LAW
ENVIRONMENT AND
DEVELOPMENT
JOURNAL
LEAD

GAALMUKT DHARAN, GAALYUKT SHIVAR (TANK DESILTATION) SCHEME IN MAHARASHTRA, INDIA: POLICY CONCERNS AND THE WAY FORWARD

Dipak Zade, Eshwer Kale, Aditya Sood, Sandeep Jadhav and Aditya Shinde

ARTICLE

VOLUME
16/2

LEAD Journal (Law, Environment and Development Journal)
is a peer-reviewed academic publication based in New Delhi and London and jointly managed by the
Law, Environment and Development Centre of SOAS University of London
and the International Environmental Law Research Centre (IELRC).
LEAD is published at www.lead-journal.org
info@lead-journal.org
ISSN 1746-5893

ARTICLE

GAALMUKT DHARAN, GAALYUKT SHIVAR (TANK DESILTATION) SCHEME IN MAHARASHTRA, INDIA: POLICY CONCERNS AND THE WAY FORWARD

Dipak Zade, Eshwer Kale, Aditya Sood, Sandeep Jadhav and Aditya Shinde*

This document can be cited as
Dipak Zade et al, 'Gaalmukt Dharan, Gaalyukt Shivar (Tank Desiltation) Scheme in Maharashtra, India: Policy Concerns and the Way Forward',
16/2 *Law, Environment and Development Journal* (2020), p. 134,
available at http://www.lead-journal.org/content/a1608.pdf
DOI: https://doi.org/10.25501/SOAS.00033482

Dipak Zade, Senior Researcher (Social Science & Climate Change Adaptation),WOTR Centre for Resilience Studies (W-CReS), 2nd floor, The Forum, Padmavati Corner, Pune, Maharashtra, India. Email: dipak.zade@wotr.org.in
Eshwer Kale, WOTR Centre for Resilience Studies (W-CReS), Pune, Maharashtra
Aditya Sood, The Freshwater Trust, Portland, USA.
Sandeep Jadhav, Watershed Organisation Trust (WOTR), Pune, Maharashtra
Aditya Shinde, WOTR Centre for Resilience Studies (W-CReS), Pune, Maharashtra

* Authors acknowledge The Nature Conservancy (TNC), India, for their financial support to conduct this research. We are grateful to Dr. Marcella D'Souza (Director, W-CReS) for her inputs in the study. We also thank Yogesh Shinde (W-CReS) for his research assistance.

TABLE OF CONTENTS

1 INTRODUCTION

The introduction section sets the tone for the paper by highlighting the critical role the reservoirs and tank systems play in human life and the broader ecosystem. The section presents the critical concerns and challenges faced in the tank management system and the chronology of policy push by the state for revitalising reservoirs and desilting tanks. It concludes with the research concern for undertaking this study.

1.1 Role of Reservoirs and Tank Systems in Human Life and the Larger Ecosystem

Reservoirs, artificial or natural, play a vital role in securing water for all forms of life and livelihoods. In India, tank development and management have a long tradition. India has about 580,000 tanks of various sizes spread over across the country, of which 150,000 tanks are located in the semi-arid region of Deccan plateau.[1] In Maharashtra alone, there are highest number (42 per cent) of irrigation dams.[2] These tanks are located in hydrologically favourable sites effectively capturing the rainfall and serving multiple uses, with irrigation having the major share. John Ambler aptly describes the usefulness of tank systems as it recharges the local groundwater, serves as a source of drinking water for livestock, and importantly, an irrigation system for crops.[3] These tanks are also a useful source of silt for fertilisation and construction material. Therefore, the tank is not merely an irrigation system that starts from the reservoir down but a wide complex system of natural resources, physical facilities, land use patterns, and managerial institutions to manage the water within. Tanks have thus a rich heritage on account of long historical antecedents in various regions of India. Over centuries, tanks and ponds constituted an important supplementary source of water to the distressed poor.[4] Even in the 21st century, tanks are relevant (in fact critical) in following the Integrated Water Resources Management (IWRM) practices, especially in the Indian context.

Community-based tank rejuvenation is of critical importance, mainly in drought-prone and arid as well as semi-arid regions. With growing water scarcity, it is an essential way in which water can be conserved for both surface and groundwater irrigation. With limited water resources, vagaries of monsoon and looming water scarcity in many parts of India, water conservation and use through such structures have received greater importance.

1.2 Critical Concerns in Tank Management

Tank irrigation systems are simple but fragile structures.[5] They have to be continuously maintained, promptly repaired and continuously monitored. Even

1 A Gurunatha, CR Shanmugham and KT Ramappa, 'Irrigation Tanks and Their Traditional Local Management: A Remarkable Ancient History of India', National seminar on water and culture, Hampi (Karnataka) (2007).

2 PK Viswanathan, M Dinesh Kumar and A Narayanamoorthy, Micro Irrigation Systems in India: Emergence, Status and Impacts (Springer 2016).

3 John Ambler, 'Basic Elements of an Innovative Tank Rehabilitation Programme for Sustained Productivity' [1992] unpublished paper, Ford Foundation, New Delhi.

4 Niranjan Pant and RK Verma, Tanks in Eastern India: A Study in Exploration (IWMI 2010).

5 Bellamkonda Sravan and Kumar R Waseem, 'Restoration of Irrigation Tank (A Case Study on Kunta Chervu in Warangal District)' (2016) 4 International Journal for Scientific Research & Development 74.

more challenging is sharing the scarce water amongst its users, particularly the farmers. Since the pre-British era, local communities took keen interest and collective efforts in periodic repair and maintenance of these structures.[6] Thus there was a feeling of ownership of these structures by communities. However, the existence of community-led practices of the tank management and engagement of local institutional arrangements by the community in managing tank systems is also questioned by authors like Davis Moore. They argue that the traditional pre-British tank management system was dominated by a handful of resource-rich people.[7]

In post-independent India, the tanks came under the ownership purview of the state government. Their management functions came under the different line departments with no integral approach and less involvement of communities, which led to the decline of these irrigation systems. The tank management system almost collapsed owing to poor maintenance and lack of interest from the state. Due to the centralised system, the community steadily lost its interest in the management of the tank systems.[8] At the other side, since decades, equity and judicious rights in tank benefits have been crucial issues of concern, the local issues such as caste and political affiliation, kinship and institutional membership are observed as deciding factors in tank benefits.[9]

1.3 Policy Push for Revitalising Reservoirs and Desilting Tanks

There have been continuous efforts to revitalise the tank systems and improve their utility. Most of these efforts may be categorised at the level of beneficiary groups, community as a whole, by state, Non-Government Organisations (NGOs), and Corporate Social Responsibility (CSR) interventions. After the independence, the percolation tanks, village tanks and lakes, which could irrigate less than 100 hectares of land, came under the jurisdiction Zilla Parishad or district administration.[10]

Intending to revitalise the tank system, the state government took many steps from time to time. In Maharashtra, through the Employment Guarantee Scheme (which later converted in Mahatma Gandhi National Rural Employment Guarantee Act and taken at the national level), during drought years, work on tank construction, silt removal and repair and maintenance were taken on a large scale. Even under Jalyukt Shivar Abhiyan (JSA), a flagship program of the state government initiated in 2016, desilting and rejuvenating of different water bodies have been taken

6 Shri Krishan, 'Water Harvesting Traditions and the Social Milieu in India: A Second Look' (2011) 46 Economic and Political Weekly 87.

