Regional adaptation activities on river basin level

Alexandra Nauditt, ITT

The Impact of Glacier Retreat in the Andes Group Workshop, UNESCO IHP, Santiago, 2015

ITT

Structure

- Introduction to ITT: Integration of research and capacity building
- Activities in the Andean region:
  - Applied research: Monitoring, Modelling and data management
  - Drought assessment and management
- Curricular development and capacity building

About ITT

Key Services:

- Education
- Research
- Capacity Development

Focus:

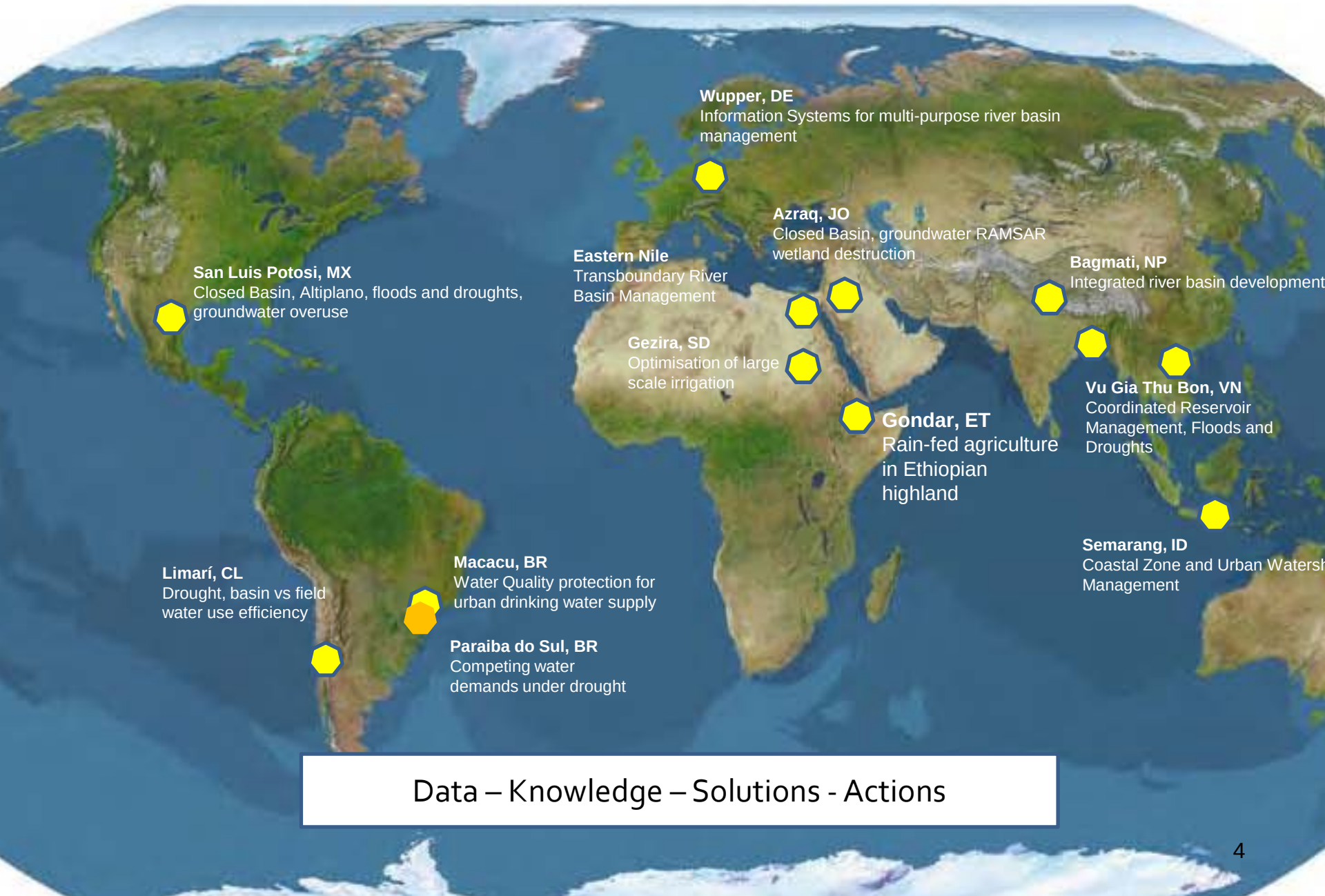
- Managing Natural Resources (Water, Land, Energy)
- Regional Resources Management (global and local links)
- Main work in Latin America, Asia, Africa

Facts and Figures:

- ITT is a central academic unit of CUAS
- Staff: total 70 (6 professors, 30 scientifc, 35 support)
- Students: 200 Msc and 35 PhD
- Budget: around 4,5 million Euro (3 million Thrid party fund

IWRM Case Studies and Joint Projects

Learning from real life problems – „Natural Labs“



Data – Knowledge – Solutions - Actions

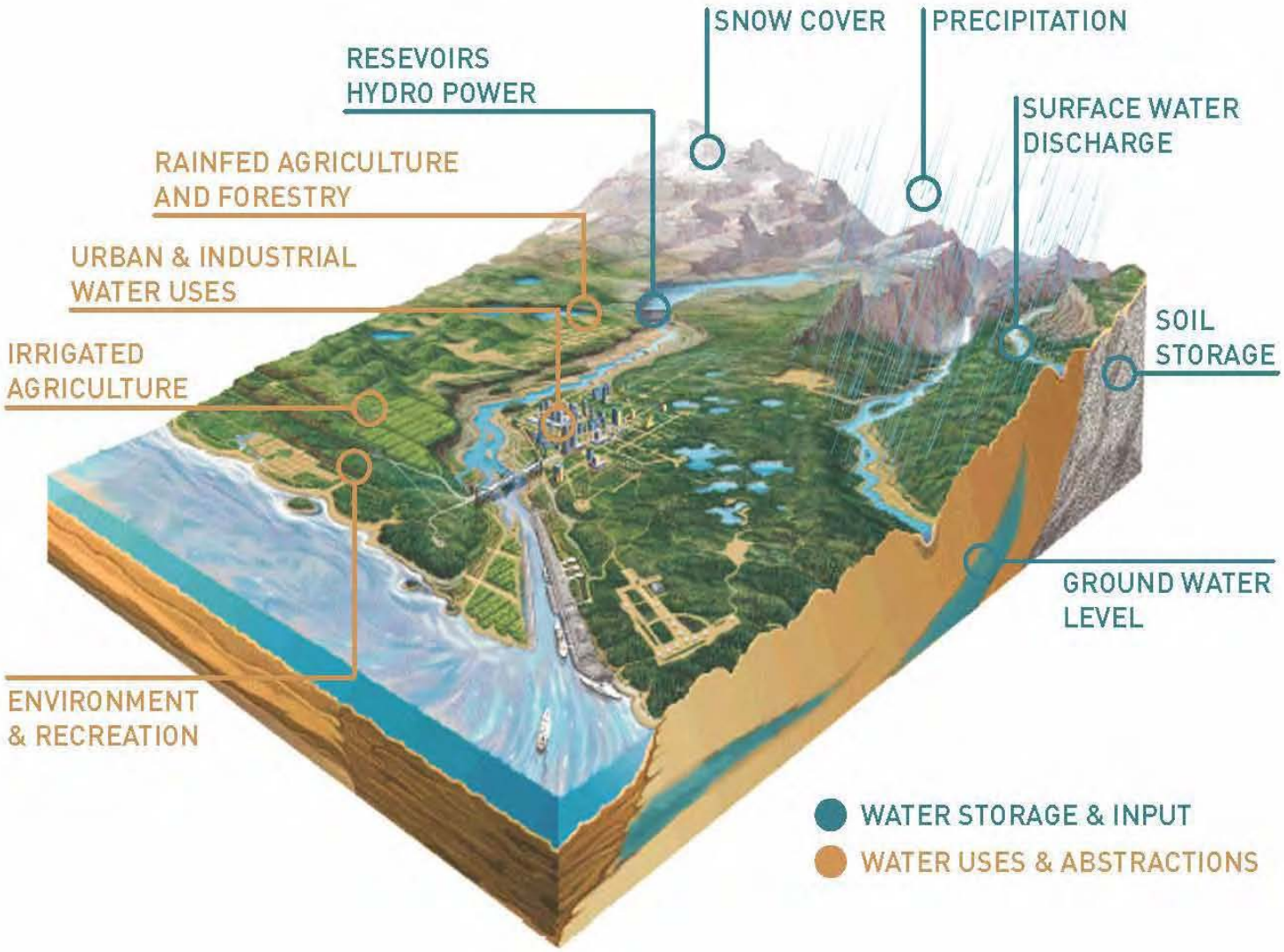
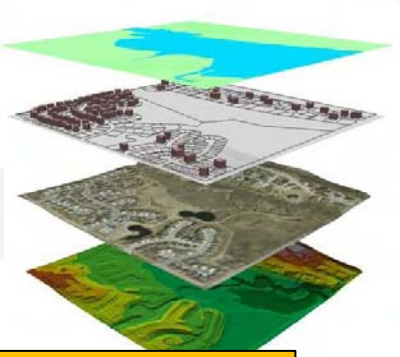


