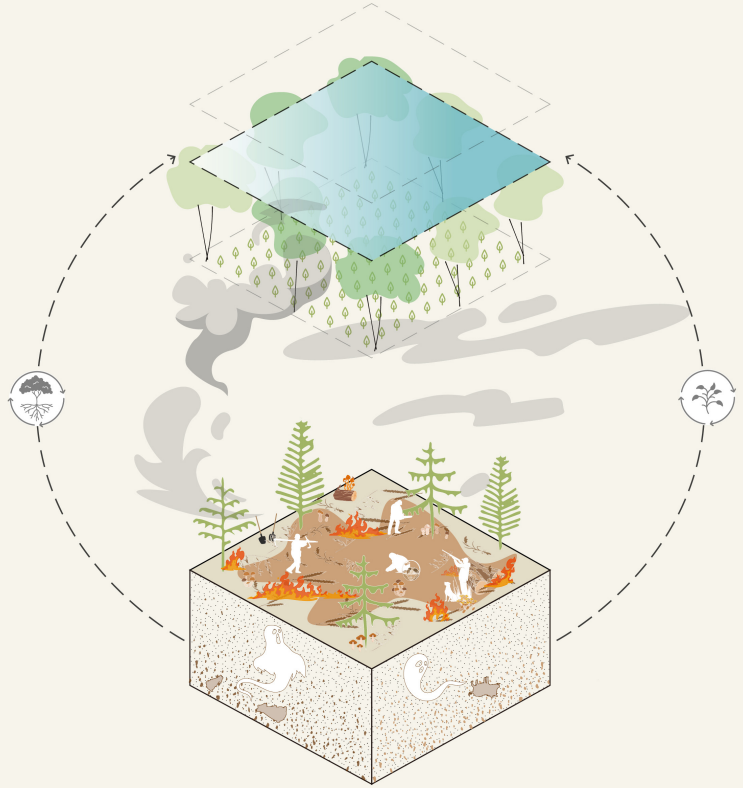


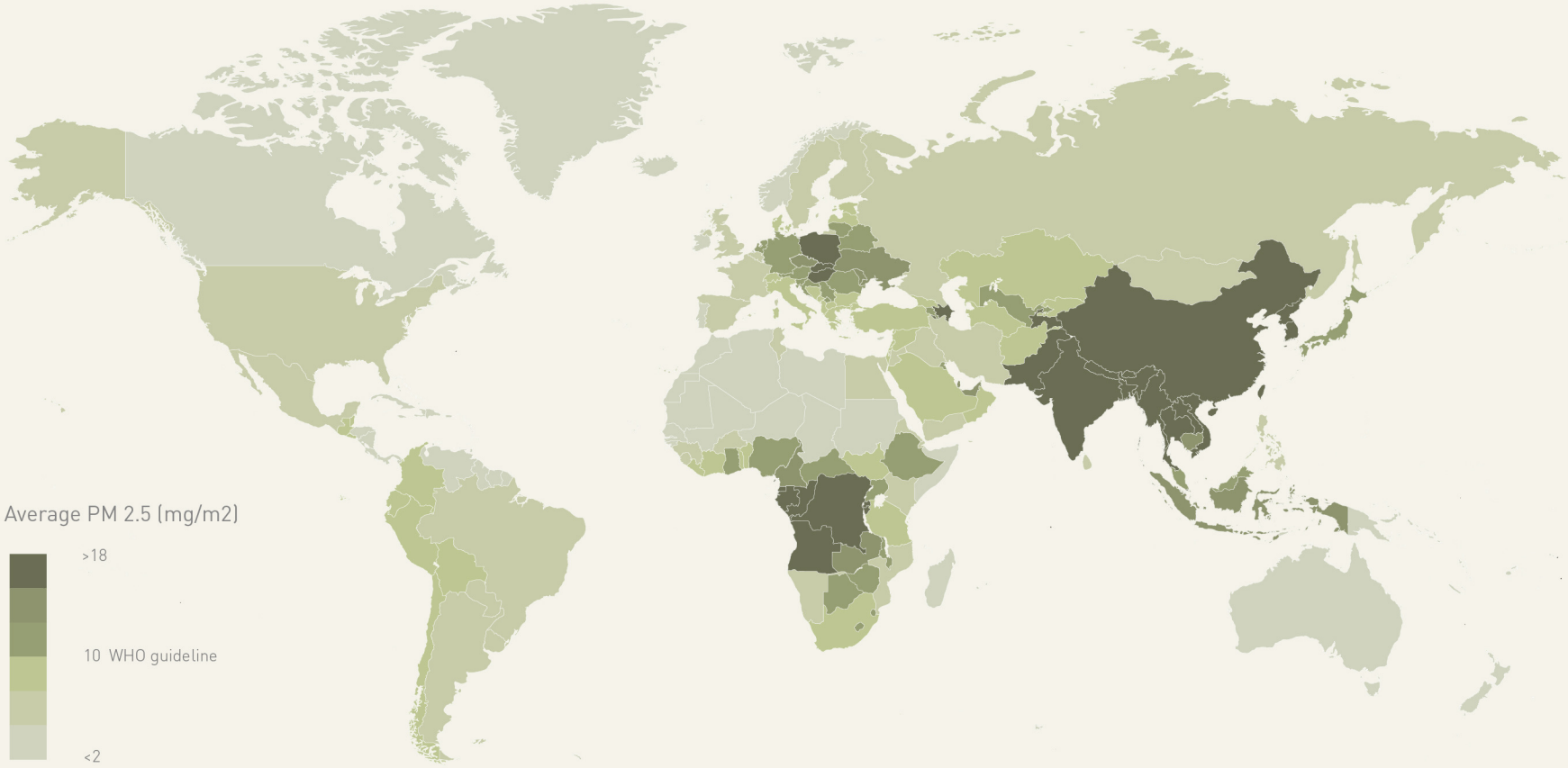
Refresh

—— Cultivating a new paradigm of integrated farming as mitigation of air pollution in Chiang Mai, Thailand

Urban Ecology Lab
Lei Qi
5545951
First mentor: Nico Tillie
Second Mentor: Remon Rooij

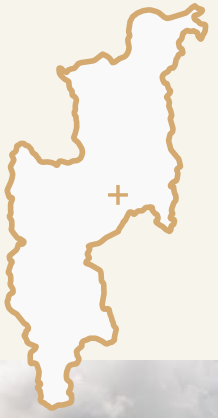
Global Air Quality

Global Air Quality (concentration of PM2.5)

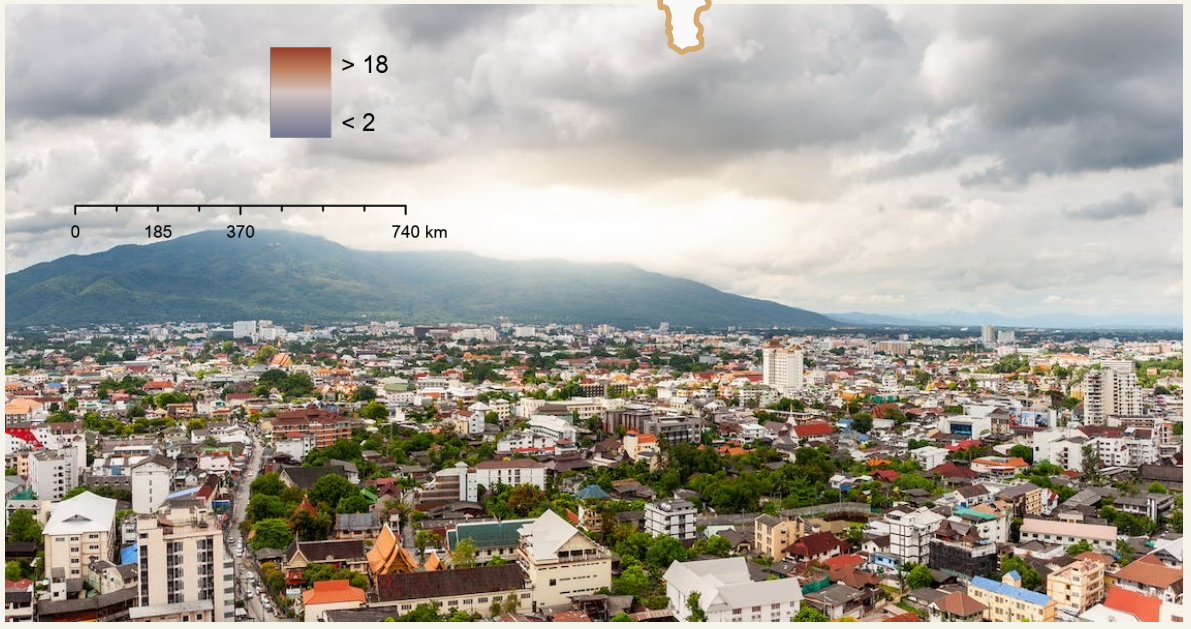


Data source: ArcGIS Online, https://www.arcgis.com/home/webmap/viewer.html?webmap=eb0e3086f6d54554a84b7cd027de9c29

Chiang Mai, Thailand



Air Quality in Thailand
(PM 2.5 Concentrations)



Chiang Mai is

2nd
large city
in Thailand.

1st
large cultivated area
in upper northern of Thailand.

Chiang Mai is the city in a valley; the **mountain landscape** and that Ping River is laid from north to south make only

30%
suitable for settlement and agriculture

Photo by Pim Kemasingki | Thu 1 Nov 2018

Data source: ArcGIS Online, https://www.arcgis.com/apps/mapviewer/index.html?webmap=eb0e3086f6d54554a84b7cd027de9c29

Agriculture in Chiangmai

Terraced Paddy Field in Chiangmai

PROBLEM STATEMENT

BURNING SEASON

Photo: MFU PHOTOCLUB

Photo: Kitsanakorn Maneerat/Colourbox
Photo: worapojnuntaa/Shutterstock

PROBLEM STATEMENT
BURNING SEASON

Photo: MFU PHOTOCLUB

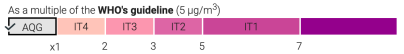
Photo: Kitsanakorn Maneerat/Colourbox
Photo: worapojnuntaa/Shutterstock

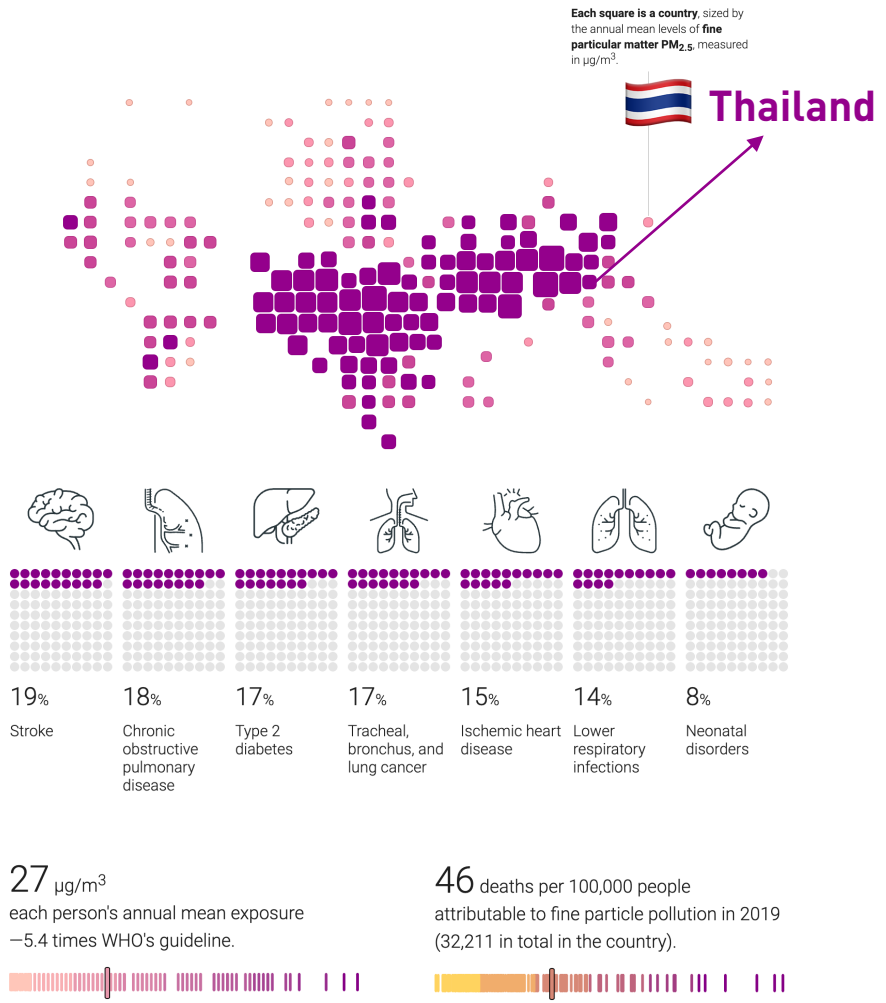
PROBLEM STATEMENT
A Cascade of Effects

Lead to severe consequences on ***both environment and human health***

Biodiversity loss
Bad health & early death

In 2019, **99% of the world population** was living in places where the WHO's strictest 2021 **air quality guideline levels were not met**.





27 µg/m³
each person's annual mean exposure —5.4 times WHO's guideline.

46 deaths per 100,000 people attributable to fine particle pollution in 2019 (32,211 in total in the country).

Data source: Institute for Health Metrics and Evaluation (IHME), 2020, https://vizhub.healthdata.org/gbd-results/

VISION + STRATEGY

1. How does **a regional strategy framework** incorporate regional landscape system and local agricultural system to control air pollution?

2. How to cultivate **a new relationship** between farmland and urban expansion that provides a sustainable crop production network?

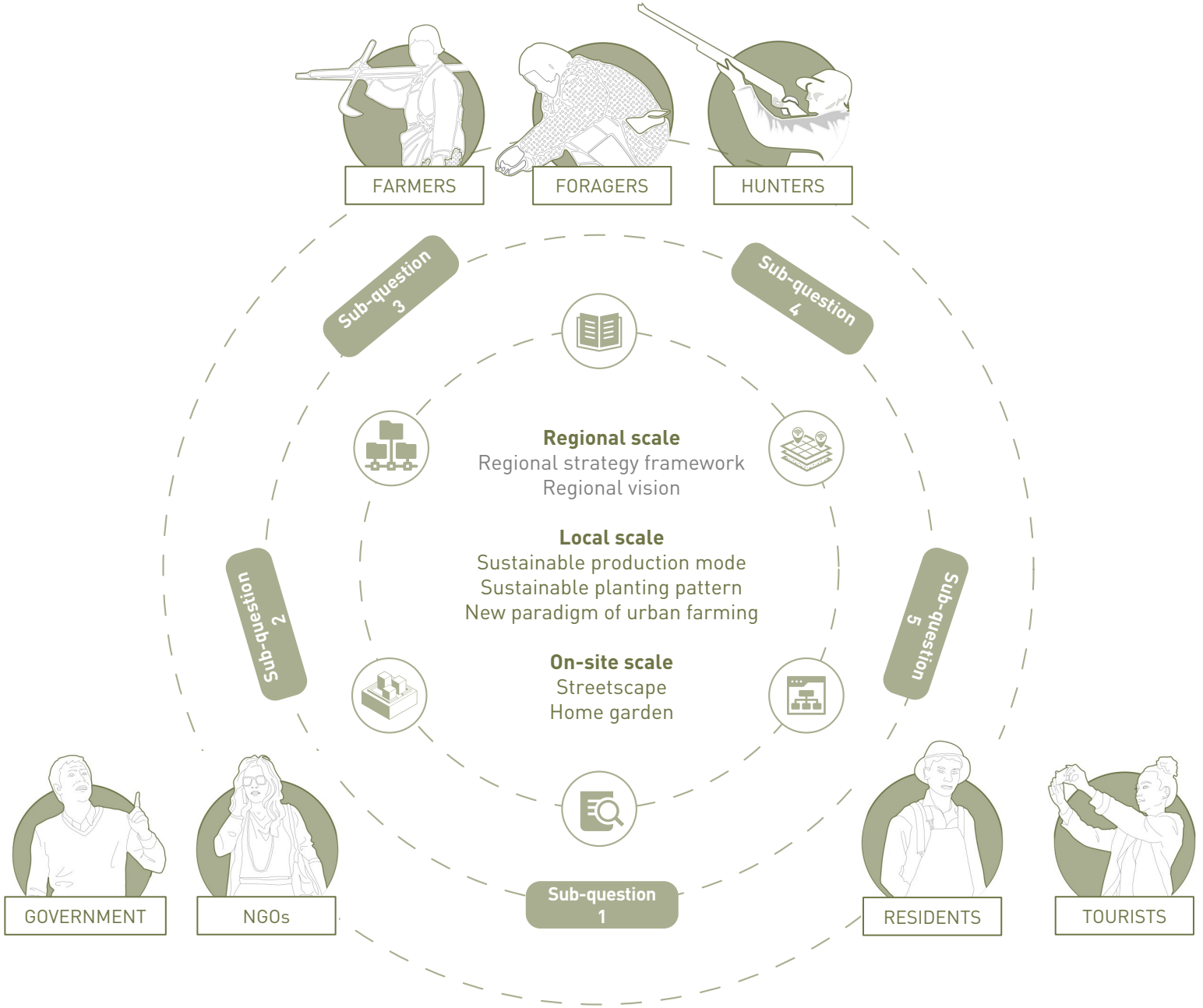
How to cultivate **a new paradigm of integrated farming practice** as mitigation of air pollution in Chiang Mai through tailoring **sustainable agriculture system** and **sustainable landscape framework** in the context of southeast Asia?

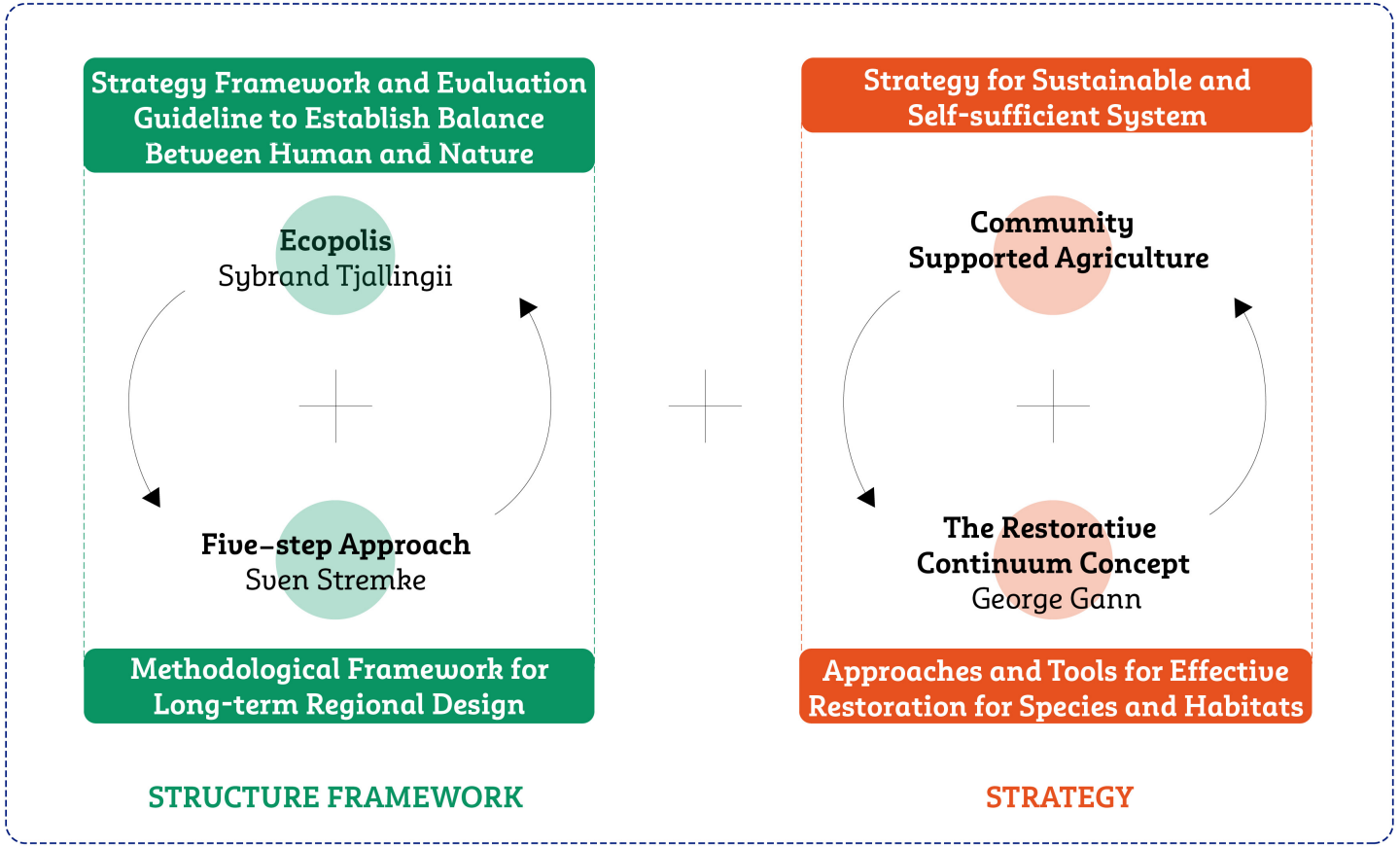
5. What is the most efficient local **vegetation species** and **planting pattern** to remove air pollution in urban area?

3. What kind of **sustainable production mode** can improve the living conditions of local residents without harming the ecological environment?

4. What kind of **sustainable cultivation pattern** of crops can be practiced in farmland in the context of Southeast Asia?

SITE 1 + SITE 2


FARMERS
FORAGERS
HUNTERS
Sub-question 3
Sub-question 4
Sub-question 2
Sub-question 5
Regional scale
Regional strategy framework
Regional vision
Local scale
Sustainable production mode
Sustainable planting pattern
New paradigm of urban farming
On-site scale
Streetscape
Home garden
Sub-question 1
GOVERNMENT
NGOs
RESIDENTS
TOURISTS


Strategy Framework and Evaluation Guideline to Establish Balance Between Human and Nature
Ecopolis
Sybrand Tjallingii
Five-step Approach
Sven Stremke
Methodological Framework for Long-term Regional Design
STRUCTURE FRAMEWORK
Strategy for Sustainable and Self-sufficient System
Community Supported Agriculture
The Restorative Continuum Concept
George Gann
Approaches and Tools for Effective Restoration for Species and Habitats
STRATEGY

Ecopolis
Sybrand Tjallingii

Strategy Framework and Evaluation Guideline to Establish balance Between Human and Nature

THE RESPONSIBLE CITY
FLOW

SUSTAINABLE FLOW MANAGEMENT

- Organic Waste Management
- Renewable Energy System

THE PARTICIPATING CITY
PARTICIPANTS

SUSTAINED COMMITMENT TO ECOLOGICAL RELATIONSHIP

- Stakeholders Involved Decision-making
- Community Engagement

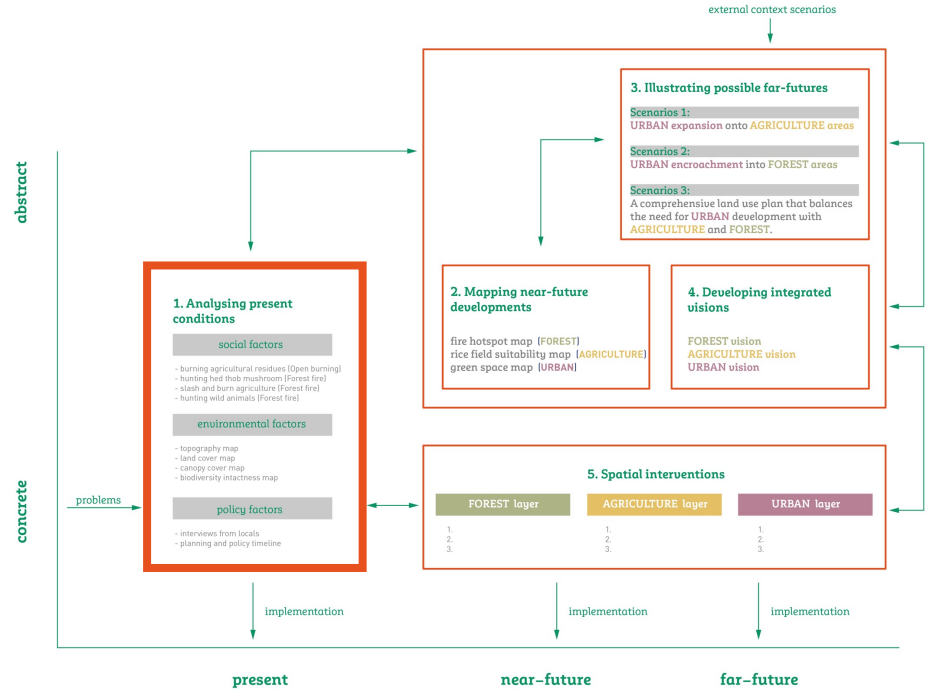
THE LIVING CITY
SITE/AREA

SUSTAINABLE USE OF AREA WITH POTENTIAL

- Enhance Ecosystem Services
- Support Well-being of Residents

Five-step Approach
Sven Stremke

Methodological Framework for Long-term Regional Design



What causes severe haze in urban area?

1 Burning Agricultural Residues

OPEN BURNING

agriculture area

Photo: https://www.iqair.com/newsroom/thailand-2021-burning-season

Hunting Hed Thob Mushroom 2

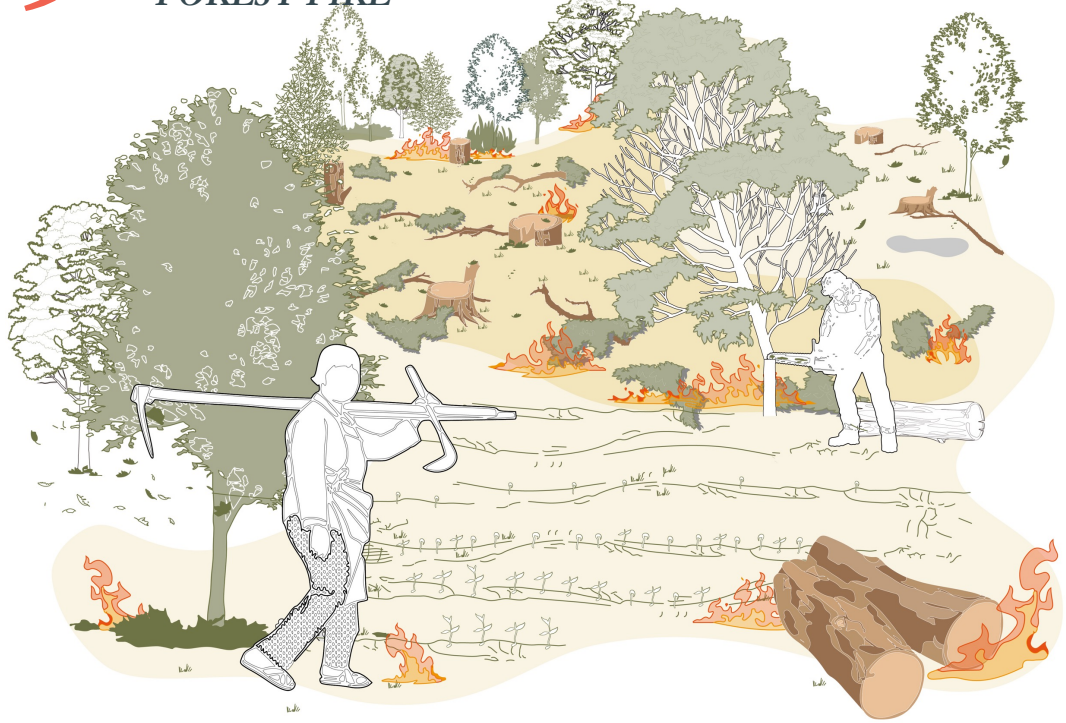
FOREST FIRE

forest area

3 Slash and Burn Agriculture

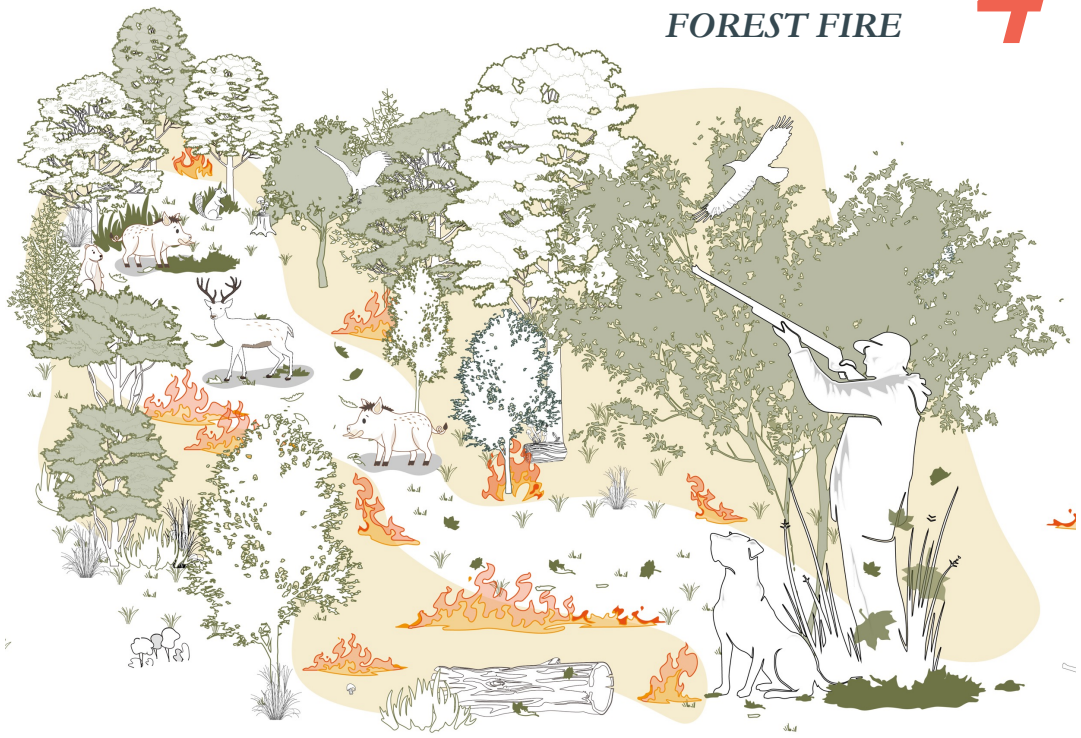
FOREST FIRE

forest area



Hunting Wild Animals 4

FOREST FIRE

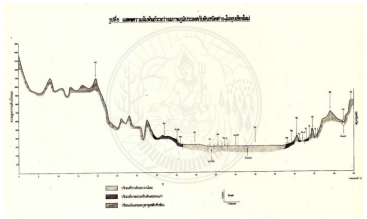


forest area

And why does it have lasting impacts?

