village, Nashik.

Table 2: Perception of Climate Change Indicators

(Percentage of households reporting each climate impact)

Climate Impact	% Households
Erratic Rainfall	72%
Prolonged Dry Spells	65%
Declining Groundwater	58%
Early Summer Well Drying	60% (Avg)

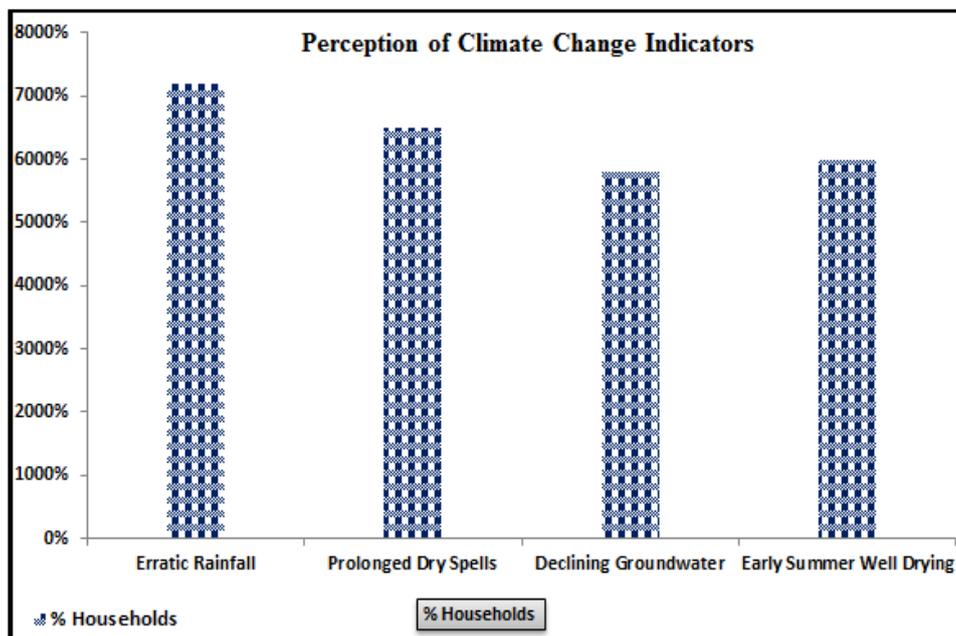


Figure 1: Perception of Climate Change

Table 2 shows the feeling of tribal households about the changed climate conditions in the Girana- Godavari basin. A major 72 percent of respondents said they had experienced erratic rainfall patterns which included; late arrival of the monsoons, unequal distributions and early retirements. This unpredictability in rainfall has critically affected rainfed agriculture that forms the major source of livelihood to majority of the tribes in the area.

In addition, 65 percent of households noticed the existence of long dry periods throughout the crop growing period and this exposed them to drought and high chances of crop failure. The problem of depleting ground water was also recognized by 58 percent of the people who were interviewed, and this is the over exploitation of borewells and absence of proper recharge systems. Also, 60 percent of households said that by February or March, before the next monsoon came, wells and other antique water resources were dry.

These views depict a clear understanding of tribal societies of the changing climatic trends. Not only do they mirror real changes in the environment; but they also highlight the increased uncertainty and risk of conventional agro-ecological systems. The information justifies the necessity of immediate measures in adapting to climate, sustainable water management, and resilience construction at the local level. Table 3:

Annual Rainfall Table (2013–2022)

Year	Nashik (mm)	Jalgaon (mm)	Ahmednagar (mm)
2013	185.0	215.1	~563
2014	26.2	249.3	~563
2015	133.8	148.4	~563
2016	12.4	196.0	~563
2017	249.4	65.8	~563
2018	146.0	23.3	~563
2019	107.6	147.5	~563
2020	364.0	83.8	~563
2021	101.1	188.5	~563
2022	93.7	196.0	~563
10-yr Avg	141 mm	141 mm	562–563mm

