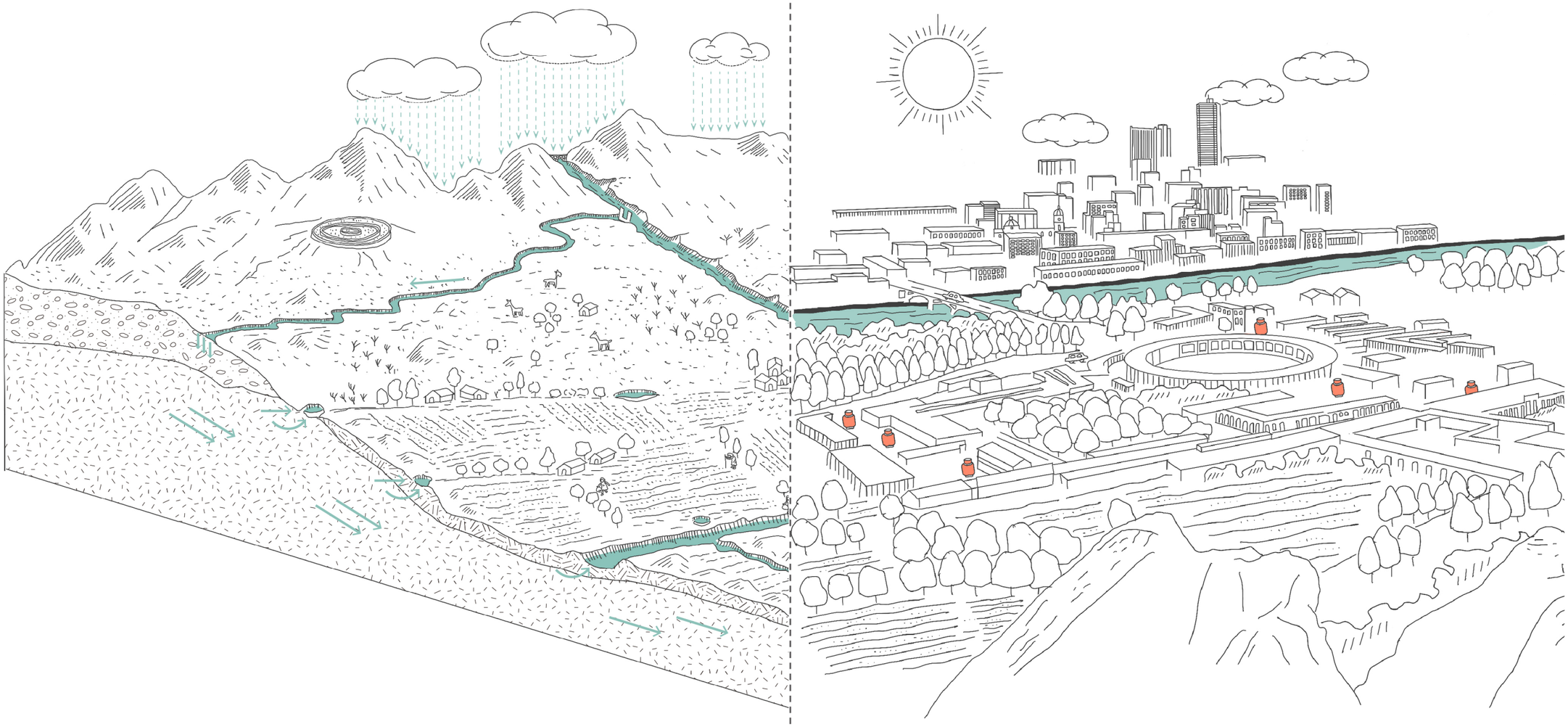

Quenching Thirst: *cooperation and interaction by living with water from Huamantanga in the hills to Lima on the coast, Peru.*

P5 Presentation
Wanning Liang 5561280
First Mentor | Inge Bobbink
Second Mentor | Luca Iuorio
Examiner | Pierijn van der Putt

Chapter I

Lima: Where the story begins

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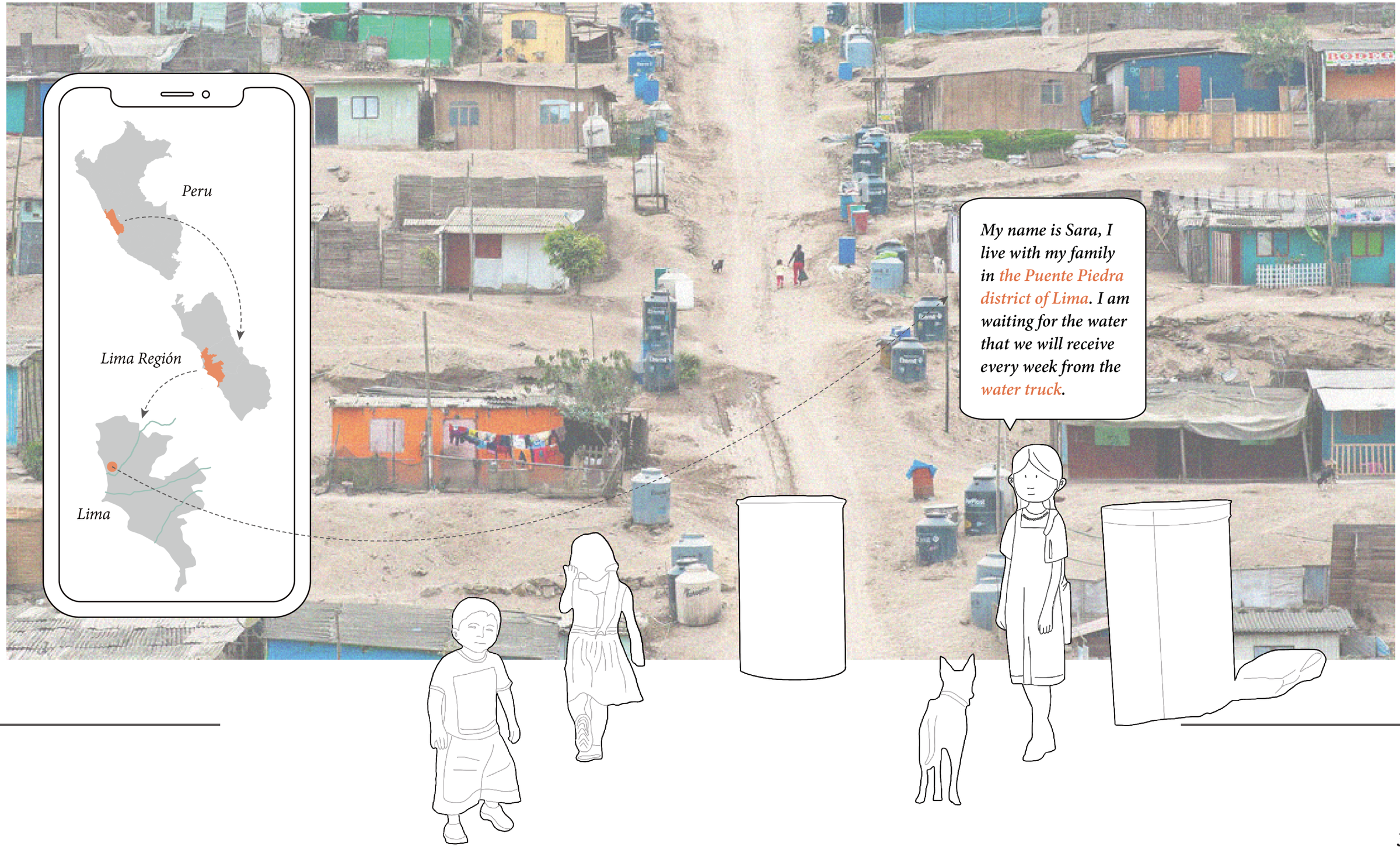
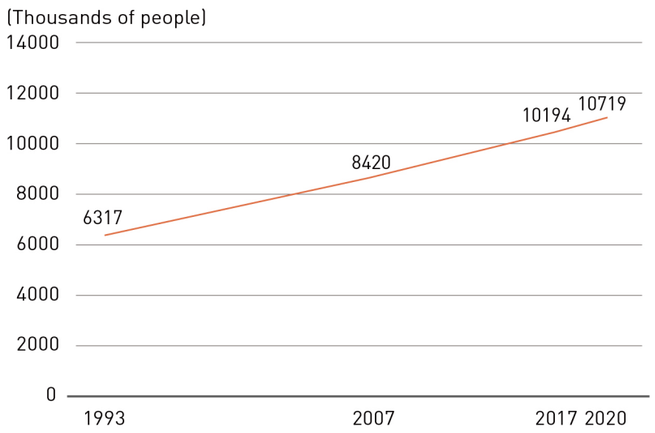


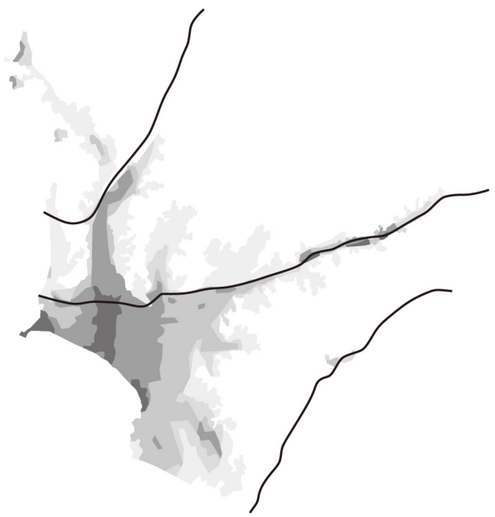
A Peruvian woman with her child climb up a steep path along the plastic water containers on the dusty hillside in Lima, Peru. Image: Jan Sochor / Alamy Stock Photo

0 5 10 km N

Population in Lima, Peru



City Expansion Map



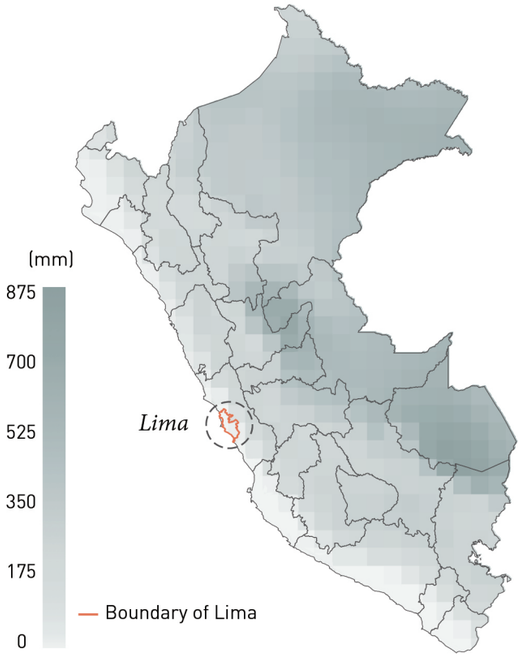
1535-1940
1940-1961
1961-1972
1972-1981
1981-1993

Pacific Ocean

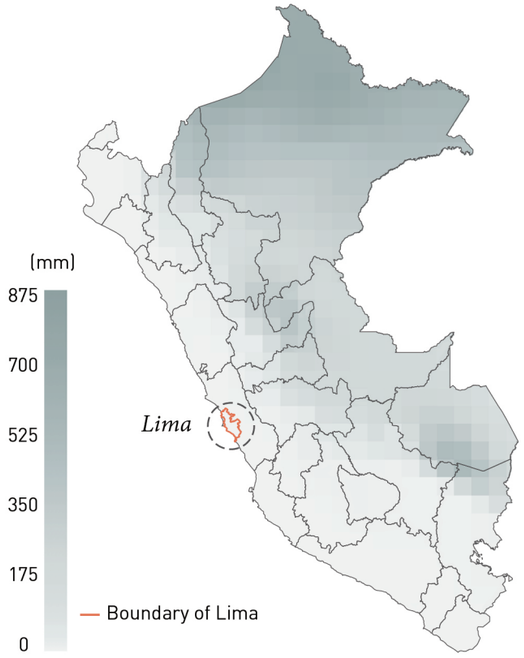
Water Facilities Map

- Water supply company
- Water tower
- Water tank
- City boundary
- Road
- Building
- Water

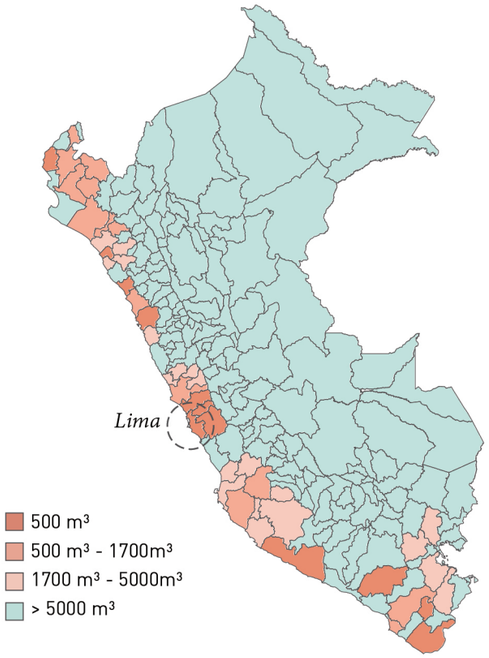
Challenges of Lima



Precipitation in Peru (Jan-Feb)



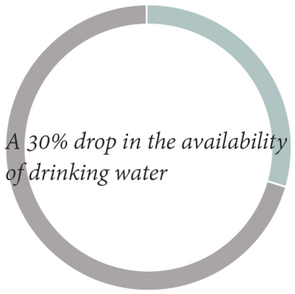
Precipitation in Peru (July-Aug)



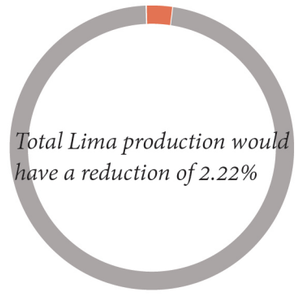
Per Capita Availability, Peru

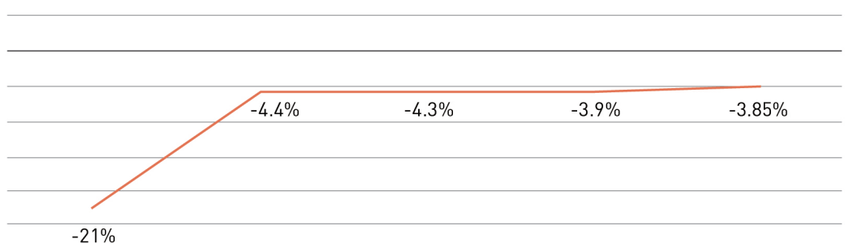


Lima's per capita water supply has reached an extremely insecure level, and the water crisis is expected to worsen over the next 15 years.

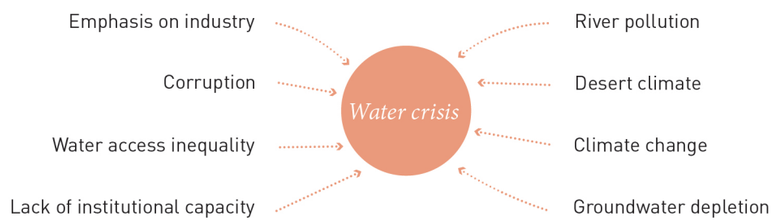


in 10-15 years

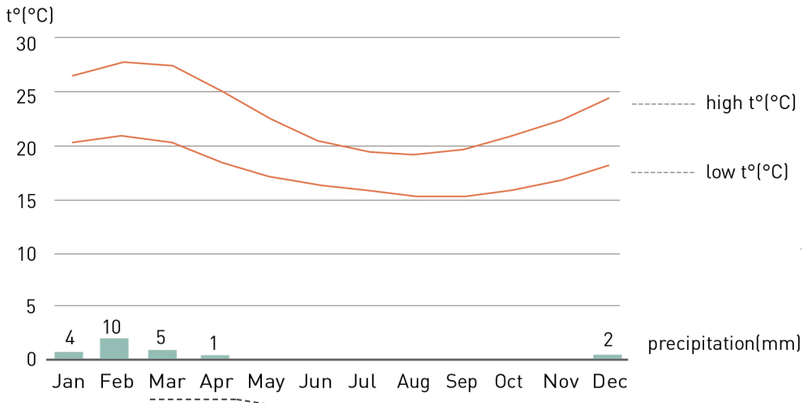




Sectors with the greatest negative impact



0 5 10 km N



Pacific Ocean

Huarangal

La Rinconada

Sol de Carabayllo

Puente Piedra

San Martin de Porres

Cajamarquilla

Carapongo

Flood Map

- Not Flooded river
- Totally Flooded river
- Totally Flooded road
- Totally damaged assets
- Possible damaged assets
- City boundary
- Road
- Building
- Other water

0 300m N



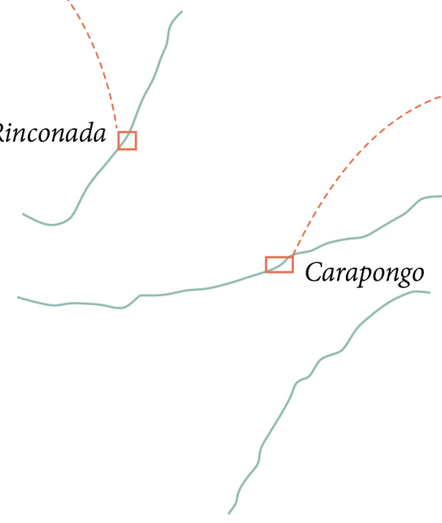
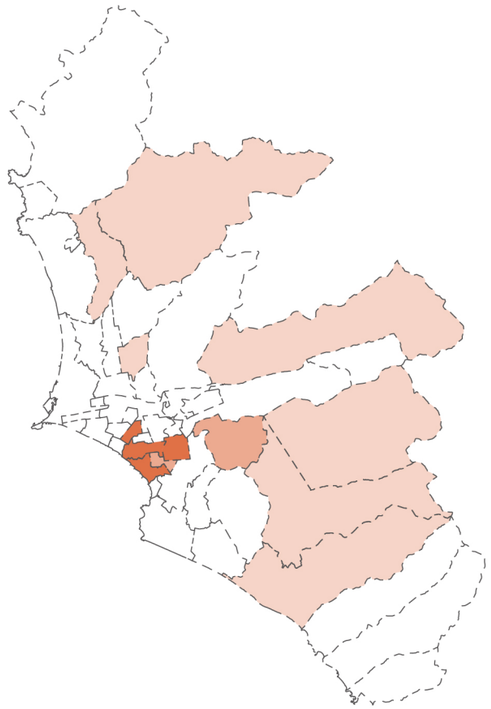




Image: Google earth

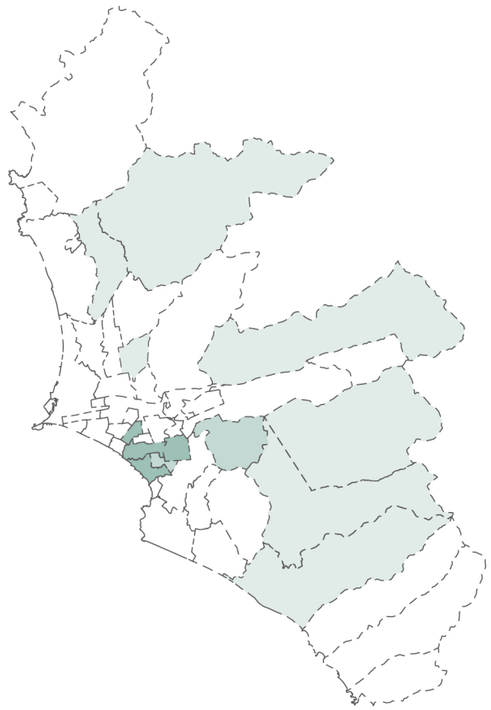


Income

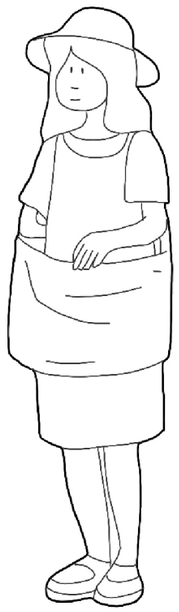




447L per day	*Water delivery once or twice a week at each location*
1.3 soles (US$0.40)/m³	*20 soles (US$6)/m³*



Municipal water access



When I think of water, I always think of the limited stagnant water in water tanks and flood-damaged houses... I have visited the lower Andes, and I long for the clear and abundant water and natural environment there.

People's attitude

Water Distribution Maps

Chapter II

Huamantanga town: A turning point

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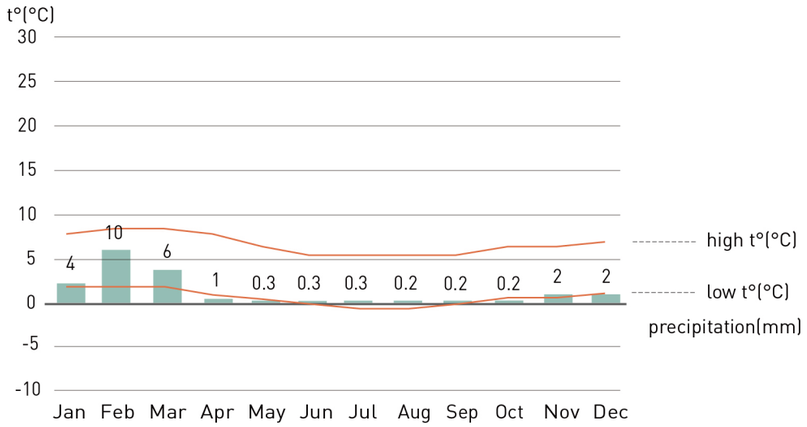
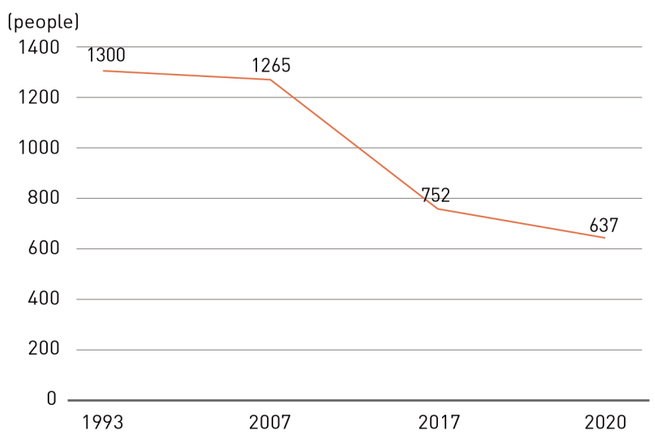
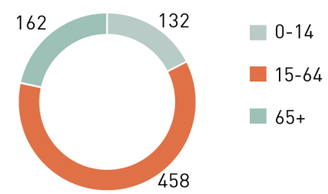
El Yaky Raymi, o Fiesta del Agua, es la celebración andina que rinde homenaje al agua. Image: ANDINA/Carlos Lezama



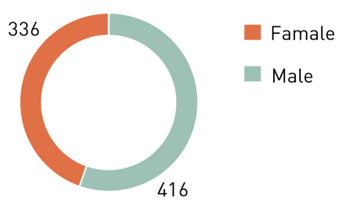
Climate of Huamantanga, Peru



Population in Huamantanga, Peru

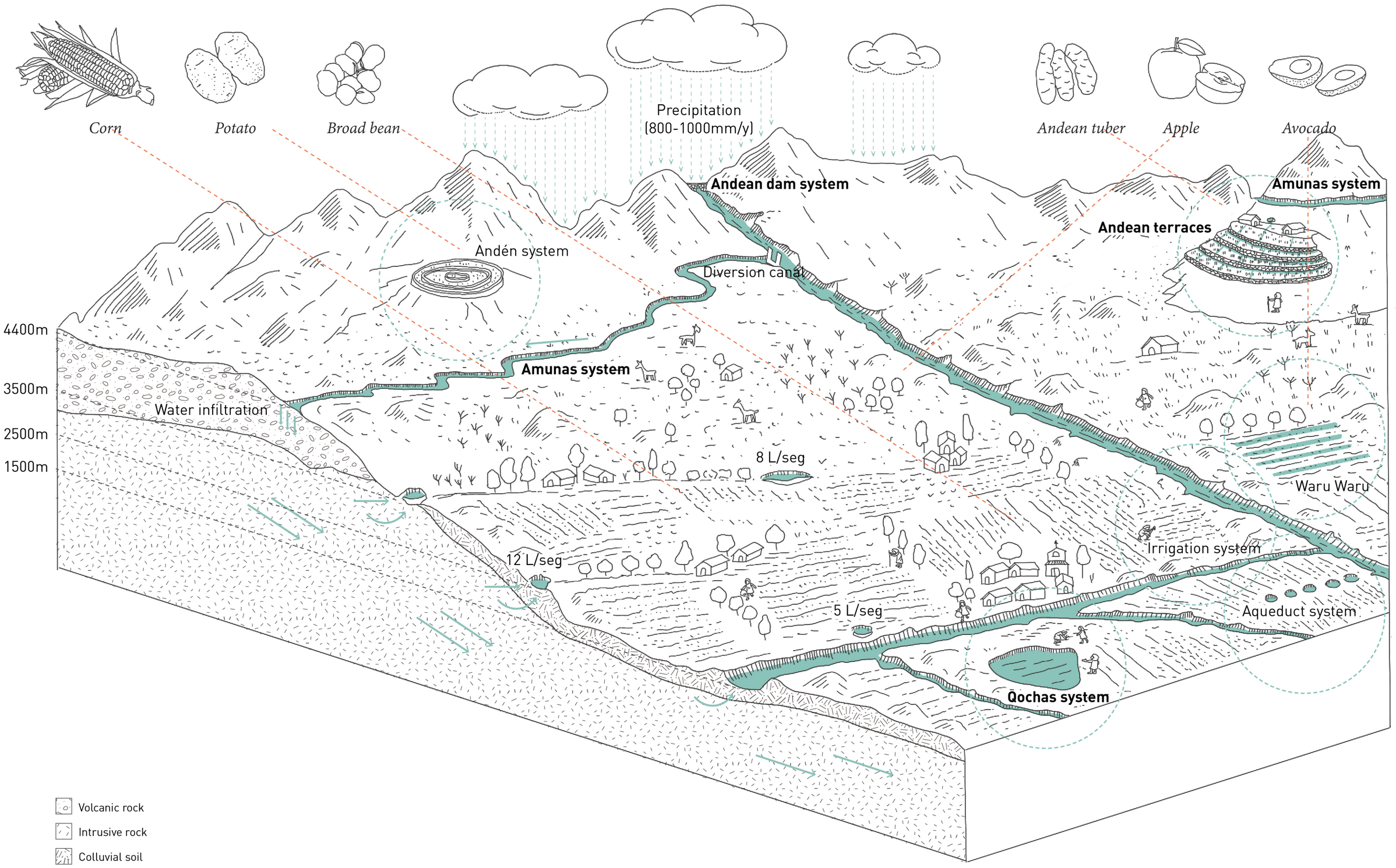


Age Groups of Huamantanga(2017)

