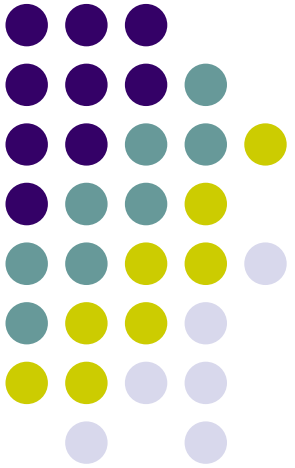
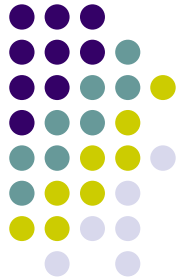
SUSTAINABLE WATER SUPPLY IN DHAKA CITY: PRESENT AND FUTURE

MD. MAFIZUR RAHMAN
Professor
Department of Civil Engineering

Bangladesh University of Engineering and Technology **(BUET)**

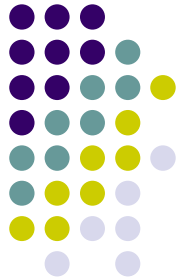


INTRODUCTION



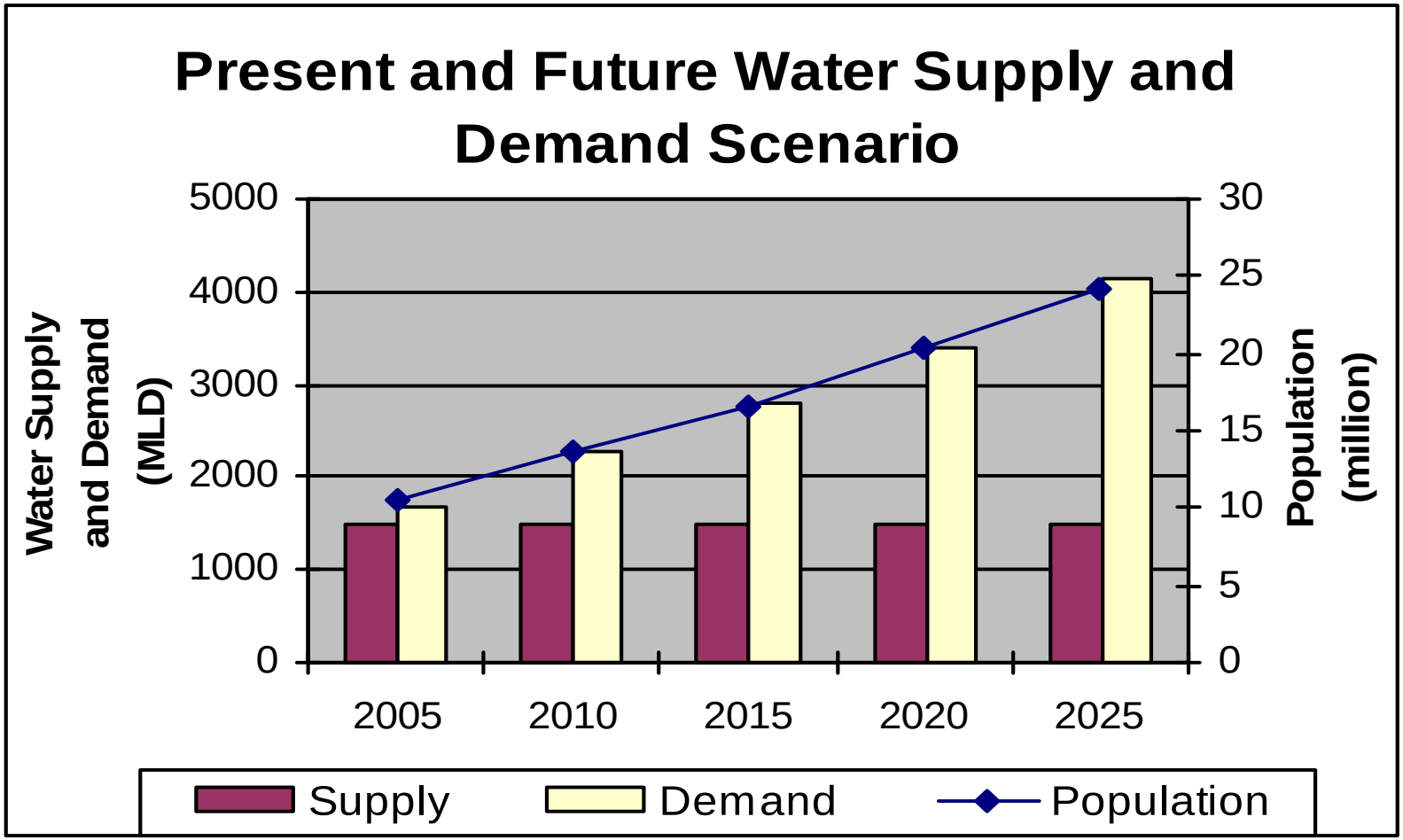
- Since 1971 Dhaka is growing rapidly in terms of area and population.
- Population: 1 million in 1971-now more than 12 million.
- The trend will continue in future.
- Increasing demands for basic city services -- the most important one being the demand for safe and reliable water supply.
- It is a great challenge for DWASA to ensure water of adequate quantity and quality round the year.

HISTORICAL WATER SUPPLY SITUATION

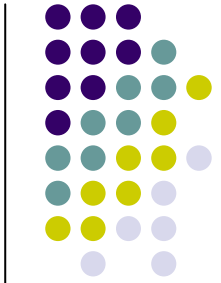


Year	Supply (MLD)	DTW
1963	130	30
1970	180	47
1980	300	87
1990	510	140
1996	810	216
1997	870	225
1998	930	237
1999	1070	277
2000	1130	308
2001	1220	336
2002	1550	394
2004	1437	382
2005	1460	423

PRESENT AND FUTURE

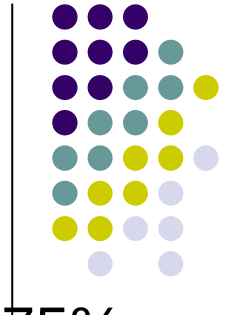


PRESENT SITUATION



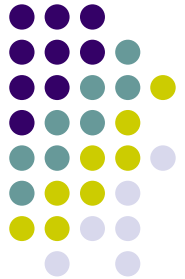
Facility/service	*Quantity*
Deep tubewell	Nearly 500 (441)
Water production	1500 mld
Treatment plant	3
Water lines	2425 km
Metered Connections	135,500
Unmetered Connections	95,900
Overhead Reservoirs	38
Roadside tap	1643

CONT……



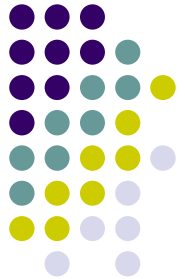
- DWASA estimates that it provides safe water to about 75% of the population in Dhaka.
- The number of people who receive piped water supply at their homes is estimated to be 5.5 million, of which 75% obtain 24-h supply and 25% an intermittent supply.
- Another 0.5 million have access to piped water via stand posts.
- An additional 3 million people who live in slums obtain bulk supply of water from DWASA pipe network.
- The remaining 3 million people receive water from their own supply system. This includes large private apartment complexes and industries, who pay DWASA a fee.
- Dhaka is facing an estimated water shortage of about 500 million liters per day (mld)-over 25% of the existing demand. It is estimated that this will increase to 1,500 mld in 2015 if no additional sources are developed.

