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National Institute of Urban Affairs

Climate Centre for Cities

WATER & ENVIRONMENT VERTICAL

TRADITIONAL & INDIGENOUS PRACTICES FOR CLIMATE RESILIENCE IN INDIA

NATIONAL INSTITUTE OF URBAN AFFAIRS (NIUA)
Traditional & Indigenous Practices for Climate Resilience in India
June 2023

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"India may be a land of over 100 problems, but it is also a place for a billion solutions."

– Kailash Satyarthi

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DEFINITIONS

Anthromes - also known as human biomes, are global ecological patterns shaped by direct human interactions with ecosystems.
- Anthroecology Lab, 2023

Biocultural Diversity - is the diversity of life in all of its manifestations: biological, cultural, and linguistic, which are interrelated (and possibly coevolved) within a complex socio-ecological adaptive system.
-The SAGE handbook of environment and society, 2007

Circular Economy - is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible.
- European Parliament, 2023

Climate Change - refers to long-term shifts in temperatures and weather patterns, which may be natural or of man-made origin.
- United Nations Development Programme, 2023

Climate Justice - is a term that acknowledges climate change can have differing social, economic, public health, and other adverse impacts on underprivileged populations.
- Yale Climate Connections, 2020

Ecosystem - is a geographic area where plants, animals, and other organisms, as well as weather and landscapes, work together to form a bubble of life.
- National Geographic, 2023

Ecosytem based Adaptation - is a strategy for adapting to climate change by harnessing nature-based solutions and ecosystem services.
- United Nations Environment Programme, 2020

Ethnoecology - is an interdisciplinary field of study that enables a human group with a land-based culture to share how they conceive the ecosystem they inhabit.
- Centre for Earth Ethics, 2020

Indigenous - The term implies those systems that are conveyed formally and informally among kin groups and communities through social encounters, oral traditions, ritual practices, and other activities.
- University of Pennsylvania, 2014

Microclimate - is a local set of atmospheric conditions that differ from those in the surrounding areas, often slightly but sometimes substantially.
- National Centre for Biotechnology Information, 2021

Nature-based Solutions - are actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature.
- International Union for Conservation of Nature, 2022

Resilience - The capacity of individuals, communities, institutions, businesses and systems within a city to survive, adapt and grow no matter what kinds of chronic stresses and acute shocks they experience.
- Resilient Cities Network, 2022

Rewilding - The act of restoration of ecosystems and reversal of biodiversity declines at a landscape scale by allowing wildlife and natural processes to reclaim areas no longer under human management ; inorder to facilitate climate change mitigation and provide socio-economic opportunities for communities..
- International Union for Conservation of Nature, 2021

Sustainability - is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- United Nations Brundtland Commission, 1987

FOREWORD

Hitesh Vaidya
Director, NIUA

"With India's population surpassing that of China and reaching a staggering figure of 1.4 billion plus, climate change is indeed an undeniable truth that we can't afford or choose to ignore."

We are at that phase in life, wherein the world is as urban as it can ever be. As I write, more than half of the global population live in cities, which is estimated to reach two-thirds of all population by 2050. Cities are also perhaps the biggest consumers and producers, and it therefore comes as no surprise that they are experiencing the brunt of climate change first-hand.

With India's population surpassing that of China and reaching a staggering figure of 1.4 billion plus, climate change is indeed an undeniable truth that we can't afford or choose to ignore. If India is to fulfil her commitment of becoming a net zero nation by 2070, achieving climate resilience becomes critical.

There is a growing demand for cities to adopt effective yet resilient climate actions to attract investments, and create a sustainable climate infrastructure. And it is at this critical juncture that the 'Traditional & Indigenous Practices for Climate Resilience in India' handbook comes in.

While the handbook does address the What, Why, Which, Where, and How of climate actions for Indian cities from a historical perspective, a key emphasis has been placed on the 'how' part in particular, as India's biggest asset is her cultural and traditional heritage. This somehow seems to have taken a backseat in this era of modernization and western influence. Cities already have a portal of solutions at their fingertips, but very few action pointers on how to implement these historical lessons from paper to reality. This is exactly what the National Institute of Urban Affairs (NIUA) has tried to do. This handbook, put together at the NIUA, is our small attempt at mainstreaming the indigenous voices of our nation into the paradigm of urbanisation.

The practices highlighted in this handbook are not the ultimate but could be treated as a beginners guide to the journey of mapping more such unique, historic, multi-faceted, and sustainable climate actions that hold immense potential for cities to replicate cross-sectoral interdisciplinary projects, which are a step towards realizing pro-growth climate-secure futures.

By means of this handbook, city administrations can gain insight into how they can approach climate action by borrowing from a ready menu of traditional and indigenous Indian practices that offer a slew of benefits such as living natural heritage conservation, community livelihood and accountability, and gender inclusivity. Most importantly, this handbook becomes a modern day Rosetta stone for translating the historic practices into today's timeline through means of a few selective case studies, most relevant to its need in climate action.

Since NIUA is the technical secretariat for G20, this handbook is a venture that resonates with the G20 theme of 'One Earth, One Family, One Future' and the U20 theme of 'Leveraging Local Potential and Identity'. It provides an opportunity for cities to learn from a nexus of collective action and immediate and impactful solutions that facilitate a platform for exchanging ideas, taking them forward and subsequently replicating them into climate action in their backyards. This handbook not only offers an opportunity for Indian cities to learn from our indigenous solutions but also offers Indian practices on a platter to the global community for a two way learning experience.

Mainstreaming of our traditional knowledge when it comes to management of our natural resources is crucial to the success of climate action and for bringing in inclusivity. With traditional and indigenous practices being a fairly new concept across the pages of urban transformation policies ; this guide not only elucidates the concept but also identifies potential entry points into the urban sector and substantiate case studies to show how indigenous knowledge can be mainstreamed. When our ancestors have left behind a rich cohort of natural heritage conservation practices as a blueprint for achieving climatic resilience, why not try to imbibe them and make the best use of it? That is perhaps where our intelligence should align at.

MESSAGES

Amitabh Kant
G20 Sherpa & Former
CEO, NITI Aayog

India's presidency of the G20 has given us an opportunity to leave a legacy of contemporary thinking for managing global urban development. And what could be better than going back into our history ; taking cues from our ancestors in how they used environment-friendly techniques for different aspects related to urban infrastructure. This compendium is a refreshing attempt in that direction.

V. Radha
Additional Secretary,
NITI Aayog

It is very encouraging to see this document, which is very well-aligned to two core elements of the Lifestyle for Environment (LiFE) mission, which is co-creating globally and leveraging local cultures. The document is a good showcase of local Indian practices that have the potential to being scaled-up for driving climate positive behavioural change in the country.

Atul Bagai
Country Head,
UNEP India

Just like retro fashion, we have started looking at the idea of circularity again as it seems attractive and trendy. But, circularity has been a way of life for millennia for indigenous peoples worldwide. By default, the traditional way of lifestyle is restorative by design, or rather, default. This compendium is a wonderful attempt to capture how such indigenous practices are centered around holistic approaches with one process or action feeding into another, subsequently fostering resilience, communication, and respect between people and nature. In the true sense, that is what achieving circularity should be all about.

Rajiv Ranjan Mishra
Former DG, NMCG

This document is a salutary effort on the part of NIUA to acknowledge and remember the great endeavour of our ancestors to coexist and conserve our natural resources. I see this effort as a firm resolve to protect the traditional knowledge and practices, now more important than ever, in view of the challenges of climate change looming large before us. This is just a first step towards sharing of our traditional knowledge with national and global stakeholders. I am optimistic that in the next few years, our cities will have implemented hybrid solutions of modern and traditional knowledge for helping in sustainable development and combating climate change.

Pampore Saffron Heritage system of Kashmir - One of the Globally Important Agricultural Heritage Systems that now stands endangered with urbanisation (Image credits - Travel Katha)

Korambus - Practice of building temporary dams for water conservation and irrigation in Thrissur, Kerala (Image credits - Green Clean Guide)

EXECUTIVE SUMMARY

"From afar, many urban present day issues seem novel and unique with no historical reference solutions to look at, but the reality is very different."

India is renowned globally for its array of diversity that infuses right from the way of living to the way the immediate local environment is managed. From afar, a lot of urban present day issues seem novel and unique with no reference solutions to look at, but the reality is a lot more than that. A huge generational void of knowledge when it comes to conjuring solutions for these issues is present primarily because our ancestors never had these kinds of issues. Their indigenous way of living was restorative, regenerative, and circular by default. It is this aspect that helped them survive the changing climatic conditions and ecosystems. However, with advancements on the technological and urban front, somehow these practices have taken a back seat.

This document, therefore, is an attempt to mainstream these practices to the forefront of the urban fabric of India. In doing so, we are not only trying to achieve climatic resilience but also help Indian cities embrace their roots in a practical and cost-effective way. Embracing our roots is not about going back to the Neanderthal ways of living but rather adapting the foundational principles of why these practices were successful ; into the present day scenario. Hence, the practices discussed in this document have been categorised into 5 pre-determined themes based on the primary concern areas of urban cores, namely land management, water security, urban ecology, food security, and circularity.

This guide gives a curated snapshot of 25 practices under these five thematic areas along with each practice viewed through an urban lens; so as to provide clarity tor mainstream them in the urban sector. Based across different regions of India, these practices will provide a baseline for ideas and inventions for Indian cities that are sitting on the inflection point of climate transitions.

By using this handbook, city managers and policymakers can:

- Understand the finer nuances of climate action – adaptation and mitigation.
- Initiate and mainstream indigenous climate actions categorised under five identified themes in their respective cities regardless of the practice origin.
- Access a carefully curated list of indigenous practices for climate action projects with action points for key stakeholders to adopt for implementation and mainstreaming.
- Sensitise themselves and the fraternity towards the possibility of using indigenous knowledge in the urban context via global case studies.

Each practice has been developed in such a way that readers would be exposed to the relevant scientific nuances of the practice along with collated information necessary for stakeholders that justify the urban relevance. This is a result of intensive secondary research and rapid baseline assessment of each practice by the team with extensive mentorship from the experienced management at NIUA. The level of detailing explored for the adaptation of each of the practice is limited to prima-facie based generic conceptualization. It is envisaged that Detailed Project Reports (DPRs) will be prepared prior to the implementation of each practice based on the concept ideas proposed in the document.

This document is merely a beginning with a selective list of practices that are primarily short-term in nature, targeting actions over a 1-5 year period. It is envisaged that adaptive implementation of these practices will yield several tangible and intangible benefits for the city in the years to come. Just like EBA and NbS solutions, these practices help achieve a cohort of non-environmental based SDG's such as SDG 1 (No poverty) and SDG5 (Gender equality). However, like indigenous practices, the study undertaken is a sentient process, which needs to grow with scientific advancements and access to more indigenous knowledges.

This shall support cities as they continue to grow in terms of infrastructure while addressing issues pertaining to management of natural resources so that the city can adopt a circular approach of progress.

"We have merely scratched the surface of it all in this document. "

Ayushi Govil,
Manju Rajeev Kanchan,
Kapil Kumar,
Kaveri Bahure

RESEARCH OVERVIEW

AIM

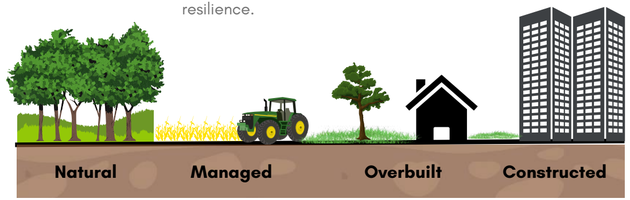
Mainstreaming and exploring the potential of indigenous and traditional practices within the urban environment of India as part of achieving climate resilience and sustainability.

METHODOLOGY

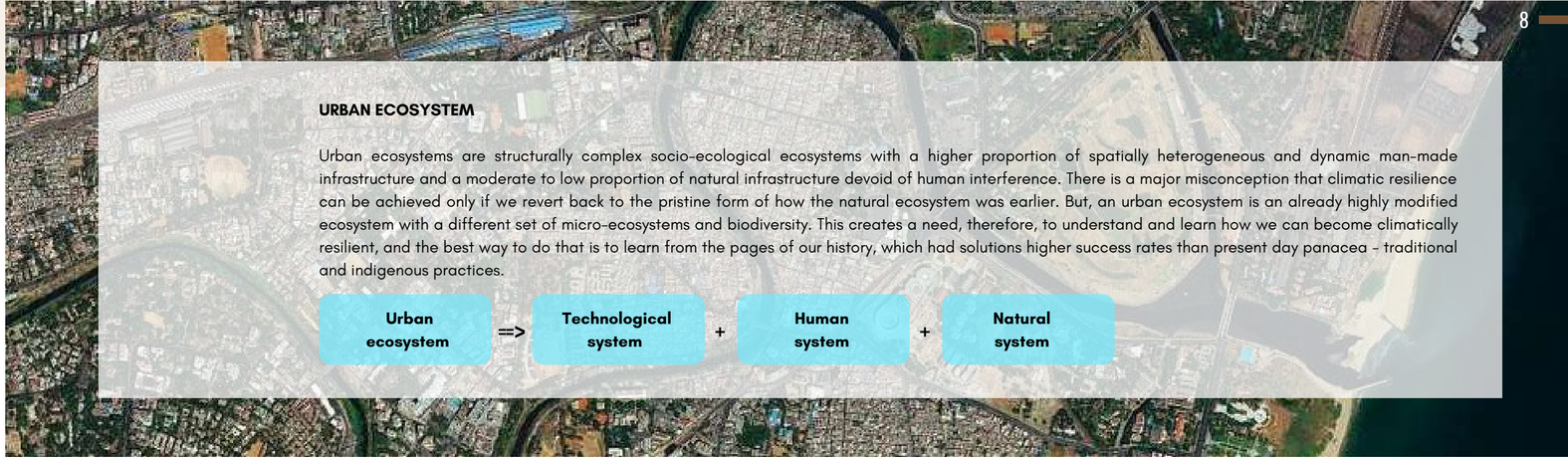
In order to better understand the ecosystem of indigenous practices, an intensive baseline study comprising a combination of secondary and primary research was carried out. This led to the development of 5 avenues which also happen to be present day urban concern areas as well - land management, water security, food security, urban ecology and circularity. A total of 25 practices under these themes have been curated and studied on the basis of selective parameters that can help implement these practices better in an urban setting.

SIGNIFICANCE

India is primarily an agrarian rural country by essence, and hence this study holds immense significance. Our way of living has always been closely associated with nature, which is reflected in our traditions and culture. This also extends towards the management of natural resources, which upon introspection have revealed an innate resilience to the natural phenomena, in addition to being aligned to our present day national and international goals. Moreover, we are expected to reach the peak of urbanisation by 2040. Bringing these practices to the forefront shall not only acquaint the present generation with their roots but also facilitate knowledge dissemination amongst urban practitioners, while inspiring urban local bodies (ULBs) to successfully adapt these practices within their jurisdiction as part of achieving climatic resilience.



Components of urban ecosystem (Adapted from article on 'Does the Ecosystem Service Concept Reach its Limits in Urban Environments?')

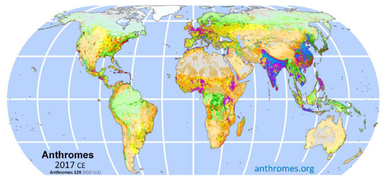


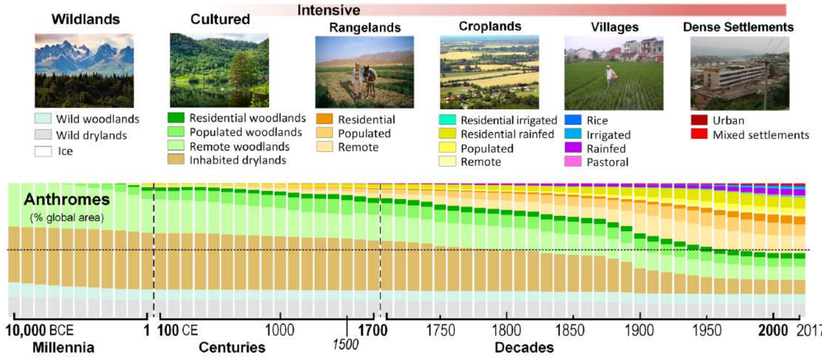
URBAN ECOSYSTEM

Urban ecosystems are structurally complex socio-ecological ecosystems with a higher proportion of spatially heterogeneous and dynamic man-made infrastructure and a moderate to low proportion of natural infrastructure devoid of human interference. There is a major misconception that climatic resilience can be achieved only if we revert back to the pristine form of how the natural ecosystem was earlier. But, an urban ecosystem is an already highly modified ecosystem with a different set of micro-ecosystems and biodiversity. This creates a need, therefore, to understand and learn how we can become climatically resilient, and the best way to do that is to learn from the pages of our history, which had solutions higher success rates than present day panacea - traditional and indigenous practices.

Urban ecosystem => **Technological system** + **Human system** + **Natural system**

Global Anthromes





Global scenario of anthromes since 2017 CE and the various typologies along with the development intensities that can be observed in today's cities. (Source - Anthroecology lab)

URBAN SNAPSHOT

Indigenous practices are a perfect amalgam of traditional ecological knowledge and culture, which makes them closely related with urban sustainability. Some snippets of concepts (global and Indian) that substantiate the relevance of this document under the urban paradigm have been shown below :-

"India will put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for "LiFE – Lifestyle for Environment" as a key to combating climate change."

Life Mission is a global government initiative of India that emphasises on borrowing from the past, operating in the present, and focusing on the future. Indigenous knowledge from our ancestors act as a handbook for achieving climatic resilience in today's world as they are based on a deep understanding of the natural environment and the interdependence between humans and nature.

"Circularity has been a way of life for millennia for Indigenous peoples worldwide."
- United Nations Development Programme

The circular economy is an economic model that emphasises the importance of reusing, repairing, and recycling materials to create a closed-loop system that is sustainable and regenerative.

Majority of the indigenous practices have been circular in their attempts to minimize wastage of resources while prioritising the preservation of natural resources and the protection and management of the environment.

"We must preserve and strengthen indigenous practices, which contribute to sustainable environmental management and provide leadership in combating climate change, nature and biodiversity loss, and pollution and waste."
- United Nations Environment Programme

Blue-green infrastructure (BGI) is an approach to urban planning and development that integrates natural elements such as green spaces and waterways with built infrastructure. Indigenous practices came up at a phase wherein humans were naturally in sync with the blue-green environment, which made them climatically resilient by default. Reviving or mainstreaming the same can help promote sustainable urban development and enhance resilience via amplifying the ecological, social, and economic benefits of natural systems.

"UNESCO, through its LINKS programme, has been influential in ensuring that local and indigenous knowledge holders and their knowledge are included in contemporary science-policy-society fora on issues such as biodiversity assessment and management (CBD, IPBES), climate change assessment and adaptation (IPCC, UNFCCC), natural disaster preparedness (ISDR) and sustainable development (Rio+20, Future Earth)."

Working at local, national and global levels, LINKS strives to strengthen indigenous people and local communities, foster transdisciplinary engagements with scientists and policy-makers, and pilot novel methodologies to furthen the understanding of climate change impacts, adaptation, and mitigation.

"We recognise the importance of the knowledge, innovations and practices of indigenous peoples and local communities in the sustainable management, use and conservation of natural resources, and their contributions to the development and implementation of strategies and plans for sustainable urbanisation."
- New Urban Agenda (P.27)

New Urban Agenda acknowledges indigenous practices and the importance of recognising and respecting the knowledge and practices of indigenous communities within the paradigm of urban development.

"Living heritage, passed on over generations and ever evolving in response to the environment, can inspire an inclusive, human-centred approach to development in this changing world."
- UNESCO

Given the important role living heritage plays in addressing the various dimensions of sustainability and its challenges, the Culture Working Group, under India's G20 Presidency, aims to mobilise the support of member states in promoting the indigenous practices by leveraging existing initiatives and mainstreaming living heritage in policy frameworks. One of the key areas under the Urban20 (U20) engagement group is 'Leveraging Local Potential and Identity'.

TABLE OF CONTENTS







A map of practices covered in this document

Each thematic area corresponds to a certain type of urban ecosystem that can be observed in Indian cities.

ACRONYMS & ABBREVIATIONS

AMRUT - Atal Mission For Rejuvenation and Urban Transformation
ATREE - Ashoka Trust for Research in Ecology and the Environment
C-CUBE - Climate Centre for Cities
CSCAF - Climate Smart Cities Assessment Framework
DPR - Detailed Project Report
EbA - Ecosystem-based Adaptation
FAO - Food and Agriculture Organization
INTACH - Indian National Trust for Art and Cultural Heritage
LiFE - Lifestyle for Environment
LINKS - Local and Indigenous Knowledge Systems
MEA - Millenium Ecosystem Assessment
MoHUA - Ministry of Housing and Urban Affairs
NbS - Nature - based Solutions
NIUA - National Institute of Urban Affairs
NMCG - National Mission for Clean Ganga
NPCA - National Plan for Conservation of Aquatic Ecosystems
ONEs - Open Natural Ecosystems
SANDRP - South Asia Network on Dams, Rivers and People
SDGs - Sustainable Development Goals
TEK - Traditional Ecological Knowledge
UHI - Urban Heat Island
ULBs - Urban Local Bodies
UNDP - United Nations Development Programme
UNEP - United Nations Environment Programme
UNICEF - United Nations International Children's Emergency Fund
URMP - Urban River Management Plan

How to use this handbook?

This handbook advocates an overall approach for effective climate intervention and provides a collative guide of proven good practices in climate action that cities can imbibe as part of adaptation and mitigation by learning from the traditional and indigenous practices that have been around since time immemorial. The information is gathered through an analysis of research studies and crowd sourcing from the partners or locals, as available. The practices captured are structured into five thematic areas as Land Management, Water Security, Urban Ecology, Food Security, and Circularity. These cases can help cities find an approach best suited to their unique contexts.

Designed to cater to city managers and policymakers, the handbook intends to stimulate and promote further thought and discussion and, most importantly, formulate projects that stimulate climate action based on indigenous knowledge. The idea is to be able to pick up bits and pieces, or even entire projects, and replicate them through contextualisation, drawing local strategies, and collaboration with local stakeholders.

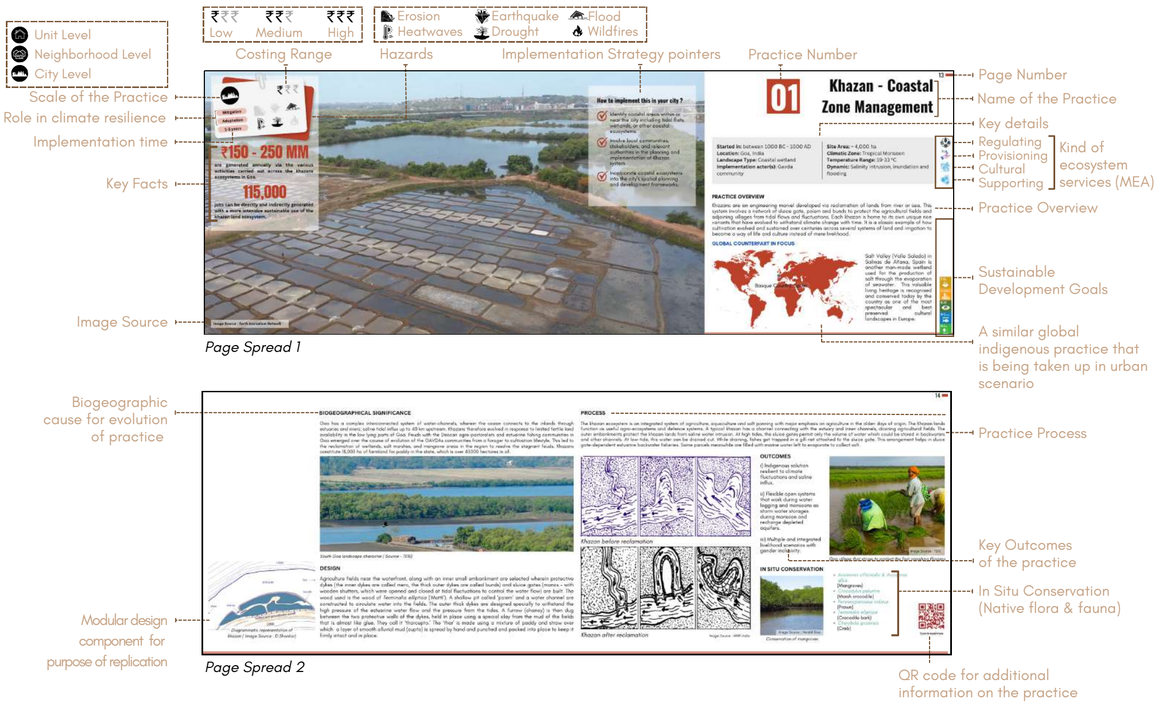
Colors for thematic areas

- Land Management
- Water Security
- Urban Ecology
- Food Security
- Circularity

Urban ecosystem sub-types

- Open Natural Systems
- Water
- Biodiversity
- Agroscapes
- Energy

How to read the spreads?



LAND MANAGEMENT

Our ancestors were quite aware of the fact that land is a precious commodity. Historical categorisation of land use was focused on sustenance in co-existence with nature. This section, therefore, focuses on practices that city departments can learn from when it comes to judicious allocation and utilization of land resources.

Image Source : Canva

Mitigation
Adaptation
1-5 years

₹150 - 250 MM

are generated annually via the various activities carried out across the khazans ecosystems in Goa.

115,000

jobs can be directly and indirectly generated with a more intensive sustainable use of the khazan land ecosystem.

Image Source : Earth Journalism Network

How to implement this in your city ?

- Identify coastal areas within or near the city including tidal flats, wetlands, or other coastal ecosystems.
- Involve local communities, stakeholders, and relevant authorities in the planning and implementation of Khazan system.
- Incorporate coastal ecosystems into the city's spatial planning and development frameworks.

01 Khazan - Coastal Zone Management

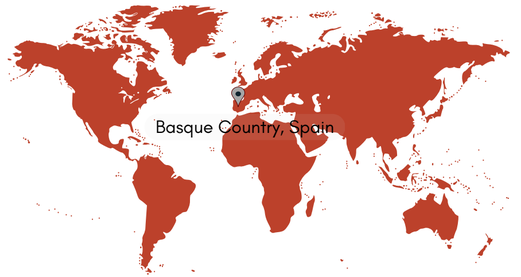
Started in: between 1000 BC - 1000 AD
Location: Goa, India
Landscape Type: Coastal wetland
Implementation actor(s): Gavda community

Site Area: ~ 4,000 ha
Climatic Zone: Tropical Monsoon
Temperature Range: 19-33 °C
Dynamic: Salinity intrusion, inundation and flooding

PRACTICE OVERVIEW

Khazans are an engineering marvel developed via reclamation of lands from river or sea. This system involves a network of sluice gate, poiem and bunds to protect the agricultural fields and adjoining villages from tidal flows and fluctuations. Each khazan is home to its own unique rice variants that have evolved to withstand climate change with time. It is a classic example of how cultivation evolved and sustained over centuries across several systems of land and irrigation to become a way of life and culture instead of mere livelihood.

