

IMPACT OF URBANISATION ON GROUND WATER REGIME - PREPARATION OF URBAN DEVELOPMENT PLAN FOR THE MANAGEMENT AND REGULATION OF WATER RESOURCES OF LUCKNOW METROPOLIS, UTTAR PRADESH

Kalpana Arun, *Scientist 'D'*
Central Ground Water Board, Lucknow

1.0 INTRODUCTION

Water is the life-blood of communities and the prime determinant of the sustainability of urban region. Settlements have always located themselves in the proximity of easily accessible water resources in the past. The reduction in availability of this resource in the past has led to decline of major civilizations in the past.

High rate of growth of urban population has resulted in demand for expanded supply of good quality water. In future wars may be fought over water rather than petrol or politics. The trials and tribulations of people facing an up-hill struggle for water envisages harrowing future when not a single drop of water will be available if the present crisis is not resolved.

It is strange that two- third of the surface of earth is covered with water and yet it's inhabitants are thirsty. But the fact is only 2.5% of this is fresh water and is stored in the icecaps of Antarctica and Greenland and as Fossil Ground Water. Only 0.26% of this is accessible and obtained from reservoirs like lakes, rivers and streams. This means that out of a huge presence of water on the earth only 0.007% is available on sustainable basis and is actually renewable.

India may have entered the 21st century as a nuclear power. It might become a crucial cog in the affluent wheel of globalization in the new millennium. But it will be a bitter irony if large masses of people are denied basic water, to drink, to cultivate their land and to quench the thirst of their cattle. The water crisis has reached threatening proportions in the country.

The rapid metamorphosis towards lop-sided modernity has triggered the use of pesticides, chemicals and fertilizers contributing towards the contamination of whatever water available. Plus, Two-thirds of the country's fresh water is lost every year due to evaporation and runoff to the sea. A recent report by the World Wide Fund for Nature And The UN Emergency Fund has blamed pollution of surface and ground water to the poor management of water resources,

inadequate legislation and faulty implementation of existing laws for the stark scarcity of water in contemporary India.

India does not lack fresh water; what it lacks is proper management of water resources. Besides, the imbalance between need and use has thwarted the sustainable use of water making it a highly vulnerable and an endangered commodity. It is estimated that India along with many other countries will face severe water stress by the year 2025.

The amount of water wasted in big cities is incredible, especially when compared to the few daily pots of water which women bring home after long treks through deserts and hills.

In fact, to give one example, the flush system in the urban toilets waste a huge amount of water, not to speak of the wastage through municipality running taps or the obscene levels of "water management in five star hotels". This poses a threat to the social fabric divide, as different groups may squabble for a decreasing quantity of water.

What adds to the agony is the contamination of water and its resources. The use of chemicals and pesticides has created a fresh water management problem. Ground water pollution has been noticed during discharge of industrial wastes into natural drains. In 1987, the number of people at risk from drinking water with excess of fluoride content was estimated at 25 million.

Preparation of urban development plan requires reliable and comprehensive information regarding historical and cultural background of the city, its landscape and topography, existing landscape pattern, population dynamics of the city and unforeseeable urban expansion and planning for the required infrastructure facilities such as transportation, electrification, water, education, recreation and medical care.

At present the Master Plan 2001-2021 for Lucknow metropolis is in existence but the exercise for the preparation of the new millennium master plan has already begun and the work has been already awarded to a Calcutta based private agency which has been entrusted with the task to draft the new master plan within a time frame of sixteen months.

In 1998, the share of ground water in the total supply of Lucknow was almost two-third. This speaks of important role of ground water in the total water resource management in the coming years.

This paper has been attempted to show the importance of conservation of water resources of Lucknow metropolis with special reference to ground water with a plan for its management and regulation.

2.0 HISTORICAL AND CULTURAL BACKGROUND AND DEVELOPMENT OF LUCKNOW.

It is believed that the city was originally founded by Lakshman, brother of Lord Ram and was originally called Lakshmanpur. The building programme of Lucknow was started by

Sheikhs in 15th Century, with their built fort 'Lakhan Quila' and the new born city got the name Lucknow.

Lucknow, which is situated on the banks of Gomti and is the capital of Uttar Pradesh, was the abode of Nawabs and has evolved from its humble origin to a bustling modern city. It has since many centuries occupied a place in the history of our country as one of the foremost and excellent centers of Hindu-Muslim composite culture.

