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Drawdown area farming: a sustainable agriculture approach and its social impacts on the rural population in Jalna district, Maharashtra

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Abstract

An integrated study of the different aspects of drawdown area farming in the submergence area of water retaining structures is presented. The aspects considered are soil, water, changing land use patterns and socio-economic impact of the rural community and are closely related in the framework of sustainable farming. Soil analysis shows that in Banegaon the soil nitrogen content is low; it has marginally higher phosphorus content, and is very high in potassium; whereas, in the Padmavati study site, the nitrogen content is medium to low, phosphorus is medium and potassium content is very high. The soils in both study locations are medium in soil organic carbon and high in clay and silt content. Analysis of the water quality shows that the overall pH and total dissolved solids(TDS) values are within the permissible limits while, the total hardness in few wells have a high value in the pre-monsoon season, which reduces in the post monsoon season. All the representative water samples show the presence of coliform bacteria which is of concern as it is likely to give rise to abdominal problems. Intestinal infections were discussed and reported in the focused group discussion in both study locations. An attempt has been made to study drawdown farming because of the better economic opportunities available to farmers as well as off-season production. Farming on the drawdown area of reservoirs has major potential benefits for local and regional development. However, farming practices on the drawdown area require proper management plans that promote sustainable agricultural practices.

Keywords: *Drawdown area farming, Submergence area, Sustainable agriculture, Sustainable rural development.*

Introduction

Agriculture is the primary livelihood activity in rural India (Kumar *et al*., 2006) being the main engine of income growth and socio economic development of these regions. Agriculture in Maharashtra is mainly rainfed (Kelley *et al*., 1997; Vyas *et al*., 2015). The recurring drought-like situation in the state makes groundwater, water through canals, water retention structures viz., reservoirs and percolation tanks alternative sources of water for agricultural and domestic use. Agriculture along the river beds, canals and large water bodies have long been practiced; and while cultivation of crops in the drawdown area of large water retaining structures is also practiced since long (Biswas 2012, Yue, J*et al.*, 2016), drawdown related aspect is insufficiently discussed.

This type of farming is done during the post monsoon and summer months when the water from the reservoir recedes, exposing the submerged area at least for the five months. There is a high possibility of cultivation of short duration crops by utilizing soil moisture, accumulated silt in the drawdown areas(Gaddanakeri *et al.*, 2009).

Farming practices in the drawdown area during the low water level period is common in large reservoir projects (Li *et al.*, 2013, 2016). The area is potential for agricultural practice, specially in summer season. Proper utilization and management of the drawdown areas for sustainable and economic crop production still remains an important concern from the viewpoint of agriculture and social-economic aspects. Water retaining structures play a key role in economic development, providing irrigation for assured yields (Bromley *et al.*, 2018). Along with the advantages in agricultural development there are certain disadvantages seen in these areas, for example excessive use of chemical fertilizers, water quality deterioration in the submergence land, resettlement, over grazing, irrational agriculture and other such issues. In order to identify these concerns emerging from drawdown agriculture, in the Bhokardan block of Jalna district, 4 villages located near two large water-holding structures, each covering an area of 256 and 193 hectares respectively, are selected for the study, on the basis of community shared some challenges with WOTR.

The fertile land in the villages of Chandai Tepli, Parashekheda Thombri, Banegaon and Padmavati villages get submerged during a normal monsoon season. During the months of November-December in a year of low rainfall and during the summer months (March to May), water in the reservoir recedes exposing the submerged area for a period of two to five months. These months provide a window for short duration crop cultivation in the drawdown area by utilizing the residual moisture and lifting water from the reservoir. Approximately 70 percent farmers cultivate their respective lands in and around the submergence areas and follow seasonal crop cultivation methods in the four villages. The major crops are maize, sorghum, chickpea, and soybean. The other crops grown in this area are water melon, muskmelon, chillies and sugarcane.

An initial survey was conducted in the drawdown area of all the four villages in the month of November 2016 with the objectives (1) to identify the cropping pattern; (2) suitable and available period for cropping; (3) the nutrient management practices specifically followed in the area; (4) land use land cover changes in *rabi* season of the study villages; (5) plot level crop mapping and the (6) socio-economic changes of farmer households practicing drawdown farming.

In this initial survey, it was observed that soil salinity and excessive soil moisture during the crop growth period results in low crop yield; excessive soil moisture encourages biological development of 'soil black worms', which consume all the seeds/seedlings sown in the field resulting in stunted growth at the very initial stage. During summers, the soil is exposed to high temperatures with high rates of evaporation which enrich the salt content of the soil, leaving it infertile for summer crops cultivation. It is also observed that farmers use more chemical fertilizer compared to the organic fertilizers, which are easily washed out of the fields by flood irrigation and/or by high dam water levels.

The water structure was constructed approximately 14 years ago. Grampanchayat wells of the surrounding villages viz, Chincholi, Deulgaon Tad, Chandai Tepli, Longaon, Khamkheda, Palaskheda and few other villages are located in and around reservoir back water area, which supplies water for domestic use to their respective villages. Till date, there are no direct health problems associated with the use of this water for drinking as 'reported' by the community. The important concerns identified in the drawdown area that actually requires attention are the need for information and knowledge on sustainable management practices; the use of scientific methods for crop cultivation and recommendations on short duration crops and the optimum use of resources for better economic returns.