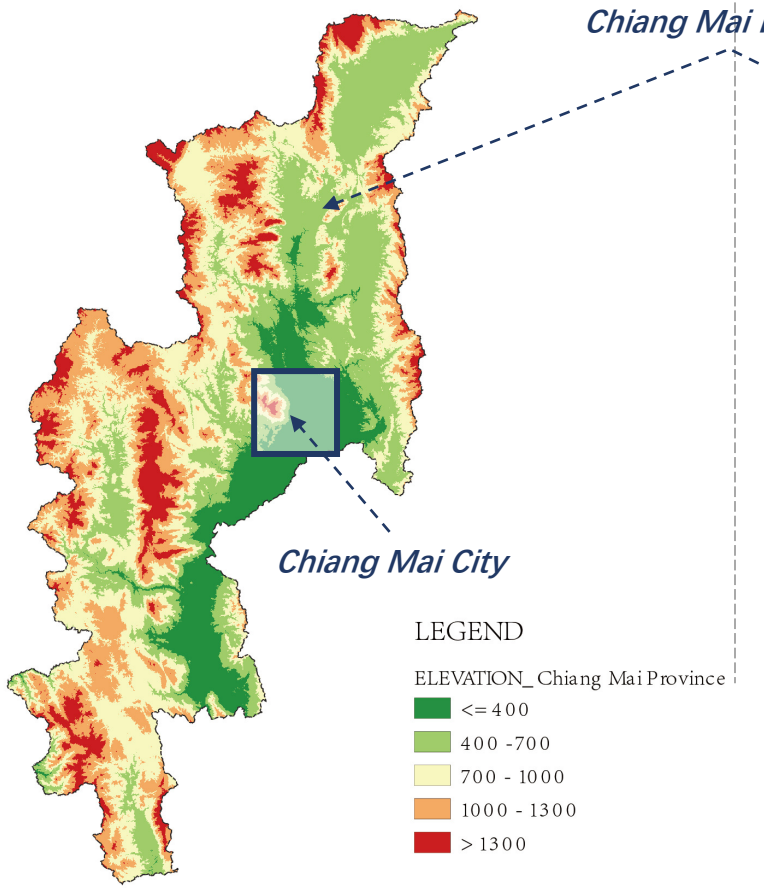
1 Topography

This mountain-valley topographical type **limits the dissipation** of air pollution



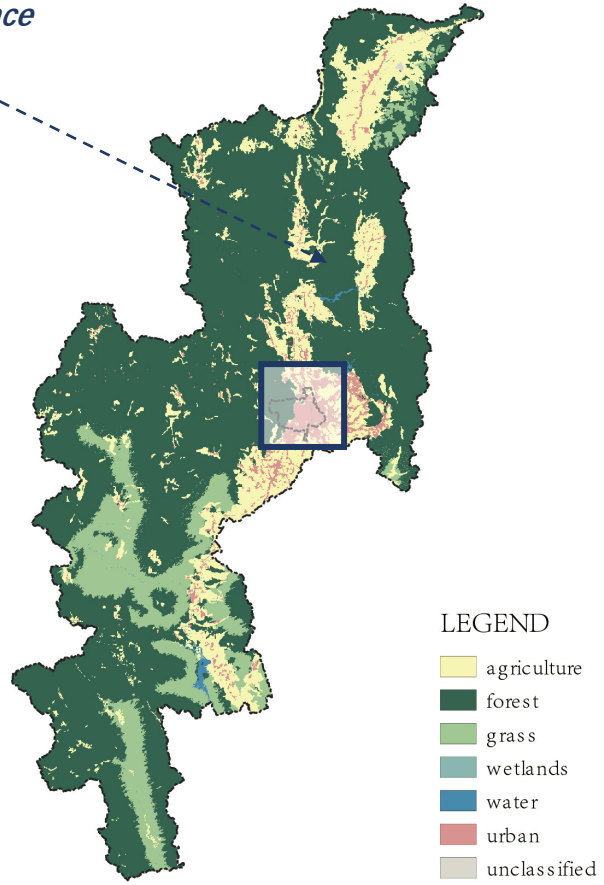
Chiang Mai Province

Chiang Mai City

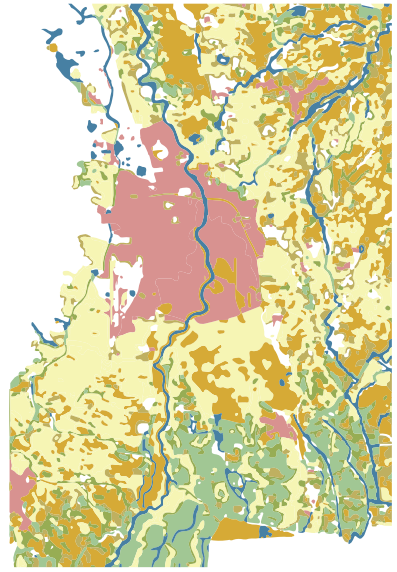


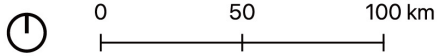
2 Land Use (Urban Expansion)

Citizen get affected easily because **residential area are mixing into agriculture area**



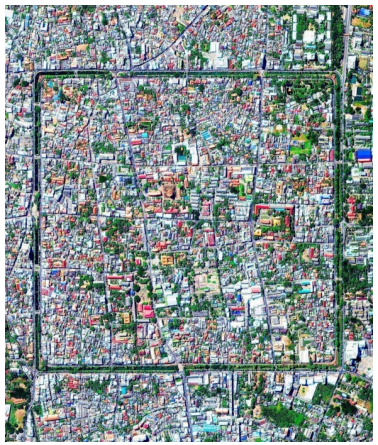
Chiang Mai City

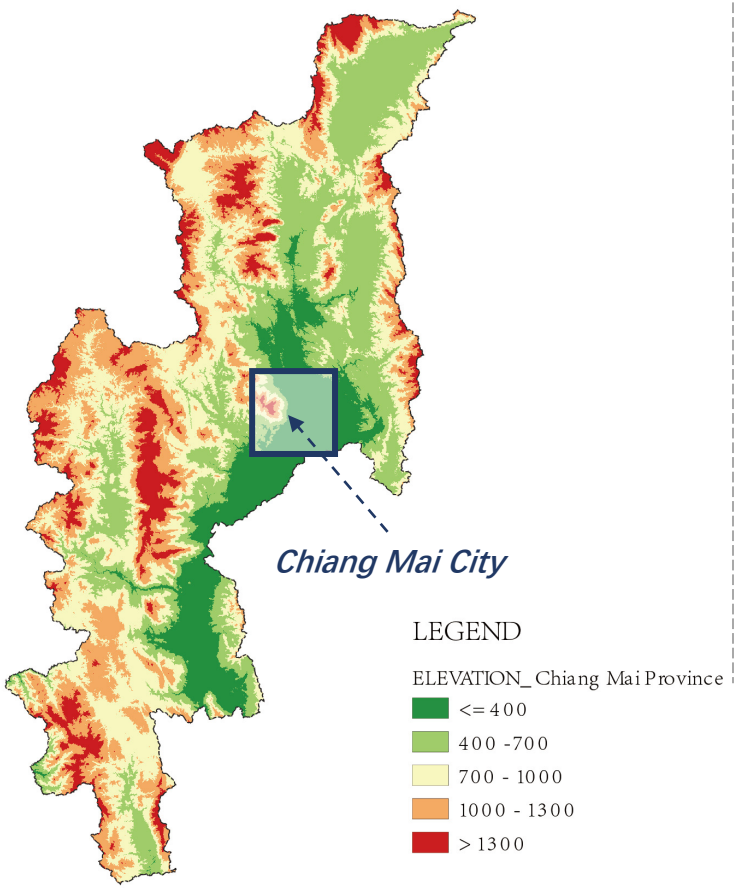




3 Canopy Cover

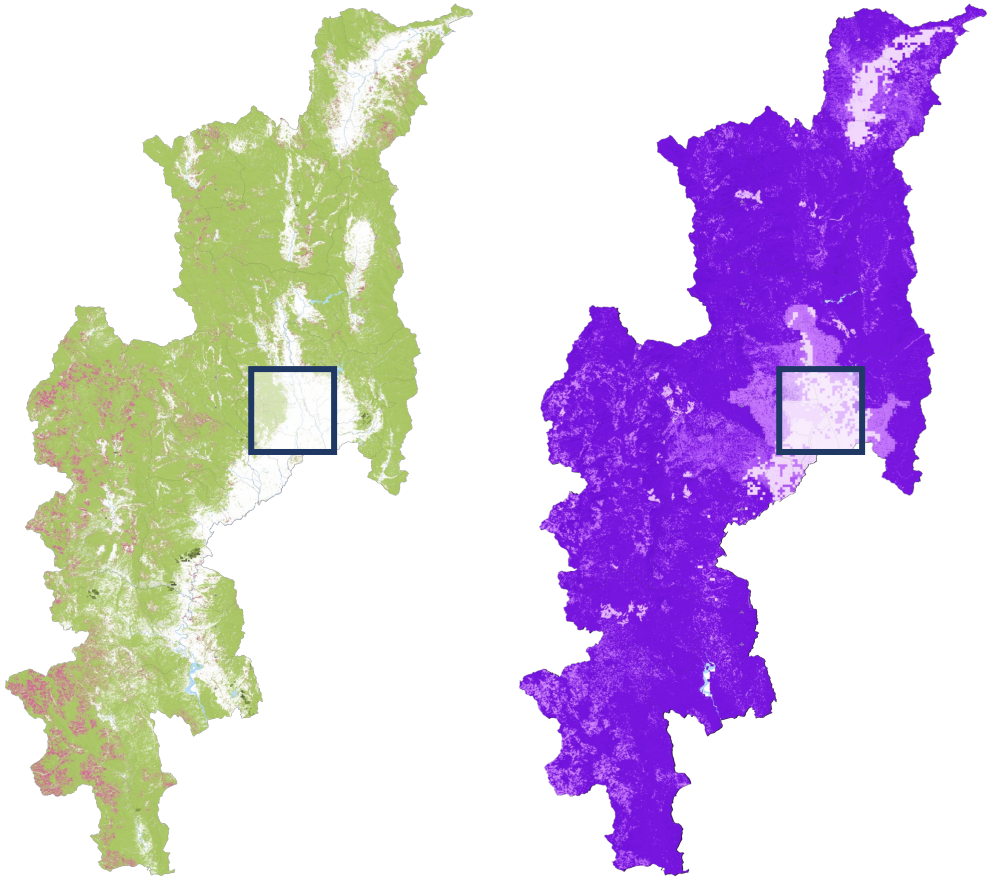
Few trees in urban area to absorb air pollutants





Biodiversity 4

Biodiversity loss weakens the ability to absorb air pollution



0 50 100 km

Why was this issue not addressed before, or was it?


When I drive a vehicle outdoor or when I go to the rice field, the symptoms will start to occur.
When we burn, we make firebreaks to control the fire.
If we do not burn residues, where will we keep rice straws?
It can destroy the surface of soil and kill earthworms. Nevertheless, we need to burn because our rice might be infected with disease
Around April, I usually have eye irritation.
It has become a way of life. It happens every year. What will be, will be. There is nothing we can do about it.

PAST
Subsistence Agriculture

1961
Shift in policy:
Agriculture products export

1980s
NGOs: Promoting sustainable agriculture

1991
NGOs: Promoting organic agriculture

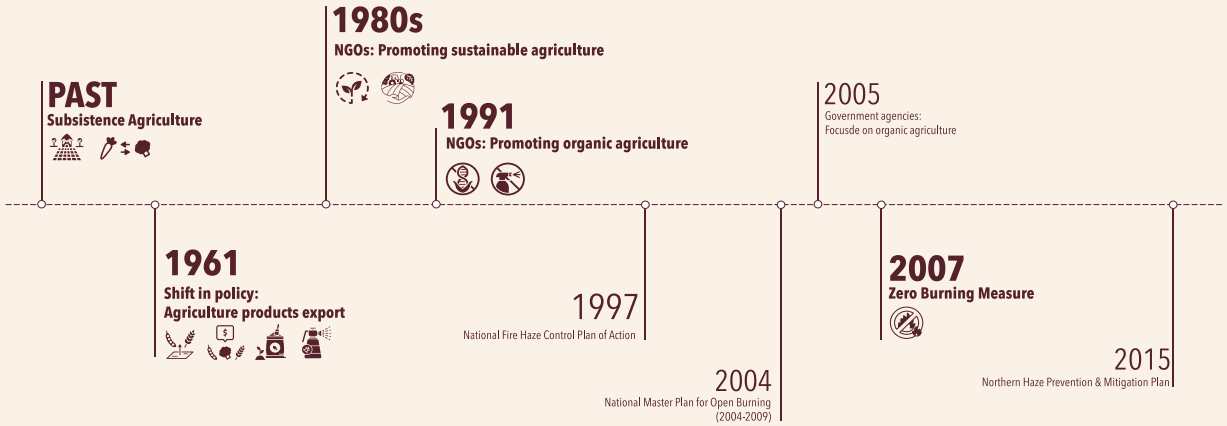
1997
National Fire Haze Control Plan of Action

2004
National Master Plan for Open Burning
(2004-2009)

2005
Government agencies:
Focusde on organic agriculture

2007
Zero Burning Measure

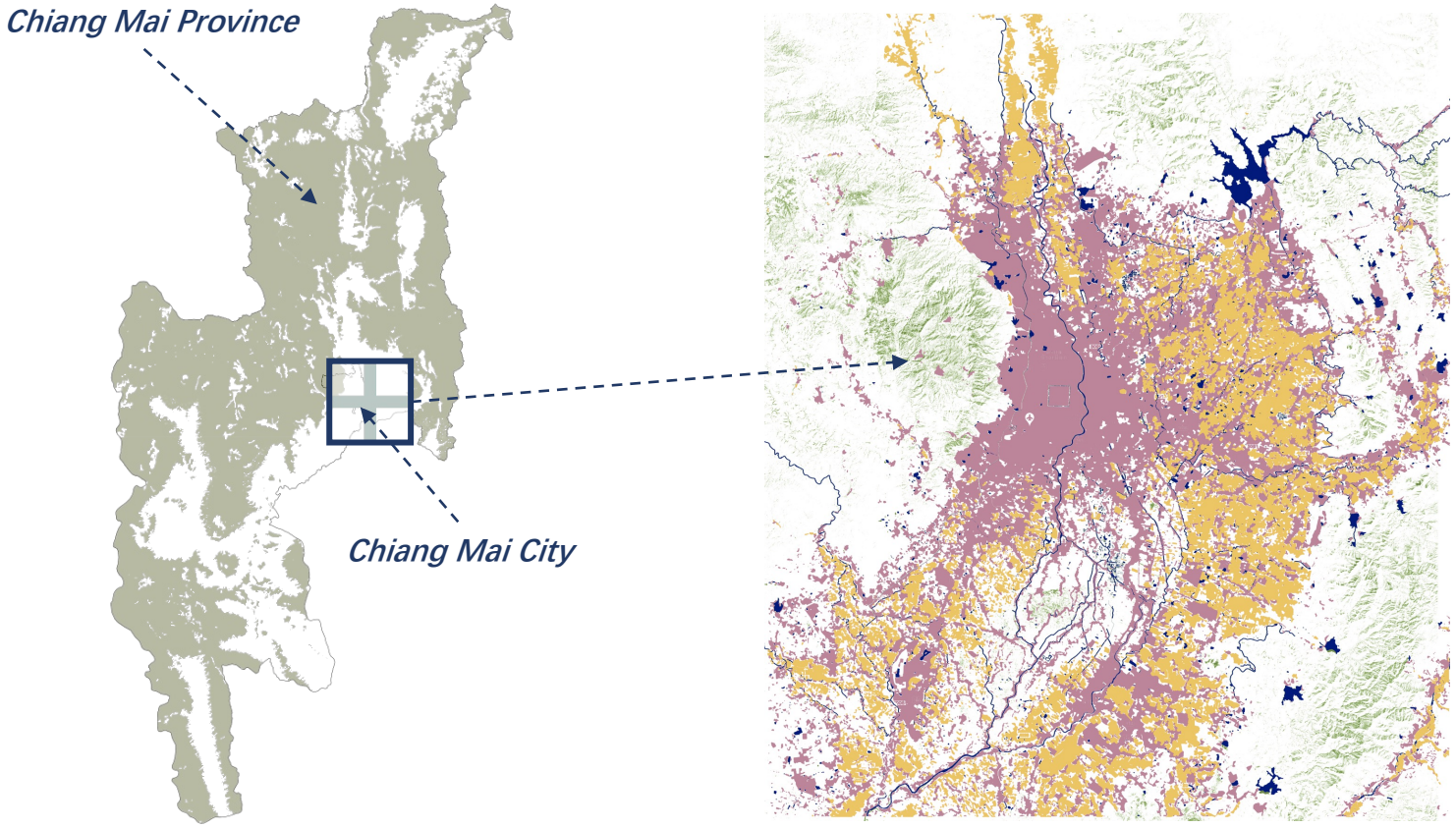
2015
Northern Haze Prevention & Mitigation Plan



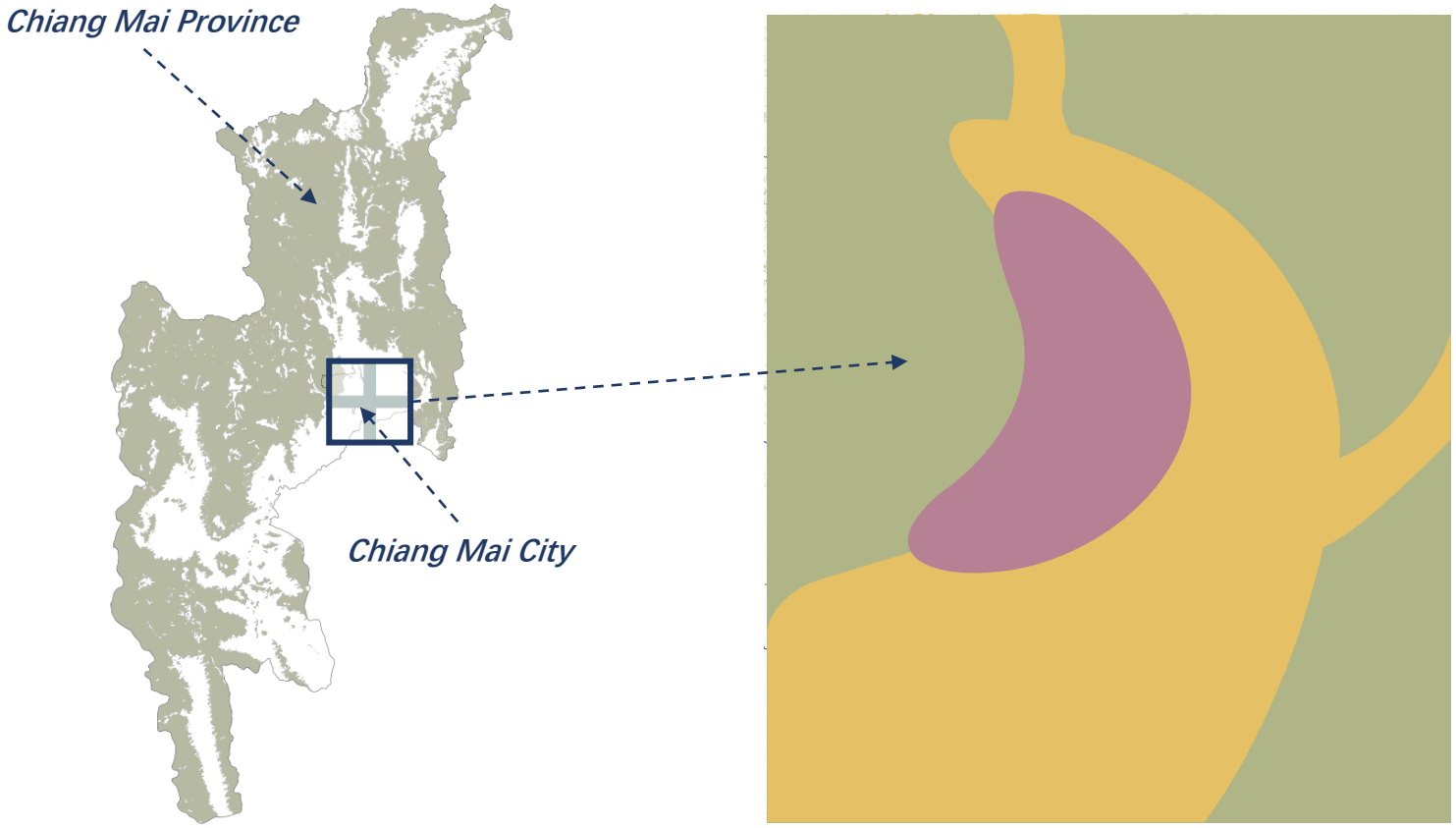
A Ban That's Never a Ban!

1. Lack of expertise and technology dealing with organic waste
2. Lack of public awareness regarding health impacts of open burning and haze
3. Inadequate and inefficiently implemented policies

