Indian Urban Centers in need for Water Sensitive Urban Planning Approach.

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ABSTRACT:
Water is a natural resource, fundamental to life, livelihood, food security and sustainable development. It is also a scarce resource. India has more than 17 percent of the world's population, but has only 4% of worlds renewable water resources while covering 2.6% of worlds land area.
Recently India too has been affected by Climate Change and Urbanization effects. Indian Urban centre's are continually facing problems of water availability.
And to addition now a day's declining water sources are a cause of immediate concern to Urban people.
The paper attempts to study the present problems in various urban centers of India related to water scarcity and availability. Also reasons for such Urban issues will be highlighted from Urban Planning point of view and suggestions , some remedies and precautions for better water availability and runoff incidents will be suggested.
A case of Bhopal as developing Urban centre with recent water issues will be studied in detail.

1.1 STUDY: INDIA

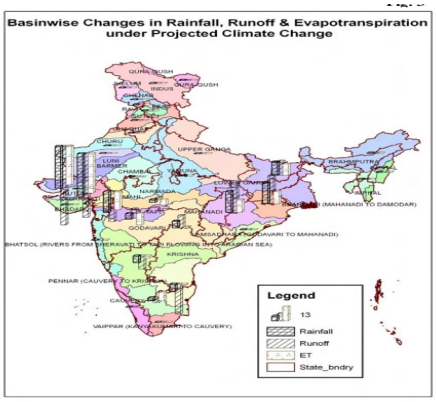
As per report a worldwide observed increase in urban land area of 58,000 km^2 from 1970 to 2000. India, China, and Africa have experienced the highest rates of urban land expansion, and the largest change in total urban extent has occurred in North America. Across all regions over all three decades, urban land expansion rates are higher than or equal to urban population growth rates, suggesting that urban growth is becoming more expansive than compact.

More than half of the world's population live in urban areas and more than 90 percent of future population growth is likely to be concentrated in cities, and mainly in poor countries.

Urbanization initiates one of humanity's most dramatic land use changes. According to the 2001 census, 27.8 % of the Indian population resides in cities, compared with 25.5% in 1990. The urban population is expected to rise to around 40% by 2020(UN-HABITAT 2003).

Urbanization - both as a social phenomenon and a physical transformation of landscapes - is one of the most powerful, irreversible, and visible anthropogenic forces on Earth. Many of the most important and significant changes associated with the impact of globalization are taking place in urban areas.

Extreme conditions posing problems of water management exist in the country – there are floods followed by droughts. Indian Rivers that are known as water provider for all, are now a day's suffering environmental degradation due to increasing Urbanization like less rainfall, more runoff and more evaporation.



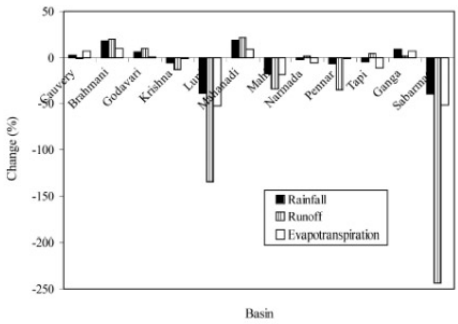


Figure 2. Changes in Rainfall, Run-off and Evapo-transpiration due to projected climate change

Figure 1. Changes in rainfall runoff in major rivers of India.

2.0 INTRODUCTION :

This paper analyzes the impact and effect of 'supply-based' water availability on urban water use with special emphasis on groundwater in an Indian context.

The level to which a given city depends on groundwater to meet its water demand depends on a variety of factors.

1. The first set of factors can be called as *physical/geographic:* availability of sufficient groundwater either from natural recharge due to combination of good rainfall and receptive sub-surface geology or from other sources such as canals, good aquifers that can store and transmit groundwater, availability of good quality groundwater that is not subject to constraints such as saline water intrusion.

2. The second set of factors is determined by the ability of the urban area to cope with its water demand from external sources.

