"Rainwater Harvesting and its Initiatives in Bangalore"

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A.R. Shivakumar [$]

Water to Bangalore

The City of Bangalore is unique in nature; most of the large cities in the world are built on the bank of a river or sea. Bangalore does not have any perennial river or sea within 100 km radius. Pumping water to the city is an expensive business. Power costs (2279 Million Rupees per year) are an additional burden. Power problems further aggravate the situation.

With the increase in population of Bangalore (6.8 Million), the demand for water too continues to increase. Borewells (common natural resource used as private source) are dug indiscriminately (as of now there are no governing laws) - a conservative estimate puts the number of borewells (dead or live) in Bangalore at 2, 00,000. As per the Hydro-Geological Atlas of Karnataka, Bangalore North Taluk comprising nearly half of Bangalore Urban area is a 'GREY' area indicating that the ground water resources are critical in this part. While a borewell brings a temporary relief to the citizens of Bangalore, it is a double-edge sword, rapidly reducing the ground water table. Every one has unrestricted access, so overexploitation is almost inevitable; it is the classic case of 'tragedy of commons'. It may be too wise to say that more than half the bore wells in Bangalore are either dead or low yielding. If the ground water is not recharged, the colossal investment in borewells is simply washed away (estimated at 4,000 Million Rupees).

Number of Bore wells in Bangalore (conservative estimate)	No.	200,000
Cost of each Bore well	Rs.	20,000
Total (private) investment on Bore wells in Bangalore	Million Rs.	4,000
Investment on water storage sump (underground tank)	Rs. per lt.	5
Total (private) investment on water storage sumps in Bangalore	Million Rs.	25,000

For centuries, the lakes of Bangalore were the answer to the city's water needs. Since 1896, the Hessarghatta and Thippagondanahalli (TG Halli) lakes in Arkavathi river basin were the primary sources of water. However, with demand far outstripping supply, water from River Cauvery was brought into the city. At present, about 958 million liter of water (from all sources) is being pumped into the city everyday. Augmentation projects under implementation may increase this to 1500 MLD by the year 2010.

Water Availability[*] (a bird's eye view of the water supply system to Bangalore city)

Year	Water source	Distance km	Design Capacity MLD	Availability 2006 - 2007 MLD
1896	Hessarghatta	20	36	0
1933	Thippagondanahalli	40	148	83
1974	Cauvery I stage	95	135	139
1982	Cauvery II stage	95	135	145
1993	Cauvery III stage	95	270	317
2002	Cauvery Iv stage Phase 1	95	270	274
2010	Planned	95	500	
	Bore wells / tankers	?	?	?
Total			**994**	**958**

* BWSSB annual report 2006 - 07

MLD - Million Liter per Day
ML - Million Liter
It – Liter

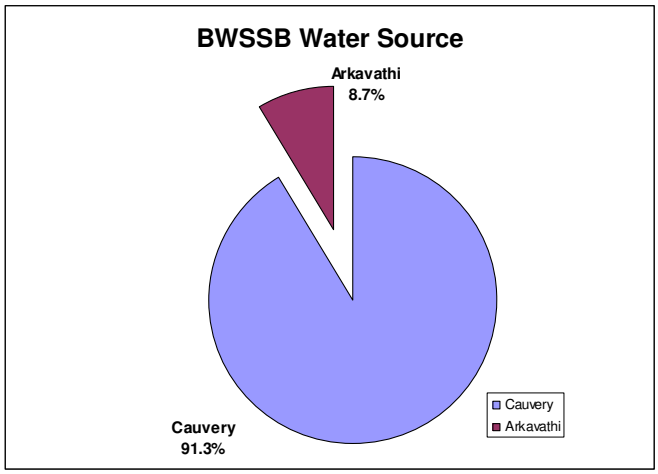
Bangalore Water Supply and Sewerage Board (BWSSB) is the official water provider for Bangalore. Water supplied by unorganized sector (tankers, bottled, bore wells etc.) though forms a significant portion, it is anybody's guess to asses the quality and quantity.