Zoom into Regional Site



Zoom into Regional Site

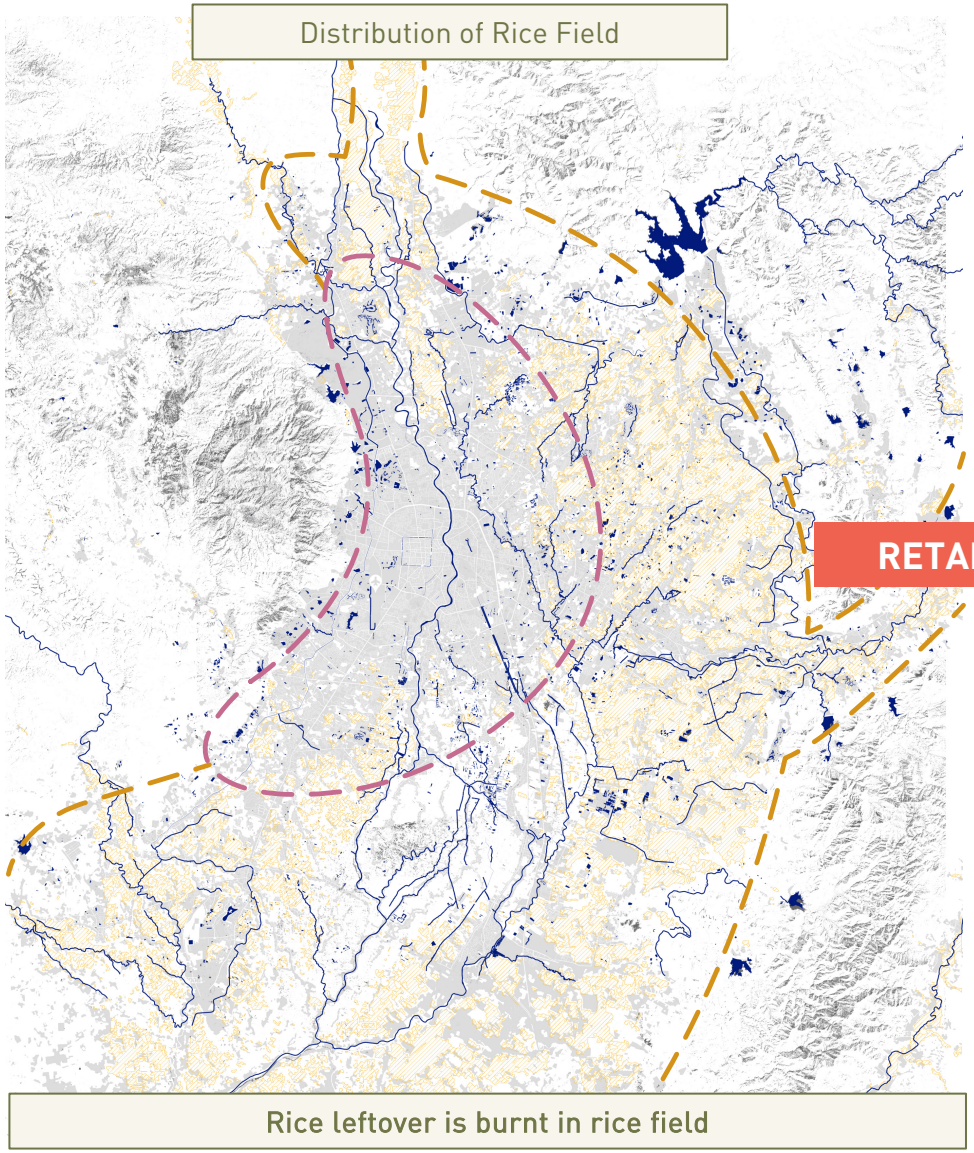


FOREST
area

AGRICULTURE
area

URBAN
area

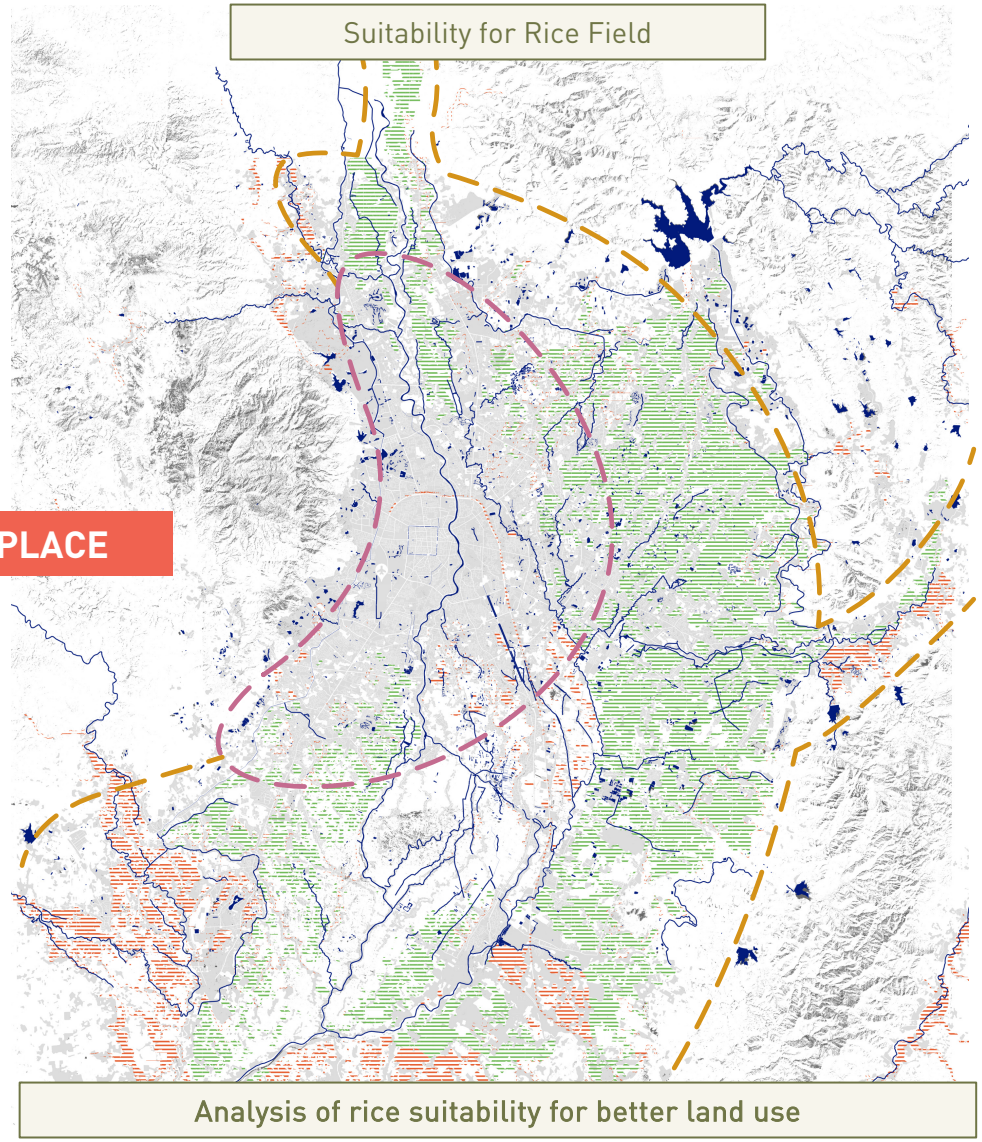
Distribution of Rice Field



Rice leftover is burnt in rice field

RETAIN *or* **REPLACE**

Suitability for Rice Field



Analysis of rice suitability for better land use

rice field

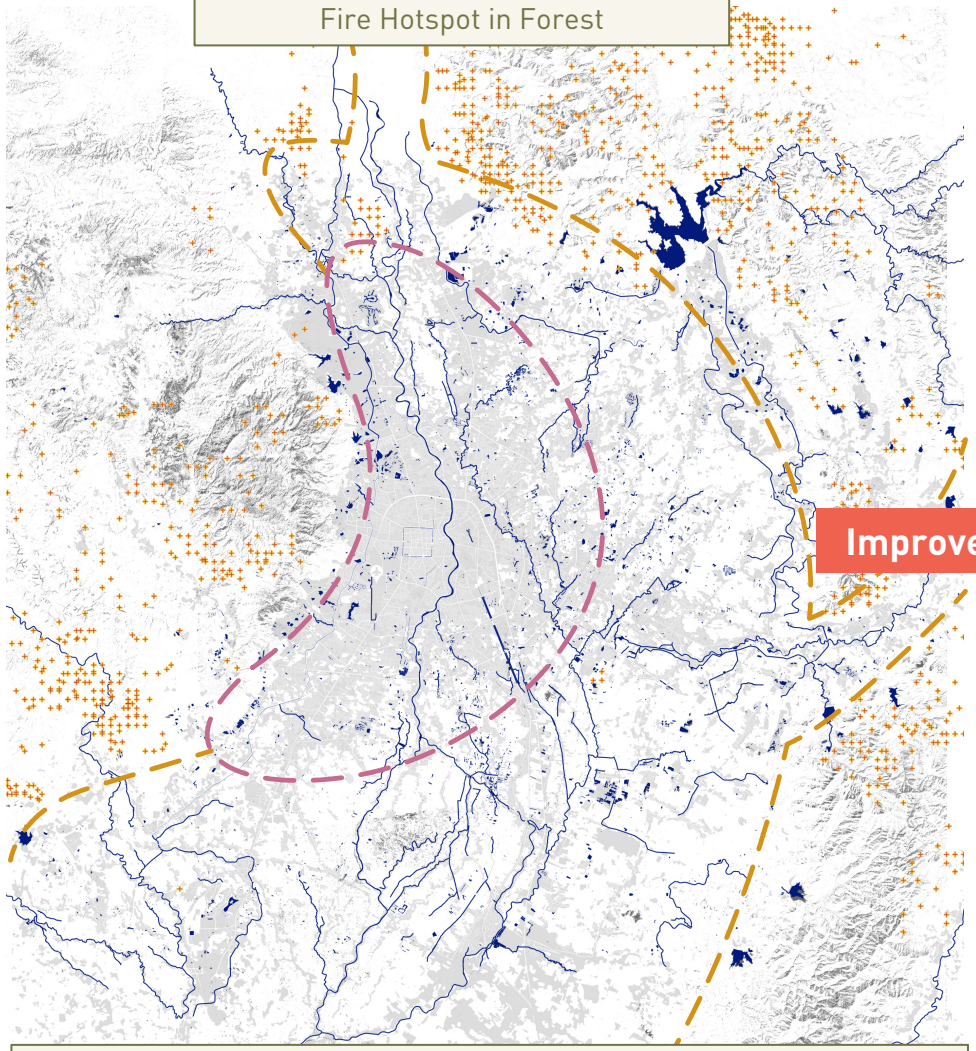
high suitabilty

low suitabilty

0 10 20 km

Data source: https://agri-map-online.moac.go.th/

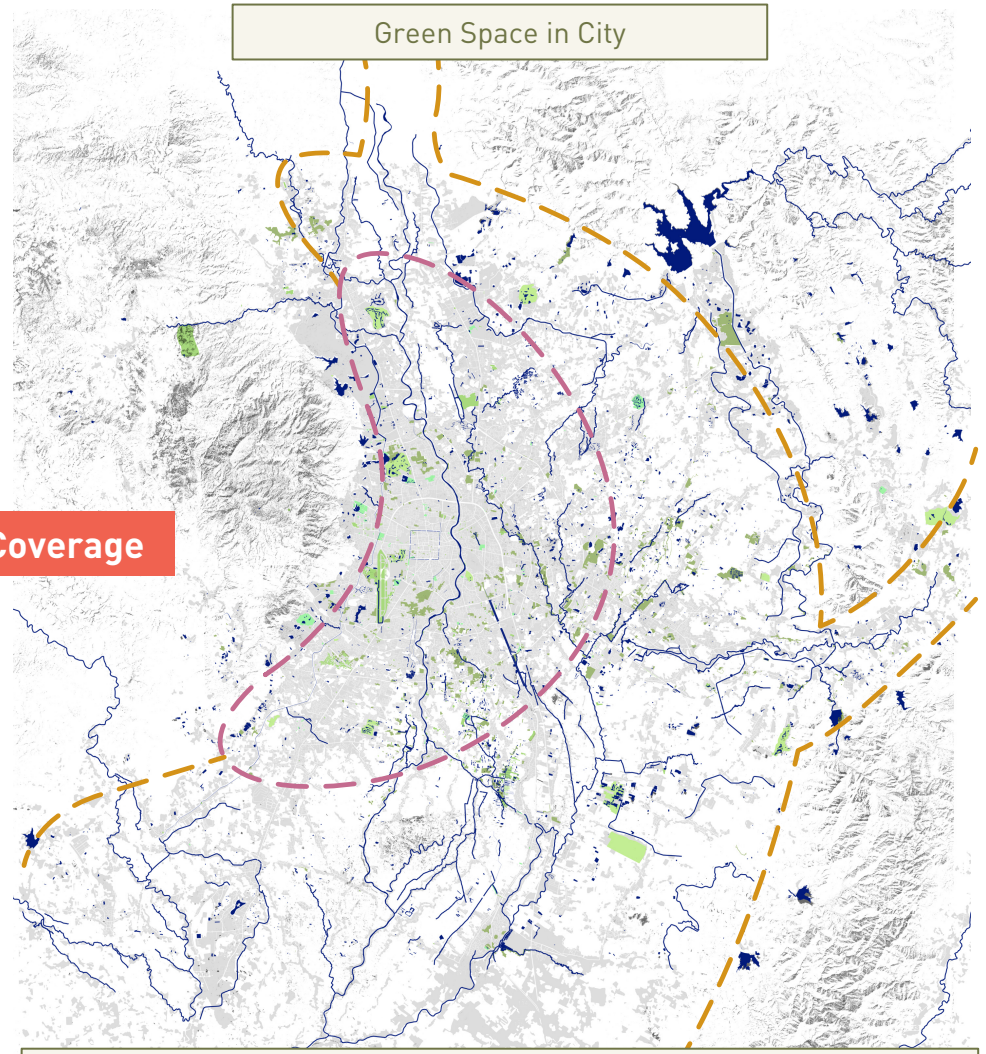
Fire Hotspot in Forest



The fires basically occur in the fringe of the forest, surrounding urban area.

Improve Green Coverage

Green Space in City



Low rate of greening in urban area obviously has very little capacity to capture air pollutants generated around.

0 10 20 km

Data source: https://www.openstreetmap.org/

Conclusion from Analysis

FOREST

damaged
undiversified

Restore Biodiversity

AGRICULTURE

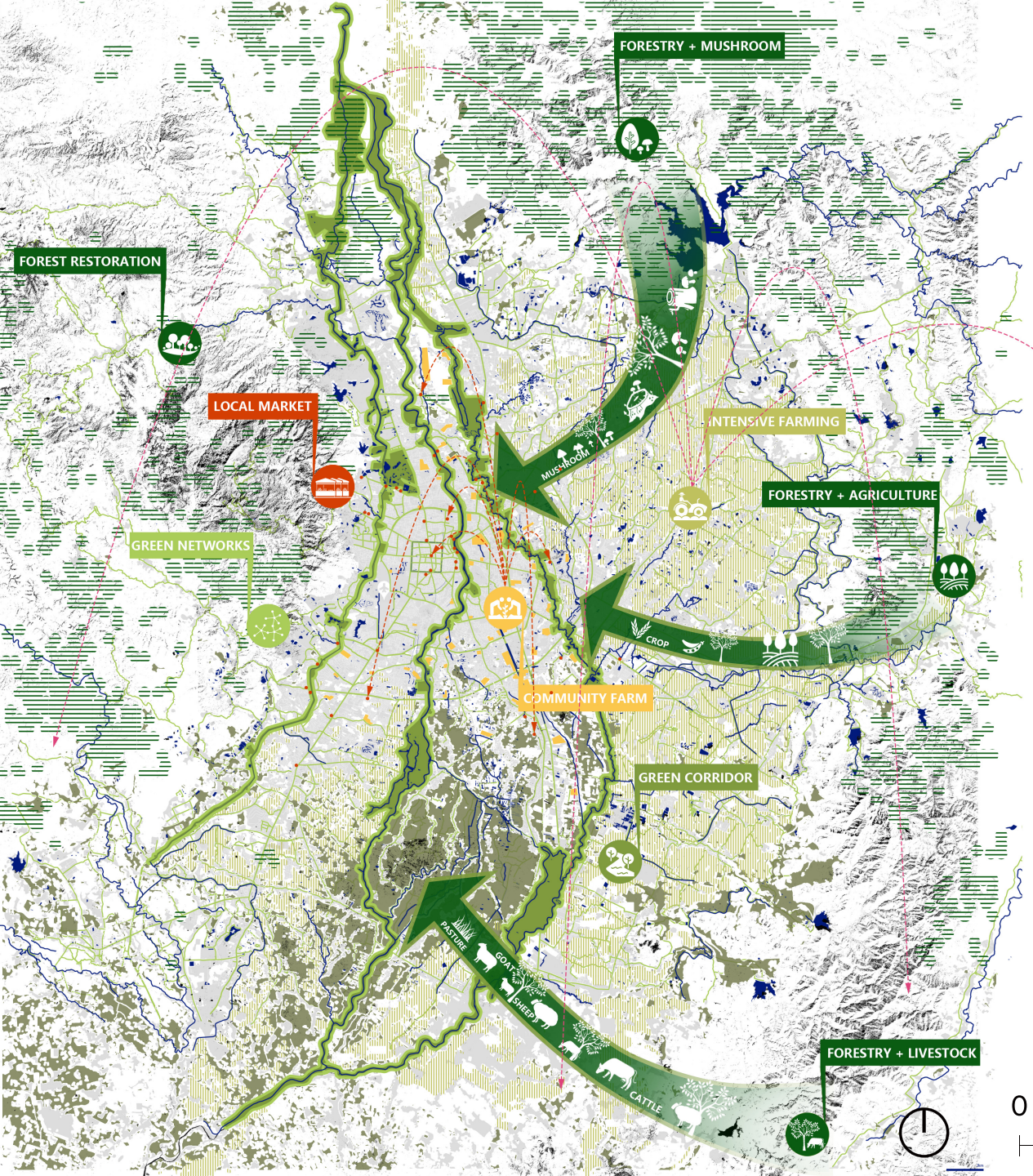
monocultural
unsustainable

Promote Sustainable Agriculture

URBAN

ungreen
air polluted

Improve Green Coverage



agroforestry

intensive agriculture

active restoration

green corridor

community farm

orchard

local market

aim at local market

aim at global market

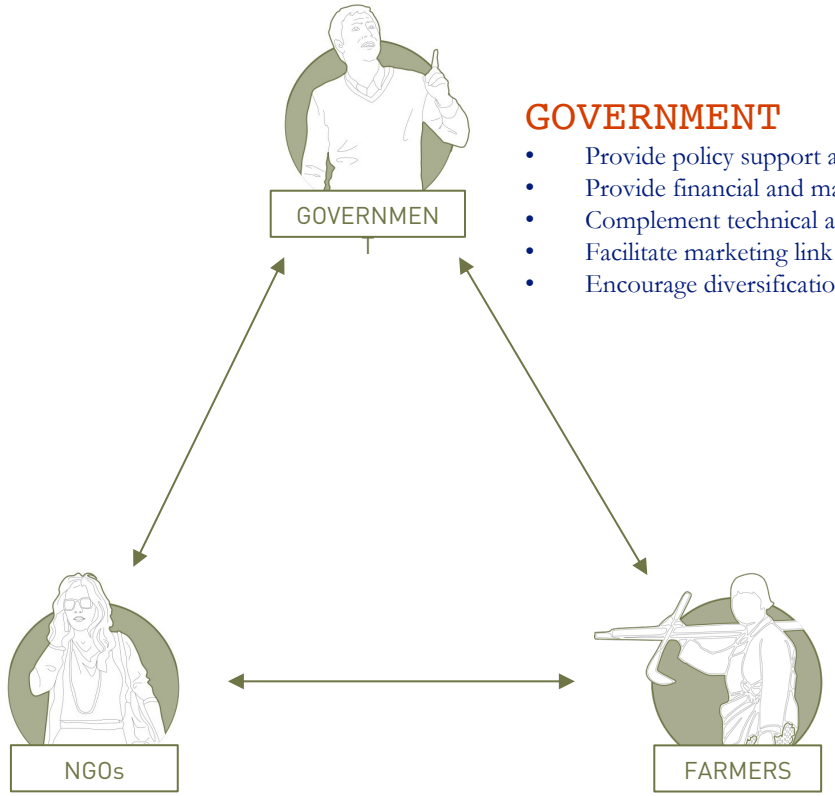
0 10 20 km

FOREST
Regenerative Scenario

AGRICULTURE
Integrated Scenario

URBAN
Haze-free Scenario

1 *Create Partnerships among Farmers, Government and NGOs*



GOVERNMENT

- Provide policy support and appropriate incentives
- Provide financial and material support
- Complement technical and facilitation needs
- Facilitate marketing link
- Encourage diversification of agricultural production

NGO

- Share information on appropriate technologies
- Provide expertise in multiple fields
- Launch community-level campaign or advocacy
- Link local knowledge and scientific knowledge systems

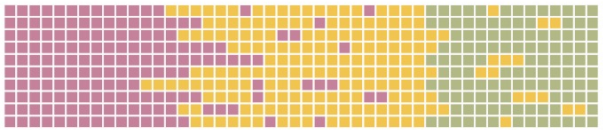
FARMER

- Share knowledge, skills, and low-cost material
- Committed to resource conservation
- Share experience and draws local supports
- Adapt and innovate agroforestry technologies

2 *Reconfigure Relationship between Farmland and Urban Development*

CURRENT

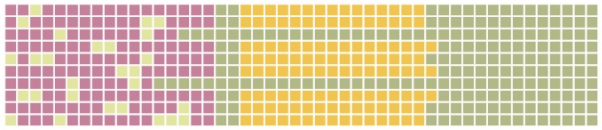
Scenario



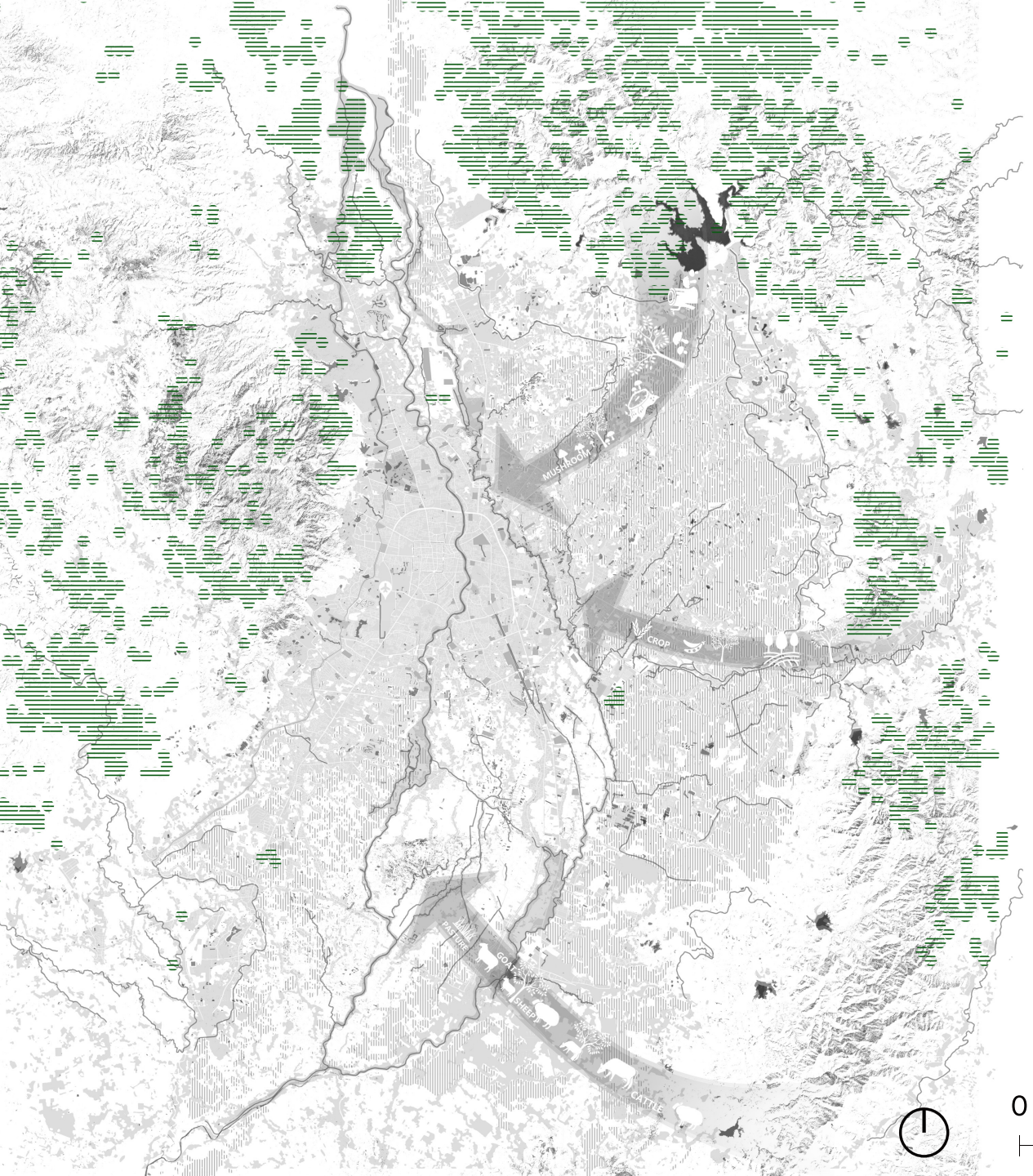
Urban area and agriculture area are merging, and farmlands are invading forest

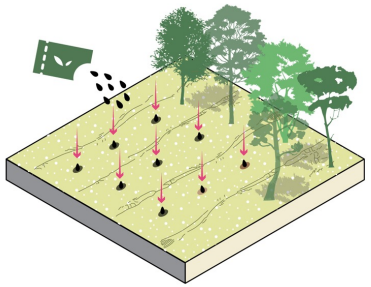
INTEGRATED

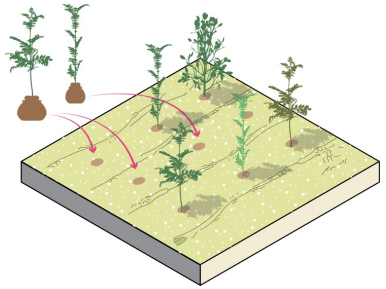
Farming Scenario

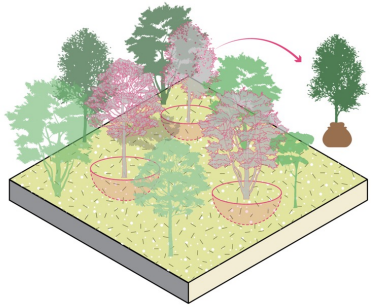


Introducing agroforestry and urban farming, more green in urban area









0 10 20 km

3 *Apply Active Restoration Methods for Biodiversity Recovery*

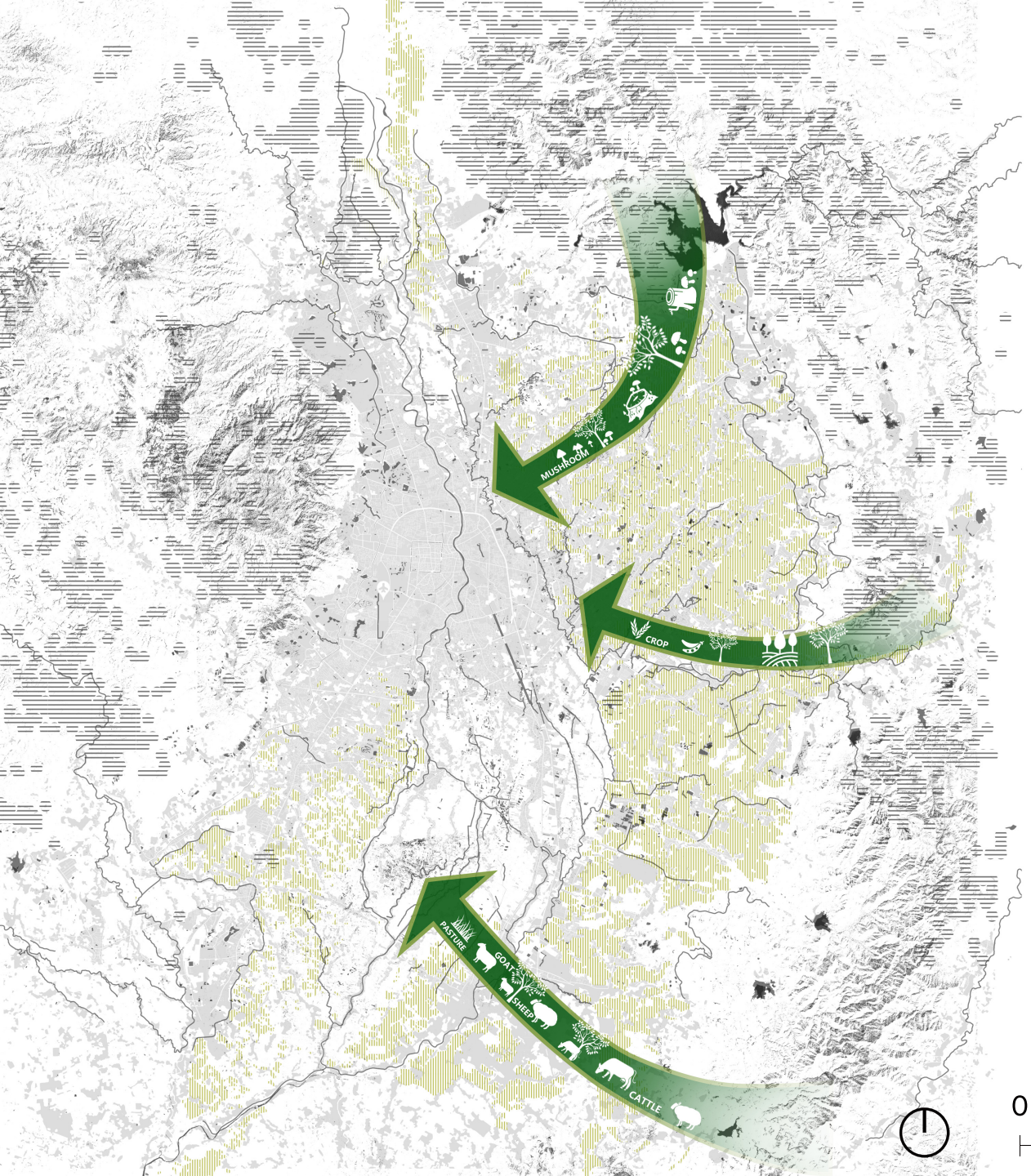
Direct seeding

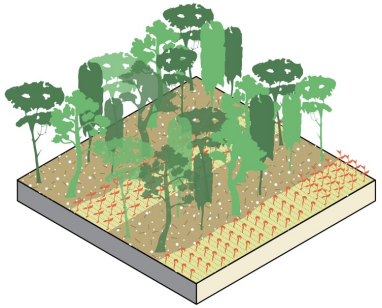
Tree seedling planting

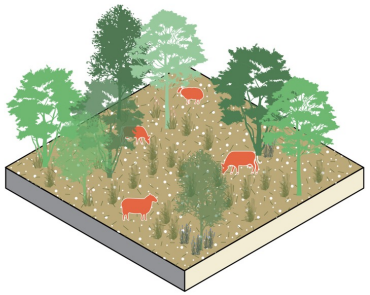
Tree transplantation

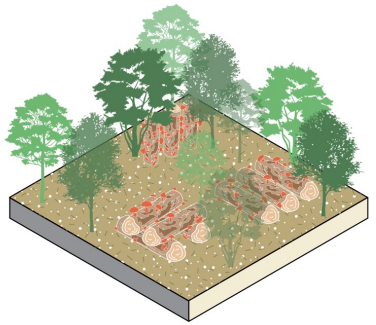
FOREST

Regenerative Scenario









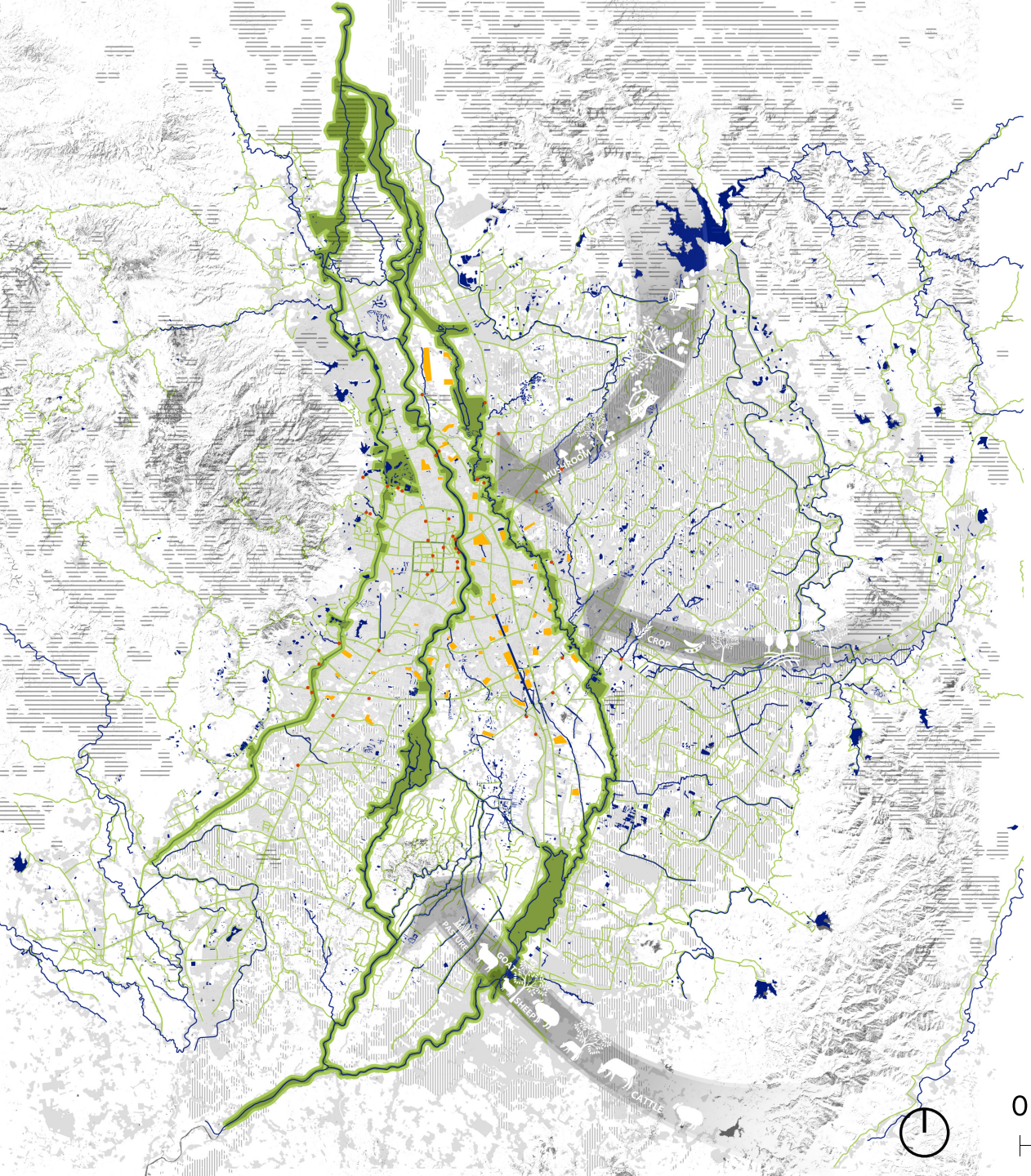
4 *Rehabilitate with Agroforestry as an Alternative to Agriculture*