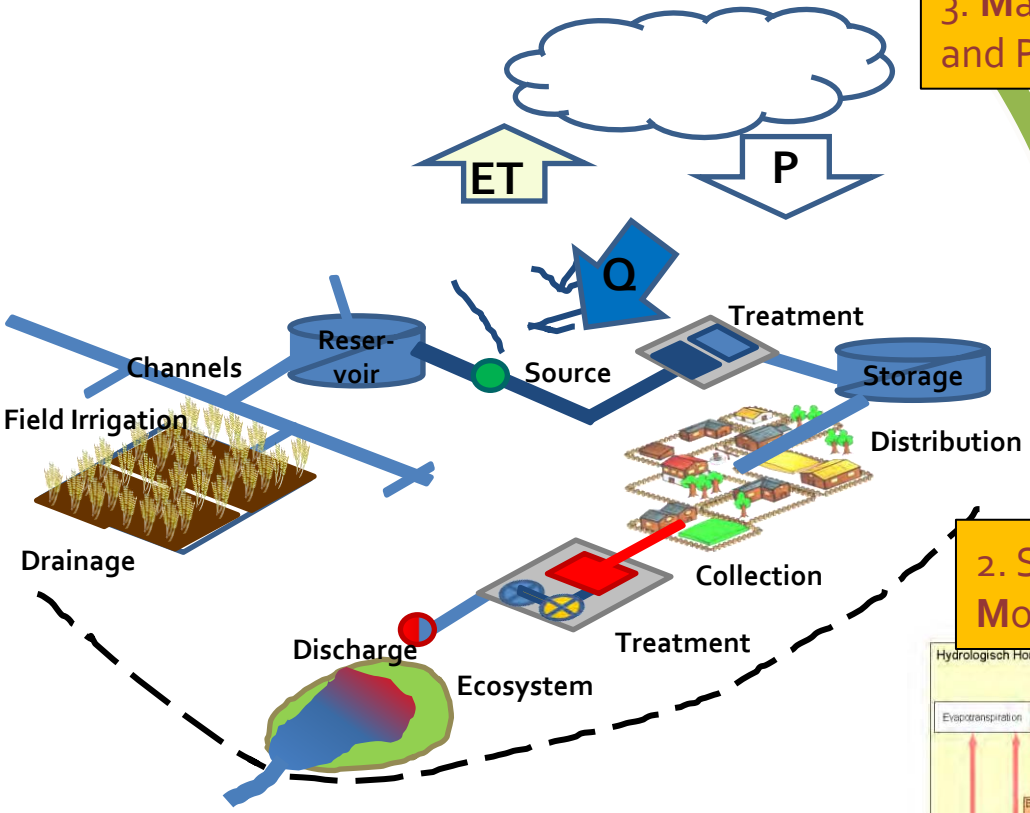
Figure: Water storage and uses: Hydrological and demand information crucial for successful drought risk decision making