7 David Mosse, 'Colonial and Contemporary Ideologies of "Community Management": The Case of Tank Irrigation Development in South India' (1999) 33 Modern Asian Studies 303.

8 M Gireesh, N Nagaraj and MG Chandrakanth, 'Rehabilitation of Irrigation Tanks in Eastern Zone of Karnataka- An Economic Analysis' (1997) 52 Indian Journal of Agriculture Economics 231-243.

9 Nicholas B Dirks, The Hollow Crown: Ethnohistory of an Indian Kingdom (University of Michigan Press 1993); Edmund Ronald Leach, Pul Eliya: A Village in Ceylon (Cambridge University Press 1961); David Ludden, 'Peasant History in South India. By David Ludden. Princeton: Princeton University Press, 1985. Xix, 310 Pp. Maps, Figures, Tables, Notes, Glossary, Bibliography, Index. $45' (1987) 46 The Journal of Asian Studies 189.

10 Aparna Pallavi, 'Restore Malgujari Tanks to Irrigate Eastern Vidarbha: Study' (Down to Earth 2015).

at large scale in the state. At the culmination of these programs, the state designed and has been implementing a specific program for desiltation purpose known as 'Gaalmukt Dharan, Gaalyukt Shivar Yojana' (literally, silt free water reservoirs and silt applied farms) policy since 2017. It has set up a 'Desilting Policy Committee' which recommended that 31,459 small dams and water tanks be desilted in the state. The revised state water policy in 2019 promotes GDGS as an important strategy for drought mitigation.[11] This initiative has a huge potential for improving drought resilience in the state. Since the last few years, many CSRs, NGOs, and private donors have aggressively initiated desiltation active at large scale in the state, mostly in Marathwada region where drought is a common phenomenon.

1.4 Desilting of Reservoirs and Tanks

Many studies, especially done in the southern Indian states of Andhra Pradesh, Telangana, Karnataka, and Tamil Nadu have recorded benefits of desilting of these tanks and the subsequent application of silt in the farms.[12] These benefits include a substantial reduction in chemical fertiliser application, an increase in the water retention capacity of the soil (thus reducing the water required for irrigation), while significantly improving crop yield. The cropping area of the main crops has increased along with the irrigated area and cropping intensity. Improved agriculture has also led to higher employment among non-farm labour. The benefit-cost ratio was positive, thus showing that the desiltation of tanks is an economically viable option.

However, most of the studies have focused on the economic aspects of the desiltation activity like the benefit-cost ratio, improved yields and income for the farmers. Some studies throw light on larger concerns

11 Government of Maharashtra, Maharashtra State Water Policy 2019 <https://wrd.maharashtra.gov.in/Site/Upload/PDF/State%20Water%20Policy%-2005092019.pdf>.

12 A Deivalatha, P Senthilkumaran and NK Ambujam, 'Impact of Desilting of Irrigation Tanks on Productivity of Crop Yield and Profitability of Farm Income' (2014) 9 1833; Rakesh Tiwari and others, 'Irrigation Tank Silt Application to Croplands/ : Quantifying Effect on Soil Quality and Evaluation of Nutrient Substitution Service' (2014) 3, International Journal, pp 001-010 ; Adithya Dahagama and others, 'Final Report De-Silting Minor Irrigation Ponds in South India/ : The Sustainability of Decentralized Resource Distribution' (University of Michigan 2014); K Lenin Babu and S Manasi, 'Estimation of Ecosystem Services of Rejuvenated Irrigation Tanks: A Case Study in Mid Godavari Basin' (International Water Management Institute Conference, Hyderabad, 2008) ; K V Padmaja and others, 'Economic Assessment of Desilted Sediment in Terms of Plant Nutrients Equivalent: A Case Study in the Medak District of Andhra Pradesh. Global Theme 3: Water, Soil and Agrodiversity Management for Ecosystem Resilience Report No. 4' (2003) 2; M Osman, YS Ramakrishna and Haffis Shaik, 'Rejuvenating Tanks for Self-Sustainable Rainfed Agriculture in India' (2007) 64(5) Agricultural Situation in India 67.

and precautions to be taken while desiltation.[13] Other important concerns like equitable distribution of silt, overall impacts of the desiltation activities on environment and downstream, and most importantly the institutional mechanism for program implementation, as well as technical assessments while implementing the work have not been studied in detail. The current study has looked into these aspects with a lens of normative concerns framework, putting sustainability, participation, equity, efficiency at the centre, and based on the experiences, suggested suitable policy modifications to make the program more robust.

1.5 The Research Concerns

In drought prone regions, the increased runoff from degraded land, due to growing erratic rainfall and lack of proper rainwater harvesting leaves very little water for the dry season.[14] The increased runoff extends the scope of soil erosion, and thus the degradation of the land. In the long run, there are few important tangible benefits of desiltation activities but environmental, equity, sustainability, efficiency and participation concerns need to be well studied. As the state has come with an important policy intervention like the GDGS, this study explores the different aspects of the scheme. GDGS has wider opportunities, but at the same time, it is necessary to evaluate this policy based on its implementation and make necessary modifications to avoid the unintended implications. Such modifications can make the provisions more practical and workable, considering the larger benefits of the GDGS scheme to farmers and villagers, ensuring environmental, equity and sustainability concerns. In this context, the present paper, based on the analysis of first-hand data from seven desiltation projects, provides the science-based recommendations for modifying the GDGS guidelines to upscale it effectively.

2 METHODOLOGY

In this section, we elaborate the research design applied in the study, the characteristic of study areas and tanks selected for the study, as well as data collection tools applied.

2.1 Research Design

The present study was an exploratory research to investigate the impact of tank desiltation on-farm production and water availability. These benefits and impacts are further analysed with lenses of equity and sustainability with institutional dimensions. A multidisciplinary approach was taken to assess this impact. Mixed methods that utilise both the qualitative and quantitative tools were used for data collection. The data was further triangulated using Geographic Information System (GIS) based analysis and the economic viability of the activity was assessed through cost-benefit analysis. In addition, secondary data on desiltation activity pertaining to input costs, beneficiary details, and work details were obtained from the local NGOs for analysis.

2.2 Context of the Region and Study Location

The state of Maharashtra in India has 36 districts, of which more than 20 districts in the north-western,