GLOBAL COUNTERPART IN FOCUS



Salt Valley (Valle Salado) in Salinas de Añana, Spain is another man-made wetland used for the production of salt through the evaporation of seawater. This valuable living heritage is recognised and conserved today by the country as one of the most spectacular and best preserved cultural landscapes in Europe.

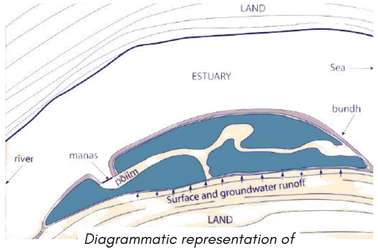
BIOGEOGRAPHICAL SIGNIFICANCE

Goa has a complex interconnected system of water-channels, wherein the ocean connects to the inlands through estuaries and rivers; saline tidal influx up to 40 km upstream. Khazans therefore evolved in response to limited fertile land availability in the low lying parts of Goa. Feuds with the Deccan agro-pastoralists and estuarine fishing communities in Goa emerged over the course of evolution of the GAVDAs communities from a forager to cultivation lifestyle. This led to the reclamation of wetlands, salt marshes, and mangrove areas in the region to resolve the stagnant feuds. Khazans constitute 18,000 ha of farmland for paddy in the state, which is over 45000 hectares in all.

South Goa landscape character (Source - TERI)

DESIGN

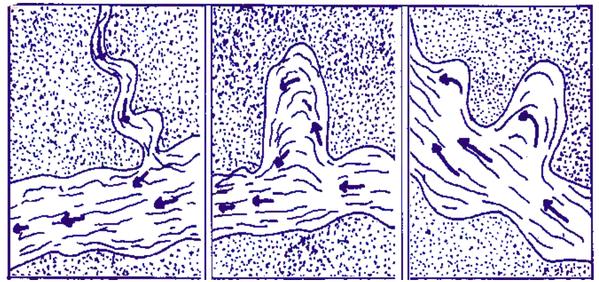
Agriculture fields near the waterfront, along with an inner small embankment are selected wherein protective dykes (the inner dykes are called mero, the thick outer dykes are called bunds) and sluice gates (manos - with wooden shutters, which were opened and closed at tidal fluctuations to control the water flow) are built. The wood used is the wood of *Terminalia elliptica* ('Matti'). A shallow pit called 'poiem' and a water channel are constructed to circulate water into the fields. The outer thick dykes are designed specially to withstand the high pressure of the estuarine water flow and the pressure from the tides. A furrow (chanoy) is then dug between the two protective walls of the dykes, held in place using a special clay from the mud of the fields that is almost like glue. They call it 'tharcupto.' The 'thar' is made using a mixture of paddy and straw over which a layer of smooth alluvial mud (cupto) is spread by hand and punched and packed into place to keep it firmly intact and in place.



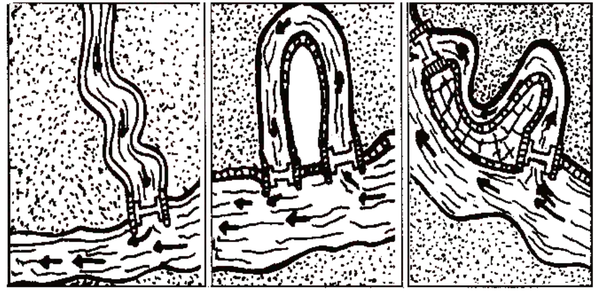
Diagrammatic representation of khazan (Image Source : D.Shankar)

PROCESS

The khazan ecosystem is an integrated system of agriculture, aquaculture and salt panning with major emphasis on agriculture in the olden days of origin. The Khazan lands function as useful agro-ecosystems and defence systems. A typical khazan has a channel connecting with the estuary and inner channels, draining agricultural fields. The outer embankments protect the khazan lands from saline water intrusion. At high tides, the sluice gates permit only the volume of water which could be stored in backwaters and other channels. At low-tide, this water can be drained out. While draining, fishes get trapped in a gill-net attached to the sluice gate. This arrangement helps in sluice gate-dependent estuarine backwater fisheries. Some parcels meanwhile are filled with marine water left to evaporate to collect salt.



Khazan before reclamation



Khazan after reclamation

Image Source : WWF-India

OUTCOMES

i) Indigenous solution resilient to climate fluctuations and saline influx.

ii) Flexible open systems that work during water logging and monsoons as storm water storages during monsoon and recharge depleted aquifers.

iii) Multiple and integrated livelihood scenarios with gender inclusivity.

Goa village that strives to protect the fast-vanishing Khazans

IN SITU CONSERVATION

Conservation of mangroves

- *Avicennia officinalis & Avicennia alba* (Mangroves)
- *Crocodylus palustris* (Marsh crocodile)
- *Fenneropenaeus indicus* (Prawn)
- *Terminalia elliptica* (Crocodile bark)
- *Charybdis goaensis* (Crab)

Scan to read more

Mitigation
Adaptation
< 1 year

40%

increase in water availability across some areas of Rajasthan that have implemented the Chauka system.

30%

increase in crop yield due to enhanced water management and better utilization of available resources using Chauka system.

Image Source : Outlook India

How to implement this in your city ?

- Evaluate the rainwater potential of the urban area by analyzing rainfall patterns, catchment areas, and available open spaces for water collection.
- Pilot testing of this practice across open spaces integrated with campuses, institutions, gated communities, etc.
- Establishing an interdisciplinary local community for accountability and capacity building.

02 The Chauka System of Rajasthan

Started in: the late 1970s
Location: Lapodiya, Jaipur, Rajasthan
Landscape Type: Arid and dry
Implementation actor(s): Lakshman Singh (known as *Water Warrior*)

Site Area: ~ 161 ha
Climatic Zone: Hot, semi arid
Temperature Range: 27-39 °C
Dynamic: Water scarcity and drought

PRACTICE OVERVIEW

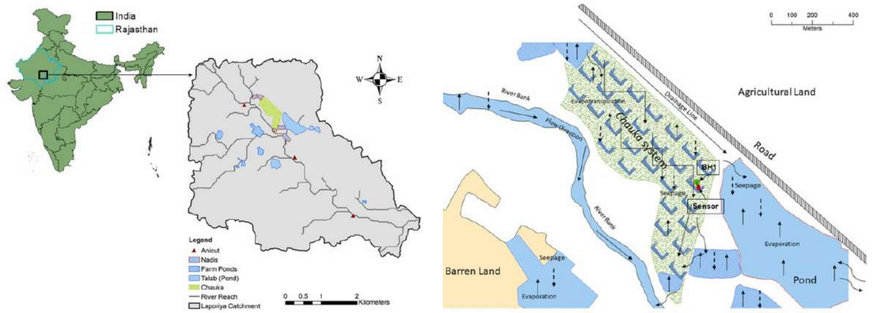
The Chauka system is a traditional irrigation practice in Rajasthan that ensures fair water distribution and efficient management. It involves the construction of rectangular fields connected by canals and embankments that collect rainwater runoff. Lapodiya village in Rajasthan has successfully implemented the Chauka system, becoming a model for other communities. The Chauka system could also be effective for regenerating pastureland in arid regions state-wide as well as globally, like Australia, Africa, and the Southwestern United States.

GLOBAL COUNTERPART IN FOCUS

The Qanat system in Iran is an ancient underground water management system. It involves the construction of underground tunnels to tap into groundwater sources and distribute water to agricultural lands through surface channels. The system ensures the equitable distribution of water among farmers and has been used for centuries in arid regions.

BIOGEOGRAPHICAL SIGNIFICANCE

In the late 1970s, Lapodiya village in Jaipur, Rajasthan faced severe drought, causing unemployment among farmers and social unrest. The attempt to address water scarcity through mud contours failed, leading to flooding during heavy monsoon rains. In response, a local resident named Laxman Singh developed the innovative Chauka system. This system, that evolved over time, incorporates rotational water distribution, rectangular fields, canals, and embankments. Each farmer or group is assigned a specific time slot for water access, ensuring fairness. The construction of fields and canals facilitates water movement, while embankments collect rainwater runoff, allowing gradual seepage into the ground.



Chauka System in Rajasthan

Image Source : Journal of Hydrology - Regional Studies

DESIGN

A chauka is a rectangular enclosure surrounded on three sides by earthen bunds or embankments (dykes). The dykes are 1.5 metres high. Trees are planted on these dykes to give them additional support to withstand rain. The embankments are constructed out of soil dug out of smaller rectangular or square borrow pits within the chauka. As an added benefit, these pits allow the water to infiltrate the soil even more effectively.

In a chauka system, a series of these rectangles are constructed in a checker-board pattern across a natural slope and connected with shallow canals. The embankments intercept the runoff rainwater and collect it at the down end of the bunded field. During heavy rainfall, the water moves gradually from one chauka to another, which gives it more time to seep into the ground.

Image Source : GVNML

Involvement of women in Chauka System

PROCESS

The Chauka system, greening of barren lands, is an irrigation practice used in arid regions. Each farmer or group is assigned a specific time slot for water access, ensuring fairness and managing water scarcity. Rectangular fields are arranged in a checkerboard pattern on a slope, connected by canals. Embankments collect rainwater runoff and facilitate gradual movement between fields, allowing better seepage into the ground. The Chauka system promotes equitable water distribution and efficient water management in arid areas.

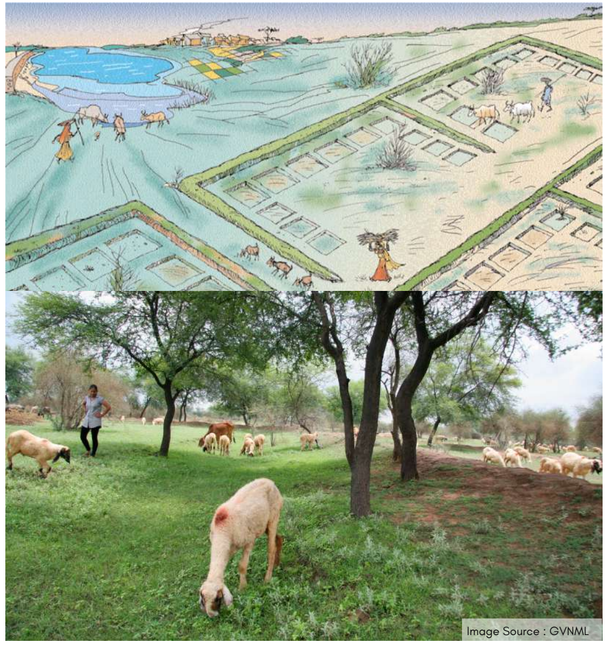


Image Source : GVNML

A fully functional and mature chauka system at work

OUTCOMES

i) The water collected in the chaukas replenishes underground water aquifers, gradually feeding the ponds and wells.

ii) Helps to maintain and regenerate natural vegetative cover.

iii) Improves water security during droughts, thereby enhancing food security and economic sustainability for farming communities.

Image Source : Mathew Good Foundation

Farmers dividing plains into several cells of chauka

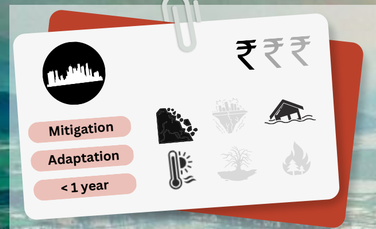
IN SITU CONSERVATION

Image Source : The Wire

Rich landscape character

- *Rynchops albicollis* (Indian Skimmer)
- *Gyps indicus* (Indian Vulture)
- *Grus antigone* (Sarus Crane)
- *Crocodylus palustris* (Marsh crocodile)
- *Tor spp.* (Mahseer)

Scan to read more



100,000

people are dependent on the phumdis and ataphums for their survival.

233

species of aquatic macrophytes of emergent, submergent, free-floating, and rooted floating leaf types are found in the lake.

Image Source : Overdrive

How to implement this in your city ?

- Pilot testing a modular small scale version of ataphums (in a similar way like floating wetlands) preferably in those waterbodies with seasonal variations in water flow.
- Exploring the possibility of integrating this practice within riverine islands of seasonal rivers and other seasonal ecosystems
- Engaging with local stakeholders for accountability and indigenous innovations.

03 Phumdis and Ataphums of Manipur

Started in: 6th century AD
Location: Loktak Lake, Manipur, India
Landscape Type: Natural freshwater lake
Implementation actor(s): Local communities and UNESCO

Site Area: ~ 4,000 ha
Climatic Zone: Moderate
Temperature Range: 0-35 °C
Dynamic: Freshwater lake ecosystem subject to seasonal water level fluctuations

PRACTICE OVERVIEW

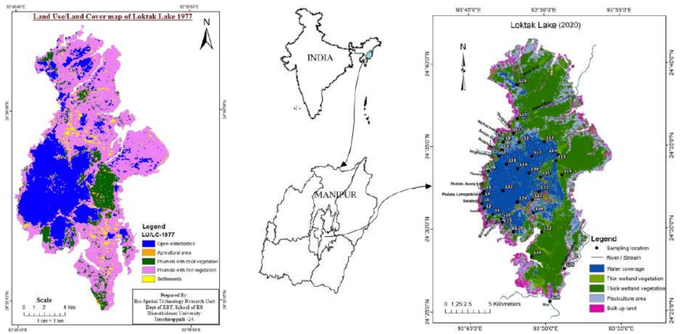
Phumdis are floating circular masses of decomposed vegetation, soil, and organic matter on Loktak Lake in northeastern India. They create diverse habitats for flora and fauna, including endangered species, and play a crucial role in the lake's ecosystem and ecological balance. Ataphums, on the other hand, are man-made floating gardens built for satisfying anthropogenic needs. Both Phumdis and Ataphums hold significant ecological, cultural, and economic value, showcasing the sustainable practices of local communities in harmony with nature.

GLOBAL COUNTERPART IN FOCUS

Chinampas in the region of Xochimilco, Mexico are artificial floating farm islands created by the Aztecs. Local organisations such as Arca Tierra have contributed to their survival by connecting their produce with prospective customers through online portals where consumers could easily order fresh vegetables, free range eggs and chinampa honey.

BIOGEOGRAPHICAL SIGNIFICANCE

The phumdis in Manipur are natural formations, which are floating circular masses composed of decomposed vegetation, soil, and organic matter on the surface of Loktak Lake. Over time, these phumdis have provided unique habitats for diverse flora and fauna. Additionally, local communities have created ataphums, which are artificial floating gardens, by piling layers of vegetation and soil on interconnected bamboo frames. Phumdis now cover nearly 50% of the lake. The spatial results in 2002 showed that the phumdi area has increased since 1989. The main causes for phumdi proliferation were the construction of the Ithai Barrage Dam, increase in ataphum fishing, pollution, growth of settlements on phumdis, etc. It was the human pressure that has aided in the growth of phumdis.



Evolution of Loktak Wetland Region

Image Source : Bio-Spatial Technology Research Unit

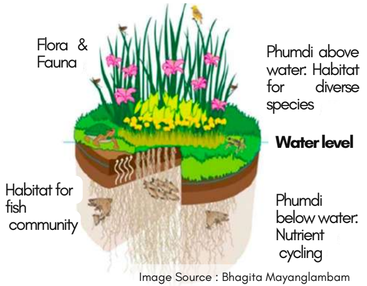


Image Source : Bhagita Mayanglambam

Anatomy of a phumdi

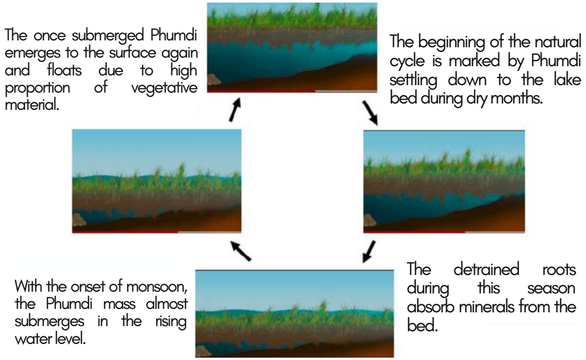
DESIGN

Floating mats locally known as 'phumdis' are a heterogeneous mass of soil, vegetation, and organic matter at various stages of decomposition. A phumdi may be initiated with a small mass of un-decomposed organic matter or a dense growth of water hyacinth that accumulates some suspended silt and is gradually colonized by grasses and other herbaceous plants. The high proportion of vegetable matter in the phumdi gives it a specific gravity and high buoyancy to keep it afloat. They float on the lake with one-fifth of their thickness above the water surface. The maximum thickness of a phumdi is 8 ft., but its thickness varies with time and space, depending on the conditions during its formative stage. The core of phumdis is composed of detritus material, which is black in colour and is highly spongy. It is constituted of organic carbon (36%), nitrogen (2.08%), organic matter (24.98%), and other residues including mineral matter (37.94%).

PROCESS

Phumdis are natural floating mats formed in Loktak Lake, Manipur, composed of decomposed vegetation, soil, and organic matter. They start with the growth of aquatic plants in shallow areas, accumulating organic material that thickens over time due to decay and sedimentation. The process of phumdis formation can be triggered by anthropogenic inferences at point or non point sources - this is one of the principles adopted of the construction of ataphums.

Ataphums are artificial floating gardens created by locals. They involve constructing bamboo or floating lengths of ropes as base frames, layering vegetation and soil on top, and allowing crops to grow. This eventually led to the creation of a new living island in Manipur. Both play important ecological roles in the lake ecosystem.



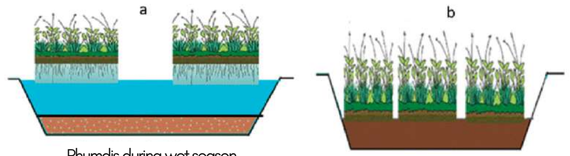


Image Source : Neelam Khare

Functioning of phumdis

OUTCOMES

i) Natural carbon sequestration and reduced greenhouse gas emissions.

ii) Helps to prevent soil erosion, filter pollutants, and retain water during periods of high rainfall or flooding.

iii) Coexistence with water ecosystems while ensuring reduced negative impacts and need for land.

Formation of an ataphum across Loktak lake

IN SITU CONSERVATION

Landscape of Loktak Lake

- *Channa marulius* (Manipur murrel)
- *Amaurornis phoenicurus* (Waterhen)
- *Eleocharis dulcis* (Water chestnut)
- *Hoplobatrachus tigerinus* (Indian bullfrog)
- *Rucervus eldii eldii* (Sangai)
- *Nemacheilus manipurensis* (Manipur loach)

Scan to read more

35,000

domestic animals are documented to be supported by the existence of orans in India.

25,000

orans are estimated to be present across the state of Rajasthan.

Image Source : Round Glass Sustain

How to implement this in your city ?

- Integrating the concept of orans with religious institution grounds as part of conservation.
- Adopting eco-friendly approaches for integrating orans with green energy sites within the city.
- Collaboration with local stakeholders and communities for accountability.

04 Oran System of Thar Desert

Started in: 600 years ago
Location: Thar Desert, Rajasthan
Landscape Type: Subtropical desert
Implementation actor(s): Local pastoral communities

Site Area: ~ 4,000 ha
Climatic Zone: Arid and subtropical
Temperature Range: 3-50 °C
Dynamic: desert forested lands and scrubs with water scarcity

PRACTICE OVERVIEW

The Oran system in the Thar Desert is a traditional community-based forest management practice that has been adopted for centuries by the local communities inhabiting the region. Orans are sacred groves or forest patches that are considered as community-managed protected areas. Orans help maintain the ecological balance and overall biodiversity in the Thar Desert. These lands, despite being a wildlife refuge and biodiversity hotspot, are today categorised as wastelands as per revenue records.

GLOBAL COUNTERPART IN FOCUS

Sui Generis Conservation Areas in Mexico refers to a category of protected areas that are recognized and managed under a unique legal framework. These areas are established to conserve and protect the cultural and natural heritage of indigenous communities.

BIOGEOGRAPHICAL SIGNIFICANCE

The Thar is one of the smallest but most thickly populated deserts of the world. Despite harsh climatic conditions and innate water scarcity, large populations call it home. In part, life here is made possible by the orans. Orans are genetic storehouses of near-natural native vegetation and secure homes for several threatened species. This concept historically evolved as a way to support the local livestock-dependent livelihoods. Unfortunately, most orans have been lost to the installation of wind turbines, power lines, and pylons.


Image Source : The Hindu


Image Source : Dhritiman Mukherjee

Orans face destruction as land is allocated for renewable energy infrastructure and power lines

DESIGN

Orans are found in arid to semi-arid areas and are formed by indigenous communities, pastoralists, and farmers. A natural resource or deity is identified as sacred by the local community, around which the oran is established. Boundaries are defined using trees or invisible markers known only to the local people. The orans also augment and sustain traditional water resources found in village forests in the form of johad, nadi, talab, baori, etc. These along with springs and rivulets found in forests are water resources that sustain both livestock and humans. The area under an oran can vary from a few square meters to several hundred hectares.

The local communities consider the forest patches as community-owned and have established customary laws, regulations, and social norms to govern them. This strong sense of ownership and collective communal responsibility contributes to the management and protection of the orans.


Image Source : Dhritiman Mukherjee

No official fence demarcates the Oran

PROCESS

The Oran system in the Thar Desert involves community identification and protection of forest patches called orans based on tree cover and growth potential. The community collectively owns and manages these areas, implementing rules to control access and harmful activities. Conservation efforts include protecting tree species, implementing grazing restrictions, and tree planting. However, in the past, electric lines were passing through oran areas due to the expansion of infrastructure in the region, which led to electrocution of various species. In view of this, it has become essential to ensure that the installation and maintenance of electric lines do not negatively impact the oran system and the surrounding ecosystem.

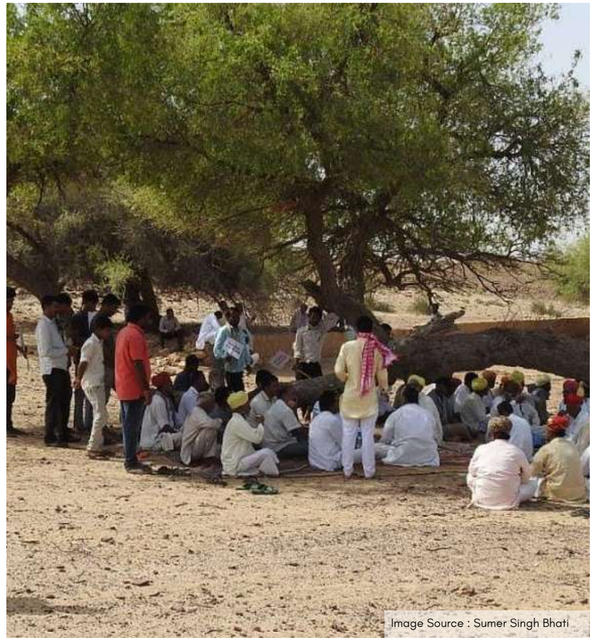


Image Source : Sumer Singh Bhati

Sacred groves of Thar desert managed and conserved by local communities

OUTCOMES

i) Microclimate regulators and, therefore, increased climatic resilience.

ii) Conservation of keystone and native species of the region.

iii) Increased community spirit and livelihood for a unified cause – conservation of nature.

iv) Indirect conservation of associated water / landscape ecosystems.


Image Source : ICCA Consortium

Women actively engaging in the conservation of nature

IN SITU CONSERVATION


Image Source : Dhritiman Mukherjee

Eryx johnii

- *Tecomella undulata* (Rohida tree)
- *Prosopis cineraria* (Khejri tree)
- *Ardeotis nigriceps* (Great Indian bustard)
- *Gyps indicus* (Indian vulture)
- *Gazella bennettii* (Chinkaras)
- *Eryx johnii* (Red sand boa)

Scan to read more

20%

agricultural land in Sikkim is known to be terraced with slopes ranging from 5 to 40 degrees.

51%

of the local communities prefer sloping terrace in the watershed.

Image Source : Pritam Laskar by Unsplash

How to implement this in your city ?

- Pilot testing can be undertaken on sites along waterfronts in integration with the riparian buffer.
- Advocate for policies and regulations that support urban farming initiatives, such as relaxing zoning regulations and providing incentives for urban agriculture projects.
- Collaborate with communities, planners, experts, and government agencies for successful implementation.

05 Pakho Khet of Sikkim

Started in: around 7th century
Location: Sikkim, India
Landscape Type: Lower hills
Implementation actor(s): Local communities

Site Area: N/A
Climatic Zone: Tropical Monsoon
Temperature Range: 19-33 °C
Dynamic: Hilly terrain subject to erosion

PRACTICE OVERVIEW

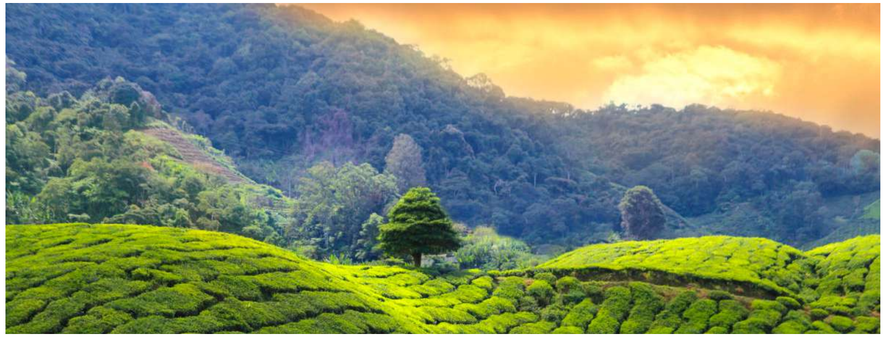
Pakho Khet in Sikkim is a comprehensive approach that utilizes various techniques to prevent soil erosion, retain water, and promote sustainable agriculture on terraced fields. It involves management of terrain through creation of contours, wherein crops are planted along the contour lines to reduce water flow and erosion. Stone bunds and check dams are constructed to slow down water and retain it on the terraces. Mulching and cover crops are used to protect the soil from erosion and promote water absorption.

GLOBAL COUNTERPART IN FOCUS

Banaue Rice Terraces, Philippines are recognised as an iconic UNESCO World Heritage Site. Identified threats and concerns with respect to these terraces are now being conscientiously and systematically addressed through efforts extended by the Provincial Government and concerned national agencies.

BIOGEOGRAPHICAL SIGNIFICANCE

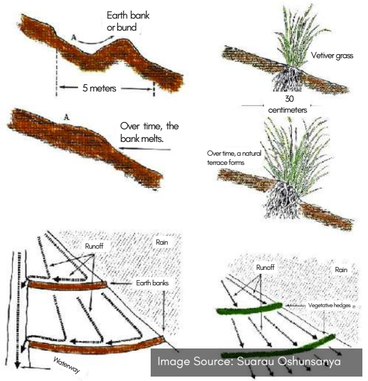
Sikkim, a mountainous state in northeast India, is characterized by its rugged terrain, steep slopes, and diverse microclimates. In such challenging geographical conditions, Pakho Khet plays a crucial role in agricultural sustainability and land management. The construction of stone terraces and cultivation of crops on these terraces enable farmers to utilize the limited arable land effectively. By creating flat platforms on the slopes, Pakho Khet allows for better water retention and prevents soil erosion, which are critical considerations in a region prone to heavy rainfall and landslides.



