Right to the City as the Basis for Housing Rights Advocacy in Contemporary India

Right of city: Number narratives of water shortages and technopolitics of water appropriation in the urban agglomeration

The case of Mumbai Metropolitan Region

Submitted by

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Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BHA	Bombay Hydrometric Area
BIS	Bureau of Indian Standards
BMR	Bombay Metropolitan Region
BMRDA	Bombay Metropolitan Region Development Authority
BWSSP	Bombay Water Supply and Sewerage Project
CIDCO	City and Industrial Development Corporation
CPHEEO	Central Public Health Environmental Engineering Origination
EWS	Economically Weaker Section
GoI	Government of India
GoM	Government of Maharashtra
gpcd	gallon per capita per day
ICT	Information and Communication Technology
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LIG	Low Income Group
lpcd	litres per capita per day
MCGM	Municipal Corporation of Greater Mumbai
MHA	Mumbai Hydrometric Area
MIDC	Maharashtra Industrial Development Corporation
MLA	Member of Legislative Assembly
MLD	Million Litres per Day
MMR	Mumbai Metropolitan Region

MMRDA	Mumbai Metropolitan Region Development Authority
MWRRA	Maharashtra Water Resource Regulatory Authority
NBC	National Building Code
NIUA	National Institute of Urban Affairs
NOC	No Objection Certificate
NWDA	National Water Development Agency
TTC	Trans-Thane Creek
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Town

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1 Introduction

> *"We have calculated the domestic demand considering the norm of 240 litres per capita per day as suggested by Chitale Sahib"*
>
> \- Deputy Hydraulic Engineer, Water Supply Department, MCGM[1]

This was the response of Deputy Hydraulic Engineer, Water Supply Department of Municipal Corporation of Greater Mumbai (MCGM). In the benchmark report produced in 1994 on - Bombay's[2] Future Water Resources and Improvement in Present Water Supply Scheme, the expert committee under chairmanship of Dr. Madhav Chitale has recommended the need of provision of 240 litres per capita per day to citizens of Mumbai for domestic use[3] (Report of the Expert Committee, 1994). Dr. Chitale, prestigious Stockholm Water Prize winner, Ex-Secretary of Ministry of Water Resources - the highest post an engineer can hold in the central government of India and highly influential figure of Indian water sector known for his technical and administrative expertise was requested to chair the expert committee to prepare a long-term plan for the development of water resources for Mumbai. The triggering factor for the appointment of the expert committee was the delayed monsoon of 1992 and rapidly dropping levels in the water supply reservoirs that had created a panic situation for Mumbai. Dr. Chitale is so respected among the engineering fraternity that the Deputy Chief Engineer referred him as *Sahib* even in his absence. The expert committee forecasted that Mumbai will be facing water shortage of 1720 million litres per day (MLD) in the year 2001 and recommended the diversion of irrigation share of Bhatsa dam to Mumbai as an emergency measure to meet the existing shortages and construction of Middle Vaitarana, Kalu, Gargai and Shai dams to meet the future water demand of 5043 MLD in 2011 and 5400 MLD in 2021. The per capita per day supply norm recommended by this expert committee were used further while projecting demand for 2041 and justifying the subsequent water resources development projects including Pinjal and Damanganga river linking projects (MCGM, n.d.-a).

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[1] Statement made by Deputy Hydraulic Engineer at Water For Slum Dialogue Forum organised as a part of Mumbai Wate Distribution Improvement Program (M-WDIP) by MCGM on March 1, 2016.
[2] The city of Bombay was renamed as Mumbai in 1995.
[3] The other water uses including industrial and commercial uses an leakages were calculated seperately.

Historically, Mumbai is claiming the water resources existing beyond its boundary by damming rivers in the hinterland to creat massive storages and laying pipelines and digging tunnels to carry water to the city. With the Damanganga interlinking project, the engineers now moved to the neighbouring state to fetch the water for the city to ensure that there will be no shortages in the future. Being a financial capital of the country, the city has received special treatment and the water demand of the city was fulfilled on high priority. In 160 years of history of the piped water supply of the Mumbai, a total of 16 water resources development projects were undertaken and completed. In addition, three projects namely Pinjal, Gargai and Dmanganga are at various stages of planning and construction. Mumbai is the only corporation in the country that constructs, owns and operates a total six water supply dams (MMRDA, 2016). Exploiting its political power being the seat of government and its ability to mobilise financial resources by collaborating with international financial institutes like World Bank, the city administrators and planners claim over the water resources of the region.

This strategy of Mumbai consisting the continuous harnessing of water resources from the region over the last 160 years has created an inequitable distribution of water resources in the Mumbai Metropolitan Region (MMR). In the context of growing cities, the scholars have illustrated the conflict over water resources allocation between urban and rural with numerous empirical examples. For example, Wagle, Warghade, and Sathe (2012) have exemplified the grabbing and diversion of irrigation water resources to meet urban and industrial water demand. Punjabi and Johnson (2018) have explained the diversion of irrigation water from Surya dam project to fulfil the municipal water requirement of Vasai-Virar municipal corporation in MMR. Going beyond the urban vs rural conflict, this paper briefly illustrates the inequitable distribution of water resources within the municipal corporations and councils of an urban agglomeration of Mumbai Metropolitan Region.

More specifically, the paper focuses on the technopolitics employed by planners and engineers to appropriate a larger share of water resources of the region. The technopolitics was played in two ways - first by constituting the river basin as a unit for the coordinated development of water resources and controlling the water resources development processes in the larger basin. Second by forecasting higher water demands for the city and demanding more water supply dams. While estimating the demand, the planners and engineers manipulated the process of demand estimation and used higher per capita per day supply standards and higher values of industrial demand to inflate the total water demand of the city. Then with these inflated demand figures, the planners constructed the narratives of water shortages through numbers and using these narratives, the continuous development of water supply resources was justified in the region. Therefore, by controlling the water resources development process in the region and manipulating the demand estimation process, the planners and engineers legitimised the *right* of the city over the available water resources of the region.

In addition, the paper raises the questions over the objectivity and validity of the per capita per day supply standards used while planning and designing entire urban water supply infrastructure from the dam to the tap located in the premises of the citizen. Moreover, the paper shows, while circulations of narratives of water shortages, the theoretically Mumbai always had an adequate quantity of water at the city level to meet the demand of the entire population. Besides, the paper reveals the double standards used by planners and engineers who forecasted water demand using higher supply standards but while serving people living in the slums of the city chosen significantly lower minimal supply standards or formally denied the water supply services.

2 Status of Water Supply in Mumbai Metropolitan Region

Mumbai is the most populous city in the country and world's 9th largest urban agglomeration (Brinkhoff, 2015; Census, 2011). Over last few decades, as an impact of rapid urbanization, it has outgrown beyond its municipal limit leading to the rise of new urban centres including Navi Mumbai, Vasai-Virar, Mira-Bhayander, Kalyan, Ulhas Nagar, Bhiwandi, and Panvel in its vicinity. Much of this growth occurred in an unplanned way resulting in increasing spatial expanse of the city from 437 km^2 to 4355 km^2 covering nine municipal corporations and eight municipal councils forming Mumbai Metropolitan Region (MMRDA, 1999). The MMR region also includes around a thousand villages.

The continuously rising population of the region has put tremendous pressure on its water resources in terms of increasing demand and changing water use pattern with an increasing share of urban and industrial activities. On the other hand, planners (e.g. CIDCO, MMRDA) are planning massive infrastructural developments in suburban areas comprising industrial, commercial and residential complexes (e.g. New CIDCO areas) which would further put pressure on water resources. The MMR has a history of developing water resources to fulfil the water requirements by tapping major rivers from neighbouring districts of Thane, Nasik and

Raigad. At present, MMR region is sourcing water from Mumbai Hydrometric Area[4] (MHA) and consuming around 5639 million litres of water per day (MMRDA, 2016).

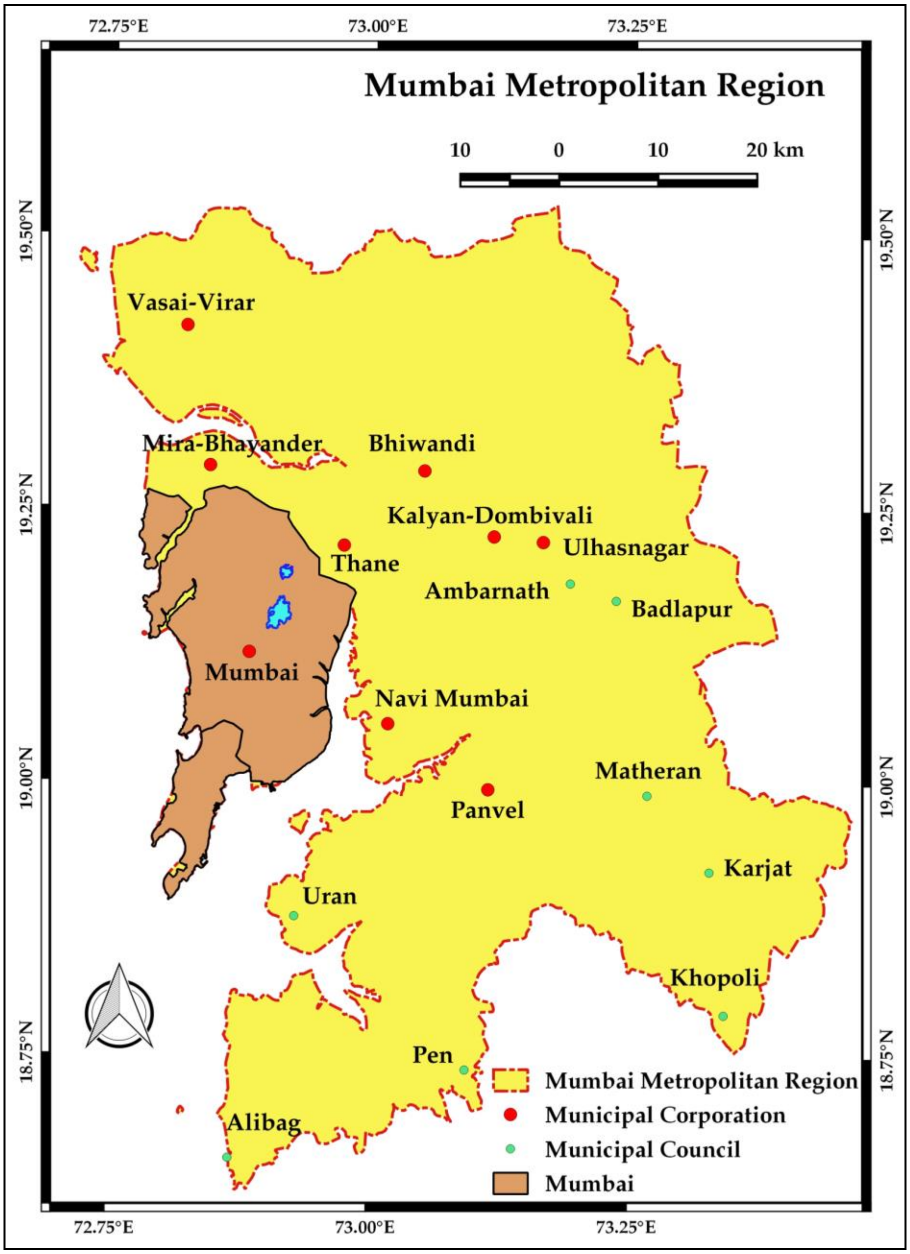

Figure 1: Map showing Mumbai Metropolitan Region along with municipal corporations and councils *(Source: Author)*

[4] Mumbai Hydrometric Area is the term used by Hydraulic Engineers to denote the geographical area comprising the catchment of water resources of the city. See section 3.3.