On the overlapping these two sets of factors, one can arrive at the general level of dependence of urban areas on groundwater and their vulnerability at present and in future to meeting their water demands from external sources and by Proper physical planning.

Table No.1.. Shows the urban centers as per world ranking and the water profile for same.

World Rank Largest urban area	World rank urban land(footprint)	Urban Area	Population Estimate	Year	Base Year Population Estimate	Density	Land Area: Km2	Density	Basey ear	Water demand	Water supply	Decline in water levels
4	43	Delhi DL-HR-UP	22,242,000	2012	21,622,000	29,700	1,943	11,500	2011	914 mgd	740 mgd	7.92 to 9.25 m
13	198	Mumbai, MAH	16,910,000	2012	16,600,000	80,100	546	30,900	2011	4525 mld	3230 mld	20cm/ year
19	80	Kolkota, WB	14,374,000	2012	14,113,000	30,900	1,204	11,900	2011	969million l/day	144.4 mil/d	9m to 16 m 45cm/ year
31	183	Chennai, TN	8,865,000	2012	8,696,000	37,700	609	14,600	2011	1026.26 ld	1586 ld	5m-10m
33	151	Bangalore, KAR	8,670,000	2012	8,499,000	30,400	738	11,700	2011	1275 MLD	1315 ld	0-2 m

38	121	Hyderabad, AP	7,903,000	2012	7,749,000	23,200	881	9,000	2011	600 mgd	340 mgd	5-20m
47	307	Ahmadabad, GUJ	6,352,000	2011	6,352,000	55,200	298	21,300	2011	863m ld	760 mld	44.5-90 m
127	464	Jaipur, RAJ	3,140,000	2012	3,073,000	48,300	168	18,700	2011	445 MLD	352.5	3m/year
140	359	Luckhnow, UP	2,963,000	2012	2,901,000	32,200	238	12,400	2011	509.85 mld	480.00	1.69 m/year
163	381	Nagpur, MAH	2,551,000	2012	2,498,000	30,000	220	11,600	2011	361 mld	515 mld	0.1 - 11.2 m
213	570	Patna, BR	2,093,000	2012	2,047,000	42,700	127	16,500	2011		136.87	4m/year
229	517	Bhopal, MP	1,924,000	2012	1,883,000	33,800	148	13,000	2011	350 MLD	232 mld	>4m/year

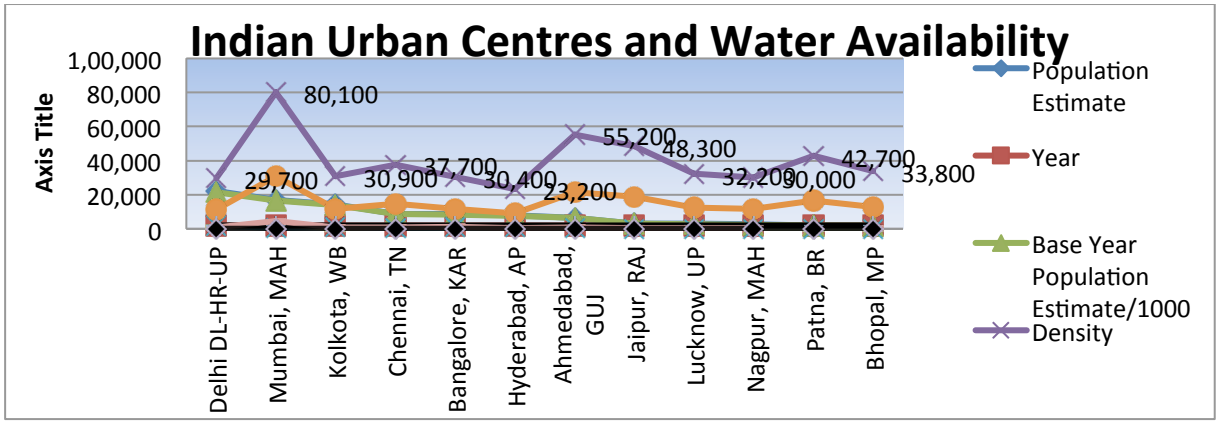


Figure 2 : Population projection, density , land area and water supply, demand and decline.

