Designing Connected Urban Green Corridors for Pollinator Conservation in Bangalore: A Scalable Framework for Indian Cities

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Abstract

Pollinators such as bees, butterflies, birds, and bats are essential to ecosystem stability and food production. However, rapid urbanization across India has led to habitat fragmentation, pesticide overuse, and biodiversity decline. This paper proposes a low-cost, scalable ecological framework to restore pollinator resilience in Indian cities, using **Bangalore as the demonstration model**. Satellite-based spatial analysis is used to identify fragmented green spaces and design **urban pollinator corridors** that connect lakes, campuses, roadsides, and community spaces. The model integrates **native tree planting, community participation, and pollinator nesting sites** with **Integrated Pest Management (IPM)** in farms. This study aims to provide a replicable city planning strategy that improves pollination services, air quality, soil health, biodiversity, and urban liveability without requiring large capital investments.

1. Introduction

Pollination is a critical ecosystem service supporting 75–80% of flowering plants and 35% of global food crops. In India, crops like mango, tomato, chilli, sunflower, mustard, and millets depend on insect pollination. However, natural pollinator populations are declining sharply due to:

- Habitat loss
- Pesticide toxicity
- Climate change
- Invasive species
- Nutritional stress (lack of floral resources)

India is undergoing rapid urbanization, with **Bangalore losing nearly 80% of its vegetation cover since 1973** due to unplanned concrete expansion. Fragmented green patches do not provide continuous forage for pollinators. This paper introduces a **connected green corridor network** that fits seamlessly into urban layouts and existing infrastructure, making ecological restoration economically practical.

2. Problem Statement: Urbanization and Ecological Fragmentation in Bangalore

Bangalore's landscape has shifted from "Garden City" to "Grey City." Fragmented landscaping using ornamental non-native plants does not support pollinators or biodiversity. Road widening has removed tree-lined corridors, and pesticides have reduced wild bee populations in peri-urban agriculture belts like Devanahalli and Hoskote.

Key Challenges:

- Loss of connected green pathways
- Air pollution and Urban Heat Islands (UHIs)
- Dependence on chemical pesticides
- Seasonal scarcity of floral resources
- No integration of biodiversity planning in city engineering projects