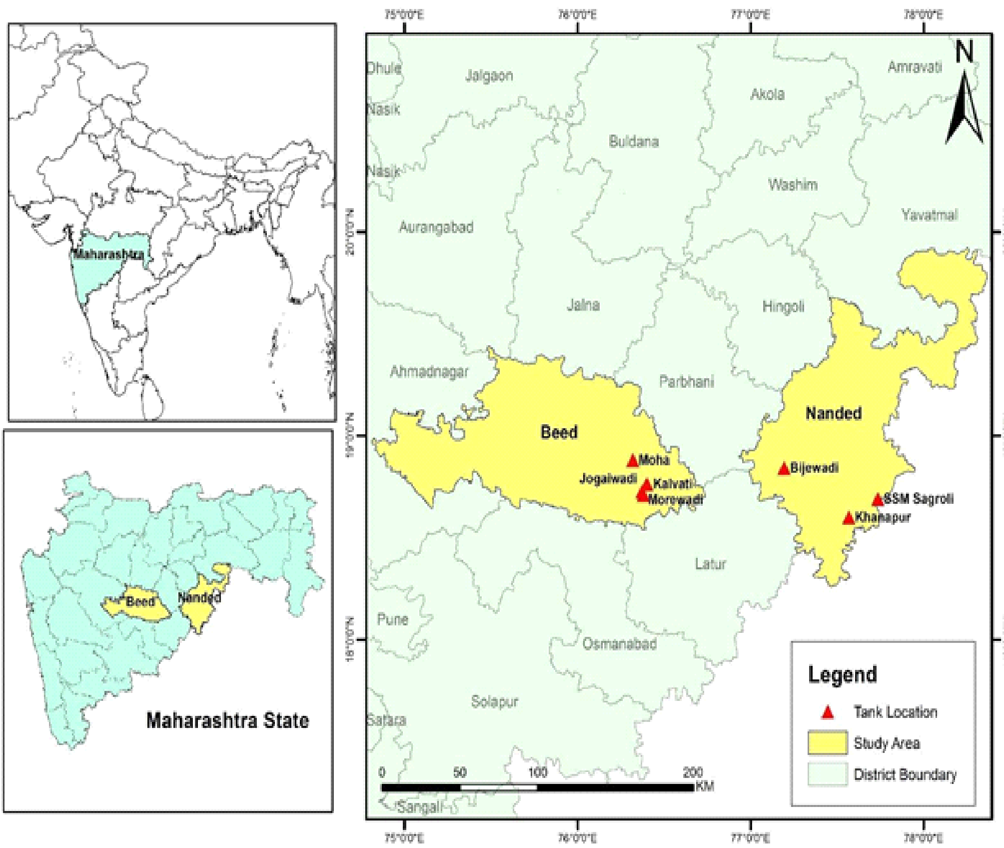
13 K Palanisami, 'Sustainable Management of Tank Irrigation Systems in India' (2006) 1 Journal of Developments in Sustainable Agriculture 34; Gyanprakash Soni, 'Conservation of Lakes - Myths and Realities of Desilting' (2010) <https://www.indiawaterportal.org/articles/conservation-lakes-myths-and-realities-desilting>; Ishwara Bhat and BB Hosetti, 'Benefits And Challenges Of Desiltation And Development On The Avifauna Of Anekere Pond, Karkala, Udupi District, Karnataka' <http://wgbis.ces.iisc.ernet.in/energy/lake2016/Faculty/12_Paper%20for%20Lake%202016%20@%20Alvas%20college.pdf>.

14 Anil Agarwal, Sunita Narain and Indira Khurana, Making Water Everybody's Business: Practice and Policy of Water Harvesting (Centre for Science and Environment 2001).

northern, as well as southern and central part of the state face regular droughts, adversely impacting communities that depend on agriculture as their primary income source. Almost 42.5 per cent area of the state is drought-prone.[15] During 2018-19, the Government of Maharashtra declared drought in 151 talukas in 26 districts affecting 85.76 lakh ha of land. Out of these, 112 talukas had severe drought.[16] The lack of adequate water has had a cascading effect on the socio-economic and environmental conditions in the region.

The research study was carried out in Beed and Nanded districts of Marathwada region. It is one of the most drought-affected regions of Maharashtra state and is characterised by regular water scarcity, frequent droughts, and consequent crop losses. Seven percolation tanks desilted by the local NGOs were selected for the study. The location of the tanks is shown in Map 1. All these tanks were desilted during the summer months (April and May) of 2016. The characteristics of the desilted tanks are provided in Table 1.

Map 1: Location Map of the Study Area



15 Maharashtra State Water Policy (n 11).

16 Government of Maharashtra, 'Economic Survey of Maharashtra 2018- 19' (2019).

Table 1: Details of Selected Tanks for the Study

S. No	Tank Name/Taluka	District	Year of Construction	Total Storage Capacity (TCM)	Total quantity of silt removed (in cu.meter)	Total cost of desiltation (in Rs.)	No. of villages benefited from silt use
1	Jogaiwadi Talab/ Ambajogai	Beed	1977	1.564	27882.4	2,63,110	13
2	Kalvati Talab/ Ambajogai	Beed	2001	167.79	5446	52166	2
3	Bada Talab (Morewadi)/ Ambajogai	Beed	Pre-independence	-	37217.6	2,61,804	14
4	Moha Dam/ Parali (V)	Beed	1979	2.37	65354.8	4,91,474	2
5	Bijewadi/ Kandhar	Nanded	1973	123	23864	2,50,000	1
6	Khanapur/ Deglur	Nanded	Pre-independence	240	26980	2,00,000	1
7	SSM Sagroli/ Biloli	Nanded	Pre-independence	210	10948	1,50,000	2

2.3 Rainfall Pattern in the Study Area

While analysing the project impact data, we need to also keep in mind the rainfall data of these two districts over the last few years. As seen in Table 2, 2015 (reference year for pre-intervention data) was a drought year. Beed and Nanded districts received much less rainfall than in a normal year.

Table 2: Rainfall History of the Last Six Years

Year	Beed				Nanded			
	District yearly rainfall (mm)	Normal rainfall (mm)	No. of Rainy days	No. of dry spell days*	District yearly rainfall (mm)	Normal rainfall (mm)	No. of Rainy days	No. of dry spell days*
2012	461.1	743.4	43	61	662.7	1017.5	61	64
2013	729.9		70	40	1111.9		71	35
2014	423.4		34	106	436.5		38	63
2015	459.6		51	58	599		61	42
2016	824.7		59	30	1124.8		66	38
2017	706.1		58	45	641.8		56	39

*Source: http://maharain.gov.in, (*Days where rain received 0 => 2.5 mm)*

In 2016, both these districts received more rainfall than normal. In 2017, there was a deficit in rainfall in both these districts. Similarly, the number of dry spell days was less and the number of rainy days was more in 2016 when compared to 2015. These changes have an impact on vegetation growth and water availability and the data is interpreted in this light.

2.4 Tools of Data Collection

The data was collected during the month of December 2017. A total of 292 farmers were interviewed, accounting for 52 per cent of the farmers who took silt from these seven tanks. Stratified sampling based on the landholding categories (small and marginal, medium and large) was used for selecting these farmers. A structured questionnaire was used to elicit information on demographics, land ownership, crop input and production, water sources and availability, economic aspects etc. Informed consent was taken from the respondents before the interviews. In addition, five Focus Group Discussions (FGD) were conducted in villages with the beneficiary farmers and two FGDs were conducted with the implementing NGO representatives to understand the intervention details, institutional aspects and benefits of the programme. In order to assess the change in soil fertility after the silt application, two soil samples were collected from farms for each of the seven tanks locations. The first sample was taken from the silt applied farm and the second from a control farm of the same farmer but with no silt application. Thus, a total of 14 soil samples were collected. These soil samples were tested for 19 physicochemical parameters. To assess the economic feasibility of tank desiltation, cost-benefit analysis was carried out. The Replacement Cost method of evaluation was used to do the analysis.

The GIS-based analysis was also undertaken to understand the changes in vegetation and water spread area. The year 2016-17 was chosen to see the changes post-desilting and 2013-14 was chosen to know the situation before desilting. The criteria for selecting the pre-desilting year was based on the rainfall. Mean rainfall was seen from the year 2012 to 2017 for the two districts Beed and Nanded, where the tanks are located. The year that had rainfall closest to the year 2016 was chosen for assessing the situation pre-desilting. Table 3 provides the framework of key variables used to understand the research issues in the study.