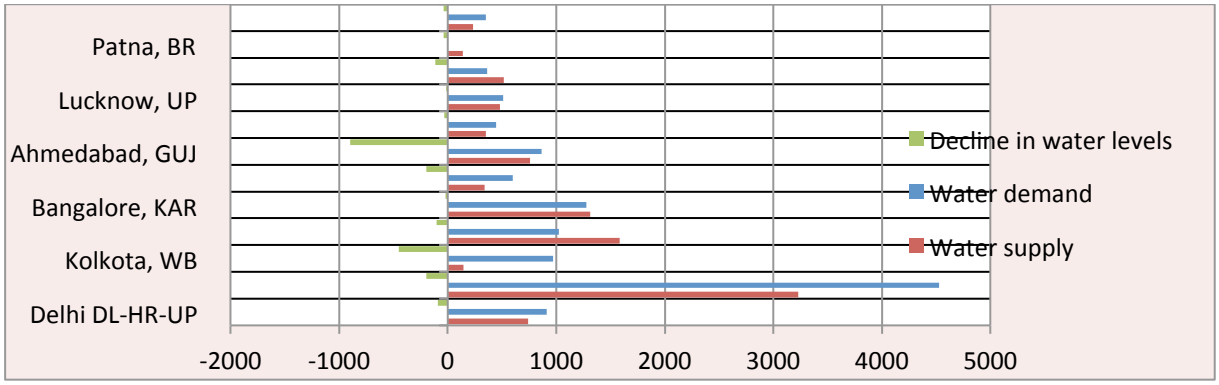


Figure 3. Indian largest urban centres and water supply , demand and declining water levels

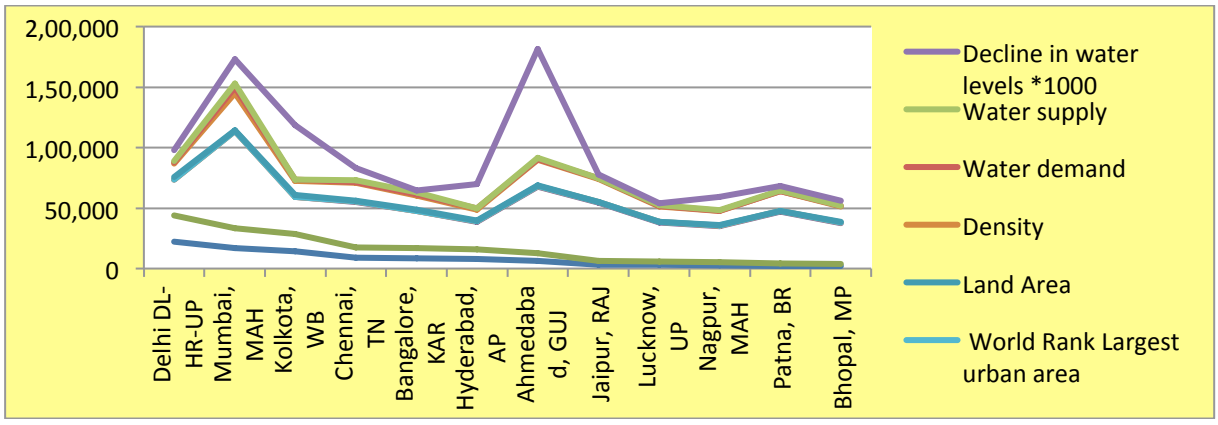


Figure 4. Water Supply, Demand and Decline in water .

