

Water-Sensitive Design of Open Space Systems

Ecological Infrastructure Strategy for Metropolitan Lima, Perú

Research project LiWa (Lima Water): „Sustainable Water and Wastewater Management in Urban Growth Centres Coping with Climate Change - Concepts for Lima Metropolitana (Perú)“ - (2008 - May 2013)

Integrated urban planning strategies and planning tools (May 2011 - May 2013)
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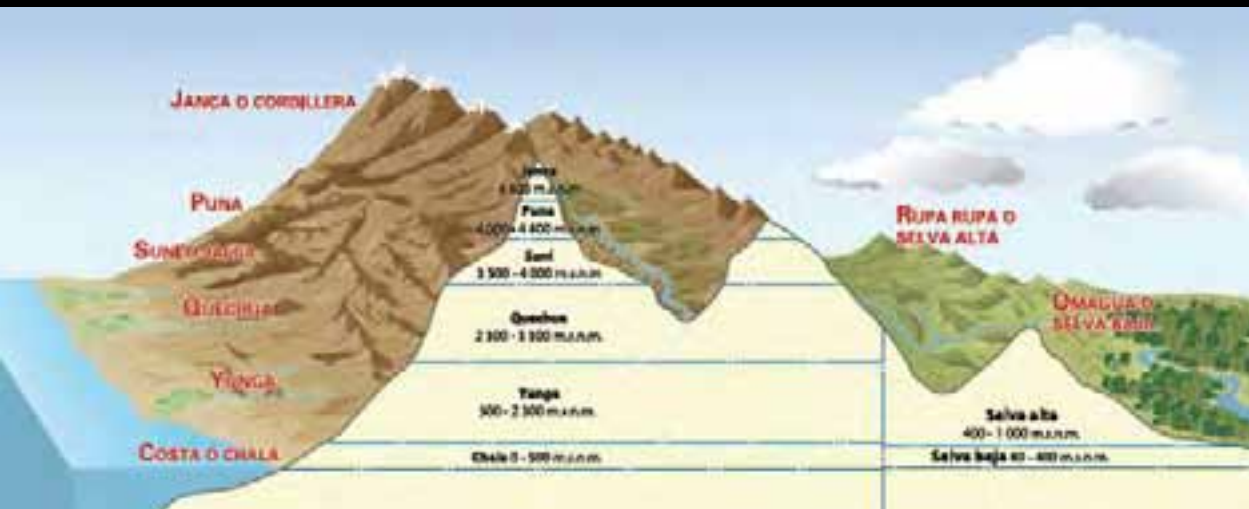
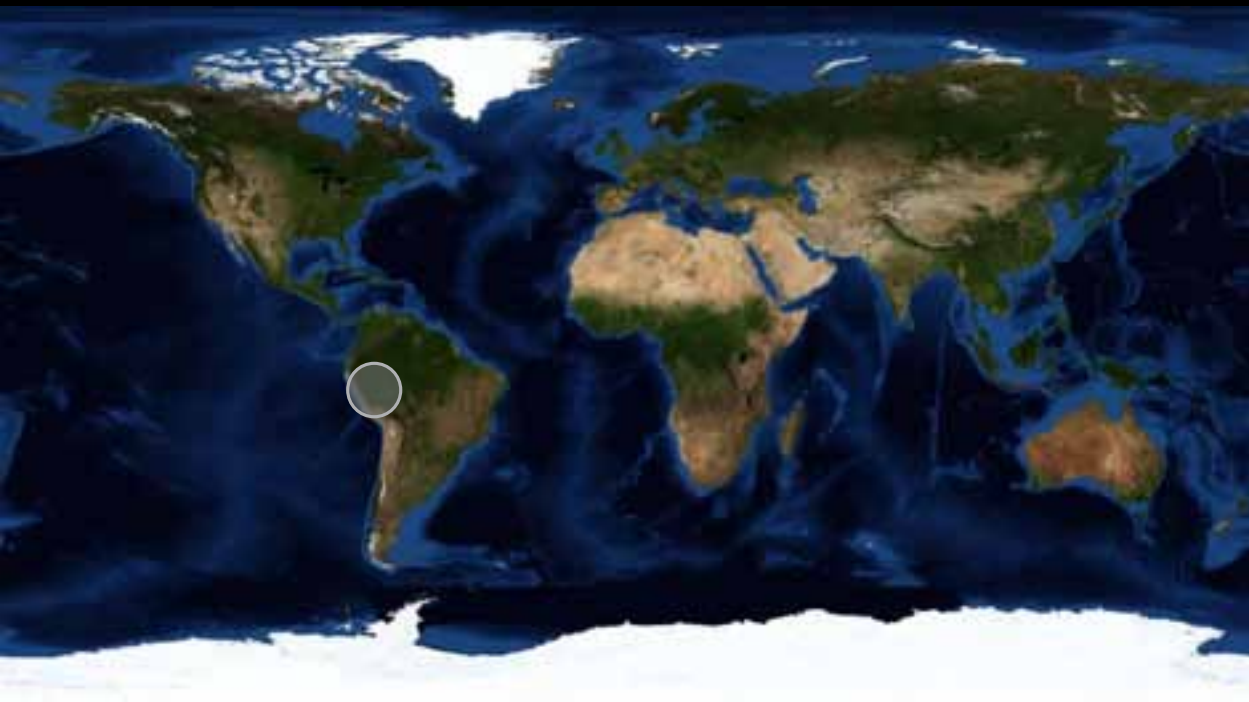
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The desire to increase green areas.

5,4 l / m² / day



Many parks and road greenery are irrigated with potable water or groundwater.

An aerial photograph showing a vast, densely packed urban area, likely Lima, Peru. The city is built on a valley floor and extends up the slopes of surrounding mountains. The buildings are tightly packed, and the terrain is hilly. In the background, more mountain ranges are visible under a clear sky.

Population: 8,5 million
(INEI, 2007)

Population growth rate: 2,1 annually
(INEI, 2002, 2005, 2006)

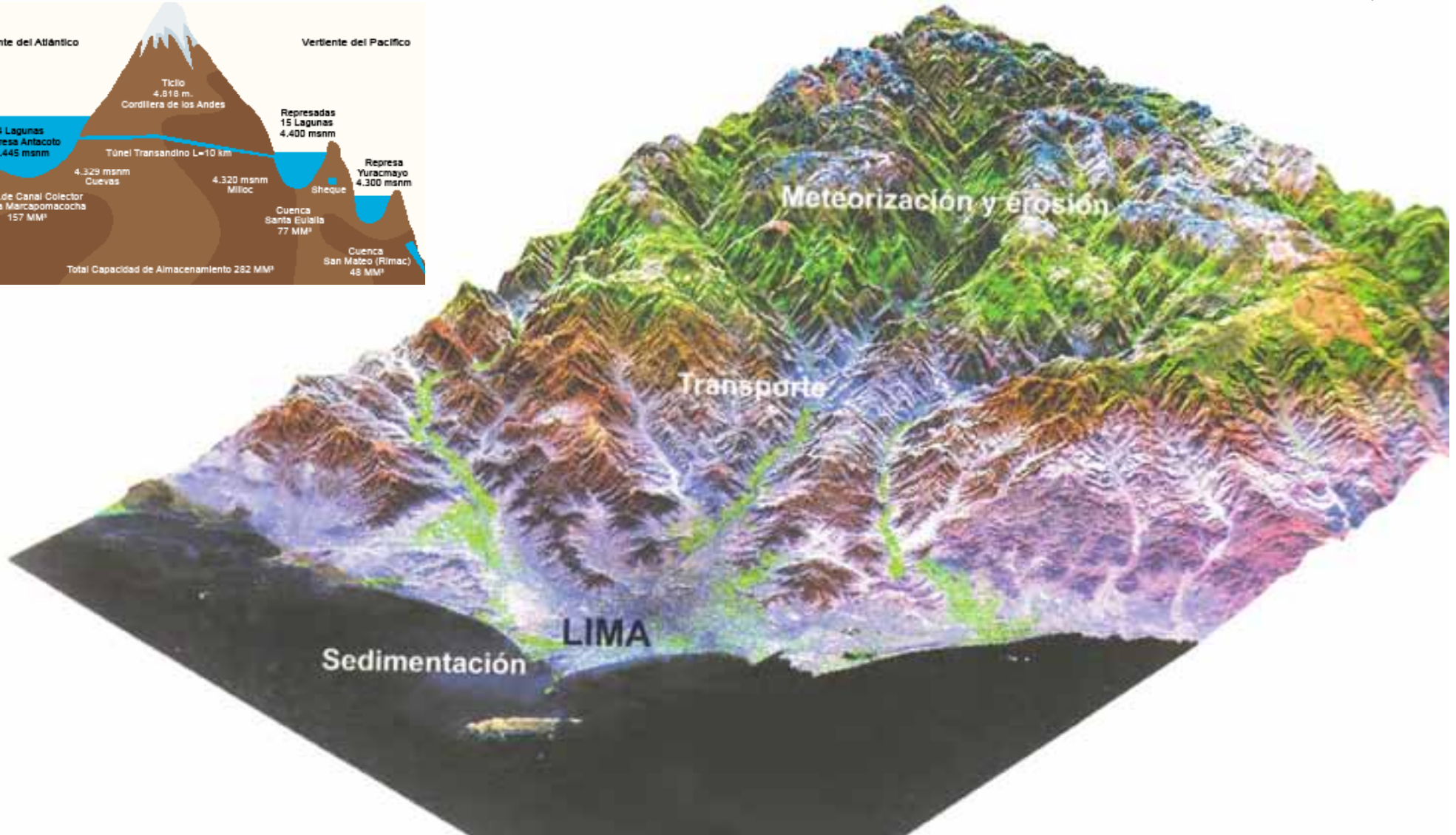
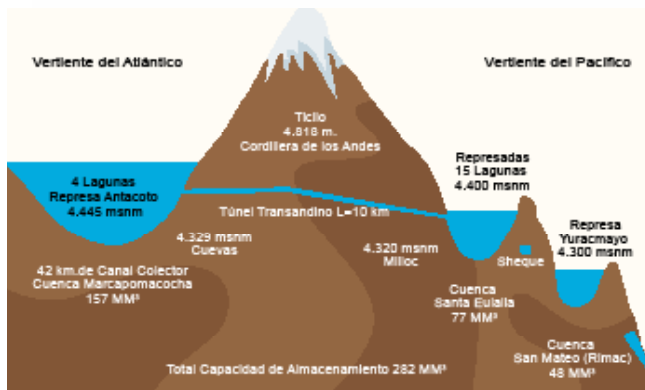
Annual rainfall: 9mm

Green areas: 4500 ha (2012)

Area: 2,801.63 km² (INEI, 2011)

Credit: evelynmerinoreyna@limamasarriba.com

How do we create an open space system that improves the disbalanced urban water cycle?