POPULATION, WATER SUPPLY, DEMAND AND DEFICIT



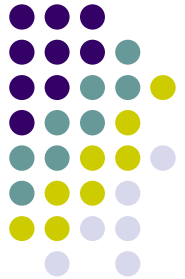
Year	*Population (millions)*	*Water Demand (MLD)*	*Water Supply (MLD)*	*Deficit (%)*
1963	0.85	150	130	13
1970	1.46	260	180	30
1980	3.03	550	300	45
1990	5.56	1000	510	49
1996	7.55	1300	810	38
1997	8.00	1350	870	36
1998	8.50	1400	930	34
1999	9.00	1440	1070	26
2000	9.50	1550	1130	25
2001	10.00	1600	1220	24
2002	10.50	1680	1300	23
2003	11.00	1760	1400	20
2010	12.27	2485	1500	40
2020	18.04	3680	1500	59

WATER SUPPLY SCENARIO IN DIFFERENT CITIES



City	*Average number of persons per connection*	*Percentage with 24-hour supply*	*Per capita consumption (lcd)*
Dhaka	30	0	117
Kathmandu	10.5	0	69
Manila	9	97	127
Ho Chi Minh	8.75	75	168
Jakarta	7.5	90	76
Phnom Penh	7	100	104
Colombo	6	60	119
Vientiane	6	50	112
Delhi	5	1	109
Karachi	5	0	198

SYSTEM LOSS IN DIFFERENT CITIES

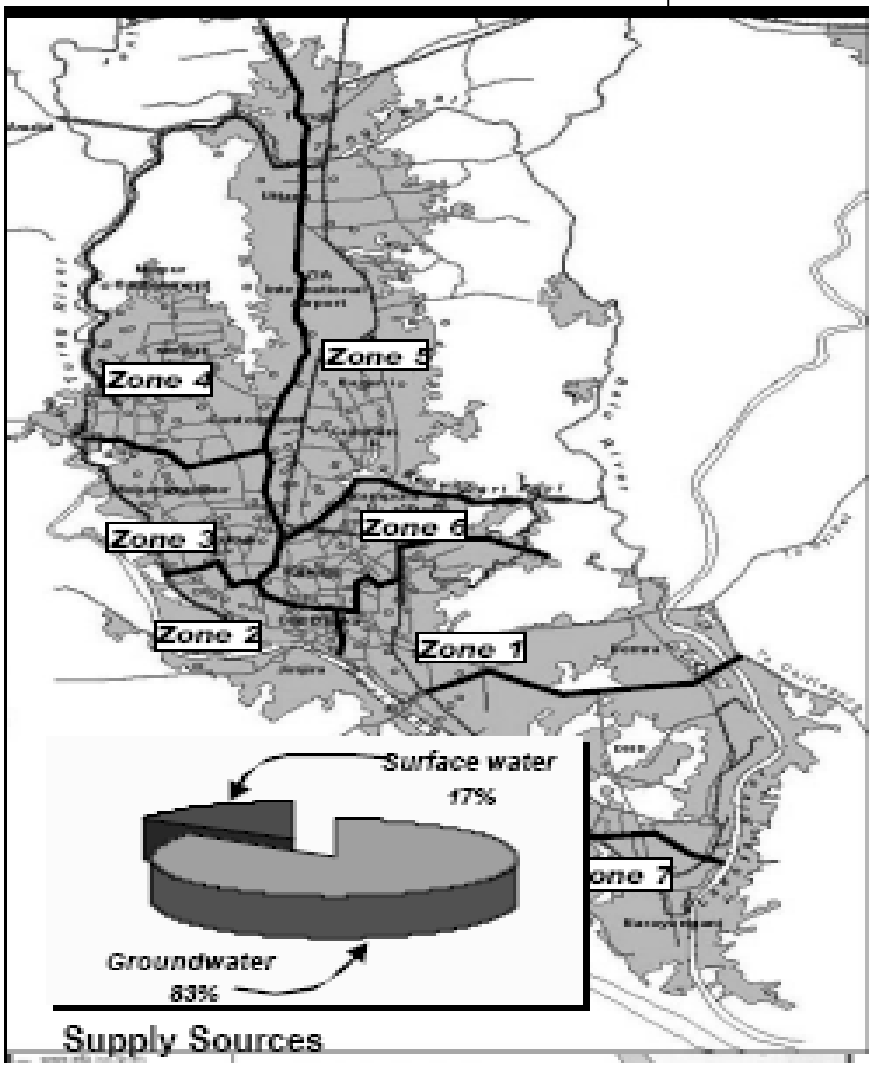


City	*Systems loss*
Lahore	40%
Kolkata	50%
Colombo	35%
Kathmandu	40%
Bangkok	38%
Dhaka	40%
Manila	44%

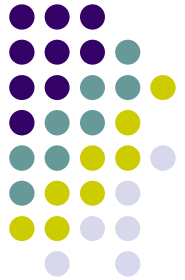
COVERAGE AND PRODUCTION

Coverage:	470 sq.km	
Connections:	212,543	
Surface water:		
Sayedabad	225	mld
Chadnighat	39	mld
Narayanganj	46	mld
Total production	310	mld
Groundwater:		
Existing DTW	441	
Total production:	1500	mld

Pipeline: 2500(appx.) km

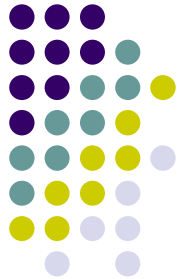


WATER SUPPLY SOURCES



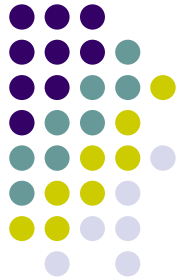
- Ground water sources: 83%
- Surface water sources: 17%
- The peripheral rivers have undergone major pollution due to indiscriminate discharge of domestic waste water and industrial effluent.
- The ground water table is rapidly declining (3 m/yr) due to a large scale abstraction. Therefore, GW is no longer a viable option.

