

Status of Restored Lakes in Bangalore: Gaps and Solutions

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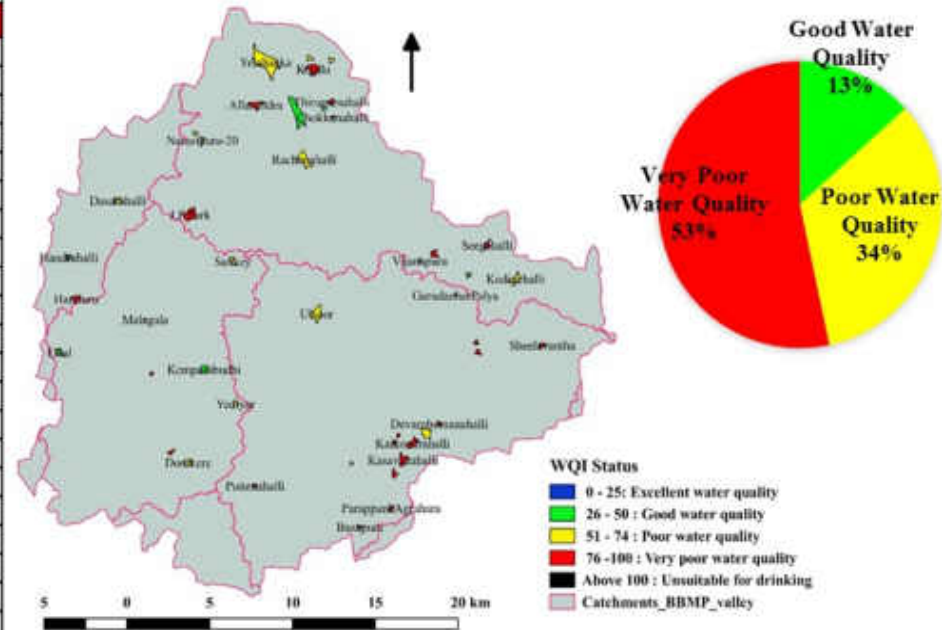
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Restored Lake?

WQI STATUS

Sl.No.	WQI Status & Lake Name	Sl.No.	WQI Status & Lake Name
I Good water quality		III Very poor water quality	
1	Jakkur	1	Kogilu
2	Kempambudhi	2	Amblipura Melina kere
3	Devasandra 1	3	Kasavanahalli
4	Ullal	4	Thirumenahalli
5	Handrahalli	5	Haraluru
6	Agrahara	6	Chinnappanahalli
II Poor water quality		7	Herohalli
1	Dasarahalli	8	Munnekolalu
2	Kattigenahalli	9	Parappana Agrahara
3	Narsipura 20	10	Garudachar Palya
4	Kodigehalli	11	J.P Park
5	Kattigenahalli kere-136	12	Sheelavanthakere
6	Narsipura 26	13	Kaikondrahalli
7	Sowl kere	14	Seegehalli
8	Doraikere	15	Basapura Lake-2
9	Sankey	16	Uttarahalli
10	Yediyyur	17	Allalassandra
11	Rachenahalli	18	Malagala (Ballehannu)
12	Ulsoor	19	Chokkanahalli
13	Vijnanapura	20	Devarabisanahalli
14	Mangamma Palya kere	21	Kowdenhalli
15	Yelahanka	22	Ambalipura Kelagina kere
		23	Deepanjali Nagara kere
		24	Puttenahalli



The monitored 45 lakes were grouped under three different WQI status I good water quality (13%); poor water quality (34%) and very poor water quality (53%).

WQI results revealed that only 6 lakes such as Jakkur, Kempambudhi, Devasandra 1, Ullal, Handrahalli and Agrahara lake had Good water quality.

GAPS IN THE CURRENT APPROACHES OF LAKES REJUVENATION

- Lack of understanding of functional aspects of a lake – ecological, hydrological and remediation aspects in addition to recreation services;**
- Agenda of lake rejuvenation is only to utilise the allocated funds (activities matching the allocated funds have been proposed and implemented) without any scientific evaluation of the lake and the need assessment;**
- Not decontaminating the lake – partial removal of contaminated silt (accumulated over a period); Reuse of contaminated silt – shoreline stabilisation, creation of ‘islands’. Contaminants in the silt leaches to the lake and maintain the contaminated status of the lake;**
- Not arresting fresh pollutants – sustained inflow of partially treated or untreated sewage and industrial effluents;**
- Removal of riparian vegetation and wetlands (which would have removed the nutrients). Riparian vegetation also aids as breeding ground for dependent biota – birds, butterflies, etc.;**
- Emphasis of rejuvenation based on civil works than on ecological restoration;**
- Converting the lake to a ‘cement bowl’ than restoring the ecology of the lake system;**
- The focus of rejuvenation is on creating jogging path and beautification of the lake than ecological restoration.**

Urban Lakes - Rejuvenation Protocol

Rejuvenation Protocol: Restore to enhance ecological integrity and not to fool public

1. DECONTAMINATE

- **Complete removal of accumulated contaminated silt in the lake. De-siltation not only enhances storage capacity but also aid in removing contamination. Adopt latest state of the art technology - wet dredging to remove deposited sediments;**
- **Scientific approaches in desilting; Remove all accumulated silt considering the original topographic contours;**
- **Do not reuse the silt (removed from the lake) for shoreline stabilisation or for creating 'islands' as the contaminants get leached to the water, impairing the chemical integrity of an ecosystem;**
- **Ensure the complete removal of silt and verification of the achieved depth through scientific survey (total station survey);**
- **Implementation of 'polluter pays' principle as per the water act 1974; Zero discharge from industries;**
- **Stop dumping of solid waste and Construction & Demolition (C & D) wastes in the lake bed, storm water drain; Treat C & D Waste as per C & D waste management rule 2016, GoI**
- **Stop Pollution – only treated sewage shall enter the lake. Sewage treatment through integrated constructed wetlands (similar to Jakkur Model – Secondary Treatment Plant (STP) + Constructed Wetlands + Algae ponds, will remove nutrients, etc.);**
- **No diversion of sewage from upstream to downstream regions and**
- **Adopt de-centralized sewage treatment option (similar to Jakkur lake – removal of chemical ions and nutrients) and reuse of treated sewage in the locality.**

2. EVICT ENCROACHERS –Reestablish Interconnectivity

- Remove all blockades at outlets as well as inlets– to prevent stagnation of water and enhance aeration in the water body;**
- Remove all encroachments without any considerations or political interventions (lake bed, storm water drains, buffer zone);**
- Remove the nexus of consultants, contractors and engineers**

3. REGULAR MAINTENANCE

- Minimum 5 years maintenance of the lake by an agency (who implemented rejuvenation);**
- Remove macrophytes (covered on the water surface) regularly;**
- Install fountains (with music and LED) to enhance surface aeration and recreation value of the ecosystem;**
- No introduction of exotic species of fauna (fish, etc.);**
- Identify Local NGO for regular maintenance and management;**
- Public Participation: Decentralised management of lakes through local lake committees involving all stakeholders - Involve local stakeholders in the regular maintenance and management**

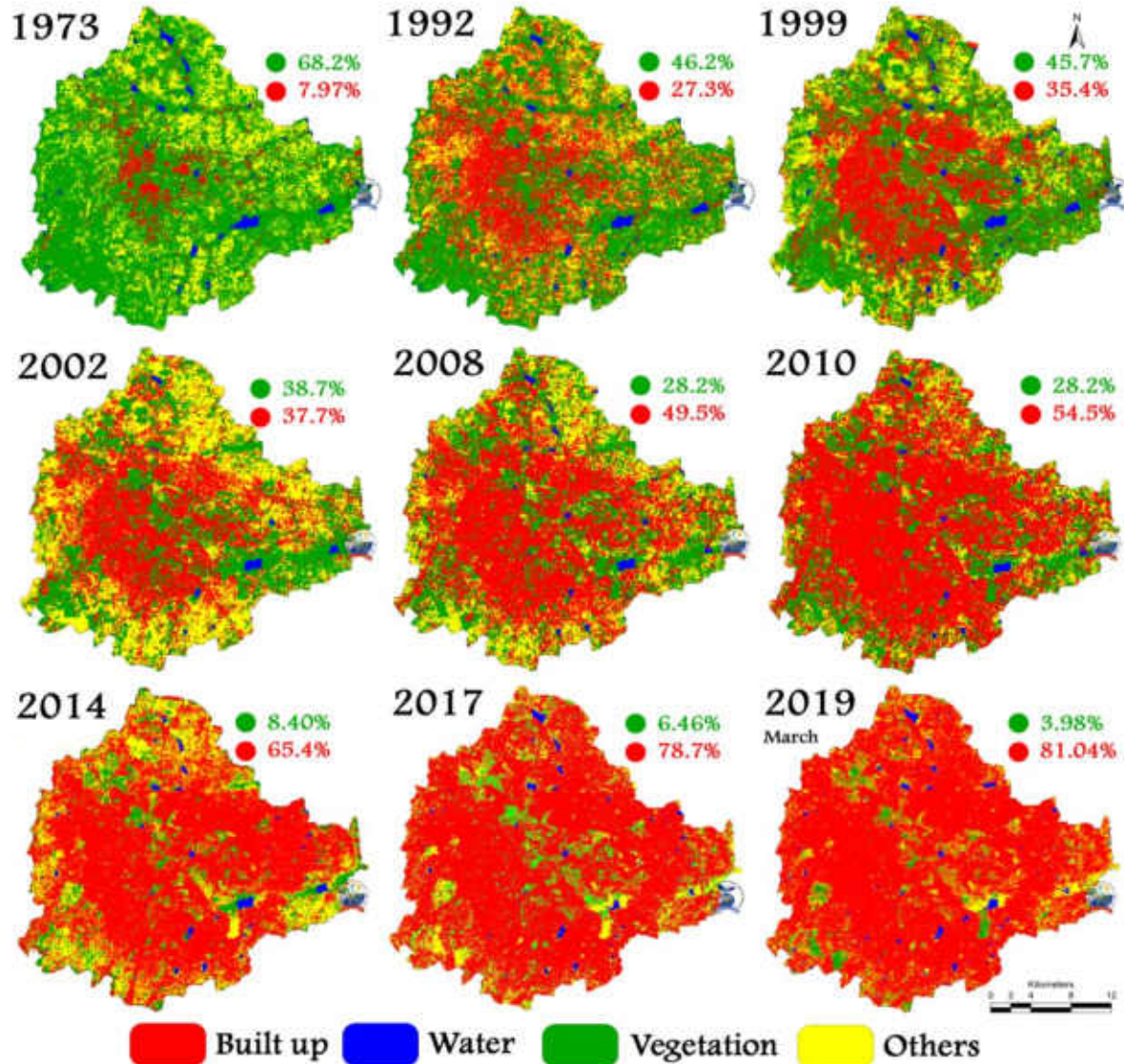
SENSIBLE POLICY & IMPLEMENTATION

- **Shun the path of rejuvenation to siphon off the public funds;**
- **Ban on use of phosphates in the manufacture of detergents; will minimise frothing and eutrophication of water bodies;**
- **Digitation of land records (especially common lands – lakes, open spaces, parks, etc.) and availability of this geo-referenced data with query based information system to public;**
- **Implementation of ‘polluter pays’ principle as per water act 1974;**
- **Planting native species of macrophytes in the buffer zone (riparian vegetation) as well as in select open spaces of lake catchment area;**
- **Restrictions on the diversion of lake for any other purposes;**
- **NO construction activities in the valley zones;**

GOOD GOVERNANCE

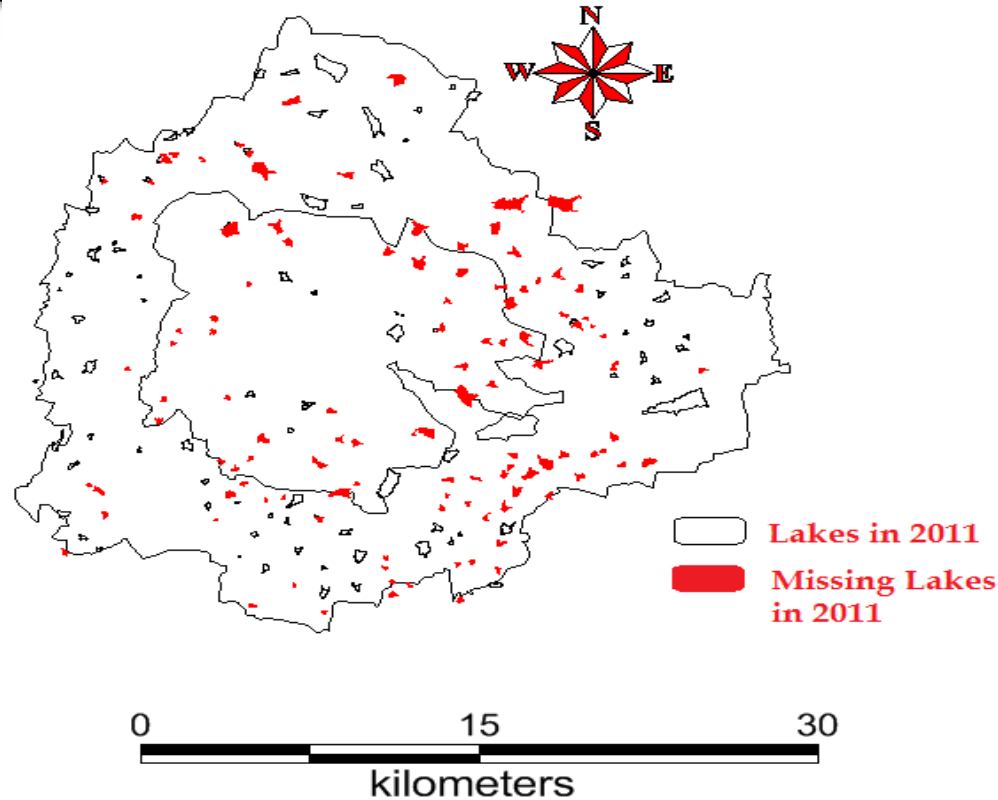
- **Protect flood plains (buffer zones) to enhance the water retention capability of the lake. Enrich floodplains with riparian vegetation so that water gets treated as it passes through riparian zones**
- **Maintain a minimum of 75 m buffer zone in urban lake and for larger lakes the buffer zone depends on the topography and shape of the catchment**
- **Avoid comparisons with the neighbouring regions (who are in the clutches of land mafia) and reduce the buffer zone**
- **Single agency with the statutory and financial autonomy to be the custodian of natural resources [ownership, regular maintenance and action against polluters (encroachers as well as those who contaminate through untreated sewage and effluents, dumping of solid wastes)]. Effective judicial system for speedy disposal of conflicts related to encroachment.**
- **Autonomous status to the agency to ensure minimal interference by the local politicians;**
- **Legislators to legislate and ensure effective implementation through the executive mechanism;**
- **Efficient decentralised administration through elimination of Land, water and Waste Mafia.**

Stop Unplanned Irresponsible Urbanisation – DECONGEST BANGALORE



1028% increase in built up area from 1973 to 2017

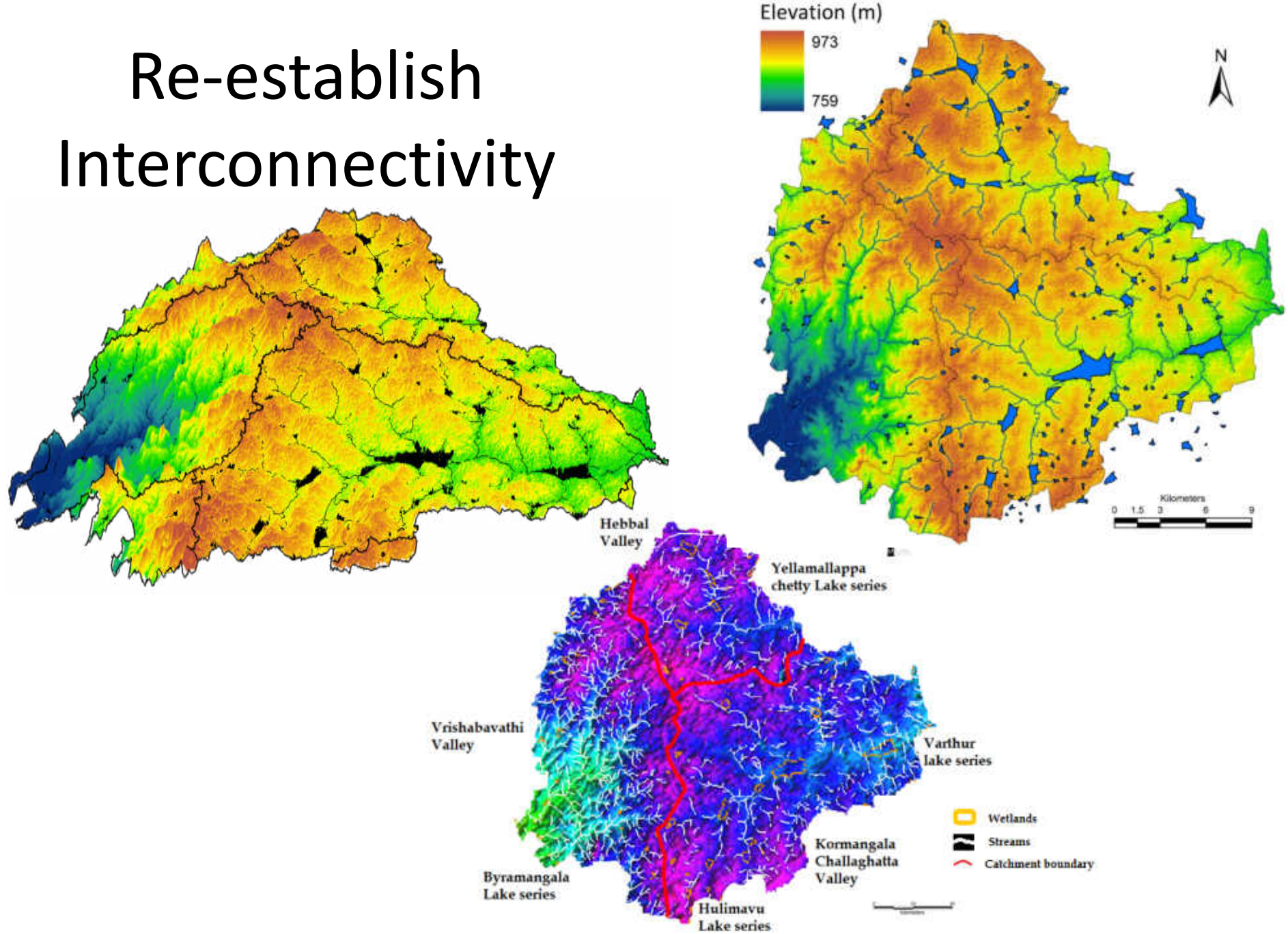
leading to a decline of 88% vegetation, 79% area in water bodies in Greater Bangalore mostly attributing to intense urbanisation process



94% landscape will be concretised by 2020

07:33:14 98.5% would be concretised by 2025

Re-establish Interconnectivity



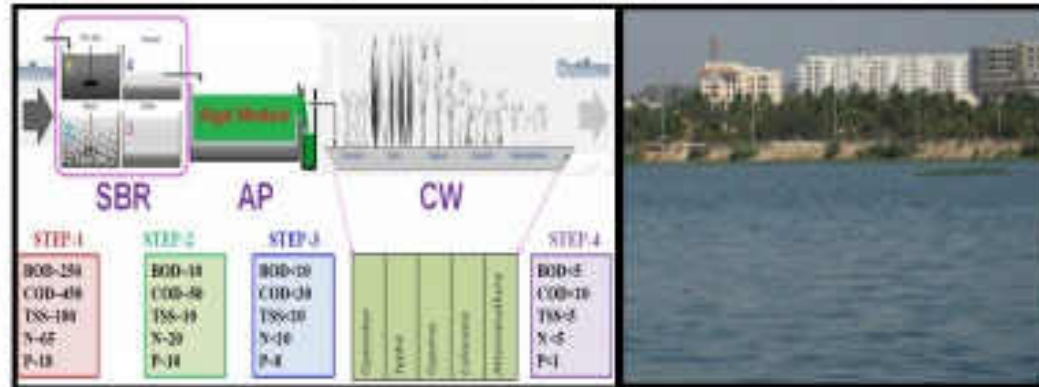
Bellandur and Varthur Lakes Rejuvenation Blueprint