Source: Lima Environmental Atlas 2010

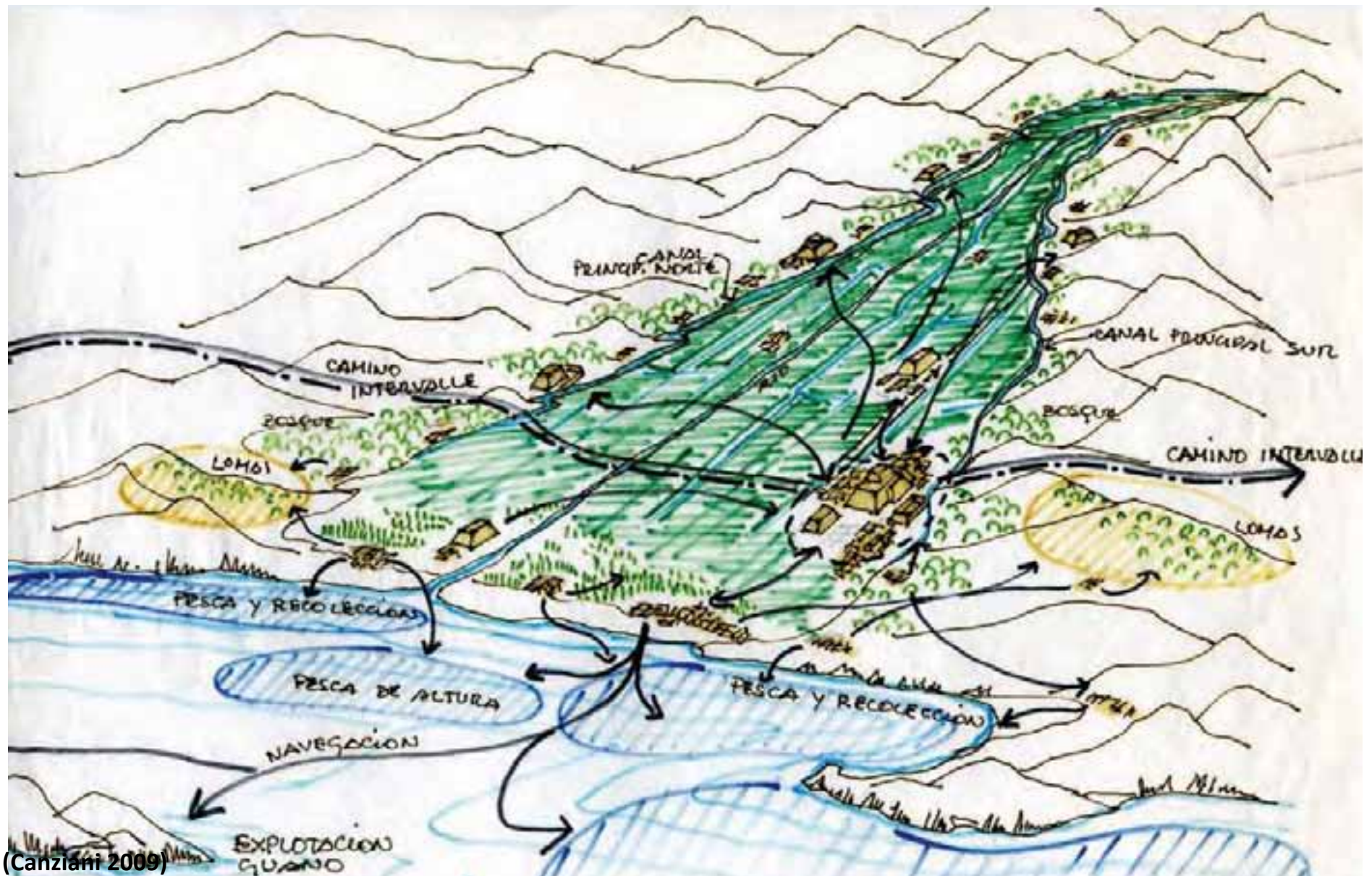
Dependent on water supply from three rivers: Rímac, Chillón and Lurín with an average monthly flow volume of 39 m³/s and high seasonal variations.



River WITH water
December - April, rain season in the Andean mountains

River WITHOUT water
June - October, dry season in the Andean mountains





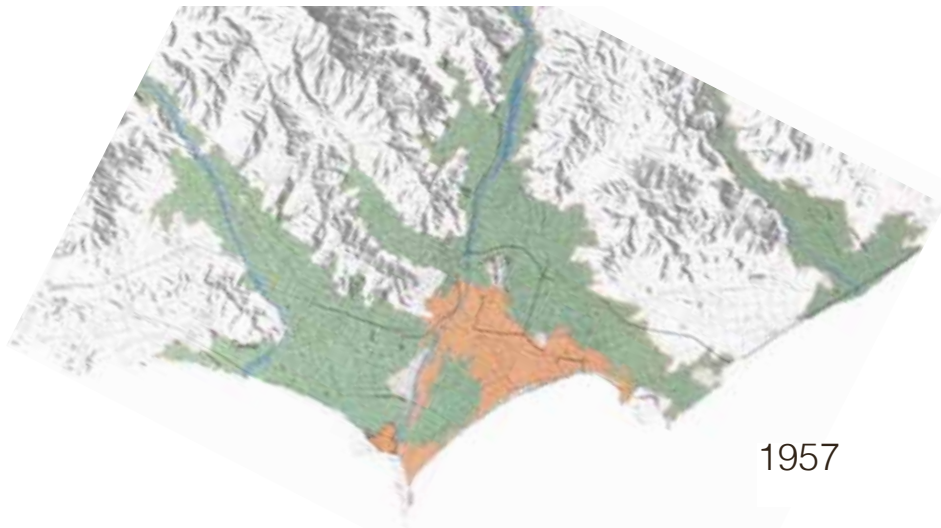
(Canziani 2009)

Source:Canziani (2009)

Historical relationship between agricultural landscape, rivers and settlements.