BWSSB was formed by an Act of State Legislature. One of the responsibilities of the Board is providing water supply and making adequate provision for sewerage and disposal of the sewage in existing and developing areas of Bangalore Metropolitan Area.

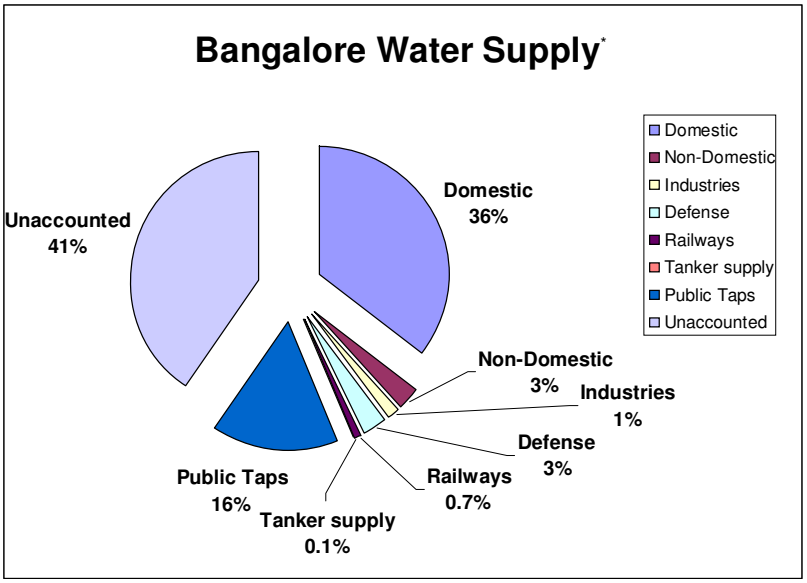
Bangalore Water supply 2006-2007			**365**
Receipt	ML	%	MLD
Cauvery	319280	91.3	875
Arkavathi	30378	8.7	83
Total	349658	100.0	958
Supply			
Domestic	124445	36	341
Non-Domestic	9734	3	27
Industries	4502	1	12
Defense	11155	3	31
Railways	2398	0.7	7
Tanker supply	253	0.1	1
Public Taps	54932	16	150
Unaccounted	142240	41	390
Total accounted	207418	59	568
Total Supply	349658	100	958
Recycled water (Tertiary Treatment)			70

Source			
CWSS 1	50679	14.5	139
CWSS 2	52820	15.1	145
CWSS 3	115628	33.1	317
CWSS 4	100153	28.6	274
Cauvery Water Supply Scheme (CWSS)			
TG Halli	30379	8.7	83
Hesargatta	0	0.0	0

* BWSSB annual report 2006 - 07



Year		2006-2007
Water supplied	ML	207,418
Water received	ML	349,658
Unaccounted	ML	142,240
Accounted	%	59
Unaccounted	%	41



* BWSSB annual report 2006 - 07

Bangalore receives 958 MLD of water each day and 41% of it is losses / unaccounted. While 36% is for domestic sector and nearly half of this 16% is through non metered "Public Fountains" (street taps). Losses and Public Fountains constitute bulk of Bangalore un-metered water supply at 57% with only 43% metered, revenue yielding supply. Among the domestic supply, consumers in the (probably the big chunk) first three tariff slabs (0-8000, 8001-25000, 25001-50000) are non remunerative (liability) with supply rate less than production cost (around Rs 25 per kl).

Production cost of water in Bangalore*		
Water Receipt during 2006 - 2007 (accounted)	kl	207,418,150
Expenditure during 2006 - 2007	Rs	5,093,188,994
Cost per kl of water supplied	Rs	25
Electricity cost per kl	Rs	11

Wastewater Treatment STP*		**Design Capacity MLD**
1	V. Valley	180
2	K & C Valley	248
3	Hebbal	60
4	Yelahanka	10
5	Madiwala	4
6	Kempambudi	1
	Total	503
Tertiary Treatment Water Availability		
1	V. Valley	60
2	Yelahanka	10
	Total	70

* BWSSB annual report 2006 - 07

Required Plan of Action for a Sustainable Water Supply System in Bangalore:

Water to Bangalore is everyone's responsibility. Rainwater Harvesting should become everybody's business. Supported by all the stake holders, BWSSB will be too willing to be a facilitator for accomplishing the task of equitable distribution of the available natural resource – WATER.