T V Ramachandra
Srinoy V

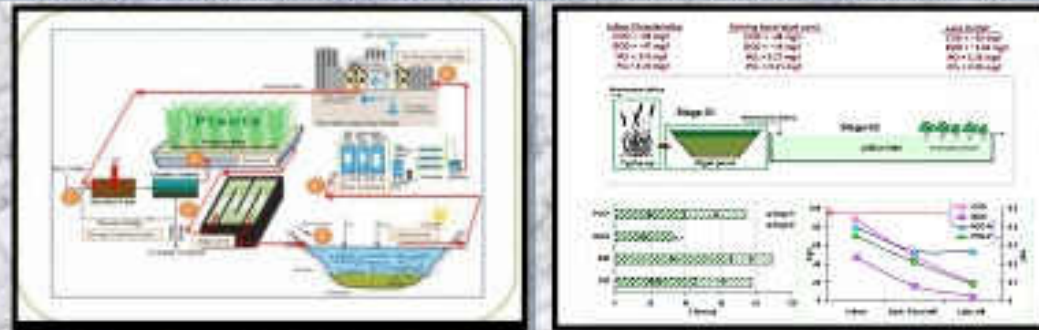
Durga Madhab Mahapatra
Aparabha K S

Vinay S
Sudarshan P. Bhat

Bharath H. Aithal



Integrated Constructed Wetlands - Wastewater Treatment for Bellandur Sewage Influx



Gautam and Vasantha Jagadisan Endowment- Lake Rejuvenation
The Ministry of Science and Technology, Government of India
The Ministry of Environment, Forests & Climate Change, Government of India
Indian Institute of Science, Bangalore 560012

ENVIS Technical Report: 116
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Varturu and Bellanduru Lakes Restoration - Blueprint



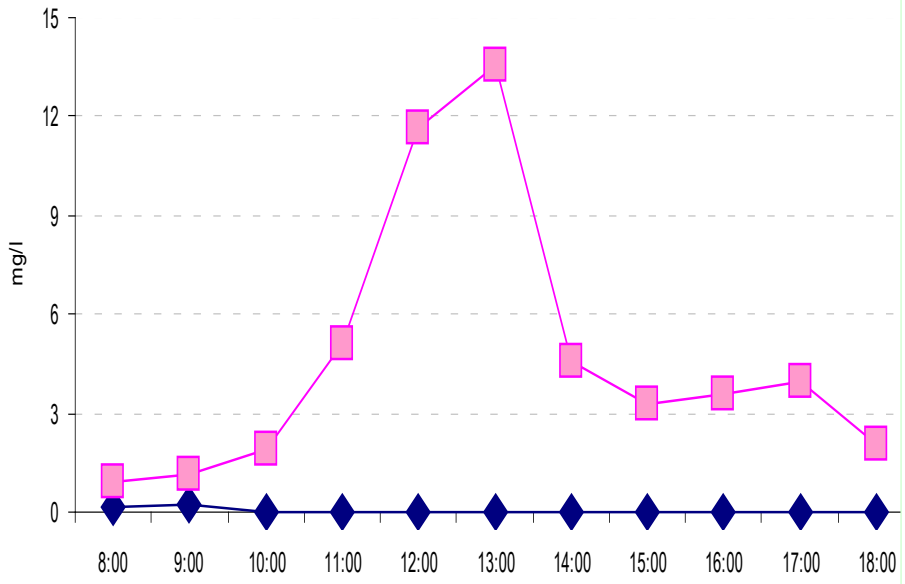
Urban wetlands - Mismanagement



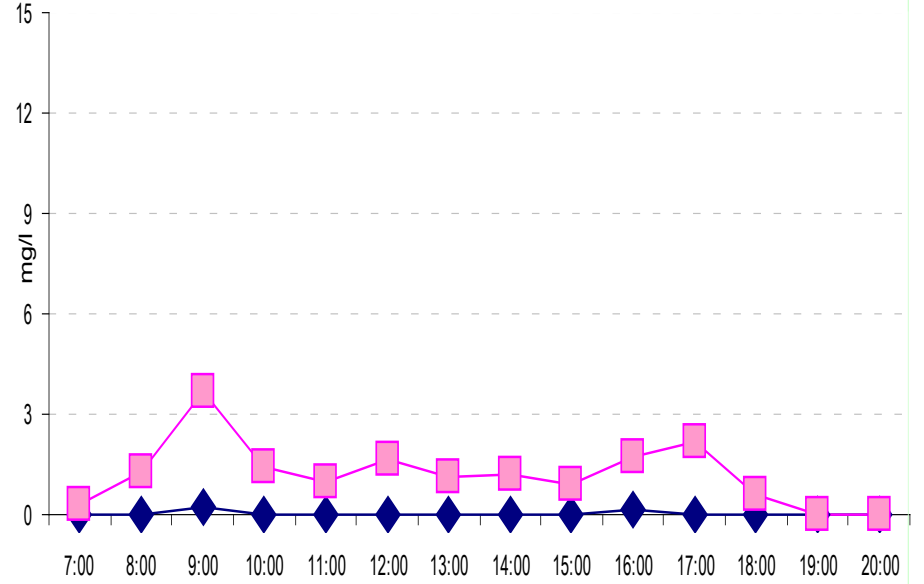
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DO

VNO VSO

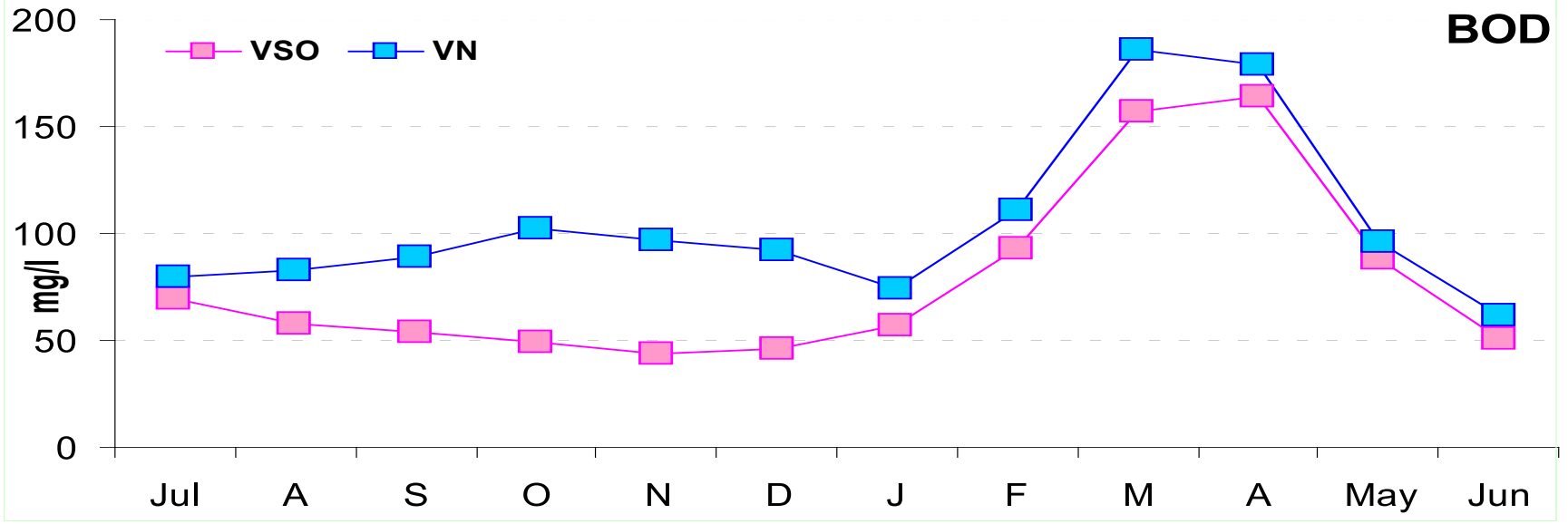


VNO VSO

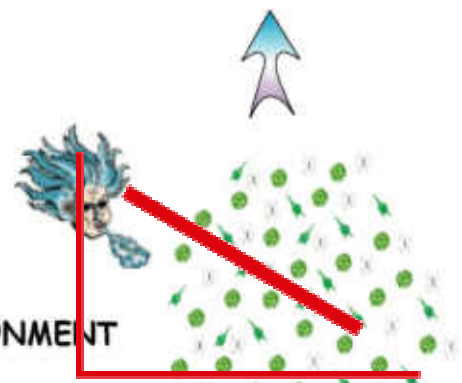
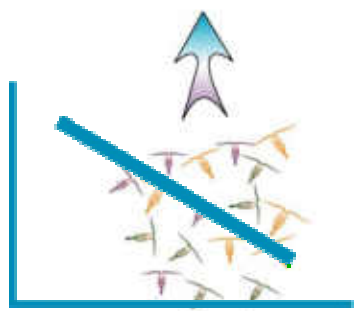
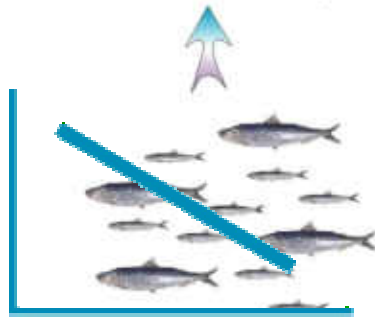
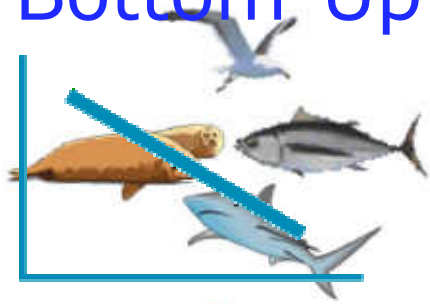


BOD

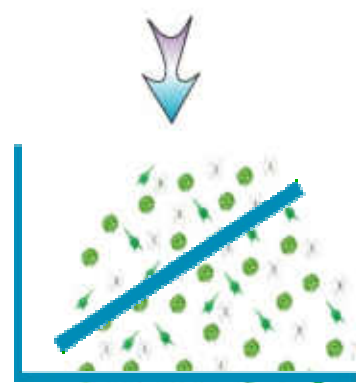
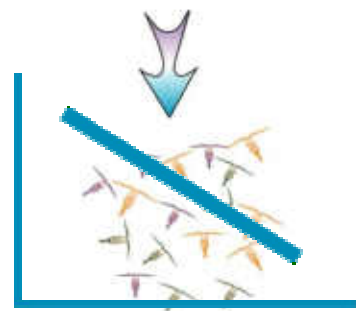
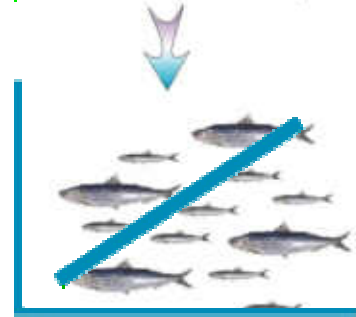
VSO VN



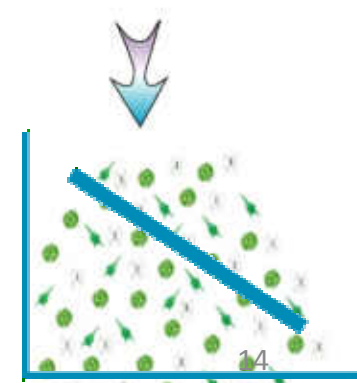
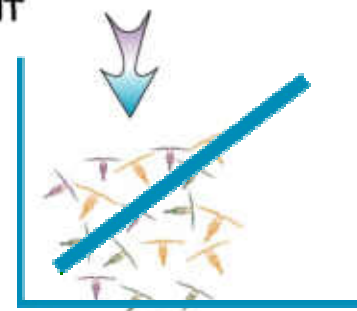
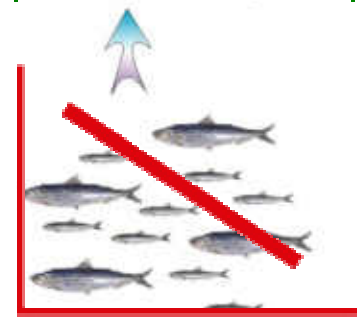
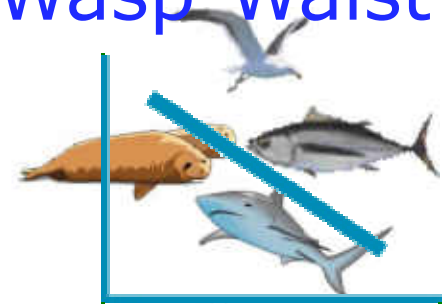
Bottom-Up



Top-Down



Wasp-Waist



Wetlands – goods and services

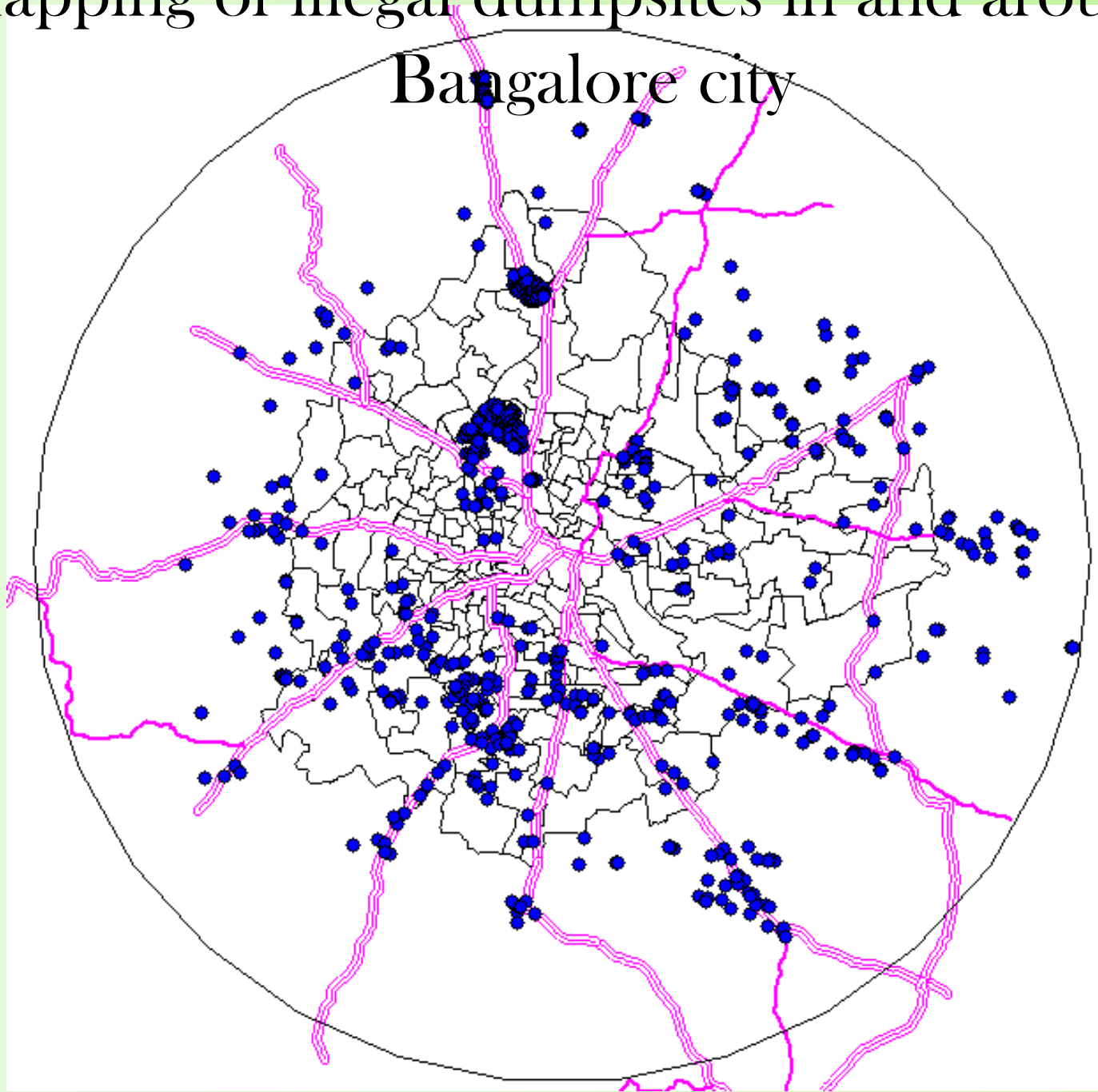
UNPOLLUTED

- Rachenahalli Lake– Rs 10500/day/hectare
 - (fish, fodder, agriculture in command area, flood mitigation, GW recharge, recreation,...)

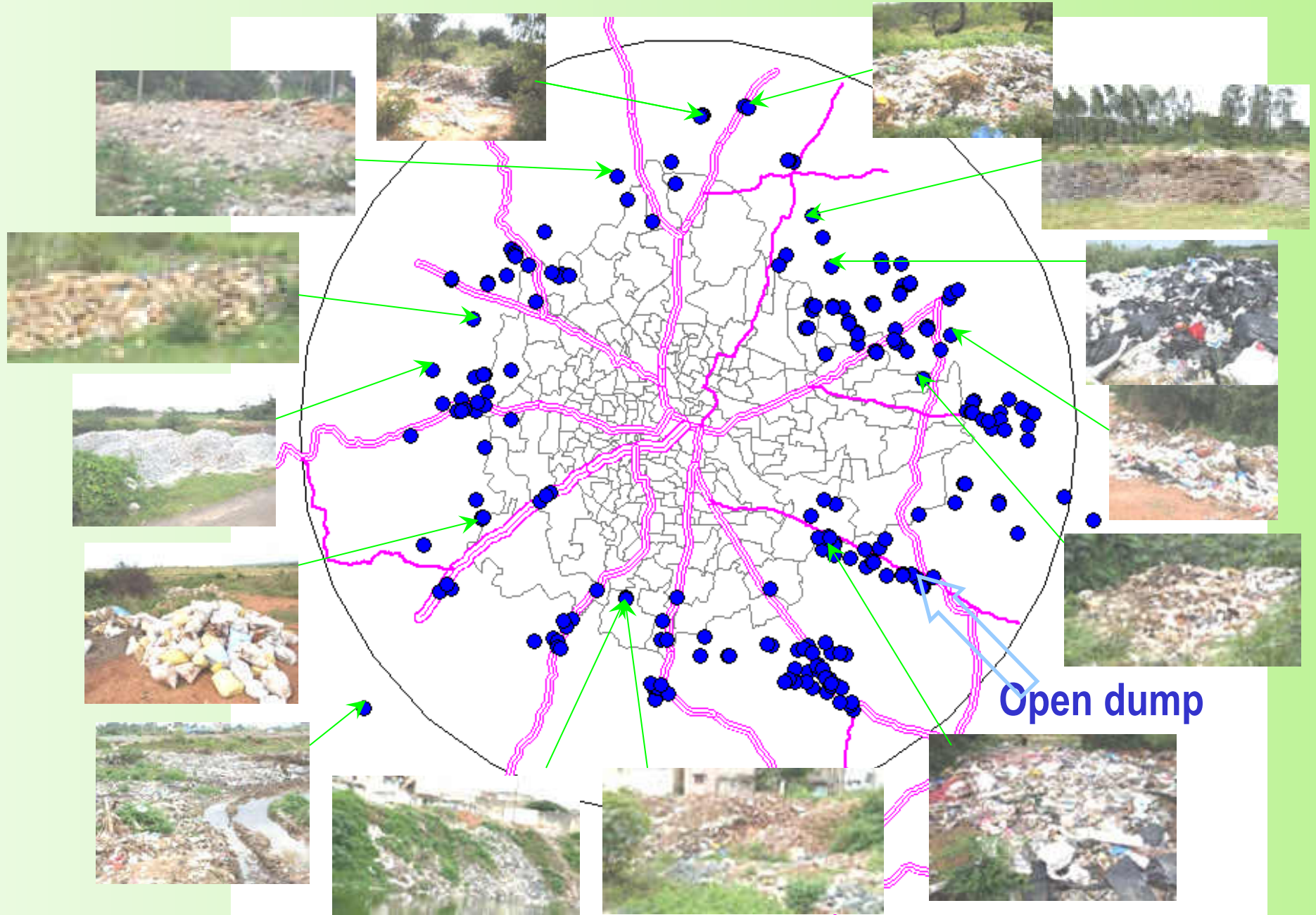
POLLUTED

- Amruthhalli Lake: Rs 20/day/hectare
(Most waterbodies are Sewage fed)

