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EMERGING GROUND WATER CRISIS IN URBAN AREAS – A CASE STUDY OF WARD No. 39, BANGALORE CITY

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EMERGING GROUND WATER CRISIS IN URBAN AREAS – A CASE STUDY OF WARD No. 39, BANGALORE CITY*

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Abstract

Ground water levels are fast depleting in urban areas due to overdraft. It is an alternate source to limited surface water supplies. This paper provides count on tubewells estimating dependence, draft, cost-dynamics and depletion in Ward No. 39 of Bangalore City Corporation. Survey to document every tubewell was conducted supported with focus group discussions. Striking realities indicate 873 tubewells[4] within a small area of 2.9 Sq. Km, an investment of 3.55 crores, the depletion levels dwindling from 90 feet in 1970's to 500 feet at present.

Background

The importance of ground water as a major source of water supply needs no mention. Development of ground water supplies has drastically increased during the 20th century. In many semi-arid and arid regions, ground water has been withdrawn at rates far in excess of recharge, leading to ground-water "mining," resulting in declining water levels and increasing pumping costs. Overexploitation anywhere is often accompanied by detrimental environmental side effects, such as land subsidence, water-quality degradation, and reduced ground-water discharge to springs, streams, and wetlands resulting in significant losses of habitat and biodiversity.

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[4] A total of 873 tubewells, out of which 101 tubewells were drilled by Bangalore City Corporation and rest belong to private organizations.

Already billions of gallons of water are being obtained every hour in the world from below the surface to meet the agricultural, domestic and industrial needs (Parbin Singh, 1997). Also it is seen that in most parts of the globe, ground water is supplied from distant places during scarcity. When water resources, be they surface or ground water, are utilized at a rate faster than they can be replenished their use becomes unsustainable. This is frequently the case with ground water; particularly in urban areas where urban growth increased “paved areas” reduce the opportunity for aquifer recharge. Protection and conservation of ground water is therefore a top priority task particularly in regions of limited available water resources.

The ground water table is depleting due to overdraft; waterlogging and salinization due mostly to inadequate drainage and insufficient conjunctive use; and pollution due to agricultural, industrial and other human activities. Ground water crisis is a critical issue in most places of the world. In North China’s Henan province, around 2 million hectares (52 per cent) of irrigated lands are served by tube wells, water table monitoring data on 358 observation wells encompassing 75,000 km^2 showed that water table decline was of 0.75–3.68 meters during 1975–87. One of Mexico’s agriculturally dynamic regions, found that water tables in 10 aquifers were declining at an average annual rates of 1.79–3.3 meters per year in the recent years.

The lack of water supply in the heart of the town is a common scene in almost all parts of the world. There is absolutely no space for recharging, which in turn is leading to poor supply. The city of Izmir in Western Turkey is fed from well fields from the neighbouring district of Manisa whose citizens have become increasingly restive about it. Bangkok, Jakarta and Mexico cities have been facing acute problems of land subsidence because of ground water depletion (Tushar Shah, 2004). The utilisation limits shown in Table 1 indicate extraction limits is more in European countries (CSH occasional paper, 2002).

Table 1.0: Ground Water Utilization in Different Countries

Country	Percentage
United states	47
Asia pacific region	32
Europe	75
Latin America	29
Australia	15

Source: National Ground Water Association

In India too, the situation is the same with heavy dependence on ground water. Demands on water have mounted with increasing population since the last 5 decades from 17 percent to 28 percent. Of the present 1.02 billion population, 285 million (27.8 per cent) live in urban areas, which comprises of 5161 towns an increase of 2.1 per cent over the proportion of urban population in 1991 census.

Based on large volume of hydro-geological and related data generated by Central Ground Water Board and State Ground Water Organisations and the existing knowledge of ground water regime, replenishable ground water resources in the country have been estimated as 432 BCM. Ground water meets 51 percent of the irrigation potential in India through more than 4 million dug wells, 5 million shallow tube wells and around 90,000 public tube wells. However, ground water management in the context of indiscriminate drilling without compensating through recharge in the long run will lead to severe scarcity problems with the growing demand and needs of water.

As indicated in Table 2 the total water requirement for domestic use for rural and urban areas is estimated as 90 km^3 and 111 km^3 in two scenarios. The water requirements of 34 million-plus cities for the years 2000, 2010, 2015 would be 8.7 km^3, 11.6km^3 and 13.2 km^3 respectively, which is included in the total requirement that is met from surface water sources and balance from ground water sources.