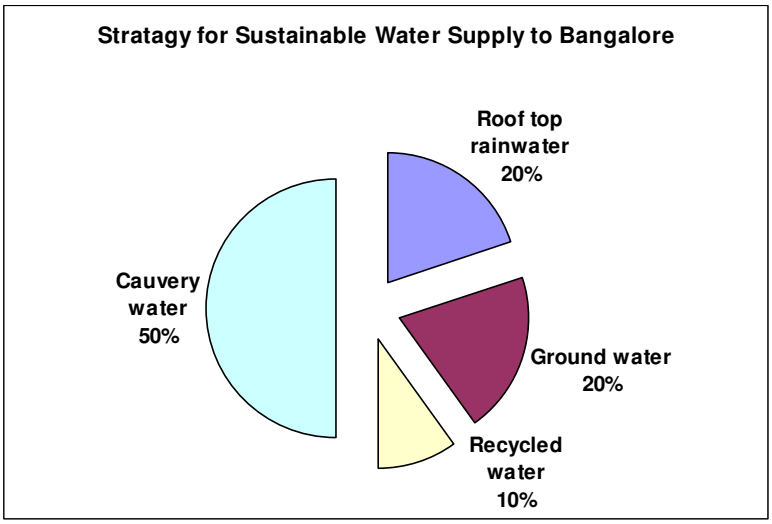
Agenda for Bangalore Infrastructure Development (ABIDe) [@]		
28th June 2008, NIAS, IISc, Bangalore		
Bangalore 2008 – Area	**sq km**	**800**
Water supply 2008	MLD	870
Water Demand 2008	MLD	1219
Short fall	MLD	349
Projection		
Supply 2015	MLD	1470
Demand 2015	MLD	2172
Short fall	MLD	702
Cauvery water supply 2008	TMC	14
Cauvery water allotment	TMC	19

@ Presentation of Chairman BWSSB on 28th June 2008 at ABIDe

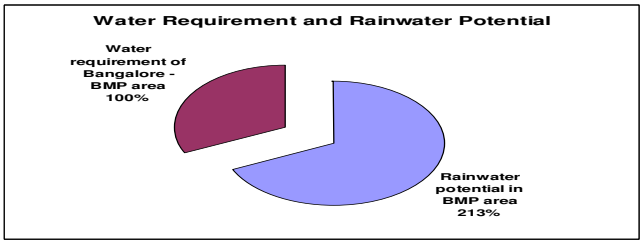
Bangalore Data[#]		**Units**	**Value**
Rainfall in Bangalore (100 years average)	a	mm	929
Rainy days in Bangalore per year		No.	57
Number of properties in Bangalore – BMP	b	No.	1,000,000
Average roof area of a property (estimate)	c	sq m	110
Sump size in each property – proposed	d	lt	5,000
Total water storage capacity in Bangalore properties – (bxd)	e	lt	5,000,000,000
		ML	5,000
Urban population	f	Million	6.8
		No.	6,800,000
BBMP area	g	sq km	800
		sq m	800,000,000
Total water supply per day BWSSB	h	MLD	958
		lt	957,968,438
BWSSB transmission losses	i	MLD	390
		%	41
Actual water supply per day – (h-j)	j	MLD	568
		lt	568,268,904
Recycled water available from BWSSB (Tertiary Treatment)	k	MLD	70
Water requirement days	l	No.	365
Million unit	m	Million	1,000,000
Rainwater potential in BMP area (annual) – (axg)	n	ML	743,200
Water requirement of Bangalore - BMP area (annual) – (hxl)	o	ML	349,658
Number of families in Bangalore – (f/5)	p	No.	1,360,000
Roof Top Rainwater Yield (Annual) – (axbxc)	q	lt	102,190,000,000
		ML	102,190
Roof Top Rainwater available (Annual) (qx0.8)	r	ML	81,752
Roof Top Rainwater available – days – (r/j)	s	No.	144
Rainwater Yield from BMP open area (Annual) – (axgx0.8-q)	t	lt	492,370,000,000
		ML	492,370
Open Area Rainwater available – days – (t/j)	u	No.	866
Total number of days rainwater available per year – (u+s)	v	No.	1,010