GROUND WATER TABLE DECLINATION



Year	*Depletion (metre)*
1996	26.60
1997	28.15
1998	30.45
1999	31.86
2000	34.18
2001	37.78
2002	41.87
2003	46.24

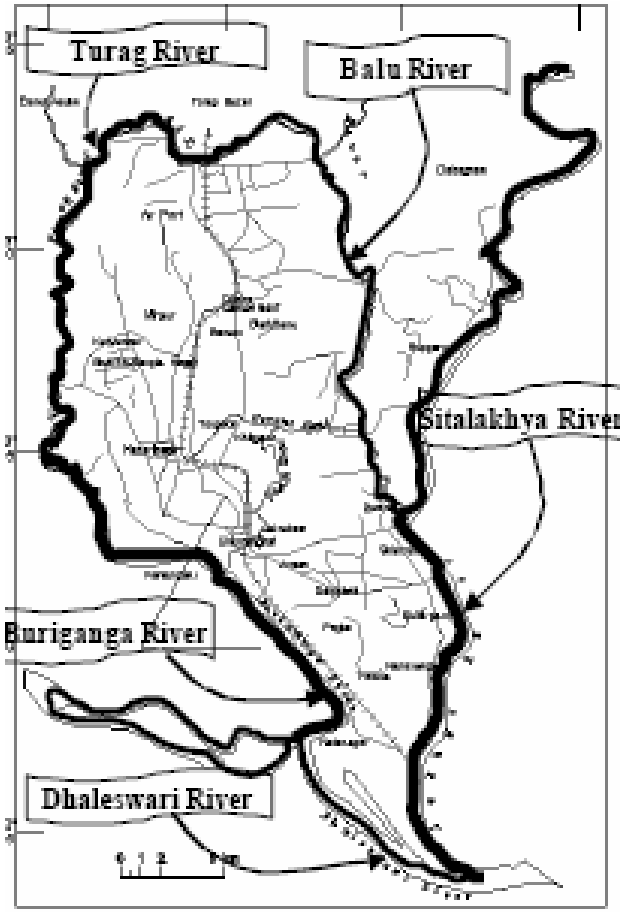
GROUND WATER QUALITY



- WASA recently found high concentrations of E. coli in the ground water of old town of Dhaka.
- They have also tested the supply water and found impurities in one of two samples (WASA, 2003).
- According to a recent joint study of the DoE and WASA, eleven pumping stations out of thirty-two showed both chemical and microbial contamination of groundwater.
- The identified contaminants were residual chlorine, coliform and faecal coliform.

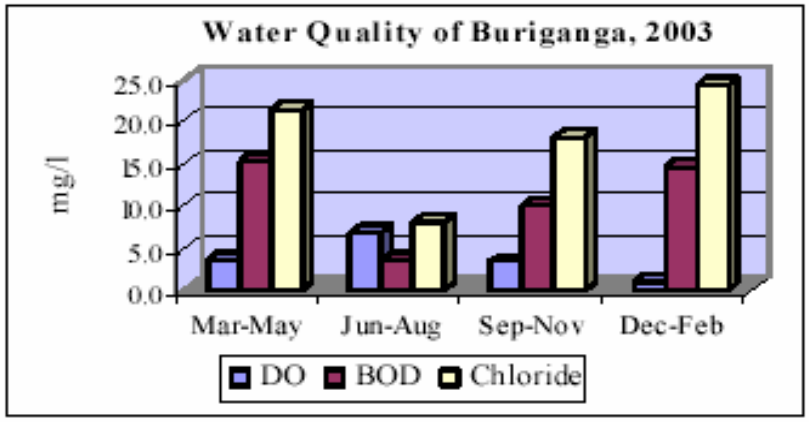
PERIPHERAL RIVERS OF DHAKA CITY

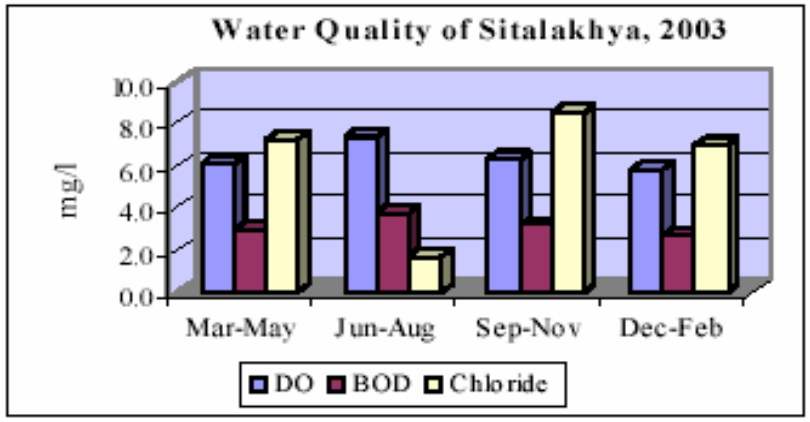
- Tongi Khal/Turag River
- Balu River
- Shitalakhya River
- Buriganga River
- Dhaleshwari River

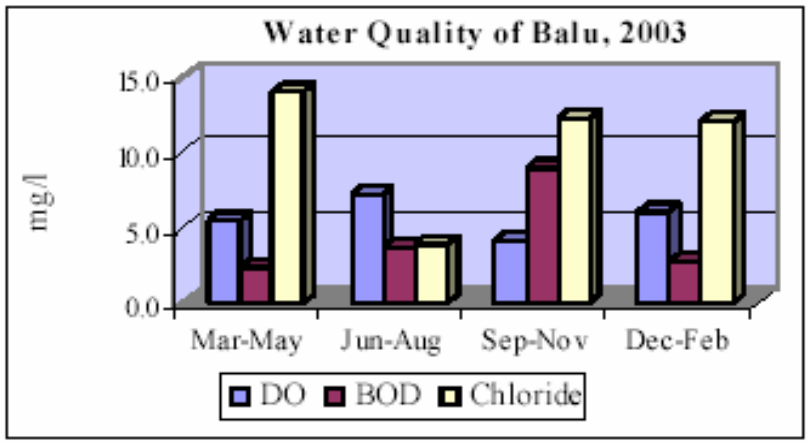


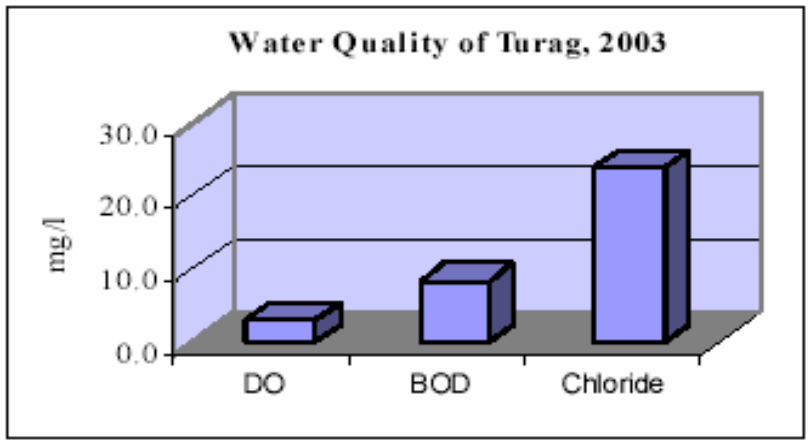
The water quality situation would further deteriorate if no pollution control measures in Dhaka watershed is undertaken

PERIPHERAL RIVER WATER QUALITY



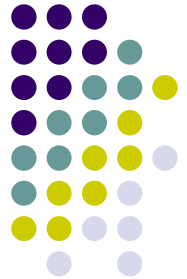






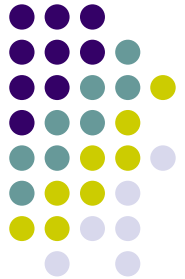
All units in mg/l except 5 days BOD at 20°C

FIND ALTERNATIVE OPTIONS



- There is an urgent need to find alternate sources for Dhaka city water supply.
- Such probable source may include:
  - exploiting the deeper aquifer (around >200m depth) and surface water sources from far-off major rivers like Padma, Meghna and Jamuna.
  - It is also worthwhile to investigate exploitable potential of aquifers located in the vicinity of Dhaka city. For this, DWASA has engaged Institute of Water Modelling (IWM) to assess various available sources in terms of water availability and quality.
  - Besides, small scale dam-reservoir systems can be set up outside Dhaka where is the higher hydraulic area by storage of water during the flood time and some rainwater harvesting system during the monsoon time.