Terrain of Sikkim (Image source - Deccan Herald)

DESIGN

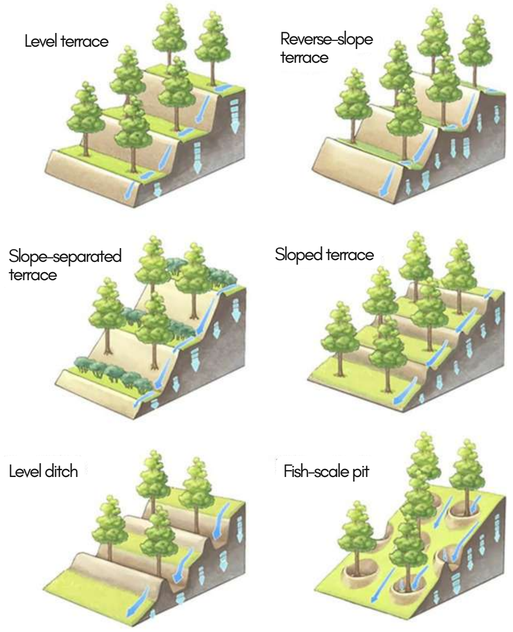
Farmers in the watershed adopt various structural measures to stabilize irrigation water for paddy cultivation, with levelled terraces being a dominant choice. The most common type of terrace in the area is the outward sloping terrace, which is typically found on the higher slopes and contours of the upper and middle ecological zone. These terraces are situated at the base of steep slopes and are supported by large retaining walls that collect slope wash. Bunds, commonly constructed using homogenous clay, are a popular choice for terrace construction, although stones mixed with clay are also used, particularly in areas with steeper slopes. To mitigate soil loss, farmers grow vegetative barriers such as grasses and pulses on the terraced land. Building the terrace walls correctly is crucial. Additionally, lower gradient slopes experience intensive agricultural usage. Farmers terrace their lands on their own initiatives with the help of bunding, stone walls, and vegetative barriers. The minimum slope requirement is 20 degrees.



Terrace/contour system

PROCESS

The process involves construction of terraced fields on the steep hill slopes post selection of suitable locations based on factors like soil quality, water availability, and slope gradient. The terraces are created by clearing the vegetation and debris, followed by placement of large stones along the edges to define boundaries and provide stability. Layers of soil mixed with organic matter, manure, and compost are added on top of the terraces to create a fertile growing medium. Stone walls are constructed along lower terrace edge for water retention and prevention of soil erosion. The walls are built using traditional techniques, with stones carefully stacked to form sturdy structures. Regular maintenance is essential to ensure the long-term effectiveness of terraces.



Terrace types in Pakho Khet

Image Source: Prabuddh Kumar Mishra, Aman Rai, S. C. Rai

OUTCOMES

i) Natural barriers for water flow regulation during heavy rainfall or monsoon seasons.

ii) Help to stabilize the soil, prevent soil erosion, and reduce sedimentation in nearby water bodies.

iii) Women manage water resources on terraced fields by channeling water from natural sources and constructing irrigation systems.

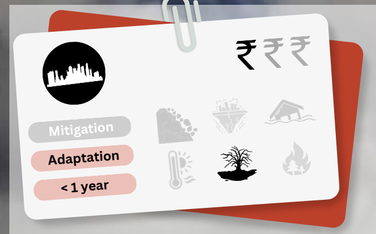
Organic Farming in Sikkim as a strategy for sustaining ecosystem services

IN SITU CONSERVATION

A section of Pakho Khet in Sikkim

- *Aconitum heterophyllum* (Indian Atis)
- *Rheum australe* (Indian Rhubarb)
- *Quercus spp.* (Oak)
- *Alternanthera philoxeroides* (Alligator weed)
- *Rhododendron spp.* (Rhododendron)
- *Alnus spp.* (Alder)

Scan to read more



₹1500 crore

is the approximate cost of barbed wire fences to secure the paddocks unlike the indigenous substitute of the live hedges in the Kangayam region.

120 m ha

area was reported as degraded land and wastelands (in 2011)

Image Source : Climate Home News

How to implement this in your city ?

- Introducing a category of land use at master plan level called 'grasslands', which include the natural grasslands across the mainland and the riverine islands within the city limits.
- Conversion of potential derelict lands and wastelands into formal grazing grounds across the city.
- Developing training programs and providing access to micro-financing or support initiatives to help individuals start small-scale urban livestock enterprises.

06 Sedentary Pastoralism across Kangayam

Started in: 1855
Location: Tamil Nadu, India
Landscape Type: Tropical grassland
Implementation actor(s): Farmers and Foundation for Ecological Security

Site Area: 3,84,100 ha
Climatic Zone: Dry, semi arid
Temperature Range: 20-37 °C
Dynamic: Drought prone open grasslands

PRACTICE OVERVIEW

The Kangayam grassland in South India has been sustainably managed for over 150 years, benefitting climate change mitigation and adaptation. Farmers, growing grass despite low rainfall, contribute to carbon sequestration and biodiversity conservation. The paddock system of grassland management in Kangayam has evolved from wasteland into an organised and consolidated system. It offers a model for replication elsewhere under similar low rainfall conditions.

GLOBAL COUNTERPART IN FOCUS

Regional Sahel Pastoralism Support Project (PRAPS) has been deployed under World Bank in 6 countries of Sahel –Burkina Faso, Chad, Mali, Mauritania, Niger and Senegal in an attempt to protect pastoral systems via resource management and animal health, facilitating market access, diversifying sources of income for pastoral households and managing conflicts.

BIOGEOGRAPHICAL SIGNIFICANCE

Kangayam grasslands are spread over three districts of Tamil Nadu state in south India, covering an area of approximately 3,841 sq km. The region lies east of the Western Ghats in the rain-shadow area. The human population has remained low until 1799 due to incessant wars, famines and occurrence of frequent droughts. The quantity of rainfall, its distribution and soil condition is hardly sufficient for raising the traditional grain crops although it does encourages healthy growth of grasses. The paddock system of grassland management has evolved from wastelands (ONEs) into an organised system of management constituting a series of good practices adopted by the farmers over 150 years.

Geographical location of the Kangayam region and satellite image of fields with hedges of B. berryi

A live hedge of B. berryi

DESIGN

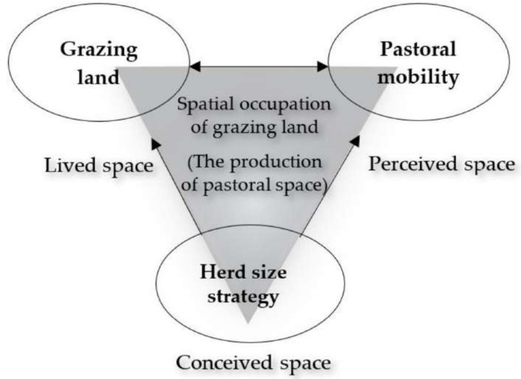
Under the paddock system of management, the grazing land is conveniently divided into paddocks of 2 - 4.5 ha. The paddocks are separated by straight rows of live hedge fences (width 0.6 - 0.75 m, height 1.5 m) made of *Balsamodendron berryi*, *Euphorbium tirucalli*, and *Euphorbium antiquorum*, is built so as to secure the animals grazing inside the field. There are 16 stalks every meter of length of the fence arranged in two rows of 8 each. The hedge is pruned every two years and gap filling is done by planting the stems during June-July. *Moringa oleifera* and *Agave americana* are also grown among the live hedges. The grazing area is designated such that it is large enough for the livestock to graze and roam around while not adversely affecting the re-germination capacity of the grasses. Inorder to maintain the ratio of livestock ownership to land, the population size was kept in check with a stable livestock : human ratio.

PROCESS

Local farmers raised live fences along the field boundaries. A system of rotational livestock grazing in the paddocks was introduced which required minimal labour input. Careful management of the grazing paddocks was adhered to, among which was the withholding of animals for a month after initiation of rain to let the grass crop come up well and maintain an optimum number of Acacia trees. Supplementary feeding is also practiced during lean period between March and June when the grass is almost completely grazed by the animals. The enclosed land was also useful for farmers wanting to experiment with selective breeding and new crops from abroad. Re-seeding of the grassland is done once in 4 to 6 years for better growth of grasses and to obtain higher biomass for livestock feeding.

Grazing land in the Kangayam region

Grazing in the field enclosed with fence



Conceptual framework of spatial occupation of grazing land

Image Source : Bayarmaa Byambaa

OUTCOMES

i) Utilisation of the wastelands for creating additional grazing areas for livestock, ensuring a sustainable supply of forage, and increasing resilience of the grassland.

ii) Rotational approach to maintain the productivity and health of the grassland ecosystem.

iii) Social inclusivity with a health female to male ratio.

Active role of women

IN SITU CONSERVATION

Pastoralists and wildlife

- *Euphorbium tirucalli* (Indian tree spurge)
- *Euphorbium antiquorum* (Triangular spurge)
- *Balsamodendron berryi* (Indian Balm of Gilead)
- *Aristida setacea* (Bristly Needle Grass)
- *Cenchrus ciliaris* (Buffel grass)
- *Blumea sp.* (Lettuce-Leaf Blumea)

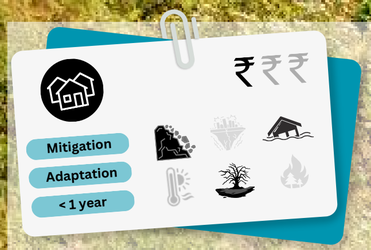
Scan to read more

WATER SECURITY

Water is one resource that not only has the capacity to initiate life but also the power to ignite a war. Indigenous practices offer us valuable ways to address the global water crisis, both in terms of the sustainable management of aquatic ecosystems and the democratic governance of safe drinking water and sanitation. This section focuses on practices that city departments can learn from, when it comes to becoming water-wise.

Image Source : India's water crisis, in photos - CNN

07 Dong Bundhs System of Assam



70,000

families (approx.) in Baksa, Nalbari and Kamrup districts of Assam are dependent on the dongs for improved quality of life.

120.16 sq.km

catchment area was conserved from disaster risk reduction (DRR) such as soil erosion and flood due to this system.

Image Source : Down to Earth

How to implement this in your city ?

- Mapping informal channels from river to agriculture fields/landscape spaces to convert them to dongs.
- Forming a Dong Bundh Committee for accountability and gaining local knowledge of the site.
- Key to success - Terrain, access to flowing water, efficient team work and corporation.

Started in: the 1930s
Location: Baksa, Assam, India
Landscape Type: Hilly terrain
Implementation actor(s): Locals of Bodo community

Site Area: around 300 square kilometres
Climatic Zone: Sub - tropical
Temperature Range: 10-35 °C
Dynamic: Geo-climatically induced water scarcity

PRACTICE OVERVIEW

The Dong Bundhs system is a community-led traditional water management practice adopted in response to the geo-climatically induced water scarcity in rural Assam. This ancient indigenous engineering knowledge of gravity-based seasonal river channelisation not only ensures water security within the community but also ensures judicious distribution of the water while maintaining a healthy e-flow along with with minimal to no wastage. The practice has also been instrumental in binding different religious and linguistic communities in the area.

GLOBAL COUNTERPART IN FOCUS

Valencia, Spain still has an ingenious maze of channels, ditches, weirs, and floodgates invented by the Moorish rulers 1,200 years ago. The whole process is held together by a unique ancient social organisation. This system of water management helps aubergines, oranges, artichokes, and olive trees to co-exist together.

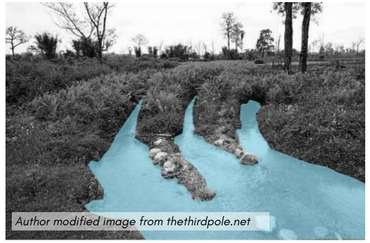
BIOGEOGRAPHICAL SIGNIFICANCE

The region of Baksa district involves a mixed topography of plains and foothills, characterised mainly by lush green forests and varieties of flora and fauna. The peculiar geologic and geomorphic characteristics, sharp fall of surface gradient, heavy deposition of coarse sediments by the rivers, subsurface flow of river and rainwater and high porosity of sediments, lack of natural water bodies and inaccessibility of groundwater, led to a severe water scarcity scenario, particularly during the winter and pre-monsoon seasons. The streams are devoid of any appreciable surface flow, despite evidence of subsurface flow; ultimately making way for this contextualised indigenous practice.

Source - CPREEC -ENVIS

Map of the Baksa region, Assam

Source - Wikimedia CC



Author modified image from thethirdpole.net

A typical dong

DESIGN

A dong is built by digging a canal in the earth, 3 feet to 10 feet deep, depending on the topography and the distance from the point of origin at a river. The length of the dong spans between 4 kilometres to 15 kilometres. While the main dongs, which start at the rivers, are about 12 feet wide, smaller subsidiary dongs that branch off from the main ones are around three feet wide.

The diversion bundhs are constructed by locally available building materials such as boulder, stone, sand, tree branches, creeper, bamboo, bushes, and tree leaves. A triangular structure with a wooden pole called Trikathi is erected in the river. After this, boulders are collected from the mountain river and put inside the Trikathi. Many such Trikathis are arranged in a series across the river with stones. This forms a crude dam that helps to channelise the river water into a big canal, which leads the clear river water into the village.

PROCESS

This simple system involves building a network of dongs via construction of a small canal from a nearby perennial source of water, such as rivers, all the way to the cultivation fields. Under the dong, small dams (bundhs) are built on a river, and the water is routed through canals to paddy fields and into the household ponds. The dongs ultimately dry out naturally or meet other large water bodies like rivers. Upon achieving the desired levels of inundation of the dongs, the bundhs are demolished. Each village is granted access to the dongs for a specific period to use the water for irrigation as well as store water in their backyard ponds. The dongs are constructed every year as water gushing down the mountain river during the rainy season washes them off.

A river during its peak flood season

Construction of dong bundhs before dry spell

Collective labour for construction of deflectors (porcupines) and dong - bundhs

Stream channelisation during dry season upon downstream demand

Flood prevention and river channelisation in the upper catchment

Process of construction of Dong Bundhs (Image credits : Bipul Das and Sonali Ghosh)

OUTCOMES

i) Increased soil erosion and flood resilience by ensuring the availability of irrigation and potable water in an otherwise water deficient region.

ii) Resilience against the impacts of prevalent sand mining.

iii) Reduced vulnerabilities of local communities to climate change.

Adapted from photograph clicked by Aparna Unni

A typical dong with subsidiary dong

IN SITU CONSERVATION

Adapted from CPREEC -ENVIS

Rice cultivation

- *Oryza sativa*
  (Ahu / Autumn rice)

Scan to read more

₹500 - 1000

per hectare is the cost of maintaining an Ahar Pyne.

12%

of the total irrigated area in Bihar today involves the system of Ahar Pynes.

Image Source : Shailendra Yashwant (India Climate Dialogue)

How to implement this in your city ?

- Pilot testing the practice within formal campuses such as schools and offices across the city. A classic example being Nalanda University in Rajgir, Bihar.
- Exploring the possibility of replacing/integrating this practice with detention and retention basins across the city.
- Modular versions in a smaller scale can be adopted in integration with rain gardens - bio swale systems across the city as part of streetscapes design.

08 Ahar Pynes System of South Bihar

Started: 5000 years ago
Location: Magadh, South Bihar, India
Landscape Type: Undulating rocky terrain
Implementation actor(s): Farmers

Site Area: 57 ha
Climatic Zone: Sub - tropical monsoon
Temperature Range: 10-30°C
Dynamic: Drought - flood prone, rugged terrain with low water retention capacity

PRACTICE OVERVIEW

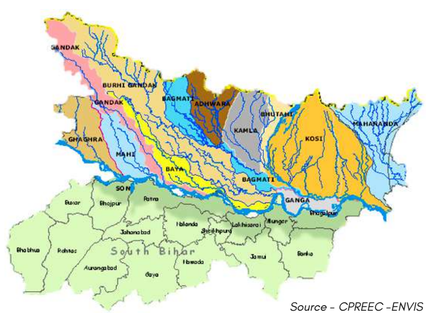
The practice of Ahar Pynes is based on harnessing the floodwaters in the otherwise relatively water-deficit and rocky terrain of South Bihar for irrigation and domestic purposes. The system converts land into a dual purpose zone - floodwater harvesting reservoir and agriculture land after draining excess waters post summer seasons. This system is known to help in both drought and flood management as noted in the case of Gaya district in Bihar, wherein recurring floods were due to the destruction of this system. 3000 of 20000 ahar-pynes are defunct as of date.

GLOBAL COUNTERPART IN FOCUS

Retarding basins in Melbourne are quite similar in concept to the Ahars of Bihar. Retarding basins are low-lying land areas, set aside to temporarily store stormwater during heavy rain and act as recreational zones during dry periods. The stored water is then slowly released into the downstream drain or waterway. They also serve as urban biodiversity hotspots.

BIOGEOGRAPHICAL SIGNIFICANCE

Bihar can be divided into two regions, namely North and South Bihar. South Bihar is bound by the Chhotanagpur plateau in the south and slopes upwards towards the South. This marked slope -- 1 m per km -- from south to north enables building of embankments. The terrain has sandy soil, leading to poor water retention capacity and low groundwater levels. Rivers here overflow only during monsoons, but the water is swiftly carried away or percolates down into the sand. All these factors make the Ahar Pyne system suitable in this region. The system is built in areas such as Gaya, Nawada, Munger, which lie in both flood-prone and drought-prone areas.



Source - CPREEC -ENVIS

South Bihar - Geography and hydrology

Source - Krishi Abhiyan Trantaknik

Source - Shailendra Yashwant

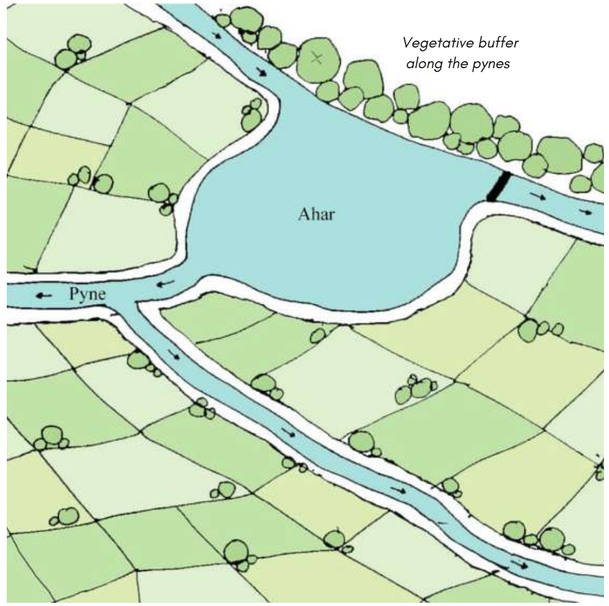
A basic reference of Ahar and Pynes

DESIGN

Ahars resemble a rectangular catchment basin with only three embankments, and the fourth side is left open for the drainage water to enter the catchment basin, following the natural gradient of the country. These are very different from the regular tanks, in that neither their beds are dug out nor do the regular tanks have elevated embankments. Water supply for an Ahar comes either from natural drainage after rainfall (rainfed Ahars) or through Pynes, where necessary diversion works are carried out. Water for irrigation is drawn out by opening outlets made at different heights in the embankment. Ahars also have waste-weir to discharge excess water, which finds further use in the form of a new Pyne. The excess water, if necessary, can be released in a small stream as well. Pynes are artificial channels constructed to utilise river water in agricultural fields. Starting out from the river, Pynes meander through fields to end up in an Ahar. Most Pynes flow within 10 km of a river, and their length is not more than 20 km.

PROCESS

The channels are dug into the soil to allow the water to flow, with raised embankments on the sides. The channel is interspersed with the ponds to collect excess water. The design of the system serves a dual purpose, draining water during floods and retaining water during droughts. While Ahars irrigating more than 400 ha are not rare, the average area irrigated by an Ahar during the early 20th century was said to be 57 ha. Ahar beds were also used to grow rabi (winter) crop after draining out the excess water that remained after kharif (summer) cultivation. Though the boundaries of Ahars and the lengths of Pynes were fixed, the exact amount of water or water rights were not defined. The allocation of water was managed independently by the farmers.



Ecosystem of Ahar and Pynes (Source - Barbhuiya et al., 2022)

OUTCOMES

i) Increased resilience to floods, droughts, erosion through a cost effective - zero waste practice.

ii) Reduced vulnerabilities of local communities to climate change.

iii) Increased food security as it is this system that made paddy cultivation possible in South Bihar.

iv) Flexible landscapes with multi usage.

Source - Forest-PLUS 2.0

Ahars used as crop bed

IN SITU CONSERVATION

Source - Forest-PLUS 2.0

Ahars with buffer vegetation

- *Oryza sativa* (Rice)
- *Casearia tomentosa* (Toothed leaf chilla)
- *Azadirachta indica* (Neem)
- *Ficus benghalensis* (Banyan)

Scan to read more :

3 to 4

families benefit from the water collected in one jheel.

2 to 3 years

is the duration for which the water collected in these systems last, enough to feed humans and livestock.

Image Source : Paaniwali baat

How to implement this in your city ?

- Capacity building of officials towards construction of the system in the true sense.
- Mapping of shallow aquifer depressions within the city, wherein the possibility of this structure can be explored.
- Key to success - Minimal concrete-based enhancement and maximum retention of the traditional concepts of the system's working.

09 Jheels - Virdas of Banni Grasslands

Started: centuries ago
Location: Banni grasslands, Gujarat, India
Landscape Type: Grasslands
Implementation actor(s): Maldharies nomads

Site Area: N/A
Climatic Zone: Arid
Temperature Range: 5-50 °C
Dynamic: Drought prone, inherent salinity, larger flat topography with small depression

PRACTICE OVERVIEW

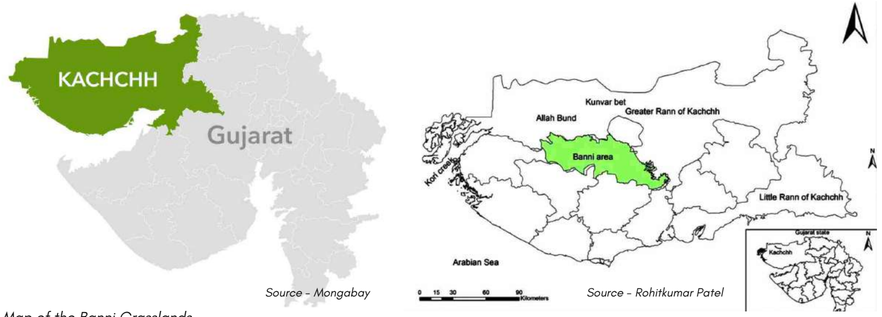
The practice of Jheel and Virdas together form the resilient water system of Banni Landscape in Kutch, India. This traditional system was the indigenous solution towards the challenges faced by the nomadic pastoral communities of the region for access to water of desired quality and desired quantity. They are a magnificent case of engaging with hydro-geology, architecture, and community governance. Their existence today validates their significance, and they are the most efficient and effective water system to fulfill the needs of Banni region.

GLOBAL COUNTERPART IN FOCUS

The Zai pits hold minor resemblance to Jheels-Virdas with a small difference. Here, small basins are constructed in which annual/perennial crops seeds are planted. They increase termite activity leading to higher water infiltration during rains. This intervention is most suitable for flat or gently sloped terrains (0-5%) with a precipitation range of 350-600 mm/y.

BIOGEOGRAPHICAL SIGNIFICANCE

With an expanse of over 3847 sq. km, Banni grasslands is presently a huge mudflat lying near the salt desert Great Rann of Kachchh in the northern part of Kachchh district, Gujarat. Historically, it was among the largest and finest tropical Asian grasslands. This region is a juxtaposition of two ecosystems - wetlands and grasslands. Around 4,000 years ago, this region witnessed high rainfall and 2,500 years later, erratic rainfall along with anthropogenic fires and herbivory together moulded Banni into the vast shrub-savanna grassland we see today. This ecological origin renders the inherent salinity and flooding that is prevailing in this region due to its closeness to the sea as well as the salt desert.



Map of the Banni Grasslands

DESIGN

Virdas are shallow wells at the interface of surface and sub-surface. Jheels, meanwhile, are shallow depressions that are excavated up to depths of 2 - 5 meter, depending on the soil type and salinity levels. This helps in removing the salinity embedded in the top soil and non-permeable clay. The final structure is a small pond with diameter ranging from 10-15 meters. These dimensions ensure more quantum and a longer monsoon runoff retention, leading to enhanced infiltration to shallow aquifers. Jheels are further connected to nearby regions by small channels to divert the maximum possible monsoon runoff. Significant grass cover is essential for free fresh water infiltration. Within each Jheel, 10 to 20 virdas, approximately 1 to 1.5 meter in diameter and 3 to 5 meter in depth, are dug. These are framed from inside in a square form using wooden trunks to support them. The inner side of these trunks are coated with a thick layer of a mix of locally available grasses and local soil, which works as a filter as well as fills the macro pores. The upper portion is plastered with the clay. The distance between two virdas is around 9 to 12 feet.

Inside of a Virda

PROCESS

On the basis of monsoon flow, the Maldharies identify terrain depressions, which are further dug and widened to form Jheels. The rainfall runoff during monsoons get accumulated in the Jheels and over time infiltrate into the shallow aquifers. Post monsoon and during summer months, these Jheels are desilted, and Virdas are dug in the same to tap the shallow aquifers. Once the water gets infiltrated to the shallow aquifers via Jheels, the monsoon's infiltrated water gets stored above the saline one due to difference in the densities. The water from the Virdas is extracted via a rubber container attached by ropes on two sides, locally known as Chades, which is put into the interconnected small channels built inside the Jheel, leading to a small tank for feeding livestocks, locally known as awada.

Jheels and Maldharies extracting water from Virdas with the help of Chades.

Awada - the livestock water - feeding place and Jheel in the background

OUTCOMES

i) Multipurpose and climate adaptable infrastructure.

ii) Eco-friendly filtration system based on nature's principles with resultant high quality of potable water, as per WHO and national standards.

iii) Conservation of contextualised indigenous technology that is sustainable and sentient in the context of a saline environment.

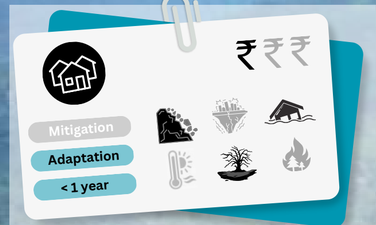
The grassland expanse in Banni region invaded by Prosopsis

IN SITU CONSERVATION

Banni buffalo

- *Bubalus bubalis* (Banni Buffalo)
- *Cattle Bos (primigenius) indicus* (Kankrej cattle)
- Grassess with no local names but are known to grow only inside the walls of the Virdas.
- Grasses of genera *Dichanthium, Cenchrus* and *Lasiurus*

Scan to read more :



6-30

farmers are benefitted from a single community accessed kuhl.