Materials and methods

An elaborate survey was conducted in drawdown areas of the two study sites in four villages during the year 2016-17 and 2018-19. The team conducted transect walks in the drawdown areas noting the soil type, existing crops and their conditions. Samples were collected at different locations for testing the soil and water quality. During the transect, the team interacted with some farmers working in their fields. Meetings of farmers were also arranged in the respective villages to discuss drawdown area cultivation to understand the challenges they are facing during cultivation and package of practices followed by the farmers. Plot level mapping was conducted in the area for the *rabi*, *kharif* and summer season to study the cropping pattern in the area. Remote sensing data of Sentinel-2A and 2B were used for the land use land cover classification (in *kharif*, *rabi* and summer season of 2016-17 and 2018-19), the validation of these classes was done using plot wise GPS locations collected on the field.

Study area

Jalna district lies in the Marathwada region of Maharashtra. Majority of its population is engaged in agriculture. The industrial development is limited in the district. The major crops cultivated in the area are jowar, bajra, wheat, pulses, groundnuts, cotton, and sugarcane. The three seasons experienced in Jalna are: a) moderately warm wet season from June to September (*kharif* season), b) cool dry season from October to February (*rabi* season), and c) hot dry season from March to May (summer season). The average temperature in the district is 20°C during winter and 41°C in summer. Rainfall is not uniform in all parts of the district. The average annual rainfall ranges between 600mm to 700mm.

The selected study area comprises two large water structures located in Banegaon and Padmavati village of Bhokardan block of Jalna district in Maharashtra (Figure 1). Banegaon is located in the southern part of Bhokardan and Padmavati village in the northern part of Bhokardan. The Banegaon water structure covers parts of three villages viz., Banegaon, ChandaiThombari and PalaskhedaThombri with an approximate area of 200 ha. The water structure in Padmavati covers parts of two villages- Padmavati and Masrul, with an approximate area of 255 ha.

Figure 2 displays the satellite false colour composite (FCC) image of the two study areas in the *kharif*, *rabi* and summer seasons of 2016-17 and 2018-19. The surface water cover in the changing seasons for the two study sites are clearly visible. The blackish-blue colour in the satellite false colour composite images represents the surface water, whereas the red colour represents agriculture.

Soil sampling

Twenty soil samples- 10 each from Pamavati and Banegaon- were collected (Figure 3) from sites having similar cropping history. The soils are tested for their chemical and mechanical properties. The testing for the chemical properties was carried out by using *Mridaparikshak* mini soil lab kit – developed by Indian Institute of Soil Science (IISS), Bhopal, approved by Indian Council of Agricultural Research (ICAR), New Delhi.

Water quality assessment:

The water samples were collected from the wells which have submergence and/or inflows from a reservoir water body.

In the Banegaon reservoir site, 10 dug wells (8 upstream and 2 downstream) and 2 control wells were identified and from the Padmavati reservoir submergence area 9 dug wells (7 upstream and 2 downstream) and 2 control wells were identified for the study (Figure 4).

All the wells are randomly distributed in both reservoir areas on either side of the reservoir wall i.e. upstream and downstream of the streamflow. Water from both reservoir and control wells were collected using standard collection (100 ml), labelling and storage procedures (stored in polyethylene plastic bottles). For each well, three samples were collected: one for in-house laboratory analysis, one for analysis of higher chemical compounds sent to a private lab and one for detection of bacterial contamination.

Base sample collection and analysis was done in February 2018 to understand general physio-chemical composition of groundwater in and around reservoir areas. Pre-Monsoon and post monsoon sets of samples were collected in June and December, 2018 respectively. All the sets were analysed for both physio-chemical and bacteriological contaminations.

The laboratory analysis of chemical parameters was carried out following standard procedure of the Bureau of Indian Standards (BIS) to test the chemical content of the drinking water samples. Physical parameters like pH, salinity, electrical conductivity, and total dissolved solids were tested on the selected field sites with the use of tracer. While the total alkalinity, total hardness, calcium hardness, magnesium hardness, chlorides, sodium, potassium were analysed in WOTR's in-house chemistry laboratory, the content of nitrates and phosphates was tested in BIS accredited laboratory in Pune.

Bacterial contamination was assessed using H2S vials which gives quick results. Vials are filled with the sample water up to the mark on the vial and kept undisturbed for 18 to 24 hours (away from direct sunlight). If the colour of the sample changes from pale brown to dark brown or black, the sample is contaminated with the bacterial content. All parameters were checked to see if they fall within the permissible category of the Indian drinking water standards as well as of the World Health Organization (WHO) international standards for the drinking water.

Land Use Land Cover

The Land Use Land Cover analysis of the study sites was done using Sentinel -2A satellite data at 10m resolution for the year 2016-17 and 2018-19, for three seasons (*kharif*, *rabi* and summer). The plot level classification was further validated using GPS location and data collected from the field. The classification was done to determine the total area under cultivation and the changing land cover in the drawdown area, during the 3 seasons. The area was divided into five basic classes for the three seasons to calculate the approximate area under drawdown farming in the respective seasons. Further the information collected from the GPS was used for identifying the types of crops grown in a particular plot/farm.

