

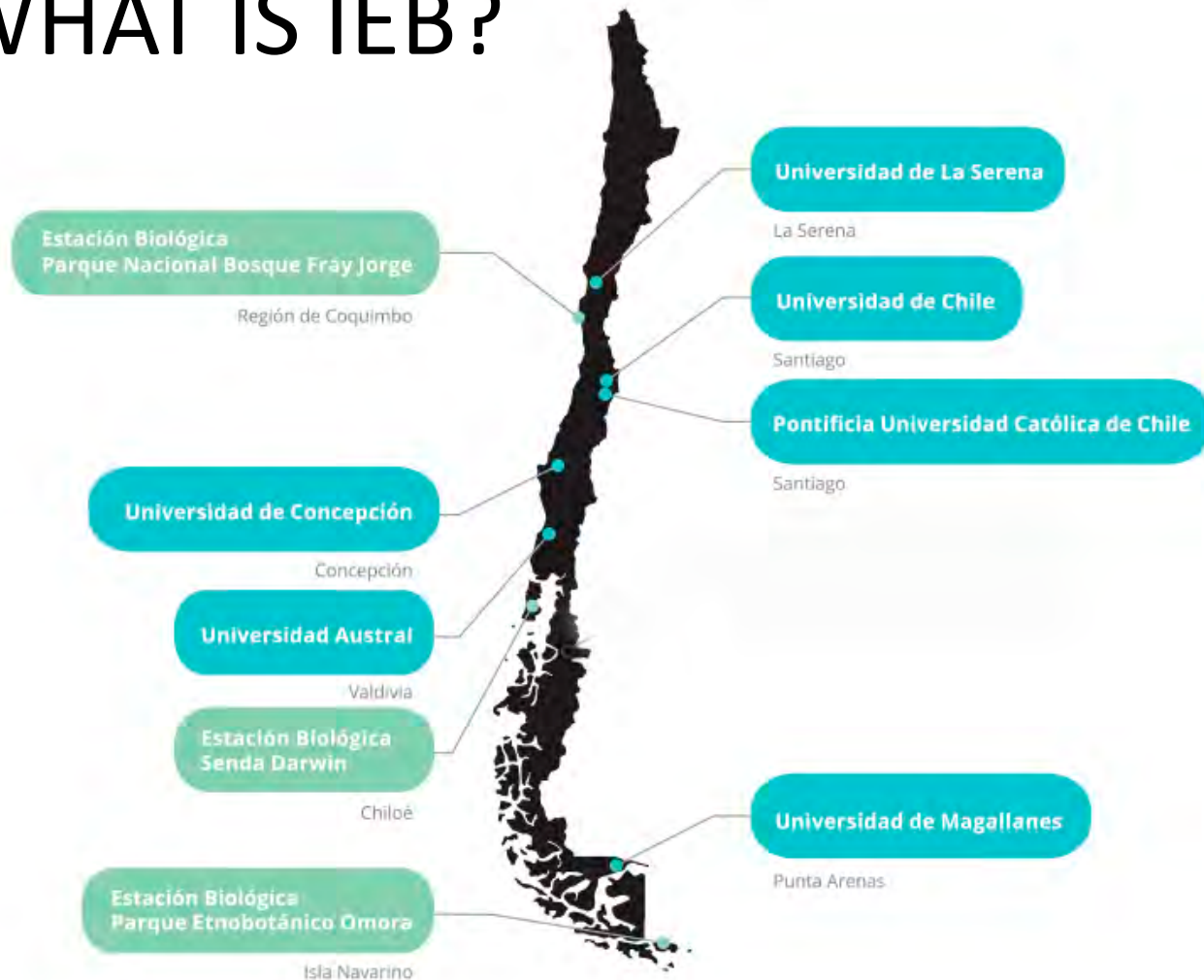


Workshop on Water Resources Management
Institute of Ecology & Biodiversity

Linking hydrology and ecosystem services for human wellbeing: case studies from mountains, forests and cities

Dr. Olga Barbosa
Universidad Austral de Chile
June 2018

¿WHAT IS IEB?



Research Center funded by MILENIO and PIA CONICYT → Network of researchers universities, and biological stations

IEB & WATER

MEDITERRANEAN AREA |

Conservation with wine industry
- *EUA study for native cover crops in vineyards.*

CONCEPCION | *Laboratory of biological invasions – invasives and water use*

CHIOLOE | *Causes and effects of water scarcity on ecosystems and local inhabitants*

CHIOLOE | *Selective cutting forest and quality of the estuaries that drain basins with evergreen forest*



CENTRAL CHILEAN ANDES | *Drought and resistance to freezing in high mountain plants*

