Augmentation of Rural Piped Water Schemes for Supply of drinking water to tanker fed villages.

A Feasibility Study

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Acronyms and Abbreviations

ESR Elevated Storage Reservoir

GIS Geographical Information System

GP Gram Panchyat

LPCD Litres Per Capita per Day

MJP Maharashtra Jeevan Pradhikaran

MSEB Maharashtra State Electricty Board

MVS Multi Village Scheme

NGO Non Government Organization

PWS Piped Water Scheme

Abstract

There are about 160 tanker fed villages in Thane district of Maharashtra State in spite of having high rainfall in the range of 2000-3000mm and biggest reservoirs like Tansa, Vaitarana and Bhatsa for supplying drinking water to Mumbai city. Many solutions have been explored in the past to provide drinking water security to people in rural area. The present study was undertaken to explore augmentation of existing piped water schemes to supply drinking water to tanker fed villages in the vicinity of coverage area of those schemes. Based on the documentation of the existing schemes, they were mapped against the tanker fed villages using GIS. The schemes were then shortlisted based on proximity analysis, strength and sustainability of source and capacity of the schemes. Out of the short listed schemes, three schemes were selected for field study from Jawhar Mokhada area dominated by tribals in which a large number of tanker fed villages are concentrated. This is the area that has a distinction of being the major supplier of drinking water to city of Mumbai through reservoirs like Upper, Lower and Middle Vaitarna.

Out of the three scheme selected for field study, Dabhosa located in the vicinity of Dehere has gained self reliance for drinking water after revival of piped water scheme located in the village that was non functional due to arrears of electricity bill. The scheme has a perennial source of water that is recharged by two check dams on the nearby river. The Suryamal scheme has excellent source of water supplying water to Gomghar from here is not feasible because of hilly terrain having deep valleys and winding roads. There are technical challenges in extending Karegaon scheme to Kiniste because of its high elevation but it needs further consideration. It is necessary to review the current rural norms for drinking water and change them for hilly terrain and tribal belt.

Since the source of current Karegaon scheme will be submerged due to Middle Vaitarna project, it is learnt that MCGM has assured to finance the new Karegaon scheme. The needs complete revamping in terms of its scope to include the cluster of tanker fed villages in its neighborhood from Gomghar to Kiniste in view social cost benefit analysis of Middle Vaitarna dam which is expected to augment drinking water supply of Mumbai city by 455MLD at a cost of Rs. 2700 crores. The total demand of tanker fed population (~14000) in Mokhada taluka is only 0.56MLD or about 0.12 % of water supplied to Mumbai from this area. If ‘inclusion’ model is adopted, the drinking water problem in this area can be solved at a tiny fraction of its project cost. Further studies are necessary to assess the feasibility of providing water to clusters of tanker fed villages here, one being Gomghar- Kiniste area and the other being Vihigaon- Kasara Kh area both from Middle Vaitarna as well as Upper Vaitarna as source.

There is yet another option to be considered in the long term in the light of the proposed Damanganga Pinjal link project planned by National Water Agency which is expected to augment drinking water supply to Mumbai city by about 2000MLD. When a project of such a large size is planned, it becomes even more necessary to adopt ‘inclusion’ model to address the problems of the local population especially related to basic needs like drinking water. In the present context, the drinking water problem of the entire Jawhar Mokhada region can be solved at a small fraction of project cost. This has also brought the issue of ownership of precious resources like water in focus. It needs to be addressed properly at national policy level by giving serious consideration it deserves.

Introduction

Maharashtra has faced several droughts in the past from time to time due to failure of monsoon or erratic pattern of rainfall. There are more than 70 talukas in 11 districts facing chronic drought conditions. This has created severe drinking water scarcity in many of these areas due to which villages in these areas have been depending on supply of drinking water by tankers and bullock carts. Besides this, many other areas face drinking water scarcity in spite of good rainfall. Thane district is one such example. There are about 60 villages in this district which face chronic drinking water scarcity out of a total of 163 tanker fed villages. A variety of solutions have been explored to mitigate the risks with drinking water security. One such attempt under the present study was focused on piped water schemes for supplying water to tanker fed villages in their vicinity.

Objectives and Scope:

The objective of the study was evaluation of preliminary techno economic feasibility for augmentation of rural piped water schemes to supply drinking water to tanker fed village/villages in the neighborhood.

The scope of study was to identify a few piped water schemes having tanker fed villages in the vicinity preferably from a geographical area where there is a concentration of large number of tanker fed villages and then undertake field trips to those schemes for further studies.

Approach and methodology:

Based on the scope and objective outlined above, the following approach and methodology was adopted.

1. Obtain documentation of Rural Piped Water Schemes from district MJP office, and RWSS department of ZP office. Also collect relevant data from other sources such as DDWS, GSDE, MJP etc

2. Review documentation of the Schemes (Scheme Design /Handover Notes/Schemes Data Spreadsheets etc)

3. Map Piped Water Schemes to tanker fed villages on GIS map

4. Shortlist Schemes based on preliminary analysis (Scarcity area, proximity analysis, source strength, scheme capacity etc.)

5. Field Study of Shortlisted Schemes.

6. Conclusion and Recommendations

Documentation Review:

Maharashtra Jeevan Pradhikaran (MJP), the apex agency was established in 1997 for provision of drinking water and sanitation in the state of Maharashtra. It is entrusted with planning, designing and executing water supply schemes. Hence, the first step was to review documentation on rural piped water supply schemes available with MJP. The

Rural Regional Piped Water Schemes (RRWS) was the natural choice for review of documentation first since they are bigger in size spanning across multiple villages and have better potential for extension to tanker fed villages in the vicinity due to larger capacity. Accordingly, the documentation supplied by MJP on a few RRWS schemes was reviewed and a preliminary capacity analysis was done for a few schemes to ascertain the excess capacity available for extension of the scheme. e.g. The daily design capacity of Murbad Village scheme is 3.75MLPD while its current daily demand is 1.4 MLPD leaving adequate excess capacity at present for supply of drinking water to the neighboring tanker fed villages, if any.

GIS Mapping

1. The next step was to visually map the RRWS schemes to tanker fed villages on Geographical Information System (GIS). The GIS map for the tanker fed villages is displayed in fig 1 below and the same for RRWS schemes is shown in fig 2.