Table 3: Key Variables for the Study

Components for evaluation	Variables
Agriculture	Land-use changes, crop area, production and yield, fertiliser and pesticide costs
Soil	Physicochemical properties of the soil and its fertility
Water	Recharge time of wells, the area under irrigation, plant water stress, water spread area, groundwater levels, rainfall
Socio-economic	Household income, migration, institutions, local contribution, distribution of benefits, livelihoods, equitable benefits, cost of excavation activity, the process of different activities in desiltation work, efficiency of work
Others	Ecosystem benefits/losses, changes in biodiversity

3 RESULTS AND DISCUSSION

This section provides the findings from the interviews conducted of 292 farmers who benefited from the desiltation activity in terms of silt use and increased well water recharge. Data from FGD with villagers and interactions with NGO functionaries are also applied in the analysis.

In total, the 292 surveyed farmers applied the tank silt on 472.5 acres of land. On average, this is about 1.6 acres per farmer. In most of the cases, tractor trolleys were used for transportation of silt as their charges are comparatively cheap. Few other farmers used tippers or hiwa (vehicles with more silt carrying capacity). The average distance between the tank and the silted farm is 2.4 km. In total, 50,131 trips were reported, which comes to an average of 172 trips per farmer. In most cases (84 per cent) farmers mixed the silt with existing soil as the silt has more clay content than farm soil. Farmers were of the opinion that mixing of the silt and existing soil also helps crop roots to take hold firmly. Half of the farmers reported an increase of 3-6 inches in the soil layer after silt application.

3.1 Economic Cost of Desiltation

The total quantity of silt removed from the seven tanks was 1,97,693 m^3 (cubic meter). The total cost for excavating this silt was Rs. 16,68,554. This cost includes the machine work, operator and diesel costs incurred by the NGOs for this work. Table 4 provides the tank-wise details of the total quantity of silt removed and the cost involved.

Table 4: Tank-wise Details of the Total Quantity of Silt Removed and Cost Involved

S. No.	Tank name	The total quantity of silt removed (in m^3.)	The total cost of desiltation (in Rs.)
1	Moha	65355	4,91,474
2	Morewadi	37218	2,61,804
3	Jogaiwadi	27882	2,63,110
4	Kalvati	5446	52,166
5	Bijewadi	23864	2,50,000
6	Khanapur	26,980	2,00,000
7	Sagroli	10948	1,50,000

The beneficiary farmers had to bear the transportation cost and the cost of spreading silt and levelling their farms. The total cost borne by the farmers included in the survey was Rs. 1,64,75,397 which is approximately Rs. 56,423 spent per farmer. Of this, a greater part (87 per cent) was spent on transportation of silt from the tank to the farm. The remaining amount was spent on spreading silt on the farm and levelling it. A large number of farmers (58.2 per cen) who took silt for farm applications belong to the small and marginal category having less than 5 acres of land. About 16 per cent of the beneficiaries were large farmers who own more than 10 acres of land. Since the silt application is a capital intensive activity, 44 per cent of the beneficiaries had to take a loan. A significant number of farmers (65 per cent) who took loans were from the small and marginal category. In the case of large farmers, only 11 per cent took loans. Most of the loans were availed from the bank but many farmers borrowed money from informal sources like friends, relatives or money lenders as reported during the group discussions. About five farmers also reported selling livestock or farmland to meet the expenses.

3.2 Changes in Key Physicochemical Properties of Soil

The pH range of tank soils was neutral to slightly alkaline whereas the Electrical Conductivity (EC) was in the normal range as seen in Table 5. The Organic Carbon (OC) content of Sagroli tank silt was very low while in Jogaiwadi and Bijewadi tanks it was in the low category. The available nitrogen content in the Sagroli tank silt was also found to be low but was high in the other two tanks' silt. The very low organic carbon and available nitrogen content recorded in the Sagroli tank soil might be due to a very high sand percentage as compared to silt and clay. The available phosphorus content in all three tanks was low. The available potassium content was low in the case of Jogaiwadi and very high in Sagroli and Bijewadi tanks.

Table 5: Soil Properties Deposited in the Tanks

Tank Name	pH	EC (dS/m)	OC %	Bulk density (g/cc)	Sand (%)	Silt (%)	Clay (%)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	CaCo3 (%)
Jogaiwadi	7.23	0.24	0.27	1.19	43.05	40.52	16.35	189	12.7	102.45	7.63
Sagroli	7.19	0.26	0.09	1.3	76.75	17.67	5.88	63	13.8	534.42	3.88
Bijewadi	7.82	0.22	0.3	1.18	23.71	52.23	22.87	210	12.5	608.35	9.5

The results obtained from soil analysis show that the silt application had a mixed impact on soil texture, bulk density and water holding capacity of the farm soil and it varied from the tank to tank. In a few cases, an increase in silt and decrease in sand percentage was observed and this is a positive change. The water holding capacity of the soil was calculated based on the contents of sand, silt and clay in the soil.[17] When clay and silt content is more in the soil then its water holding capacity is also more. The control farms of Moha, Khanapur and Bijewadi shows higher water holding capacity than silt applied farms because of higher organic carbon, silt and clay percentage in the control plots.

Application of silt from Kalvati, Morewadi, Sagroli, and Bijewadi tanks improved organic carbon content in the soil as compared to control farms. However, the pH of the soil was not much affected by the silt application.

17 Thomas Scherer, David Franzen and Larry Cihacek, 'Soil, Water and Plant Characteristics Important to Irrigation' (NDSU 2017) <https://www.ag.ndsu.edu/publications/crops/soil-water-and-plant-characteristics-important-to-irrigation>.

Table 6: Changes in Soil Properties When the Silt Applied in the Farms

Soil properties	Kalvati		Moha		Morewadi		Jogaiwadi		Sagroli		Khanapur		Bijewadi	
	S*	C*	S	C	S	C	S	C	S	C	S	C	S	C
pH	7.44	7.24	7.28	7.20	7.28	7.29	7.21	7.48	7.25	7.55	7.17	7.55	7.45	7.38
OC (%)	0.57	0.18	0.30	0.39	0.24	0.18	0.18	0.48	0.60	0.27	0.30	0.45	0.57	0.30
Sand (%)	42.27	51.3	55.81	37.77	44.82	51.81	39.14	16.91	34.01	16.15	51.32	26.15	48.24	20.2
Silt (%)	39.71	29.84	26.90	39.44	36.37	30.39	44.38	33.45	46.86	65.1	32.26	53.18	29.82	58.7
Clay (%)	17.93	18.79	17.19	22.71	17.89	17.72	16.39	49.56	19.05	18.67	16.24	20.59	21.85	21.03
N (Kg/ha)	399	126	210	273	168	126	126	336	420	189	210	315	399	210
P (Kg/ha)	12.28	12.06	11.84	12.28	11.62	12.06	12.5	11.84	12.50	12.06	12.72	12.06	12.28	13.16
K (Kg/ha)	57.03	184.8	426.6	594.6	453.0	463.6	594.6	453.0	67.59	637.92	280.94	713.96	421.4	709.74
CaCo3 (%)	10.13	12.13	12.25	9.38	13.25	11.38	11.25	12.13	9.62	11	9.38	10.63	10.75	7.25
WHC (%)	72.82	56.64	60.1	73.01	58.13	58.35	65.6	62.86	70.03	68.43	58.23	78.91	58.48	75.84

*(*S= Silt applied farm, C= Control farm)*

The calcium carbonate content in the soil decreased in silt-applied farms in Khanapur, Sagroli, Jogaiwadi, and Kalvati. This may be due to low calcium carbonate composition in silt deposited in tanks and the quantity of silt applied in a unit area. The trends in available nitrogen, phosphorus and potassium content in silt-applied soil were varied due to variations in the composition of nutrients in tank silt (Table 6).

