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in Mining and Industrial Processes

Approaches of Integrated Hydrologic Modeling for Water Resources Management in Chilean Basins

Sergio Duarte, Pablo Chong and Yerko Olivares

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The University Of Queensland
AUSTRALIA

SMI ICEChile

GECAMIN

REALITY OF WATER IN CHILE

- Climate change
- Water scarcity
- Temperature increase
- Droughts
- Extreme events

Santiago, Chile
June 2023

Hasta 43°C: estudio anticipa que Santiago y zona central vivirán el verano más caluroso de la historia

Investigación realizada por Patricio González, agroclimatólogo de la Universidad de Talca, proyectó que, en algunas zonas como Santiago se espera que se registren olas de calor de tres a diez días consecutivos, "con temperaturas máximas extremas promedio sobre los 35° C".

THE SIGNFICANCE OF WATER RESOURCES MANAGEMENT

- Less water availability
- Changes in weather patterns
- Increase in water demand
- Sustainable use of water
- Planes Estratégicos de Gestión Hídrica (PEGH) → PERHC

10 noviembre, 2021

Chile sumará 14 años consecutivos de sequía y proyectan aumento en olas de calor

Por: Agenda País

Megasequía: La "nueva normalidad" en la que vivirá Chile

El informe "Megasequía: Diagnóstico, impactos y propuestas" del Centro de Estudios Públicos (CEP) analiza el panorama climático actual del país y señala que, si no se buscan soluciones oportunas, las condiciones del país se volverán adversas para todos los sectores productivos del territorio, afectando a la totalidad de la población.

ANALYZING BASINS FROM A INTEGRAL PERSPECTIVE

- Surface –groundwater interaction
- Contributions of irrigation to groundwater recharge
- Effects of changes in seasonality
- Zero degree isotherm disturbance

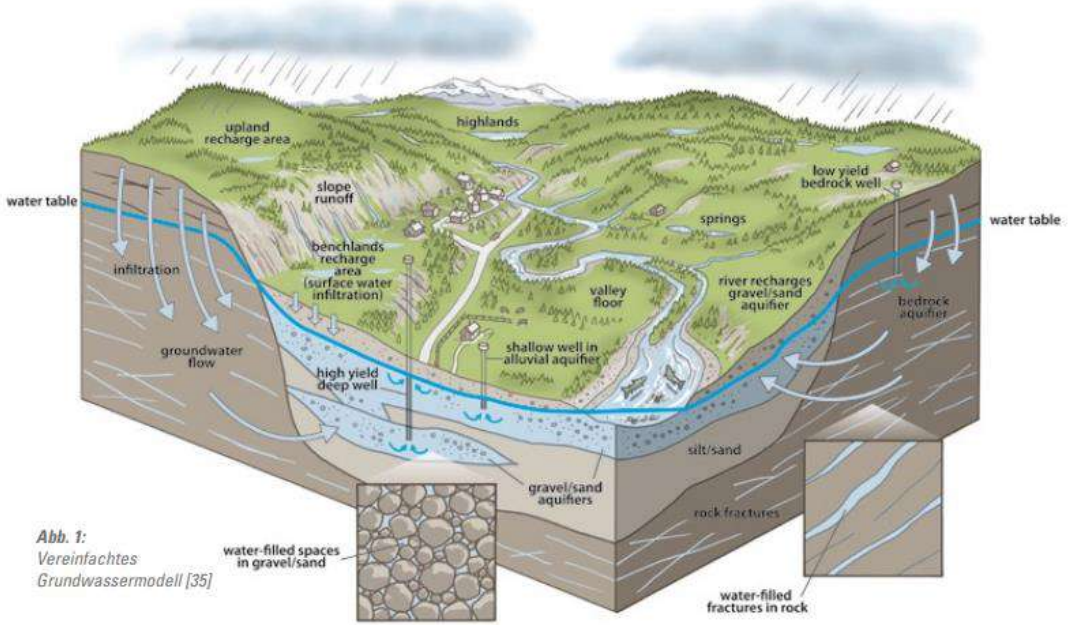
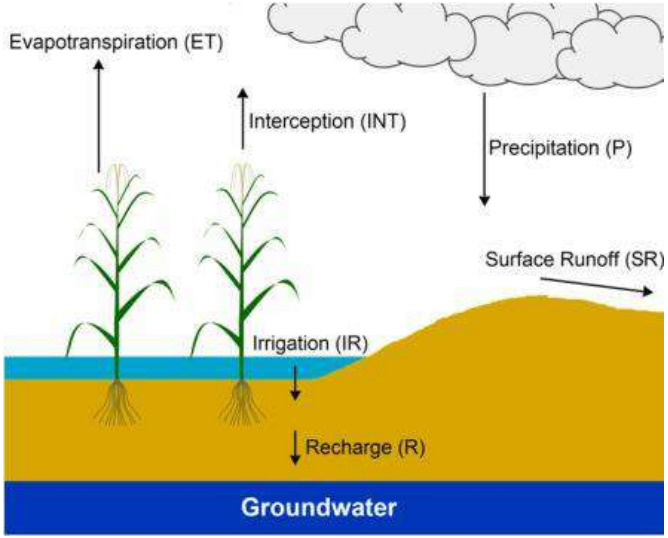