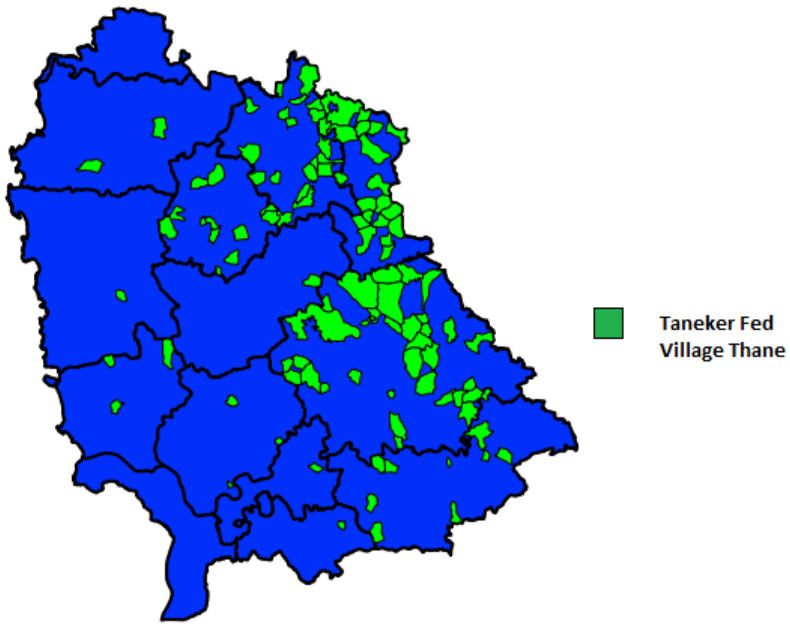

Fig 1- Tanker fed villages in Thane District

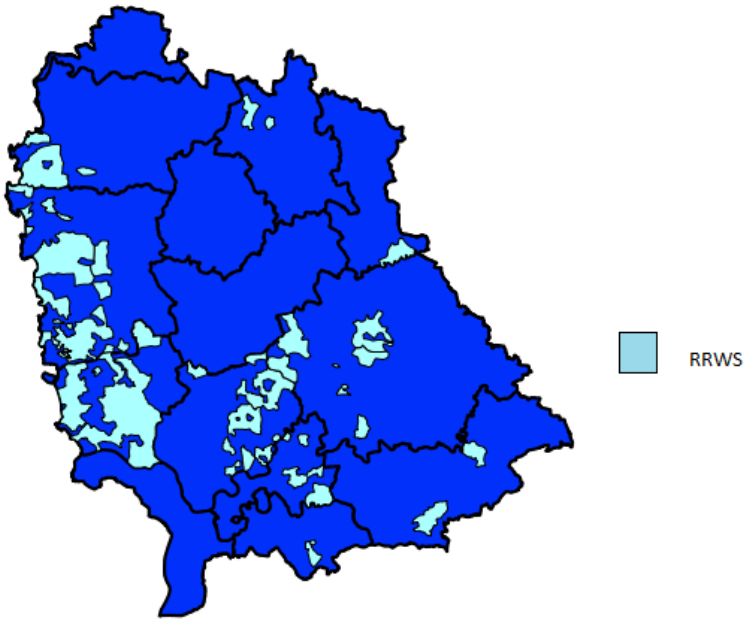

Fig 2 - Regional Rural Piped Water Supply (RRWS) Schemes in Thane district

A mere visual observation of the GIS maps was quite revealing. It is seen that the schemes are mostly concentrated in the western part while the majority of tanker fed villages are concentrated on the eastern side of Thane district. It is also interesting to note that the most of tanker fed villages are concentrated in Jawhar, Mokhada and Shahapur and Murbad taluka out of which first three are dominated by tribal population.

2. Since RRWS schemes failed to provide the desired solution, it was decided to look at all the remaining schemes. The schemes data for the state of Maharashtra was obtained from Department of Drinking Water and Sanitation (DDWS), GoI site. Here the schemes are classified into two categories.

    i. MJP Schemes: This category includes medium to large schemes planned and executed by MJP. It is to be noted that prior to implementation of Swajaldhara program in 2003, execution of piped water supply schemes was done solely by MJP

    ii. ZP Schemes: This category includes schemes executed by ZP after the implementation of Swajaldhara program in 2003 after which the responsibility of planning and execution of small and medium size schemes (up to a budget of rupees 5 crores per current standards) was entrusted with ZP. In order to ensure reasonable size and capacity for selected schemes, a lower limit of rupees 30 lakh was set to filter out smaller size schemes.

3. Next these schemes were laid on GIS as separate layers as shown in Fig 3 and Fig 4 below and mapped to tanker fed villages as shown in Fig 5.

