Ecological Planning and Design for Peripheral Urban Waterbodies - A Case of Ahmedabad City

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Relevance and Urgency

- Disregard for natural environment has weakened our cities tolerance for climate change impact. Further growth on the periphery consistently affects and threatens existing waterbodies. This is while our cities face acute challenges of climate change like urban floods, temperature rise, sinking, increased carbon emissions, and more. To mitigate these issues, cities need to grow resilient by aligning with, and not against, the natural cycles and ecosystems. Waterbodies like lakes and streams are potential sites to mitigate these challenges and achieve resiliency.
- Other concerns regarding lakes are over equity in access to natural waterbodies changing existing livelihoods.
- Growth of many Indian cities is guided by framework of Development Plan and realized, specially in Gujarat, through vehicle of Town Planning Schemes. However, TP schemes do not consider ecological drivers such as catchment areas and drainage patterns which are crucial to the existence of waterbodies. This disjunction results in loss of lakes' micro and macro ecosystem networks and hence their significant role in local ecosystem, livelihoods, and as natural drainage system. As plot boundaries are demarcated and roads built, many ecological and livelihood patterns get disrupted: lakes' catchment, natural water drainage, movement of wild and domestic animals and hence animal husbandry, and access to water for farming.

Ahmedabad Flood, 2022- Law Garden

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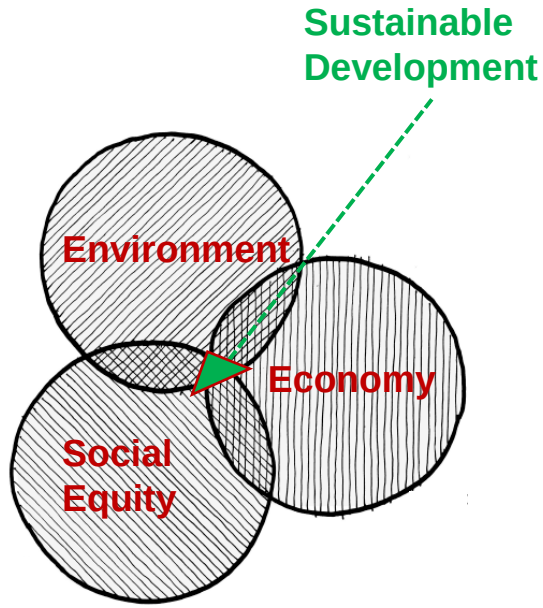
Ecological Planning and Design

This paper recommends **ecological planning and design**, at various **scales**, for a resilient urban development and recommends such **studies** to be included in the process of preparing TP schemes and before laying them out. The ecological **design** of these waterbodies as public spaces using nature-based strategies can be carried at site level.