VALDIVIA | *Urban ecology and wetlands conservation*

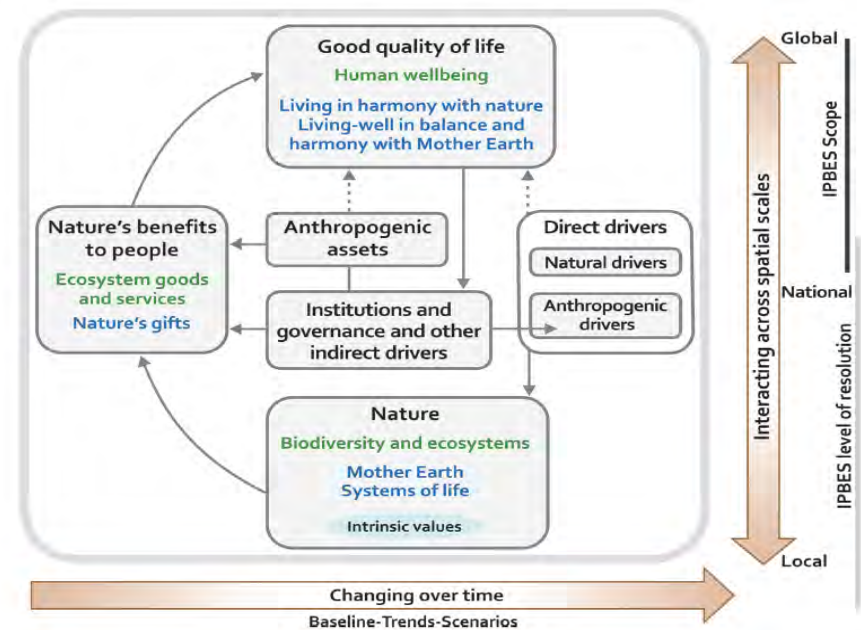
CHIOLOE | *Carbon balance in the forest and peatbog in the Senda Darwin*

OMORA PARK | *Freshwater invertebrates of Cape Horn and Antarctica*

CONCEPTUAL MODEL: Ecosystem Services

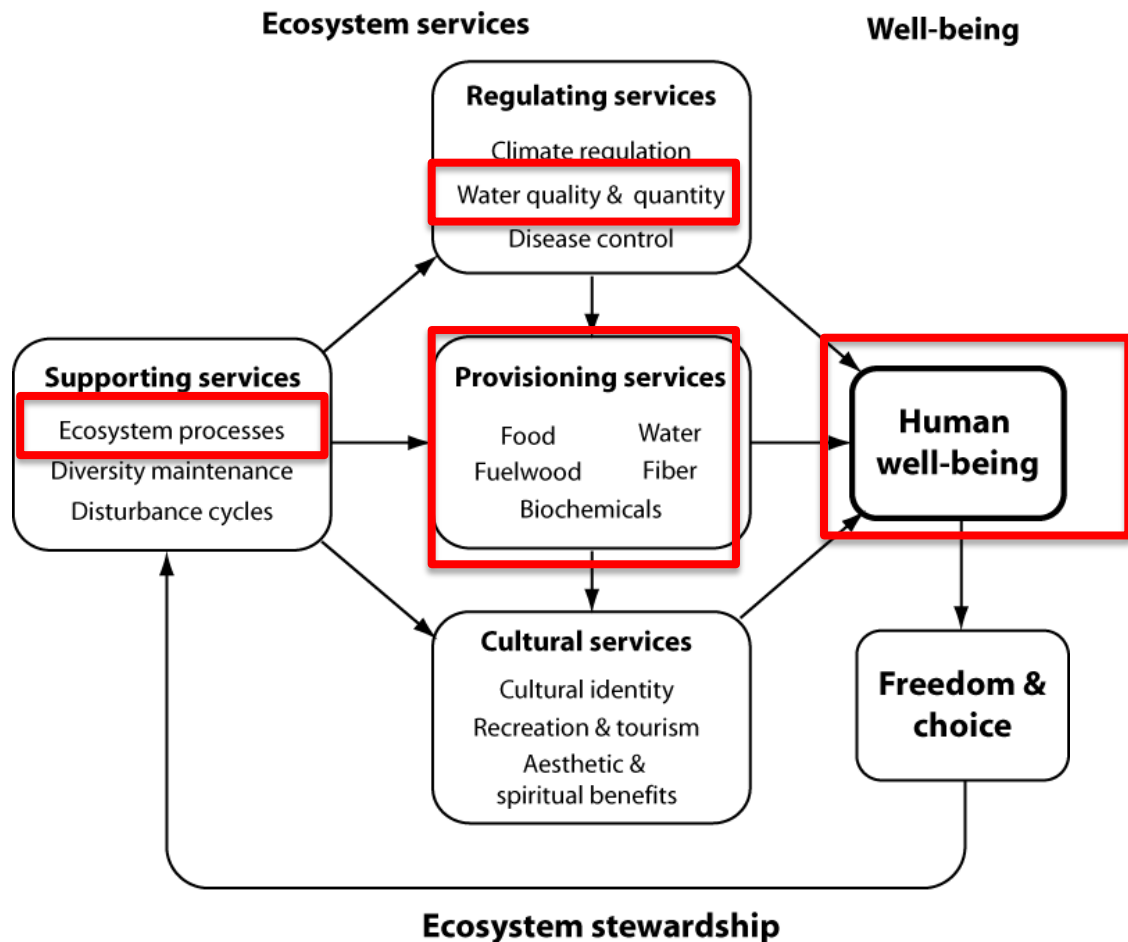


Millennium Ecosystem Assessment 2005



Intergovernmental Science-Policy
Platform on Biodiversity and
Ecosystem Services 2017

Ecosystem services from the *earth stewardship approach*: water as a connecting element



Dynamic water distribution: coupled effects of land change use and climate change



CHILOÉ WATER SCARCITY FOR HUMAN USE

- The rural communities of the Chiloé Archipelago have water supply problems for human use during the last 8 summers.
- Today problem is tackled by Municipalities and Regional Government with emergency actions → distributing water in trucks.
- High cost temporal solution → does not cover the basic needs of water for human consumption established by the World Health Organization (WHO; Howard and Bartram 2003).