Some of these sources are located at a distance of more than 100 km. In addition, 10 more dams are planned in MHA to harness its remaining water potential e.g. Bhugad, Kalu, Shai, Pinjal, Poshir, Damanganga and Gargai. Development of these dams and transfer of water to MMR raises serious questions, as hundreds of villages located in the vicinity of these dam reservoirs are experiencing severe drinking water crisis (Hooda & Desai, n.d.).

In addition, planners have started preparing ambitious plans to transfer additional 2,450 MLD[5] water from Damanganga basin by constructing Damanganga-Pinjal river linking project (Indian Express, 2014; NWDA, 2014). Thus, initially planners have restricted themselves to Mumbai Hydrometric Area and now with these ambitious plans, they are pulling resources from neighbouring basins, increasing water footprint of the city over hundreds of kilometres affecting lives of at least thousands of individuals and leading to concerns of equity.

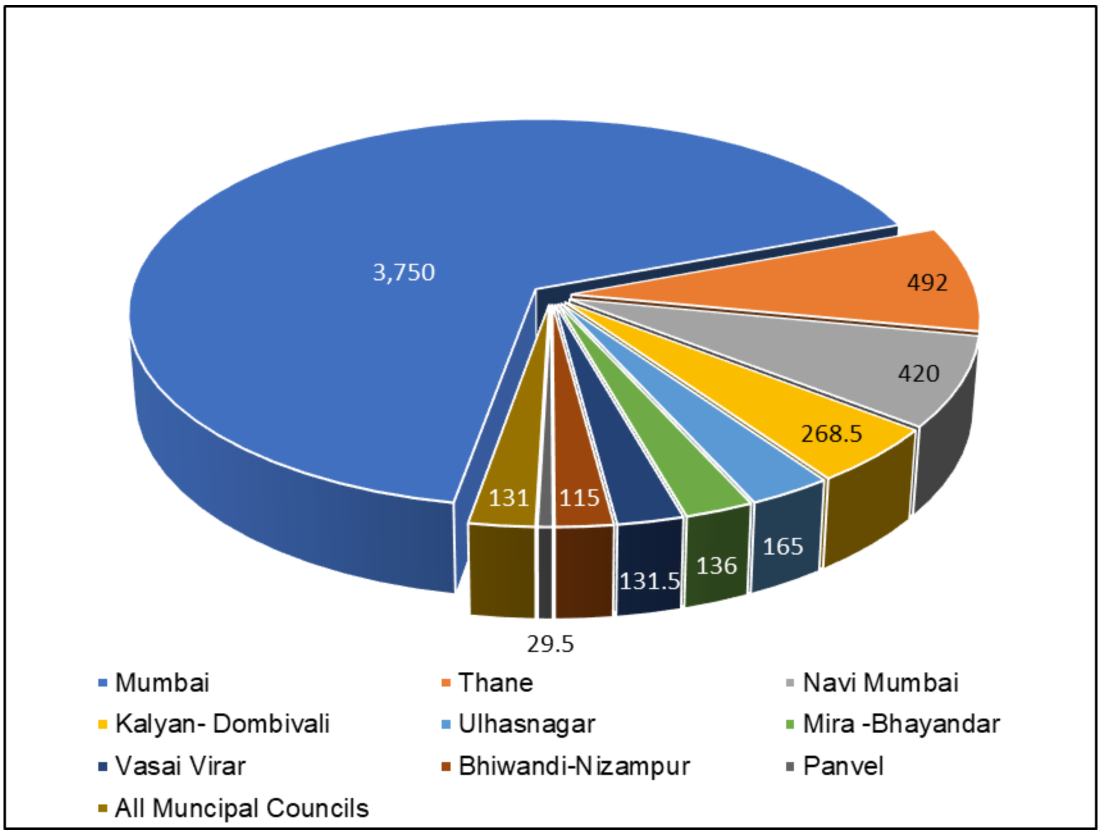

Figure 2: Water supply for municipal corporations and councils in MMR in million litres per day[6].

[5] Share of Mumbai municipal corporation in this water transfer is 1586 MLD

[6] Data source: MMRDA (2016)

Though on one hand planners are continuously bringing more water in MMR region exploiting neighbouring basins, the urban local bodies and villages located within MMR are facing serious water distribution issues. Entire MMR region does not enjoy the benefits of large water resources development projects in an equitable manner. The data indicates the wide disparity exists within the MMR boundary. Out of total supply of 5639 MLD, Mumbai alone consumes 67 per cent of water accounting for 3750 MLD followed by Thane (492 MLD) and Navi Mumbai (420 MLD). Total nine corporations alone consume almost 98 per cent share of the available water (Figure 2).

For total nine corporations, the status of water supply services and water supply sources is as follows (MMRDA, 2016):

- Mumbai: At present Mumbai receives total 3750 million litres per day (MLD) of supply from seven reservoirs namely Vihar, Tulsi, Tansa, Modak Sagar, Upper Vitarana, Bhatsa and Middle Vaitarana. Out of seven reservoirs, except Bhatsa all other reservoirs are owned and operated by Municipal Corporation of Greater Mumbai.
- Navi Mumbai: Navi Mumbai has its own dam Morbe which has a capacity of 450 MLD. However, at present Navi Mumbai draws 360 MLD from Morbe dam and 60 MLD from MIDC.
- Thane: Thane receives total 492 MLD of supply from Bhatsa, Shahad Water Supply Scheme (Ulhas River), Tansa and Barvi (owned by MIDC).
- Kalyan-Dombivali: Kalyan Dombivali Municipal Corporation (KDMC) receives 268.5 MLD from Barvi, Shahad water supply scheme and from local barrages.
- Vasai-Virar: Vasai-Virar Municipal Corporation (VVMC) receives total 131.5 MLD from Surya and local barrages. It is one of the fastest growing municipal corporations in India.
- Mira-Bhayander: Mira-Bhayander receives 136 MLD from Barvi (MIDC) and Shahad water supply scheme.
- Bhiwandi-Nizampur: Bhiwandi-Nizampur municipal corporation receives 115 MLD from Tansa and Shahad water supply scheme.
- Ulhasnagar: Ulhasnagar receives 165 MLD supply mainly from Barvi and Shahad water supply scheme.

- Panvel: Panvel receives 29.5 MLD mainly from MIDC and Dehrang dam locally managed by the corporation.

2.1 Adequacy of Water Supply among cities in MMR

The adequacy of water supply services at the city level is measured using the per capita per day of water availability. This measure indicates the theoretical availability water covering the entire population of the city and does not consider the issues associated with internal distribution system leading to inequitable supply within the city.

As per the per capita per day water supply standards issued by Central Public Health Environmental Engineering Origination (CPHEEO)[7], for the cities with the existing or contemplated sewer network, the maximum domestic water supply level is 135 litres per capita per day (lpcd) and for the metropolitan cities the maximum recommended supply level is 150 lpcd only (CPHEEO, 1999). It should be noted that this supply level also includes water requirements of various institutions, commercial establishment and minor industries excluding bulk water users[8]. Recently, the Maharashtra Water Resource Regulatory Authority (MWRRA) has issued an order prescribing minimum permissible water supply limit for various urban and rural local bodies (MWRRA, 2018). As per these norms, the municipal corporations with a population more than 50 lakhs are to be supplied water with maximum 150 lpcd and corporations with less than 50 lakhs populations are entitled to 135 lpcd only.

Comparison of per capita consumption across urban centres in MMR regions reveals the disparity exists among various cities at the source level (refer to Figure 3). Cities of MMR are clearly divided into water surplus cities and water scarce cities. Mumbai, Navi Mumbai, Thane and Kalyan-Dombivali are water surplus municipal corporations. On the other hand, Vasai-Virar, Mira-Bhayander, and Bhiwandi-Nizampur municipal corporations are water scarce urban centres.

In MMR, Mumbai consumes the highest quantity of domestic water per capita (excluding water required for major industries) accounting for 252 lpcd (MMRDA, 2016) which is 1.6 times more

[7] CPHEEO is Central Public Health and Environmental Engineering Organization (CPHEEO) is a technical wing of the Ministry of Urban Development, Government of India, that defines norms, standards, technical guidelines for urban water supply and sanitation including solid waste management in India

[8] However, the meaning of bulk water user is not clearly defined by CPHEEO

than the CPHEEO standards (refer Figure 3). Following Mumbai, Navi Mumbai, Thane and Kalyan-Dombivali municipal corporations consume 240, 211 and 194 lpcd respectively (MMRDA, 2016). These values of consumptions are much more than the standards prescribed by CPHEEO and MWRRA. On the other hand, Vasai-Virar municipal corporation, the fastest growing urban local body in MMR only consumes 70 lpcd, almost 50% less than the set norm of 135 LPCD. Similarly, Bhiwandi-Nizampur and Mira-Bhayander municipal corporation receive only 100 and 105 lpcd respectively. Among municipal councils, Alibag is one of the worsts urban centre in MMR as it receives only 41 lpcd of water supply which is even less than the rural water supply norm of 55 of lpcd (GoI, 2013).

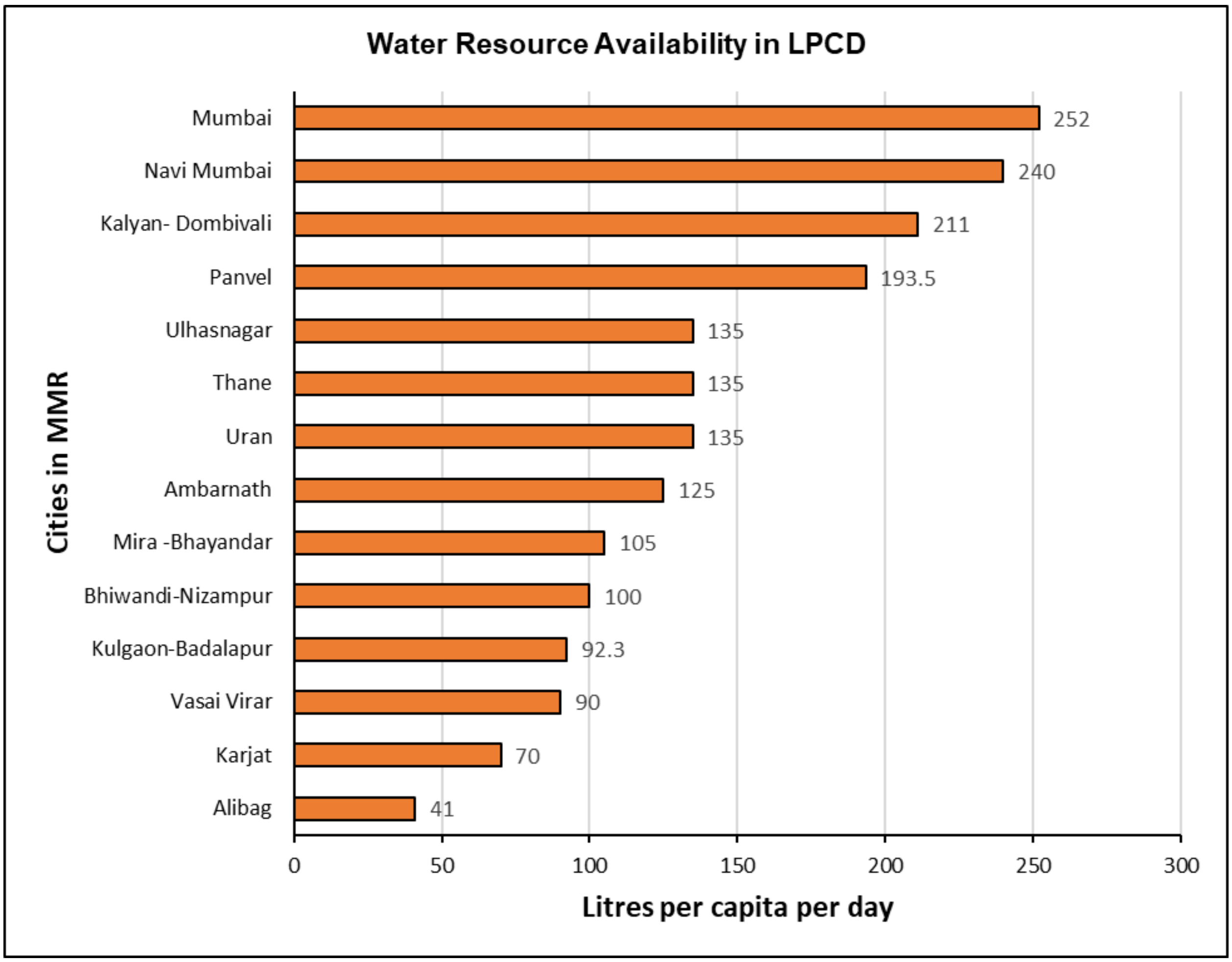

Figure 3: Water resource availability in litres per capita per day[9]