Focus Group Discussions

Socio-economic data was collected through focus group discussions (FGDs) in both villages, with the farmers practicing drawdown farming. It tried to capture their cropping pattern, Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Integrtaed Disease management (IDM) practice and health impacts on humans.

In Banegaon around 300-350 farmers practice drawdown farming in the submergence area. Usually the agricultural activities start late in the *kharif* season when the water begins to recede. The farmers get a minimum of two agriculture seasons for cropping, and if water is available, they cultivate a crop in the summer season too. Since the past 15-16 years, drawdown farming has been practiced in this area. Initially it was very limited, and only few farmers took it up, but in recent years, cultivation has expanded. The irrigation department of the Maharashtra government charges the farmers Rs. 500 per acre per year as a cultivation tax. The major crops cultivated in the flood plains are jowar, wheat, gram, maize, sugarcane, vegetables like brinjal, ladies finger and watermelon and muskmelon.

Padmavati village was relocated in 1998 when the dam was constructed. They started practicing drawdown farming in the submergence area in the later years. In this village, 2 cropping seasons and the third summer cultivation are practiced based on the availability of water in summer. It was observed that water availability is always good in this village. Majority of the farmers grow vegetables - fenugreek, coriander, lady-finger, green gram, green pea, spinach, chilly, tomato, etc. The irrigation department of the state levies the cultivation tax from the farmers.

Results and discussion

Soil Analysis

Soil type in the Banegaon drawdown area is predominantly clay having higher porosity and moisture retention capacity. The average values of sand, silt and clay are 21 percent, 29 percent and 50 percent respectively. The soil samples were tested to check the availability of the basic elements of nitrogen, phosphorus and potassium. The available nitrogen in the samples collected from Banegaon drawdown area ranges from 124.97 kg/ha to 198.45 kg/ha with an average value of 182.41 kg/ha. Most of the soil samples show low availability of nitrogen. Phosphorus ranges between 11.53 kg/ha to 51.54 kg/ha with an average value of 27.92 kg/ha and the samples show marginally high to very high phosphorus availability. The available potassium in the soil samples range between 319.17 kg/ha to 846.30 kg/ha with an average value of 500.97 kg/ha. All the samples have very high potassium levels. The results from soil tests of the Banegaon area reveal that the soil is low in nitrogen content, marginally high in phosphorus availability and very high in potassium content. The organic content of the soil ranges from 0.32