Facing the two sides of Chiloé Island



- 8 of 10 Municipalities of Chiloé Province executes emergency programs for water supply to rural locations
- The Municipalities most affected were Quemchi (12000 people) and Ancud (7000 people)
- 24 million liters of water were delivered to more than 24000 inhabitants between December 2014 and April 2015. (Frêne *et al.* 2017)

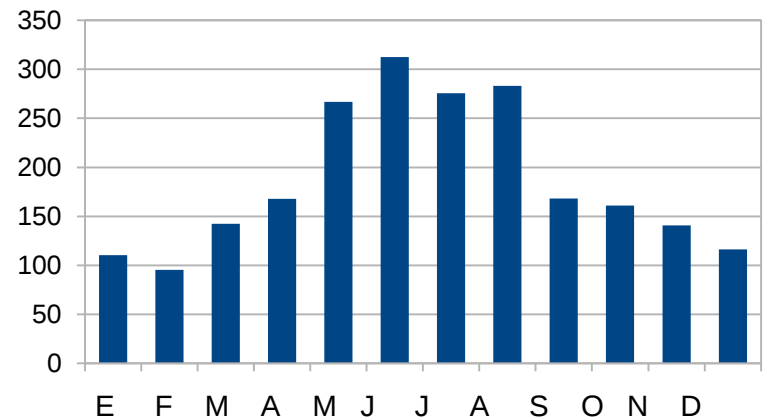
Causes and effects of water scarcity : Climate Change (models predicted this!)

Changes in precipitation patterns:

25% **summer rain decreases** by 2050 (Aceituno *et al.* 2007) + **higher rainfall intensity in fall and winter** → summer droughts that negatively affects water provision for agricultural activity and ecosystem functioning (CR2 2016).

Summer precipitation (%) according to
annual rainfall

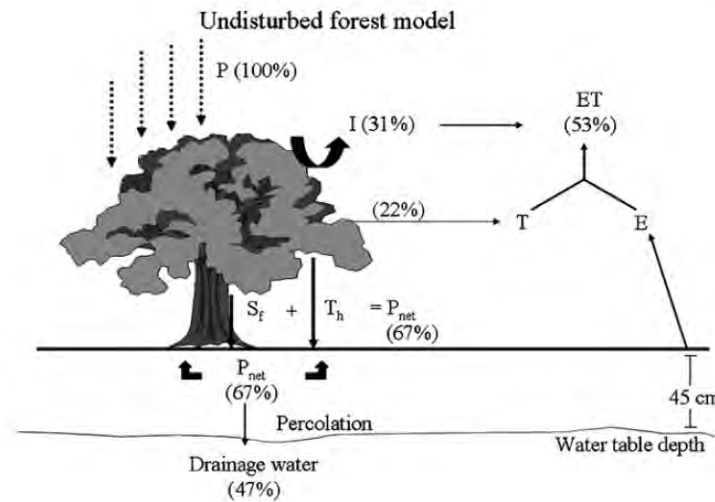
Rain annual pattern (mm / month)



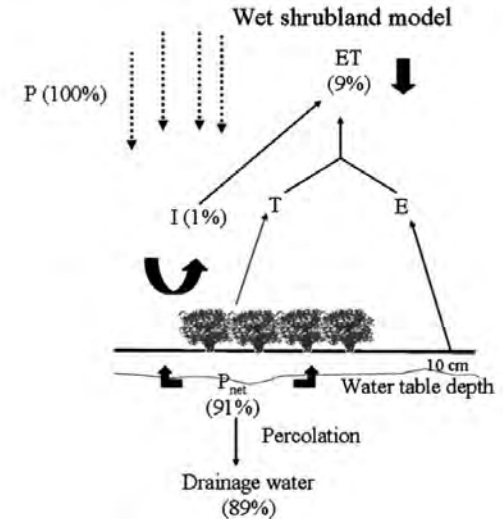
Causes and effects of water scarcity: Land Change Use

Land use change in the last 100 years has diminished the capacity of watersheds to store and regulate water flows, due to loss or degradation of forest ecosystems and wetlands

Evapotranspiration → percolation → water table depth



Water balance in a 60 year Chiloé evergreen forest (2002-2003)



Water balance in a Chiloé shrub succession after forest clear-cut (2002-2003)



Diaz et al 2007

Solution: Participatory drinking water network (RPA) with 3 main components

- Log term hydrologic monitoring
- Design of water distribution network plus raising public funds water intake (government and municipality)
- Watershed management plan (establishing good practices to increase soils store water capacity and regulate streamflow at catchment scale)

STAKEHOLDERS involvement:

Local governments are key actors, both to finance infrastructure and to promote local water governance process.