STRATEGIES FOR SUSTAINABLE WATER SUPPLY

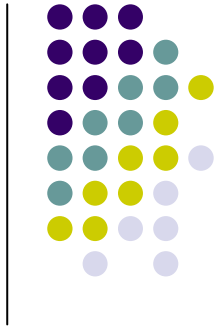


- **Conjunctive Use of Ground and Surface Water**
- **Rain Water Harvesting**
- **Reduce Unaccounted for Water**

CONJUNCTIVE USE OF GROUND AND SURFACE WATER

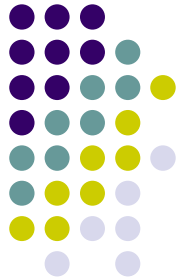
- For a sustainable water supply system there should be a balanced development of surface and groundwater.
- Groundwater extraction in Dhaka is already beyond the sustainable limit.
- Groundwater extraction must be reduced in this area to allow the groundwater table to stabilize and recharge to an acceptable level.
- Conjunctive use of surface water resources would allow the recovery of the groundwater table.

CONT……



- The ultimate goal will be to reduce the contribution of groundwater in the total water supply from 83% to around 50%
- The share of surface water to be increased from 17% to around 50%.
- The first part is easy, but the management of surface water is going to be an difficult due to:
  - High initial capital cost
  - High pollution of the urban rivers around Dhaka that might lead to the failure of the conventional treatment methods for human consumption.

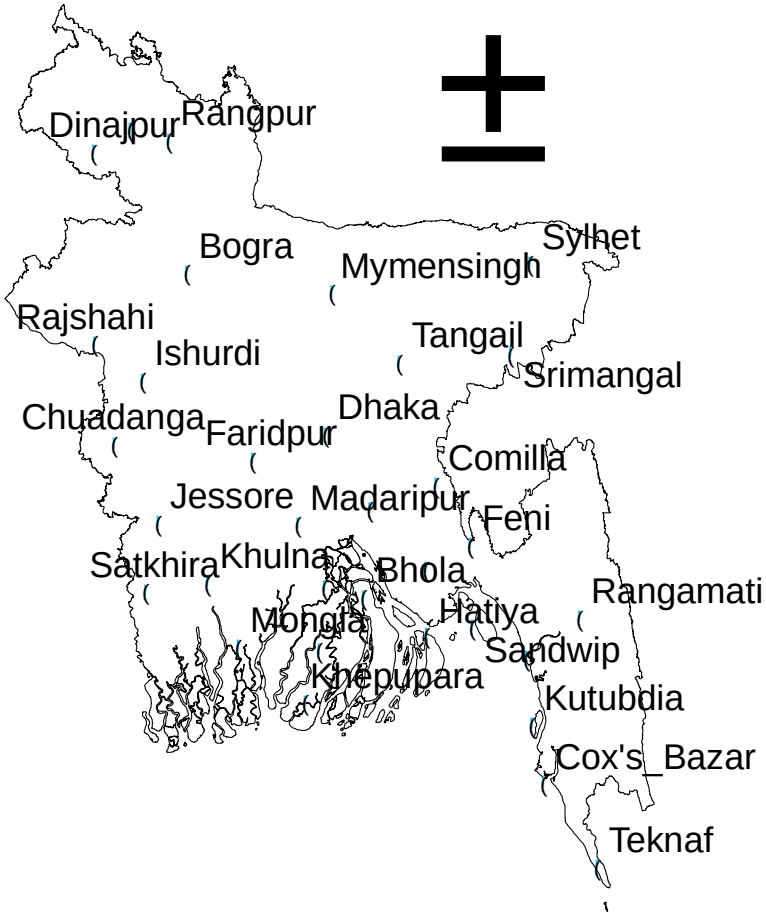
NEEDED WATER SOURCES FOR FUTURE WATER SUPPLY



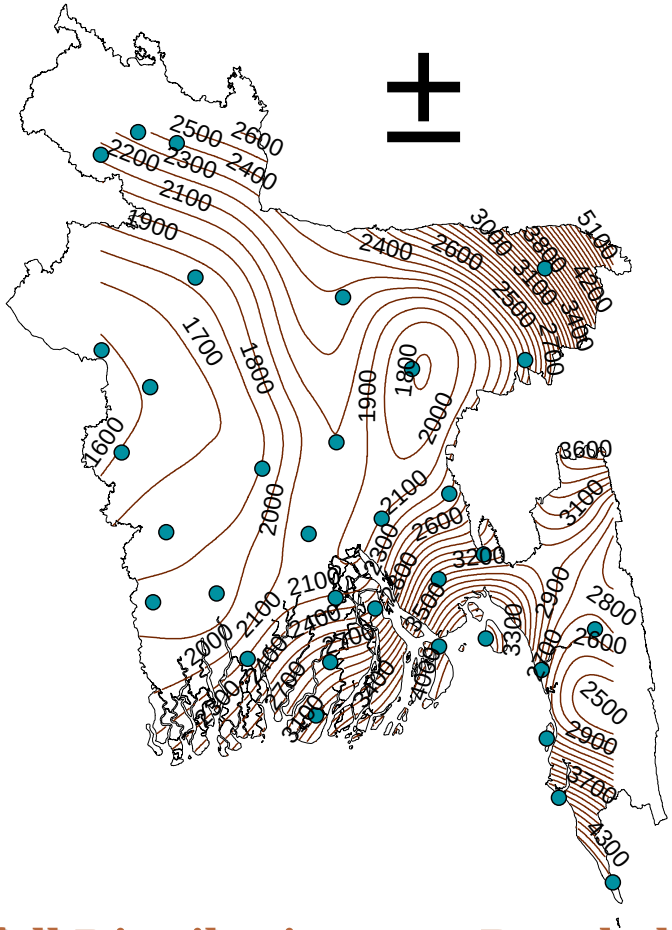
	2010	*2015*	*2020*	*2025*
Total consumption demand (MLD)	1,775	2,000	2,629	2,950
UFW (%)	40%	40%	40%	40%
Total production required (MLD)	2,485	2,800	3,680	4,130
Needed water sources:				
Ground water (MLD)	1,050	1,050	1,050	1,050
Sayedabad SWTP I (MLD)	225	225	225	225
Sayedabad SWTP II (MLD)	225	225	225	225
SWTP III (Khilket) (MLD)		500	500	500
SWTP IV (Padma) (MLD)		500	500	500
SWTP V (Sayedabad 3) (MLD)			500	500
SWTP VI (MLD)			500	500
SWTP VII (MLD)				500
Total (MLD)	1,500	2,500	3,500	4,000

RAINWATER HARVESTING IN DHAKA CITY

Spatial Distribution of annual rainfall over Bangladesh (10 year average, 1996 to 2005)



BMD Stations of Bangladesh



Rainfall Distribution over Bangladesh

The average annual rainfall of Dhaka city for ten consecutive years (1996 to 2005) is found to be 2098 mm, which can be considered to be good enough for storing water for later use.