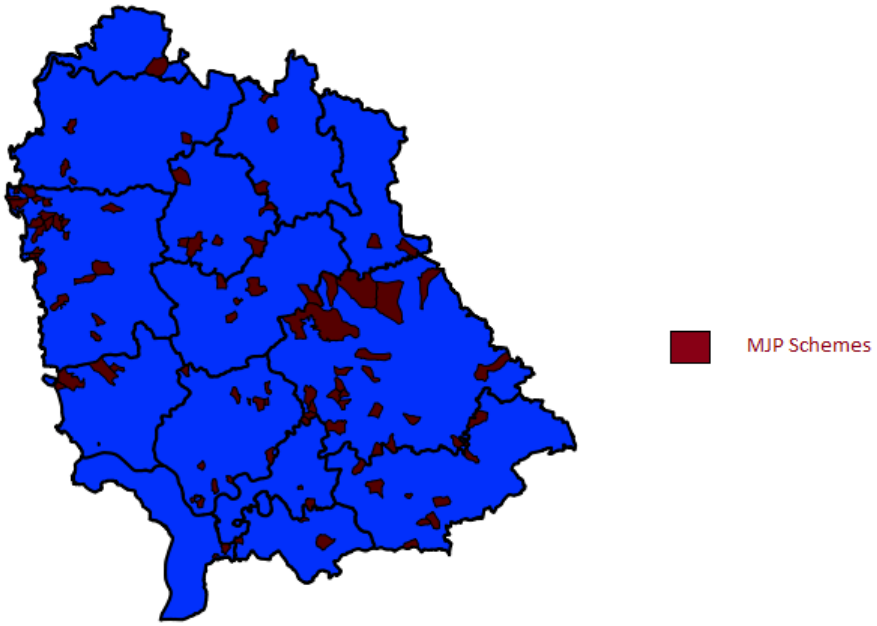

Figure 3- MJP Schemes in Thane District

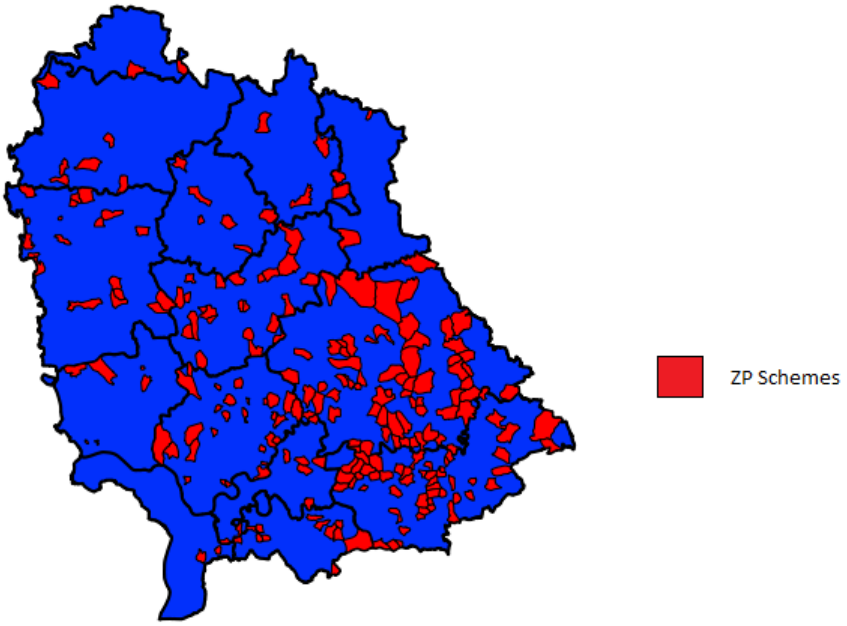

Figure 4- ZP Schemes in Thane District

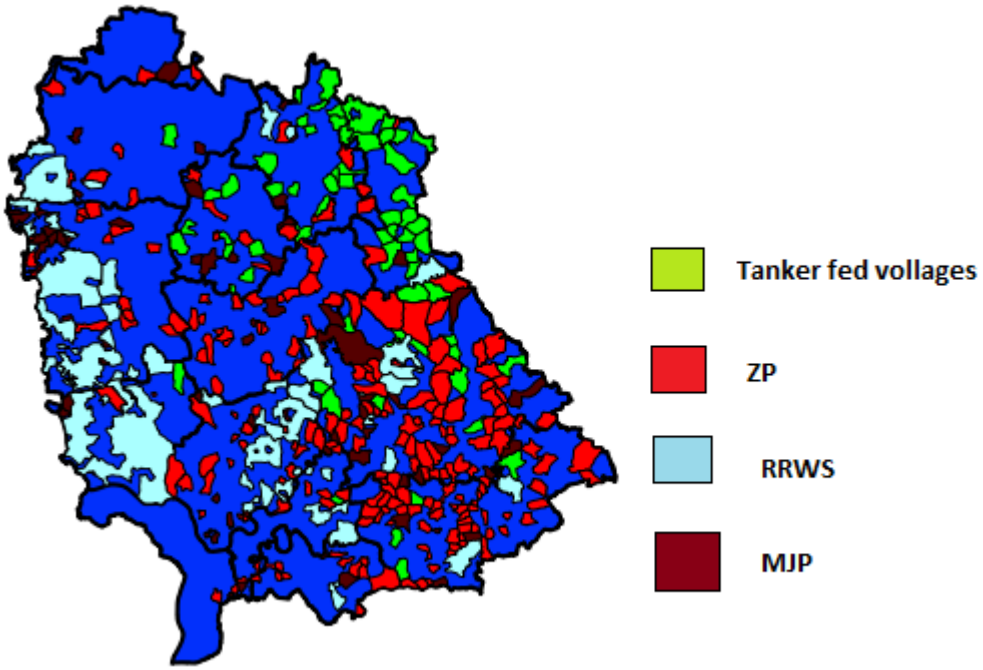

Figure 5 - Mapping of All Piped Water Schemes with tanker fed villages

4. Next the schemes were shortlisted based on proximity analysis on GIS maps and other key determinants, such as strength and sustainability of source of schemes, their capacity and extensibility. The shortlisted schemes are displayed in Fig 6 below.

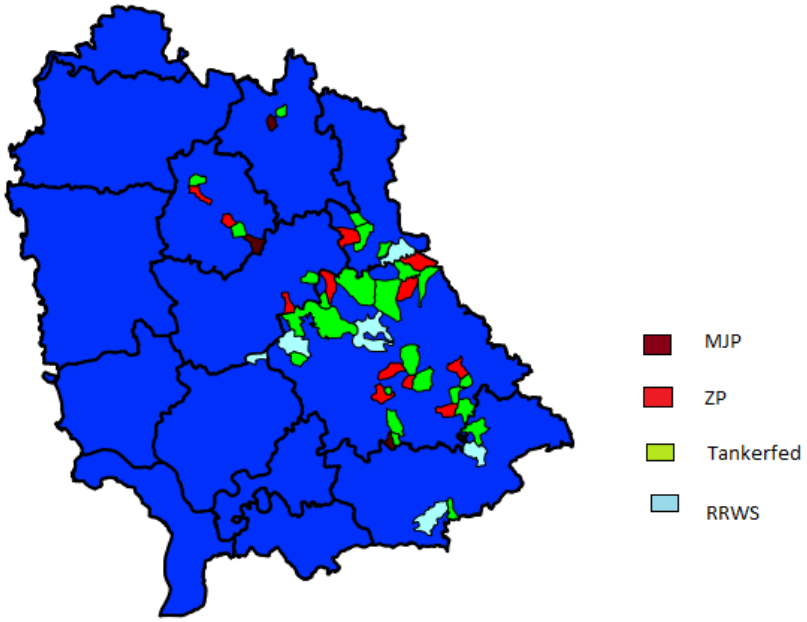

Figure 6- Shortlisted Schemes mapped with associated tanker fed villages

Geographical Location Analysis

Table 1 below displays taluka wise distribution of schemes, no. of tanker fed villages, population covered by schemes in that taluka along with population of tanker fed villages. The following observations were made from this data.

i. The tribal belt of Thane district covering Jawhar, Mokhada and Shahapur have the highest population of tanker fed villages in spite of high rainfall (about 3000mm) and the largest supply of drinking water to Mumbai(about 3000MLD).
ii. Jawhar and Mokhada taluka has the lowest percentage of population covered by piped water schemes.
iii. Jawhar and Mokhada taluka has the highest ratio of tanker fed population to the population covered by piped water schemes.

Name of taluka	No. Of schemes	Total Population	No. of Tankefed villages	Population of Tankerfed Villages	Population Covered(ZP)	Population Covered(MJP)	Total Population Covered(MJP + ZP)	Percentage Covered	Ratio of tankerfed population to population covered
Ambernath	20	105020	No data	No data	27354	5437	32791	31.224	No Data
Bhivandi	34	388725	4	7204	12325	88092	100417	25.832	7.174
Dahanu	6	334745	No data	No data	8877	68895	77772	23.233	No Data
Jawhar	4	116815	28	11398	2727	5476	8203	7.022	138.949
Kalyan	13	257503	No data	No data	5803	69847	75650	29.378	No Data
Mokhada	3	79006	30	14093	No Data	3514	3514	4.448	401.053
Murbad	56	199610	14	4771	44351	9808	54159	27.132	8.809
Palghar	40	456134	3	3456	20762	106531	127293	27.907	2.715
Shahapur	93	292305	52	15665	46715	44726	91441	31.283	17.131
Talasari	1	137042	No data	No data	No Data	15884	15884	11.591	No Data
Vasai	5	370523	3	3514	5757	No Data	5757	1.554	61.039
Vikramgad	8	118102	8	3020	5289	209	5498	4.655	54.929
Wada	29	159905	No data	No data	12993		12993	8.125	No Data

Table 1: Taluka wise Piped Water Schemes coverage vs. Tanker fed population

Selection of Schemes for Field Study

Based on the geographical location analysis and the shortlisted schemes, the following three schemes in Jawhar/ Mokahda were selected for field study.

i. Dehere Medha Scheme
ii. Suryamal Scheme
iii. Karegaon Scheme

The relevant data for these schemes along with all the shortlisted schemes is presented in Table – 2 below