Many Mohalla's were built up to the south of the Chowk, during the reign of Akbar. Asaf-ud Daula made many significant additions in the city and it grew up around Chowk mainly on the western side. It was then that the Charbagh, Aishbagh came into existence. Amjad Ali Shah further expanded the area of the city and many famous areas like Aminabad and Hazratganj were built up. The credit of setting up Kaiserbagh, Alambagh, Sikandarbagh goes to Wazid Ali Shah, the last mogul of Avadh.

After the freedom struggle of 1857, inspite of the great efforts, the city fell into the hands of British's. It was then that the Brigadier General Sir Robert Napier, designed a plan for Lucknow especially for Defence purposes. Lucknow expanded further after partition due to influx of refugees and also due to rural and urban immigration in the city.

3.0 LANDSCAPE OF LUCKNOW

The landscape of Lucknow has broadly resulted from the fluvial process of river Gomti during Quarternary times. The area forms part of the Lower Gangetic Plains and comprises alluvial sediments brought by the river from the outer Himalayas. The deposits present belong to Quarternary era and primarily comprise of sand, silt and clay. In retrospect it is remarkable to note that the planners of old Lucknow had made the maximum utilization of landscape. The town development is mainly in the higher terrace, which is free from the floods and ravages of water logging. The natural drainage channels like Ghazi-ud Din Haider Canal were diverted and deepened by them for the disposal of effluents and excess surface runoff into the Gomti.

4.0 DEMOGRAPHIC ANALYSIS OF LUCKNOW

In 1961, the Lucknow Urban Agglomeration had a population of 6.56 lakh. The rural population of 124 villages was 1.10 lakh. The total population of Lucknow metropolis was 7.66 lakh. When in 1981, the population of urban Agglomeration rose to 10.08 lakh and Lucknow attained the status of a metropolitan city. The 1991 Census showed that the Lucknow Urban Agglomeration has reached a population size of 16.69 lakh and the rural population of 161 villages included in Lucknow metropolis was three lakh. Thus, the population of Lucknow Urban Agglomeration grew over three times since 1951.

The projected population of Lucknow Urban Agglomeration is as under :

Table 1 : Projected Urban Sprawl - Lucknow Metropolis

YEAR	POPULATION PROJECTED (LAKH)
2000	22.8
2001	23.7
2011	32.5
2015	37.3
2021	45.3

Between 1991 and 2021, a population of about 28 lakh will be added to Lucknow Urban Agglomeration and about 5 lakh of population would be added to the rural areas. The task of providing safe drinking water for such large population under environmental sustainable conditions is a major challenge of local authorities.

In 1991, the overall density of Lucknow NMP was 52.22 percent persons per hectares. However, the density of older part of the city was more than 400 persons per hectares. The land use pattern of Lucknow shows an increasing emphasis towards residential areas. The cascading growth of population is causing imbalance in the land use pattern, it is further causing multifarious problems like water scarcity problem, polluted environment.

5.0 AREA AND LAND USE AND PATTERN

The visual study carried out by RSAC of LISS III data of 1997 showed the Urban Area of Lucknow is 206.72 sq.km. and the rural area is 504.93 sq.km. Thus, an area of 711.65 sq.km. is taken for planning purposes.

The land use pattern of Lucknow shows an increasing emphasis towards developing residential areas as the percentage is increasing from about 30% of 1965 to 67% as proposed to be developed by 2001 A.D. This imbalance in favor of urbanization is effecting the sector of transport, employment, public and semi-public facilities.

Table 2 : Land use pattern

LANDUSE PERCENTAGE	1965	1987	2001
Residential	29.29	48.91	67.20
Commercial	1.85	2.43	4.10
Industrial	3.31	6.50	3.10
Institutional(Public and Semi-Public)	16.86	15.02	8.2
Transport	13.69	10.38	9.5
Recreational	4.0	3.78	7.9
Vacant and Water Body	31.0	12.98	-

6.0 LAND USE AND URBAN SETTLEMENTS OF LUCKNOW CITY AND ITS ENVIRONS FOR 1997,

(Based on the study done by RSAC, Lucknow, digital analysis of IRS LISS III and PAN merged data)

The study provides an over view of the actual land use. It shows that 17% of the total city area comes under unplanned and high density built up area and the new colonies which come under land and high density built up area is only 15% of the city area. Besides this, the vegetation coverage spread over about 10.24% of the city on both sides of Hyder Canal , along the railway lines e.g. in the fringe areas of Lucknow-Faizabad Road, which is badly encroached upon.

7.0 SUBSURFACE CONFIGURATION AND AQUIFER DISPOSITION

The distribution of aquifer system in the area and following observations emerge from the perusal of the same two groups of aquifers are discernible down to a depth of 245m. The sediments are generally fine textured in upper part of aquifer becoming medium grained progressively with depth. The aquifer system is overlain by a top clay bed which is silty and sandy at places of variable thickness.

