

Progress on groundwater processes understanding in the hyper arid northern Chile and implications for groundwater management

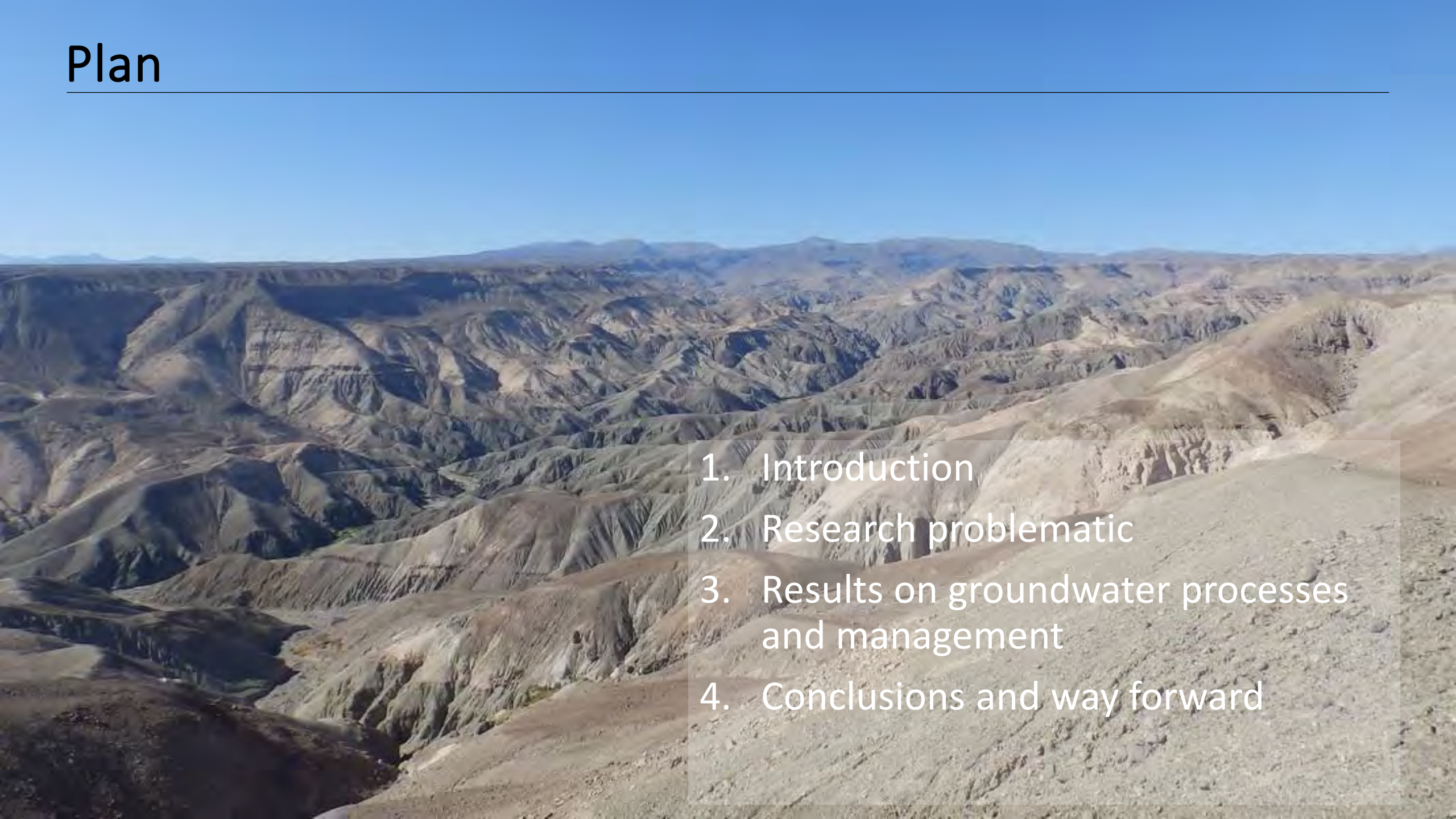
Elisabeth Lictevout

Chile-China workshop on water resources management in China and Chile

Santiago, Wednesday, June 27th, 2018



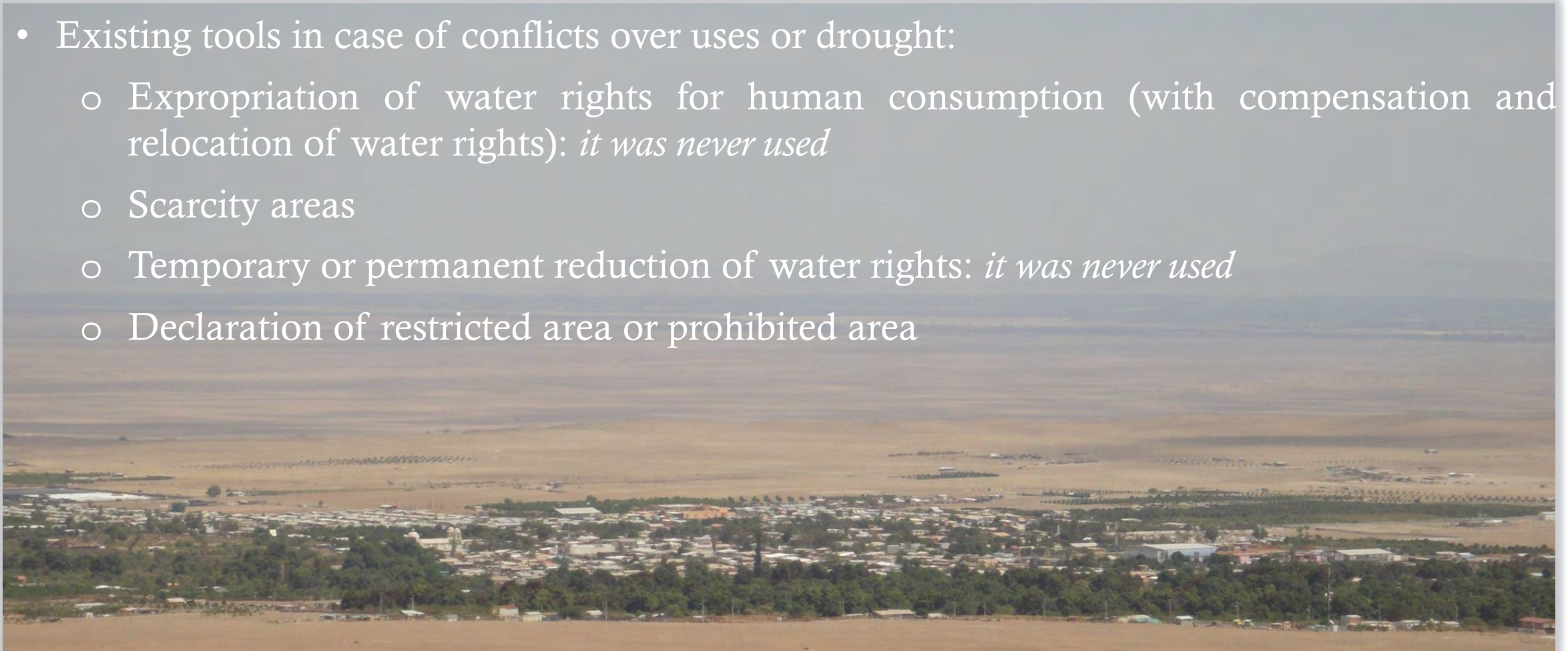
Plan

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1. Introduction
 2. Research problematic
 3. Results on groundwater processes and management
 4. Conclusions and way forward

1. INTRODUCTION

Groundwater management in Chile

- Groundwater extraction starts in the 1980s (surface water granted / large mining projects).
- Same (surface water) legislation was applied to groundwater
- DGA estimates the balance recharge vs. demand. If $>0 \Rightarrow$ DGA grants water rights
- Existing tools in case of conflicts over uses or drought:
 - Expropriation of water rights for human consumption (with compensation and relocation of water rights): *it was never used*
 - Scarcity areas
 - Temporary or permanent reduction of water rights: *it was never used*
 - Declaration of restricted area or prohibited area