Figure : Variation of total annual rainfall of 10 year duration (1996-2005) of Dhaka city

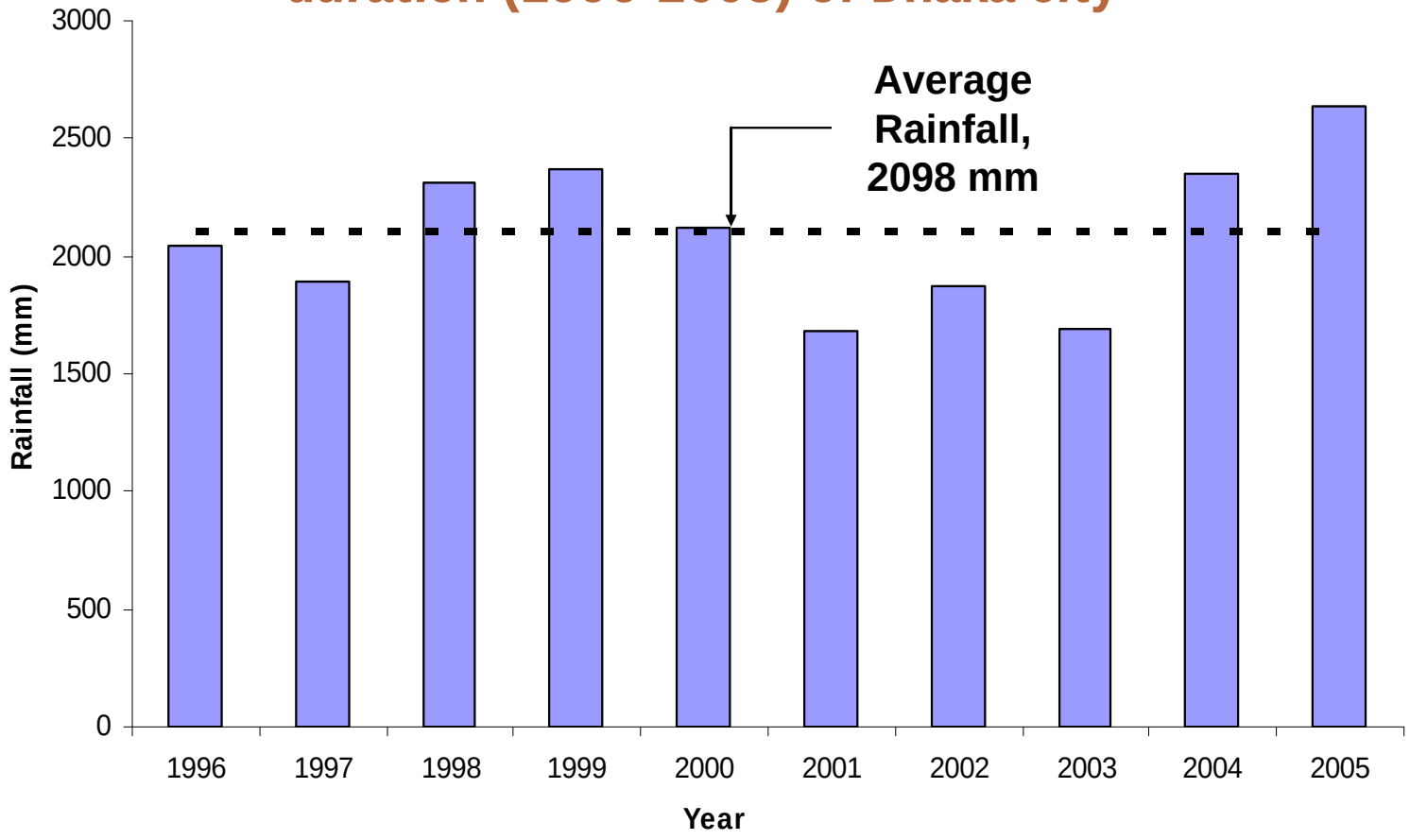
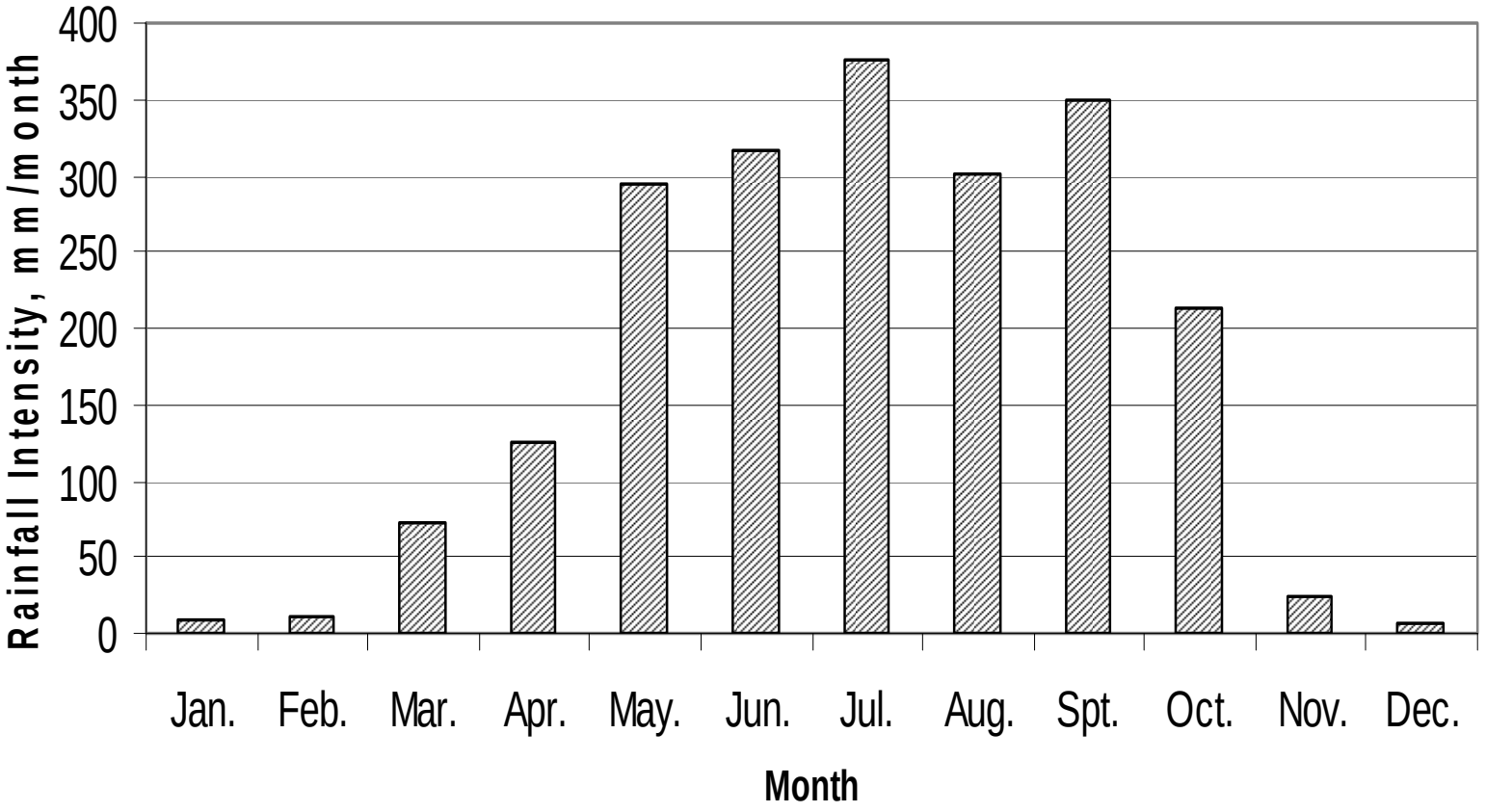