8.0 WATER SUPPLY

8.1 Existing water demand and supply scenario

Present drinking water requirement of the city is 703.42 ml/d considering WHO specifications on 250 lpcd. However, it is partially met since the supply is about 4 to 6 ml/day with the break of 126 ml/day from surface water sources and 300 ml/day from ground water sources during 1998.

8.2 Projected demand of water and expected shortfall in the supply

The importance of protected water supply was experienced and the water works came into existence in 1894. Since then the population has increased many fold and accordingly the requirement for protected water supply has also increased. But it has not been possible for the civic authorities to increase the supply capacity commensurate with the growth of population and its total demand.

The only source of water in Lucknow in earlier days was through river Gomti. The domestic consumption per capita was only 40 gallons per day. The water consumption towards industrial base was negligible. Due to the change in the cultural habit, the per capita water consumption has increased tremendously. The commission on urban population has estimated the requirement of water which has been assumed for the rest of the urban population living in various categories of town and other than class I cities and metros.

Generally, in urban areas too, growth of population is probably faster than fulfilling the water requirements. Considering WHO specifications of 250 lpcd the present drinking water requirement of the city is 550 mld. The current water supplied by the Lucknow Jal Sansthan is

only 426 mld. The table below shows expected per capita water consumption for the present and future.

Table 3 : Projected per Capita Water Consumption for the Present and Future

AREA	POPULATION PROJECTED (LAKH)	DEMAND MLD	SUPPLY MLD		GAP BETWEEN SUPPLY AND DEMAND MLD
			RIVER WATER	GROUND WATER	
1999	21.9	550.00	126	300	124.00
2000	22.80	569.25	126	300	143.25
2001	23.39	583.00	126	300	157.00
2007	28.55	713.75	126	300	287.75
2015	37.31	932.75	126	300	506.75
2021	45.00	1125.00	126	300	699.00

The above table shows that the dependence on ground water is considerably more than the surface water. Presently about 70% of the water requirement is supplemented by ground water resources while only 30% of the water requirement is supplemented by surface water. It is inferred that 28% of our population would suffer from water scarcity by the year 2021 unless suitable measures for its management are not taken.

9.0 CAUSES AND EFFECT OF URBANISATION

The point that is to be stressed is that this crisis is man made, designed by entrenched structures and actually accentuated by worsening pollution and ecological devastation. There is not a single river near a city which has escaped decay and the huge waste from urban gutters, chemical and industrial effluents and miscellaneous filth that has turned them into slow streams of dense poison.

Based on the study of pattern of population growth it is observed that ground water resources are being affected in two ways.

1. The concentration of population is very high in older parts of the city.
2. Enhancement of the paved area.

Firstly concentration of the population is affecting the first of top aquifer system and the pressure on it is increasing day by day. Secondly, the enhancement of paved area is reducing the ground water recharge. These two factors are adversely affecting the ground water regime entailing its proper management.

The C.G.W.B. is monitoring ground water regime of Lucknow district through a network of twenty-three hydrograph stations regularly.

The long term analysis of water table from these hydrograph station is given below in Table No. 4

Table 4 : Long Term Behaviour of N.H.S. in Lucknow District

N.H.S.	LOCATION	MEAN WATER LEVEL(M)	PERIOD	TREND
LKO 01	MALIHABAD	4.41	1977-97	-1.82
LKO02	MOHANLALGANJ	4.07	1977-97	-2.04
LKO03	AMAUSI	5.25	1977-97	-4.52
LKO04	KAKORI	9.27	1977-97	-5.08
LKO05	MAL	4.54	1977-97	-3.66
LKO06	INTAUNJA	8.74	1977-97	-3.11
LKO07	CHINHAT	4.98	1977-97	-1.66
LKO08	GOSAINGANJ	2.44	1977-97	+2.38
LKO09	BANI	4.85	1977-97	-1.66
LKO10	AMINABAD	11.38	1977-97	-12.37
LKO11	GOSAINGANJ	2.34	1977-97	+1.09
LKO12	NAGRAM	1.97	1989-97	+0.23
LKO13	NIGOHAN	6.95	1989-97	-4.07
LKO14	GANGA GANJ	10.41	1989-97	-1.59
LKO15	ARJUN GANJ	6.61	1989-97	-0.76
LKO16	SINSANDI	5.19	1989-97	-5.44
LKO17	BAKSHI KA TALAB	7.25	1989-97	-4.71
LKO18	RAHIMABAD	8.08	1989-97	-4.71
LKO19	KATHWADA	10.70	1989-97	-2.65
LKO20	KUSHAN GANJ	7.00	1989-97	-2.51
LKO21	NARAYANPUR	5.05	1989-97	-3.48
LKO22	KAHAWAH KHERA	1.58	1993-97	-0.02
LKO23	MUNSHI GANJ	5.36	1993-97	+1.57