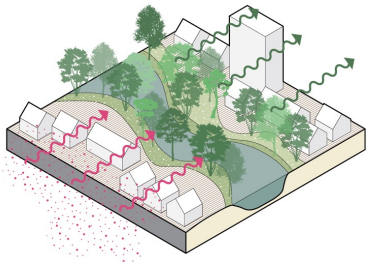
Forestry + Agriculture

Forestry + Livestock

Forestry + Mushroom farming

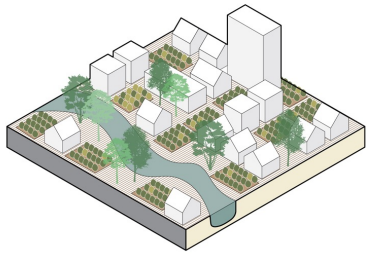
AGRICULTURE
Integrated Scenario





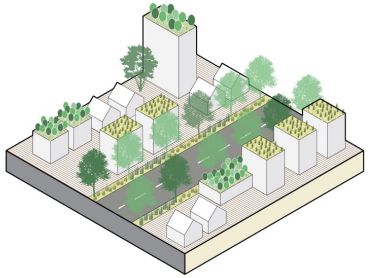
5 *Improve Green Coverage and Build Green Network*

Green corridor as filter



Urban farming

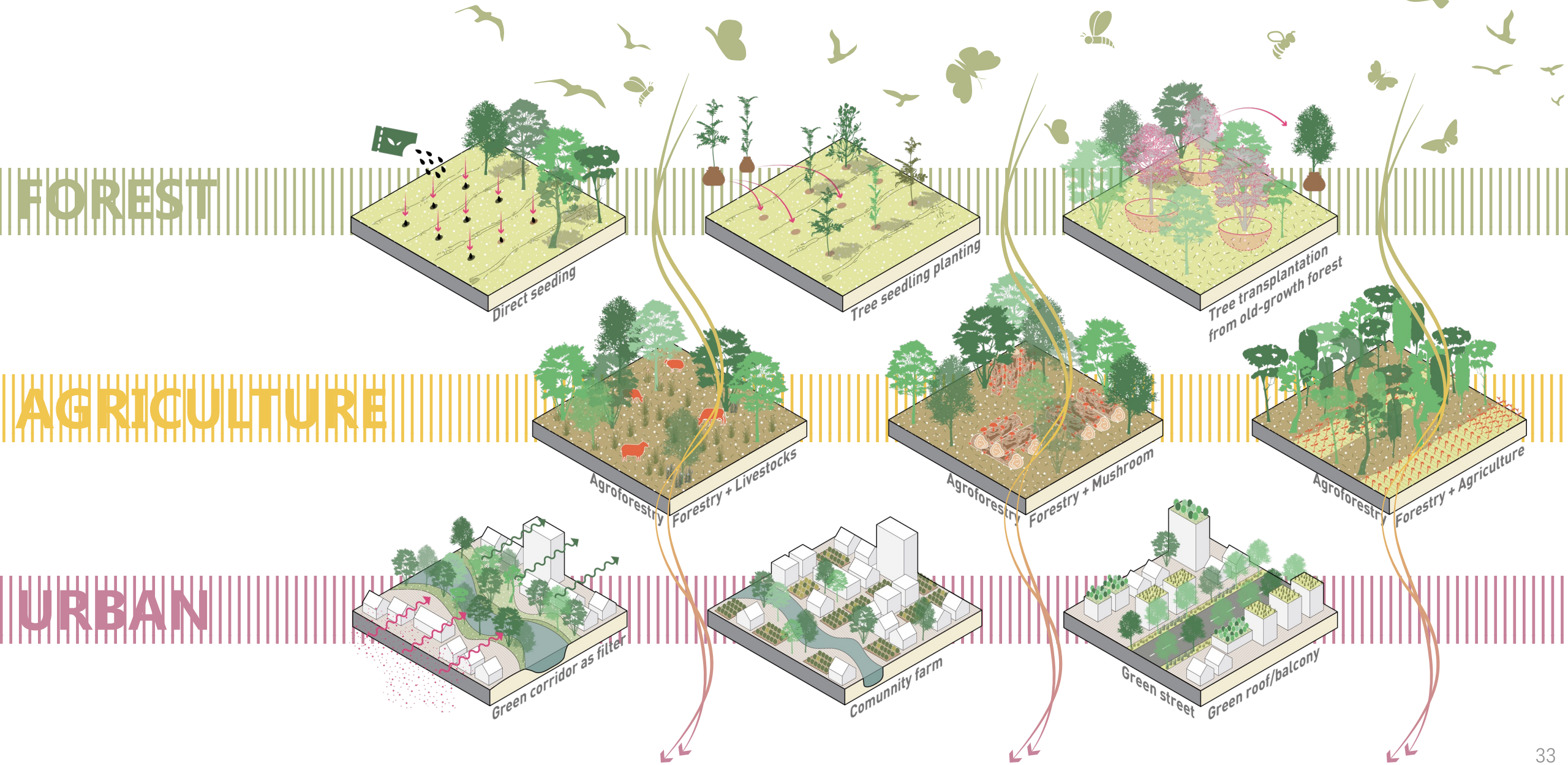
Urban greening



URBAN
Haze-free Scenario

0 10 20 km

Synthesis of Layers



Current situation

Proposed scenario - 5 years

Improvements have been made in **reducing fragmentation**, leading to a potential **enhancement in air quality**. This progress can be attributed to the decrease in open burning and forest fires.

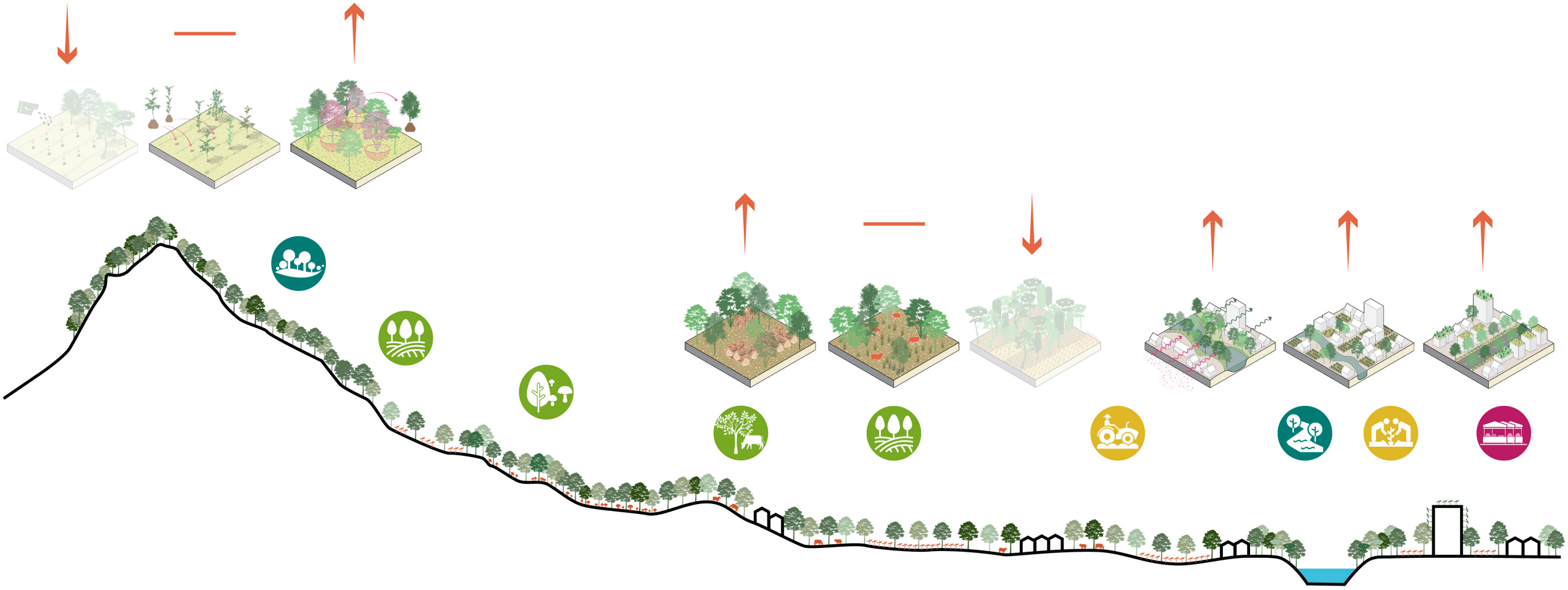
Proposed scenario - 20 years

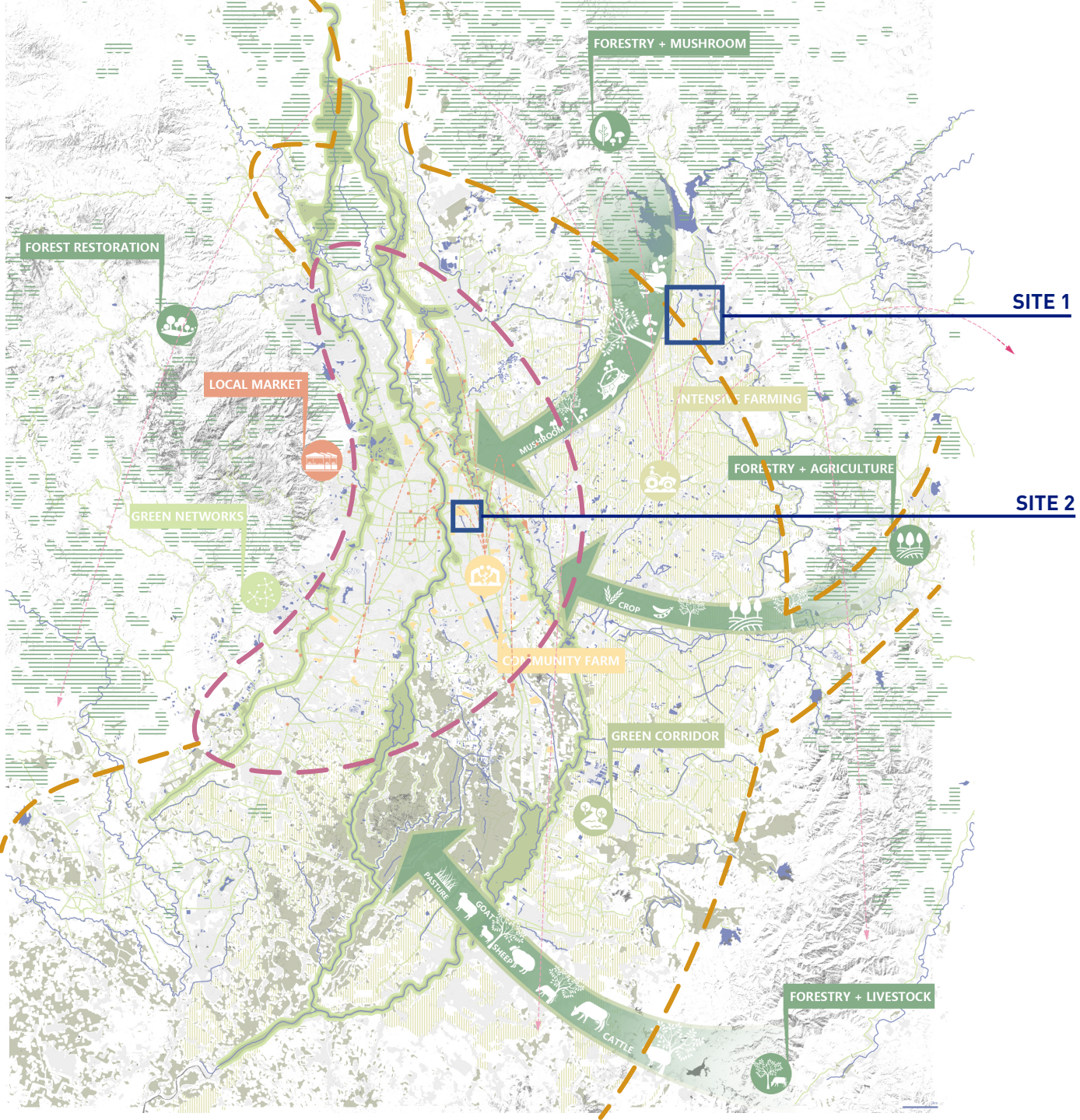
The ongoing efforts to address fragmentation **have resulted in further improvements**. As a result, air pollution has become a thing of the past, even during the burning season.

STRATEGIC POSITIONING & PHASING

STRATEGIC POSITIONING & PHASING

STRATEGIC POSITIONING & PHASING





RURAL

PILOT PROJECT 1

Forestry + agriculture (Agroforestry)
Forestry + livestock (Agroforestry)
Forestry + mushroom farming (Agroforestry)

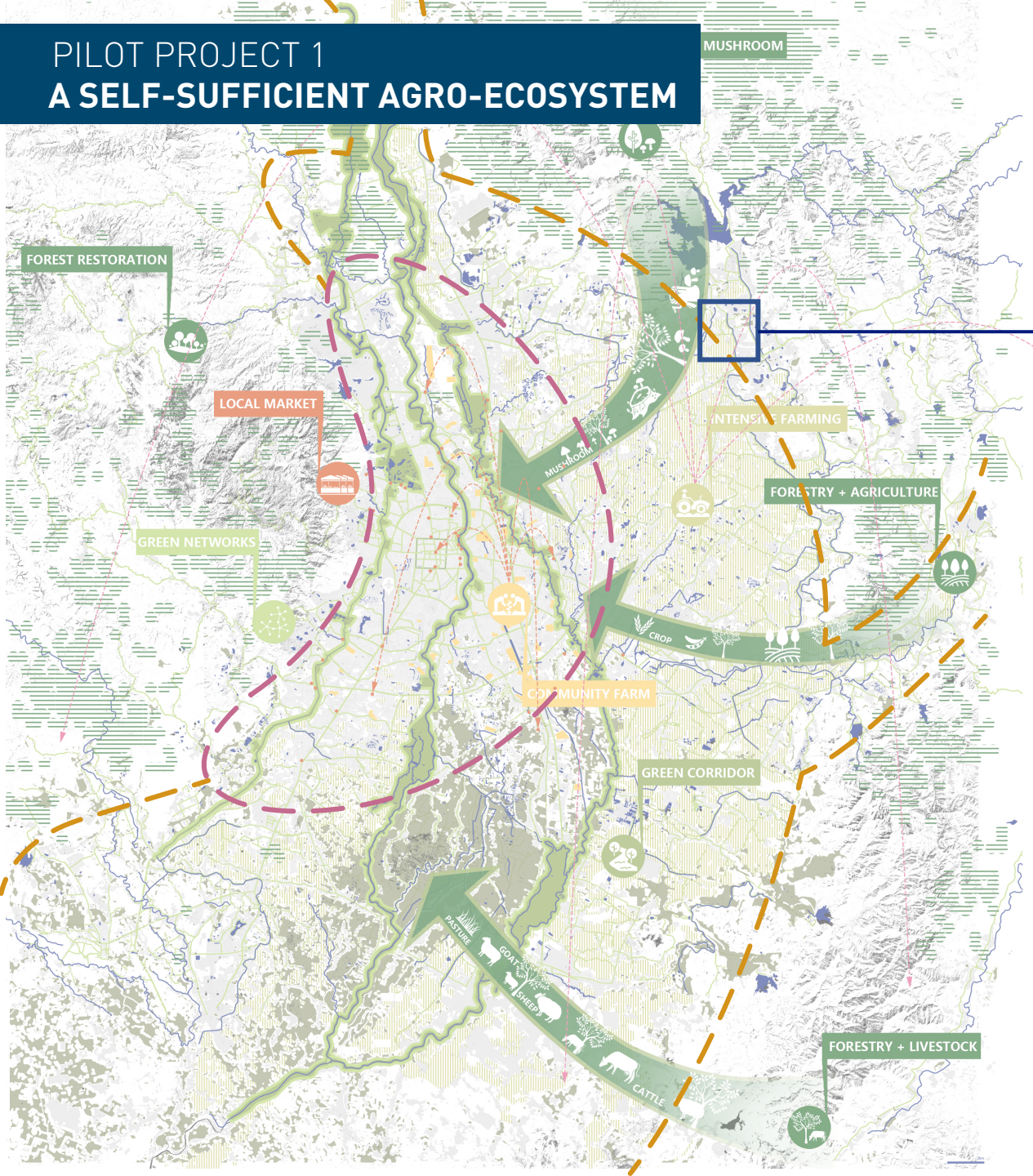
URBAN

PILOT PROJECT 2

Local farmer market (Sustainable production mode)
Community farm (Urban farming)
Streetscape (Urban farming and greening)

PILOT PROJECT 1

A SELF-SUFFICIENT AGRO-ECOSYSTEM

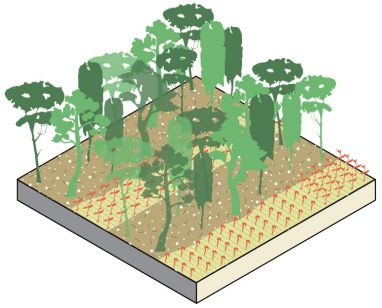


RURAL

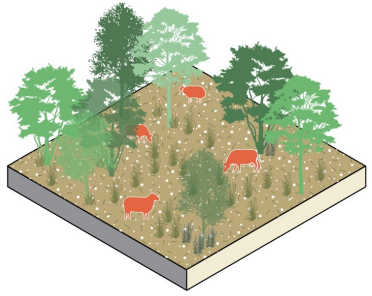
PILOT PROJECT 1

Forestry + agriculture (Agroforestry)
Forestry + livestock (Agroforestry)
Forestry + mushroom farming (Agroforestry)

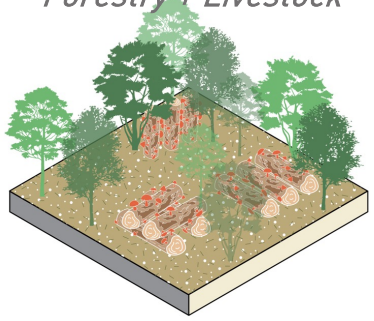
Choeng Doi, Doi Saket District



Agroforestry
Forestry + Agriculture



Agroforestry
Forestry + Livestock

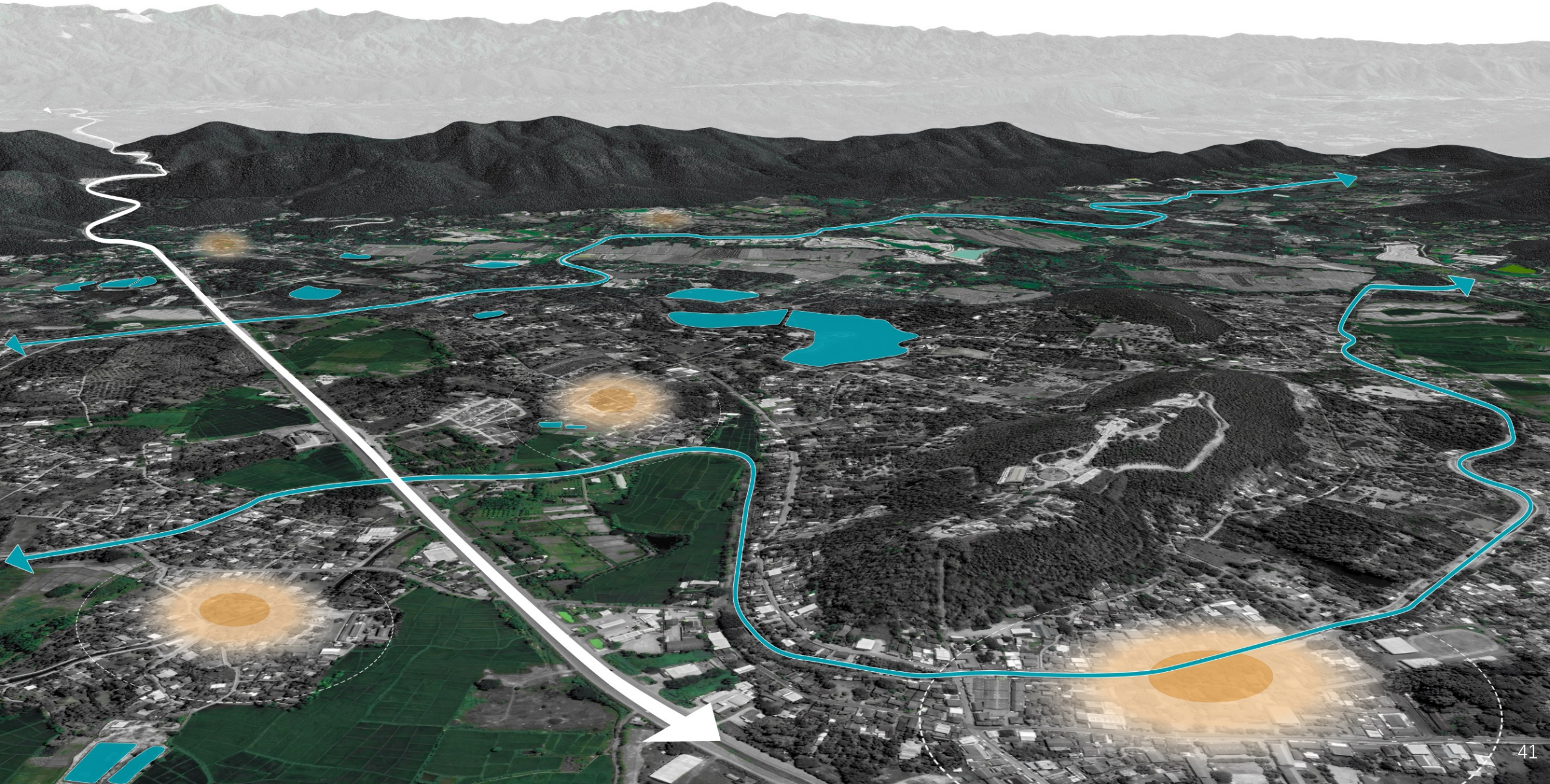


Agroforestry
Forestry + Mushroom farming

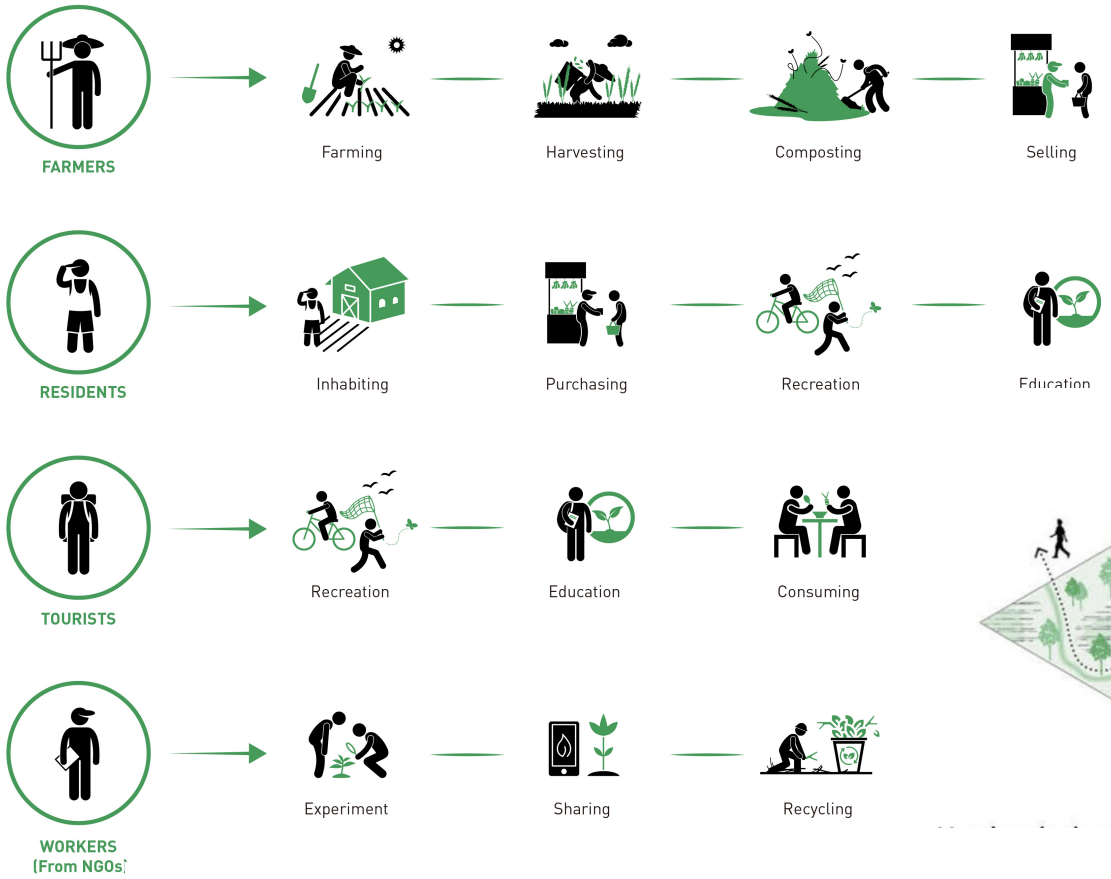
Village

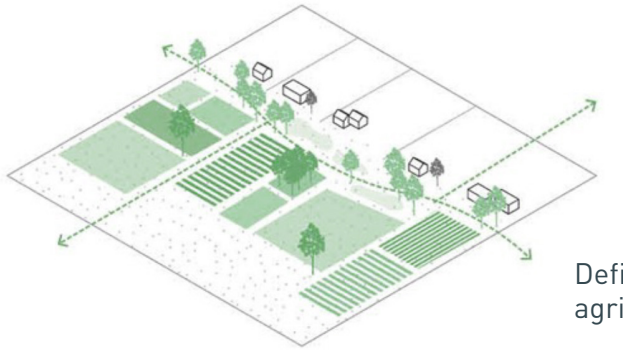
Agriculture

FRAGMENTATION

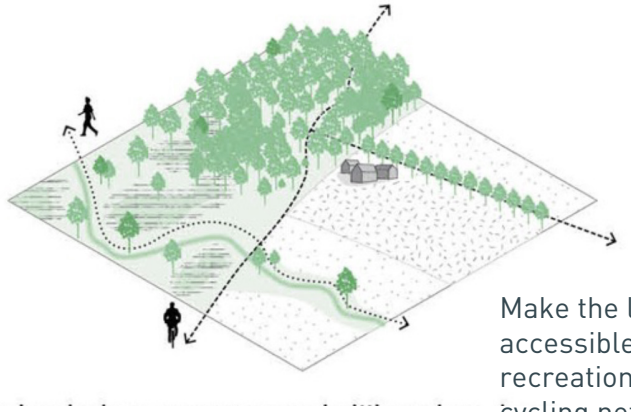


DESIGN PRINCIPLE
Actors analysis & Potentials

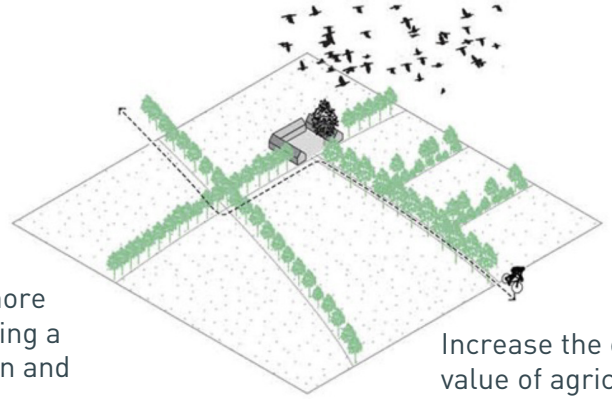




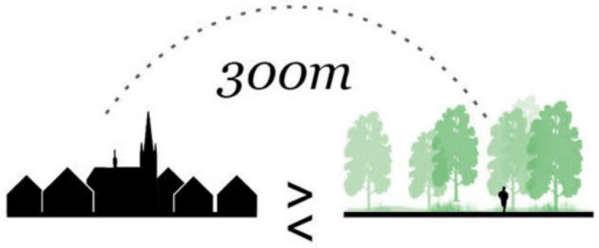
Define and activate the border of agriculture land and villages