Water system management: the basin as the key system

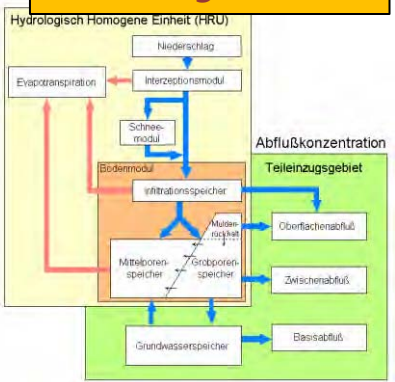


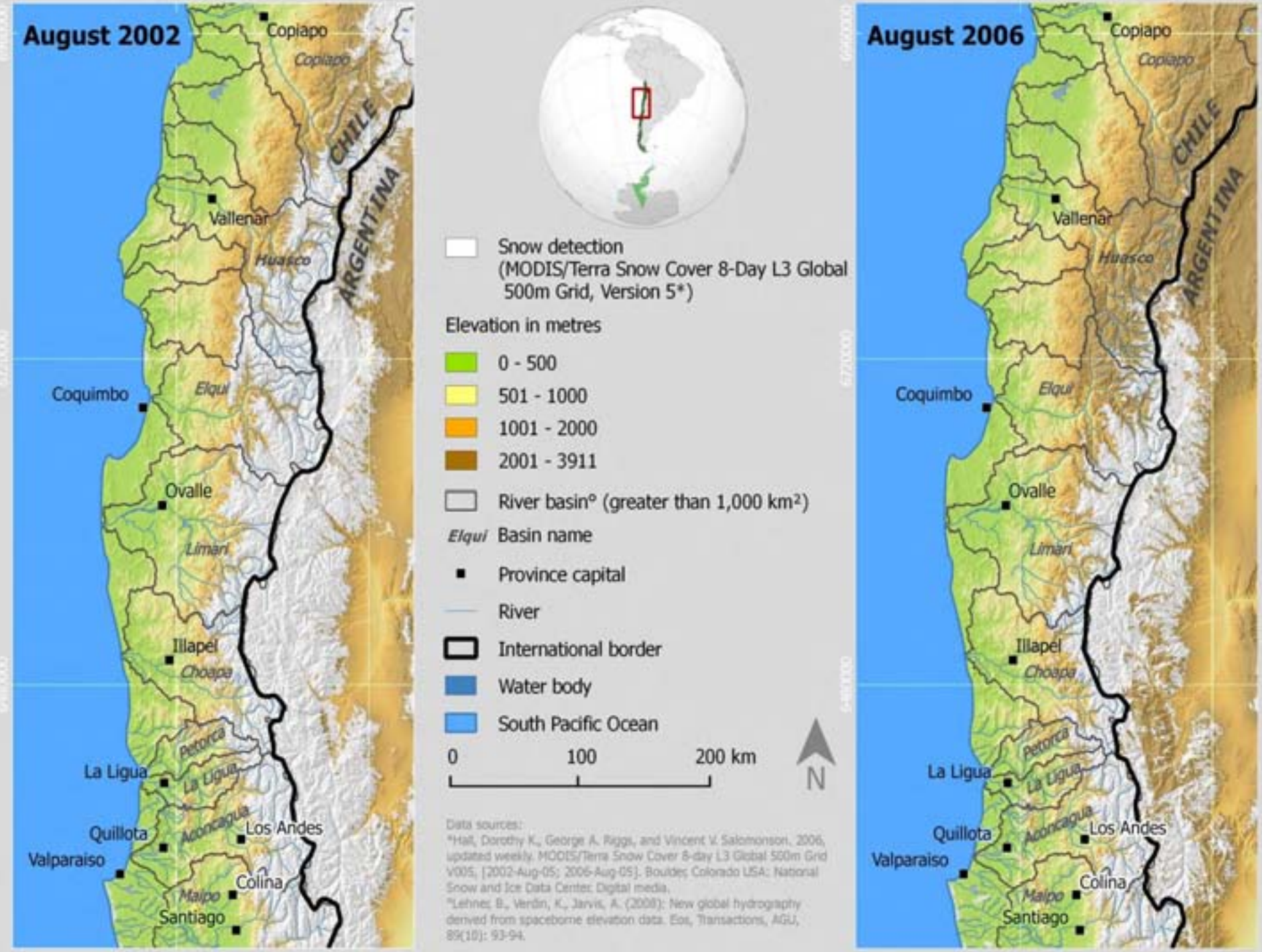
3. **M**anagement and Planning

1.Environmental **M**onitoring



2. System **M**odeling




August 2002
August 2006
Copiapo
Copiapo
CHILE
ARGENTINA
Vallenar
Huasco
Coquimbo
Elqui
Ovalle
Limari
Illapel
Choapa
Petorca
La Ligua
Aconcagua
Quillota
Los Andes
Valparaiso
Colina
Maipo
Santiago
Snow detection
(MODIS/Terra Snow Cover 8-Day L3 Global 500m Grid, Version 5*)
Elevation in metres
0 - 500
501 - 1000
1001 - 2000
2001 - 3911
River basin° (greater than 1,000 km²)
Elqui Basin name
Province capital
River
International border
Water body
South Pacific Ocean
0
100
200 km
N
Data sources:
*Hall, Dorothy K., George A. Riggs, and Vincent V. Salomonson. 2006, updated weekly. MODIS/Terra Snow Cover 8-day L3 Global 500m Grid V005, [2002-Aug-05; 2006-Aug-05]. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media.
°Lehner, B., Verdin, K., Jarvis, A. (2008): New global hydrography derived from spaceborne elevation data. Eos, Transactions, AGU, 89(10): 93-94.

WEIN

Information and monitoring system to improve water use efficiency in Northern Central Chile

Consortium:

Development of a monitoring and information system to improve water use efficiency in the Limarí Basin - WEIN

Duration: 01.08.2012-31.12.2014

Funded by:

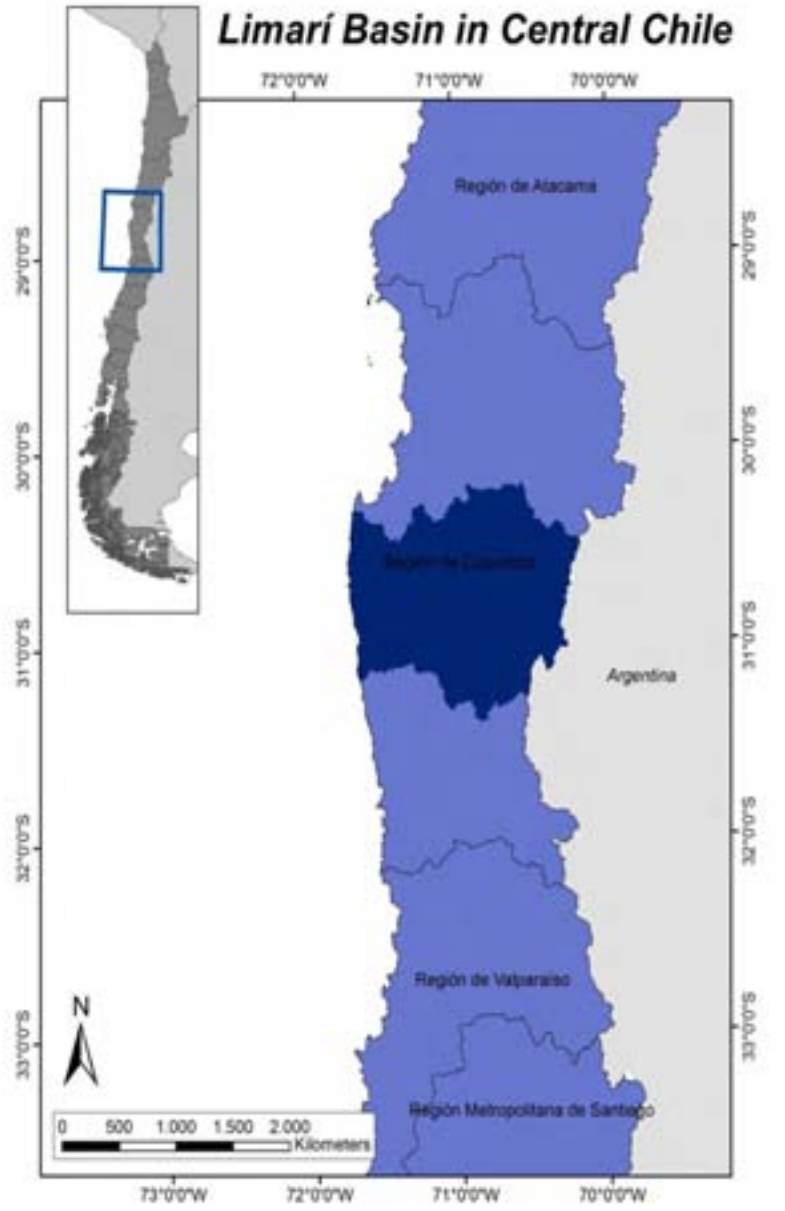
Bundesministerium für Bildung und Forschung

Web based River Basin Information system to support drought management in Northern-Central Chile

Consortium:

Facultad de Agronomía, Universidad Católica de Valparaiso, CEAZA, Department of Geoinformatics of University of Jena, DGA

http://www.basin-info.net/river-basins/limari-chile

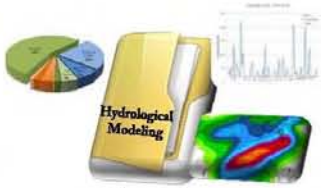


Limarí Basin, size 11.696 km

- Elevation: Pacific coast to the Andes: 0-5500 m
- Average annual rainfall: 120 mm
- strong Precipitation gradient from North to South

Monitoring, Data management, Modelling

Climate, Hydrology, Water
User Analysis
Spatial Information:
- Land Use Mapping
- Imagery and Remote Sensing Based Surveys
- GIS



River Basin assessment
Hydrological Modeling: Water Availability
Forecasting (rain-runoff), Water Demand and Allocation Modeling

Water use efficiency and
Management of water related risks

KNOWLEDGE

MONITORING

Warning messages

Isotope and Geochemical tracer analysis

Ground Water level and quality monitoring

Discharge and Runoff monitoring

Water level monitoring

Field Measurements Offline Data, Laboratory Data, etc.