Abb. 1:
Vereinfachtes Grundwassermodell [35]

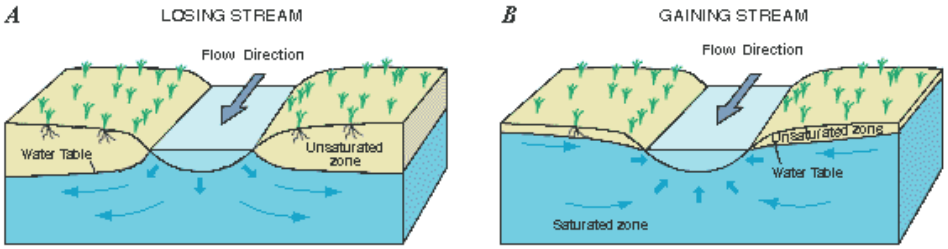
Source: Advanced Mining Solutions (2011)

SURFACE-GROUNDWATER INTERACTION

- Recharging processes
- Irrigation effects
- River-aquifer interaction
- Different types of aquifer

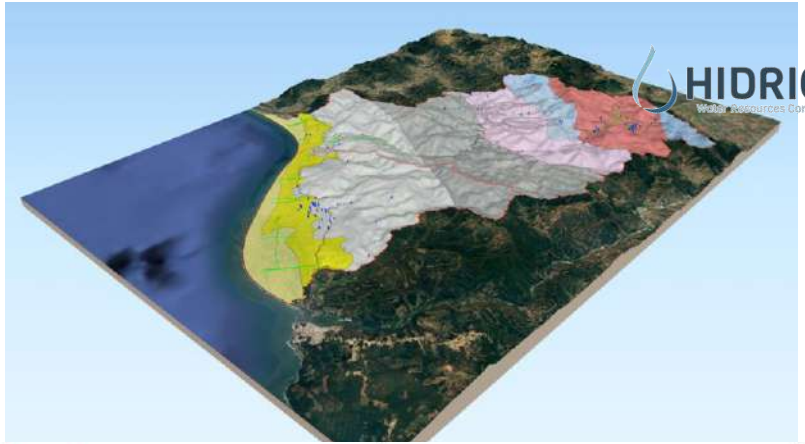


Source: Tulip et al. (2022)

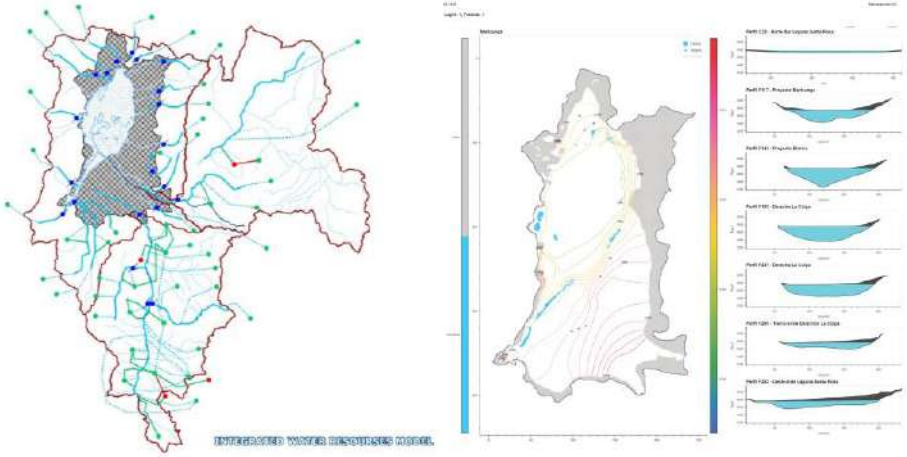


Source: USGS Circular 1139 (1998)