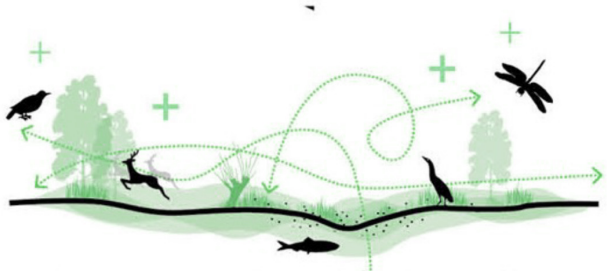
Make the landscape more accessible by introducing a recreational pedestrian and cycling network



Increase the ecological value of agriculture area



Link green space with residential area



Canal structure as ecological corridor with space for water and biodiversity

Reuse organic waste for other uses, such as composting and energy production

Native Shade Trees

Air filtration
CO2 removal
Nutrient cycling
Water retention
Soil retention

Banana

Air filtration
Sustainable revenue stream
Local food source

Crop

Sustainable revenue stream
Local food source

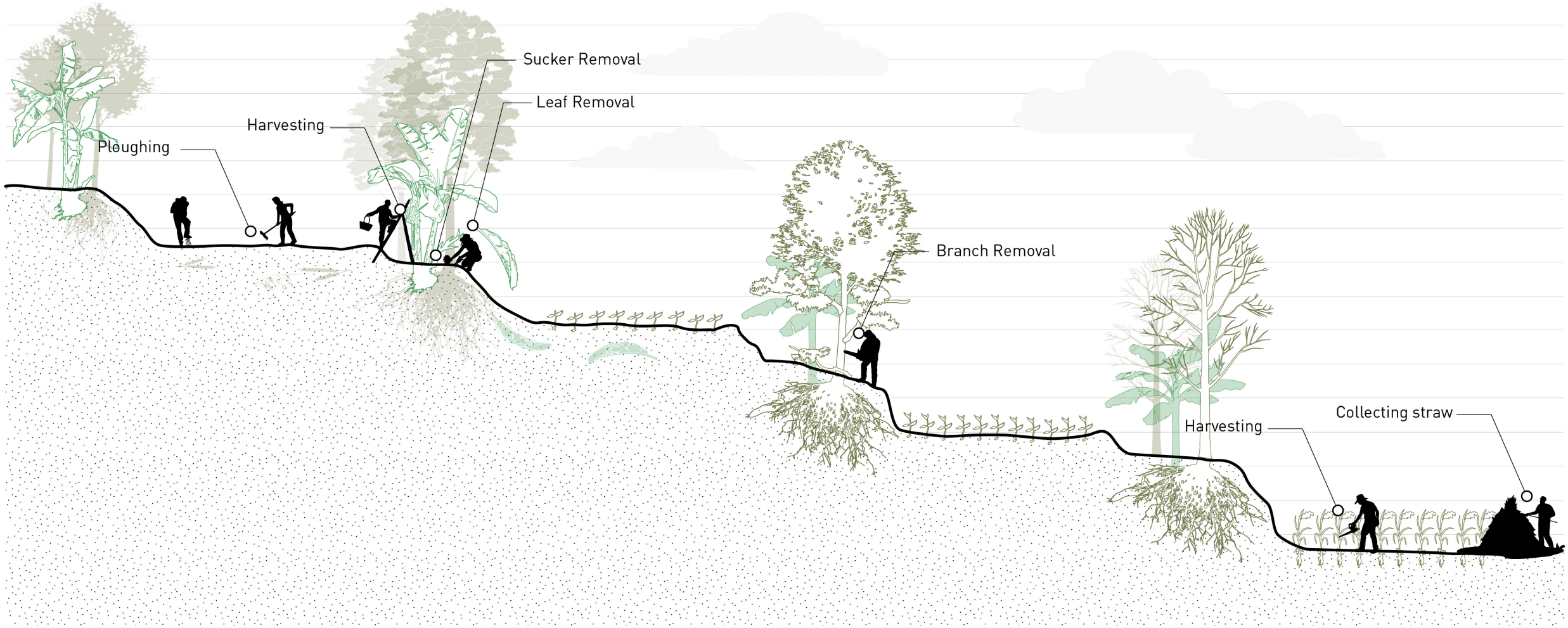
STRATEGIES
RICE-BASED AGROFORESTRY

Spring

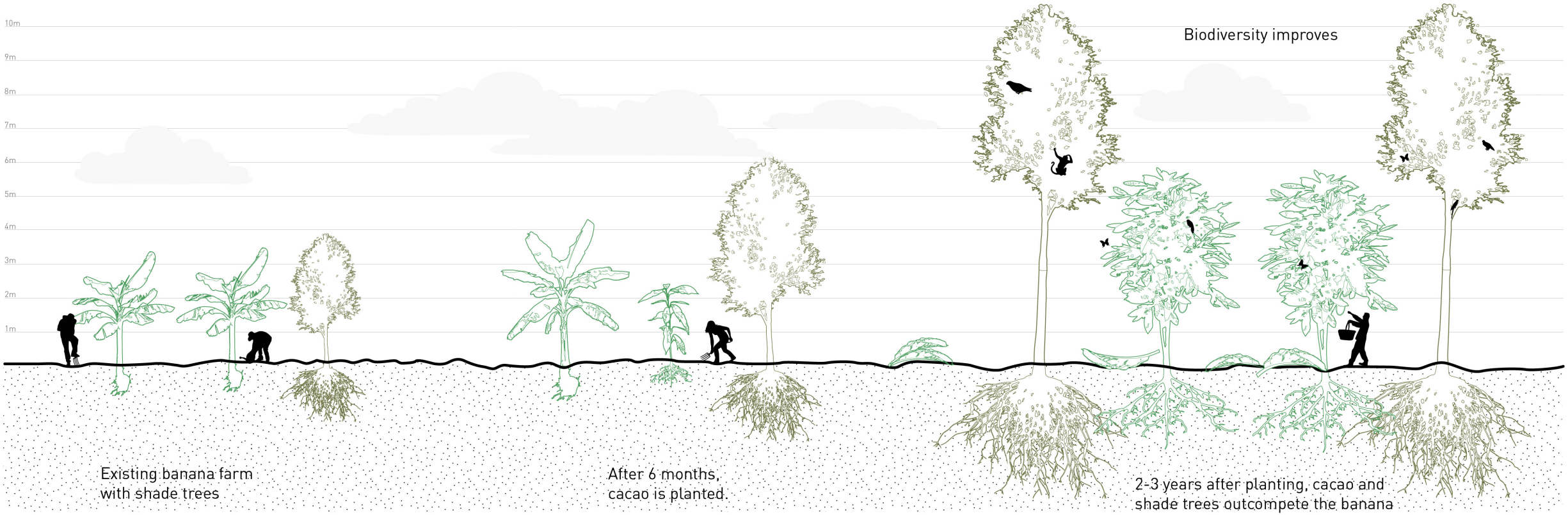
Summer

Autumn

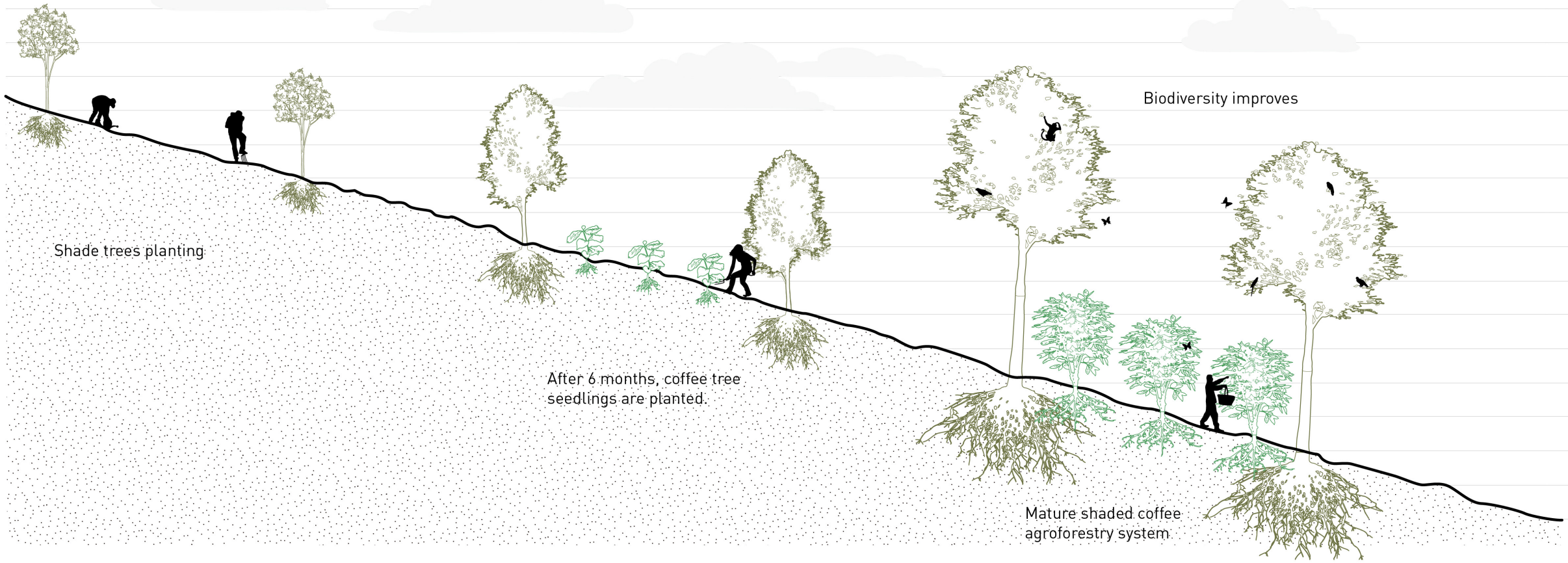
Winter



CACAO AGROFORESTRY

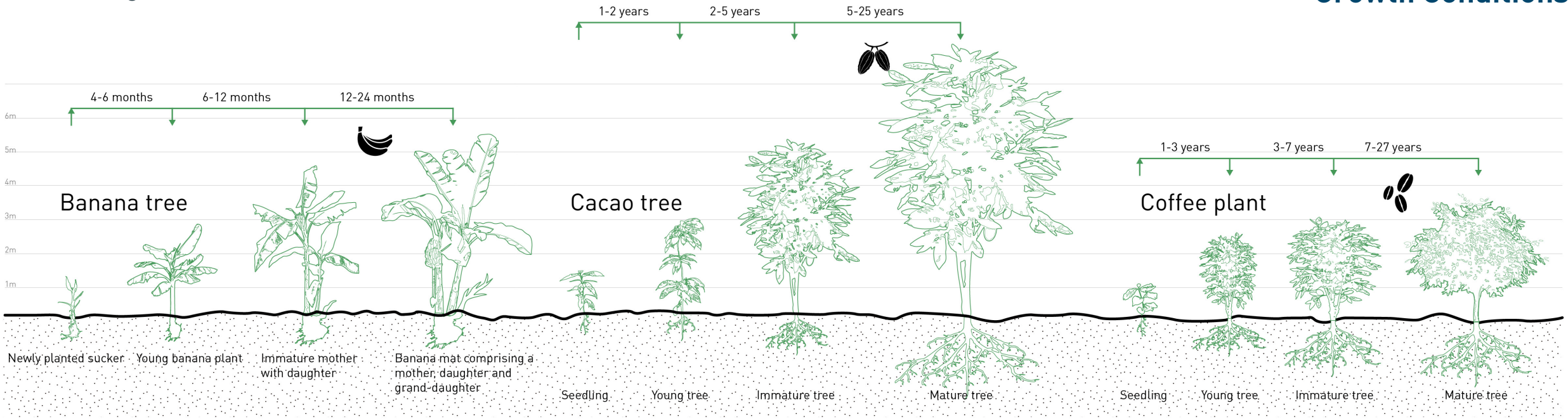


COFFEE AGROFORESTRY



Growth Stages & Growth Conditions

Growth Stages



Growth Conditions

sunlight / partial shade

well-draining soil rich in organic matter

keep soil moist

windproof

dappled/partial shade

well-draining soil rich in organic matter

keep soil moist

windproof

dappled/partial shade

well-draining, nutrient-rich soil

high altitude

no water-logging

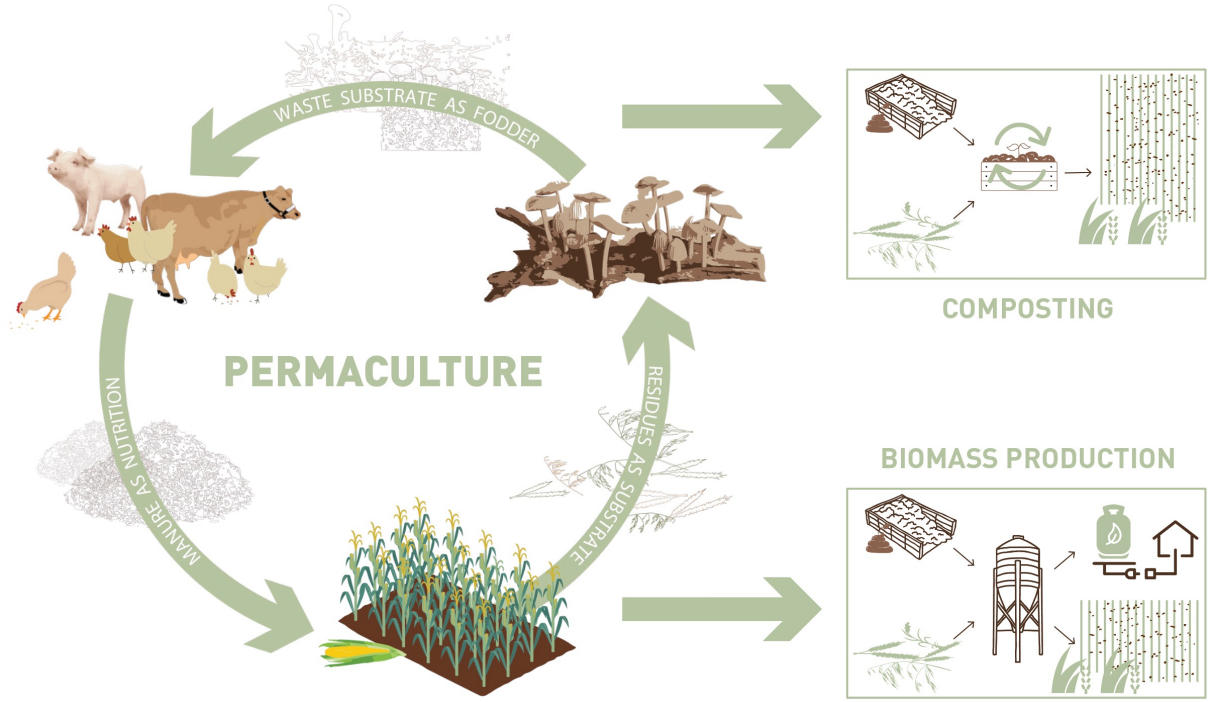
large and board leaf

no clay

no water-logging

shallow root

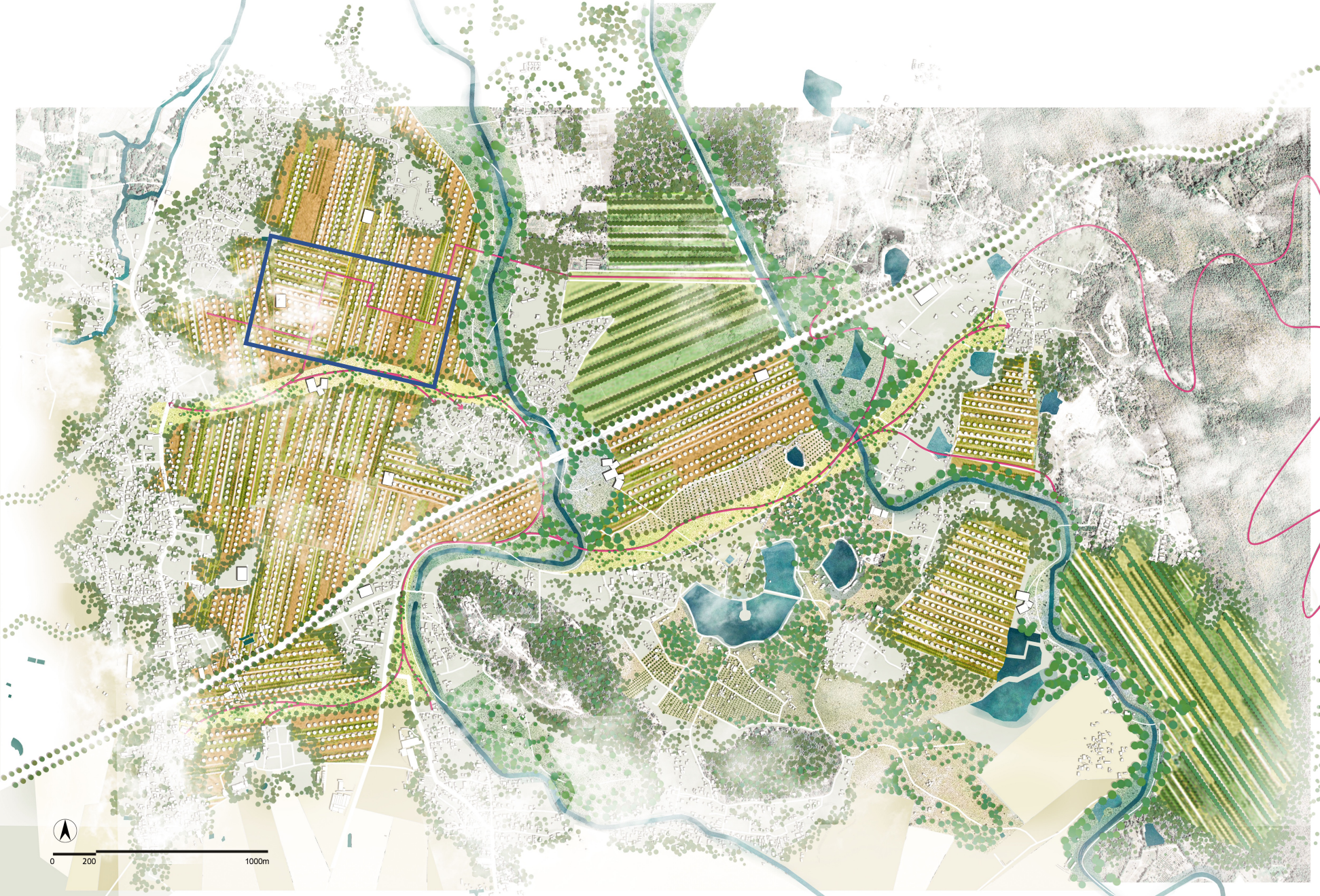
Community Supported Agriculture & Organic Waste Management