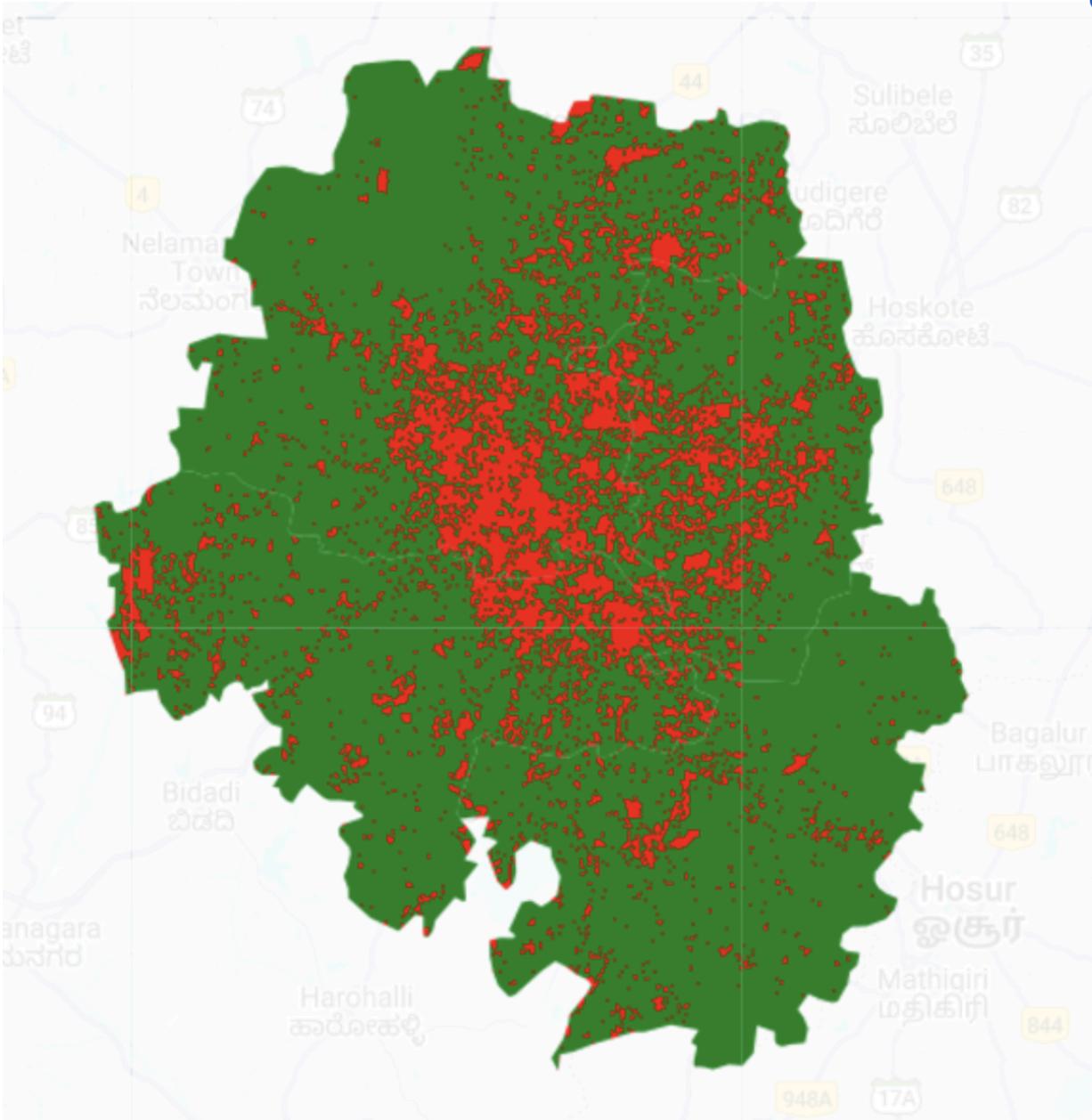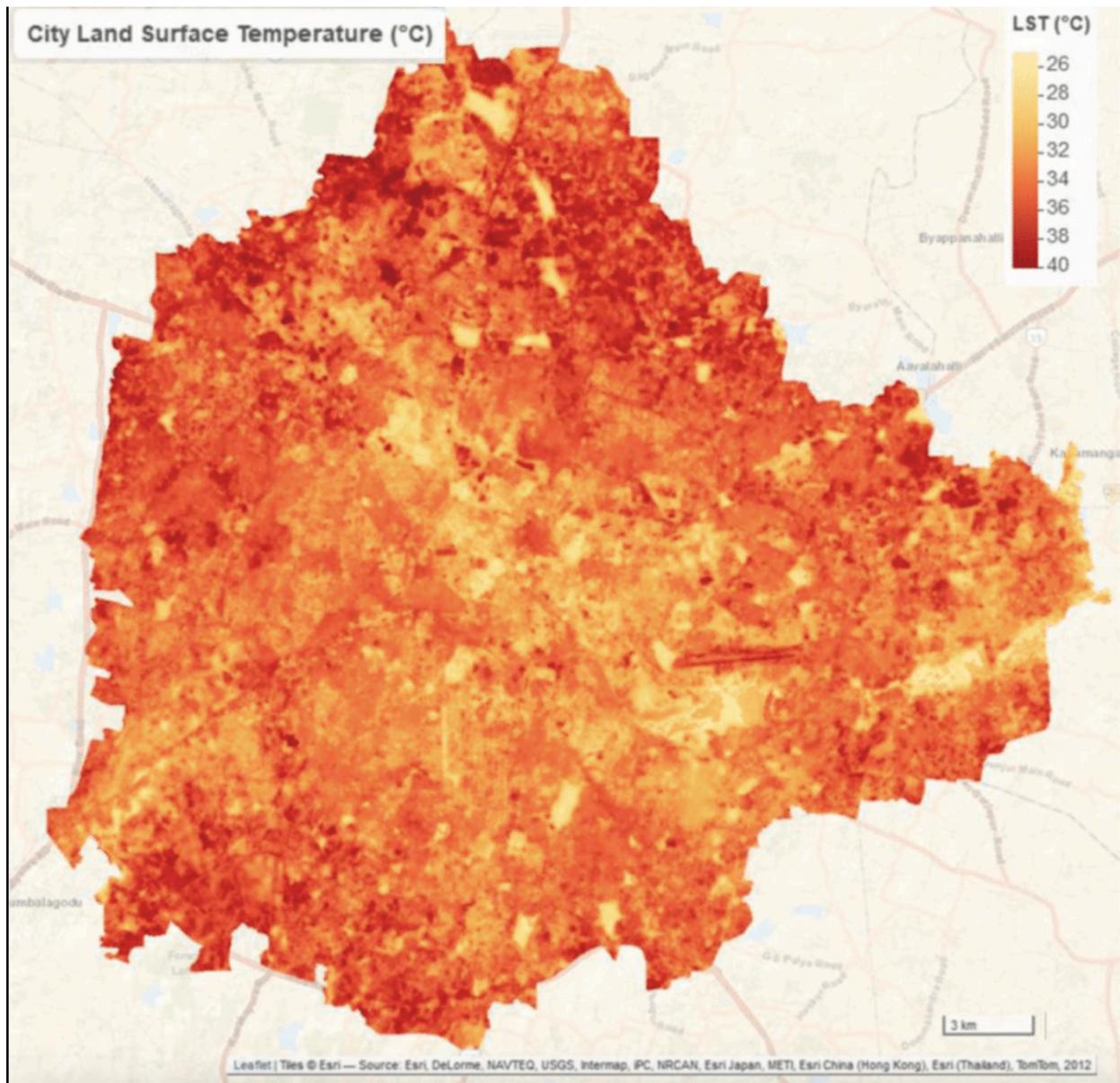**Figure Placeholder 1: Bangalore Green Cover Change 1973–2020**