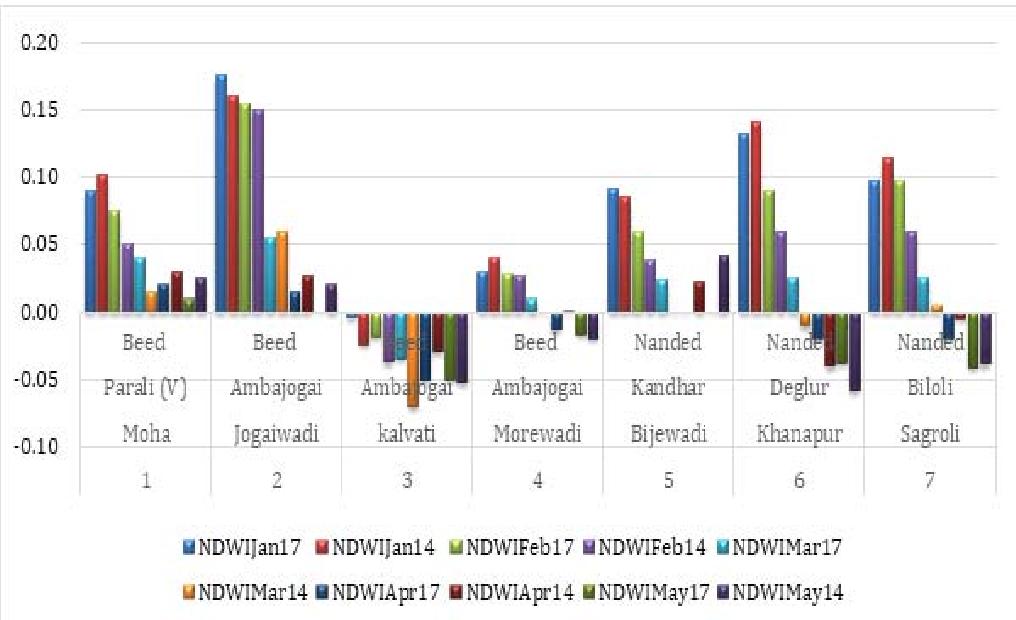
3.3 Impact on Water Availability and Irrigation

Within the 292 households surveyed, 33 have a well or borewell and these are used only for irrigation. All of these are located downstream of the tanks, mostly within a 2 km distance. Most of the wells are less than 40 feet deep whereas the borewell depth ranges between 200-400 feet. The average recharge time of the wells during the Rabi season (November) has decreased by four hours (from 11 hours to 7 hours) and for the summer season (March) by two hours (from 14 hours to 12 hours). Desiltation of the tanks has helped recharge the groundwater tables. During group discussions, farmers said the duration of water availability in the tanks had increased during summer months due to their increased storage capacity. The area under irrigation (of 33 households) increased from 57 acres to 75.3 acres (32 per cent) in the Kharif season for the three main crops (cotton, soybean, and bajra). The number of irrigations provided to main crops has moderately reduced. A similar trend is observed in the Rabi season where the irrigated area of the three main crops (jowar, wheat and Bengal gram) increased from 18.7 acres to 26.7 acres (43 per cent).

This trend is also reflected in the opinions of the farmers. During the group discussions, farmers reported that desiltation has led to an increase in water percolation from the tanks. There is an observable increase in water levels of wells in a radius of about 1-2 km from the tanks. Farmers believe that the irrigated area has increased due to increased water availability. This has enabled them to cultivate Rabi crops in larger areas.

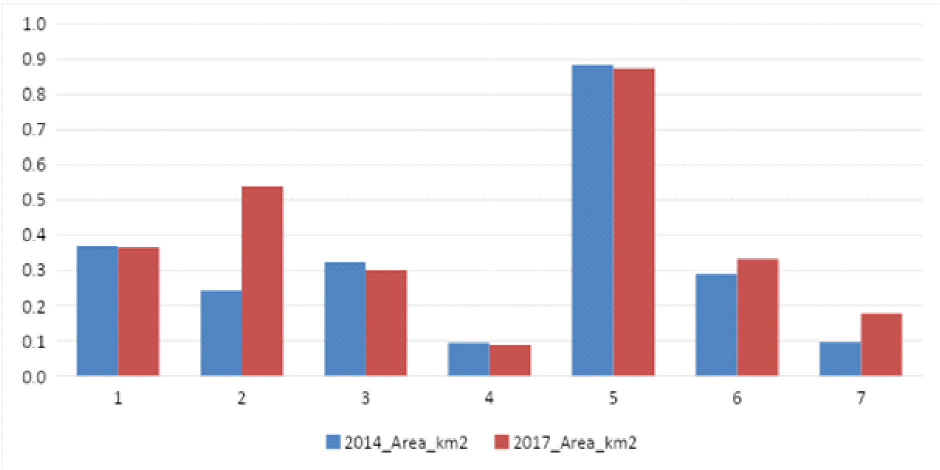
The GIS analysis also highlights that the region was less water-stressed after desilting in the months of February and March. Figure 1 shows Normalised Difference Water Index (NDWI) for the months January to May (15th of 1st month to 15th of 2nd month) for 2017 and 2014. In general, Kalvati and Morewadi have higher water stress. From the figure, it is evident the NDWI values are lower in 2014 as compared to 2017, except in the months of January, April, and May. Although water stress is much lower in the month of February and March, there is no impact of desilting in January and April and May. One reason for this is that there is usually water available in the month of January even without desilting and there is no water in April and May, even after desilting. The figure shows that the difference between months in 2017 is smaller as compared to the difference between the same months in 2014. This indicates that the region was less water-stressed in 2017 and that the transition to a water-stressed situation was more gradual than in 2014.

Figure 1: Normalized Difference Water Index for the Selected Tanks After Desiltation



The following Figure 2 provides the surface area of the water in the reservoirs in February of 2017 and 2014. There is no clear trend. Three of the reservoirs (Jogaiwadi, Khanapur and SSM Sagroli) show a higher surface area and the other four show lesser areas. There could be many reasons for this, including the relative proportion of the tanks desilted, desilting locations within the tank, and the topography of the tank surface.

Figure 2: Area of Water Body Compared for February 2014 to 2017 in Selected Tanks

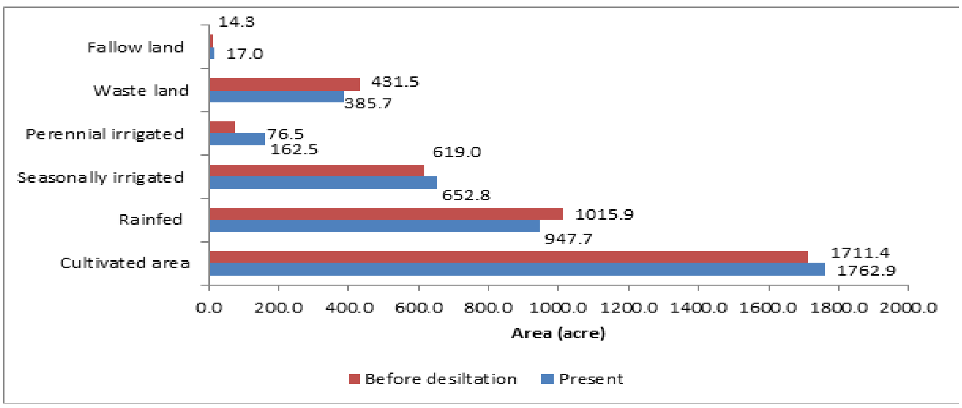


With desilting, as the storage of the tanks increases, they retain more water and even have some water left in February. Thus, more water is available in the tanks during drier months.