The data on decadal rainfall of 2013-2022 of Nashik, Jalgaon, and Ahmednagar districts show that there is a tendency of large inter-annual variability especially of Nashik and Jalgaon districts. There were severe changes in Nashik, as the minimum level of the rainfall was 12.4 mm in 2016 and the maximum was 364 mm in 2020. Jalgaon also had unpredictable patterns with an average of 23.3mm in 2018 and a high of 249.3mm in 2014. By comparison, Ahmednagar had comparatively steady rainfall with an average rainfall of approximately 562-563mm/yr over the decade though internal taluka deviation is likely to exist. In general, Nashik and Jalgaon are characterized by the evidence of rainfall uncertainty and climatic stress, and Ahmednagar has a regular but moderate rhythm of rainfalls. This fluctuation, particularly at Nashik and Jalgaon, is consistent with the local beliefs about unpredictable monsoons and justifies the effects of monsoons on agriculture and availability of water in the study region.

Table 4: Drought Years in Nashik, Jalgaon & Ahmednagar (2013–2023)

Year	Nashik	Jalgaon	Ahmednagar
2013	☐	☐	☐
2014	–	–	–
2015	☐	–	☐
2016	☐	–	☐
2017	–	–	–
2018	☐	☐	☐
2019	–	–	–
2020	–	–	–
2021	–	–	–
2022	–	–	–
2023	☐	☐	☐
Total Events	5	3	5

☐ denotes that the district was officially declared to be in drought during the year.

Most often, droughts in these districts took place in 2013, 2015, 2016, 2018, and 2023.

In Nashik and Ahmednagar, there were five years of official drought each between 2013–2023 and Jalgaon experienced three. The worst drought in the region was in 2013 that was one of the worst droughts in forty years. There were other major droughts in 2015, 2016, 2018 and 2023 and each time that happened, it was declared by the state. Large areas of Jalgaon and Ahmednagar, in 2018 13 and 12 talukas in Jalgaon and Ahmednagar, respectively, were declared rain-deficient. This common occurrence of the drought is consistent with the experiences of the tribal community in the region such as drought of crops, shortage of water, and seasonal migration.

Water Shortages and Livelihoods

The problem of water scarcity has had a devastating impact on agricultural production:

68% of the households stated that they had experienced complete or partial crop failure in the past two years because of no irrigation and unpredictable rains.

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Water Shortages and Livelihoods

The problem of water scarcity has had a devastating impact on agricultural production:

68% of the households stated that they had experienced complete or partial crop failure in the past two years because of no irrigation and unpredictable rains.

- The area of cultivation by families was decreased by 56% and especially those crops that demanded a lot of water such as cotton and maize.
- Mean yield of jowar and bajra dropped by 25- 30 percent of what it was five years ago.

Other non-farm activities like fishing and gathering of smaller forest produces (e.g., mahua, tendu) also have reduced as a result of an ecological degradation and loss of natural resources.

Alternative 3: Water Harvesting on Women. Other non-farm activities like fishing and gathering of smaller forest produces (e.g., mahua, tendu) also have reduced as a result of an ecological degradation and loss of natural resources.

Alternative 3: Water Harvesting on Women.

Table 5: Water Collection Burden on Women

Issue	% Households Reporting
Walk >1.5 km for Water	74%
Health Issues (back pain, UTI)	55% (est.)
Reduced Time for Other Work	62% (est.)