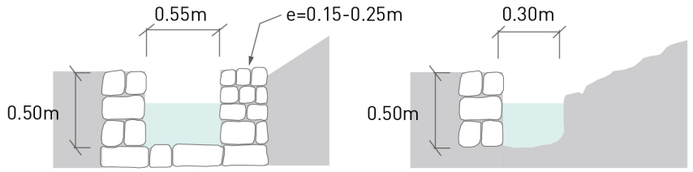


Gender Groups of Huamantanga(2017)

Traditional Andean water-related life

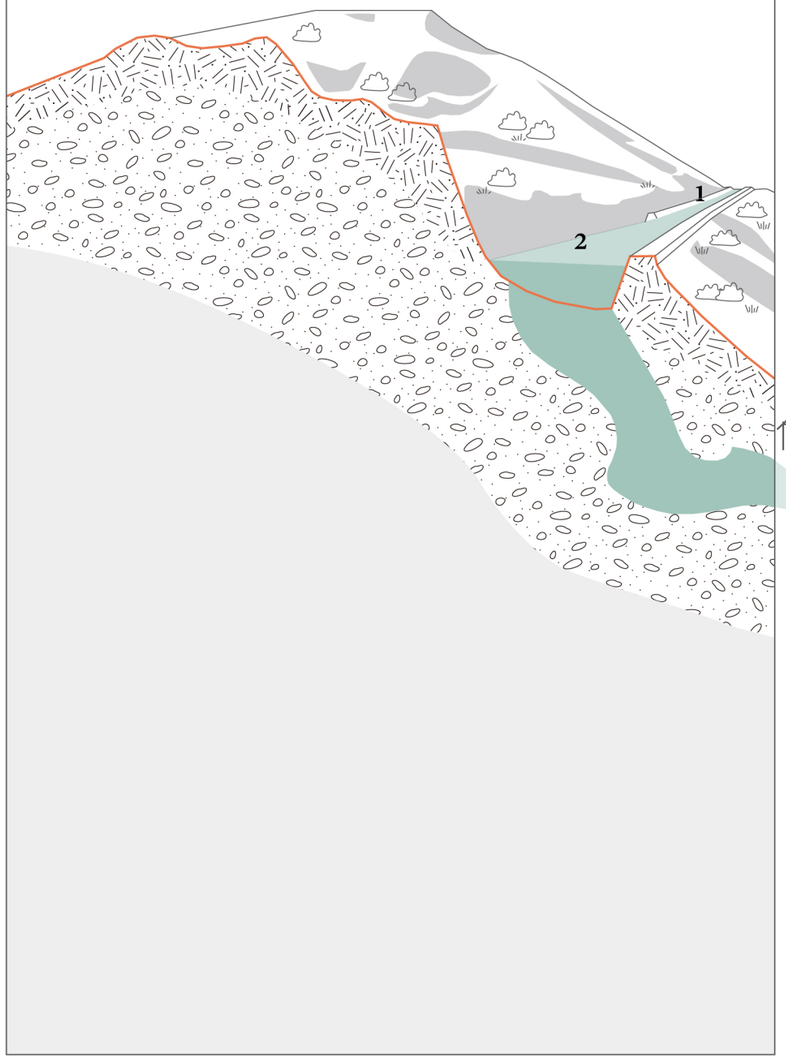


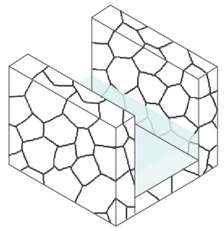
Man-made recharge system: Amunas



Section 1

Section 2





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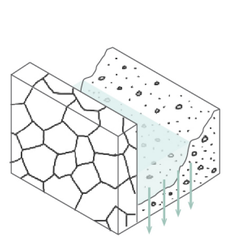

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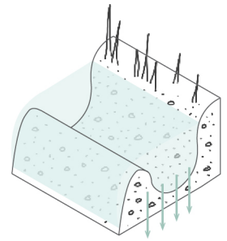

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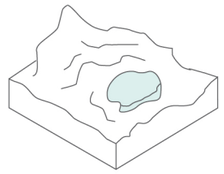

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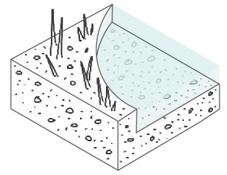

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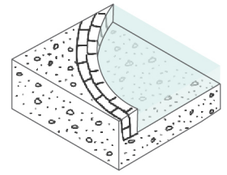
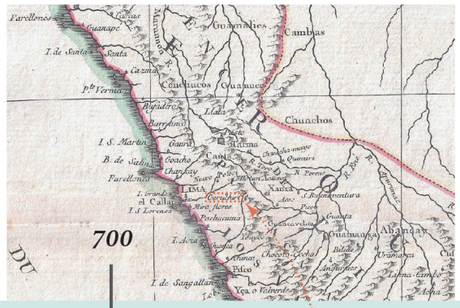


1 Infiltration canal (Stone base) 2 Infiltration canal (Soil base) 3 Infiltration hillslope 4 Spring 5 Wetland or Pond 6 Farmland

History of Amunas



700

Created 1,400 years ago

By prehistoric peoples who lived in what is now the province of Huarochiri

For extending the rainy season's bounty



The so-called "comuneros" uphold customs for the upkeep of the Amunas

They hold ceremonies around their cleaning and blessing

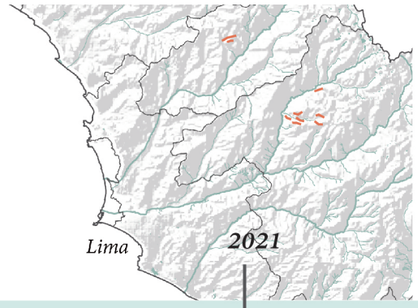


Recent centuries have seen a decline in the ability of water to infiltrate during the rainy season as a result of local people grazing and even overgrazing the hillsides

Numerous Amunas have been abandoned as a result of poor management

2015

The government announced it was funneling $112 million of Lima's water fees into programs designed to help the Andes adapt to climate change and offer water quality improvements, with $26 million of that going into "green infrastructure" programs that include the restoration of these ancient structures Amunas.



2021

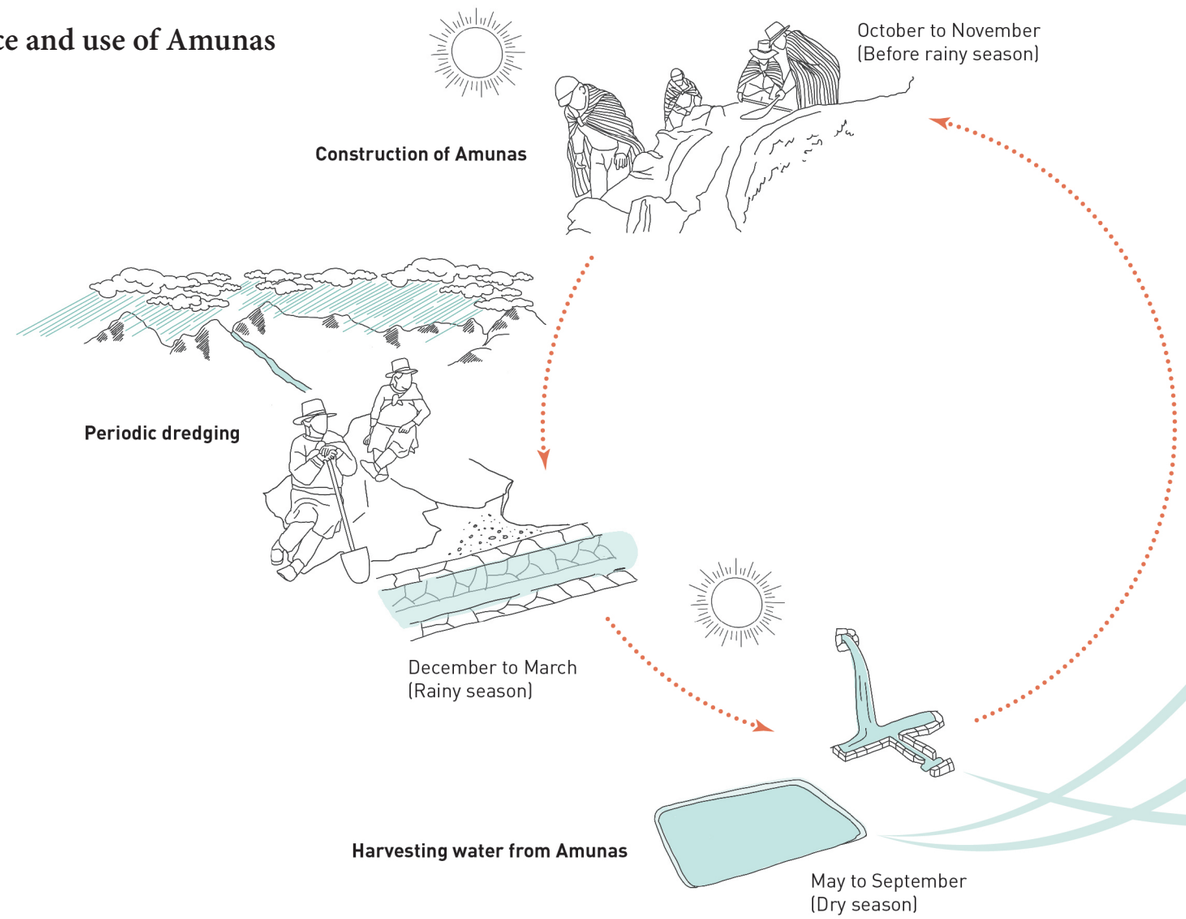
9 Amunas have been restored

They contribute 3,275,925.75 m³/year to the Chillón and Rímac river basins.

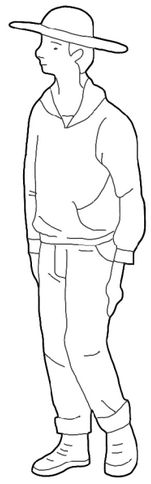
2025

Government plans to complete restoration of 67km of Amunas by 2025

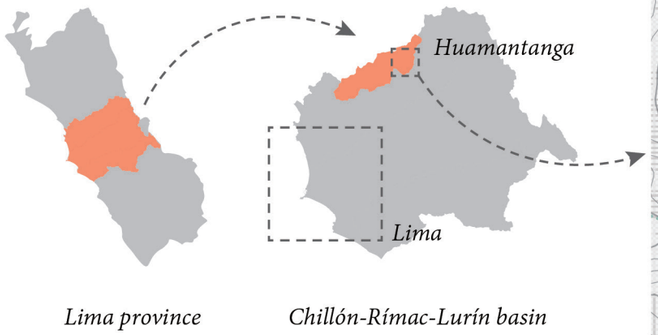
Maintenance and use of Amunas



The most striking thing about Amunas is that the Comuneros know the path of water flowing through the ground and know which canal feeds which spring, as my father also used to tell me.



Distribution of groundwater recharge systems



Lima province *Chillón-Rímac-Lurín basin*

Amunas need to be restored
Bofedales

River
Stream
Amunas
Lake
Pond
Reservoir
Residential area

0 1 2km N

Huamantanga town

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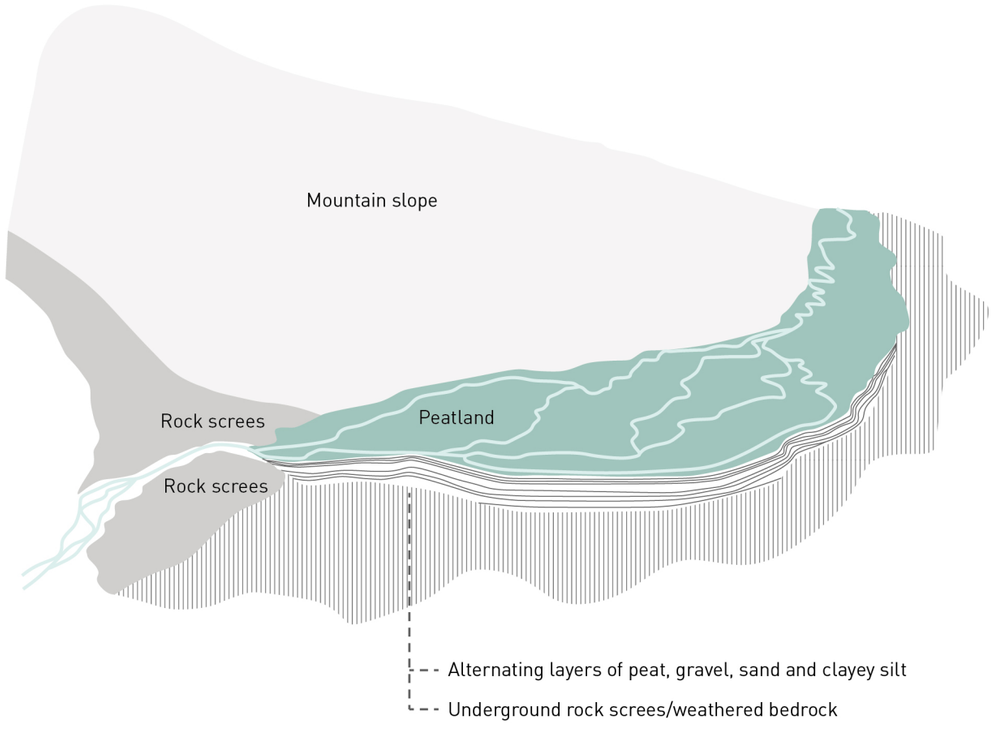
Bofedales(Natural recharge system) © TURBERAS DE CHILE

Natural recharge system: Bofedales



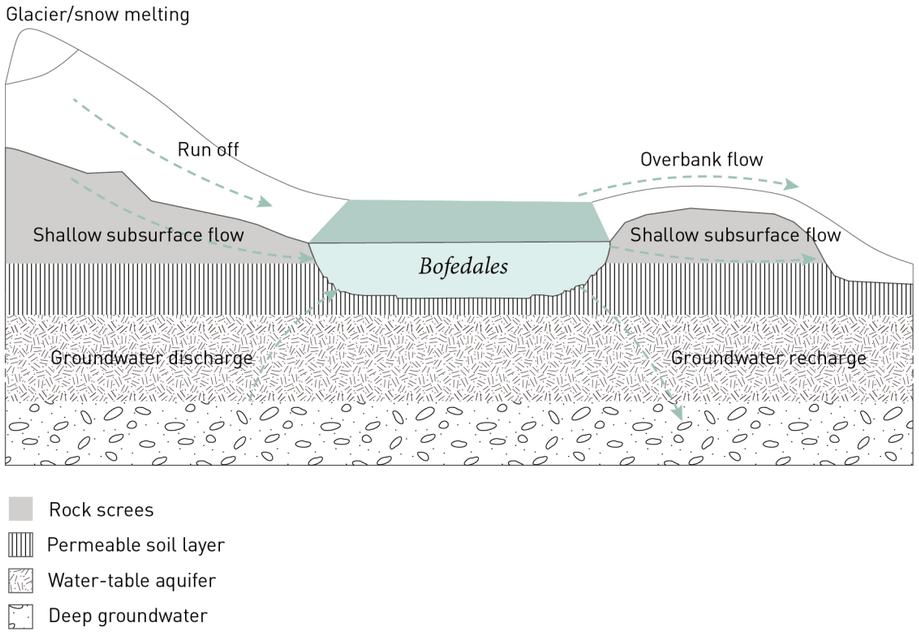
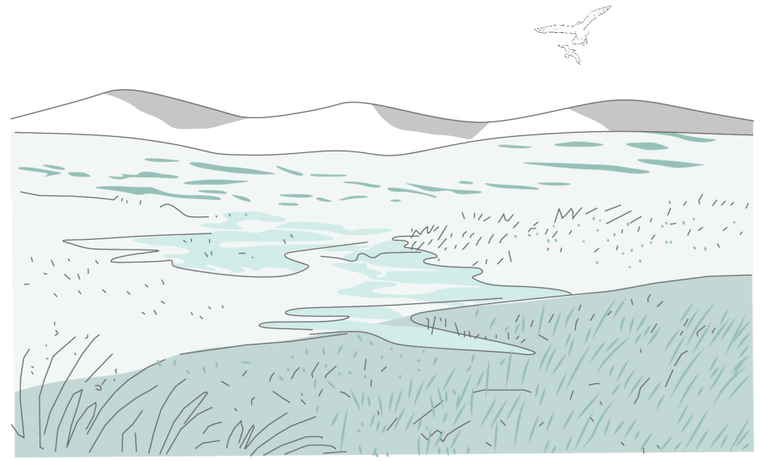


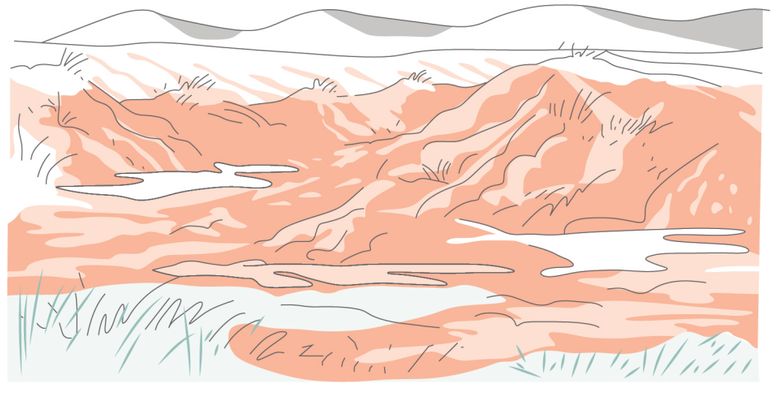
Diagram of Bofedales



Peatland in good condition



Peatland in intermediate condition



Peatland in bad condition

Water spirit in the traditional water-related life

Andean cosmovision

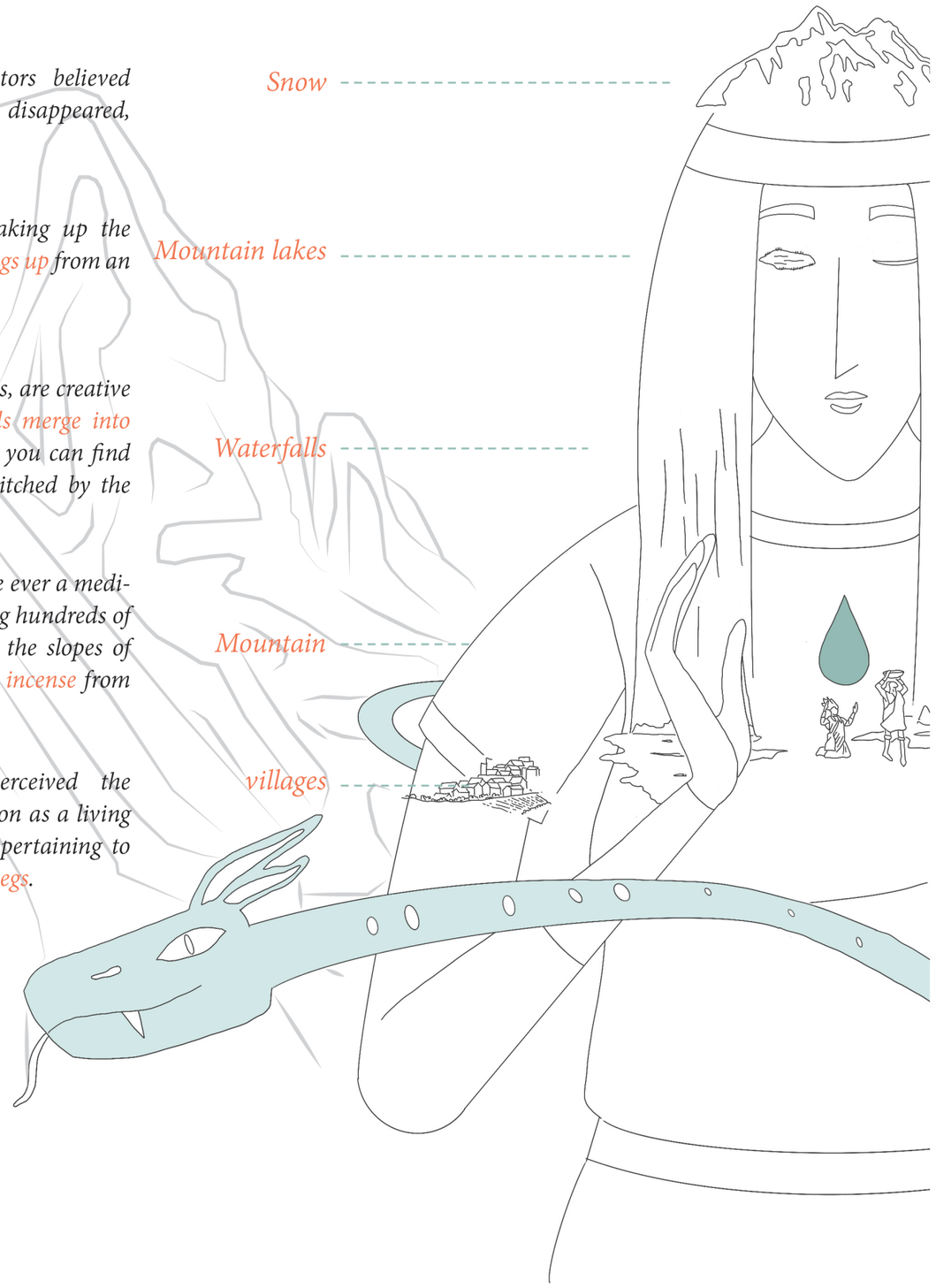
The Andean ancestors believed that if all the snow disappeared, the world will end.

Mountain lakes making up the eyes, where life springs up from an underlying world.

Waterfalls, like lakes, are creative places where worlds merge into one another, where you can find treasure or be bewitched by the mountain spirits.

The Callawaya were ever a medicine people, carrying hundreds of healing herbs from the slopes of this mountain, and incense from the jungle.

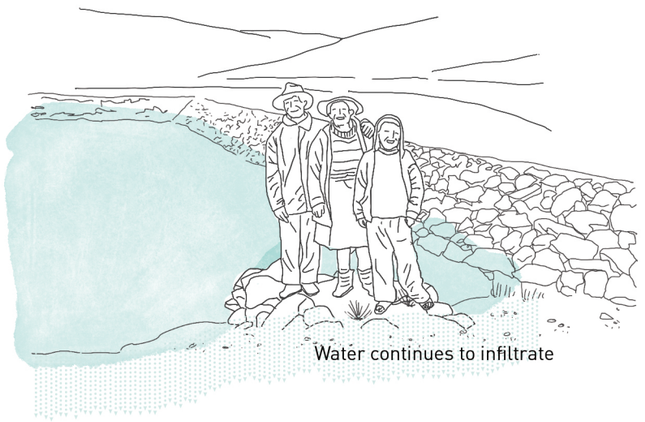
Andean people perceived the mountain they live on as a living body, with villages pertaining to its heart, arms and legs.