S.No	Name Of the Tankerfed Village	Current Vil_Pop	Scheme Name	Source Name and Type	Estimated Cost (Rs.)	Scheme Design Population	Hab / School Covered
1	Dabhose	443	DeheraMedha	Pimpurna Lake (Surface Water)	30026000	5476	19
2	Gomghar	762	SURYMAL PWSS	Suryamal Openwell (Ground Water)	4600000	3505	1
3	Pathardi	650	SURYMAL PWSS	Suryamal Openwell (Ground Water)	4600000	3505	1
4	Kiniste	844	Karegaon	Vaitarna River (Surface Water)	11792000	3514	3
5	Mal	638	Tokawade	Dam (Manivali)	15721000	7257	10
6	Kasara Kh.	1215	TELAMWADI PWSS	Openwell (Ground Water)	4287214	-	13
7	Balwandi	510	TEMBHA PWSS	Openwell (Ground Water)	7451508	1863	4
8	Dhadhare	800	Apate P.W.S.S.	Openwell (Ground Water)	5603038	350	4
9	Ambekhor	400	Apate P.W.S.S.	Openwell (Ground Water)	5603038	350	4
10	Shirol	114	MOKHAVANE PWSS	Openwell (Ground Water)	8000000	-	1
11	Vehloli Bk.	241	MUSAIWADI PWSS	Openwell (Ground Water)	5224466	200	2
12	Kothare	45	SARANGPURI PWSS	Openwell (Ground Water)	5384281	97	6
13	Asnoli	82	NANDWAL PWSS	River (Surface Water)	1452000	-	3
14	Shivaneri	870	DHASAI PWSS	River (Surface Water)	7294564	2099	4
15	Aghai	180	Kharadi	River (Surface Water)	4871000	6840	7
16	Khadki	245	ANANDPUR PWSS	Openwell (Ground Water)	5005608	713	1

Table 2: Shortlisted Piped Water Supply Schemes

Field Study Observations

A. Dehere Medha Scheme and Dabhosa

Dabhosa, a tanker fed village has a total population of 1159 including the population of Sambarpada, a habitation belonging to it. It is located in the close vicinity of Dehere Medha scheme, a multi village rural water supply scheme servicing 6 villages and 6 habitations with a total design population of 16,400. Dabhosa as shown in Fig 7 below.

Figure 7 - Dabhosa and Dehere Medha Scheme

Figure 8 Dabhosa, Sambarpada and Water Fall

Although Dabhosa is a tanker fed village, the problem here is different than that experienced by most of other tanker fed villages. It was revealed during the field trip that Dabhosa had to depend on tanker water because the piped water scheme there has been non functional due disconnection of electric supply on account of nonpayment of electricity bill. According to Mr. Lokhande, Deputy Engineer, Rural Water Supply department, ZP, the MSEB bill amount of Rs. 32,000 had swelled to a total outstanding amount of Rs. 91,000 due to accumulated charges and fines over a period of time. There are two other wells close to Sambarpada that are used by the villages until the month of January. Thereafter they had to depend on tanker water.

The scheme at Dabhosa is based on a dug well near a river as shown in Fig 9 below. There is no shortage of water in the well even during summer months. There are two check dams in the river one on either side of the well as shown in Fig 10 help to recharge water in the well.

Figure 9 - Piped Water Scheme at Dabhosa

Figure 10- Source Strengthening Check Dams at Dabhosa

It was due to persistent efforts of the Sarpanch of Dabhosa together with the intervention of Mr.Lokhande, the RWSS official in Jawhar sub division, the scheme was revived recently by waiving off the fines and paying off the MSEB bill. After the revival of the scheme, the people in Dabhosa and Sambarpad have gained self reliance for drinking water problem. If the scheme functions smoothly, there is slim chance for Dabhosa to appear in the list of tanker fed villages.

Fig 11 Deputy Engineer Mr. Lokhande and Asst Engineer Mr. Chavan

During initial assessment, Dabhosa water fall shown below in Fig 12 was considered as an alternate source of water for Dabhosa and Sambarpada.However, it was observed during field visit that the Dabhosa water fall cannot be used as an alternate water source due to the steep slope on the sides of the fall and the difficult terrain which would make the scheme non viable.

Figure 12 - Dabhosa Water Fall

B. SuryaMal Scheme and Gomghar:

Gomghar village with a population of 620 is located between Khodala and Suryamal is a tanker fed village as shown in Fig 13 below. There is no piped water scheme in Gomghar. The people here depend on two wells, namely Bandhil Vihir and Kel Vihir, both at a distance of about 300m and below the village level. Due to a large elevation difference between the wells and the village, the people have to negotiate a steep gradient to fetch water. Both the wells dry up by the end of March and the village has to depend on tanker water thereafter. According to Kalpana Hanre, the Sarpanch, they

have never proposed a piped water scheme. Taking into account the local terrain, high altitude of Gomghar village(418 m) and large elevation difference between the source and the village, any piped water scheme here may not be viable per current rural norms for cost of water according to Mr. Sunil Chavan, Sub Engineer, RWS dept, Mokhada.