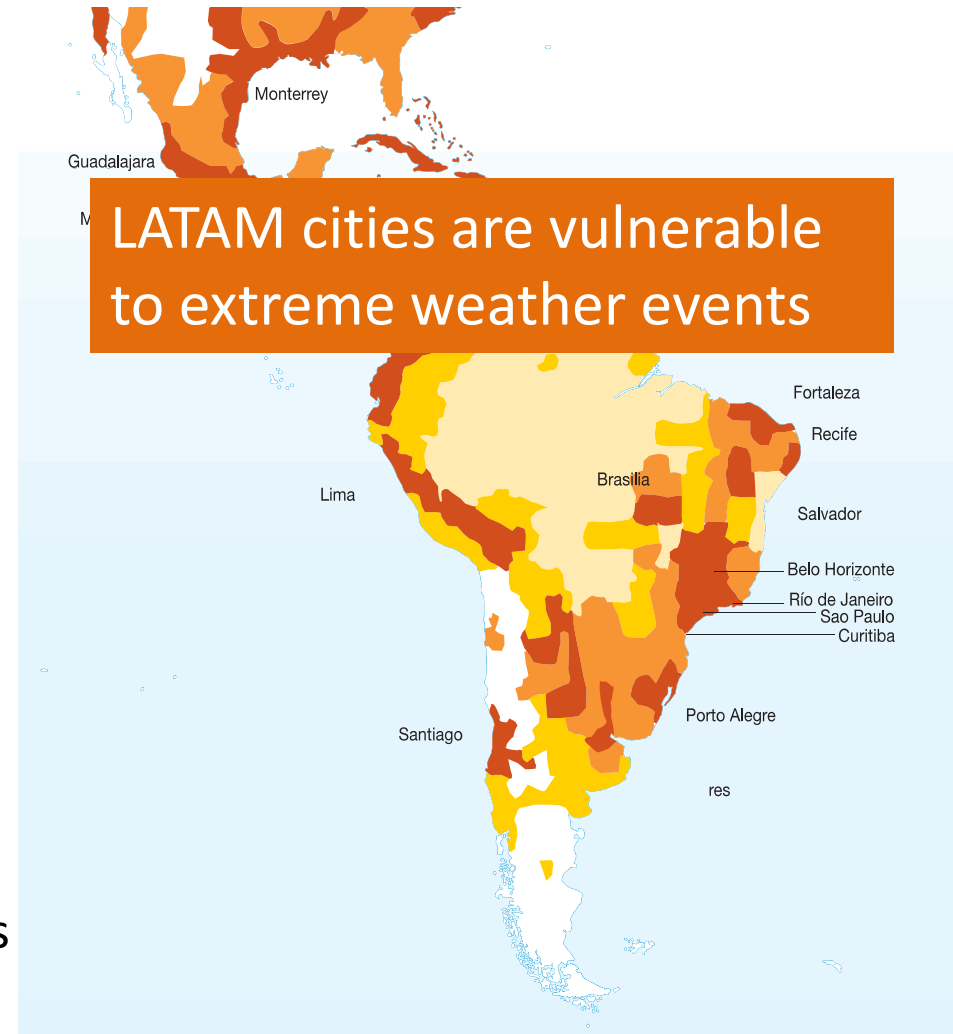


LATAM | CITIES, NATURAL HERITAGE AND VULNERABILITY TO CLIMATE CHANGE



Regional Assessment of Latin America: Rapid Urban Development and Social Economic Inequity. Pauchard & Barbosa 2013

Social inequity is amplified in urban areas
Barbosa & Villagra 2015



VALDIVIA: URBAN RESILIENCE TO EXTREME WEATHER EVENTS

- Current population: 165,000
- Biodiversity hotspot situated in temperate rainforest and wetlands
- Mean annual precipitation = 1870 mm
- Rapid development and sprawl into wetlands
- Unregulated real state market
- Significant increase in urban flooding
- Sustainability initiatives, but little funding

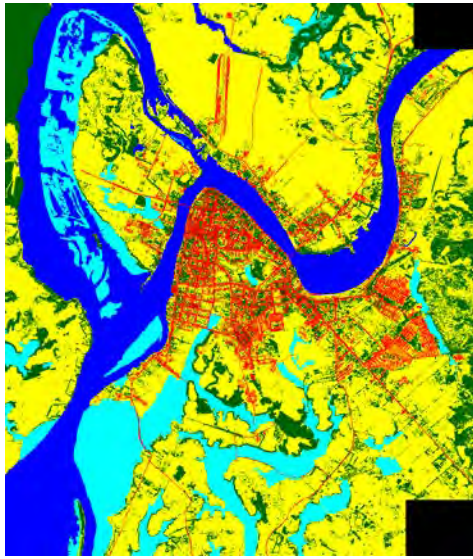


Valdivia Surface has dramatically changed in time: earthquakes, fires, agriculture, urbanization