Figure: Monthly Distribution of average Rainfall of 10 years in Dhaka city



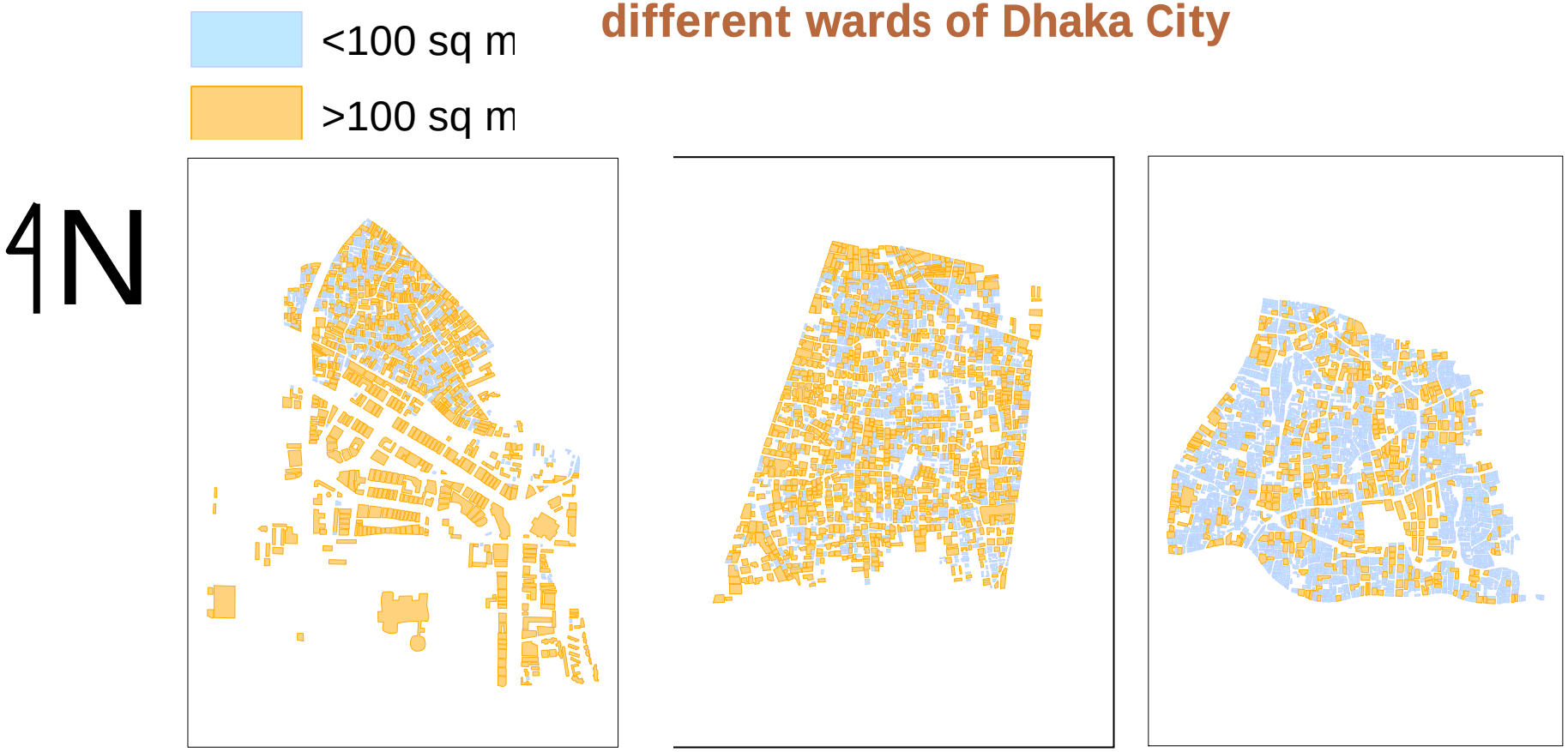
Simple Analysis to evaluate the portion of water available to meet the water demand of Dhaka city:

The population of Dhaka city is about 12 million (Rajuk 2004). The calculated average annual rainfall of Dhaka is 2098 mm.

A building with a terrace of 100 sq metre area can harvest about 125874 litres of water at 60 % efficiency. The loss of rain water may be due to evaporation from the rooftop and first flush which may be lost to the drainage system. This translates into water availability of about 345 litres per day. With a gross water demand of 180 lpcd, 5 families of 30 members will require 5400 litre of water per day. This indicates that around 6.4% of the water demand can be met by RWH with individual harvesting system.

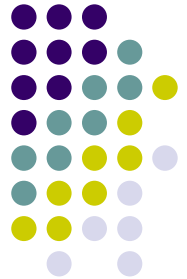
The Roof size distribution from building area of different wards of Dhaka city have been mapped using GIS. From information about 29 wards of Dhaka city, 97% buildings of ward 32 have more than 100 m^2 area (maximum), while ward 50 has 43% (average) and ward 69 has 14% (minimum).

Figure: Building area suitable for Rain Water Harvestng in different wards of Dhaka City



