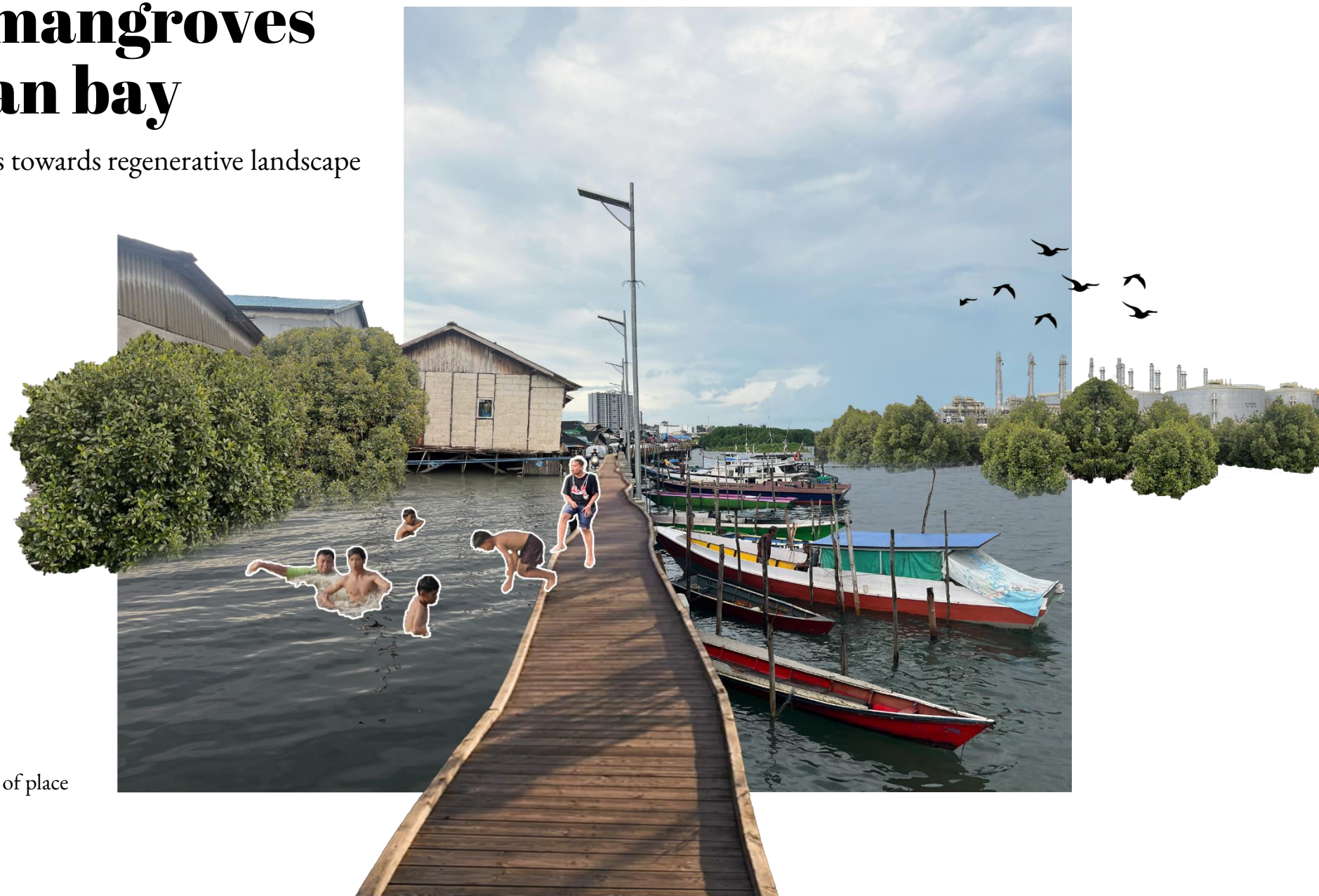
reclaiming mangroves of balikpapan bay

designing socio-spatial strategies towards regenerative landscape



P5 Presentation – 20th June 2025
frithasya jeniardina purba | 5991617
msc urbanism
graduation studio: metropolitan ecologies of place

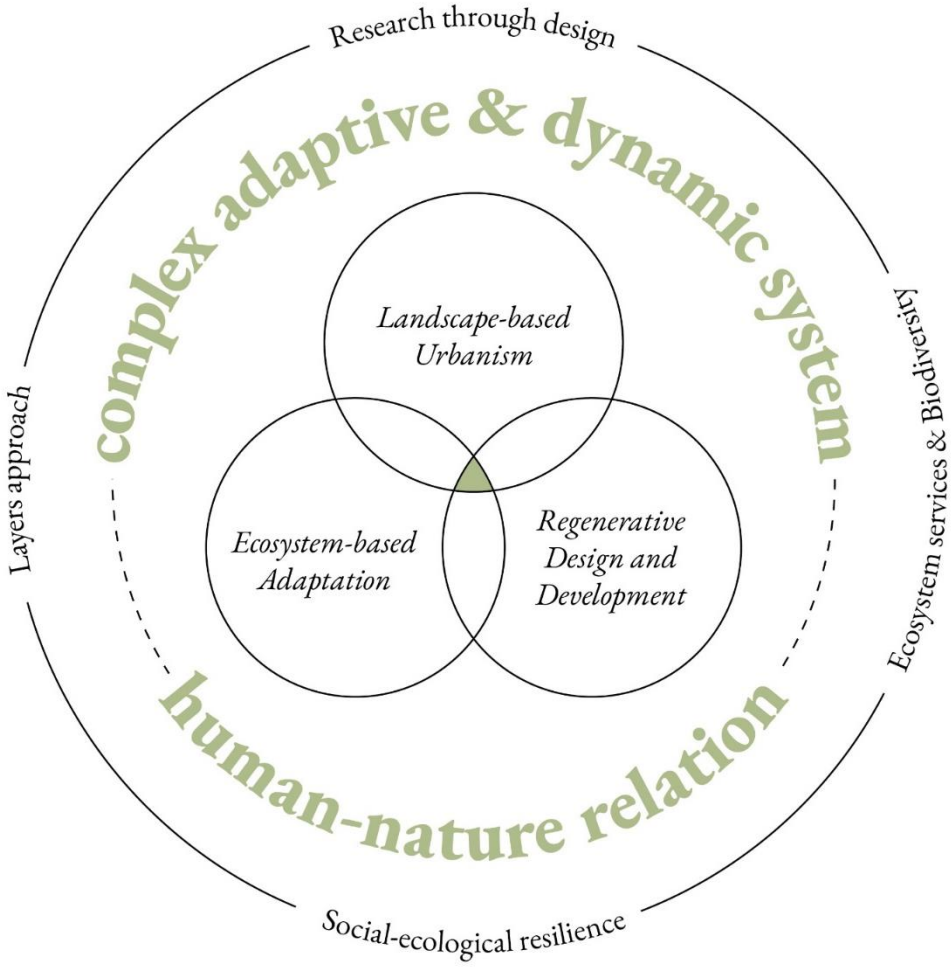
contents

problem statement | research question | analysis | design process | conclusion & reflection

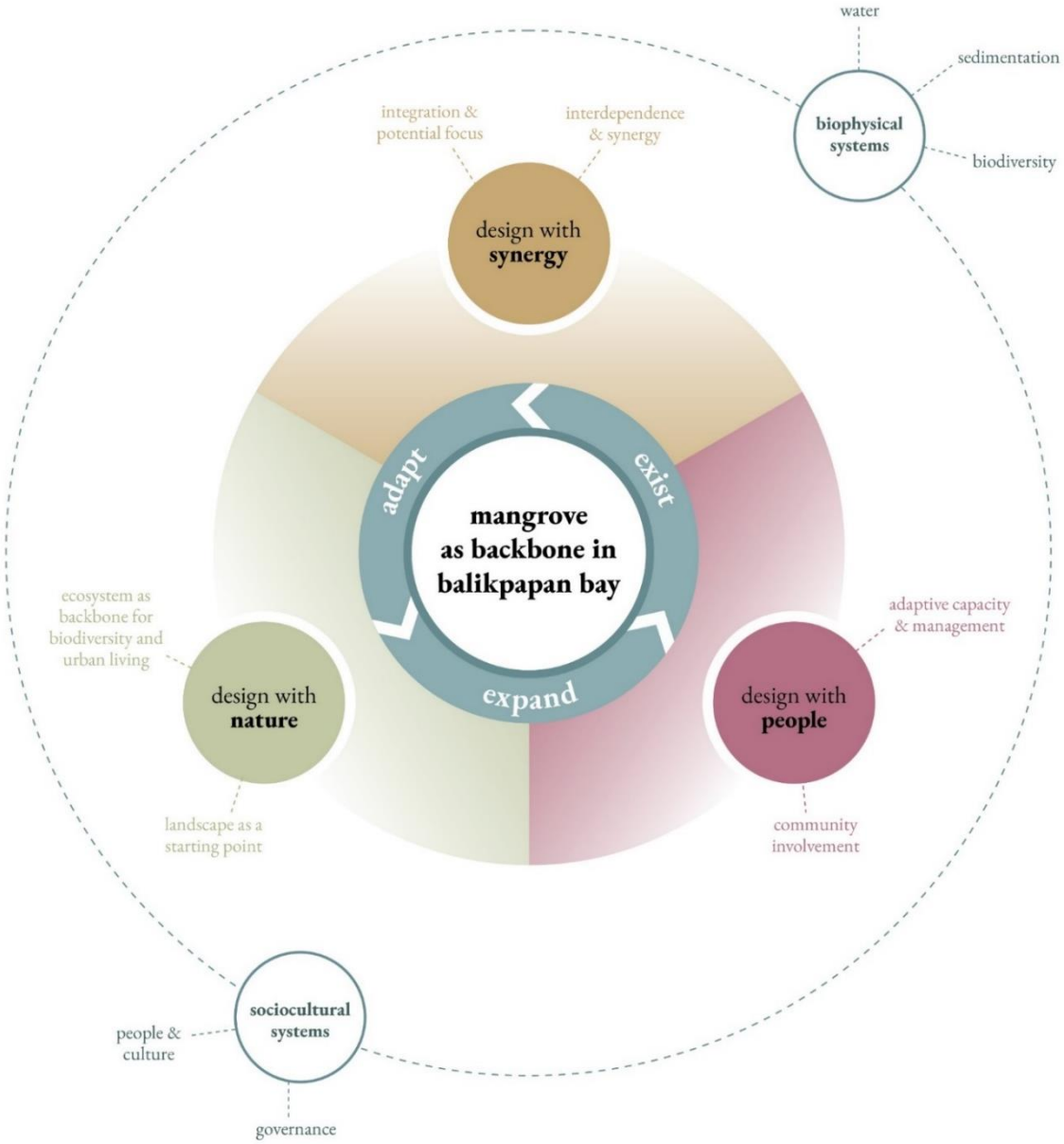
research question

what landscape-based socio-spatial strategies can be applied to regenerate the mangrove ecosystems in balikpapan bay and catalyse social-ecological resilience?

theoretical and conceptual framework



theoretical framework

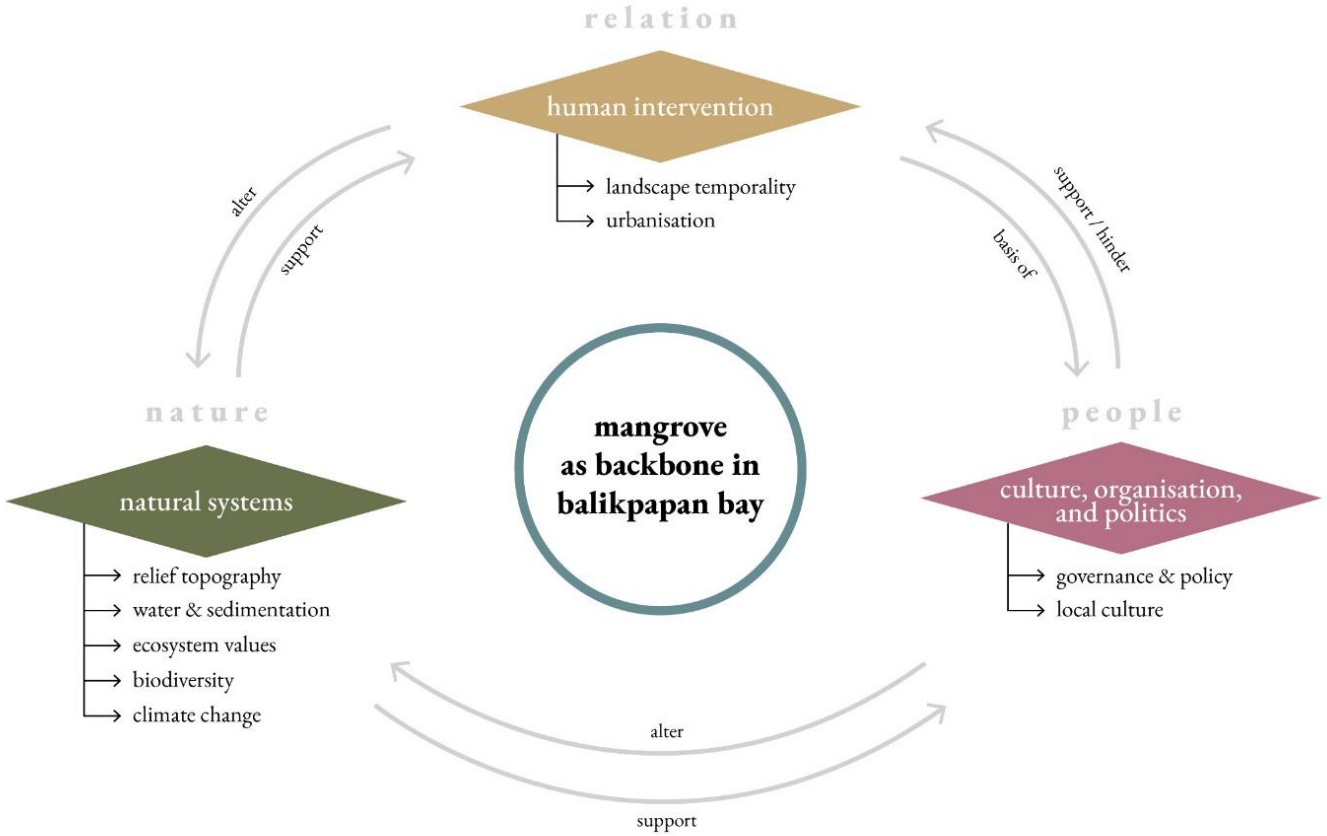


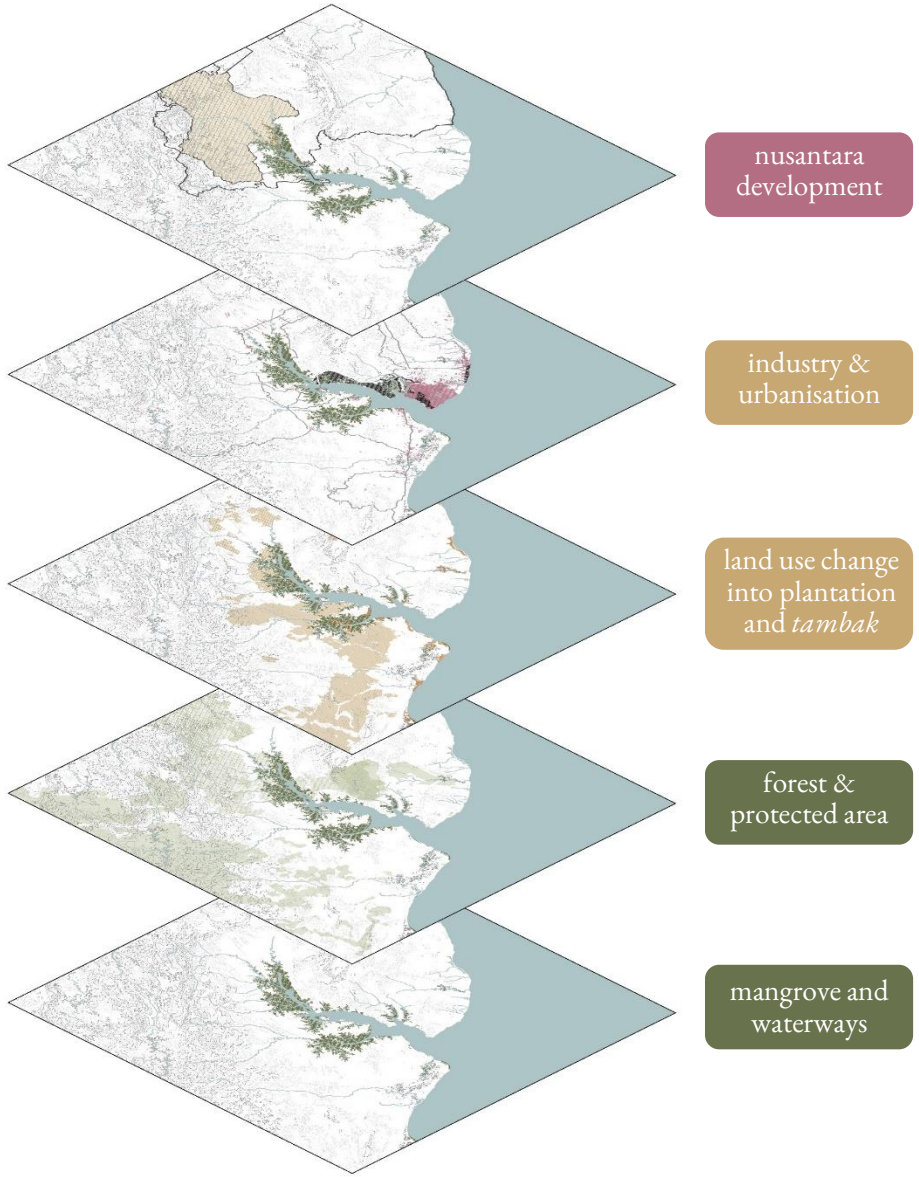
conceptual framework

analysis

unravelling the layers

unravelling the layers as sub-systems





current conditions

Nipah-nipah in lower salinity water (riverine area)

Bakau in more saline water (estuarine brackish)

15.600 ha
mangrove forest area

sepaku river

semoi river

riko river

wain river

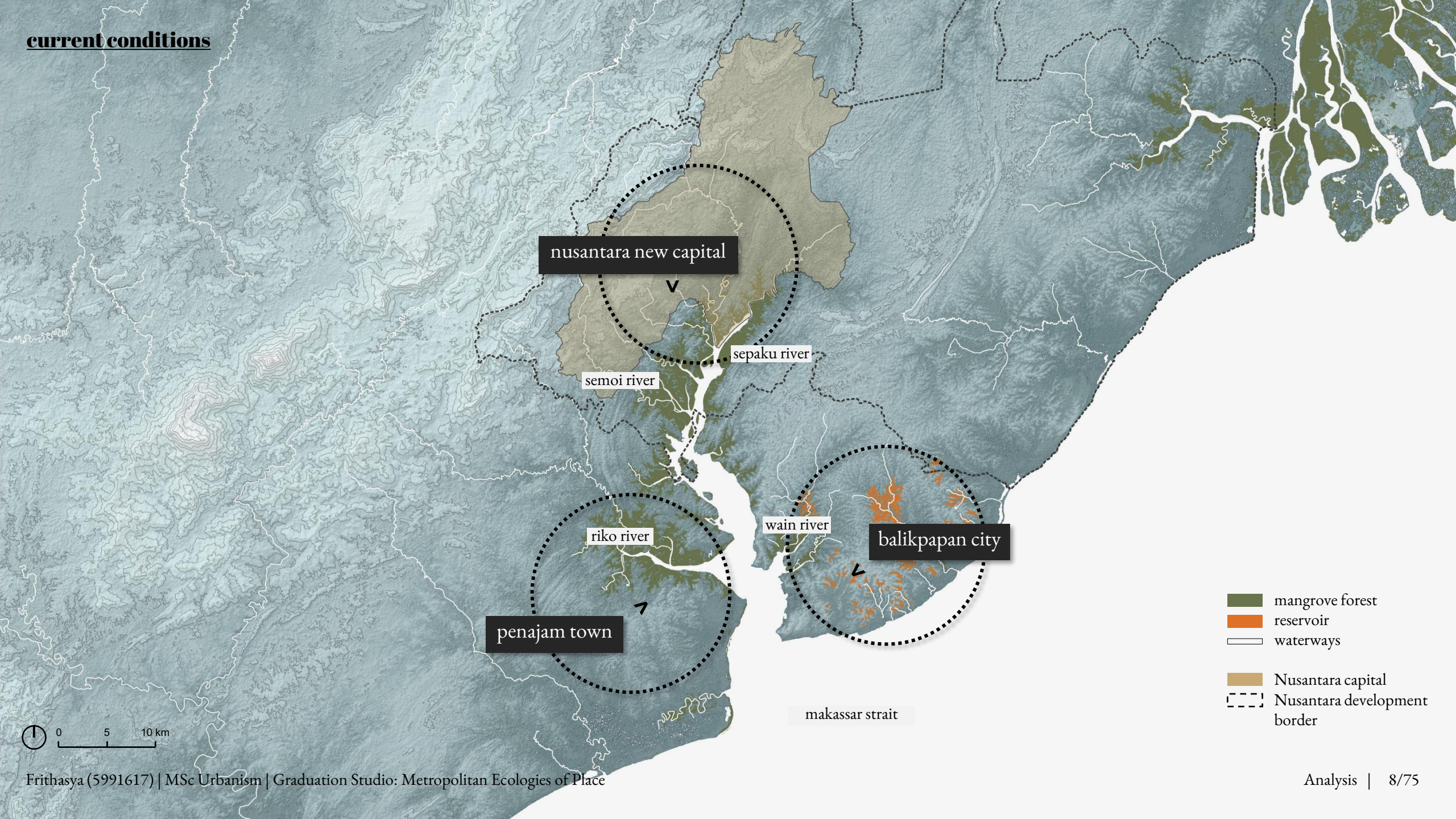
makassar strait

0 5 10 km

mangrove forest
reservoir
waterways

Nusantara capital
Nusantara development border

current conditions



land use changes

palm oil plantations

aprobior.id, 2021

tambak / aquaculture

google earth, 2025

0 5 10 km

mangrove forest
palm oil plantation
tambak (aquaculture)
industrial area
urbanised area
Nusantara capital
Nusantara larger development border