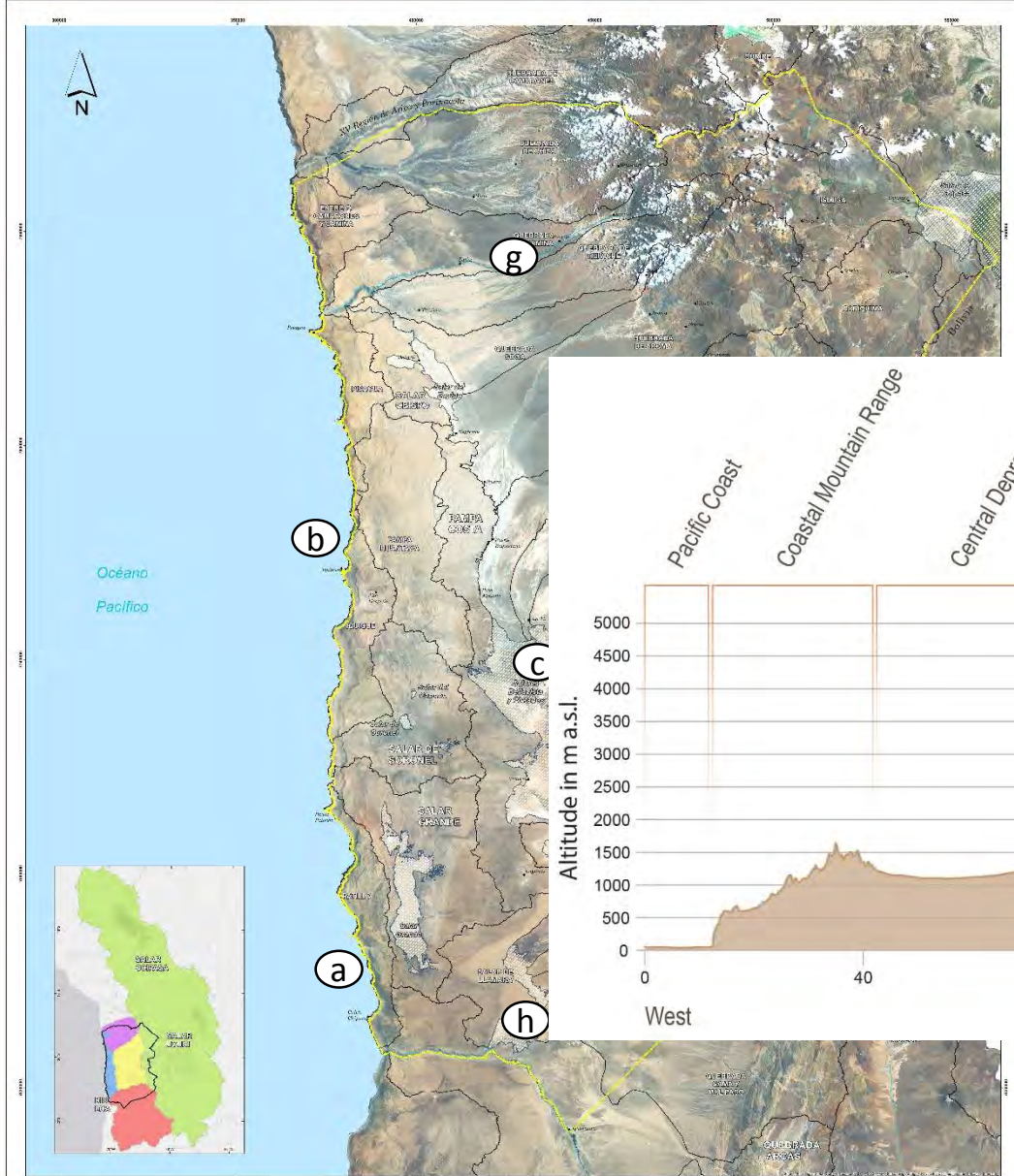


1. INTRODUCTION

Groundwater management in Chile

- How and when to declare a restriction area?
 - Severe groundwater levels dropdown
 - Demand higher than recharge
 - Studies show that the demand caused a reduction of more than 5% of the volume stored during a period of 50 years
 - Risk superficial water courses flows affectation
 - Increase of extractions in one sector affects the availability in other sectors
 - Contamination risk





LEYEND

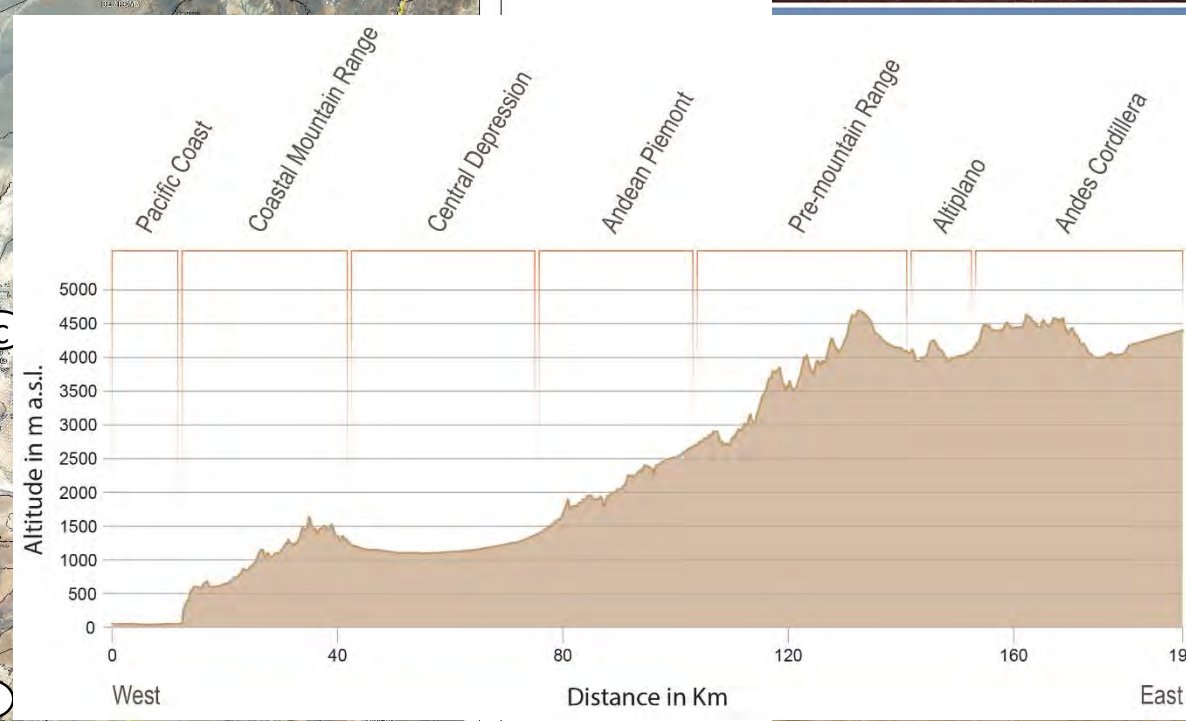
Hydrographic Units

- Zone I. Coastal Unit, arheic
- Zone II. Central Depression Unit, endorheic
- Zone III. Altiplano Unit, endorheic
- Zone IV : Salar de Llamara – Rio Loa Unit, exorheic
- Zone V. Camiña Unit, exorheic

- Water catchment or sub-catchment limit
- Region of Tarapaca limit
- Main quebradas
- Streams
- Localities