SOFTWARE

Water Ressource Information and Irrigation Water management for mobile devices

Data Transfer

Warning messages

Web-Based Water Information System via Sensor Web Enablement-Standards of OGC

Data Transfer

Water Information and Management System

STAKEHOLDERS

Stakeholders, Water Users and Institutions in the agricultural and urban sector

Collecting Information

Information Transfer of Water Policy

Decision Support, Management and Training

Collecting Information

Tools for drought assessment and management: Information is crucial for drought management

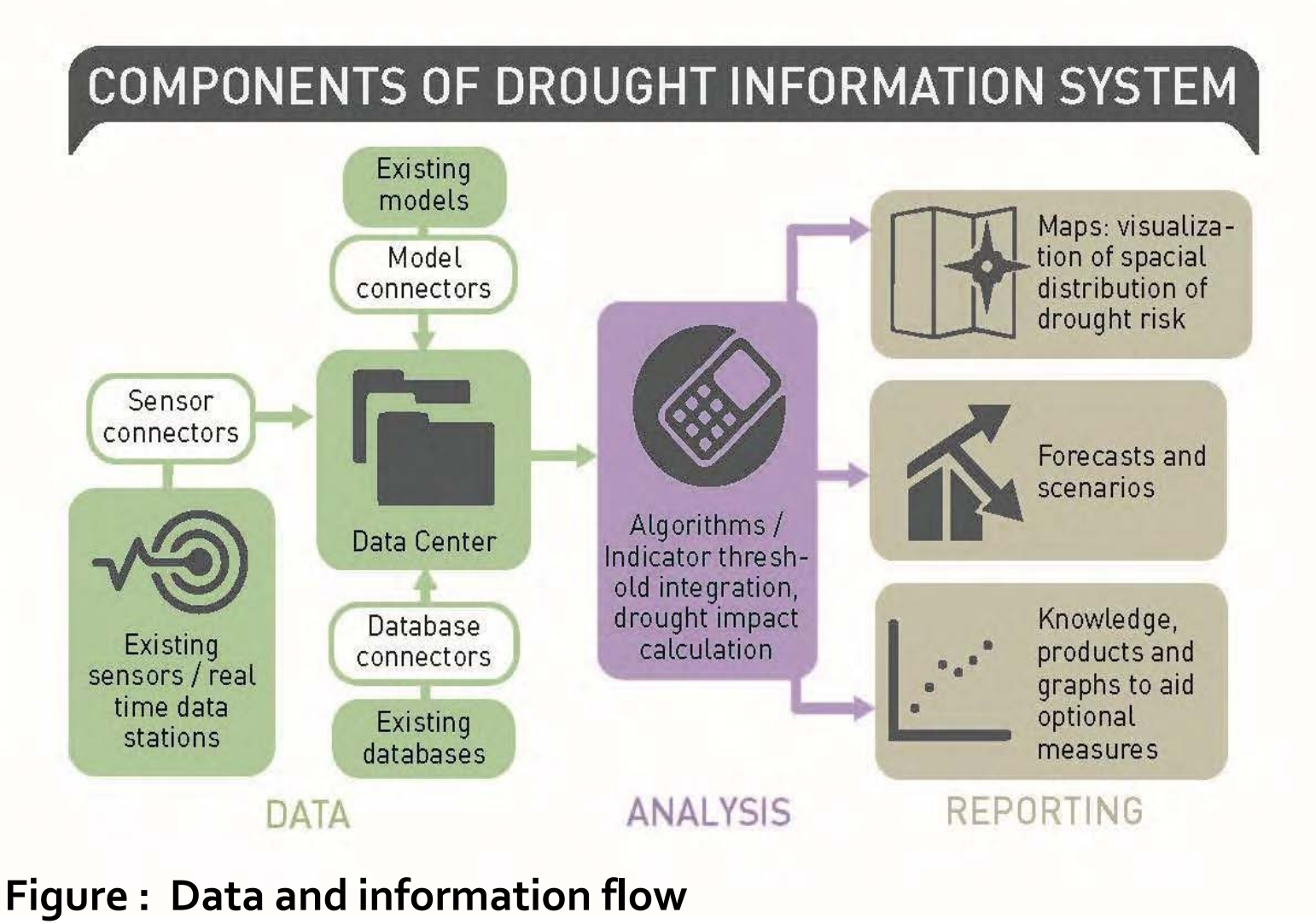


Figure : Data and information flow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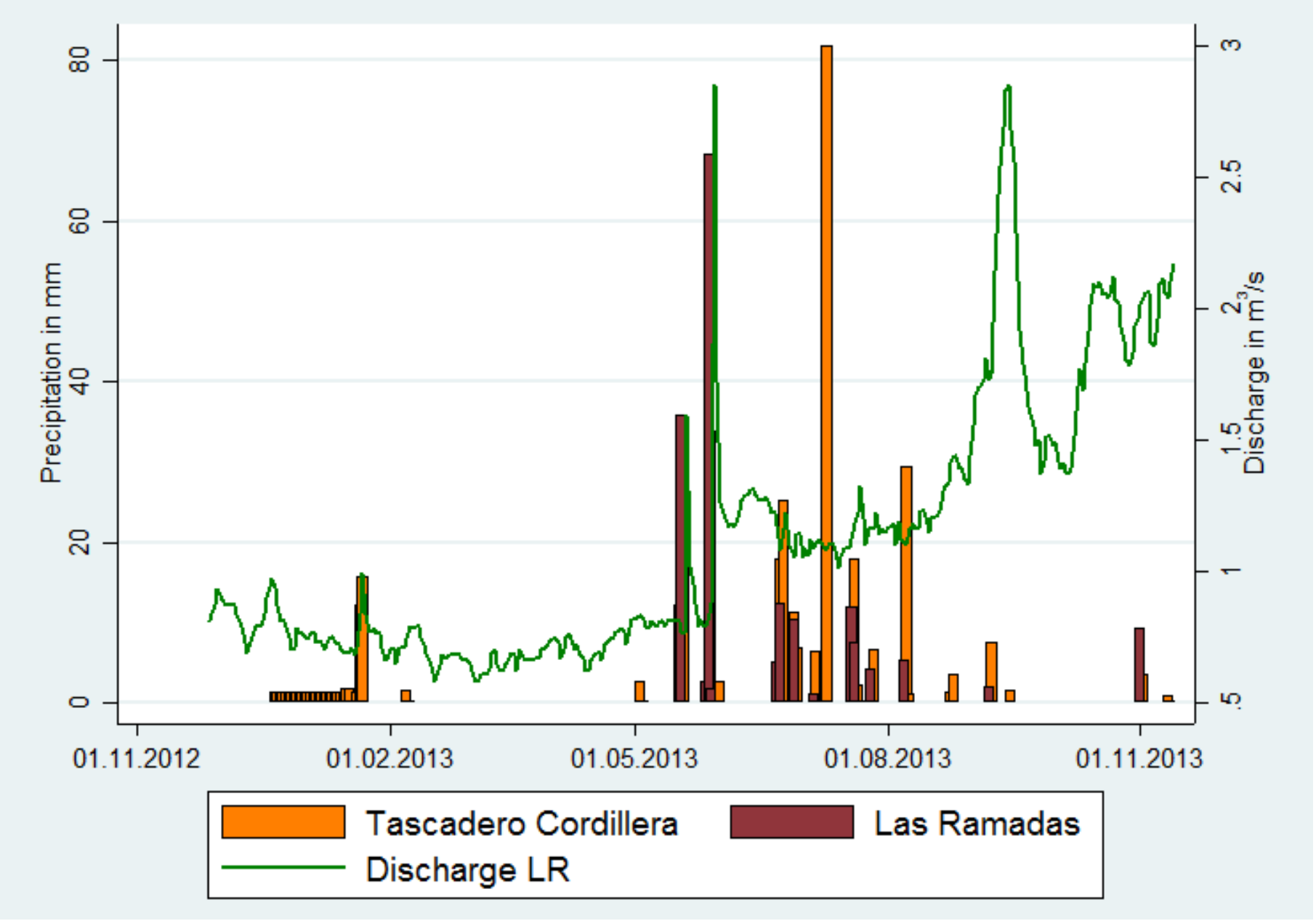

Precipitation recorded in the Cordillera (Tascadero station at 3500m) in 2013 compared to precipitation in Las Ramadas and discharge in Las Ramadas

Which tool should be applied in which environment? Hydrological rainfall-runoff and water allocation modelling