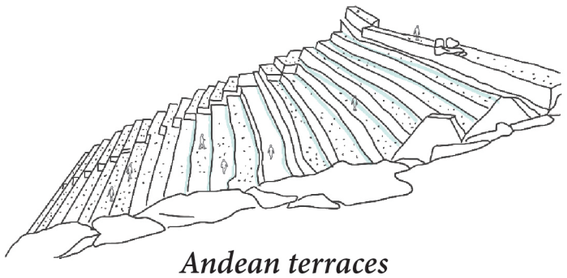
Traditional water works



Amunas canal



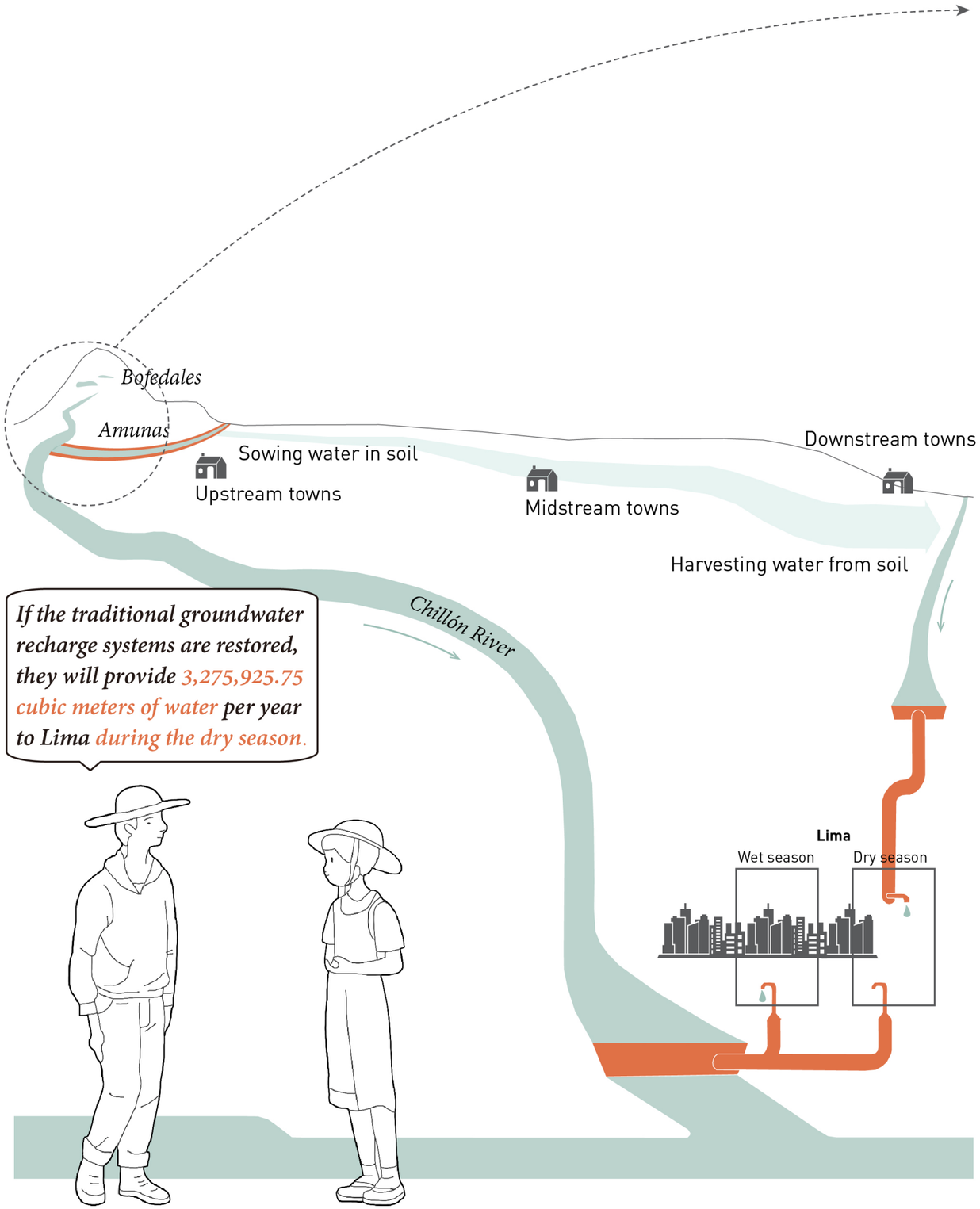
Qochas(Pond)

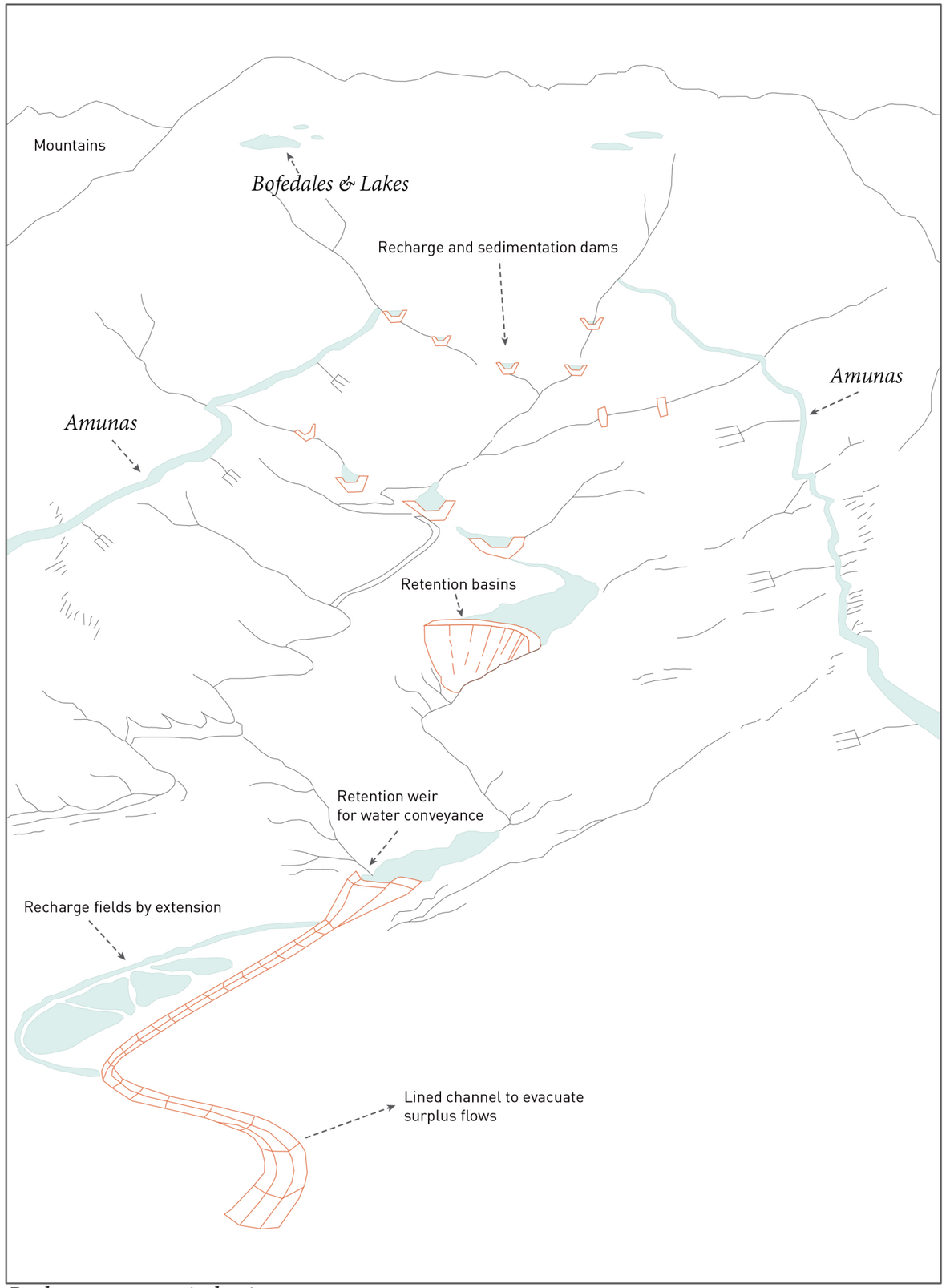


Andean terraces

https://dark-mountain.net/living-landscapes-climate-change-in-the-andes/

New water opportunities

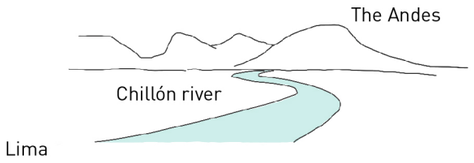


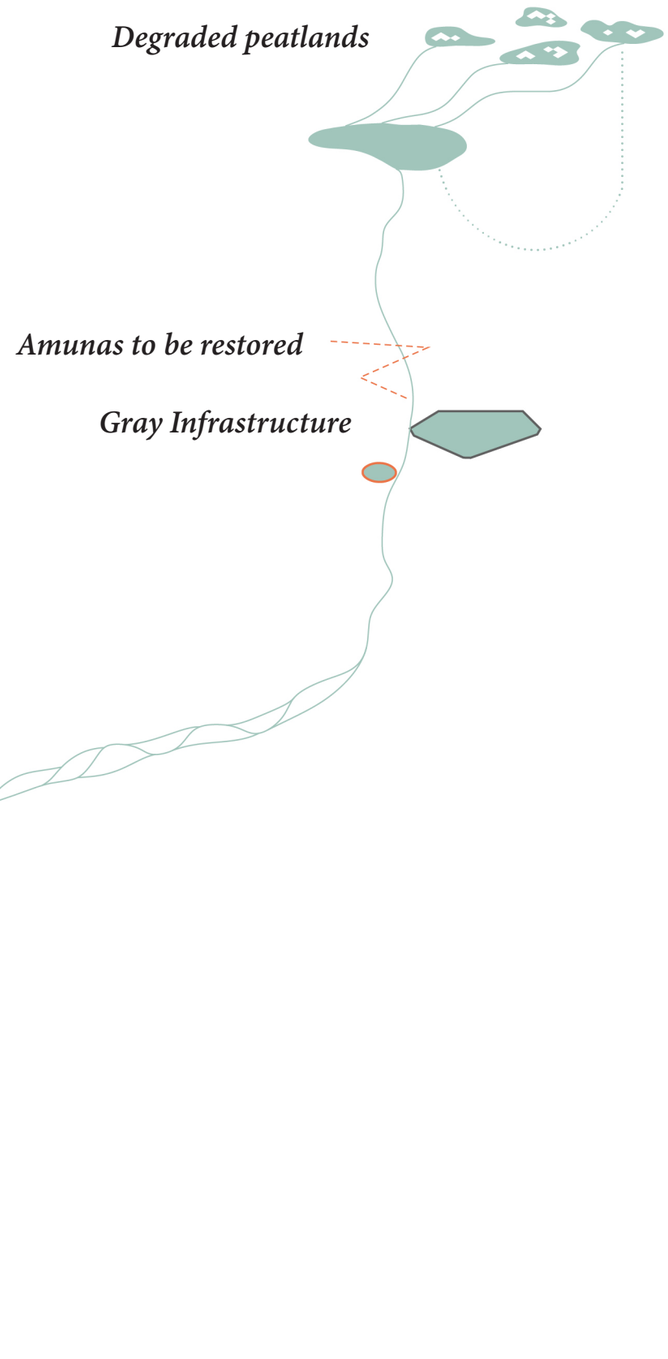


Recharge systems in basin

Chapter III

The design project


The Andes
Chillón river
Lima

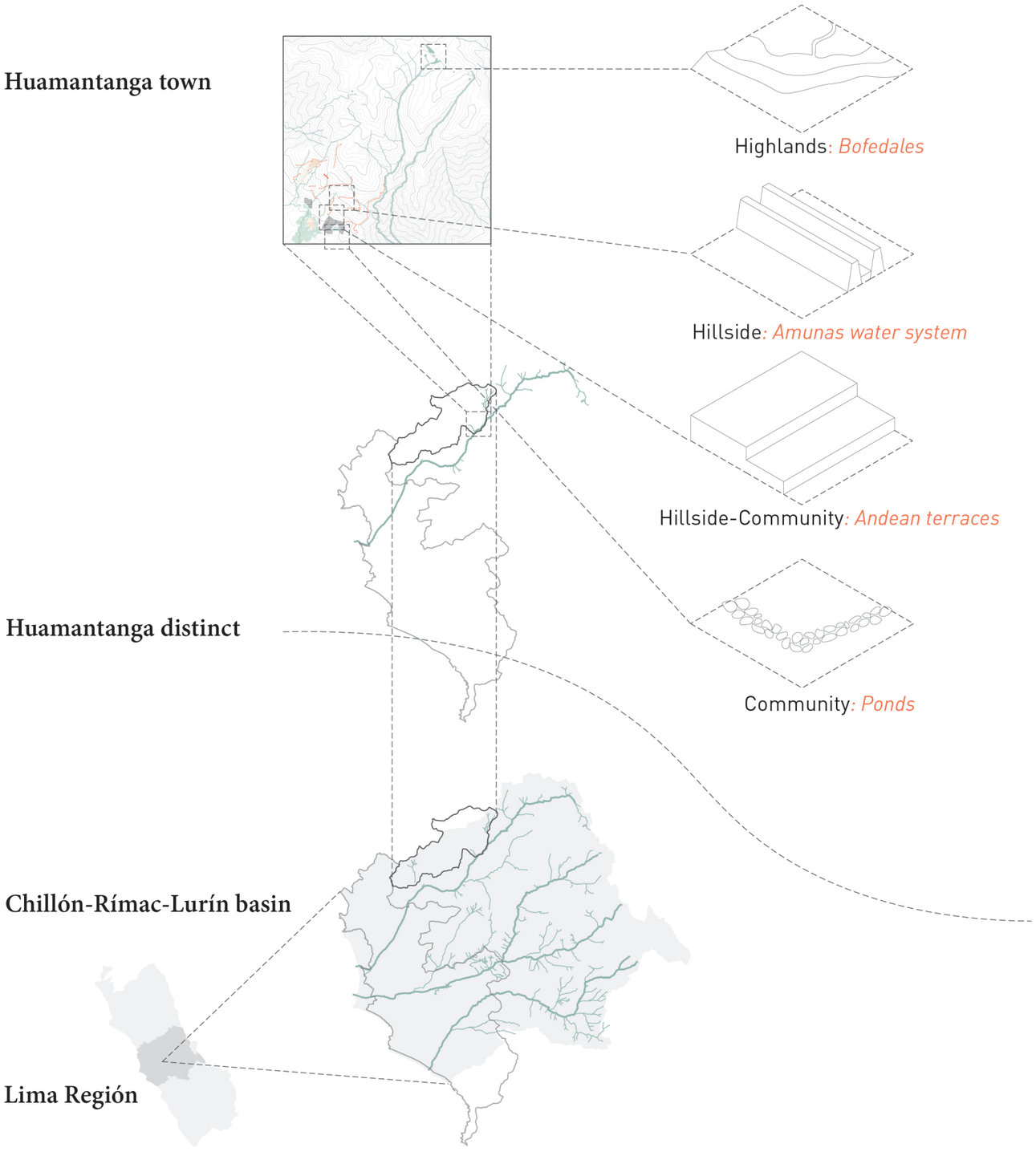

Degraded peatlands
Amunas to be restored
Gray Infrastructure
Seasonal Flooding
Water shortages

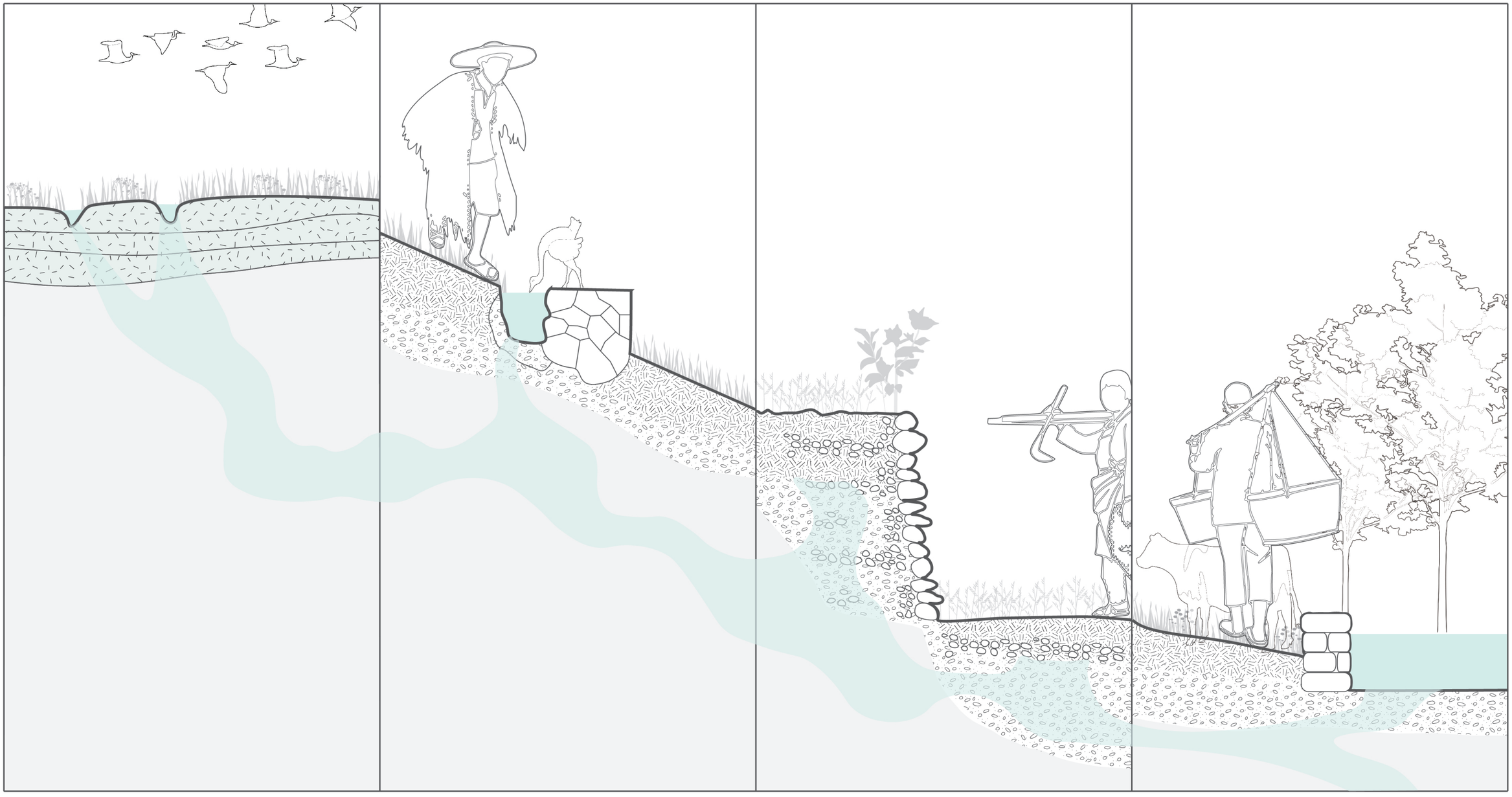
Concept


Huamantanga
Chillón river
Lima

Existing waterway
New surface waterway
New underground waterway
Enhancement of natural recharge system
Enhancement of artificial recharge system
Water recharge point in downstream village
New water intake point in the city
New floodplain park
Lima-Chillón part
Downstream villages
River Chillón
Wetland
Village
Amunas
Lake
Bofedale

Scale		*Goal*	
		Environmental	**Social**
Huamantanga town	Highlands: *Bofedales*	Recharge the aquifer Conservation of biodiversity	Value peatland ecosystem
	Hillside: *Amunas water system*	Recharge the aquifer	Water self-sufficiency in the dry season Preservation of traditional wisdom
	Hillside-Community: *Andean terraces*	Recharge the aquifer Mitigation of soil erosion Water filtration	Food self-sufficiency and diversity Preservation of traditional wisdom
Huamantanga distinct	Community: *Ponds*	Recharge the aquifer	Water self-sufficiency in the dry season Recreation and rituals
Chillón-Rímac-Lurín basin		**Recharge the aquifer** **Connectivity of water systems**	**Paradigm for the integration of water system restoration with ecology and agriculture**
Lima Región			

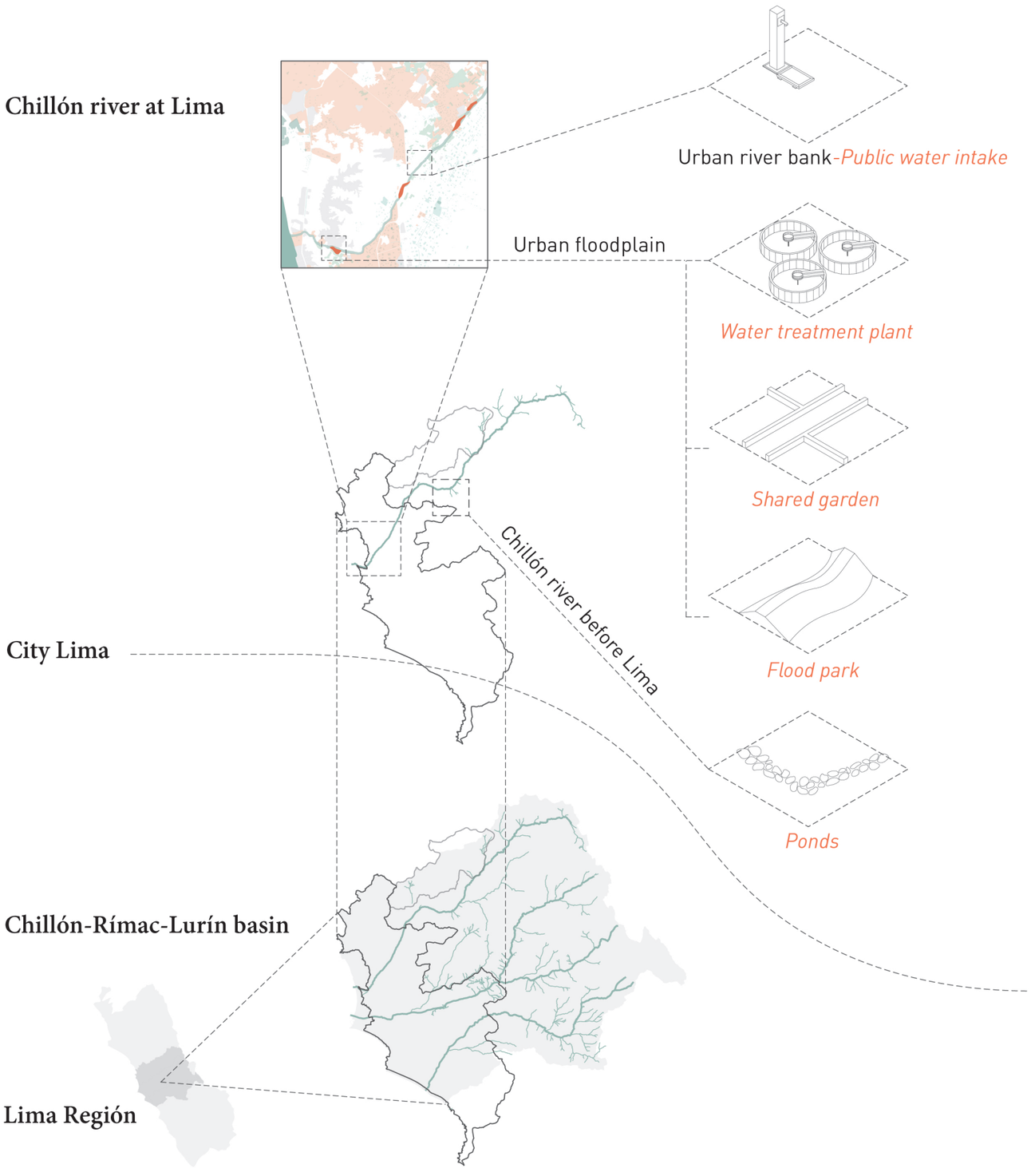




Progressive aquifer replenishment

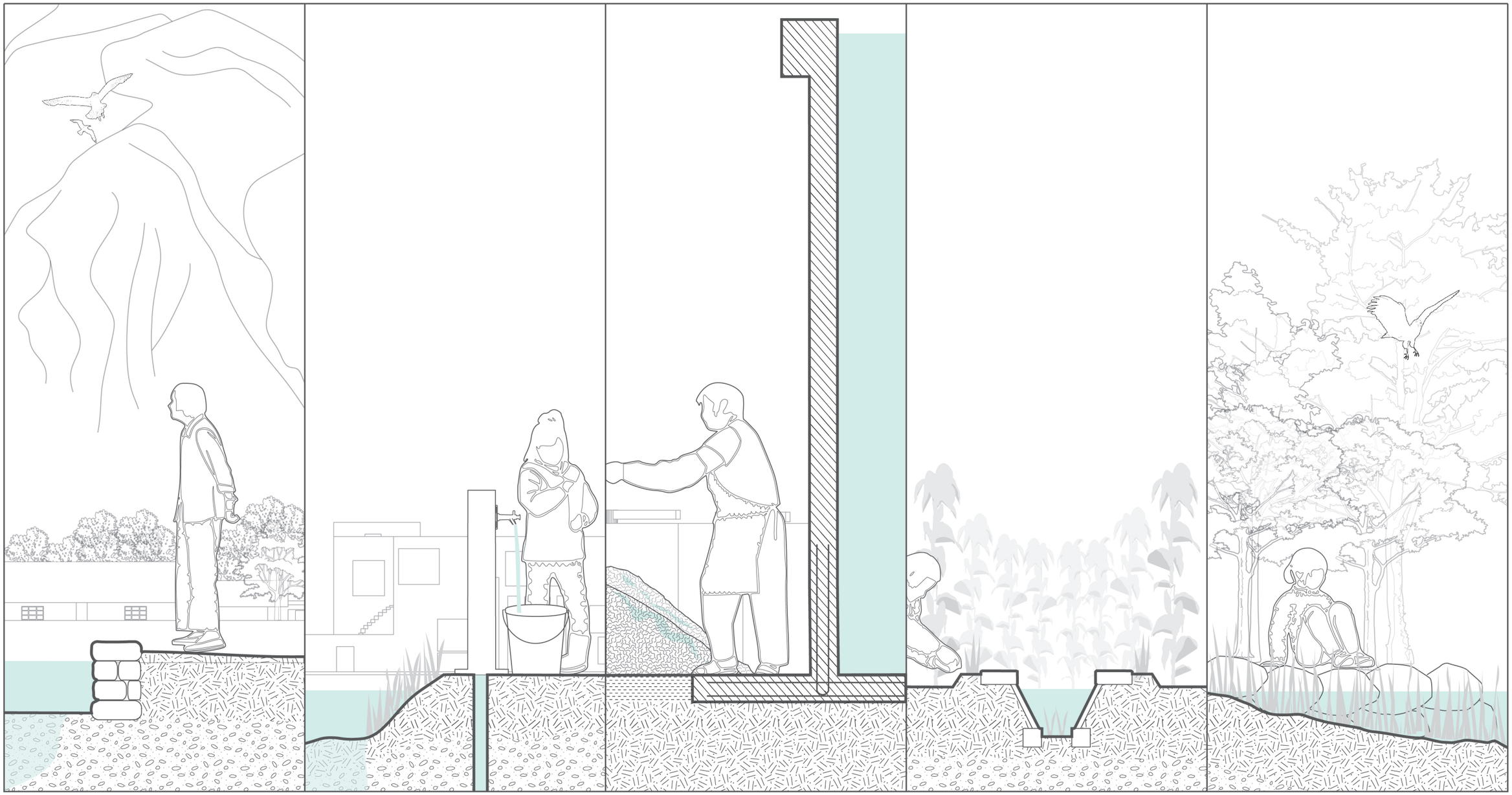
Rock Peat Soil Gravel

Scale



Goal

	Environmental	**Social**
Urban river bank-*Public water intake*	Flood risk resilience strategy	More convenient access to water New gathering points
Water treatment plant	Water purification	Maximum use of waste water Education and recreation
Shared garden	Further purification of water Soil fertility	Food self-sufficiency and diversity Community cooperation
Flood park	Further purification of water Flood risk resilience strategy	Education and recreation
Ponds	Recharge the aquifer	Water self-sufficiency in the dry season
Chillón-Rímac-Lurín basin	**Increase in green space** **Increase resilience to flooding**	**Alleviate the water crisis**