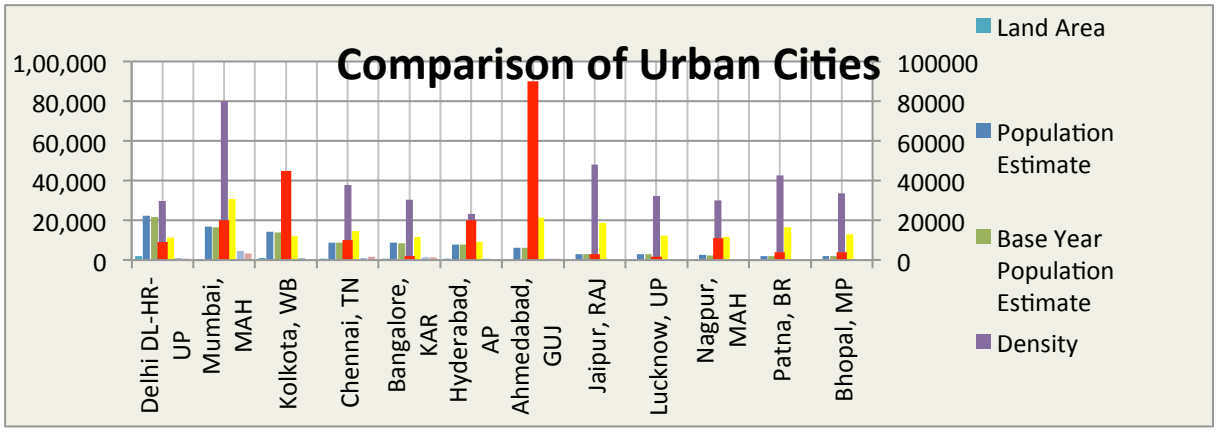


Figure 5. Urban centers and their comparison.

3.0 OBSERVATION :

Urban Centers like Ahmadabad and Mumbai are facing high density as well as drastic declining water levels. Jaipur , Kolkata comparatively have average adjustment of water supply due to projects, but Kolkata facing water levels declining. Chennai has developed a network from out sources and fulfilled the demands . Luckhnow Jaipur, Bhopal , Patna , Bangalore though have less declined water levels still have limited capacity of water and total water content would be remaining same . Bhopal recently faced the drying of its Upper lake in 2009 to 4% of its surface area thus leaving people without water.

Major cities have more demand due to high living standards and also due to more number of Slums.

Many cities have less land and more population that makes less area available for open parks and other natural surfaces.

The planning norms for land use in Master plans for various cities are as follows:

Table No. 2. Land use distribution as per UDPFI Guidelines (UDPFI- Urban Development pland formulation and Implementations Guidelines)

Land use category	Percentage of Developed Areas			
	Small	Medium	Large	Metro
Residential	45-50	40-45	35-40	35-40
Commercial	2-3	3-4	4-5	4-5
Industrial	8-10	8-10	10-12	12-14
Public-Semi Public	6-8	10-12	12-14	14-16
Recreational	12-14	18-20	18-20	20-25
Tranport & Communication	10-12	12-14	12-14	15-18
Agriculture & Water bodies	Balance	Balance	Balance	Balance
Total Developed area	100	100	100	100

This Shows that only 15-25 % of area is kept for recreation, water body and agriculture, which also we see are many times paved and converted into developed ones. This reduces natural recharge of Urban Land surfaces creating less recharge and more runoff.

3.1 URBANIZATION AND WATER MANAGEMENT:

Urban Planning has been left quite behind, by the speed of Urbanization as it has steadily replaced open spaces and forced dramatic changes to watersheds in the process. Natural drainages have been

replaced by human structures, or reengineered for human purposes. Human land use activities have imposed significant influences on watershed processes. The Activities proposed or going on land surfaces do not favor the natural processes many times and hence hamper their working. Urban Planners are facing limitations in coping up with this particular problems of decreasing Water resources and shortage in natural recharging of ground water.

When an area is developed for housing or other urban purposes, the immediate hydrologic effect is to increase the area of low or **zero infiltration** capacity and to increase the efficiency or speed of water transmission in channels or conduits (Dunne and Leopold 1978).