Evaluation of the performance of different hydrological models

Lumped conceptual models, spatially distributed models, semi-distributed models to 1. assess pristine data scarse catchments to understand generation of base flow, origin of snow, groundwater glaciers and to 2. develop seasonal water available prediction tool

- e.g. J2000, HBV light, SWAT, WIMMED, WEAP, TOPKHAPi

To improve knowledge on:

- Hydrological processes, cycle and balance
- aereal precipitation in mountainous catchments
- Groundwater response


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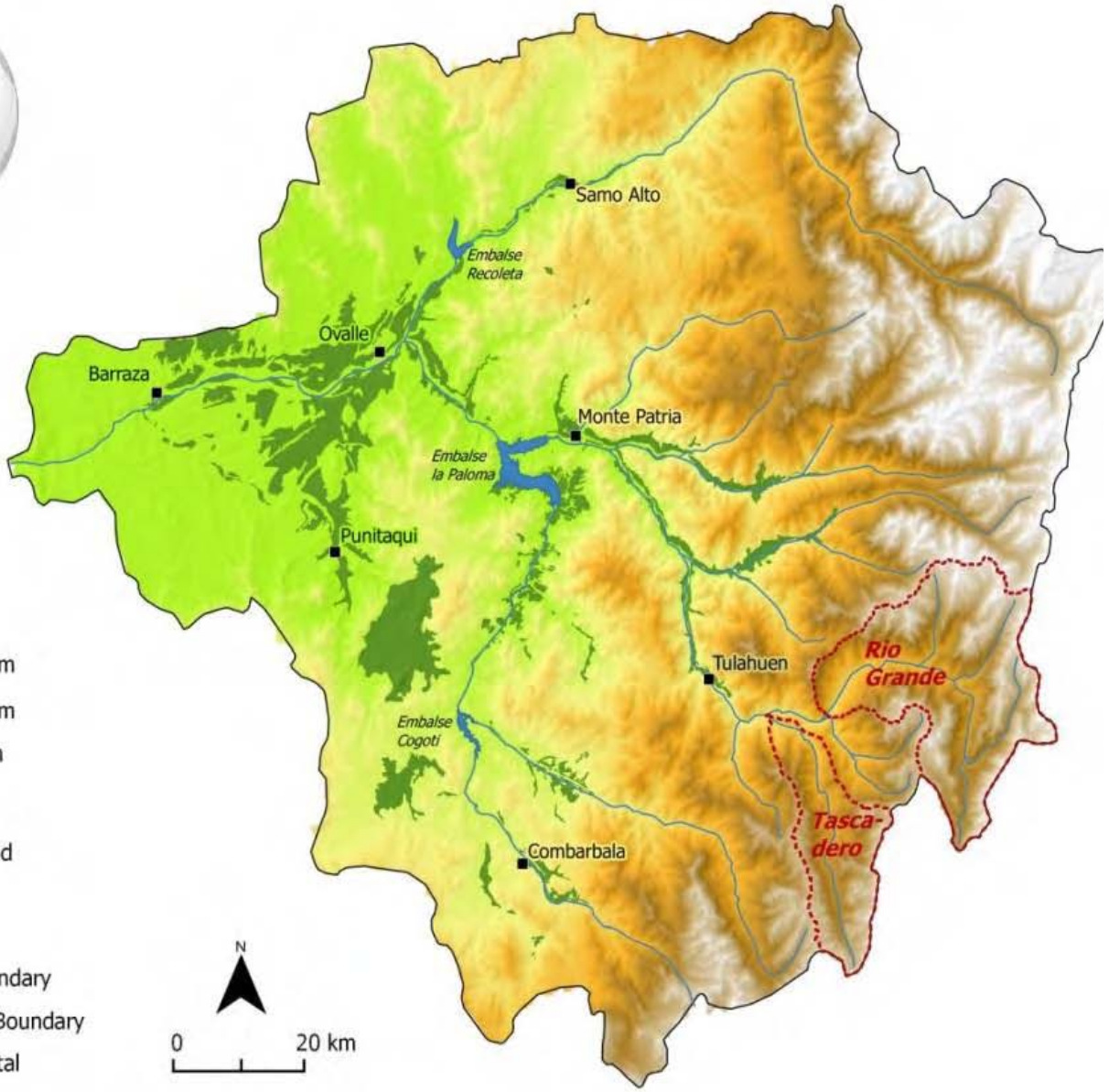
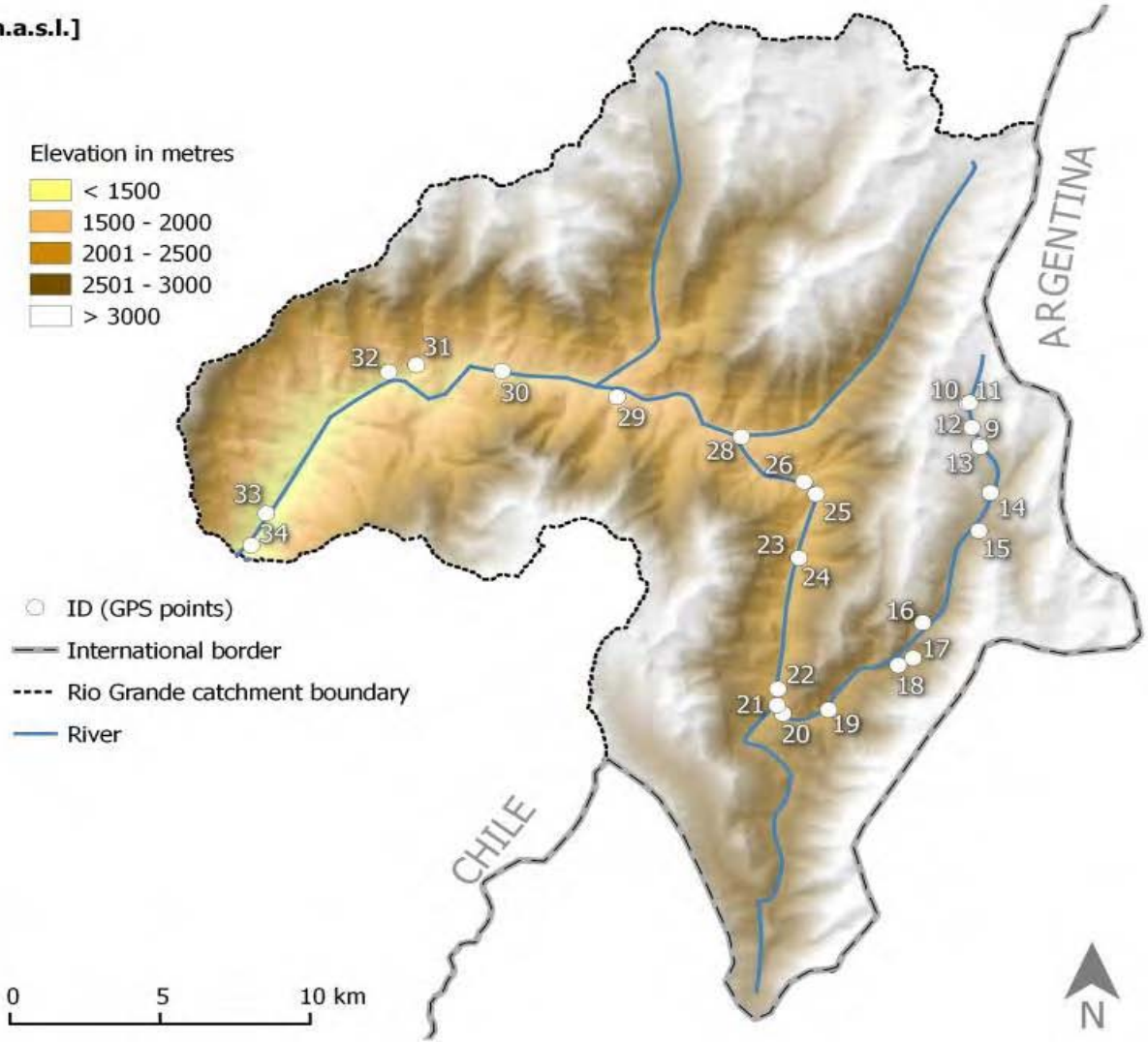


