Individual/organisation/institution 1:
Name: Seema Sukhani
Email address: seema@iisc.ac.in
Contact number: 08527812869

Mentor: Prof. H.N. Chanakya
Email address: chanakya@iisc.ac.in
Contact number: 080-22933046

Waterbody restoration and participatory protection involving next Generations

WRAPPING

Promoting Citizen Science and Experiential Learning at Puttenahalli /Jakkur Lakes

Indian Institute of Science
Bangalore 560 012
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Waterbody Restoration and Participatory Protection involving Next Gen (WRAPPING) : **Promoting Citizen Science and Experiential Learning at Puttenahalli /Jakkur Lake -be a Citizen Scientist for Day'**

Project Mentor– Dr. HN Chanakya, CST, IISc, Bangalore

A. Significance of Urban freshwater Bodies:

Lake as a Keystone – The Background: Man-made water bodies loosely termed lakes have made the Deccan Plateau habitable, sustainable and also support a rich biodiversity of avian, aquatic and amphibian life - something impossible in the other wise semi-arid region of Deccan. These lakes were conceived, designed, participatorily built (voluntary work), maintained and socially sustained by locally evolved practices. Many lakes that survive today have been built between a Century to a Millennium ago – meaning that they have been sustained by predominantly local efforts and have socially controlled systems to share their benefits. Much has been written, discussed and even 'resurrected' about this great human effort that has been carried out with simple tools, community knowledge, participatory efforts to build over a 100,000 of these in Peninsular India alone (Reddy, 1987; Shah, 1995; KSCST – 1989 & 2012).

In last few years, there is a resurgence of peoples' participation in conservation of urban freshwater ecosystems – driven by aesthetics, sustainability, climate action and open space issues (Balasubramanian, 2016). It is opportune to recreate and bring back peoples' participation and collective knowledge for conservation of urban water bodies while also using modern science and technology to ensure sustainability.

Organically Linked and Living System: Although man-made, these lakes had changed the ecosystems to such a point that water bodies could be found every 3-4 km in any direction. Human settlements now began to move away from river beds and settled in really dry zones such as Chitradurga, Bellary, Chamarajanagar, Bengaluru, etc. The city of Bengaluru is known to have had >400 lakes and supported a city for over 500 years. Much of these lakes were designed as a series of cascading water bodies wherein when one lake filled up, the water overflowed into the spillways to fill the next lake downstream. No runoff water was ever wasted. Water usage and sharing was locally governed and controlled to provide sufficient water (security) for 2-3 years in a row. Reliable water had changed the agriculture pattern, brought stability and prevented summer or dry season migration. The water sharing pattern was strongly a socio-political arrangement providing equity for humans, cattle and other living beings including migratory birds and travellers. Separate arrangements /zones were earmarked for drinking water, human use, cattle and irrigation with multiple strategies for emerging or reigning droughts. Water was nearly always present in the vicinity and these water bodies made it happen. Such 'water security' had changed the eco-system to such an extent that amphibians and water birds colonized these water bodies and many migratory birds made it their winter homes coming in from as far as Siberia.

The shifting of control of these lakes from people to the government (Minor Irrigation Department), the discontinuation of yearly maintenance (desilting) by local people, the discontinuation of recycling of silt, draining of tanks to avoid mosquito breeding, loss of storage capacities and dead storage volume, growth of cities that engulfed these lakes, choking of inflow channels, entry of sewage into these lakes and loss of water quality, emergence of canal and bore well irrigation systems, etc. reduced the dependence of people on these water bodies and all of these tanks gradually became defunct or remained merely ornamental. In this way their key functions apart from providing easy water access – namely stabilizing ground and sub-soil water, moderating peak summertime temperatures, drinking water to animals (domestic and wild), buffering against severe droughts and dry spells, maintaining water access for nearly 9 dry months of the year, etc. Alternative water sources such as borewell and canal systems focused individual use and control while the imperatives and capabilities of joint water resource management was quickly lost as little had been done over the last 4-6 decades. The rapid decline in ground water resources due to lack of recharge through tanks, sewage ingress and loss of water quality and aesthetics, the psychological need for water front spaces, the realization of the buffering role of these water bodies in environment and climate, etc. have made people to have a resurgence of bringing back these water bodies. New models of joint management needs to emerge and should be tuned to emerging needs /capability of the people nearby wherein water supply from rivers or other sources will co-exist with well maintained 'Lakes".