3.4 Impact on Land Use

Figure 3 indicates that the area under cultivation and seasonally irrigated area increased 3 per cent and 5 per cent respectively. The perennially irrigated area showed

Figure 3: Changes in Land Use Pattern in the Study Area

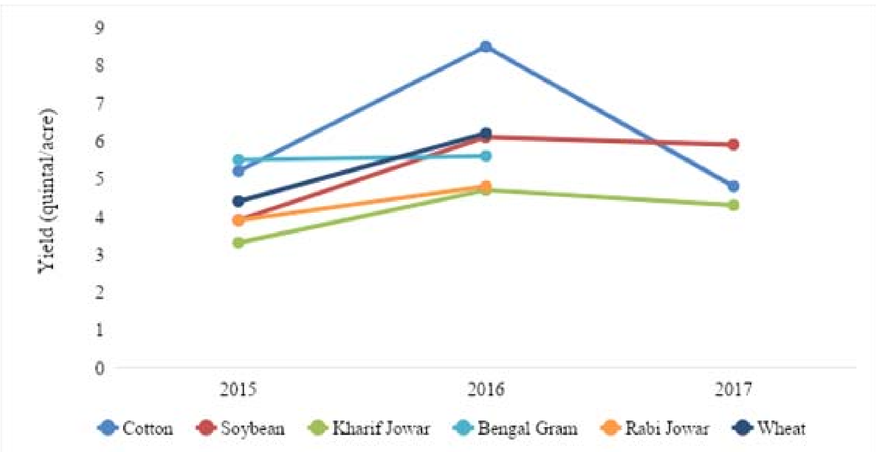


a significant increase of 112 per cent. Rainfed area and wasteland reduced by 7 per cent and 11 per cent respectively.

3.5 Changes in Agriculture Production and Inputs

Soybean, jowar, black gram, and green gram are the main Kharif crops in the area. Other crops grown in Kharif are marigold, sunflower, seed cotton, sesame, and safflower. Bengal gram, jowar, and wheat are the main Rabi crops. Cotton, turmeric and pigeon pea are the main two seasons-crops. Apart from these, farmers also cultivate groundnut, safflower, and onion during Rabi season. Figure 4 highlights the changes in yield for the main crops grown in the region for three years.

Figure 4: Changes in Yield of Main Crops



The area under cultivation of cotton, soybean and black gram shows an increase of 6 per cent, 39 per cent and 31 per cent respectively in Kharif 2016 as compared to Kharif 2015. A corresponding increase in the yield is also observed during this period. The increase in yield in 2016 is a result of silt application as well as good rainfall. The base year 2015 was a rainfall deficit year and hence the yield was below average. In 2017, the cotton crop suffered from a pink bollworm pest attack which affected production. During the group discussions, it was seen that the farmers had a positive perception of the benefits of silt application. They felt that silt application increases production by about 50 per cent and at the same time reduces the fertiliser cost by about half. The crops also look visibly healthy. Farmers also mentioned a change in cropping pattern – there is a shift towards cash crops with more households cultivating soybean and cotton.

Few farmers reported cultivating summer crops (groundnut) and fodder crops which were not taken before. A positive change is observed in the area under intercropping. This has increased from 48.2 acres to 192.5 acres in the Kharif season (+300 per cent). Pigeon pea is generally sowed between cotton, jowar, black gram, soybean and green gram. Intercropping provides guaranteed income in case of crop failure and is also beneficial for soil health while preventing soil erosion.

The group discussions revealed farmers' anxiety about using silt for the first time. Farmers have invested significant money in silt application and feared if the production was not good it would lead to a loss. Hence, few applied fertilisers in the farms where silt was applied (even though it was not needed). Farmers were also of the opinion that silt application reduces weed growth and hence the de-weeding cost is reduced.

A slight reduction in chemical fertilisers use is observed for the major crops. The per acre cost of chemical fertiliser usage has reduced by 8 per cent and 9 per cent in the case of cotton and soybean respectively for the Kharif season. For the Rabi season, per acre cost has reduced by 15 per cent and 6 per cent for jowar and Bengal gram respectively. In the case of perennial crop sugarcane, a marked reduction in per acre cost by 31 per cent is reported for chemical fertilisers. There is no change observed in the per acre cost of pesticides for cotton. However, the cost shows an increase of 10 per cent and 20 per cent for Bengal gram and soybean respectively. This may be due to an increase in pest attacks.

3.6 Cost-benefit Analysis

The cost-benefit analysis was carried out for three out of seven reservoirs. For the rest, this was not done as the soil sample could not be taken from the tanks. The tanks were filled entirely with water during the survey period. The expenses incurred by the NGOs for excavating the silt were considered as the cost. This includes the machine work, diesel and operator costs. The value of the silt excavated from the tank was quantified in terms of fertiliser equivalent cost of different nutrients (N, P, K, Zn, Cu, and Fe) retrieved from it. This was considered as the benefits of desiltation. The values were calculated based on the current market prices of fertilisers which would have been needed to replenish the equivalent quantity of nutrients applied through the silt as shown in Table 7.

Table 7: Benefit in Terms of Value of Nutrients from the Silt Excavated

Tank	Value of nutrients in terms of rupee equivalent						
	N	P	K	Zn	Cu	Fe	Total
Jogaiwadi	45823	13279	49250	6094	66499	111231	292176
Sagroli	5998	5666	100876	2440	19706	10894	145580
Bijewadi	43578	11186	250305	3682	94501	57724	460976

(Note: The cost of urea, single super phosphate, muriate of potash, zinc sulphate, copper sulphate, ferrous sulphate is Rs. 600, Rs. 900, Rs. 1,600, Rs. 4,500, Rs. 18,000 and Rs. 2,200 respectively for 100 kg)

The benefit-cost ratio (BCR) of the tanks was calculated under two scenarios- first with only the silt excavation as the cost and second with excavation, transportation and application cost considered. The benefits of silt application in terms of crop production accrue for about five years as reported by the farmers. Hence the BCR was also computed at the end of year one and year five as shown in Table 8.

Table 8: Benefit-cost Ratio Calculated at Year One and Year Five Under Two Scenarios

Tank	B:C Ratio in Year 1		B:C Ratio in Year 5	
	With excavation cost	With excavation, transportation, application cost	With excavation cost	With excavation, transportation, application cost
Jogaiwadi	1.11	0.11	5.55	0.54
Sagroli	0.97	0.12	4.85	0.61
Bijewadi	1.84	0.21	9.22	1.03
Average	1.31	0.15	6.54	0.73

In the first scenario, the BCR of the three tanks was 1.31 and 6.54 at the end of year one and year five respectively. This indicates that the desiltation activity was economically viable even when only the fertility of silt from the tanks is considered as the benefit. In the second scenario, the average BCR at the end of year 5 is 0.73. Here, indirect benefits of desiltation such as increased water storage capacity, improved soil texture and water holding capacity are not considered. The BCR will be more if these indirect benefits are also taken into account.