Figure 2: Urban Heat Island Distribution in Bangalore

3. Research Objectives

1. Map green space fragmentation in Bangalore using satellite imagery.
2. Identify ecological priority zones for pollinator corridor restoration.
3. Propose a low-cost, scalable native planting model.

4. Integrate citizen, urban, and peri-urban farming participation.
5. Develop a blueprint replicable across major Indian cities.

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4. Methodology

4.1 Data Sources

- **Satellite Images:** Sentinel-2, Google Earth Engine
- **NDVI Vegetation Index** for vegetation density
- **Land Surface Temperature** to detect UHIs
- **Bangalore Master Plan** for urban zones

4.2 GIS Procedure

- Identify high-fragmentation zones
- Map ecological anchors (lakes, campuses, parks)
- Generate connectivity corridors
- Layer urban heat/green potential zones

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5. Results – Proposed Urban Pollinator Corridor Network

5.1 Ecological Anchors

These are areas to connect:

- Cubbon Park
- Lalbagh
- IISc Forest
- Sankey Tank
- Hebbal Lake
- Jakkur Lake
- HSR Layout Parks
- Sarjapur Lake belt

Figure 3: Vegetation Change Map of Bengaluru (2006-2019)

LEGEND

VEGETATION CHANGE
(2006-2019)

Positive change

No change

Negative change

Other classes
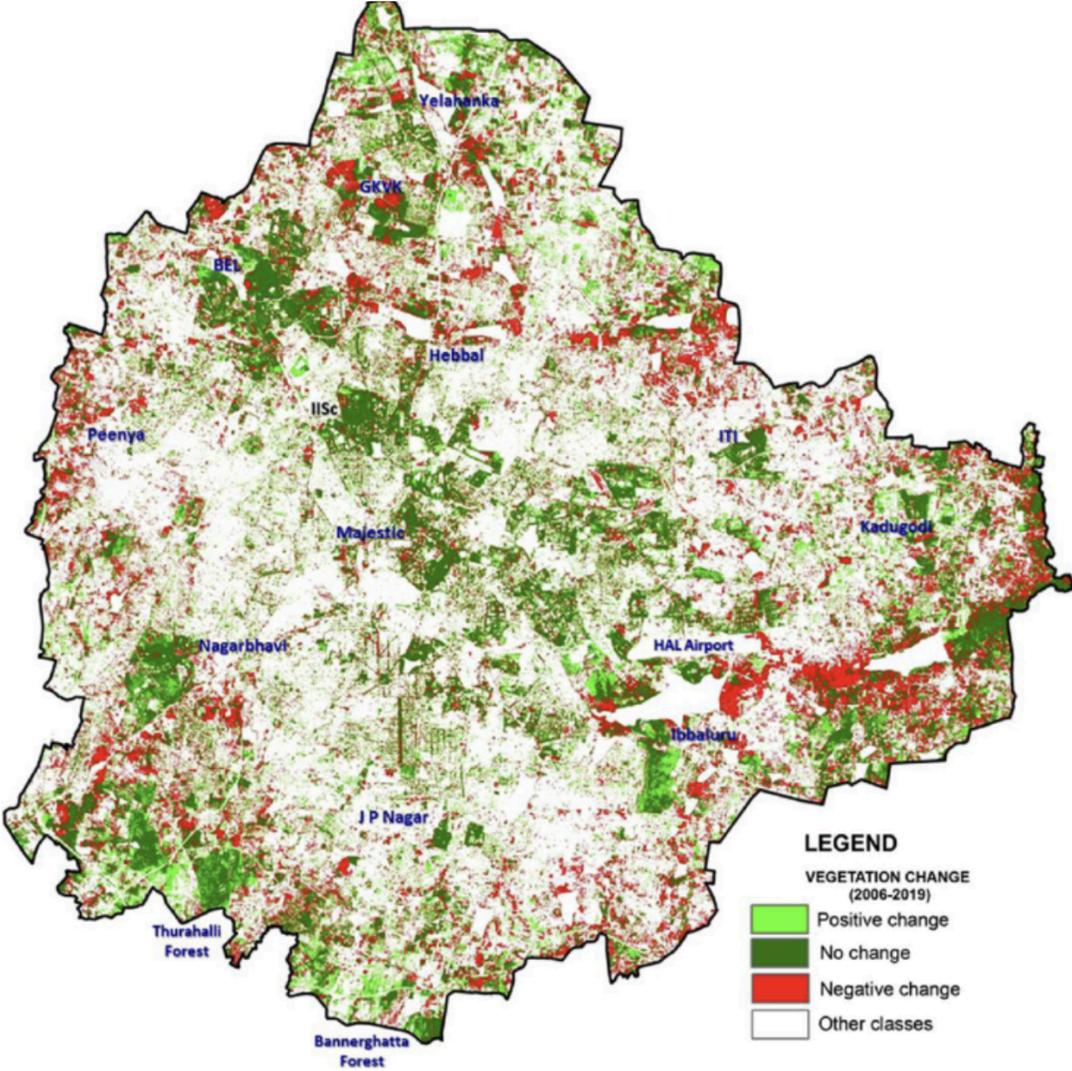
a) Tree Census using GPS.