nusantara new capital planning

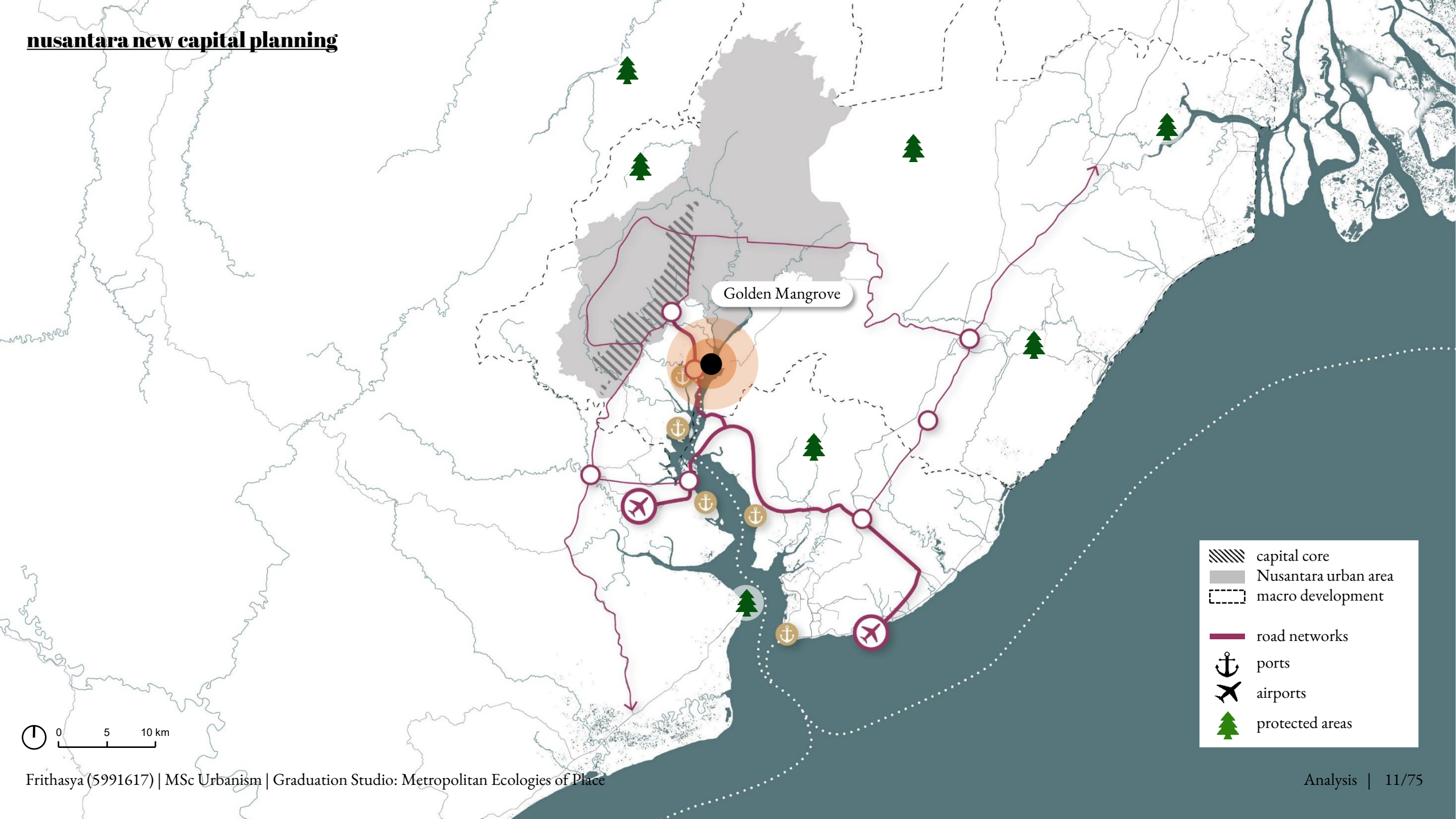
Nusantara toll road construction

capital core
Nusantara urban area
macro development

road networks
ports
airports
protected areas

0 5 10 km

nusantara new capital planning



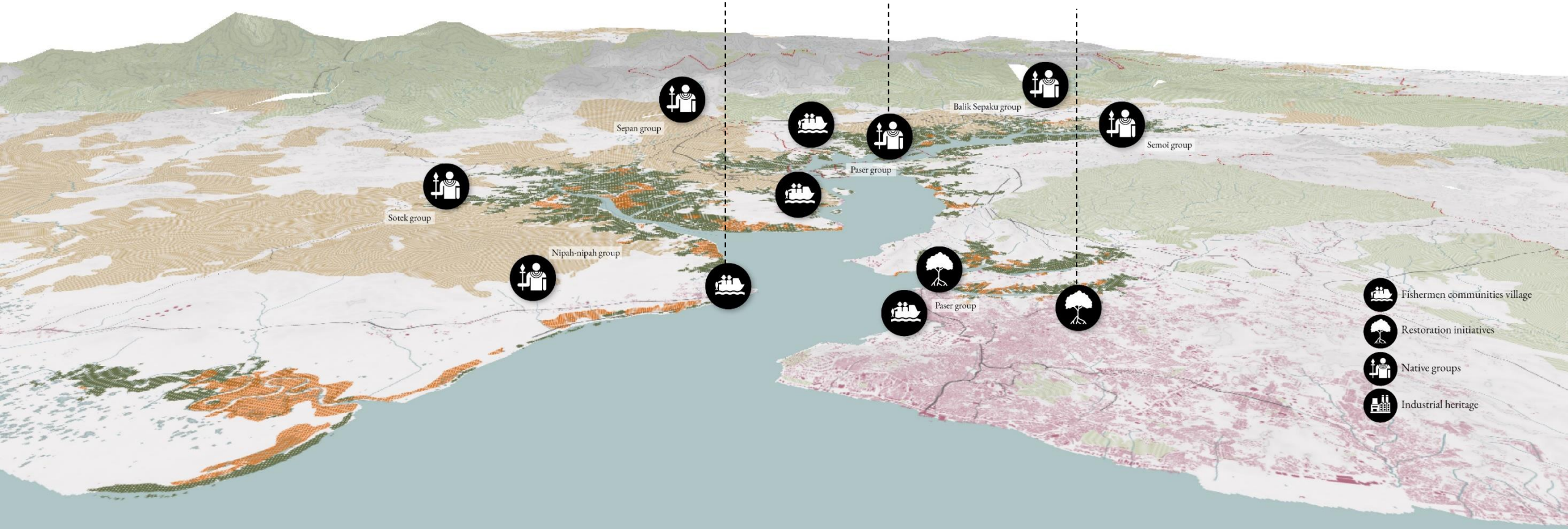
socio-environmental potentials

Vernacular architecture

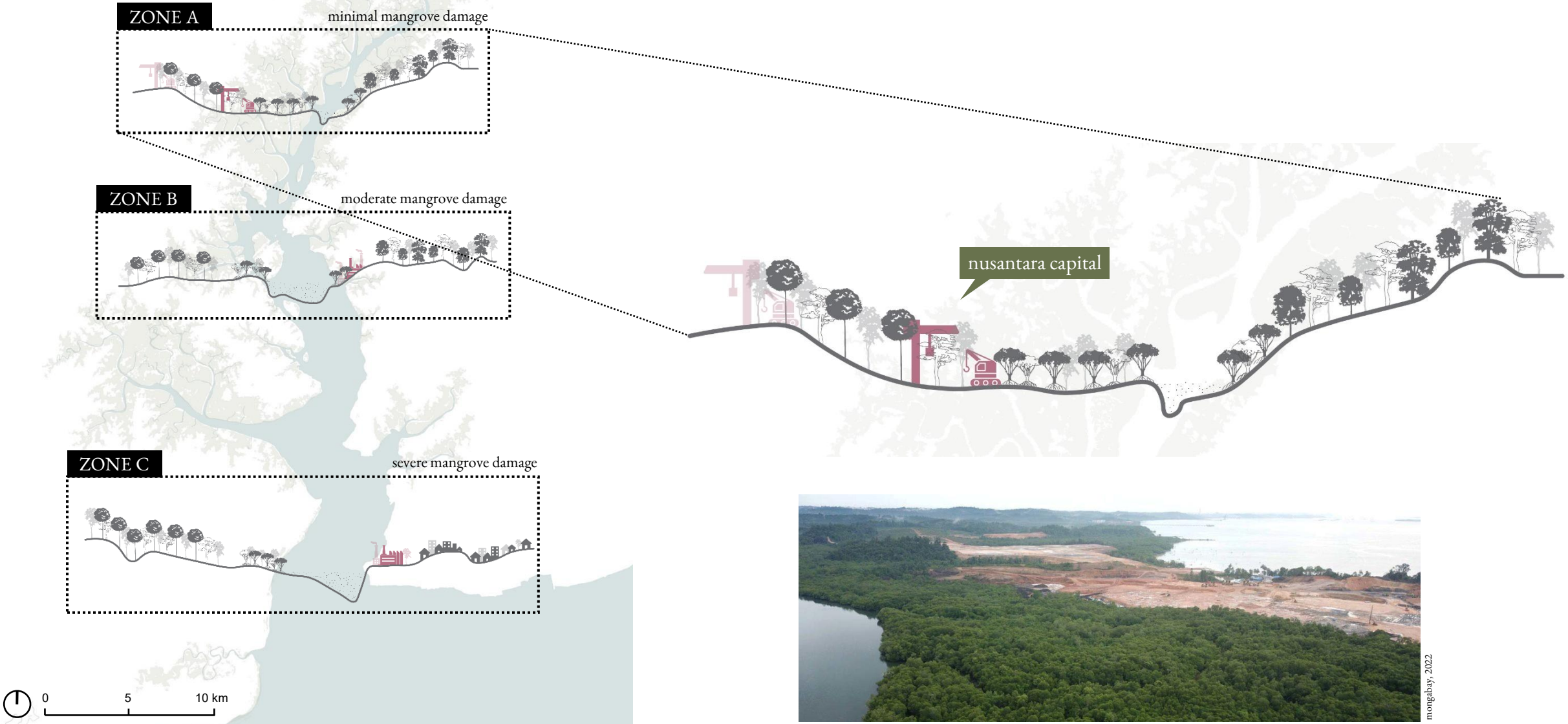
dispar.katimprow.go.id, 2022

"Golden" mangrove
Sacred Forest

Graha Indah Mangrove
Restoration Center



analysis conclusion



mongabay, 2022

analysis conclusion

ZONE A

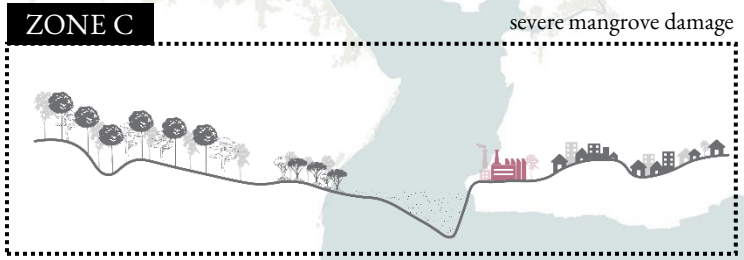
minimal mangrove damage

ZONE B

moderate mangrove damage

ZONE C

severe mangrove damage



mongabay, 2022

0 5 10 km

analysis conclusion

ZONE A

minimal mangrove damage

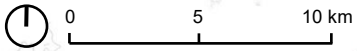
ZONE B

moderate mangrove damage

ZONE C

severe mangrove damage

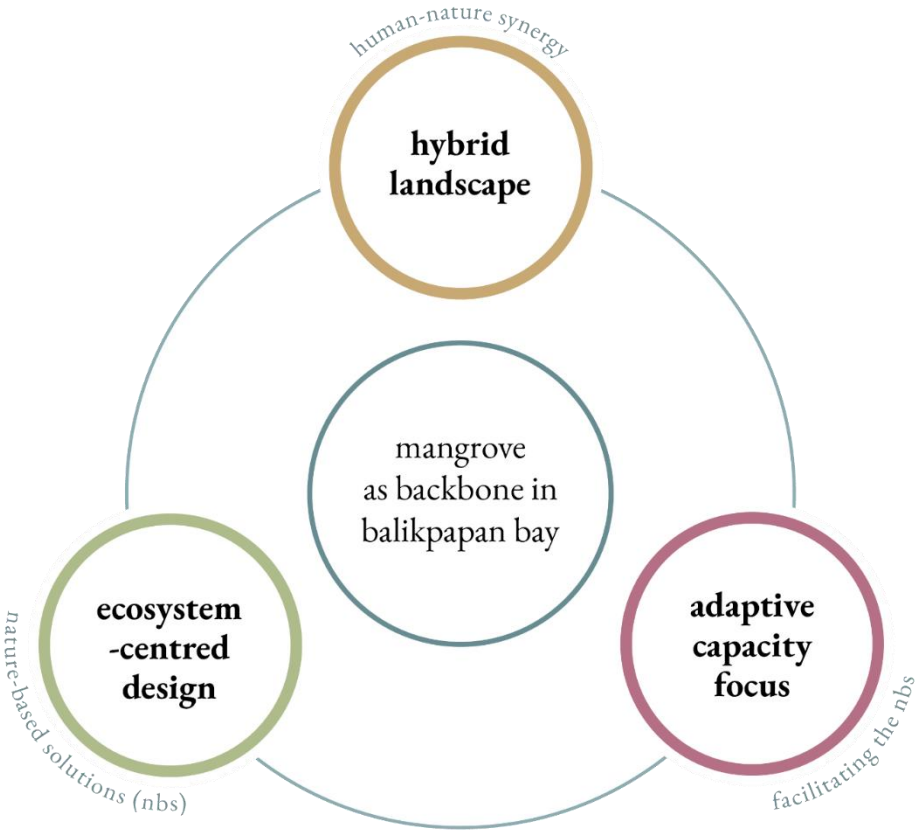
anwar et al., 2021



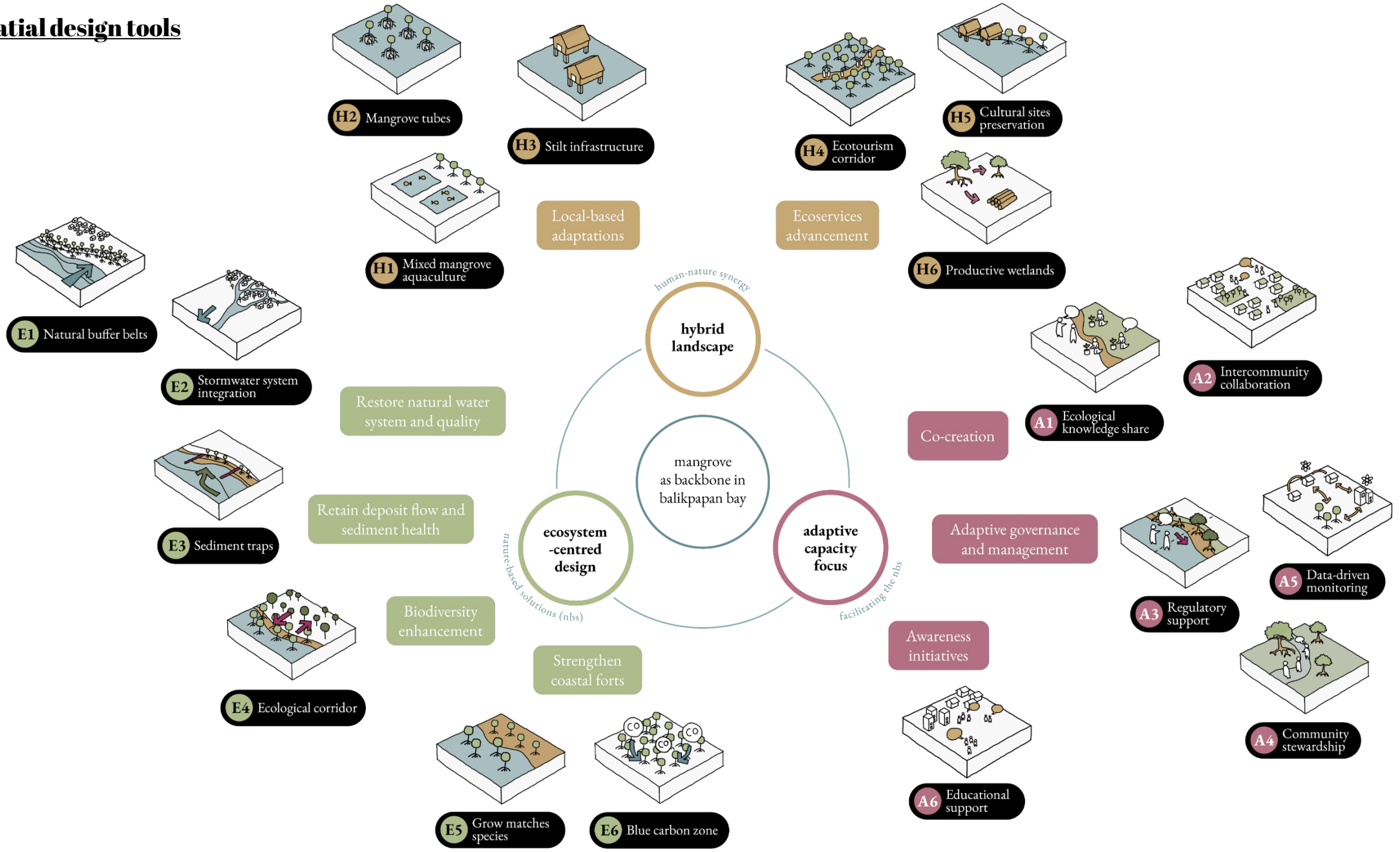
design process

design principles, explorations, and strategic projects

concepts to principles

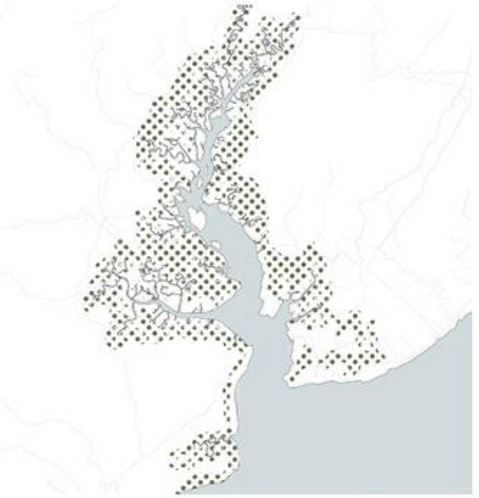


socio-spatial design tools



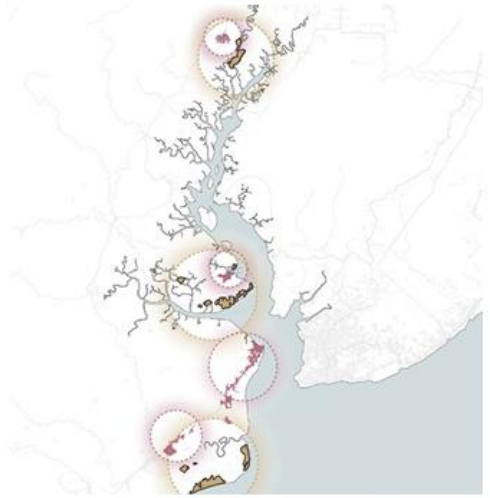
regional visions

Ecological restoration

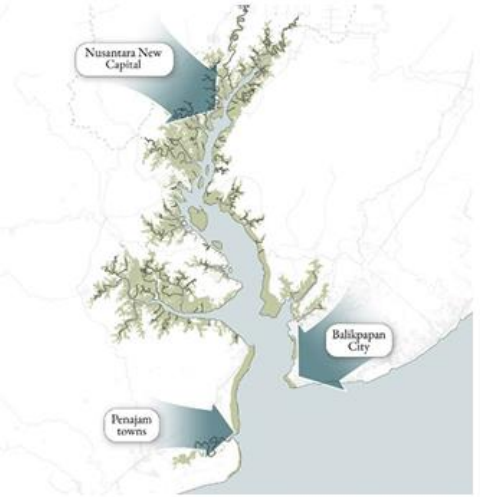


Habitat linkage

Coastal protection zones



Nature-positive livelihood support



Human-nature reconnection

zones focus goals

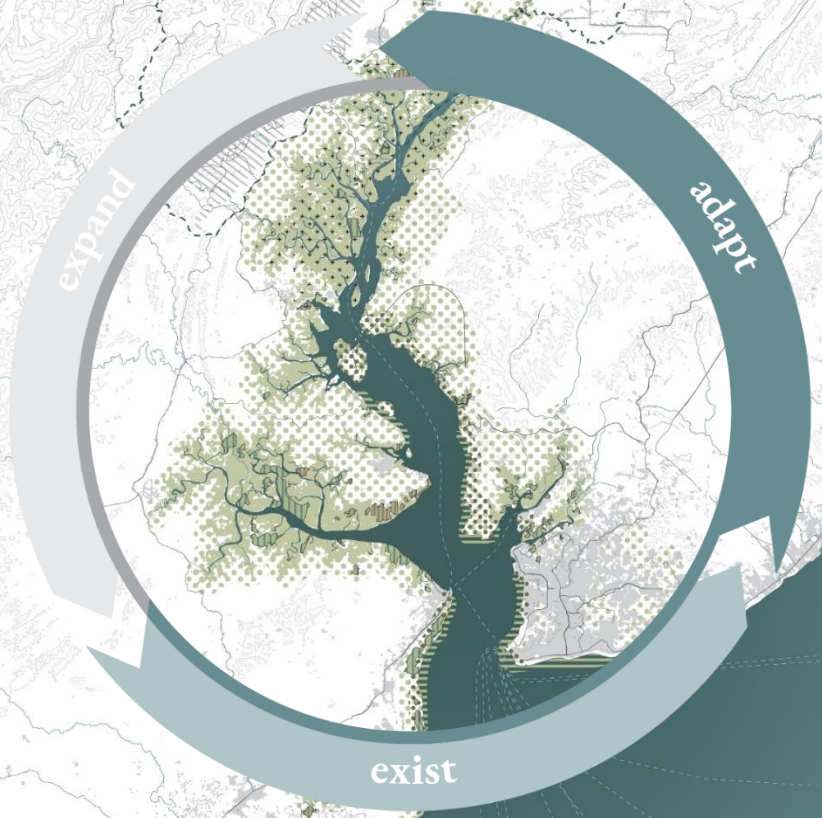
zones focus goals

zones focus goals

zone A

ZONE B

zone C



0 5 10 km

zones focus goals

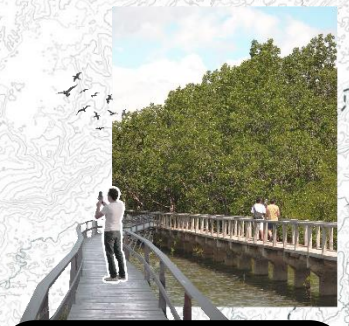
ZONE A

zone B

zone C

0 5 10 km

strategic projects

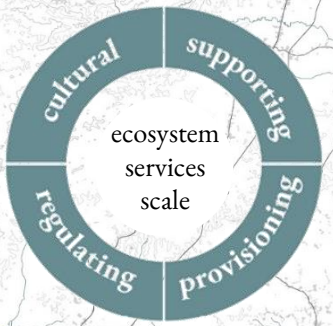


strategic projects 01
nusantara heritage forest