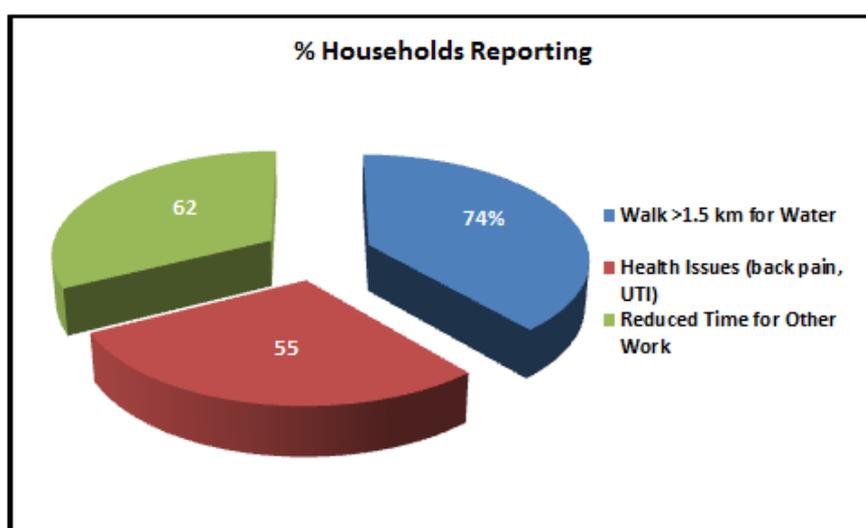


Figure 2: Water Burden on Women

□ shows that the district officially was under a drought declaration that year.

The most common times when droughts occurred in these districts were 2013, 2015, 2016, 2018, and 2023.

Nashik and Ahmednagar experienced five drought years each with Jalgaon having three. In the year 2013, the worst drought in the region was experienced that was one of the worst droughts in the past 40 years. Other major droughts were experienced in 2015, 2016, 2018, and 2023 with each event declared officially by the state. Massive areas of Jalgaon and Ahmednagar, 2018 alone, are declared rain-deficient in 13 talukas of Jalgaon and 12 of Ahmednagar. This common repetition of the drought coincides with the tribal community of the area whereby crop failures, water scarcity, and seasonal migration are being witnessed.

Water Shortage and Lifestyle effects

Water shortage has been a serious hit to agricultural production:

- 68 percent of households said they had failed in all or part of their crop in the past two years because of the absence of irrigation and unpredictable rains.
- 56 percent of families shrunk the cultivated land, especially crops that consumed a lot of water such as cotton and maize.
- Average jowar and bajra yield had decreased by 25-30 percent over five years.

Ecological degradation and loss of resources have also resulted in non-farm livelihoods (fishing and collection of small forest produce e.g., mahua, tendu) declining.

Alternative 3: Water on the Head of Women.

Table 6: Migration Push Factors

Push Factor	% Households Mentioning
Water Scarcity	82%
Crop Loss Debt	64%
Lack of Local Jobs	51%

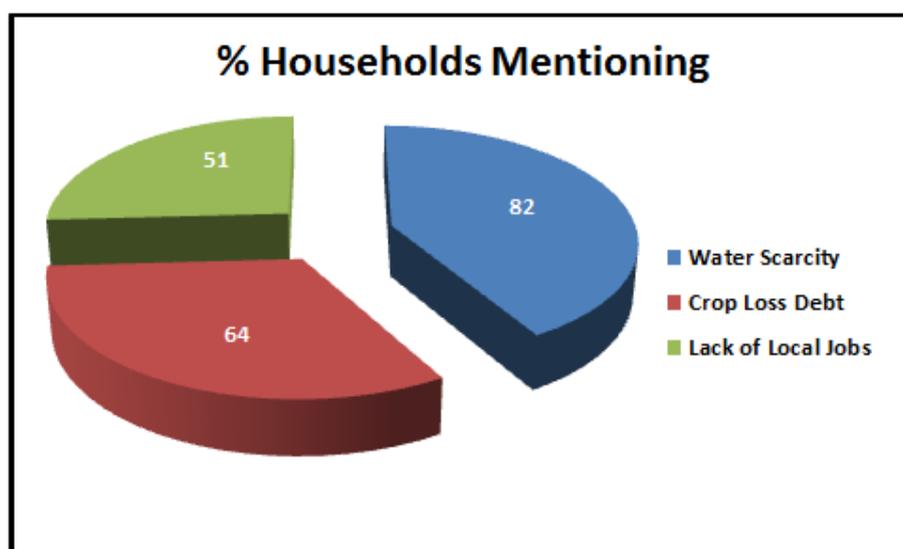


Figure 3: Push Factors for Migration

The main factors leading to tribal migration in the Girana-Godavari basin are identified in table 6, indicating that socio-economic vulnerability and environmental stress were closely interconnected. Water scarcity which was reported by 82 percent of homes was found to be the strongest force that is driving families to migrate because 82 percent of households indicated that the lack of water to carry out farming activities and domestic use is the most influential factor. The result is consistent with the overall degradation of the local water resources due to climate in the study area.