32 ha

area of land can be irrigated by a single kuhl channel.

Image Source : The Statesman

How to implement this in your city ?

- Forming an interdisciplinary committee for accountability, gaining local site knowledge and possible avenues for improvising.
- Capacity building of officials towards construction of the system and how it may be integrated with the hydel projects within city or in the range of influence.

10 Kuhls of Kangra Valley

Started in: the 1800s
Location: Kangra valley, Himachal Pradesh, India
Landscape Type: Mountains and valleys
Implementation actor(s): Local farmers

Site Area: N/A
Climatic Zone: Tropical monsoon
Temperature Range: 0-32 °C
Dynamic: Rain shadow area with sufficient precipitation

PRACTICE OVERVIEW

Kuhls are yet another gravity-flow based ingenious irrigation systems, devised centuries ago to tap distant glaciers for water, that transformed a lunar-like terraineous region of India in the Himalayan region into an agrarian success story. They are a part of a centuries-old heritage with its origin credited to the birth of a caste - Kohlis. Kangra valley in Himachal Pradesh has the most extensive network of these engineering marvels. Approximately 715 major and over 2500 minor Kuhls irrigate more than 30,000 hectares in the valley (Baker 1996).

GLOBAL COUNTERPART IN FOCUS

Peru's Amuna system begins with the collection of water at the top of the San Pedro de Casta mountains. With Lima's water supply under increasing pressure, efforts are being taken to rescue this five-mile-long amuna, excavating it from the accumulated earth and refurbishing it in a pilot project that holds promise for this arid landscape.

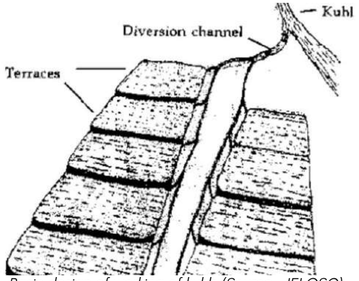
BIOGEOGRAPHICAL SIGNIFICANCE

The system of Kuhls is indigenous to the region of Kangra, Mandi, Hamirpur majorly. Constraints around climate, geography, and the socio-economic landscape have limited the agricultural productivity of the region due to increased reliance on rainfall, which is usually erratic. The region falls in the rain shadow area. The soil is dry and lacks organic matter. Most of the springs have either become seasonal or have been extinct, largely due to ecological imbalances. As a result, farmers face a dual problem—availability of water and access to that water to irrigate their fields.This is what paved way for the origin of Kuhls in the region. Though primarily meant for irrigation, Kuhls also provide hydropower for gharats (water mills) or for turning potters' wheels or water for domestic uses other than drinking.

The biogeography of Kuhls region in Himachal

DESIGN

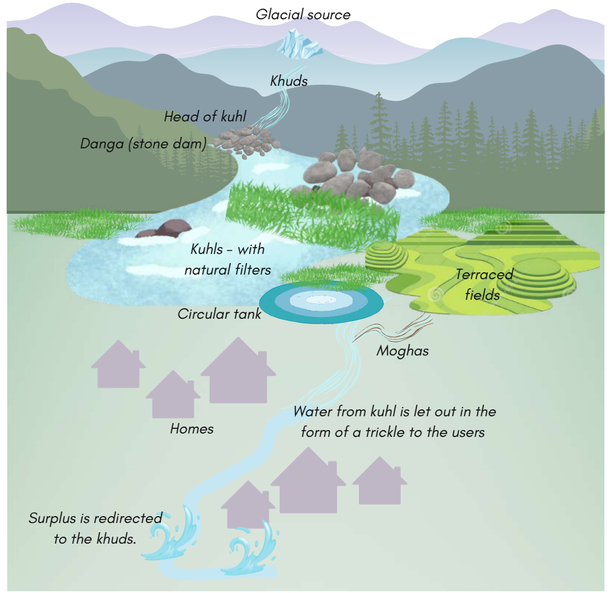
Kuhls bring snowmelt and rainwater to the fields and hamlets in the alluvial plains that slope down from the snow-capped Dhaula Dhar range of the Western Himalayas. All Kuhls differ in terms of size, length, and coverage of area for irrigation. They tend to vary in terms of vastness and slope/gradient of the cultivated area, productivity, and water-holding capacity of the soil of the cultivated area. The crucial portion of a kuhl is its head at the glacier, which is to be tapped. The head must be kept free of debris; hence, it is lined with stones to prevent clogging and seepage. Running water comes directly from the stream, and the bed of the kuhl is filled with small stones and various grasses, which act as natural filters, keeping the water free of debris and excreta of animals grazing on the hills. The kuhl is provided with moghas (kuchcha outlets) to draw out water and irrigate nearby terraced fields. The water flows from field to field and surplus water, if any, drains back to the natural stream (khud).The natural pace of water helps nourish the surroundings, wherein several types of herbs can grow.



Basic design of working of kuhls (Source - IEI GSC)

PROCESS

A danga (large wall of stones) diverts the flow of the natural stream (khuds) to the channel along the natural gravity path to distribute to the landowners downstream. In the village, the Kuhl leads to a circular tank from which the flow of water can be regulated. Water is allocated to farmers in turns, with farmers in higher elevations given first priority. When there is need to irrigate, water is let out of the tank in a trickle. Water from the Kuhl is collected throughout the night and released into the exit channel in the morning. By evening, the tank is practically empty, and the exit is closed. This cycle is repeated daily. Kohlis are the traditional water masters of Himachal, supervising the allocation process for irrigation of fields and settling disputes among the farmers; they are believed to possess miraculous powers as the point men of deities who provide water.



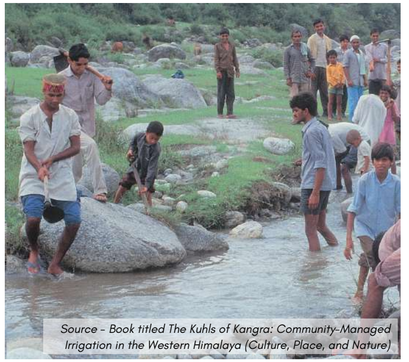
Process of functioning of Kuhls (Source - Author)

OUTCOMES

i) Unified community that works towards conservation and management of the water sources.

ii) A natural ecosystem formation that thrives on the flow of Kuhls.

iii) Absence of gender disparity when it comes to water allocations, even in women-headed households.



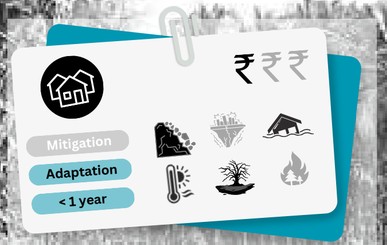
Communal spirit

IN SITU CONSERVATION

Natural vs concrete Kuhls

- *Herbs*
- *Rhododendron campanulatum (Pink Rhododendron)*
- *Indigenous river bed vegetation*

Scan to read more :



12,000 +

tribal members joined hands in the spirit of community service, called 'Halma' to solve their integrated issues, water management and conservation being one of them.

Image Source : Jetir

How to implement this in your city ?

- Forming an interdisciplinary committee for accountability, gaining local site knowledge, and possible avenues for improvising.
- Understanding the local dam technology in the region and exploring the possibility of mainstreaming that in the city.

11 Pat System of Bhitada

Started in: 1956
Location: Bhitada, Madhya Pradesh, India
Landscape Type: Hilly terrain
Implementation actor(s): Bhill tribals

Site Area: N/A
Climatic Zone: Hot and general dryness
Temperature Range: 22-35 °C
Dynamic: Hills with water scarcity

PRACTICE OVERVIEW

The Pat system is a rudimentary water channelisation practice developed by the native Bhill tribal communities of the village of Bhitada. This seeming defiance of the law of gravity is a system that takes advantage of the peculiarities of the terrain to divert water from swiftly flowing hilly streams into irrigation channels called pats. This is a practical and ecologically sound method of water management developed in response to the state's destructive practices, which have ravaged the region's environment since the British colonial rule.

GLOBAL COUNTERPART IN FOCUS

The ancient Moorish invention of acequias has been providing water to the Sierra Nevada mountains for more than 1,000 years, making life possible in one of Europe's driest regions. The system, working on the principles of ecohydrology, recharges the aquifers as well.

BIOGEOGRAPHICAL SIGNIFICANCE

Bhitada is a small agro-village in Jhabua district in western Madhya Pradesh, India, at the confluence of stream Kari and river Narmada. With an area of 3,782 sq. km, the area has hilly and undulating terrain; majorly a degraded waste lands matrix. The biggest concern here is the lack of water. Jhabua hills have been denuded of trees since the British era and after, which killed the water-retention capacity of the landscape. The combination of being drought-prone, inferior lands with steep slopes, and deforestation severely impacted the livelihood of tribals while also causing severe water scarcity.

The terrain of Jhabua

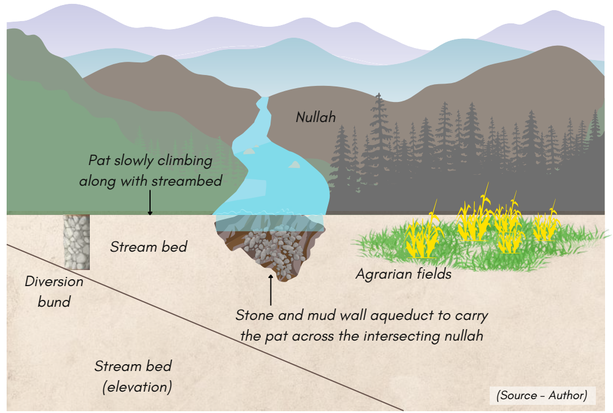
DESIGN

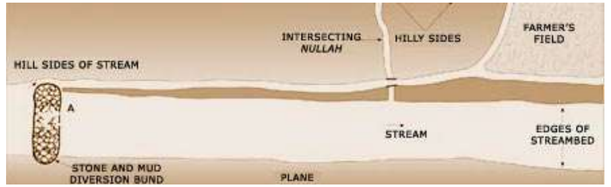
The entire system was devised in a crude fashion according to the peculiarities of the terrain to divert water from swift-flowing hill streams into irrigation channels called pats. The minimum documented length of a pat is 4 km. The diversion bunds across the stream are made by piling up stones and then lining them with teak leaves and mud to make them leakproof. The pat channel has to negotiate small nullahs that join the stream on and off and also sheer cliffs, before reaching the fields. Stone aqueducts have to be built to span the intervening nullahs.

All the components built as part of the system infrastructure are based on years of indigenous experiences and an accidental discovery under local demand. There are no fixed dimensions for the pat, and the design is custom-made according to each family's intelligence and demand.

PROCESS

The tribals of Jhabua efficiently divert water from hill streams into irrigation channels called pats, using the peculiar characteristics of the terrain. Water is then passed through deep ditches and stone aqueducts to form an irrigation system that can be used by the local communities. The villagers irrigate their fields by turns. The channel requires constant maintenance as some parts of the channel get destroyed during floods, and it is the duty of the family irrigating the fields on that particular day to take care of the pat. It takes about two weeks to get the pat flowing and the winter crop is sown in early November.





Plan and sectional view of pat system (Source - Making water everybody's business)

OUTCOMES

i) Eco-friendly water harvesting infrastructure.

ii) Regulated passage of aquatic fauna due to the eco-friendly nature of dams.

iii) Conservation of traditional indigenous technology that is sustainable and sentient.

IN SITU CONSERVATION

- *Tectona grandis* (Teak)

Scan to read more

Mitigation
Adaptation
< 1 year

₹100-150

per 0.72 m dug is not merely the initial cost of digging a surangam but also the only expenditure needed due to low maintenance.

2-3

houses are catered for with the construction of one surangam.

Image Source :V Govindankutty

How to implement this in your city ?

- A proper hydrogeological assessment of the region and proposed site (length, slope and branching, etc.) should be done prior to construction.
- Forming an interdisciplinary committee for accountability, gaining local site knowledge, and possible avenues for improvising.
- Capacity building of officials towards construction of the system.

12 Surangams of Western Ghats

Started in: around 1977 - 1997
Location: Karnataka and Kerala, India
Landscape Type: Rugged mountain with laterite soil
Implementation actor(s): Farmers

Site Area: N/A
Climatic Zone: Tropical monsoon and humid
Temperature Range: 3-25 °C
Dynamic: Seasonal flooding and water scarcity in dry months

PRACTICE OVERVIEW

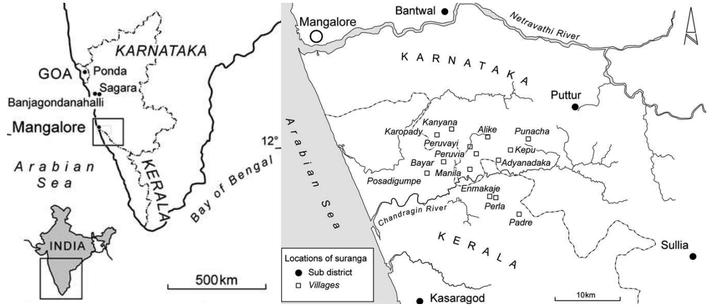
Surangas or Thurangams are an indigenous hydraulic engineering marvel to tap into the groundwater resources in an otherwise difficult topographical environment of Western Ghats. These groundwater harvesting tunnels are excavated by a single man, sometimes over his lifetime, so as to ensure continuous water supply for the following generations as well. The system is designed in such a way that it is always low on carbon emissions throughout its lifetime.

GLOBAL COUNTERPART IN FOCUS

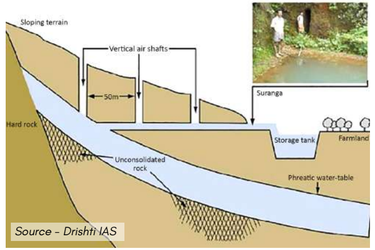
The Aflaj irrigation system in Oman is a similar practice, which is getting restored by the Ministry of Agriculture, Fisheries and Water Resources (MAFWR) in South Batinah. The directorate continues to maintain these systems and has also drawn up an action plan to study and ensure water availability in these sites, in line with Oman Vision 2040.

BIOGEOGRAPHICAL SIGNIFICANCE

Despite being one of the wettest areas in India and one of the world's richest biodiversity hotspots with forested mountains, steep terrains, and lush vegetation, the Southern Western Ghats region still faced water scarcity. The sloping laterite terrains and high rainfall with minimal to zero access to surface water due to the seasonal character of the surface water systems are a few factors that made way for the origin of Surangams in India. The local geographical conditions ensured an increased dependence on ground water directly by tunnels. This technological innovation holds some resemblance to the Qanats of Afghanistan with some theories crediting the origin of Surangams to the latter.



The Western Ghats region where the surangams are predominantly found (Source - Darren Crook)



Basic design of Surangams

DESIGN

There are generally two types of Surangams- rectangular and dome shaped. The Surangams are the size of the person who built it, usually around 2.5 feet wide and 5.5 feet high. The entrance to a Surangam and the entire construction is buried below a thick layer of carbon sequestering vegetation, indigenous to the South Western Ghats. The entrance is intentionally kept small to avoid large animals, crabs, bats, and humans (freedom fighters) from habiting them. A surangam is about 0.45-0.70 metres (m) wide and about 1.8-2.0 m high. The length varies from 3-300 m. Usually several subsidiary surangams are excavated inside the main one. If the surangam is very long, a number of vertical air shafts are provided to maintain the atmospheric pressure inside. The distance between successive air shafts varies between 50-60 m. The approximate dimensions of the air shafts are 2 m by 2 m, and the depth varies from place to place. Surangams are dug in places where the hydrogeological profile consists of lateritic and weathered rocks. Labourers with sound knowledge of the slope, formation of water, catchment, and local details can locate potential areas.

PROCESS

The source of water is narrowed down by the local labourers on the basis of parameters like terrain slope, soil structure, catchment areas and local flora and fauna. Tunnels are dug through the laterite hillock through which water seeps out and into the tunnel. Groundwater flows through these tunnels under gravity and is collected in ponds near the houses or connected to local irrigation networks. This water is used for agriculture, drinking, and other domestic purposes. Wastage of water due to the continuously flowing nature of groundwater is avoided by draining the surplus water to overflow ponds at strategic junctions and sometimes redirected to the houses to irrigate the backyard horticulture home gardens, subsequently leading to groundwater recharge.

The restorative nature of Surangams

OUTCOMES

i) Reduced carbon emissions due to overhead carbon sequestering vegetation.

ii) Efficient cost effective exploitation of groundwater.

iii) Aquifer recharge and replenishment.

Native vegetation above the surangam entrance - source of carbon sequestration

IN SITU CONSERVATION

Asian palm civet

- *Paradoxurus hermaphroditis* (Asian Palm Civet)
- *Varanus bengalensis* (Bengal Monitor Lizard)
- *Cycas circinalis* (Queen Sago)
- *Hystrix indica* (Indian crested porcupine)

Scan to read more

13 Bamboo Drip System of Meghalaya

97%

population depend on this system to cultivate paddy, betel leaf, and black pepper in seasonal rotations.

15 days

to build a system covering one hectare of land by two workers.

Image Source : Photographer Duvo Ruho

How to implement this in your city ?

- Pilot testing the practice within formal campuses such as schools and offices across the city.
- Formalising the practice at a master plan level for irrigation within eco-sensitive zones of the city.
- Preparing a database of the open spaces within the city that can be irrigated using this practice. This may be explored for treated waste water from STP as well.

Started: 2 centuries ago
Location: East Meghalaya, India
Landscape Type: Rocky terrain
Implementation actor(s): Tribal farmers of Khasi, Jaintia and Garo

Site Area: N/A
Climatic Zone: Temperate - tropical
Temperature Range: 19-29 °C
Dynamic: Low water retention and ground channeling capacity, steep terrain slopes

PRACTICE OVERVIEW

The traditional and indigenous practice of bamboo drip system involves an innovative utilisation of the water resources present across the hilly terrains for watering the low lying seasonal crops. This timeless and traditional technology uses locally available material while harnessing the forces of gravity. The hill tribes have, since long, trusted the use of this system as a means to fulfilling domestic, agricultural, and customary needs. Its function continues to prevail as long as it continues to rain and the bamboo continues to grow.

GLOBAL COUNTERPART IN FOCUS

As part of Greenhouse Aqueduct Project at UC Berkeley USA, an aqueduct system was made using on-site grown bamboo (*Phyllostachys bambusoides*). Water is collected from the rooftop and is stored in a 200 gallon cistern. Water from the cistern flows through bamboo channels and irrigates the plants in the green house.

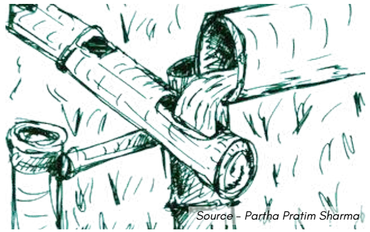
BIOGEOGRAPHICAL SIGNIFICANCE

Bamboo is regarded as the bloodline of Northeast India with the hills of Meghalaya being home to an estimated 3,108 sq. kilometers of bamboo forests with 38 different bamboo species. The Jaintia, Khasi, and Garo hills of Meghalaya are largely made up of steep slopes and generally rocky terrain, where the soil has low water retention capacity and the use of groundwater channels is impossible. During dry seasons and winters, this system gains prominence as perrenial springs and streams are capable of catering to the drinking needs. This traditional practice is localised depending on variables such as replenishable bamboo supplies, upland water sources, and presence of traditional terrace agriculture.

Bamboo forests of Meghalaya

DESIGN

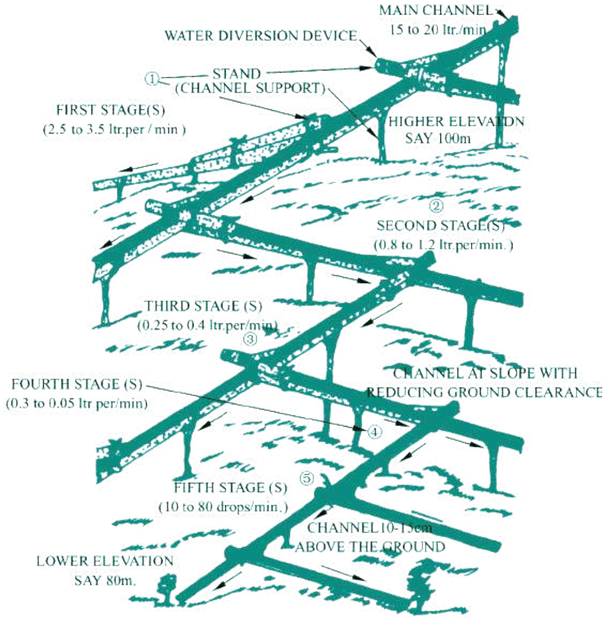
The farmers identify an available water source and an adjacent sloped area of land with at least 30 meters in variation of height between former and latter. Bamboo shoots and forked branches are sliced, and the wider shoots are placed in the first channel and the smaller pipes in the last section (at least 5 stages). A series of holes are punctured in the shoots and spaced equidistantly. Care is taken to ensure that ground clearance progressively descends so that the water may be dropped near the plant roots in the last section (10-15 cm above ground). To reinforce the structure, pipes and forked branches are tied together using fiber-rich twine as rope. At points of diversion, smaller bamboo shoots may be used to redirect water. The advantages of using bamboo are two-fold: it prevents leakage, increasing crop yield with less water, and makes use of natural, local, and inexpensive material. The natural hollow makes bamboo a conduit for water. Depending on the slope and the direction in which the water needs to travel to reach the field, different sizes of bamboo are used.



Node junction of bamboo irrigation

PROCESS

An assortment of holed bamboo shoots zig-zag downhill, diverting the natural flow of streams and springs across terraced cropland. About four or five stages of irrigation bamboo shoots zig-zag from the water source to the last point of application. Along the way, 18-20 liters of water will eventually disseminate at a rate of 20-80 drops per minute. Materials used during installation last around three years, while maintenance is limited to cleaning and reinforcement after seasonal monsoons. Cost is also limited to labour, which can be carried out by farmers themselves. The few materials needed are a small dao (a type of local axe), bamboo strands of various sizes, forked branches, smaller bamboo shoots used for the channel diversions, and two willing labourers.



Bamboo irrigation network process (Source - Permaculture Research Institute)

OUTCOMES

i) Reduced hard infrastructure through use of a viable eco-friendly material such as bamboo.

ii) Controlled and sensitive exploitation of natural water sources with minimal to zero wastage.

iii) Conservation of traditional indigenous technology that is sustainable and sentient.

Bamboo connection detail

IN SITU CONSERVATION

Black pepper

- *Bambusa* (38 types of bamboo sp.)
- *Oryza sativa* (Paddy)
- *Piper betle* (Betel leaf)
- *Piper nigrum* (Black pepper)

Scan to read more

URBAN ECOLOGY

The traditional way of living is proof of the respect our ancestors had for local biodiversity, which became key to long and healthy living. Today, it is a different story, for urbanisation has triggered a domino effect that has toppled the entire health pyramid of the natural ecosystem. This section focuses on practices that city departments can learn from, when it comes to achieving ecological equilibrium in urban environments.

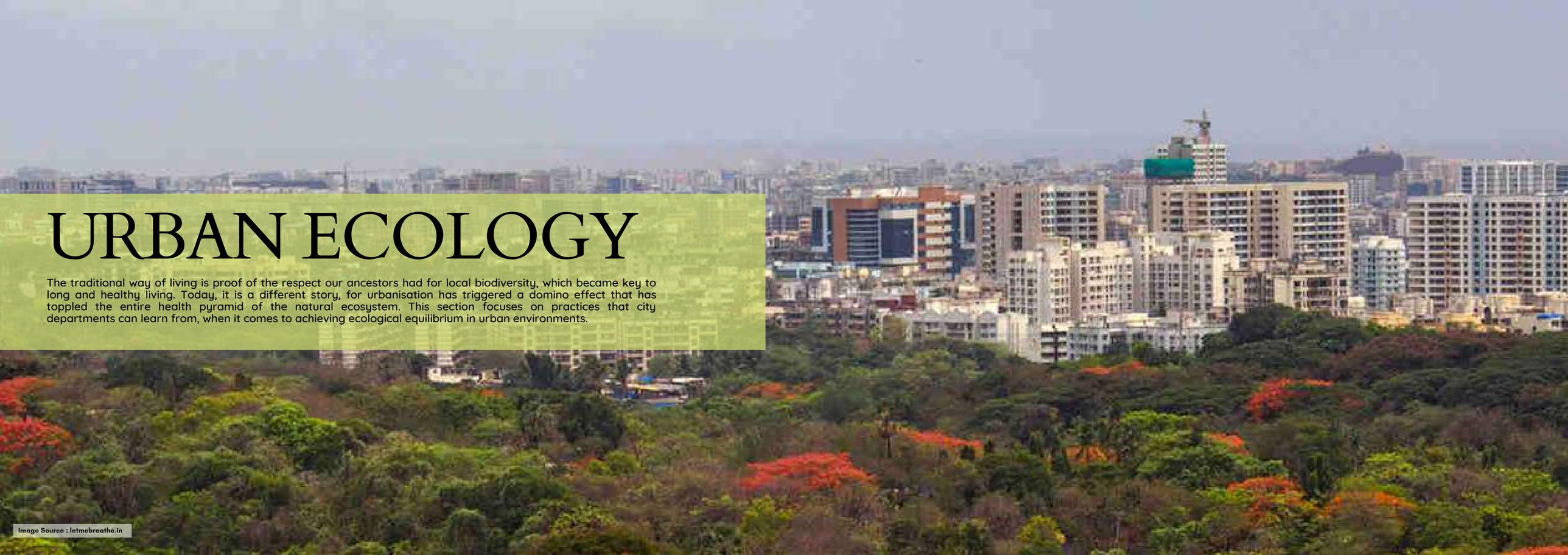


Image Source : letmebreathe.in

14 Soliga Adivasis and Taragu Benki

Mitigation
Adaptation
< 1 year

80%

of vegetation quality of forests within the Biligiri Rangaswamy Temple Tiger Reserve has declined with absence of native grasses and lantana invasion due to restrictions by the forest department on Taragu Benki.

350%

rise in forest fires across Karnataka were majorly due to restrictions by the forest department on Taragu Benki.

Image Source : Scroll.in

How to implement this in your city ?

- By preparing a baseline along with the city forest department office of the various forest types within the city - urban miyawaki sites, reserve forests, etc.
- Capacity building of both officials and local community towards sensitisation and relevance of the practice.
- Narrowing down pilot demonstration sites (preferably at city periphery) for exploring and improvising the practice.