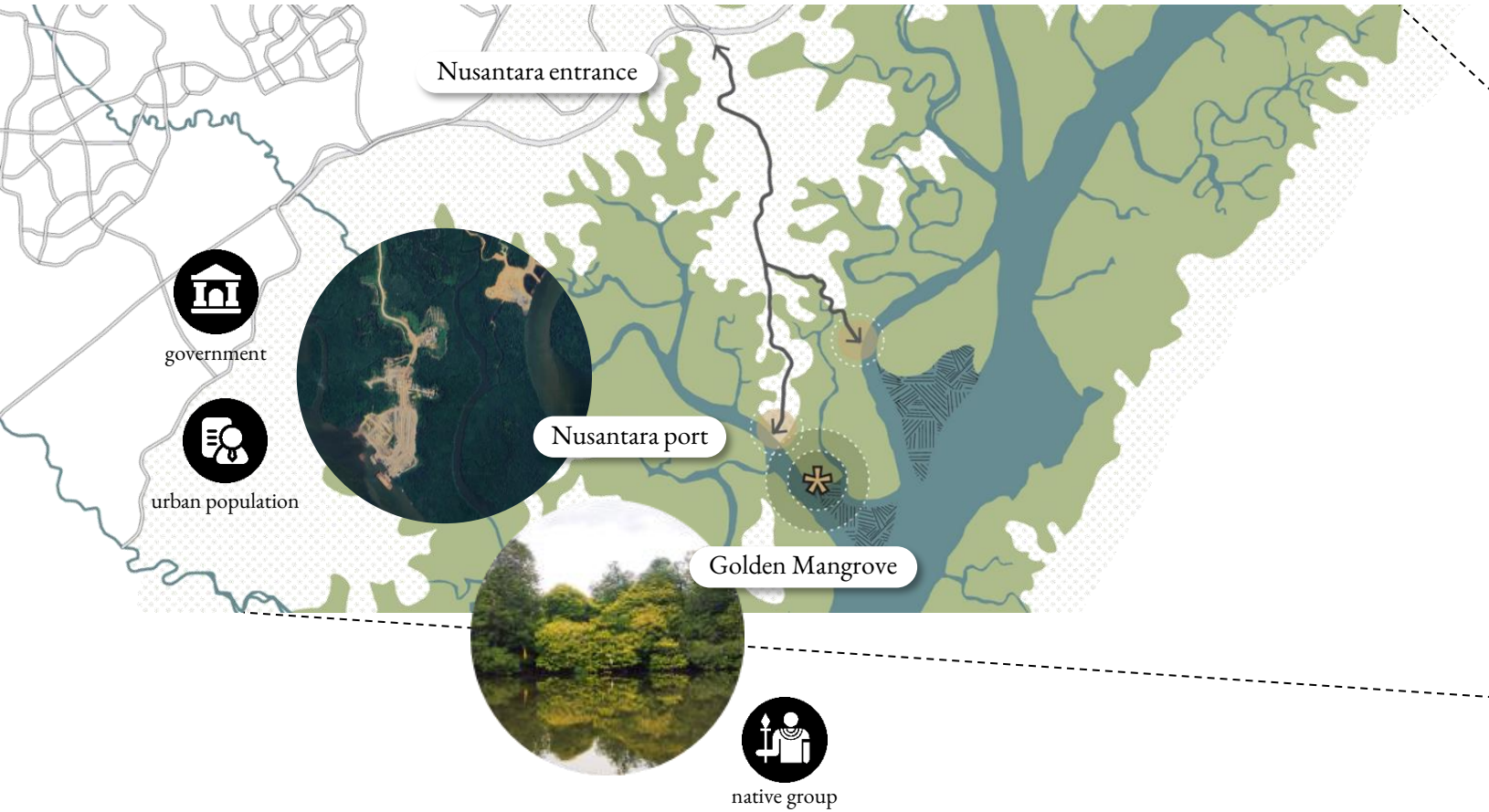
strategic projects 02
eco-infiltrating urban industry

key project
a new *tambak* system

added values

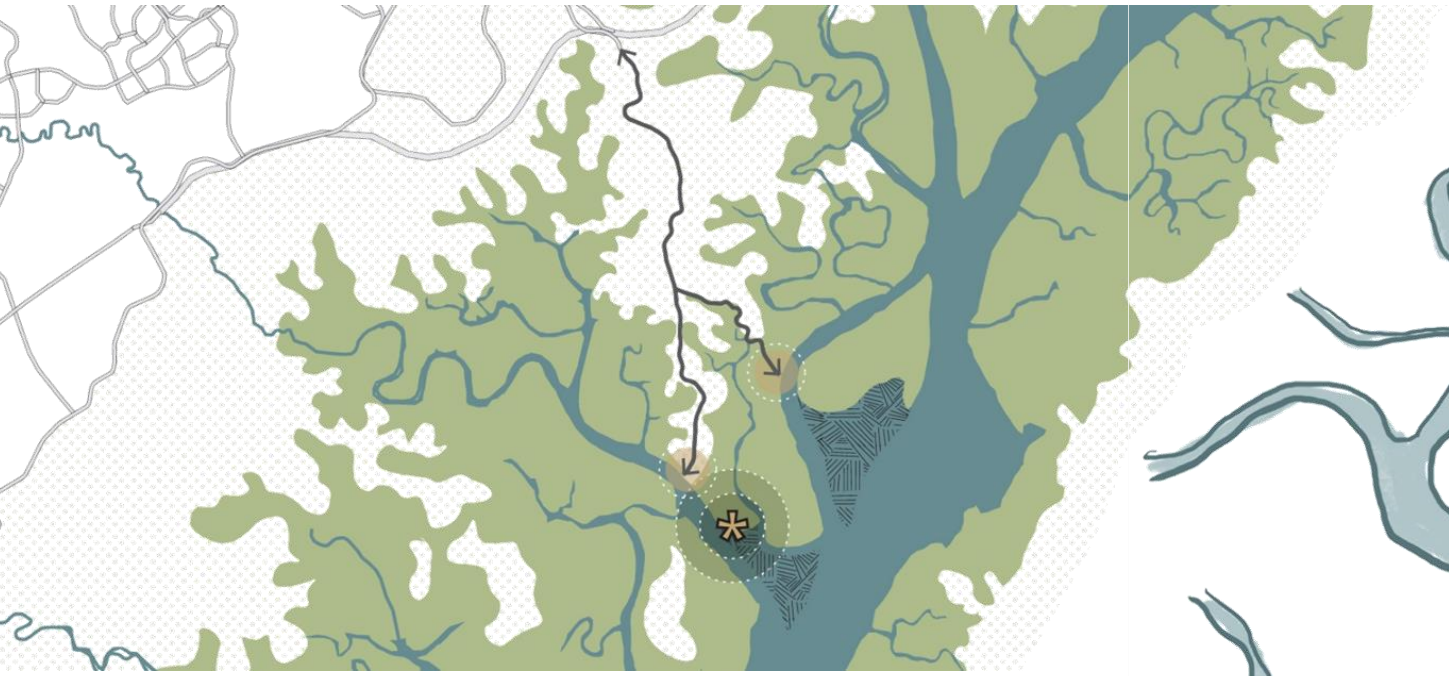


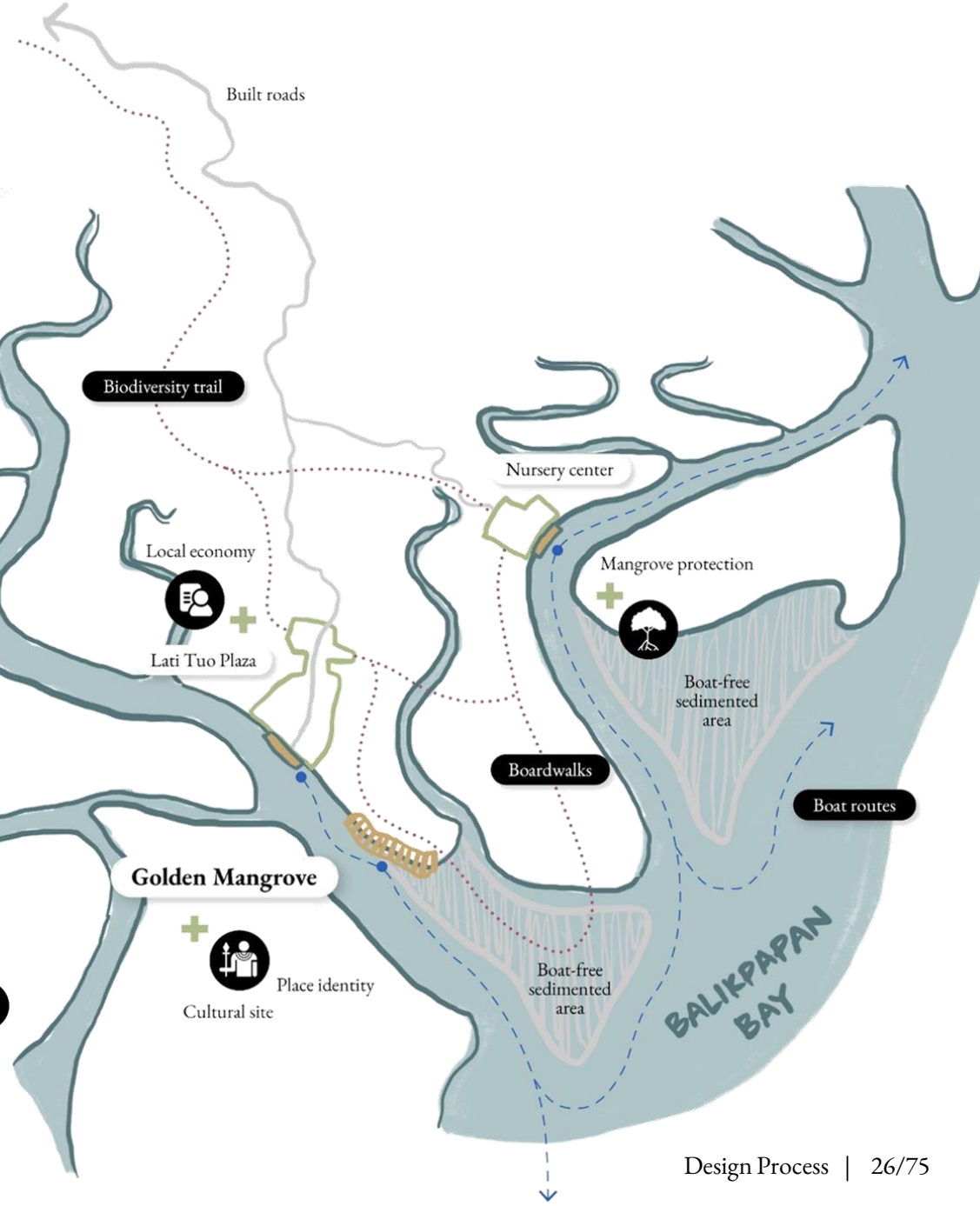
0 5 10 km



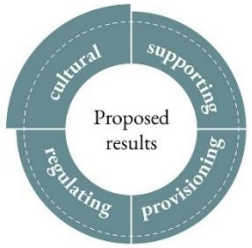
Spatial Frameworks

strategic projects 01
nusantara heritage forest

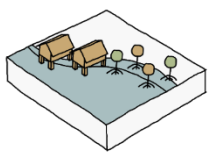


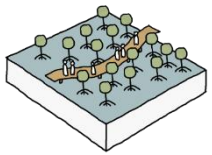


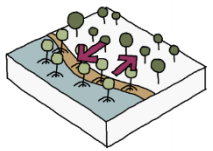
ecosystem services scale



design tools


H5 Cultural sites preservation


H4 Ecotourism corridor


E4 Ecological corridor


E2 Stormwater system integration

Spatial Frameworks

strategic projects 01
nusantara heritage forest

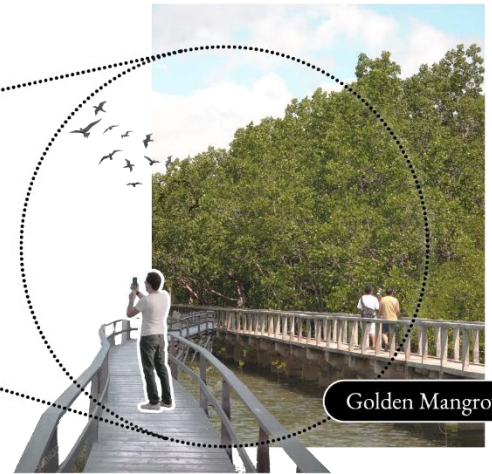
Start point

Nursery

Lati Tuo Plaza

Tropical rainforest walk

Mangrove forest walk



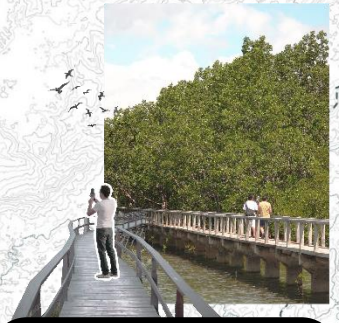
Golden Mangrove boardwalk

Biodiversity Trail

strategic projects 01
nusantara heritage forest

Lati Tuo Plaza

key and strategic projects



strategic projects 01
nusantara heritage forest

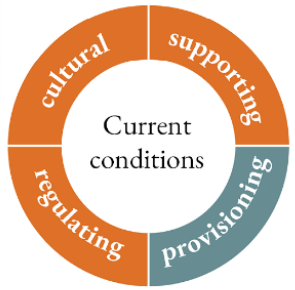
strategic projects 02
eco-infiltrating urban industry

key project
a new *tambak* system

0 5 10 km

strategic projects 02
eco-infiltrating urban industry

ecosystem services scale



Refinery Plants

fishermen communities

kampung atas air
fishermen village

Refinery Plants

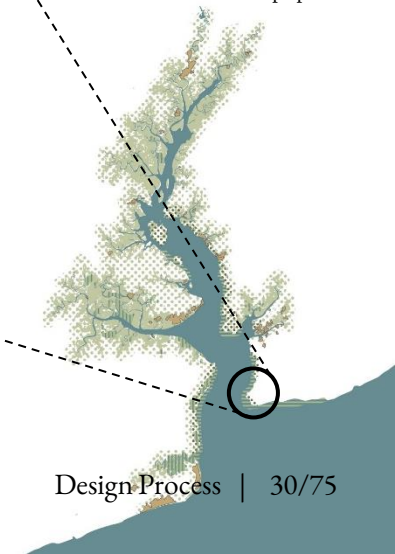
Balikpapan City

industry

industrial coastline

erotion-prone city beach

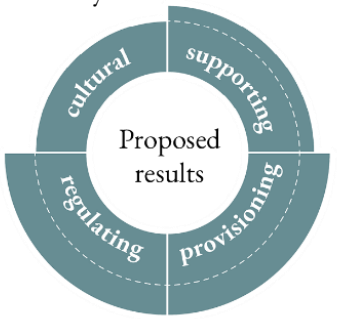
urban population

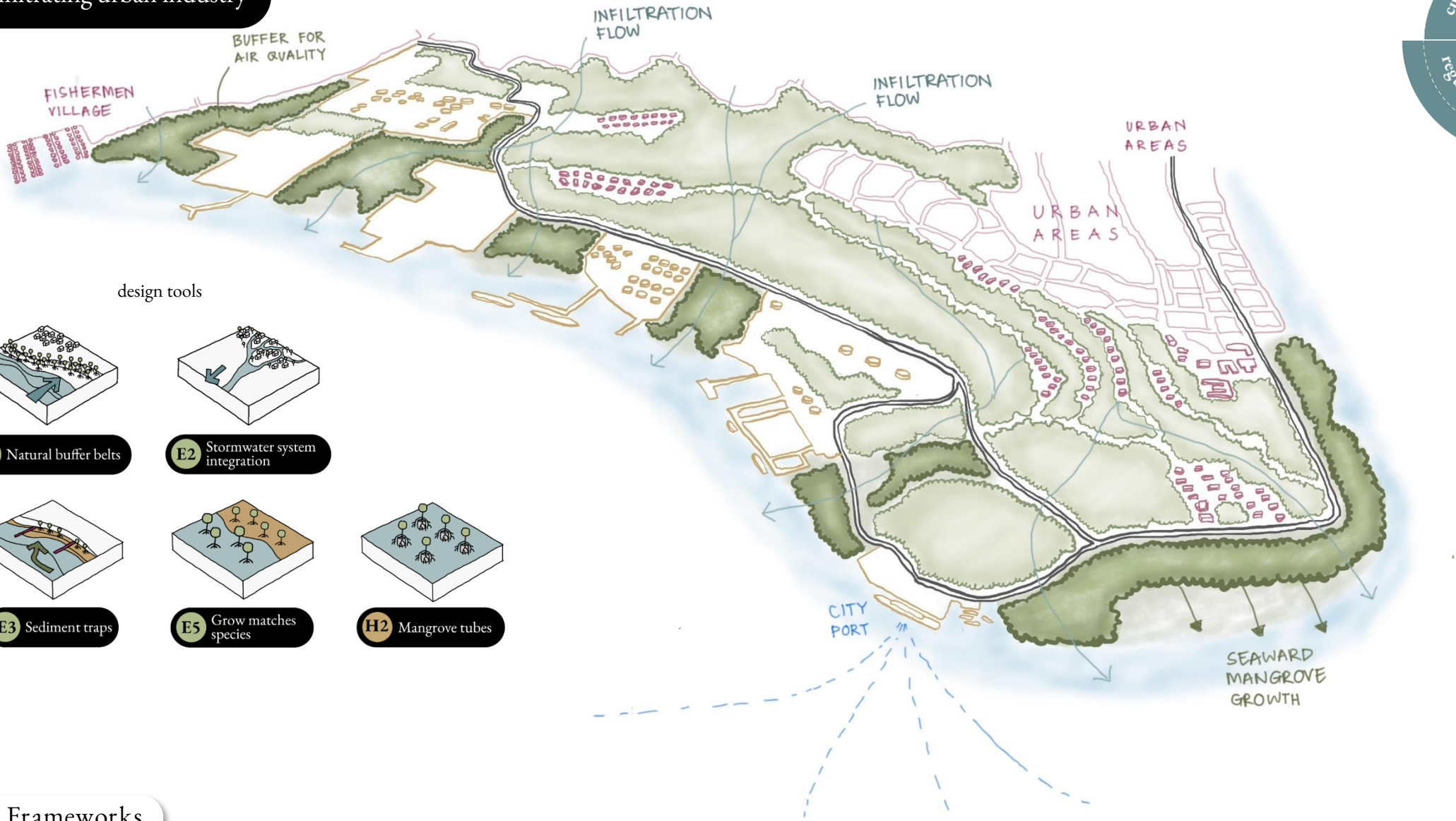


Spatial Frameworks

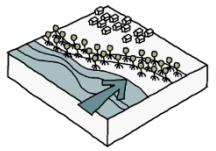
strategic projects 02
eco-infiltrating urban industry