Availability of Rainwater in Bangalore to meet the demand – (v/30)	w	Months	33.7
Detergents used in each house per month	x	kg	5
Detergents used in Bangalore per day – (pxx/30)		kg	226,667
		tone	227
Detergents used in Bangalore per day		truck loads	23
Per capita water availability BWSSB – (h/f)	y	lt	141
Per capita water availability actual – (j/f)	z	lt	84

BBMP, BDA and BWSSB annual reports and websites



Strategy for Sustainable Water Supply to Bangalore	**100**	**763**
	%	MLD
Roof top rainwater	20	153
Ground water	20	153
Recycled water	10	76
Cauvery water	50	382



Water Requirement - How to meet?	Million Liter	MLD
Total	207,418	568
Roof top rainwater available	102,190	280
Roof top rainwater required	55,708	153
Water required from ground water recharge	55,708	153
Potential for ground water recharge and withdraw	390,180	1,069

Recycled water for secondary water use required	27,854	76
Recycled water for secondary water use available	25,550	70
Cauvery water required	139,269	382
Cauvery water available	349,658	958
Excess Cauvery water available for new areas in BBMP	210,389	576

Twelve Point Plan of Action for a Sustainable Water Management Strategy for Emerging Greater Bangalore:

1. Roof top Rainwater Harvesting system made and enforced compulsorily for both old and new properties under BBMP
2. All the properties under BBMP (roof area 110 sq m and above – 30X40 ft) should have a rainwater sump / tank with minimum 5000 lt capacity (most of the properties already have – 5X5X7ft). Apartments and institutions must have bigger rainwater sumps in accordance to their roof area
3. All the properties under BBMP should have additional sump / partition in RWH sump with minimum 1000 lt capacity for Cauvery water
4. Encouragement to have open wells and shallow borewells in each property – overflow of roof top rainwater from sumps to flow in to artificial recharge pits / open wells – a word of caution, around 227 tons / 23 truck loads of detergents used every day in Bangalore – one of the main constituent of ground water pollution
5. Enforcement of strict effluent treatment in all commercial and industrial establishments. Encourage eco friendly detergents, soaps and shampoos (main source of groundwater contaminant from domestic sector)
6. Ground water recharge through intermittent recharge trenches in storm water drains and strict enforcement to avoid gray water in storm water drains
7. Public parks and open places to have rainwater harvesting and ground water recharge through open wells – public park's watering requirement supplemented with recycled water and each ward of BBMP to have 100 kl rain water banks (tank/sump for emergency, fire etc.)
8. Tree based parks to be developed and phase-out large patches of lawn (green deserts). All public parks to be maintained by using only organic manure and permitted pesticides
9. Permit ground water withdrawal proportional to ground water recharge in institutions and commercial water users (bottling plants, tanker supply etc.)
10. BWSSB to -
    - Establish dual supply system (initially to bulk users and new layouts)
    - Enhance tertiary treatment from 70 MLD to 150 MLD
    - Supply of water to all its users based on the quality and quantity requirement
    - Meter all category of users (currently 57% un-metered) - including public taps and social institutions to have better water auditing (including private commercial borewells)
11. Bulk users like defense, railways and BBMP to generate their own recycled water and reduce dependence on BWSSB
12. All lakes and water bodies in BMP area to be rejuvenated in phased manner and maintained by BWSSB as reservoirs of buffer storage and ground water augmentation facilities

This pioneering effort is a long term plan with sustainable and environmentally sound strategies. The day may not be too far to see "Bruhath Bangalore" a positive phenomena with Sustainable Water Supply System a success story for the cities in the country to follow.