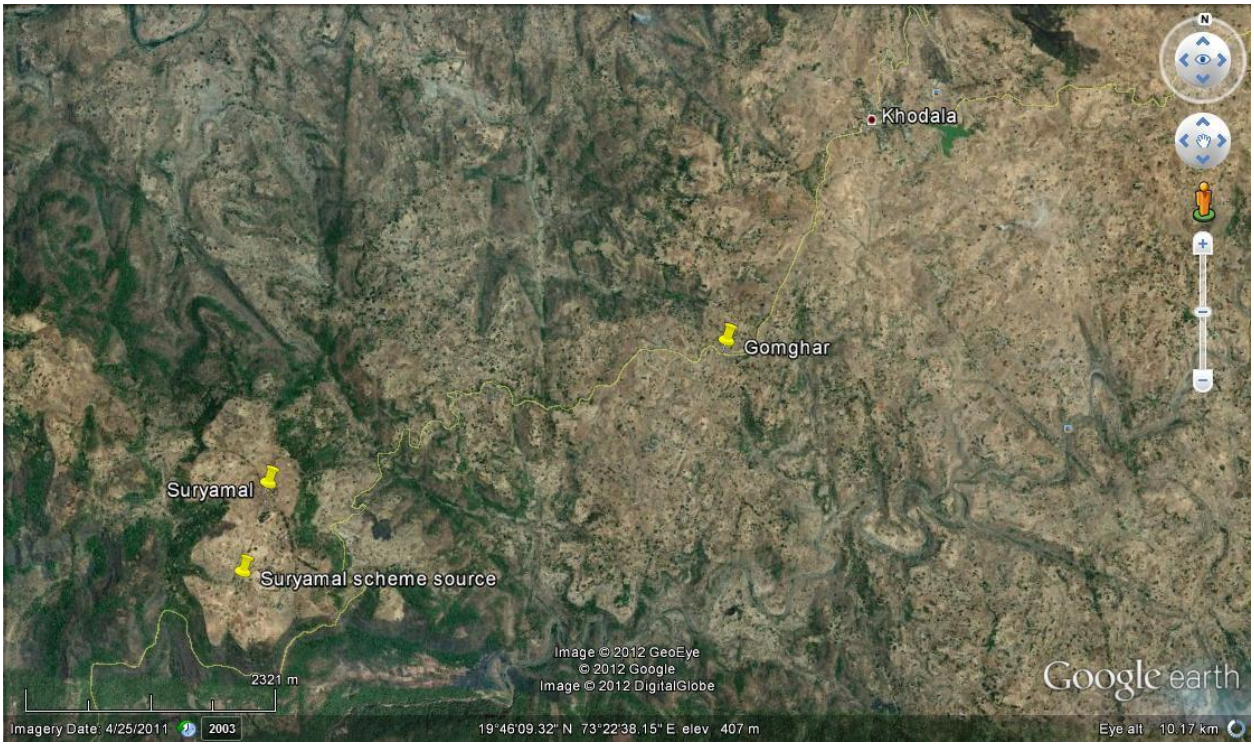

Fig 13: Suryamal and Gomghar location map

The current water scheme in Suryamal based on a dug well located about 200m from the village was commissioned in the year 1992 but it eventually became non functional needing major repairs. They have proposed a new scheme based on the same water source. In the meanwhile, they have recently got the old scheme repaired with the help of RWS officials. Besides this, there is separate scheme based on the same well for a student population. the Sarpanch, The distinct feature of the scheme as shown in Fig 14 is that the well is always full of water round the year. According to Kalpana Patil, the Sarpanch, the water level never drops below more than a meter. It was observed that upstream there were water recharge structures such as boulder bunds and a check dam like structures as shown in Fig 15 below. The correlation between the water level in the well and these watershed structures would an interesting topic of research but it is out of scope of current work.

Figure 14 - Suryamal Piped Water Scheme

Fig 15 – Water Recharge structures – Suryamal

The scheme has been functioning well after repairs as confirmed by the Sarpanch. According to her, the scheme is used only for providing drinking water to the village population through a network of 12 stand posts. The villagers use a bullock cart with 200 lit water drum ad shown in Fig 16 below for meeting their additional water needs every trip currently costing Rs. 50.

Figure 16 - Cart used for fetching water

The Gomghar village is located at about 10 kms by road from Suryamal. Although the prospects of augmentation of Suryamal scheme look bright based on the strength and sustainability of source, the unfriendly terrain between Suryamal and Gomghar(Fig 17 below) intercepted by hills, valleys and winding road combined with high altitude of Gomghar village(418 m) makes the proposition non viable. Similarly, extension of this scheme to provide water to Pathardi is also ruled out because of same factors and longer distance (15 kms).

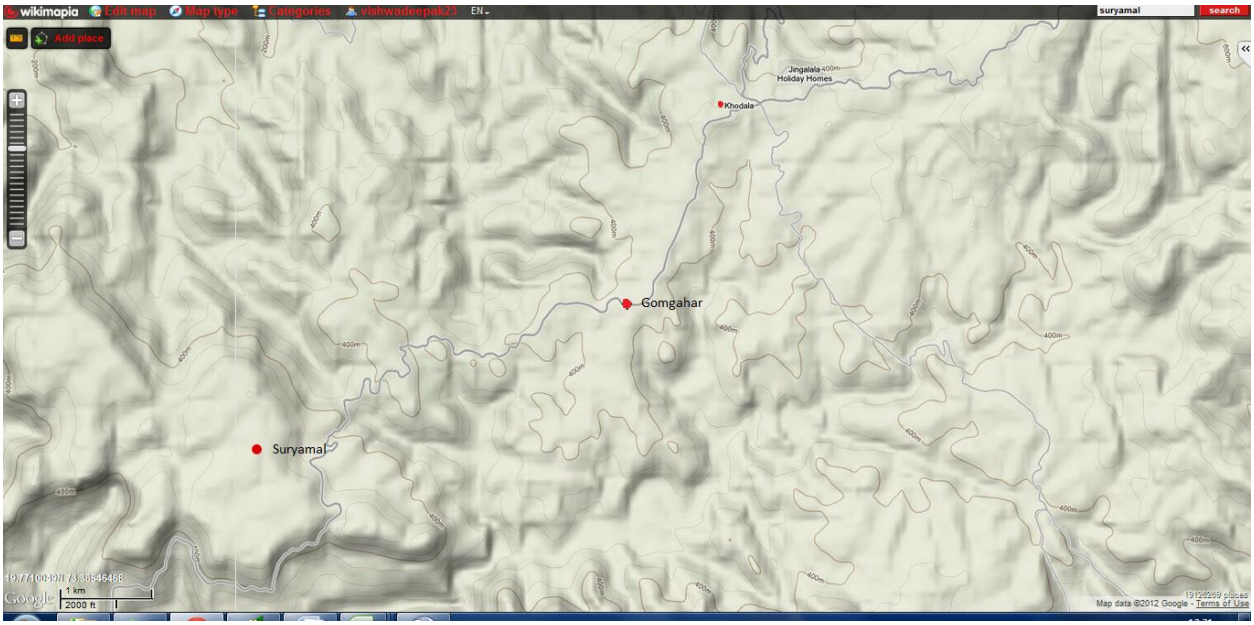

Figure 17 Suryamal Gomghar Terrain

C. Karegaon Scheme and Kiniste

Kiniste located in the neighborhood of Kochale village which is covered under Karegaon scheme, is one of the tanker fed villages in Mokhada taluka. There are three wells in Kiniste out of which two are located within a distance of 200m and the third is at a distance of 1km from the village. One of the first two wells is used for meeting drinking water needs while the other is used for household purpose but both the wells dry up by end of March. The third well lasts until April end. Thereafter the villagers of Kiniste have to depend on tanker supplied water.

Fig 18 - Dried well in Kiniste

The old scheme in Kiniste based on a dug well as source is non functional partly due to drying up of source and partly due to nonpayment of electricity bill, consequent closure of scheme and theft of assets. The only visible asset of the old scheme is a GSR located on the nearby hill.

The proposed multi village scheme at Wakadpada covering Kiniste based on Sayade dam as source has ran into problems during the inception stage itself partly because of opposition from Wakadpada villagers and partly due to its geographical position. Kiniste is located at a distance of 6 kms from the source. According to Mr. Sunil Chavan, the RWS official in Mokhada, its distant location makes it uneconomical as it fails to fulfill the rural piped water costing norms. On the other hand, the Wakadpada folks want to limit the scope of the scheme for themselves because of their apprehension of operational issues of multi village scheme. If Kiniste folks fail to pay regular tariff, they fear that they may have to suffer as the scheme may close down as has happened with other schemes in many other areas.

The point to point distance between Kiniste and Kochale is only 1.6km and an ESR of Karegaon scheme is located in Kochale. Hence the extension of Karegaon scheme to Kiniste looks logical to Kiniste folks.