Credit: evelynmerinoreyna@limamasarriba.com

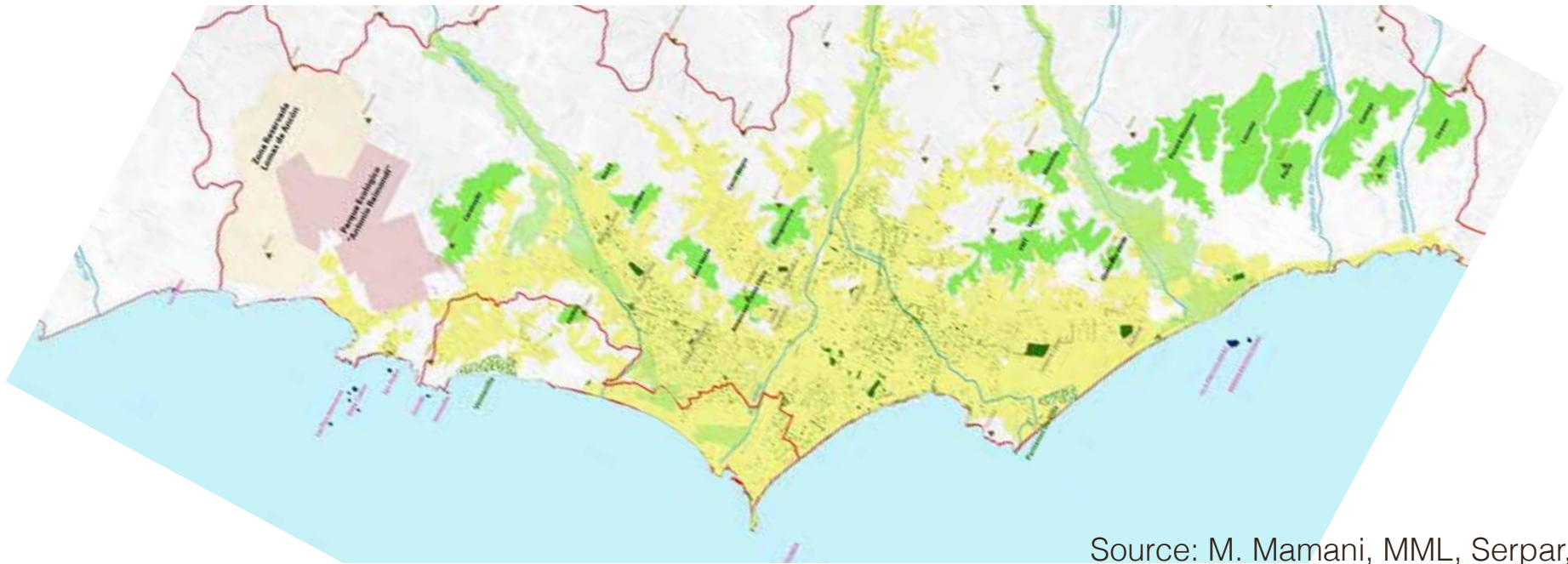


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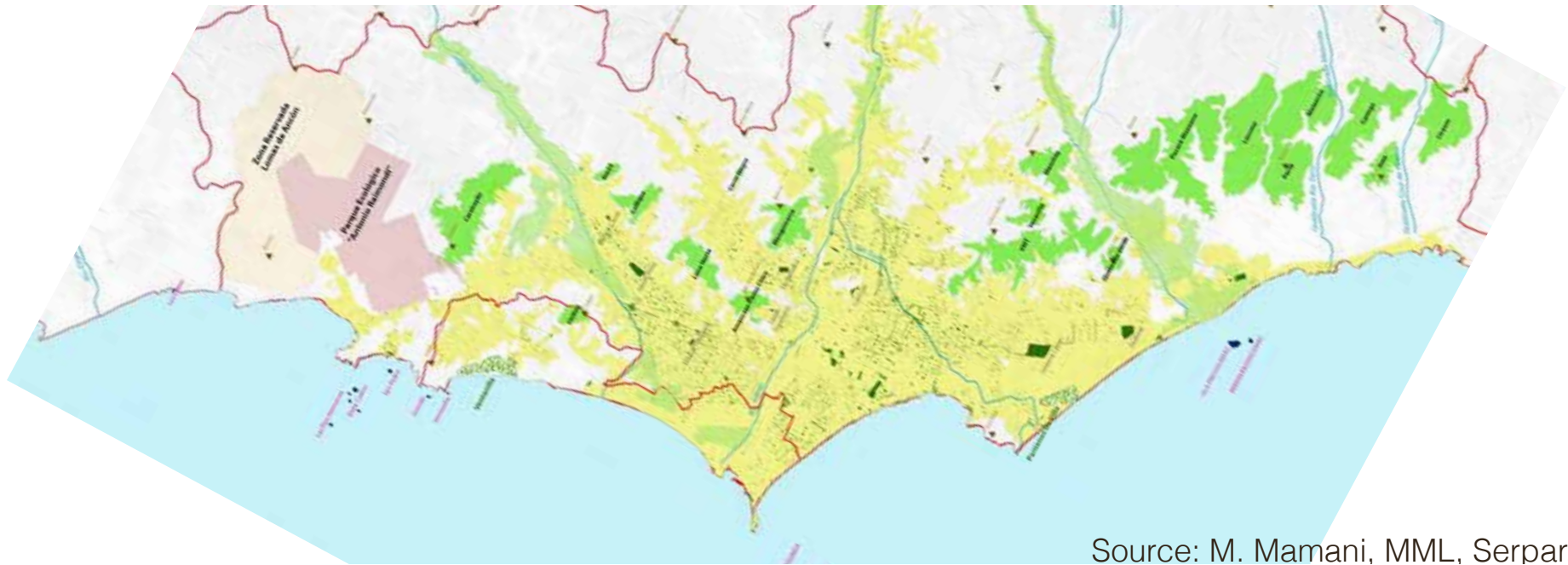
2011

Uncontrolled urban growth, loss of agricultural valleys and chanalisation of rivers