Elevation
- > 3000 m
- > 2000 - 3000 m
- > 1000 - 2000 m
- > 500 - 1000 m
- 0 - 500 m
- Agricultural Land
- Reservoir
- River
- Catchment Boundary
- Subcatchment Boundary
- Commune Capital

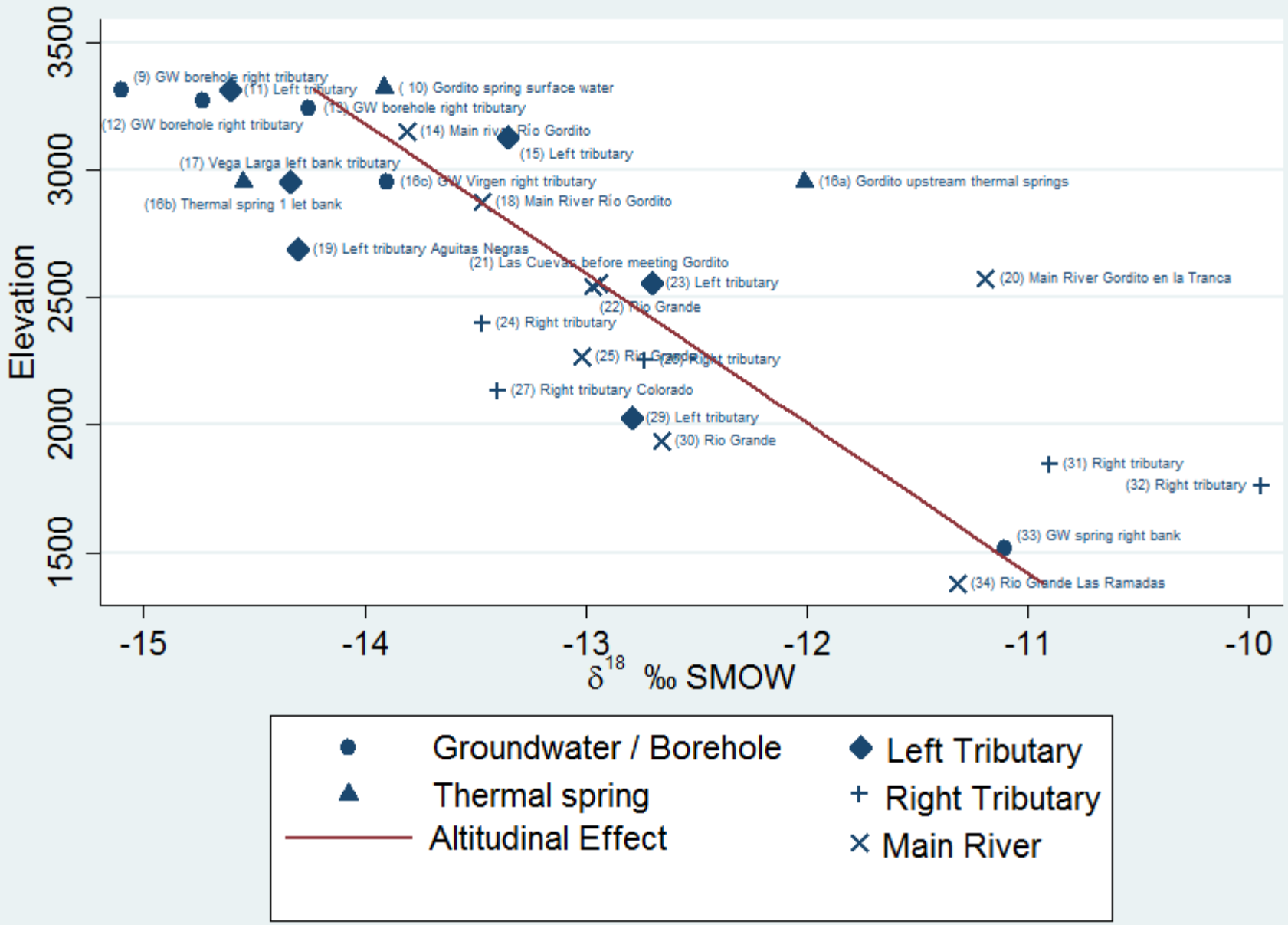
- Strong spatial and temporal variability of precipitation,
- average rainfall 120mm per year
- Pot Evapo-traspiration
- > 1000mm
- Hydrological year May to April

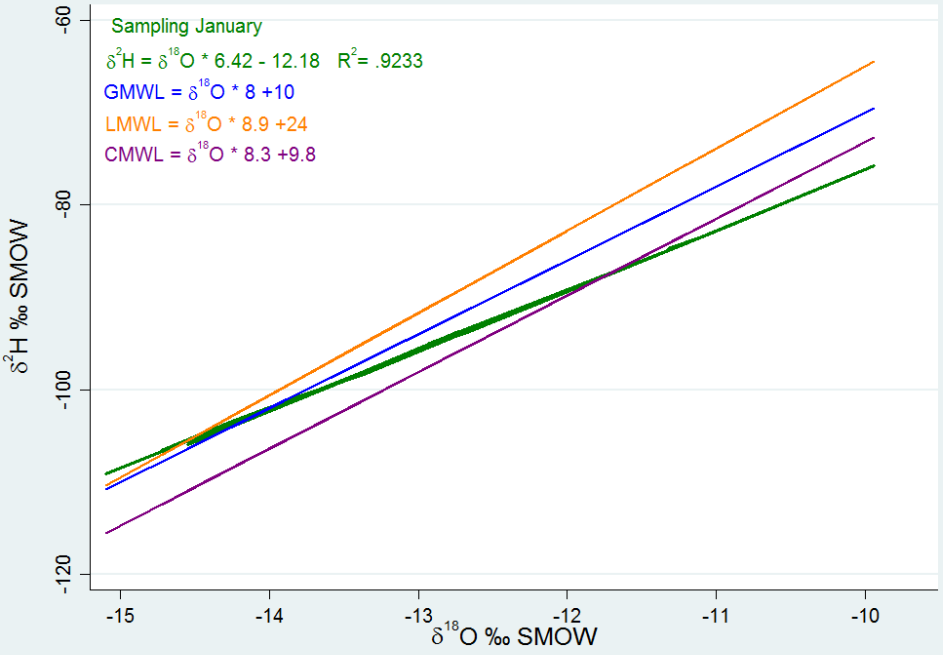
Limarí Basin, Rio Grande (544km^2) and Tascasdero (242 km^2), total size 11.696 km,