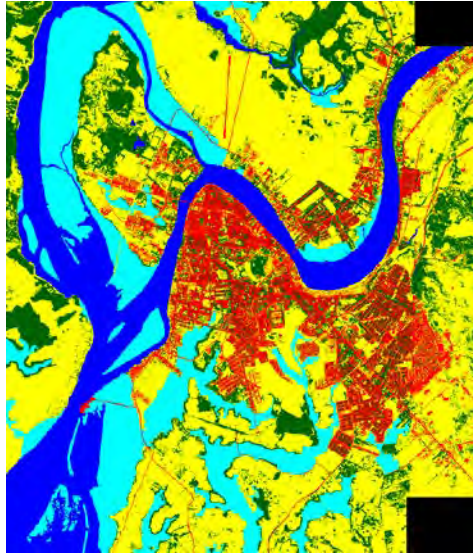
TRIMETROGON 1943



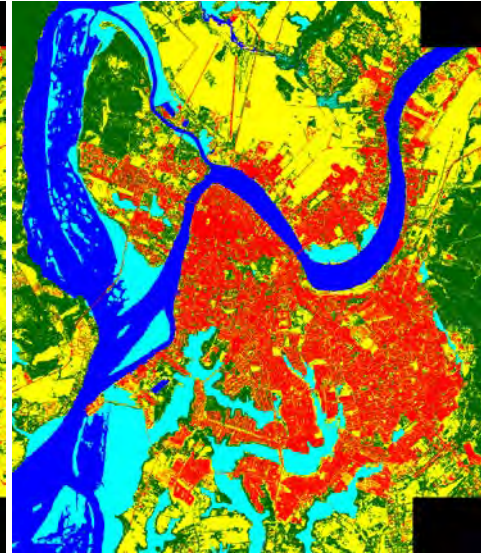
OEA 1961



CH39 1983

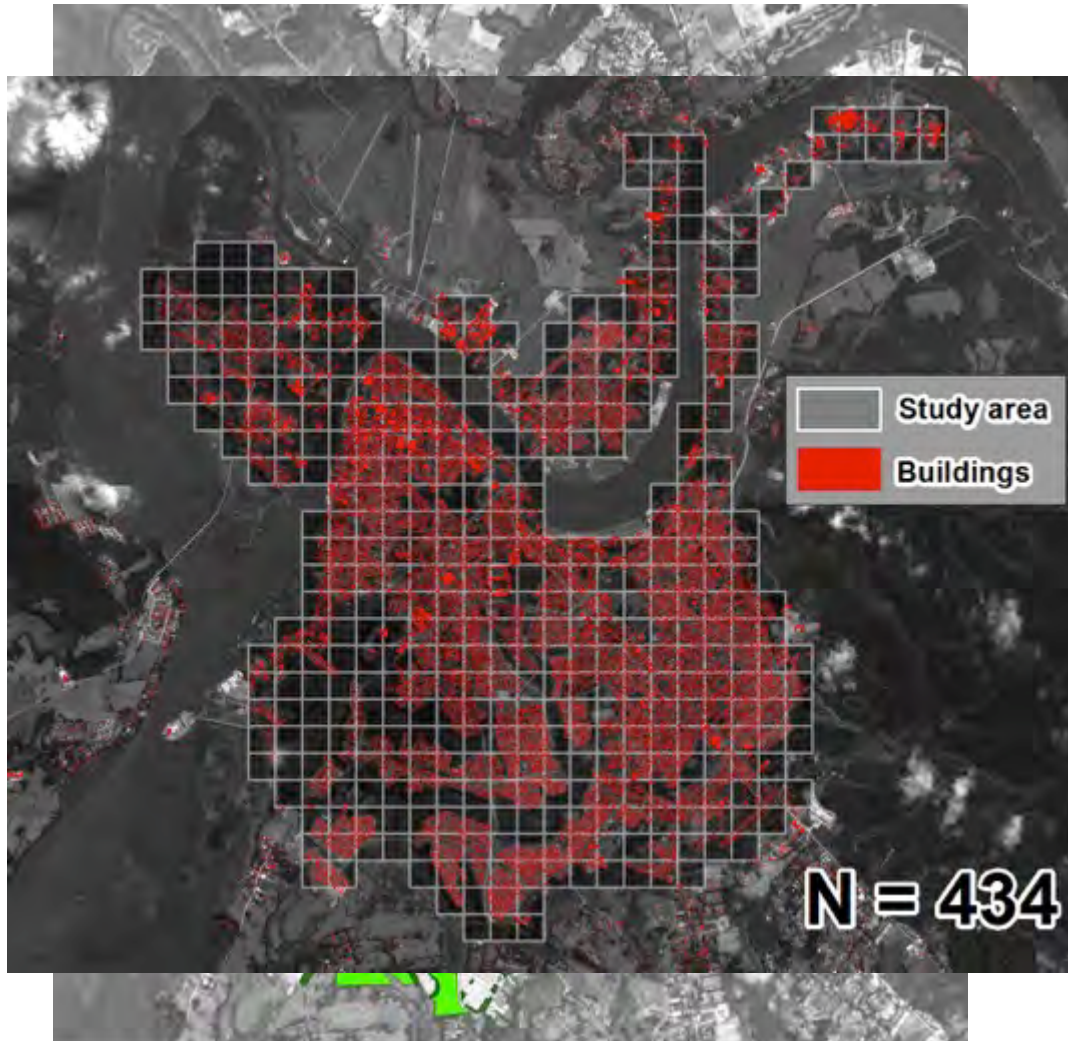


GeoEye 2010



How these changes have modulated ecosystem
services provision in time?