ecosystem services scale

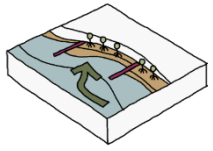




design tools


E1 Natural buffer belts

E2 Stormwater system integration

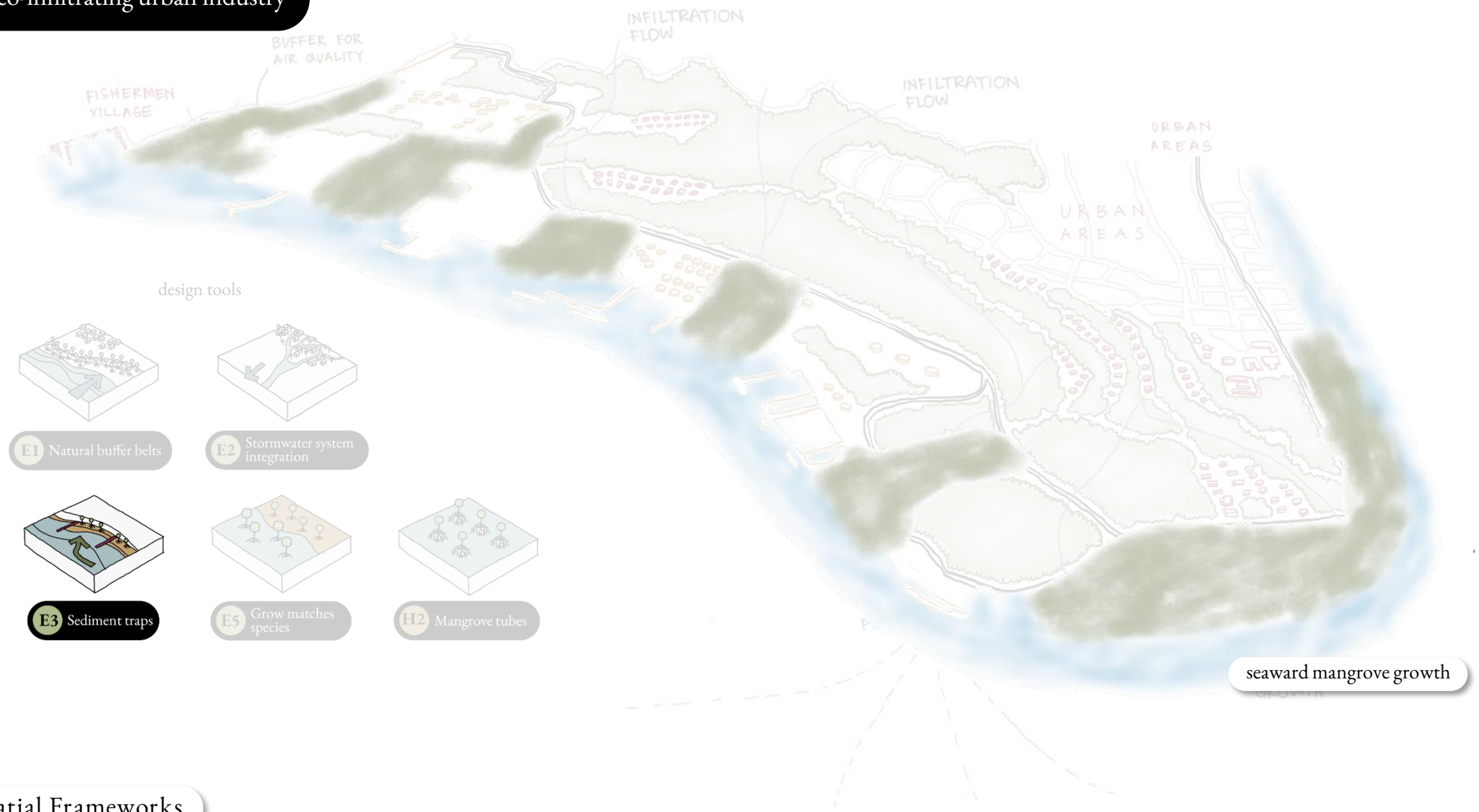

E3 Sediment traps

E5 Grow matches species

H2 Mangrove tubes

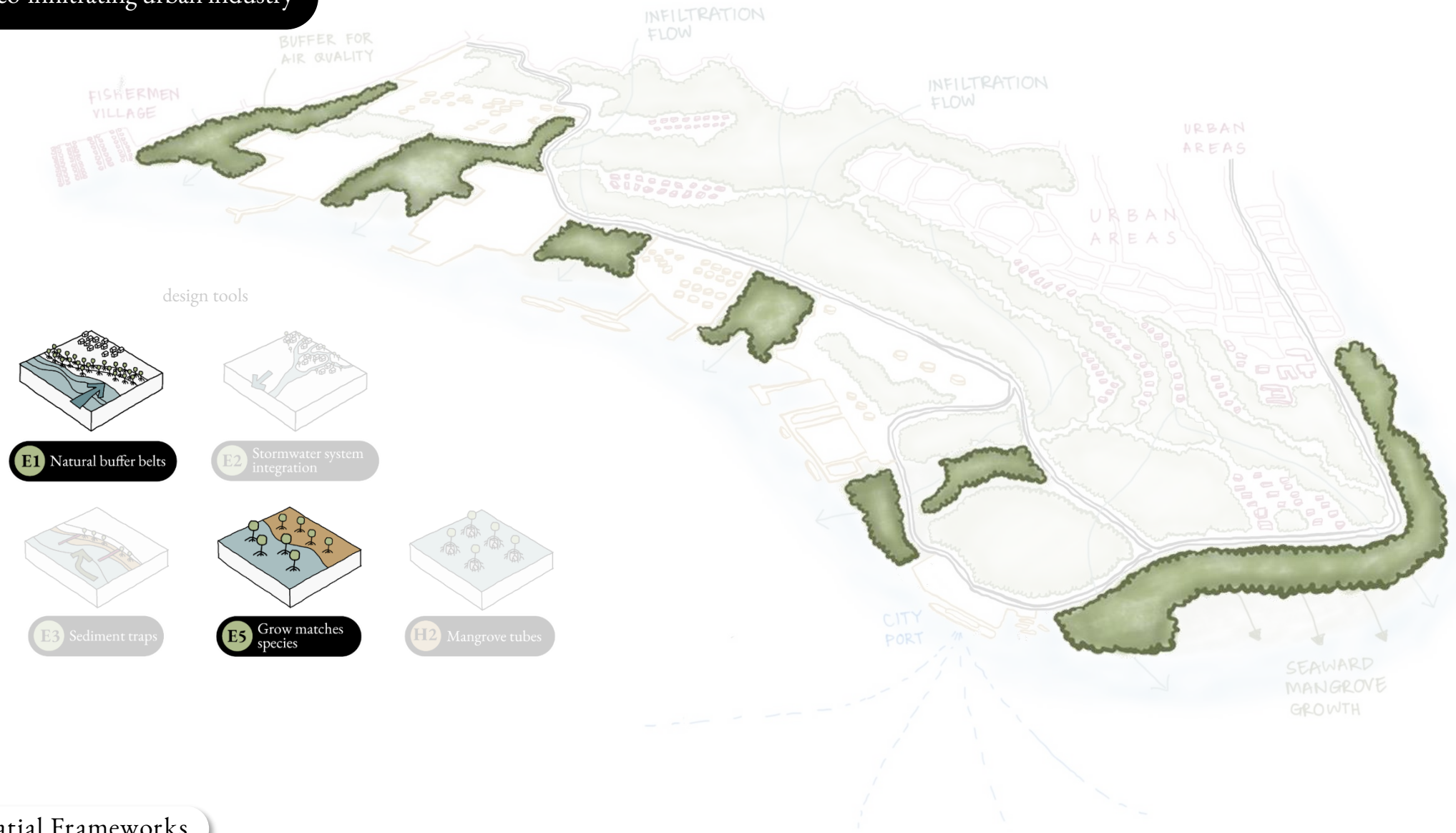
Spatial Frameworks

strategic projects 02
eco-infiltrating urban industry



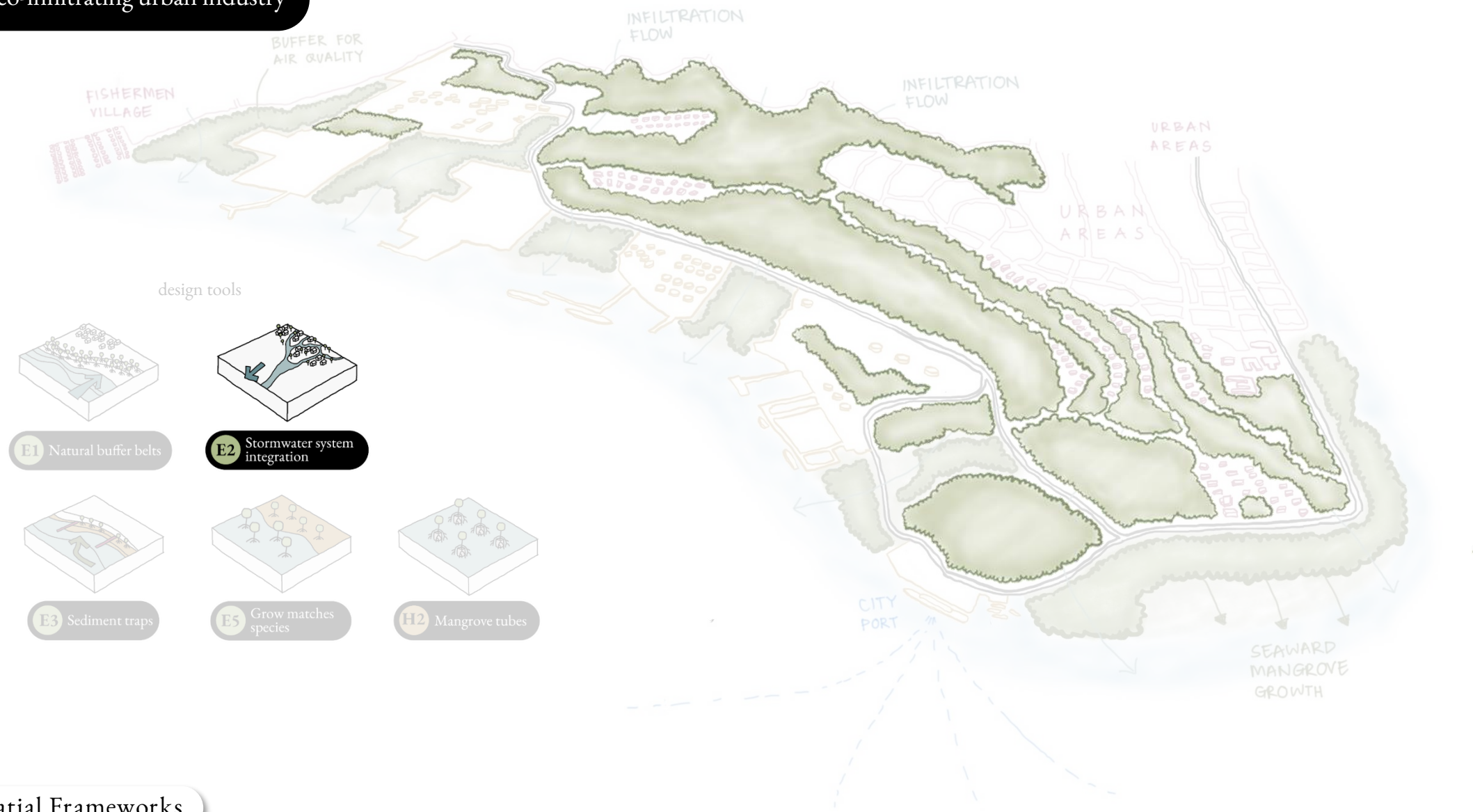
Spatial Frameworks

strategic projects 02
eco-infiltrating urban industry



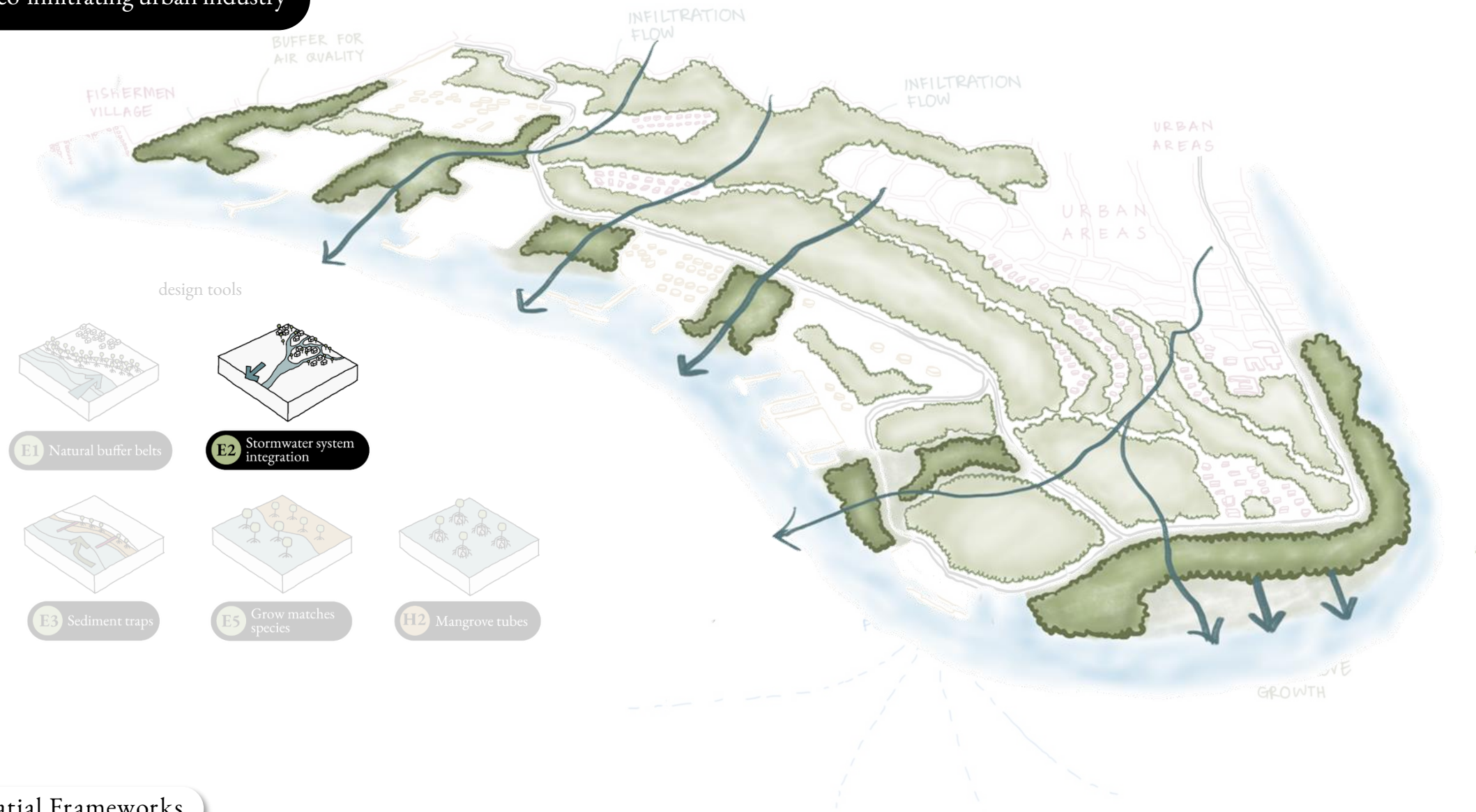
Spatial Frameworks

strategic projects 02
eco-infiltrating urban industry



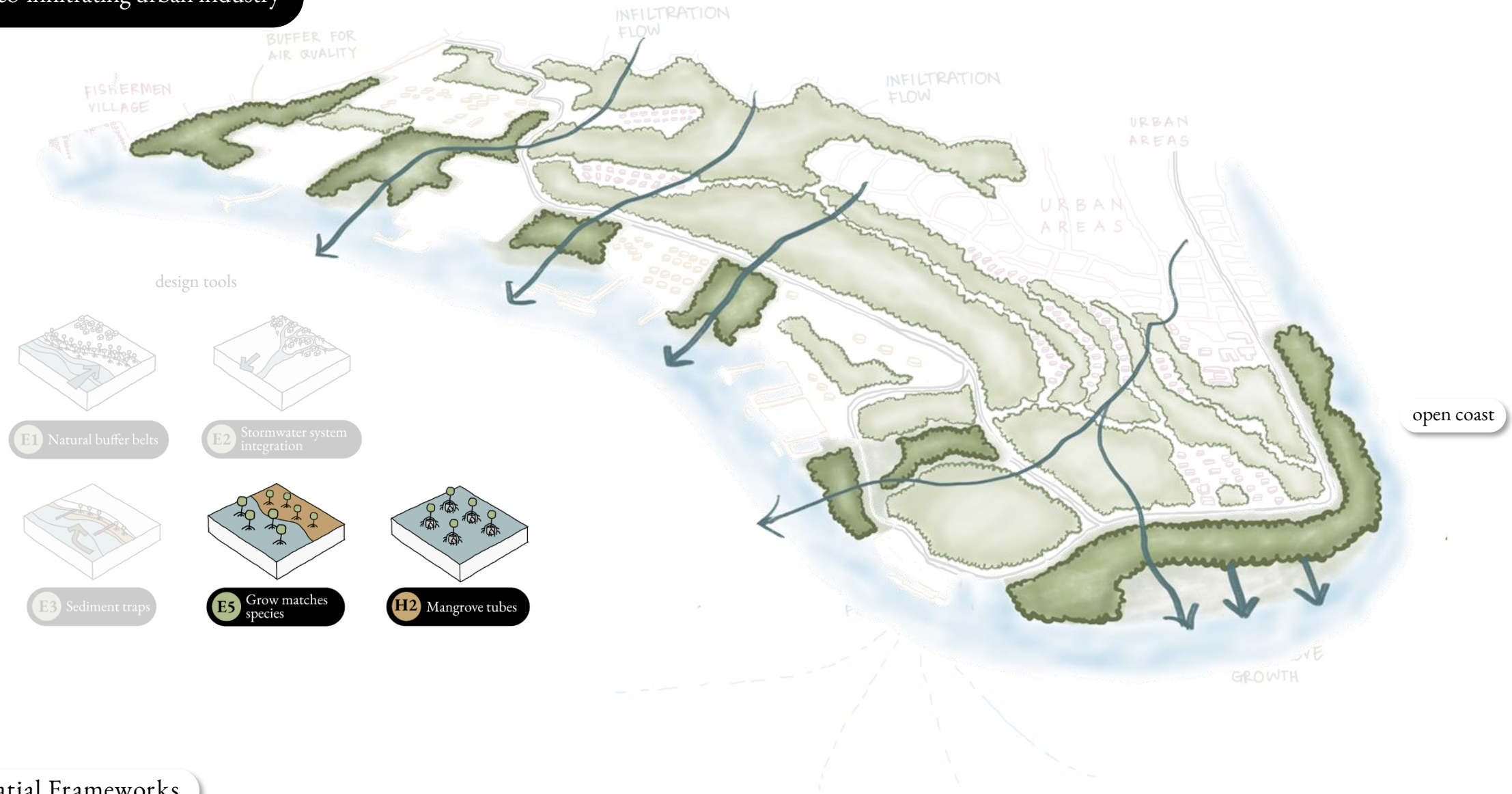
Spatial Frameworks

strategic projects 02
eco-infiltrating urban industry



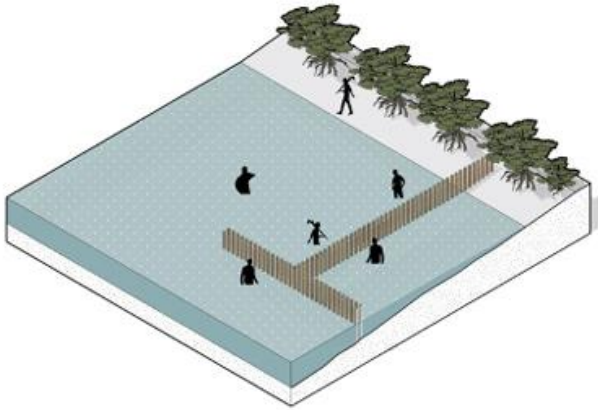
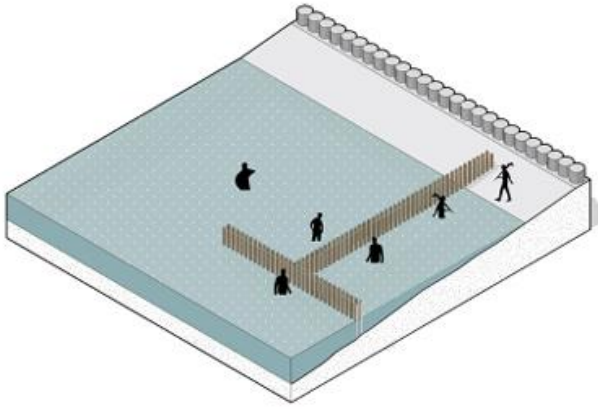
Spatial Frameworks

strategic projects 02
eco-infiltrating urban industry

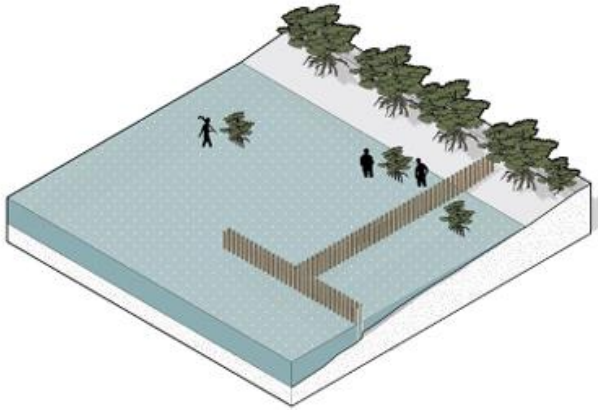
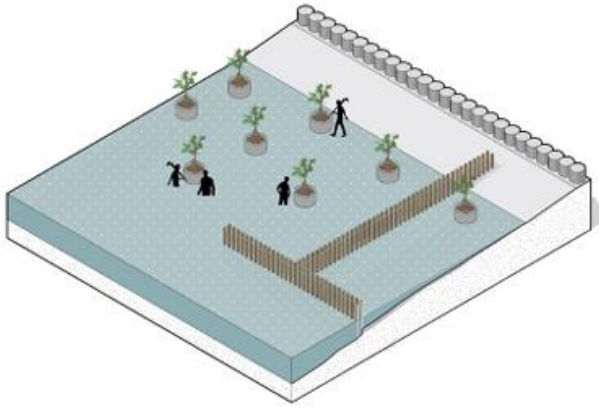


Spatial Frameworks

strategic projects 02
eco-infiltrating urban industry

	Initial stage	Next stage	Future stage
Intertidal coast	 Wooden permeable structure is built using eco-friendly local materials with the help from community.	As sediments start to build, young mangrove trees can be planted.	Deposited sediments rises the seabed, mature mangroves restore the biodiversity. Construction
Open coast	 Stronger permeable structures is built by combining heavier materials, such as rocks, to support existing concrete breakwater.	Young mangroves are planted with concrete tubes (*buispot* method) to avoid the trees being swept away by the waves .	Deposited sediments support a good base for growing mangroves as a hybrid approach to help wave attenuation. Concrete tubes act as a supporting breakwater.

strategic projects 02
eco-infiltrating urban industry

	Initial stage	Next stage	Future stage
Intertidal coast			
	Wooden permeable structure is built using eco-friendly local materials with the help from community.	As sediments start to build, young mangrove trees can be planted.	Deposited sediments rises the seabed, mature mangroves restore the biodiversity. Construction
Open coast			
	Stronger permeable structures is built by combining heavier materials, such as rocks, to support existing concrete breakwater.	Young mangroves are planted with concrete tubes (*buispot* method) to avoid the trees being swept away by the waves .	Deposited sediments support a good base for growing mangroves as a hybrid approach to help wave attenuation. Concrete tubes act as a supporting breakwater.