Fig 19 Karegaon Scheme Scope and Kiniste

The source of current Karegaon scheme will be submerged due to Middle Vaitarna Project undertaken by Mumbai Municipal Corporation to augment supply of drinking water to Mumbai city by about 450 MLD, Karegaon scheme is being revamped. But the scope of the proposed Karegaon scheme has been left unchanged as shown in Fig 19 above. At this juncture people from Kiniste have been demanding for augmentation of its scope to include Kiniste because of its proximity.

They argue that the water from Kochale ESR, a part of Karegaon scheme, can be easily pumped to Kiniste ESR from the old scheme and distributed to people. Alternatively, the design of new Koregaon scheme can build a separate ESR and pipelines for Kiniste.

Mr. Sunil Chavan, Asst Enginner, RWS has a different perspective. Although the point to point distance between Kiniste and Kochale is just 1.6km, there is no direct road connectivity between the two villages. Instead there is a deep valley and a hill separating Kochale from Kiniste which located at an elevation of 100m higher than Kochale as shown in terrain map fig 16 below. Thus a combination of factors related to geography of the region poses technical challenges for extension of Karegaon scheme to Kiniste. This demands more rigorous engineering approach and detailed feasibility study which is out of scope of current work. Mr. Chavan said they would look into the problem again.

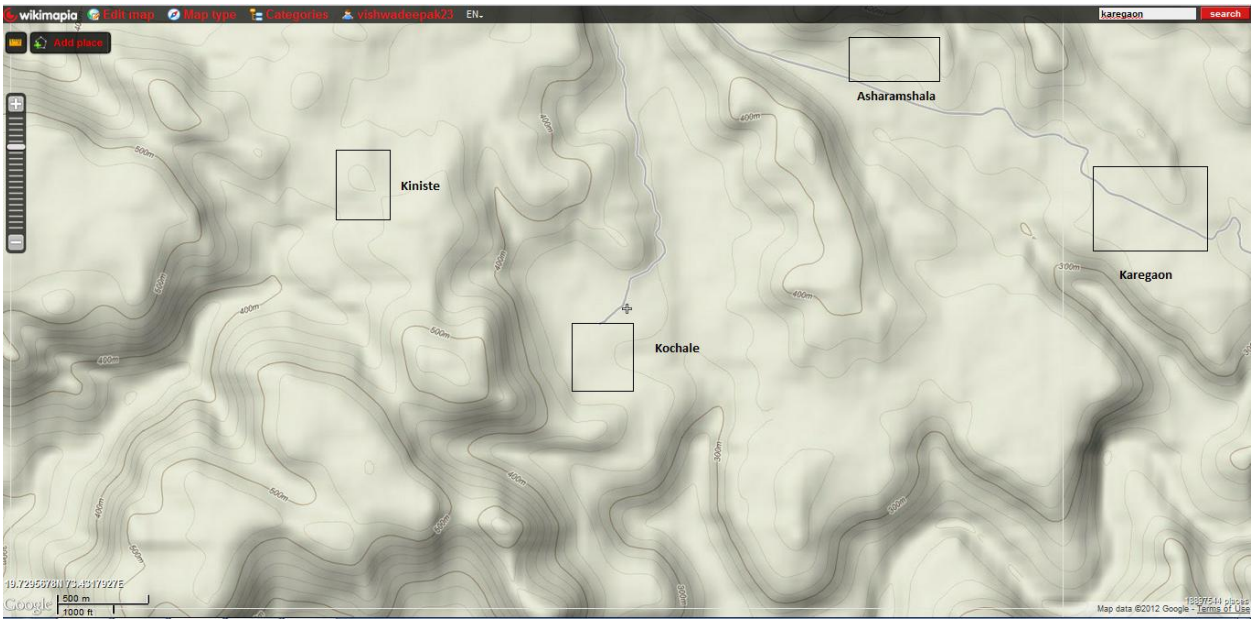

Fig 20 Terrain of Karegaon Scheme

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Middle Vaitarna/Upper Vaitarna and clusters of Tanker fed Villages

The logical offshoot of the foregoing analysis of drinking water stress and individual schemes in this area was to redefine the problem itself to seek solution on a different level. The common problem associated with the tanker fed villages in this area is high elevation due to which an individual piped water scheme proposed for such villages fails to satisfy rural costing norms of Rs. 2330 per capita. As a result, a different solution space has to be created after redefining the problem. As it is known that Karegaon scheme is submerged and a new scheme is being proposed. At this juncture many villages have been demanding that they should be included in the new scheme. They are also questioning the current 'exclusion' model of drinking water supply to big cities like Mumbai. The perception of people here is that their water is taken away but they are left high and dry. According to people here, they are not opposed to it as long as their problem is addressed as part of the same project.

The total demand of tanker fed population (~14000) in Mokhada taluka is only 0.56MLD or about 0.12 % of water supplied to Mumbai from this area. If 'inclusion' model is adopted, the drinking water problem in this area can be solved at a tiny fraction of its cost. The operational cost can be reduced by taking water from Upper Vaitarna thereby taking advantage of its higher altitude (~ 600 m) and gravity flow of water to a large area.

Given this background, it may be worthwhile to revisit the scheme and include the cluster of tanker fed villages in the scope of Karegaon scheme and assess its feasibility with Middle Vaitarna as source. The two clusters marked Zone A and Zone B are depicted in Fig 21 and 22. Similar exercise can be done with Upper Vaitarna as source and the two options can be compared to each other. This needs further investigation and is out of scope of present work.