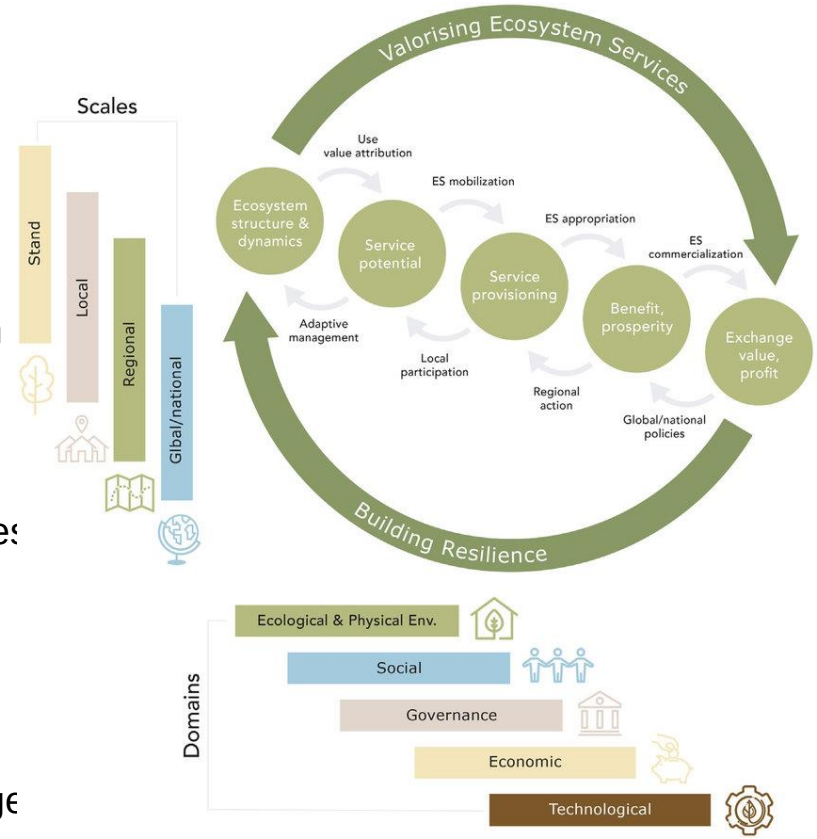
- Peripheral lakes and streams are dependent on their water processes and larger ecological networks. Hence hydrological, topographic, and biodiversity documentation and studies, such as natural drainage pattern, catchment areas, etc. should form the basis for planning and design decisions made for and around these water bodies. At local scale, ecological design of these lakes help mitigate climate change impacts by acting like a sponge for the area and preventing urban floods, decrease temperatures due to park-cool-island-effect and natural wetlands, and other ecological services.
- A corresponding urban process, Social-Ecological Urbanism (SEU) recognizes human's social and recreational activities as a contributing element within an ecosystem, co-existing and interdependent with the natural ecosystems and related biodiversity. This concept acknowledges the interconnectedness of social, ecological, and economic systems. If incorporated in planning and urban design process, it will help achieve and maintain resiliency in urban environmental systems.
- Applicability of such process depends on its integration within existing established frameworks for planning. Hence, in this paper the framework of Development Plan and Town Planning Scheme are presumed.



Environmental and Health Benefits

Increasing quality of life and well-boing, decreasing environmental costs and harms

- Urban environmental benefits like ecosystem services*, reducing urban heat island effects, creating urban cool park effect, increase carbon footprint, enriching the biodiversity, and charging aquifers that increase local ground water levels.
- Mitigating adverse effects of climate change through ecological functions, like absorbing and directing run-off rainwater and hence, lessening urban flood, water-logs and associated health hazards, improving air quality, and balancing temperatures
- Enhance mental health: contact with nature induces relaxation, decreases stress and anxiety.
- Facilitate communal engagement and diminish social seclusion through incorporating amenities such as seating areas, play areas, exploration areas, within naturally enhanced environment
- The phenomenon of stormwater runoff constitutes a significant environmental concern due to adverse effects such as inundation, sedimentation, and contamination of water bodies. Implementing and upkeep of conventional stormwater management methods, such as drainage systems and pipelines incur high costs. Ecological planning, zoning, and design of urban areas and urban spaces contribute to and complement storm water management and network.



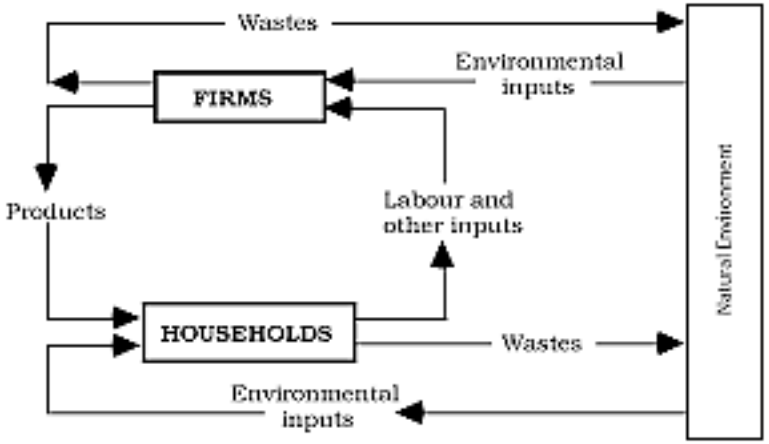
Roadmap to develop a stress test for forest ecosystem services supply, Kramer, Koen et al.