Mapping of illegal dumpsites in and around Bangalore city



Details about illegal dumpsites in city periphery





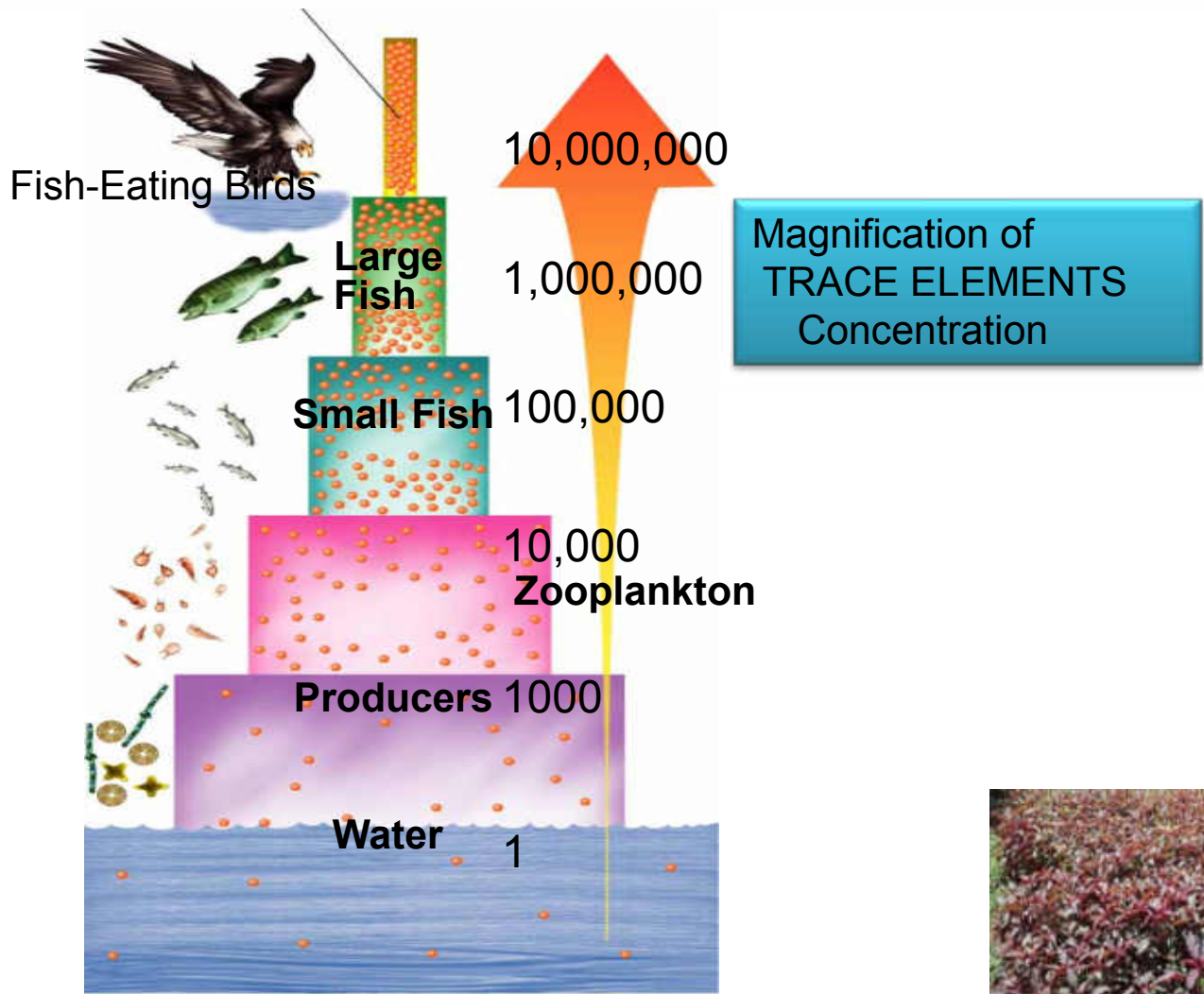
BURNING ISSUE



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Consequences of polluting water bodies – HEAVY METAL IN FOOD CHAIN



Cost effective, sustainable solution

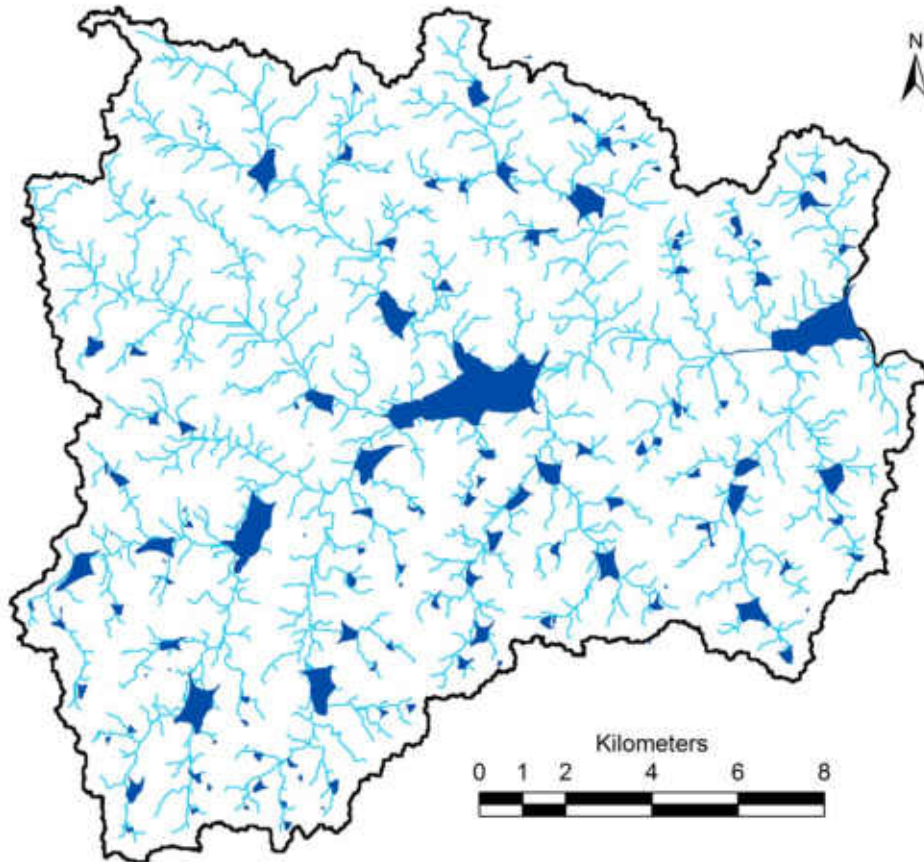
Rejuvenation Blueprint

- Optimal rainwater harvesting through functional lakes
- No Sewage Diversion – Decentralised treatment
- Treatment option – Similar to Jakkur Lake: STP + Constructed Wetlands+ Algal ponds
- Desilting – to increase storage capacity and also decontamination of lake
- Functional ETP (industries – zero discharge, polluter pays principle)
- Custodian – with financial and management autonomy (address issues of encroachment, pollution)
- RWA to manage with all stakeholders

- Understand – Physical,
Chemical and Biological
Integrity

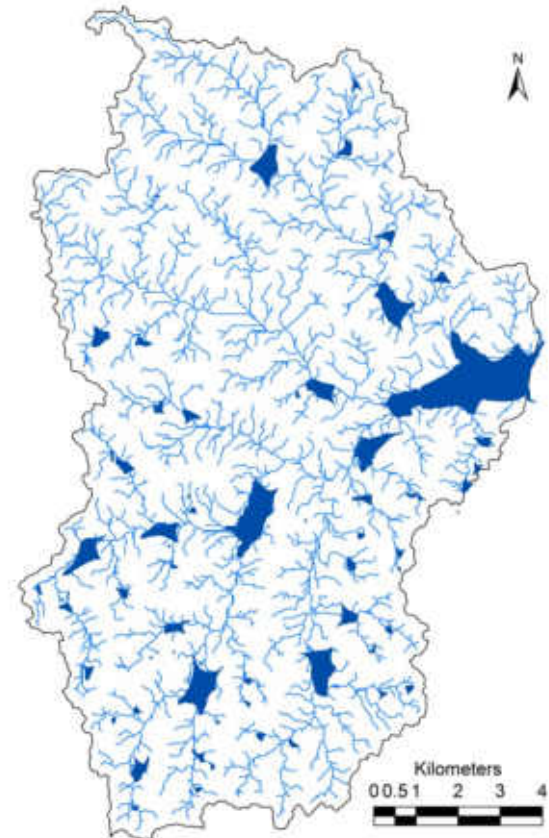
Varthuru and Bellanduru valleys

Varthuru Lake Catchment



Catchment area : 279 square kilometers.

Bellanduru Lake Catchment

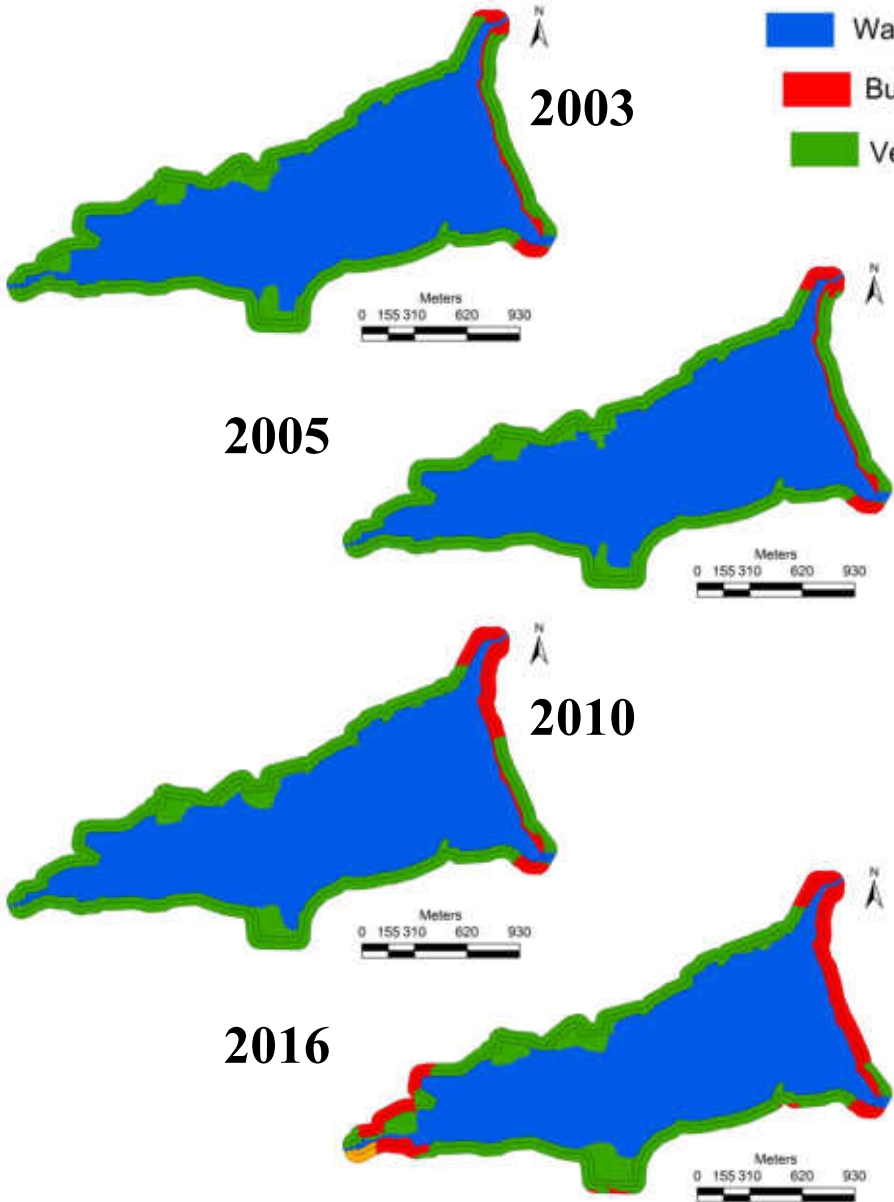


Catchment area : 148square kilometers.

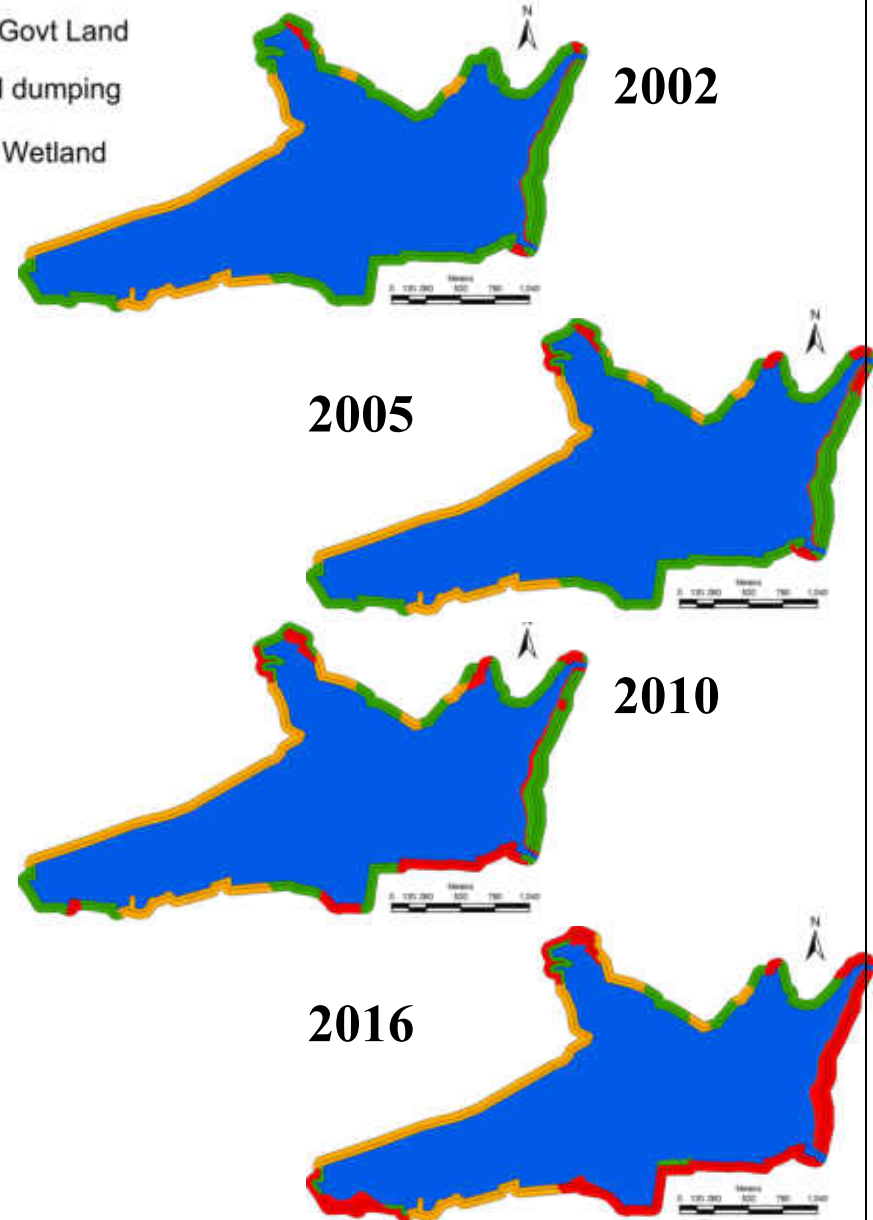
**REMOVE ALL ENCROACHMENTS : LAKE BED, STORM WATER DRAINS
(Rajakaluve)**

Landscape dynamics around the lake (75 m buffer)