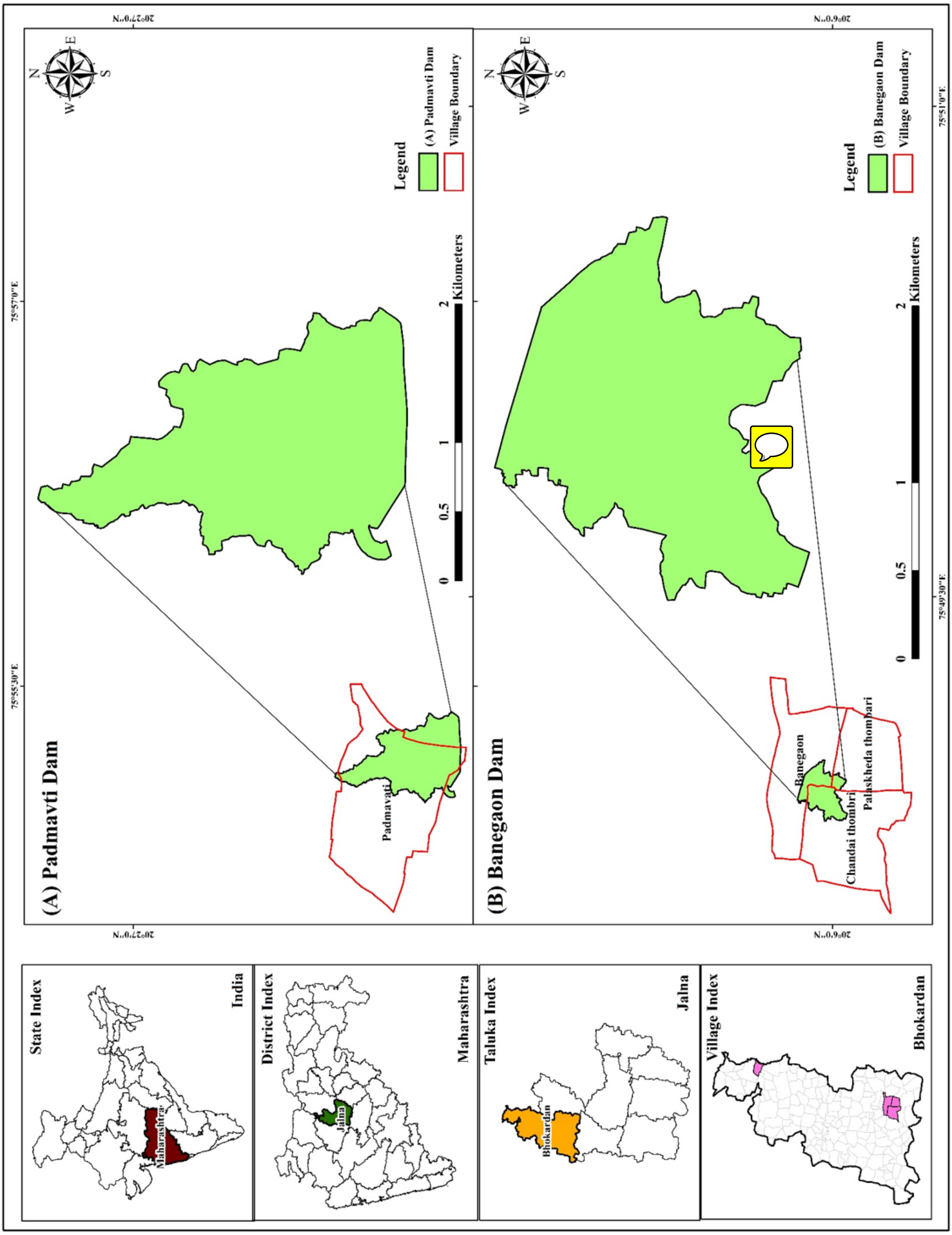

Fig. 1. Location of the study sites A) Padmavati and B) Banegaon in Bhokardan block of Jalna district in Maharashtra.

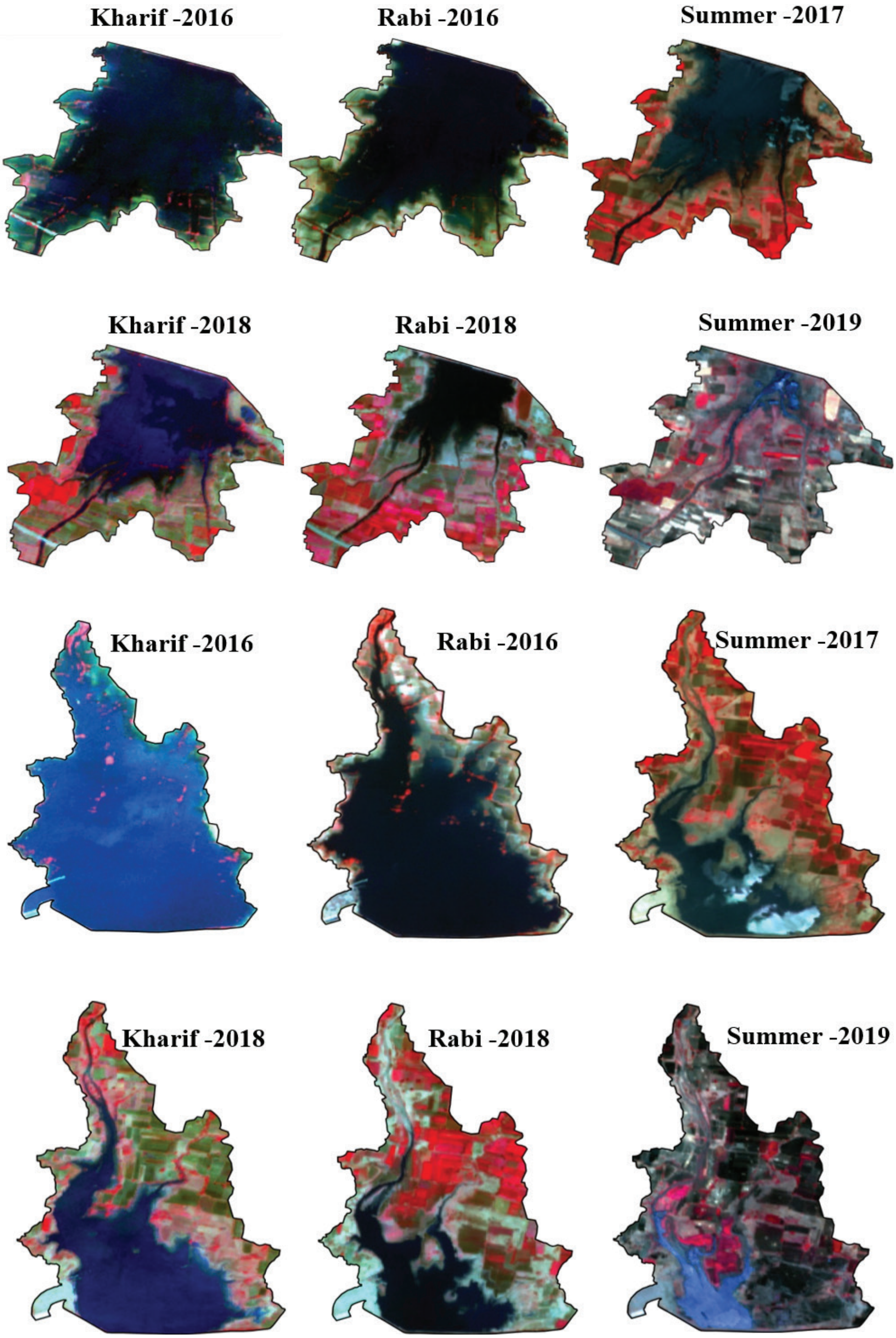

Fig. 2. Surface water in reservoir area in the Banegaon (upper set) and Padmavati (lower set) during agricultural seasons in 2016-17 and 2018-19.

percent to 0.57 percent with the average value of 0.46 which indicates medium availability of organic carbon.