Urban form and ecosystem services provision



57% → non sealed surface

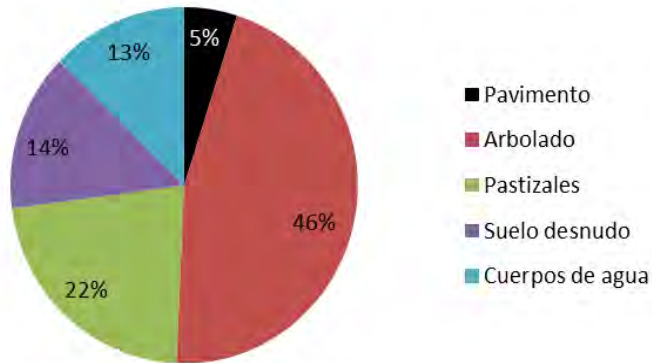
Green spaces - Formal GS :
11,6%

Green spaces - Informal GS:
23,6%
(10% = wetlands)

Domestic gardens: 27,9%

Green spaces have very different ground cover depending in their formal informal status

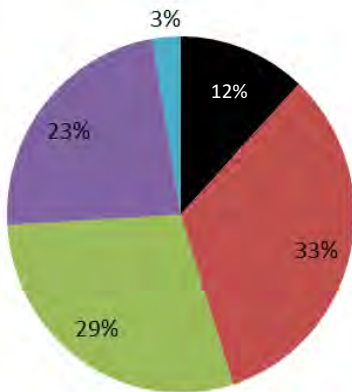
Cobertura Avs Totales



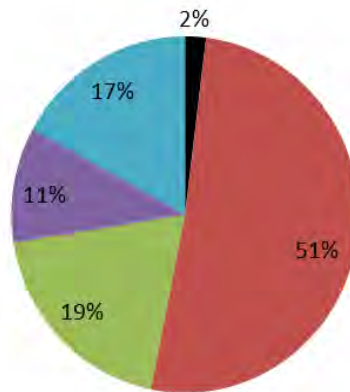
Informal Green Spaces: less in number, bigger size double de Surface of all formal Green spaces

Informal Green Spaces: have more trees, water and less pavement and bare soil

AVs Formales



AVs Informales



Urban form and type of green space will affect city hydrology

Loosing the function of wetlands and flood mitigation

 Humedales monitoreados
 Cuencas de humedales



Storage dynamics and capacity of wetlands

Installing surface water level monitoring

Monitoring seasonal soil moisture content

Future work: Stormwater and flood exposure

Updating city's stormwater management model (EPASWMM) with storage dynamic data → how to combine current infrastructure of storm water collector with Green Infraestructura (wetlands and more)



Historical context?

... wetlands are a huge challenge

Valdivia, the city of water?



Dutch map (ca. 1643) - Universidad de Göttingen, Germany .

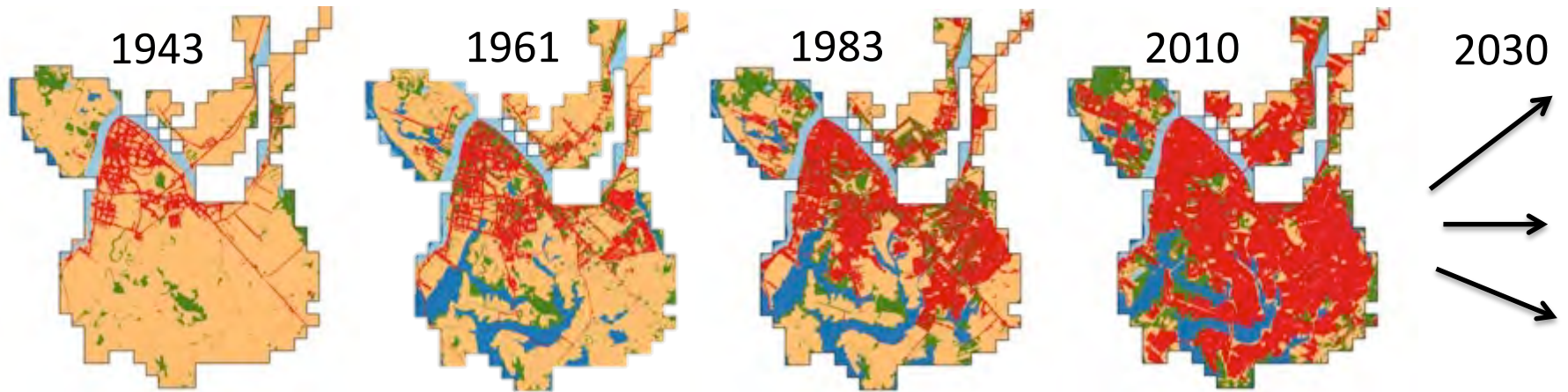
“Guadalfquén”: River

Mallín: underwater pastures(vega)