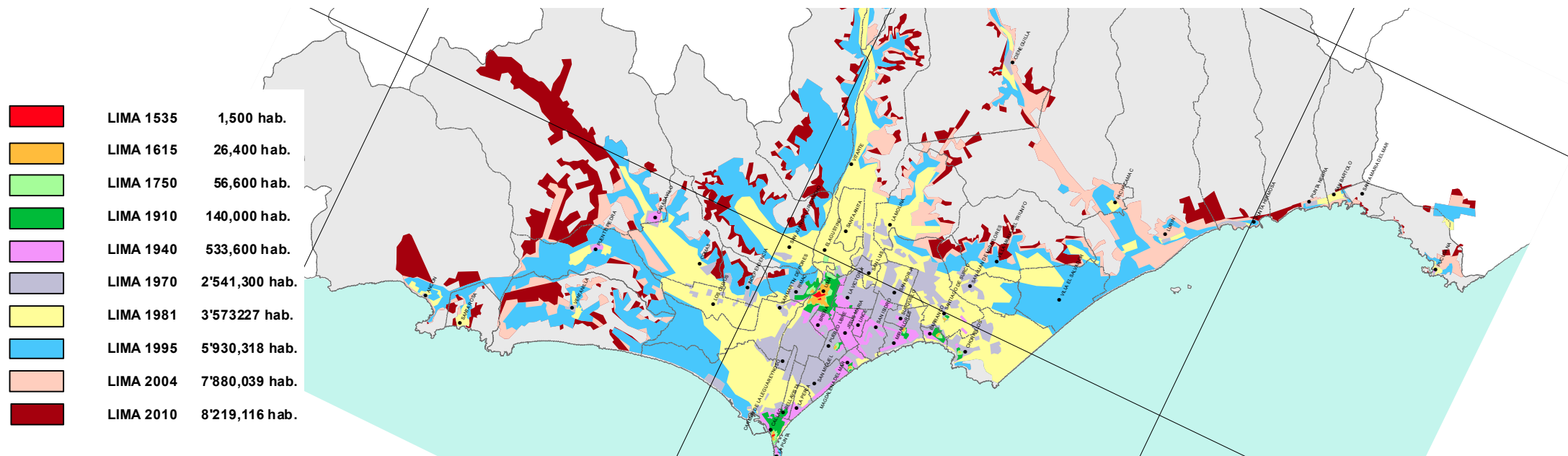
Source: M. Mamani, MML, Serpar, 2012

Occupation of coastal wetlands followed by water pollution

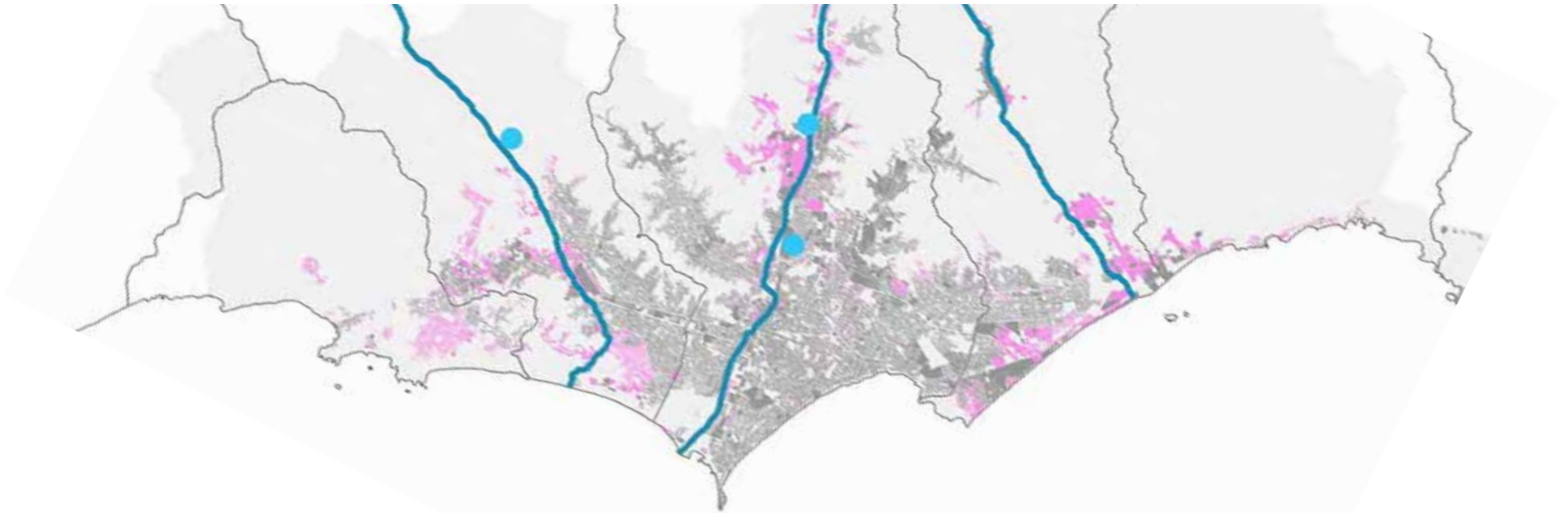


Source: M. Mamani, MML, Serpar, 2012

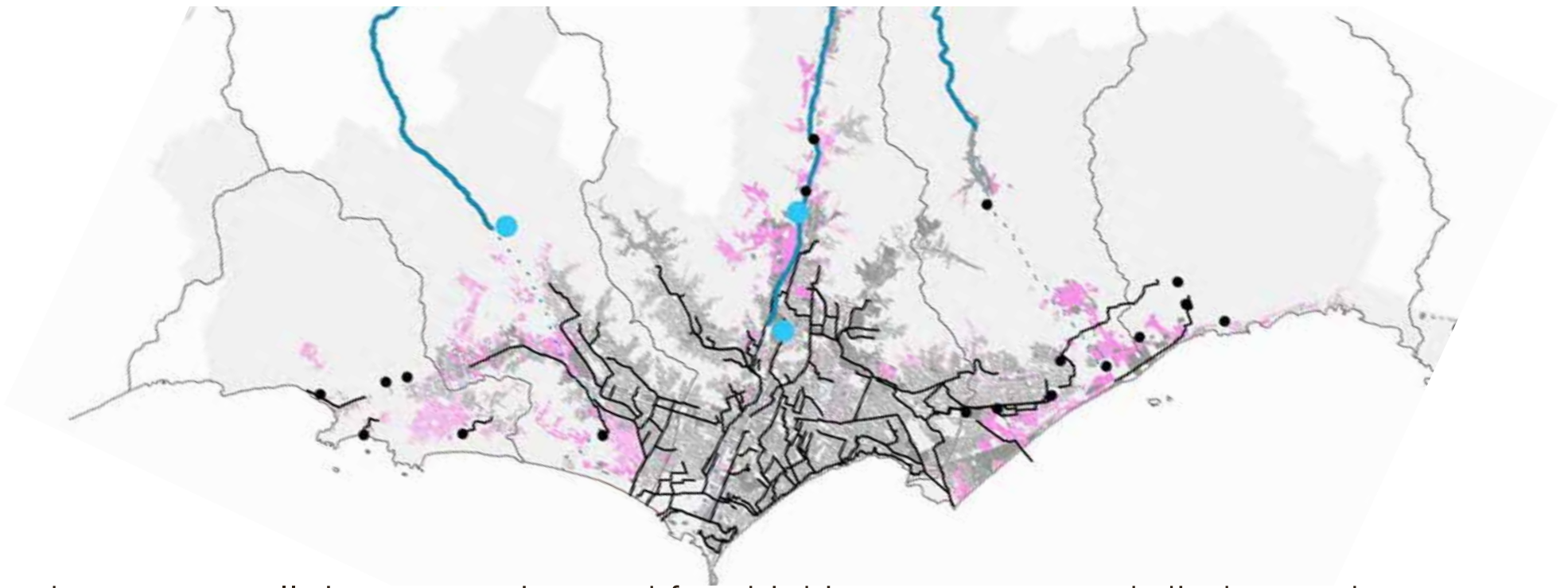
Disappearance of seasonal biotope loma



Occupation of vulnerable areas on the slopes of the dry hills



81% of the city's population is connected to the public water supply network
almost 1 million people without water connection (INEI 2007)



In the dry season all river water is used for drinking water, ... and discharged as treated or untreated wastewater into rivers and ocean.



Designed green open spaces are disconnected from hydrological structures and have high maintainance and investment to control natural processes.



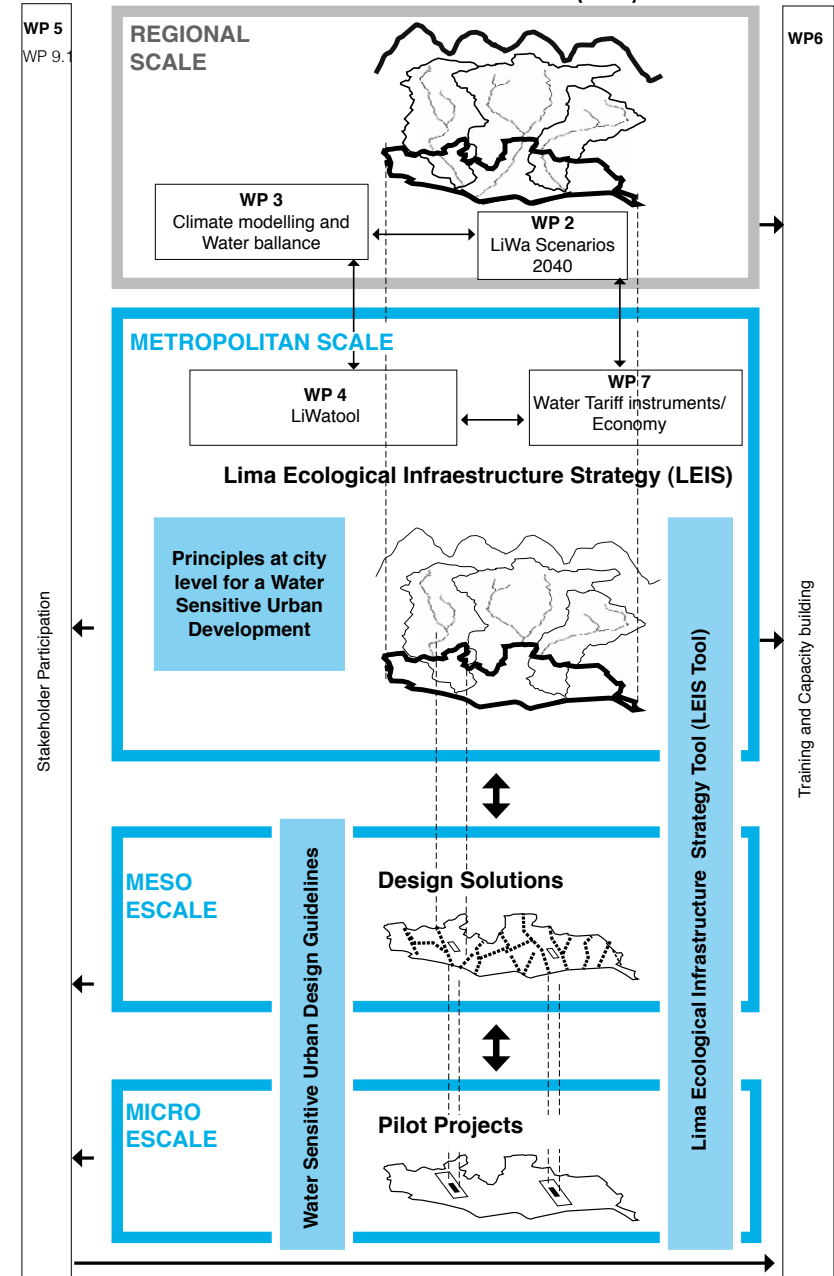
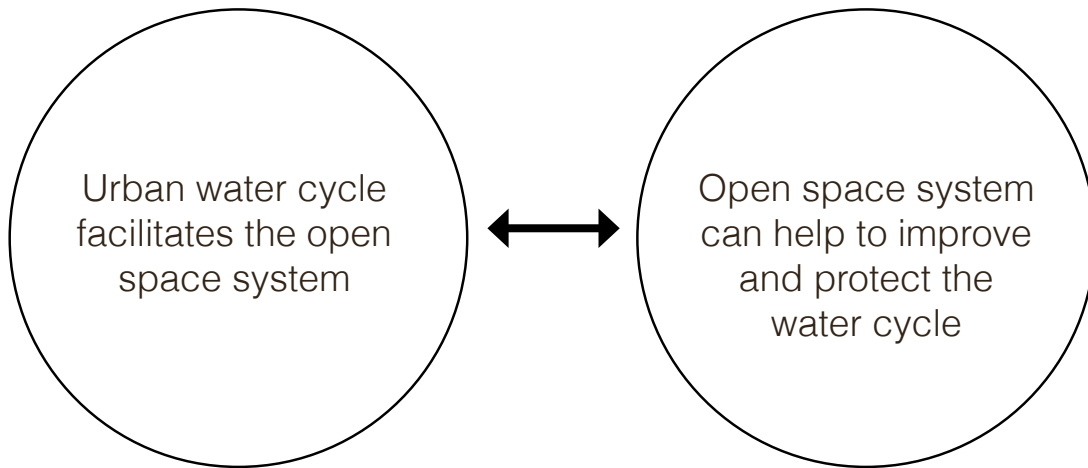


Lima's hydrological structures, water infrastructure and the design of open space need radical rethinking to make **urban** and **natural systems** perform in concert with one another and keep up with the increasing water demand for a growing liveable city.



Developing concepts for Metropolitan Lima Ecological Infrastructure Strategy

.. conceptual strategy based on the flows of water and the provision of ecosystem services.



Principles for water sensitive urban development are harmonised with the Concerted Regional Development Plan (2012-2025)



Protect, develop and implement open space system considering availability and integrated management of water resources.

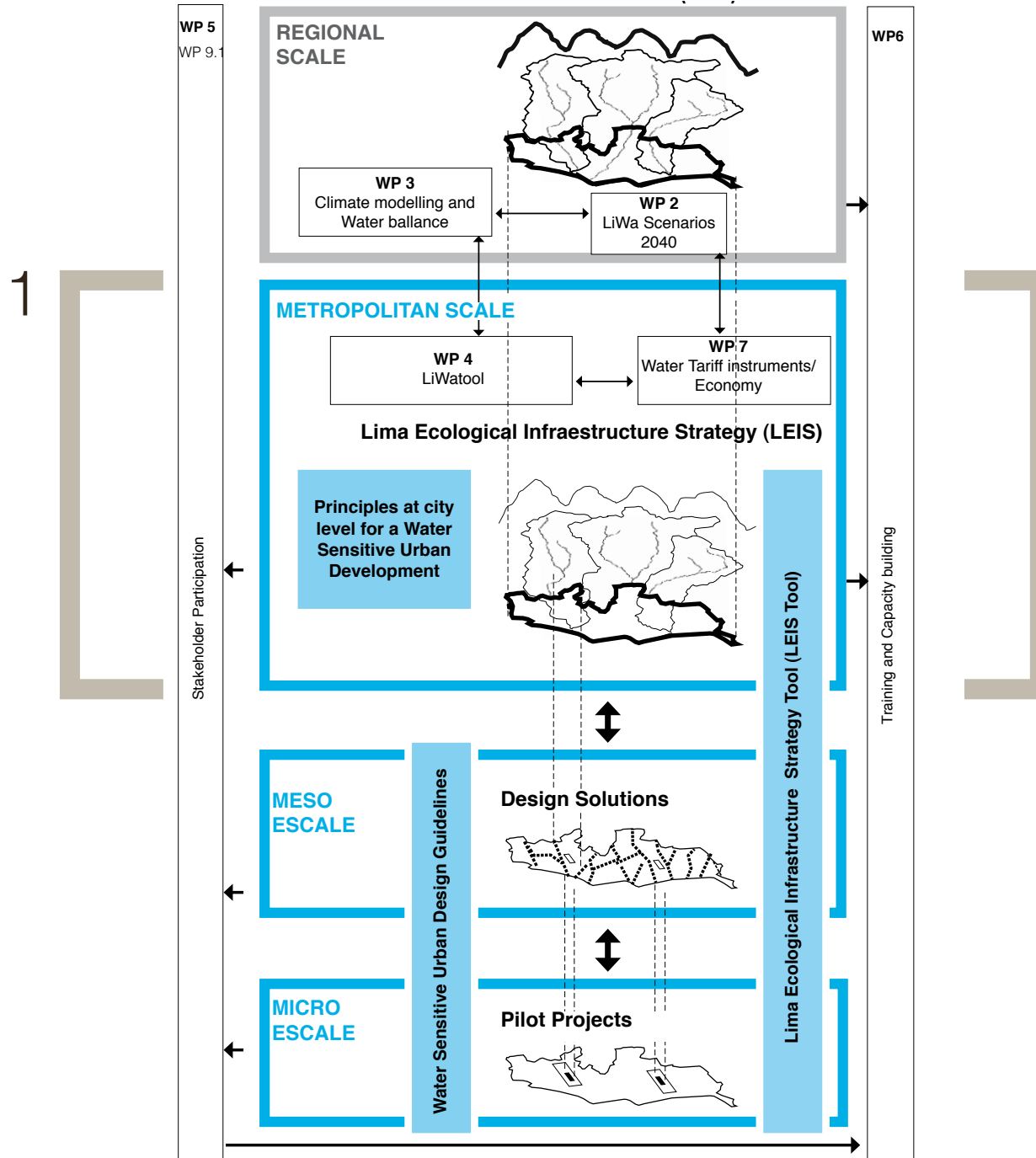
Protect and consolidate agricultural land and add value to improve ecosystem performance