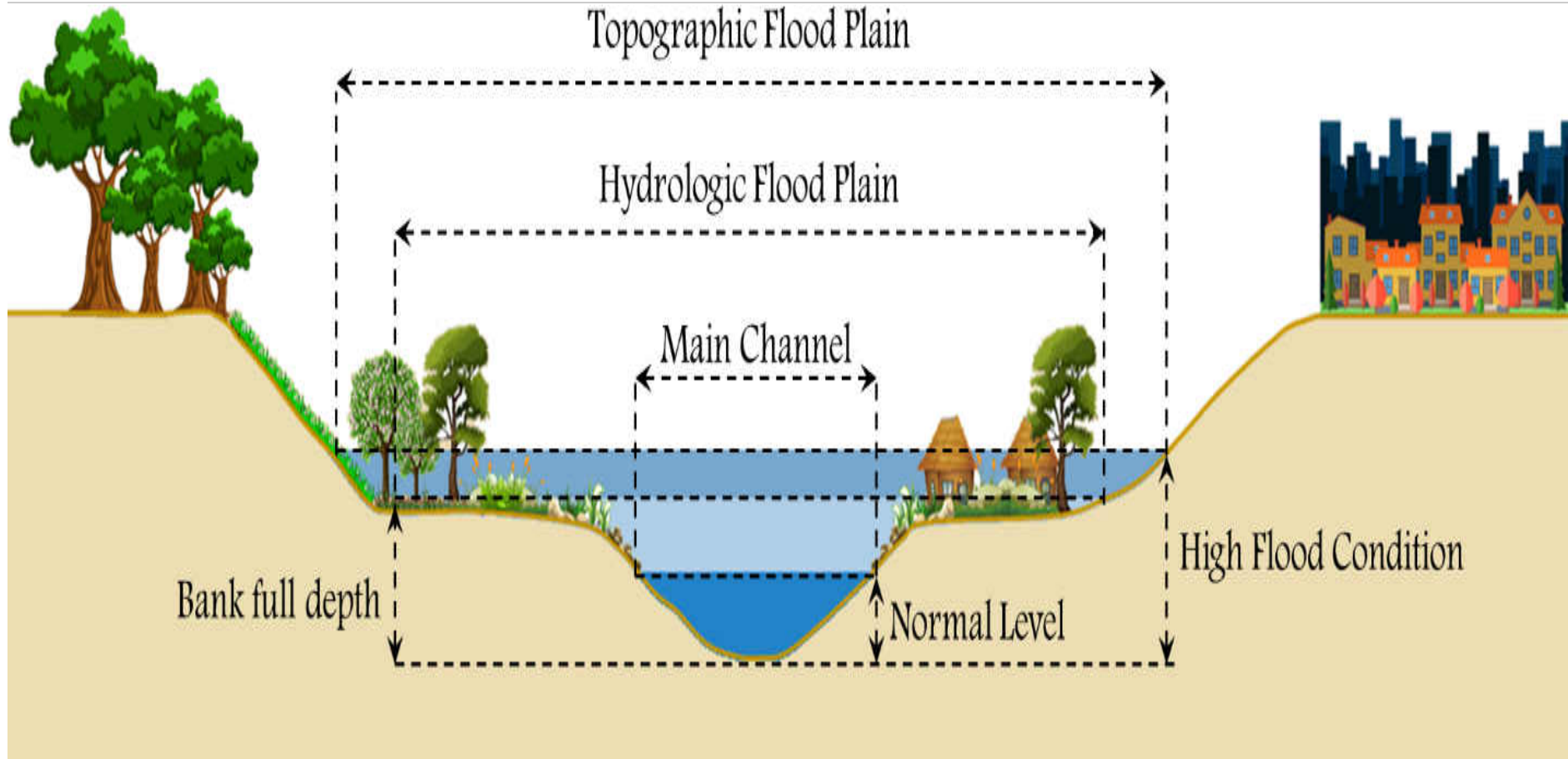
Varthuru

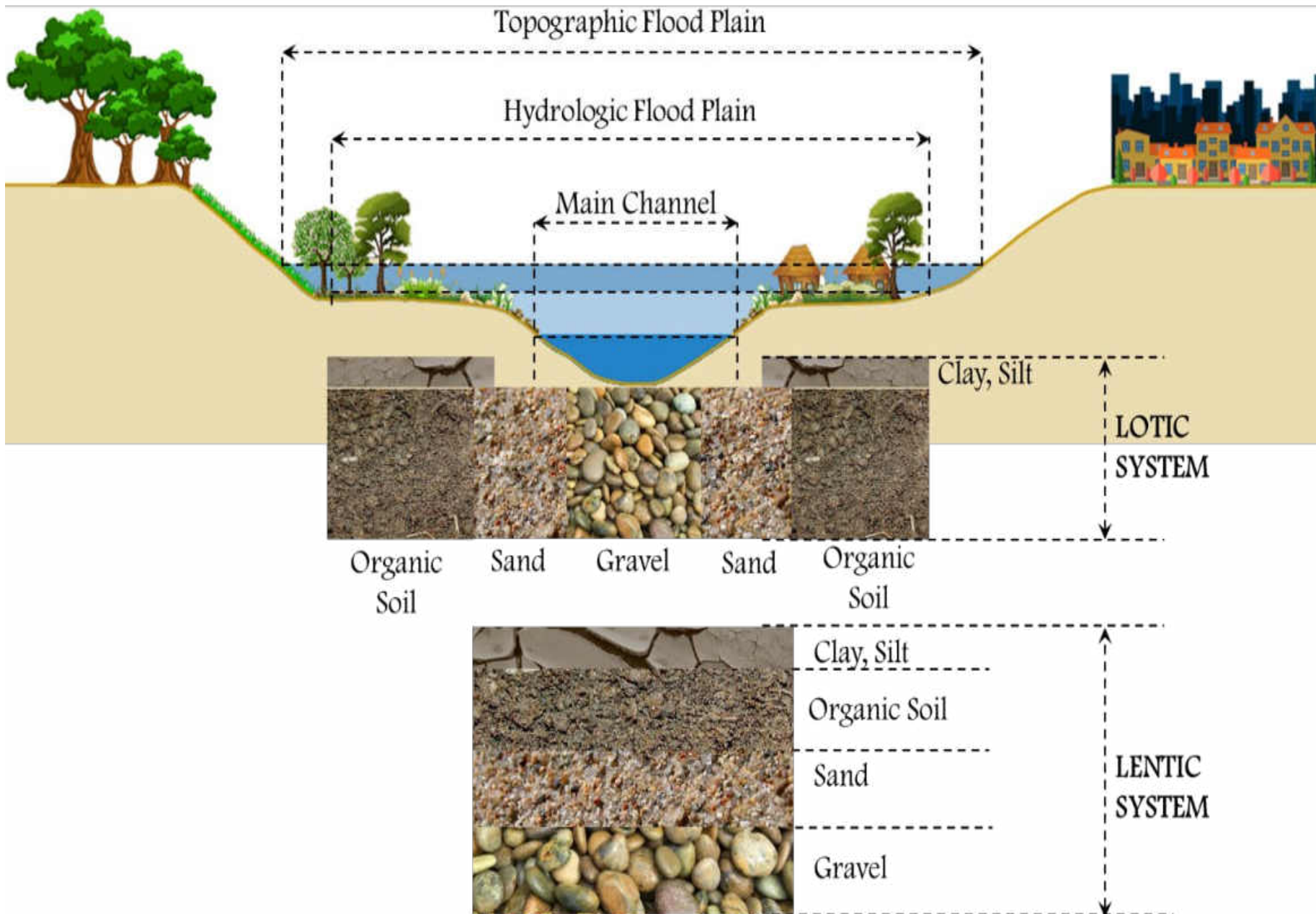


Bellanduru

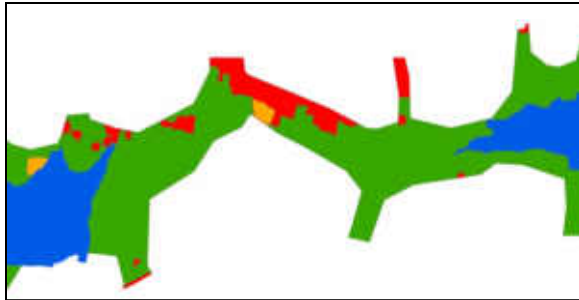


Flood Plains – based on the size of a water body and shape of the catchment





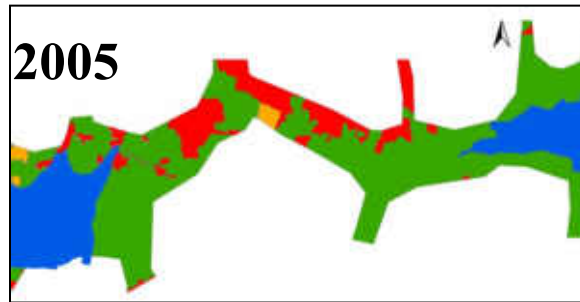
Valley Zone Alteration



2002

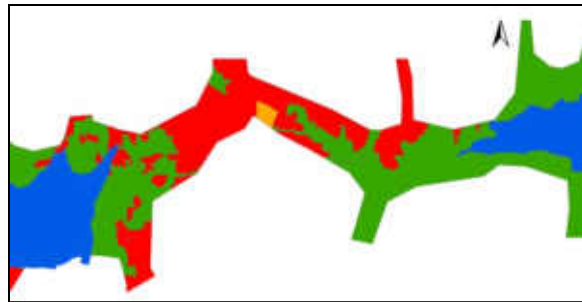


2002

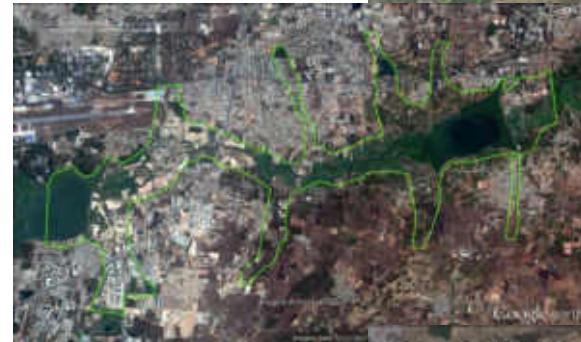


2005

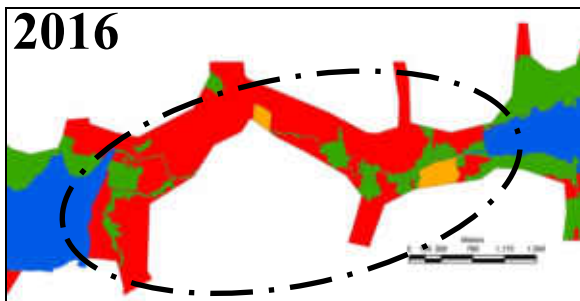
2005



2010



2010



2016

2016

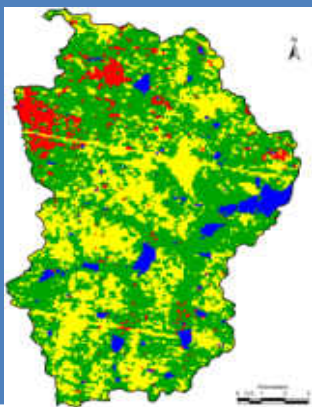


BUILT UP

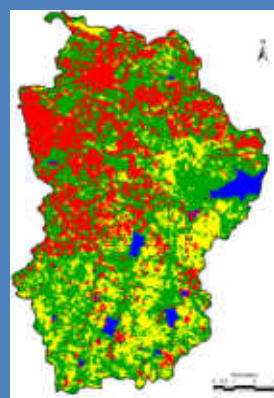


Encroachments

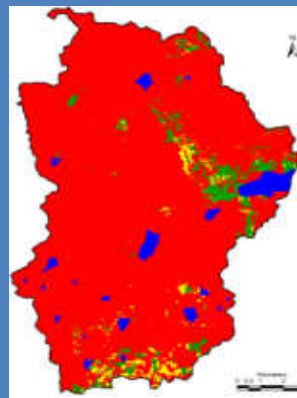




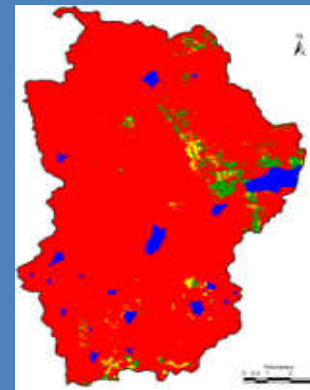
1973



1992



2016



2020

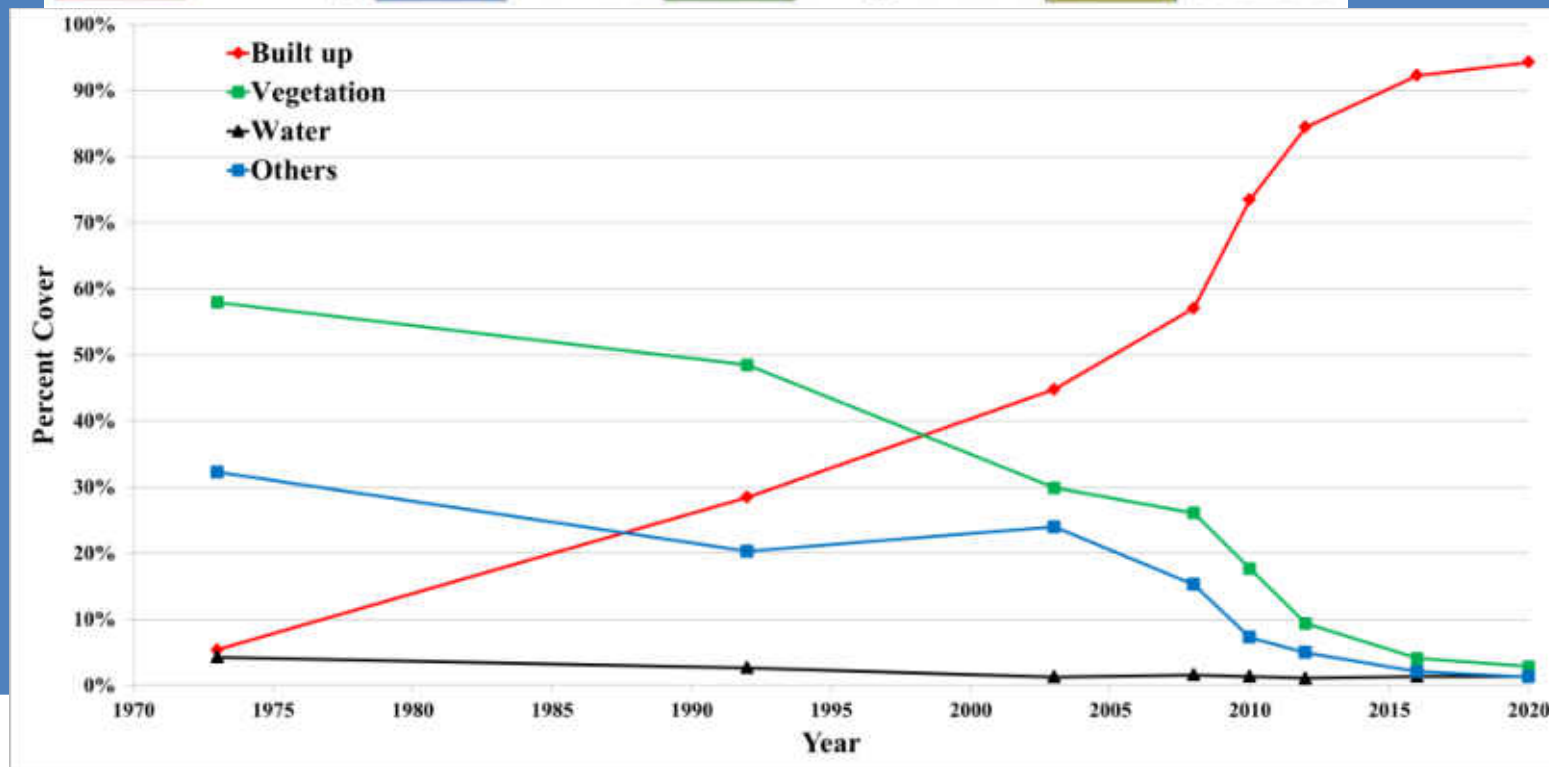
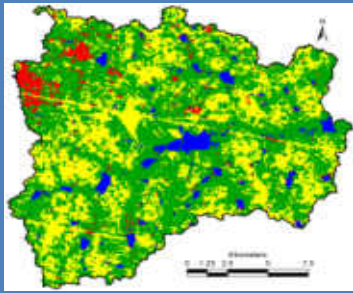
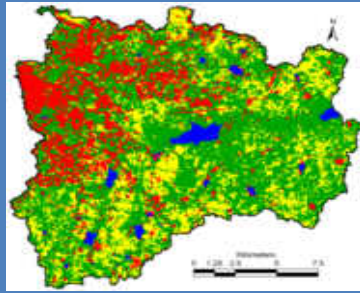


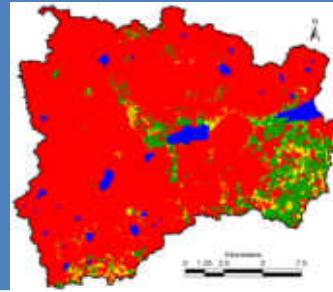
Figure 2.3: Land use dynamics in Bellandur Catchment



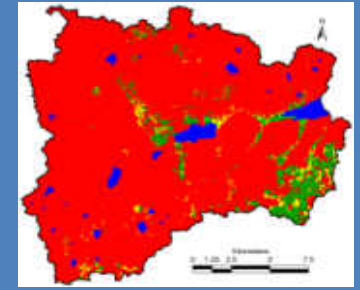
1973



1992

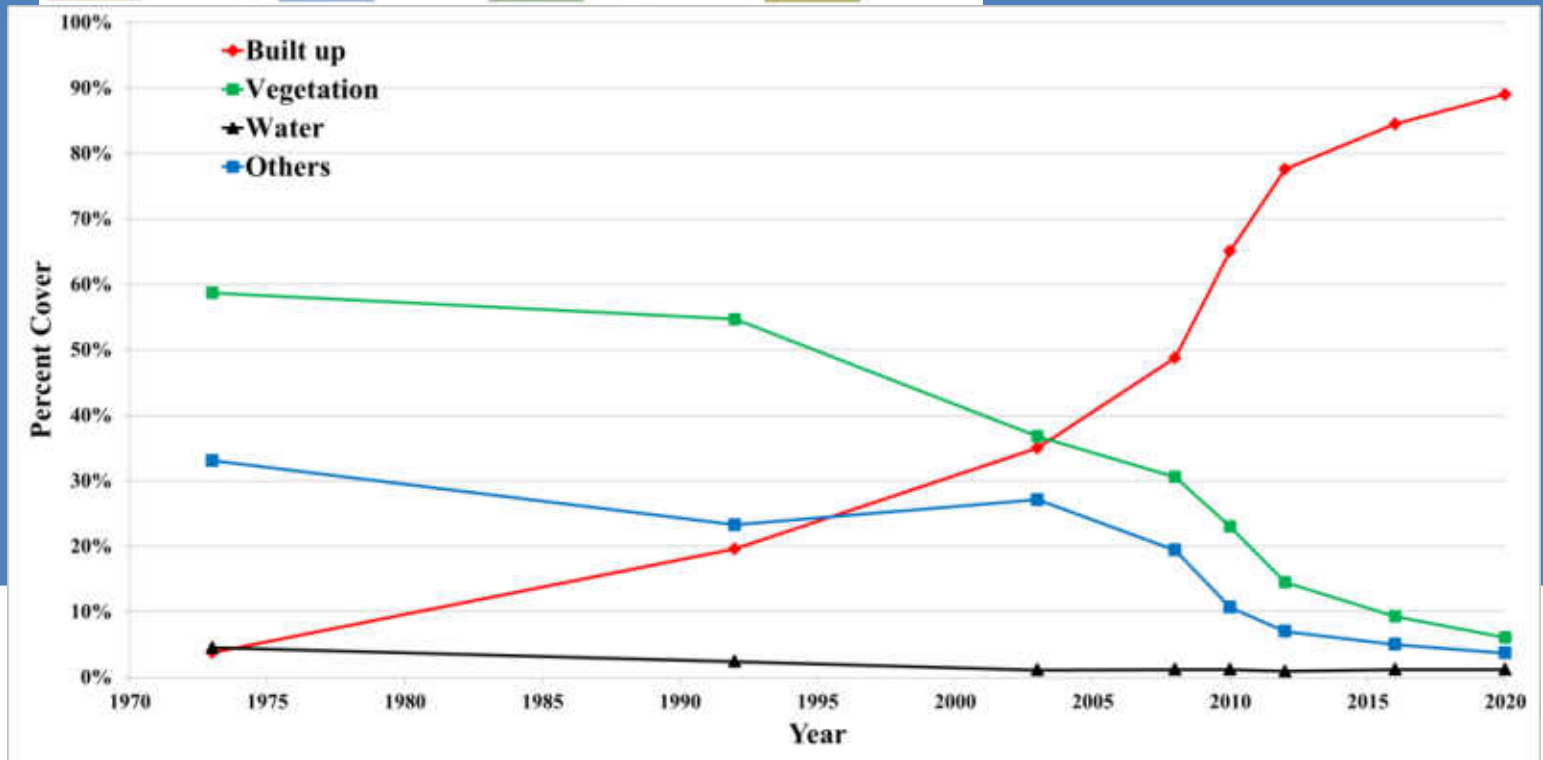


2016



2020

Source: EWRG, CES, IISc, 2016



Quantify accumulated silt – Scientifically

Bathymetry

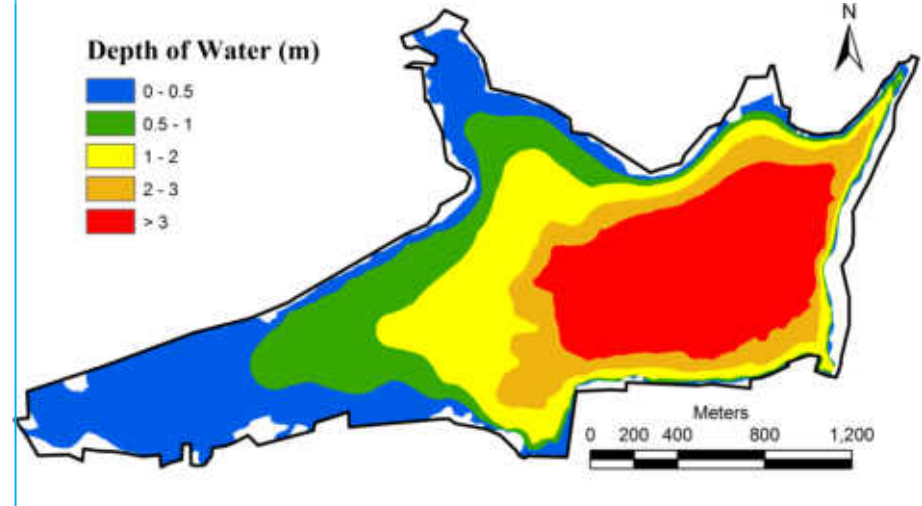
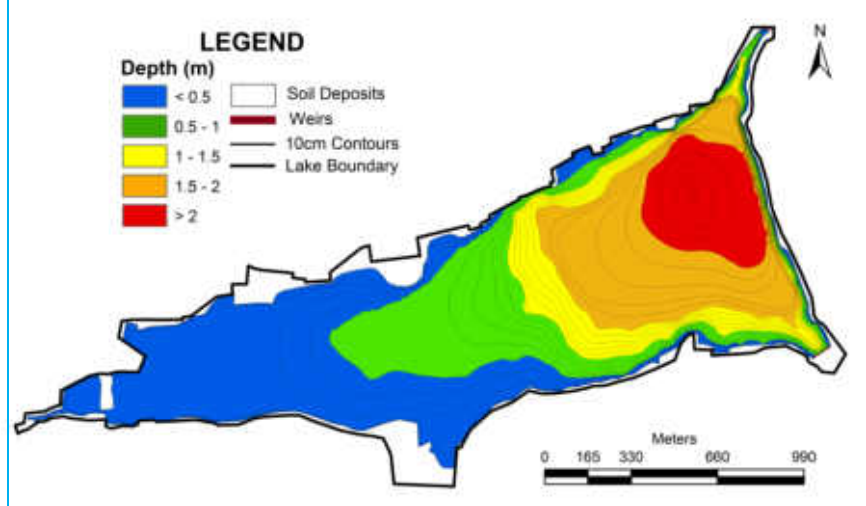
Varthuru