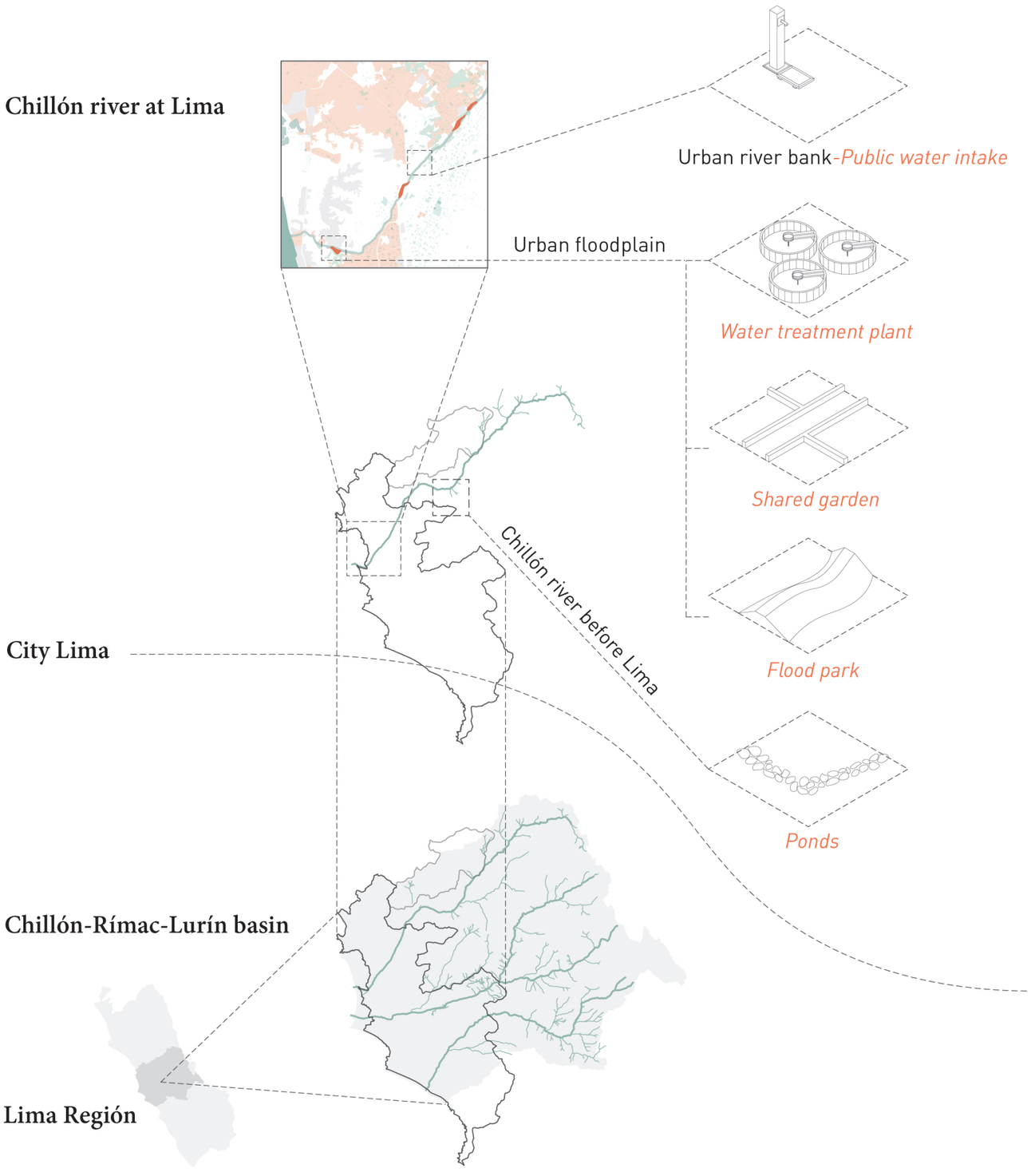


Diversified means of water access and use

Soil Concrete Gravel

Scale

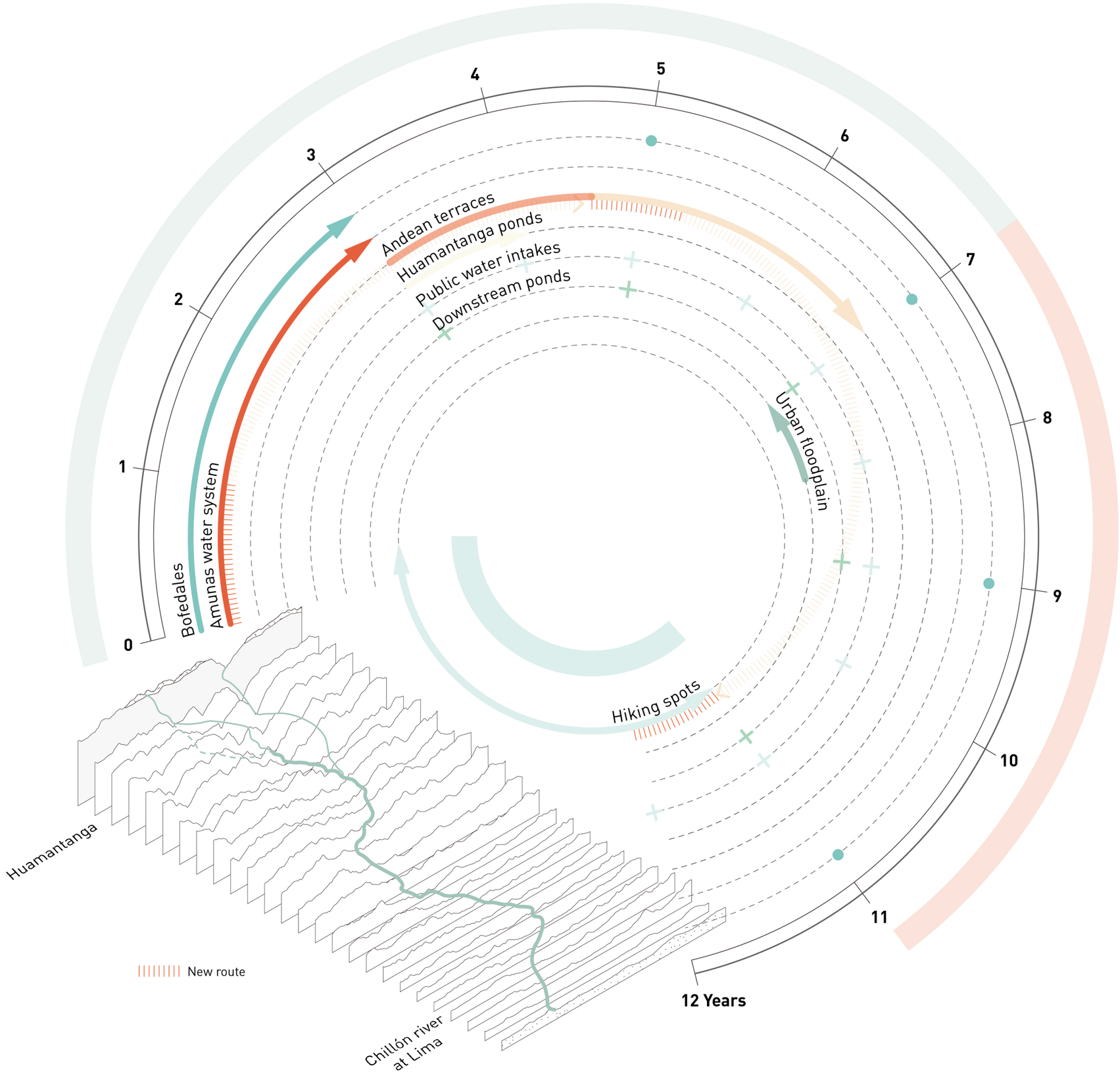
Goal

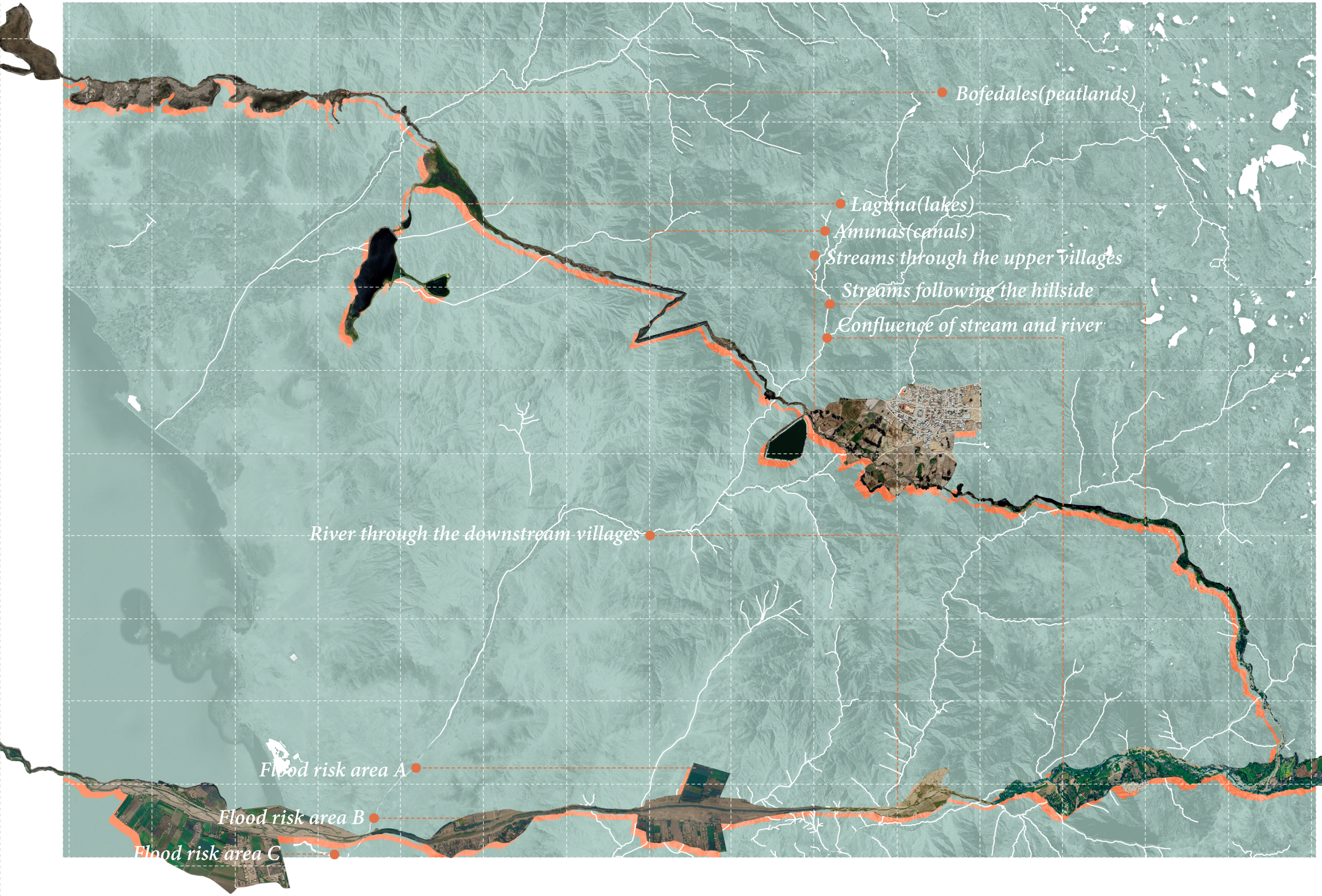


	Environmental	Social
Chillón river at Lima	Flood risk resilience strategy	More convenient access to water New gathering points
Urban river bank-*Public water intake*		
Urban floodplain		
Water treatment plant	Water purification	Maximum use of waste water Education and recreation
Shared garden	Further purification of water Soil fertility	Food self-sufficiency and diversity Community cooperation
Flood park	Further purification of water Flood risk resilience strategy	Education and recreation
Ponds	Recharge the aquifer	Water self-sufficiency in the dry season
City Lima	**Increase in green space** **Increase resilience to flooding**	**Alleviate the water crisis**
Chillón-Rímac-Lurín basin	**Recharge the aquifer** **Balance river flow**	**Public awareness of water** **Regional cooperation**
Lima Región		

Stages:

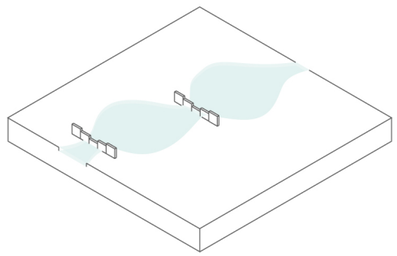
- Sowing and Harvesting
- Regaining and Retaining
- Circularity and Win-win



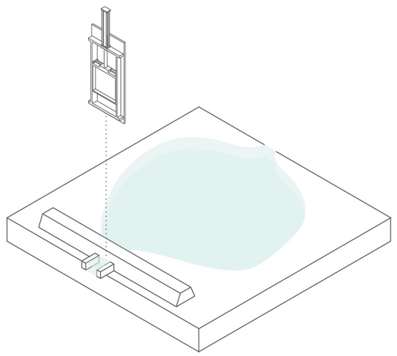

Bofedales(peatlands)
Laguna(lakes)
Amunas(canals)
Streams through the upper villages
Streams following the hillside
Confluence of stream and river
River through the downstream villages
Flood risk area A
Flood risk area B
Flood risk area C