NUMERICAL MODELS AS A REPRESENTATION OF REALITY

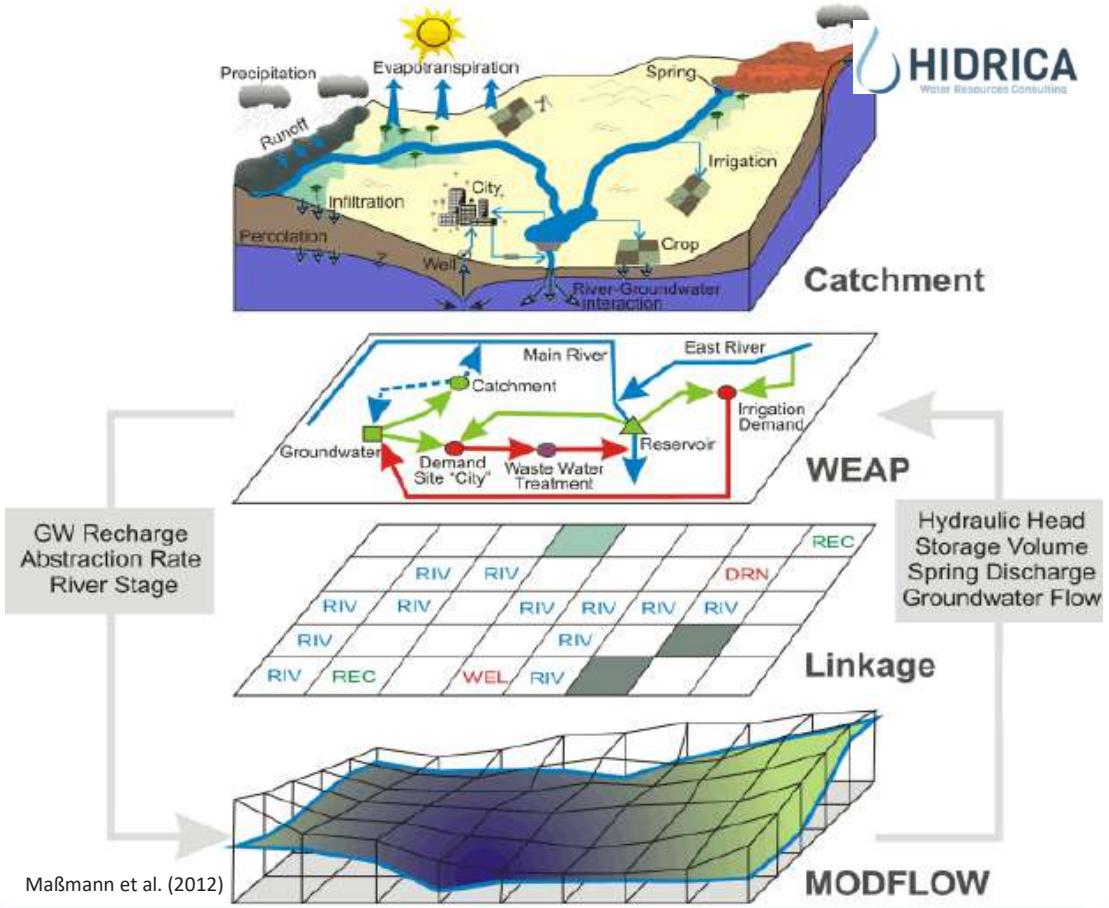


- Surface and groundwater models
- Represent processes and dynamics of interest
- Assess the effect of particular scenarios and conditions