Transform high risk areas as part of the ecological infrastructure.

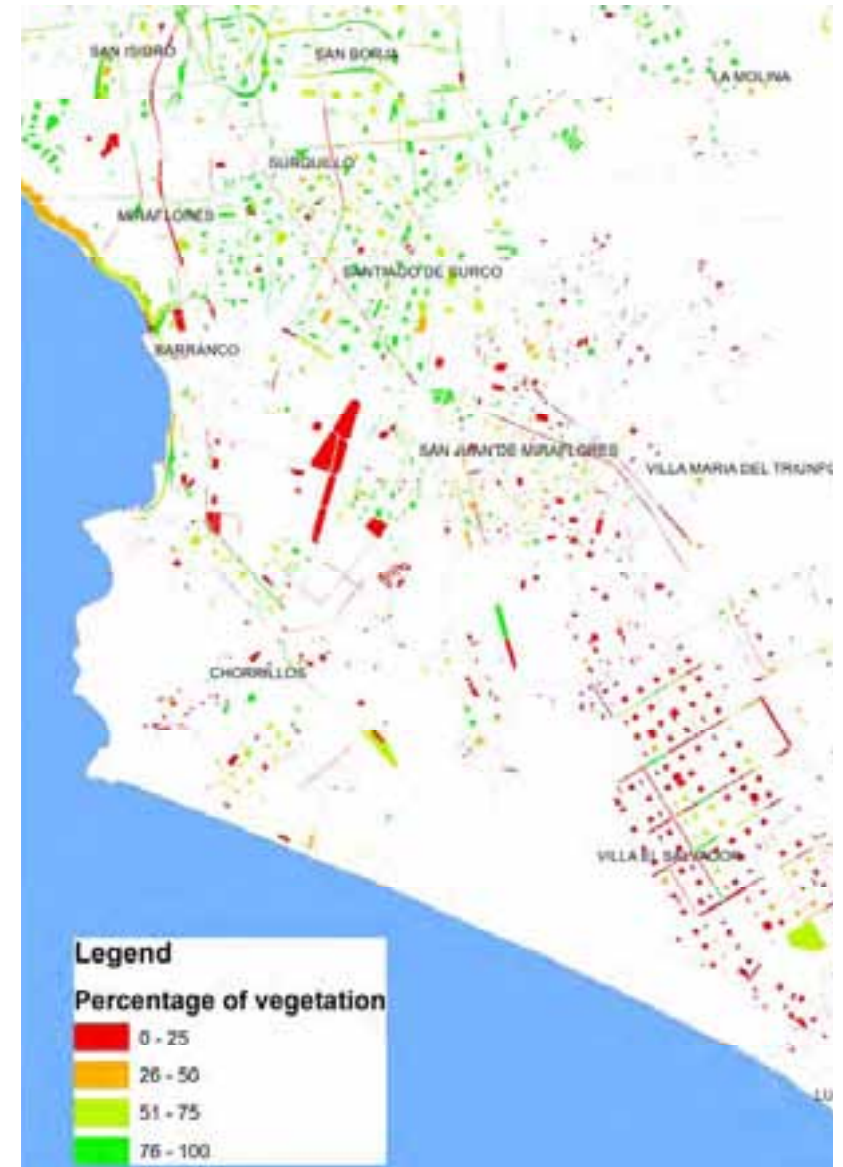
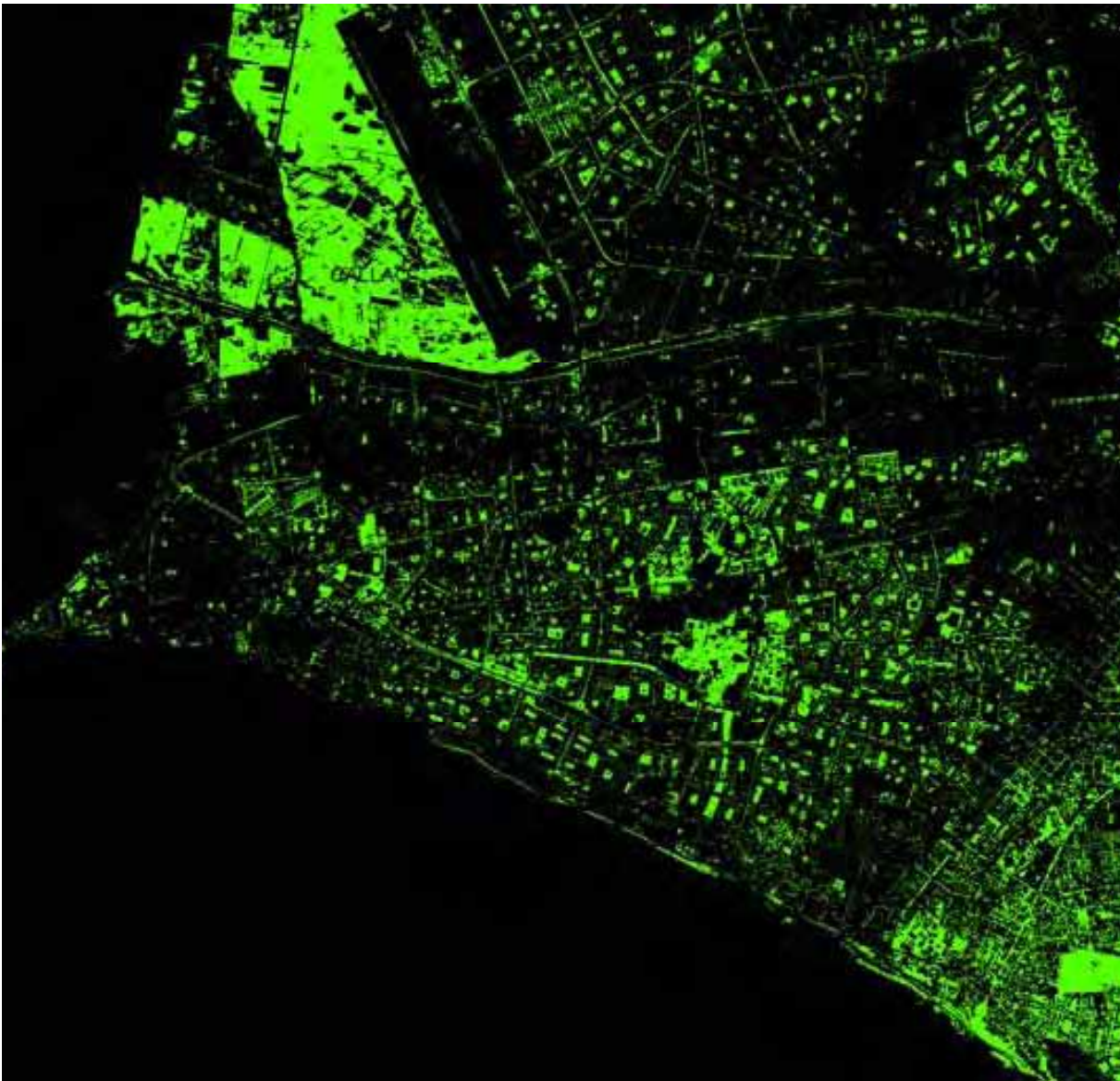
Promote water sensitive urban development that considers water catchment, saving, treatment and reuse of water in the city