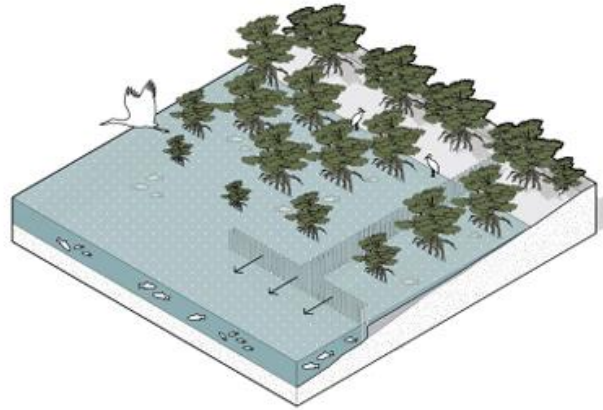
strategic projects 02
eco-infiltrating urban industry

Initial stage | Next stage | Future stage

Intertidal coast

Wooden permeable structure is built using eco-friendly local materials with the help from community.

As sediments start to build, young mangrove trees can be planted.

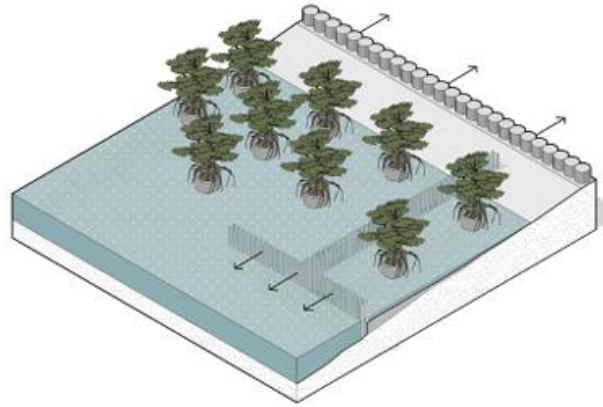


Deposited sediments rises the seabed, mature mangroves restore the biodiversity. Construction

Open coast

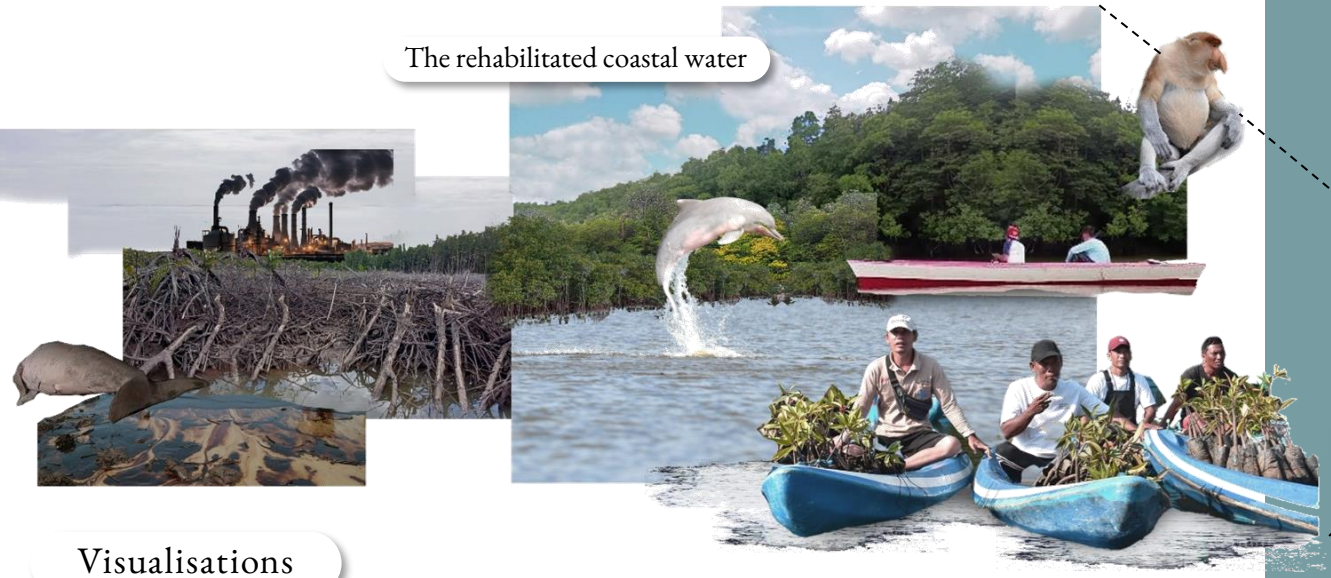
Stronger permeable structures is built by combining heavier materials, such as rocks, to support existing concrete breakwater.

Young mangroves are planted with concrete tubes (*buispot* method) to avoid the trees being swept away by the waves .



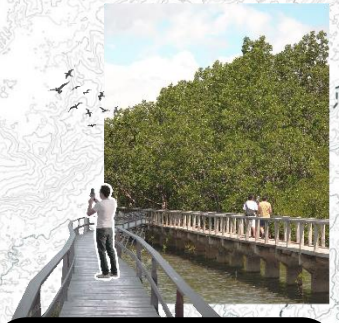
Deposited sediments support a good base for growing mangroves as a hybrid approach to help wave attenuation. Concrete tubes act as a supporting breakwater.

strategic projects 02
eco-infiltrating urban industry



Visualisations

key and strategic projects



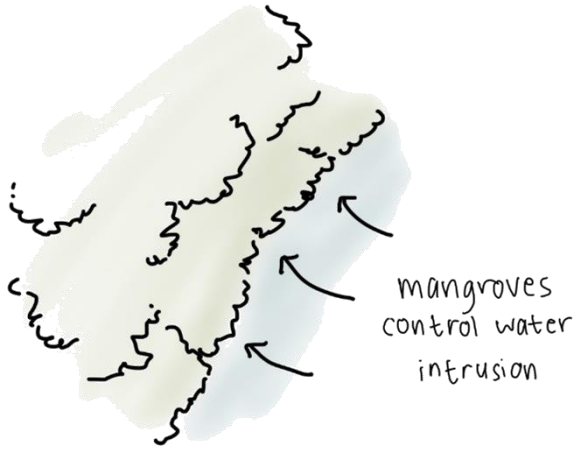
strategic projects 01
nusantara heritage forest

strategic projects 02
eco-infiltrating urban industry

key project
a new *tambak* system

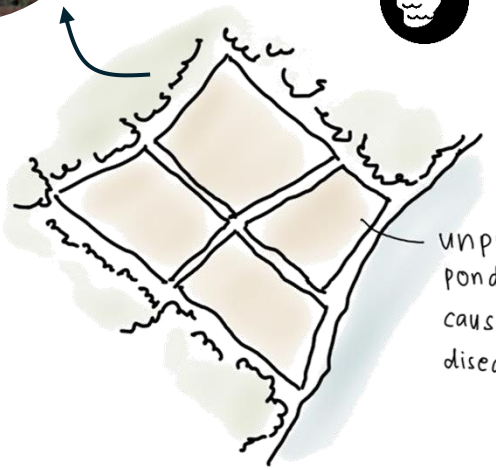
0 5 10 km

key project
a new *tambak* system



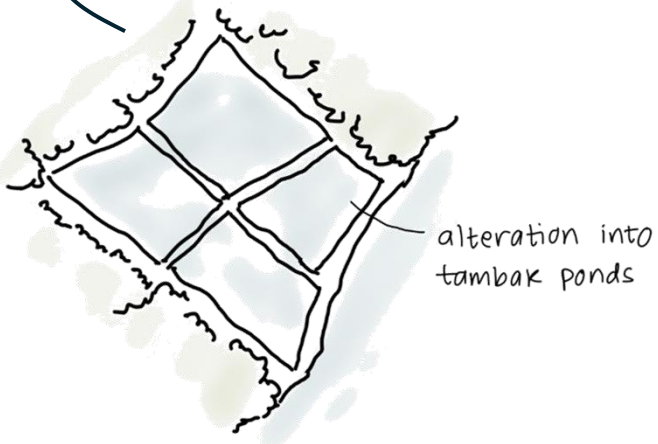
natural condition

economical & environmental loss

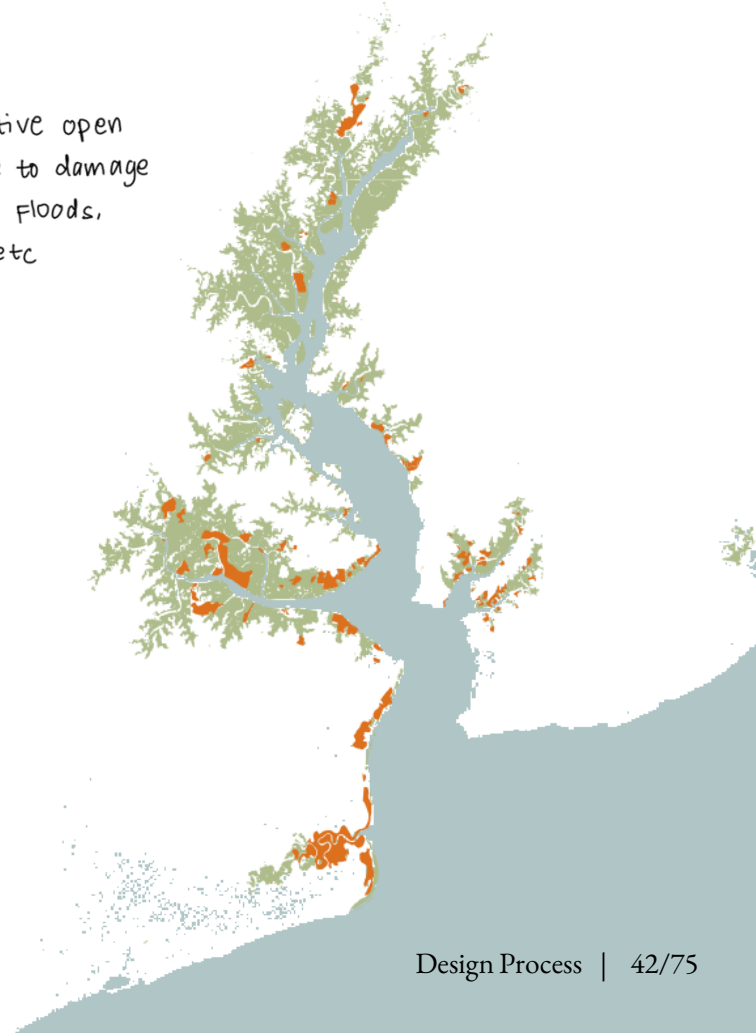


altered condition

economical value

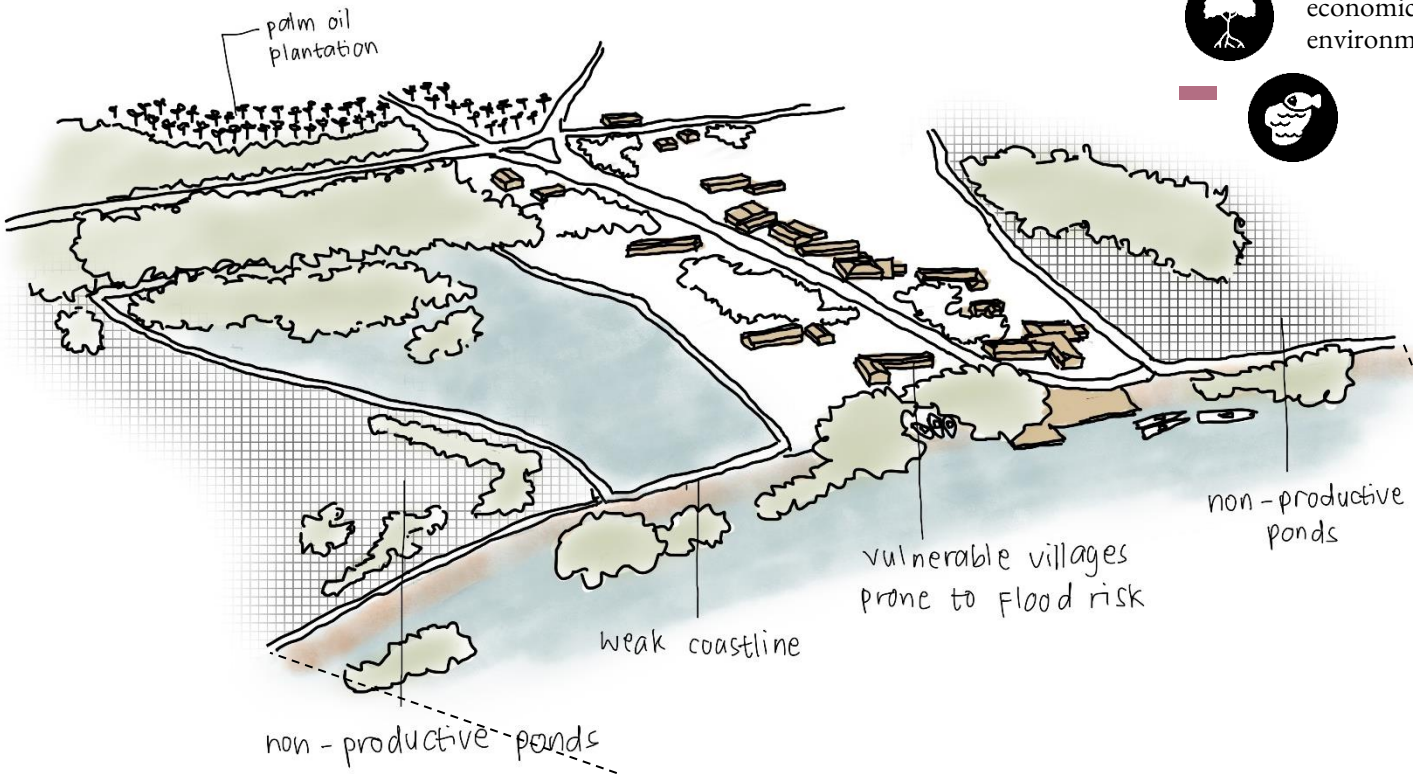


altered condition



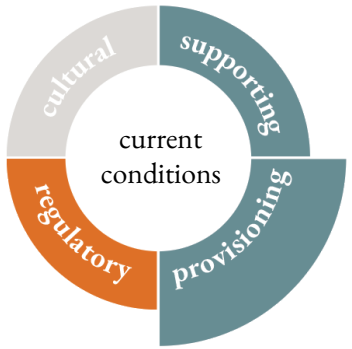
Current conditions

key project
a new *tambak* system



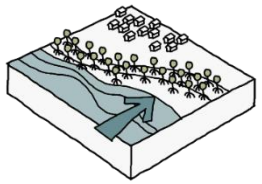
economical & environmental loss

ecosystem services scale



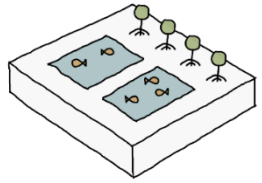
Current conditions

main design tools:



E1 Natural buffer belts

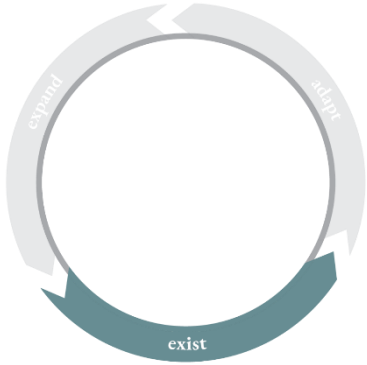
regenerating lost forests

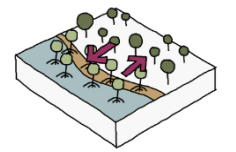


H1 Mixed mangrove aquaculture

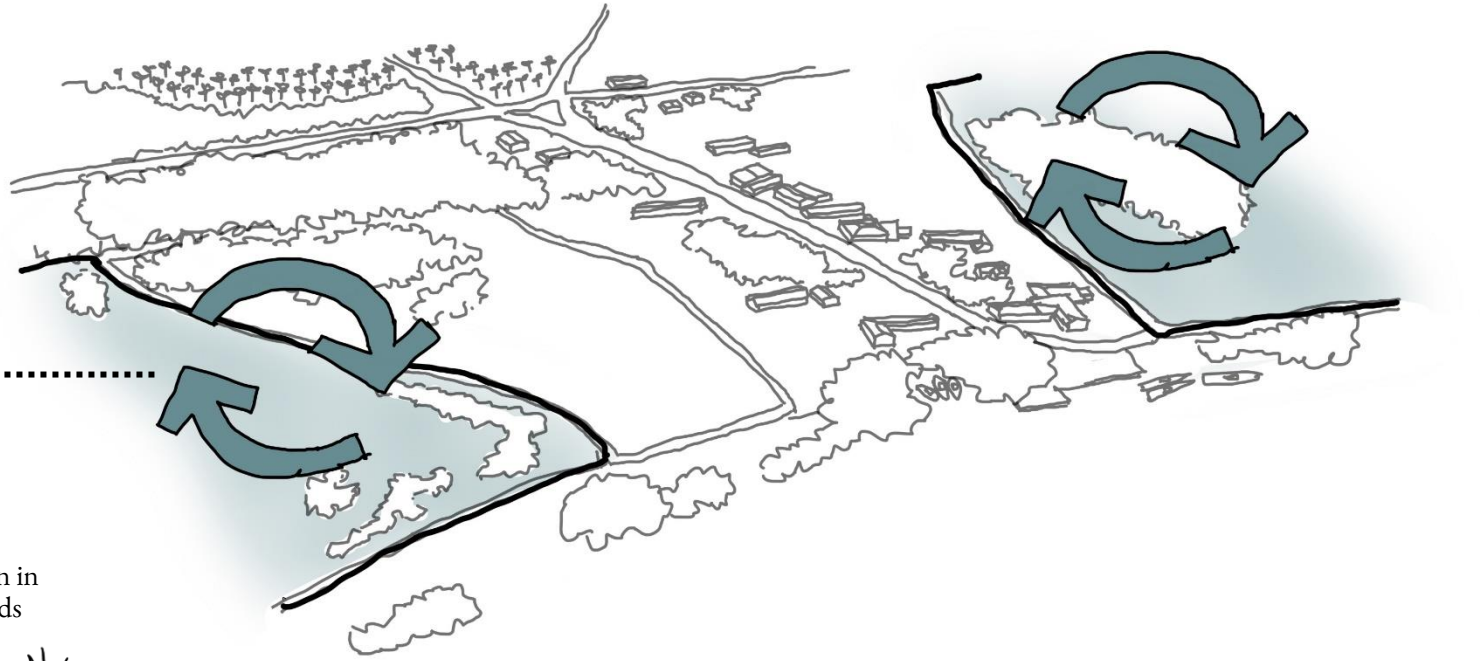
using mangrove-*tambak* mosaic

key project
a new *tambak* system





E4 Ecological corridor



water bioremediation in non-productive ponds

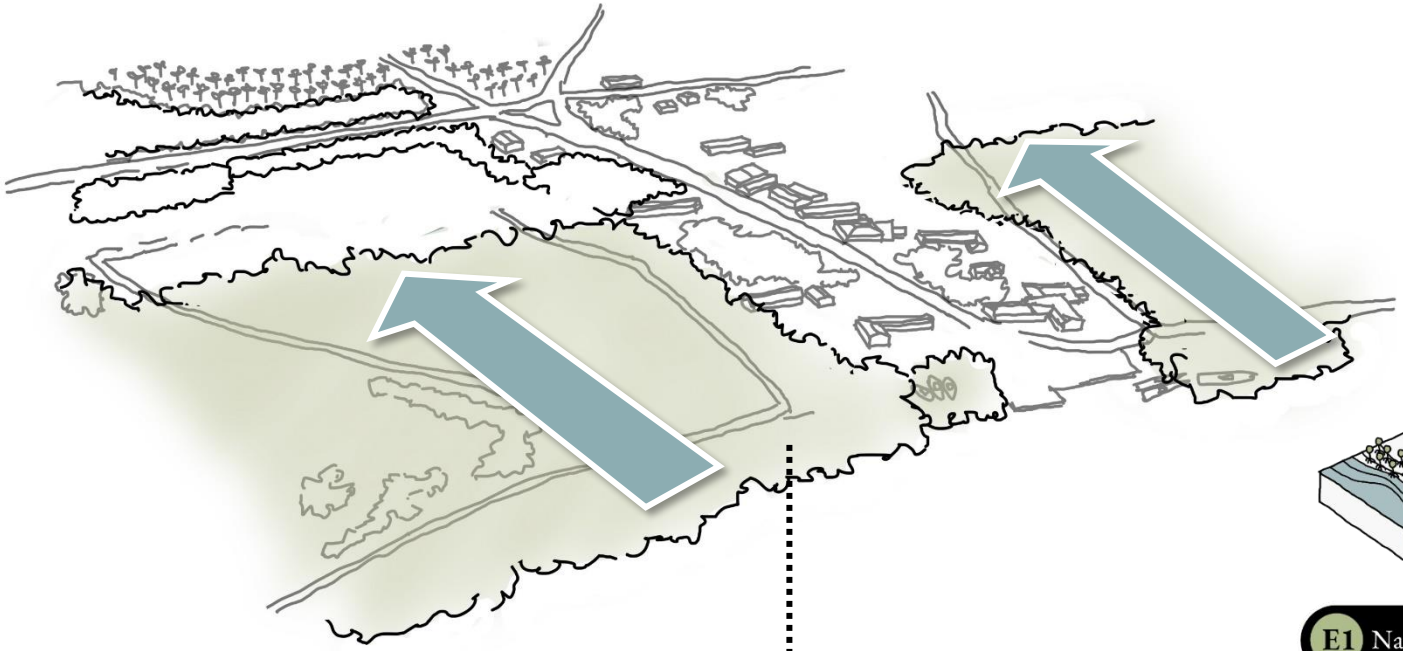
milkfish

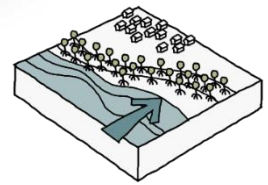
water hyacinth

vetiver grass

Spatial Frameworks

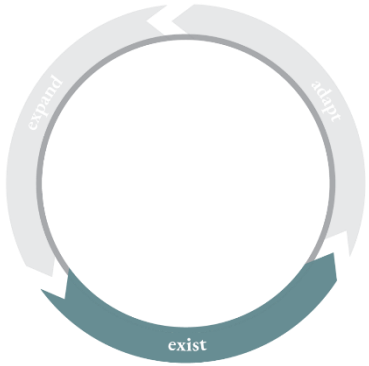
key project
a new *tambak* system





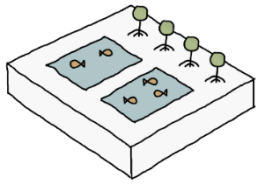
E1 Natural buffer belts

80 meters mangrove buffer belts to tambak ponds (adapted from Femke Tonneijck et al., 2022)