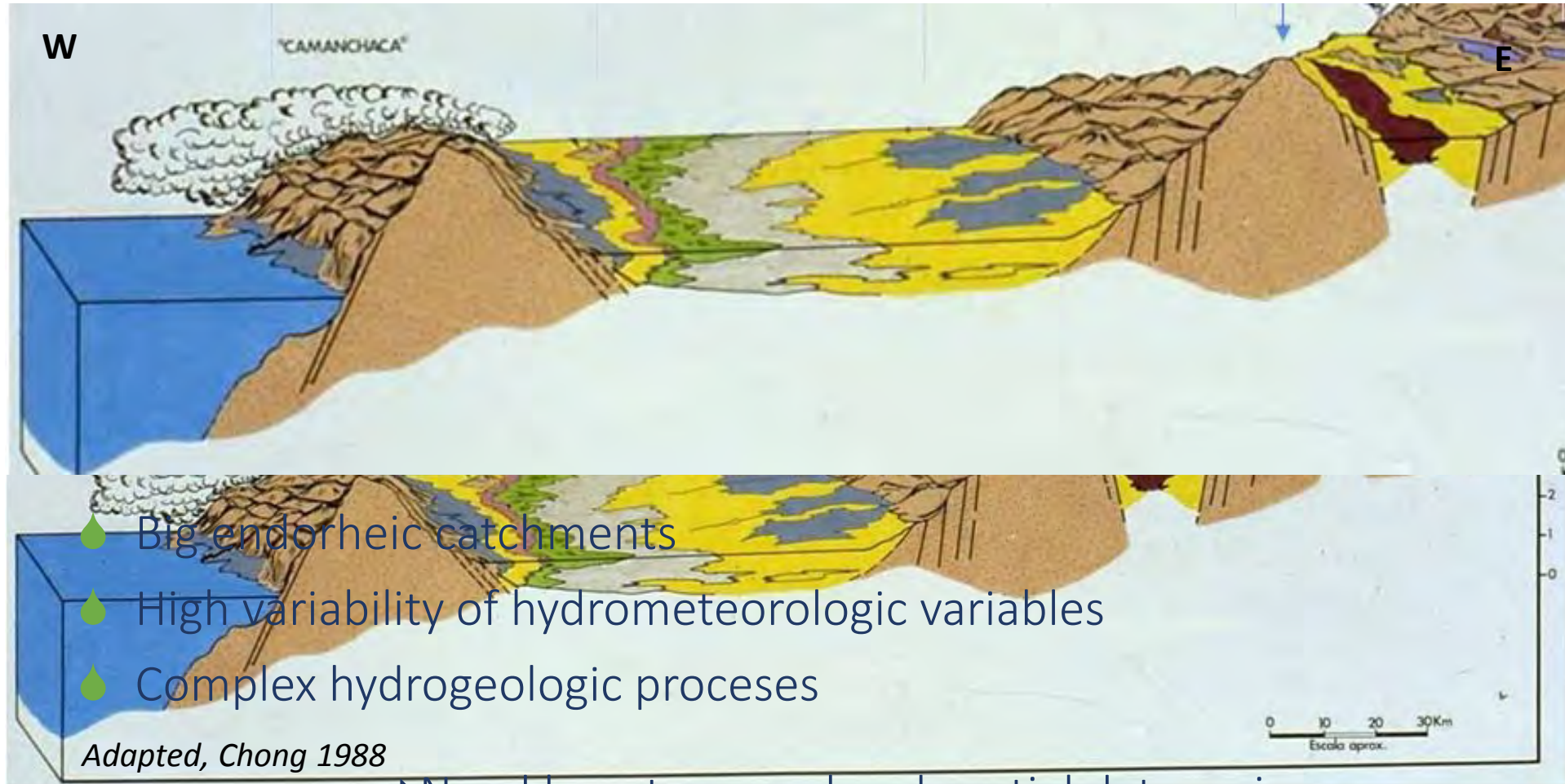
0 10 20 40 60 80

Datum WGS 1984 Huso 19 Sur



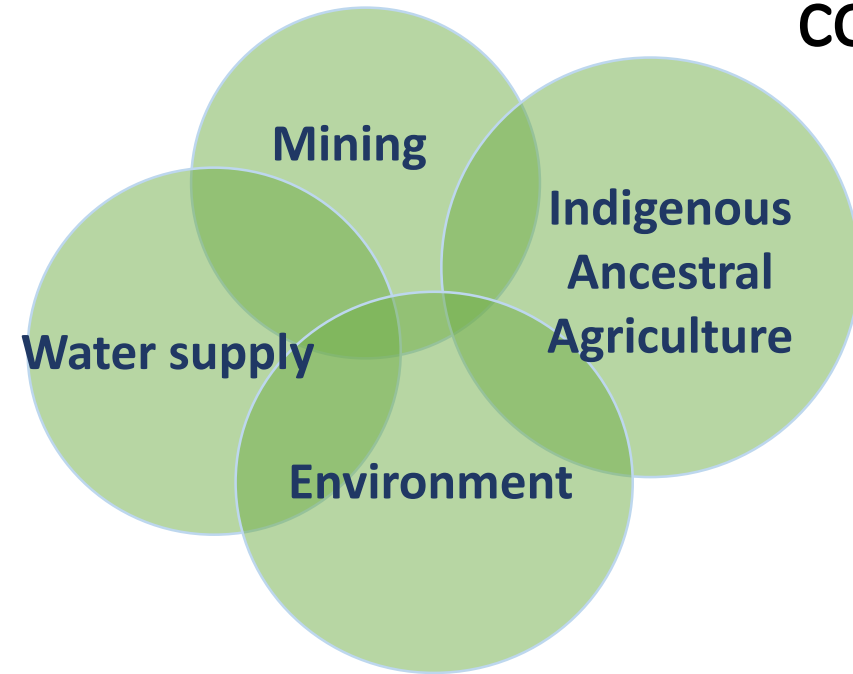
1. INTRODUCCIÓN

Climate, geomorphology & hydrology



⇒ Need long temporal and spatial data series

Water resources and socioeconomic context

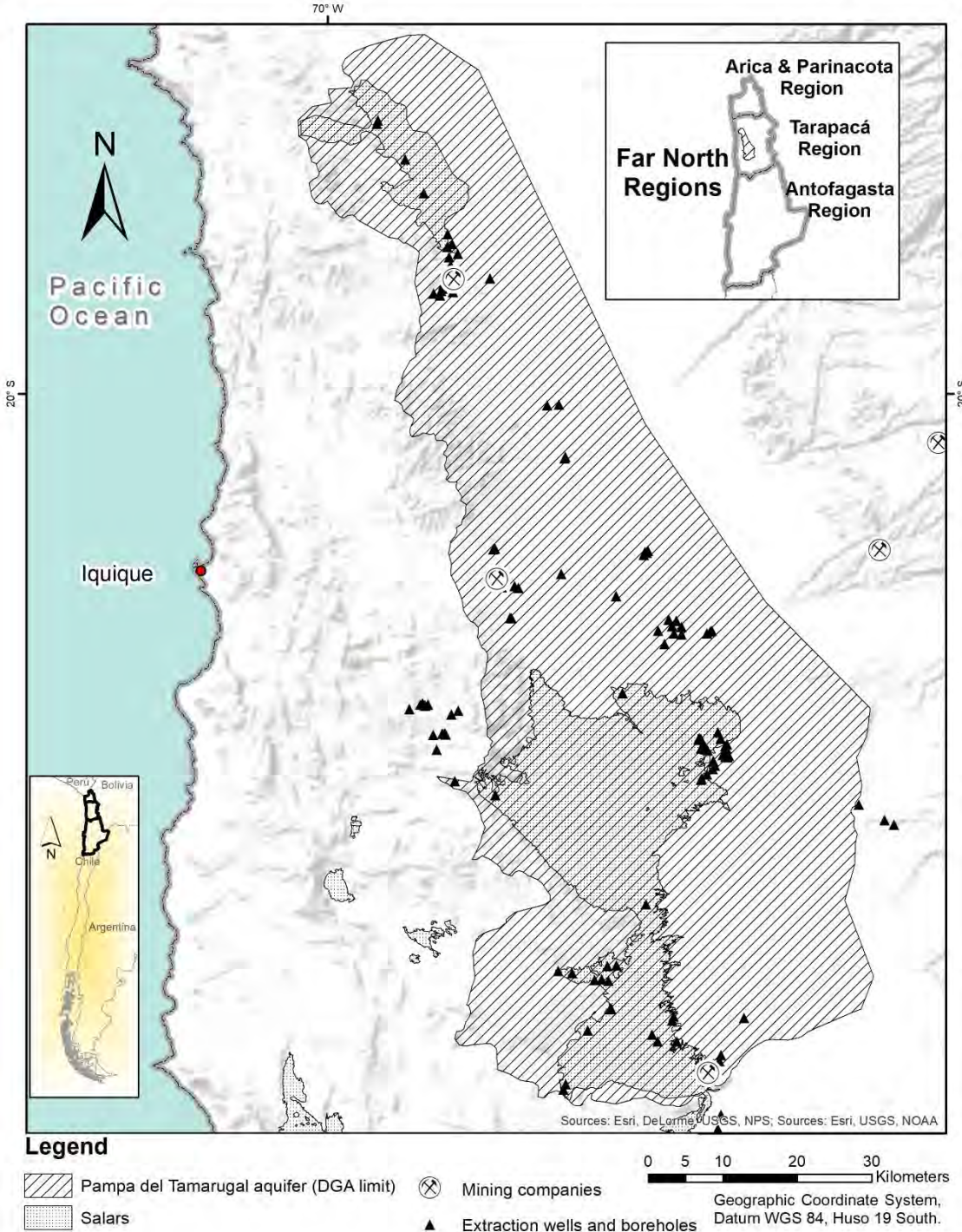


→ Competition for water use

→ High demographic rate