Coverage

The coverage of water supply services is also poor in some cities in MMR. Though Mumbai claims to have 100 per cent coverage, most of the non-notified slums have not been formally covered by formal water supply in Mumbai. The water supply of Vasai-Virar only covers 80 per cent of its population. Mira-Bhayander and Bhiwandi-Nizampur have coverage of only 90 per cent. Among, municipal councils, Alibag has the least coverage. The municipal council of Alibag only provides water supply services to 30 per cent of its population. In the case of Karjat, the coverage is just 65 per cent (MMRDA, 2016).

2.2 Water supply in MMR villages

The villages in MMR are facing severe water issues. In case of coverage, only 64 per cent of villages are having 100 per cent access to piped water supply and 19 per cent of villages are not covered under any of the piped water supply schemes. In terms of quantity of water supply, none of the villages in the MMR receives 70 lpcd water as recommended by the committee appointed under the leadership of Dr. Chitale. In fact, 24 per cent of villages of MMR are in a worst situation as they receive less than 40 lpcd (MMRDA, 2016). This supply level is significantly lesser than the rural drinking water supply norm of 55 lpcd prescribed by National Rural Drinking Water Program (GoI, 2013).

3 *Right* of city: Technopolitics of water appropriation

For analysing the process of water appropriation, I am using the concept of technopolitics. In the next sub-section, I am reviewing the literature defining the concept of technopolitics and subsequently describing the technopolitics associated with the process of water appropriation in MMR.

[9] Data source: MMRDA (2016)

3.1 What is technopolitics

The term technopolitics is very broad and the scholars have defined and interpreted it in multiple ways. Gagliardone (2014) has used technopolitics '*to account for the ability of competing actors to envision and enact political goals through the support of technical artifacts*'. The technical artifacts or technology is considered as a mean to achieve political intentions by competing actors. Here, the politics is in between multiple actors, in imagining and achieving the political intent with the same technology. Gagliardone (2014) has explained this by citing an example of the Ethiopian government-led information and communication technology (ICT) projects where international donors supported ICT (as technology) to promote openness and democratic processes. However, the same ICTs were appropriated by the government to support its ambitious state and nation-building process.

Mitchell (2002) in his book - Rules of Experts: Egypt, Technopolitics and Modernity, refer technopolitics as 'hybrid of technological expertise and political power' (Sneddon & Fox, 2011) that emerged in Egypt in the twentieth century as a part of the national growth and economic development. The use of technological expertise leads to concentration of power. Egypt had adopted and implemented variety of expertise belonging to modern engineering, technology and social sciences imported from west as a template under the guidance of World Bank, IMF and USAID to '*improve the defects of nature, to transform peasant agriculture, to repair the ills of society, and to fix the economy*' (Mitchell, 2002, p. 15). These involved the construction of High Aswan Dam, establishing the fertilizer plant, and the introduction of high yielding hybrid corns, helicopters for spraying chemicals and oil-stabilized mud bricks. All of these technologies failed to deliver the promises and moreover created new problems. Mitchell has analysed the technopolitics to illustrate how technology (expertise) is deeply embedded within politics and to reveal the 'extra-scientific' origin of these technological interventions adopted for the growth of the nation.

Similarly, Sneddon (2012) defines technopolitics as a complex coproduction of technology and politics where geopolitical and economic problems are combined with technical knowledge. The 'hybrid' and 'co-production' approach underemphasizes the role of the agent in this process which is adequately emphasized in the earlier definition of Gagliardone (2014) that focuses on the competing actors. For Anand (2017, p. 246), the technopolitics is 'the way in which political relations are formed and reproduced through technological assemblages'. Technopolitics is also used to describe the way rulers deploy technology to re-engineer society and legitimize their political authority (Low, 2015). Therefore, the technopolitics redefines the relationship between rulers and ruled.

Recently, scholars working in the domain of internet and communication technology are relating technopolitics with the use of new technology such as computer and internet to 'advance political goals' and support democratic and anti-capitalist movements (Kellner, 2001). Here technopolitics is conceived as strategy empowering citizens by providing a voice to the excluded groups neglected by mainstream media. The Arab spring, occupy wall-street and 15-M Movement of Spain are some of its examples (Kurban, Peña-López, & Haberer, 2017). Though I have mentioned this definition to provide a comprehensive review of scope and meaning of the technopolitics, I am not using this term in my subsequent work as this term is used narrowly in the context of internet and ICT.

Hecht (2001) focusing on the practice and materiality define technopolitics as '*strategic practice of designing or using technology to constitute, embody, or enact political goals'* (p. 256). This definition more focuses on the technological aspect including the component of the practice of design and use rather than the social aspects, unlike the earlier definitions. Since I am more interested in investigating the process of water appropriation, where the process of demand estimation (technology) or the concept of basin management (technology) is used as a tool, as explained below, in the process of appropriating more water resources from the region, I will be following Hecht's definition throughout my work.

Technopolitics vis-à-vis politics of technology

The technical choices shaping the technology are predominately derived from social or political. Then the question is why we cannot refer the politics linked with the technology as 'politics of technology' or 'politically constructed technology'. If the technopolitics is - 'strategic practice of designing or using technology', then why it cannot be reduced to just 'politics of practices'. The reason is we can reduce to politics alone but it does not capture its true meaning. When we refer it as 'politics of technology' then the assumption is the technology is idle and lying there and it can be used by the agent to achieve her political goals. However, in reality, technology has certain hardness or materiality. The material characteristics of technology allow, limit or facilitate certain types of politics only [10]. The material aspect of the technology shapes the ‘political effectiveness’ of the technology and the term ‘politics of technology’ does not capture the material agency of the technology (Hecht, 2001).

Moreover, the material aspects of the technology give birth to or shape technical expertise or proficiency. The expert authority has an origin in the material aspects of the technology and this expertise provides a political voice to professionals (the other additional factors include socio-political status, educational background and organisational affiliation). As Hecht (2001) argues these professionals do not take part in the politics through political parties. They acquire the space in the political arena because of their engagement with the technology in planning, designing, implementation, operation and maintenance. The skills of these professionals differentiate them from the other politicians and provide them with an additional edge strengthening their authority. The word ‘politics’ alone does not capture the ‘the nature or the power of the strategic practices in which experts engaged’ (Hecht, 2001, p. 257).

3.2 **Water demand estimation: a number game**

The process of urban water demand calculation is considered as a standardised process based on scientific principles. The process is carried out by experts using their sectoral knowledge and experience and the process is viewed as objective and apolitical in nature. Based on the numbers produced via demand calculation process, political leaders and administrators mobilise the resources for hunting new water resources and subsequently developed them.

Before going further, here, I am quickly reviewing the complex process of urban water demand estimation. The domestic water requirement is a major component of total urban water demand. The future water requirement is determined by a number of factors including population growth, the extent of industrialisation and commercialisation, technological advancement, and changing behavioural patterns and all these factors have their own unpredictable trends (Trifunovic, 2006). The domestic water demand is estimated following per capita water demand (Mays, 2000). The per capita per day water supply standards are predefined by appropriate authorities (as explained

[10] For materiality and technology refer Kallinikos, Leonardi, and Nardi (2012), Leonardi (2012) and Orlikowski and Scott (2008)

in Section 4). Following these set standards, the total water demand is calculated by multiplying the per capita demand with a forecasted population of the city[11].

During this process, the planners and engineers manipulate the numbers to produce the numbers supporting their political agendas. For example, in Lilongwe, capital of Malawi, while designing the distribution network supplying water to the low-income area, the engineers used significantly lower population projection rates and computed figures with lower daily water demand of the localities resided by the poor. This has two-fold impacts - first lower water demand figures reduce the diameters of pipes and size of service reservoirs and therefore reduce the capital invest during the implementation phase of the network running towards poor. Second, during operations, the network with smaller dimensions (diameter and storages) can carry an only smaller share of water towards the poor localities and justifies on the grounds of limited carrying capacity the diversion of a larger share of water towards the affluent zone of the city (Tiwale, forthcoming).

In subsequent sections, the paper illustrates the planners and engineers inflated water demands of the city to claim larger water share form the region. This inflation in water demand was achieved by manipulating the process of demand estimation and using the higher values of per capita per day supply standards without any proper justification. For example, for justifying Pinajl, Gargai and Damanganga, Mumbai’s water demand for the year 2041 is estimated as 5940 MLD. In general, these figures are accepted as it is assuming that these figures are produced by the planners and engineers following the scientific and rational procedures which are subsequently verified by the experts. As paper demonstrates, using these inflated current and future water demand figures and comparing with these figures with available supply, the planners and engineers construct the narratives of water shortages. Using these narratives, they justify the need for additional water and appropriate a larger share of water from the basin for the city by constructing dams. However, the irony is while delivering services within the city the supply

[11] The demand also includes institutional, commercial and industrial water demand. The calculation of institutional and commercial water demand is very difficult as it requires lots of data, therefore in absence of the data this demand is estimated as certain percentage of domestic water demand and accordingly the per capita supply norm is raised. The per capita norm generally also covers minor industries. The water demand of bulk industrial consumer is separately computed.

norm was conveniently ignored and moreover the supply was restricted by prescribing formal rules.

Here the mathematical procedure of demand estimation which is considered as a neutral and natural based on the set of standardised principles are used as a tool to legitimise the appropriation of water in the region. So far, this process is ignored and received least attention by critical sociologists, urban geographers and STS scholars.

3.3 Technopolitics of hydrological boundaries: Origin of BHA/ BMRDA

Basin as a management unit

Following hydrological boundaries for managing water resources is considered the most appropriate and scientific approach (UNESCO, 2006). The basin as a unit for management facilitate the decision makers to resolve the upstream-downstream issues related to water allocations that are triggered by growing competition. For the coordinated and cooperative development of water resources involving multiple stakeholders, the organisation with hydrological boundaries is considered as most suitable and efficient for managing water resources.