Apart from the cost benefit analysis, the average gross annual income of farmer was also enquired. The per farmer average gross annual income from the land with silt application (472.5 acres) increased from Rs. 37,489 to Rs. 92,855. The high value in the post-desiltation period could be a result of a silt application coupled with good rainfall. The rainfall in 2015 was below average, resulting in lower production and income losses for the farmers.

3.7 Concerns of Participation, Sustainability, and Equity

Effective and inclusive institutions and capacity building of beneficiary groups is the key to ensure that the project activities get implemented in a judicious manner as well as the impacts of it sustain for a longer period. At the institutional level, although Government Resolution (GR) on GDGS clearly mentions that in each village where tank desiltation is planned, the 'Village-level Monitoring Committee' has to be formed for planning, executing and monitoring tank desiltation activities. However, we observed that in only two project villages Moha and Bijewadi, committees comprising local people were formulated. Here, the committees were formulated mainly due to proactiveness and interest of villagers rather than a mandatory process during the desiltation activities and strong push by NGO. To ensure transparency, Moha village implemented additional steps like making public announcements to inform people, using a coupon system for paying the vehicle owners and making payments through the bank. All farmers who registered their names got the silt as required. In Moha, women SHG were of great help to needy farmers when they provided timely loans which were channelised through gram panchayat. In the rest of the villages, there was no consultation and the desiltation activities were planned with village key leaders, Sarpanch and their close followers. Therefore, the inclusive committees comprising diverse interest groups, such as rainfed farmers and small landholders were not visualised and practised in the desiltation activities in most villages.

Of the total sample of 292 households that benefited from seven desilted tanks, there are 170 small, 75 medium and 47 large farmers. When it comes to the amount of silt imported and applied in farms, large farmers have used the highest quantity of silt. Even, there is no evidence reported where the landless and artisans, such as pottery makers, local and non-commercial brick kiln makers etc. benefited from the silt that was removed from the tanks. When rainfed farmers and small landholders were asked about not having the more benefits of silt, the common answer was that the importing silt is a costly affair and they did not have the money to pay tractor operators when the work was in progress. Another challenge reported by farmers was the absence of proper roads, as the vehicle carrying silt had to travel through another farmer's land. In a few cases, landowners charged money for allowing the vehicle to transit through their farm which also increased the transportation costs. Even, we found villagers were not well aware of whether the water harvesting potential created through desilting tanks will affect the water flows in downstream and will change the water allocation in the cluster of villages. In a nutshell, we found the clear lack at institutional level in most villages and hence no measures were visualised for sustaining the benefits, for example taking measures so that tanks don't get silted again in the short run.

3.8 Other Benefits

During the group discussions, it was reported that a slight reduction in migration was observed. In village Moha, it was reported that within one year of desiltation, farm prices have doubled as they are more fertile and have increased water availability. Farmers were of the opinion that silt application helped the growth of crops and increased biomass. Hence, the farms are yielding more crop residue. This has led to more fodder for the livestock. In Bijewadi and Sagroli, people were of the opinion that the greenery surrounding the tanks has also increased. In the Sagroli tank, many birds were also sighted during the field visits. As an income-generating avenue, commercial fishing has been done in the tanks of Moha and Sagroli since the last few years. The contracts are given to local persons and the revenue generated is shared between the person and local village government body.

4

POLICY ANALYSIS OF GDGS

In this section, based on the above analysis, field observations and authors' experiences of working in this sector over the years, specific modifications are proposed to revise the main provisions made in the two important Government Resolutions (GR) issued by the government of Maharashtra on the GDGS scheme.

These two GRs are,[18]

1)GR-1: Government Resolution (dated May 6, 2017)- Government of Maharashtra (GoM) (Code number of GR is 201704101302368426) for Tank Desiltation

2)GR-2: Government Resolution (dated December 6, 2017)- Government of Maharashtra (GoM) (Code number of GR is 201712061616303426) for Village Monitoring Committee for Tank Desiltation

4.1 Criteria and Process for Selecting the Tank for Desiltation

Selection of the tank for desiltation is an important process in the GDGS scheme, and in the GR-1 mentioned above, criteria for selecting the tanks are specified. In addition to present criteria of age of the tank and its command area, while prioritising tank for desiltation, we propose the groundwater recharge potential of the tank also should be assessed for

18 Implementing Gaalmukt Dharan and Gaalyukt Shivar (GDGS) Yojana 2017 ; Formation of monitoring committee at village level for GDGS scheme 2017.

suitability. If it is not taken into consideration, then the excess water stored after desiltation works will be exposed to evaporation leading to water losses. There are certain situations where the GR prohibits undertaking or selecting the tanks for desiltation work, such as tank with irrigation potential of 0 to 100 hectare, tank area under private ownership of a farmer or when there is no clarity about land ownership. Here, we propose that along with the irrigation potential of the tank, the amount of silt deposited should also be considered as important criteria for selecting the tank. If tanks are silted to around 75 per cent of its full water storing capacity, then the government should consider desiltation. Tanks under private ownership should also be considered for desiltation as it results in groundwater percolation benefits and silt availability. For the approval purposes, the Gram Panchayat may take the written permission from the owners of land prior to submission of the proposal to the Tahsildar.

The GR made a positive provision that tanks with more quantity of sand will not be considered for desiltation. Further, a negative list of tanks constructed by the Revenue Department should be created where there is presence of sand in the structures. To strengthen this provision, we propose that the negative list should be put in the public domain so that it is accessible to all stakeholders and to ensure that the provision is not violated. In addition to these criteria, we propose that the quality of silt in the tank should be tested by a responsible NGO/Agency, in case it is planned to be applied on farmlands. This is to ensure that it does not negatively affect the existing quality of soil and crop production.

4.2 Institutional Issues

For the effective implementation of the tank-desiltation work in villages, the GR-2 has suggested formation of a Village-level Monitoring Committee (VMC) and has mentioned the proposed structure of the committee and its responsibilities. The composition of the committee is proposed as i) Village Sarpanch-as President, ii) Gram Panchayat member (One)- as Member, iii) Farmers Representative- as Member, iv) NGO representative- as Member, v) Talathi/Gramsevak- as Member, vi) related Section Engineer- as Member and Secretary. Besides these, we recommend that the VMC may also have representation of women SHG, women farmers, landless households, and of minority communities (SC/ST/OBCs). All village level members of VMC should be selected through Gram Sabha. Along with the formation of VMC, there should be clear provisions about conducting periodic meetings and documenting the procedure of meeting during the project. In addition to the existing responsibilities mentioned in the GR, the VMC must i) undertake awareness activities in the village regarding the desiltation plan, ii) display and update information about the plan and execution of the desilting activity daily at the public places during the work in progress, so that people are well informed, iii) in case of surplus silt, nearby villages, may also be invited to take away the silt for their farms, iv) sort out the issues concerned to making temporary roads where it requires, vi) suggest ways and means to compensate the farmers getting affected by temporary roads, as it affects the farmland of farmers, vii) giving priority to small and marginal farmers for silt import and ensuring that all sections of farmers benefit from this activity.