Water design

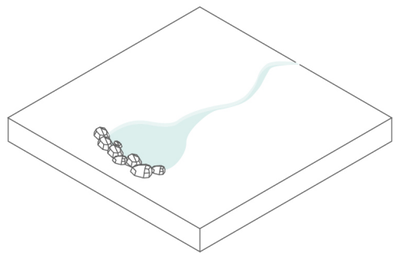
Storing/Slowing down water



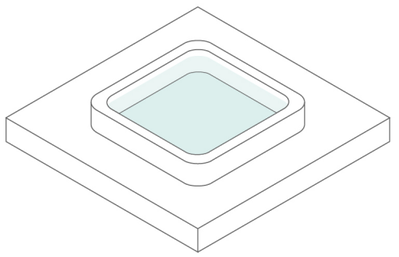
Baffle



Dam with sluice

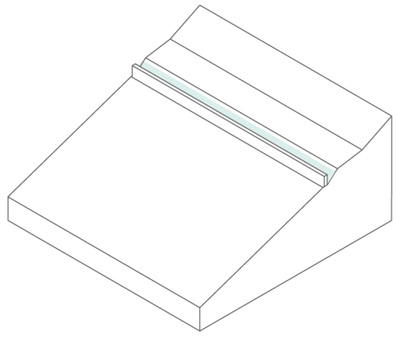


Stone barrier

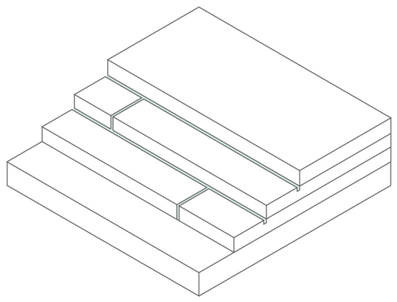


Pond

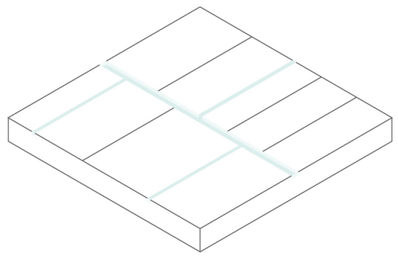
Guiding water



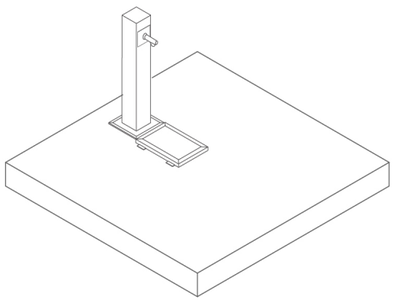
Canal



Ditches on the terrace

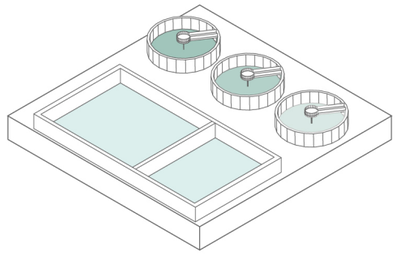


Ditches on the farmland

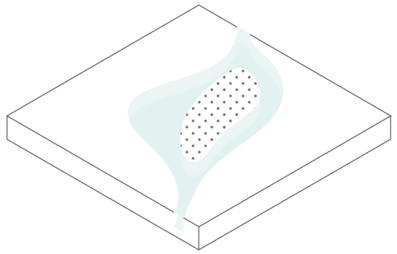


Water intake

Purifying water

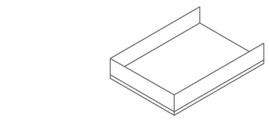


Water treatment plant

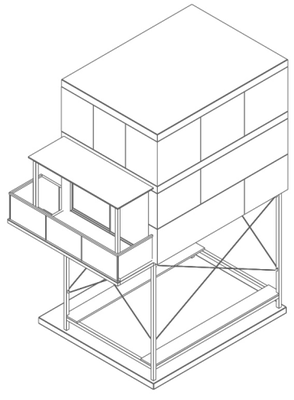


Wetland

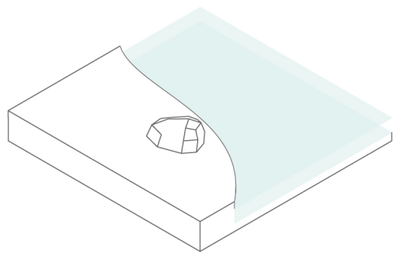
Experiencing water



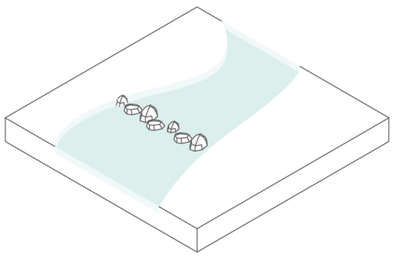
Viewing platform



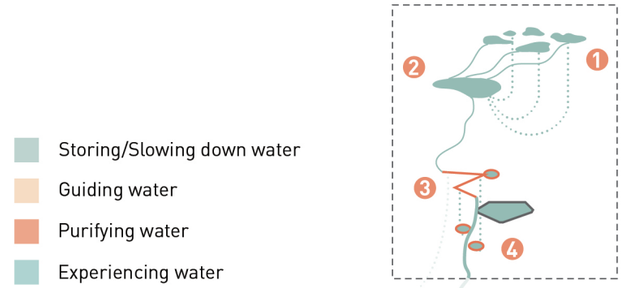
Viewing tower

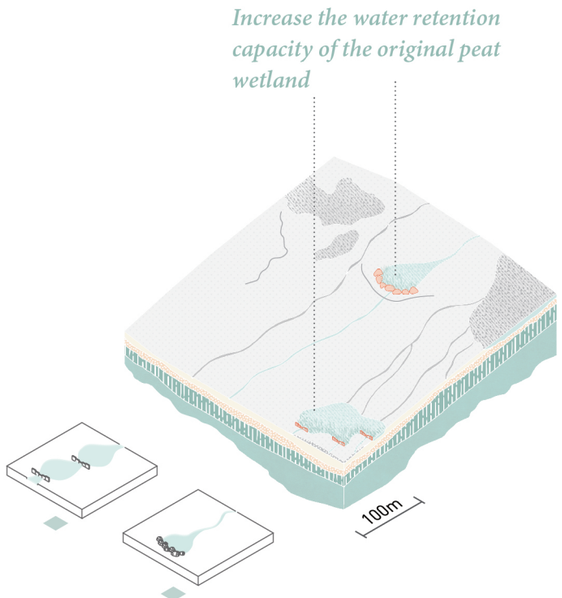


Viewing stone

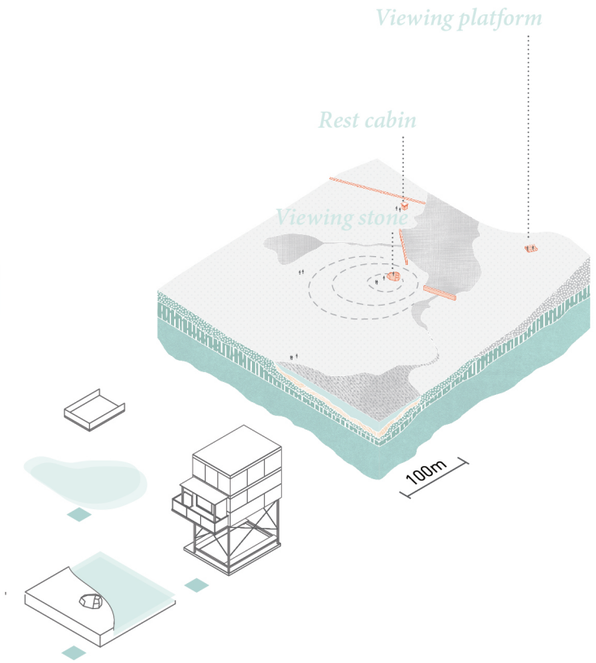


Stone bridge

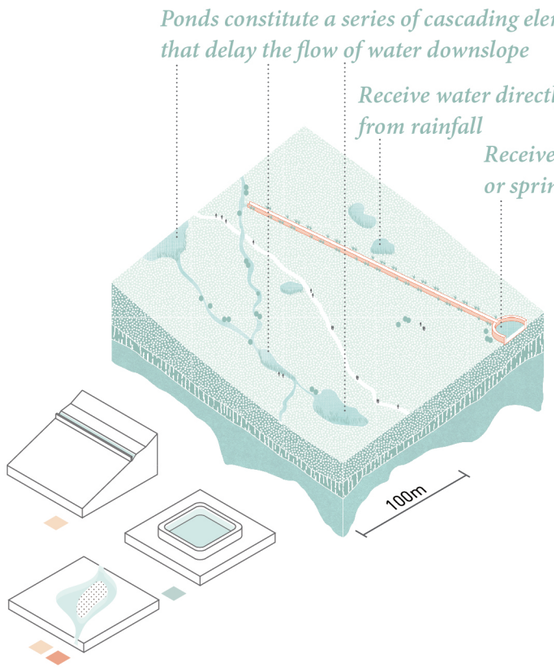




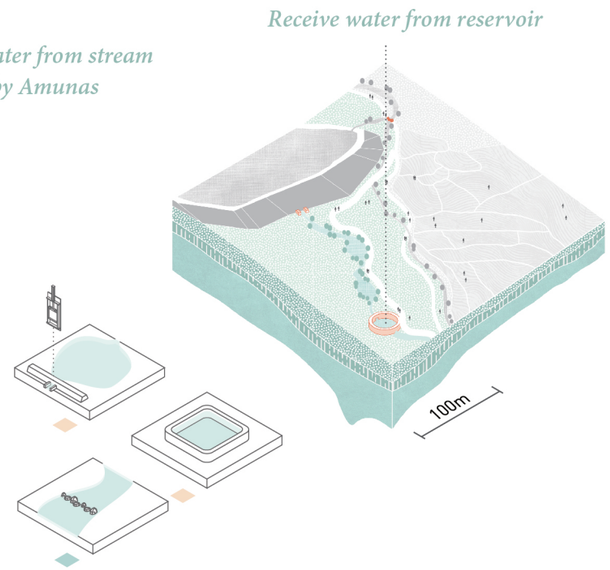
1 Highland bofedales



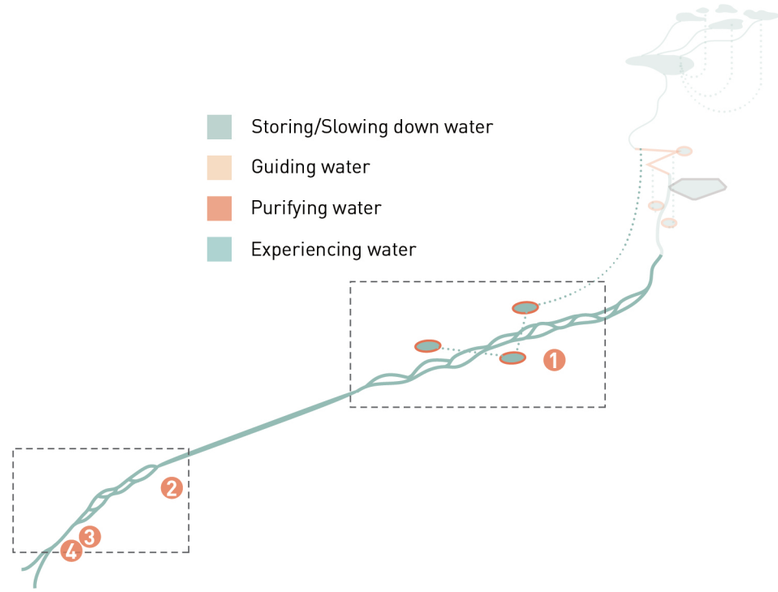
2 Hiking terminal lake

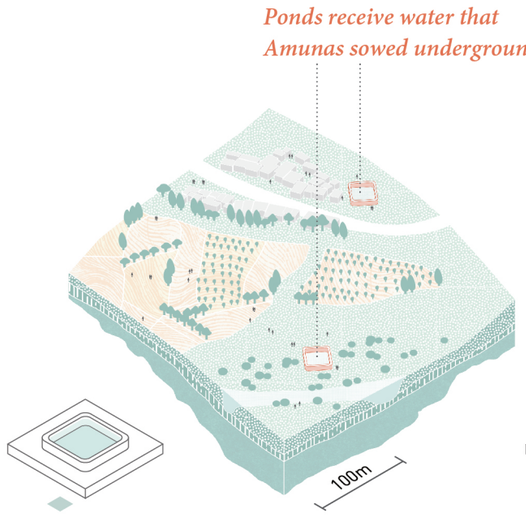


3 Restored Amunas on the hillside

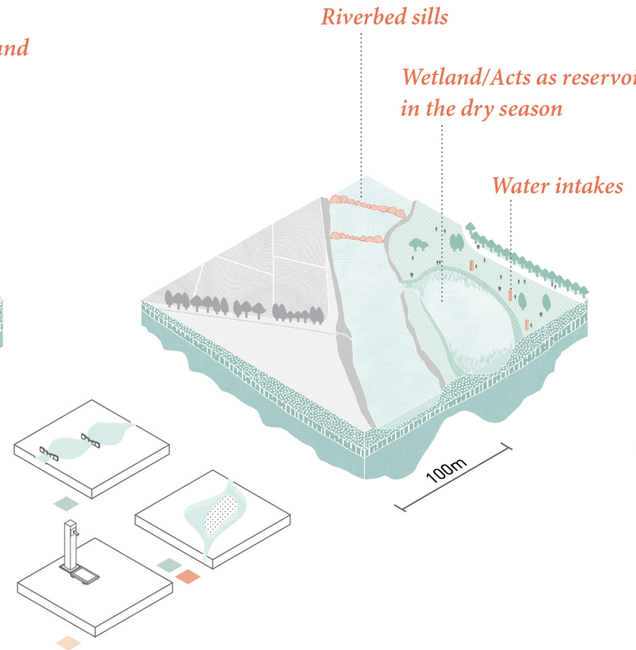


4 New ponds in Huamantanga

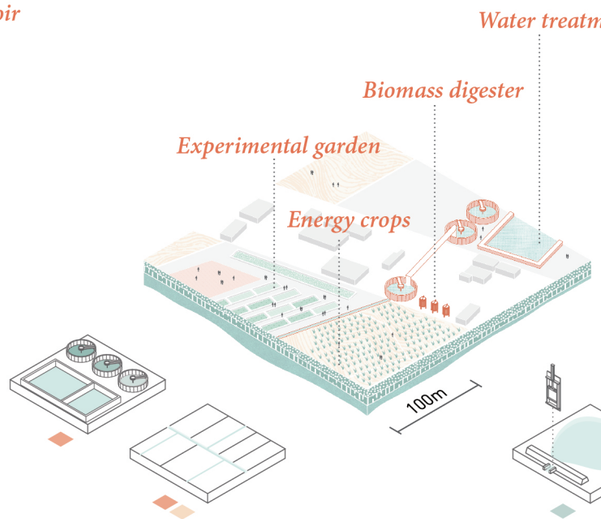




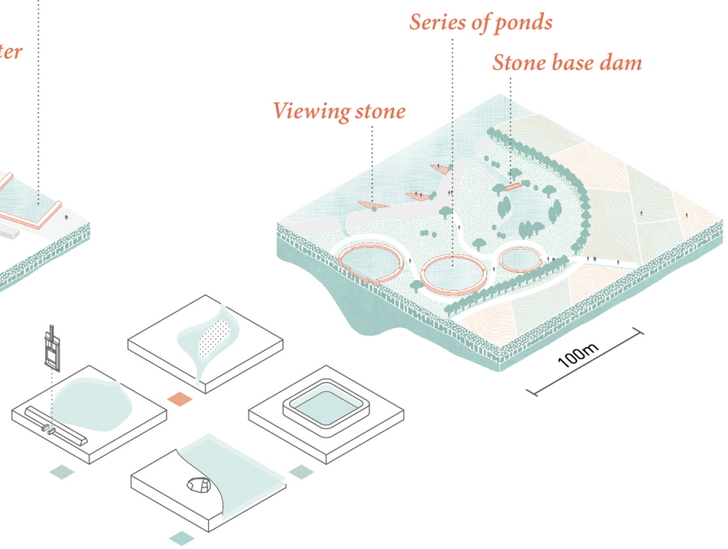
1 New ponds in downstream villages



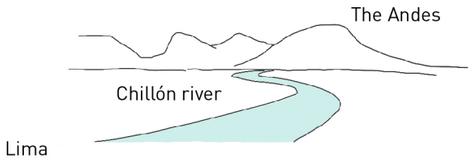
2 Wetlands in urban flood risk areas



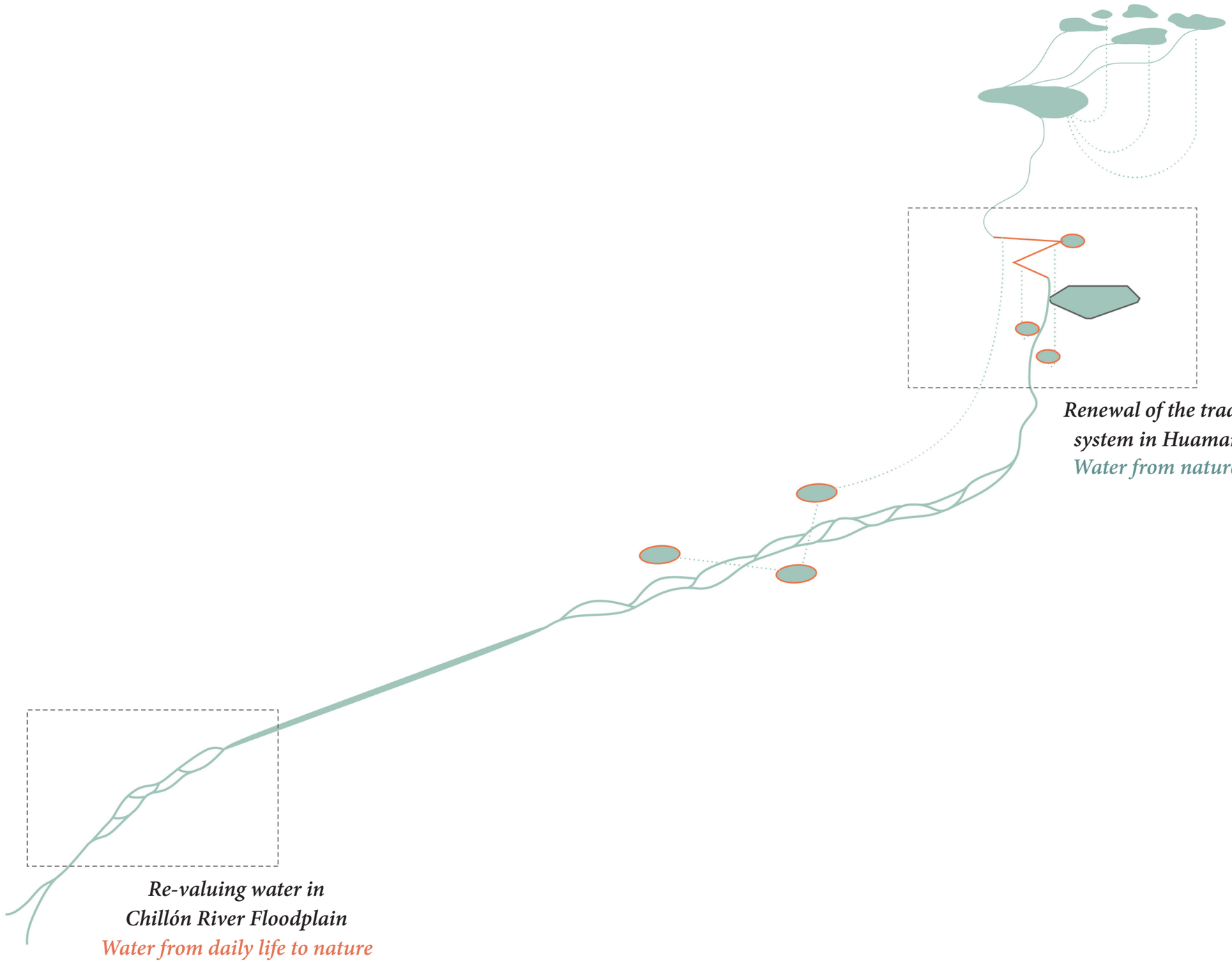
3 Wastewater treatment plant & Shared farm



4 Urban floodplain

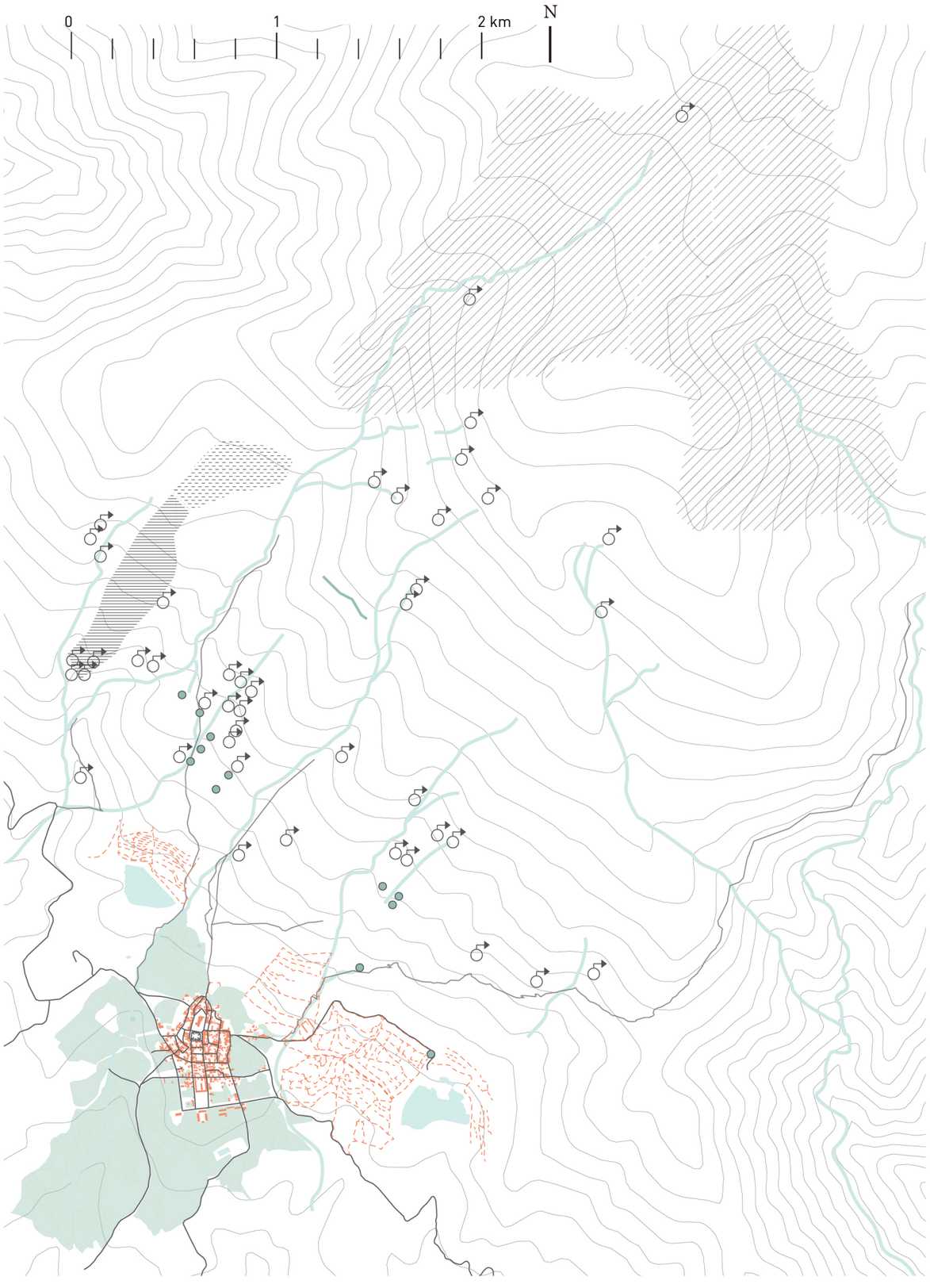

The Andes
Chillón river
Lima

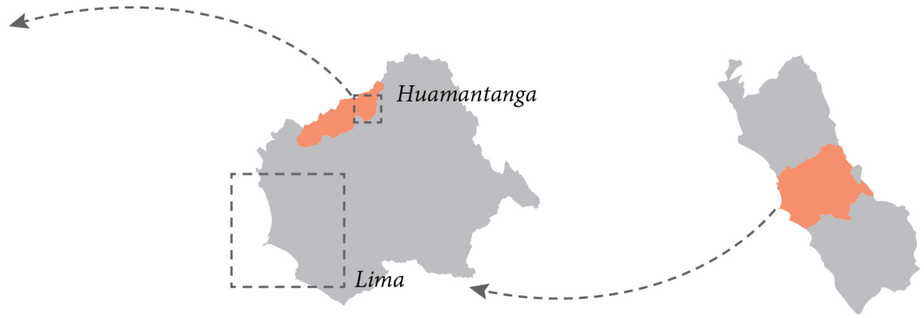
Peatland restoration
Restored Amunas
New ponds in upstream town
New ponds in downstream towns
Balanced water flow



Renewal of the traditional water system in Huamantanga town
Water from nature to daily life

Re-valuing water in Chillón River Floodplain
Water from daily life to nature

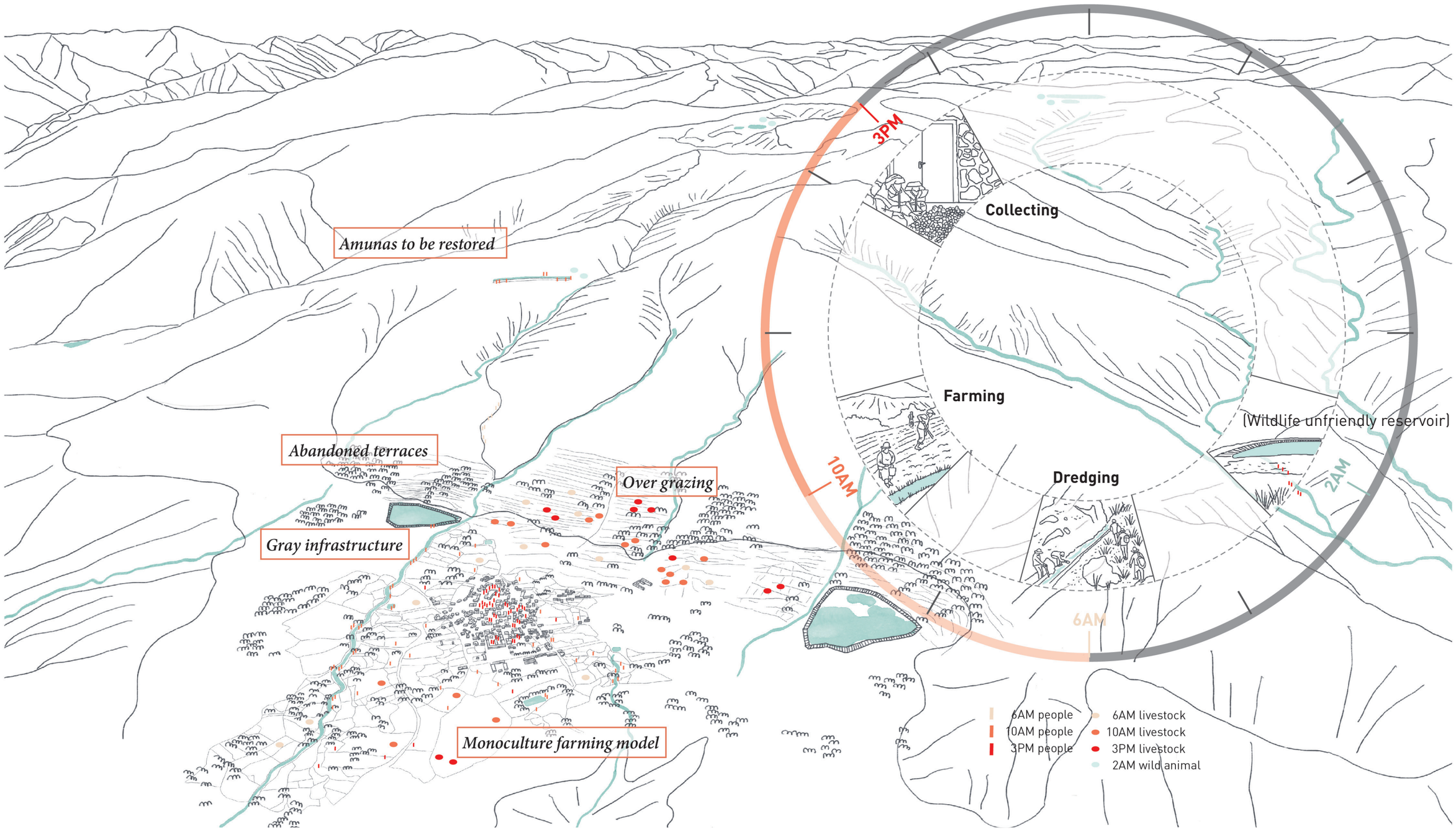


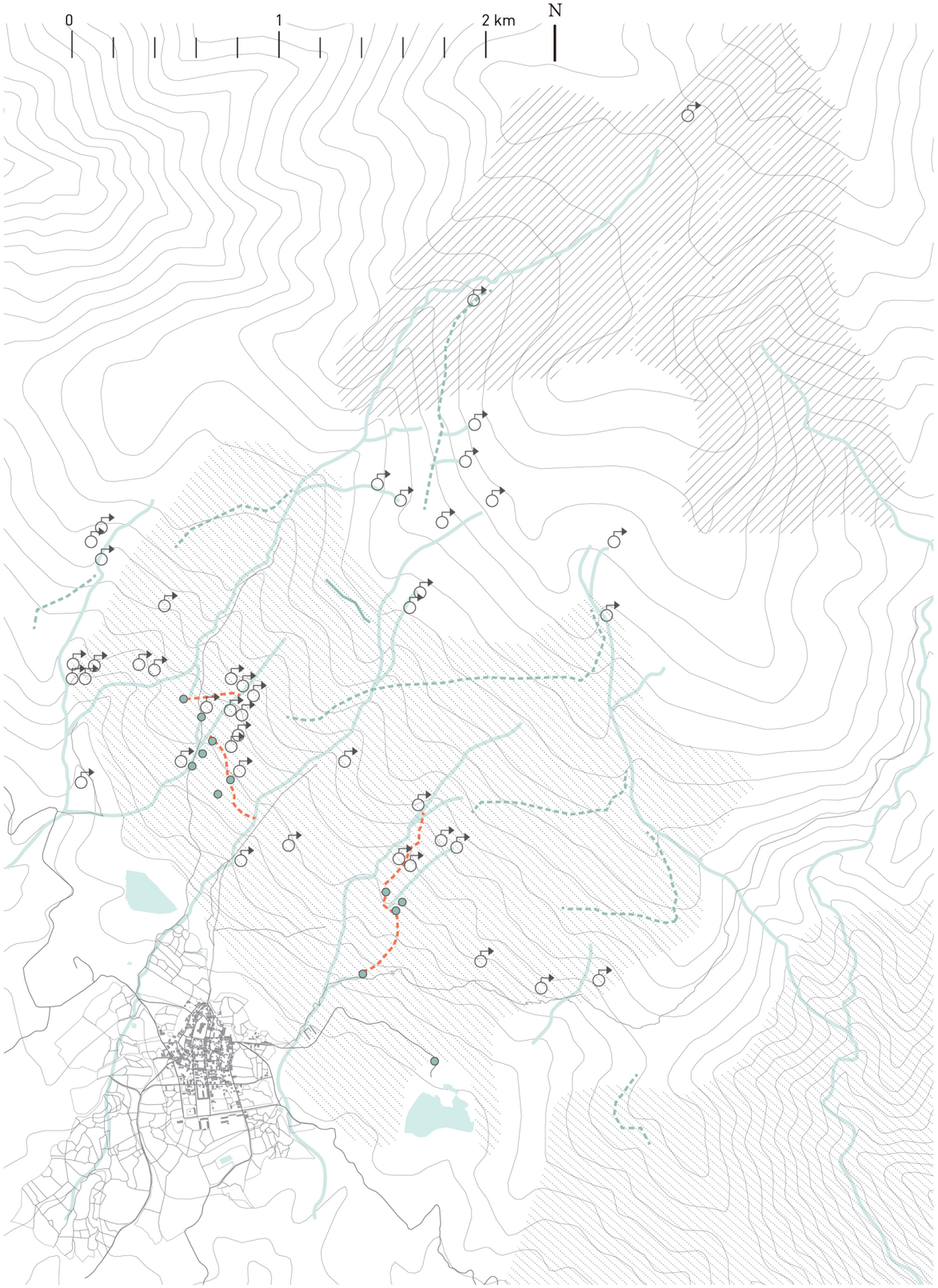


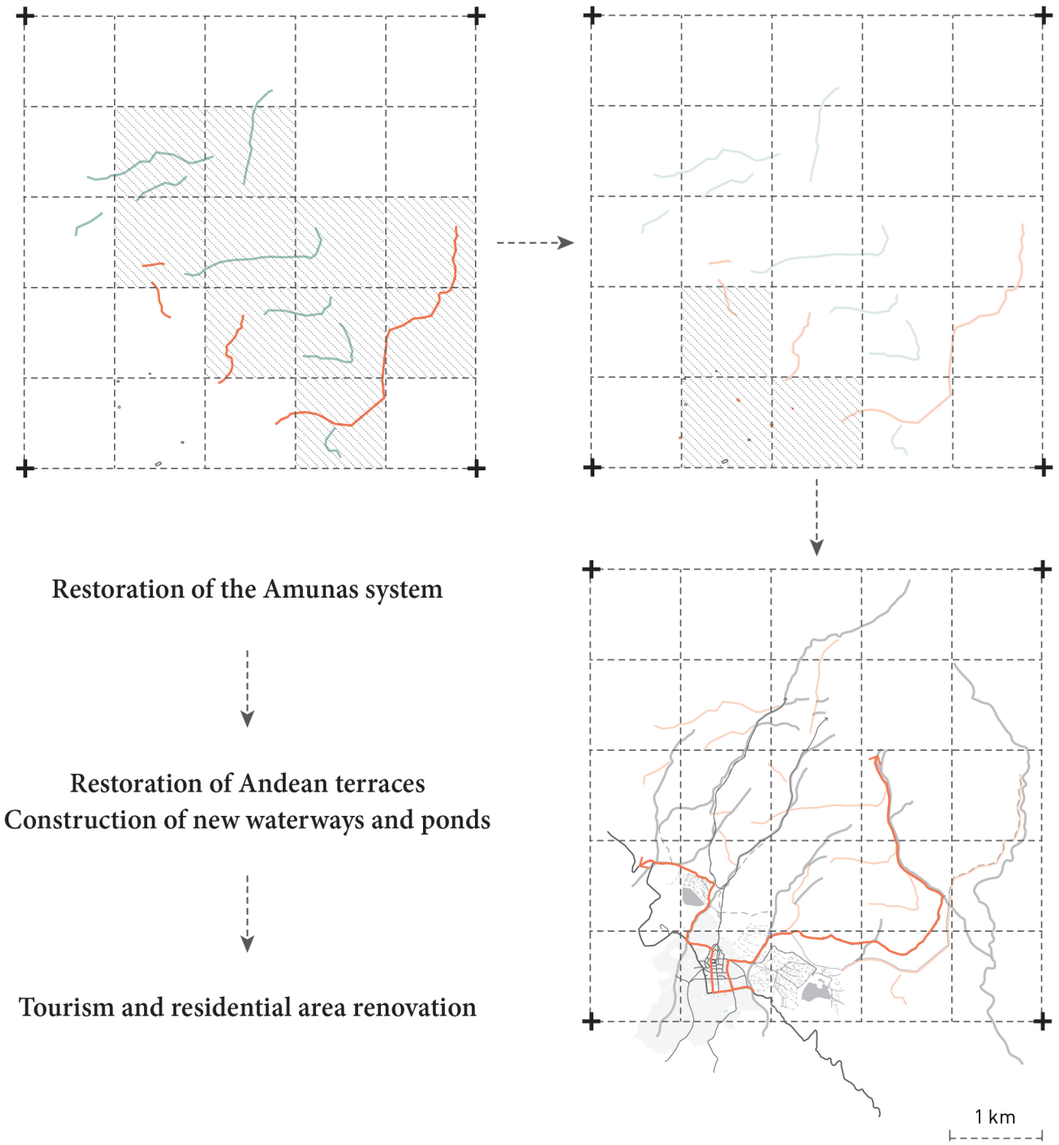
Catchments
Infiltration area
Percolation area

Stream
Road
Route trace
Amunas infiltration canal
Trace of terraces
Water
Residential area
Spring
Wetland

December 2022, wet season







Infiltration canal to be restored
Diversion canal to be restored
Catchments
Infiltration area
Stream
Road
Route trace
Amunas infiltration canal
Water
Residential area
Spring
Wetland

Changes in pond water level in Huamantanga

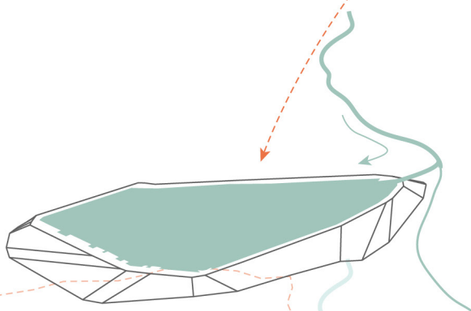
Volume of water

	a.	b.	c.	d.	e.
April 2021	○	●	○	◐	●
September 2020	●	◐	○	○	●
July 2019	●	◐	●	◐	●
June 2017	●	○	●	●	●
August 2016	●	○	○	○	●
May 2016	○	○	●	○	●
April 2016	●	◐	●	○	●
June 2014	●	○	○	○	●
June 2012	○	○	○	○	●
April 2010	●	●	●	●	●

The first Amunas started to restore

2015

Two new water reservoirs started to be built



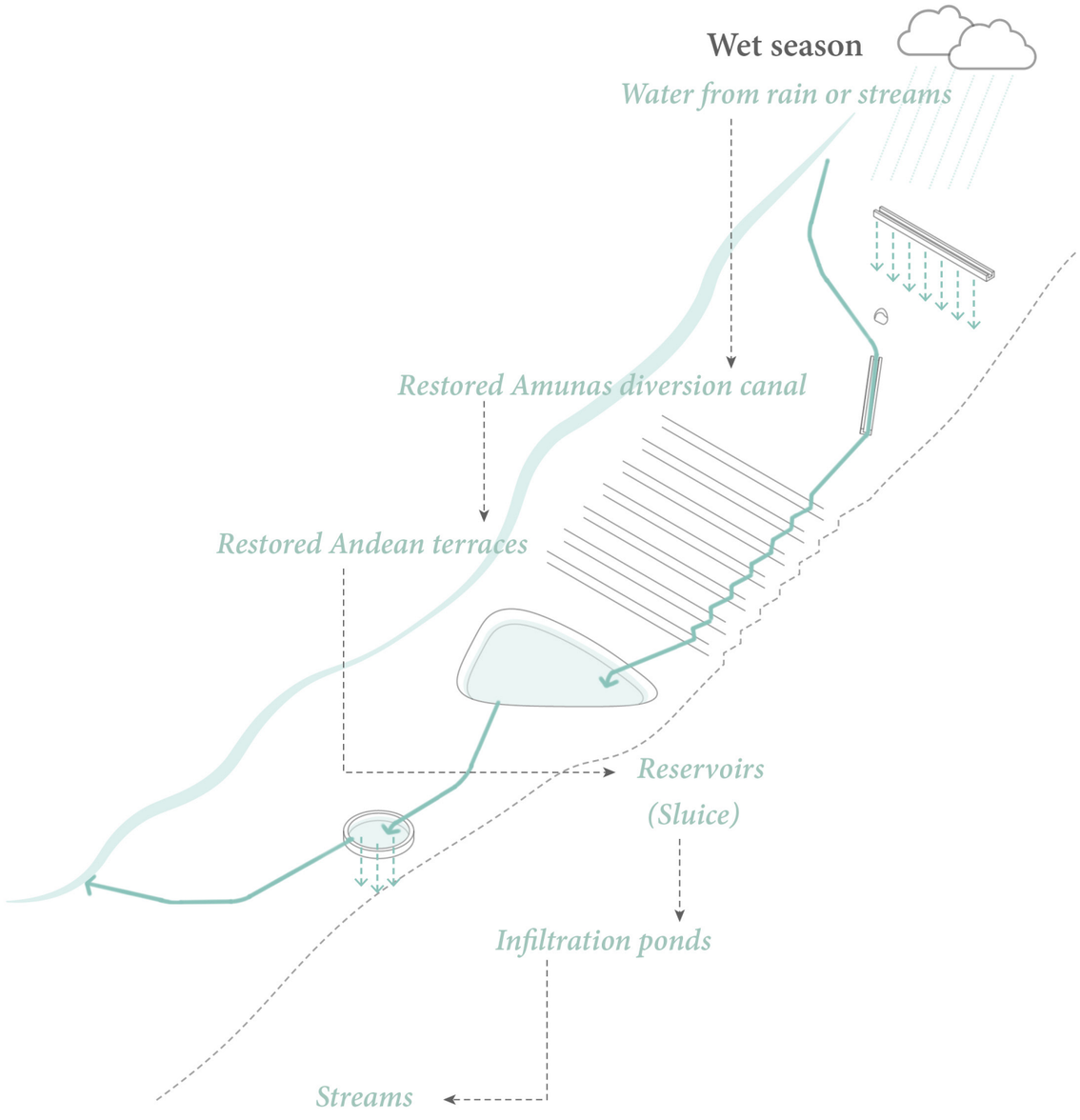
New ponds in Huamantanga

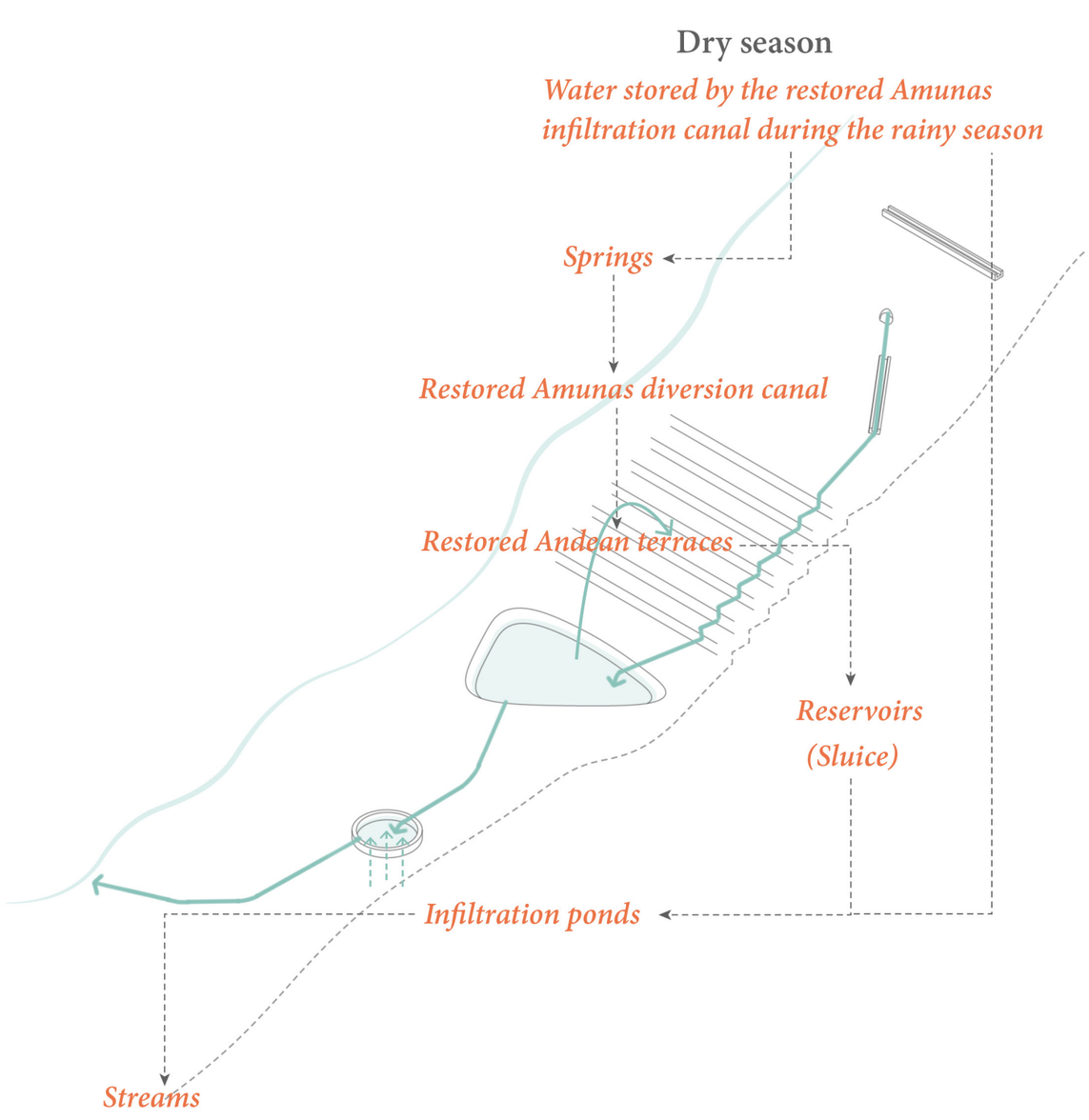
- Water
- Restored infiltration canal
- Restored diversion canal
- Existing pond
- New pond
- Sluice
- Spring
- Wetland

Get water from...