The Padmavati drawdown area has clay soil typecharacterised by higher porosity and moisture retention capacity. The average values of sand, silt and clay are 24 per cent, 25 per cent and 50 per cent respectively. The available nitrogen in the soil samples collected ranges from 100.35 kg/ha to 313.60 kg/ha with an average value of 206.98 kg/ha. Most of the soil samples show medium to low availability of nitrogen; phosphorus ranges between 8.41 kg/ha to 23.47 kg/ha with an average value of 15.45 kg/ha. Most of the soil samples show medium to low phosphorus availability. The available potassium in the soil samples ranges between 230.72 kg/ha to 668.64 kg/ha with an average value of 482.38 kg/ha. Almost all soil samples show very high availability of potassium. The results indicate that the soil in the Padmavati drawdown area is medium to low in nitrogen content, medium in phosphorus availability and very high in potassium availability. The organic content of soils ranges from 0.15 per cent to 0.71 per cent with an average value of 0.45, showing medium availability of organic carbon.

Both the study areas have high silt and clay content which can hold soil moisture for a long period and have medium levels of soil organic content. These soils are good for a variety of vegetable crops.

Water quality analysis

The set of 23 wells samples each for pre-monsoon (March-May) and post-monsoon (November-February) seasons were analysed for drinking water quality. Samples from the villages have pH and total dissolved solids(TDS) values well within BIS permissible limits (SI 2013). Total alkalinity of three samples in pre-monsoon season from each of the reservoirs show high values exceeding the permissible limit of 600 mg/L. The alkalinity in groundwater in the study area can be attributed to the geogenic processes that involve the weathering and dissolution of carbonate and bicarbonate rich rocks (Agarwal *et al*., 2008.) The number of samples having high total alkalinity in the pre-monsoon period reduces to one sample in the Padmavati reservoir area in the post-monsoon season, which may be lowered due to dilution post rainfall.

The total hardness of one sample from each of the reservoirs exceeds the permissible limit of 600 mg/L. The hardness of the water is the measure of the calcium and magnesium content and determines the water's capacity to form the foam with soap. In the post monsoon, none of the samples exceed the permissible limit of the total hardness but tend to show higher values.

Table 1 and 2 show the water quality parameters and drinking water standards by BIS and WHO and the samples are checked if under permissible limits.

WHO standards (WHO 2011) indicate that the phosphates in drinking water shall not exceed 0.1 mg/L, whereas there are no prescribed norms by BIS. All 23 samples in both the seasons have phosphate content less than 0.5 mg/L. A high phosphate content in freshwater may cause eutrophication i.e. can cause rapid growth of aquatic plants (Singh *et al*., 2013).

Total coliform in any 100 ml sample of water was not detectable (MPN/100 ml). It

Table 1: Chemical analysis for Pre-monsoon set of samples

Parameter	Range of Samples		Indian Standard drinking water specification		WHO Standards	Total Samples exceeding Permissible Limit	
	Min.	Max.	Desirable Limit	Permissible Limit	Permissible Limit	Number	per cent
pH	7.31	8.82	6.5 to 8.5	No Relaxation	-	1	4.3
TDS (mg/L)	320	840	500	2000	-	0	0
Nitrates (mg/L)	5	38.6	45	No Relaxation	-	0	0
Phosphates (mg/L)	<5	<5	-	-	0.1	0	0
TA (mg/L)	317.7	750.2	200	600	-	6	26.1
TH (mg/L)	220	692	200	600	-	2	8.7
Chloride (mg/L)	16	122	250	1000	-	0	0
Sodium (mg/L)	19	46	-	-	50	0	0
Potassium (mg/L)	4.7	187.8	-	-	-	0	0
Total Coliform (MPN/100ml)	Present		not detectable in 100 ml sample			23	100

Table 2: Chemical analysis for Post-monsoon set of samples

Parameter	Range of Samples		Indian Standard drinking water specification		WHO Standards	Total Samples exceeding Permissible Limit	
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Total Coliform (MPN/100ml)	Present		not detectable in 100 ml sample			23	100