Spatial Frameworks

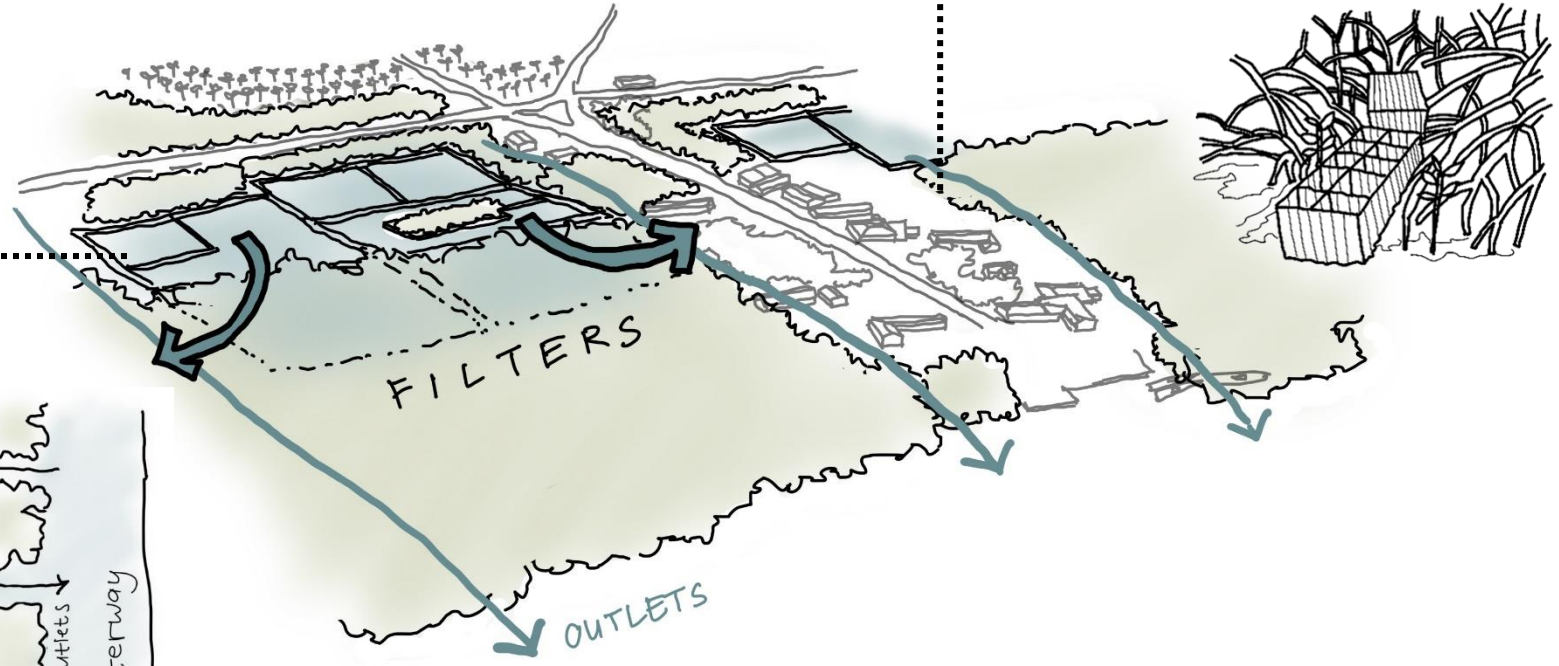
key project
a new *tambak* system

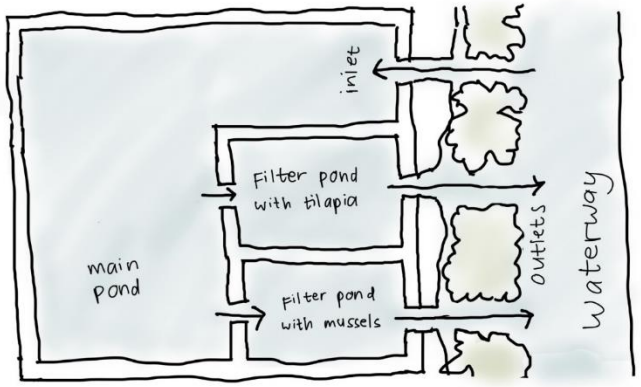


H1 Mixed mangrove aquaculture

diversification of commodity adds economical value

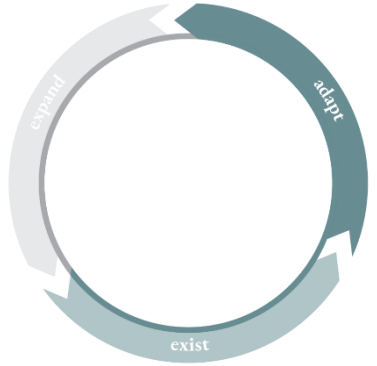
mud crab cage culture around the mangroves as a non-intensive small-scale aquaculture





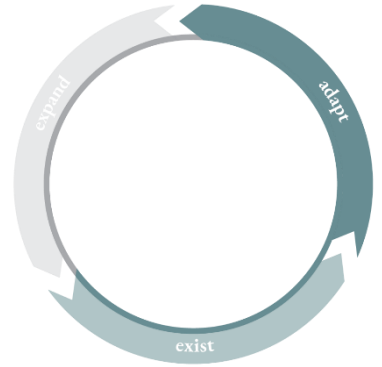
mangrove-*tambak* mosaic modifications

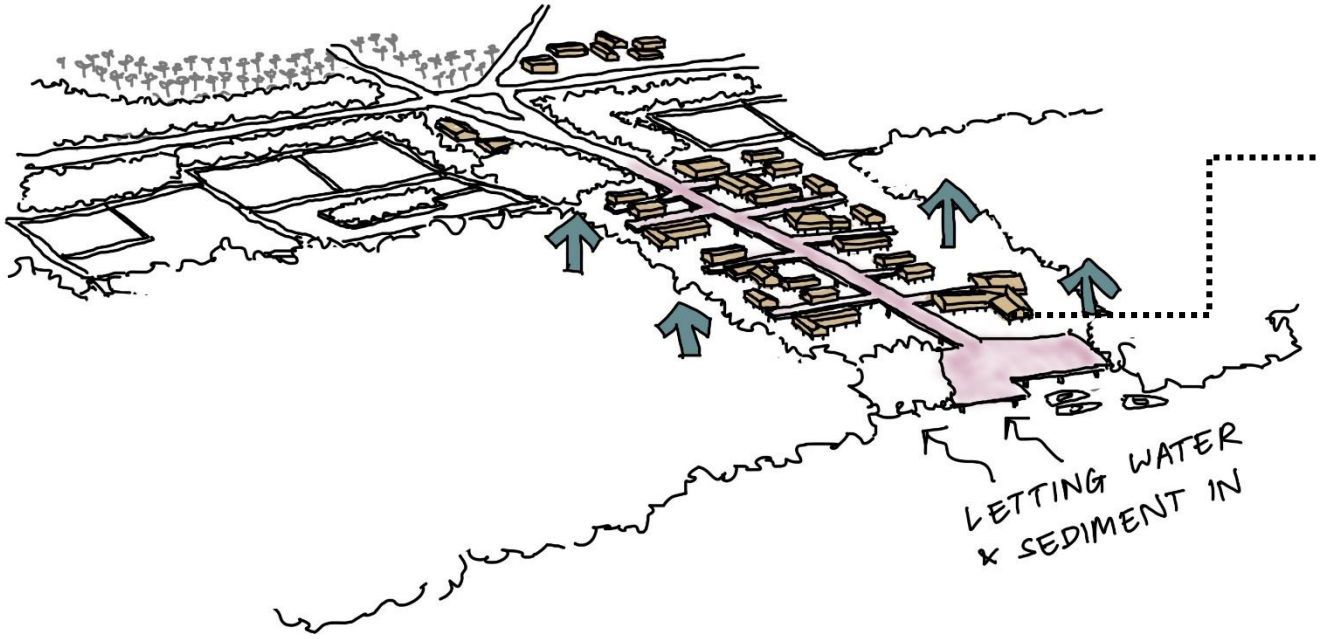
integrate mangrove into the tambak systems (MMA) as natural water filters and shade



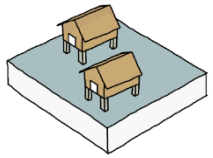
Spatial Frameworks

key project
a new *tambak* system





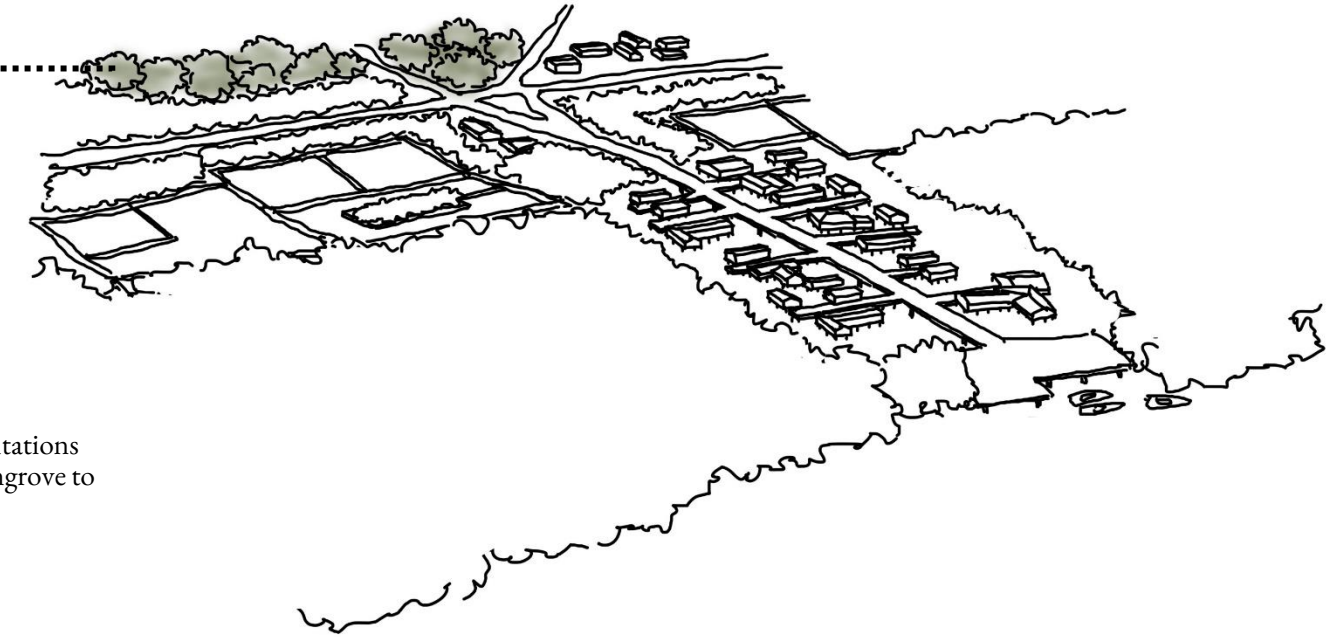
develop more climate-resilient villages with stilt buildings



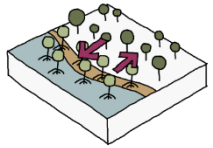
H3 Stilt infrastructure

Spatial Frameworks

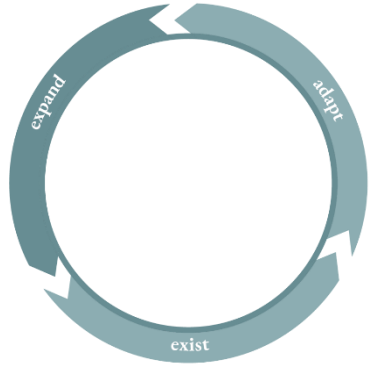
key project
a new *tambak* system



reforestation of palm oil plantations
as animal corridors from mangrove to
inland forests