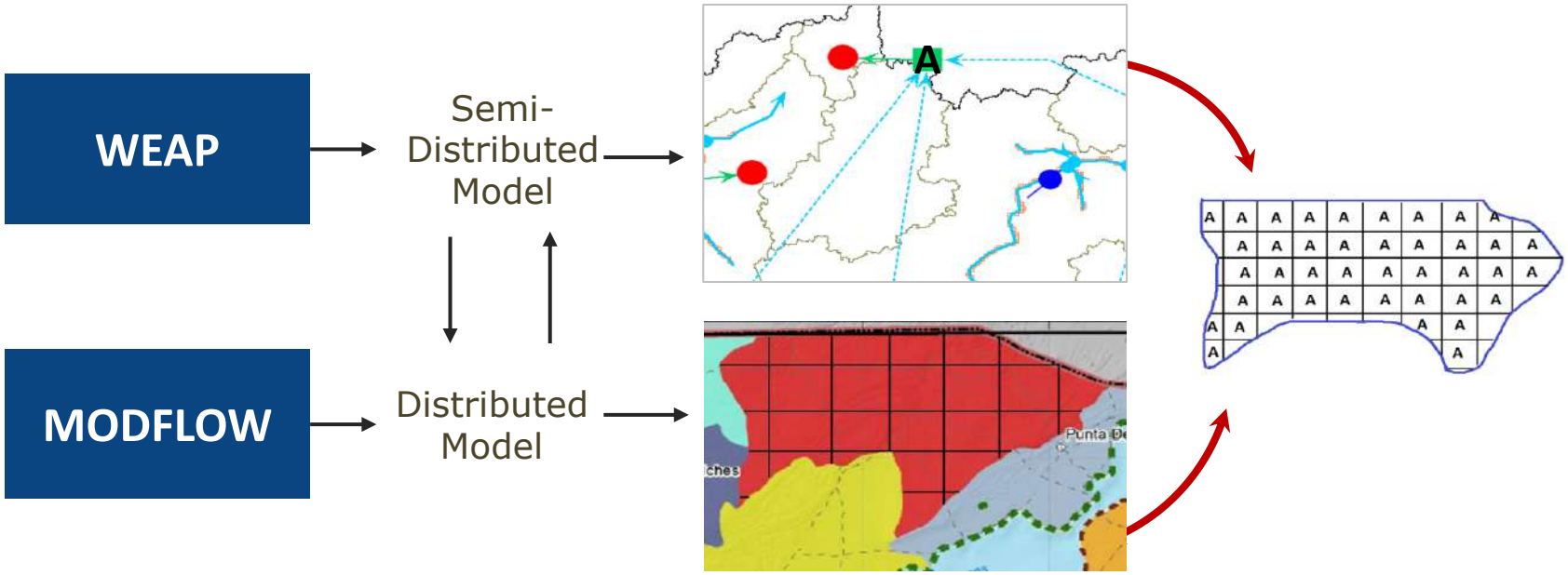
TAKING ADVANTAGE OF BOTH TYPES OF MODELS AT THE SAME TIME

- Directly linked models using computational platforms WEAP and MODFLOW
- Independently integrated models according to some limitations of each case