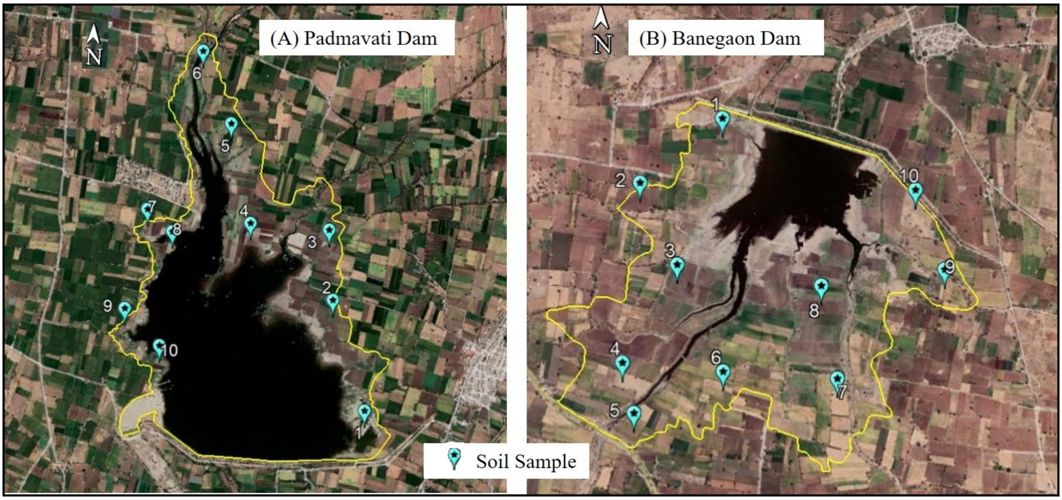

Fig. 3. Location map of soil sample collected in A) Banegaon and B)Padmavati study sites.

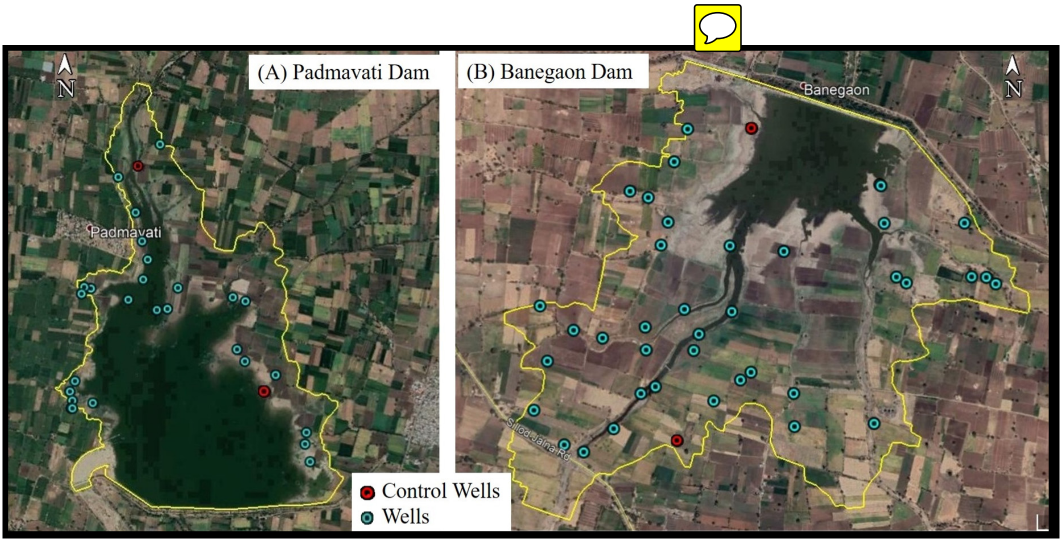

Fig. 4. Location of well water sample collected. A) Banegaon and B) Padmavati study sites.

shows the presence of bacterial and faecal contamination of the water (Nicholson *et al*., 2017). All 23 samples for both seasons test positive for total coliform content. Open defecation and uncontrolled microbial and bacterial activities in soil may be possible sources of coliform contamination.

Effects on drinking water quality

Any particular chemical element or compound and/or bacterial content in excessive amounts is toxic to the body. For example, regular consumption of very hard waters can have a laxative effect and also a negative impact on the urinary/kidney system (Sengupta 2013).