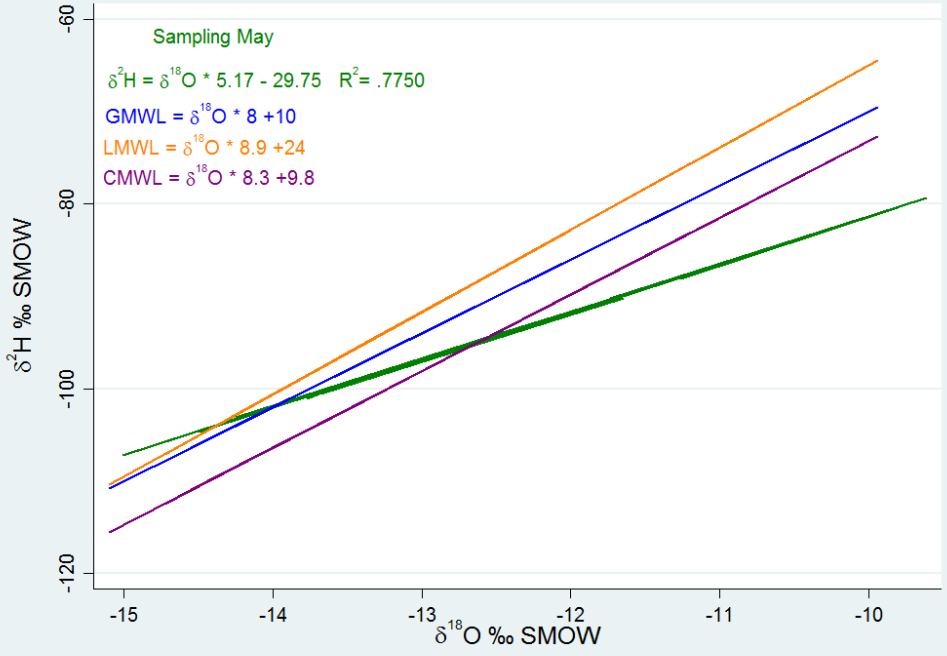
ID	Location	Elevation [m.a.s.l.]
9	GW borehole right tributary	3302
10	Gordito spring surface water	3383
11	Left tributary	3382
12	GW borehole right tributary	3333
13	GW borehole right tributary	3293
14	Main river Río Gordito	3204
15	Left tributary	3177
16	GW Virgen right tributary	3002
17	Vega Larga left bank tributary	2976
18	Main River Gordito	2942
19	Left tributary	2683
20	Main river Gordito en la Tranca	2571
21	Las Cuevas before meeting Gordito	2558
22	Rio Grande	2529
23	Left tributary	2378
24	Right tributary	2369
25	Rio Grande	2270
26	Right tributary	2246
28	Left tributary	2133
29	Left tributary	1958
30	Rio Grande	1861
31	Right tributary	1847
32	Right tributary	1765
33	GW spring right bank	1418
34	Rio Grande Las Ramadas	1386

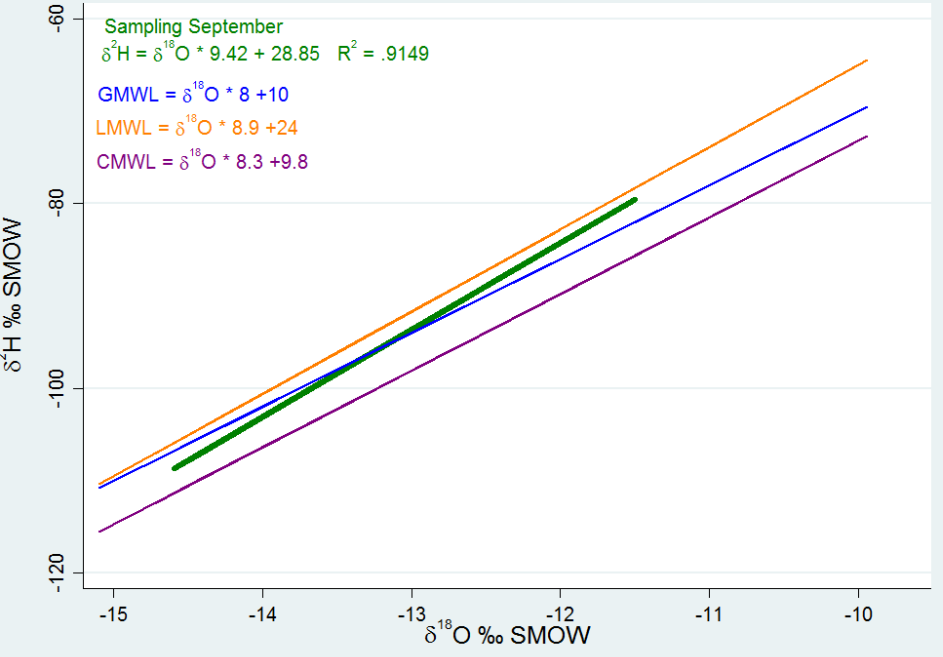


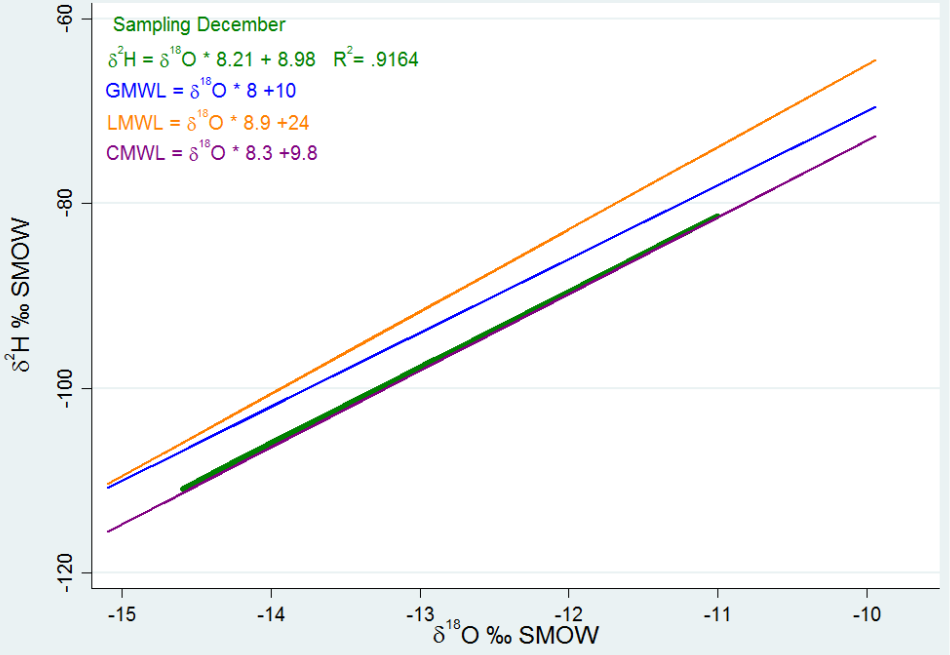
Stable Isotope values sampled seasonaly in stream waters spring, summer and autumn


Elevation
3500
3000
2500
2000
1500
-15
-14
-13
-12
-11
-10
δ18 ‰ SMOW
(9) GW borehole right tributary
(11) Left tributary
(10) Gordito spring surface water
(12) GW borehole right tributary
(13) GW borehole right tributary
(14) Main river Río Gordito
(15) Left tributary
(17) Vega Larga left bank tributary
(16c) GW Virgen right tributary
(16a) Gordito upstream thermal springs
(16b) Thermal spring 1 let bank
(18) Main River Río Gordito
(19) Left tributary Aguitas Negras
(21) Las Cuevas before meeting Gordito
(23) Left tributary
(20) Main River Gordito en la Tranca
(22) Río Grande
(24) Right tributary
(25) Río Grande
(26) Right tributary
(27) Right tributary Colorado
(29) Left tributary
(30) Río Grande
(31) Right tributary
(32) Right tributary
(33) GW spring right bank
(34) Río Grande Las Ramadas
Groundwater / Borehole
Thermal spring
Altitudinal Effect
Left Tributary
Right Tributary
Main River


Sampling January
δ²H = δ¹⁸O * 6.42 - 12.18 R²= .9233
GMWL = δ¹⁸O * 8 +10
LMWL = δ¹⁸O * 8.9 +24
CMWL = δ¹⁸O * 8.3 +9.8
δ²H ‰ SMOW
-60
-80
-100
-120
-15
-14
-13
-12
-11
-10
δ¹⁸O ‰ SMOW