Table 2: National Water Requirement for Domestic and Municipal Use (Quantity in km^3)

Scenario	Year 2010	Year 2025	Year 2050
Low Demand			
Surface water	23	30	48
Ground water	19	25	42
Total	42	55	90
High Demand			
Surface water	24	36	65
Ground water	19	26	46
Total	43	62	111

Source: Navalawala, B. N. 2000

Different states in India paint a gloomy picture with regard to ground water situation. In Gujarat and Rajasthan ground water overuse is causing fluoride contamination, creating a major public health crisis. In coastal India, overexploitation of ground water has resulted in high levels of salinity in the water, making it unfit for human consumption or farming. In Punjab, Haryana and Western Rajasthan, the main consequence has been salinity; in hard-rock Southern India, it is declining well yields and increasing pumping costs arising from competitive deepening of wells. In West Bengal, the consequence is arsenic contamination. In Ahmedabad and Jodhpur in Western India and Chennai in the South Indian state of Tamilnadu support thriving private ground water businesses that draw water from tube wells in the neighbouring hinterlands for supplies to high-income residential areas because ground water tables in the cities are falling at a rate of 7–10 ft/yr.

Chennai city faces severe constraints in supplying adequate water, the agency has resorted to procure ground water from far off distant places. The dependence of ground water in the surrounding villages has increased the depth of water table from 60-80 to 120-130 feet. The agencies draw water from private tubewells owned by local farmers through pipe networks for which agencies pay the farmers. As the agencies pay the well owners a good amount, tubewells have mushroomed all round the Minjur area. The growing water supply business has generated a good amount of business to truck and tanker owners and supportive staff. Indeed, the truck operators have diverted their business to water supply business owing to high profits levels. Water procured by private tubewell owners or the agencies do not treat water before supplying.

Ground water serves 85 percent of the rural population's drinking water requirement and nearly half of the urban and industrial requirements in Karnataka. The National Family Health Survey indicates that only 3 percent of households in 1998-99 made use of surface sources compared with 11 percent of households in 1992-93. With the gradual decline of traditional sources, people started extracting ground water not only for drinking but also for agriculture and industrial purpose. The overexploitation of the ground water has resulted in failure of existing wells used for irrigation and drinking water.

The ground water status of Karnataka in March 2004, indicates that out of 175 taluks, 22 are over exploited where the extraction levels are more than 100 per cent, 9 taluks are 90 per cent exploited, 102 together form - partly overexploited/critical/semi-critical while 51 taluks are safe. Out the total area of the state, about 30 per cent is over exploited (DMG, 2005). Owing to over exploitation of ground water, number of dug wells has dried up resulting in loss of Rs.2000 crores invested by farmers. On the other hand, the geologists of the Department of Mines and Geology have concluded that this has led to scarcity of drinking water, increased unit cost of well, increased energy consumption, drop in efficiency of pumps and productive lands have become fallow (Reddy et.al, 2000).

Kolar city mainly depends on ground water resources, however 97 per cent of it is non-potable. The local urban authorities and private agencies are facing a major challenge in meeting the water demand of the city. The per capita supply is almost close to one-third of the urban water supply norms. The average depth of water table is 600 feet plus. During scarcity, the private water suppliers meet the water demand through tankers and bullock carts (Raju et al, 2004)

Of the 208 urban local bodies under the Karnataka Urban Water Supply and Drainage Board, 151 depend on river water whereas 47 depend on ground water. Besides, maintenance, poor distribution systems have also added to the problem. In the early 1970s, Karnataka's rural population, which constituted about 42 million of the total population of 53 million, could meet its drinking water needs largely from open wells as ground water levels were at an average depth of three to five meters. Presently about 64 percent of rural habitations are covered with more than 55 litres per capita per day of water supply. One estimate suggests that about three lakh wells dug in the 1970s have gone dry, and shallow open wells have been replaced by deeper tubewells. At present there are about two lakh drinking water tubewells in the State and 12 lakh irrigation tubewells as against about two lakh irrigation wells in the 1970s (State of the Environment Report 2003, GoK).

With this backdrop, the study aims to understand ground water status in an urban area at a ward level, estimate the number of tubewells and to understand the extent of dependence on ground water and investments made. Ward No. 39 was chosen mainly because it is situated at the outskirts of the city, a combination of old areas merged into Corporation limits and upcoming new layouts.