* Direct and indirect benefits humans receive from ecosystem

Economical Benefits

Direct or indirect economical benefits for the whole area and for visitors

- Cost benefits in maintenance as processes are partially or fully natural, self-organised, and less dependant on external factors
- Contributing to water related infrastructure and less ground modulation decrease cost of construction and maintenance
- Use of local species of plants decrease maintenance and need for irrigation and initial expenditure
- Escalation of property values and, subsequently, a surge in tax revenues for the municipal administration
- With online feedback systems, increasingly tourists and local visitors searching for quality outdoor areas are drawn to well-designed and ecological public spaces offering unique experiences. Improved tourism boosts local economy and increases tax revenues.
- Public spaces with significant vegetation and water presence lower average temperatures of the area. Thus, not only comfort levels and quality of life improves, but energy consumption for cooling indoor spaces and its related expenditure also decrease.
- Investments in urban ecology and ecological protection need to have their benefit-to-cost ratio analyzed for Indian cities to uncover this potential.



Framework: Study and Document

Although the paper is oriented towards zoning, planning, and designing in and around lakes on periphery in an ecological manner, the framework and learnings to other public spaces, masterplans, ecologically potent areas to achieve resiliency in urban areas.
Ecological networks expand beyond deliberated boundaries and frameworks of urban development. This conflict often disrupts the natural system's function and in long run intensifies the adverse impact of climate change and reduces resiliency in urbanised areas.
However, the ecological networks can be understood in a comprehensive and interconnected manner. This signifies two main points: the need for an in-between scale framework, between that of DP and TP, and the need for studying the area's ecological drivers and processes in an overarching manner.
Learning from ecological study and design of 2 lakes and one stream in Ahmedabad, this paper proposes a layer-wise documentation of ecosystem and investigating interdependency of its elements of water, ground, and vegetation. The study looks into these natural factors and features, both independently and in relationship with each other to extract principles for study, planning, and design.

- Terrain: Ground form, soil composition, ground's conditions specifically on the edges and transitions
- Vegetation: Species, their combinations, their water and soil requirements, and seasonality
- Hydrology: sources of water, quality and pollution, its flow patterns and collection, and seasonality
- Climate: its patterns, changes, extreme conditions
- Scales, time, seasonality

Framework: Scale, transformation, and Time

- The study and subsequent resolutions has to be done in at least two of the following scales to ensure **comprehensiveness**:

- **Micro**: dividing the site of the lake to smaller ‘zones’ based on the natural character and immediate context
- **Meso**: the site of lake and its immediate surroundings –Site is the designated boundary within the TP scheme
- **Macro**: the watershed or catchment area of the water body, this is usually much larger than the area of the waterbody itself and can be identified through topographic analysis of water drainage pattern

- **Seasonality** as a inherent aspect of ecosystem should be studied through factors of time and change.
- An ecosystem evolves through time and as a composition of its elements and the dynamic interrelationship in between them. Any changes in one element will change the system and affect the rest of the elements in return. To accommodate the dynamic nature of ecological drivers, cyclic patterns of climate, and progressive urbanization, **Flexibility** is a goal while planning and designing
- To allow the natural environment of the site to adapt to the changes brought by design and planning, a phased development slows the ecological drivers to acclimate.

Framework: Plan, Zone, Design

- A **socio-ecological process**: Design as a process and not a product, to incorporate ecological thinking into spatial making of the urban space. Resilient planning and design to allows flexibility; change is nature of an ecosystem.
- **Layered zoning, layout, and design** instead of generic impressions for deeper knowledge of each ecological driver. Priorities set through examining interdependencies between drivers integrating social spaces and human access and movements accordingly to minimize conflicts. E.g. water flow, velocity, and collection directs type and intensity of plants and creates ground conditions like wetland. Former is a potent social spaces and latter requires limiting of human access.
- **Spatial zoning**: Categorizing programs based on impact intensity and desired human engagements with nature. Example: zones with limited human access like bird nesting areas, and zones benefitting from human activities, like flower gardens for pollination, spaces for introspection with low impact adjacent to densely vegetated areas. This harmonious integration provides benefit of interacting with nature to people while maintaining it within a desirable limit for nature.

Framework: Design through Scales

To implement the socio-ecological lens to make public spaces in an integrated and comprehensive manner, the spatial design strategies are to be followed in 3 scales of Micro, Meso, and Macro.