- Reservoir
- Stream
- Underground

0 250 500 m N


Wet season
Water from rain or streams
Restored Amunas diversion canal
Restored Andean terraces
Reservoirs
(Sluice)
Infiltration ponds
Streams


Dry season
Water stored by the restored Amunas
infiltration canal during the rainy season
Springs
Restored Amunas diversion canal
Restored Andean terraces
Reservoirs
(Sluice)
Infiltration ponds
Streams

Masterplan

- Water
- Restored infiltration canal
- Restored diversion canal
- Existing pond
- New pond
- Sluice
- Spring
- Wetland
- New pastures
- Warehouse

Trees along the new waterway:

· Highlight the waterway
· New walking space

Reforestation:

· Reduced soil compaction
· Improving groundwater infiltration capacity

New animal captivity option:

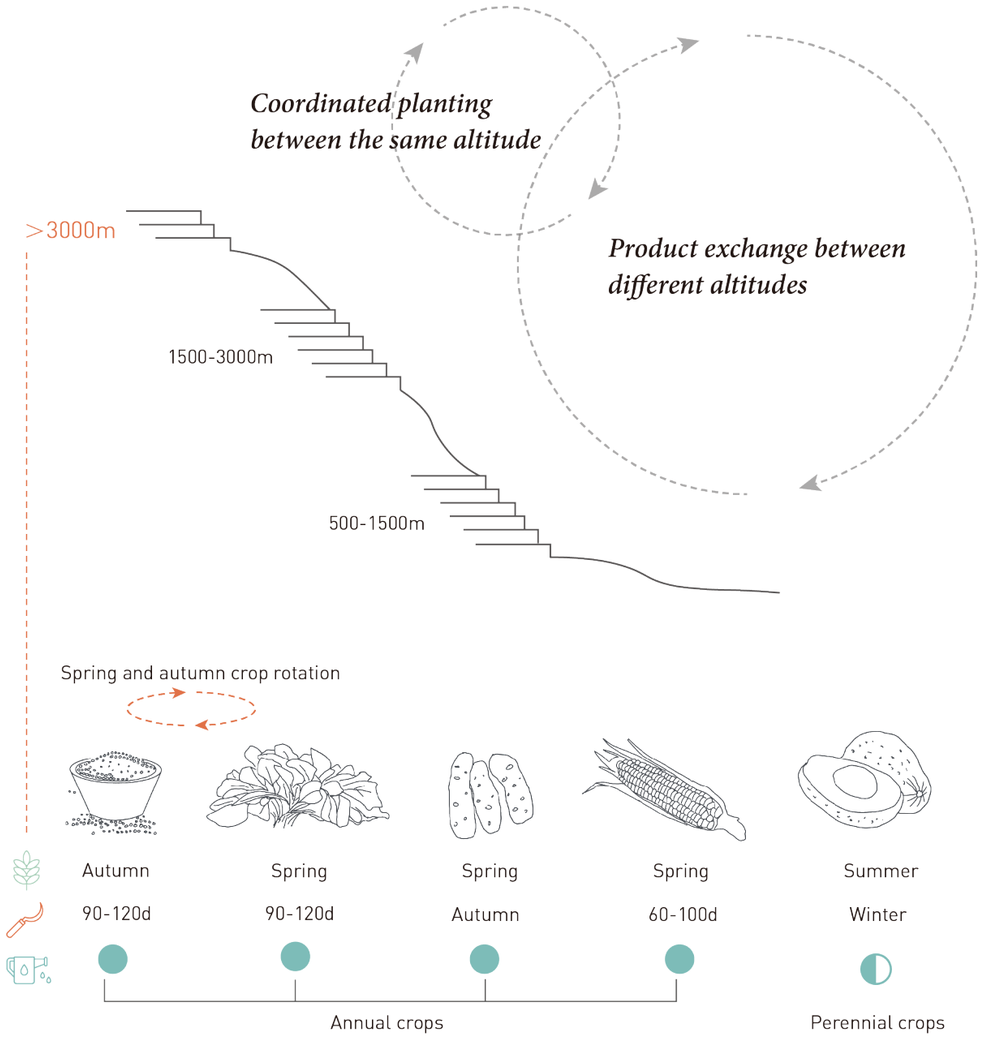
· Protection of hillside vegetation and soil
· Protection of streams
· Convenient for people to make handicrafts

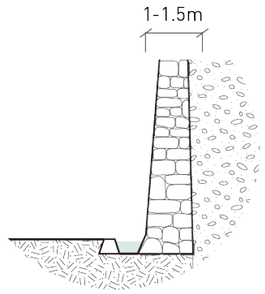
Column of trees:

· Fence to keep animals out
· Prevent soil erosion
· Landmark

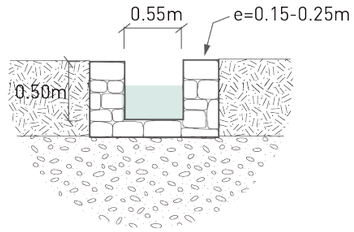
0 250 500 m N

Designed layers

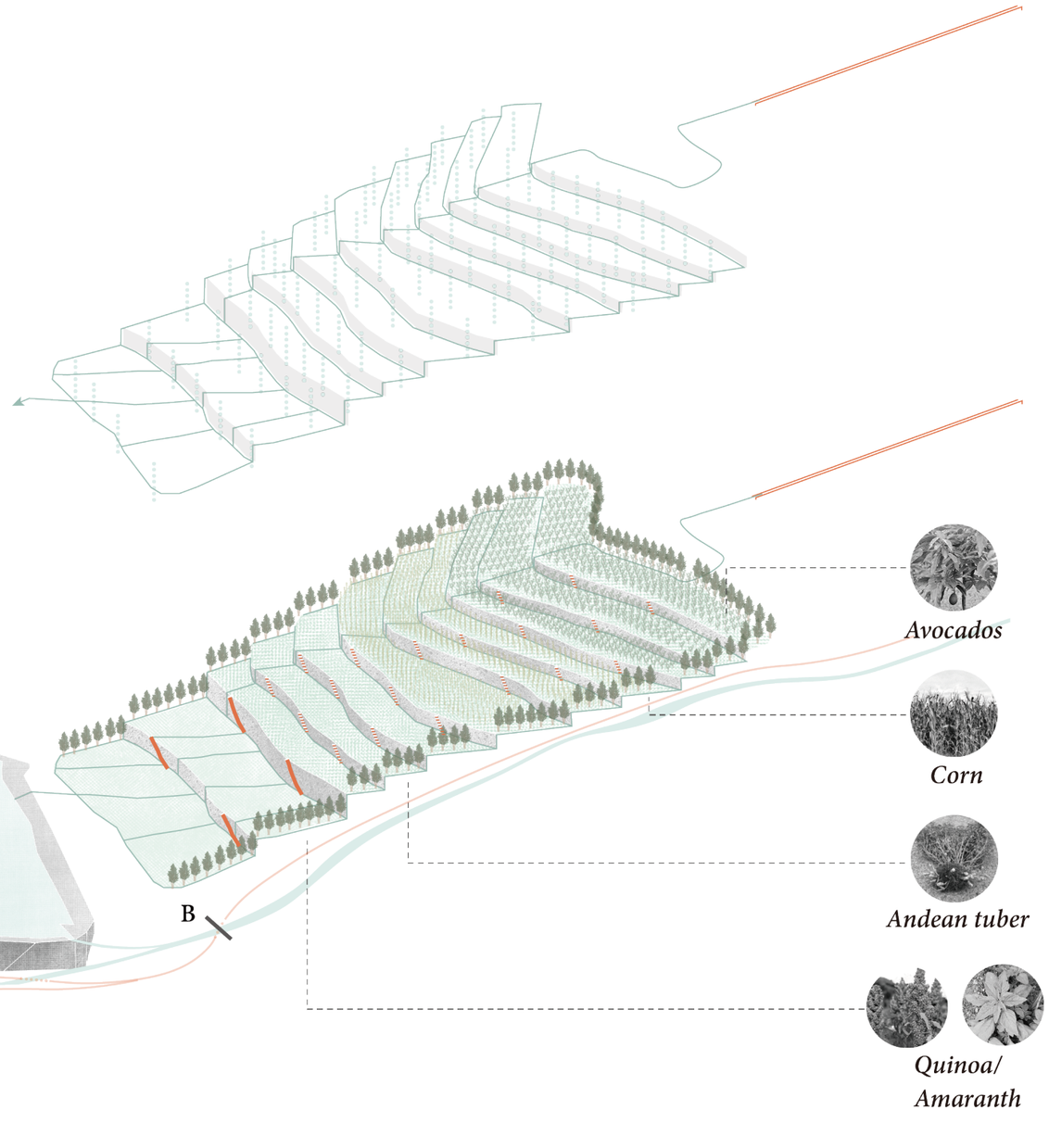




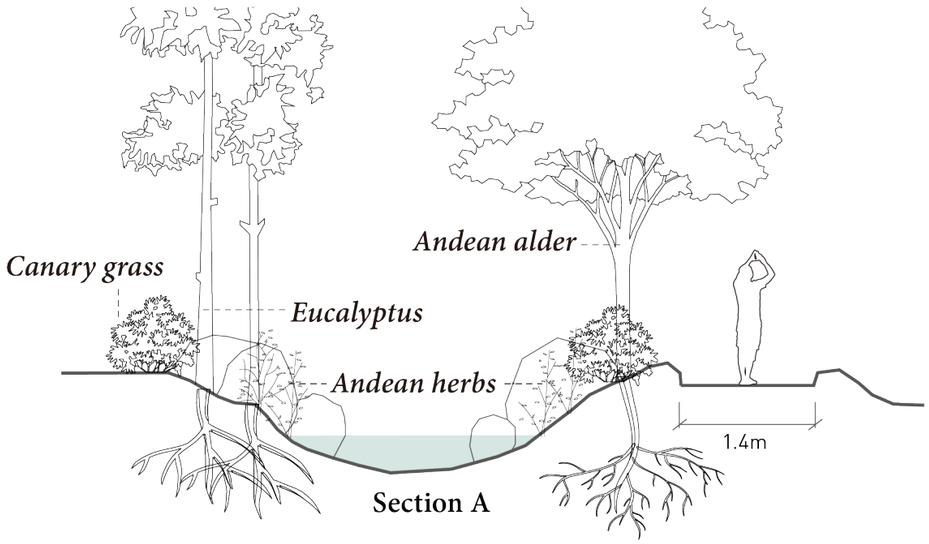
Section of ditch on the terraces



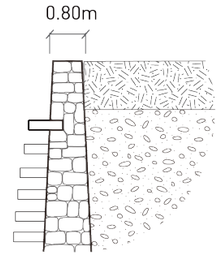
Section of Amunas canal



Designed layers



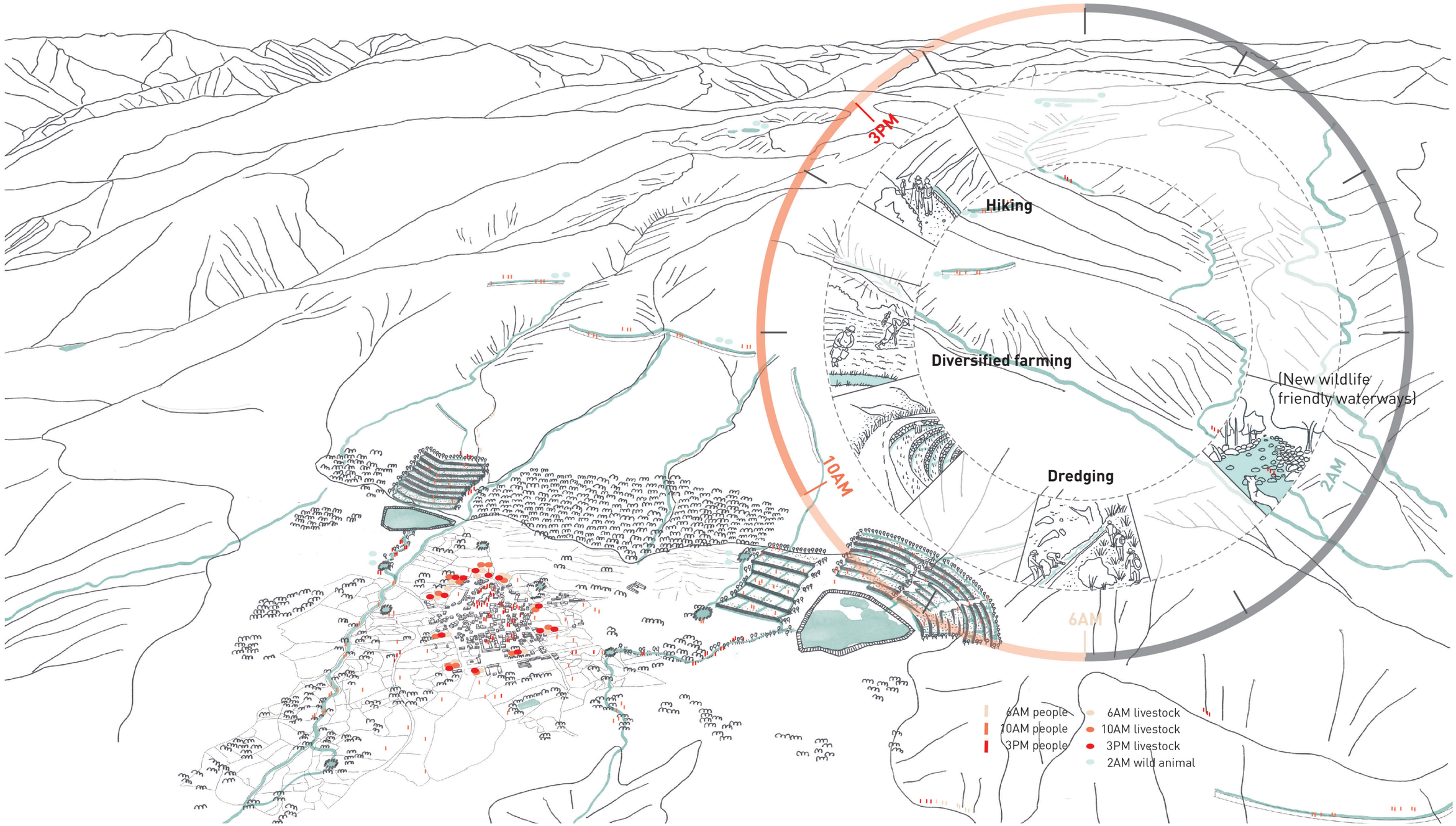
Section A



Section of stairs on terraces wall

Section B

December 2035, wet season





▲ Preparation stop
● Rest stop

Routes to restore Amunas

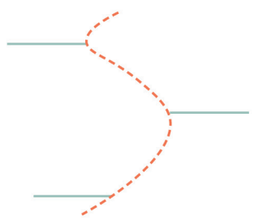


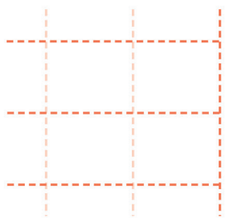
Routes for terrace farming

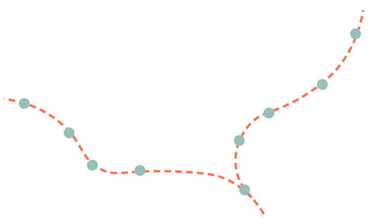


A For visiting
B For hiking

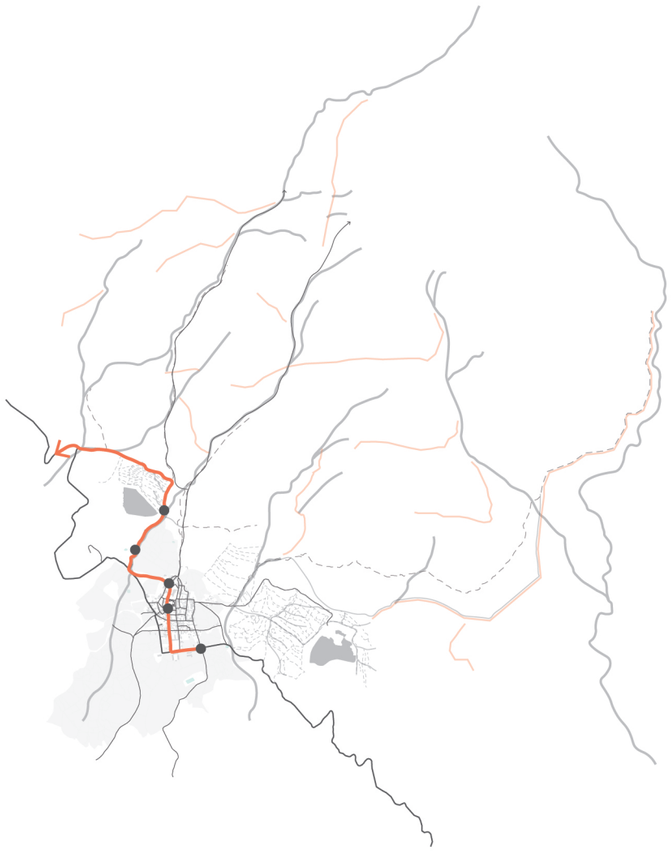
Routes for visiting and hiking

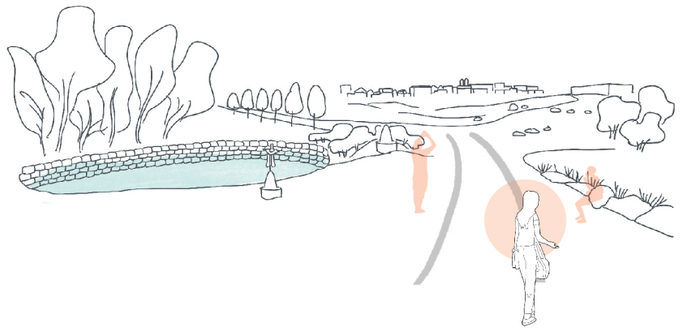






Visiting route in 2035

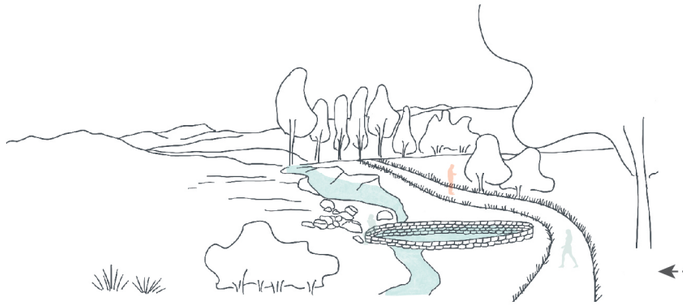




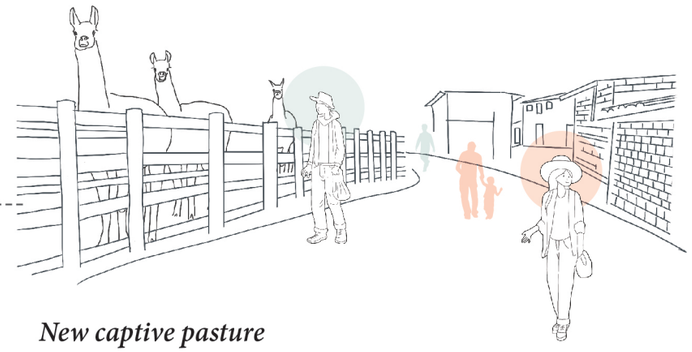
Entrance to the town



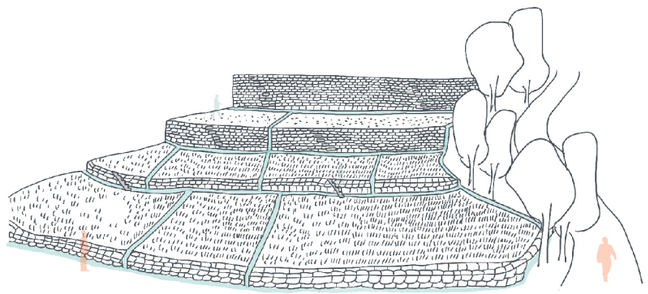
Town Center: Alpaca wool products store



Path follows the new waterway



New captive pasture



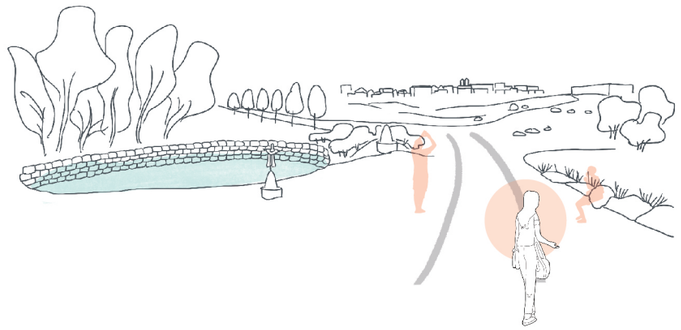
Restored terraces

Visitor

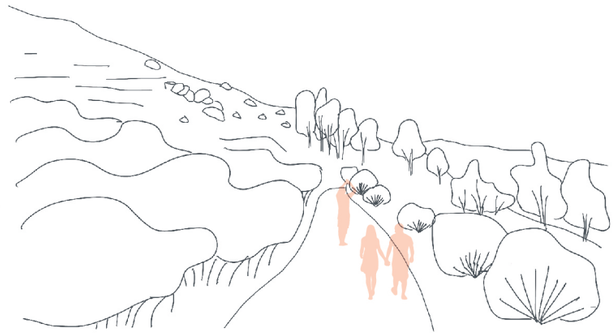
Resident

Hiking route in 2035





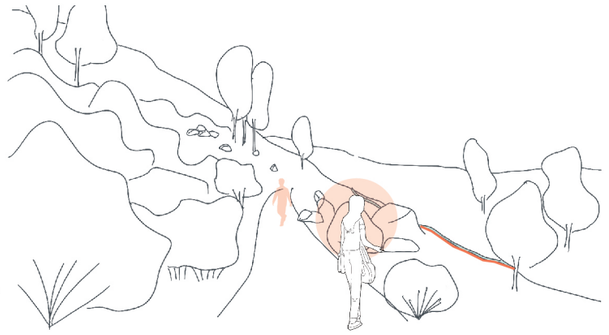
Entrance to the town



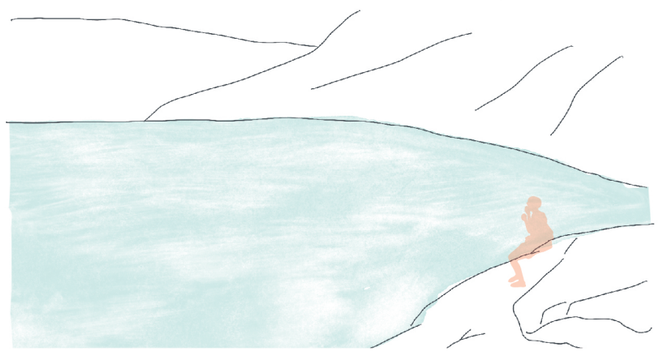
Mountain Path



Path along the Amunas



Seeing Amunas from a distance

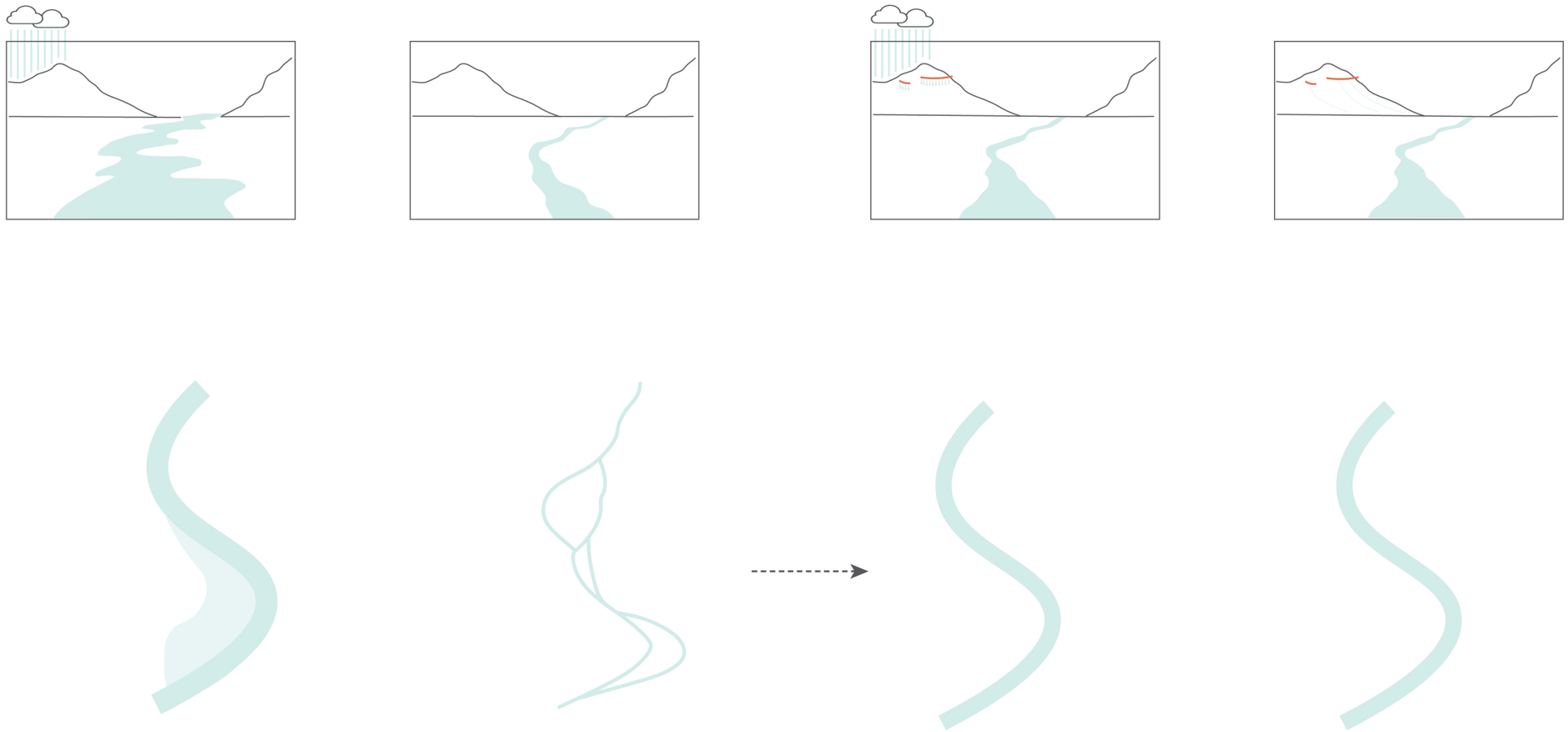


Hiking Terminal Lake

Visitor

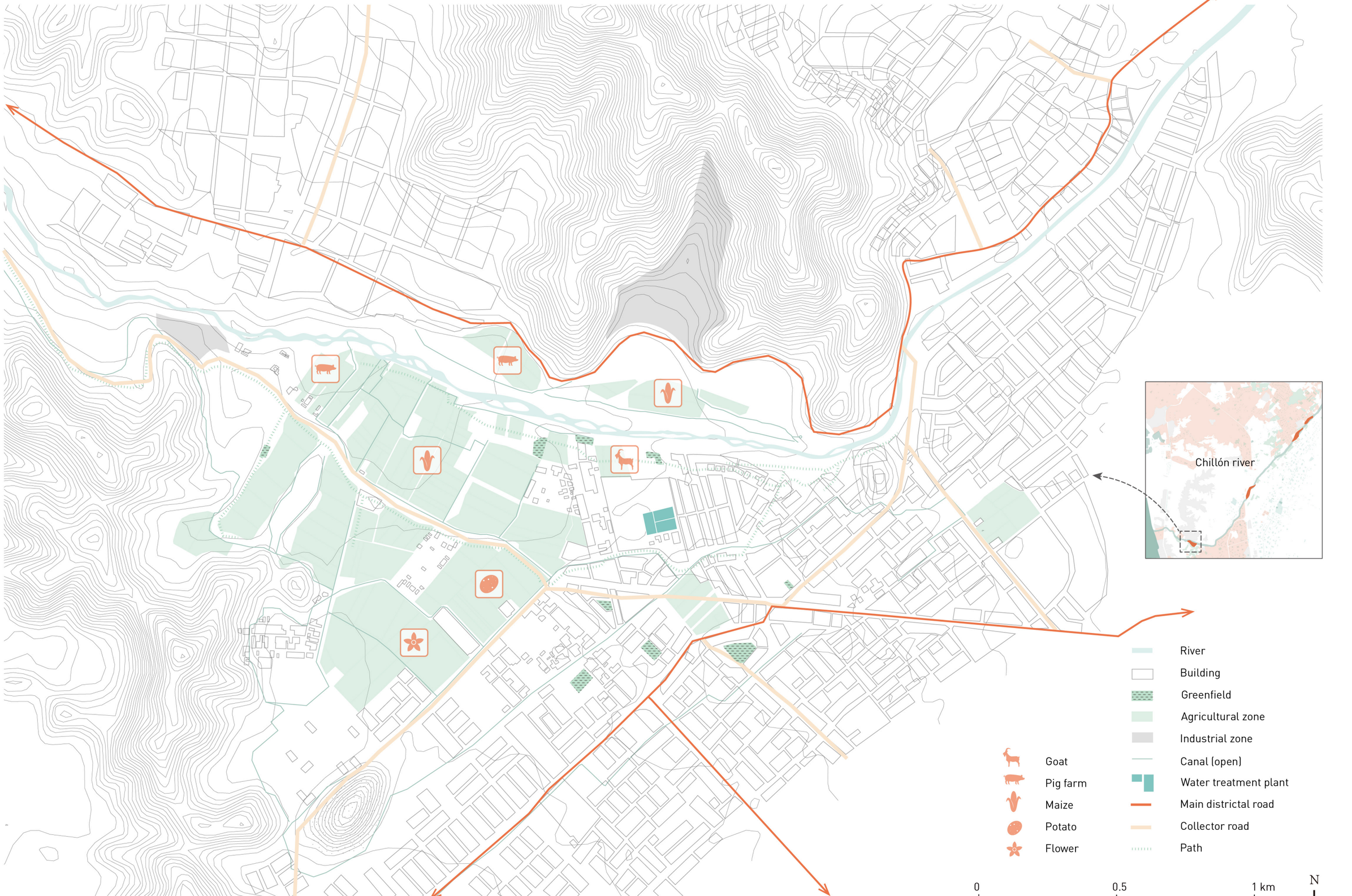
Resident

Balanced Chillón River Flow



Summer *Winter* *Summer* *Winter*

Current plan of urban floodplain



Current extreme water conditions



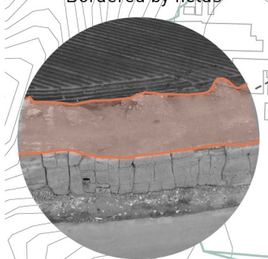
Current waterway in urban floodplain

Gray water outlet not connected to the public sewer network

Historic Flood Wall



Bordered by fields



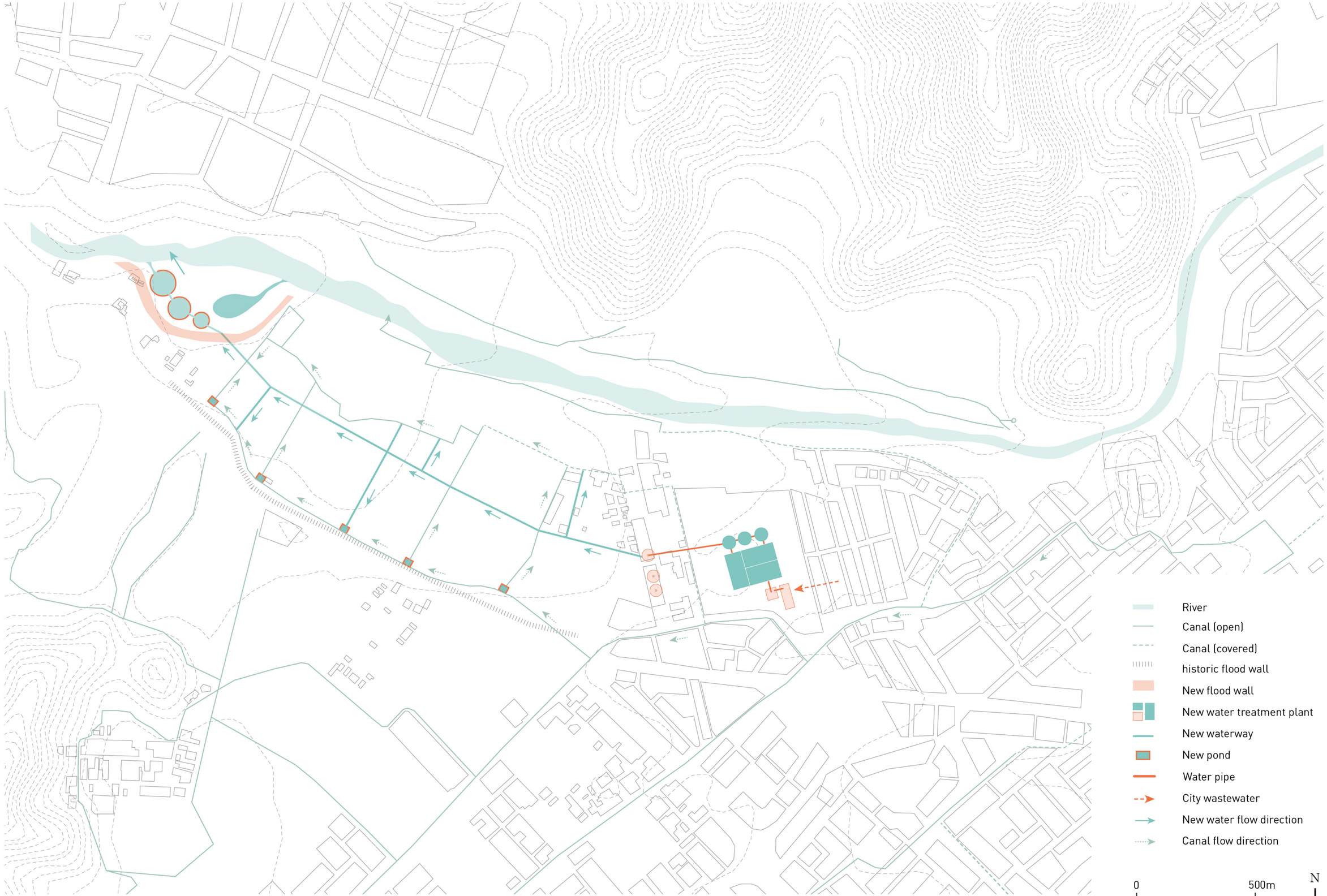
Separate wall

Irrigation canal no longer visible

River
Building
Industrial zone
Canal (open)
Canal (covered)
historic flood wall
Floodplain
Water treatment plant
Water outlet
City wastewater
Canal water outlet

0 500m N

New waterway in urban floodplain



Masterplan of urban floodplain

Tertiary purification:
new floodplain

Ecological Riverbank

Secondary purification:
shared farmland

Primary purification:
upgraded wastewater treatment plants

Biomass digestion plant

- Path
- Flower field
- Energy crops
- Experimental garden
- Existing agricultural land
- New waterway
- Canal (open)
- Canal (covered)
- historic flood wall
- New pond
- Water pipe
- Forest
- Stone beach
- Green field
- City wastewater
- New water outlet

0 200m N

Experimental garden

Water celery



Natural water purification

Kale



Spinach



Peruvian chili



Lima bean



Aquatic Watercress



Natural water purification

I see the purified sewage being used here and I feel closer to the water. This is also an opportunity for the community to increase cooperation.

Corn



Jojoba



Tequila



Biomass Digester

Energy crops provide poor communities with more economical energy opportunities, and people are willing to shift their old farming practices. New waterway provides water for farmland during the dry season.

Flower field

Dandelion



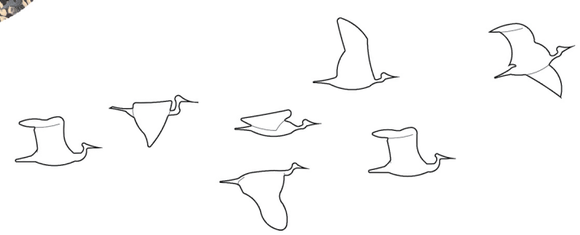
Hemerocallis

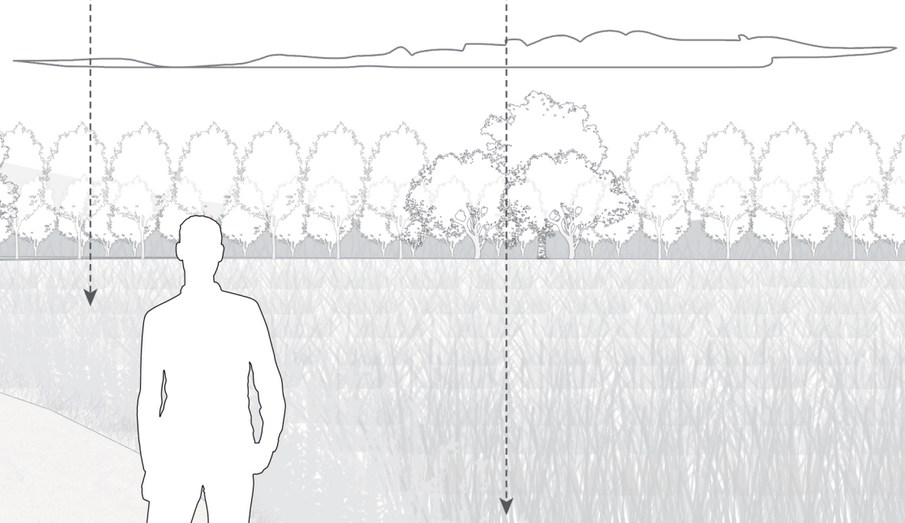


Black Eyed Susan

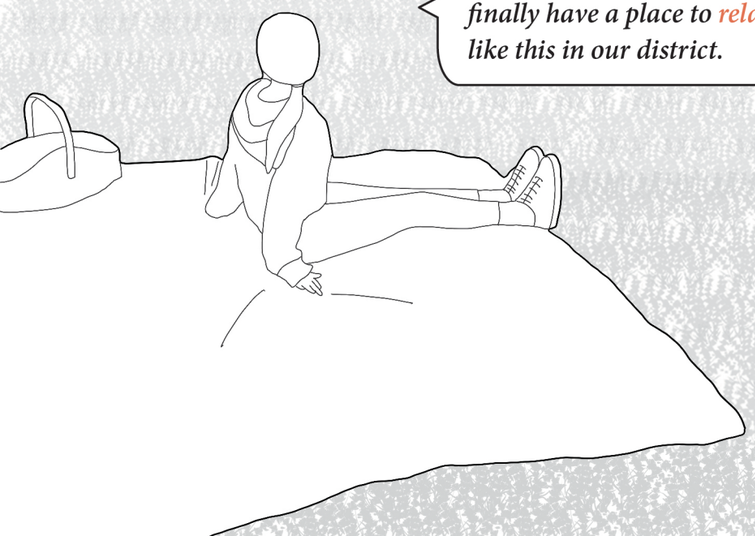




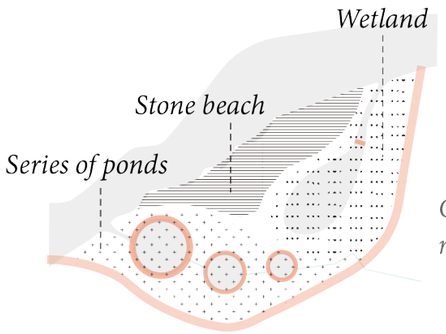




Flower fields are attractive places for me, and my family and I often come here for picnics and walks. Without going to downtown Lima, we finally have a place to relax like this in our district.

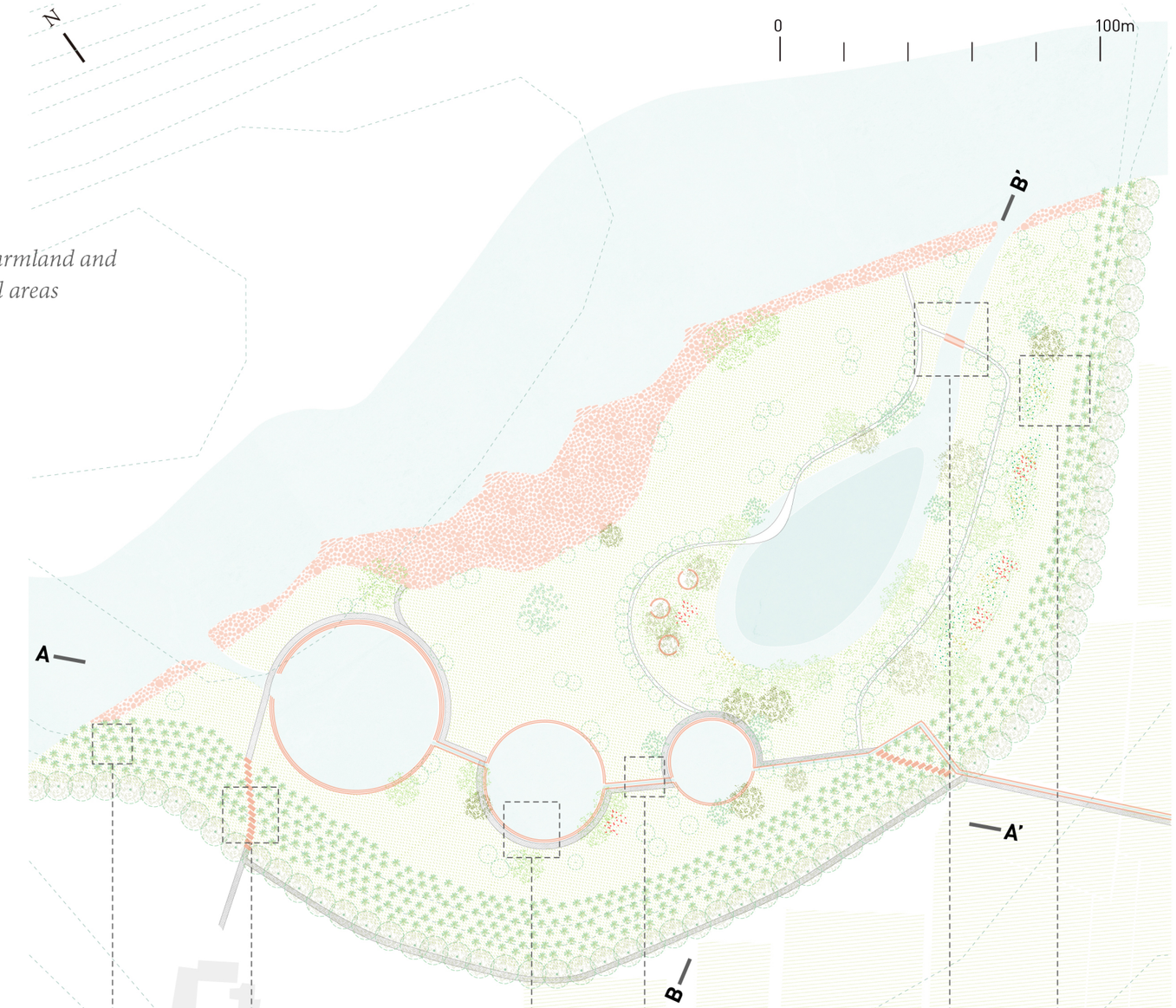


Detailed plan



Current farmland and residential areas

Zoning Diagram



Materially



Andean grass



Steps on terrace wall



Qochas



Amunas



Qochas



Andean herb



Section A-A'



Section B-B'

Detailed design: A



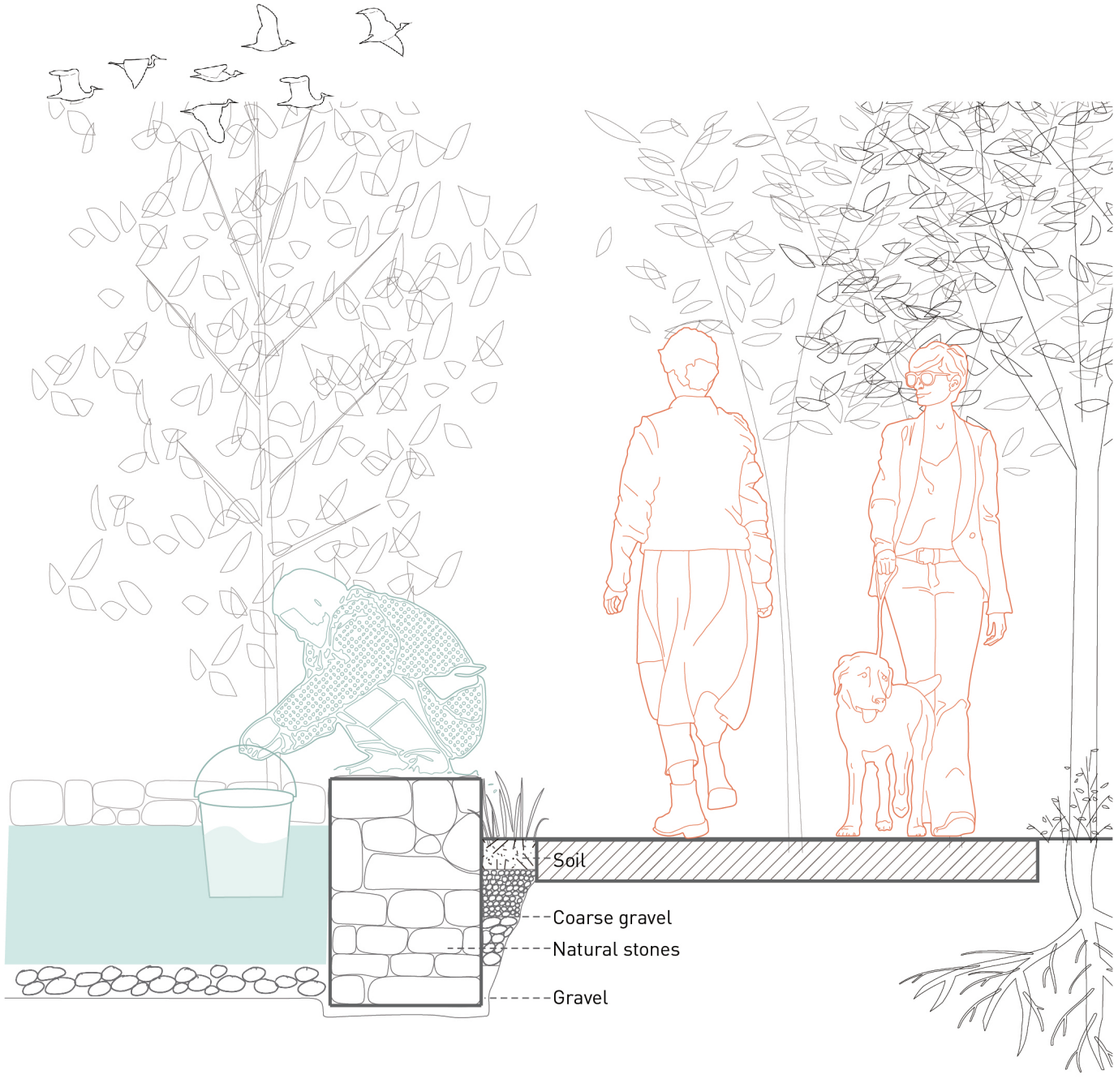
Atmosphere
Quiet and shaded

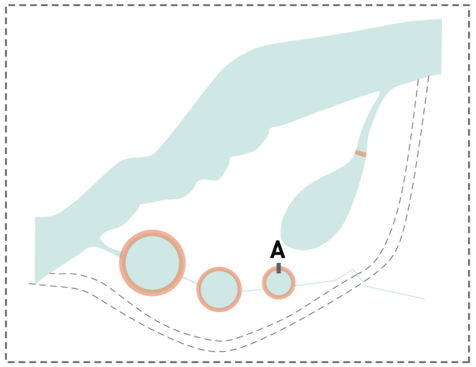


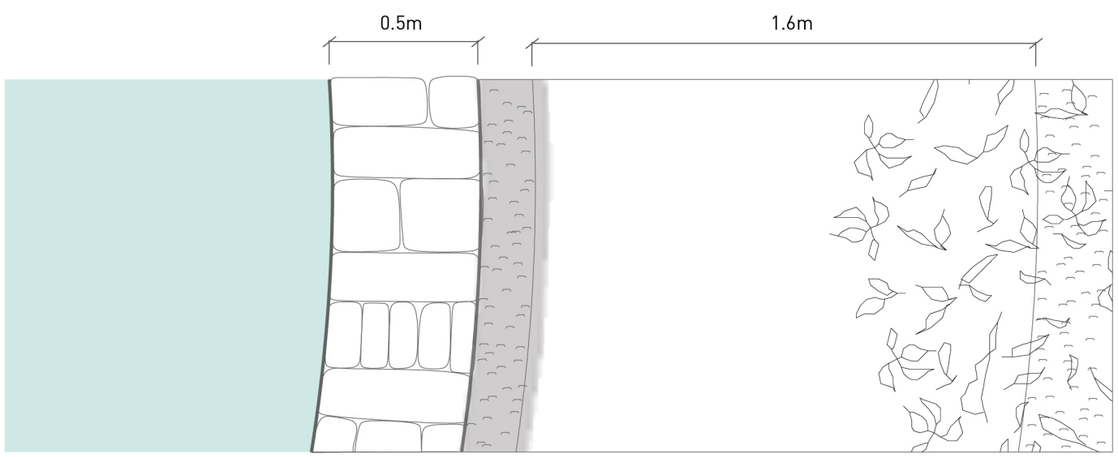
Role of water
Part of the landscape, purification