Moreover, 64 percent of the respondents had blamed their migration choices to because of debt caused by frequent crop failure. Having unpredictable rainfall and lack of adequate irrigation facilities, most of the tribal farmers are in the rut of borrowing and loss thus survival strategy is long-term or seasonal migration.

Lastly, in 51% of households, the inability to find local job opportunities was a major factor in migration. Lack of non-urban rural livelihoods drives the young people and the working age population to find out labor-intensive employment in the urban areas, which may be insecure and exploitative.

The combination of these elements indicates a multi-dimensional crisis in the intersection of ecological pressures and economic precarity with involuntary displacement and further rural despair among tribal populations.

Gendered and Social aspects of water insecurity

The affected segment of the population is women especially:

Females in 74% of households, and during summer, in 74% of households, they had to walk more than 1.5 km daily to collect drinking water.

- More time spent in collecting water means that women will have less time to focus on income generating or educational activities.
- Some of the women complained about health problems such as the pains in the back and urinary infections as a result of long distance water carrying.
- The social disparities also exist:
- Lower caste tribal communities (e.g., Katkari) were not allowed to enjoy the benefits of having access to the private wells which belonged to the dominant families.
- Government water tankers were erratic and largely did not serve remote hamlets.

Responses and Coping Mechanisms

Communitarians have devised localized responses to structural difficulties:

- Water sharing in-between neighbouring homes (reported by 48%).
- Building of temporary check-dams of local materials (stones, soil).
- Change to less water consuming crops such as pulses and millets.
- Two villages recorded the use of self-help groups by women who began the rainwater harvesting tanks through the assistance of NGOs.

Nonetheless, the institutional support was low:

Only two villages out of 12 villages had operating watershed management projects.

Only a quarter of the families were receiving any government subsidy or scheme regarding water or agriculture.

Discussion

The research indicates that environmental degradation, particularly water shortage has emerged as a major cause of movement of tribal people in the Girana-Godavari basin. The association between livelihood insecurity and rainfall variability is in line with other studies related to climate-driven migration in India (Ghosh et al., 2020; Aggarwal et al., 2020).

The problem of groundwater depletion adds to this crisis: 58 percent of households mentioned that they experienced a well drying out earlier, which was in line with national results in the Central Ground Water Board (CGWB, 2021). The

hydro-social model assists in understanding the interaction between ecological pressures and social inequalities, inadequate infrastructure, and policy oversights to generate imbalanced vulnerabilities (Zwarteveen and Boelens, 2014).

The experiences of women also point to the cross-interaction of gender and environmental stress. Their overworking in water harvesting limits their livelihood choices and causes gendered poverty (Singh, 2019). However, such inequities within a household are ignored in majority of climate adaptation policies in Maharashtra (Mehta, 2013).

Although community-based interventions like check dams and crop diversification result in resilience, they are not well supported. The failure of formal response to local-level adaptation and the ongoing breach of this fulfills the definition of what Joy et al. (2014) thought of as an institutional drought in India a governance failure, not just a rainfall failure.

This research demonstrates that the connection between the shifting climate and water shortage and increased migration among tribal population in the Girana-Godavari basin exists closely. Many indicated that rain has become unpredictable with 72% reporting longer dry periods (65% of people indicated longer dry periods). These observations are consistent with larger-scale climate research in peninsular India that indicate the existence of increasingly unpredictable monsoons and increased dry periods over the last several years (Ghosh et al., 2020; Kulkarni et al., 2020).