Water Supply in Bangalore City

Bangalore, known, as the Silicon Valley of Asia, is one of the major class I cities in South India with a population of 5.6 million (Census 2001). It is a rapidly growing city with congregation of software and automobile industries. The increasing demands on the agencies providing infrastructure is obvious. Demand to meet the water requirements has been enormous. Bangalore has no perennial river, which resulted in the growth of many lakes, acting as a source of ground water recharge earlier. Currently, following rapid urbanization, these lakes have vanished and have been converted into residential and commercial localities

Bangalore Water Supply and Sewerage Board, an organization responsible for providing water supply and sewerage system has implemented Cauvery Water Supply Schemes in 4 stages. Thippagondanahally, which was the earlier source, has dried up recently. Nearly 753 MLD of water is drawn from the source and per capita of water supplied is 100 to 110 LPCD. In addition, BWSSB through its 6235 tubewells supplies 66 MLD of ground water. There has been an demand-supply gap in surface water supply. The distribution system within the city particularly in the core areas is 70 to 100 years old and water quality has been affected by corrosion of the pipes. In addition, this has resulted in leakage and loss of water to the extent of 35-40 percent.

As BWSSB is struggling to cope up to meet the increasing demand, people are resorting to alternative sources of ground water. The phenomenal growth of tubewells in Bangalore Urban district from 5,000 to around 4.08 lakhs over the last three decades indicates the increased dependence on ground water. It is estimated that 750 MLD of ground water is being extracted everyday (Refer Annexure 1).

The expansion of core areas of Bangalore have extended and reached the outskirts, in the process, areas, which were once villages, have been included into the city limits. These areas are unplanned, densely populated and poorly equipped with basic minimum facilities. It was observed that with uneven agglomeration, houses situated at the urban fringe or newly developing areas are facing a great problem without full coverage of surface water supply, ultimately leading the users to find their own alternative.

Methodology Followed

Secondary information was collected from the Ward Office. A pilot survey was conducted for 200 households through personal interviews following which all households having tube wells within the ward were interviewed with a questionnaire covering information related to tube well depth, status, year of drilling, usage of water, investment and maintenance cost made towards ground water, reasons for drilling etc. High school children and college students were involved in the survey with due training.

Ward No. 39 - An Overview

Bangalore City Corporation with seven wards was formed in 1949. Since then, the number of wards has been increasing due to incorporation of surrounding areas on a continuous basis. In 1971, it increased to 63 wards, to 87 in 1991, to 100[5] in 2001 consecutively.

Earlier Ward-39 was a village that belonged to Gangondana Halli Village Panchayath. Later in 1996, it was incorporated into the Bangalore Mahanagara Palike and converted as a ward. Hence it comprises of both revenue areas (around 85 per cent) and Bangalore Development Authority areas (15 per cent) (refer Table No 3). Presently it covers an area of 2.9 sq kms and is located towards south west of Bangalore. There are 8,000 households (of which around 1000 are in BDA layout) covering a population of 41,182 according to 2001 census (male population – 21,432 and female – 19,750). The literacy rate is 60.5 per cent with total literates being 24,934. The number of voters increased from 11,000 in 1996 to 35,000 in 2001.

There are five slums in the ward. These slums are located at Pantharapalya (on Mysore road), Chandra Layout and Gangondana Halli. The areas within the ward differ in development with regard to infrastructure facilities[6] . Due to expansion of the core area, the villages situated at the outskirts were incorporated into one whole area. As

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[5]During the study period (2004), the number of wards in BMP area was 100 which has been upgraded to 145 in 2007.

[6]Nagarabhavi, Nagarabhavi I stage, Chandra layout (partly), NGEF layout (partly), Vidyagiri layout, Jyothi nagar, Pantharapalya, Nayandahalli, Gangodanahalli, ITI layout.

the villages were undeveloped, they still remain congested and densely populated. However, the areas that are newly formed into layouts are better planned. These areas can again be categorized into commercial, residential and commercial cum residential.

Table 3: Areas Under Revenue, BDA and BDA Approved Private Society Layouts

Revenue pockets	BDA layouts	Newly developed BDA approved society layouts
Pantharapalya	Chandra layout	ITI layout
Gangodanahalli	Nagarabhavi I stage	Guru Sarvabauma nagar
Nagarabhavi village		NGEF layout
Nayandahalli		Vidyagiri layout
		Jyothi nagar
		Vinayaka layout (extension of Nayandahalli)
		Income tax layout
		Teachers colony

Source: Based on Survey, 2004

Water Source in Ward No. 39

Ward No. 39 gets water from both surface and ground water sources. Earlier they were entirely dependent on ground water. There are different schemes like Mini water supply and tubewell with hand pump maintained by BWSSB supplying ground water for poor sections without water fee.

While 52 per cent of the population depends entirely on the ground water sources. 46 per cent depend on both ground water and surface water sources as shown in Table 4. Dual dependence on sources was found among households as bore wells were drilled during construction in the absence of alternative source. In some of the newly developed areas like NGEF layout, Vidyagiri layout etc., where the pipe water supply is not available, water is supplied by the private agencies drawn from tubewells.