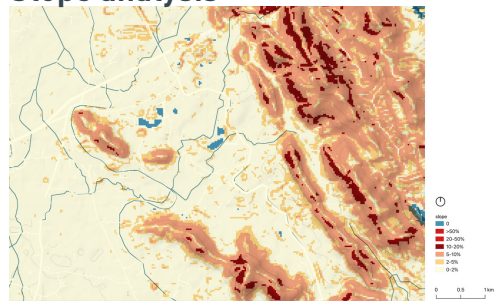
TOWARDS A SELF-SUFFICIENT SYSTEM

MASTERPLAN

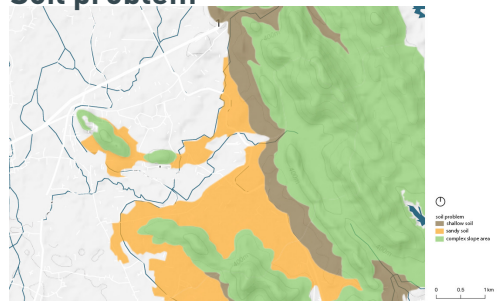
A Self-sufficient Agro-ecosystem



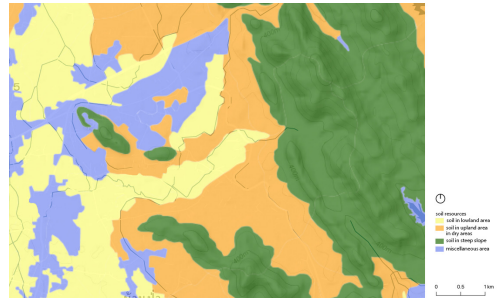
Slope analysis

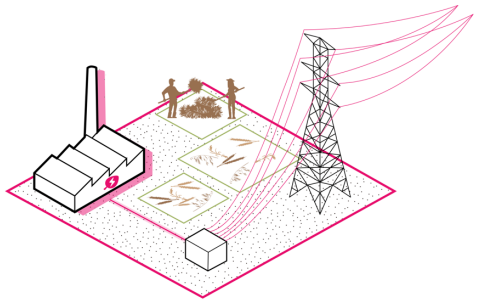


Soil problem

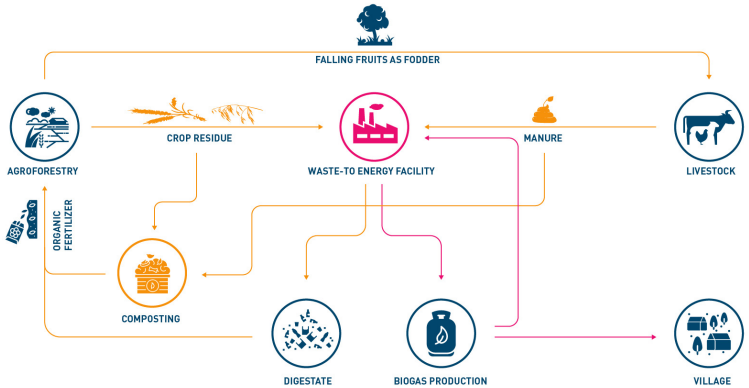


Soil resources

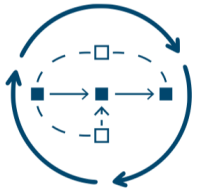




waste-to-energy facilities

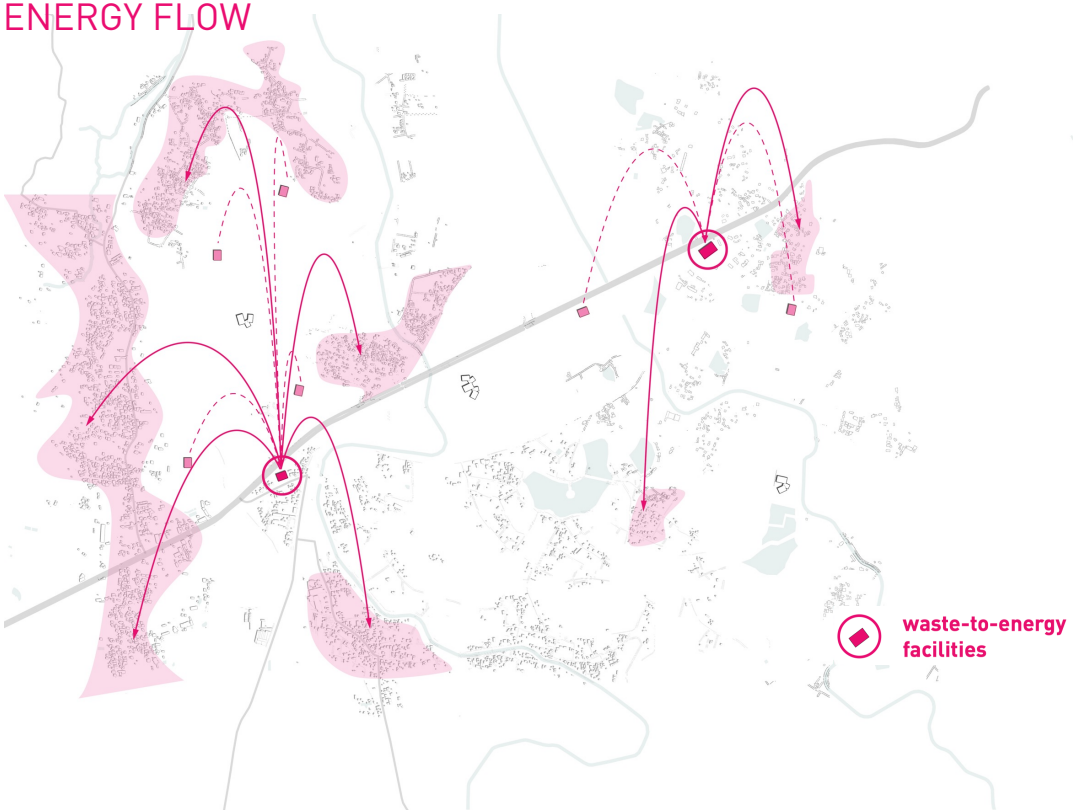


composting

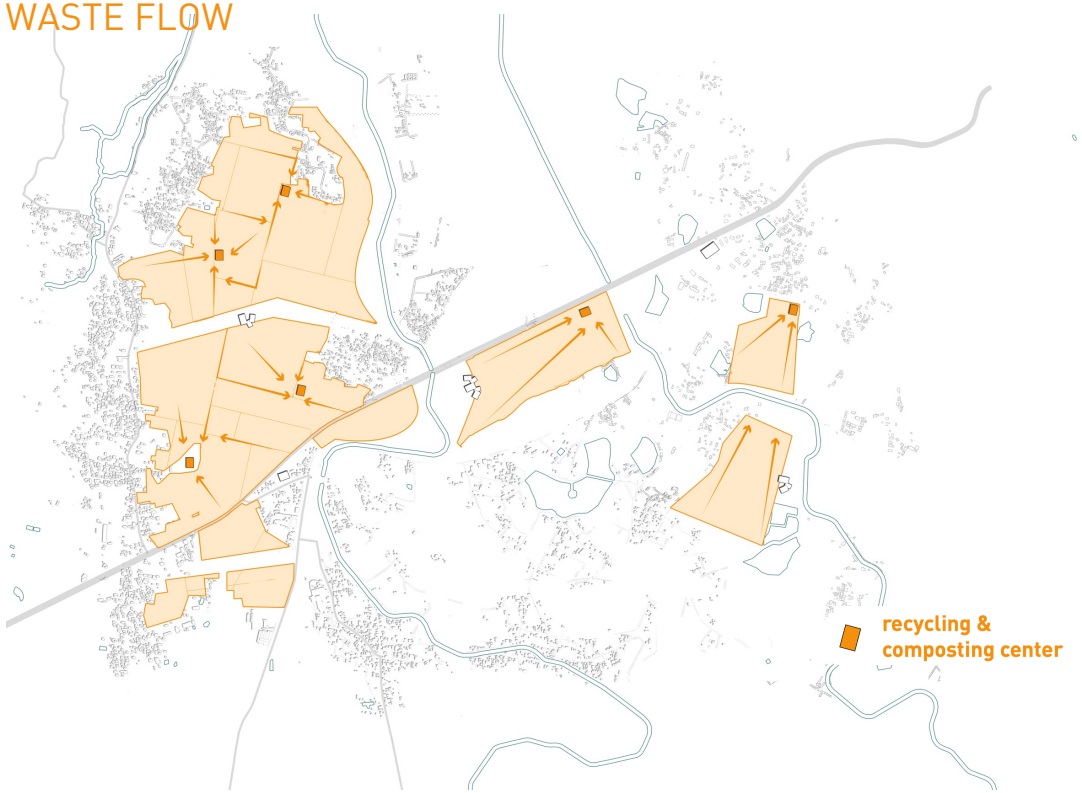


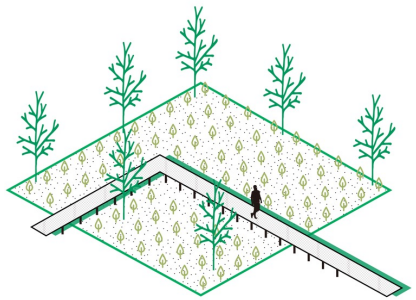
SUSTAINABLE FLOW MANAGEMENT

ENERGY FLOW

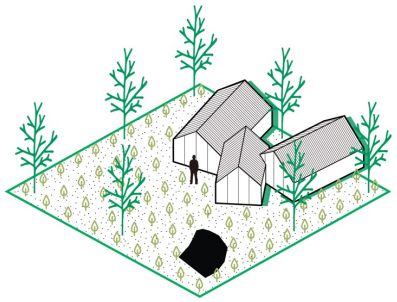


WASTE FLOW

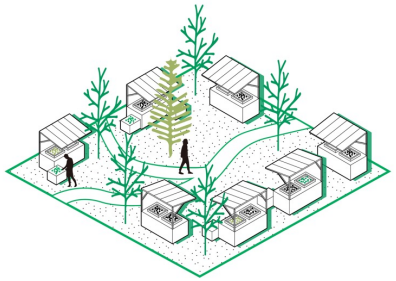




boardwalk in field



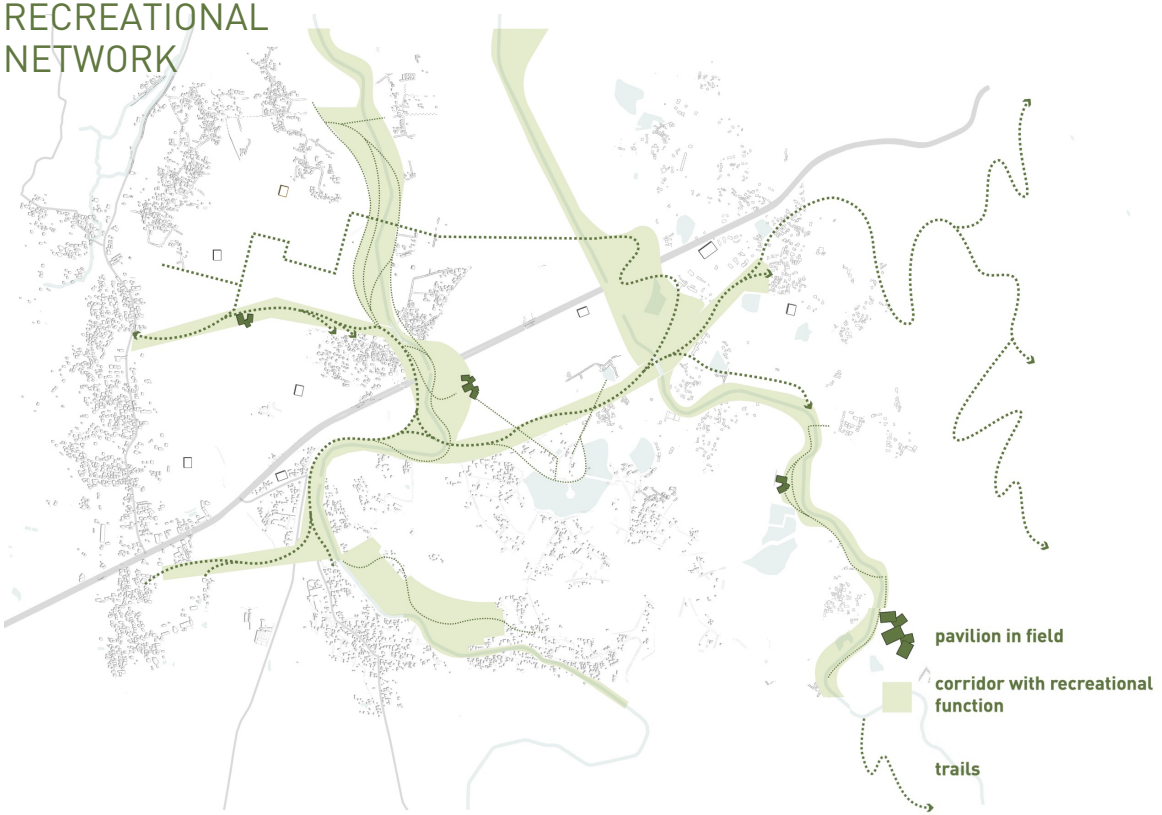
pavilion in field

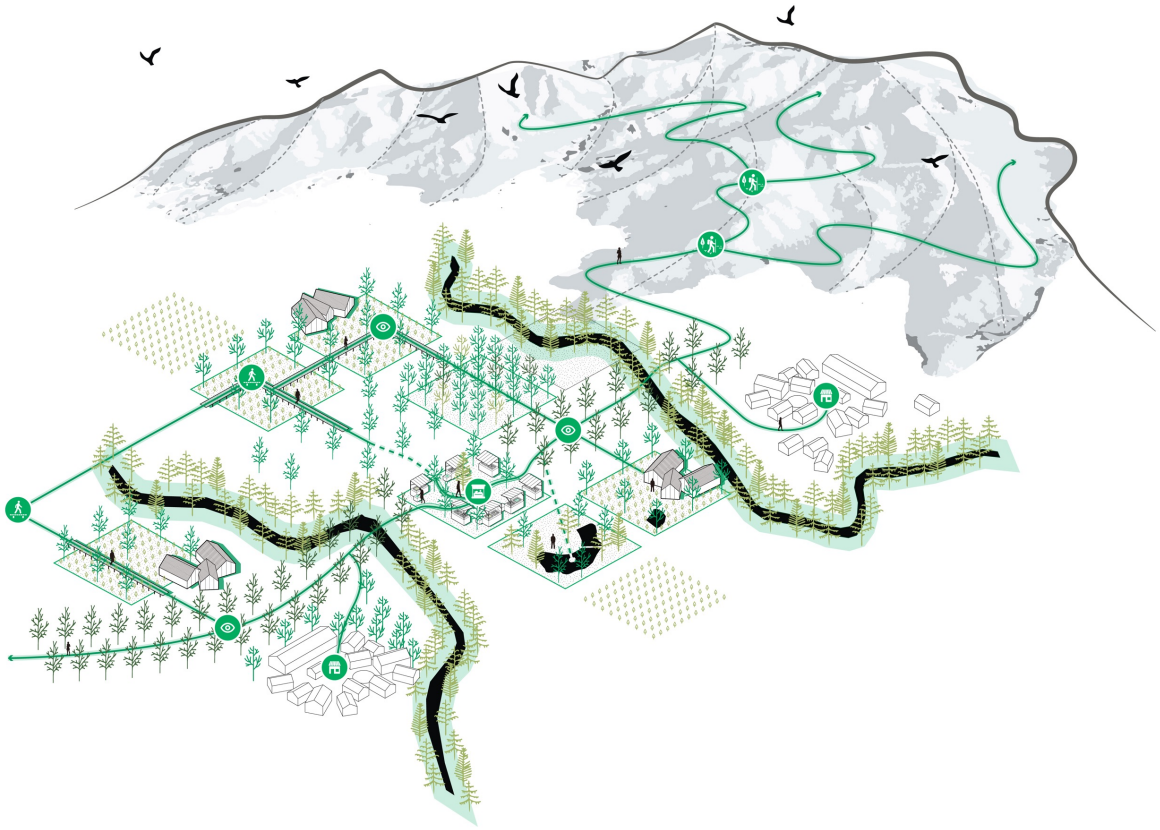


farmer market

SUSTAINABLE USE OF AREA WITH POTENTIAL

RECREATIONAL NETWORK





SUSTAINED COMMITMENT TO ECOLOGICAL RELATIONSHIP

HOW TO IMPLEMENT IT IN CHIANG MAI?

participatory design guideline and bottom-up approach

Incentives and Policy Support:

Advocate for supportive policies, regulations, and incentives, and involve all stakeholders especially **farmers** in decision-making processes to ensure the implementation of agroforestry.

01

Education and Awareness

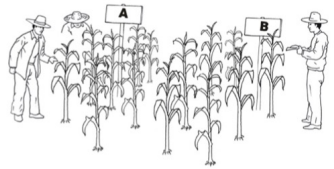
Collaborate with local research institutions and university such as Chiang Mai University to provide farmers with up-to-date information, best practices, and case studies related to agroforestry.

02

Field Demonstrations

Organize workshops, training programs, and to educate farmers about the principles and benefits of agroforestry.

03



Pilot Projects

Establish demonstration plots or pilot projects in collaboration with willing farmers to showcase the potential of sustainable agricultural practices such as agroforestry.

04

Community Engagement

Promote the sharing of success stories and highlight the economic benefits of agroforestry, such as increased crop yields, and additional income streams from timber, fruits, or mushroom from farmers who have successfully transitioned to agroforestry, serving as role models for others.

05

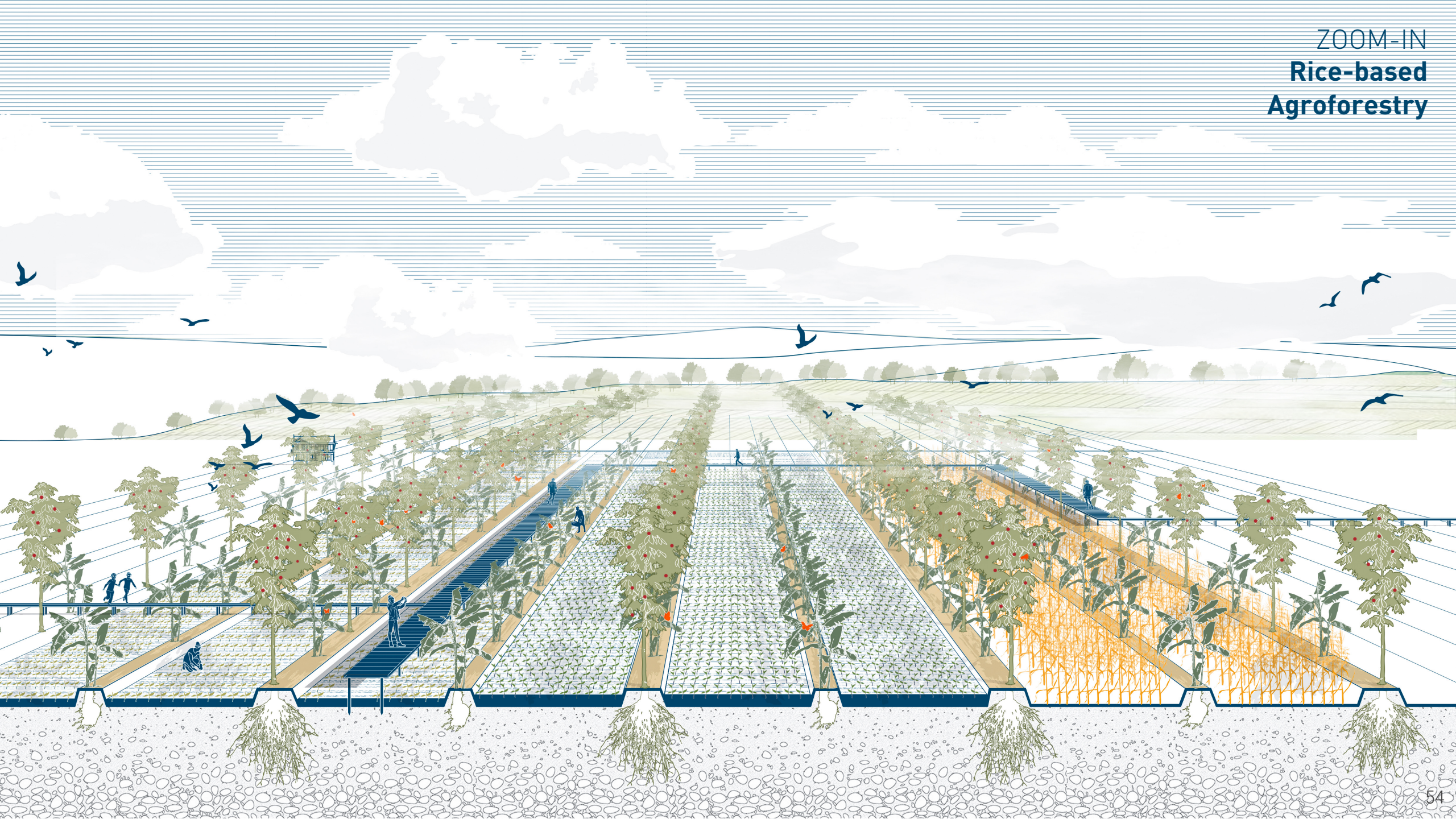
Zoom-in 1

ZOOM-IN

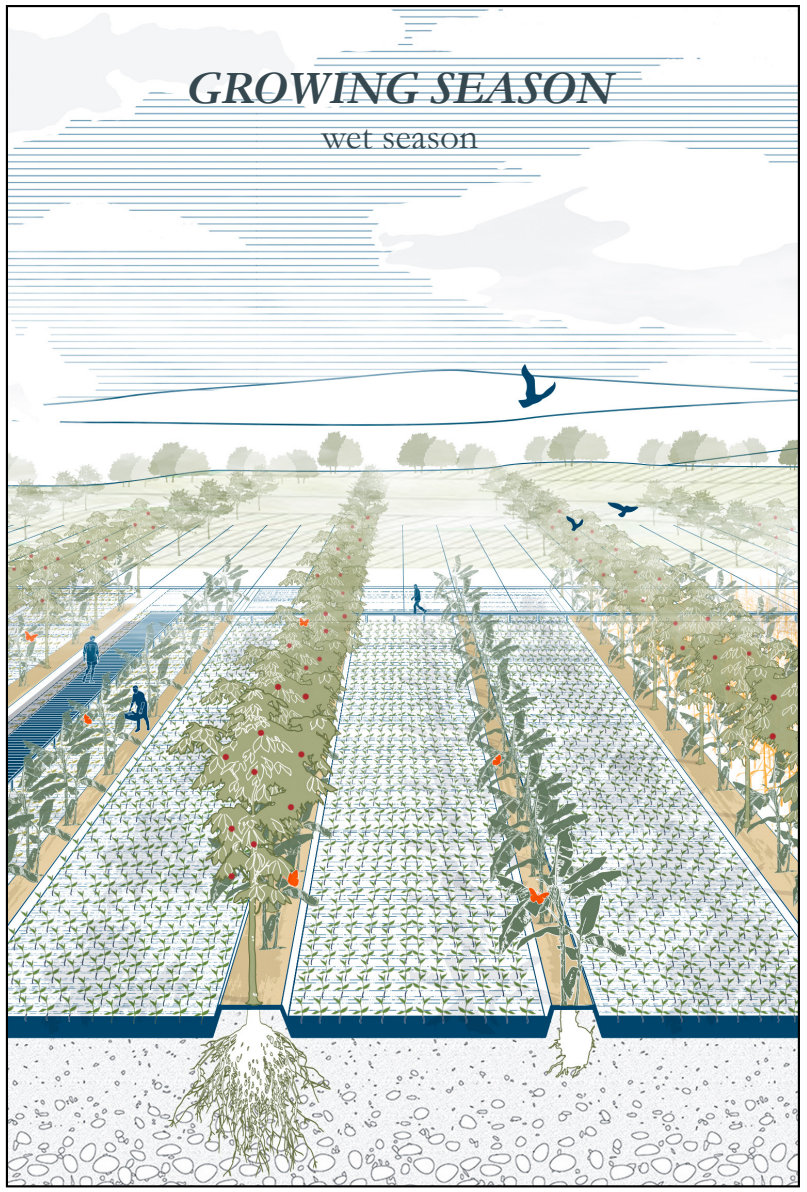
Current Situation

ZOOM-IN

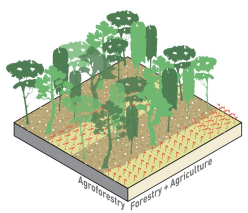
Rice-based Agroforestry



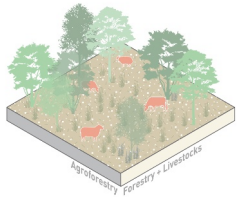
RICE-BASED AGROFORESTRY



Phase 1



70%



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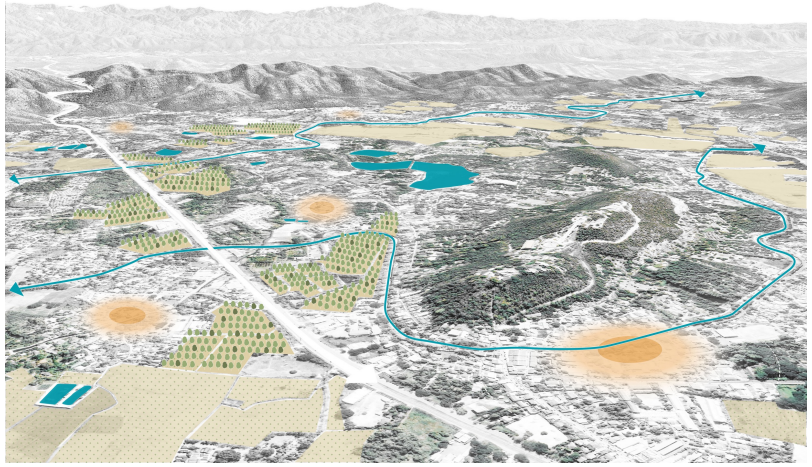
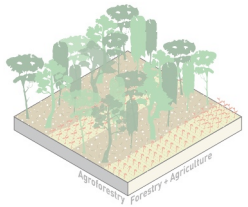


Phase 2



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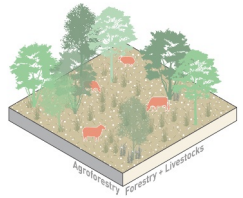

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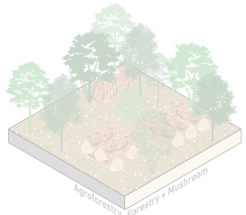

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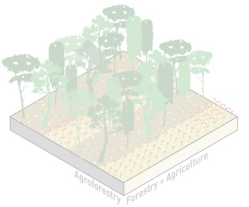
Phase 3



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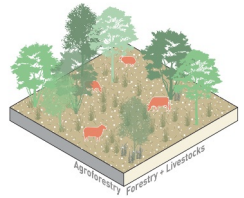

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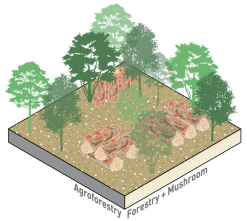

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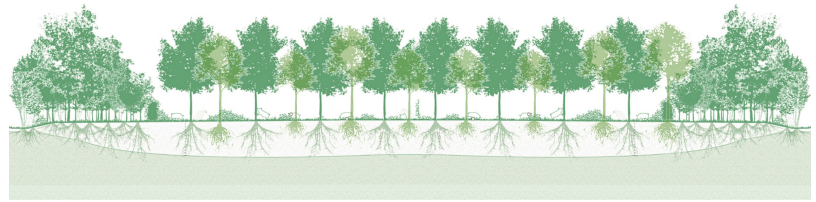
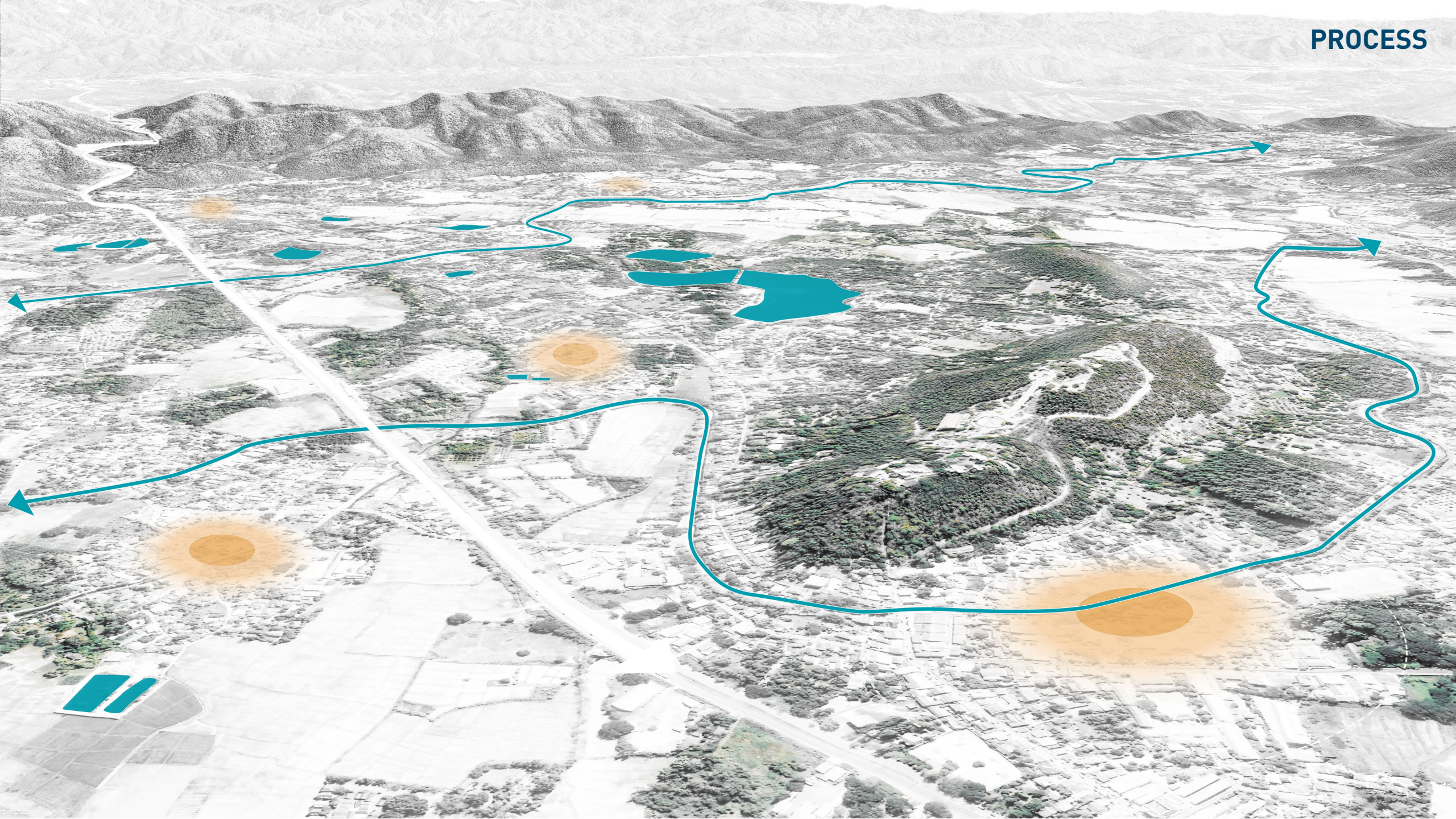


PROCESS



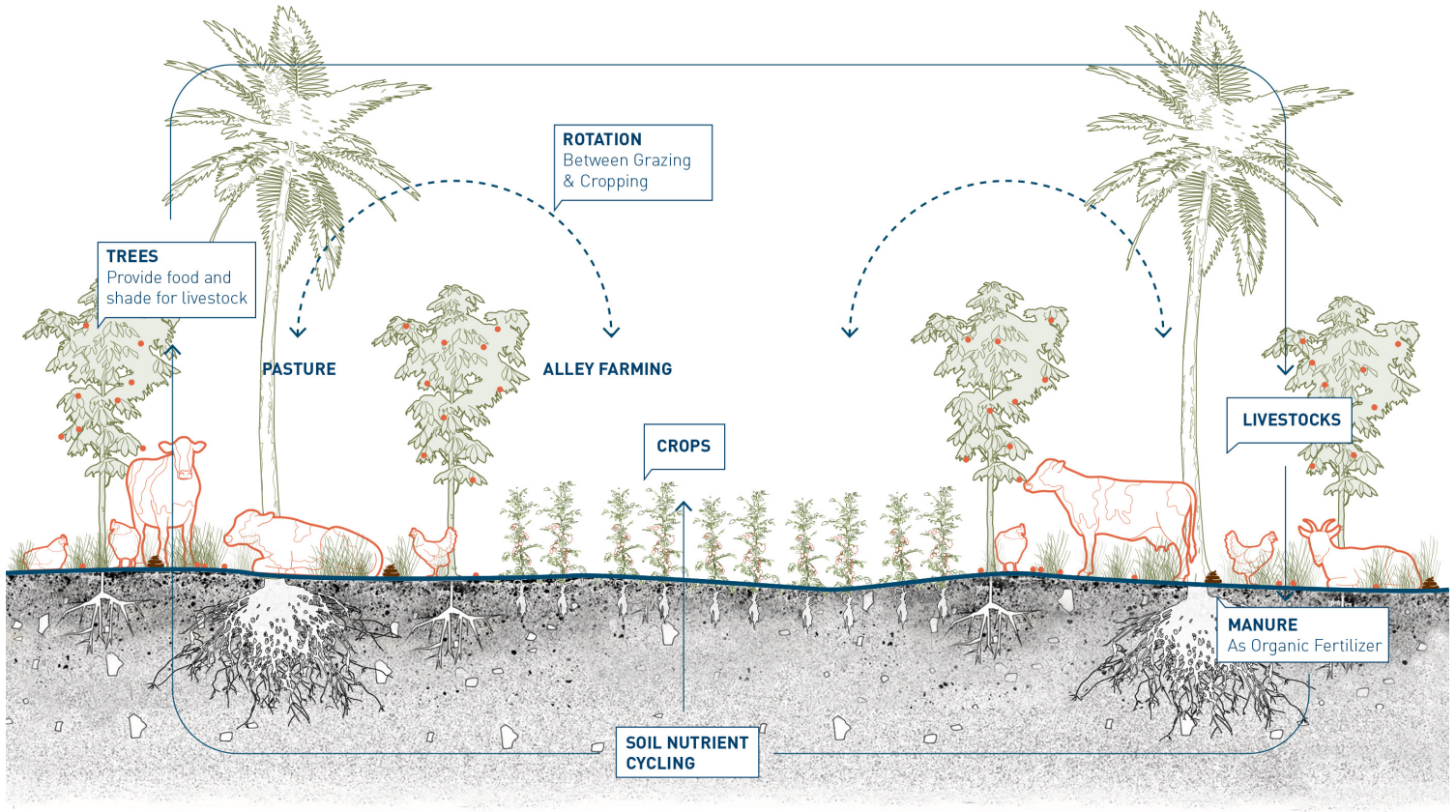
PROCESS

PROCESS

PROCESS

Above the Rice

Livestock Observation

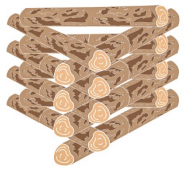


Mushroom Safari

MUSHROOM CULTIVATION STRUCTURE

Loose Crib

Loose Lean-To



Triangle

Upright A-frame

MUSHROOM FACTSHEET

Oyster Mushroom
Pleurotus spp.