Cost of water to Bangalore has varied over the years and today, the project of Cauvery water supply costs Rs 68 per liter of installed capacity and a recurring cost of establishment, treating, pumping and distribution on an annual basis – Supply Side Management (SSM). On the other hand the one time investment cost of Rainwater Harvesting is Rs 139 and has no recurring cost to the public utility – Demand Side Management (DSM). Cost of RWH to a new house is (mostly) part of the house plan and will support to augment the public utility water supply in a sustainable manner.

Cost - Cauvery Water Supply Scheme Stage IV Phase II of BWSSB*		
Expected year of commissioning 2011	Units	Value
Designed capacity	MLD	500
Total Cost	Million Rs	33,837
Japan Bank for International Co-operation	Million Rs	28,307
Government of Karnataka	Million Rs	2,765
BWSSB	Million Rs	2,765
Cost per liter of installed capacity	**Rs**	**68**

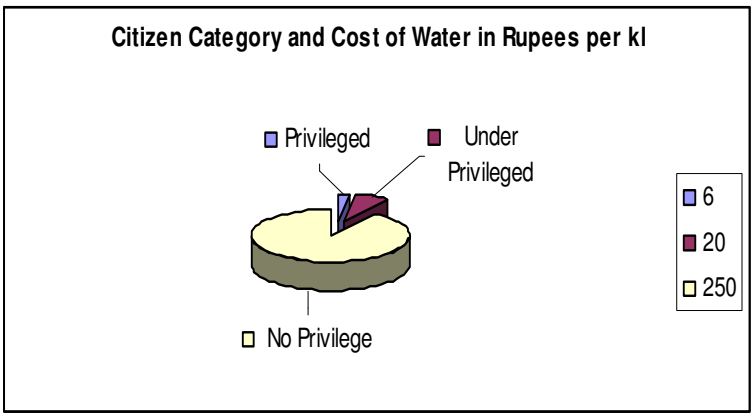
* BWSSB annual report 2006 - 07

Cost of Rainwater Harvesting (average estimate for a typical House)		
Cost of Piping in each property	Rs	4,500
Cost of providing RWH Filter	Rs	3,000
Cost of Sump of 5000 lt capacity	Rs	25,000
Cost of Additional Electric Pump and plumbing	Rs	5,500
Cost of relaying flooring / pavers	Rs	1,000
Total Cost of Rainwater Harvesting for a House	Rs	39,000
RWH cost for all the properties of Bangalore	Rs	39,000,000,000
RWH cost for all the properties of Bangalore	Million Rs	39,000
Water that can be harvested from roof tops of all properties	MLD	280
Cost of RWH water per liter of installed capacity	**Rs**	**139**

Citizens of Bangalore with authorized BWSSB water connection have the privilege of getting water of better quality for Rs 6 per kilo liter and pay after a month. Second category of citizens having no access to BWSSB supply will pay in advance Rs 20 per kilo liter (more than thrice the cost of BWSSB supply) from a tanker supply (private operator with no assured water quality). Third category of citizens without proper house pay on the spot Rs 250 per kilo liter (forty times the cost of BWSSB supply) and the quality of water is the least of all. It is a paradox that citizens of higher income group pay lesser rate for water and get better quality with assured supply; on the other hand citizens of lesser income group pay much higher rate for water and get poorer quality water and supply.

Cost of water at supply end from BWSSB (first 8000 lt)*	Rs per kl	6
Cost of water supplied by tanker (private operator) - Rs 300 per tanker of 6000 lt	Rs per kl	20
Cost of water to a individual (no access to BWSSB supply) - Rs 3 per pitcher / pot of 12 lt	Rs per kl	250

* BWSSB annual report 2006 - 07



Rainwater Harvesting (RWH)

Adequate availability of water sustains and improves life. What is needed is harnessing the nature's bounty and use it properly. Rainwater Harvesting holds the key in bridging the gap between demand and supply. "By capturing the rainwater where it falls", we can supplement the available supply that can be used for many purposes. Traditional Rainwater Harvesting in Karnataka underlines the importance of step wells, lakes, tanks, channels etc. as water storage bodies, the basic purpose of which was to establish a chain of water storage structures.