Bellanduru



Current Depth

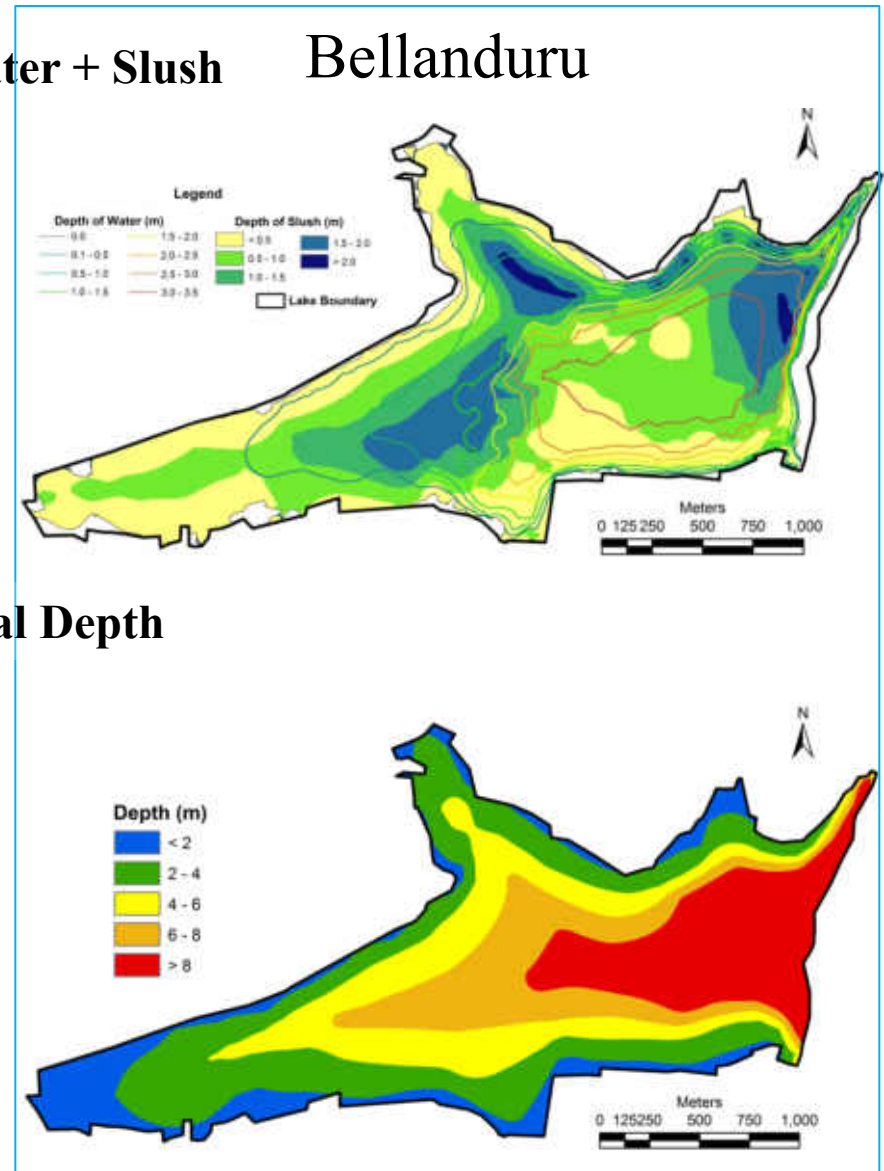
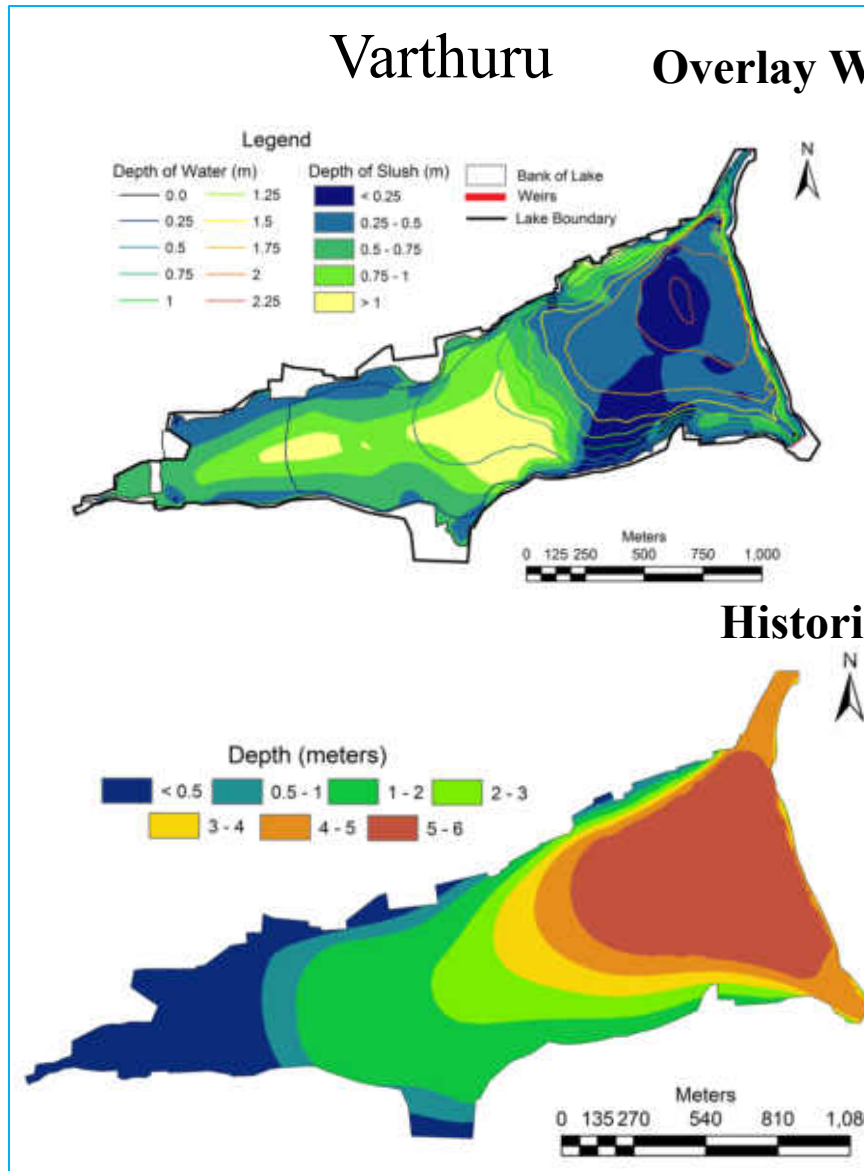


Bathymetry

Varthuru

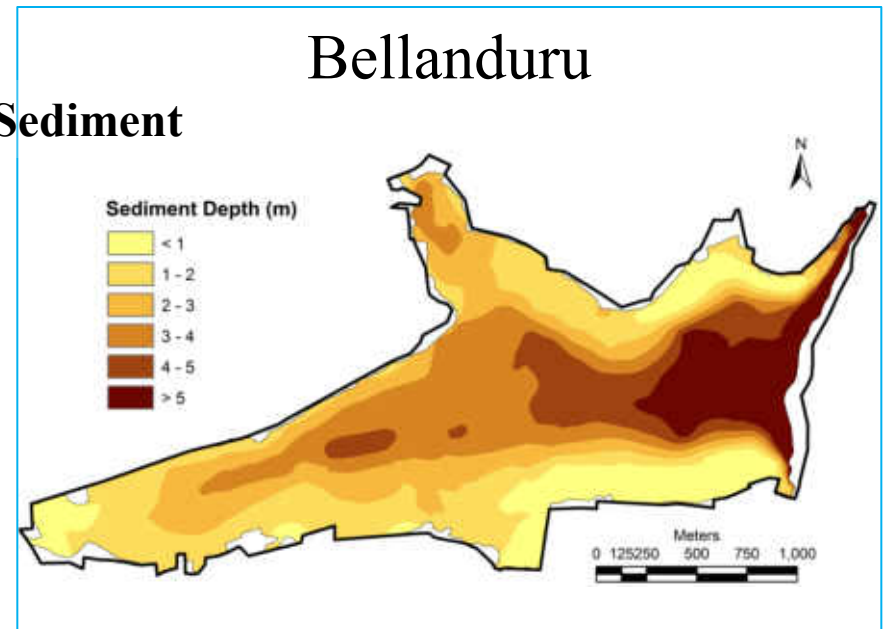
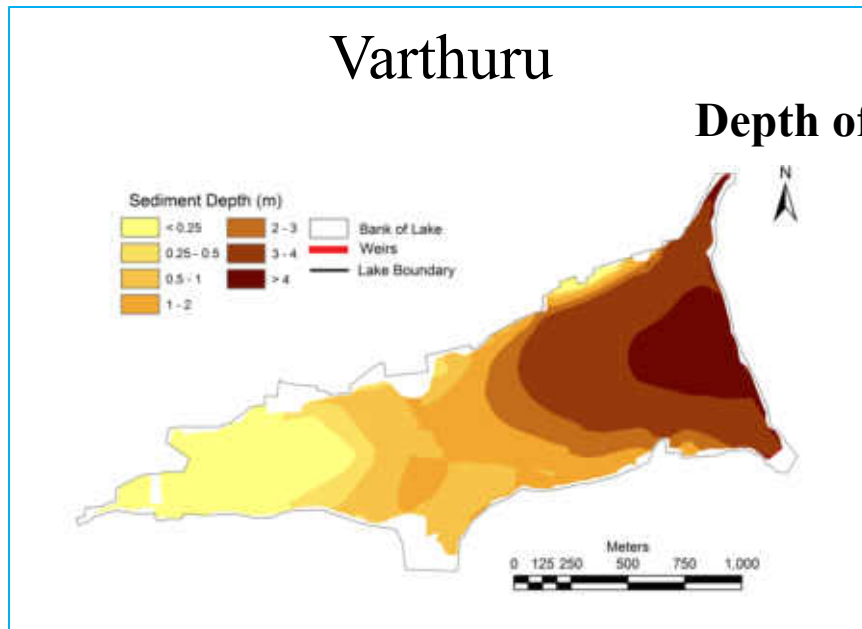
Overlay Water + Slush

Bellanduru



Historical Depth

Bathymetry



Sno	Description	Unit of measurement	Varthuru	Bellanduru
1	Surface area of Lake	Hectare	190.78	367.34
2	Storage Volume	Million cubic meters	6.10	18.67
3	Current Storage Volume of Water	Million cubic meters	1.61	5.50
4	Volume of Slush deposit	Million cubic meters	0.62	6.56
5	Volume of Sediment deposits	Million cubic meters	3.87	6.60

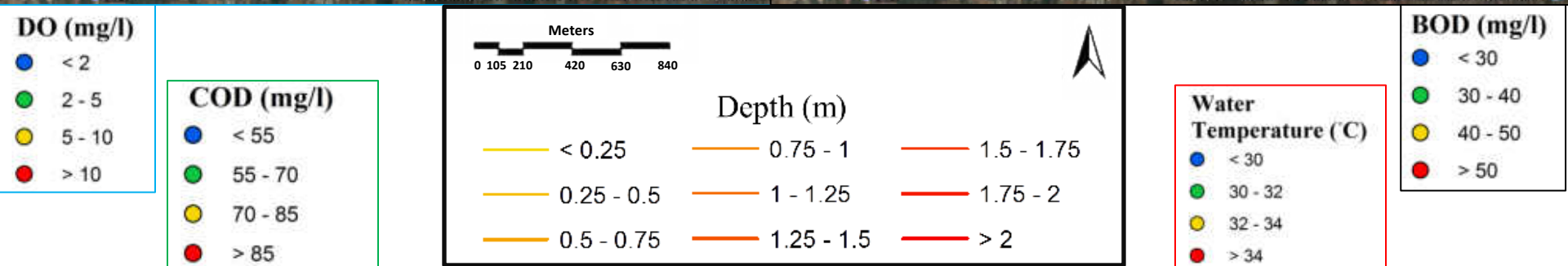
Understand – Physical, Chemical and Biological
Integrity

Water Quality - VARTHURU

DISSOLVED OXYGEN

BIOCHEMICAL OXYGEN DEMAND

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CHEMICAL OXYGEN DEMAND

WATER TEMPERATURE

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WATER TEMPERATURE

pH

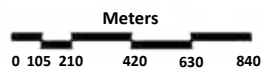
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Water Temperature (°C)

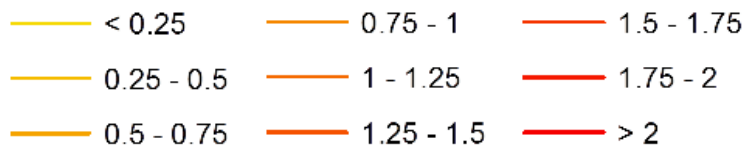
- < 30
- 30 - 32
- 32 - 34
- > 34

Alkalinity (mg/l)

- < 520
- 520 - 540
- 540 - 560
- > 560



Depth (m)



Turbidity (NTU)

- < 40
- 40 - 50
- 50 - 60
- > 60

pH

- < 8
- 8 - 8.25
- 8.25 - 8.5
- > 8.5

ALKALINITY

TURBIDITY

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TOTAL HARDNESS

MAGNESIUM

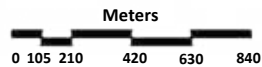
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Total Hardness (mg/l)

- < 230
- 230 - 240
- 240 - 250
- > 250

Calcium (mg/l)

- < 62.5
- 62.5 - 65.0
- 65.0 - 67.5
- > 67.5



Depth (m)

- | | | |
|------------|------------|------------|
| < 0.25 | 0.75 - 1 | 1.5 - 1.75 |
| 0.25 - 0.5 | 1 - 1.25 | 1.75 - 2 |
| 0.5 - 0.75 | 1.25 - 1.5 | > 2 |



Water Temperature (°C)

- < 30
- 30 - 32
- 32 - 34
- > 34

Magnesium (mg/l)

- < 16
- 16 - 18
- 18 - 20
- > 20

CALCIUM

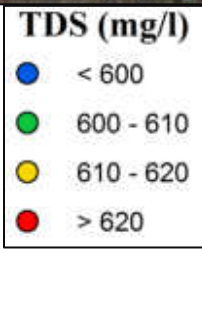
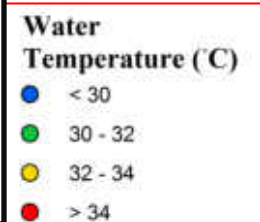
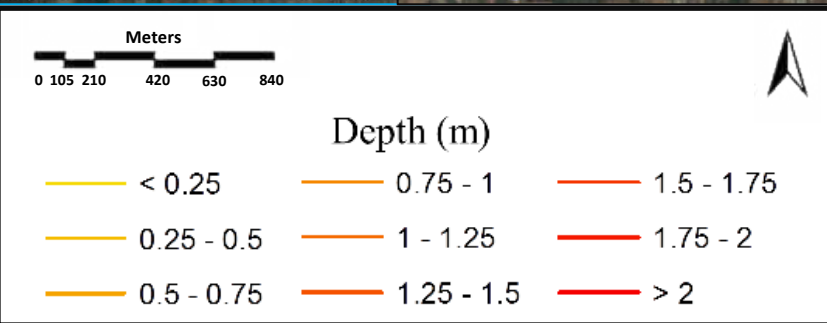
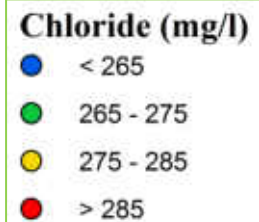
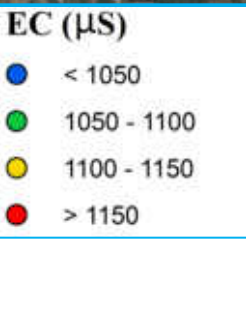
WATER TEMPERATURE

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ELECTRICAL CONDUCTIVITY

TOTAL DISSOLVED SOILDS

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CHLORIDES

WATER TEMPERATURE

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SODIUM

POTASSIUM

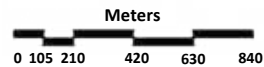
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Sodium (mg/l)

- < 100
- 100 - 115
- 115 - 130
- > 130

Nitrate (mg/l)

- < 0.275
- 0.275 - 0.300
- 0.300 - 0.325
- > 0.325



Depth (m)



OP (mg/l)

- < 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

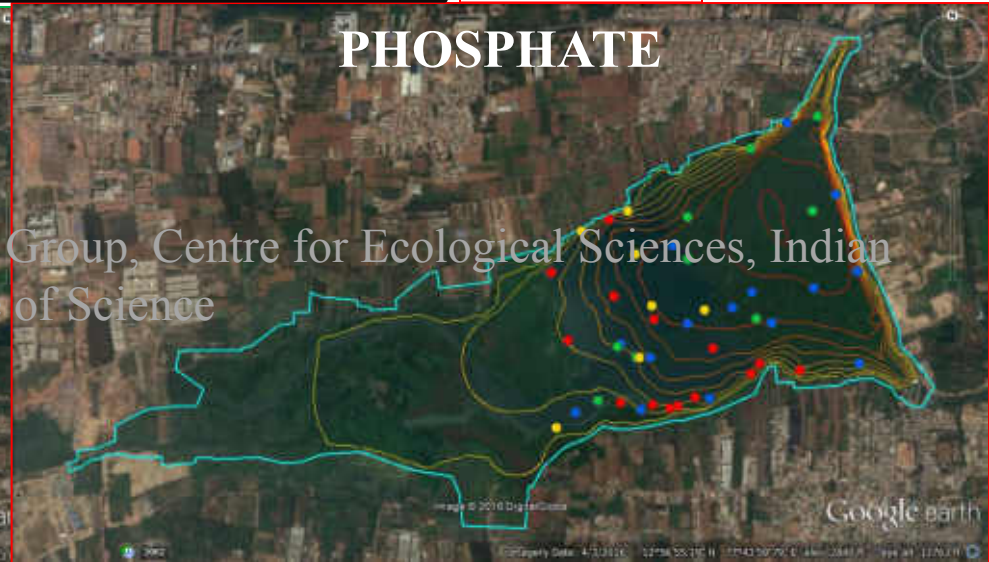
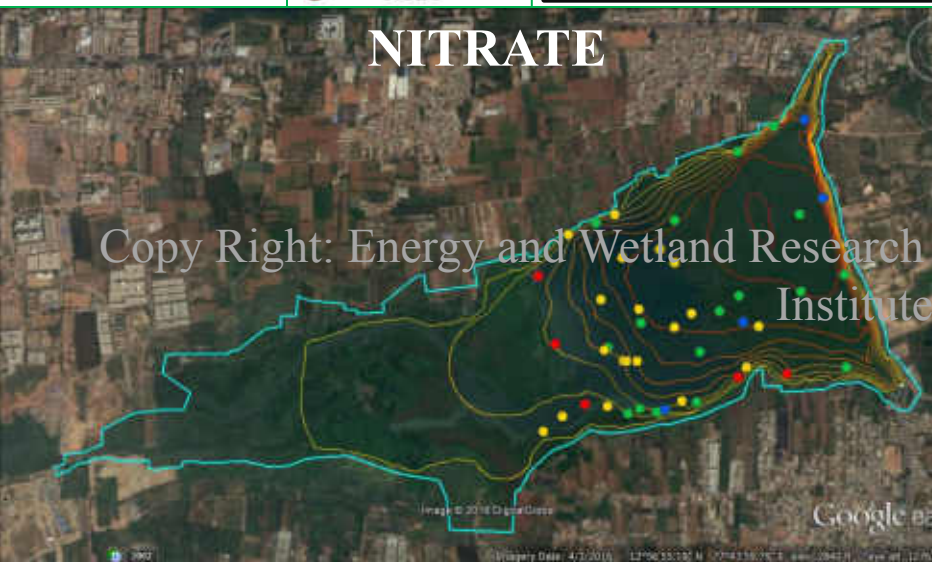
Potassium (mg/l)

- < 20.0
- 20.0 - 22.5
- 22.5 - 25.0
- > 25.0

NITRATE

PHOSPHATE

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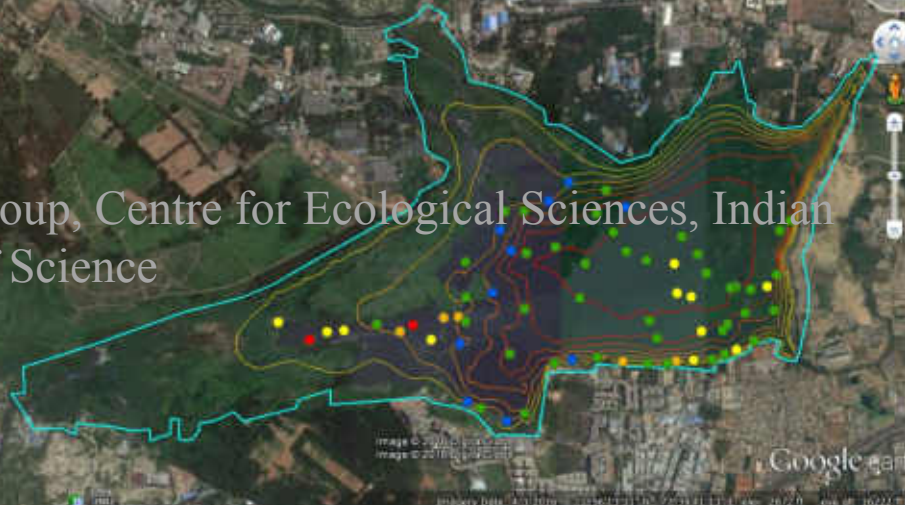
Water Quality – Bellanduru