Started in: 1960
Location: Karnataka, India
Landscape Type: Dry deciduous forests
Implementation actor(s): Soliga tribe

Site Area: N/A
Climatic Zone: Temperate - tropical
Temperature Range: 19-29 °C
Dynamic: Forested areas, savannas, or mixed tree-grass systems

PRACTICE OVERVIEW

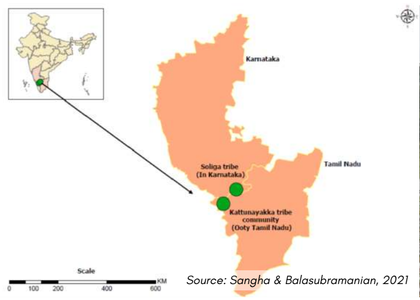
Fire is one of the five elements of nature that has not only been revered for its warmth and light but also for its cleansing properties and its innate ability to shape the character of the environment it is present in. The traditional practice of Taragu Benki by the Soliga tribe of Karnataka is a perfect example of that. This controversial practice involved the usage of fire in a controlled manner as a part of cleansing the forest lower storey to be rid of debris while also preventing natural fire hazards during the dry season.

GLOBAL COUNTERPART IN FOCUS

Australia is infamous for recurrent wildbush fires. One such practice conservation initiatives includes Firesticks Alliance Indigenous Corporation, that is centred around indigenous fire-stick burning. This alliance was established to document, share traditional understandings in addition to providing on ground training and planning of the cultural practice.

BIOGEOGRAPHICAL SIGNIFICANCE

Forest fires are not a new phenomenon in most Indian forests. Savannas (mixed tree-grass systems) constitute a major portion of the forests in Bandipur-Mudumalai, Bandipur Tiger Reserve, etc. Here, grass-fueled fires have been a regular feature in the dry season for a very long time. Taragu Benki holds cultural and ecological significance as it helps maintain the health and biodiversity of the forest ecosystem, critical to the survival of many endemic species. The practice originated as a means of safety, food production, and landscape management. The controlled burning not only clears the forest floor of debris and promotes the growth of new vegetation but also inadvertently favours the quality of the forests.



Source: Sangha & Balasubramanian, 2021

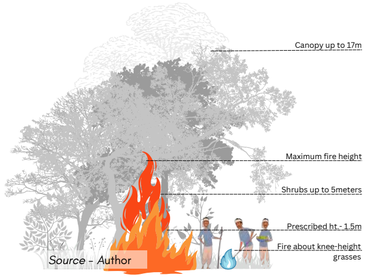
Source - Vivek Muthuramalingam

Location of Soliga tribe and the region where Taragu Benki is practiced

DESIGN

Forest fires may be broadly classified into landscape fires and wildfires. Landscape fires are seasonal with moderate intensity (with few instances of high intensity), easily controllable and having a low environmental impact (primarily positive impact). Wildfires are defined as extreme events of high intensity that are not only difficult to control but also have severe social, economic, and environmental impacts. On the basis of height and extent, forest fires can be of three types - surface fires, ground fires, and crown fires. Surface fires burn only surface plant litter. Ground fires, also called underground or subsurface fires, burn within humus, peat, and vegetation piles that are dry enough to burn. Crown fires are the most intense and dangerous forest fires as they burn whole trees and can spread rapidly across tree tops due to winds.

The design of Taragu Benki results from the Soliga Adivasis' long-term observations and understanding of the forest ecosystem. These fires fall under the ground-level fires category - that go up to 2 -3 feet in height. They are lit mostly in the months of January and February. Additionally, the resultant ash acts as a natural soil fertilizer.

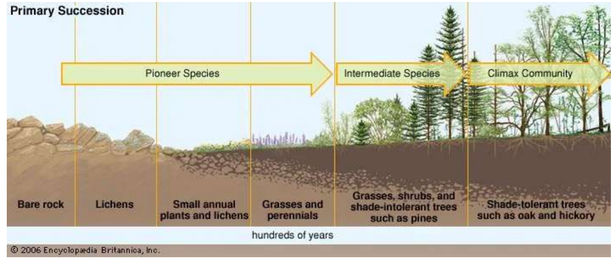


Source - Author

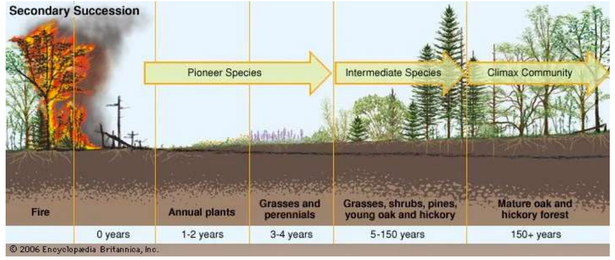
Cool and hot fire height (Modified from creative spirits)

PROCESS

The process typically begins by selecting a suitable area for burning. This is done by taking into consideration various factors such as wind direction, soil type, and the types of vegetation present. The area to be burned is typically chosen during the dry season, after the monsoon season, when the forest floor is moist and covered with dry leaves, twigs, and other debris. Once the area has been selected, the Soliga Adivasis create a firebreak around the perimeter of the area to prevent the fire from spreading beyond the designated area. This is typically done by clearing a strip of land around the perimeter of the area. After the firebreak has been created, the Soliga Adivasis start the controlled burning by using a torch made of dry leaves or grass. They carefully control the intensity and duration of the fire by using tools such as sticks and branches to create small flames that burn quickly and do not damage the larger trees.



Primary succession begins in barren areas with the pioneer species with each successive stage modifying the habitat by altering the amount of shade and soil composition resulting in a stable vegetative environment.



Post Taragu Benki, secondary succession is initiated which modifies the disturbed landscape to result in a modified species composition that can thrive in the disturbed landscape.

OUTCOMES

i) Natural and eco-sensitive method of invasive species regulation such as lantana plant, known for its pyrogenic abilities and therefore enhanced destructive nature of the fires.

ii) Contribution to local livelihoods.

iii) Improved soil health, increased biodiversity, and regulation of wildfires.

Source - India's Endangered

Presence of invasive species in the absence of forest fire

IN SITU CONSERVATION

Source - Madhusudan S.R.

Life post forest fire

- *Shorea robusta* (Sal)
- *Tectona grandis* (Teak)
- *Bambusa* (Bamboo)
- *Madhuca longifolia* (Mahua)
- *Ficus benghalensis* (Banyan)

Scan to read more

15 Piscicidal Plant Fishing in Nagaland

Mitigation
Adaptation
< 1 year

300

plant species with piscicidal properties have been reported from India.

100

of these 300 plants are reported from the northeastern region.

Image Source : The Lungleng Show

How to implement this in your city ?

- Establishing a nursery with native piscicidal plant species on the basis of intensive and continuous research with experts and local communities.
- Carrying out a baseline of fishing communities and wayward lone fishers and exploring a possibility of substituting their techniques with this practice.
- Using tourist sites with recreational fishing to build local capacities via integration of this practice.

Started: 2 centuries ago
Location: Nagaland, India
Landscape Type: Rivers
Implementation actor(s): Agami tribe, Lotha tribe, and Sumi tribe in Nagaland

Site Area: N/A
Climatic Zone: Humid subtropical climate
Temperature Range: 21-40 °C
Dynamic: Riverine ecosystem with prevalence of fishes

PRACTICE OVERVIEW

Fish harvesting using piscicidal plant species a.k.a fish poisons has been a common practice by tribals across Nagaland. The practice banks on nature's way of curbing and regulating the species population in the food chain/web through usage of floral species. These floral species play the role of predators in this practice by assisting the known apex predator in the planet - humans. These are not only biodegradable but unlike synthetic pesticides used in aquaculture, they do not linger around in the food chain and cause harm as a result of the same.

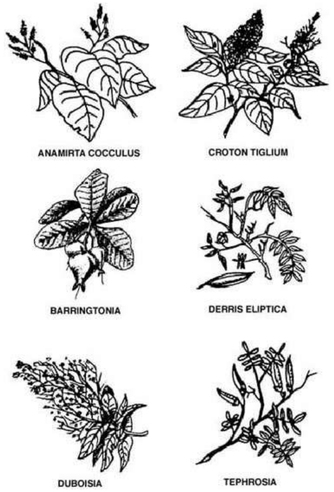
GLOBAL COUNTERPART IN FOCUS

As per a research finding, the use of piscicidal plants in Southwestern Nigeria is on the increase. This is perhaps a visible encouragement of the fact that people have started to disengage from the use of outlawed synthetic agrochemicals in the aquatic environment for purpose of aquaculture in the wild, as advocated by W.H.O.

BIOGEOGRAPHICAL SIGNIFICANCE

Nagaland is known for its rich biodiversity, with a rich water nexus harbouring a diverse range of fish species. Majority of the rural tribal population still depend on traditional shifting cultivation, hunting, and fishing for their sustenance. Efficient fish culture is possible only when a conducive environment is achieved for the targeted species. Weeding of unwanted fishes, therefore, becomes essential for a healthy aquaculture environment. Subsequently, less toxic native plant derivatives were used as fish poisons. It allows communities to fish within their local ecosystems with minimal negative impact on the fishes and the aquatic environment.

Natural biogeography of Nagaland



Known global fish poison families (Source - Chuck Kritzon)

DESIGN

The species are chosen based on their ability to release natural substances that immobilize or kill fish when introduced into the water. The plant parts, such as leaves, bark, or roots, are gathered and processed via grinding, crushing, or soaking the plant material in water to extract the piscicidal compounds. Post preparation, it is introduced into the water by pouring the extract directly into the water or creating barriers / enclosures to contain the fish within the treated area. The practice exploits the principle of inhibition of oxidative phosphorylation - a biochemical reaction in the mitochondria of animal cells leading to deoxyfication and subsequently forcing the fish to surface up or settle at the bottom of the waterbody. The piscicide impact among fish species vs the poison quantity used during a particular occasion is variable as it depends on a number of factors including participant count and dimensions of the water body in which it is used.

PROCESS

The practice is conducted with varying levels of social complexity: from tribe activities to large tribe 'fishing festivals'. The logistics and knowledge exchange is done well in advance. The process unfolds once the piscicide is released into the water. The ideal time for the practice is when the water level is low before the onset of monsoons. The captured fish are then collected using traditional fishing tools like nets, baskets, or by hand. Once gathered, the fish are processed, which typically involves cleaning, gutting, and may include drying or cooking, depending on the local community's preferences. Only men are allowed to participate in the activity at the start of the operation. Women usually tend to participate during the harvesting of the fish. The design and process of piscicidal plant fishing in Nagaland reflects the region's cultural heritage, traditional ecological knowledge, and sustainable approach to utilising natural resources.

Extraction of piscicidal plants and preliminary pounding of the plant parts - mostly roots

Wood platforms construction across the river for tpounding of fishes

Mass pounding of roots with short poles

Construction of stone platform for pounding and threshing of roots

Traditional bamboo fish barrier construction

Final produce collected and distributed

OUTCOMES

i) Sustainable fishing environment.

ii) Natural pest management technique with minimal to no environmental impacts.

iii) Gender inclusive with both men and women complementing each other.

vi) By selectively targeting fish species, the balance and diversity of aquatic fauna is maintained.

Minimal environmental impact upon release of piscicide

IN SITU CONSERVATION

Derris elliptica

- *Derris spp.* (Derris)
- *Antiaris toxicaria* (Antiaris)
- *Lonchocarpus spp.* (Barbasco)
- *Cyprinus carpio* (Common Carp)
- *Millettia pachycarpa Benth* (Milletia)

Scan to read more

Mitigation
Adaptation
< 1 year

8%

of the total habitable land surface on the planet are owned by faith-based institutions making them the world's third largest category of financial investors.

225

species of resident and migratory birds annually take shelter in Puri Jagannath Temple and Chilika Lake.

Image Source : Scroll.in

How to implement this in your city ?

- By preparing a baseline of the religious instituitions in the city and the kind of species that may be conserved within the insituition premises.
- Capacity building of the general public and the officials towards the importance of species being conserved in the city.
- Including a category of 'in situ conservation sites' as a land use zonation in the city masterplan.

16 Faith-Based In Situ Conservation

Started in: Immemorial
Location: India
Landscape Type: Diverse settings
Implementation actor(s): Local communities

Site Area: N/A
Climatic Zone: N/A
Temperature Range: N/A
Dynamic: Varied environments depending on the species to be conserved

PRACTICE OVERVIEW

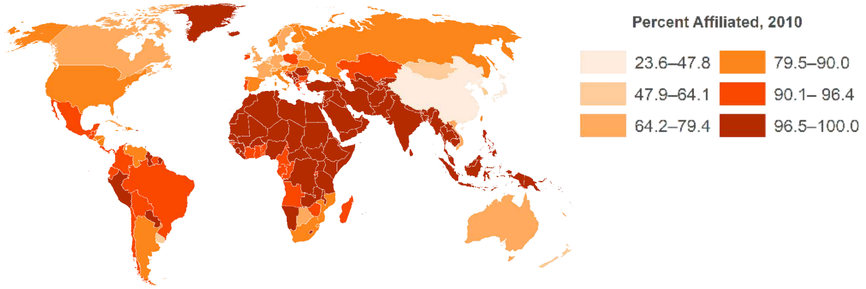
India has a rich tradition of faith-based conservation practices that aim to protect both animal and plant species. Rooted in cultural and religious beliefs, these practices have a profound impact on biodiversity conservation in the region. Communities protect endangered animal species like fish, turtles, tortoises, deer, blackbucks, peafowl, and birds. These traditions demonstrate a deep connection with nature and aim to preserve biodiversity through sustainable practices and reverence for wildlife.

GLOBAL COUNTERPART IN FOCUS

Inspired by the spiritual teachings highlighting the intrinsic value of nature, Rwanda's Anglican movement is part of a growing number of faith-based organizations helping to restore global forests. An estimated hundreds of millions of trees in the last 20 years have been planted and conserved according to UNEP and partners.

BIOGEOGRAPHICAL SIGNIFICANCE

Many of the most important conservation places in the world are sacred. The biogeographical significance of faith-based conservation practices in India lies in their contribution to the preservation and protection of the region's unique biodiversity. These practices serve as localized conservation efforts that help safeguard endangered animal and plant species within specific habitats. By revering and protecting these species based on cultural and religious beliefs, communities contribute to maintaining the ecological balance and integrity of their local ecosystems. These practices showcase the co-existence of humans and nature, highlighting the cultural and spiritual value placed on biodiversity conservation, and fostering a sense of stewardship towards the region's natural heritage.



As of 2010, India falls under the higher bandwidth with almost the entire nation following a religious affiliation which further highlights the impact faith-based conservation can have on the preservation of nature (Source - Columbia Climate School)

Temple ponds - an element of conservation

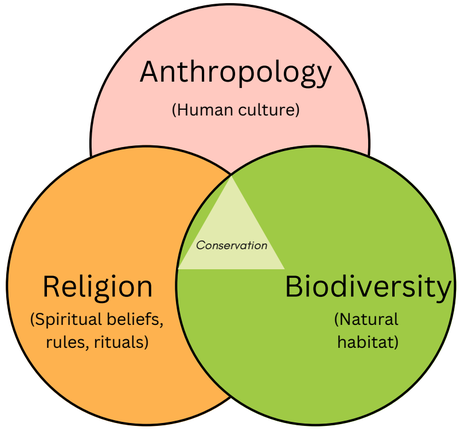
DESIGN

The idea behind faith-based conservation practices involves integrating cultural and religious beliefs with environmental stewardship. It revolves around the recognition of the sacredness and spiritual significance of nature and its inhabitants. Communities actively protect and conserve endangered species and their habitats based on these beliefs. The design includes rituals, taboos, and customary laws that prohibit hunting, fishing, or harming these species. Decision-making processes involve community participation and the involvement of local religious or temple committees.

The spatial element of faith based conservation is flexible according to the region as the only governing factor for conservation is faith. This makes the practice highly compatible for the urban domain. Right from a tree along the streetscape to a temple pond - any element can be taken up for in situ faith-based conservation.

PROCESS

Faith-based conservation practices involve a process that includes several key steps. It starts with the recognition of the spiritual and cultural significance of certain species or habitats based on religious beliefs. Community engagement plays a crucial role, with community members actively participating in conservation efforts, such as patrolling and monitoring. Decision-making is a collective process involving local religious committees to ensure alignment with cultural practices. Sustainable resource management practices are emphasized, ensuring the long-term viability of the species and habitats. The conservation practice continues to adapt over time while preserving core cultural and religious values, creating a harmonious relationship between humans and nature.



The triad of faith-based conservation

Source - Author

OUTCOMES

i) Protection and preservation of the biodiversity hotspots.

iii) Promotion of sustainable resource management.

iv) Fostering of community engagement and empowerment.

v) Preservation of cultural and religious values.

Faith-based conservation and women

IN SITU CONSERVATION

Great Indian Bustard

- *Olive Ridley Turtles* (Lepidochelys olivacea)
- *Asian Elephants* (Elephas maximus)
- *Bengal Tigers* (Panthera tigris)
- *Irrawaddy Dolphins* (Orcaella brevirostris)

Scan to read more

₹₹₹

Mitigation

Adaptation

< 1 year

13,000 +

sacred groves have been documented at present in India.

Himachal Pradesh

is the state with the maximum amount of sacred groves in India.

Image Source : Getty Images

How to implement this in your city ?

- By engaging with local communities, environmental organisations, and urban planners to garner support for the project.
- Through emphasising the conservation of native plant species and promoting biodiversity within the sacred grove.
- Establishing a maintenance plan to ensure the long-term survival of the sacred grove.

17 Sacred Groves as Ecological Refugia

Started in: Immemorial
Location: India
Landscape Type: Forest
Implementation actor(s): Local communities of the region

Site Area: N/A
Climatic Zone: N/A
Temperature Range: N/A
Dynamic: Majorly forest-based

PRACTICE OVERVIEW

Sacred groves in India are critical sanctuaries of religious and cultural significance. These protected forests serve as vital biodiversity hotspots, preserving endangered species and maintaining ecological balance. Customary laws prohibit exploitation, highlighting the urgent need for their conservation. These groves symbolize the intricate connection between humans and nature, showcasing the importance of cultural and ecological preservation.

GLOBAL COUNTERPART IN FOCUS

In recent times, increased mining activities in Nigeria's South West have polluted the Osun River at the Osun-Osogbo Sacred Grove - a national monument and UNESCO World Heritage site. To preserve its cultural heritage, Google Arts & Culture has partnered with The Adunni Olorisha Trust and CyArk to launch the first and largest digital library of content, showcasing the Osun Osogbo Sacred Grove.

BIOGEOGRAPHICAL SIGNIFICANCE

Sacred groves are present in almost all states of India. The native tribals of the area believe that nature is sacred and needs to be worshipped. Sacred groves are patches of wilderness conserved owing to their perceived importance attached to a village deity. These are miniature evergreen forests within areas of human settlements, nurtured by tradition and sustained by beliefs. They often act as gene pools for traditional crop varieties and medicinal plants, safeguarding valuable genetic resources for future generations. Some of the groves are in fact the last remaining fragments of unique ecosystems in the world, which have vanished in other parts of the nation and world due to urbanisation.

Source - Dinesh Kumar Vishwakarma

Source - Wikimedia cc

Sacred groves in India

DESIGN

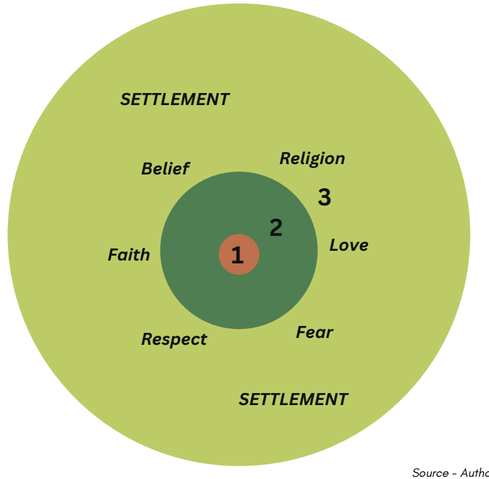
The design of sacred groves as an indigenous practice is shaped by the cultural and spiritual beliefs of local communities. Sacred groves are designated areas within the natural landscape that are revered and protected due to their perceived sacred or divine nature. The design of these groves involves a combination of physical, ecological, and spiritual elements. Specific tree species are often selected based on their symbolic or medicinal value, contributing to the biodiversity and ecological richness of the groves. Sacred structures or altars are sometimes present, serving as focal points for rituals, ceremonies, or offerings. These design elements are carefully established and maintained to preserve the cultural, spiritual, and ecological significance of the groves. Sometimes, the village can have more than one grove or a village may not have a sacred grove, in which case, a few villages share a grove. Many sacred groves have old, giant trees, with girth ranging from less than one meter to two meters and above. The sacred groves can be easily identified in the rural landscape as an island of forests.

Source - Indian Express

Schematic representation of sacred groves

PROCESS

The process of establishing and managing sacred groves as indigenous forests involves several interconnected steps. First, specific areas of cultural importance are identified and designated as sacred groves, recognized for their spiritual and ecological significance. Next, customary laws, rituals, and taboos are established to safeguard these sacred sites from exploitation and ensure their long-term protection. The local community actively engages in conservation efforts, which include activities like tree planting, selective harvesting, and nurturing biodiversity. Traditional knowledge and practices, passed down through generations, play a crucial role in guiding sustainable forest management. This holistic approach integrates spirituality, culture, and ecology, fostering a deep connection between humans and nature while safeguarding the forest ecosystem for the benefit of present and future generations.



Source - Author

Zone 1 - Heart of sacred groves where the deity may be found
Zone 2 - Sacred buffer of sacred grove for conserving Zone 1
Zone 3 - Surrounding settlements that conserve Zone 1 and 2 based on the above emotions

OUTCOMES

i) Intangible benefits in the form of a plethora of ecosystem services at the city's disposal.

ii) A natural repository of the keystone and native species of the region and nation.

iii) Conservation of local indigenous communities and their heritage.

iv) Unified communities.

Source - Mongabay

IN SITU CONSERVATION

Source - Getty images

Temple with animal figurines on the premises of a sacred grove

- *Ficus benghalensis* (Banyan tree)
- *Madhuca longifolia* (Mahua)
- *Emblica officinalis* (Indian gooseberry)

Scan to read more

₹1.12 lakhs

can be earned through this practice on a single acre of land.

12

different types of crops can be grown on a single plot of land.

Image Source : Mongobay

How to implement this in your city ?

- Collaboration with the local farming communities and stakeholders to incorporate this practice within their lands.
- Pilot testing the practice across campuses, gated residential communities, agricultural institutes, riverside farmlands, etc.
- Preparing a database of the urban open spaces such as wastelands for exploring the efficiency and increase innovation of the practice.

18 Akkadi Saalu of Karnataka

Started: 2 centuries ago
Location: Karnataka, India
Landscape Type: Agricultural land
Implementation actor(s): Indigenous communities, local villagers

Site Area: N/A
Climatic Zone: Agro climatic zone
Temperature Range: 20-32 °C
Dynamic: Rainfed agricultural land

PRACTICE OVERVIEW

Akkadi Saalu is an indigenous intercropping system of Karnataka that encourages biodiversity conservation in the process of securing a wholesome yield from the farmlands. Known by various names across India, it is a type of rainfed agriculture with a strong emphasis on gender equality, women leadership, and integration of ancestral wisdom. Akkadi Saalu is all about promoting biological diversity, soil health through natural means, and most importantly, viewing each and every species through the lens of equity and equality rather than considering them as menace.

GLOBAL COUNTERPART IN FOCUS

Farmers in different parts of the Nepal such as Kavre district, adjacent to the capital Kathmandu, have now decided to return to traditional agroforestry practices for these multi-fold benefits they offer.

One such program run by World Neighbors, an NGO based in the US, not only ticks almost all the boxes on the list of benefits offered by agroforestry, but also empowers women.

BIOGEOGRAPHICAL SIGNIFICANCE

The region of Kolar in Karnataka is a semi-arid belt known in particular for its harsh summers when drought-like conditions prevail. Large parts of agricultural land here are undergoing degradation, affecting crop yield and farmers' incomes. Akkadi Saalu holds significant biogeographical significance in Karnataka due to its crucial role in conserving and sustainably managing the region's diverse biodiversity. This indigenous practice helps convert degraded rain-fed plots into biodiverse agroecological farms with good yield. By fostering a harmonious relationship between humans and the environment, Akkadi Saalu plays a pivotal role in maintaining ecological balance and safeguarding Karnataka's unique biogeographic heritage.

Kolar region in Karnataka

Quality of soil in Akkadi Saalu

DESIGN

Akkadi Saalu, an indigenous agricultural practice observed in Karnataka, features a distinct design that harnesses the power of water conservation and soil protection. The size of the plot preferred for this practice is approximately 1 acre. Native seeds are preferred as they are well-suited to the local conditions. The primary crop is intercropped with crops that have different growing periods ranging from 3 to 6 months. The intercropping plants are usually placed in the periphery of each plot. Earthworms and other soil organisms are used to create preferential pathways. Selection of the plants is based on their diversity in rooting systems to aid in filtration and spread soil moisture. Because of the emphasis on high soil organic carbon and moisture, farms following Akkadi Saalu require very little ploughing.

Two key features of Akkadi Saalu include the use of trap crops and bird attractors. Trap crops like castor are deliberately chosen to attract unwanted pests that feed on them and leave the main crops alone, while bird attractor plants attract birds that feed on pests and the grain/fruit on them, and leaving the main crop alone.

PROCESS

Akkadi Saalu was promoted keeping in mind that the crops may grow for two agricultural seasons - monsoon (kharif) and winter (rabi). One of the primary characteristics of the practice is its equal focus on food and fodder. A variety of seeds are sown just before the first pre-monsoon rains. A couple of weeks post germination, the soil is turned over, which not only increases the organic matter in the soil but also ensures that the seeds of most weeds have germinated and been eliminated. In the monsoon season, multiple crops are grown. Post kharif harvest, the soil is turned over, and the crop residue is mulched, and the field is sown again with four or five types of seeds. The diversity of harvest timings ensures that benefits accrue at different times. The field is covered with crops for almost 8 months of the year, relying entirely on soil moisture with no supplementary irrigation. The discarded crop residue is used as manure for the main crops grown in the next season. The constant soil mulching ensures that organic matter is conserved and soil is nutrient-rich.

Character of the Akkadi Saalu ecosytem

OUTCOMES

i) Conservation of local biodiversity including those that are generally perceived as weeds in the region.

ii) Reduced pressure on the aquifers of the region.

iii) Gender inclusivity and therefore social empowerment and livelihood.

iv) Natural carbon sequestration.

Gender equality

IN SITU CONSERVATION

Pest feeding on trap crops

- *Ricinus communis* (Castor)
- *Lumbricina* (Earthworms)
- *Arachis hypogaea* (Groundnut)

Scan to read more

FOOD SECURITY

Agriculture was the turning point in history that took us from being nomads and foragers to what we are today. However, with the increase in population, we are unable to meet the demand vs supply quotient without impacting natural resources negatively. This section, therefore, focuses on practices that city departments can learn from when it comes to sustainable food production with minimal negative ecological impacts.

Image Source : DH Photo/Govindaraj Javali

Mitigation
Adaptation
1 - 5 years

₹ 82,074/ha

cost of production incurred for rice in Kuttanad of one cultivator (2015-2018).