In the 1960s, Government of Maharashtra (GoM) appointed a British Consultant Binnie and Partners to study the water resources of Bombay Metropolitan Region (BMR, now MMR) that was formulated for planning purpose in 1965 (World Bank, 1973). The consultant observed the boundaries of BMR are not coinciding with the hydrological boundaries of the rivers flowing through BMR. For coordinated and efficient development of water resources of Mumbai Metropolitan Region, the consultant recommended the formation of centralised authority controlling water resources of the area larger than BMR comprising at least twelve river basins. This recommendation was accepted by the GoM and formulated a larger catchment comprising the four major basins including Vaitarana, Ulhas, Patalganga and Balganga and covering 11,950 km^2 as a Bombay Hydrometric Area (BHA, now MHA) (BMRDA, 1985). The BHA includes following rivers basins and sub-basins:

- Vaitarana basin - including Vaitarana, Tansa, Pinjal and Gargai river basins located northwards of MMR
- Ulhas basin: including Ulhas, Bhatsa, Shai, Kalu, Barvi, Poshir, Shilar rivers located in the central zone

- Rivers draining to Dharamtar creek including Patalganga and Balganga

Though apparently BHA was formulated for avoiding the competition and optimal development of water resources in proper sequence to maximize the economic benefit of the region, in reality as evidence suggests, the intention for demarcating BHA was to gain more control over the water resources of the region. As the report prepared by the British Consultant Binnie and Partners reveals - the consultant had critically commented on the approach of GoM and MCGM for not appreciating the dependence of Mumbai on mainland areas while planning for water supply for Mumbai (World Bank, 1973).

Mumbai municipal corporation was the only rapidly growing urban centre in the region until the 1960s. There was a total of nine municipal councils in the region, however, these were small and satisfying their water demands with locally available water resources. If the population of 1961 census compared then it is evident that out of an entire urban population of the region, total 92% urban population (4.15 million) was living only within Mumbai municipal boundary (Bombay Metropolitan Region Planning Board, 1974). Mumbai with such large population was heavily dependent on the mainland for the water resource. Out of 959 MLD of daily water supply, 93% of water was coming from the mainland - Vaitarana basin (refer Figure 4) (World Bank, 1973).

During the same period, other government agencies initiated water resource planning in the region. Maharashtra Industrial Development Corporation (MIDC) encouraged industrialisation in Kalyan-Dombivali-Ulhasnagar-Ambarnath-Badlapur belt and Trans-Thane Creek (TTC) region (refer to Figure 4). As a part of this industrial belt development, MIDC estimated water requirements which were much higher than the local abstraction schemes. As a result, MIDC started water resource assessment of the region to construct a suitable reservoir to satisfy the industrial demand and initiated planning for Ransai and Barvi dams.

On another hand, City and Industrial Development Corporation (CIDCO) was planning a ‘twin-city’ (now Navi Mumbai) in Trans-Thane region across the Mumbai harbour and it was forecasted that the new city will have a population of two million in 1991 (refer Figure 4). As a result, CIDCO was assessing water resources outside its region to satisfy the water demand of the twin-city. Moreover, other municipal councils of the region were demanding and exploring additional water resources beyond their municipal limits to satisfy their urban water demands.

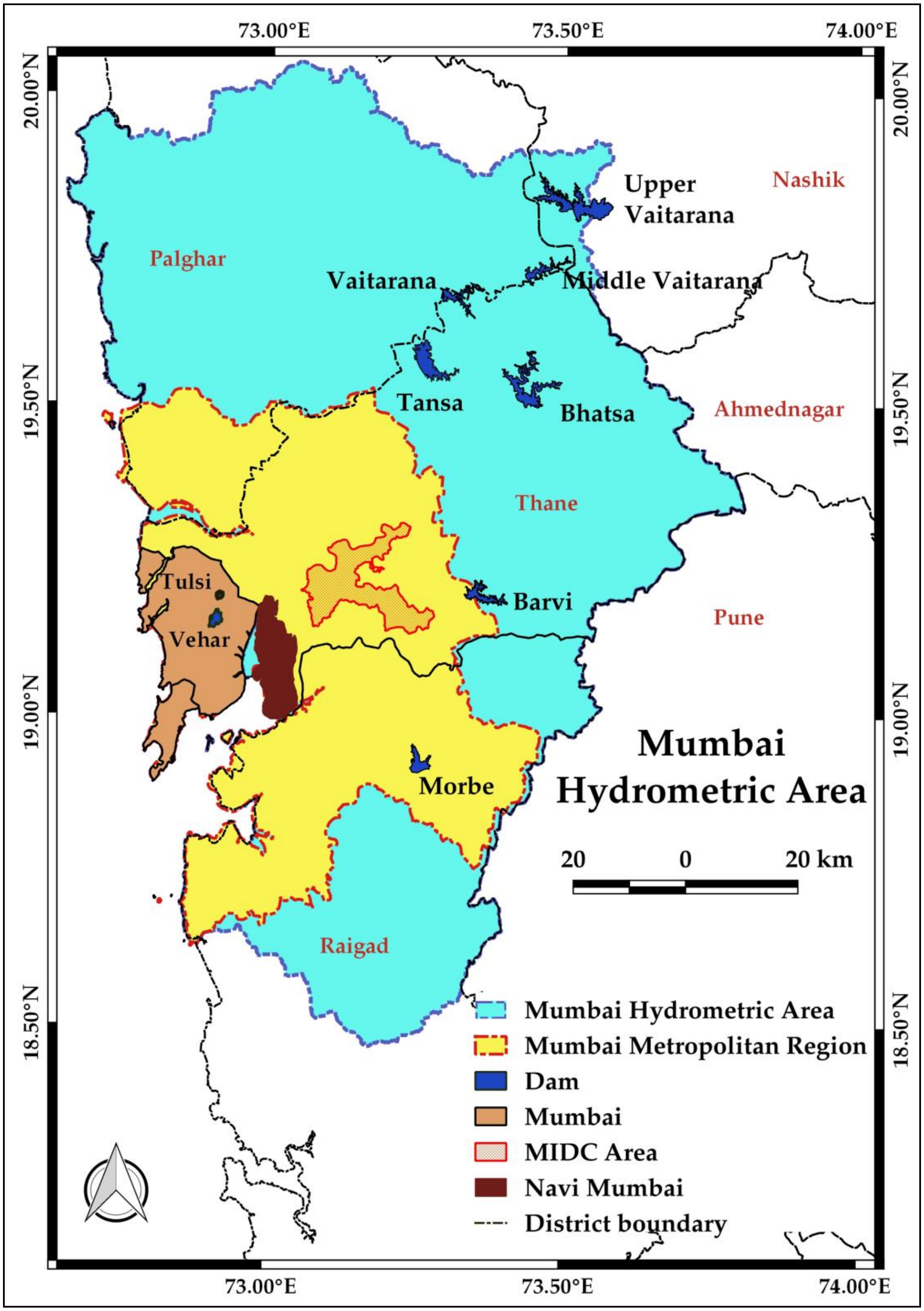

Figure 4: Mumbai Hydrometric Area *(Source: Author)*

In 1966, irrigation department of Government of Maharashtra (GoM) initiated construction of Upper Vaitarana hydropower scheme. In addition, GoM was encouraging irrigation in the region and planning for an irrigation dam - Bhatsa on river Bhatsai in Ulhas basin (refer to Figure 4). As per the Konkan Irrigation Development High-Power Committee, till the 1960s all the dams built in the Konkan region were built for water supply only and no dam was built for irrigation purposes that negatively affected the growth of the Konkan region (Irrigation Department, 1981). Therefore, the development of the Bhatsa reservoir was considered as a promising developmental initiative for the growth of the region. Apart from hydropower and irrigation, Upper Vaitarana and Bhatsa were also planned to supply water to Mumbai. So, MIDC, CIDCO, Irrigation Department of Government of Maharashtra and small municipal towns were planning for development of water resources in the region.

In light of this situation, the consultant Binnie and Partners raised questions over the uncontrolled and uncoordinated development that will lead to an inefficient allocation of scarce water resources. Further, it estimated by 1991, though water supply of Mumbai will increase quantitatively, its total water share will drop from 82 per cent to 60 per cent in the region. Considering the dependence on the mainland, it was realised that the water resource planning of Mumbai is not possible without considering the coordinated development of existing available water resources in the larger metropolitan region (World Bank, 1973). This was one of the driving forces for demarcation of BHA and formulation of Bombay Metropolitan Region Development Authority (BMRDA, now MMRDA) in January 1975[12].

In fact, formation of a centralised authority before April 1, 1975 controlling water resources in the region that will be larger than Bombay Metropolitan Region comprising catchments of at least twelve rivers was one of the conditions for getting financial assistance from World Bank for Bombay Water Supply and Sewerage Project (BWSSP) (World Bank, 1973). As a part of this project, Mumbai municipal corporation executed Bhatsa - I, Bhatsa - II and Bhatsa - III project and constructed treatment facility, conveyance system and improved internal distribution system (World Bank, 1973). So, it is evident that facilitating improvement in Mumbai’s water supply services was one of the driving forces for the inception of MMRDA[13]. The constitution of the

[12] Before MMRDA, there was Bombay Metropolitan Region Planning Board for planning of MMR region.

[13] Though MMRDA is not directly controlling the activities in MHA region, MMRDA has a control over the development activities within BMR region[13]. As per the MMRDA Act, 1974, no authority or agency can undertake any activity within MMR jurisdiction that is specified by MMRDA and that can potentially adversely affect the overall development of the region. So MMRDA has control over the development of water resources done by other agency.

Mumbai Metropolitan Region Development Authority prescribed by MMRDA Act, 1974 reflects the control of Mumbai over the functioning of MMRDA.

Controlling MHA and MMRDA

As per the MMRDA Act, 1974, the metropolitan authority consists of total 17 members and out of which, total six members (almost 35 per cent) directly represents the interest of Mumbai and these members includes - Mayor of Mumbai, three Councillors of Mumbai, Commissioner of Mumbai and Chairman of Standing Committee of Mumbai corporation (GoM, 1975). Only two members directly represent the interests of the rest of the MMR including all other municipal corporations, councils and villages belong to MMR[14]. These two members are Members of Legislative Assembly (MLA) representing the constituency completely or partly falling under MMR. Apparently, if the constituency of any of the MLAs covers Mumbai then the MLA can represent Mumbai in addition to above mentioned six members (GoM, 1975). This illustrates the skewed representation of urban local bodies and villages in the metropolitan authority of MMR.

Contrary, the Maharashtra Metropolitan Region Development Authority Act, 2016 applicable for all metropolitan regions of the state except MMR constitutes the metropolitan authority providing direct representation from all urban local bodies. These members include Mayors, Chairman of Standing Committees and Commissioners of all municipal corporations, and presidents of two municipal councils alternatively appointed by the state government (GoM, 2017).

In comparison to other metropolitan authorities of the state, in MMR apart from Mumbai, remaining 16 corporations and councils and around one thousand MMR villages hardly get any representation during decision making and execution process. So, MHA is appearing to be formulated following the hydrological boundaries as a scientifically supported best management unit, at the end it turns out to be a medium securing the interests of Mumbai which has reflected over time in the appropriation of resources by Mumbai in Mumbai Hydrometric Area.