DISSOLVED OXYGEN

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BIOCHEMICAL OXYGEN DEMAND



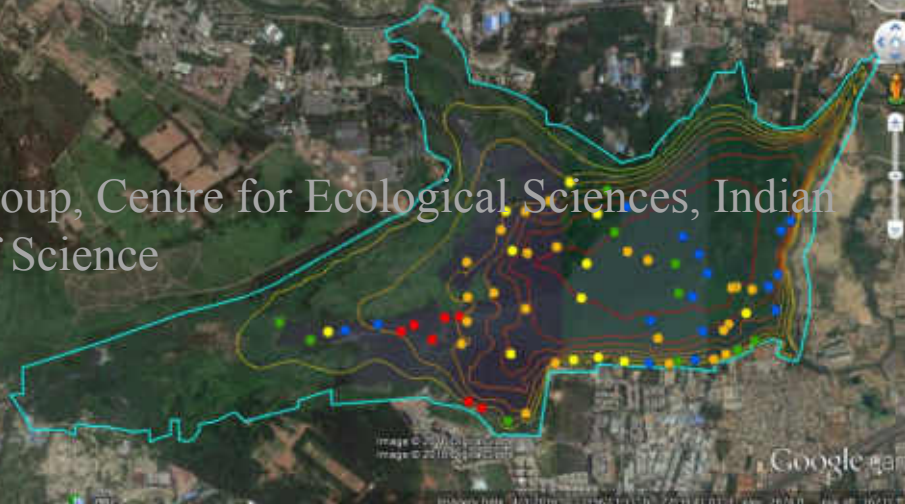
DO (mg/l) <ul style="list-style-type: none">< 0.50.5 - 1.01.0 - 2.52.5 - 5.0> 5.0	COD (mg/l) <ul style="list-style-type: none">< 5050 - 7575 - 100100 - 150> 150	Depth (m) <ul style="list-style-type: none">< 0.50.5 - 11 - 1.51.5 - 22 - 2.52.5 - 3> 3	Water Temperature (°C) <ul style="list-style-type: none">28 - 3030 - 3232 - 3434 - 3636 - 38	BOD (mg/l) <ul style="list-style-type: none">< 2525 - 5050 - 7575 - 100> 100
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CHEMICAL OXYGEN DEMAND

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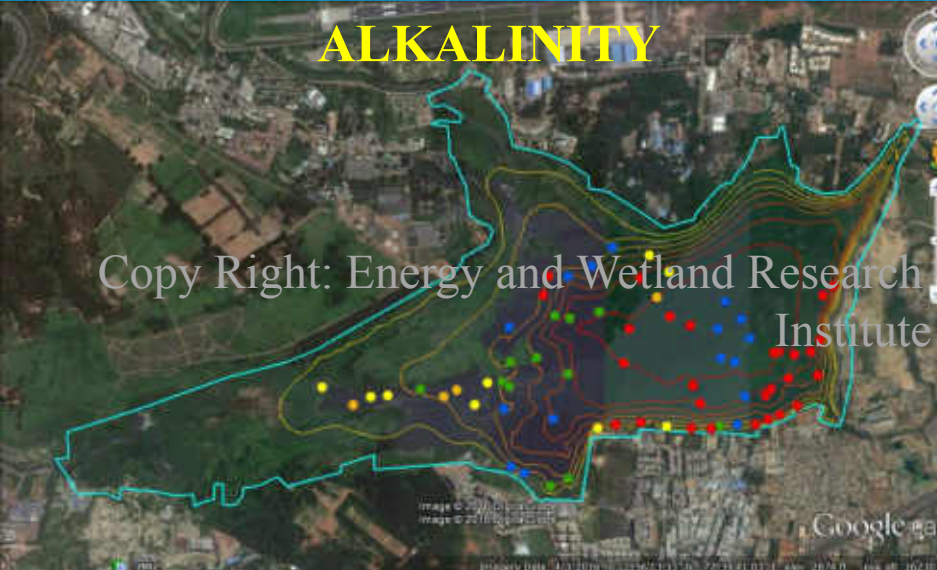


WATER TEMPERATURE

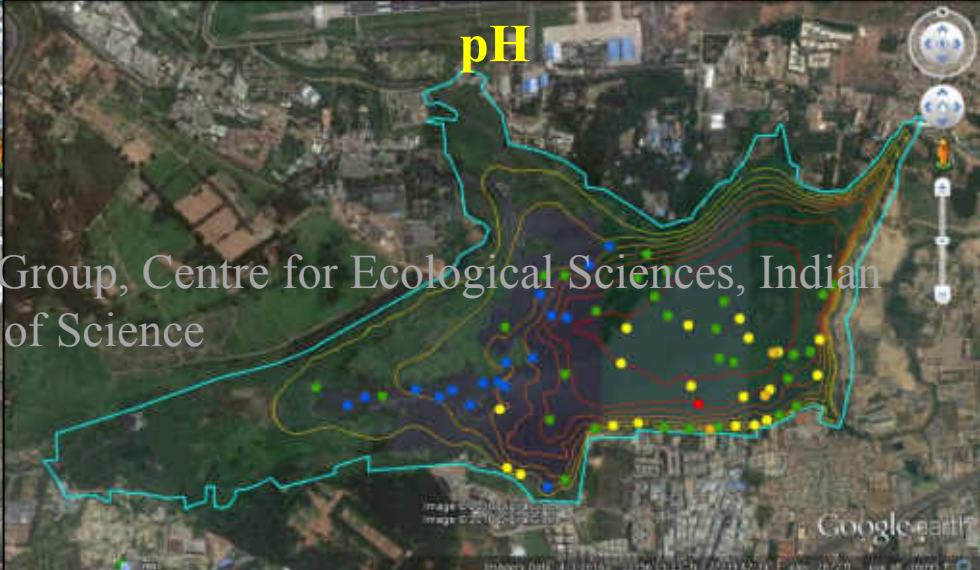


ALKALINITY

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pH



Alkalinity (mg/l)

- < 425
- 425 - 450
- 450 - 475
- 475 - 500
- > 500

Turbidity (NTU)

- < 25
- 25 - 50
- 50 - 100
- 100 - 200
- > 200

Meters
0 140 280 560 840 1,120

Depth (m)

- < 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- > 3

Water Temperature (°C)

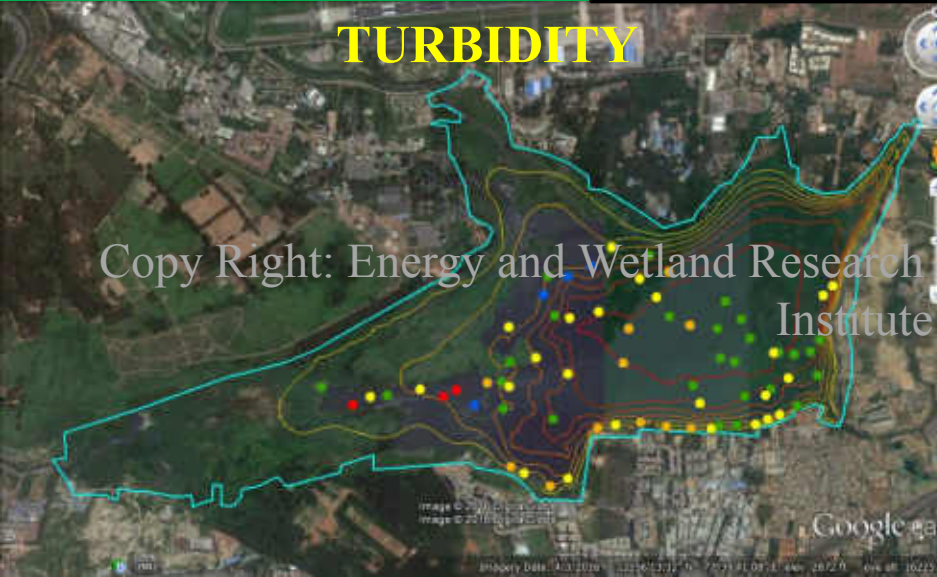
- 28 - 30
- 30 - 32
- 32 - 34
- 34 - 36
- 36 - 38

pH

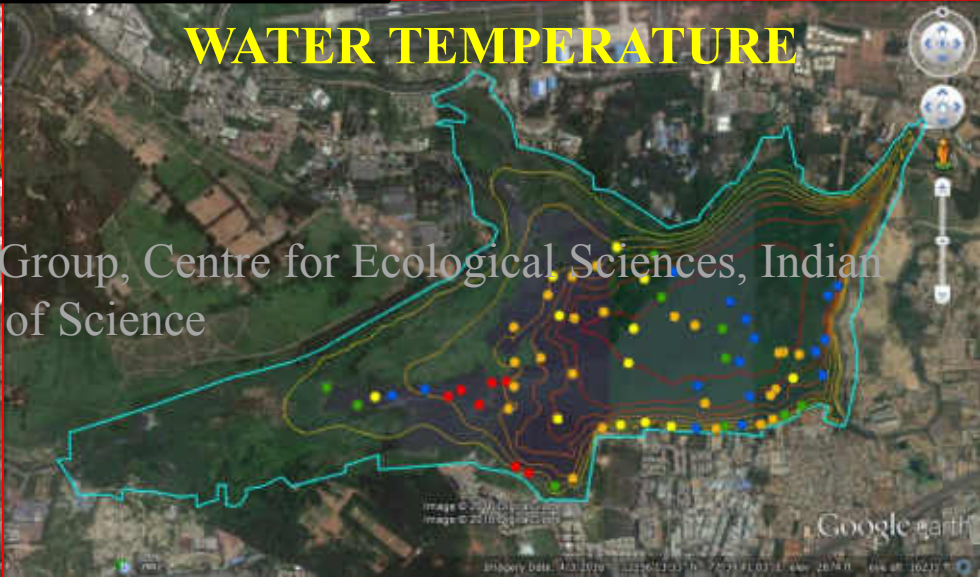
- < 7.75
- 7.75 - 8.00
- 8.00 - 8.25
- 8.25 - 8.50
- > 8.50

TURBIDITY

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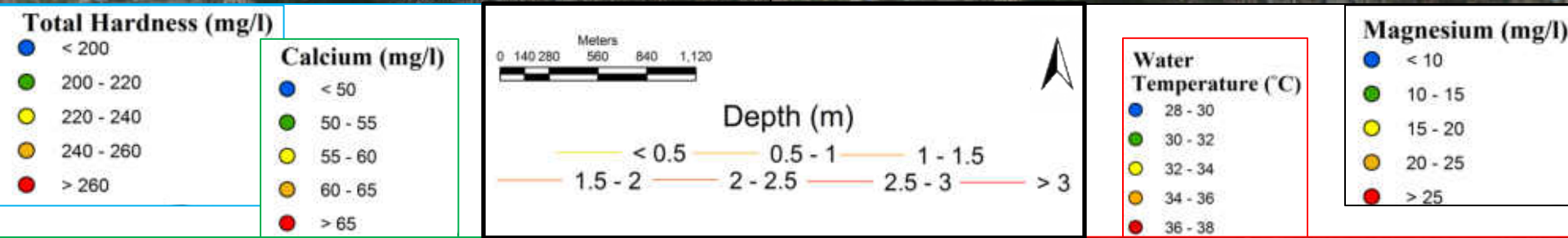
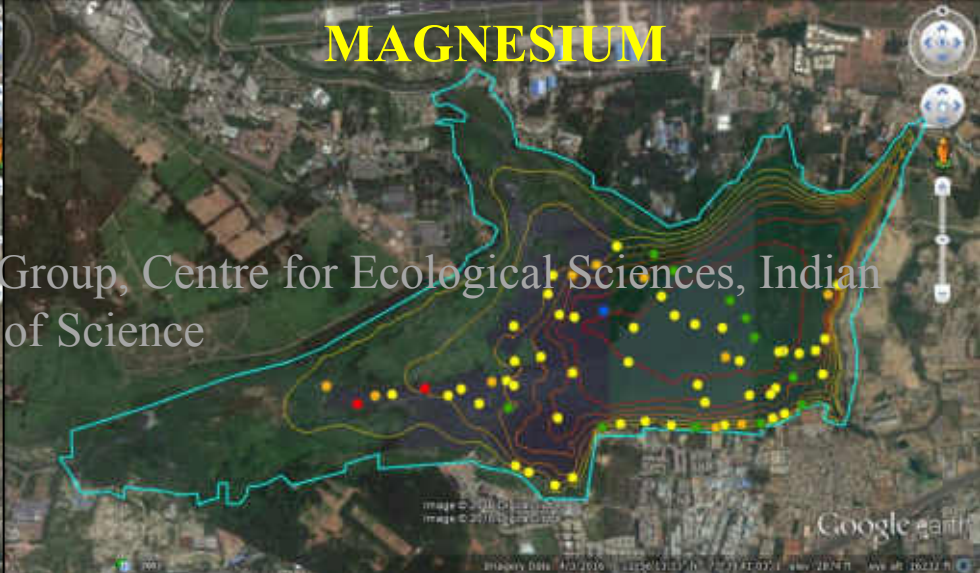
WATER TEMPERATURE



TOTAL HARDNESS

MAGNESIUM

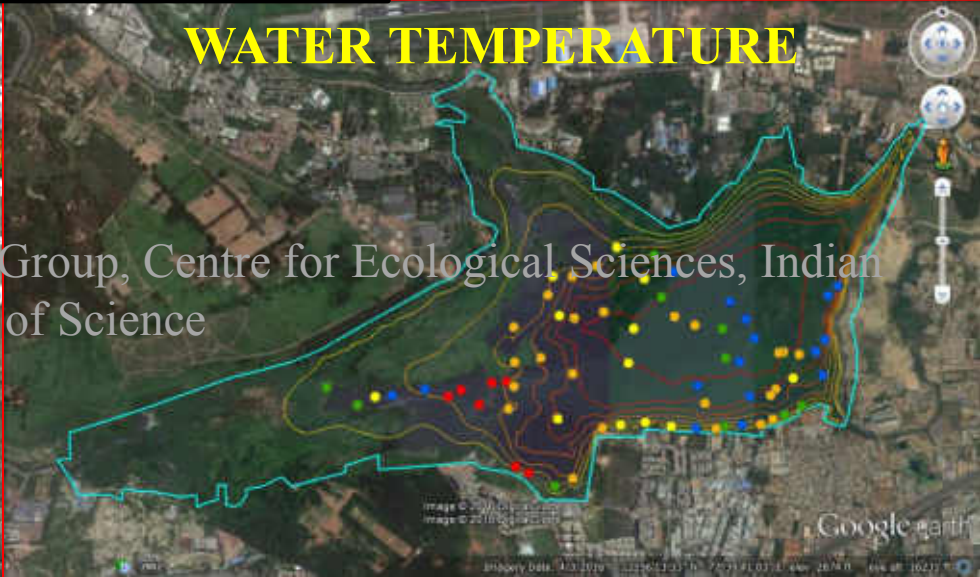
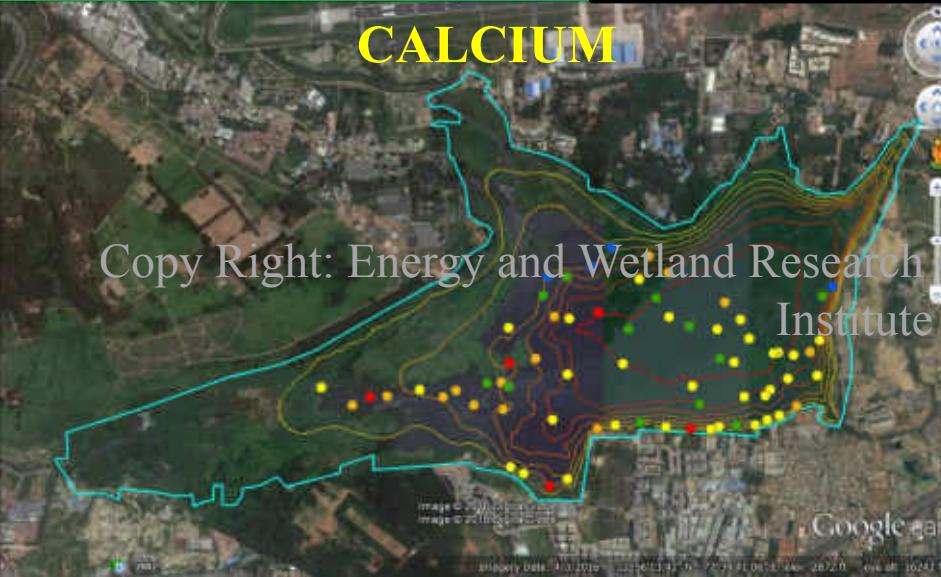
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CALCIUM

WATER TEMPERATURE

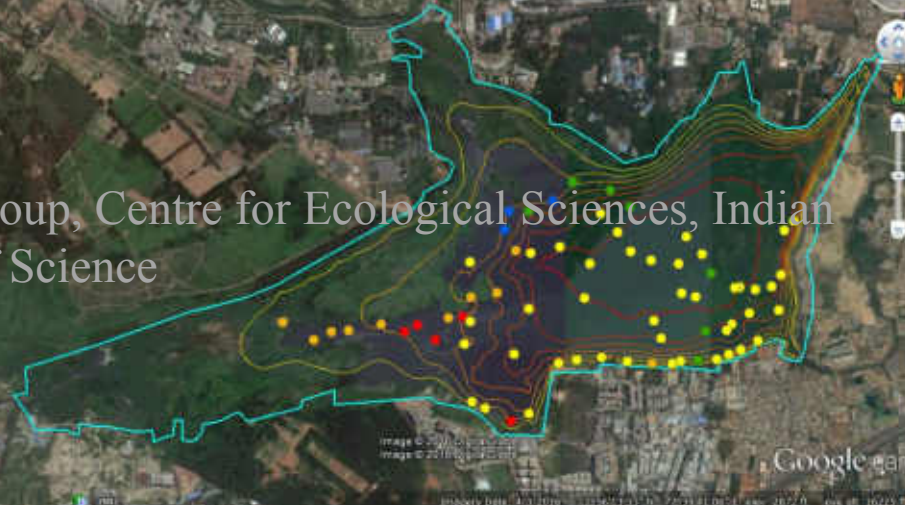
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ELECTRICAL CONDUCTIVITY

TOTAL DISSOLVED SOLIDS

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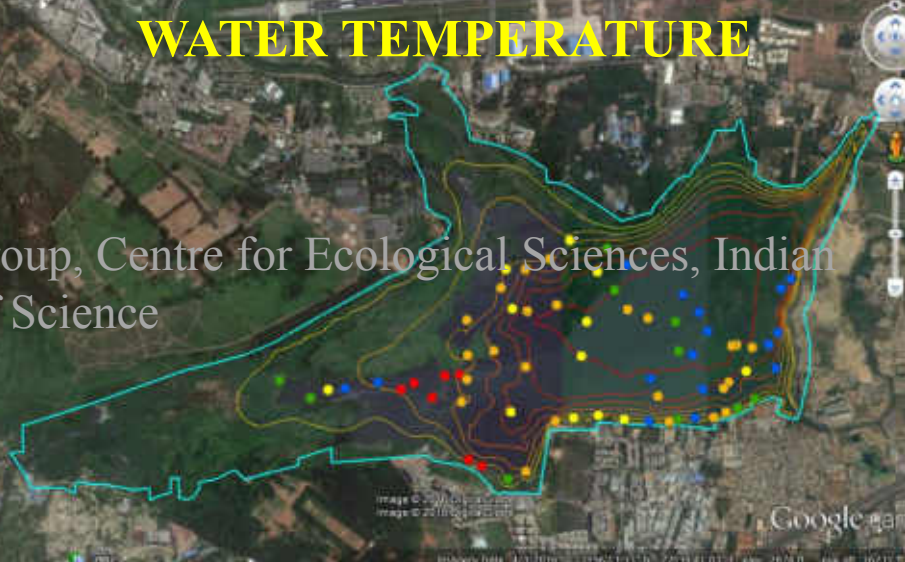
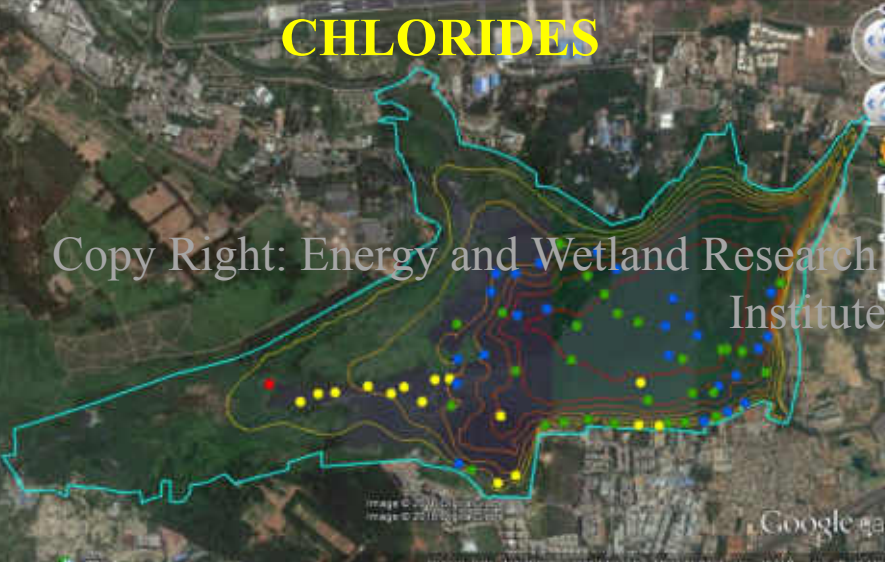