Table 4: Source of Water

Source	Frequency	Percent
Tubewell	371	52.3
Tubewell and pipe water connection	322	45.4
Tubewell, pipe water connection and seller's connection	5	0.7
Tubewell and seller's connection	12	1.6
Total	710	100

Source: Based on survey, 2004

Variation in Density and Access to Water

The total number of tubewells in Ward No. 39 is 873 out of which 772 are private tubewells while the tubewells drilled by the Bangalore City Corporation is 101. Out of 873 tubewells, higher percentages around 81 per cent are found in household sector[7]. (Refer Table 5).

Table 5: Total Number of Tubewells in Ward No. 39

Particulars	Number of tubewells	Percentage
Households	710	81.3
Commercial establishments like Industries, Hotels, cinema theatres, hospitals, hostels and institutions	42	4.8
Public water supply through MWS and BWHP	101	11.6
Organisations	20	2.3
Total	873	100.0

Source: Based on survey

As indicated in Table 6, the density of tubewells is high in newly developed areas (around 30 tubewells were found in a single street out of total 35 households). It can be observed from Table 6

[7] All the information discussed in this paper are based on the 710 tubewells found in household sector (privately owned tubewells)

that the new areas are prone to drill more tubewells indicating 85 per cent. The newer areas belong to the higher income group who invest on drilling tubewells. With no restriction imposed on drilling tubewells and lack of alternatives available as part of poor governance has resulted in massive economic and environmental costs.

Table 6: Area – wise Number of Tubewells in Ward No. 39

Areas	Number of Tubewells
Newly developed	
Chandra layout	188
Gurusarvaboma nagar	28
ITI layout NGB	40
ITI layout	21
Metro layout	45
Vidyagiri layout	27
Vinayaka layout	43
Nagarabhavi	170
Jyothi nagar	38
Total	600
Old areas	
Pantharapalya	9
Gangadonahalli	39
Nayandahalli	62
Total	110

Source: Based on survey, 2004

With the introduction of surface water, the usage of ground water is reduced. Free riding was noticed by using hosepipes from MWS taps to their storage sumps evading investment on surface water connection. Gurusarvaboumanagar entirely depends on ground water with no access to surface water supply. ITI layout has 25 households. In 1979, ITI House Building Society had drilled 3 tubewells with an overhead tank and pipelines. But it has not been made functional even to this day. All the houses constructed had to drill a tubewell as they had no other alternative. Older areas, which were formerly villages with unplanned and highly congested areas, have become a part of the ward. Tubewells are sparse in these areas. Though these areas have pipe water supply and mini water supply, the water scarcity was high. This is due to insufficient and irregular supply of water because of low pressure.

Wells – Current status

There are 681 tubewells in working condition while the rest are defunct or dried up. It was observed that the wells drilled with lesser depths have dried up due to deeper drilling of new tubewells in the vicinity. Among the 101 tubewells drilled by the Corporation only 61 are functional (refer Table 7)

Table 7: Tubewell Status in Ward No. 39

Status	Noumber of Borewells	Percentage
Working	681	95.9
Not working	29	4.1
Total	710	100

Source: Based on survey, 2004

There are about 42 open wells in the study area which are seen only in areas of Nayandahalli, Chandra layout, Ganagondanahalli and Pantharapalya. Out of this, 35 per cent have dried up while 54 per cent have water and is used for secondary purpose (Table 8). In Pantharapalya, one of the old areas, the main source of water supply was open wells. While 10 per cent of the open wells are neglected owing to dumping of garbage and introduction of Mini Water Supply. Nevertheless, a small number of households use the water from these neglected open well for secondary purpose. All open wells in

Nayandahalli have dried up and people completely depend on ground water supplied through Mini Water Supply and street taps. Some parts of Pantharapalya and Nayandahalli have surface water connection.

Table 8: Number of Open Wells in Ward No. 39

Status	No. of open wells	Percentage
Working	23	54.8
Neglected	4	9.5
Dried	15	35.7
Total	42	100.0