- GIS database for all institutions to coordinate actions

Ecological Infrastructure Strategy for Lima



Water demand study



Source: geoeeye foundation, Jan. 2012

Source: Green Inventory Serpar, Sept. 2012

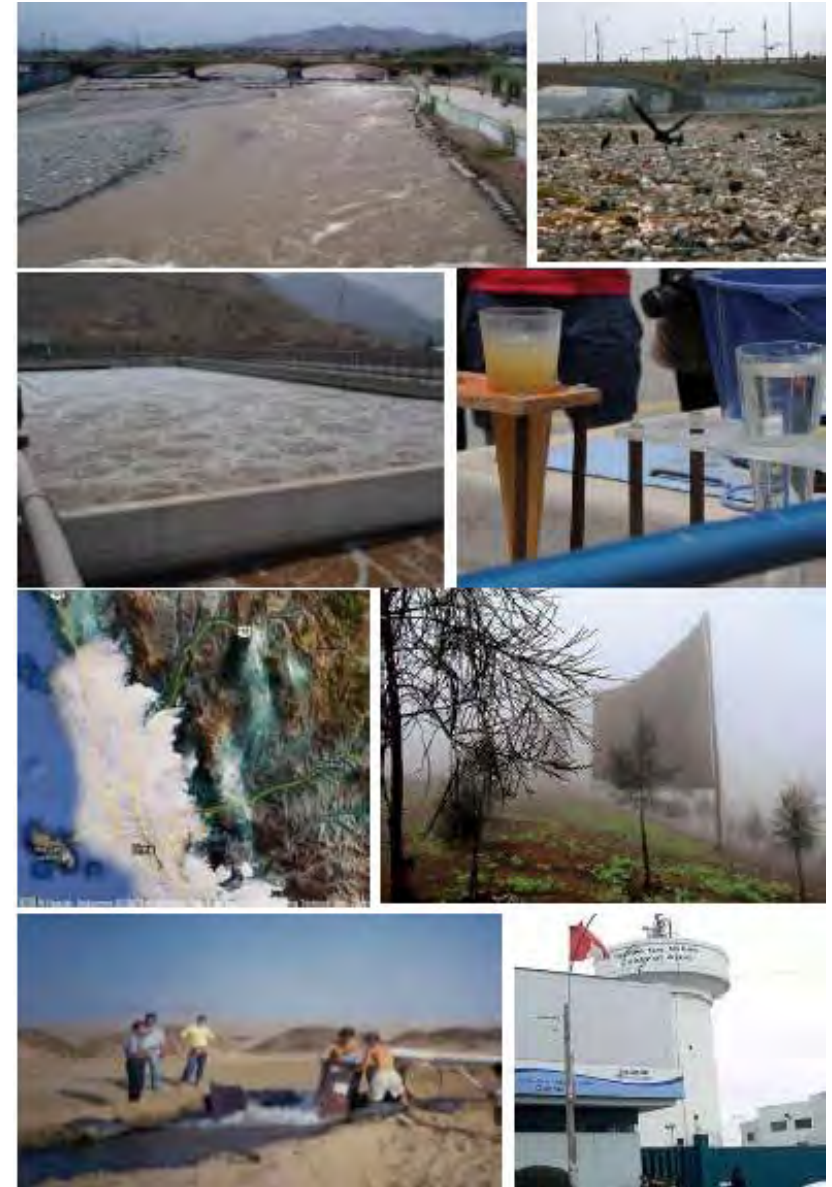
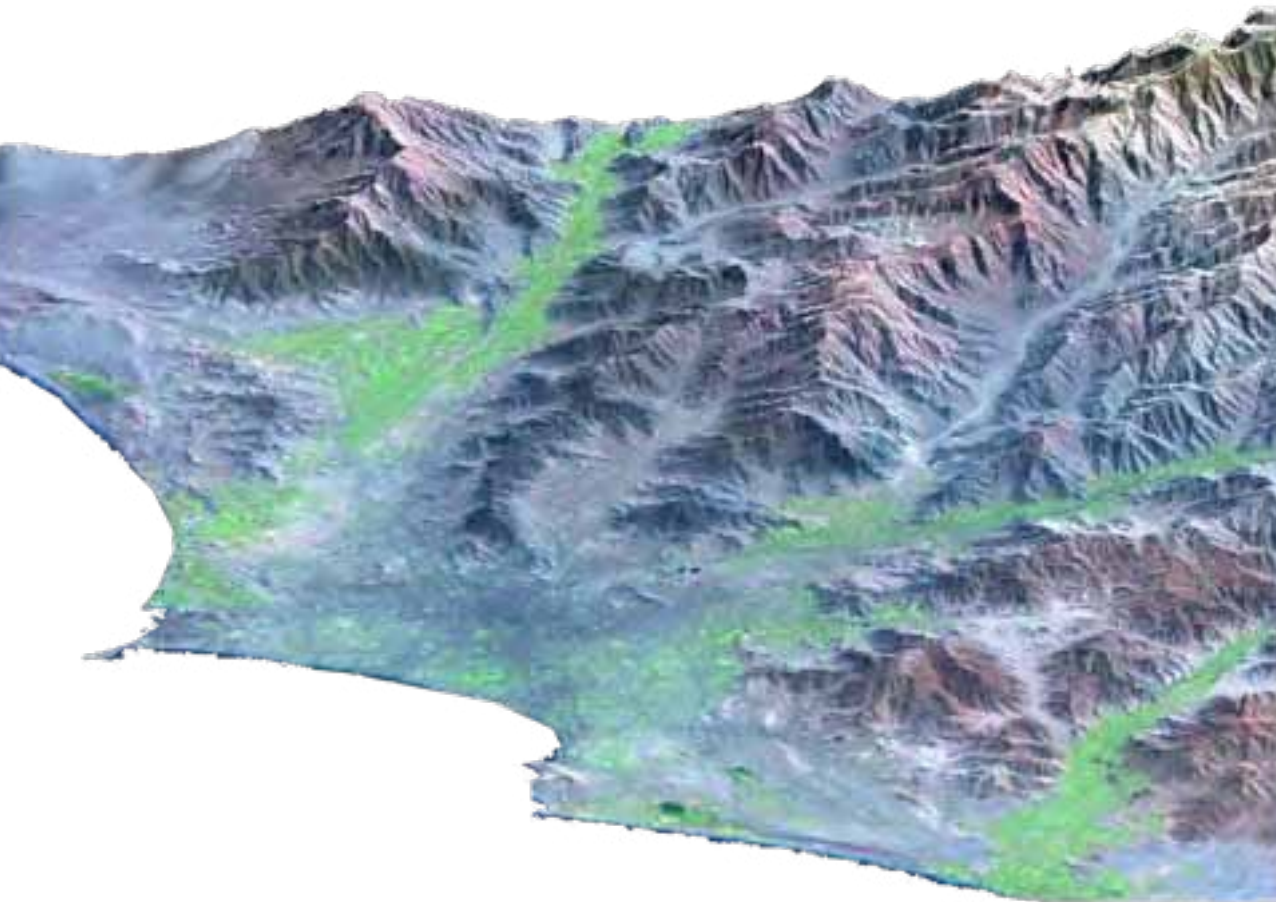
To green all as park registered areas the water demand would increase dramatically.

Water availability study - City as a water source

77 % of population connected to sewerage network

18 wastewater treatment plants (treating, however, only a small fraction of the wastewater production)

10% reused for irrigation of green areas (Moscoso 2011)



Different areas offer different sources of water: natural or man-made water sources and other areas with no water source.

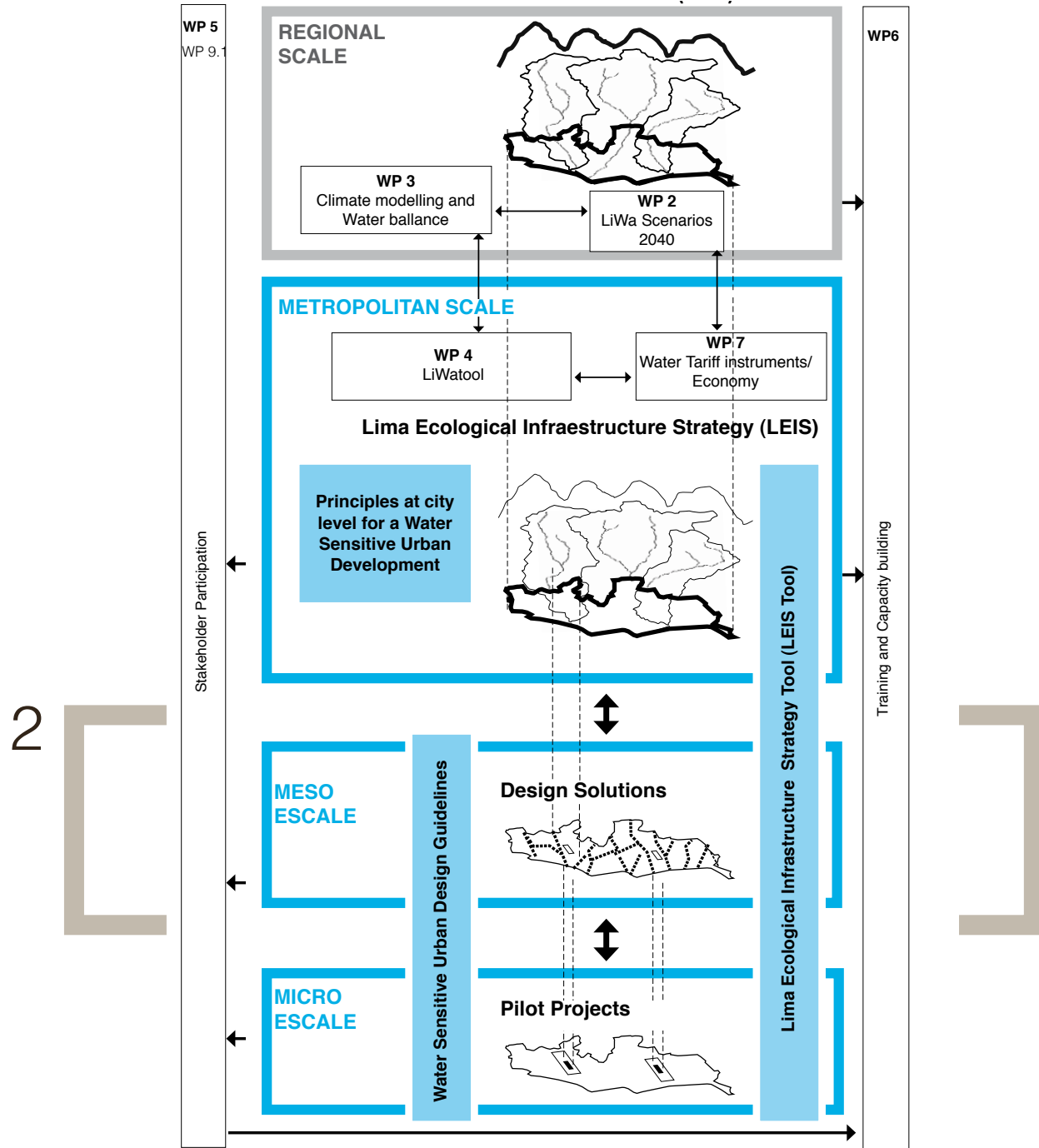
Hydro-urban units

Linking water and open space in different urban settings



Combining information layers about natural and man-made water sources and urban structures, which are key to identifying site-specific suitable design solutions.