4.3 Planning, Execution, Monitoring

For implementation of the activities, the GR states that the Sub-Divisional Officer (SDO-Prant) from the Revenue Department will be the implementing officer of this scheme. In cases where the farmers or NGOs submit a proposal for transporting silt, the Tahsildar, after technical scrutiny, must send the proposal for administrative sanction to the SDO. In cases where the farmer/NGO spends own funds to excavate and transport silt, prior notice related to tank desiltation activity should be given to Tahsildar/ Talathi/Deputy Engineer (Dams) along with the schedule of work by farmers or NGO. We strongly recommend that the concerned Gram Panchayat should be the central decision-making body in project submission and implementation along with the VMC. The SDO should be the project sanctioning authority and the Gram Panchayat should work closely with him for project implementation. Following steps are proposed in this regard to follow. i) Farmers or NGO approaches the respective Gram Panchayat expressing their interest in tank desiltation. They should prepare a detailed proposal of the desiltation work and present it in Gram Sabha for approval. ii) The Gram Panchayat has to give prior notice to the Tahsildar or the designated officer regarding the tank to be desilted. 3) Then the engineers help the Gram Panchayat to estimate the tank's suitability for desiltation and the quantity of silt available 4) accordingly, the VMC under the guidance of Gram Panchayat prepares the list of farmers surrounding the tank and other farmers of the village. 5) Willingness and readiness of these farmers along with their consent and the quantity of silt demanded needs to be obtained by the VMC. 6) The list of farmers who apply for importing the silt and who are allowed for import should be displayed at a public place along with the budget of the activity. 7) Engineers responsible for monitoring and supervision should visit periodically to ensure that siltation work is being implemented as per the guidelines.

For monitoring and evaluation, the GR proposes that the tank under desiltation should be inspected regularly by the Deputy Engineer, Junior Engineer and Executive Engineer from time to time and the work be stopped immediately if desiltation activity threatens the safety of the tank. The work will also be monitored and evaluated by third-party agencies. Here it is proposed that to get the complaints of farmers addressed at primary level, these Engineers/VMC functioning under GP be assigned the function of hearing the farmers' grievances and resolving them. The Engineers monitoring the desiltation activities should be accountable if the safety of the tank is compromised. Regarding evaluation of work, VMC and the representative of Tahsildar should jointly monitor the desiltation work, along with external/ third party. Mid-term evaluation, during the work progress, should be mandatory by the agency to rectify any violation of norms. If any party (farmers/ villagers/contractors) have complaints regarding ongoing work, there should be appropriate authority nominated by the Sub- Divisional Officer (SDO) to register or hear these complaints and sort them out. Regarding the provision of payment instalment terms, in case of delays for releasing payment to NGOs after submission of all necessary documents, the additional interest for the delayed period should be paid by the government.

4.4 Inclusive Benefits

As a precondition of participation, the GR specifies that the farmers will bear the expenses required for transportation of silt from percolation tank to their farm. Our data and observations show that the most silt benefits are taken by large farmers as they imported and applied large amounts of silt compared to medium and smallholding farmers. Therefore, it is suggested that partial grant/support or interest-free loans need to be provided to small and marginal farmers to ensure the equitable benefits of public money on tank desiltation to all sections of the community. The temporary approach road made from the tank to the existing public road which passes through the private land of many farmers-must be demarcated by the VMC with the help of the Talathi, and if required, the Tahsildar as it is one of the issues of dispute among farmers. Also, there should be a financial provision in the project that once the desiltation of the tanks gets completed, the temporary approach road made in the fields of farmers should be cleared as it affects agricultural farms severely.

4.5 Ensuring the Ecosystem Health

The GR specifies precautions to be taken while work is under progress such as ban on excavation of murum and sand and not restricting desiltation to a certain distance from the walls depending on the tank size. To make this provision stronger and ensure its effective implementation, we propose that there should be a provision of cancelling the license or imposing a penalty on machine operators, implementing NGO and the Engineers responsible for monitoring. Only that quantity of silt should be excavated which would help to restore the original water storage capacity of the tank. Along with this, while deciding the depth for desiltation, the hydro-geology in terms of groundwater recharge capacity of the submerged area needs to be factored. These precautions are essential because changes in the topography and hydrology of the area around the tank due to its desiltation may impact the sustainability of downstream flows affecting the biodiversity and ecosystem; hence care must be taken that downstream flows don't get affected negatively.

5 RECOMMENDATIONS AND CONCLUSION

The cost-benefits analysis clearly indicates that when silt is mixed with topsoil in farmland, it helped farmers to cut down their input cost for chemical fertilisers, hence at level of economic returns, the GDGS program is much viable. However, to address and enhance the important concerns of community participation, equitable benefits, accountability, and transparency as well as environmental sustainability, we propose that the GDGS programme needs major restructuring, particularly at the level of ground implementation. At the principal level, since the cost of desiltation activities (apart from silt transportation) comes from public investment, it needs to be ensured that benefits of silt application go across different sections of farmers, i.e., including rainfed, small and marginal farmers. The criteria for selecting the tank for desiltation is a crucial aspect, along with the silt deposited in the tank, the geo-hydrology of the water storage area needs to be assessed to realise the water percolation possibilities of potential stored water after desiltation.

At institutional as well as monitoring and evaluation level, the programme needs a broader restructuring. When it comes to institutions, there needs a drastic shift in the programme. The inclusion of village-level representatives such as representatives of women farmers, rainfed farmers, SHGs and resource-poor will undoubtedly ensure that the VMC addresses the issues of all categories of villagers. Rather than NGOs and groups of farmers, Gram Panchayat needs to be treated as an important agency to approach Tahsildar and as the key agency in planning and executing the desilting activities with help of VMC. As the fields of farmers get affected because of silt transport by tractors, the issue needs to be sorted out by paying compensation to such farmers to repair their farmland.

Expecting that GDGS, a stand-alone programme, will deliver or be sustainable in the long run does not seem feasible. There are already enough observations that programs such as Jalyukt Shivar Abhiyan (JSA), where its focus is on specific activities of desilting and deepening streams and rivers, have not resulted in sustainable and judicious outcome.[19] Therefore, since there is no provision for treatments of the catchments in GDGS, as in the case of a comprehensive watershed development and management programme, the tanks would get filled up with silt in no time. So, we propose the need to make GDGS as a part of an Integrated Watershed Management Programme (IWMP) at the national level.

At the level of state, the existing policy instruments in the water and agriculture sector, such as Maharashtra Irrigation Act, 1976, Maharashtra Water Resource Regulatory Authority Act, 2005 and, Maharashtra Management of Irrigation Systems by Farmers Act, 2005 do not fit well with the tank desiltation activities carried under GDGS. As in the last few years, desiltation of tanks and lakes as well as rivers and streams under GDGS and Jalyukt Shivar Abhiyan have become the central issue of concern, there is a need for a special comprehensive law devoted to the desiltation issues (rather than issuing periodic GRs). Such law is essential to regulate the overall desiltation planning and execution activities which at one hand will be beneficial to the diverse set of stakeholders engaged in these activities and at other, will ensure that desilting activities don't affect ecosystem services and integrity in the long run.

19 Neha Bhadbhade and others, 'Can Jalyukt Shivar Abhiyan Prevent Drought in Maharashtra?' (2019), Vol 54 Economic and Political Weekly 12-14.

LEAD Journal (Law, Environment and Development Journal) is jointly managed by the Law, Environment and Development Centre, SOAS University of London
soas.ac.uk/ledc
and the International Environmental Law Research Centre (IELRC)
ielrc.org