4.0 URBAN DEVELOPMENT SIGNIFICANTLY CHANGES THE HYDROLOGICAL CYCLE..

The main changes of the physical pathways of the water cycles due to urbanization include:

- removal of natural vegetation drainage patterns;
- loss of natural depressions which temporarily store surface water;
- loss of rainfall absorbing capacity of soil;
- creation of impervious areas (e.g., rooftops, roads, parking lots, sidewalks, driveways)
- provision of man-made drainage systems (e.g., storm sewers, channels, detention ponds).

Therefore, although the hydrological cycle consists of the same elements, their proportions in urban area are significantly different due to following reasons:

- interception of rainfall is reduced due to removal of trees;
- precipitation is usually higher than in rural areas;
- evapotranspiration is much lower;
- surface run-off is much larger;
- ground-water run-off, infiltration and recharge is small;
- water storage is much lower;
- runoff volumes and peak flows in rivers are higher;
- frequency of surface runoff is increased.

These changes impact strongly water habitats: increased discharges erodes stream beds and banks, exports high concentrations of pollution into the rivers, wetlands and reservoirs, destabilizes ecological processes, handicap ecological stability of ecosystems. All this not only reduce aesthetic values of the city, but also restrict provision of ecosystem services and causes water-related problems to the urban population, related to flood risk, water supply, drainage, wastewater collection and management.

Alterations to natural drainage basins , either by the impact of forestry, agriculture, or urbanization impose dramatic changes in the movement and storage of water and thereafter availability of water.

5.0 CASE STUDY –BHOPAL CITY

Built up Area Calculation- Chronological Method using GIS Imageries for Subsequent years and calculating the urban sprawl by grid cover.

Changes in land use affect basins in the two hydrologic regimes differently. Where overland flow predominates, Run-off moves at rapid, surface flow rates. Thus, urbanization in regions of HOF (in which water runs over the land surface) increases the net percentage of precipitation that reaches the channel

The study of Paper involves the impact assessment of changes in natural drainages in some wards in Bhopal City, India along with Villages in natural vicinity to predict the impact of urbanization and built up areas to natural recharging and subsurface flow of precipitation.

The villages having natural environment are also assessed to study impact of land use on different soils

Table No.3 *Comparative Analysis of Built up in safe side of Natural Working System.*

S.N	WARD	Recharge (year)						Drop in Recharge % Average	Increase in Built up %
		1991	1994	1996	2001	2004	2009		
1	25(Tulsi nagar)	12.56 9.49	17.83 11.56	17.07 9.80	10.64 3.20	9.65 4.23	12.76 3.21	Decrease 75% to 25%	44.7 to 70.43%
2	26 (Panchsheel)	8.65 8.26	12.28 10.35	11.76 9.71	7.33 4.56	6.65 1.07	8.79 0.97	Decrease 95% to 11%	2.64% to 88.96%
3	27 (MANIT)	135.19 134.29	191.98 134.29	183.82 188.60	114.55 179.61	103.87 107.00	137.32 95.39	Decrease 99% to 69%	0.31 % to 11.71%
4	28(Chuna Bhatti)	666.59 643.62	946.63 821.73	906.41 761.14	564.83 457.16	512.13 338.32	677.14 398.52	Decrease 96.55 % to 58.85%	2.22% to 41.14%
5	45(Ravishankar Nagar)	208.41 159.64	295.97 229.98	283.39 220.78	176.601 137.70	160.13 125.42	211.70 175.32	Decrease 76.59 %to	76.6 % to 85.86%
6	48(Arera Colony)	136.72 90.03	194.16 60.69	185.91 46.19	115.85 16.42	105.05 13.50	138.88 7.08	Decrease 65.84 %to 6.73%	0.16 to 94.9%
7	52 (Shapura)	25.22 24.10	35.82 33.18	34.29 31.13	21.37 11.80	19.38 10.20	25.62 13.25	Decrease 95.55% to 51.71%	1.11 to 48.27%
8.	34 Jawahar nehru	10.97 3.53	15.57 4.47	14.91 2.41	9.29 1.20	8.43 0.62	11.14 0.80	Decrease 32.17% to 7.18%	58.52 % to 92.79%
Villages in Nagar Palika									
1	Akbarpur	10.43 9.87	14.82 13.92	14.19 13.14	8.84 5.86	8.02 4.76	10.60 3.90	Decrease 94.63 to 36.79%	2.81 % to 63.23%
2	Nayapura	29.93 28.22	42.51 39.78	40.70 37.47	25.36 22.34	23.00 19.07	30.41 23.88	Decrease 94.28 to 78.52%	3.88 to 21.46%
3.	Bairagarh Chichli	53.41 52.85	75.84 73.96	72.62 70.29	45.25 43.73	41.04 39.60	54.25 52.33	Decrease 98.95 % to 96.46%	0.86 to 3.55%
4.	Neel bad	26.24 25.10	37.2735.53	35.68 34.03	22.24 20.82	20.16 18.72	26.66 24.22	Decrease 95.65 % to 90.84%	1.01 % to 9.15%