Shimeji Mushroom
Hypsizygus tessulatus

Shiitake Mushroom
Lentinula edodes

Straw Mushroom
Volvariella volvacea

Plant Associates

oak beech

chestnut birch

maple

Wild Nutrient Sources

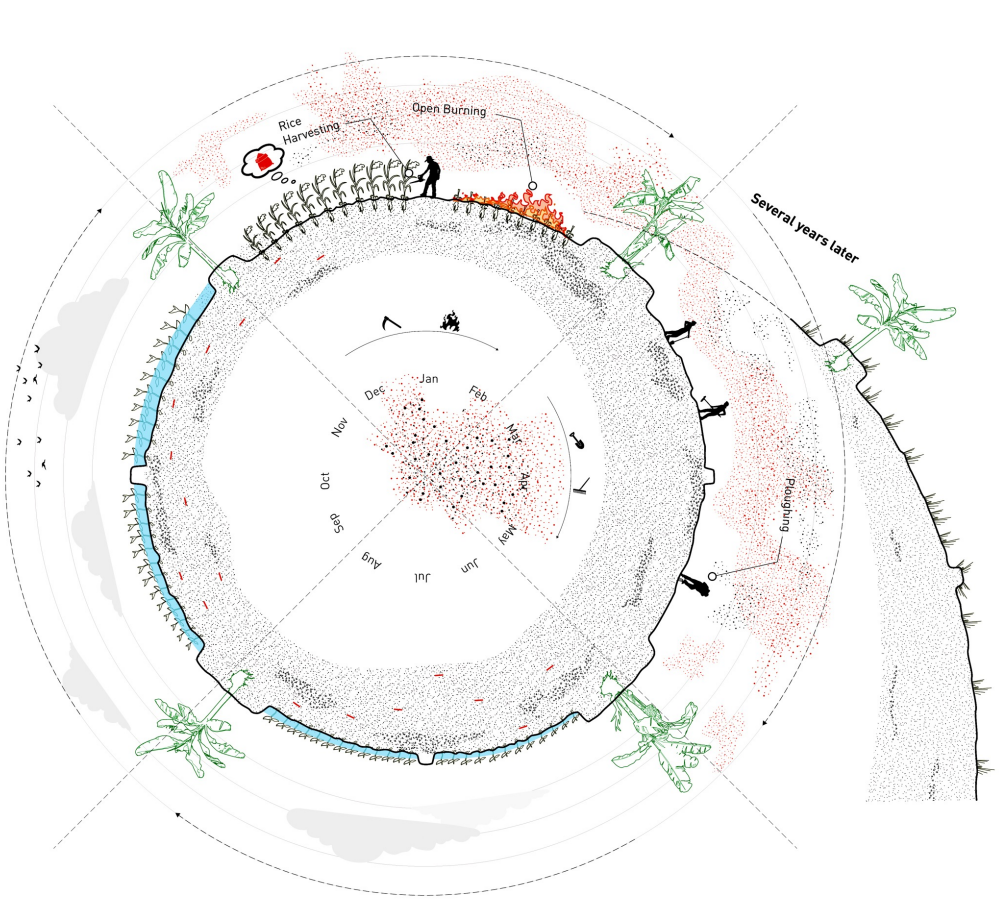
Lignin (hardwood trees)

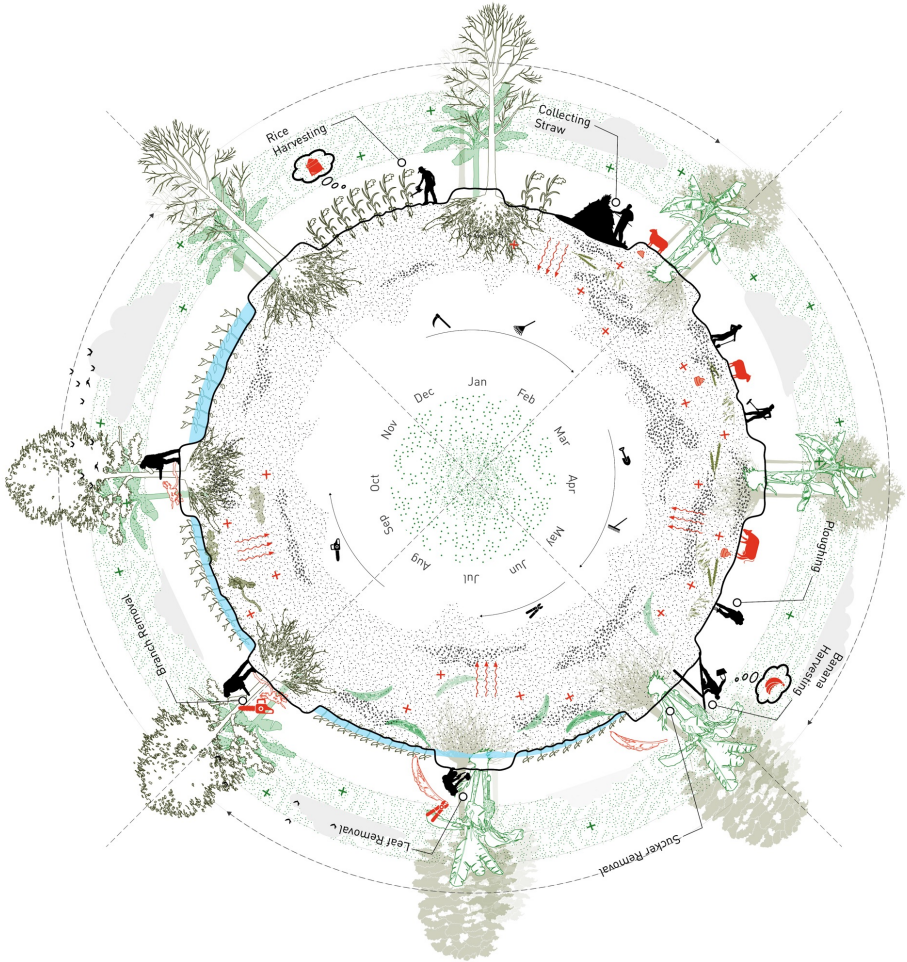
Cellulose (agricultural waste)

Above the Rice

Livestock Observation

Mushroom Safari





Existing - 1 year cyclic

With intervention - 1 year cyclic

Traditional agricultural system ----------▸ Sustainable agricultural system

Ecologically

soil fertility ↗

air pollutant ↘

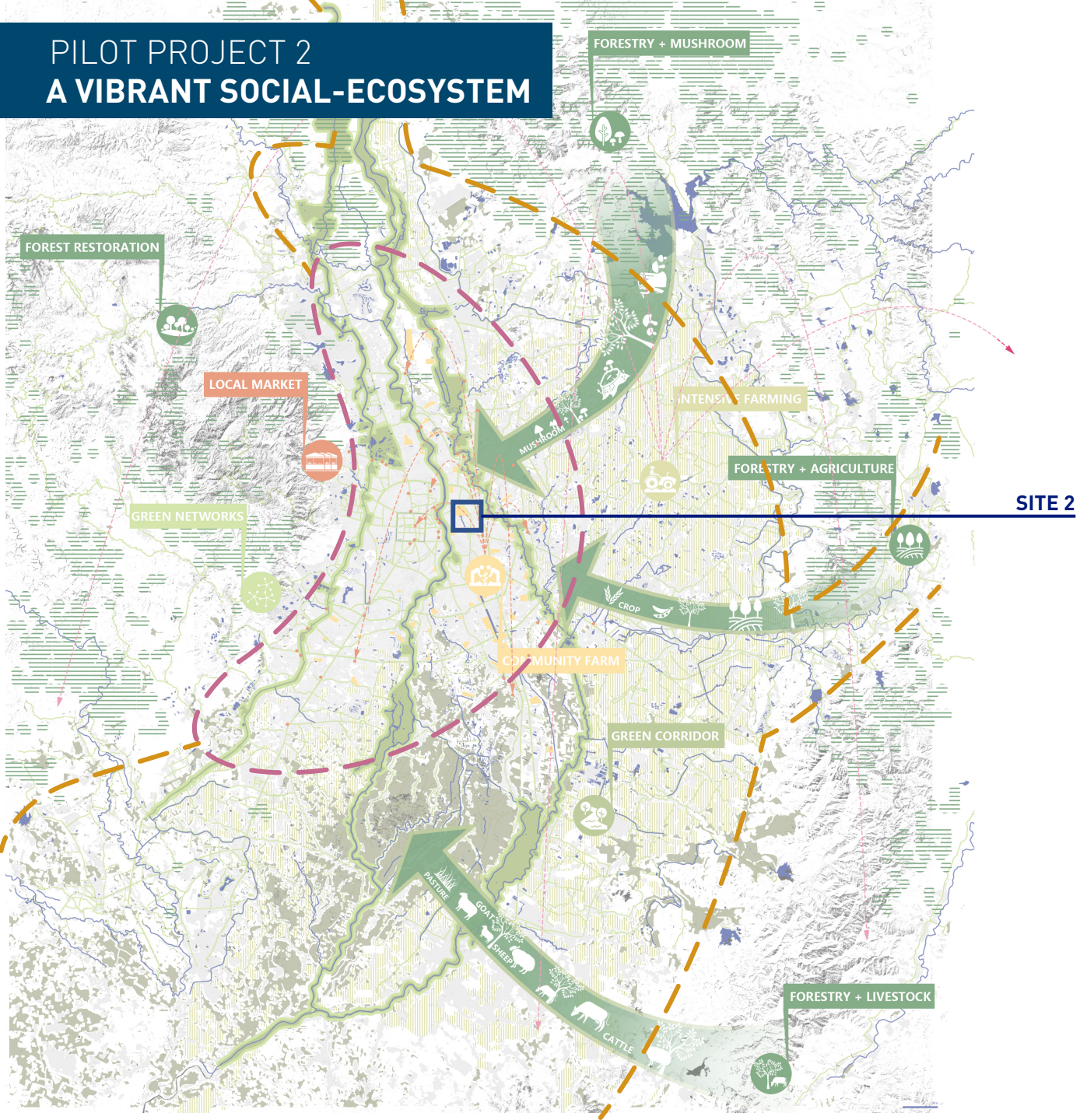
biodiversity ↗

Economically

production (rice, banana, maybe timber) ↗

PILOT PROJECT 2

A VIBRANT SOCIAL-ECOSYSTEM

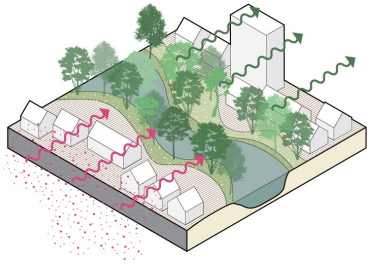


URBAN

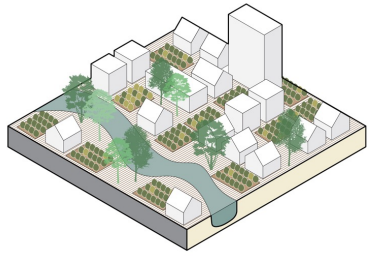
PILOT PROJECT 2

Local farmer market (Sustainable production mode)
Community farm (Urban farming)
Streetscape (Urban farming and greening)

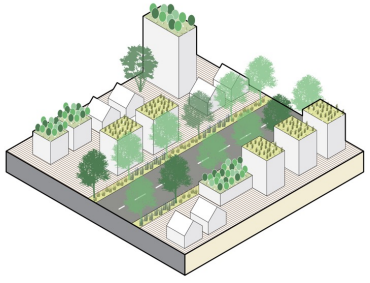
San Phranet, San Sai District



Green corridor as filter



Urban farming



Urban greening

Under-utilized Urban Voids

San Phranet, San Sai District





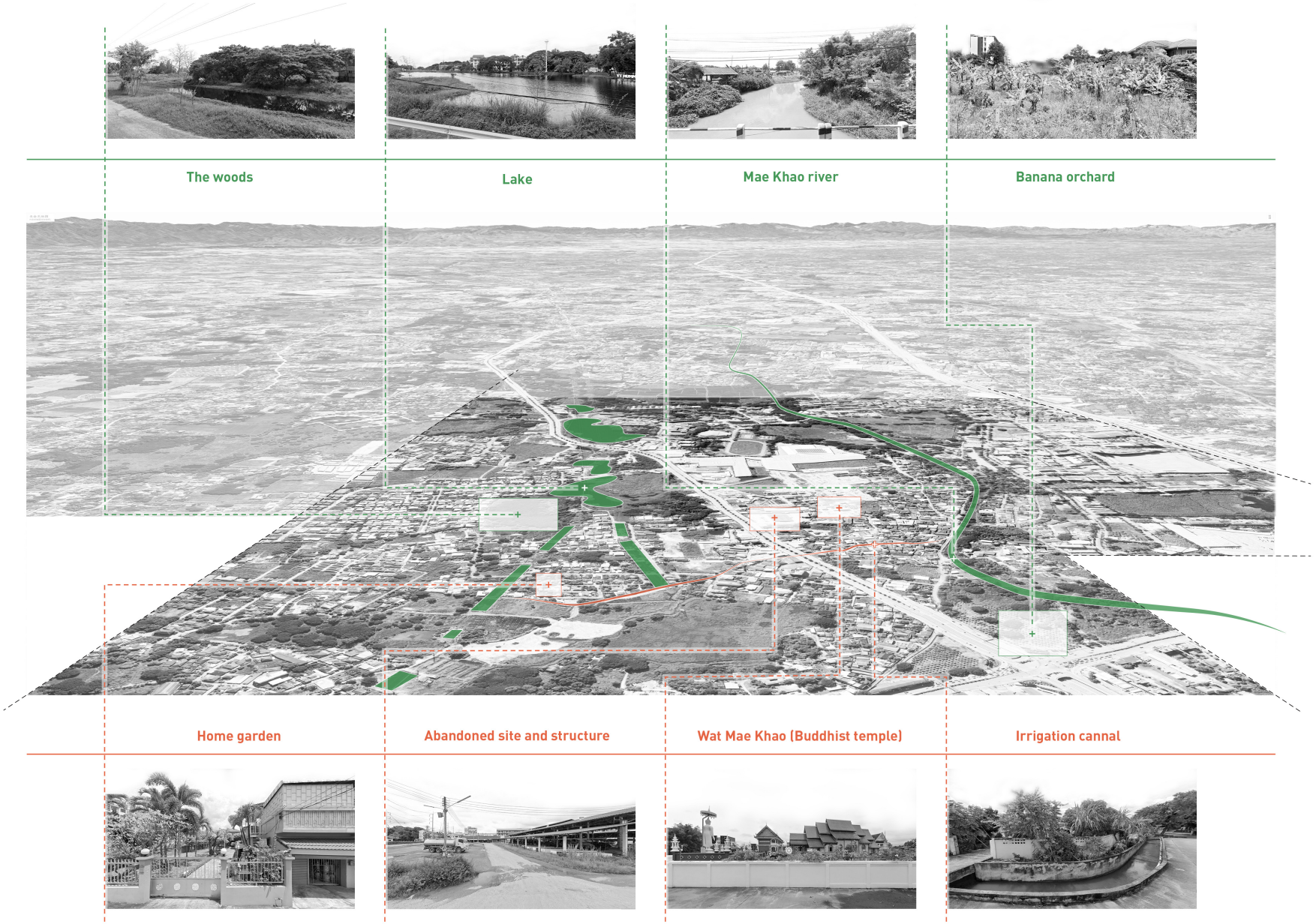



edge and buffer voids

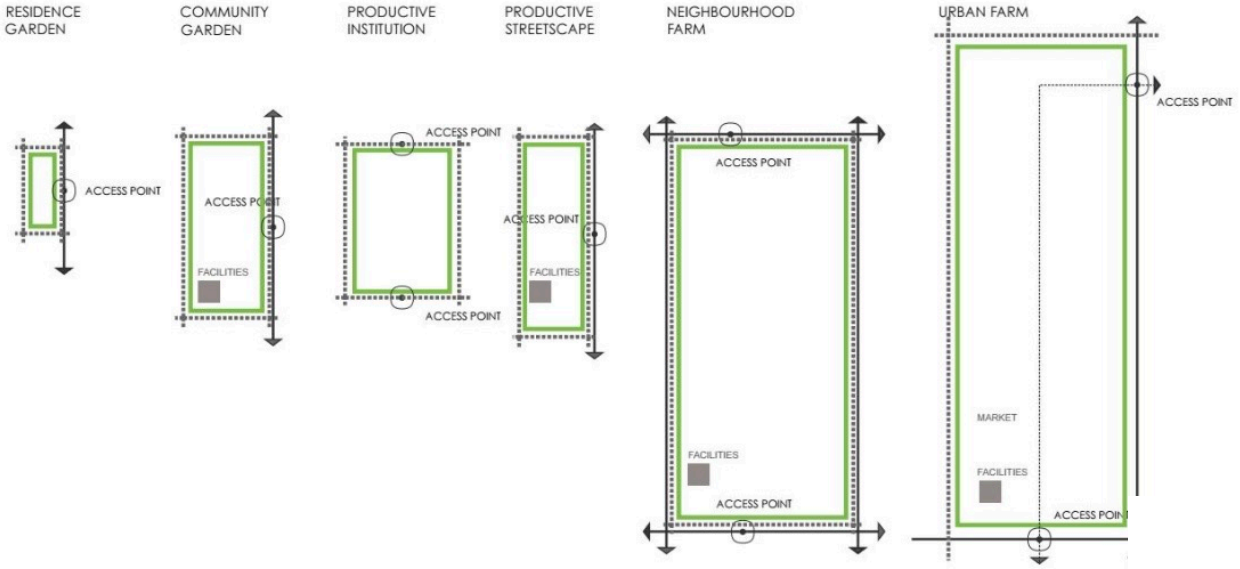
infrastructure voids

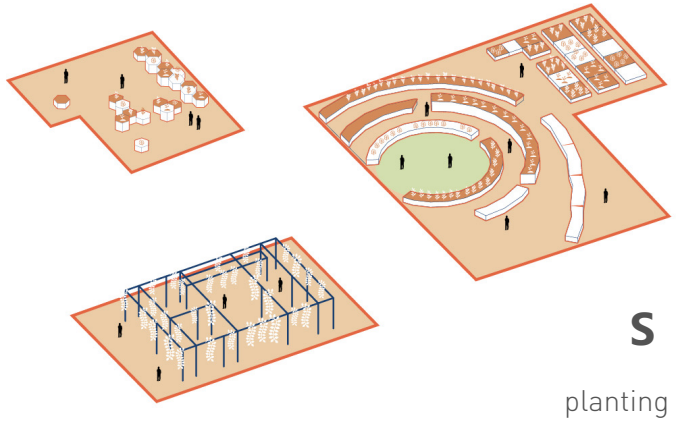
vacant plot

Landscape Resources and Potentials



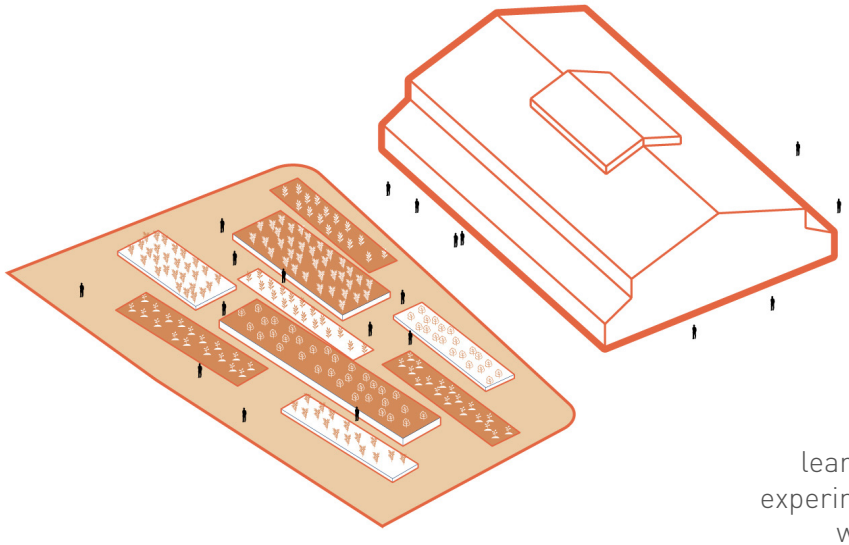
Urban Farming Elements





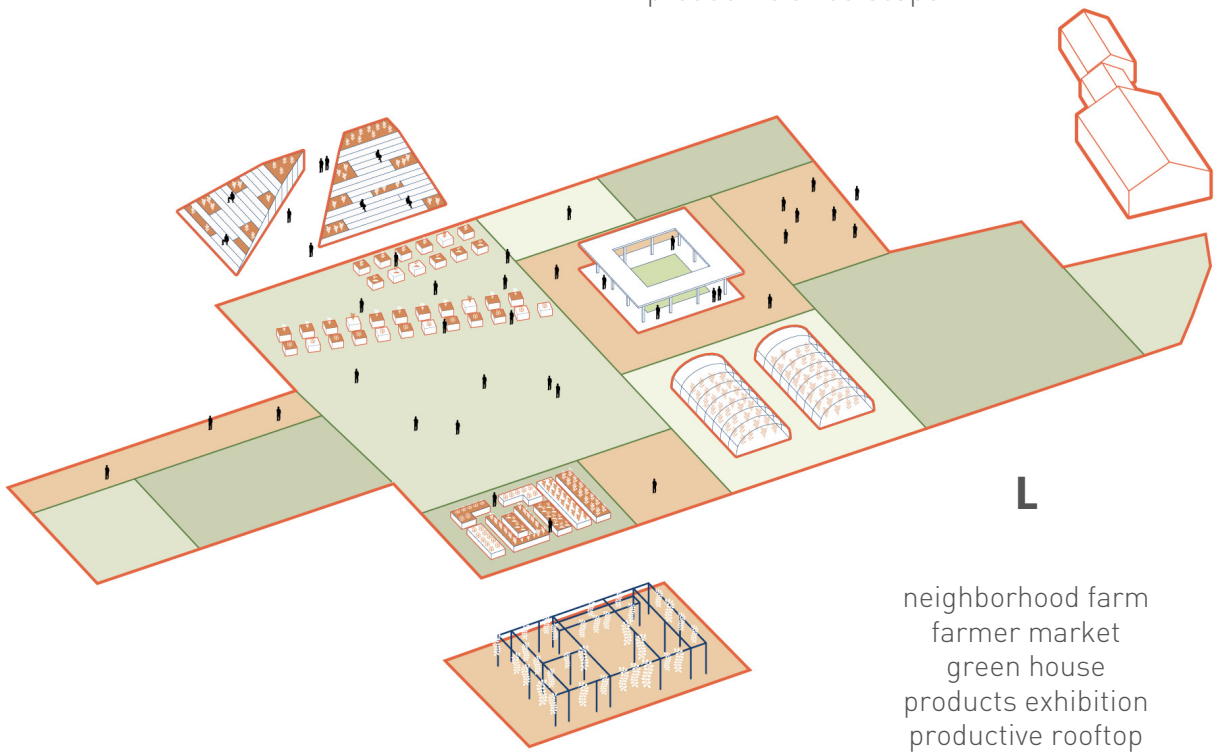
S

planting box
community garden
home garden
productive streetscape



M

learning center
experimental farming
workshop
local market



L

neighborhood farm
farmer market
green house
products exhibition
productive rooftop

GREEN NETWORK

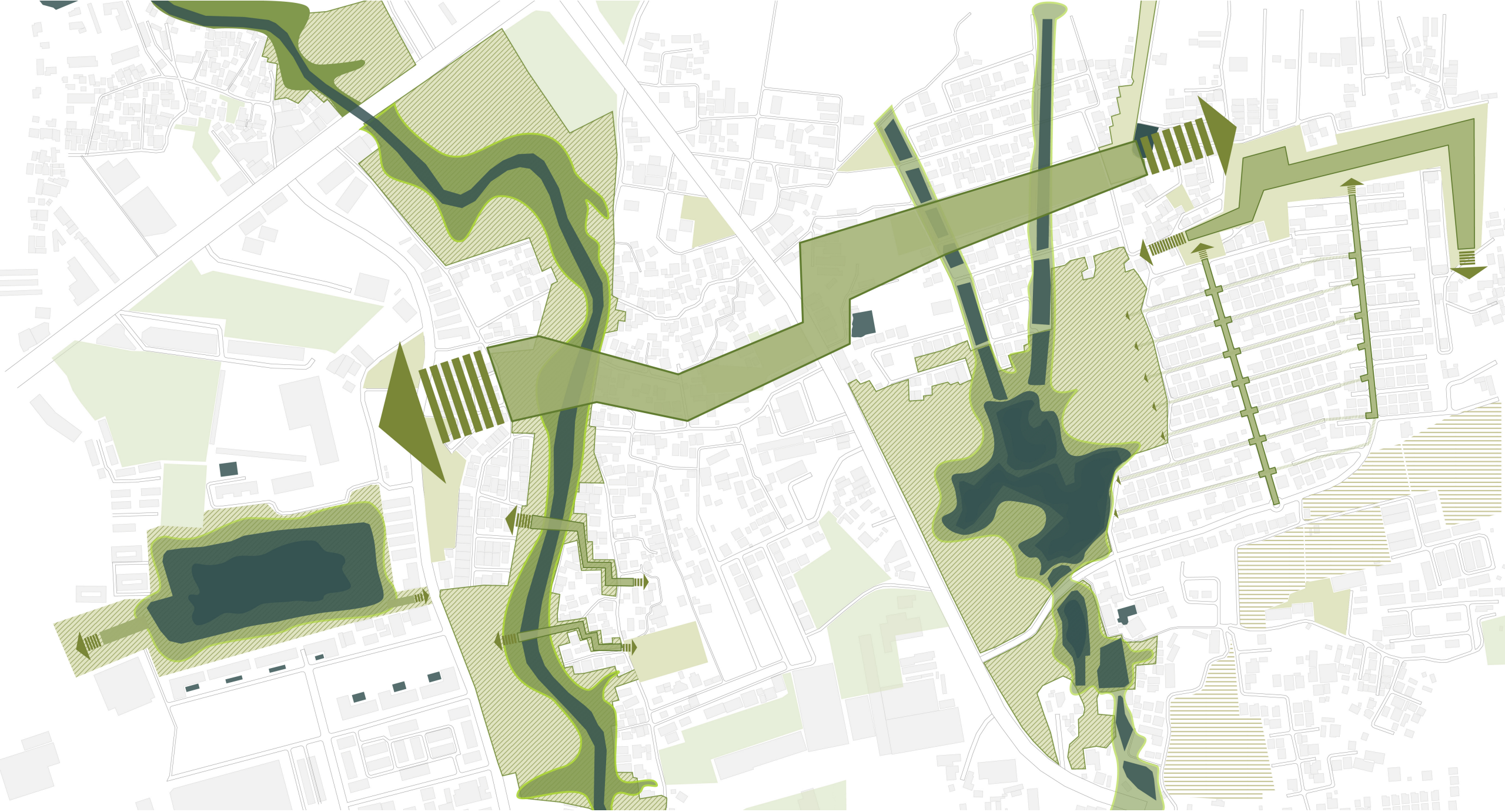
Improve functionality and connectivity of green space by preserving the ecological function and building vibrant recreational green corridor

URBAN FARMING

Introduce urban farming system to activate urban void and enhance green coverage

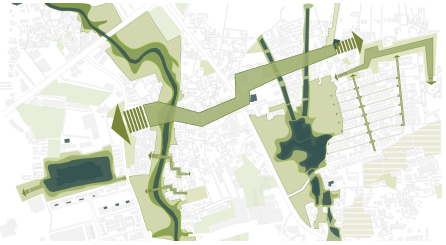
COMMUNITY CONNECTIVITY

Enhance community connectivity by improving mobility system and connecting urban farming areas