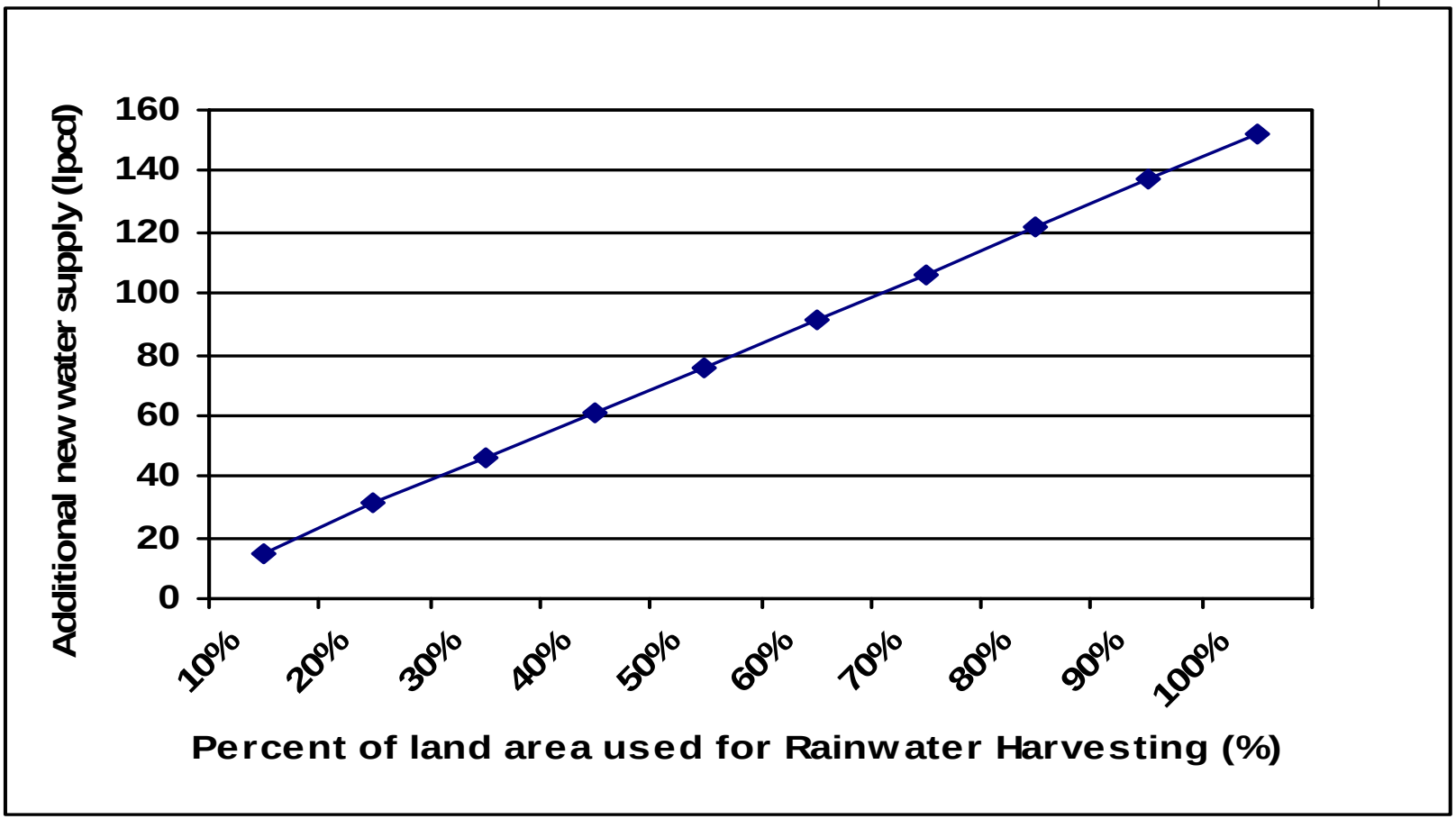
ward 32 ward 50 ward 69

ADDITIONAL WATER SUPPLY FROM RAINWATER HARVESTING



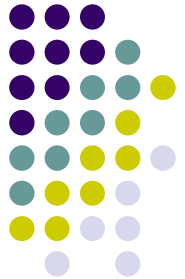
Total population (million)	Average annual rainfall (mm)	Service area (km^2)	Percent of service area used for rain water harvesting (%)	Additional water generated (billion British gallons per year)	Additional water generated (lpcd)
12	1901.5	350	10%	15	15
			20%	29	31
			30%	44	46
			40%	59	61
			50%	73	76
			60%	88	91
			70%	103	106
			80%	117	122
			90%	132	137
			100%	147	152

CONT……



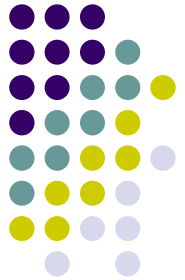
Additional water supply from rainwater harvesting with different percentage usage of land area in Dhaka city

DWASA EFFORTS FOR RAIN WATER HARVESTING



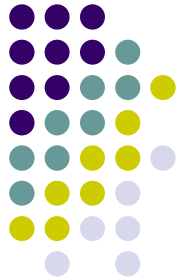
- In 2002 Dhaka WASA collected and utilized 11.5 million litres of rainwater from rooftop of its administrative building.
- This water has been supplied for non-potable uses thereby reducing the building's water demand considerably from other sources such as surface and groundwater.
- Plans are in place to set up a rainwater collection system in government buildings, semi-government buildings and buildings of autonomous bodies.
- If more buildings could be brought into such a program it will not only greatly reduce demands on the conventional water sources, but also significantly reduce run-off, thus reducing flooding problems.
- In case of a severe storm, part of the run-off can be used for induced groundwater recharge as has been done in DWASA's Rooftop Rainwater Harvesting Project.

RAINWATER HARVESTING POLICIES



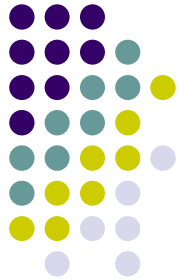
- Small Community based RWH
- Schools, Hospitals, Play grounds, parking areas, shopping malls be brought under RWH
- GW recharge and storage by RW
- Tax rebate for the land owners implementing RWHS

UNACCOUNTED FOR WATER



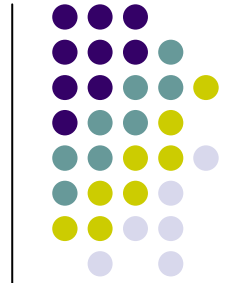
- Reduction of unaccounted for water is restricted due to two major reasons:
  - Firstly, inadequate institutional capacity and authority of DWASA for comprehensive monitoring and control of pilferage.
  - And secondly, aging of distribution pipe in many areas causing major leakage from the system.

HOW MUCH WATER CAN BE SAVED THIS WAY?