Some Areas though urbanized maintained recharge but some areas though rural failed the expected recharge. Recharge has decreased in areas with instant development of Built up areas indicating the increase in Impervious layer to the geology of the area.

This decreases the pervious layer and increases evaporation along with runoff resulting in Wastage of water and less water table called water recharge.

The areas having Basalt stone with water level 3-6m is most suitable for urban development as the water table depth of 3-6m soil gets affected by the foundation and excavation activities of the development.

5.0 CONCLUSION :

The present scenario of water resources and their management in India has given rise to several concerns, important amongst them are;

1) Large parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security.

2) Issues related to water governance have not been addressed adequately.
3) There is wide temporal and spatial variation in availability of water, which may increase substantially due to a combination of climate change, causing deepening of water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc.
4) Absence of meaningful water framework law .
5) Not enhancing means and innovations for water available for use.
6) Absence of Strong Institutional arrangements. No Proper Hydrogeological planning.
7) No scientific application of Planning components and demographical projections.

7.0 STUDY AND WORK DONE WORLWIDE:

- Seattle, Washington has efficiently incorporated the plan of "Seattle's Natural Drainage Systems" practically and observed the positive changes.

- Grounds Anderson, have prepared numerous impact analyses receiving approval from the Harris County Flood Control District, the City of Houston, FEMA, TxDOT, Harris County, the City of Pasadena, Fort Bend County, City of Sugar Land, HCTRA and other jurisdictions across the State of Texas.

- 3. . Greenhill avenue area storm drainage study Public works department, Capital Planning & Implementation Division Hamilton .

- Environmental assessment and Finding.**, Surface Water Drainage System,** United States Department of Energy,Rocky Flats Environnemental Technology SiteGolden, Colorado.

- Enhanced filtration and contaminant degradation opportunities offered by natural drainage systems , Washington, DC .
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- Preliminary Drainage Study for Clearwater Lodge, Mammoth lakes, California.

8.0 SUGGESTIONS :

Urban Planning now a days is equipped with modern means as well as best technologies, but the basic knowledge of natural processes is still lagging behind from the hands of Urban Planners. Development of Schemes , Projects, Cities etc are only supported by plans and statistics of natural resources but indulging this knowledge in Planning and in implementation is too less than required.

Detailed estimate of Climate change impacts and Landscape modification on water resources at regional and Local level are currently very problematic due to inadequate Water Data.

1. Wise land use, the protection and maintenance of groundwater systems and technical installations for the simple access to groundwater resources are key to prevent groundwater contamination, ensure sustainability of economic investments, and groundwater availability during extreme (flood or drought) conditions.
2. Technical know-how is fundamental in assuring that land use planning takes groundwater conditions into account.
3. Open areas have to be made available in order to catch water in polder and inundation plains. Promoting public parks and reducing soil sealing to a minimum necessary could be an option to increase infiltration.

Urban cities in immediate need

1) Water sensitive urban developments
When land is developed for urban uses, natural hydrologic processes and features should be incorporated wherever possible. Natural catchment features can be achieved by:

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