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[14] Other members of MMRDA include - minister of urban developemnt, minister of housing, minister of state for urban development, one member of Maharashra Legislative Council nominated by GoM, chief secretary of GoM, Secretary, urban development department, GoM, secretary, housing department, GoM, Managing Director, CIDCO and metropolitan commissioner.

4 Objectivity and validity of norms and standards

In the case of urban water supply services, the per capita consumption standards are the founding stone for the design of entire urban water networked infrastructure. As based on these numbers, the current and future urban water demand is calculated. Accordingly, the strategy of development of water resources infrastructure along with the conveyance infrastructure to carry water from the source to the city in a time bound manner is decided and subsequently, these infrastructures are built. In addition, within the city, the size of the water treatment plant, multiple storage reservoirs, service reservoirs, transport mains, pumping stations, secondary and tertiary distribution system and in-house plumbing is determined based on the per capita consumption standards. Apart from the development of network infrastructure and associated capital investment, the operational cost of the utility is also determined by the per capita consumption standard followed by the utility[15].

In the case of Indian cities, historically multiple expert committees were appointed to fix the per capita per day consumption standards. The government authorities, for example, CPHEEO and BIS have also issued their own standards in their respective manuals. The history of per capita consumption standard indicates, these standards were frequently revised and multiple standards significantly differing from each other are in operation simultaneously creating utter confusion over the numbers quoted by each of these authorities. None of the published standards provides any rationale for the quoted figures of per capita consumption standards, either theoretical or empirical. So far, at present, the for a metropolitan city, the per capita per day consumption standard that is enforced varies between ‘maximum 150 lpcd’ to ‘minimum 200 lpcd’. Here, I am briefly reviewing these standards.

While mentioning, the per capita per day consumption norm for an urban area, various technical documents sometimes include or exclude the non-domestic water use. For simplification and clarity, throughout my work, I am using the term *gross* litres per capita per day to indicate that figure also includes the non-domestic water use. Otherwise, only litres per capita per day will indicate only domestic water use.

[15] For example, in case of urban water supply services, utility spends significant portion of the operational costs on electricity that is needed to pump the water against the gravity. The electricity consumption is directly proportional to quantity of water pumped in the system.

In 1963, Central Council of Local Self Government appointed Zakaria Committee to address the question of augmentation the financial resources of urban local bodies under the chairmanship of Dr. Rafiq Zakaria then the Minister of Urban Development Government of Maharashtra (Zakaria Committee, 1963). The Zakaria committee prescribed the service standards for drinking water supply for the different levels of urbanisation. For domestic and non-domestic water use, the committee recommended the supply standard of gross 270 lpcd for the metropolitan cities with more than 20 lakh population and gross 202 lpcd for the cities with population ranging between 5 to 20 lakhs. The recommended standards were biased towards the big cities as it recommends only 45 lpcd of piped water supply for the small town with the population of 5-20 thousand to cover only drinking, cooking and bathing requirements and which additionally needs to be supplemented with the other local sources for rest of other domestic[16] and non-domestic uses.

Later in 1976, an Expert Committee was appointed for preparation of a Manual on Water Supply and Treatment by Public Health and Environmental Engineering Organisation, Ministry of Works and Housing (GoI, 1976). This expert committee revised these differential standards and recommended gross 125 - 200 lpcd for the cities with population more than fifty thousand. Also, the committee upgraded the norms for the smaller towns with a population up to ten thousand to gross 70 - 100 lpcd. The committee did not cite any reasons for the revision of the earlier standards and the rationale for proposing new recommendations (GoI, 1976).

As a part of International Drinking Water Supply and Sanitation Decade (1981-1990), Ministry of Works and Housing, Government of India prepared National Master Plan India in 1983 recommending new per capita water consumption norm for the cities (GoI, 1983). Unlike, the earlier consumption standards based on the level of urbanisation, the new recommendation provided a very broad range from gross 70 to 250 lpcd for the urban areas with an average of 140 lpcd. With such a broad range, the utility of this recommended water supply level was questionable while designing a water supply services for the cities.

However, in the same year 1983, Bureau of Indian Standards (BIS) published two standards - National Building Code (NBC) of India 1983 (BIS, 1983) and Code of Practice for Water Supply in Buildings (IS 2065: 1983) prescribing the minimum supply standard of 200 lpcd with full

[16] It includes flushing, washing clothes and utensils and cleaning floor.

flushing system (BIS, 1985). Additionally, these codes recommended the supply norm of 135 lpcd for lower income group (LIG) and economically weaker section (EWS) of the society. These BIS standards were significantly different from the other standards - first, they only prescribed the minimum level of consumption of 200 lpcd without any upper cap on consumption and second, they only covered the household level water consumption for buildings and not covering the non-domestic water use.

Surprisingly, BIS revised its own standards within four years and in 1987 published a Handbook on Water Supply and Drainage with special emphasis on plumbing (BIS, 1987). The handbook takes cognisance of the standards recommended by the expert committee in 1976 and recommends a minimum supply level of 135 lpcd for all residents with the full flushing system. This BIS standard providing the minimum level of supply has lowered the supply level by almost 33 per cent in comparison to earlier recommendation without providing any rationale.

In 1989, National Institute of Urban Affairs (NIUA), New Delhi labelled the gross average per capita availability of 142 lpcd in cities in India as extremely low levels of services. In its research studies series titled - Upgrading Municipal Services Norms and Financial Implication, prepared for the Ninth Finance Commission, NIUA pushed the standards recommended by Zakaria Committee in 1963 prescribing gross 202.5 lpcd (45 gpcd) for the cities with population more than 5 lakh (NIUA, 1989). The NIUA ignored the earlier Expert Committee norm recommended in 1976 and also conveniently dropped the higher standards prescribed by Zakaria Committee of gross 270 lpcd for the cities with population more than 20 lakhs.

The Bureau of Indian Standards again revised its standard of minimum 135 lpcd prescribed in 1987 and recommended new standards after six years in the Code of Basic Requirement of Water Supply, Drainage and Sanitation (IS 1172: 1993) published in 1993 (BIS, 1993). This new code was different from earlier BIS code in two ways - first, it provided the minimum supply standards based on the level of urbanisation instead of recommending the flat value like the earlier issued standard and second, the recommended standards included the non-domestic use as well. The BIS code recommended the minimum supply standard of 150-200 lpcd for the cities with the population more than one lakh with the full flushing system. In addition, BIS code has revised the population criterion used to defined the level of urbanisation from 5 lakh recommended by Zakaria Committee and fifty-thousand recommended by the Expert Committee of 1976 to one lakh (BIS, 1993). And following earlier practice, the earlier norms revised and these new norms were issued without providing any rationale. In addition, this code retained the earlier supply norm of 135 lpcd for LIG and EWS category. Later, the same standards were continued by BIS in the revised National Building Code published in 2005 and 2016 (BIS, 2005, 2016). This indicates how different conflicting supply standards following different definitions (in terms of inclusion or exclusion of non-domestic demand and level of urbanisation) are prescribed by BIS alone for the cities under different codes ranging from minimum 200 lpcd (National Building Code of 1983 and IS 2065: 1983), to minimum 135 lpcd (Handbook on Water Supply and Drainage, 1987) to 150-200 lpcd (ISS 1172:1993, NBC 2005, 2016) in such a short span of time without providing any rationale.

Meanwhile, in 1999, the CPHEEO published manual on Water Supply and Treatment and prescribed new per capita supply levels. As per these standards, for the cities with the existing or contemplated sewer network, the maximum water supply norm is gross 135 lpcd and for the metropolitan cities, the maximum norm is extended to gross 150 lpcd only (CPHEEO, 1999). These norms also include the commercial, institutional and demand of minor industries exist within the city boundary but excludes bulk consumers[17]. In comparison to earlier norms, the CPHEEO significantly reduced the per consumption standards and prescribed the maximum water supply norms putting a cap on the consumption level unlike the minimum supply standards recommended by BIS.

In the year 2006, Ministry of Urban Development initiated the process of development of standardised service level benchmark with reference to basic municipal services (GoI, 2008). The process included a core group working on service level benchmarks including Institute of Chartered Accountants of India (ICAI), Water and Sanitation Program (WSP), Public Record of Operations and Finance (PROOF), and Municipal Commissioners of Bengaluru, Hyderabad, Jaipur, Kolkata and Pune. The Ministry of Urban Development adopted the service level benchmarks covering water supply, sanitation and solid waste management suggested by the core group after consultation in 2008. As per these standards, the gross per capita per day supply should be 135 litres including domestic and non-domestic uses but the standard excludes the bulk

[17] However, the meaning of bulk consumer is not clearly defined by CPHEEO.

industrial consumers. The standard of 135 lpcd is applicable for all urban centres irrespective of the population of the city (GoI, 2008).

At present, the Ministry of Urban Development is enforcing these norms through massive city-modernisation scheme spending billions of dollars including Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Urban Infrastructure Development Scheme for Small and Medium Town (UIDSSMT), Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart City Mission. Under these centrally funded schemes, all the state governments and urban local bodies have to follow the norms prescribed by CPHEEO while planning and designing all the water supply and sanitation infrastructure projects in order to receive financial support from the central government.

Recently in January 2018, the Maharashtra Water Resources Regulatory Authority (MWRRA) prescribed the limits for bulk water entitlements provided to the urban local bodies including municipal corporations and councils. As per the order issued by MWRRA, the permissible water supply limit for the municipal corporation with a population more than fifty lakhs is 150 litres per capita per day including domestic and non-domestic use and leakages (MWRRA, 2018). This standard is consistent with the CPHEEO standard but differs from the standard prescribed by the Ministry of Urban Development.

At the national level, the water supply standards are recommended or prescribed by multiple agencies including BIS and CPHEEO. It is apparent that the network water infrastructure spread across the city and till the service connection is designed with the standards prescribed by CPHEEO and beyond service connection, the plumbing of residential and commercial buildings is designed with BIS standards comprising national building code and both the standards as described earlier fluctuates significantly over time. This indicates the lack of coordination between the national level standard prescribing organisations. However, surprisingly, the Director, Civil Engineering division of the Bureau of Indian Standards was one of the members of the Expert Committee that prescribed the CPHEEO standards. In spite of apparent involvement of BIS in the standard making process of CPHEEO, the CPHEEO standards prescribed in 1999 are not being reflected in the standards subsequently prescribed by BIS over years e.g. National Building Code of India 2005 and 2016.

Astonishingly, none of the above-mentioned document including Zakaria Committee report, CPHEEO manual, NIUA study series and all BIS standards provides any information about the origin of these multiple figures quoted. These prescribed standards do not provide any rational, evidence or any empirical data to substantiate the figures of per capita supply standards. While revising the standards, CPHEEO and BIS do not comment anything about the status of the earlier standards or mention the issues associated with the earlier standards. Except for Zakaria committee, none of the above-mentioned standard document provides the break-up of per capita standards describing the water consumption under different category including drinking, washing, bathing, cooking, losses etc. Even in the case of Zakaria committee, the break-up of the consumption norms appears to be highly overestimated (Zakaria Committee, 1963). This raises questions over the validity and rationality of the per capita water supply standards prescribed by experts involving civil engineers, water resources planners, urban (town and country) planners, public health engineers and environmental engineers.

In subsequent sections, I am reviewing the historical water resources development process with specific focus on how current and future water demand of the city is estimated and how based on the forecasted numbers, government undertakes various water resources development measures to bring more water into the city. Moreover, I am also reviewing the adequacy of actual water supply service delivery as against the demand forecasts made. In the case of Mumbai, the historical development of water supply services can be categorised in two timeframes - Mumbai during the colonial era and post-independence era.