Need for a future focused participatory model : The nature of shared water dependence as well as methods of social controls has been changed today. There is a need to build both a sense of participation and mechanism for shared monitoring and control of this common resource founded on the "blessing of the commons" while acknowledging the possibility of recurrence of the "Tragedy of Commons". In this age of information the "participation" takes on a different strategy and need for waterbodies sees a new dimension

Monitoring and Conservation of Urban Water Bodies and Ecosystem Services: The impacts of increasing urbanisation on freshwater ecosystems are complex and include increased chances of flooding, modified sediment and nutrient load and changes in the timing and duration of algal blooms. Moreover, chemical pollution from human activities and litter adversely affect elements of natural ecosystems and harms the quality of the local water resources.

B. Puttenahalli / Jakkur Lake

Puttenahalli Lake was one of Bengaluru's pristine lakes in North Bengaluru (not to be mistaken with its Southern Cousin). It has been restored with participation of local people. It is now a haven for bird-watchers. Some of trees and plants grown around the lake include Mahogany, Cadamba, Portia tress, Singapore Cherry, Paradise tree, Badminton-ball tree and *Pterygota alata* (Buddha coconut). About 80 species of birds, both non migratory and migratory, have been spotted at the lake. This includes - Spot billed duck, Purple heron, Eurasian (common) coot, Indian pond heron, Garganey and Common kingfisher.

Puttenahalli as urban waterbody functions as freshwater ecosystems and performs vital ecological functions, providing essential environmental services. Its major functions include:

- Provide freshwater sources for the city in case of dire emergencies
- Control urban flooding by absorbing /retarding storm water runoff
- Support biodiversity by providing habitats / nursery grounds for aquatic and semi-aquatic organisms. Rich in aquatic floral vegetation that maintain the micro environment necessary for the health and well-being of the fauna
- Recharge groundwater aquifers in addition to their role as a store house in their zone of influence thereby enhancing water availability.
- Provide recreational place that confer socio-cultural and recreational benefits, some of which translate into direct economic benefits through tourism. They provide nesting areas for birds.
- Education, learning and research opportunities
- Socio-cultural: Water is an integral part of Indian culture. Water bodies have been considered sacred for various reasons and uses and their presence have been ingrained in the socio-cultural ethos.

C. Project Information

The project will focus on incorporating Citizen Science and Experiential Learning to help further strengthening conservation and restoration efforts at Puttenahalli and Jakkur Lakes (North Bengaluru). The project will use experiential learning approach to develop educational, research and interpretation learning opportunity for students, teachers, resident citizens, volunteers, students (future custodians) and bird watchers at Puttenahalli and Jakkur Lakes.

1. Project Objectives

To get citizen scientists involved in understanding the drivers of change in blue and green spaces at Puttenahalli and Jakkur Lakes. Citizen Scientists help monitor the variation in water quality in different seasons of the year (CST, Sheshadripuram College, Students)

To get citizens involved in a long term monitoring of water quality, bird survey, tree mapping and understand the impact of seasonal variations (CST, Volunteers + College Students).

To map the drivers of change in the catchment of the water body and their relationship with water quality (CST, YPLBCT and Jalaposhan).

To understand external weather events (precipitation, temperatures), ecosystem dynamics (algal blooms, nutrient peaks) that relate to the direct surroundings (urban/green) and activities (the level of human activity and population – with inputs from CST).

Improve the understanding of freshwater, ecosystems services, avifauna, bees and butterflies and the drivers of change that compromise the resources and the services that they provide (all stakeholders).

To relate variations in water quality and seasons with species distribution

This project will engage the citizen scientists in a more structured, scientific and systematic manner in a long term monitoring programme. It involves scientists, researchers, students, local residents and local officials to participate in biodiversity surveys (water, birds, frogs and trees), documentation and analysis.