b) Trees from remote sensing data through pattern classifiers.

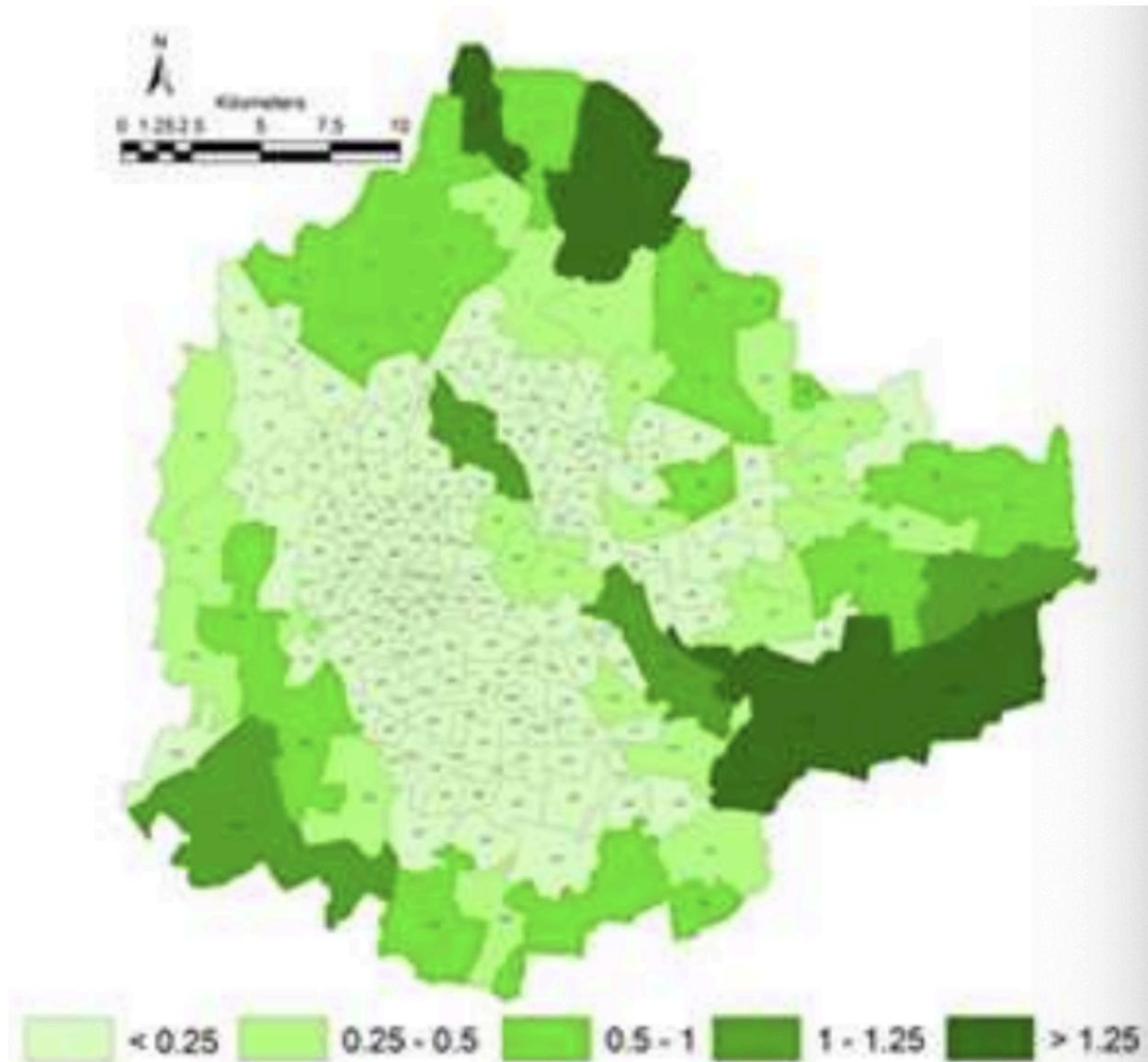**Figure 4: Tree Distribution in the Indian Institute of Science Campus**