Pampa del Tamarugal Aquifer :

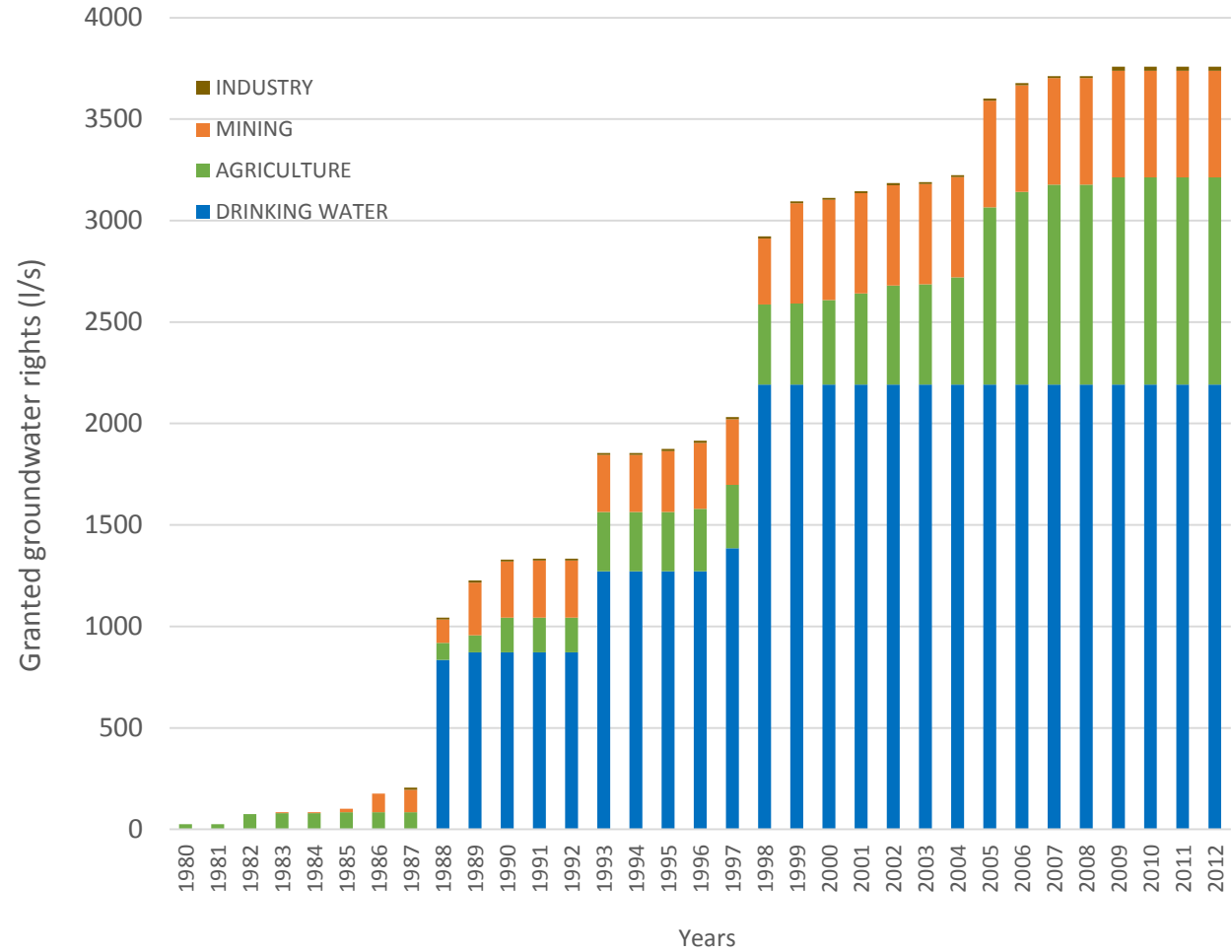
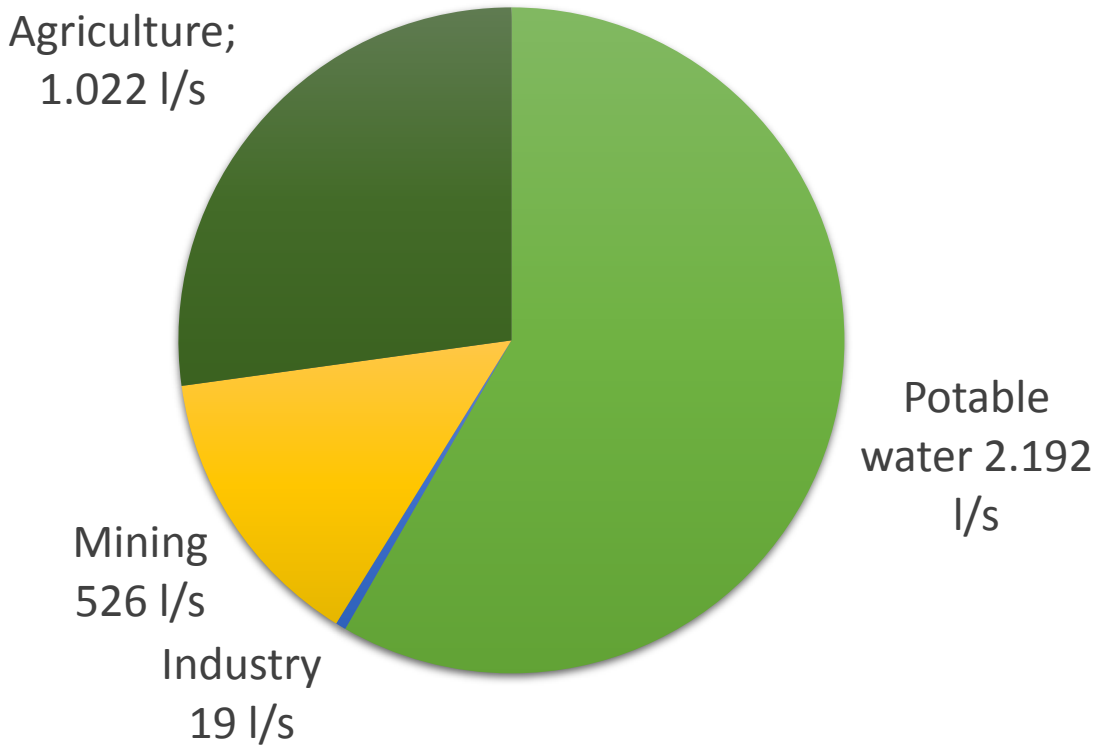
- Important water resource for the Northern Chile
- Declared restricted area in 2010



1. INTRODUCTION

Water resources and socioeconomic context

Share of groundwater rights allocated between type of use in the Pampa del Tamarugal aquifer