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Understanding urban water cycle and open space design



Survey of 20 cases representing different typologies of open space

Source: Google Earth, geoeye 2012

Water sensitive design prototypes

Study area: Irrigation channels Chuquitanta
San Martin de Porres Municipality



Green areas (land use, type of vegetation, irrigation demands in dry season and wet season, type of irrigation, source of nutrients, etc.)

Water sources (water quality, quantity)

Aesthetics and ecology of water (visibility, accessibility, bench structure and if and how water is reflected in the design of the open space)

Maintenance costs and institutional framework

Existing relationship between water, open space and people



solid waste → neglected, dangerous area
wastewater → poor water quality

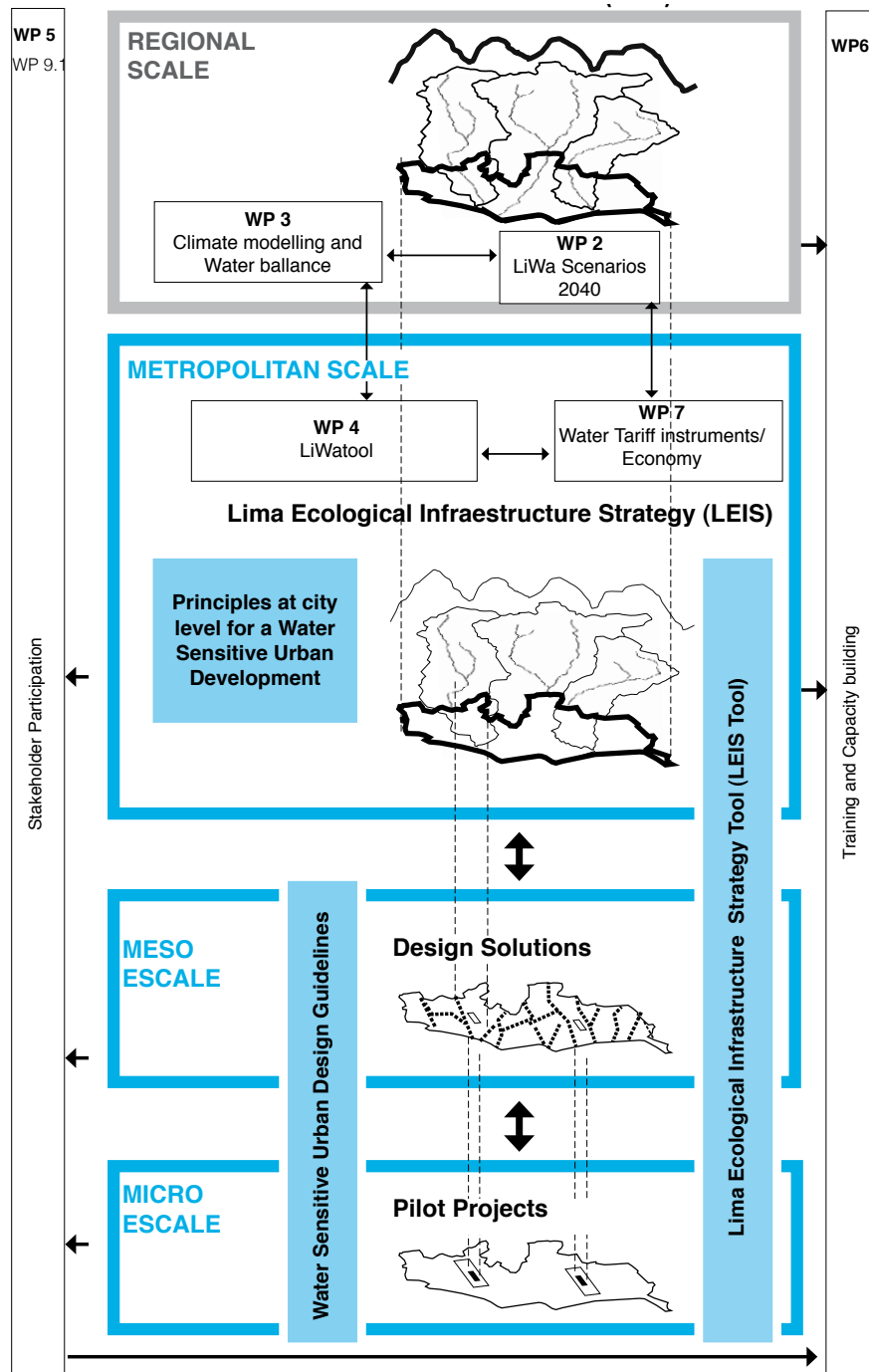
Open space design providing essential environmental services
Green purification corridor



Designing open spaces which purify water, purify wastewater, harvest water from the fog, recycle nutrients, maintain the character of the place, etc.

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Demonstration area - Lower Chillón River Watershed



View from the Cerro El Paraíso towards the industrial area in Callao.

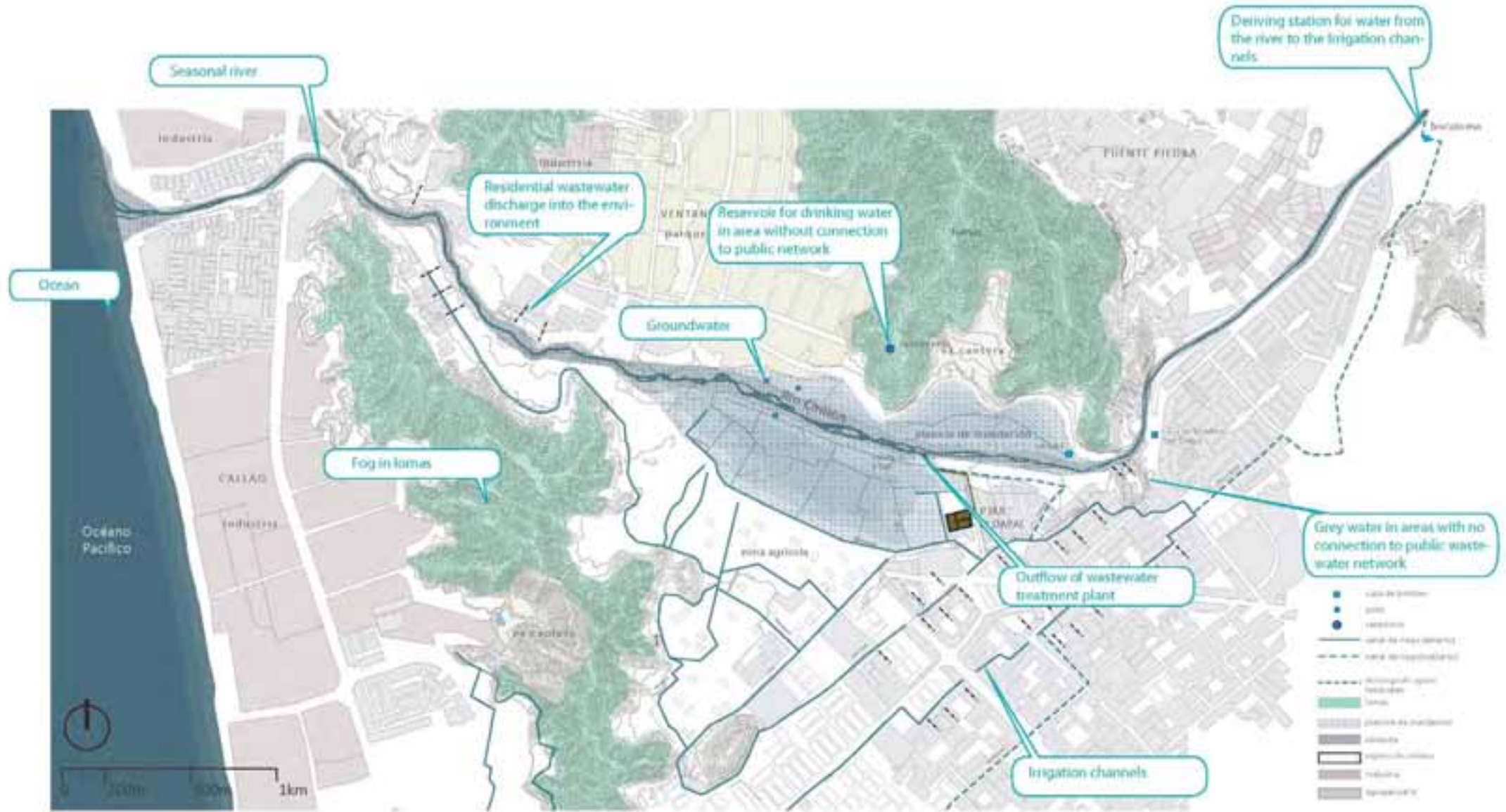


Agricultural fields in the Chillón Valley with the Pre-Inca huaca El Paraíso in the foreground.