2. **Methods and Activities:** The water quality; avian, butterfly, odonates, plant /tree, micro-algal biodiversity will be monitored at 15d intervals by a group of dedicated students volunteers (about 60) and citizen volunteers (about 20) for the two lakes. They will constantly report this to the mentor on a monthly basis and this will be shared with citizen volunteers. Formats for this activities will be developed based on locational needs and capability of personnel involved. Citizen volunteers as well as other participants from other lakes will be trained once a month so that they can take up similar activities around their residences in Bangalore. Over a period of 14 months, the project will organise 5 Citizen Science Days at the Lake sites to raise the awareness and participation of several types of stakeholders. Scientific institutional partners / schools / eco club / resident welfare associations will participate as Citizen Scientists in this "1-Day Programme".

- *Example of local research priority description :* Studies show that freshwater biodiversity begins to decline when catchments have more than 30% agricultural land use or as little as 0.5% for urban development, and it progressively deteriorates (Allan 2004, McGarrigle 2009). However, small water-bodies (ponds, ditches, headwaters) can provide 'clean water refuges', because they have small isolated catchments that can stay pollution free (Williams *et al*. 2004). These refuge waterbodies are also biodiversity hotspots with high gamma diversity: supporting a significant proportion of the species present in impacted landscapes (Clarke et al. 2008). Recent evidence shows that smaller waterbodies may now be declining in quality and are at risk from new stresses including climate change (Williams *et al*. 2010), there is an urgent need for better knowledge and protection of the small waterbody network.

- Puttenahalli and Jakkur Lakes are unique systems in that as a result of urbanization, there is plenty of sewage ingress which keeps the nutrient levels reasonably high to support high micro, meso and macro-flora and faunal diversity and a luxurious food chain. This supports very high fish, butterfly, odonate and bird populations while the tropical climate makes the nutrient cycling and species growth rates very rapid. The CST group has monitored such lakes for over two decades and suggested more slower and more controllable species successions and is now being followed by the local city officials and these two lakes will be among the first of the few lakes to be restored as per these suggestions and guidelines. In other words, lessons learnt from this exercise will go a long way in policy making and become exemplars for the future of lake restoration in Peninnsular India (with about 100,000 such water bodies).

- Analysis - Relationships between rainfall conditions and input water quality, ecosystem conditions to examine using standard analysis methods. As indicated above, many large water bodies were monitored for long periods and adequate data collected on the current scenario and there is a need to show human centric methods for restoration and more importantly citizen-led monitoring and custodianship /stewardship that can spread to other areas. Recent trends and future scenarios in regional climate data will be analysed and assessments of possible trends will be made in water body quality and vulnerability to degradation. Measurements and observational data which includes gathering information about nutrient loads and concentrations, turbidity, algal blooms, land use and shore line characteristics as well as photo-video-graphic documentation. Interim progress of the project and background information to be shared with the citizen scientists on a regular basis that enable forecast and predictions.

- *Example of project methods - (number of volunteers, training, monitoring activity concept):* There could be 7 to 8 citizen scientist training days. Each training event will engage and train participants in water quality, shoreline and birds survey.

- *Example of project methods - (sampling programme design, number of locations, measurement methods)*: The environmental measurements could include: pollution risk (i.e. land use type, obvious sources or biological evidence of pollution), basic waterbody hydrology (measured as water level or drawdown, flows), water quality (colour and transparency), chemical water quality: nutrients (total N and PO_4) including cumulative load and sinks.

- *Key areas of research and monitoring at an Urban Freshwater Eco-system:*
    - *Water Quality Assessment:*
      1. Visual observations: general conditions pertaining to: water flow, quality, odour; ecosystem, buffer, flora, weeds, algal blooms, etc; buffer condition- vegetation types, invasive, non-invasive, pollution (garbage), land use in flood plain, resource use by people in general and specific uses. This will predict the potential loads with run-off.
      2. Bio-chemical measurements: recorded using field testing (with equipment)- pH, salinity, electrical conductance, total dissolved solids, dissolved oxygen, nutrients- ammonia, nitrates, nitrites, phosphates (chemically at the lab or with probes if available). Integration of remote sensing into lake monitoring to address consistent, long term monitoring.