2. Research problematic

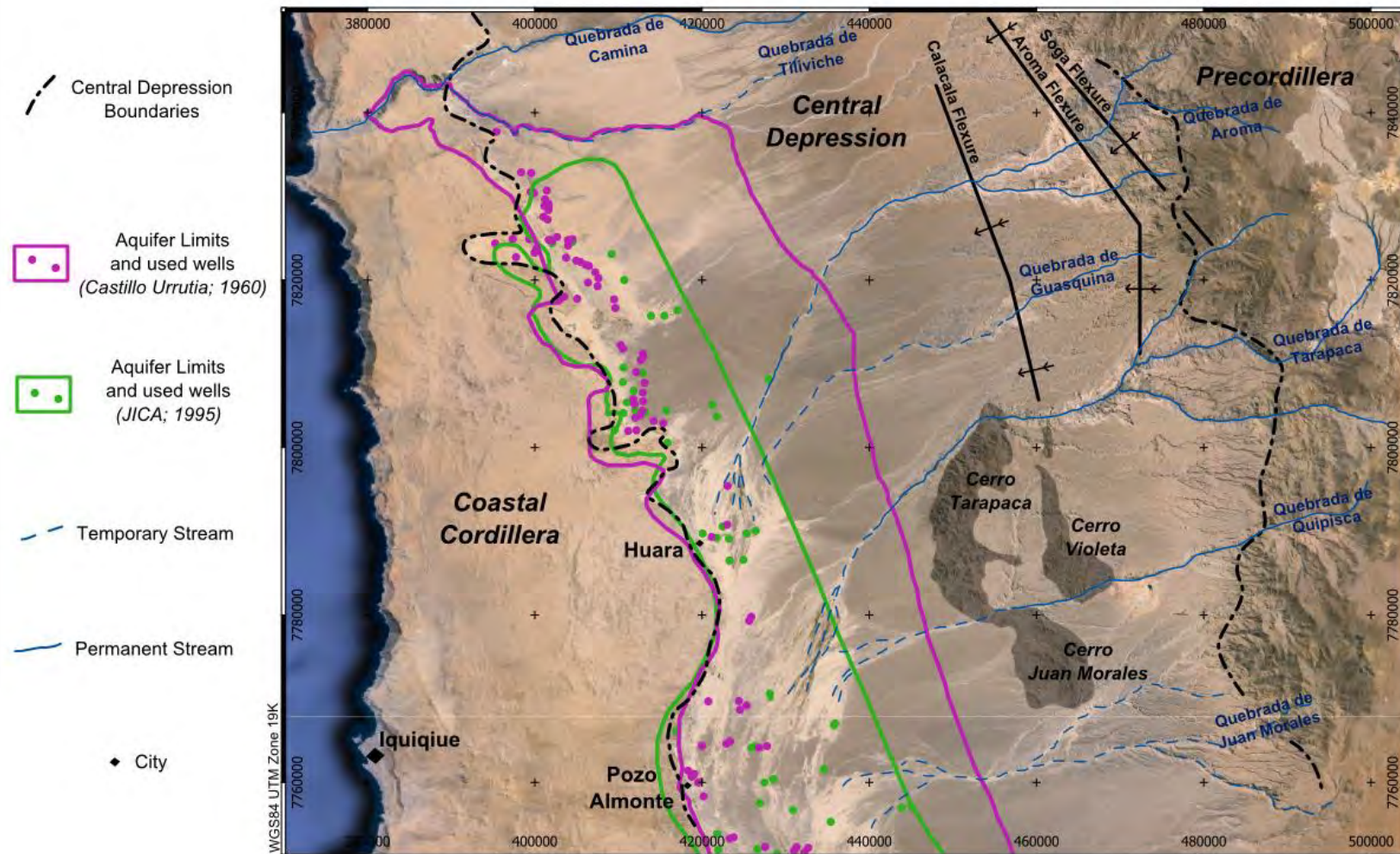
1. Groundwater processes understanding

Questions:

- ¿Aquifer limits?
- ¿Recharge?
- ¿Evolution in the last decades?

Objective:

- Conceptual model elaboration
- Predictive model elaboration



2. Research problematic

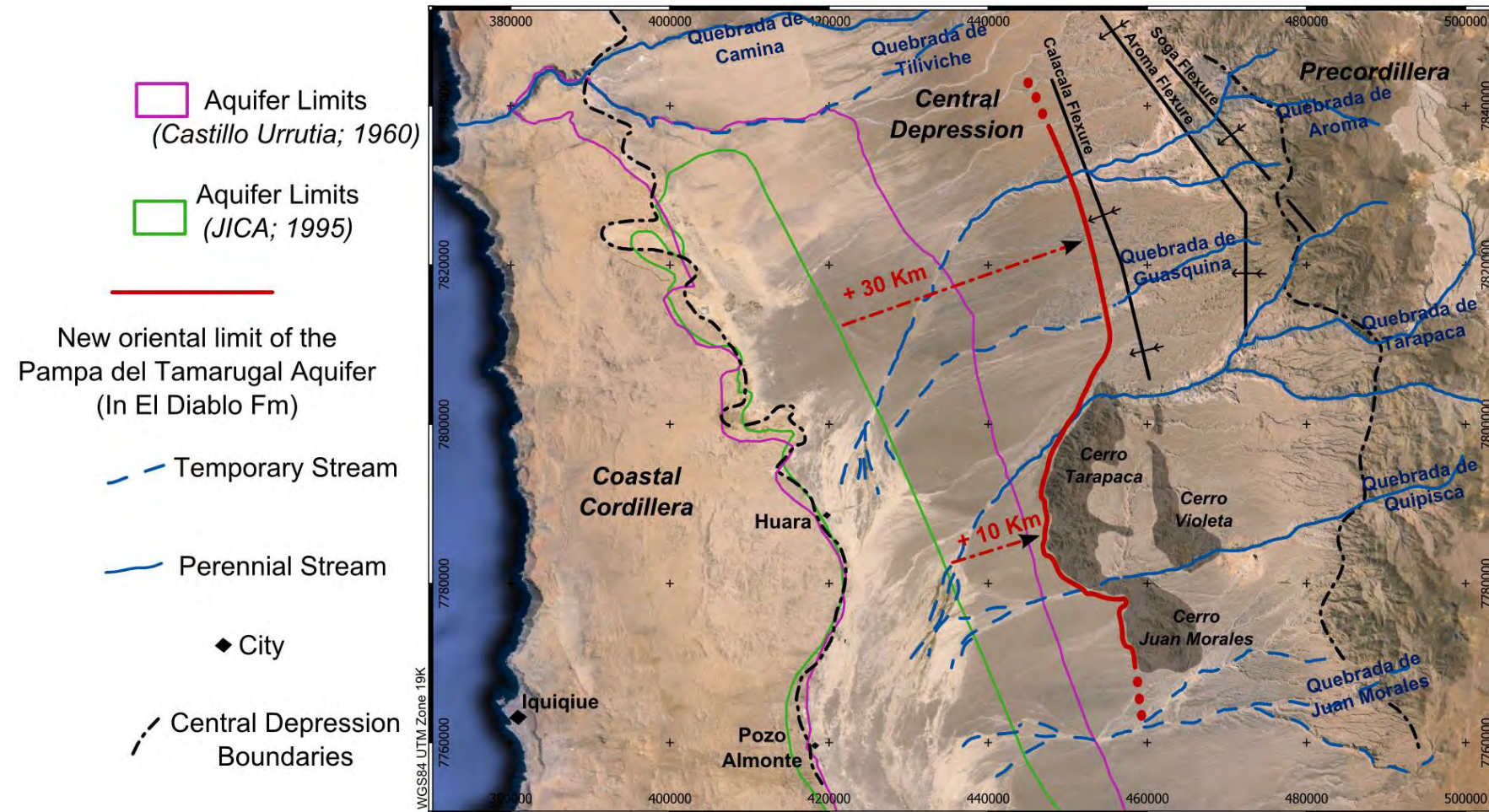
2. Groundwater management understanding

Questions:

- Is there really an imminent risk of depletion ?
- How the authority can manage groundwater and take decisions given the unknown variables and high uncertainties on data?
- Is the declaration of restricted area an efficient tool for groundwater management in arid areas?