5 Colonial Bombay: Per capita water supply planning and service delivery

The history of the development of water supply resources of Mumbai is full of narratives of increasing water population and severe water shortages. It also reflects the anxiety of city planners toward bringing more and more water for the city and also securing the sources for the future. Starting from British civil engineer Henry Conybeare who has taken painstaking efforts while designing first piped water supply scheme of Mumbai - Vehar in the 1850s (Dossal, 1988) to Dr. Chitale who prepared a planning report for Mumbai's future water resources in 1994. The documents and reports produced by civil engineers, experts and water resources planners narrates the stories of water shortages through numbers and construct the situation of crisis by comparing the population of the city with the available water supply and convincingly argue for the development of new water resources. As explained below, the planners consistently and continuously put forward the figures with higher water demand and these exorbitantly higher water demand figures computed by using higher per capita per day consumption norm, citing commercial and industrial activities of the city. However, the irony is while delivering services within the city the supply norm was conveniently ignored and moreover the supply was restricted by prescribing formal rules.

During colonial times, the Mumbai was the focus of British rulers as it was evolved as a rapidly growing trade centre with one of the finest harbours in the world resembling its configuration with the harbour of New York. Also, geographically it was a 'nearest point of contact with Europe' (Conybeare & Locke, 1858). Therefore, following European supply norms, British engineers and planners ensured an adequate supply of water to the city of Mumbai and as a result, by the end of 19th century, the average gross per capita per day supply in colonial Mumbai was much higher than the per capita supply enjoyed by residents of London (Bolton, 1884; Hardy, 1991; Stonebridge, 1927).

By the middle of the 19th century, Mumbai was fetching water from the locally available public and private tanks, and wells. In summer of 1845, Mumbai experienced severe water shortages as a result, a two-member committee was appointed to assess the status of the island well water and its adequacy. The situation was so alarming, the appointed committee submitted the report within twenty-four hours highlighting scarcity of water, suffering experienced by the people and contamination of local water sources (Tulloch, 1872). The British engineers were assigned the task of exploring the nearby sources from where water can be brought in the city. The records indicate, during the scarcity of 1854, water was imported from Elephanta island via steamers and boats and from Salsette (or Sashti) island via railway on daily basis (Conybeare & Locke, 1858). Then engineers explored multiple options and finalised the valley of Gopar on adjoining island of Salsette to constructed a reservoir at Vehar as it was the cheapest and the convenient option as a water source. In 1860, the Vehar scheme was commissioned and 32 million litres per day was brought into the city and it was the beginning of centralised piped water supply system in the history of the city of Bombay.

The Vehar scheme was designed by British engineers following the experiences of constructing similar schemes in UK cities like London, Liverpool, Manchester, Bristol, Glasgow and

Leicester and using latest available technology (Broich, 2007; Doshi, 2014). Following European norms and considering locally available water resources, the Vehar scheme was designed to provide gross 91 litres per capita per day (or 20 gallons[18] per capita per day) covering entire population of the city (Conybeare & Locke, 1858; Dossal, 1988; Tulloch, 1872)[19]. In 1850, Londoners were also receiving 20 gallons per capita per day (Hardy, 1991).

With the increase in population, to ensure the adequate per capita water availability and avoid water shortages, the supply was further augmented by constructing another reservoir - Tulsi upstream of Vehar in 1879 and also raising the height of the Vehar dam in 1886. Meanwhile, the city increasingly became dependent on the externally fetched piped water supply. Moreover, the British sanitary engineers were closing down local sources of water supply including wells and tanks citing them as breeding grounds of mosquitoes (Broich, 2007). Successively, to meet the increasing water demand of the city, engineers moved beyond Salsette island and explored water resources on the mainland. Meanwhile, in 1890, the failure of monsoon created a panic situation that led to the execution of construction of Powai waterworks on the tributary of the Mithi river as an emergency measure to meet the anticipated water shortages. However, soon after its completion within a year in 1891, it was discovered that the water quality was not fit for human consumption and therefore the idea of integrating Powai with the Mumbai water supply network was dropped (Stonebridge, 1927).

In 1892, the Tansa scheme was commissioned to harness the water resources from Vaitarana basin from the mainland. With Tansa, the piped water supply of Mumbai raised to 143 MLD (excluding the local tanks and wells) which was equivalent to gross 173 lpcd (38 gallons per capita per day) covering entire population as per the 1891 census (Stonebridge, 1927). During the same period the water supply of the city of London was 28.6 gallons per capita per day in 1882 (Bolton, 1884) and 27.8 gallons per capita per day in 1900 (Hardy, 1991). Thus, at the end of the nineteenth century, the per capita supply of Mumbai was almost 37% higher than the London.

Subsequently, the Tansa scheme was expanded in phases in 1915, 1925 and 1948 to harness its entire potential of 410 MLD. This expansion ensured the adequacy of supply for the growing

[18] 1 imperial (UK) gallon = 4.546 litres
[19] Alone Vehar was capable of supplying 10 gallons per capita per day (45.5 LPCD) for the entire population.

city. For example, in 1926 These dams cumulatively supplying 286 MLD adequate enough to provide gross 225 lpcd covering entire 1.27 million population of Mumbai. In the year 1941, the water supply was providing average gross 273 lpcd to Mumbai meeting the prevailing standard of 227 lpcd[20] (World Bank, 1973).

Though during the colonial period, the supply was planned and designed following considering the entire population of the city, the actual delivery of water supply services was following different practices. For example, though Vehar scheme was designed with the provision of 91 lpcd covering entire population, the first commissioner of Bombay - Arthur Crawford was against providing in-house connection to native poor and only insisting for setting up public sources - standpipes (Kelkar, 2015). Given the sparse spread of the network and a limited number of standpipes, it was impossible to fetch the adequate quantity of water for native poor.

Moreover, the native poor were blamed for excessive use of water and wastage. However, during the same period in England, the increased use of water was promoted as it was linked with improved sanitation and waste was considered as a structural part of the system (Kelkar, 2015). Though natives were blamed for wastage of water, faulty distribution system, leaky plumbing and defective standpipes imported from England were some of the major reasons for the excessive leakages and losses from the system. Hardy (1991) has noted even the London water supply system was facing similar issues related to wastage because of leaky system and 'neither scrupulous nor thoughtful' consumers (p. 79). In spite of this, the colonial rulers preferred to construct the narratives of 'wastage of water by native poor' to hide their technological inefficiencies and deny native poor their share of water. Surprisingly, at the same time, they continued the practice of watering the street with water procured from Vehar scheme as a sanitary practice. Often, the streets were watered excessively making them slippery and dangerous for pedestrians (Kelkar, 2015). This indicates during planning the water was brought in in the name of poor people but during actual delivery, it was used by ruling elite class to meet their own demands. On one hand, the colonial rulers denied water to native poor and on the other, the poor were not in a position to afford the cost of the extension of the network to their localities for private connection[21] (Dossal, 1988). As a result, the native poor people were never

[20] 50 gallons per capita per day
[21] As per the rule, the consumer has to pay for the extension of the network towards his/her premise

able to consume their share of 91 lpcd of water with which the Vehar scheme was originally constructed.

6 Mumbai in post-independence era: Water demand estimation and narratives of water shortages

After independence MCGM, MMRDA and Government of Maharashtra commissioned several studies and appointed several committees to estimate the current and future water demand of the city. Based on the demand calculations, these reports recommended the strategies for the development of new water resources for the city of Mumbai. Following these recommendations, the Municipal Corporation of Greater Mumbai and GoM undertook several water resources development projects time to time to secure a required quantity of water from the neighbouring regions.

Following the colonial trend, after independence, the search for new water resources continued under the leadership of then the Special Engineer of Mumbai corporation N. V. Modak. The search for new water resources took engineers further inland beyond Tansa. In 1957, Mumbai constructed Vaitarana reservoir in Vaitarana valley contributing around 490 MLD to satisfy the growing thirst of the city. In the year 1961, Mumbai was providing average gross 232 lpcd (51 gpcd) to the entire population to meet domestic as well as non-domestic demand (Bombay Metropolitan Region Planning Board, 1974; World Bank, 1973).

However, in subsequent years, the supply has fallen to gross 180 lpcd and the situation was termed as a ‘miserable’ by the planners of Bombay Metropolitan Region (Bombay Metropolitan Region Planning Board, 1974) and hence demanded more water for the residents of the city. This situation along with the failure of monsoon in 1966 triggered the development of Upper Vaitarana dam with high priority in 1965 and Bhatsa dual purpose dam in 1968 (Bombay Metropolitan Region Planning Board, 1974; Report of the Expert Committee, 1994; World Bank, 1973).

6.1 Inflated per capita per day supply standards

In late 1960, MCGM and GoM appointed British consultants Binnie and Partners (India) Ltd. to study water supply situation of Mumbai. The consultant studied the availability of water resources and identified that the water demand in 1991 for the MMR region will exceed the available water resources of the region. The report presented the existing water supply shortage of 29% in the year 1971 and demanded immediate action to improve the water supply situation of the city (World Bank, 1973). These numbers narrating shortages justified the World Bank supported Bombay Water Supply and Sewerage Project (BWSSP) undertook by the municipal corporation in 1973 to enhance the water supply from the Bhatsa dam in three phases - Phase-I, II and III each bringing 455 MLD to the city[22] (World Bank, 1973, p. 18).

As a part of this project, the World Bank estimated the domestic water demand for 1981 with 186 lpcd and concluded that the city will face a shortage of 21% while serving domestic users (World Bank, 1973). There were two errors in this shortage forecast - first, the household consumption level of 186 lpcd was high even with household tap connection. Second, as per the World Bank staff appraisal report, even after completion of the project, at least 38% city population was projected to access water through standpipes mostly living in slums with one standpipe providing access to average 330 persons (World Bank, 1978). This project itself was aimed to install ten thousand additional taps in slums with access to standpipe within 100 meters from the dwellings[23] (World Bank, 1978). Under these situations, the 330 standpipe users cannot fetch and consume 186 litres per person in a day and moreover, when the supply is intermittent and only a few hours of the day with inadequate pressure. Therefore, for 38 per cent population, the forecasted demand was unrealistic and it raises questions over the numbers forecasting shortages for the city.

In 1974, while preparing the regional plan for BMR for estimating the Mumbai's water demand, planners used the norm of gross 335 litres per capita per day[24] including non-domestic water demand and projected the demand of around 4000 MLD for the year 1991 (Bombay Metropolitan Region Planning Board, 1974; MMRDA, 1999). This value of 335 lpcd was much higher than even the Zakaria Committee recommendation (270 lpcd) and that itself was on higher side.

In 1978, MCGM independently estimated the demand for 1991 as 3050 MLD. This demand indicates the gross per capita per day consumption of 365 litres including non-domestic

[22] This project also had some coponents focusing on improving the distribution of water within the city.
[23] Project justification, p32, SAR 1978
[24] (approx. 75 gpcd) For urban areas 335 lpcd and for rural areas 110 lpcd: Ch10, P1 MMR 1996

use[25](Kirloskar Consultants Limited, 1978) which is exorbitantly very high. For domestic use alone, the norm of 200 lpcd was used which was higher than the norms recommended by the Expert Committee in 1976 as their 200 lpcd also included non-domestic use. Based on this estimate of 3050 MLD, the Mumbai was forecasted to face a severe shortage of around 550 MLD in spite completion of Phase-III of BWSSP. Later in 1981, the consultant appointed by BMRDA revised the estimated demand with minor modification as 3066 MLD for the year 1991 (Kapre, 1981). For avoiding the shortage in future, the consultant recommended the construction of Middle Vaitarana and Kalu[26] dam for the Mumbai city.