Catrico: drainage

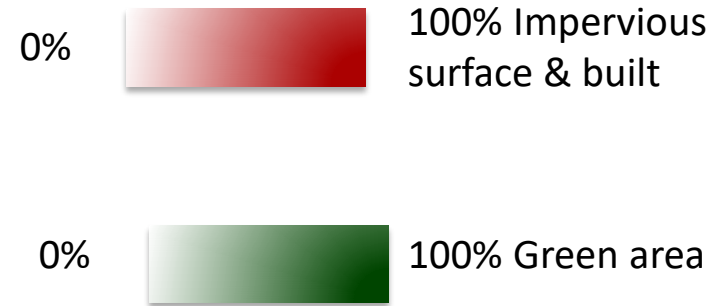
Canoa monoxila: individual canoe

Framing the past, present, and future of Valdivia



Strategic future (2030) scenarios: existing strategies

Business as usual: lack of regulations



Smart growth: increased density

Valdivia Sustainability Plan of Action



BID 2015

Urban Resilience to Extreme Events Sustainability Research Network



Baltimore, MD

Hermosillo, Mexico

Mexico City, Mexico

Miami, FL

New York, NY

Phoenix, AZ

Portland, OR

San Juan, PR

Syracuse, NY

Valdivia, Chile



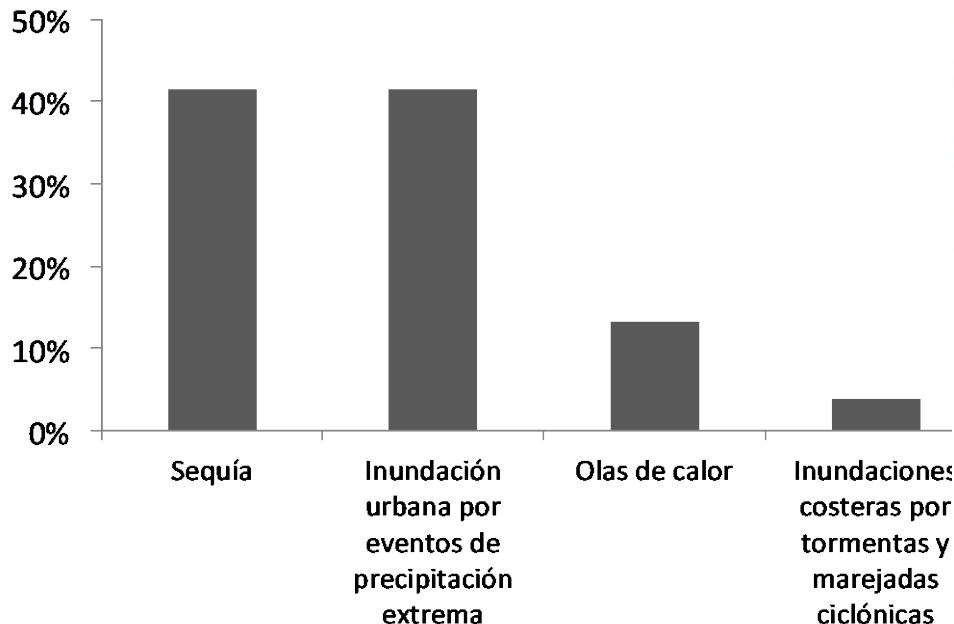
Universidad Austral de Chile
Conocimiento y Naturaleza