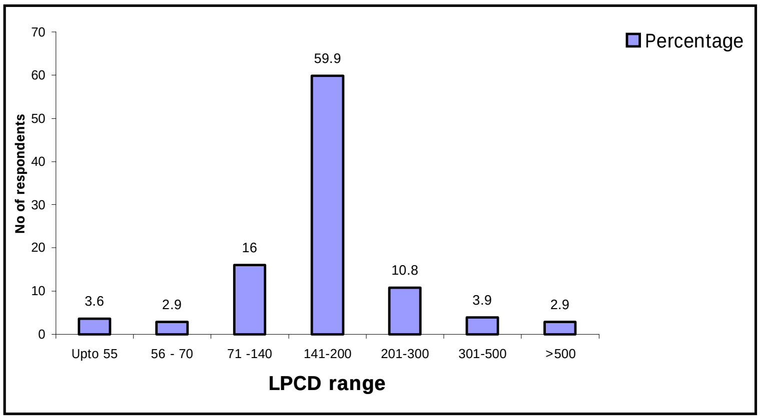
Source: Based on survey

Water Usage in Study Area

Sources and Water consumption vary in between areas. It was difficult to estimate the quantities of surface and ground water used by the respondents because in majority of the houses, both the surface and ground water are stored in the same sump or tank. Annexure 2 indicates the total water consumption in Ward No. 39. About 60 per cent of the households use 750 to 1000 liters per day. Similarly 60 per cent of the respondents' per capita water consumption (lpcd) ranges between 140 to 200 litres[8] , which is above the recommended level of 140 LPCD for an urban area in the National Water Policy 2002. Six per cent of the respondents consume below 55 LPCD mainly seen in the older areas like Gangondanhalli, Nayandahalli and Pantharpalya and 10 per cent are in the range of 201-300 and 6 per cent consume more than 300 lpcd (fig 1)

[8] The total volume consumed in each household was collected during primary survey. The per capita of water consumed was estimated by dividing the total water consumption by the household size.

Fig 1: Water consumption -Litres per day per person



Water Sellers

Marketing water was seen in various parts of Ward No. 39. While two major associations supplied water to large number of households, there were also households selling water to their neighbours. However with the introduction of surface water, some water sellers lost contracts. Table 9 depicts the details on water market in the study area.

Table 9: Water Market in Ward No. 39

Area	Charges in Rs. Per Month
Vidyagiri layout	250
NGEF layout	60
Nagarabhavi village	
1st seller	300
2nd seller	50
3rd seller	30

Source: Based on survey

At Vidyagiri layout, 250 sites have been allotted. The society had promised the people to provide water supply and collected an initial deposit of Rs.5000/- from the households. Water, which was supplied by the society, was stopped after 2 ½ years as there were many defaulters, Consequently the contract was given to one of the residents who installed meters. Presently, there are 65 houses, and not all purchase water as they have their own tubewells. The contractor charges Rs.250/- for 25,000 litres of water and water used over and above that will be accounted and the slab rates are higher. Bills are given to all households and if unpaid water supply was disconnected and hence payments are regular. This initiative has helped in evading defaulters.

The members of NGEF society were interested in reducing investment costs. The society drilled two tubewells and built three overhead tanks and laid pipelines. Only some lanes are given to contractors and water is supplied for three hours in a day. As the households have built huge storage tanks, they never faced scarcity. It was a rule that none of the households should drill tubewells in the NGEF layout. In the construction period water was supplied to the households. Households are charged Rs.50/- to Rs.70/- per month for unlimited supply. However, lately, there has been opposition from the people who have purchased sites from the NGEF employees and have built flats. They have drilled tube wells against the rules of the society and from then on violations have been common. A sum of Rs.1000/- was fixed as fine for violation and people conveniently got used to paying up the sum but were keen on drilling their own tubewells. There are households having dual connections – own tube well and from the society. Lately, option of introducing surface water supplies was not preferred as people did not want to invest on fresh deposits and were satisfied with the present system of supply by the society. Although the society functioned as an effective institution managing water supply, there were mixed responses with expansion of the area.

Waste Water Stream

The river Vrishbhavathy, a tributary of river Arkavathy originates in north-east Bangalore. Part of the river flows in Ward No. 39 too. The river in turn has two sub streams viz, river Vrishabhavathi and Nagarabhavi stream. This river is heavily polluted as polluted water from domestic, commercial and industrial activities flows into it. It is estimated that there are about 79 industries (21 major and 58 small scale industries), which discharge their effluents into the river. Out of the 79 industries, only 18 per cent have been found to have effluent treatment plants. It is estimated that the volume of industrial effluents, domestic sewage and combined effluents discharged into the river is 4.5 MLD, 0.9 MLD and 0.3 MLD respectively, the larger share being the industries (82 per cent) (RHHC(S), ICMR, 1993).