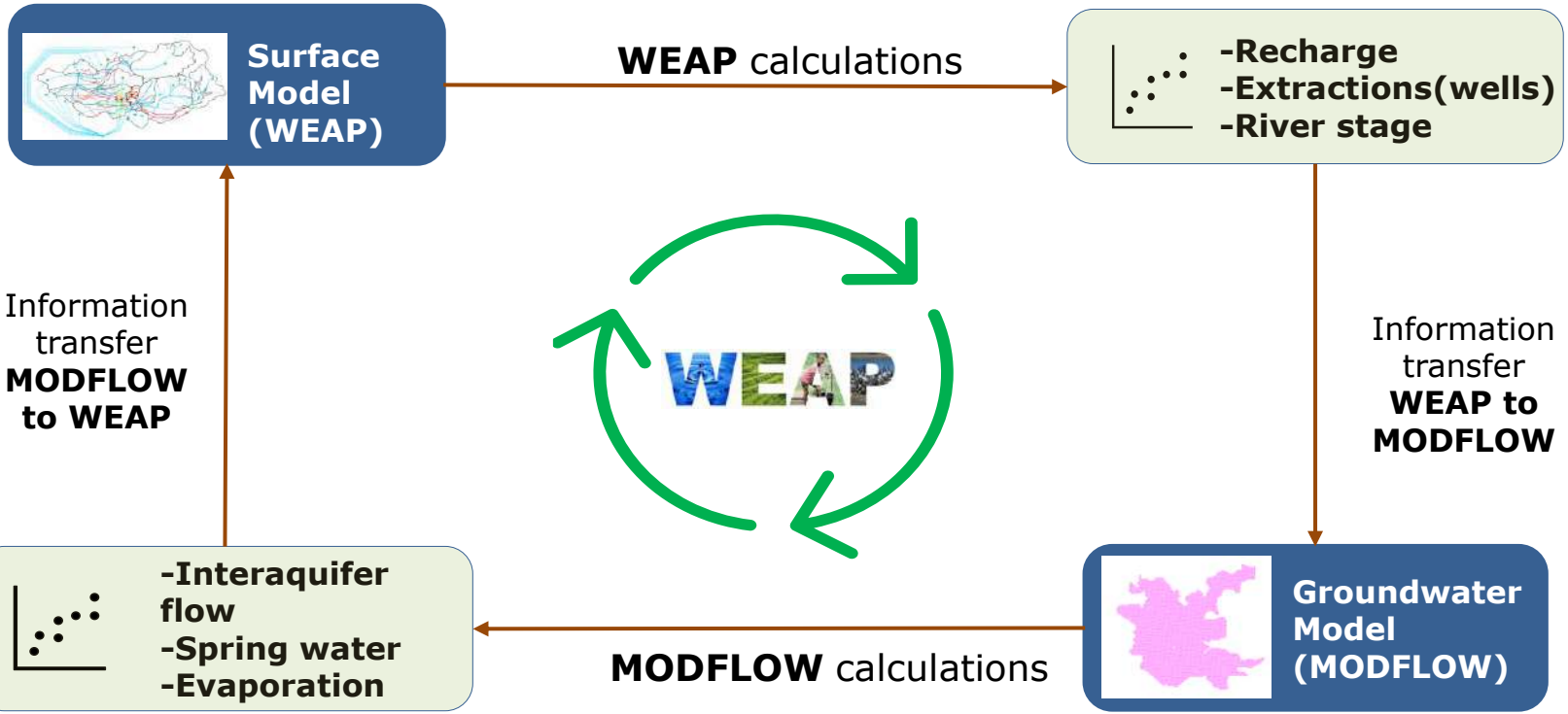


Maßmann et al. (2012)

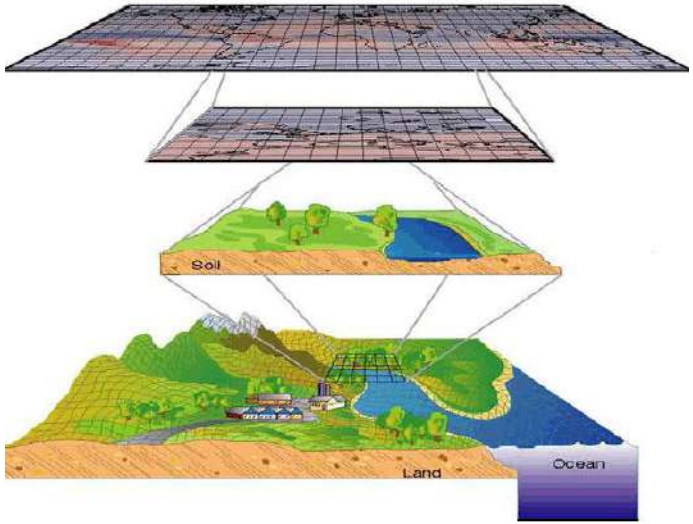
COUPLED MODELS: ALTERNATIVE 1, DIRECTLY LINKED

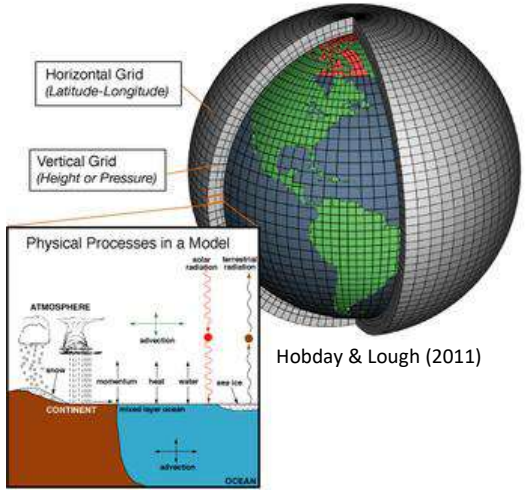


COUPLED MODELS: ALTERNATIVE 2, INDEPENDENTLY INTEGRATED



HOW TO CONSIDER THE CLIMATE CHANGE?