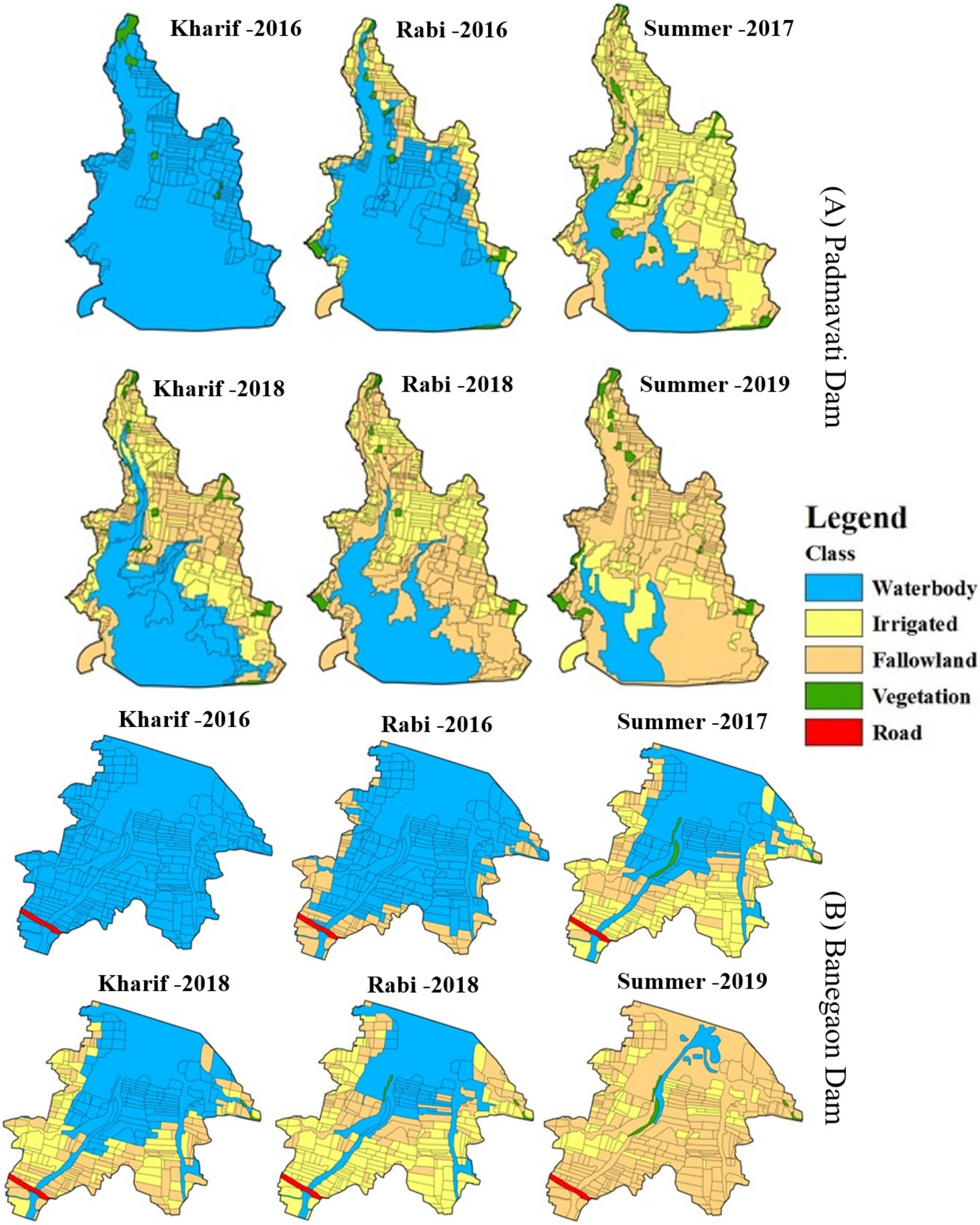

Fig. 5. Classified image of the study sites for year 2016-17 an 2018-19.

Hardness also causes scaling and corrosion of metal objects. Water contaminated with bacteriological and/or faecal particles can cause gastrointestinal diseases and hepatitis. Continued intake of such contaminated water may cause prolonged illnesses.

For both Banegaon and Padmavati reservoirs, several private wells are dug in the reservoir submergence area. The frequent use of chemical fertilizers and pesticides in agriculture contaminates the primary source which is reused for agriculture as also for humans, livestock and domestic purposes. During summer and water scarce times, these wells are the only source for drinking water. As seen from the results, the chemical parameters tend to saturate during high temperature weather conditions due to high evaporation and low dilution when water becomes scarce. This leads to repetitive enrichment of salts or contaminants.

In case of the Banegaon reservoir, few Grampanchayat wells are located in the submergence area from which water is distributed to surrounding villages namely Chincholi, Deulgaon Tad, Palaskheda, ChandaiTepli, Kamkheda and Longaon. In both reservoir areas, organic as well as chemical fertilizers are used with a preference for chemical fertilizers. Crop selection also changes the pattern of fertilizer usage. In reservoir areas near the reservoir wall, mostly vegetables, melon, watermelon and other water intensive and sensitive crops are cultivated.

The reservoirs are very rarely desilted. A few farmers sometimes carry silt to their farms in some quantity. Though reported that silt is not accumulated in large quantities in the reservoirs due to stream capacity, flow rate and topography, the central portions of the dams accumulate large quantities of silt and minerals. If desiltation is not considered, the minerals and/or contaminants would pass towards the downstream point water sources which are currently in safe conditions. The overall agricultural practice, reservoir's natural dynamics and lack of awareness regarding drinking water quality and its effects may result in unfavourable conditions and give rise to health issues.

Land Use Land Cover (LULC) analysis

The area was classified into five major classes of the three seasons of *kharif*, *rabi* and summer. Figure 5 represents the classified images of the study area.

In the year 2016 both the reservoirs were at their full capacity hence there was no agricultural activity in the *rabi* season in the drawdown area. Maximum agricultural activities were carried out in the summer due to availability of irrigation facilities and soil moisture in the submerged area. In Banegaon, 25 percent area and more than 50 percent area in Padmavati was under active agriculture. In the year 2018- a year of low rainfall, the *kharif* and the *rabi* season has higher higher cultivation under drawdown farming , 25 per cent and 45 per cent area in Banegaon, and 25 per cent and 27 per cent area in Padmavati was cultivated respectively. In the summer season the cultivation under drawdown farming reduced to 15 per cent area in Banegaon and 21 per cent area in Padmavati due to the low water availability.