Objective:

- Groundwater management model

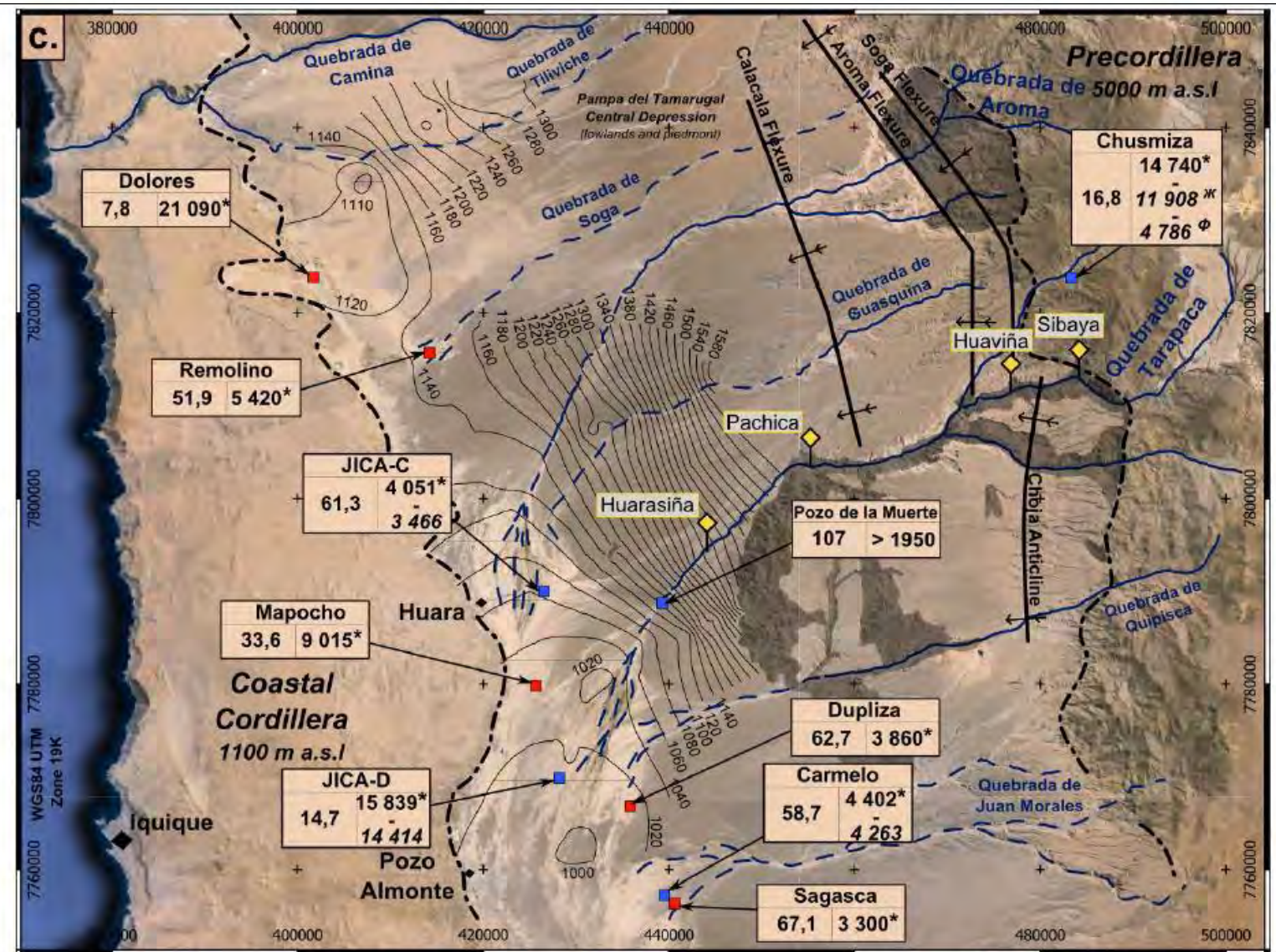
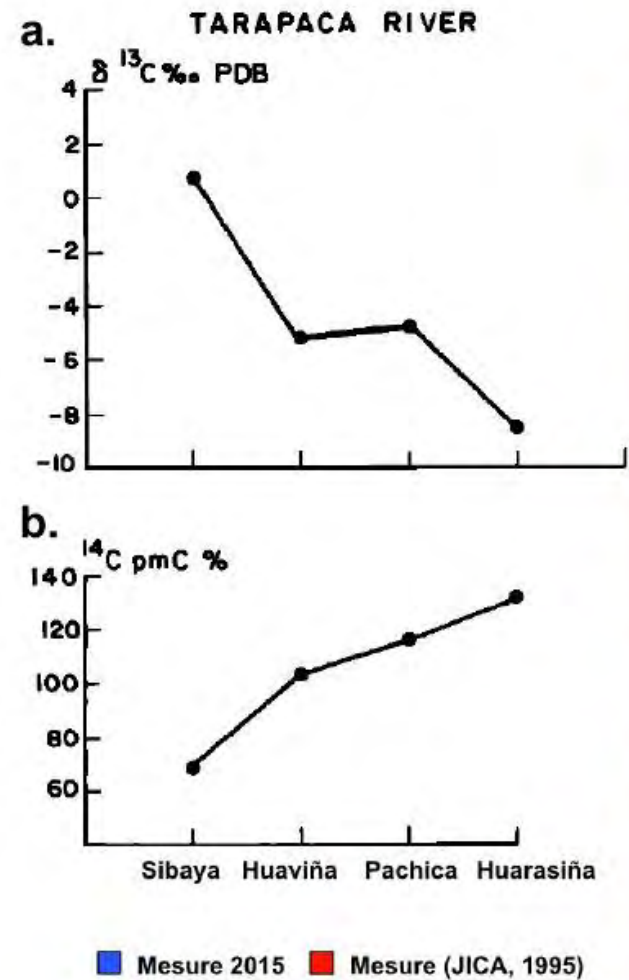


Significant increase of the aquifer surface...

⇒ Increase of the groundwater volume

Viguier, 2016; Viguier et al, 2018.

3. Results



----- Bordures de la Depression Centrale ◆ Ville - - - - - Ecoulement temporaire ——— Ecoulement permanent ——— Isopièze de 2015 (m a.s.l.) ■ Affleurements du Substratum

Nom	
^{14}C (pmC)	âge (année BP)
14C (pmC)	âge (année BP)

pmc : Percent Modern Carbon
* âge maximum (sans correction)
âge corrigé
BP : Before Present (1950)

Viguié, 2016; Viguié et al, 2018.