To identify the pollution sources, a walk through survey was carried out along the stretch. It was noticed that there were approximately around 75 households (near Nagarabhavi 2nd stage) which discharged the sewage directly into the stream in Ward No. 39. In addition, a few institutions like Bangalore University, Institute for Social and Economic Change, National Law School of India University, Atomic Energy Department and Sports Authority of India that are located on the bank of the river are also discharging wastewater into the stream. The volume of wastewater entering the stream from these institutions is estimated at 0.17 MLD (Table 10) (K.V. Raju, et.al, 2004). Open defecation by the slum dwellers located on the river bank (for ex. slums near Nagarabhavi, Mysore road of Ward No. 39) is a common scene that has resulted in the increased level of Biological Oxygen Demand, Chemical Oxygen Demand and E – coli. In addition, damage to sewerage system in the catchment area of the valley is contributing to the pollution (BWSSB, 2001)

Table 10: Pollution Sources

Institutions	Quantity of Water Consumed (litres per day)	Volume of Wastewater Generated (litres per day)
Bangalore University	NA	NA
Department of Atomic energy	1,10,000	88000
ISEC	53,000	42400
NLSIU	50,000	40000
Total	2,13,000	1,70,400

Source: Based on survey

The physico-chemical analysis of ground water collected throughout the stream at Peenya Industrial Area, Nandini Layout, Kamakshi Palya, Rajajinagar Industrial Area, near Mysore road and near Nagarabhavi revealed the presence of total dissolved solids, alkalinity, total hardness, magnesium, nitrates, COD and BOD in excess of prescribed standards as indicated in Annexure 3. The ground water collected at Mysore road and Nagarabhavi areas of Ward No. 39 appeared very hard, due to over exploitation of ground water resources. Similarly, the concentration of total dissolved solids is more in the ground water in Mysore road, Nagarabhavi and Peenya Industrial Area. The concentration of nitrates in the samples collected at Mysore road, Nagarabhavi and Peenya is more compared to the permissible limits indicating the seepage of municipal sewage into the ground water.

The main source of high BOD and COD content in the water samples may be attributed to the flow of industrial effluents from the industries and also the domestic sewage (organic wastes). In the ground water samples of Nagarabhavi area, the BOD and COD contents were 120 mg/l and 180 mg/l in excess of permissible level again indicating the seepage of municipal sewage into the ground water. However, the latest effort by BBMP to remove silt from the Vrishabavathi sewage canal at Bapujinagar on Mysore road, the remodelling of storm water drains and removal of encroachments promises prevention of further contamination.

Key Issues

Dependence on Ground Water

Ground water is one of the major sources of water supply in Ward No. 39. However, of late some areas have been connected with PWS from surface water source. The usage of ground water has decreased with the introduction of surface water supply; however, this varies among different areas and also consumption patterns. It was not possible to estimate the exact quantities of surface and ground water used as in majority of the houses; both the surface and ground water are stored in the same sump or tank.

Ground Water Depletion

Since ground water is highly vulnerable and important resource it is essential to understand the environmental implications of over exploitation. If intensive pumping from an aquifer continues, then adverse effects may occur resulting in declining ground-water levels which over the years has a direct correlation with increase in number of wells (refer Table 11). Tubewells have increased multifold after 90's with drastic increase of 53 percent in 2000 consequently the depths have reached more than 500 ft.

Table 11: Depth of Tubewells Over the Years in Feet

Year of drilling	0 – 100	101-200	201-300	301-400	401-500	Above 500	Total	Percen-tage
1966-1970	0	0	1	0	0	0	1	0.1
1971-1975	0	1	0	0	0	0	1	0.1
1976-1980	0	0	1	0	0	0	1	0.1
1981-1985	1	6	0	0	0	0	7	1.0
1986-1990	2	13	1	0	0	0	16	2.3
1991-1995	4	41	22	3	1	1	72	10.1
1996-2000	4	180	44	2	1	1	232	32.7
2001-2004	18	148	196	9	7	2	380	53.5
Total	29	389	265	14	9	4	710	100.0

Source: Based on survey

Increasing the depths have impacted on the quality of water, specifically hardness. In areas where there is more hardness, people resort to transport water from the other areas (from relatives and friends) or they purchase mineral water for drinking. Hardly any households got the water tested.

People are aware of the depletion of water resources. They are also clear that there has been an increase in the number of tubewells and the tubewells drilled with deeper depths which would lead to drying up of tubewells drilled much earlier. However, in areas like Chandra Layout, although the tubewells had dried up, people had not made any efforts to rejuvenate them because they did not feel the need due to sufficient supply of surface water and did not want to invest further.

Wasted Investments on Tubewells

Frequency of drilling tubewells has increased enormously since the year 2000 which may be attributed to the formation of new layouts and migration from the core areas to the outskirts. The reasons for drilling tubewells varied in different areas within the ward. The upcoming areas had no other alternative than drilling tubewells, as ground water was the only source.