EC (μS) <ul style="list-style-type: none"><math>< 1000</math>1000 - 10501050 - 11001100 - 1150> 1150	Chloride (mg/l) <ul style="list-style-type: none"><math>< 250</math>250 - 260260 - 270270 - 280> 280	Depth (m) <ul style="list-style-type: none"><math>< 0.5</math>0.5 - 11 - 1.51.5 - 22 - 2.52.5 - 3> 3	Water Temperature ($^{\circ}\text{C}$) <ul style="list-style-type: none">28 - 3030 - 3232 - 3434 - 3636 - 38	TDS (mg/l) <ul style="list-style-type: none"><math>< 500</math>500 - 550550 - 600600 - 650> 650
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CHLORIDES

WATER TEMPERATURE

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SODIUM

POTASSIUM

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Sodium (mg/l)

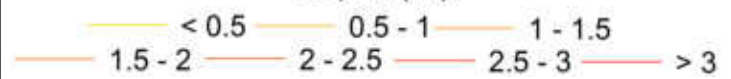
- < 75
- 75 - 100
- 100 - 125
- 125 - 150
- > 150

Nitrate (mg/l)

- < 0.30
- 0.30 - 0.35
- 0.35 - 0.40
- 0.40 - 0.45
- > 0.45



Depth (m)



Phosphate (mg/l)

- < 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- > 3.5

Potassium (mg/l)

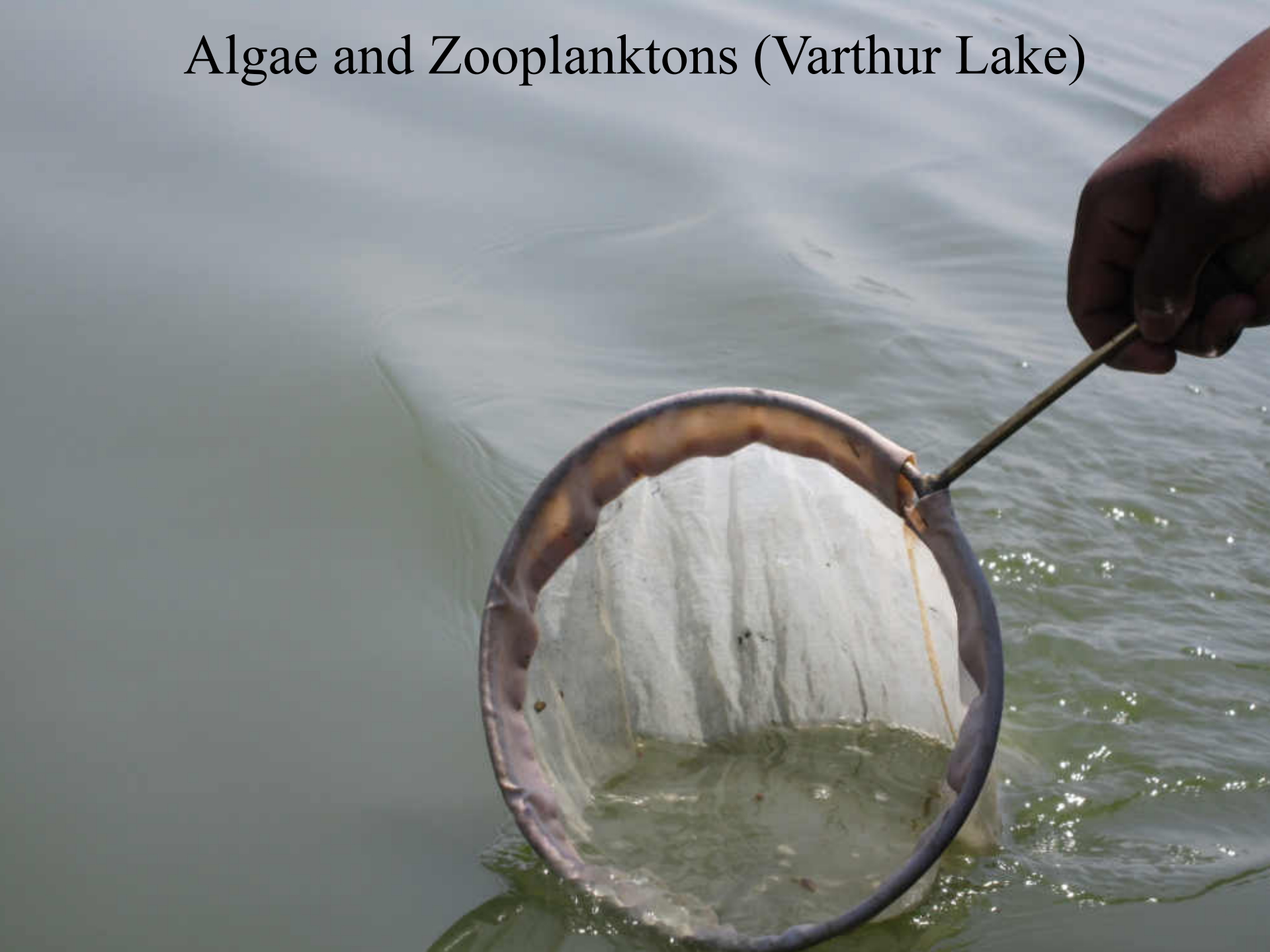
- < 17.5
- 17.5 - 20.0
- 20.0 - 22.5
- 22.5 - 25.0
- > 25.0

NITRATE

PHOSPHATE

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Algae and Zooplanktons (Varthur Lake)

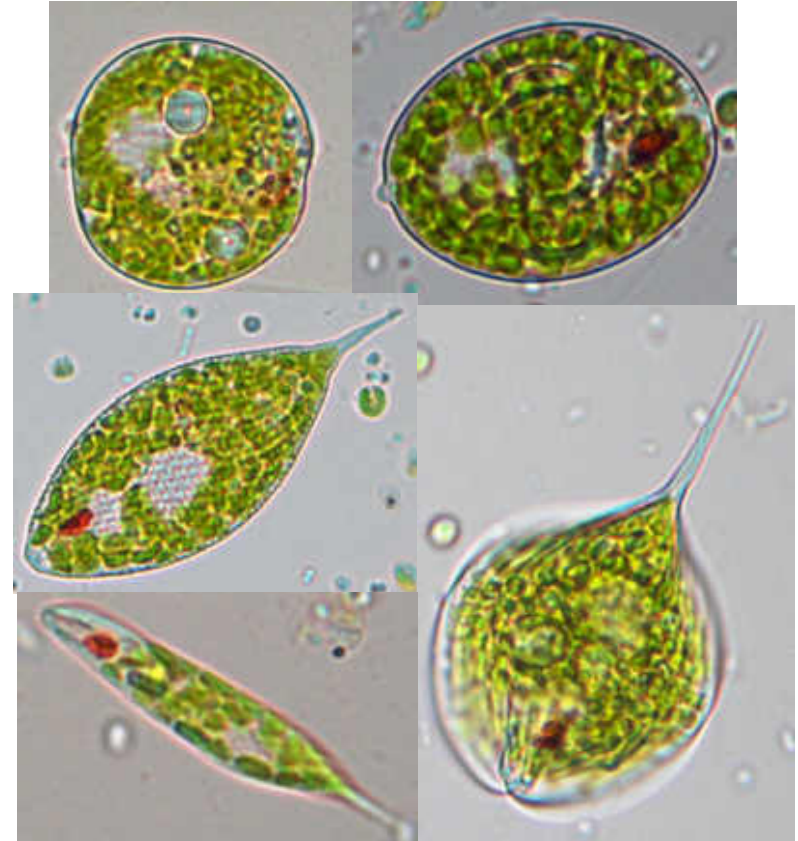


Algae in Varthur Lake

Chlorophyceae



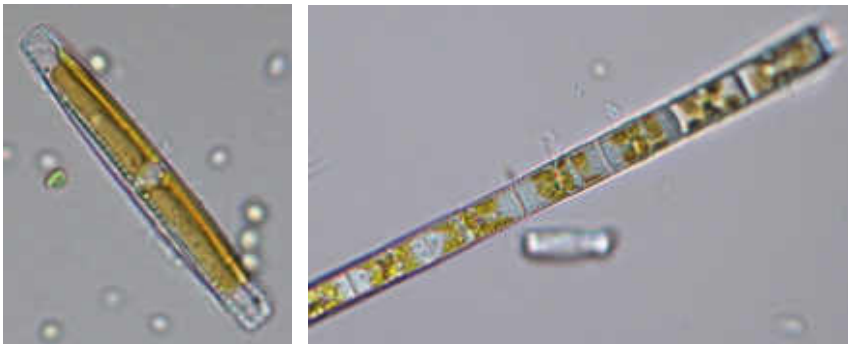
Euglenophyceae



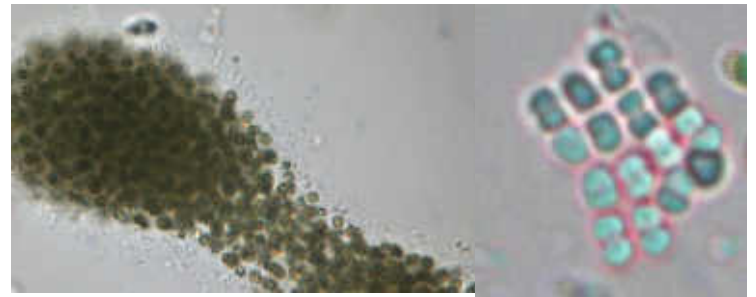
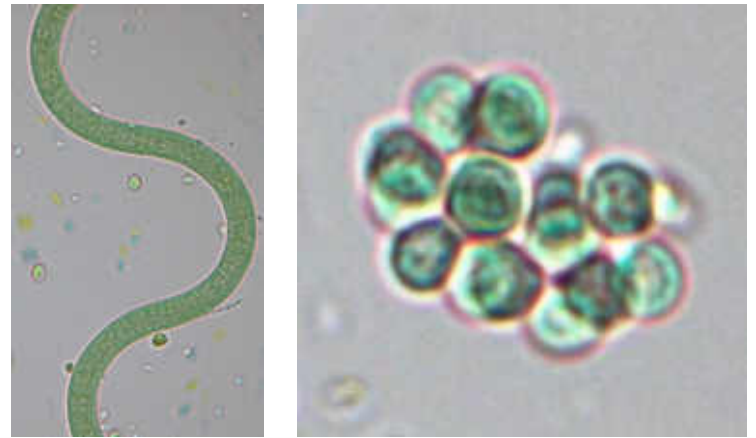
= these species are good indicators of water pollution

Algae in Varthur Lake

Bacillariophyceae

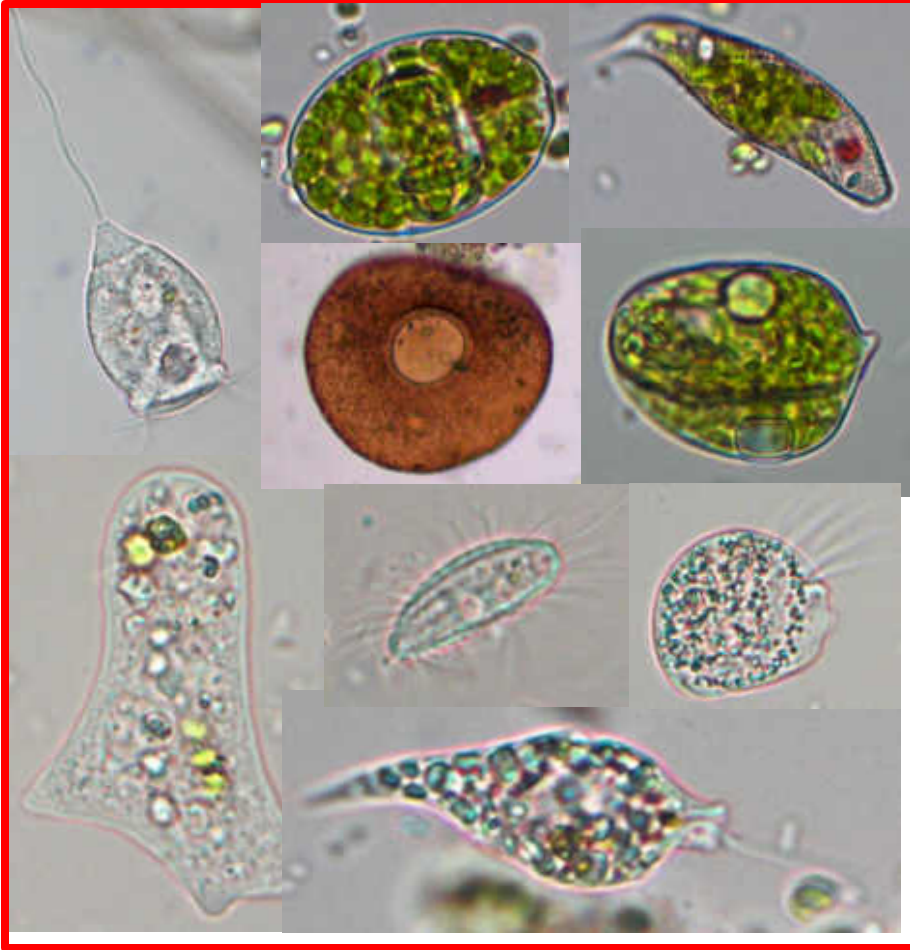


Cyanophyceae

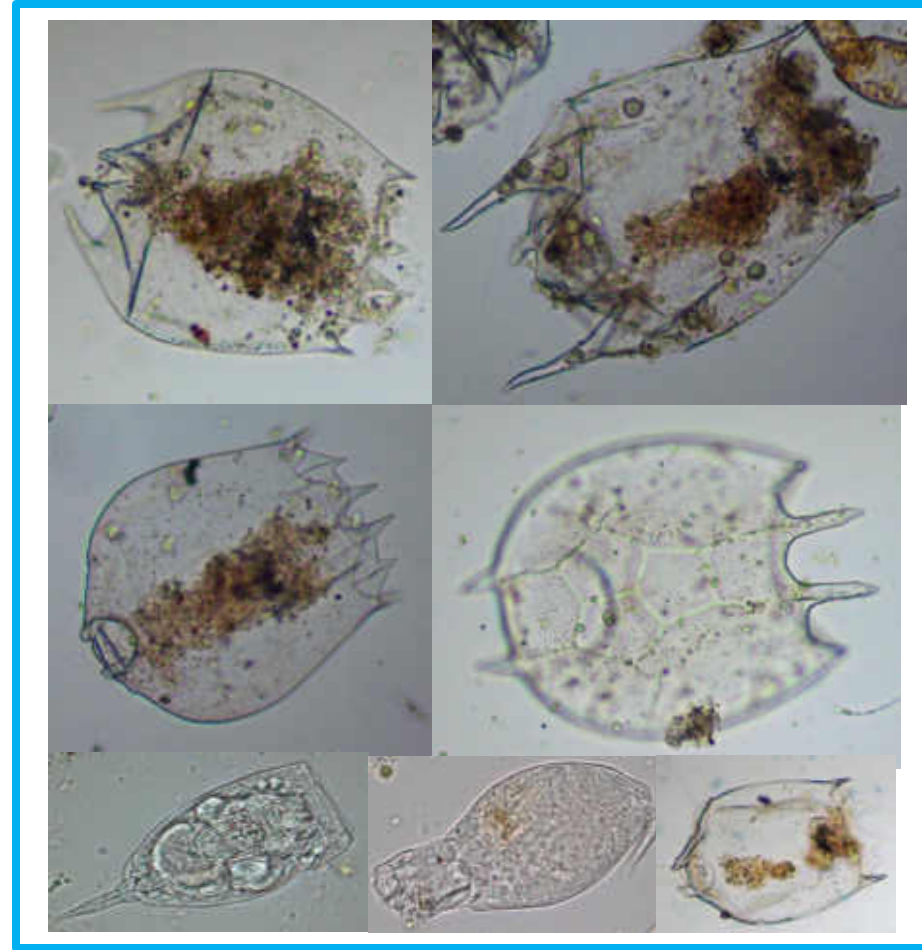


Zooplanktons in Varthur Lake

Protozoa



Rotifers



Dominance of Protozoa and Rotifers indicates pollution due to sewage

Zooplanktons in Varthur Lake

Cladocera



Copepoda





Macrophytes



Macrophytes of Bellanduru Lake

3/31/2016



Image © 2016 DigitalGlobe

Google e

2002

Imagery Date: 3/31/2016 12°56'04.40" N 77°39'36.01" E elev 2873 ft eye alt 177

GPS	Loc	PLANT	PART	C %	N %	
	1 B1	WH	AG	32.7	3.2	Near the bund (outlet)
	1 B1	WH	BG	38.0	3.2	
	220 B24	WH	AG	36.1	3.7	BELLANDURU LAKE
	220 B24	WH	BG	39.8	3.5	
	226 B26	WH	AG	36.0	3.9	
	226 B26	WH	BG	36.6	2.6	
	265 B28	WH	AG	37.6	3.7	
	311 B31	WH	AG	35.7	3.5	
	333 B32	ALT	AG	39.0	3.3	
	333 B32	ALT	BG	39.3	4.1	
	490 B45	TYPHA	AG	40.1	2.4	
	490 B45	TYPHA	BG	36.4	3.0	
	490 B45	WH	AG	36.5	3.7	
	490 B45	WH	BG	36.7	3.3	
	698 B59	WH	AG	37.6	3.9	
	707 B60	WH	AG	35.4	3.6	
	707 B60	WH	BG	36.0	3.0	
	708 B61	WH	AG	35.2	3.4	
	800	WH	AG	36.3	4.1	
	800	WH	BG	35.2	4.5	
	804 B69	WH	AG	37.3	4.2	
		WH-WATER HYACINTH	BG-BELOWGROUND(ROOTS)			
		ALT-ALTERNANTHERA	AG-ABOVEGROUND(SHOOTS)			