A perusal of the above table show that the average water level in Lucknow city and its adjoining area is 6 mbgl and the average trend of water level is -2.85 m. It is further pointed out that the areas in the vicinity of Canal Command are showing rising trend. e.g. (Gosainganj, Munshiganj,

Nagram). Long term analysis of water table at (Aminabad) hydrograph station in the central part of the city area indicates that during the last twenty years, the water level has gone down from 6m to 17m due to over exploitation of ground water resources in the city and the rate of decline of water level at Aminabad Hydrograph station is 0.56 m/yr showing alarming situation. This also confirms that the maximum fall in waste level is found in those areas where population density is high.

What is needed today is water management and conservation strategy with adequate policy intervention. An active participation of the local communities people should be made to pay for water to curb it's wastage and political interest have to be sidelined to achieve this. Any wastage of water should be regarded as criminal.

10.0 PLAN FOR MANAGEMENT OF WATER RESOURCES

Water scarcity brings with it a "cascade effect" on the entire range of activity. In any case 70% of water from lakes and underground water is used for irrigation purposes and for daily needs. There is no option. Some hard decisions have to be taken. Water for urban usage needs to be shifted towards agriculture.

We must manage our water resources and landuse in such away that the growth of population keeps pace with our water requirement. Otherwise Delhi like situation would arise where the Apex court had to intervene to check the indiscriminate exploitation of our ground water resources. Following Plans for the management of our ground water resources of Lucknow Metropolis are suggested:

1. It is recommended that while preparing the Master Plan of the city ,a corresponding water management scheme should also be chalked out for the city planners. For this they should seek the approval of Ground Water Authority and its 'No Objection Certificate'.
2. No compounding schemes should be allowed for the sake of Government revenue.
3. Where multistoried complexes are proposed water demand could be met by tapping deeper aquifers (Second or Third) after carefully considering the quality aspect. Similarly in highly dense areas, only deeper aquifers should be tapped to meet the water demands.
4. Similar guidelines should be made for catering water needs in the industrial sector Group Housing Scheme, multi storied complexes and commercial set-ups.
5. Only vertical growth should be allowed in areas where land is costly and only those builders should be given permission who can afford costly tubewells.
6. It is also suggested that the growth of the city should be in a self contained polycentric pattern of development. This would help in reducing stress on the first aquifer as the population would be more or less evenly distributed.

7. Recharge of ground water regime by adopting various means like roof top rain water harvesting and surface run off rain water harvesting could a be few of the measures which can be adopted.
8. To recharge the ground water regime, small pits having beds of permeable material may be made mandatory in the open space/ lawn of each dwelling unit so as to force the roof top water to percolate into ground water.
9. The government and the NGO's should launch a public awareness campaign. Alternative technologies and community participation for water conservation may help to combat this scarcity..

11.0 REGULATORY FRAMEWORK REQUIRED FOR MANAGEMENT OF WATER RESOURCES

We must monitor our water resources so that they are fully replenished prior to further exploitation. Our aquifers should be given due time for replenishment and recharge. There must be constant monitoring so that water table may not further go down. For this following regulatory measures are suggested.

1. A Model Bill to regulate and control the development of our ground water resources should be passed. The framework of this bill should be such that at the macro level the ground water development agency should seek No Objection Certificate from the Ground Water Authority. While preparing the Master Plan of the city with regards to the management of water supply from the surface and ground water resources.
2. Registration of existing users in the State and introduction of permits for drilling water wells and extraction of ground water.
3. Payment of surcharge for industrial withdrawals.
4. In order to recharge the ground water regime, the small pits having beds of permeable material may be made mandatory in the open space/lawn of each dwelling unit so as to accommodate roof top rainwater into ground water.
5. The development authority should seek advice from Central Ground Water Authority/CGWB regarding suitable sites for artificial recharge purposes. Such areas for artificial recharge should be left as open spaces, parks etc in the Master Plan 2001-2021.
6. Using ground water through borings at present is completely free so that unjudicious use of water is inevitable. The use of such water can be regulated through regulations.
7. The drainage of wetlands, destruction or diversion of natural drainage lines in the landscape, reclamation of low- lined lands, the filling of ponds and sundry water bodies continue unabated.