The investment made towards drilling tubewell includes drilling cost, motor or pump sets cost, casing pipes, construction of overhead tank and sump. Cost varies according to the depth ranging from Rs.35,000 to Rs.50,000. Striking realities reveal that there are 873 tubewells within a small area of 2.9 sq kms, with huge investment made to the extent of Rs. 3.55 crore.

Apart from the cost of investment, operation and maintenance costs of tubewells are high. As the depth of water increases, the water needs to be lifted higher to reach the land surface leading to more energy consumption. As the lift distance increases, so does the energy required to drive the pump. Thus, power costs increase as ground-water levels decline. Depending on the use of the water and the energy costs, it may no longer be economically feasible to use water for a given purpose. Second, ground-water levels may decline below the bottom of existing pumps, necessitating the expense of lowering the pump, further deepening the well, or drilling a deeper replacement well. Thirdly, the yield of the well may decline below usable rates.

With the incorporation of Ward No. 39 into the Corporation limits, surface water was introduced and people have taken surface water connections inspite of having tubewells. Huge loss in terms of financial investments of Rs. 3.55 crore for drilling bore wells by newly developing layouts could have been avoided provided they were given surface water connection prior to the development of the layout depicting poor planning and co-ordination.

Absence of Institutional Set-up

Tubewells are the major source through which ground water is drawn, but documenting all issues related to tubewell is not the assigned responsibility of any department. Ground Water Department monitors ground water draft through the observation of wells across the states. Unless efforts are taken towards understanding the basic status of the extent of ground water usage, ecological damage will continue. Dependence on ground water is evident from the increasing number of bore wells significantly over the years. However, no serious thought has been given towards finding alternatives.

Poor Co-ordination among the Operational Departments

Poor co-ordination among different departments in providing infrastructure facilities within a ward was obvious. There is no common vision in the authorities allotting sites and those developing infrastructure facilities. Departments work on parallel lines, which results in chaotic development and waste of investments for both the government and the people. Providing surface water to the layouts consequent to them incorporating into the Corporation limits resulted in huge investments made by households on drilling bore wells.

Suggestions for Ground Water Management

- Government of India had circulated a Model Bill for regulation and extraction of ground water in the year 1990-91. The Central Government has since been repeatedly urging the State Governments to pass an appropriate legislation to introduce regulatory measures to protect sources of drinking water. The Karnataka Ground Water (Regulation for Protection of Sources of Drinking Water) Bill, 1999 proposes to bring into effect several regulatory measures. The Act proposes the vesting of authority in some officer of the Government (like the Deputy Commissioner) to regulate the use of groundwater for public good. This regulation includes the power to restrict extraction of groundwater through wells and pumps, which are within 500 meters of a public water supply. It empowers the officer to declare a watershed as “overexploited” and restrict, in specific ways, the extraction of groundwater in such a watershed.” In Karnataka, the State Cabinet on May 14, 2007 cleared the Karnataka Groundwater (Regulation and Control) Bill 2007 based on which the State Ground Water Authority would be established.

The Authority’s role would be to see that (a) registration is compulsory to all owners of open wells and tubewells (b) notify areas of ground water overexploitation. (c) no person, household or firm will be allowed to use ground water without the permission of the Authority. (d) obtain permission from the authority to dig a well or drill a tubewell made compulsory. (e) tubewell drilling agencies to register with the body. The Authority is empowered to i) cut power supply and acquire an open well or a tubewell if the owner fails to register himself, ii) to confiscate the machinery of agencies if they refuse to abide by the rules and iii) any violation would lead to imprisonment of six months and a penalty of Rs. 5,000/-. Apart from these it would be important to involve Geologists systematically to evaluate the ground water status at required intervals and integrate Department of Mines and Geology in this endeavor. Information on status and numbers should be in the public domain for more transparency. Alternative arrangements can be made where group wells could be encouraged to save costs. It would be important to make recharging ground water mandatory. This would provide a database on the number of tubewells drilled within a particular area which would facilitate policy decisions based on the geological conditions. Focus should be on reducing drilling of tube wells by providing options to the consumers in terms of better management of water resources.

- Rainwater harvesting is the need of the hour and States like Maharashtra, Punjab, New Delhi, Andhra Pradesh, Kerala, Tamil Nadu, Goa and West Bengal have already enacted Legislation almost making it compulsory. Rainwater harvesting is yet to gain momentum in terms of implementation, in Bangalore, which has around 5000 structures. Revised Master Plan 2015 recommends rainwater harvesting to be made compulsory for buildings beyond 2400 Sq ft, which is a welcome initiative, although it is relevant only to upcoming new areas; however, efforts towards extending the same to older areas needs to be taken up. BWSSB is working out options of promoting rainwater harvesting and would be more useful if it is taken up at each ward level. The production cost to the Board for 25 kilolitres of water (the amount of water a family consumes a month on average) is Rs. 590. A consumer is given a subsidy of Rs. 375, which means a loss of over 60 per cent for BWSSB. The Board, therefore, should offer an economic incentive to people who consume less piped water. In Ward No. 39, rainwater harvesting is not practiced in any part of the ward and BWSSB should take effective publicity drive.