View from the Hill Santa Cruz towards the river mouth of the Chillón River behind the mountain range in the background.

Ecological infrastructure for Lower Chillón River Watershed



Utilisation of local water sources, not drinking water and groundwater.

RIVER



IRRIGATION CHANNEL

30/37



POND



GREY WATER



Temporary installations of water sensitive design prototypes / Summerschool 2012



Needs of the local inhabitants, local knowledge and local materials.



	Sample taken in the middle of the spring, near outlet and shore
	11:00 PM
	7.1
	25.9 !
	4.6 !
	0.025
	25 !
	0
	0.5

water sampel 2: spring
muestra 2: puquio

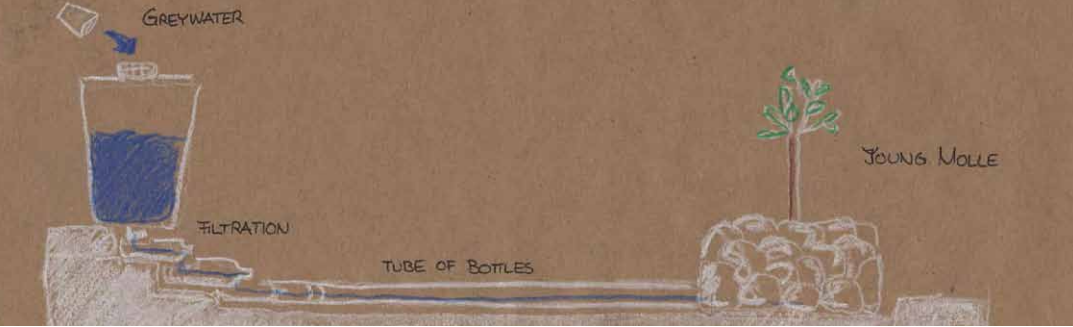
! Water Temperatures are high but not too high to support aquatic life. pH is slightly basic but is within Peru's limits for water that can be used for irrigation of short- and long-stemmed plants.

! Nitrate and Nitrite levels exceed Peru's limit for water that can be used for irrigation of short- and longstemmed plants.



Source: K.McElhinney, Master Thesis, 2012, ILPÖ

Interdisciplinary process for designing of water sensitive open spaces.



Temporary installations of water sensitive design

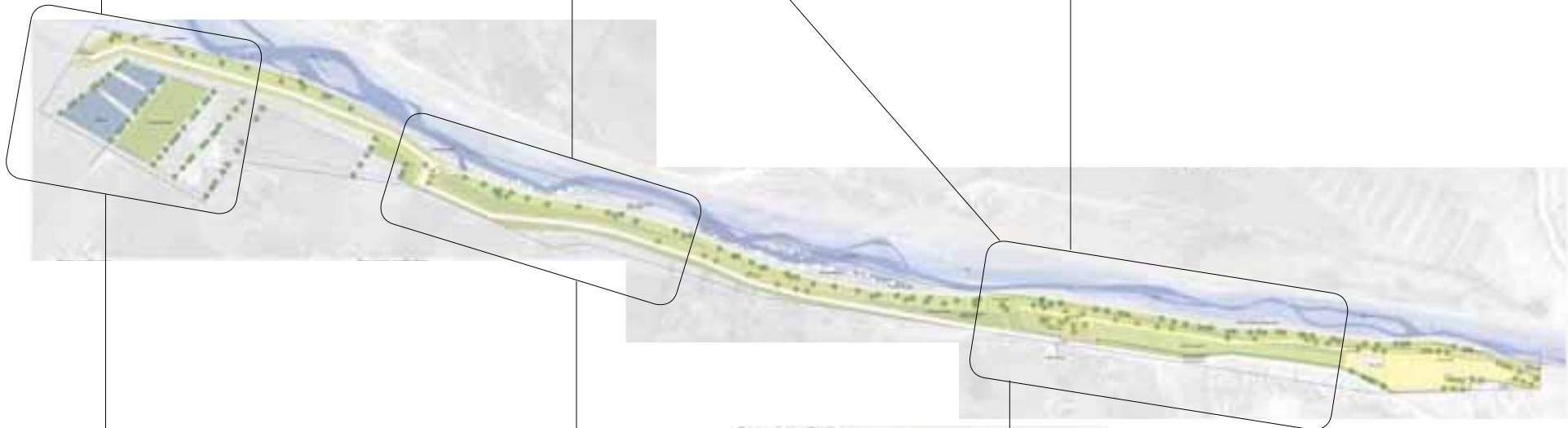
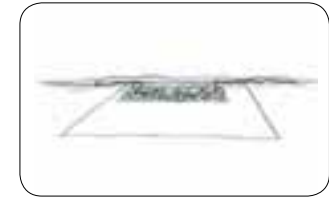
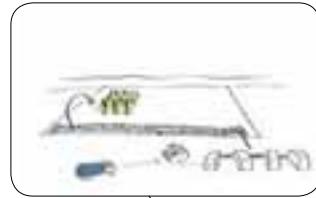
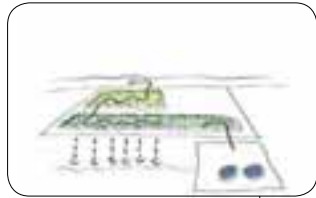
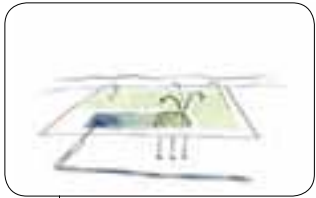
Strategic project - Seasonal River Park at the Chillón River

Treatment reservoir

Wetland park

Grey water treatment and reuse for Urban agriculture

River dike



Water purification
+ Production of agricultural products
+ Recreation
+ Saving cost for other water
+ Saving maintenance of green areas



Water purification
+ Green area
+ Recreation
= saving cost of water for irrigation of large green areas and reducing maintenance of green areas, low maintenance intensity of wetlands

Typical section: Watergardens - Waterside



Grey water purification
+ Recreation
+ Production of agricultural products
+ Save by itself
= saving cost for installation of grey water treatment and reuse in the public water treatment system
+ saving maintenance of green areas

Typical section: Watergardens Park - Upstream



Flood protection
+ Recreation
+ Green area
+ Save by itself
= saving cost for irrigation and reducing maintenance of green areas

Typical section: Watergardens Park - Downstream

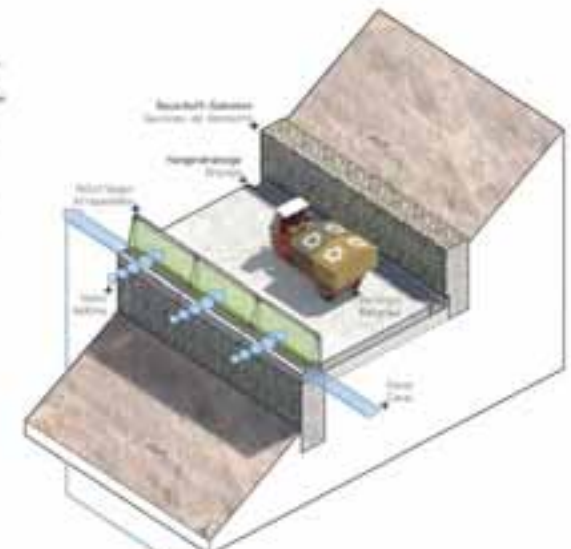
Strategic project - Lomas park ... park captures water from the fog



Nebelfänger Atrespanmitla

Das an Nebelfängergründer getragene Wasser trifft in der Kanal und fließt ab. Das untere Niveau dient als Regenrinne.

Es gibt eine feste per se angeschlossen gibt es in einem f... (text is partially obscured)

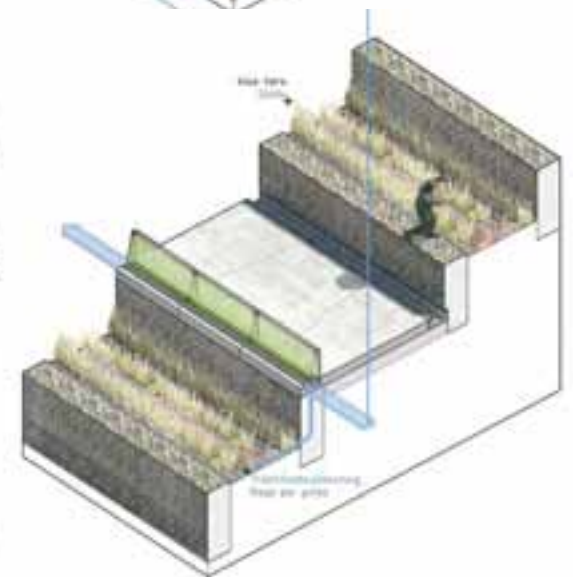


Aloe Vera Sibila

Die Aloe Vera Pflanze eignet sich für den gewöhnlichen Anbau in reiner Aloe der Lokale. Auf Grund der Technik, kann Aloe auf die Wurzeln der zuvor geernteten Pflanzen zu setzen, damit es zu besserer Veranschaulichung der Pflanzenwurzeln.

Sobal eignet sich die Bewässerung über eine Tropfbewässerungssystem.

La Sibila este... (text is partially obscured)



While designing a place/area we alter the water flows. A planned intervention, based on the understanding of the urban water cycle and natural processes, initiates new natural process with new ecosystem services for the city.

Such places can provide services such as water purification, wastewater purification, water harvesting from fog and nutrients recycling, and thus create an essential and regenerative infrastructure for the city.

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Research project LiWa (Lima Water)

<http://www.lima-water.de/>

Integrated urban planning strategies and planning tools (May 2011 - May 2013)

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