MASTERPLAN

A Vibrant Social-ecosystem



GREEN NETWORK

URBAN FARMING

COMMUNITY CONNECTIVITY

Zoom-in 1

Dynamic Hub for Urban Farming

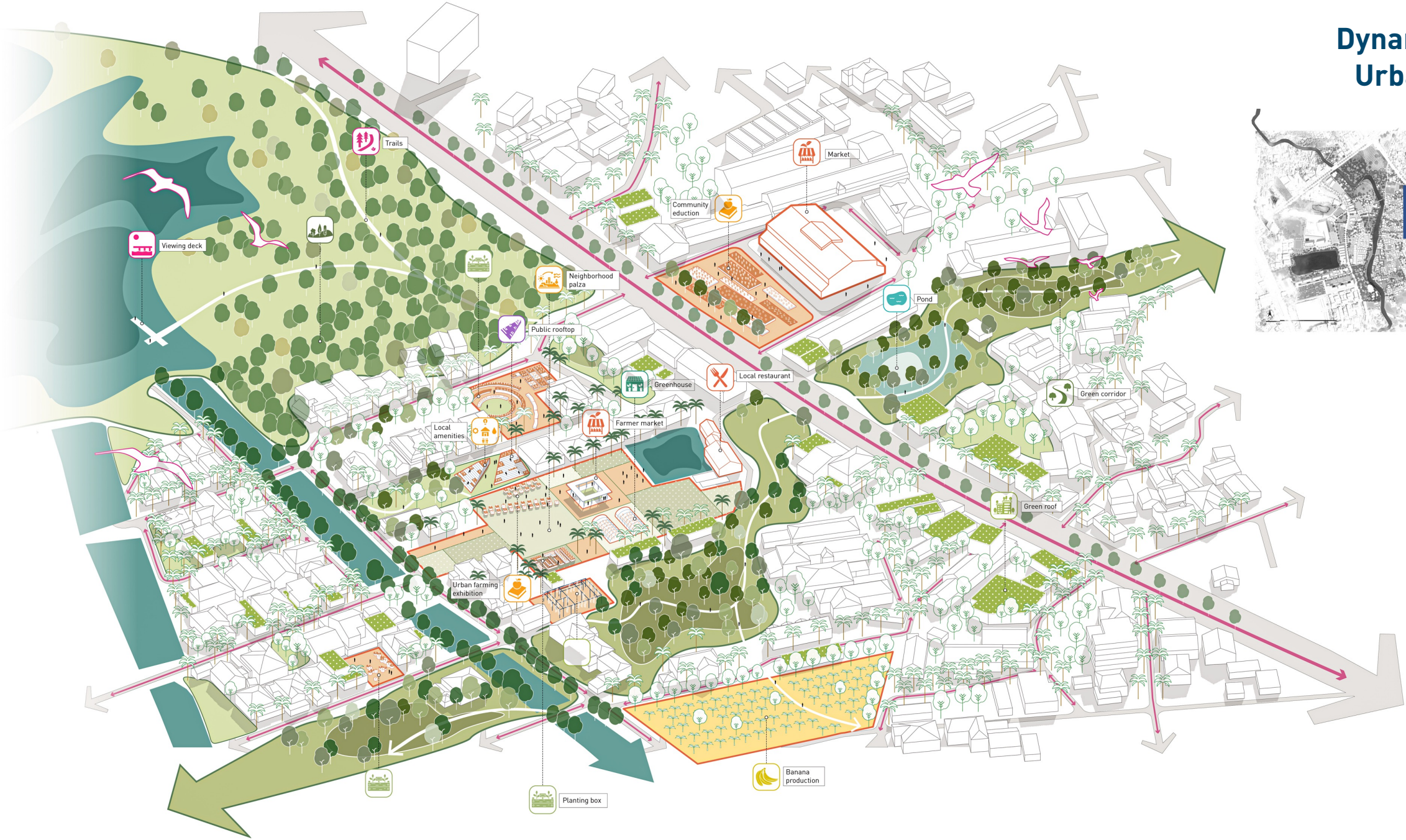
GREEN NETWORK

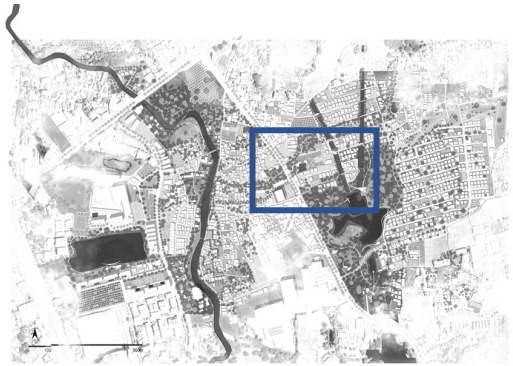
URBAN FARMING

COMMUNITY CONNECTIVITY

ZOOM-IN 1

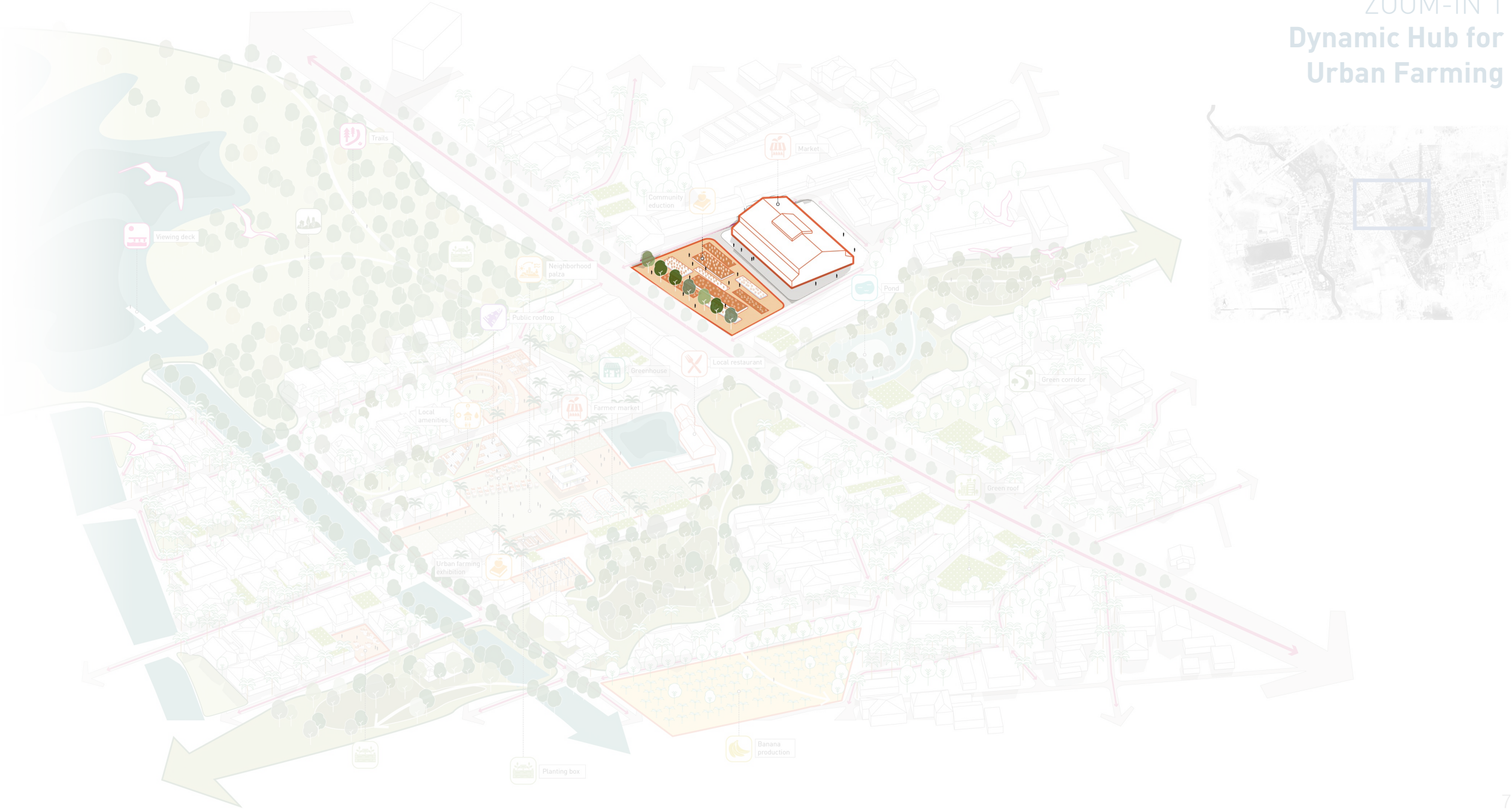
Dynamic Hub for Urban Farming





ZOOM-IN 1

Dynamic Hub for Urban Farming



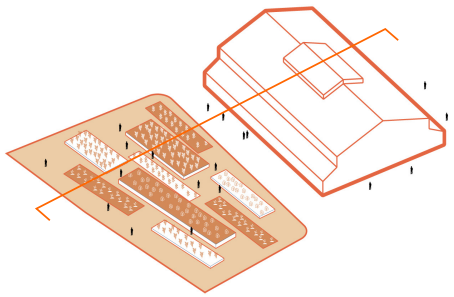
ZOOM-IN 1

Current Situation

ZOOM-IN 1

Activator of Open Space

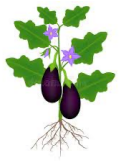
Transformation of abandoned structure



garlic

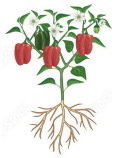
vegetable

tomato



eggplant

cucumber



chili pepper

Pine

Pinus kesiya & merkusii

Australian pine

Casuarina equisetifolia

Ciper

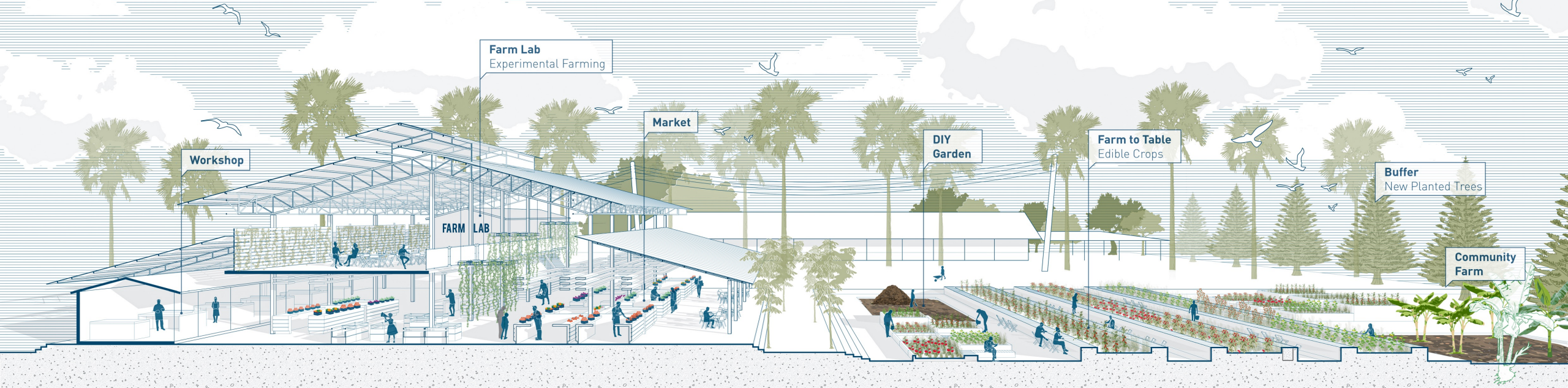
Cupressus Sempervirens(a.o.)

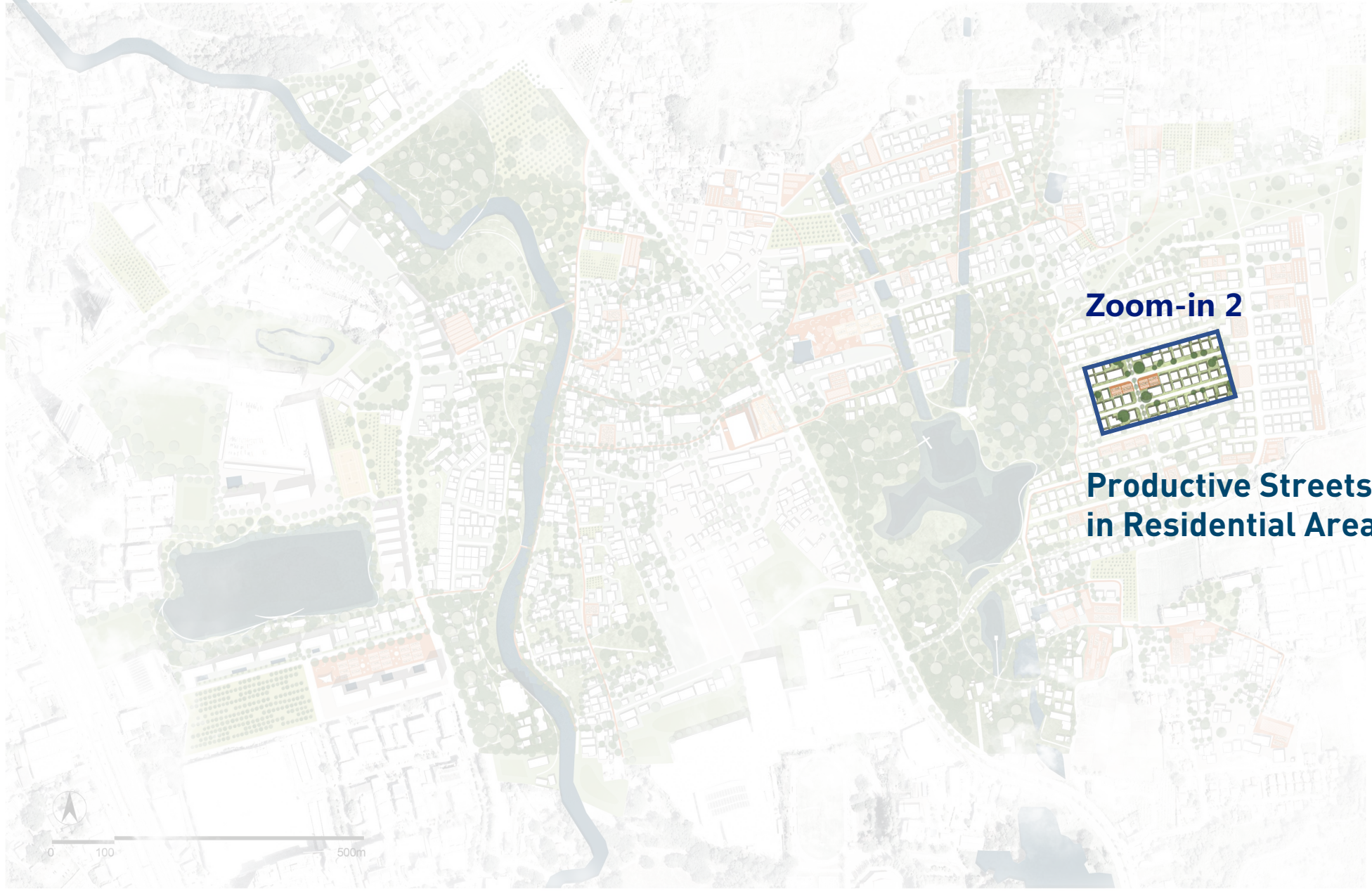
Yellow trumpet flower

Tecoma stans

Banana

Musa sp.





Zoom-in 2

Productive Streetscape in Residential Area

ZOOM-IN 2

Productive Streetscape in Residential Area

Orchid tree

Bauhinia purpurea

Yellow allamanda

Allamanda cathartica

Yellow trumpet flower

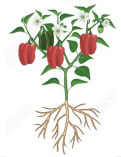
Tecoma stans

Pine

Pinus kesiya & merkusii

Banana

Musa sp.



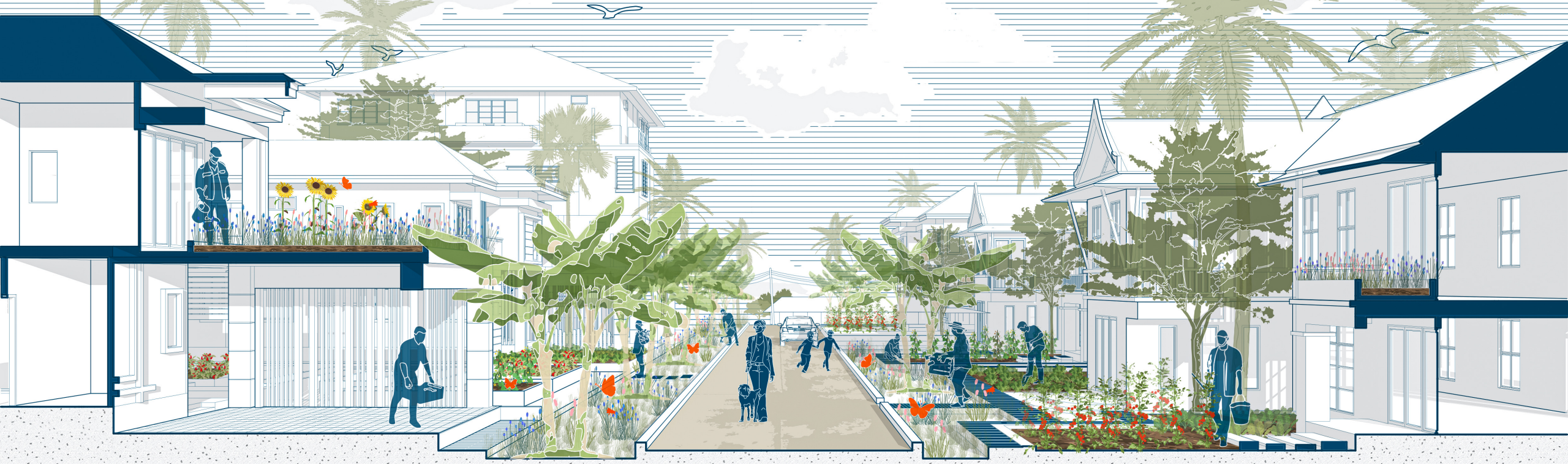
chili pepper

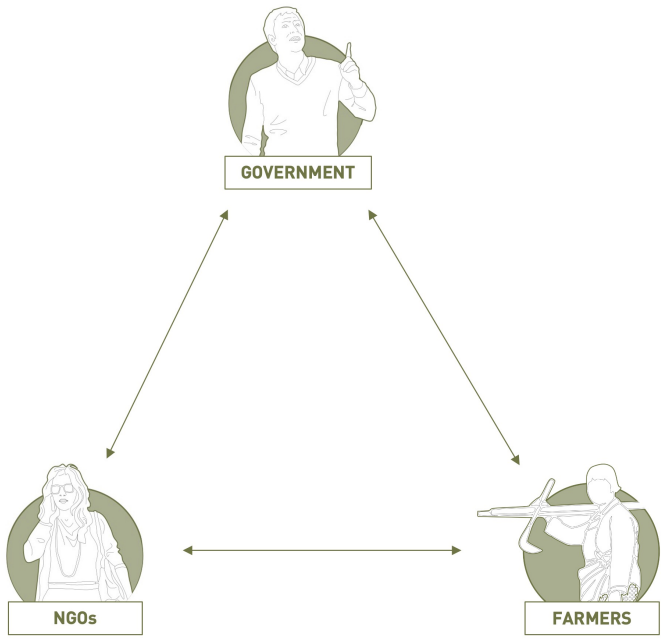
tomato

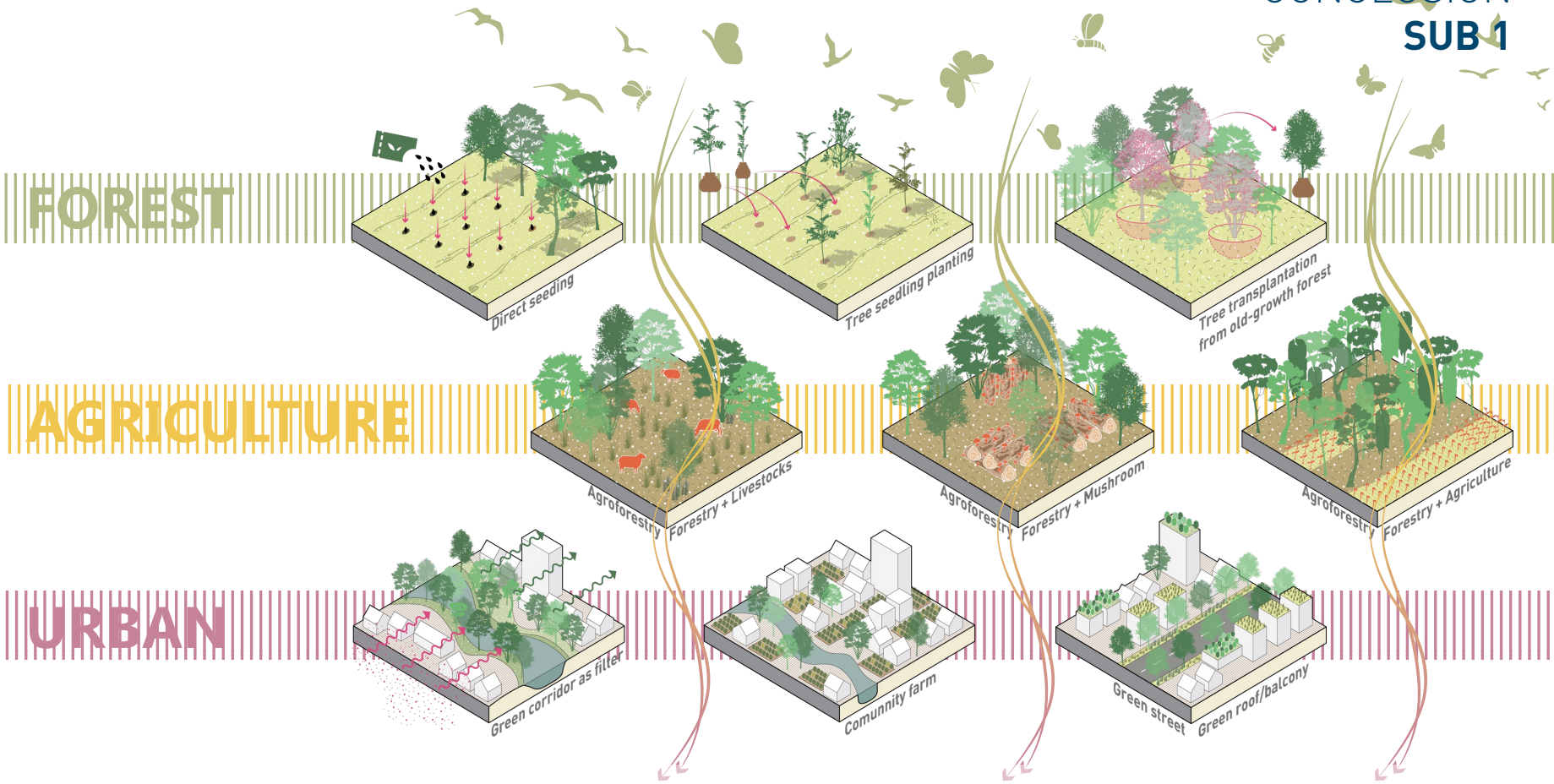
garlic

vegetable

peanut







How does a **regional strategy framework** incorporate regional and local agricultural system to control air pollution?

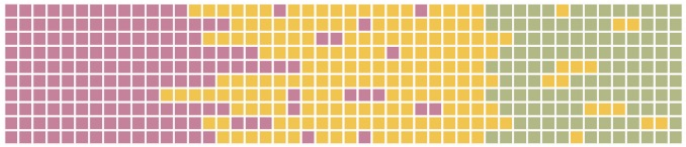
How to cultivate a **new relationship between farmland and urban expansion** that provides a sustainable crop production network?

What kind of **sustainable production mode** can improve the living conditions of local residents without harming the ecological environment?

What kind of **sustainable cultivation pattern** of crops can be practiced in farmland in the context of Southeast Asia?

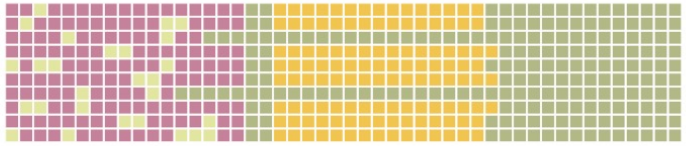
What is the **most efficient local vegetation species** and **planting pattern** to remove air pollution in urban area?

CURRENT
Scenario



Urban area and agriculture area are merging, and farmlands are invading forest

INTEGRATED
Farming Scenario



Introducing agroforestry and urban farming, more green in urban area

Define the Boundary of Urban and Agriculture Area

How does a **regional strategy framework** incorporate regional and local agricultural system to control air pollution?

How to cultivate a **new relationship between farmland and urban expansion** that provides a sustainable crop production network?

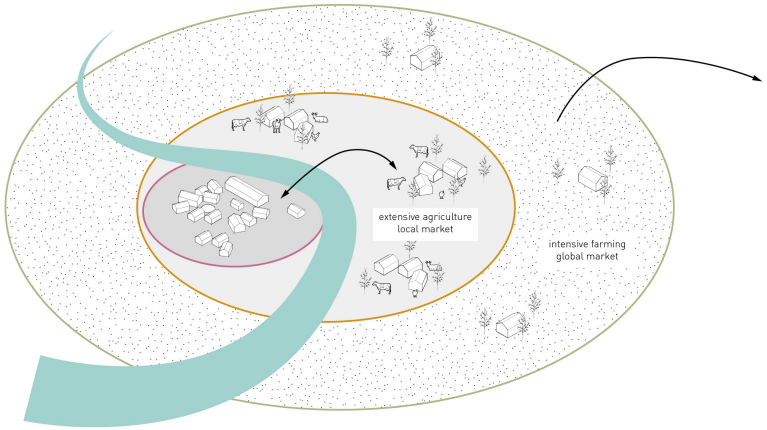
Encourage Mixed-use Development

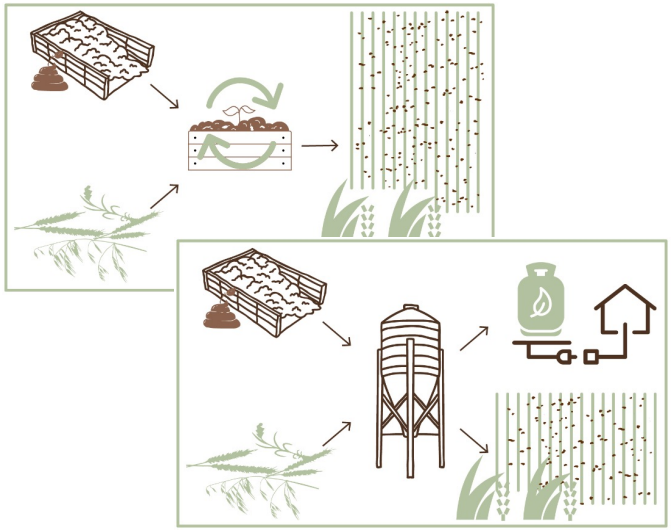
What kind of **sustainable production mode** can improve the living conditions of local residents without harming the ecological environment?

Promote urban farming and urban greening

What kind of **sustainable cultivation pattern** of crops can be practiced in farmland in the context of Southeast Asia?

What is the **most efficient local vegetation species** and **planting pattern** to remove air pollution in urban area?





Agroforestry + Intensive Farming

- ***Agroforestry —> local market***
- ***Intensive farming —> global market***

Community Supported Agriculture (CSA)

- **Short chain**
- **Distribution point**

Organic Waste Recycling

- **Composting network**
- **Waste-to-energy facility**

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Conclusion

Sub 5

Efficient Tree species

Efficient Shrub species

CONCLUSION
SUB 5

PM10 removal

Pride of Barbados

Caesalpinia Pulcherrima

Ciper

Cupressus Sempervirens(a.o.)

Yellow trumpet flower

Tecoma stans

Splitleaf philodendron

Monstera deliciosa

Banana

Musa sp.

Yellow allamanda

Allamanda cathartica

NOx and OZONE removal

Australian pine

Casuarina equisetifolia

Pine

Pinus kesiya & merkusii

Norfolk Island pine

Araucaria heterophylla

Jackfruit

Artocarpus heterophyllus

Devil tree

Alstonia Scholaris

Orchid tree

Bauhinia purpurea

How does a **regional strategy framework** incorporate regional and local agricultural system to control air pollution?

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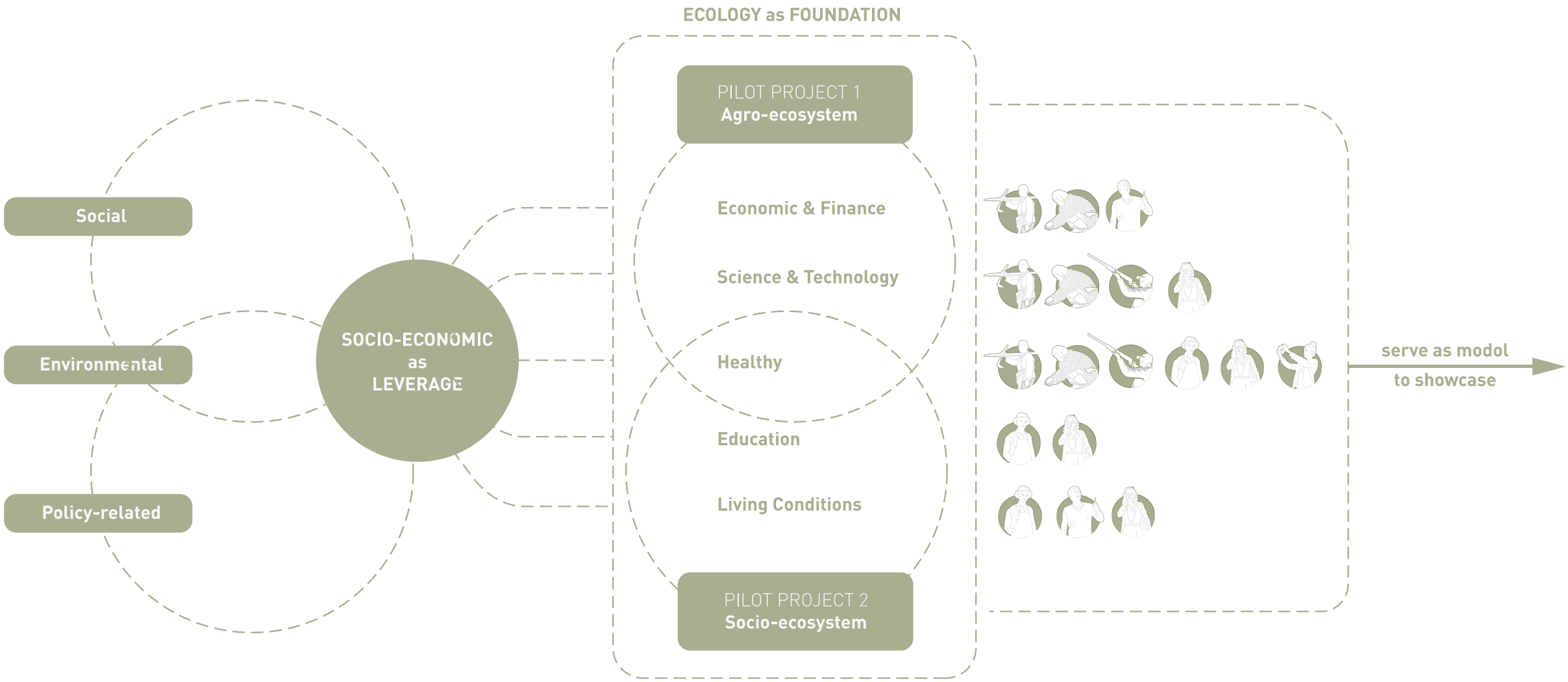
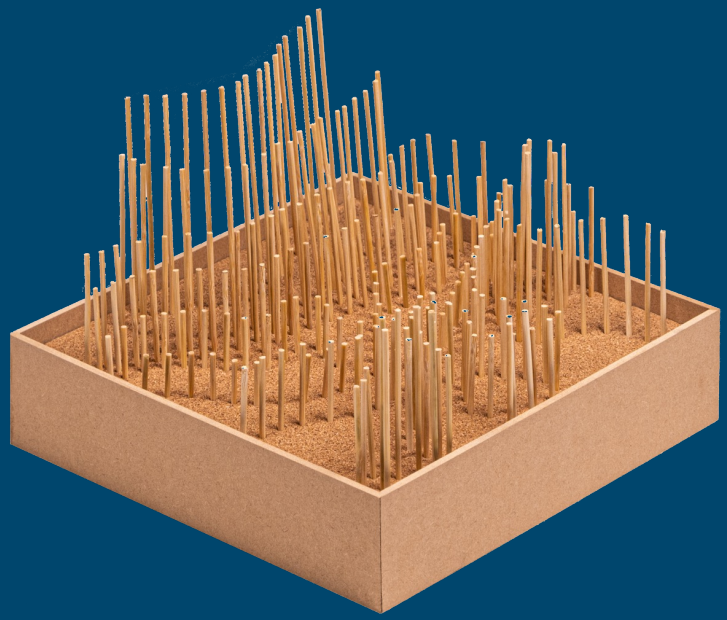
Reference: Hoffman, M. H. A., & Tonneijk, A. E. G. (2010). Urban green: relief for the city with focus on Chiang Mai, Thailand.

How to engage farmers as active participants in transition to sustainable system?



Thank you for your attention!

A new paradigm of integrated farming as mitigation of air pollution in Chiang Mai, Thailand



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