2 lakhs

farmers are dependent on the Kayalnilam farming system for their survival and livelihood.

Image Source : The Statesman

How to implement this in your city ?

- Identify suitable areas repurposing underutilized or vacant land, weak water draining abandoned land parcels, coastal zones.
- Formalizing similar land uses at a master plan level with guidelines to implement and ensuring compliance with health and safety standards.
- By providing economic incentives, communicating and educating residents to adopt this sustainable farming practice.

19 Kuttanad Kayalnilam Farming System

Started in: the 1800s
Location: Kuttanad, Kerala, India
Landscape Type: Low-lying wetland
Implementation actor(s): Water-workers, farmers, fishermen

Site Area: ~ 50,000 ha
Climatic Zone: Tropical monsoon
Temperature Range: 22-35 °C
Dynamic: Seasonal flooding and salinity intrusion

PRACTICE OVERVIEW

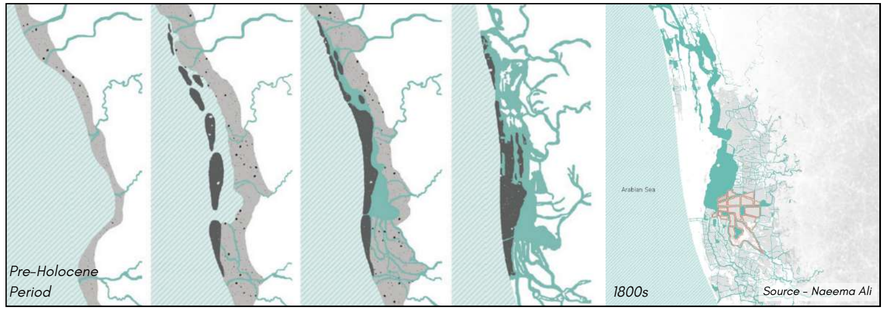
The Kuttanad Kayalnilam is a traditional water-land utilisation system that practiced paddy farming below sea level for more than a century. The system intelligently accommodates seasonal flooding and salinity intrusion, allowing the farmers to grow rice, coconut, and other fruit trees through the local technology and water management practices associated with the Kayalnilams. The practice is a perfect example of how it is possible to coexist efficiently with water.

GLOBAL COUNTERPART IN FOCUS

Ramli agricultural system in the lagoons of Ghar El Melh, Tunisia, is an agricultural practice based on a passive irrigation system where the roots of the plants are fed in all seasons by the rainwater stored and floating on the surface of the sea water through the movements of the tides in response to the lack of cultivable coastal land and poor-quality soil.

BIOGEOGRAPHICAL SIGNIFICANCE

Kuttanad *is* a low-lying wetland at the mouth of the Vembanad Backwaters in India. Due to this area's unique geographical phenomenon, life here revolves around water with the daily activities, livelihoods and seasonal celebrations. During the Pre-Holocene period this was a shallow embayment in the Arabian Sea that later silted up, giving rise to a deltaic formation at the confluence of four major river systems and the backwaters. In the 1800s, when the region encountered an acute food shortage, these virgin landscapes, considered a gift from the backwaters, were reclaimed in a process colloquially known as Kayalkuthu which literally translates to thrusting into the backwaters.

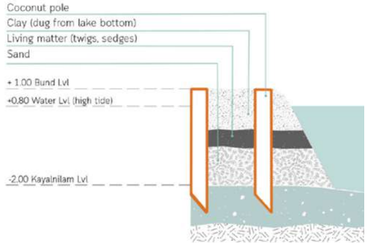


Evolution of Kayalnilam

DESIGN

The Kayalnilam system is composed of bio-bunds and canals, with dewatering technologies and temporary barriers to block salt. The bunds separate the canals which hold water used for irrigation. However, to avoid excess water entering the paddy fields, dewatering technologies that periodically remove water, are placed at strategic junctures between the bunds and the canals. An exterior bund 2m above the intertidal level acts as a sea defence barrier.

Traditionally, wheels of 10 ft to 12 ft in diameter with a blade width of 1 ft to 15 ft were used. They were pedalled manually by men to remove water. The water wheel ranged from 4-leaved to 18 leaved. Owing to the extensive labour, these wheels were later replaced by a technology crafted by local blacksmiths which runs on electric power.

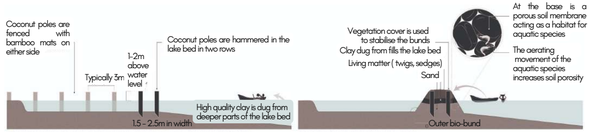


Kayalnilam Construction section detail

Source - Naeema Ali

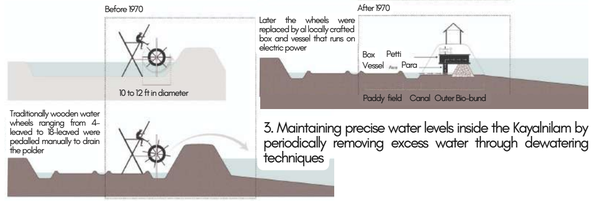
PROCESS

The people of Kuttanad live in harmony with the seasonal mixing of fresh and saline water, with kayalnilams being flooded to create a watery landscape for aquaculture and duck rearing. Paddy fields accommodate excess water during heavy rains while the soil is enriched with silt and duck droppings. Post-monsoon, water levels recede and paddy fields are dewatered to begin growing crops before the next saltwater intrusion from the sea.

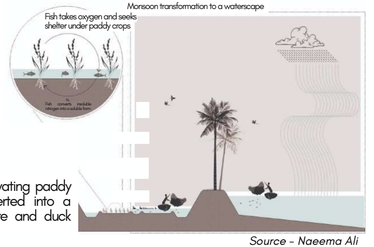


1.A framework for the bio-bund is erected using coconut poles and bamboo mats, along the periphery of the shallow parts of the lake bed.

2. The channels of the bund is filled with locally available materials.



3. Maintaining precise water levels inside the Kayalnilam by periodically removing excess water through dewatering techniques



4. The Kayalnilams are used for cultivating paddy crops. During monsoon, it is converted into a seasonal waterscape for aquaculture and duck rearing

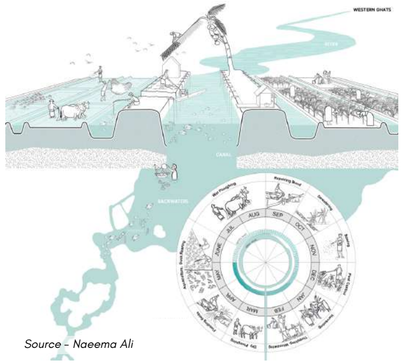
Source - Naeema Ali

OUTCOMES

i) Helped bolster food security against climate change in water-stressed environments.

ii) Increased area for paddy cultivation due to intensive reclamation process.

iii) Increased livelihood opportunities (agriculture, aquaculture) for farmers and fishermen.



Circular & Cyclical Water System Diagram

IN SITU CONSERVATION

Cyclical operations in harmony with the ecological entities

- *Anas platyrhynchos domesticus* (Chemballi ducks)
- *Penaeus indicus* (Shrimps)
- *Eleocharis dulcis* (Water chestnut)
- *Alternanthera philoxeroides* (Alligator weed)
- *Nympaea pubescens* (Pink Water Lily)
- *Fimbristylis miliaceae* (Hoorahgrass)

Scan to read more

₹₹₹

Mitigation

Adaptation

>1 years

70%

of the 30,000 population of Ziro valley depends on agriculture whereas the rest of the population is involved in ecotourism, plantation of commercial crops, and timber.

400 - 500 kg/ha

is the yield generated across this system which is 3 - 4 times average yield of paddy in the state.

Image Source : The Skift

How to implement this in your city ?

- Pilot testing the practice within formal campuses, building terraces situated at higher elevations across the city.
- Exploring the possibility of promoting organic farming methods, maintaining traditional water management systems, and preserving native plant species.
- Capacity building and cross sectoral R&D for efficient innovation of the practice.

20 Apatani Cultural Landscape of Ziro

Started in: the 1100s
Location: Ziro, Subansiri, Arunachal Pradesh, India
Landscape Type: Pine-clad gentle hills
Implementation actor(s): Apatani tribe

Site Area: ~ 2800 sq.m
Climatic Zone: Humid subtropical to temperate
Temperature Range: 10-38 °C
Dynamic: Geo-climatically induced water logging & scarcity

PRACTICE OVERVIEW

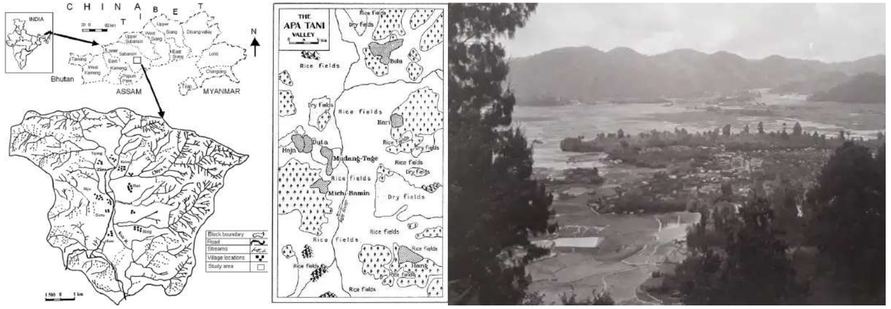
The Apatani tribe has a distinct agricultural system called paddy-cum-fish cultivation, where they grow rice and rear fish together in flooded fields. This method provides a reliable food supply and preserves the ecological balance of the region. Their advanced irrigation techniques, terraced fields, and water management systems demonstrate their understanding of the local ecosystem and ability to adapt to the difficult terrain.

GLOBAL COUNTERPART IN FOCUS

Konso Cultural Landscape consists of 200 km2 of stone walled terraces and fortified settlements. *Yelas*, a key feature of this landscape, is built by placing a few courses of stones transversally to the river, where fine sediments entrained within running water are deposited, permitting more drystone courses to be added and further alluvial sediments to be captured.

BIOGEOGRAPHICAL SIGNIFICANCE

The Ziro valley, home to the Apatani, lies in the lower ranges of the eastern Himalayan region in the Lower Subansiri district of Arunachal Pradesh. The state hosts different types of forests that form an integral part of the State's biodiversity. The Ziro valley has a unique bowl-shaped topography, with vast paddy fields (locally referred to as *Aji*) interspersed with settlements in the low-lying area. The paddy fields are spread across approximately 32 sq. km which are surrounded by hill ranges, covered with dense bamboo and pine forests. The valley supports rich biodiversity and efficient conservation of crucial watersheds to ensure perennial streams flowing into the valley.

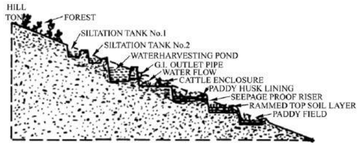


Evolution of Apatani tribe cultural landscape

Source - Scientific Figure on ResearchGate by R.C. Sundriyal | Image Source : Rupesh Bhomia

DESIGN

The system is an integration of food production and water management with the agricultural fields conserved and managed to provide food security and livelihood while conserving the traditional varieties of agricultural biodiversity. Wetland rice cultivation in Ziro valley is practised in broad and well-levelled terraces with strong bunds in which the hill streams are trapped, channelised and diverted into primary, secondary and tertiary networks to provide water in the terraces. The terrace bunds have a breadth of 0.6 - 1.4m and height 0.2 - 0.6m depending on the terrain character and size. Water from one terrace reaches another through bamboo or wooden pipes. Fish pits in the plots ensure water remains for pisciculture even when the field is drained off especially in the flowering and the grain maturity stage. The boundaries of individual agricultural fields are demarcated through bunds, irrigation channels and by planting bamboo sticks.



Profile section indicating terrain modification

Source - Scientific Figure on ResearchGate by Anup Das

PROCESS

During January and February, dykes are made along the permanent terraced fields; there is a provision of inlets and outlets for water irrigation, with bamboo screens to avoid the loss of fish. In each plot, small dams, locally called *Kiile*, are made for irrigation purposes and are located in different areas to manage irrigation water in their respective agriculture fields. The flow of water, through humanmade channels, is regulated by the locals so that no blockage occurs. The agricultural fields are well demarcated with elevated boundaries where barley and finger millet are grown. Thus, the fertility of the soil in the Apatani rice fields and gardens is always intact and results in the yielding of abundant harvests.

The primary crops grown here are rice, millet, and maize. Bamboo and pine are planted around the fields. The fields are separated by 0.6 m high earthen dams supported by bamboo frames. These dams serve to hold water and soil in the fields.

Millet is grown on the bunds to strengthen them, as well as on dry hill slopes. Water is distributed through a management system that ensures irrigation equitably to fields located in the upstream and downstream areas

(Image credits : Image 1-2-3 CPREEC - Apatani Farming System, 4. Tanmoy Bhaduri)

OUTCOMES

i) Sustainable agriculture that provides food security and support the local economy. Also, optimize water management, and improve land productivity.

ii) Women play a significant role in sustainable resource management and efficient economic development.

iii) Cultural Identity and Tourism that raises awareness about the importance of preserving indigenous practices.

Paddy field during monsoon period in Ziro Valley

IN SITU CONSERVATION

Source - DownToEarth | Stuart Blackburn

Apatani tribal man with Mithun

- *Bos frontalis* (Mithun)
- *Bucerotidae* (Hornbill)
- *Ursus thibetanus* (Himalayan Black Bear)
- *Ailurus fulgens* (Red Panda)
- *Oryza sativa* (Paddy Rice)
- *Bambusoideae* (Bamboo)

Scan to read more

50 - 60 kg

of fish is harvested per hectare from paddy-cum- fish culture as an additional income and food supply.

3 - 4 tons

per hectare paddy is harvested. The village has 1,664 households that make a population of 7,298.

Image Source : The Canva

How to implement this in your city ?

- Awareness and training on sustainable agricultural practices, crop diversification and integration of livestock and poultry.
- Create policies and provide incentives that encourage farmers to adopt the Zabo Farming System.
- Infrastructure facilities like developing irrigation systems, improving access to markets and transportation and setting up processing and storage facilities for agricultural produce.

21 Zabo Farming System of Nagaland

Started in: immemorial
Location: Kikruma village, Nagaland, India
Landscape Type: Hilly and mountainous
Implementation actor(s): Village farmers

Site Area: ~ 1,000 ha
Climatic Zone: Humid subtropical climate
Temperature Range: 10-30 °C
Dynamic: Rain-shadowed area

PRACTICE OVERVIEW

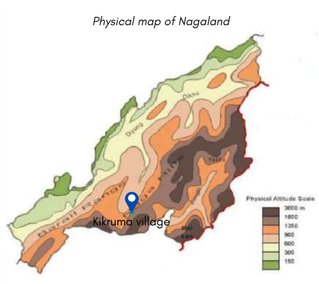
The term Zabo refers to the impoundment of water and is an indigenous farming system. It is also known as *Dzüdü* or *Ruza* in other parts of the district. This self-organizing system in the village of Kikruma, situated at an altitude of 1270 meters in the rain shadowed area of Phek district, Nagaland, encompasses forests, horticulture, agriculture, fishery, and animal husbandry to effectively manage its water, forests, and farms. This system is based on a strong foundation of soil and water conservation practices integrated into the hilly terrain.

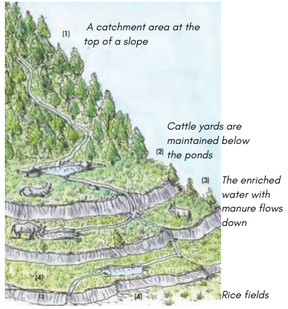
GLOBAL COUNTERPART IN FOCUS

In 1984, North Kordofan in the Sudan was hit by the worst drought of this century. Many water sources simply dried up. UNICEF responded by mounting an emergency water programme, aimed in particular at the manual rehabilitation of hafirs. This endeavor aimed to improve water availability and enhance the resilience of communities in the face of drought and water scarcity.

BIOGEOGRAPHICAL SIGNIFICANCE

Nagaland, a mountainous state in northeastern India, is a biodiversity hotspot located in the Indo-Malayan region. It features diverse forests, including tropical, subtropical evergreen, and unique broad-leaved moist temperate forests. The region's biodiversity represents a transitional zone between the Indian, Indo-Malayan, and Indo-Chinese biogeographic regions. Despite sufficient rainfall, water scarcity persists in the Kikruma region due to surface runoff, prompting the development of an elaborate water harvesting system called Zabo. Zabo incorporates water harvesting, recycling, and conservation practices to control soil erosion and maintain soil fertility.





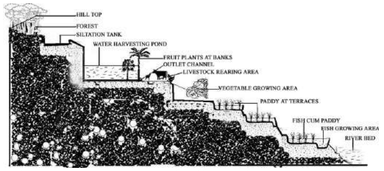
Evolution of Zabo system of farming

(Map Source : B. C. Kusre, Kh. S. Singh | Image credits : Ramesh Ananda Vaidya, ICIMOD)

DESIGN

The word "Zabo" means impoundment of water. The three-tier system consists of the top of the hill having protected village forestland (forest area); the mid-hilly residential area with water-harvesting ponds called Rüza, cattle yard and dairy farms and the third lower section where paddy fields, and fishery ponds of the farmers are located

The ponds are constructed in such a way that the distribution of water is uniform. Inlet channels are dug to carry water from one pond to the next. It is generally practiced in land holdings of 2.0 to 2.5 ha. The catchment area is under permanent vegetation. Water body is approximately 0.2 ha area pond of 1.5 to 2.5 m depth (shallow) located below the catchment area with a suitable silt trap. The bottom and sides of the pond are rammed and compacted to reduce seepage losses. The water stored is used during the lean period. While during summers, it is let into the rice fields located in the lower region of the slope after which the water ultimately reaches the river basin. The paddy fields are also used to rear fish with a huge variety of medicinal plants and herbs grown over the bunds of the fishery ponds.



Levels and placement of different farming activities

Source - Scientific Figure on ResearchGate by Raj K. Singh

PROCESS

Zabo has a combination of forest, horticulture, agriculture, fishery and animal husbandry with well-founded soil and water conservation base on one hill. It involves the preservation of forests on the hill tops to provide the catchment for the water. At the next level ponds are dug out to hold rainwater, which is brought there through small channels. These channels are even dug across roads. They serve as reservoirs with their bottom and sides rammed and compacted so as to reduce seepage. The water is passed through cattle yards and carries the dung of the animals to the fields below which is perfect to meet the nutritional needs of the soil.

Village conserved forest area at the top and paddy field at the lower section

Using a pole tied to a gunny bag, a farmer rams and compresses the side wall of a pond

Rainwater from hilltop channelling down to the harvesting pond

Water channel with bamboo check dam made to control soil erosion

Water from siltation pond flowing to the main harvesting pond

Water flowing from harvesting pond to the main paddy or rice field

(Image credits : I.Amenla & Keviu Shuya | CHAPTER 3 Zabo (Zabü) Farmingof Kikruma Village, Nagaland, India)

OUTCOMES

i) Efficient water management, biodiversity conservation and sustainable agriculture.

ii) Integrated approach enables effective rainwater harvesting and promotes biodiversity through agroforestry.

iii) Conservation of intergenerational knowledge transfer and community collaboration.

Levels of terraces from forest at top to paddy fields at bottom

IN SITU CONSERVATION

Source - ndsu.edu/TARO

Colocasia esculenta (Ahu)

- *Amaranthus tricolor* (Kholar)
- *Colocasia esculenta* (Ahu)
- *Eleusine coracana* (Kubei)
- *Amaranthus viridis* (Akibi - leafy vegetable)
- *Phaseolus vulgaris* (Ngou/ Bean)
- *Morus spp.* (Amora/ Mulberry)

Scan to read more

Mitigation
Adaptation
>1 years

320 - 480 q. ha

of Dal Lake yields vegetables and fruits equivalent to that in an area of 160 q ha of regular land farming.

6000+

families depend on floating gardens farming produce.

Image Source : The Statesman

How to implement this in your city ?

- Pilot testing a modular version in a similar way like floating wetlands preferably in small-sized artificial waterbodies.
- Exploring the possibility of integrating this practice within the riverine islands of rivers.
- Establish support networks and platforms for knowledge exchange and provide technical assistance and guidance throughout the process to ensure successful implementation.

22 Floating Gardens of Kashmir

Started in: time immemorial
Location: Dal Lake, Srinagar, Jammu and Kashmir, India
Landscape Type: City lakes
Implementation actor(s): Water-workers, farmers, fishermen

Site Area: ~ 2,000 ha
Climatic Zone: Temperate continental
Temperature Range: -2 to 30 °C
Dynamic: Flooding

PRACTICE OVERVIEW

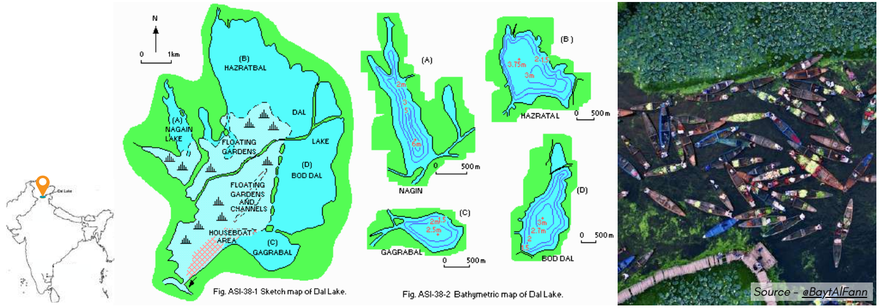
The Floating Gardens of Dal Lake are a unique attraction located in Srinagar, India. These gardens are made up of a series of man-made islands that float on the surface of the lake, and are used for growing a variety of vegetables and flowers. The gardens are tended to by local farmers, who use traditional techniques to cultivate their crops. Floating gardens are of two kinds which are locally called 'Radh' and 'Demb' types.

GLOBAL COUNTERPART IN FOCUS

Floating gardens in Pirojpur, Bangladesh are created by weaving together water hyacinth and other plants, forming floating beds held in place by bamboo poles. These gardens allow farmers to cultivate vegetables and crops, even in flood-prone areas, providing food security and livelihood opportunities for the community.

BIOGEOGRAPHICAL SIGNIFICANCE

It is believed that the practice was introduced by the early inhabitants of the region who utilized the abundant aquatic vegetation present in the lakes and water bodies. Over generations, the local communities developed innovative techniques to create and maintain the floating gardens. They observed the natural growth patterns of aquatic plants and devised methods to collect and assemble them into floating platforms. The boatmen identified specific aquatic plant species suitable for constructing floating gardens. The boatmen continually adapted their practices to the changing conditions of the lakes and addressed challenges such as erosion and fluctuations in water levels.



Evolution of Floating Garden of Dal Lake, Kashmir *(Source - International Lake Environment Committee Foundation)*

DESIGN

Floating gardens are of two kinds: Radh and Demb types. The Radh type of floating gardens are made of long strips of lake reeds having a breadth of about 2m and can be pulled from one place to another. Second, Demb type of floating gardens are formed along the sides or sometimes in the middle of the lake when the water is shallow. The boatmen gather weeds and intertwine their roots, creating a strong bond between them.

The boatmen maintain the floating gardens at a thickness of 1 to 2 meters, with a width of approximately 2.5 to 3.0 meters and lengths ranging from 45 to 90 or even 135 meters. They have a clever technique for connecting small pieces together by joining them end to end and planting willow cuttings along the seam. The cuttings penetrate deep into the adjacent margins, resembling boat cramps, and their extensive root systems unite the gardens securely.

Lotus plants fill sections of Dal Laker

PROCESS

Floating gardens in Kashmir's Dal Lake are created by collecting weeds, such as *Typha augustata* and *Phragmites communis* (known as Pech and Nargasa in Kashmiri), from the lake itself. Occasionally, other hydrophytes like *Trapa spp.* (Gair, Singhara in Urdu) and the endangered *Eurale ferox* are also used. The boatmen press the roots of the weeds together, forming a cohesive mass that cannot easily be separated. The boatmen then trim the tall culms and create mats, which float in the lake and become the floating gardens. To increase the thickness of the gardens, additional layers of weeds are added in subsequent years. This layering process helps maintain the garden's thickness as it naturally erodes over time due to the constant water movement underneath.

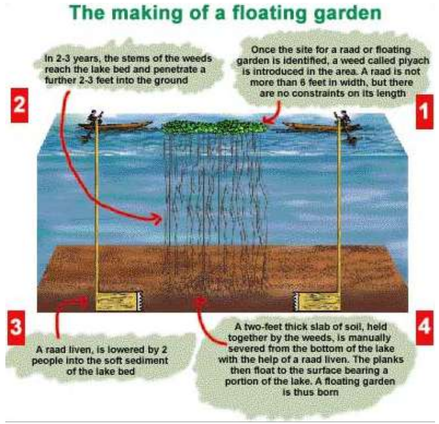


Image source : Lake agriculture

1. ***Introduction of Piyach Weed:*** Once the site for a raad (floating garden) is identified, a weed called piyach is introduced into the area. This weed serves as a foundation for the floating garden.
2. ***Formation of the Raad:*** Over a period of 2-3 years, the piyach weed's stems grow and penetrate around 2-3 feet into the lake bed, which is typically 5-6 feet deep.
3. ***Lowering of the Raad Liven:*** Large pincer made up of two planks, each 3 feet in width, is lowered into the soft sediment to start the process of raising the floating garden.
4. **Severing and Floating of the Lake Bed:** A 2 feet thick slab of soil held together by the piyach weed is manually severed from the bottom of the lake.

OUTCOMES

i) A unique opportunity for cultivating a wide range of plant species, including ornamental flowers and vegetables.

ii) The use of organic materials and locally available resources promotes sustainability and minimizes environmental impact.

iii) Preserving the fragile ecosystem by acting as natural filters, improving water quality & food security.

Local carrying vegetables cultivated in the floating garden

IN SITU CONSERVATION

Native species Kashmiri Carp

- *Cyprinus carpio kashmirensis* (Kashmiri Carp)
- *Alcedo atthis* (Common Kingfisher)
- *Lutrogale perspicillata* (Indus Smooth-coated Otter)
- *Nelumbo nucifera* (Lotus)
- *Phragmites australis* (Common Reed)

Scan to read more

Mitigation
Adaptation
>1 years

4S

Parambu System of Kerala promotes Syntropy, Synergy, Security & Sovereignty

1 sq. m.

of land within a mature Parambu system supports a diverse community of lifeforms due to the presence of seven different strata

Image Source :

Image Source : Ann Rochyne Thomas

How to implement this in your city ?

- Formalising the land use planning initiative at a master plan level for any construction within floodplain (delineated and actual extended) zones of the city so that it may be integrated with the riparian buffer.
- Preparing a database of the built structures with backyards on area basis that may be utilised for this practice.