Table 3: Average crop production in drawdown area of Banegaon.

Crop	Productivity (per acre)
Wheat	5 to 7 Quintal
Jowar	4 to 6 Quintal
Maize	30 to 35 quintal
Gram	4 to 5 Quintal
Sugarcane	45 to 50 tons

(Source: FGD)

Table 4: Average crop production in drawdown area of Padmavati.

Crop	Productivity (per acre)
Crop	Productivity (per acre)
Beans	4 to 5 Quintal
Maize	10 to 30 Quintal
Cowpea	0.5 to 1 Quintal
Groundnut	1 to 2 Quintal
Green gram	05. to 1 Quintal
Soybean	8 to 10 Quintal

(Source: FGD)

Focus Group Discussions (FGDs)

The farmers informed that the application of chemical fertilizers (such as urea, 10:26:26, potash danedar, super phosphate etc.) is high, approximately 60 -100 kg of fertilizers per acre of cultivated land with the hope to increase the yield. Farmers also applied pesticides e.g. corazon, monosil, algrip, twice or thrice in the month. During discussions, most farmers reported that in the last few years white grub infestation was found in the area which required weedicide use to prevent such pests. The production is quite good as compared to the regular farm in these areas, but this type of farming is not assured, as during unseasonal or heavy rains the reservoir gets flooded resulting in crop failure. In case of irrigation the flood irrigation method is widely used in these areas. The average crop production in the Banegaon area is given in table 3.

From the field observations and the FGD it was observed that the wells which are the source of drinking water for the villages are located adjacent to the reservoir's submergence area. In the last copuple of years, villagers experienced increased incidence of stomach related health issues. Water purification methods are not robust in the villages. At the end of the discussion, the farmers mentioned the need for some guidance to improve their drawdown farming methods as they have to be very cautious while performing farming in the reservoir area.

In Padmavati the farmers shared that drawdown farming is the major livelihood and income source. The soil is very fertile as compared to the land received from the government in compensation for their land lost to the water structure. Similar practice of excessive application of chemical fertilizers (3-4 bags of fertilizersf per acre) like urea, 20:20:13, 18:18:10, super phosphate, sulphate etc., along with pesticide and weedicide was practiced by farmers of the village. Pesticides were spayed approximately 4-5 times for a crop. The drawdown farming in Padmavati also faces the white grub infestation. In this area some farmers practice micro-irrigation like drip and sprinkler and the rest of the farmers practice flood irrigation. Table 4 depicts the average production of crops in the Padmavati area.

The source of drinking water here are the wells located adjacent to the reservoir's submergence area. The people of the village have observed an increase of stomach related health problems and frequent viral infections. Farmers are willing to adopt sustainable farming methods to improve their flourishing financial status.

Proper recommendations and gudilines are not available for the cultivation in the drawdown area. However, based on the group discissions with the farmers in the study it was observed that drawdown farming is practiced on a large sacle and is one of the major source of livelihood and income in the study area. The landuse land cover analysis demonstrates cultivation is carried out in almost 25 to 45 per cent of the area under drawdown farming. The soil analysis results signifies high silt and clay content soil with good moisture holding capacity and moderately rich (0.32 - 0.57 percent) organic content suitable for growing fodder, green gram and vegetable crops in the drawdown area. The water quality analysis was one of the concerns in the study area. Water samples collected from the surrounding wells of the drawdown farming area had presence of bacterial and faecal matter. The alkalinity and hardness in the drawdown area was higher in the pre-monsoon seasons whereas, the post monsoon samples did not exceed the permissible limit of total hardness but had higher values, that can result in negative impact on the health of people consuming the water.

Conclusions

The analysis reveals that the local people could be trained to utilize the drawdown habitat to its full potential only with sound ecological knowledge and sustainable agricultural practices. Use of weedicide or excessive use of pesticide to control the infestation of white grub is not a good practice and requires appropriate IPM to reduce the use of agrochemicals for plant protection. Proper crop rotation based of the agricultural experts advice can be useful to prevent the infestation of soil borne pest disease attack. As the soil in the drawdown study area is higher in clay and silt content, such heavy soils are good in holding moisture for a longer period and farmers are using synthetic nutrients in higher quantities, the infestation of weeds is inevitable. For this hand weeding is highly recommended instead of using weedicides. This pilot study has been done for two water bodies(reservoiers), more technical studies needs to be done in areas with different climatic and socio-economic conditions to assess and understand long term impact on drinking water quality and health conditions. Recommendations are to be prepared and disseminated to the farmers, practicing drawdown farming. In short it is emphasized that the drawdown area should be utilized in a manner indicating suitable crops and their management by making surveys of representative villages in the study area. There is a wide scope in the future to study the changing chemical and biological properties of the soil in the drawdown area in the following years. The effects of the drawdowing farming resulting in to changing cropping pattern and water quality would be another area of concern in the coming years. Drawdown farming is a great method for generating extra income and for a sustainable development, however an awareness needs to created among the farming community practicing drawdown farming to adopt for organic, sustainable and scientific methods of cultivation.

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