Experience
Walking







Detailed design: B



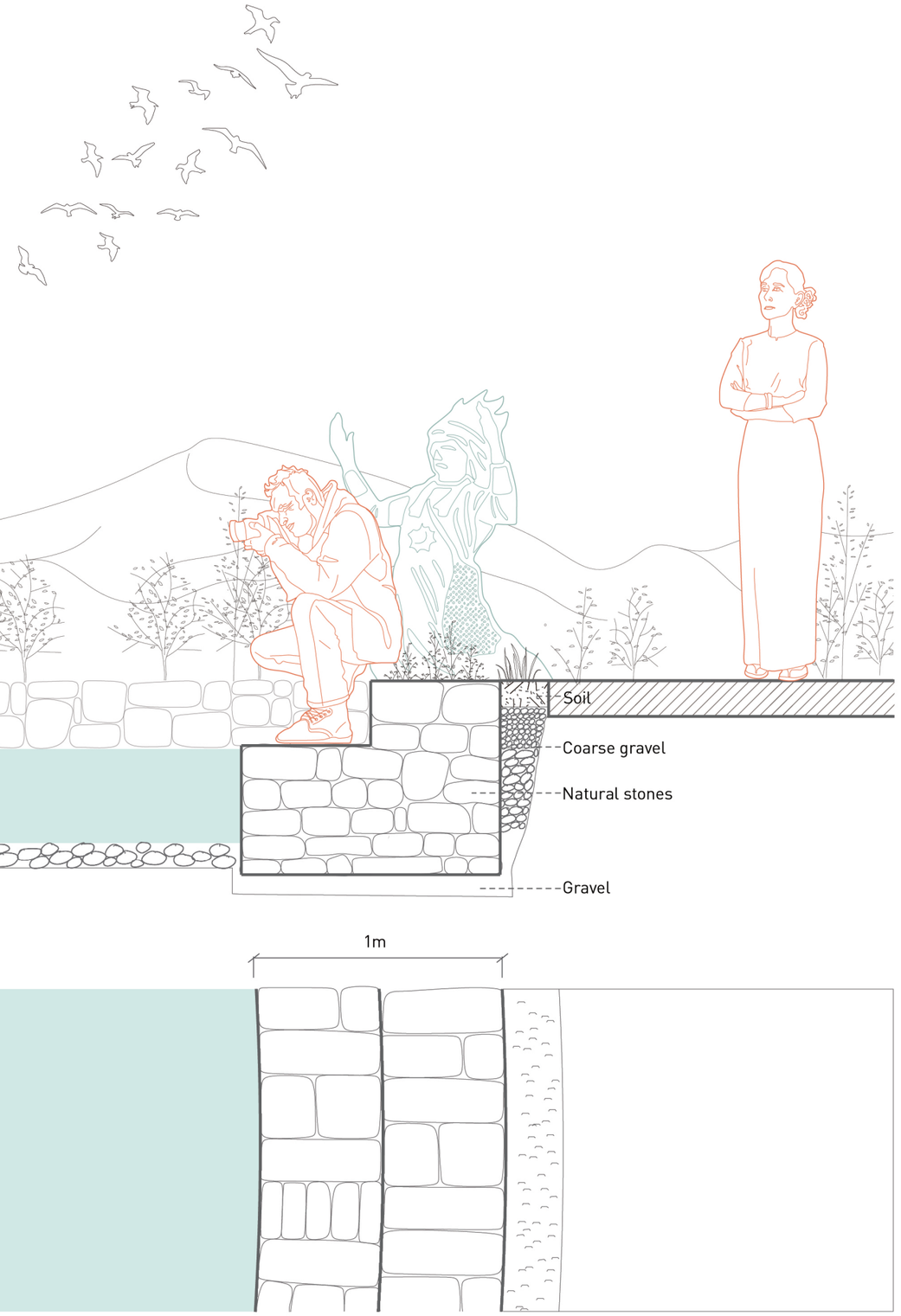
Atmosphere
Active, with a wide view

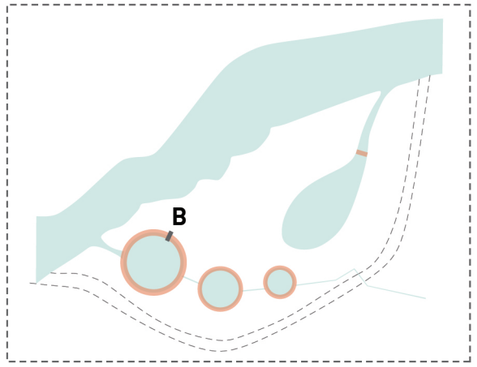


Role of water
Part of the landscape, purification



Experience
walking, resting, taking photos, gathering





Detailed design: C



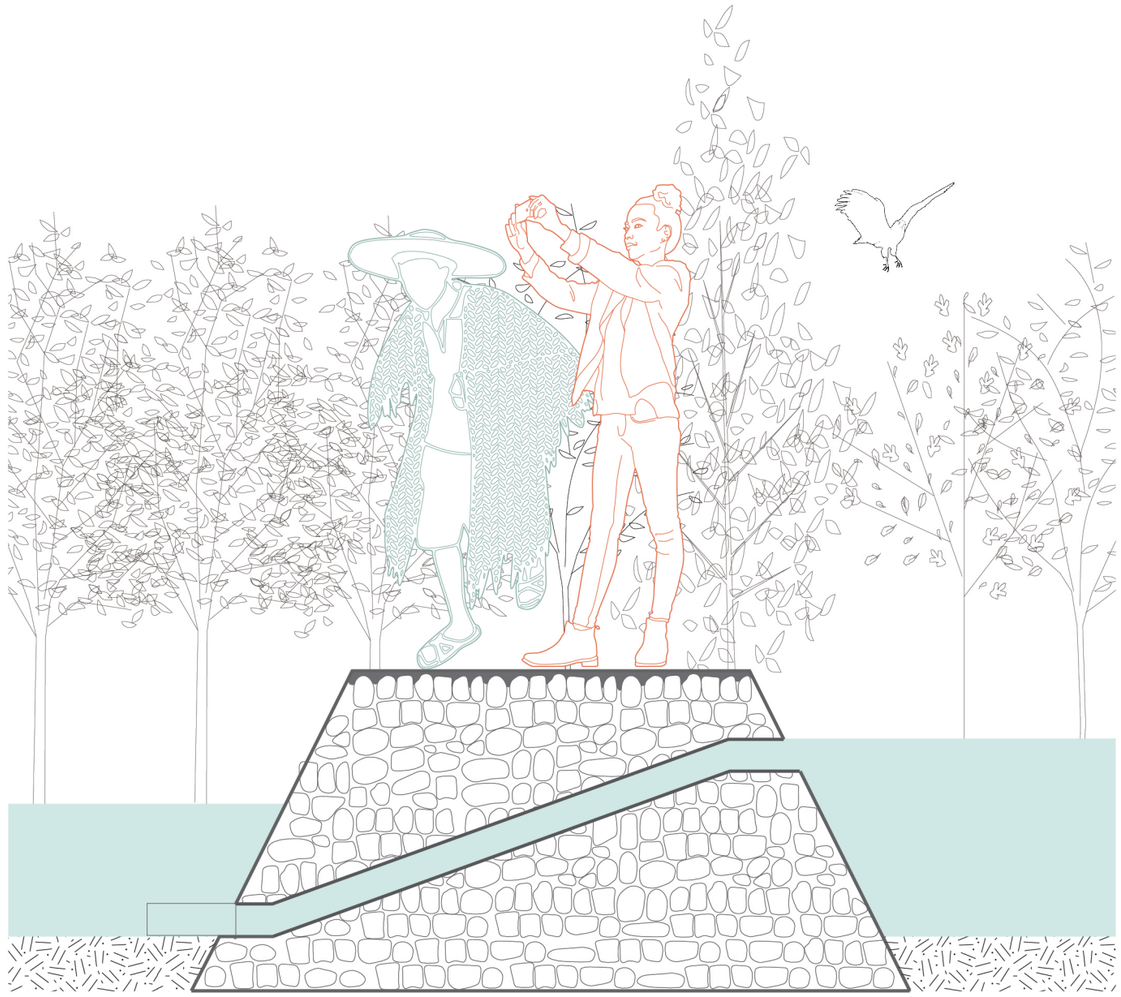
Atmosphere
Quiet and open space

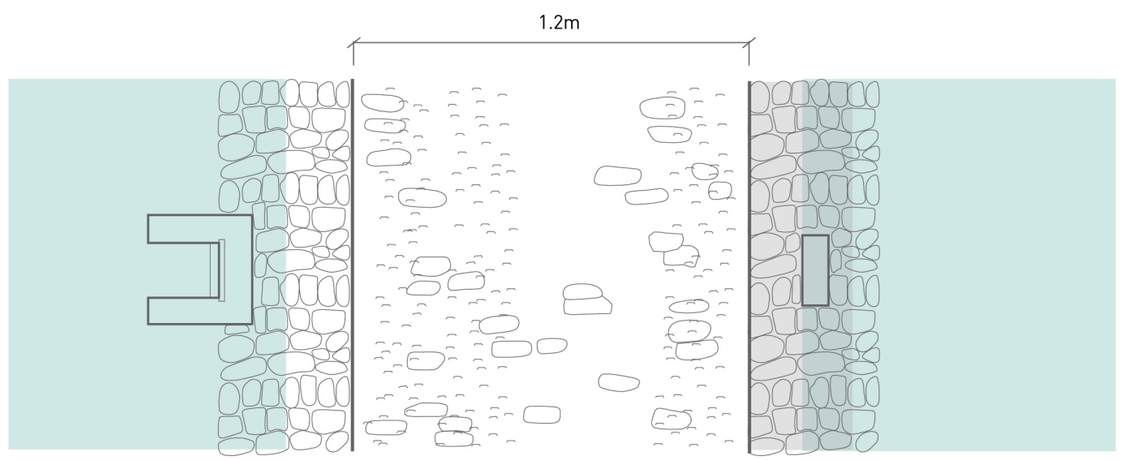


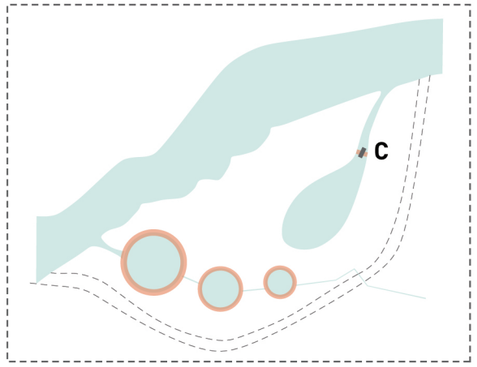
Role of water
Part of the landscape, reservoir

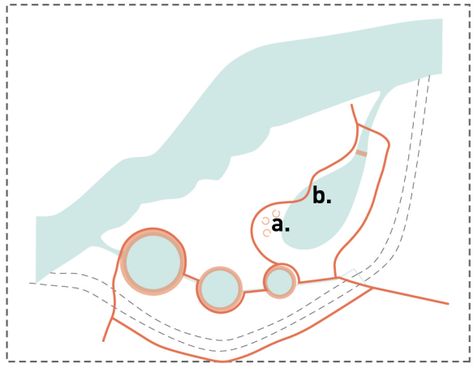


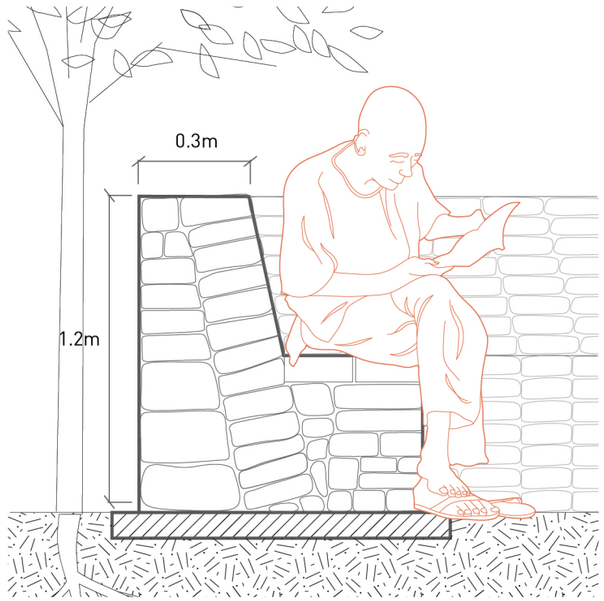
Experience
walking on the dam



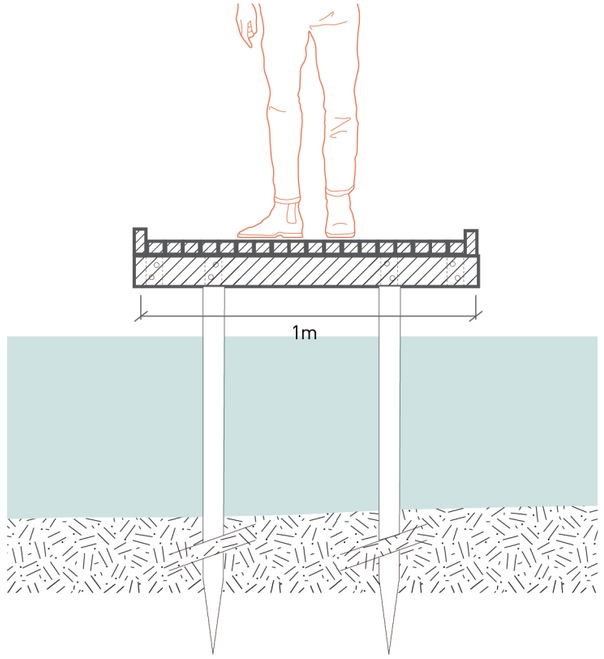








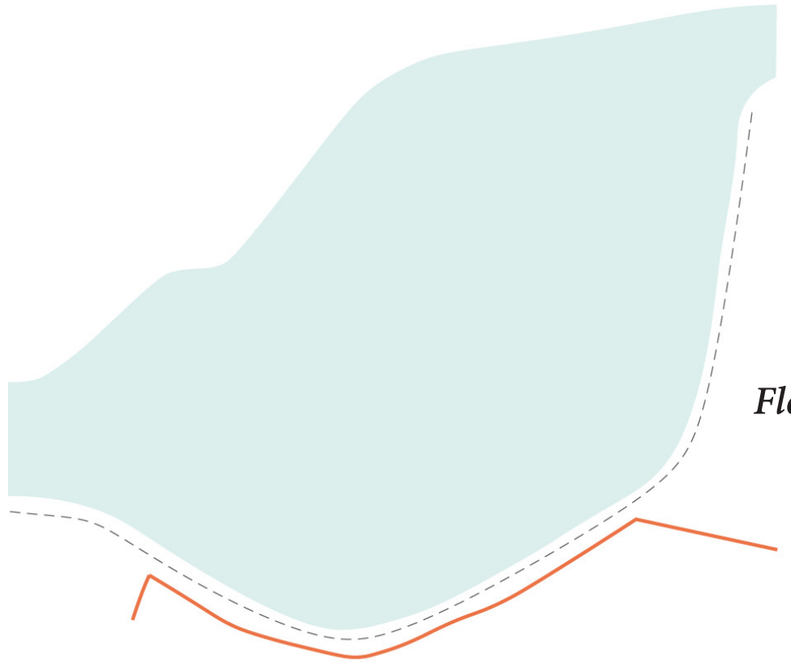
Section of bench



Section of bridge



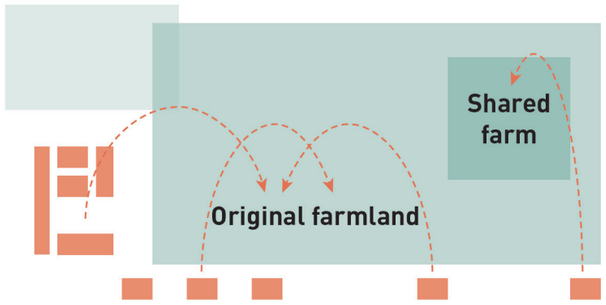
Drought



Flood

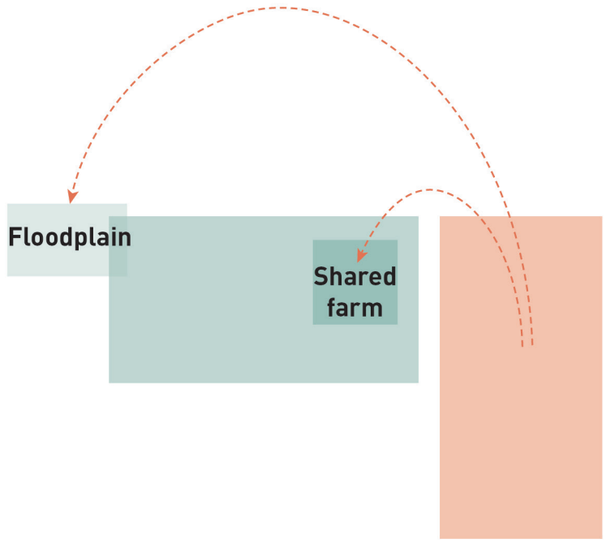
Extreme water conditions still possible

Pedestrian flow analysis



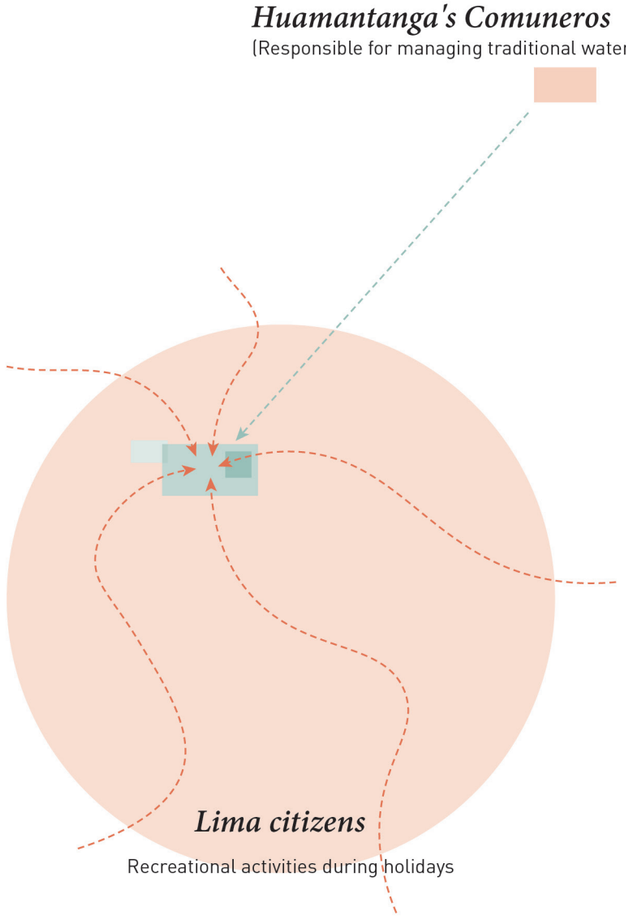
Nearby farmers

Daily Farming



Nearby Communities

Community collaboration during the weekend

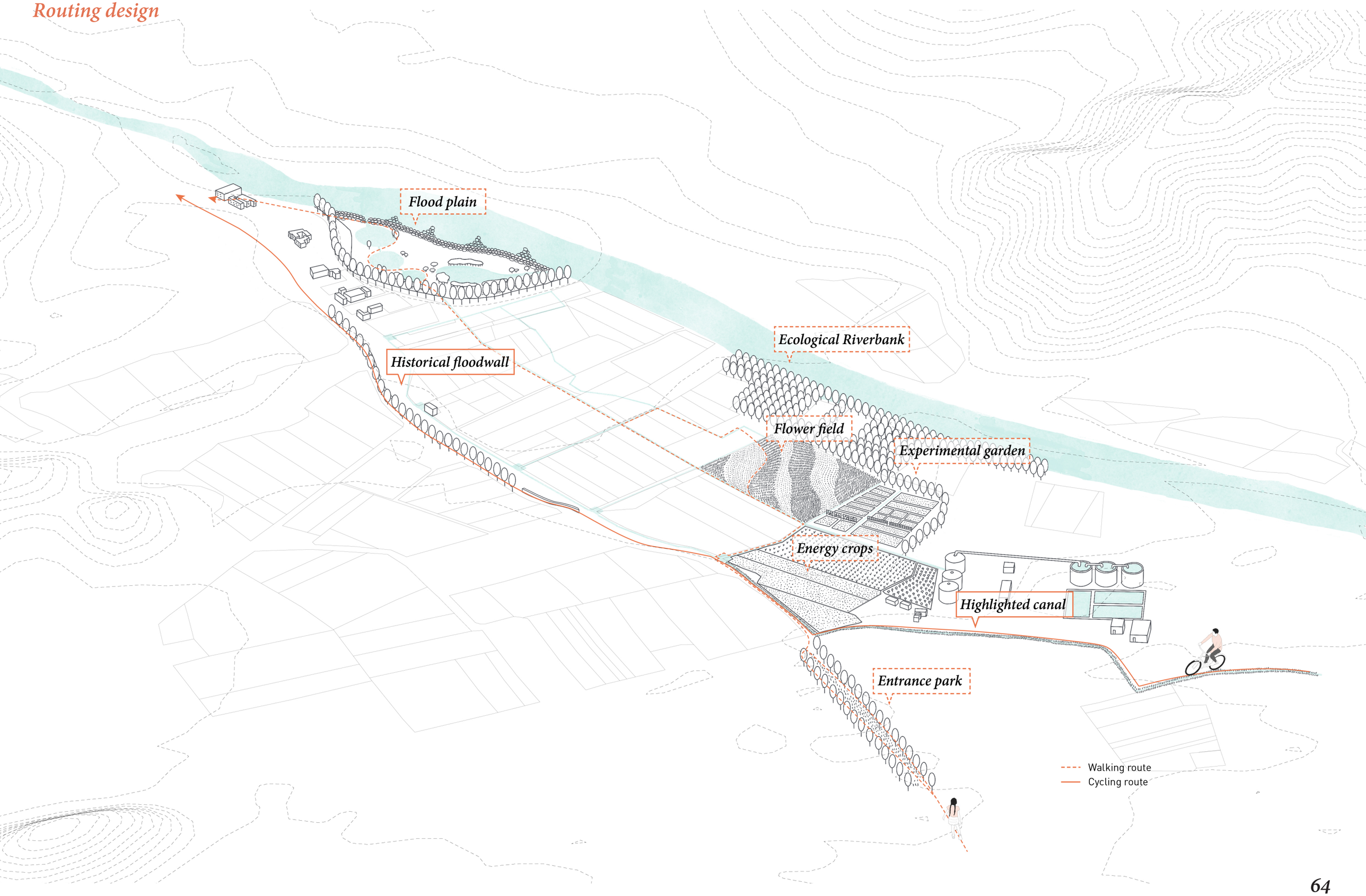


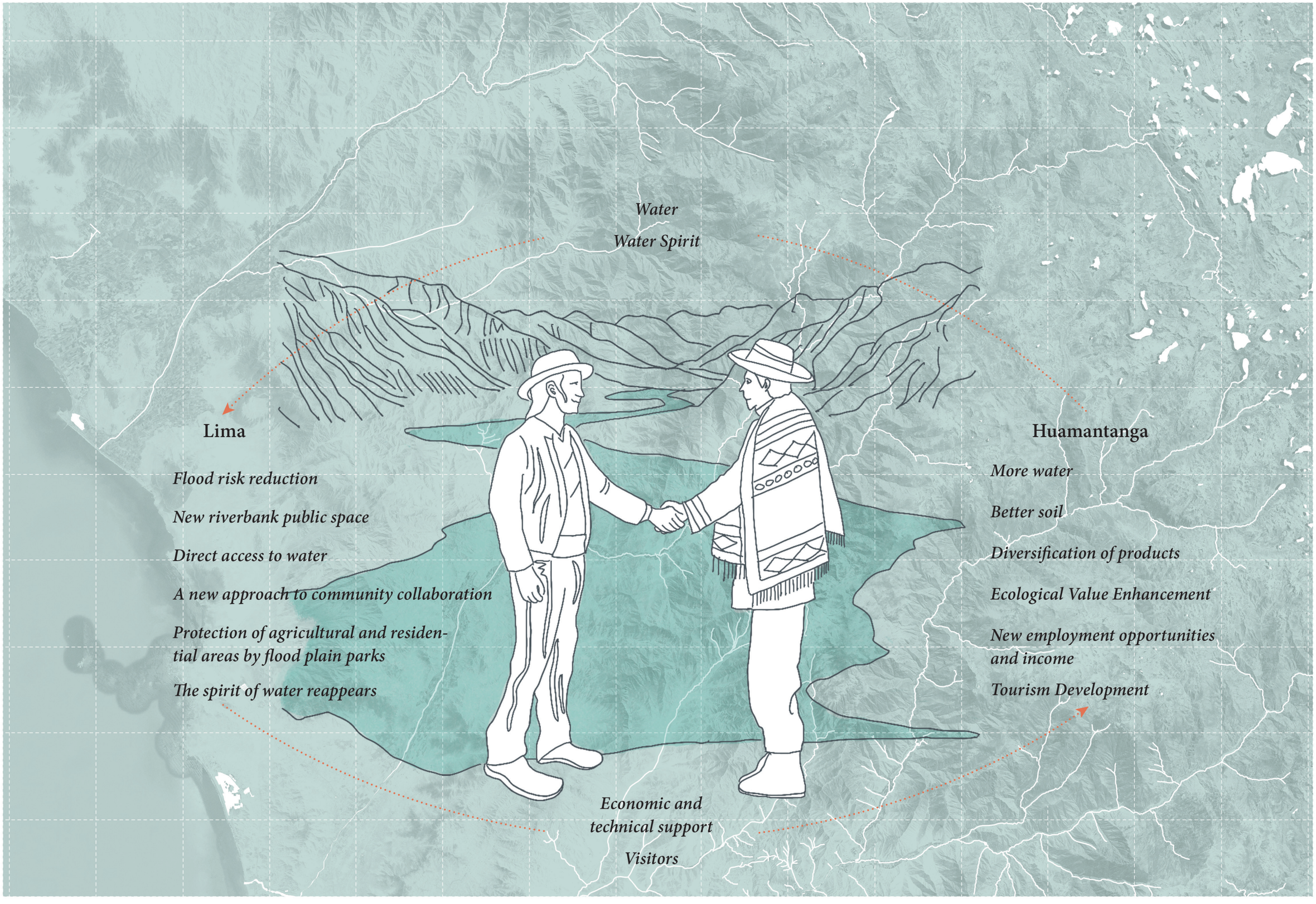
Huamantanga's Comuneros

(Responsible for managing traditional water systems)

Lima citizens

Recreational activities during holidays


Flood plain
Historical floodwall
Ecological Riverbank
Flower field
Experimental garden
Energy crops
Highlighted canal
Entrance park
Walking route
Cycling route


Water
Water Spirit
Lima
Flood risk reduction
New riverbank public space
Direct access to water
A new approach to community collaboration
Protection of agricultural and residential areas by flood plain parks
The spirit of water reappears
Huamantanga
More water
Better soil
Diversification of products
Ecological Value Enhancement
New employment opportunities and income
Tourism Development
Economic and technical support
Visitors



2023



2035



... ...