Ground water is even becoming less accessible. In our survey 58 percent claimed that their wells nowadays dry up much sooner than previously. This tendency is representative of regional literature, as it demonstrates that groundwater reserves are dwindling throughout the Deccan area as a result of excessive exploitation and a lack of adequate recharge (CGWB, 2021). Indeed, other studies have indicated that the Godavari basin is putting itself in a very dangerous water stress situation, particularly in arid habited regions such as Jalgaon and Ahmednagar (Shah & Kulkarni, 2016).

One of the primary causes of the migration of people is water issues. In this research 82 percent of families claimed absence of water was their largest motive behind migration. It agrees with previous research studies which have established that now the stress on the environment- drought in particular is a significant cause of rural migration in India (Deshingkar & Start, 2003). Individuals are immigrating to some cities such as Nashik and Aurangabad where they tend to engage in employment of hard, low-paid jobs with little coverage (Srivastava, 2011).

The women are particularly vulnerable. Approximately 74 percent of our female respondents, during the summer, walk over a distance of 1.5km daily just to get water. This day to day struggle is physically challenging because of the backache and infections and it also decreases the time in which women can engage in farming, education or earning a living. Other gender and climate change research also demonstrate the occurrence of this trend in India (Singh, 2019). However, these gender-specific questions are seldom taken into account by the government policies when they think over the climate or water project planning (Mehta, 2013).

Although there are a few villages making efforts to address such problems themselves, by constructing small check dams, or by replanting to crops that require less water, government aid is extremely minimal. Active watershed programs were only in place in 2 of the 12 villages and less than 30 percent of households received assistance via any government program. This demonstrates a severe policy-reality discrepancy, particularly in tribal regions (Joy et al., 2014).

This analysis also demonstrates the importance of the hydro-social approach, i.e. considering two issues simultaneously: the water problems and the social ones. It assists us to comprehend how caste, inequality in land as well as absence of officials support make the surviving climate effects even more complex on tribal families (Zwarteveen and Boelens, 2014). In this respect, migration is not only an economic problem, but also a social one that is associated with greater injustices.

The only way to really assist these communities is to have a combination of solutions which include improved farming practices, local management of water, assistance to women and actual involvement of the tribal voices in the planning. The water crisis cannot be solved only using infrastructure but it requires fairness, participation and long-term thinking.

Conclusion

This paper evidently demonstrates that the climate change is posing significant issues in the Girana-Godavari basin to the tribal groups. Abnormal rain (72%), increased dry seasons (65%), and declining groundwater reserves (58%) have made people difficult to cultivate food, access water and make a living. It most impacts women - approximately 74 percent of the population has to walk more than 1.5 kilometers each day to find water, which results in health issues (55 percent) and inadequate time to work or study (Singh, 2019). These difficulties have caused a high number of families to migrate. About 82 percent reported that they went due to water shortage, debt due to loss of crop (64 percent) and unavailable jobs locally (51 percent). These are consistent with other studies about the causes of migration to the urban areas due to drought and deplorable conditions in rural areas seeking employment (Deshingkar and Start, 2003; Srivastava, 2011). However, the government support is very minimal. Even the programs available are not assisting most of the families, and vital measures such as groundwater mapping or watershed development are not in place in many villages (CGWB, 2021; Joy et al., 2014). This puts communities to work alone with little resources and increasing stress. The remedy to this situation is through better water planning in the area, agriculture which is capable of managing dry periods as well as alternative employment especially in the case of tribal families. The needs of women should also be included in these plans. Most of all, the traditional knowledge and relationship with land and water should be taken seriously in the government policies and the tribal voices should be heard (Mehta, 2013; Baviskar, 2004). Broadly speaking, this paper demonstrates that poverty is not the only cause of migration- it is an effect of more fundamental issues in the distribution of water, land and support in tribes. In order to alleviate forced migration and make people live better, we must have equitable, community-based measures that will take care of the environment as well as social issues.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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