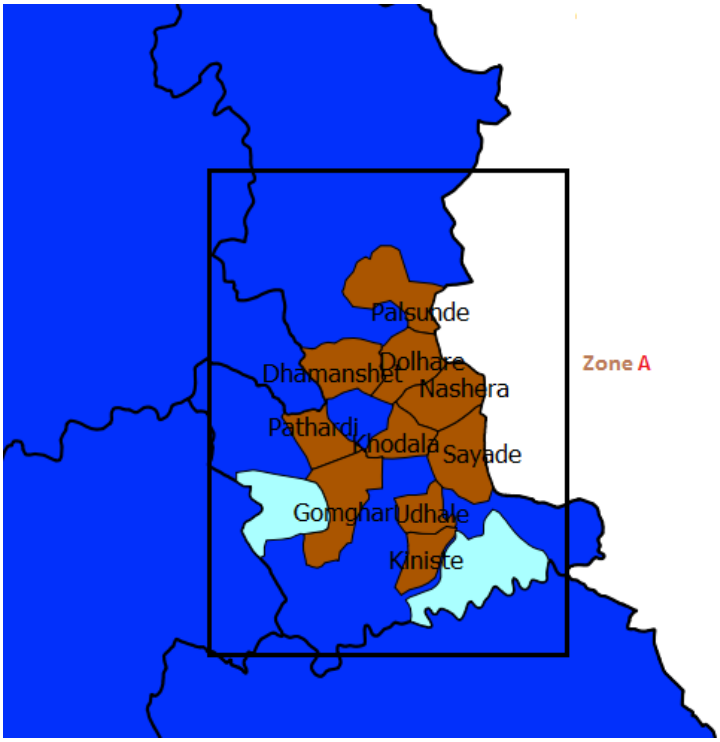

Fig 21 – Cluster of tanker fed villages in Zone A

S.No	Name of Village	Elevation (metres)	Source	Distance from source (km)	Population
1	Palsunde	393	Middle Vaitarna	19.4	sakurli palsunda 770+733
2	Dhamanshet	377	Middle Vaitarna	15.9	Data Not available
3	Dolhare	381	Middle Vaitarna	14.6	133
4	Adoshi	201	Middle Vaitarna	13.1	134
5	Pathardi	193	Middle Vaitarna	12.9	650 botoshi pathardi
6	Nashera	357	Middle Vaitarna	13.6	464
7	Sayade	419	Middle Vaitarna	10.2	168(sayade jogalwadi)
8	Gomghar	418	Middle Vaitarna	9.8	Data Not available
9	Kiniste	460	Middle Vaitarna	3.7	844 (only kiniste)
10	Udhale	420	Middle Vaitarna	6.4	445
11	Khodala	442	Middle Vaitarna	11.5	3084
12	Shirasgaon (lies in between but is not	243	Middle Vaitarna	11.8	134
13	Jogalwadi (as above)	423	Middle Vaitarna	8.4	168

Table 3: Elevation and Population Data for Zone A villages

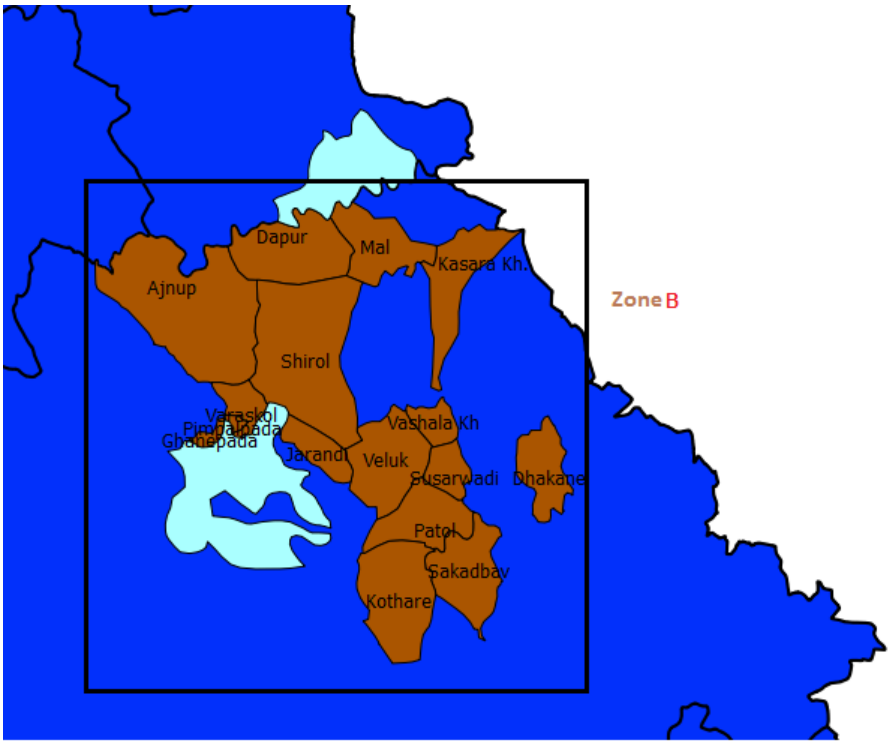

Fig 22 – Cluster of tanker fed villages in Zone B

S.No	Name of	Elevation	Source	Distance from source (km)	Population
1	Dapur	220	Middle Vaitarna	3.2	Data not available
2	Ajnup	277	Middle Vaitarna	9.2	Data not available
3	Shirol	334	Middle Vaitarna	8.5	750
4	Varaskol	208	Middle Vaitarna	12	Data not available
5	Pimpalpada	274	Middle Vaitarna	13.3	538
6	Ghanepada	229	Middle Vaitarna	14.7	163
7	Jarandi	205	Middle Vaitarna	13.7	Data not available
8	Veluk	255	Middle Vaitarna	14.8	1048
9	Mal (Patilpada)	538	Middle Vaitarna	4.1	638 mal + 198 patilpada
10	Kasara Kh.	376	Middle Vaitarna	7.5	1215
11	Vasala Kh.	302	Middle Vaitarna	13.7	Data not available
12	Susarwadi	277	Middle Vaitarna	13.7	Data not available
13	Dhakane	295	Middle Vaitarna	18.9	476
14	Patol	256	Middle Vaitarna	14.5	650
15	Kothare	222	Middle Vaitarna	23.1	Data not available
16	Sakadbav	230	Middle Vaitarna	22.9	593