However, as per the projection of World Bank report, even after successful completion of BWSSP, total 45 per cent city population will access water through standpipe in 1991 with one standpipe used by average 300 people (World Bank, 1978). Then the question is how 300 people accessing a single standpipe can fetch 335 lpcd (MMRDA, 1999) or 200 lpcd (Kirloskar Consultants Limited, 1978) as mentioned above in a day with intermittent supply provision. In reality, in the year 1991, total 55.3 per cent population was residing in a slum (Mahadevia, 1998) and most of them were accessing water through a standpipe. Consequently, this raises questions over the methodology adopted for forecasting demand of 4000 MLD or 3066 MLD that used a single supply norm for entire city population irrespective of considering the socio-economic situation of the social strata of the city. While estimating the demand and forecasting big numbers, water supply planners conveniently do not answer this question.

Immediately after two years in 1983, MMRDA prepared a detailed water resources plan for the MMR region and submitted to the state government as a perspective plan for 2001. As per the plan, the water demand of the Mumbai was estimated with the considerably higher norm of 234 lpcd including only domestic water use. The total water demand was estimated as 4384 MLD for the year 2001 (BMRDA, 1985). Based on this report, the Mumbai was officially allowed to developed additional sources including Middle Vaitarana, Kalu[26] and Gargai dam and total 1710 MLD water were allotted to Mumbai alone to fulfil the future water demands (MMRDA, 1999).

[25] Only for domestic use the norm of 200 lpcd was used during calculation that excludes all non-domestic use and leakages.
[26] Later the Kalu is allotted to other ULBs in MMR region and instead water from Pinjal and Damanganga-Pinjal project is allotted to Mumbai.

Thus, when the Phase-II of BWSSP was going on, Mumbai had already had the water allotted from an additional three reservoirs.

As a Phase-II of BWSSP in 1986, the water demand of the city was calculated as 4358 MLD for the year 2001. The demand calculations indicate the projected gross per capita per day demand was 341 litres including non-domestic use, again it was significantly high. Based on this demand calculation, the report concluded that even after completion of BWSSP Phase III, the Mumbai will face a shortage of 638 MLD and therefore recommended the completion of Middle Vaitarana dam with high priority before 1994 (World Bank, 1986).

This indicates, how every time multiple agencies and consultants applied higher gross per capita per day norm and inflated the water demand estimation figures. Moreover, the demand estimation calculations found to be used different per capita per day supply norms without citing adequate rationales.

6.2 **Inflating water demand: Grabbing irrigation water**

In 1994, the committee appointed under the chairmanship of Dr. Madhav Chitale (hereinafter Chitale Committee) estimated the water demand of the city as 4620 MLD and 5043 MLD for the year 2001 and 2011 respectively (Report of the Expert Committee, 1994). There were two major flaws in the estimation process followed by the Chitale Committee that inflated the forecasted demand figures unreasonably. First, the Chitale Committee estimated the domestic water demand by assuming supply norm of 240 lpcd which was the highest norm ever used for domestic water supply calculation by any of the earlier agency. Second, as explained in the next sub-section, the estimated industrial water demand was unrealistically higher.

As per census 1991, 2001 and 2011, the slum population of Mumbai was 42, 54 and 41.3 per cent respectively (Reference). The 240 lpcd supply norm means, the average household in Mumbai with approximately five persons (O'Hare, Abbott, & Barke, 1998) consumes 1200 litres per day. Considering the situation of slum dwellers and kind of supply provision (low pressure and mostly through standpipes), it is near impossible to consume so much water. Moreover, the average slum dweller in Mumbai does not have a space to store 1200 litres of water (means six 200 litres barrels which are commonly used by people). Therefore, more than 40 per cent population of the city was not capable of consuming 240 lpcd and it is unrealistic to assume the population of slum dwellers will reduce significantly in two-three decades, yet Chitale

Committee preferred to use such a high norm and forecasted higher demand figures. The demand figure reflects the gross per capita per day demand as 390 lpcd.

Based on these figures, the Chitale Committee narrated the story of water shortages and as a remedy, Dr. Chitale recommended the diversion of irrigation component of Bhatsa dam towards Mumbai as a temporary and emergency measure. The reason for the slow development of irrigation infrastructure in the command area of the Bhatsa was cited as a reason for the temporary diversion (MCGM, n.d.-a; MMRDA, 1999).

As per the original agreement between the Irrigation department and MCGM, the irrigation department was supposed to share only 75% its storage (approximately 1365 MLD) with MCGM. However, by using narration of shortages proposed by Chitale Committee, the MCGM has successfully diverted the entire storage of Bhatsa dam to meet its urban demand. Though it was initially diverted as a temporary emergency measure, however, MCGM has constructed the additional abstraction, conveyance and treatment capacity to accommodate this diversion (MCGM, n.d.-a). Since completion of Phase-I of Bhatsa in 1981, till today even after almost 37 years, the Bhatsa irrigation project of the Konkan region which is one of the most backward regions of the Maharashtra state has not fulfilled its irrigation promises.

Again in 1999, the regional plan of MMR prepared by MMRDA reemphasised the recommendation of Chitale committee. While estimating the domestic water demand of Mumbai for the year 2011, the plan had used the norm of 250 lpcd. The total demand estimated for Mumbai for 2011 was 4471 MLD. Following these demand calculations, the report forecasted the shortage of 970 MLD in 2001 and therefore the report recommended the immediate development of Middle Vaitarana dam (477 MLD). Since this development was not possible before 2001, the MMR regional plan reiterated the recommendation made by the Chitale Committee to divert 455 MLD water reserved for irrigation from Bhatsa (MMRDA, 1999). This indicates how while mathematically calculating the demand of slum dwellers planners use such unrealistic norms and inflate the overall demand of the city and support the construction of new dam projects and diversion of water from other sectors.

6.3 Inflated Industrial Demand

Often in the case of Mumbai, the higher gross per capita per day supply standards are justified on the ground of higher non-domestic - commercial and industrial demand of the city. The water consumption figure indicates the industrial water demand has significantly reduced post-1980 because of closer and sickness of many industrial units (Bhide, 2015; MMRDA, 1999). In 2004-05, the total non-domestic water use in Mumbai was around 335 MLD. Though in absolute terms the non-domestic use appears to be large in Mumbai but in terms of its share in the total water supply of 3248 MLD, it is only 10.3% of total supply (GoM, 2005). However, ignoring the trend of significant reduction in industrial water demand, planners continued to project higher industrial water demand.

For example, in 1994 while estimating water demand for the year 2001, Dr. Chitale considered the total non-domestic use as 700 MLD[27] and based on this consideration he predicted the demand as 4620 MLD and narrated the story of water shortages. And as an expert, he further suggested a remedy for water shortages and recommended the diversion of 455 MLD water from Bhatsa irrigation project to Mumbai as an emergency measure (Report of the Expert Committee, 1994) and this recommendation was executed by GoM and MCGM to avoid shortages.

However, Dr. Chitale did not notice that in 1992 itself prior to the formation of Chitale Committee, the actual industrial water consumption was only 322 MLD (MMRDA, 1999) in Mumbai and as mentioned above, the data shows the total non-domestic water use in 2005 was maximum 335 MLD (GoM, 2005). Therefore, the recommended demand was higher by 365 MLD. Considering the losses of 24% (total 87.6 MLD) as calculated in the report, the recommendation made was unnecessarily higher by 452.6 MLD[28] which is almost equivalent to emergency measure proposed by Dr. Chitale - 455 MLD diversion of irrigation water. This indicates, with realistic consideration of non-domestic demand the emergency measure could have been avoided. Dr. Chitale had also estimated the non-domestic demand for 2011 and 2021 as 700 MLD. However, as per the data, the industrial demand in Mumbai in 2016 was only 352 MLD (MMRDA, 2016).

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[27] Dr. Chitale recommended 700 MLD as a non-domestc water demand for year 2011 and 2021 also which was highly unrealistic

[28] Total unnecessarily additonally forcasted demand = additional forecasted deamnd (365 MLD) + losses incurred in the network and treatment plant while delieveing the additional forecasted demand i.e. 87.6 MLD calculated at the rate of 24% of 365 MLD. Thus total additioanlly forecasted demand is 452.6 MLD

Similarly, in 1986, the World Bank report estimated the demand for 1991 as 3568 MLD and concluded that Mumbai will face a shortage of 638 MLD[29] and therefore recommended the construction of Middle Vaitarana dam of capacity 455 MLD before 1994 (World Bank, 1986). However, while demand estimation in 1986, the industrial demand was considered as 785 MLD in 1991 but in reality, as mentioned earlier, data indicates the actual industrial water consumption in 1992 was only 322 MLD (MMRDA, 1999). The planner had recommended an additional 463 MLD. Considering the distribution and treatment losses calculated as 24% (111 MLD) in the report, the total additional recommendation was 574 MLD[30]. So total unnecessary estimation of industrial water demand was much higher than the capacity of recommended Middle Vaitarana Dam (455 MLD) and close to the quoted figure of water shortages. It means there was no shortage of water in 1991.

In fact, the trend of industrial water consumption indicates the industrial water demand is consistently decreasing in Mumbai. In 2016, the share of industrial water demand was only 352 MLD, the 9.4 per cent of total water demand.

6.4 Moving beyond MHA: Entering into the paradigm of interlinking of rivers

After diversion of Bhatsa water and completion of Middle Vaitarana in 2014, today Mumbai receives around 3750 MLD with an actual average gross per capita per day supply is 252 lpcd which is 68% higher than the prescribed CPHEEO standard of 150 lpcd. Yet, planners and engineers are narrating the water supply shortage of 790 MLD (MMRDA, 2016). According to MCGM, the water demand is 5940 MLD for the population of 17.24 million in the year 2041 which is accounting for gross per capita per day consumption of 345 litres. With such high per capita per day consumption norm, MCGM has projected the shortage of 2845 MLD in 2041 (MCGM, n.d.-b) and using this humongous shortage figure, the Mumbai is justifying the implementation of Gargai (440 MLD) and Pinjal (865 MLD) dam constructions and Damanganga - Pinjal river linking (1586 MLD) project (NWDA, 2014). Since, with Gargai and Pinjal dam, Mumbai is exploiting entire potential of Mumbai Hydrometric Area, the planners have moved beyond MHA and embarked on Damanganga - Pinjal river linking project to bring water from Damanganga basin to Mumbai.

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[29] Even after completion of BWSSP Phase-III

[30] 463 MLD * 1.24 = 574 MLD

Moreover, the forecasted demand figures vary significantly across various reports. For example, as per the video documentary released by MCGM on Pinjal project, the total water demand of Mumbai in 2017 is 4300 MLD (MCGM, n.d.-b) and as per the regional plan prepared by MMRDA in 2016, the total water demand of MCGM is 4770 MLD (MMRDA, 2016). Therefore, all these incidences raise questions over the demand estimation method followed by the experts and also the authenticity of the numbers produced based on which the major decisions are made by the governments.

7 Double standards in service delivery: supplying water to slums

Though throughout the history after independence, the water supply engineers always portray the narratives of water shortages, theoretically, Mumbai always had adequate water to satisfy the need of entire population as per the CPHEEO average per capita per day supply standards (Figure 5). However, since beginning the poor are receiving inadequate water services in the city.