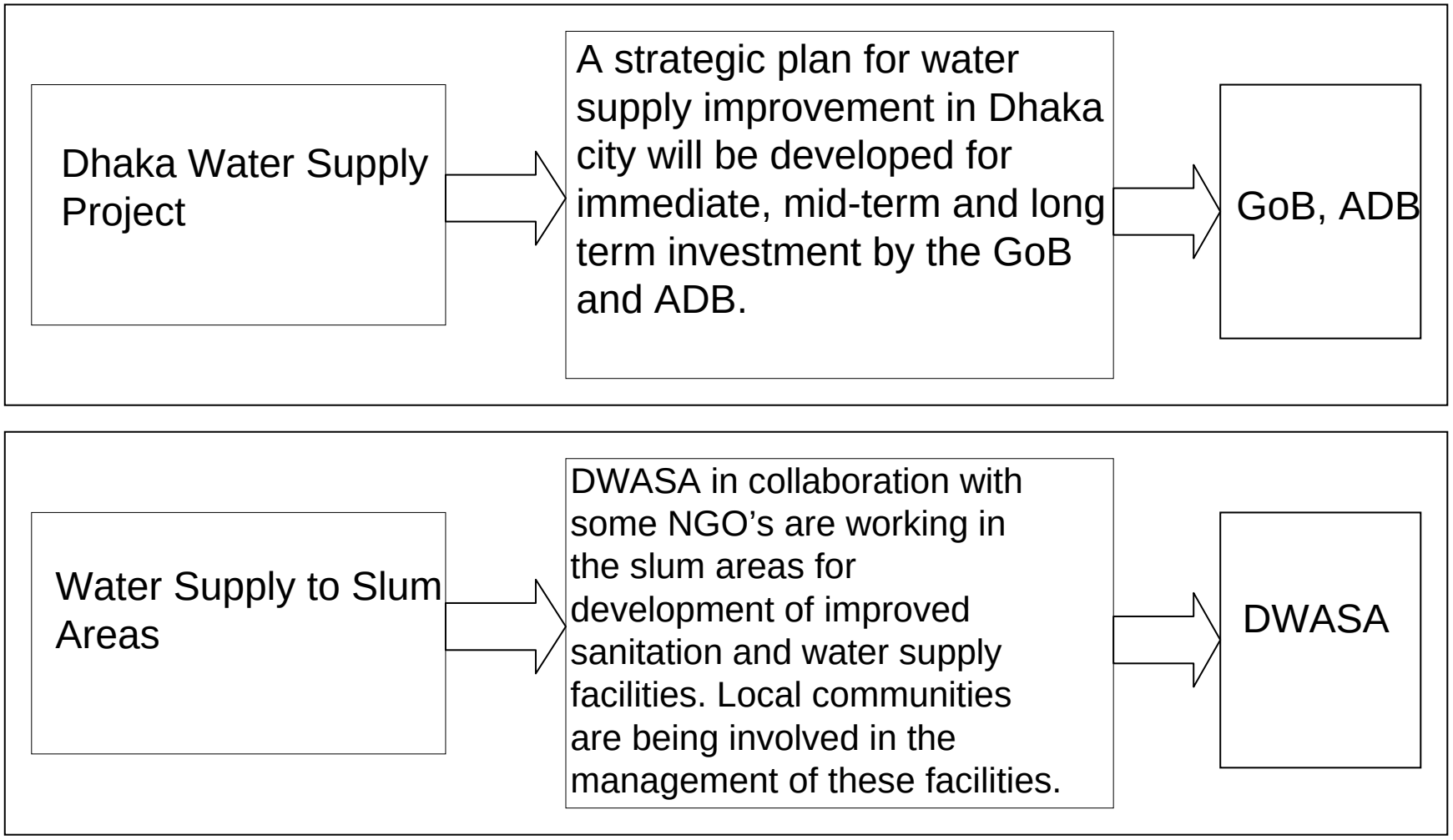
- The answer depends on the extent of loss reduction.
- Let's assume that DWASA's estimate of 10 percent system loss by 2020 is achievable.
- Then even at a production level of 1 Mm3/day, the annual savings will be about 110 Mm3 of water. At a rate of 300 liters per day, which is much higher than the current per capita consumption of about 180 liters per day, it will still serve 1 million additional individuals.
- Alternately, these savings will be equivalent to having a fifth unit of the Sayedabad Surface water Treatment Plant, implemented for free (or at a small cost compared to the other units). This definitely seems to be a goal worth pursuing.

DWASA INITIATIVES

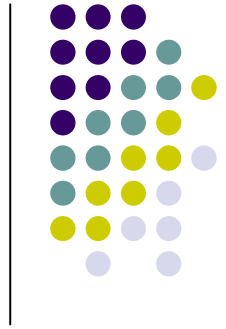


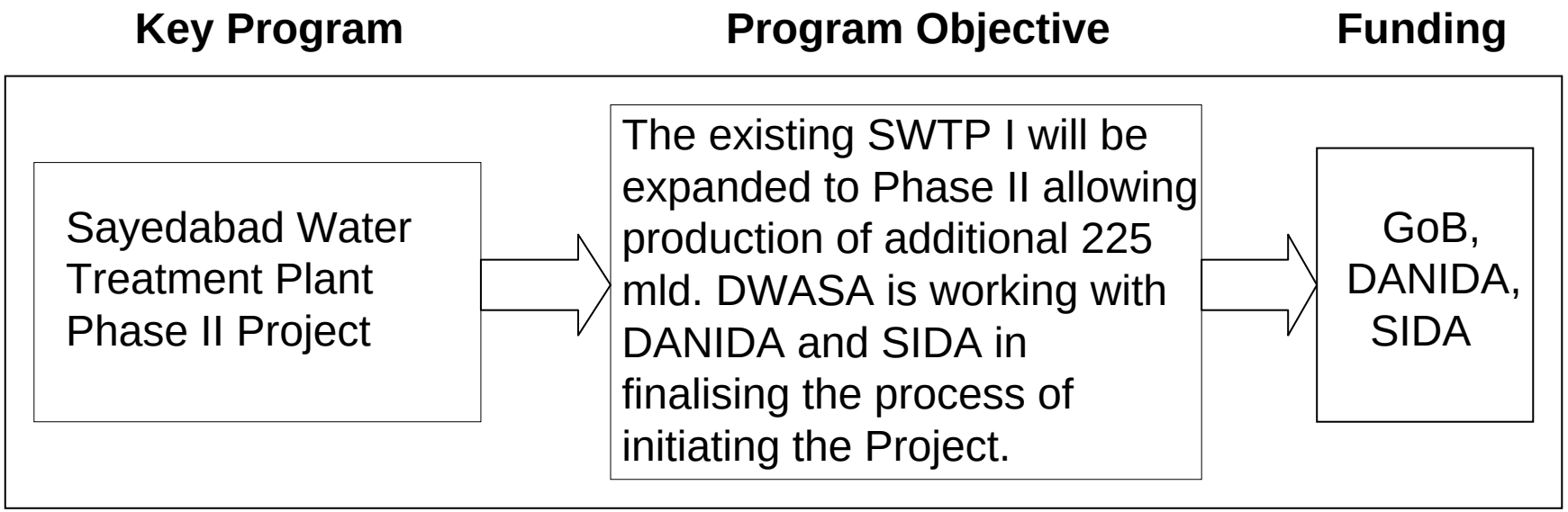
Key Program	Program Objective	Funding
Study on resource assessment and monitoring of water supply sources for Dhaka city	The study will assess all available sources for water supply to the city in terms of water availability and quality. Long-term sustainability of the sources would also be assessed.	DWASA Research Fund
Development of GIS based MIS, network analysis and system metering	A comprehensive database of all utility services will be developed. All system information will be mapped. A water distribution system model of Dhaka city will be developed.	DWASA Research Fund

CONT……

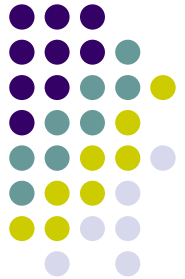

Key Program
Program Objective
Funding
Dhaka Water Supply Project
A strategic plan for water supply improvement in Dhaka city will be developed for immediate, mid-term and long term investment by the GoB and ADB.
GoB, ADB
Water Supply to Slum Areas
DWASA in collaboration with some NGO's are working in the slum areas for development of improved sanitation and water supply facilities. Local communities are being involved in the management of these facilities.
DWASA

CONT……




Key Program
Program Objective
Funding
Sayedabad Water Treatment Plant Phase II Project
The existing SWTP I will be expanded to Phase II allowing production of additional 225 mld. DWASA is working with DANIDA and SIDA in finalising the process of initiating the Project.
GoB, DANIDA, SIDA

EXPECTED PLANS AND FUTURE TASKS



- Encourage water conservation to manage long term investment requirements.
- Strengthen the pipe network to cope with future distribution of surface water.
- Integrated water Resources Management be considered with provisions for adequate GW recharge.
- Promotion of RWHS in the urban areas.

THANK YOU

Further contacts: mafiz@agni.com

Co-Authors
SHAHRIAR QUAYYUM
MOHAMMAD MOHSIN
Graduate Students, Dept. of Civil Engineering
BUET, Dhaka