3. Optical measurements: turbidity (Secchi disk), euphotic depth. Field water analysis kits will be purchased to measure physico-chemical parameters. Titrimetric and colorimetry tests will be carried out using these kits, while hand-held portable instruments will be used for measuring pH, Salinity, Electrical conductance, Total dissolved solids and dissolved oxygen. Dr. HN Chanakya (Chief Scientist, CST, IISc, with over 30 years experience in this area) will anchor this segment. After discussion with partners, this segment will be carried out primarily by Sheshadripuram College, Yelahanka students of 2nd and 3rd years (about 60 in 10 batches continuously on a once weekly basis). The YPLBCT and Jalaposhan will provide logistic and leadership support at the Puttenahalli and Jakkur lakes respectively. They in turn benefit by training citizen scientists with whom data will be shared and discussed.

- *Bird Diversity Assessment:*
  1. Point counts and total bird counts from sampling location. Identification and listing of species observed during different seasons.
  2. The observer(s) perform a standardized survey along a series of points, searching bird species- both water birds and terrestrial. For each species detected, they record the distance from the point. The high quality data generated during this programme besides giving us a clarity on the ecosystem health will also positively contribute towards effective management practice for urban fresh water conservation. Prof Subramanya (Dept. of Entomology and Bird Expert of >30yrs) will anchor this segment. After discussion with partners, this segment will be carried out primarily by Sheshadripuram College, Yelahanka students of 2nd and 3rd years (about 10 batches continuously on a once weekly basis). The YPLBCT and Jalaposhan will provide logistic and leadership support at the Puttenahalli and Jakkur lakes respectively.

- *Example of project methods - (feedback and follow up)*: Follow up activities to make regular (quarterly) communication with the volunteers who have been on the programme. This communication will report latest results, provide brief hints, tips and reminders, a short story that brings in a 'big picture' issue, updates on where data gathered. Most of the students and citizen scientists will be encouraged to make videos and ppts of the findings and mutually the outcomes and impacts with fellow scientists first and later with the experts. These become a log as well as database for future training.
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3. Equipment and Resources

- Physico-chemical and microscopy facilities will be made available at the sites for student volunteers to collect data, analyse water samples, provide status reports, induct and train fresh student and adult volunteers. Water testing kits, pH meter, will be placed at the two lakes in protected rooms for ease of testing. ,
- Hand held GPS units, Binoculars, Field Guides and Bird Checklist, Map of the area, Learning Trails Mapped for training will be used. IISc have a full fledged world class ecology and environment departments and their equipment and expertise will be made use of from time to time for more sophisticated analysis.

4. **<u>Citizen Science and Experiential Learning Day - Itinerary</u>**

- **Introduction:** Overview of Citizen Science
- **Methods:** About Be a Citizen Scientist for a Day Programme
- **Discussion:** Learning of Citizen Scientists and their contribution to survey / data
- **Survey themes:** Plants, Birds, Insects, Birds and Moth Studies
- **Field Surveys** & **Research orientation**

- Survey techniques - Hands on field work
- Use of Water-testing, DBH, GPS, survey Bird diversity
- Use of field guides
- Methodology - Field Survey Techniques; Materials and Equipment; Data entry; Data analysis
- Fortnightly Surveys – Appropriate trails will be evolved and used as transects for documentation; Appropriate sized quadrants will be created for diversity assessments. Standard ecological techniques will be used for measurements and reporting diversity.
  - Birds
  - Butterflies and odonates
  - Algal, nematodes, flagellates micro-flora and fauna (aquatic) in different regions
  - Plant and tree biodiversity
  - Aquatic fauna as permissible
- Data Collection on Plants; Data Collection on Birds; Data Collection on Insects; Data Collection on Moths; Data Collection on Reptiles & Amphibians; Data Collection on Water Quality

TimeLine & Deliverables

5. **Timeline**

Project timeline is January 2019 to April 2020

Stage	Start (months)	End
Preparations	February 2019	March 2019
Citizen Science and Experiential Learning Programme at Puttenahalli (12 to 14 Citizen Science Days)	March 2019	September 2018
Equipment and Resources for Programme, Data collection	March 2019	March 2020
Analysis of the impact of the project	February 2020	March 2020
Monitoring and follow up (Final Technical Report)	March 2020	April 2020