- Creating awareness through campaigns on water conservation through mass media communication more intensely among the common people is of urgent need to save the precious resource. Such campaign on water conservation is also important and should be done in phases and planned approaches for effective implementation. In Ward No. 39 wastage of water was observed by households and slum dwellers which is, also obvious in other parts of Bangalore.

➢ Setting up a taskforce exclusively to regulate water supplies – for both surface and ground water sources will be useful. This taskforce may come up with clear guidelines to govern the water resources, its utilisation mechanisms, regulating the use, maintaining its quality and ensuring efficient use of available resources (fresh and reuse of wastewater, roof water harvesting) for sustainable use of natural resources. The taskforce would be helpful to coordinate all relevant departments and evolving strategies and guidelines covering the entire urban district area. Task force should network with ward level offices for coordinated efforts for better management of water resources.

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Annexure:

Annexure 1: Ground Water Draft from Various Sectors in Bangalore

Particulars	**Number of wells**	**Methodology**	**Quantity of water extracted in MLD**
Domestic use	2,61,573	From survey and assuming 1000 L per day per tubewell	261
Non domestic	65,393	———	———
Irrigation	28,250	KPTCL	———
Agencies	13,235	Concerned departments	156
Industries	4,400	DAG	46
Parks	413	Survey	15
Com. Establishments	432	Survey	11
Tankers	100	Survey	162
Others (Institutes, Offices, Hotels, Hospitals etc)	18,643	Assuming 5,000 L per tubewell	95
Total ground water extracted	3,26,966	——-	746

Note: The results above have been evaluated from survey

Annexure 2: Water Consumption in All Areas of Ward 39 in litres per day

Newly developed Areas										Old Areas which were formerly villages			
Water consumption in liters per day	Chandra layout	Guru sarva boma	ITI layout NGB	ITI_CL	Jyothi nagar	Metro layout	Vidya giri layout	Vina yaka layout	Nagara bhavi	Panthara palya	Ganga dona halli	Nayand halli nagar	Total
Upto 250	4	0	0	0	1	0	0	1	5	0	0	0	11
251 – 500	23	7	2	0	5	4	2	4	22	0	1	5	75
501 – 750	18	3	2	0	2	1	1	1	14	0	1	6	49
751 – 1000	94	14	22	14	17	21	7	17	84	5	24	30	349
1001 – 1500	4	1	0	0	0	1	1	1	15	0	1	3	27
1501 – 2000	11	0	0	0	3	4	0	2	6	0	0	6	32
2001 – 3000	9	0	0	0	2	3	0	1	3	0	0	4	22
3001 – 5000	4	0	0	0	1	1	0	1	3	0	0	3	13
>5000	1	0	0	0	0	1	0	1	1	0	0	1	5
Total	168	25	26	14	31	36	11	29	153	5	27	58	583

Annexure 3: Ground Water Quality in and Around Vrishabhavathy River

Sl. No.	Constituents	Desi rable limits Mg/L	PI Area	Nan dini Lay out	Kama kshi palya Indus trial area	Mysore road	Nagara bhavi 1st stage
1	Ca mg/L	75	173	51	83	122	134
2	Mg mg/L	30	49	36	33	45	43
3	Na mg/L	—	187	67	117	125	165
4	K mg/L	—	2	1	8	16	9
5	Fe mg/L	0.3	0.55	0.45	0.698	0.17	0.025
6	HCO_3 mg/L	200	549	287	456	407	508
7	CO_3 mg/L	—	Nil	Nil	Nil	Nil	Nil
8	Cl mg/L	250	316	76	98	190	207
9	NO_3 mg/L	45	54	18	27	66	71
10	SO_4 mg/L	200	98	64	69	122	104
11	TDS mg/L	500	1190	490	700	920	1020
12	SC µhmos/cm	—	2080	840	1210	1560	1740
13	TH mg/L	300	628	272	340	484	508
14	PH	6.5-8.5	7.03	7.83	7.46	7.44	7.08
15	F mg/L	1.0	0.24	0.37	0.22	0.28	0.29
16	COD mg/L	5	Nil	Nil	Nil	Nil	180
17	BOD mg/L	2.5	Nil	Nil	Nil	Nil	120
18	DO mg/L	>4	—-	—-	3.4	5.7	Nil