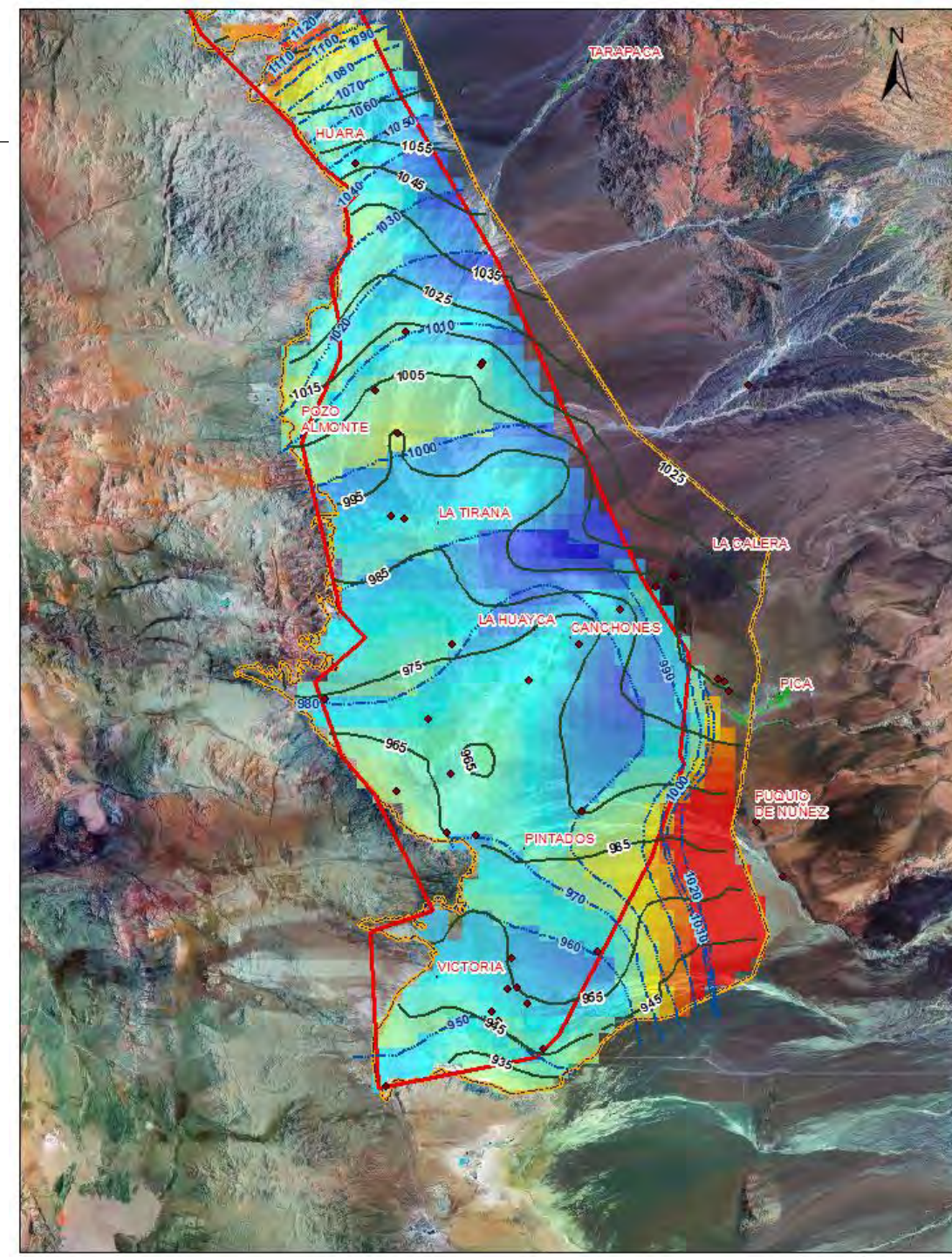
3. Results

Comparison of the piezometric level between 1957 (Castillo, 1960), 1993 (JICA, 1995) y 2013 (Lictevout et al., 2014):

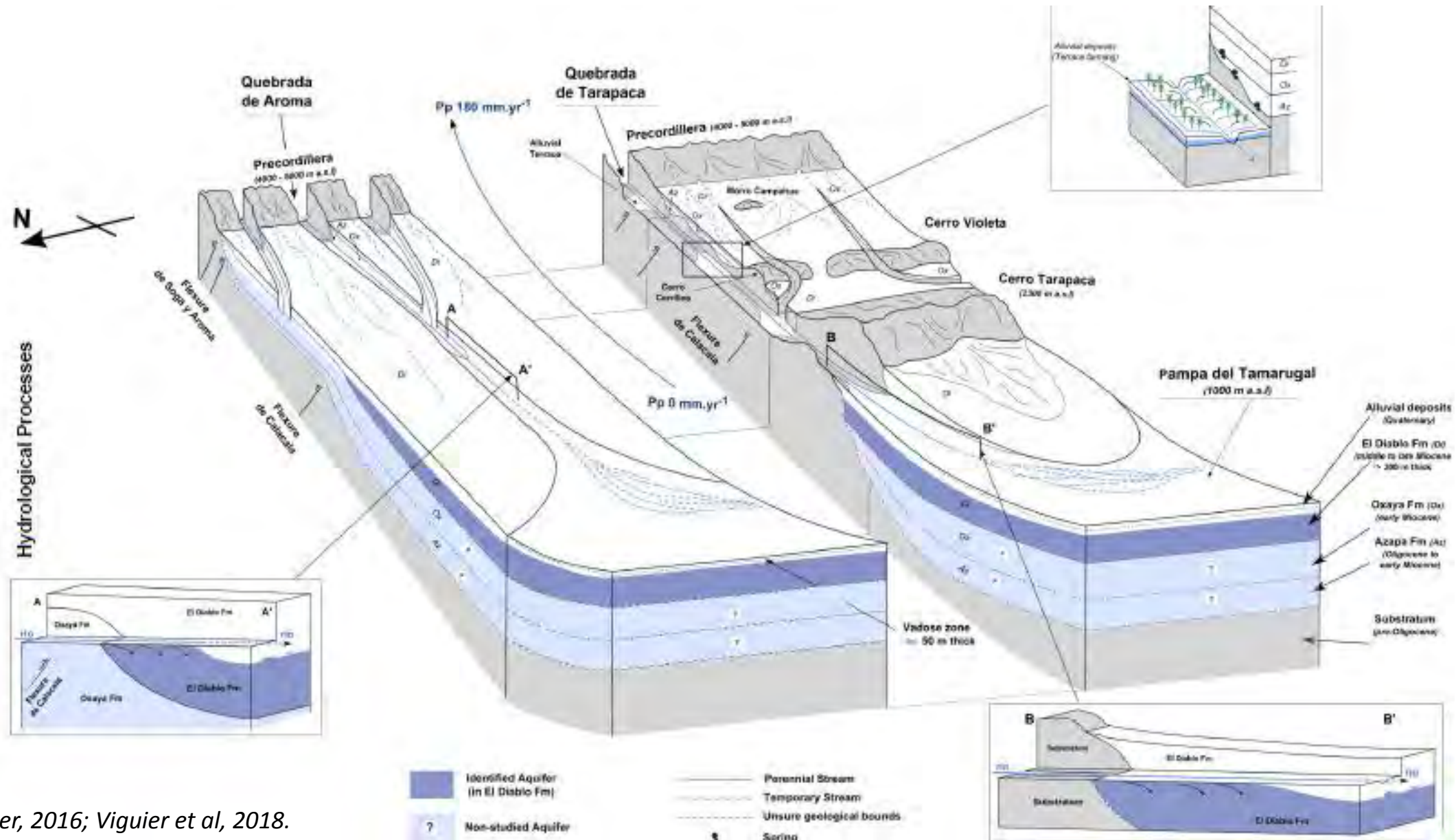
- **Average** 5.6 cm/year, reaching 12 to 17 cm/year in some places \Rightarrow 1 to 2 metres in 2 decades
- Today's average: 2 cm/year
- In the north, decrease of 5 to 10 meters.
- In some area, GW level is stable or increasing.
- In the Centre-South area, decrease of 5 a 10 m
- Uncertainties in the Southeast