Hobday & Lough (2011)

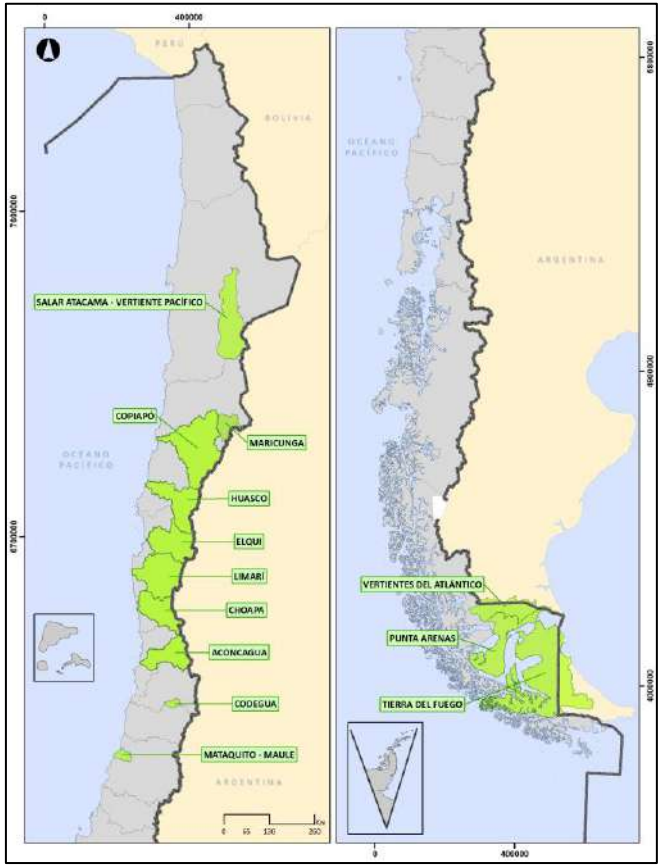
- Use of general circulation models for climate variables
- Different scenarios to assess sensivity of important variables
- Range of validity of the results

https://climatemodeling.earth.indiana.edu/research/dynamical-downscaling.html

REGIONAL CHALLENGES

Different zones of Chile present particular characteristics for the water management

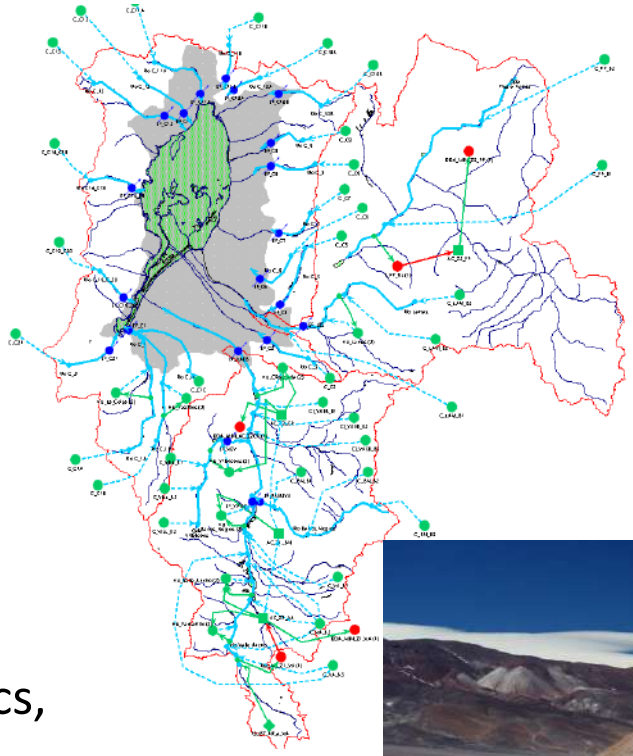
- Arid zones and salt flats
- Estimation of agricultural demand
- Protection of ecosystem functions



Places of Chile where PEGHs and models were developed

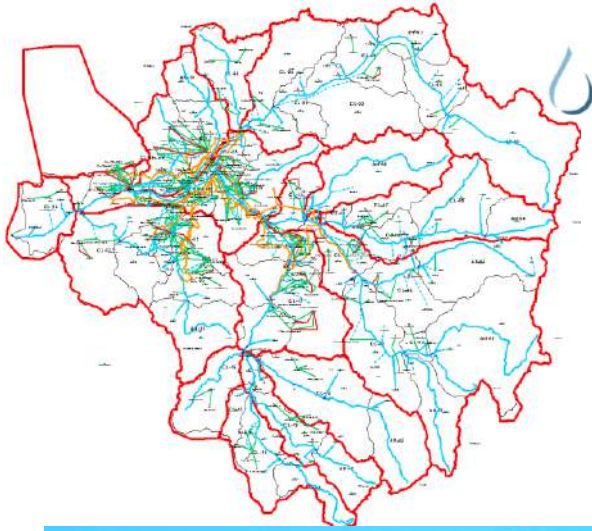
EXAMPLE 1: ARID ZONES

- Sporadic surface flows
- Few surface water rights and a large number of groundwater rights
- Complex underground dynamics, becoming more relevant in the analysis