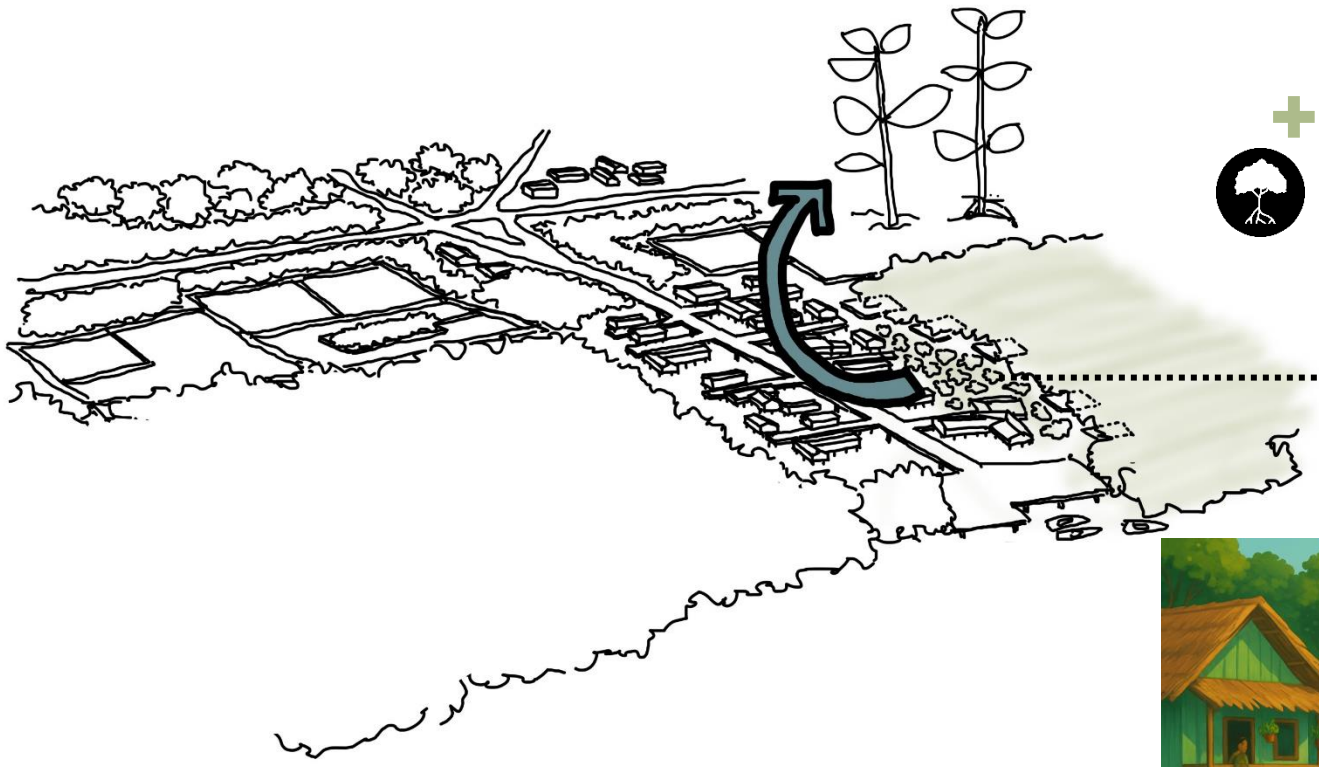


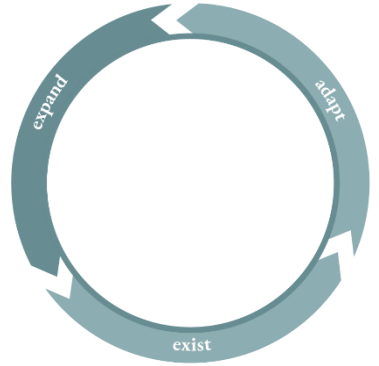
E4 Ecological corridor



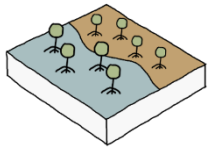
Spatial Frameworks

key project
a new *tambak* system





integrating mangrove nursery with villagers

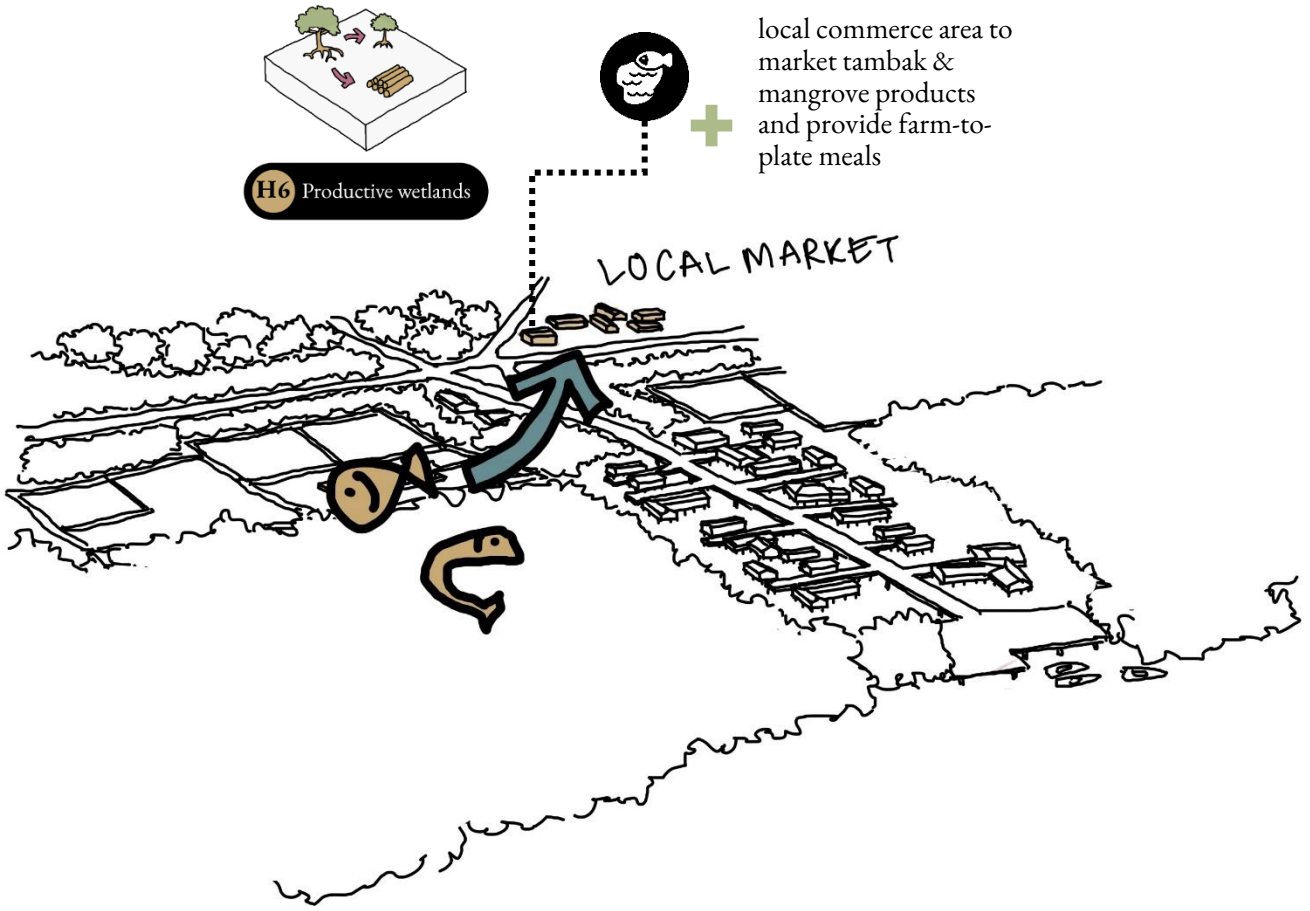


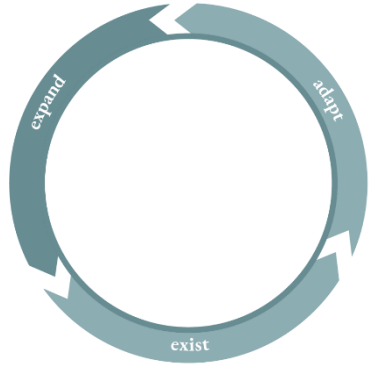
E5 Grow matches species

AI-generated. 2025

Spatial Frameworks

key project
a new *tambak* system

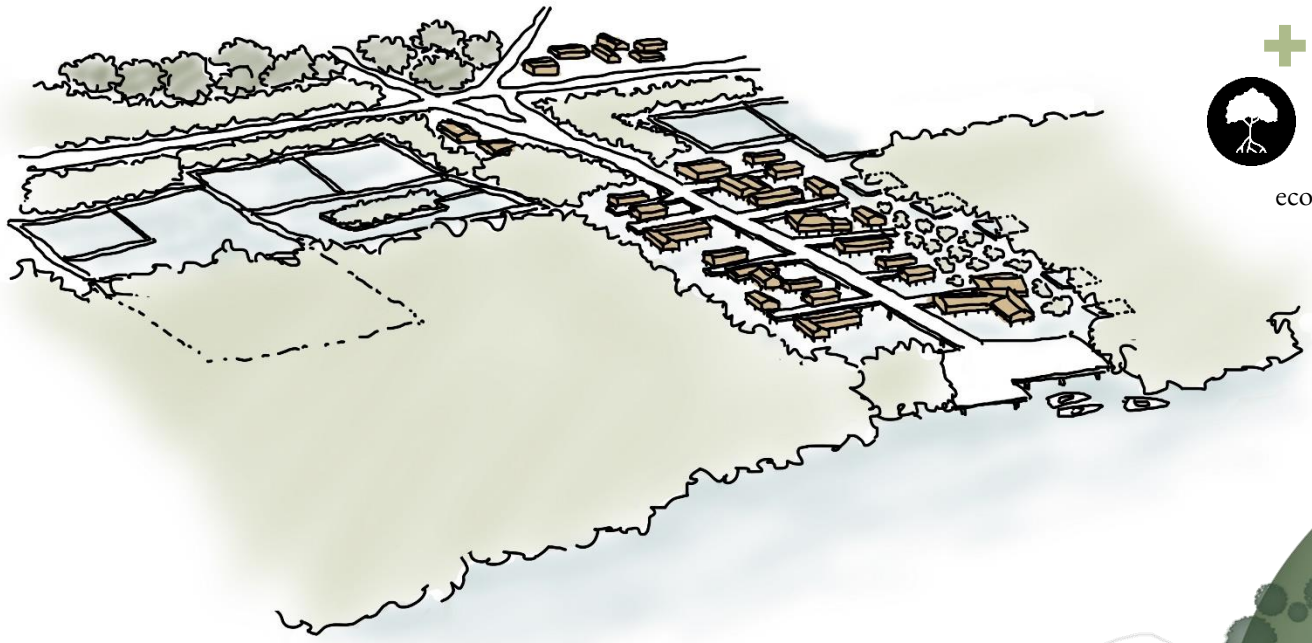




Spatial Frameworks

key project
a new *tambak* system

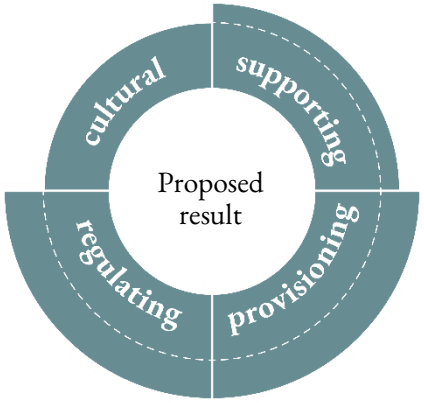
local economy benefit



ecological benefit

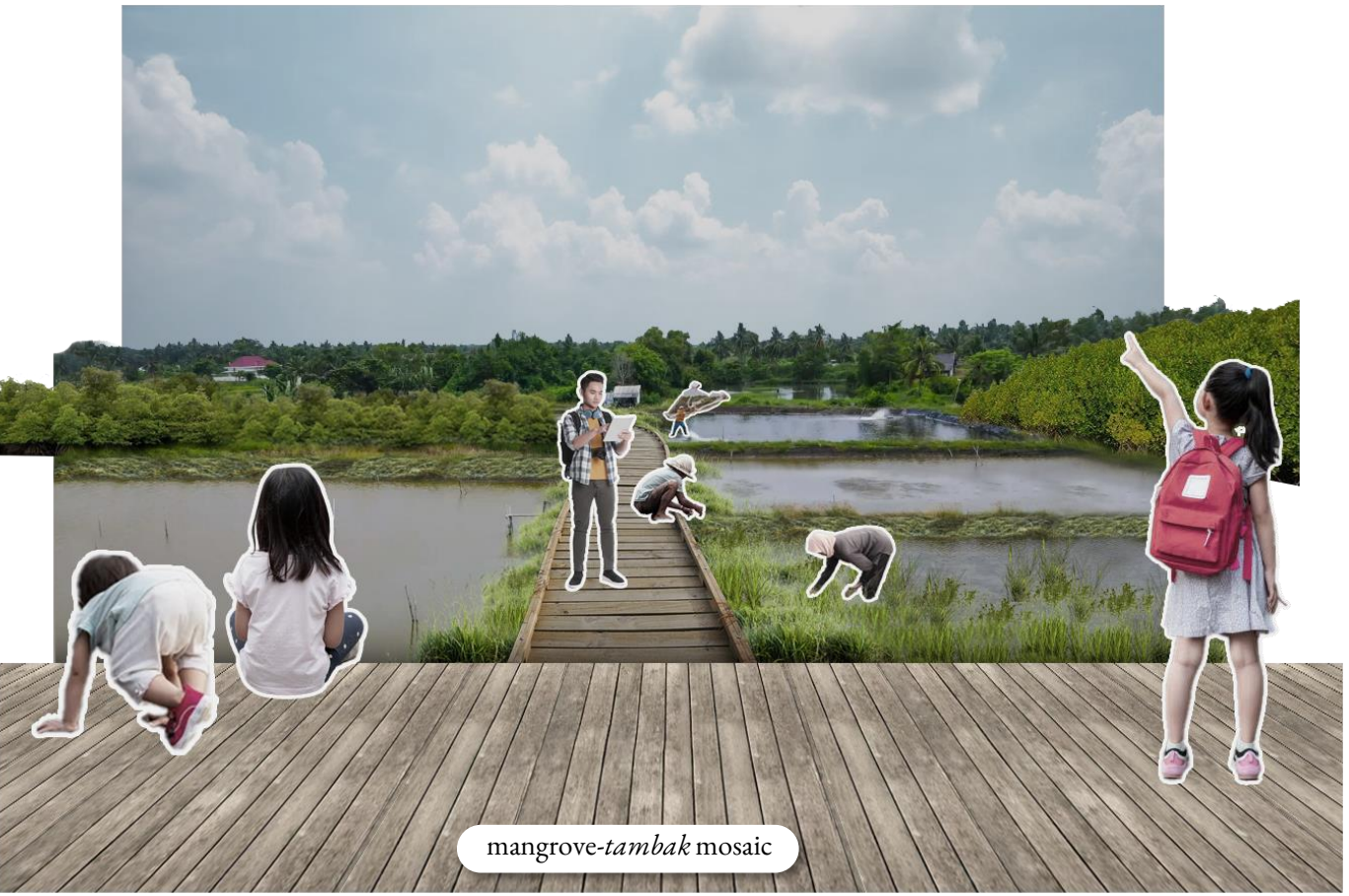
biodiversity benefit

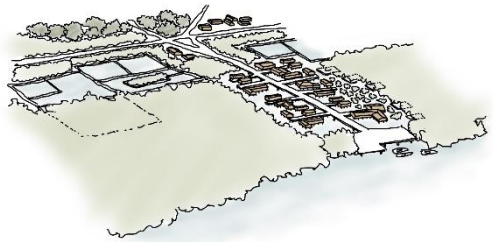
ecosystem services scale



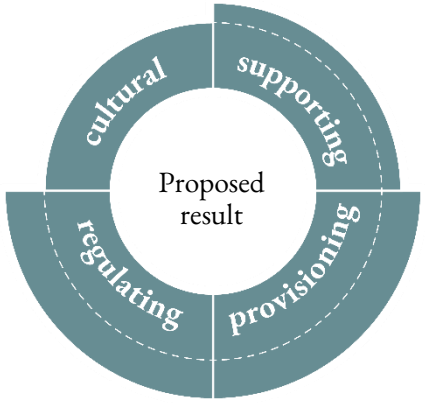
Spatial Frameworks

key project
a new *tambak* system





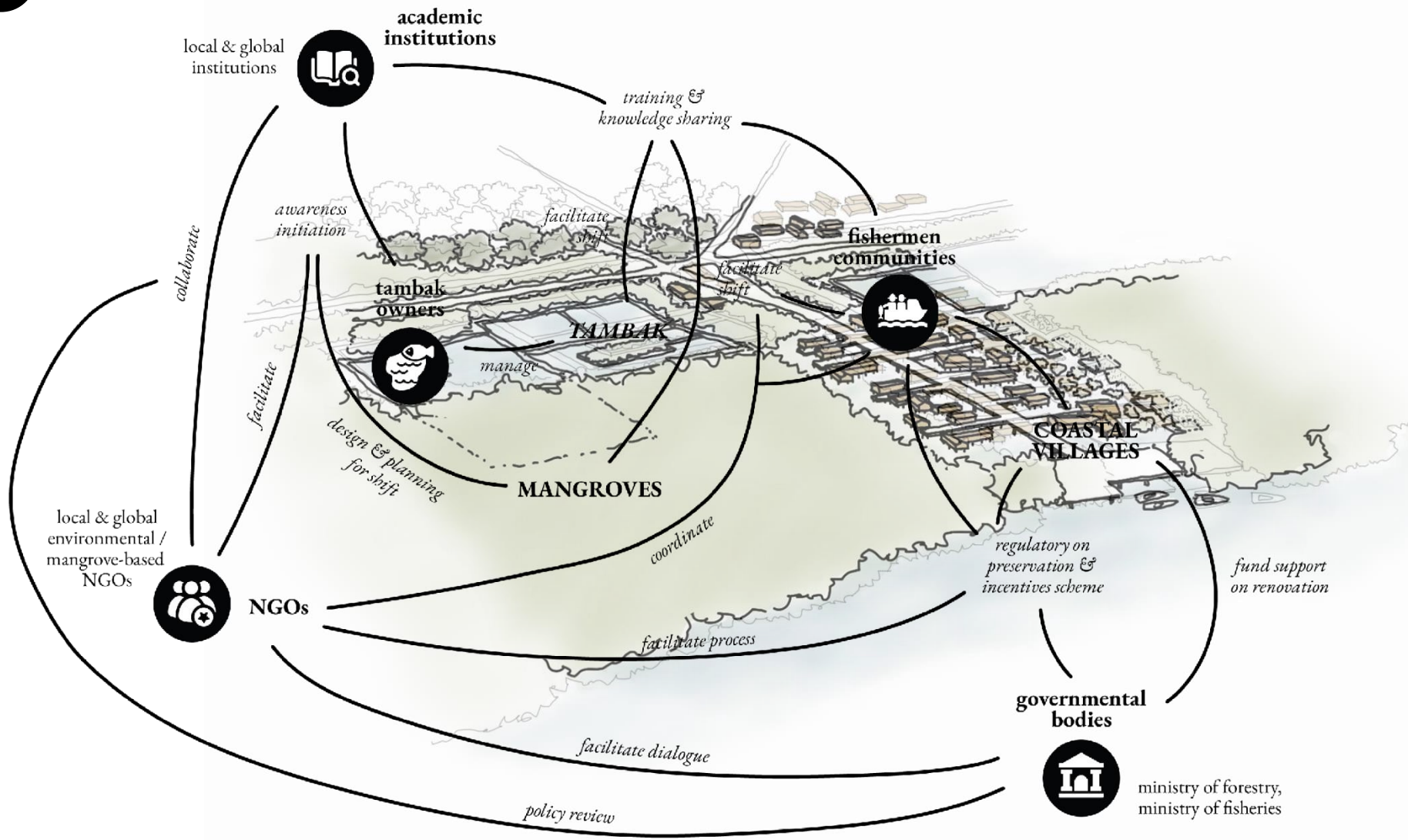
ecosystem services scale



AI-generated, 2025

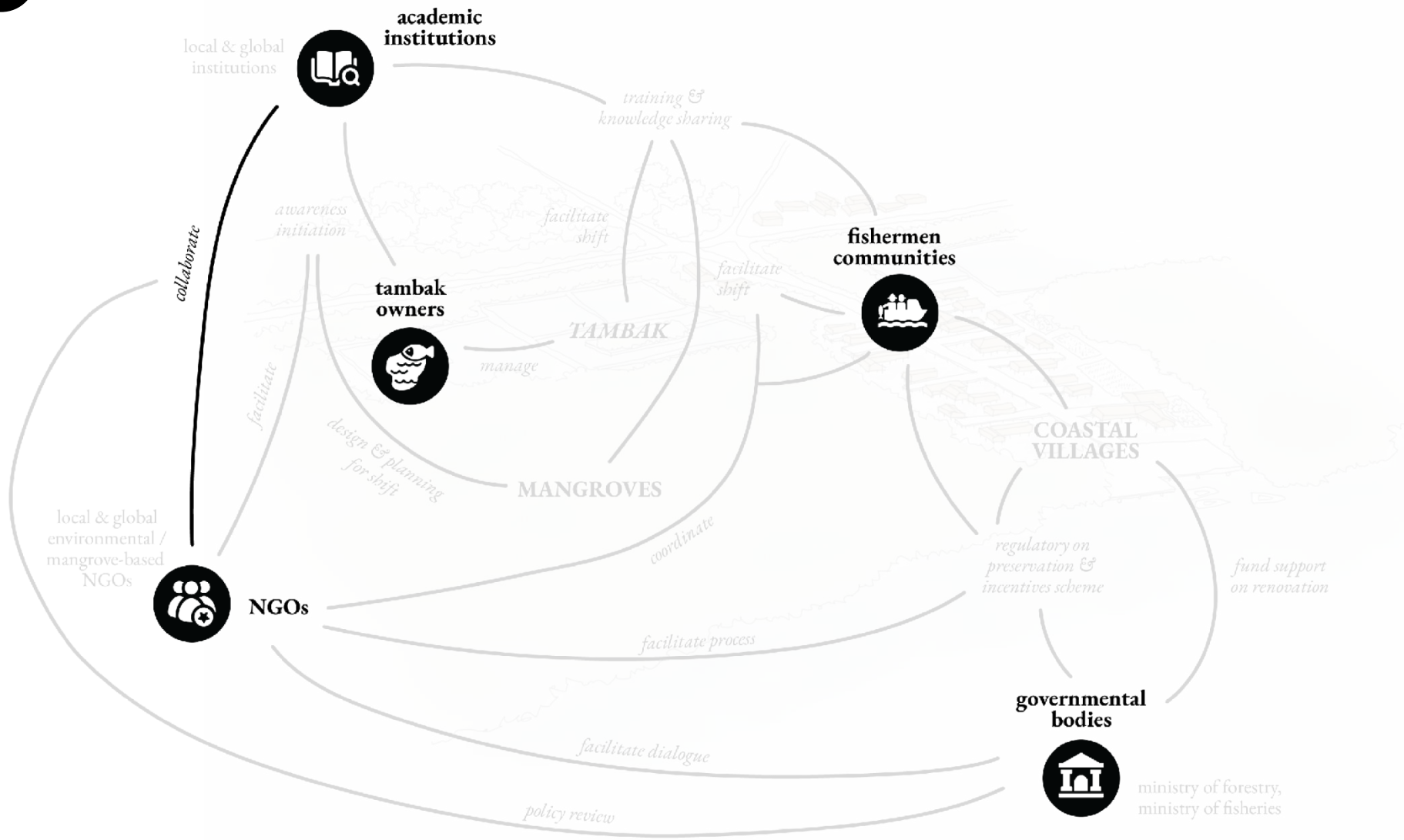
Visualisations

key project
a new *tambak* system



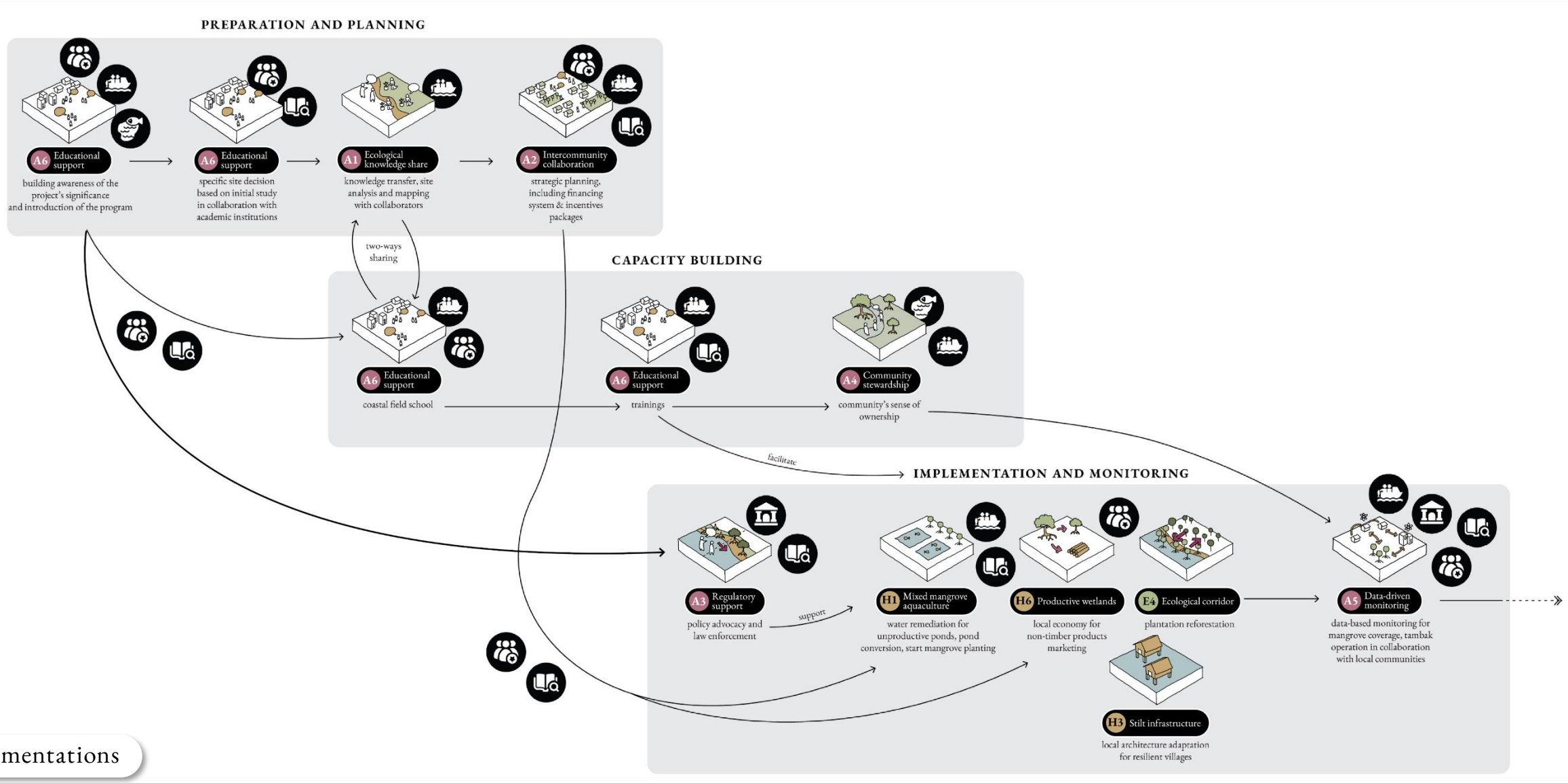
Implementations

key project
a new *tambak* system

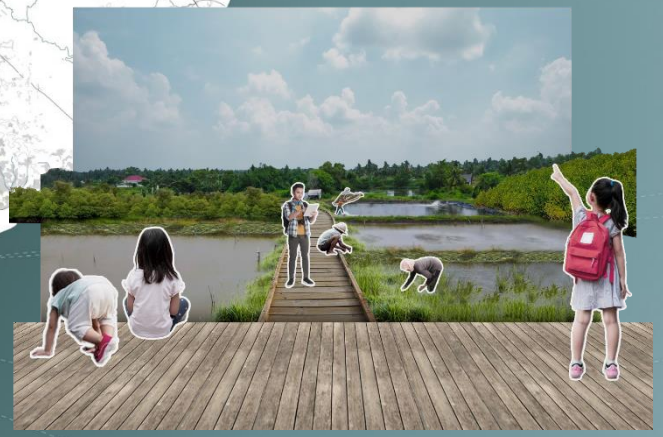


Implementations

key project
a new *tambak* system



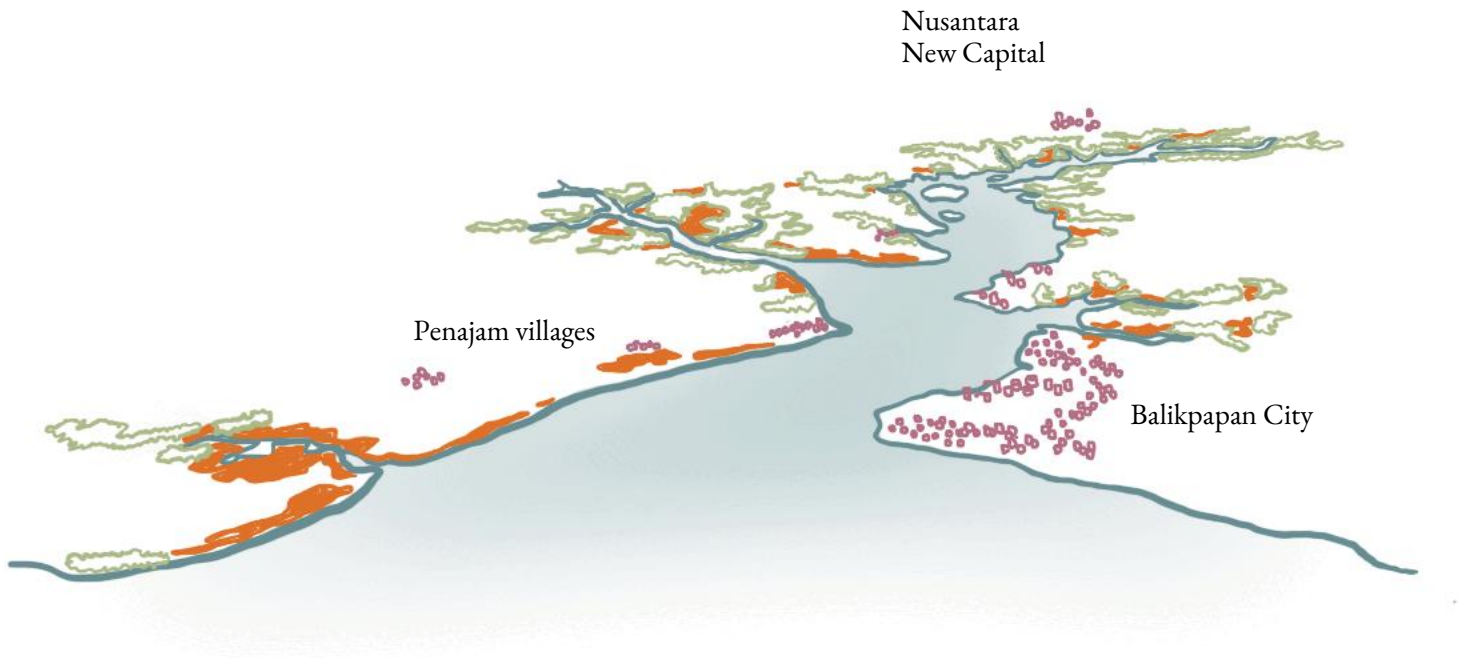