23 Parambu System of Kerala

Started in: 19th century
Location: Kerala, India
Landscape Type: Low-lying Land
Implementation actor(s): Village farmers & Neighbourhood residents

Site Area: ~0.1 to 10 ha
Climatic Zone: Tropical monsoon
Temperature Range: 20-35 °C
Dynamic: Land with fertile soil

PRACTICE OVERVIEW

The Parambu System is a form of pastoral agroforestry unique to Kerala. It is a type of traditional homestead silvopasture that is based on the integration of family based agricultural and pastoral activities within a closely knit neighbourhood network. This decentralized farming system works on the principles of ecological succession and a delicate balance of entropy vs syntropy which gradually reflects the close relationship between the community, land, and agriculture.

GLOBAL COUNTERPART IN FOCUS

In Panama, the practice implemented by a school of farmers provided a solution for cattle ranching's heavy environmental footprint in a country where cattle is king. The woody plants and improved soils of silvopasture systems resulted in an estimated 26 gigatons to 42 gigatons of carbon dioxide sequestered globally before it has a chance to contribute to climate change.

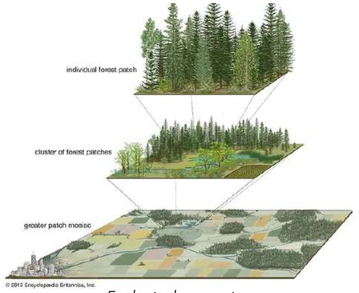
BIOGEOGRAPHICAL SIGNIFICANCE

The term 'Parambu' loosely translates to open backyard behind the house with no fixed assigned uses. Traditional homes across Kerala (majorly the aristocrats) always were designed with a portion of land left open for a plethora of uses such as agriculture, pastoralism, burials etc. These lands are usually left untouched for the most part with the exception of initial cultivation. These lands may be considered similar to the modern day agroforestry lands. The harvest of long term crops restarts the ecological succession cycle within the parambu lands.

Parambu across cities in Kerala

DESIGN

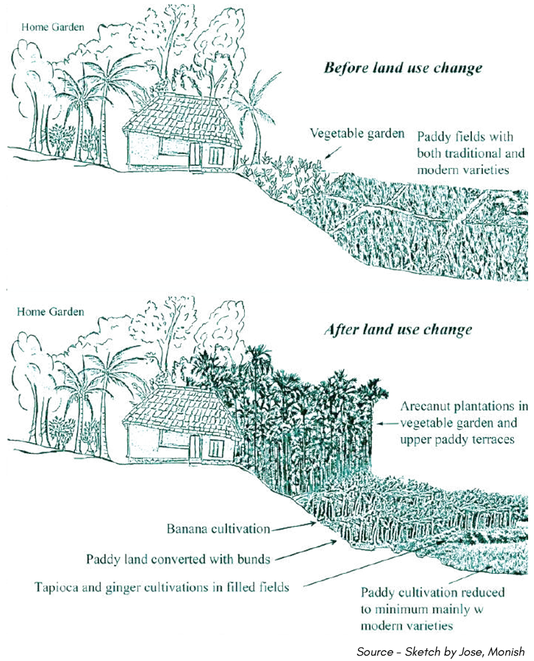
The parambu culture is based on a fundamentally different perception and nature interpretation unlike conventional agriculture and monocultural plantation norms. The Parambu System can be classified as two - Mature Parambu and Smaller micro-Parambu. A mature Parambu is a natural forest that can consistently provide adequate provisioning services - food, medicine, fuel, and timber, in addition to other ecosystem services. The significantly smaller micro-Parambu are seen in urban household yards and in the shared open space of some apartment complexes in densely populated cities. Understanding the ecological interactions between species and the geophysical environment is critical. The area of a single parambu can range from a few cents to a few acres. The self sufficiency of the system is dependent on the rich ecological strata - a canopy laver of over 30 ft, a sub canopy layer of 10 - 30 ft, a shrub layer, herbaceous layer, thick groundcover layer, underground rhizosphere and a climber layer. The plant consortiums within a single parambu system across the same climatic zone and neighbourhood is different which increases local biodiversity and resilience.



Ecological succession
Source - Encyclopædia Britannica, Inc.

PROCESS

The design process of the Parambu System involves several key steps. The primary goal of the system is process based ecological regeneration. The agricultural land is divided into "parambus," Farmers choose traditional paddy varieties that are well-adapted to the local agro-climatic conditions and possess genetic diversity. Organic farming techniques are employed, which minimize the use of agrochemicals and promoting natural inputs like organic manure and compost. Controlled irrigation methods, such as alternation of wetting and drying, are utilized to optimize water usage and maintain water balance in the paddy fields. A no- till policy is adopted unless absolutely necessary to ensure increased soil fertility.



Source - Sketch by Jose, Monish

OUTCOMES

i) Resilience to climate variability and food insecurity.

ii) Ensuring sustainable crop production and long-term soil conservation providing livelihood support.

iii) Traditional farming techniques and preserving indigenous knowledge.

iv) Conservation of the surrounding biodiversity, adjacent ecosystems and associated fauna.

Vegetation quality in a parambu

IN SITU CONSERVATION

Native Jackfruit sp. of Kerala

- *Cocos nucifera* (Coconut Palm)
- *Artocarpus heterophyllus* (Jackfruit)
- *Ratufa indica* (Malabar Giant Squirrel)
- *Amaurornis phoenicurus* (White-Breasted Waterhen)
- *Hevea brasiliensis* (Rubber Tree)
- *Tectona grandis* (Teak)

Scan to read more

CIRCULARITY

Waste was never a concern for our ancestors due to the circular lifestyle that they led. However, today it is perhaps the biggest issue in cities. The biggest principle that can be learnt here is that waste is merely a resource that is at a wrong place at a wrong time due to human construct of mind. This section therefore focuses on practices that city departments can learn from when it comes to treating waste as a valuable resource.

Image Source : Circleofblue.org

Mitigation
Adaptation
1 - 5 years

70,750

men and women are employed in maintaining fishponds, catch fishes, grow paddy and vegetables because of this wetland.

$38.54 MM

Estimated annual economic value of the wetland.

Image Source : Ashoka Trust for Research in Ecology and the Environment Community Environmental Resource center (ATREE CERC)

How to implement this in your city ?

- By preparing a spatial baseline and database of the natural hydrological connectivity and infrastructure in the city at a masterplan level.
- Identifying low lying depressions or wetland areas adjacent to sewage outflow points in the city.
- Involvement of local stakeholders and communities in planning, decision-making and M&E mechanism.

24 Wastewater Bheris of Kolkata

Started in: 1748
Location: East Kolkata, West Bengal, India
Landscape Type: Marshy salt lakes
Implementation actor(s): Farmers and fishermen

Site Area: 12,500 ha.
Climatic Zone: Tropical wet-and-dry
Temperature Range: 17-32 °C
Dynamic: Seasonal flooding and history of salinity intrusion

PRACTICE OVERVIEW

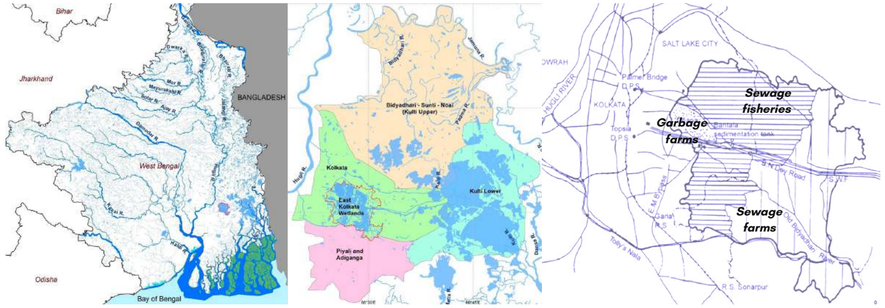
East Kolkata Wetlands (EKW) is world's largest and perhaps oldest integrated resource recovery practice based on a combination of agriculture, aquaculture and sewage treatment. It is a classic example of historic adaptation of indigenous practice to solve current day urban concerns. This Ramsar site forms a dynamic and incredibly resilient urban circulatory system with conduits catering to the demands of fisheries, waste management system, agriculture, horticulture, local communities and grazing - all right at the outskirts of the city.

GLOBAL COUNTERPART IN FOCUS

The historic Western Treatment Plant a.k.a. Werribee Sewage Farm of early 1890s is an adaptative modification of the natural landscape morphologies of Port Phillip Bay and Bellarine Peninsula, Australia. This Ramsar site (22,897 ha) is an ecosystem powered by Melbourne's waste, recycling more than 40 billion litres of water each year.

BIOGEOGRAPHICAL SIGNIFICANCE

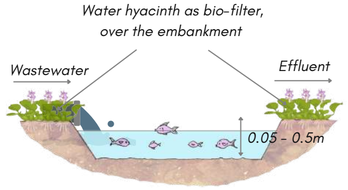
Located on the eastern fringes of Kolkata city, EKW forms a part of the extensive inter-distributory wetland regimes between Hooghly and now dead estuarine Bidyadhari river - another distributary of Ganga - Brahmaputra delta. These shallow water bodies a.k.a. bheries were salty in nature due to historic connectivity with Adiganga and thus named salt lakes which were embanked by locals for saline water fishing towards the end of 19th century. However, Kolkata's urban expansion, rapid deltaic process changes, extensive hydrological fragmentation, and riverbed choking has resulted in the city's eastward movement towards the wetlands which has consequently led to the shrinkage in wetland area with time.



The hydrological relevance of East Kolkata Wetlands (Source [From LHS] - EKWMA and WISA (2021), Dhrubajyoti Ghosh)

DESIGN

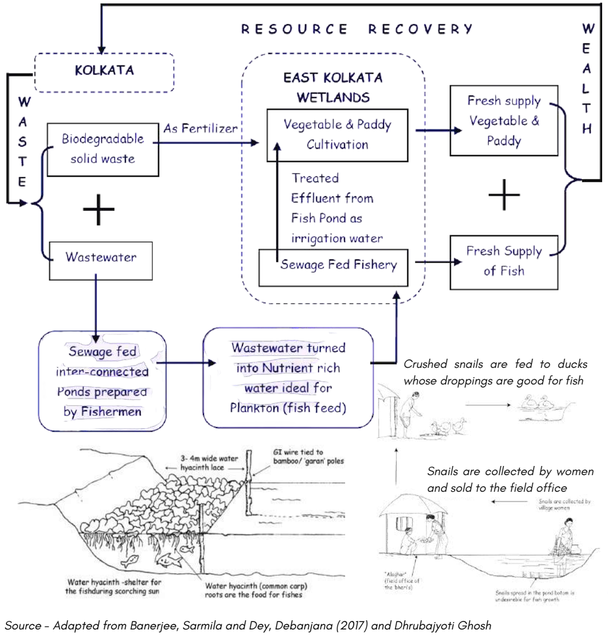
The functioning of EKW system is dependent on 4 core factors namely (a) the hot and humid climate, (b) the bheris, (c) adequate sunshine and (d) abundance of water hyacinth. Bheris are shallow, flat-bottomed lagoon type of ponds that vary between 50 and 150 cm in depth and can be as large as 0.4 to 0.5 sq. km in size. These dimensions provide a better pond volume - surface ratio, thereby creating more favourable condition for photosynthesis and algal bloom to take place. A series of bheris are lined for ideal waste water fishery to act as egg ponds, nursery ponds, rearing ponds, stocking ponds and finally harvesting ponds. The embankments of the bheris are lined using water hyacinth to protect the dykes from waves, provides shelter to fishes, oxygenate and removes heavy metals from water (phytoremediation). Bamboo sluice helps prevent entry of unwanted fish and escape of cultured fish. This natural waste-water recycling mechanism is capable of removing E.coli, which cannot be cleaned by conventional sewage treatment plants in advanced countries.



Working of Bheris - modular unit of EKW (Source - Author)

PROCESS

Waste recycling in the EKW involves three principal resource recovery practices, viz., sewage-fed fisheries, paddy-cultivation by utilizing fish pond effluents and farming of vegetables using organic waste as fertilizer. The wastewater of Kolkata flows through underground sewers to pumping stations in the eastern fringe of the city and is then pumped into open dry-weather-flow channel. Around 254 bheris receive the incoming sewage water that undergoes a process called bioremediation. Organic sewage matter along with sunlight cause the growth of planktons, which acts as fish feed while also helping to purify the water received. Sufficient oxygenation is produced to allow for natural elimination of pathogen/ fecal coliform. The output water is then utilised to grow vegetables in adjoining fields.



Source - Adapted from Banerjee, Sarmila and Dey, Debanjana (2017) and Dhrubajyoti Ghosh

OUTCOMES

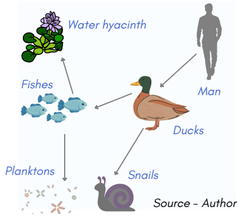
i) Reduced financial burden on Kolkata by purifying around 1,000 mm litres of sewage water daily. Around ₹2.2 crores a year is saved on the cost of a conventional STP.

ii) Approx. 40% - 50% of the city's vegetables and 33% of fish requirements are met.

iii) Solace from pollution by acting as carbon sink; locking over 60% carbon from the input wastewater.

EKW as carbon sinks for city of Kolkata

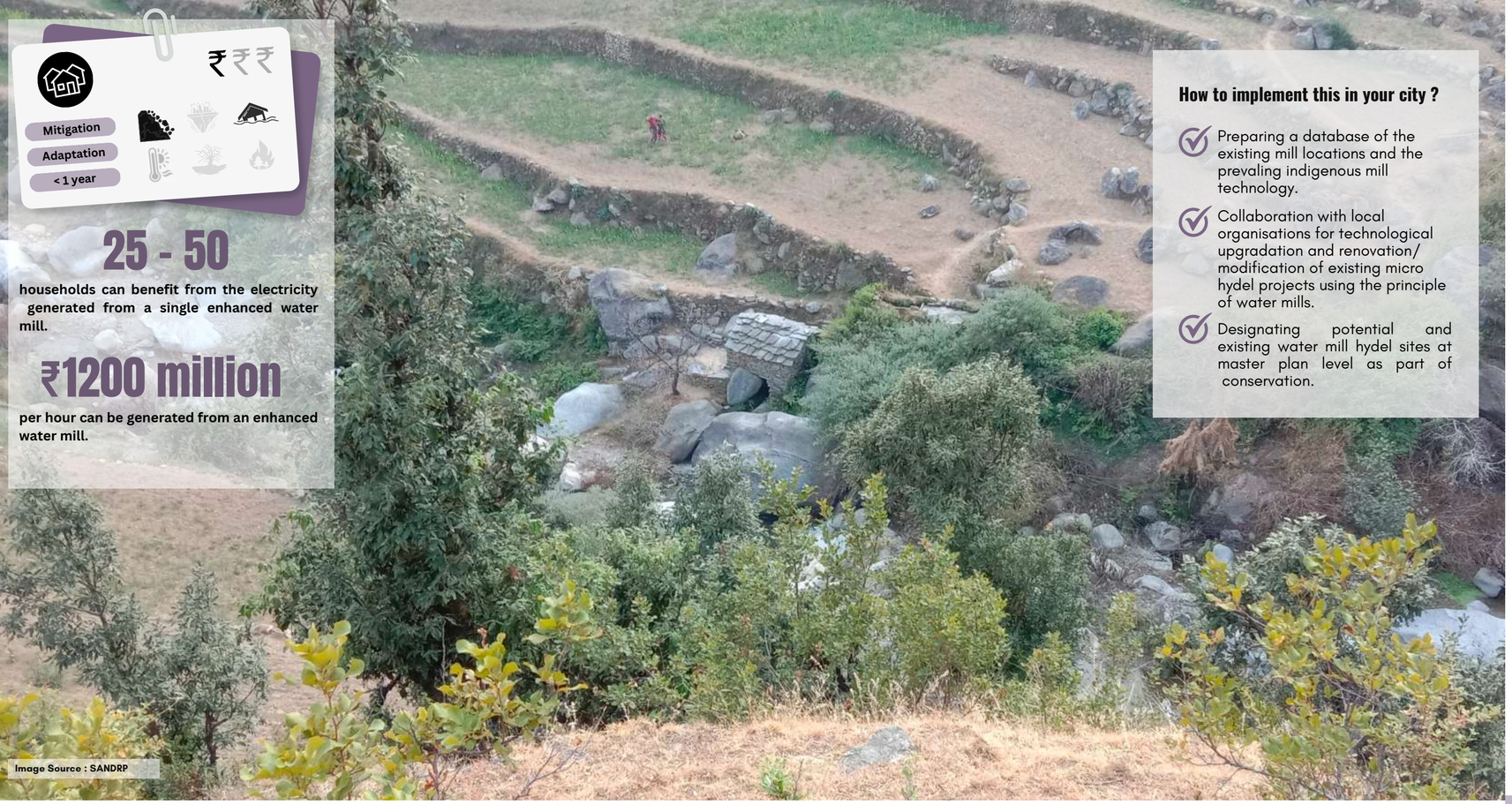
IN SITU CONSERVATION



Source - Author

- *Herpestes palustris* (Bengal Marsh mongoose)
- *Emberiza aureola* (Yellow-Breasted bunting)
- *Prionailurus viverrinus* (Fishing cat)
- *Nettapus coromandelianus* (Cotton pygmy goose)
- *Schoenicola striatus* (Bristled grassbird)
- *Avicennia officinalis* (Indian mangrove)

Scan to read more



25 - 50

households can benefit from the electricity generated from a single enhanced water mill.

₹1200 million

per hour can be generated from an enhanced water mill.

Image Source : SANDRP

How to implement this in your city ?

- Preparing a database of the existing mill locations and the prevaling indigenous mill technology.
- Collaboration with local organisations for technological upgradation and renovation/ modification of existing micro hydel projects using the principle of water mills.
- Designating potential and existing water mill hydel sites at master plan level as part of conservation.

25 Water Mills - Blue Green energy

Started in: 4th century AD
Location: Northern and North East India
Landscape Type: Hill - Valley terrain
Implementation actor(s): Local communites

Site Area: N/A
Climatic Zone: N/A
Temperature Range: N/A
Dynamic: Slope terrain with flowing water source

PRACTICE OVERVIEW

The traditional water mill system is a natural and sustainable technology that has been developed through centuries of experience; ranging throughout the Himalayan ranges of India, from Kashmir to Arunachal Pradesh. This practice is proof of the fact that the origin of modern technology can be traced back to indigenous systems. Water mills have been used to drive a mechanical process of milling, hammering, and rolling and are a portion of the agricultural, cultural, and industrial heritage.

GLOBAL COUNTERPART IN FOCUS

Eftimie Murgu/Rudăria, a commune in Caraș-Severin County, Western Romania is known for its 22 water mills. A non-profit active in the region of Banat, Western Romania, is working to repair and revive the region's forgotten water mills and therefore support the communities in exploring the tourism potential of the area. They have repaired 13 of them in 2020.

BIOGEOGRAPHICAL SIGNIFICANCE

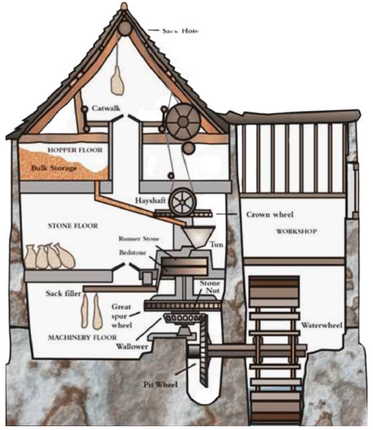
Water mills are usually built beside a flowing source of water supply such as streams, rivers, or even gravity-based underground hydrotechnological water source such as qanats. On the natural front, the character of the mill is governed by the nature of water ecosystem and topography. The system is further optimised with the mill's proximity to the water source for immediate return of water to the natural course. The suitability of the natural environment, reflected in the current status of its components determined the nature of agricultural production and possibility to locate watermills.

Traditional water mill ecosystem

DESIGN

The design of water mills are contextualised to the region of origin, however, they all share a similar basic mechanism. There are three distinct types of water mills. The simplest and probably the earliest was a vertical wheel with paddles on which the force of the stream acted. Next was the horizontal wheel, with a vertical shaft attached directly to the wheel used for driving a millstone. Third was the geared mill, driven by a vertical waterwheel with a horizontal shaft. The design of the traditional water mill is quite simple and they are built and maintained manually using locally available stone and wood and are constructed near or above a water source.

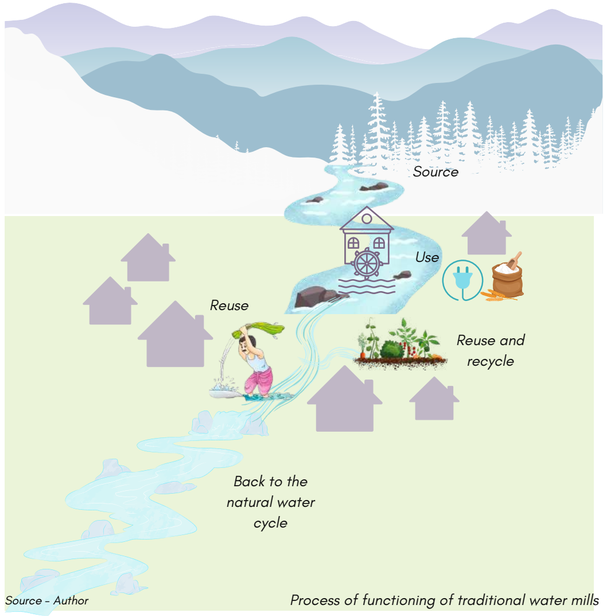
Water is led from the stream via a channel, extending towards the mill house through a wooden tube made of a hollow tree trunk. A wooden vertical shaft runs through the floor of the mill house and is attached directly to the grinding stones. This shaft has wooden blades or a wooden wheel that rotates the top pair of grinding stones set on the floor of the mill house. The operational capacity depends on the flow of water and the weight of the grinding stones.



Generic model of traditional water mill
(Source - Scholarly Community Encyclopedia)

PROCESS

A water mill is a construction that uses the power of water to turn a wheel or turbine for the mechanical process, such as milling for flour, lumber sawing, or textile production facilities, as well as metal shaping, such as grinding, rolling, or wire drawing, and by using the potential and kinetic energy of water flow, the water mill could rotate a large water wheel. The water mill is the first work machine constructed by man for the use of natural, mild, and renewable energy source. A productive technique converts the kinetic energy of the running water into mechanical energy that grinds the grains. The water that grinds the grains, flows out of the mill further down and is diverted to a vegetable patch or the spot where clothes are washed before rejoining the main water stream - circular way of functioning through recycling and reuse, hence eco-friendly.



Source - Author

Process of functioning of traditional water mills

OUTCOMES

i) An integrated watermill model offers positive frame for further green energy production, multifunctional source of power and community development.

ii) Aquatic fauna - friendly systems due to the large compartments for the water and the low speed.

iii) Solace from pollution and therefore less/no load on STP and naturally a no-wastage system.

A traditional water mill (gharat) in Himachal Pradesh

IN SITU CONSERVATION

- *Local catchment flora*
- *Fishes and aquatic fauna specially the migratory ones*

Scan to read more

WAY FORWARD

Image Source : Square Yards

IMPLEMENTATION

Directions for successful implementation in urban scenario

	Name of Practice	Salient pointers for successful implementation of the model in cities
	01 **Khazans of Goa**	• Ideal site location include coastal wetlands and low lying water logged depressions within a city that is subject to continuous saline intrusion ; flood prone. • Protective dykes / embankments to be made thick enough to sustain water erosion and made of eco-friendly materials. • Salt tolerant planting variants to be adopted for agriculture. • Sluice gates to regulate constant passage of fish spawn in an eco-sensitive manner. • In case of salt panning, constant supply of solar energy is required.
	02 **Chauka System of Rajasthan**	• The site to have a natural slope not exceeding 0.5-2% for gravity based flow of water with access to a nearby drain to remove excess water and recharge the adjacent water systems. • soil to possess moderate to good infiltration capacity - sandy loam to loamy etc.
	03 **Phumdis and Ataphums of Manipur**	• Access to a still freshwater source (water body or wetland) that is seasonal in nature (i.e should have low water levels at one point in time) within a city that is known to have fisheries industry or consume fishes as a dietary staple. • Started inoculum for phumdi can include a small mass of undecomposed organic matter or dense growth of water hyacinth (if prevailing in the ecosystem) that accumulates some suspended silt and gradually subject to native colonisation by grasses and other herbaceous plants. • Maximum thickness = 8ft with provision to vary with local environment conditions. • The level of nutrient in the water source and silt need to be regulated actively to control the proliferation extent and avoid invasion of species. • Identifying location specific template avenues for using recycling phumdis in advance such as biomass composting etc. in case of a invasion.

	Name of Practice	Salient pointers for successful implementation of the model in cities
	04 **Oran System of Thar Desert**	• Actively used open grazing lands may be formalised at a masterplan level. • Open lands rich in biodiversity with access to a waterbody may be conserved using this practice in association with sacred groves. • Community engagement and accountability is essential.
	05 **Pakho Khet of Sikkim**	• Slopes to be designed outward facing with an angle > 30 degrees and the width to be determined by natural slope gradient. • Slope height = 2 - 5m, Slope length = 15 - 35m • Can be practiced around water sources as well by integrating it with the riparian edge as bio engineering soil stabilisation technique
	06 **Sedentary Pastoralism across Kangayam Grassland**	• Actively used open grazing lands, grasslands and urban wastelands may be formalised at a masterplan level for sedentary pastoralism in association with local communities of the region. • Selected urban wastelands and grasslands across river islands within the city boundary may be selected for this purpose. • Grazing frequency needs to be regulated to allow grasslands to be regenerated.
	07 **Dong Bundhs System of Assam**	• Depth = 3 -10 feet deep, length = 4 -15 kilometres, width = 3 - 12-feet wide • Applicable to all flowing water sources within the cities limits. • Defunct canals adjacent to agriculture fields may also be modified for this purpose.