Ingressions to Bellanduru and VArthuru Lakes



BELLANDURU LAKE

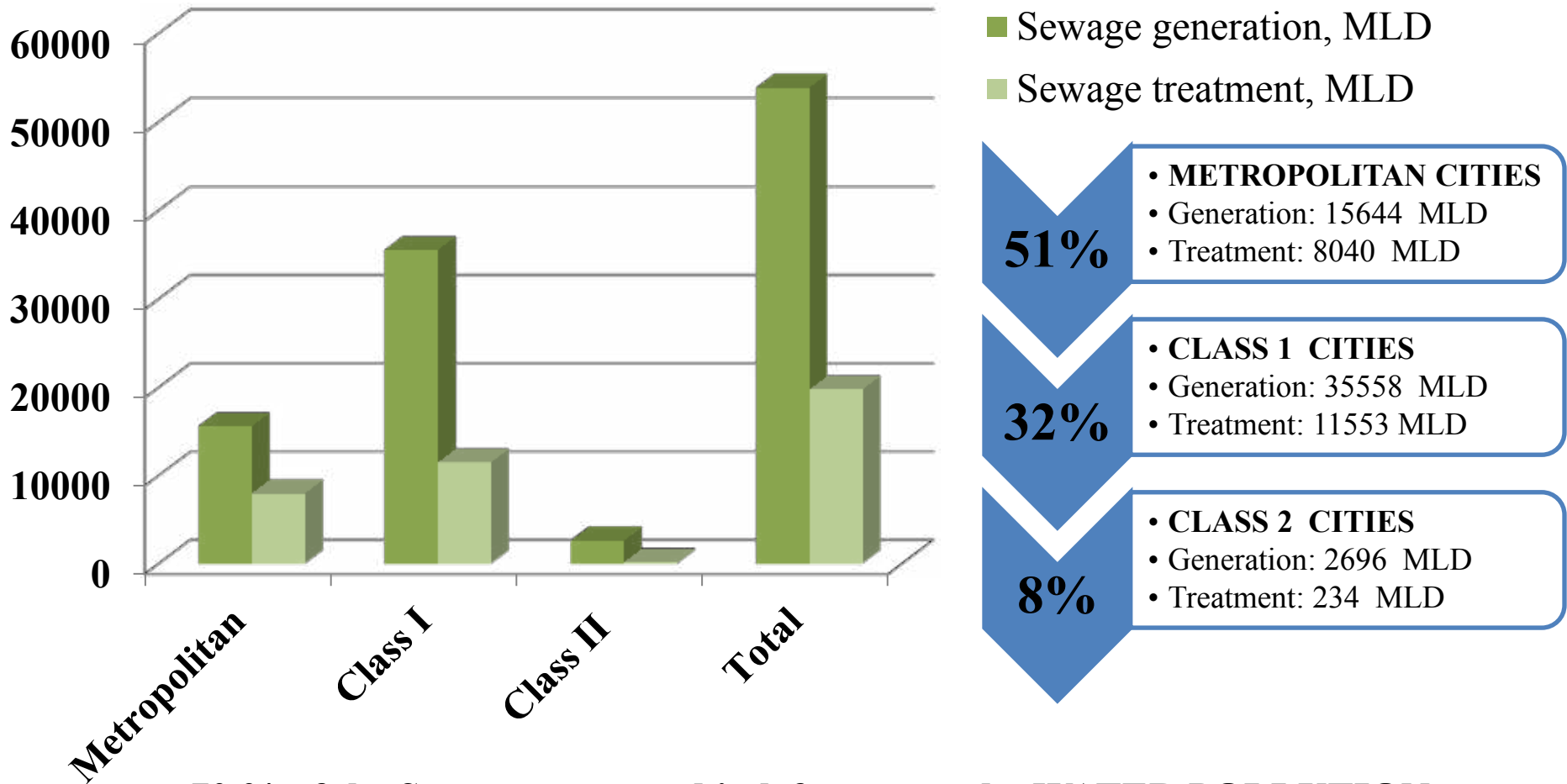
VARTHURU LAKE





Quantification and Evaluation of Treatment Plants and Sediments

Sewage Generation & Treatment in India



~70 % of the Sewage generated is left untreated – WATER POLLUTION

BELLANDUR

**Influent Sewage (mg/l): BOD: 120-410; COD: 190-960; TSS: 90-390;
N: 20-95; P:4-18**

ASP

BOD<30
COD<250
TSS<30-50
N~45
P~5

UASB

BOD<30
COD<250
TSS<40-50
N~25
P~5

SBR

BOD<10
COD<50
TSS<10
N <10
P<1

MBR

BOD<5
COD<50
TSS<1
N <10
P<1

MBBR

BOD<30
COD<250
TSS<100
N ~45
P~5

AP

BOD<30
COD<100
TSS<40
N ~10
P~5

LOW LAND FP
+
ECONOMICAL

Chlorination

COSTLY

**CPCB discharge
norms (mg/l)**
BOD < 30
COD < 250
TSS < 20

**Tertiary Treatment
(Wetlands)+ Nutrient
Rem. + Chlorination**

BOD<5
COD<30
TSS<5
N <5
P<1

WATER
RE-USE

DISCHARGE
INTO LAKES

Elemental Characteristics of slush and sediments

Sl no	Description	Measuring units	Slush	Sediment
1	Bulk Density	kg/m ³	500	1700
2	Weight of Brick (including wastage)	kg/unit	4	4
3	Cost of Brick	Rupee/unit	5	5
4	Sand Loading capacity of 1 truck (10 wheel)	Tons/truck	25	25
5	Cost per Truck Load	Rupee/truck load	25000	25000
2	Organic Carbon	%	18	8
3	Nitrogen	%	3	0.35
4	Phosphorous	%	2.5	0.28
5	Cadmium	mg/kg	7	2.4
6	Cobalt	mg/kg	8	5
7	Copper	mg/kg	68	30
8	Iron	mg/kg	20935	13580
9	Manganese	mg/kg	140	98
10	Nickle	mg/kg	26	20
11	Lead	mg/kg	7	6.5
12	Zinc	mg/kg	106	45
13	Sodium	mg/kg	2175	2075
14	Potassium	mg/kg	7750	6025
15	Calcium	mg/kg	581	608
16	Magnesium	mg/kg	433	1452
17	Organic Matter (1.72 times Organic Carbon)	conversion factor	1.72	1.72
18	Cost of Nitogen (N)	Rupee/kg	12	12
19	Cost of Phosphorous (P)	Rupee/kg	70	70
20	Cost of Potassium (K)	Rupee/kg	34	34
21	Cost of Organic Manure (TOC)	Rupee/kg	150	150
22	Cost of Iron (Fe)	Rupee/kg	278	278

Revenue generation from slush and sediments: Nutrients in Bellandur & Varthur Lake

Sl no.	Description	Unit of measurement	BELLANDURU LAKE		VARTHURU LAKE	
1	Surface Area	hectares	367.34		190.78	
2	Water Storage Capacity (historical)	M.m ³	18.67		6.10	
3	Current Water Storage Volume	M.m ³	5.50		1.61	
			SLUSH	SEDIMENT	SLUSH	SEDIMENT
4	Volume	M.m ³	6.56	6.60	0.62	3.87
5	Weight	M.Ton	3.28	11.22	0.31	6.58
6	Total Organic Carbon	Ton	590432	897932	55980	526184
7	Total Nitrogen	Ton	98405	39285	9330	23021
8	Total Phosphorous	Ton	82005	31428	7775	18416
9	Cadmium	Ton	23	27	2	16
10	Cobolt	Ton	26	56	2	33
11	Copper	Ton	223	337	21	197
12	Iron	Ton	68671	152424	6511	89320
13	Manganese	Ton	459	1100	44	645
14	Nickel	Ton	85	224	8	132
15	Lead	Ton	23	73	2	43
16	Zinc	Ton	348	505	33	296
17	Sodium	Ton	7134	23290	676	13648
18	Potassium	Ton	25421	67626	2410	39628
19	Calcium	Ton	1906	6824	181	3999
20	Magnesium	Ton	1420	16297	135	9550
21	Organic Matter	Ton	1015544	1544443	96286	905036
	Gross Income from N @ 25% Eff.	Crore Rupee	29.52	11.79	2.80	6.91
	Gross Income from P @ 25% Eff.	Crore Rupee	143.51	55.00	13.61	32.23
	Gross Income from K @ 25% Eff.	Crore Rupee	21.61	57.48	2.05	33.68
	Gross Income from TOC @ 25% Eff.	Crore Rupee	3808.29	5791.66	361.07	3393.89
	Gross Income from Fe @ 25% Eff.	Crore Rupee	477.26	1059.35	45.25	620.77
		Crore Rupee	11455.46		4512.25	
	Combined Income from Nutrients	Crore Rupee	15967.72			

Revenue generation from slush and sediments: Construction assets from Bellandur & Varthur Lake

Sl no	Description	Unit of Measurement	Bellandur Lake		Varthur Lake	
1	Surface Area	Hectares	367.34		190.78	
2	Water Storage Capacity (historical)	M.m ³	18.67		6.10	
3	Current Water Storage Volume	M.m ³	5.50		1.61	
			SLUSH	SEDIMENT	SLUSH	SEDIMENT
4	Volume	M.m ³	6.56	6.60	0.62	3.87
5	Weight	M.Ton	3.28	11.22	0.31	6.58
6	Bricks	Numbers	820045125	2806038275	77750000	1644325000
7	Gross Income from Bricks	Crore Rupee	410	1403	39	822
OR						
8	Number of Truck Loads	Number	131207.22	448966.12	12440.00	263092.00
9	Gross Income as Sand	Crore Rupee	328.02	1122.42	31.10	657.73

Fertilizer Use (tons/ha):

Total N can fertilize ~4723347.25 Ha of agricultural land ~ equal area of Punjab

Total P can fertilize ~22289211.95 Ha of agricultural land ~equal to area of UP

Total K can fertilize ~16885675.48 Ha of agricultural land ~ equal to area of AP (Seemandhra)

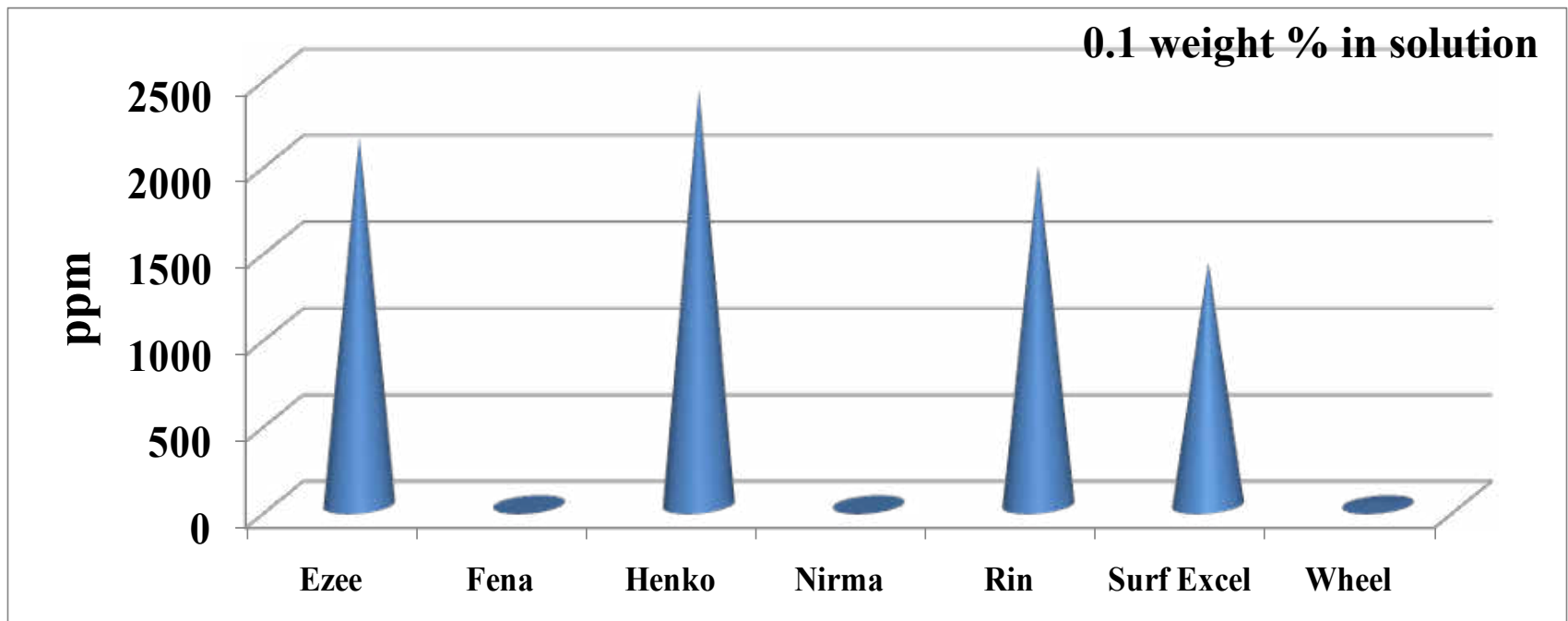
Phosphorus Influx into Lakes

Bellandur Lake

- ✓ 15-20 tons/day – Total Influx
- ✓ 113432 tons stored in slush/sediments
- ✓ 4-8 tons/day escape from the lake as effl.
- ✓ >100 tons present as macrophyte biomass
- ✓ ~210 tons present as algal biomass
- ✓ ~80 tons present as bacterial biomass
- ✓ ~20 tons as floating debrii

Varthur Lake

- ✓ 12-18 tons/day – Total Influx
- ✓ 26191 tons stored in slush/sediments
- ✓ 2.8-6 tons/day escape from the lake as effl.
- ✓ >85 tons present as macrophyte biomass
- ✓ ~175 tons present as algal biomass
- ✓ ~68 tons present as bacterial biomass
- ✓ ~24 tons as floating debrii

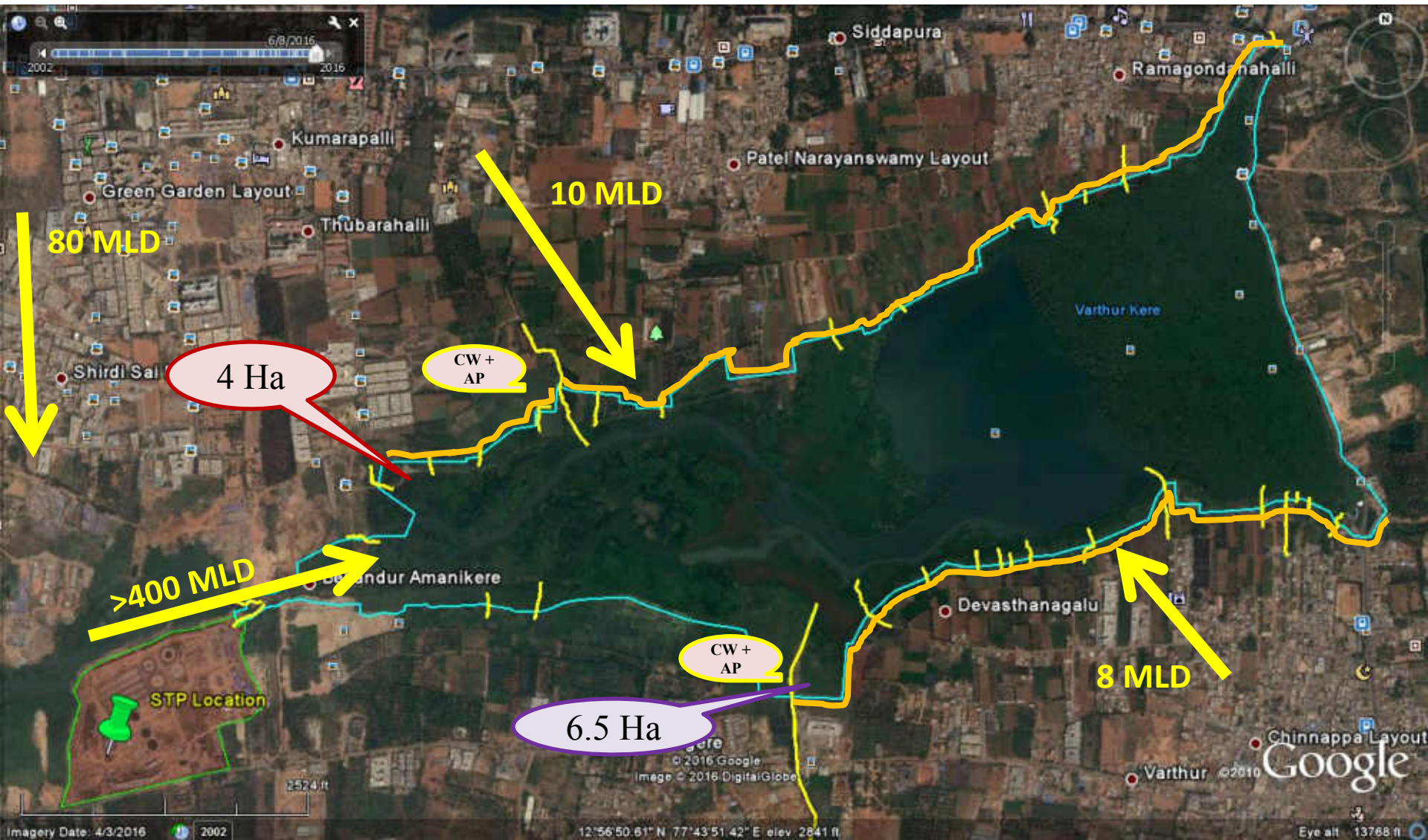


Wastewater influx – Bellandur Lake

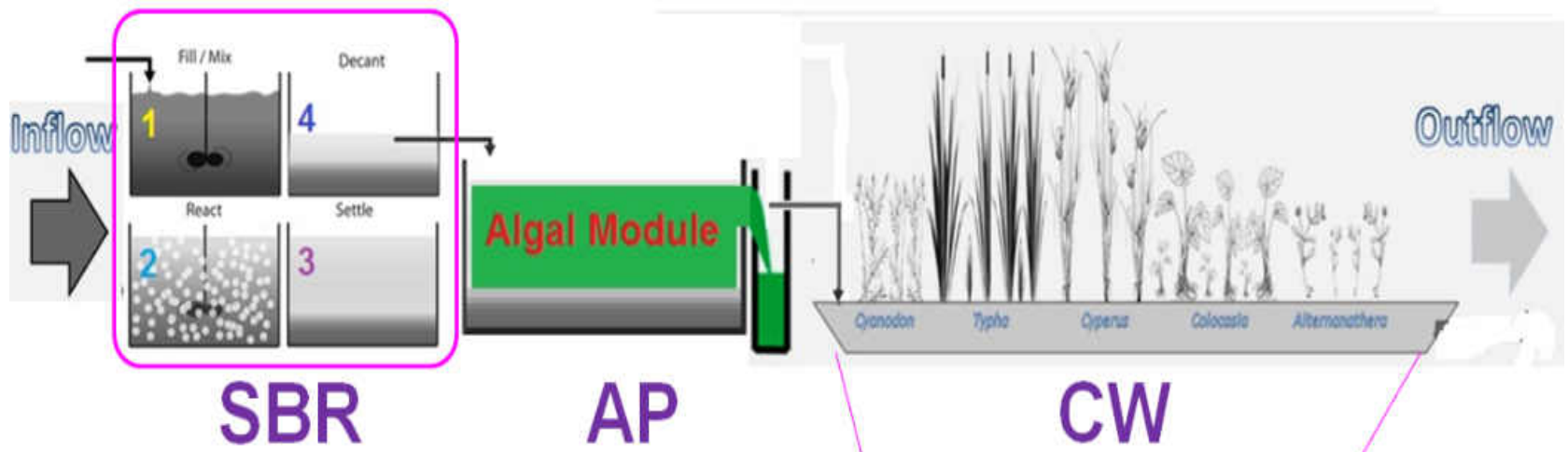


Bellandur lake: >100 MLD → SBR – 10 Ha + 5 Ha Const. Wetland + 5 Ha AP

Wastewater influx – Varthur Lake



Varthur Lake: ~18 MLD → AP – <6 Ha + 2 Ha (Const. Wetland)



STEP-1

BOD~250
COD~450
TSS~180
N~65
P~18

STEP-2

BOD~10
COD~50
TSS~10
N~20
P~10

STEP-3

BOD<10
COD<30
TSS<10
N<10
P~8

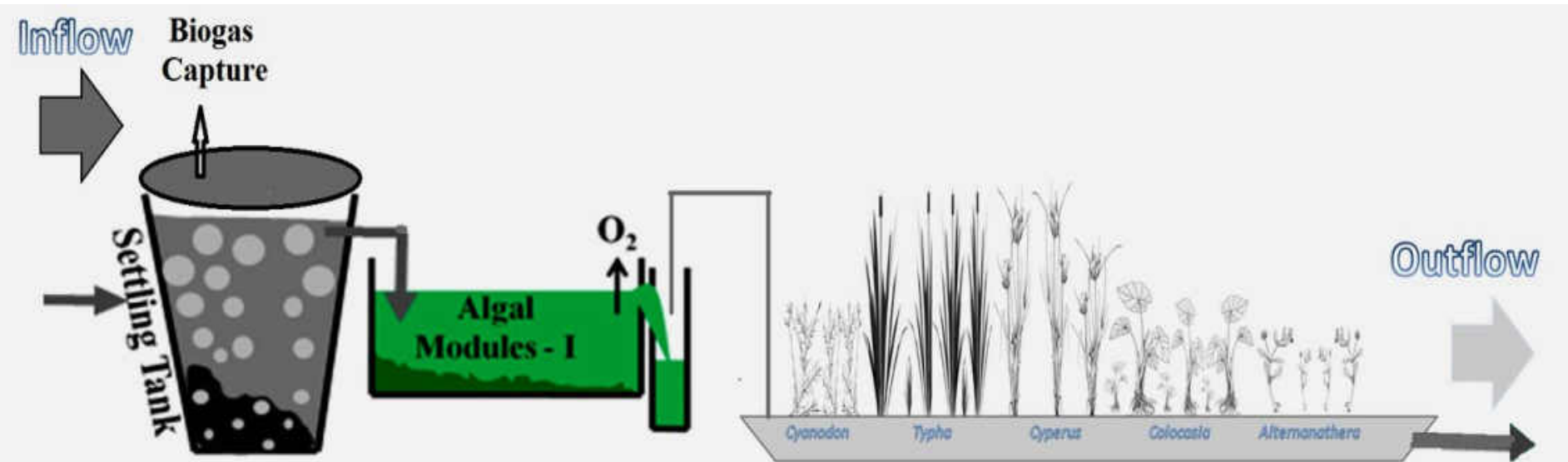
Cyanodon
Typha
Cyperus
Colocasia
Alternanathera

STEP-4

BOD<5
COD<10
TSS<5
N<5
P<1

Integrated Wetland treatment option

Wastewater Treatment System for peripheral waters channelized to AP+CW for Varthur Lake



STEP-1

BOD~200
COD~350
TSS~100
N~60
P~18

STEP-2

BOD~120
COD~280
TSS<60
N~55
P~15

STEP-3

BOD<30
COD<100
TSS<30
N~10
P~5

STEP-4

BOD<5
COD<20
TSS<5
N <5
P<1

Treatment of ~18 MLD of WW from peripheral inlets – Area req. <6 Ha (AP) + 2 Ha (CW)

Phosphorous in Detergents

- Wise-use of Phosphorus for Prosperity
- Missed Opportunity of Indian Industries
- Sensible Manufacturing
- Opportunity for Young Enterprenuers

It is the responsibility of Indian
Detergent Manufacturers to clean
up Eutrophic Water bodies

*MEG- Indian Army,
IISc Joint Venture
with active participation
of public*



THANK YOU