Figure 5: Ward-wise trees per person

5.2 Corridor Design Features

Feature	Purpose	Cost
Native tree streets	Shade, forage	Low
Lake buffer planting	Biodiversity	Low
School/community gardens	Citizen integration	Low

6. Native Species Planting Model

6.1 Tree Layer

- **Banyan (Ficus benghalensis)** – keystone species
- **Neem (Azadirachta indica)** – pollinator & medicinal
- **Peepal (Ficus religiosa)** – long flowering season
- **Jamun (Syzygium cumini)** – fruit pollinators
- **Indian Laburnum (Cassia fistula)** – bee-attracting
- **Mango (Mangifera indica)** – seasonal foraging

6.2 Shrub + Ground Layer

- **Hibiscus, Gliricidia, Wild Tulsi, Tecoma, Ixora, Lantana (native variant)**

Prominent trees of Bangalore

Acacia auriculiformis Cnn. Ex Benth.
Bauhinia purpurea L.
Bombax malabaricum DC.
Cassia spectabilis DC.
Cocos nucifera L.
Delonix regia (Bojer ex Hook.) Raf.
Polyalthia longifolia (Sonn.) Thwaites
Spathodea campanulata P. Beauv.
Millingtonia hortensis L.f.
Pongamia pinnata
Bauhinia variegata L.
Albizia lebbeck (L.) Benth
Peltophorum pterocarpum (DC.)
Roystonea regia (H.B.K) O.F.Cook
Casuarina equisetifolia L.
Tectona grandis L.f
Grevillea robusta Cunn. Ex R. Br.
Swietenia macrophylla King
Cassia fistula
Milletia ovalifolia
Michelia champaca L.
Samanea saman (Jacq.) Merr.
Tabebuia rosea (Bertol) DC.
Murraya koenigii
Psidum guajava L.
Mangifera indica
Saraca asoca (Roxb.) de Wilde
Thespesia populnea (L.) Sol. Ex Corr. Serr.
Solanum grandiflorum
Parkia biglandulosa
Lagerstroemia speciosa (L.) Pers.
Castanospermum australe Cunn. & Fraser
Butea monosperma
Enterolobium cyclocarpum
Tabebuia impetiginosa (Mart. Ex DC.) Standl.
Tabebuia aurea (Manso) benth. & Hook.f. ex S. Moore
Dolichandrone platycalyx
Eucalyptus tereticornis
Callistemon viminalis (Soland. Ex Gaertn.) G. Don

Acacia auriculiformis Cnn. Ex Benth.

Spathodea campanulata P. Beauv

Cassia fistula

7. Community and Farmer Integration

Urban Strategy

- Balcony gardens
- Bee hotels
- Pollinator-friendly parks
- Zero-pesticide zones

Farmer Strategic Implementation

- Reduce pesticides
- Introduce IPM tools
- Seasonal flower strips
- Bee nesting protection

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8. 10–15 Year Implementation Plan

Phase	Timeline	Focus
Phase 1	0–2 years	Maps + pilots + native nurseries
Phase 2	3–7 years	Corridor expansion + schools + wards
Phase 3	8–15 years	Policy integration

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9. Conclusion

This framework reconnects fragmented urban landscapes while supporting biodiversity, agriculture, and public health. It is **scalable across Indian cities** such as Pune, Hyderabad, Ahmedabad, Chennai, and Delhi with minimal investment by using **existing public land + native ecology + community action**.