\Rightarrow **Limited aquifer overexploitation**

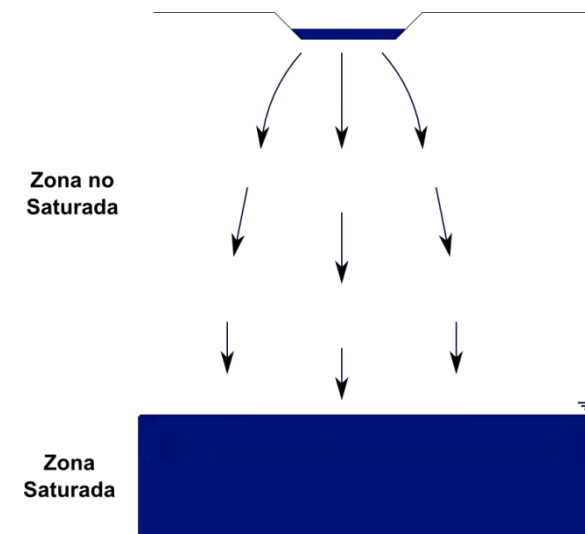
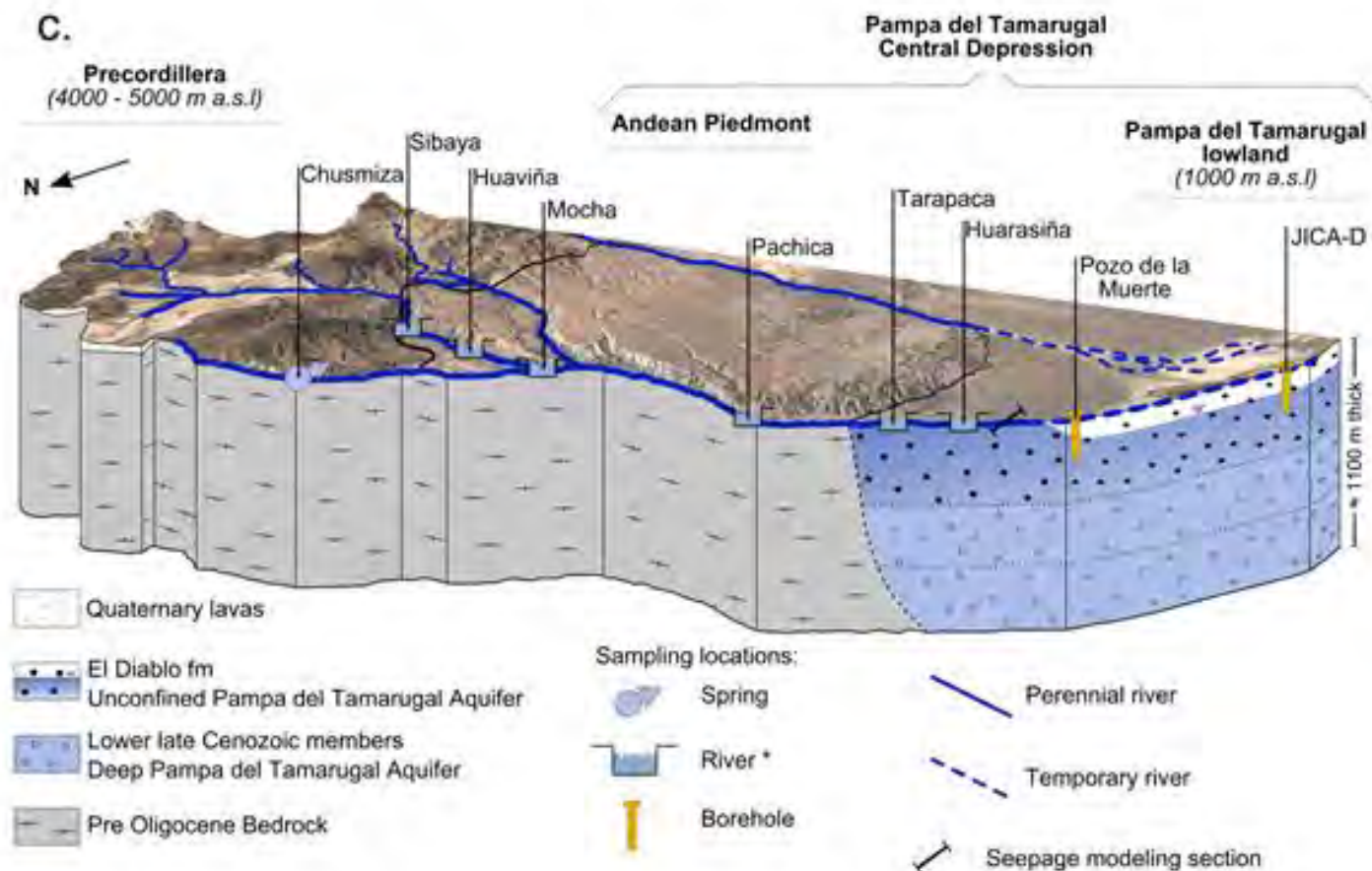
Lictevout et al, 2014.



3. Results



3. Results



3. Results

- Declaration of restricted area:
 - a convenient *status quo* for some stakeholders...
 - ... a useless measure for GW management for the others
- Inconsistencies in the calculations which justify the declaration (not challenged)
- Community representatives did not take part of the decision to establish a *status quo*.
- The establishment of a water users association is a failure because of the opposition of farmers and indigenous communities which will have no participation in decision-making.
- Regional research center produced information challenging the status quo ⇒ funds withdraw and obliged to stop research

⇒ Is there a pilot in the management system?

4. Conclusions and way forward

- Water management consider as a mean and no as an object in itself
- Provision of scientific information was not able to trigger a genuine discussion between actors

Who benefited the declaration of restriction:

- Use of water scarcity at political level
- Water business (cost of 1 l/s)
- Economic monopoly (without water, no competitor can come)
- Regarding understanding of groundwater processes, great progress, even if still many unknowns remain.

Lictevout et Faysse, 2018.

4. Conclusions and way forward

Simulación de las tendencias futuras de los recursos hídricos basada en escenarios futuros (cambio climático, presión antrópica)

Retrospective Modeling (1960-2018)

- Clima and water uses
- Hidrologic model
- Calibration/validation
- Sensivity analysis (uses)

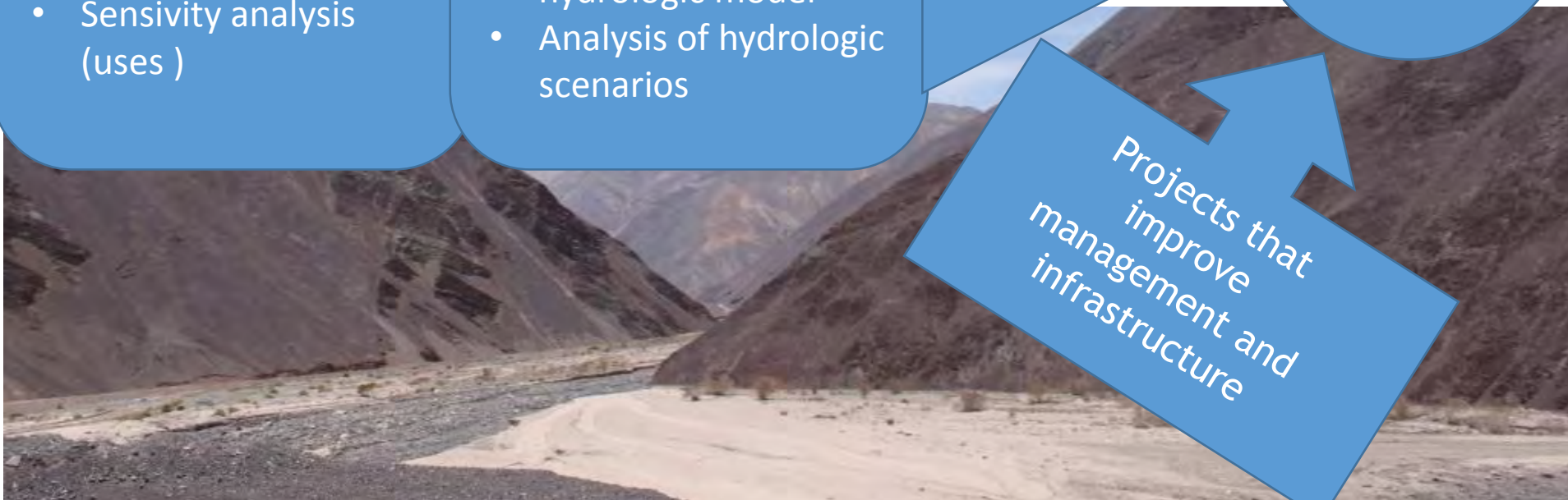
Prospective modeling (long term 2050)

- Climatic/uses scenarios
- Integration of the scenarios in the hydrologic model
- Analysis of hydrologic scenarios

Impact on
the water
resources

Adaptation
strategies

Projects that
improve
management and
infrastructure



4. Conclusions and way forward

- Need for a genuine, well-informed participatory discussion between local stakeholders, which calls for sound data on groundwater resources and uses.
- ... could lead to a joint decision on future aquifer management regarding the following question: *should the amount of water pumped be reduced to ensure that groundwater levels remain stable or should it be increased to enhance economic development?*
- Solutions to groundwater extraction needs while preserving environment
- A participatory process as proposed by community representatives (whereby the power of decision-making is not proportional to the water rights held)
- However, this calls for a radical change in the legal organisation of groundwater user associations.

Thank you for your attention!