Over the centuries, many region-specific water harvesting structures have evolved. While the basic principle of Rainwater Harvesting remains the same, the nomenclature differs from region to region and dialect to dialect. It is the process of collecting and storing rainwater in a scientific and controlled manner for future use.

With a massive concreting and asphalting of ground areas, the soil exposed for rainwater infiltration has decreased, leading to a drastic fall in the ground water table and disappearance of open wells. In the last 30 years, Bangalore has experienced seven years of drought. The quest for water has resulted in over exploitation of ground water. On an average, the ground water level has progressively declined by 10 meters between 1978 and 2003.

Consequent to all this, the quantity of run-off water in the storm water drains has increased tremendously. Rainwater Harvesting is all about conserving this water, thereby supplementing the present supply.

Rainwater Harvesting and Bangalore's water requirement

Rainfall in Bangalore (100 years average)	Mm	929
Rainy days in Bangalore per year	No.	57
Number of properties in Bangalore – BMP	No.	10,00,000
Average roof area of each property (estimated)	Sq m	110
Sump size in each house – proposed	Lt	5,000
Total water storage capacity in Bangalore residences	ML	5,000
Urban population	No.	68,00,000
BBMP area	sq km	800
Total water supply per day BWSSB (installed capacity)	MLD	994
BWSSB transmission losses	%	41
Actual water supply per day (available) 59% of 994	MLD	568

Thousands of RWH tanks spread over Bangalore at every property and hundreds of rejuvenated lakes in Bangalore will together act as buffer zones to hold precious water to avoid flooding of storm water drains and low lying areas.

Success Stories - KSCST

Karnataka State Council for Science and Technology (KSCST) is the first State Council in the country to be established to address science and technology issues of the state. Council has established RWH in twenty landmark buildings and four exhibition plots for demonstration of cost effective and sustainable RWH and ground water recharge technologies at Bangalore and Tumkur such as Vidhana Soudha, BMP head office, BWSSB – BSK field office, Fire station, Beedy workers colony, RTO office, Pollution Control Board, Deputy Commissioner's office etc. Over thirty RWH training programmes for various target groups covering Planners, Architects, Engineers, Contractors, Plumbers, Masons etc. have been conducted. In addition several awareness camps in different wards of Bangalore and Tumkur were also organized. To cover all the districts of Karnataka, Council has established RWH resource and training center for the southern states at Mahatma Gandhi Regional Institute for Rural Energy and Development in Bangalore and District RWH Nodal Centers at all the 27 districts in the state. Technical support is also being provided in establishing RWH system in 176 villages (one each in every taluk of Karnataka) and 23,680 rural schools in the state (probably the world's largest RWH project – Current Science volume 92, N0.2, 25 January 2007, page 161) a programme of Rural Development and Panchayat Raj, Government of Karnataka.

Action Plan

Government of Karnataka has made RWH compulsory in Bangalore for carton category of buildings. BWSSB as brought in an amendment to its act and the existing houses on a plot of 2400 sft and above, new houses on a plot of 1200 sft and above need to adopt RWH. A 'Helpdesk' has been established since October 2009 at KSCST in the Indian Institute of Science campus. Several training programmes and awareness camps are being conducted to facilitate implementation of RWH in Bangalore. Around 800 plumbers, contractors and entrepreneurs have been trained to take up RWH in Bangalore. RWH Helpdesk at KSCST is providing necessary support and technical information to the citizens of Bangalore to implement scientifically correct, cost effective and sustainable methods of RWH and ground water recharge.

The target apart from large buildings in public and private sector is around 1,00,000 houses to implement RWH in this year. It is estimated that the water requirement of this target group is around 50 MLD and a conservative estimate of roof top rainwater harvesting can provide 20 MLD, which is around 40% of the supply.

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$ Senior fellow and Principal Investigator – RWH, Karnataka State Council for Science and Technology,
Indian Institute of Science, Bangalore 560 012.