Source: https://www.geovirtual2.cl/MVpaisaje/tur351Maricunga01.htm,

EXAMPLE 2: AGRICULTURAL AREA

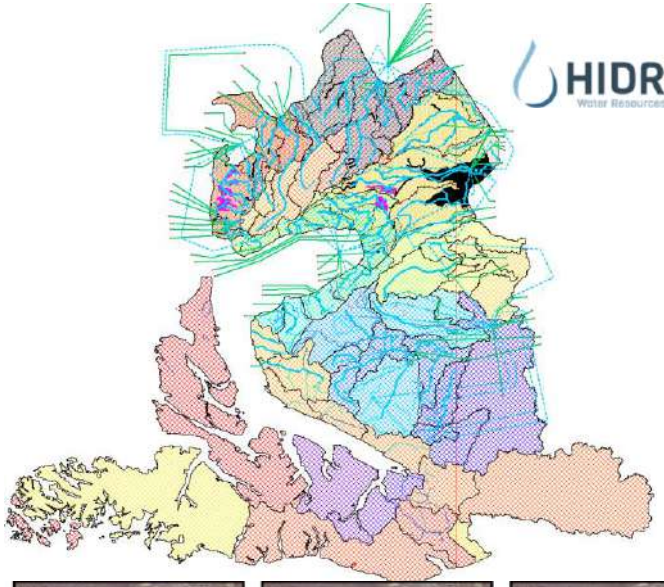


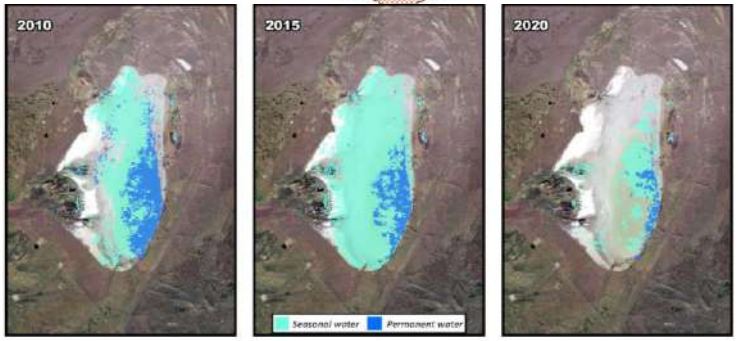
- Relevance of agricultural demand and irrigation recharge
- Important surface-groundwater interaction
- Large number of users with water rights

Source: https://www.aconcaguadigital.cl/

EXAMPLE 3: AUSTRAL ZONES

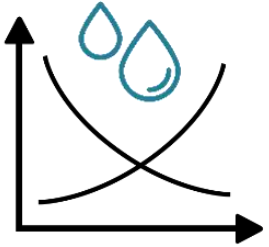
- High interaction with coastal edge
- Use of water rights is less than other areas of the country
- Little-studied underground system





ADVANTAGES OF THIS APPROACH

- Complete vision of the system in a single model to represent a **unique water balance** of a basin

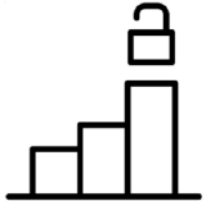


- Comprehensive **basin management** for planning and strategic decision making

- Development of **dynamic tools** that can be adapted to different increasingly unfavorable scenarios

TO CONSIDER

- **Time and effort** of this type of models is higher than other models
- Quantity and quality of **information available** affects the construction and validation of the models
- Different **types of projects** will have different objectives, changing the approach
- Needs and technology in **constant evolution and development**



NEXT CHALLENGES

- Addressing water and **climate challenges** requires a partnership between industry, goverment and privates
- Optimize **modeling times** through advanced programming methods
- Develop of coupled models that consider **other types** of requirements and systems

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