Table 4: Zone B Villages – Elevation and Population Data

Table: Elevation Data for Zone A and Zone B villages

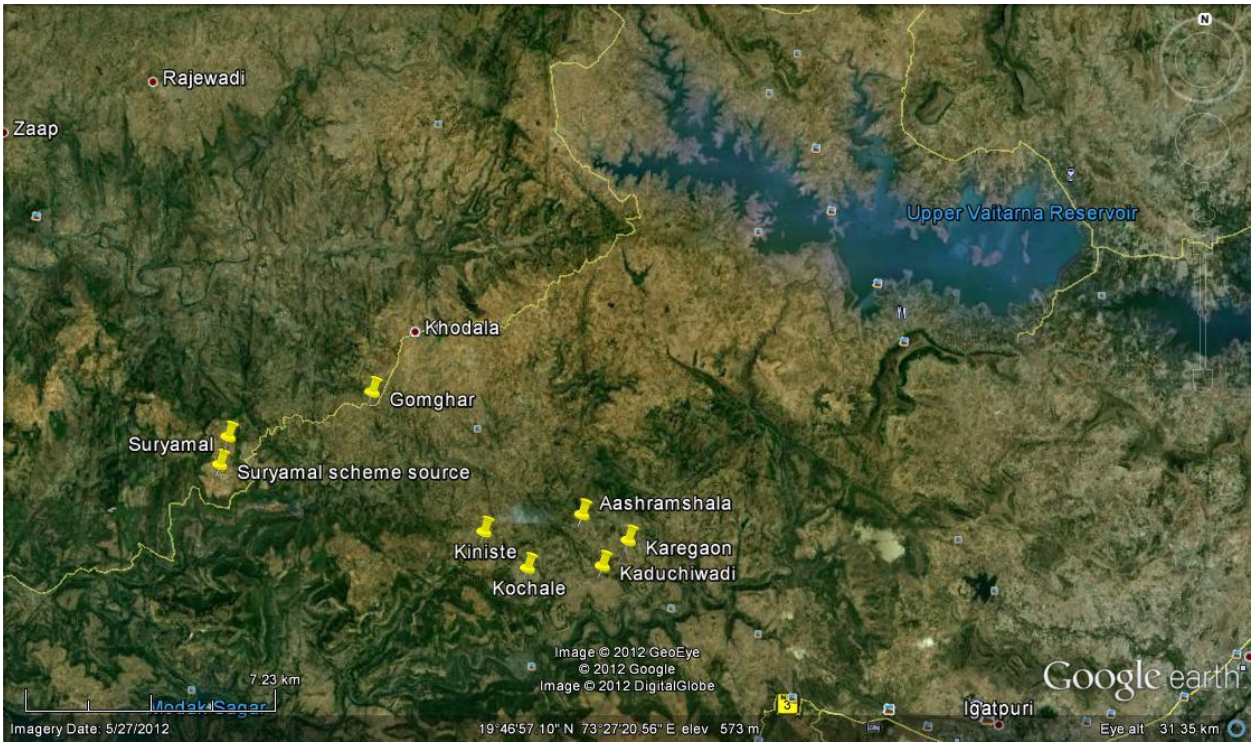

Fig 23: Upper Vaitarna with redefined scope of Karegaon Scheme

Damanganga Project and Drinking Water Problem in Jawhar Mokhada

A grand scheme was planned a few years back as part of river grid project for augmentation of water supply to Mumbai from 3000MLD to 5000MLD, the proposed Damanganga Pinjal link project initiated by National Water Agency. The high level plan is to bring the water from Bhugad and Khargihill reservoirs to Pinjal and put it into Modak Sagar through a tunnel as depicted in Fig.24 and Fig 25 below. As The entire population of Jawhar and Mokhada taluka put together is close to 200,000. Even at a demand of 70 LPCD, the total demand is 14 MLD which is only 0.7 percent of augmented water supply to Mumbai city. The additional cost calculated at urban norms of Rs. 7000 per capita, works out to be less than 1% of the project cost. other words, setting right perspective and priorities by adoption of inclusion model, the chronic drinking water problem in Jawhar Mokhada could be solved. What it needs is the vision, commitment and political will. Even if the cost is calculated at urban norm

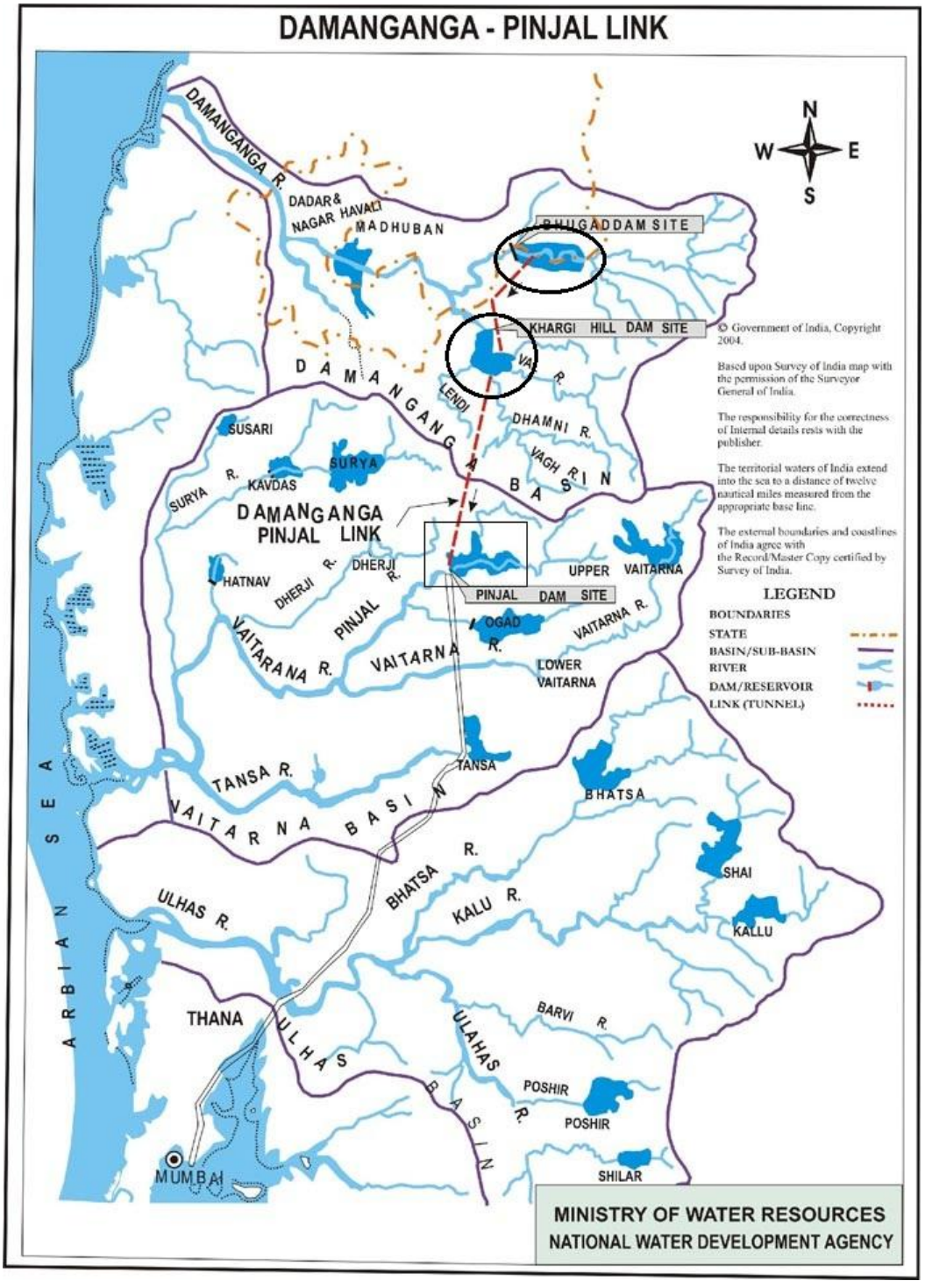

Fig 24 – Damanganga Pinjal Link Project

Fig 25 Damanganga Project sites map

Conclusions, Recommendations and Future Work

- The revived Dabhosa scheme has a perennial source with apparently sustainable water recharge system.
- The plan to extend Suryamal scheme to Gomghar doesn't seem feasible.
- Further studies are necessary to evaluate techno economic feasibility of augmentation of Karegaon scheme for Kiniste due to elevation difference of about 100m.
- Further studies are necessary for techno economic feasibility of a potential Karegaon RR scheme that covers the cluster of villages in Zone A (Gomghar to Kiniste) and Zone B (Vihigaon – Kasara area).
- Further studies are necessary for techno economic feasibility of a potential Karegaon scheme based on Upper Vaitarna to take advantage of gravity flow of water from Upper Vaitarna located at higher altitude.
- Further studies are necessary to evaluate 'inclusion' model for its social cost/benefit analysis.
- The present rural norms of Rs. 2330 per capita needs serious review for hilly terrain and tribal areas where there are large number of schemes fail to meet those norms due to high elevation of villages or longer distance due to winding roads with sharp turns increasing both the capital cost as well as operational cost of schemes.

- While executing city water supply projects, ‘inclusion’ model should be adopted to address the problems of local population as against the ‘exclusion’ model currently followed.

- The ownership issue of precious resources like water needs to be handled at the national policy level.