6.* Project Outputs / Outcome / Deliverables

1. The project's scientific outputs can be summarised for publication in scientific and popular publications.
2. Series of Citizen Science and Experiential Learning Programme at Puttenahalli and Jakkur lakes.
3. Equipment and Resources for Programme at Puttenahalli and Jakkur Lakes (capacity)
4. Water quality monitoring and use of data loggers to record and monitor water quality. Biodiversity monitoring with citizen scientists for listing of bird diversity, trees, bees, butterflies, frogs, bathymetry.
5. Data retrieved from fortnightly measurements that provide clear insight on the characteristics of the water in relation to surrounding land use/cover, successions, seasonality, etc. How long should wastewater be quarantined before being used to augment water shortage in the water bodies, etc.

Mentor/ Anchor

CST, IISc Bangalore (HN Chanakya)

Stakeholders and Trainers

Sheshadripuram College, C.A. Site No. 26, Yelahanka New Town, Bengaluru, Karnataka 560064
Yelahanka Puttenahali Lake and Bird Conservation Trust (Prof KS Sangunni)
Jakkur lake protection committee (Jalaposhan, Ms Annapoorna, President)
Prof Subramanya, Dept. of Entomology (Bird Expert), GKVK Campus Bangalore 560065

Group /Organization	Water Quality (Biochemical)	Lake water (physico-chemical)	Algae Survey	Bird Survey	Butterfly Survey	Odonate Survey	Volunteer trainig 4 surveys	Land Use & upkeep	Citizen Exposure	General Handling	Bathymetry	
CST Team	Y		Y				Y	Y	Y		Y	Y
Jalaposhan Team									Y	Y	Y	Y
YPLBCT									Y	Y	Y	Y
Seshadri. College	Y	Y		Y	Y	Y	Y					Y

Monthly Commitments

CST Team	4			4			1	0.1	0.25		0.04	1
Jalaposhan Team									0.25	4	0.04	1
YPLBCT									0.25	4	0.04	1
Seshadri. College	**4**	4		2	1	1	1					1
Staff									1			

Institution - CST						
Water Quality (Biochemical, physicochemical)				Equipments		
Test	Samples (frequency/month)	Cost (Rs/month)	Cost(12months)	Activity	Cost (Rs/month)	Cost(12months)
Filterable COD	40	1000	12000	Sampling bottles	25	6250
BOD	40	1000	12000	Turbidity meter	4	20000
COD	40	1000	12000	Redox meter	4	25000
NH4	40	2000	24000	Operational Cost		
PO4	40	1500	18000	Boat hire	500	6000
NO3/redox	40	2000	24000	Bathymetry		5000
TDS	40	50	600	Sheshadripuram college (food/travel/ stationary etc)	5000	60000
TSS (turbidity)	40	50	600	Emergency		2000
Chloride	40	1000	12000	Student program		
Hardness	40	1000	12000	Short Exposure to schools (food/travel/ stationary etc)	6000	72000
pH/Temp	40	10	120	Recording sheets	500	6000
DO	40	10	120			
Algal count	40	50	600			
Ni, Cr, Co, Cu, Pb (4samples)						
Heavy Metals (1m)	4	4000	48000			

Summary Table showing annual and total budget break up.		
1	Operation costs	80000
2	Field Survey Equipment and consumables	51250
3	Consumables and chemicals	175000
4	Student exposure/travel	90000
5	Honoraria to trainers	25000
6	Contingency, publications, video-drones and brochures	50000
	Total	471250
7	Overheads (5%)	23562.5
9	Total	494812.5

CST- Water Quality involves Filt COD, Tot COD, BOD, algal diversity, PO4, NO3, NH4, eH, Cl, Hardness, TSS, TDS
Lake water done at PutttnaehallI and Jakkur - DO, Photic zone, turbidity, pH, algae count and diversity, EC
Bird /Odonates /Lepidopteran Diversity Survey – to be specified by Dr Subramanya
Citizen & volunteers Exposures, to Bird /Algae /water quality /plants diversity (total 4 weeks)
Surveys will be carried out alternately at Puttenahalli and Jakkur Lakes every Sunday