Directions for successful implementation in urban scenario

Name of Practice	Salient pointers for successful implementation of the model in cities
 **08** **Ahars - Pynes System of South Bihar**	• Principles applying to present day detention and retention basins may be used • Ideal site location include a natural depression zone with a marked slope -- 1 m per km -- from south to north • Provision for proper inflow - outflow needs to be provided
 **09** **Jheels - Virdas of Banni Grasslands**	• Ideal for cities with shallow aquifer systems • Regular desilting of the systems are required • Significant grass cover (native grasses) is essential • Minimum distance between two dug wells = 9 - 12 feets • Proper outflow provision and avenues for use need to be identified
 **10** **Kuhls of Kangra Valley**	• Regular cleaning of the systems are required to avoid contamination • Natural slope is essential for allowing gravity based flow of water • The start point needs to be at a higher elevation from the water source • Water source needs to be kept clear of debris • Community engagement and accountability is essential
 **11** **Surangams of Western Ghats**	• Access to groundwater and rainfall is essential • The surangams require dimensions of 0.45-0.70 m width, 1.8-2.0 m height and length of 3-300 m • The distance between successive air shafts (2 x 2m) in case of longer surangams varies between 50-60 m • Regular cleaning of the systems are required to avoid contamination

Name of Practice	Salient pointers for successful implementation of the model in cities
 **12** **Pat System of Bhittada**	• Regular cleaning of the systems are required to avoid contamination. • Community accountability is essential.
 **13** **Bamboo Drip Irrigation of Meghalaya**	• Access to a steady supply of bamboo species of various sizes and fibre rich twine, a water source and an adjacent sloped area of land with at least 30 meters in variation from the irrigation site. • For gravity based flow with minimal to no wastage , the site area should be capable of accommodating a minimum of 5 stages of bamboo diversions.
 **14** **Soliga Adivasis and Taragu benki**	• Open sites to be selected based on parameters like topography, road network, slope, forest types and proximity to water bodies. • Controlled ground-level fires of 2 -3 feet in height to be practiced in presence of experts. • Presence of moderate moisture and low biomass in the litter to be burnt is required • To be carried out in/towards the end of/immediately after dry seasons.
 **15** **Piscicidal Plant - Based Fishing of Nagaland**	• Access to a flowing water supply with a recorded presence of fishes within a city that is known to have fisheries industry or consume fishes as a dietary staple. • Access to piscicidal plants that are indigenous to the city or region and bamboo sp. for tying the piscicidal extracts. • Ideal time is when the water level is low and before the onset of monsoon rains. • To be carried out with support from local experts that are aware of the intensity of poison impact on the fishes and ecosystem

Directions for successful implementation in urban scenario

Name of Practice	Salient pointers for successful implementation of the model in cities
 16 **Faith-Based In Situ Conservation**	• Existing sacred groves in the city to be identified, mapped and conserved • Ideal sites for new groves include reserve forest tracts within cities, open lands with identified presence of endemic and native biodiversity. Parts of urban parks and gardens, lands adjacent to religious institutions (temples, churches etc.) natural ecosystems such as wetlands, riparian buffer etc. may also be modified as sacred groves at a master plan level
 17 **Sacred Groves as Ecological Refugia**	• Existing sacred groves in the city to be identified, mapped and conserved • Ideal sites for new groves include reserve forest tracts within cities, open lands with identified presence of endemic and native biodiversity. Parts of urban parks and gardens, lands adjacent to religious institutions (temples, churches etc.) natural ecosystems such as wetlands, riparian buffer etc. may also be modified as sacred groves at a master plan level • Local community guardians need to be assigned for the conservation of these groves • Natural vegetative succession of sites is to be permitted with minimal intervention from human end
 18 **Akkadi Saalu of Karnataka**	• Sites/agricultural lands of max 1 acre that are rainfed and where dryland agriculture can be practiced need to be identified • Native crop seeds are preferred – At least 25 to 30 kilograms of various types of seeds need to be established per land holding • Soil health to be studied prior to practice and naturally enhance during and post practice
 19 **Kuttanad Kayalnilam Farming Practice**	• Ideal for wetlands and depressions with prolonged water logging and saline intrusion • Expansion of land into water by reclamation or by the use of dykes must be done in a regulated manner • Use of local building materials allow a higher degree of flexibility and permeability for seasonal exchange of salt and water

Name of Practice	Salient pointers for successful implementation of the model in cities
 20 **Apatani Cultural Landscape of Ziro**	• Elevated terrain with gentle slopes and access to water sources is essential. • Soil character should be permeable and have water-retaining capacity. • Field water depth is the limiting factor. • The entire cultivation procedure is 100 % organic and devoid of artificial soil supplements.
 21 **Zabo Farming System of Nagaland**	• Works on the principle of integrated natural resource management. • Minimum land requirement is 2 – 2.5 ha. The catchment area is under permanent vegetation. • Constructed water basins are shallow with approximate size of 0.2 ha area and 1.5 to 2.5 m depth ; located below the catchment area with a suitable silt trap. Rammed bottom and side edges for reduced seepage losses.
 22 **Floating Gardens of Kashmir**	• A water ecosystem with moderate flow such as wetland , lake etc. is preferred • Basic principles of floating wetland module are applicable
 23 **Parambu System of Kerala**	• Can be practiced on a land as small as 1 cents – may be integrated as part of masterplan by allocating a portion of community open spaces for this system • Should allow provision for seven different strata of vegetative succession – a canopy layer of over 30 feet, a sub-canopy layer of 10-30 feet, a shrub layer, a herbaceous layer, a thick ground cover layer, an underground rhizosphere, and a climber layer, as well as their interactions. • A no-till strategy is followed unless absolutely necessary with minimal to no artificial pest management.

Directions for successful implementation in urban scenario

Name of Practice	Salient pointers for successful implementation of the model in cities
 24 **Wastewater Bheris of Kolkata**	• Availability of about 10.46 Mega joule/ sq. meter per day solar radiation • Natural or induced humidity • Terrain with low lying depressions is preferred. The shallow ponds / depressions to be modified to 50 - 150 cm depth and area of max 0.4 - 0.5 sq. km • Abundance of native bio filters or existing invasive bio - filters species like water hyacinth • Easy access to continuous supply of sewage • Easy access to farm/horticulture sites for release of treated waste water • Water cleaning to be done using a combination of kerosene, lime and khol or eco-friendly substitute • Incase of aquaculture - A series of shallow ponds are needed sequentially for different stages of production: egg pond, nursery pond, rearing pond, stocking pond and harvesting pond, with proper inlet and outlet channel management (preferably natural gravity regulated) • Introduction of native fresh water fishes like Indian Major Carps etc. to be done after introduction of waste water in order to allow optimal time to be provided for conversion of the waste into fish feed
 25 **Water Mills - Blue Green Energy**	• Access to a flowing water source • Availability of natural slope for gravity based flow of water preferably

Living Root bridges of Khasi Tribes, Meghalaya - a unique global example of how solutions to today's concerns can be long-term, seamless and integrative with nature through bioengineering which is perhaps the modern day version of indigenous practices. (Image credits - National Geographic)

URBAN SYNERGIES

Synergies with the various dimensions of Urban Initiatives at global and national level.

- **CLIMATE SMART CITIES ASSESSMENT FRAMEWORK, NIUA**

Climate Centre for Cities (C-Cube) has been supporting the Ministry of Housing and Urban Affairs (MoHUA) in implementing the ClimateSmart Cities Assessment Framework (CSCAF). CSCAF is a first-of-its-kind national assessment framework on climate relevant parameters for Indian cities. 226 cities participated in 2021-22 to assess their development in 28 indicators across 5 thematic areas - Urban planning, green cover and biodiversity; Energy and green buildings' Mobility and Air Quality; Water Management and Waste Management. The alignment of indigenous practices with these indicators will encourage cities to develop a roadmap for adopting contextualized climate resilient actions. *[Table 1]*

- **GLOBAL & NATIONAL MISSIONS, FUNDING AGENCIES, TARGETS, FRAMEWORKS**

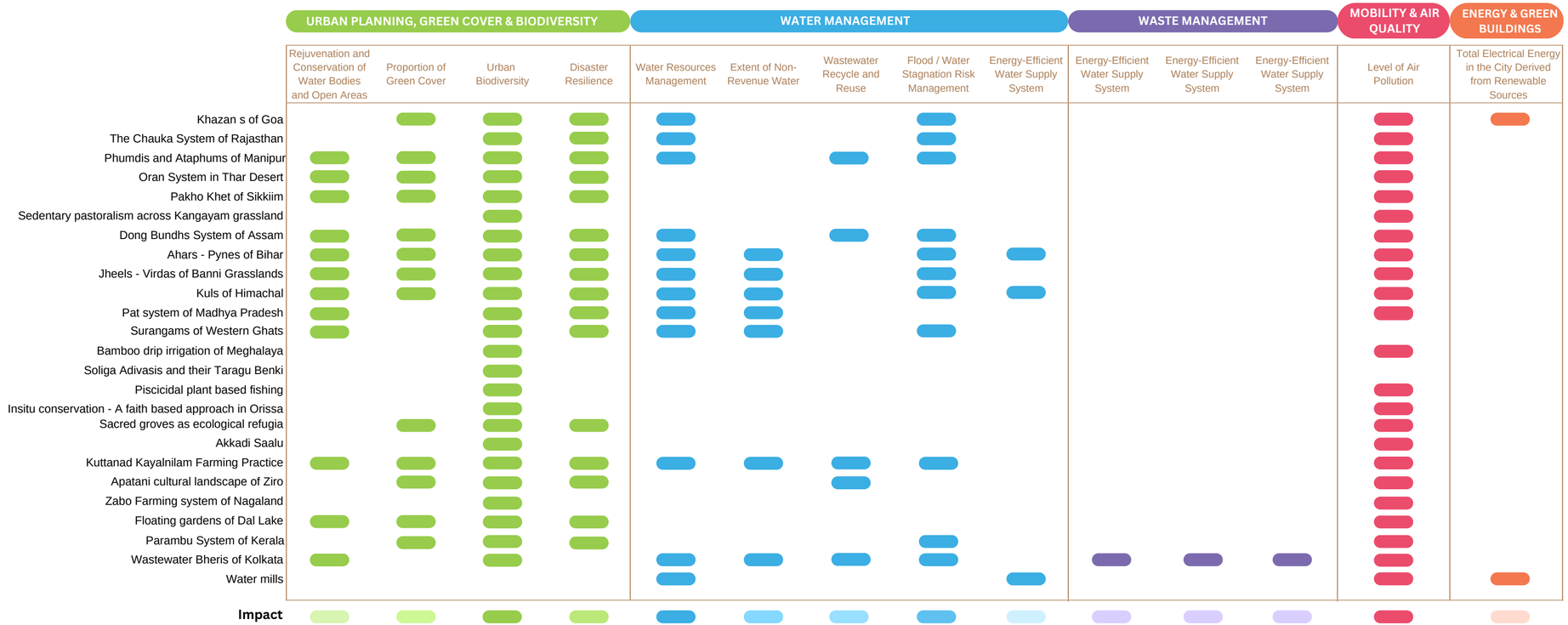
By linking indigenous practices with existing missions, funding agencies, targets, and frameworks at a global and national , cities become better equipped to translate this indigenous wisdom from paper to practice so as to create more inclusive, sustainable, and resilient societies. This integration promotes the preservation of indigenous knowledge systems while also contributing to global efforts towards a more equitable and environmentally conscious future. *[Table 2]*

- **URBAN RIVER MANAGEMENT PLAN FRAMEWORK, NIUA**

NMCG and NIUA have developed Urban River Management Plan (URMP) framework under MoHUA which has presently been developed for 5 cities. URMP is based on the three pillars of sustainable development – Environment, Economics and Social - all 3 focused towards ensuring a healthy urban river ecosystem. In some way or other, most indigenous practices are linked towards water as life originated near water. [Table 3]

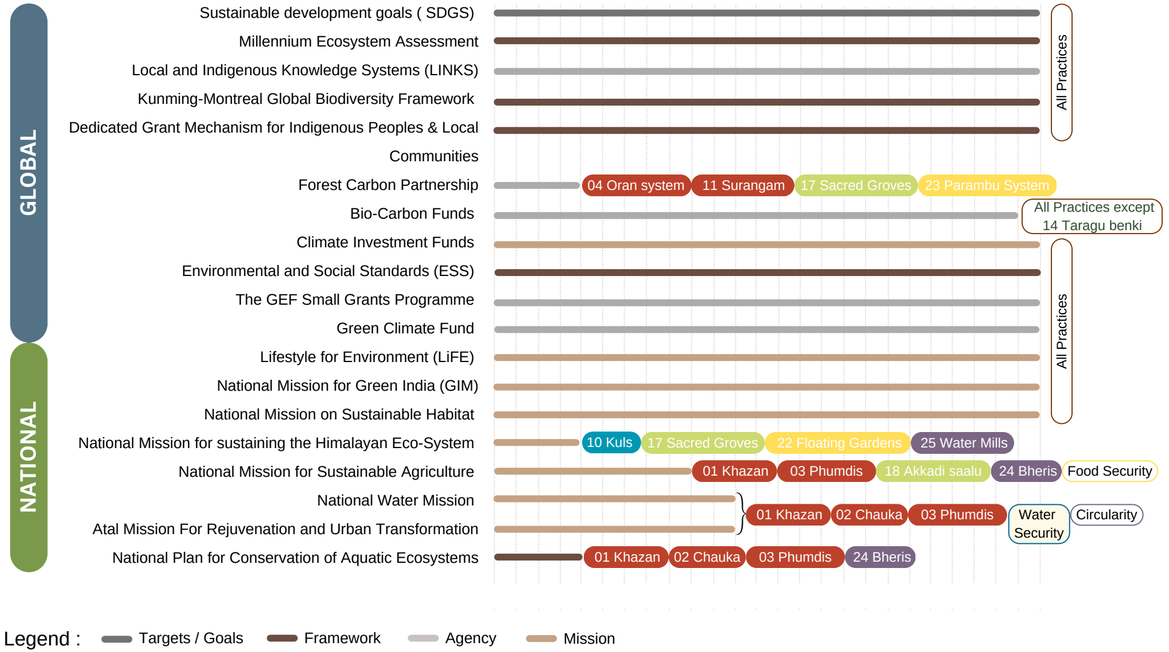
Table 1 : CLIMATE SMART CITIES ASSESSMENT FRAMEWORK (CSCAF), NIUA

**Disclaimer - The synergies discussed in the tables are not exhaustive and there is always scope for more synergies to be drawn.*



URBAN SYNERGIES

***Table 2 : Global & National Missions, Funding, Targets and Frameworks**



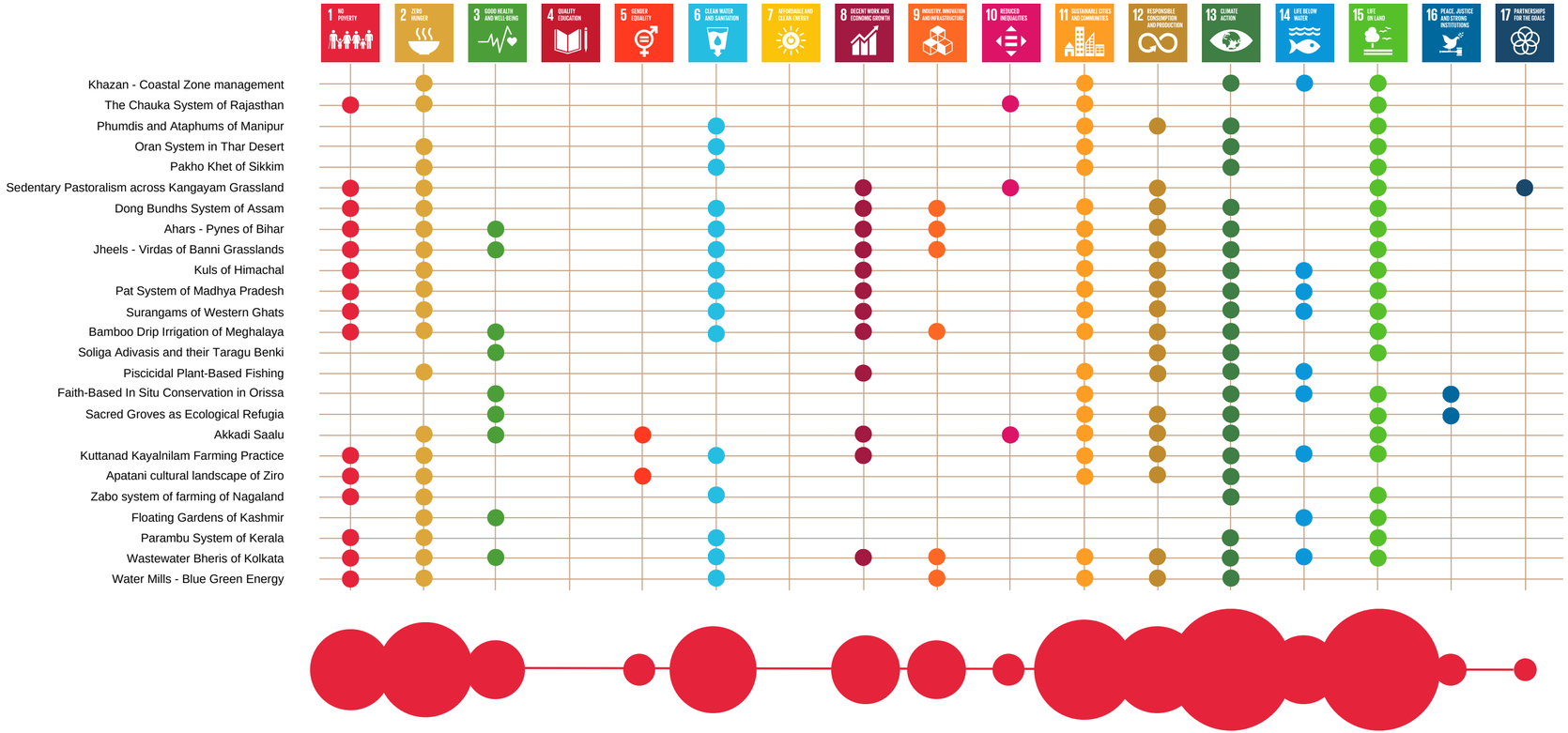
**Disclaimer - The particulars discussed in this table are not an exhaustive list. NIUA does not accept responsibility for any future modifications in the scheme of the particulars discussed.*

***Table 3 : Urban River Management Plan Framework, NIUA**

	Regulation of activities in floodplain	Pollution free river	Rejuvenate waterbodies and wetlands	Enhance riparian buffer	Increased reuse of treated wastewater	Maximum good quality return flow	Eco-friendly riverfont projects	Leveraging economic potential of the river	River sensitive behaviour among citizens	Engage citizens in river management activities
Khazans of Goa			●			●		●		
The Chauka System of Rajasthan									●	
Phumdis and Ataphums of Manipur			●			●		●	●	●
Oran System in Thar Desert										
Pakho Khet of Sikkiim	●			●			●	●	●	●
Sedentary pastoralism across Kangayam grassland	●								●	
Dong Bundhs System of Assam	●		●	●		●			●	●
Ahars - Pynes of Bihar	●		●			●	●	●	●	●
Jheels - Virdas of Banni Grasslands								●	●	●
Kuls of Himachal			●	●		●			●	●
Pat system of Madhya Pradesh			●					●	●	●
Surangams of Western Ghats									●	
Bamboo drip irrigation of Meghalaya			●			●	●		●	●
Soliga Adivasis and their Taragu Benki			●	●					●	●
Piscicidal plant based fishing	●	●	●	●				●	●	●
Insitu conservation - A faith based approach in Orissa			●	●			●	●	●	●
Sacred groves as ecological refugia				●						
Akkadi Saalu	●	●		●			●	●	●	●
Kuttanad Kayalnilam Farming Practice	●	●	●	●				●	●	●
Apatani cultural landscape of Ziro									●	●
Zabo Farming system of Nagaland			●	●				●		
Floating gardens of Dal Lake	●	●	●	●		●		●	●	●
Parambu System of Kerala	●		●	●		●	●	●	●	
Wastewater Bheris of Kolkata		●	●	●	●	●	●	●	●	●
Water mills		●					●	●	●	

**Disclaimer - The synergies discussed in the tables are not exhaustive and there is always scope for more synergies to be drawn.*

SUSTAINABLE DEVELOPMENT GOALS



This section is proof of how indigenous practices in India are closely linked to the Sustainable Development Goals (SDGs) as they contribute to several dimensions of sustainable development.

These practices embody traditional knowledge and skills that promote communal well-being and sustainable livelihoods, aligning with Goal 1 (No Poverty). They emphasise sustainable agriculture and traditional farming methods, supporting Goal 2 (Zero Hunger) by enhancing food security and promoting biodiversity conservation. Indigenous practices also prioritise environmental stewardship, natural resource management, and the preservation of cultural heritage, aligning with various other SDGs such as Goal 6 (Clean Water and Sanitation), Goal 11 (Sustainable Cities and Communities), and Goal 15 (Life on Land). Furthermore, they foster social inclusion, empowerment, and the preservation of indigenous cultures, contributing to Goal 10 (Reduced Inequalities) and Goal 16 (Peace, Justice, and Strong Institutions).

By recognising and aligning these practices with SDGs, we can tap into their potential to address social, economic, and environmental challenges. This linkage promotes cultural diversity, inclusivity, and the rights of indigenous communities, ensuring sustainable development strategies are rooted in local contexts while also reflecting indigenous peoples' needs. The significance lies in transformative change, wherein integrating indigenous practices within the SDGs paves the way for sustainable development that respects diverse cultural traditions while addressing global challenges.

Legend

Low Moderate High impact

GOALS AND OPPORTUNITIES

Climate change is inevitable and as a planet and nation, we are coming to terms with the same. EbA and NbS have been mainstreamed extensively in response to the same, however, the solutions broadcasted are more biased towards the problems of global north while their efficiency in global south is debatable. This is where our diverse repository of indigenous knowledge could step in.

Indigenous knowledge predominantly observed in the global south remains unacknowledged while the truth is that they have time and again proved their mettle in the stand against time which comes from a strong backing of years of place-based knowledge. And in the context of India, the documentation is ever rarer or the knowledge remains highly confined to the realm of indigenous communities and academia.

The world is amidst earth's sixth mass extinction which will not only drive species extinction but also these valuable and tangible knowledge of humans; capable of helping the global south survive. Traditional and indigenous practices are a highly commendable substitute for highly sophisticated hybrid technologies noted in the global north. In fact some of these practices shown in the next page can even be assimilated into the Indian context. This document is also a substantiate effort to conserve these practices while driving home the fact that this is a two-way learning opportunity for both India and the rest of the world. The idea being sold here is not to switch back to the historic ways of living and dining. Rather, it aims at a hybrid approach involving an amalgam of traditional local knowledge and modern day advancements to generate a resilient yet sustainable solution to combat the ill-effects of climate change. These practices are not panacea for replacement or doing away with concrete grey infrastructure but instead it works at reducing the risk simulated due to excessive glorification of high-tech infrastructures in the name of modernisation. In the process of modernisation, humans as such have started to forget the most important thing of all – it is the intelligence and empathy of human mind that has brought us here on the route to development. Advancements like artificial intelligence (AI) and grey infrastructural development can only take us so far; before we are forced to succumb to the glory of nature.

We, at NIUA have merely initiated the beginning of turning back towards our roots with the vision of better and glorious future. There is as usual, always scope for more.

For these practices are a reminiscence of the time when human development was a perfect marriage of advancement and an innate empathy for nature.

– Ayushi Govil, Manju Rajeev Kanchan, Kapil Kumar, Kaveri Bahure


Boma Corrals of the Maasai, Kenya


Uotsukirin (Fish-Breeding Forest) of Japan


Fish trap of Comox harbour, Canada


Half moon farming practice in Sahel


Sea clam garden walls of Canada


Sangjiyutang Mulberry Dyke and Fish Ponds in Huzhou and Shenzhen, China


Totora Reed Floating Islands


Chinampas of Aztec

FINAL THOUGHTS

Our message to key stakeholders for the future of indigenous practices in today's scenario

"We are the first generation to feel the impact of climate change and the last generation that can do something about it." — Barack Obama

Dear readers,

As we approach the last juncture of this document, it is only fair that we leave out a trailblazer on how the baton may be passed ahead in this race against time for climate resilience. Indigenous practices may seem like relics and totems of an ancient way of living; long forgotten and meant to be kept that way. But it is not so for they guard the portal to a resilient future for not just India but the planet as a whole.

The omnipresent global warming and climate change has escalated enough to generate a demand based vacuum for a set of solutions that are regenerative by character and indigenous practices seamlessly fit in like the right puzzle piece. But if they are to be mainstreamed into the urban sector, a team of avengers need to unite. The involvement of stakeholders at the right time can create a strong impact in preserving one of the most valuable anthropological heritage for the future.

With the G20 presidency and LIFE Mission, India is already under a global spotlight which means there cannot be a better time than now to work towards uplifting our indigenous knowledge while subsequently shaping the future of Indian sustainability. Each one of us are inevitably vital to the future of our glorious heritage.

At a macroscale, cities need to initiate efforts towards embracing our actual roots instead of merely colonial ones. The key to climate resilience lie in the use of nature sensitive local innovations that are contextualized to the point of intervention. All this is easily possible with traditional and indigenous practices as they are practically tailored to their region of origin. Their organic nature makes them relatively easy for adaptation to different local contexts as well.

There is also an extensive need to build the environmental literacy of cities. Here is where indigenous and local communities come into the frame. Their extensive repository of experiences and knowledge need to be tapped and made permeable to the urban world. Academicians and researchers can assist in this through their intense research work under this paradigm. This is, however, not a one way permeability that we are talking about. For indigenous knowledge to be made accessible, cities need to create an environment conducive for facilitating easy transfer of knowledge.

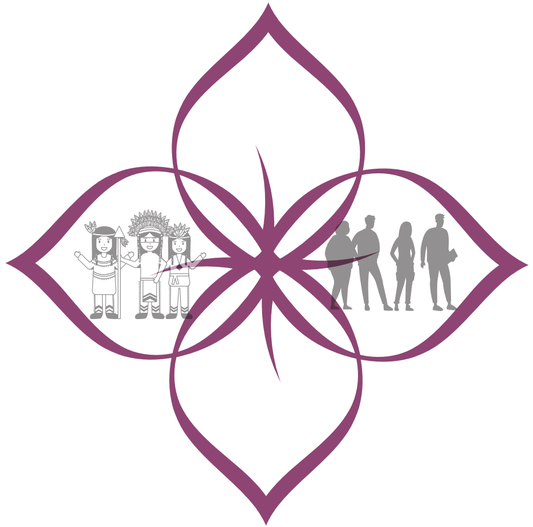
There is a misconception among a huge faction of today's generation that indigenous and traditional practices cannot be used in today's scenario due to factors such as spatial constraints, misconstrued side effects etc. that once governed the foundation of ancient civilizations. In the process of doing so, they fail to recognise that these practices originated at a time in history when we were still connected in deep to the natural threads of existence. This is perhaps the biggest USP that sets indigenous and traditional practices apart from NbS as the prime focus of the latter is on deriving solutions by banking on the ecosystem services.

offered by an element of a larger ecosystem such as mangroves. Their strength of resilience was visibly noted despite supply chain disruptions due to COVID-19 ; in the indigenous communities that still imbibe these practices.

Modern day grey infrastructure is efficient enough to resolve only those problems for which they were designed but these practices constitute infrastructural components that offer a multitude of tangible benefits such as community spirit, livelihood, inclusivity etc. in addition to the slew of environmental benefits that we already know of. Understanding the principle of these practices and then adapting or replicating the same to a different setting is what we need to be looking at.

This is exactly what as the think tank for urban sector, NIUA has attempted to do at. As discussed in this document, at a national and global level, there are no dearth of funding opportunities for implementing these practices. This therefore implies that it is more of a perceptional change that is required for the conservation and implementation of these practices in the urban sector. As a nation, we have a lot of scope to learn from within and from other nations as well. The same can be said for the other nations that can learn a lot from the repository of Indian traditional and local knowledge.

Let us all therefore work towards reconnecting with our present by collaborating with our past inorder to create a better future as a planet.



Scan to collaborate with us