Macro scale: Connectivity with larger water processes and ground form while situating the site within urban networks; here water capacity calculations should be conducted to accommodate flood and seasonality

Meso scale: Zoning and spatial design to ensure planned ecological and social strategies at site level: shaping the ground, planning water flow, selecting and allocating vegetation, considering seasonality, flood mitigation strategies, and more

Micro scale: Nature-based spatial strategies follow meso-decisions & require details for implementation: ground modulation follows water flow and requires detailed design for levels, materials to increase ground permeability, plant species to stabilize water edges and create micro-habitats, and more.

Challenges

- Ecological studies are addition to conventional processes and hence as extra steps, increase duration of process, and the pace of project can be affected.
- For the micro-ecosystem to adjust with the changes from design and planning implementation, phasing of the project is essential.
- Lack of information on upcoming road type and levels in TP is a challenge while designing ecological public spaces, e.g. devising edge design in response to surrounding roads. Thus, after implementation conflict in workings of the public space and the road network may arise, hindering access and uninterrupted surface water-flow.

Potentials

- Large number and spread of peripheral lakes makes the proposed ecological processes very impactful at the scale of a neighborhood as well as macro-scale of an area. The mentioned benefits, hence, would be accessible by larger population of citizens.
- To prepare and mitigate climate change impacts, guidelines that support ecological networks in urban or peri-urban areas and for designing urban lakes or other public open spaces, in a resilient manner are crucial and urgent. A framework is also required for larger areas at scales between DP & TP
- These potentials lie in their capacity to accommodate both humans (and their social activities) and natural ecosystems (and related biodiversity). In India, recent momentum in planning and designing public spaces and hence their increasing footprint in urban fabric, adds to that potential.

Learnings: Water Sources, Volume, Drainage Pattern, and Quality

- Sources of water: Catchment area run-off, Streams, STP and WTP release, other waste-water, storm-water network release
- Existing water in peri-urban lakes and streams shall not be taken for granted. Changes to ground form during urban development disrupt water drainage patterns and drastically shrink catchment area of lakes. Hence, loss of a main source leaves lakes with considerably lower water level.
- Most of peri-urban lakes receive large shares of STP release which ensures existence of water in lakes. Originally, surface drainage was their main source of water giving them seasonal characters. STP water often is contaminated. This endangers lake's environment and biodiversity. Untreated, polluted waste-water from adjacent settlements or industries adds to lakes' pollution.
- Water pollution is an issue. Treating water is an objective, by designing natural filtration or chemically, before draining into lake
- Necessary to calculate volume and pace of water received in lake to decide water levels: Summer, Monsoon, Floodline, and work out flood mitigation spatial strategies, ground's levels, and modulation around lake accordingly. For this, volume of water from each source is to be calculated considering the upcoming scenario of development. For example, increase in stormwater release due to higher velocity of run-off due to paved ground can be mitigated through designing the process of slowing water and fileting it through ground and vegetation strategies.
- Ecological planning and design is a continuous processes and not a finite one as built and natural environments are ever-changing. and adapting. Hence in making design decisions, adaptability shall be born in mind.
- Time is an important factor both during study and documentation of site and in reimagining through spatial planning and design.

Learnings:

- TP schemes are planned not considering the topography. This makes responding to context problematic and during the implementing phase, existing undulations of ground create ruptures.

- TP regularizes ownerships, but short on implementation regulatory framework. Thus, decisions for developing are taken at plot level and hence lack cohesion. This conflict with continuous nature of ground and natural water drainage patterns creates development with incohesive ground levels and obstructed surface water flow: floods, water logs, blocked access, unintended sharp level drops, unresolved road levels, difficulty executing underground urban infrastructure, and more.

- Proposed TP schemes require information on levels and ground elevation as well as detail on proposed roads like sections with street elements, road level elevation specifically at intersection, mapping and detail of existing trees. Availability of this information would facilitate applicable ecological design resolutions.

- Public spaces if designed ecologically, can contribute to the urban infrastructure and take load off. For example, as part of sewage or stormwater network they can mitigate urban flood, purify STP release water, and increase ground water levels. This has financial benefits for the urban authority and the tax payers.

- To anchor a response at the intersection of ecology and spatial design, it is paramount to include experts in ecology, botany, horticulture, hydrology, and other fields from site study stage to conceptualizing and implementing that considers the existing ecosystem or re-imagines it.

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Climatic challenges and fast-paced urban development call for resilient urban solutions.

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