Implementations



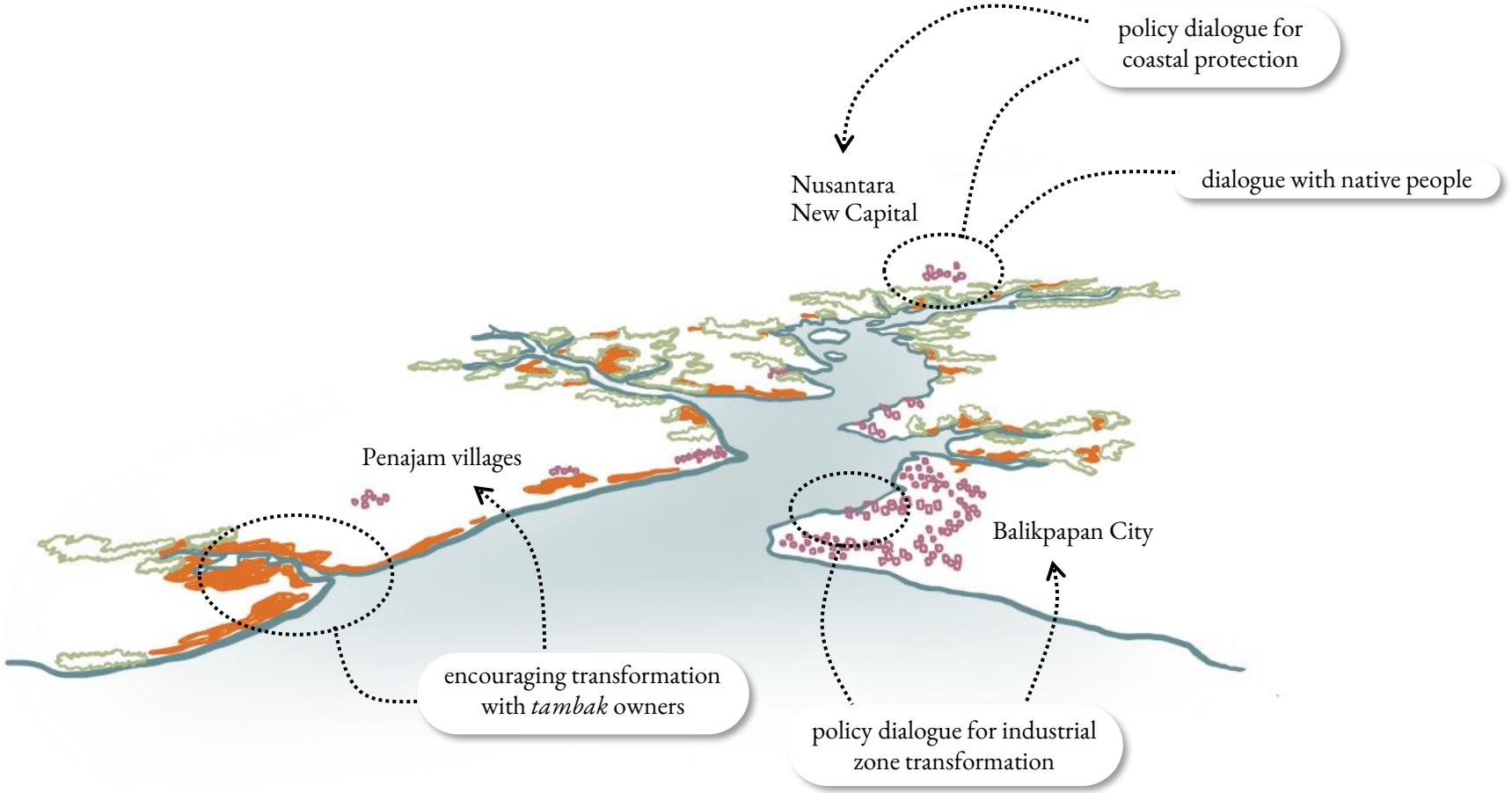
0 5 10 km

a living system in balikpapan bay

a living system in balikpapan bay



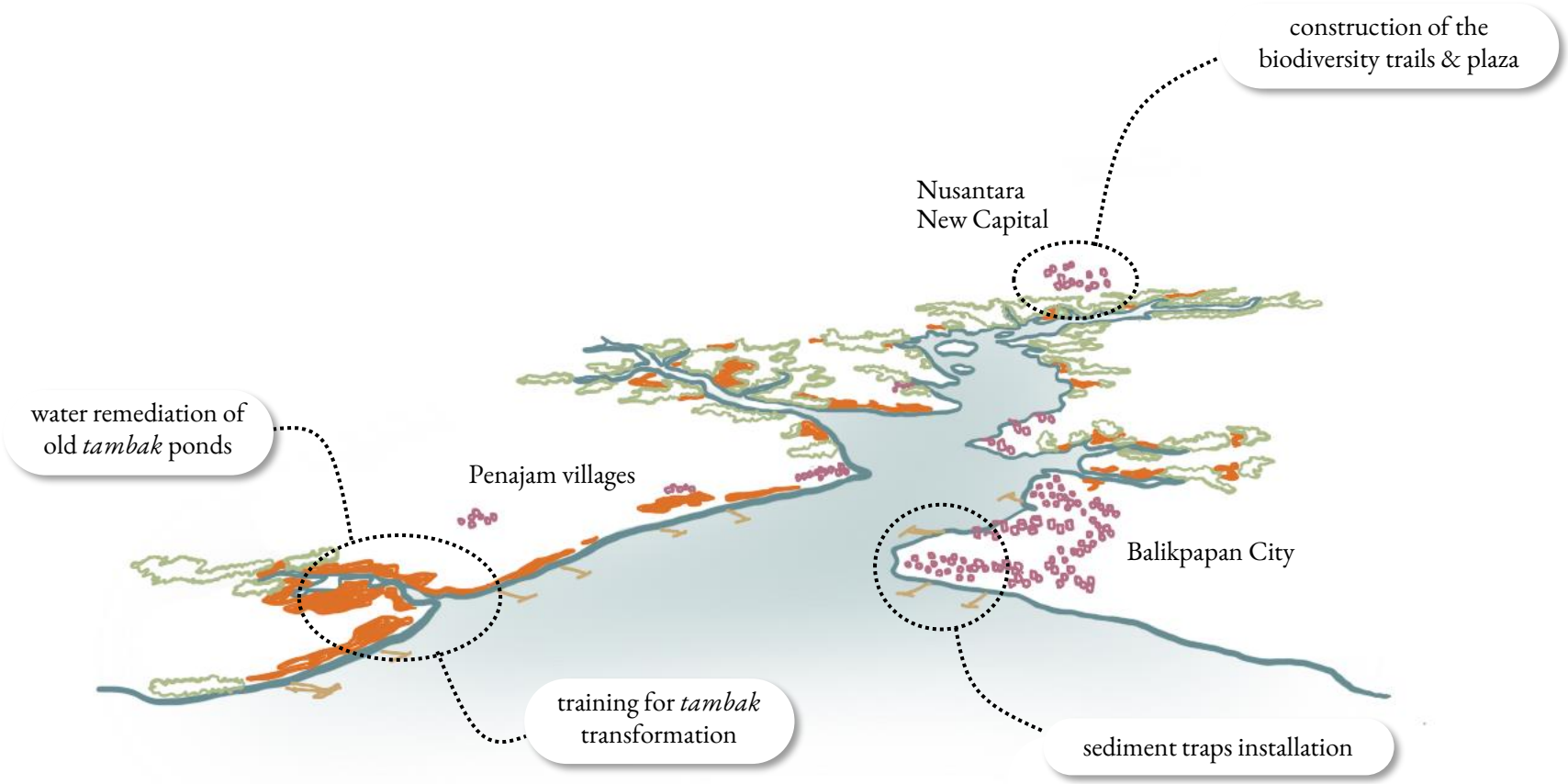
a living system in balikpapan bay



The initial phase is mainly non-spatial strategies, including fostering awareness, knowledge transfers, and advocating policy adaptations

First steps

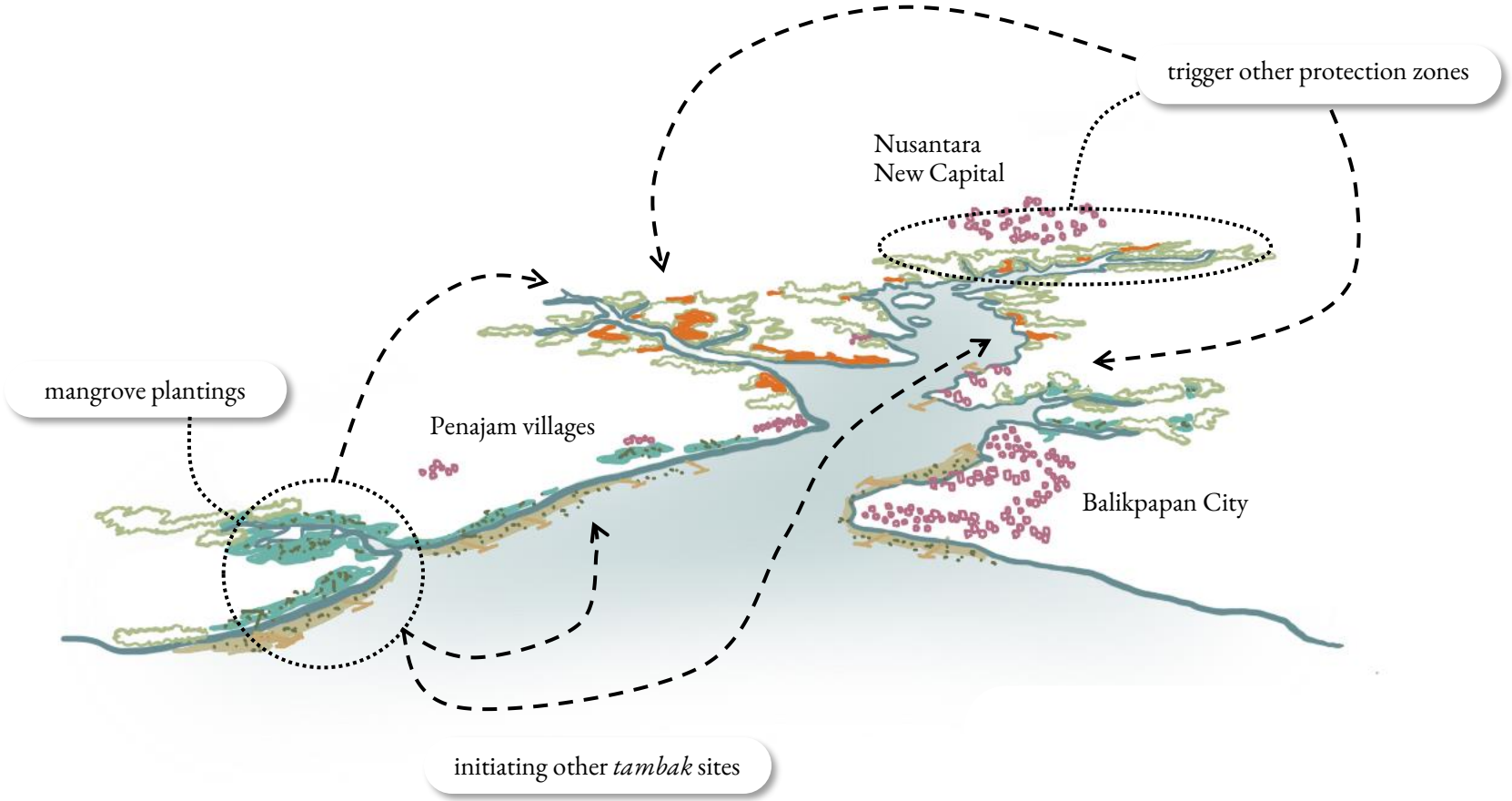
a living system in balikpapan bay



Physical construction of some strategies start, while polluted tambak water are being rehabilitated

Second stages

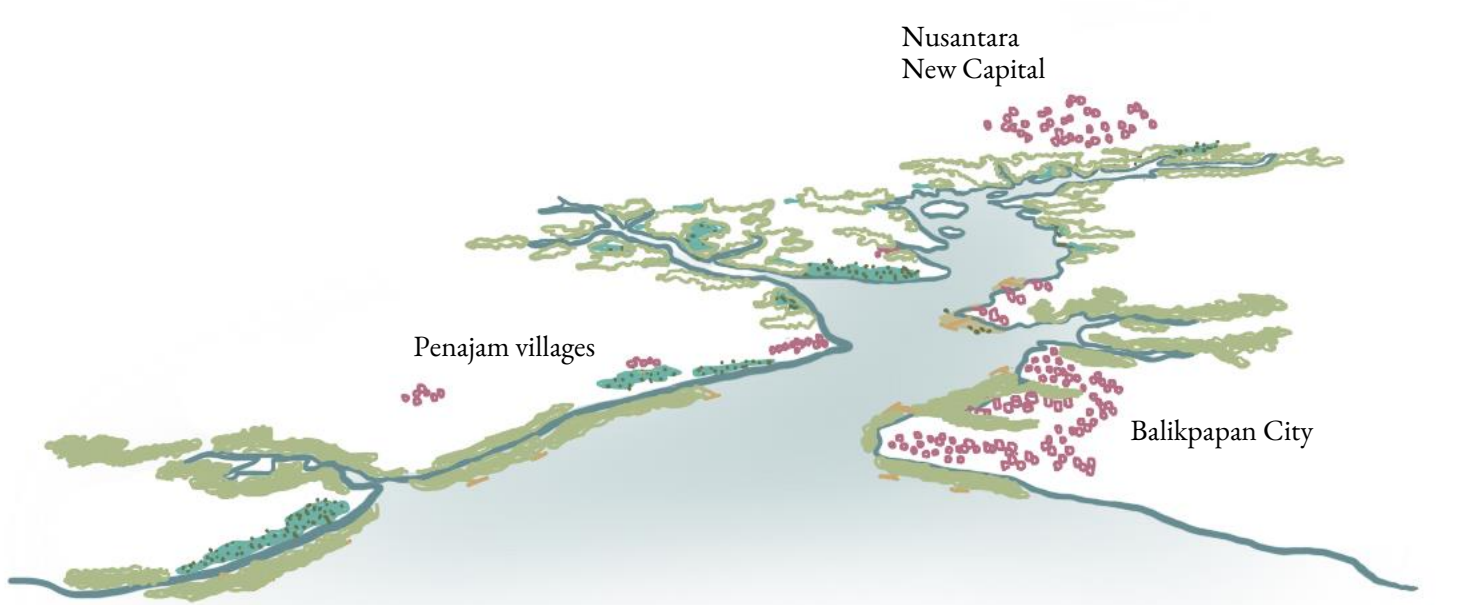
a living system in balikpapan bay



Some strategies trigger other sites to initiate,
and transformation of the old *tambak* start

Third stages

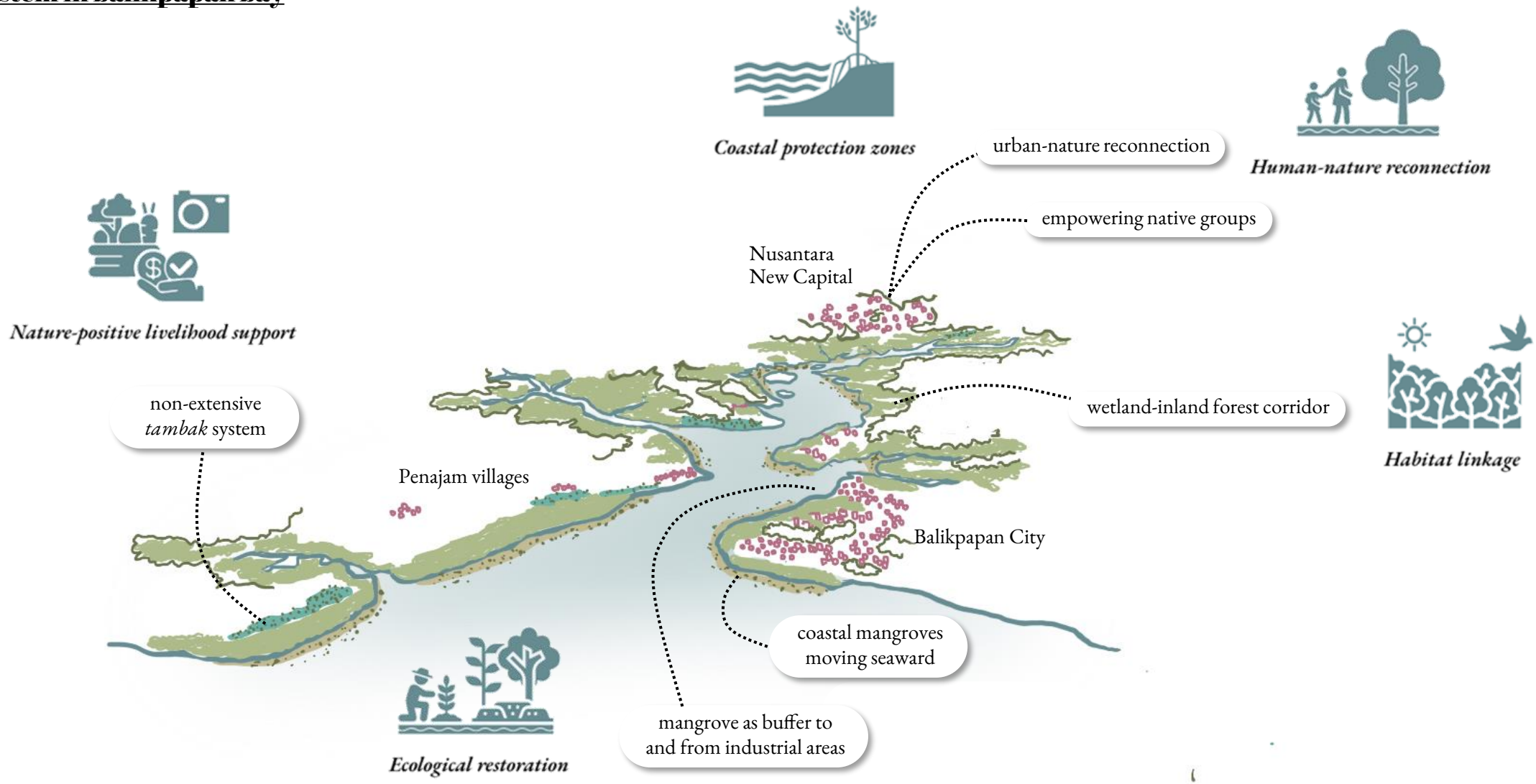
a living system in balikpapan bay



Planted mangroves are stabilised and ready for seaward colonisation

Fourth stages

a living system in balikpapan bay



Regenerated mangrove ecosystem
covering Balikpapan Bay's coastline

Ultimate stage

conclusion & reflection

conclusion & reflection

conclusion & reflection

conclusion & reflection

from polluted water and lost biodiversity...

...to regenerated ecosystem for people and by people