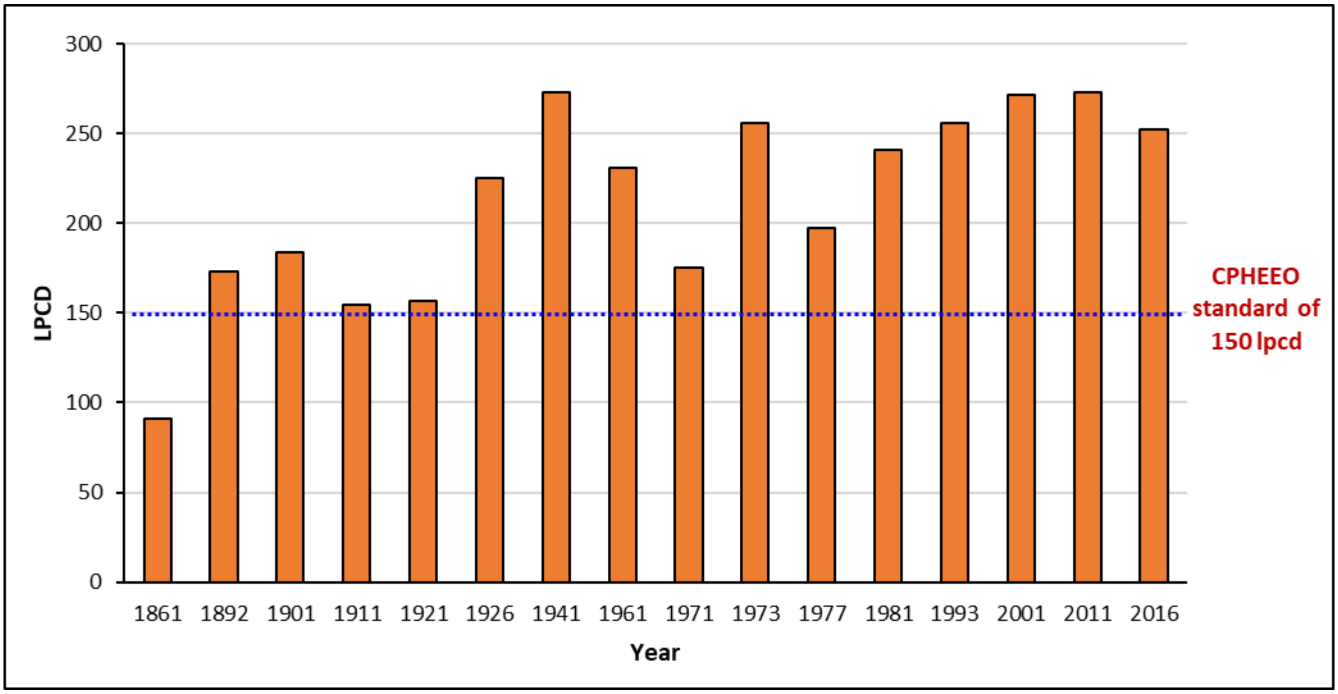

Figure 5: Historically available water supply for the city of Mumbai in gross litres per capita per day[31]

[31] It is the ratio of total quanity of water supplied to the city in litres per day to the population of the city

For example, in 1972-73, after completion of Upper Vaitarana, the water supply of Mumbai was capable enough to supply 256 lpcd covering its entire population (Report of the Expert Committee, 1994). However, during the same period, only 80% of the population was covered through the piped water supply network (World Bank, 1996). It means, though at city level 256 litres of water was available for each individual, the 20 per cent of the population was not able to access their share of water. Moreover, as reported by BMRDA planners, total 6,31,888 people in slums were served with 482 water taps, accounting for one tap serving 1311 persons (Bombay Metropolitan Region Planning Board, 1974). This indicates, though theoretically, Mumbai has received more than adequate quantity of water the significant proportion of people was not getting adequate quantity of water and urban scholars have illustrated this fact by conducting several studies. Here, my argument is - though there was enough water available, the city administrators restricted the access in two ways. First, by limiting the water supply norm and second by not providing the formal access to water supply services to the non-notified slums of the city following the cut-off date.

7.1 **Limiting slum supply**

During estimating water demand, planners use per capita per day water supply standard covering the entire population, including the slum population. Based on these demand estimation figures, Mumbai demanded and secure water resources from MHA and beyond. However, the same city administrator follows different norms while supplying water the slum population.

For example, the water forecast for 1991 was calculated domestic use with 200 lpcd covering the entire population including slum, however, during 1991 the water supply norm for the slum was only 45 lpcd. It means while building dams, the slum dwellers demand was estimated at 200 lpcd and the officially the actual service delivery was restricted less than 25 per cent of the original norm. The Chitale Committee had used the norm of 240 lpcd for calculating the demand for 2011 and 2021 but even in 2017, as per the Deputy Municipal Commissioner, Special Engineering of Mumbai Municipal Corporation, the corporation provides only 100 lpcd to slum dwellers (Bambale & Wadhavane, 2017).

Here, the engineers and water resources planners are computing the water requirement of slum dwellers using higher per capita standards while appropriating water share of the region and justifying dams but at the same time supplying water to the slum dwellers at much lower supply level following double standards.

7.2 **Policy of Cut-off date**

MCGM do not provide water to all slums in Mumbai and even today, there are many slum pockets which are not formally connected to the city water supply network. Till 2014, MCGM was officially denying water to non-notified slums and slums settled on the land owned by the central government agencies (for example railways) unless those agencies issue ‘no objection certificate’ (NOC).

In 1996, then Sena-BJP government which had the first time came into the power after raising the issue of ‘sons of the soil’ - *Bhumiputra*, amended Maharashtra Slum Areas Act of 1971 (Murthy, 2012). As per this amendment slums residents who can produce a proof of residency prior to January 1, 1995, were entitled to security of tenure and access to basic services including water, and eligible for rehabilitation in formal housing. This amendment of cut-off date was introduced to put a cap on the inflow of migrants to the city. The amendment segregated slum residents into two categories, first residents possessing proof of residency prior to the cut-off date (notified slums) and second, residents who arrived after 1995 or who did not have proof of earlier date but residing prior to 1995 (non-notified slums). The residents of the second category were officially denied from accessing the basic services. The government revised this cut-off date to January 1, 2000 in 2014 (The Economic Times, 2014) and again to January 1, 2011 in 2017 (Gangan, 2017).

The cut-off date was not applicable for the slums located on land owned by the central government as these lands come under the legislative jurisdiction of the central government and rules and regulation set by the state of Maharashtra are no more applicable for them. Therefore, the municipal government is unable to extend the services to these lands unless and until 'No Objection Certificate' (NOC) has been issued by concern authority. In most cases, the central government authorities are reluctant to issue NOC under the impression that it may assist the resident to claim land tenure. Subbaraman et al. (2012) have aptly described these lands as 'No Man's Land', where nobody is responsible for nothing. In 2014, in response to public interest litigation filed by an NGO - Pani Haq Samiti, The Bombay High Court passed judgement and ordered Mumbai municipal corporation to provide water to all irrespective of land tenure.

However, all these people living in Mumbai are counted while estimating the demand for the city and water from the distant valley is brought in Mumbai on their name but the same water was not delivered to the same people following the policy of cut-off date till 2014[32] and those slum dwellers to whom water was delivered but at much lower standards than those for demand estimation. In a way, engineers are using slum dwellers to capture water resources of the region.

8 Conclusion

The paper analyses the technopolitics associated with the water appropriation and illustrates how the processes which are considered as scientific, rational and apolitical in nature are used by the planners and engineers to control the water resources of the region. Often such processes are taken for granted and are accepted without challenging the intentions of the experts. In case of MMR, following the hydrological boundaries and the concept of the basin as an appropriate and scientific unit for management of water resources, the Mumbai Hydrometric Area (MHA) was formulated for coordinated and efficient development of water resources of the region. However, the paper reveals how subsequently the concept of MHA is used to control the water resources of the mainland to protect the interests of Mumbai.

The process of demand estimation is considered based on scientific and rational principles. The numbers produced by engineers and planners through this process are accepted by the rest of society. There is an inherent belief that the process followed by the expert is neutral and apolitical. Since this process deals with technical stuff and numbers, so far it is ignored by the critical sociologists and urban scholars and even the STS scholars have not scrutinised the demand estimation process.

The per capita per day water supply standard used for the demand estimation is a cornerstone of a piped water supply and following this figure the sizing of entire urban water infrastructure is done and capital and operational costs of water supply services are determined. The paper challenges the objectivity and validity of the per capita supply norm. By doing historical analysis, the paper illustrates how different authorities and expert committees recommended significantly different standards for per capita supply. Moreover, multiple conflicting standards issued by multiple authorities were in operation at the same time. More importantly, none of the

[32] Still today there are many pockets in the city which are not connected to formal water supply.

standard setting authority or expert committee has provided any rational or justification for the numbers prescribed. In absence of any rationale, the standards were set governing entire urban water supply services.

Analysing the case of Mumbai within MMR, the paper uncovers that the planners and engineers have consistently used higher per capita supply norms throughout the history of Mumbai. Using these higher norms, the planners forecasted the inflated figures of water demand and constructed the narratives of water shortages. These narratives of shortages produced by the experts like Dr. Chitale through numbers justified the demand for more water for the city of Mumbai. Moreover, the expertise and stature of Dr Chitale is used to legitimised the excessive water demand of the city. Based on these demand estimation figures, the newer water resources were secured and developed for the city. This created an inequitable distribution of water in the metropolitan region.

The paper further reveals the double standards followed by the planners and engineers. These experts like Dr. Chitale forecasted demand of the city using norms like 240 lpcd covering the entire population and appropriated the excessive resources from the region. However, while delivering services to slum dwellers, the experts chose to apply minimal supply norms like 100 lpcd for notified slums and officially denied the services to people living in non-notified slums. Considering the existing official supply norm of 100 lpcd for slum, the experts were additionally claiming the water of 140 litres per slum dweller per day. This additional claim is huge as more than 40 per cent of the city population is living in the slum. This clearly demonstrates that the experts used the entire population of Mumbai while claiming the resources from the region but then they chose to apply the minimal norms while actually delivering the services. Thus, the slum dwellers were merely used by planners for demanding a higher share of water from the region without any intention of delivering the same to the slum residents. The calculation indicates that even with the norm of 240 lpcd for non-slum dwellers which itself is very high, the planners are claiming 30 per cent more water from the region for domestic use.

Therefore, by tweaking the process of demand estimation the experts produce the numbers demanding more water and justify the *right* of the city of Mumbai on the water resources of the metropolitan region depriving other 16 municipal corporations and councils and around thousands of villages.

The paper raises the larger questions about the concept of per capita per day water supply norm which is at the basis of designing and operating the piped water supply system. As illustrated, the per capita supply norm is not objective, moreover, the planners manipulate the standards and used the convenient standards for demand estimation. The bigger problem is in the case of Mumbai, it is impossible to ensure the delivery of the service as per the standard selected (or manipulated) by the planners. In the distribution network there are no bulk meters and as per the operation engineers, most of the consumer meters are non-functional. And this is true for the water supply distribution network of major Indian cities. In such a scenario, the standard of per capita supply becomes meaningless during the service delivery. Therefore, the per capita standard is neither objective and valid nor it is possible to use them during the service delivery. As a result, the planners and engineers conveniently use them to appropriate more water resources from Mumbai hydrometric area.

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