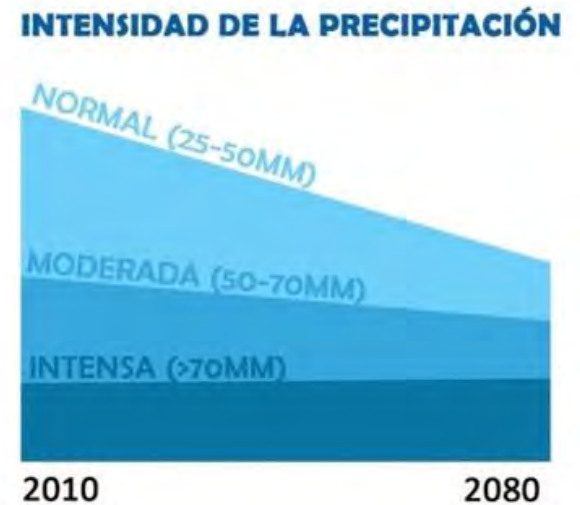
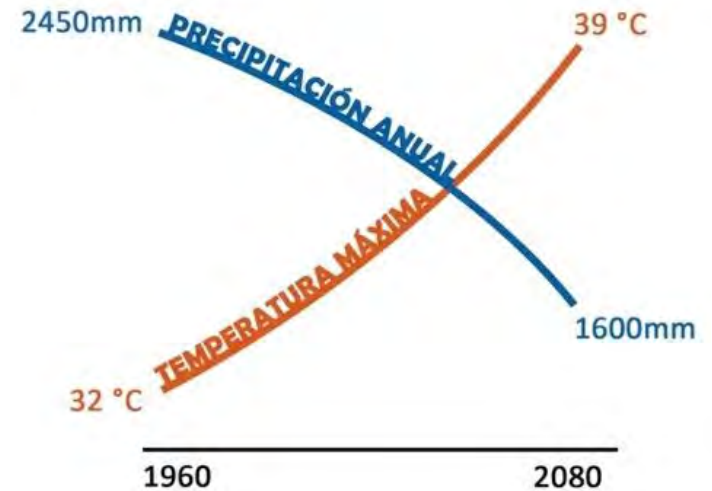
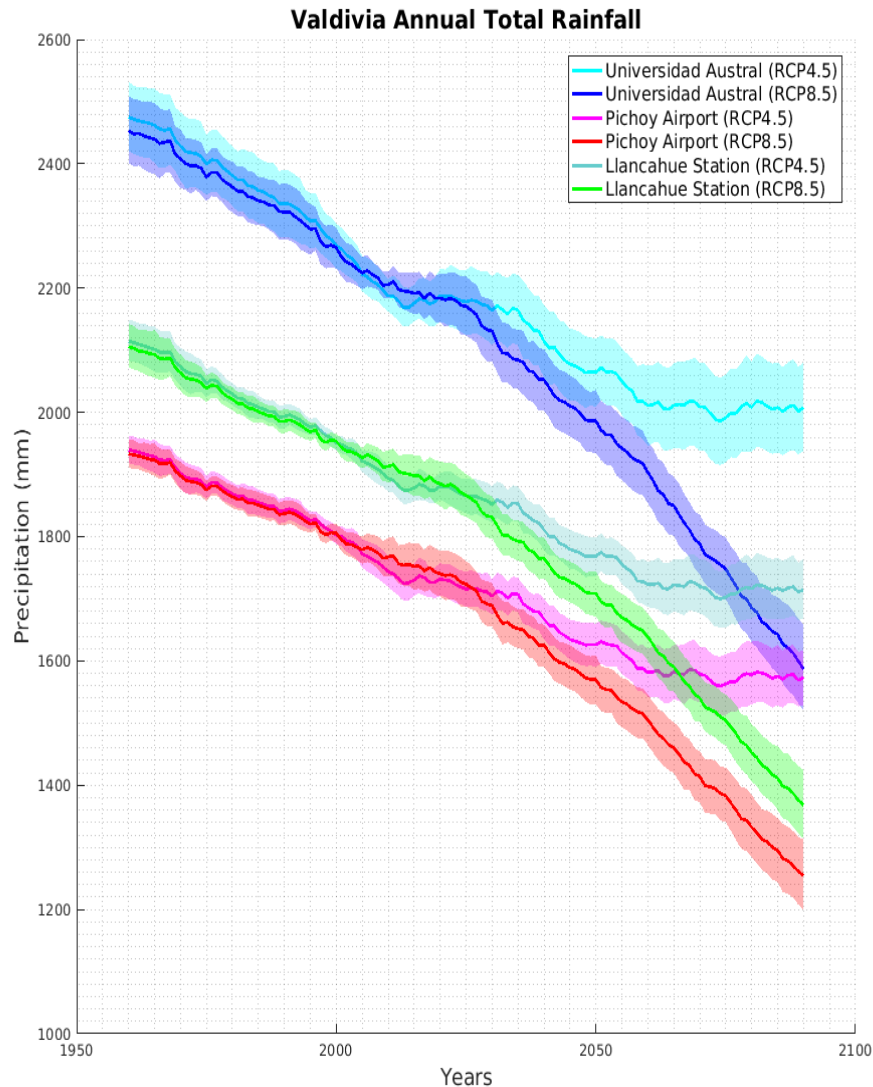
46 participants: Decision makers from local and central government, community leaders, private sector

What's your vision for “Valdivia of the future”

Future weather events that Valdivia will face?



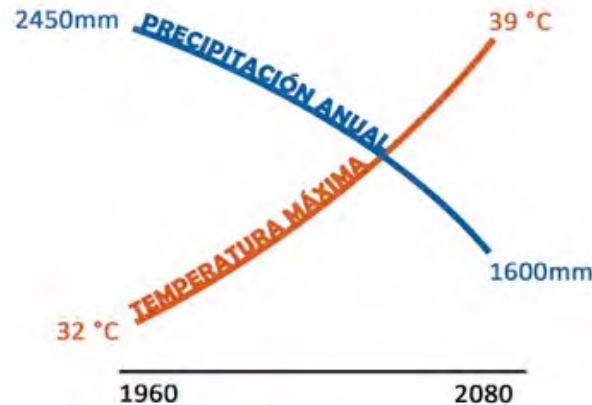
Putting data in the right language



Working with local stakeholders to feed climate models to achieve a better of future with climate projection data



Historic trends and current vulnerability to extremes (e.g., current inundation zones in Valdivia)



Future precipitation and temperature projections (e.g., Valdivia; Climate & Hydrologic Extremes working group)



SETS strategies identified in practitioner survey and existing governance documents to address extreme events (e.g., Valdivia flooding strategies)

Valdivia scenarios

**Transformative:
Inclusive City**



**Transformative:
Innovative City**



**Transformative:
Eco-Wetland City**



**Transformative:
Friendly City**



**Adaptive: City Resilient to
Flood & Drought**



Linking knowledge and visions to action

Co-produced future visions help
refine and achieve sustainability &
resilience goals



Valdivia **Sustainability**
Plan of Action



Support long-term planning and decision making

Conclusion: Work in progress

- Water scarcity and seasonality plus extreme weather events are URGENT topics to address
- We are constrained by data availability to improve our analytical power → collaboration is essential
- If we do not engage stakeholders in our research questions, it will be difficult to expect changes in policy making!!!



¡THANK YOU VERY MUCH!

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Management**

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More info at:

<http://icaev.cl/academicos/olga-barbosa/>

www.ieb-chile.cl

<https://sustainability.asu.edu/urbanresilience/>

www.vccb.cl