Sampling May
δ²H = δ¹⁸O * 5.17 - 29.75 R²= .7750
GMWL = δ¹⁸O * 8 +10
LMWL = δ¹⁸O * 8.9 +24
CMWL = δ¹⁸O * 8.3 +9.8
δ²H ‰ SMOW
-60
-80
-100
-120
-15
-14
-13
-12
-11
-10
δ¹⁸O ‰ SMOW


Sampling September
δ²H = δ¹⁸O * 9.42 + 28.85 R² = .9149
GMWL = δ¹⁸O * 8 +10
LMWL = δ¹⁸O * 8.9 +24
CMWL = δ¹⁸O * 8.3 +9.8
δ²H ‰ SMOW
-60
-80
-100
-120
-15
-14
-13
-12
-11
-10
δ¹⁸O ‰ SMOW


Sampling December
δ²H = δ¹⁸O * 8.21 + 8.98 R²= .9164
GMWL = δ¹⁸O * 8 +10
LMWL = δ¹⁸O * 8.9 +24
CMWL = δ¹⁸O * 8.3 +9.8
δ²H ‰ SMOW
-60
-80
-100
-120
-15
-14
-13
-12
-11
-10
δ¹⁸O ‰ SMOW

Results of tracer and geochemical assessment

- First stable isotope dataset for this region: => provides consistent seasonal reference values

- Streamwater mainly fed by snowmelt in spring and groundwater in summer and autumn

Results of tracer and geochemical assessment

- no fossil groundwater (geochemical composition)
- Intraannual homogeinity in conductivity =>no contribution from deep groundwater
- Homogenous geochemical composition despite geothermal springs

Site appropiate drought assessment, monitoring and forecasting

Drought assessment and management tools depend on the scale, topography, demand side and other site specific drought relevant indicators:

- Rainfed agriculture: SPI and Vegetation based indices
- Irrigated agriculture: threshold methods
- Storage as reservoirs and groundwater: threshold methods
- Snowmelt driven systems: snow storage thresholds
- …..

International capacity building projects on the development of methodological learning units related to water resources management

- CapWater: developing and teaching learning units for water resources assessment: monitoring, data management and modelling
- EDUNEXUS: case study centered cooperation on education + research on the Water-Energy Food Security Nexus (CCG, Catholic University of Chile, ITT)
- PARTNAR: transformation partnership on Participatory Planning and Natural Resources Management – Curriculum Development
- CNRD: Centers for Natural Resources and Development
- ….

Target Group

- Professionals and scientists who would like to get an insight in mountainous hydrology and get to know monitoring and modelling tools to assess high elevation catchments
- Public sector decision makers and water users who need to deal with water availability predictions under climate change

General Information

The need for practical training related to water resources in Andean countries will grow in the coming years, because both society and governments are getting more aware of the emerging water related problems in their countries. Hence the overall goal of the symposium and training is to increase awareness about the vulnerable Andean hydrology and its key role for the regional environment and water availability predictions.

The science policy dialogue in this field of research is of utmost importance for the region to increase the public focus on research and monitoring efforts in mountainous catchments. Tools to assess water resources in pristine Andean headwaters are introduced to enable decision makers to select appropiate measures to obtain valuable information.

Discharge measurements in the Cordillera, Chile (ITT)

Venue and Date

Santiago, Chile
17th-20th November 2015

Organizer

UNESCO IHP - International Hydrological Programme,
Koen Verbist
Institute for Technology and Resources Management in the Tropics and Subtropics ITT - Cologne University of Applied Sciences
Universidad Católica de Valparaiso
CAZALAC

Contact

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k.verbist@unesco.org
Alexandra Nauditt,
Institute for Technology and Resources Management,
alexandra.nauditt@fh-koeln.de

The symposium and the training is supported by:

CAZA

Centro UC Cambio Global

CNRD Center for Natural Resources and Development

CAZALAC

Symposium and Professional Training

Understanding the role of Andean hydrology for water management: tools and concepts

17th – 20th November 2015
Santiago, Chile

Background

Growing population, economic development and climate change are increasing the challenges for sustainable water resources management. Hydrological risks are expected to significantly increase in South America as confirmed by recent reports of IPCC (2014) and IPCC-SREX (2012). Education and training at all levels play an important role. Future water professionals need to understand the fundamentals of water related information to contribute to a sustainable decision making process. Understanding the provenance and generation of reliable hydro-meteorological and water quality data is indispensable for modeling the hydrological conditions and for water management. Relevant skills related to monitoring, modelling as well as adequate storage, transfer, analysis and visualization of data are of utmost importance for water system understanding, regional and intersectoral cooperation and scenario development.

Objectives

The training course has the following objectives:

- enable participants to select adequate methods to assess Andean catchments for long and short-term discharge predictions
- Understand key aspects about monitoring and modelling in mountainous catchments

Set up of the climate station (ITT)

Key topics

Monitoring — Information Management — Modelling

1. Introduction Characteristics of mountainous catchments, key aspects of groundwater, spatial and hydro-meteorological data assessment
2. Hydrological modelling: introduction and application by each group, comparison of J2000, HBV, WEAP applications
3. Climate monitoring: introduction, parametres, snow weight, snow water equivalent
4. Monitoring in tributaries

Trainers

The lecturers are professors and professional experts from:

- Institute for Technology and Resource Management, Cologne
- UFrontera
- CEAZA/ CAZALAC
- Universidad de Chile
- Universidad Católica de Valparaíso

Training methods

- Key lectures
- Exercises and group works
- Excursion: 1 day field trip
- The official language of the symposium and the training course is Spanish.

High elevation Andean region (ITT)

Training Workshop

Tuesday	Wednesday	Thursday	Friday
Introduction to tools for hydrology assessment in mountainous catchments	Field Trip: Monitoring Climate and Discharge	Introduction to hydrological modelling approaches	Introduction to
		Comparison of different applications	Parallel working groups
Lunch		Lunch	Lunch
Introduction to climate monitoring		Parallel working groups	Presentation of the results
Working group on field trip preparation		Working groups	

Gracias!

Danke Obrigada

For more Information log on to:

www.basin-info.net/limari

www.hidro-limari.info

www.itt.fh-koeln.de

Related Publications

Nauditt, A., Soulsby, C., Rusman, A. Schüth, C., Ribbe, L., Álvarez, P. & Kretschmer, N., (2014): Synoptic tracer surveys of streamwater isotopes and geochemical tracers to understand runoff processes in a semiarid Andean headwater catchment, Central Chile. Submitted to Hydrological Processes (2014). Wiley & Sons, Ltd.

Nauditt, A., Birkel, C., Soulsby, C., & Ribbe, L. (2015): Assessment of hydro-meteorological extremes in semiarid Andean headwater catchments based on conceptual hydrological modelling. Submitted to Hydrological Sciences Journal

Souvignet, M.; Laux, P.; Freer, J.; Cloke, H., Quang Thinh Dang; Tran Thuc; Cullmann, J.; Nauditt, A.; Flügel, W.-A.; Kunstmann, H. & Ribbe, L. (2013), Recent climatic trends and linkages to river discharge in Central Vietnam, Hydrological Processes (2013), DOI: 10.1002/hyp.9693

Nauditt, A.; Ribbe, L; Kretschmer, N. (2014), River basin inventory and state of the basin reporting tool for the Limarí river basin, Central Chile (2014), Journal of Natural Resources and Development (Submitted)

Ribbe, L; Nauditt; Firoz, ABM. (2014), River basin inventory and state of the basin reporting tool for the VuGIaThuBon river basin, Central Vietnam (2014), Journal of Natural Resources and Development (Submitted)

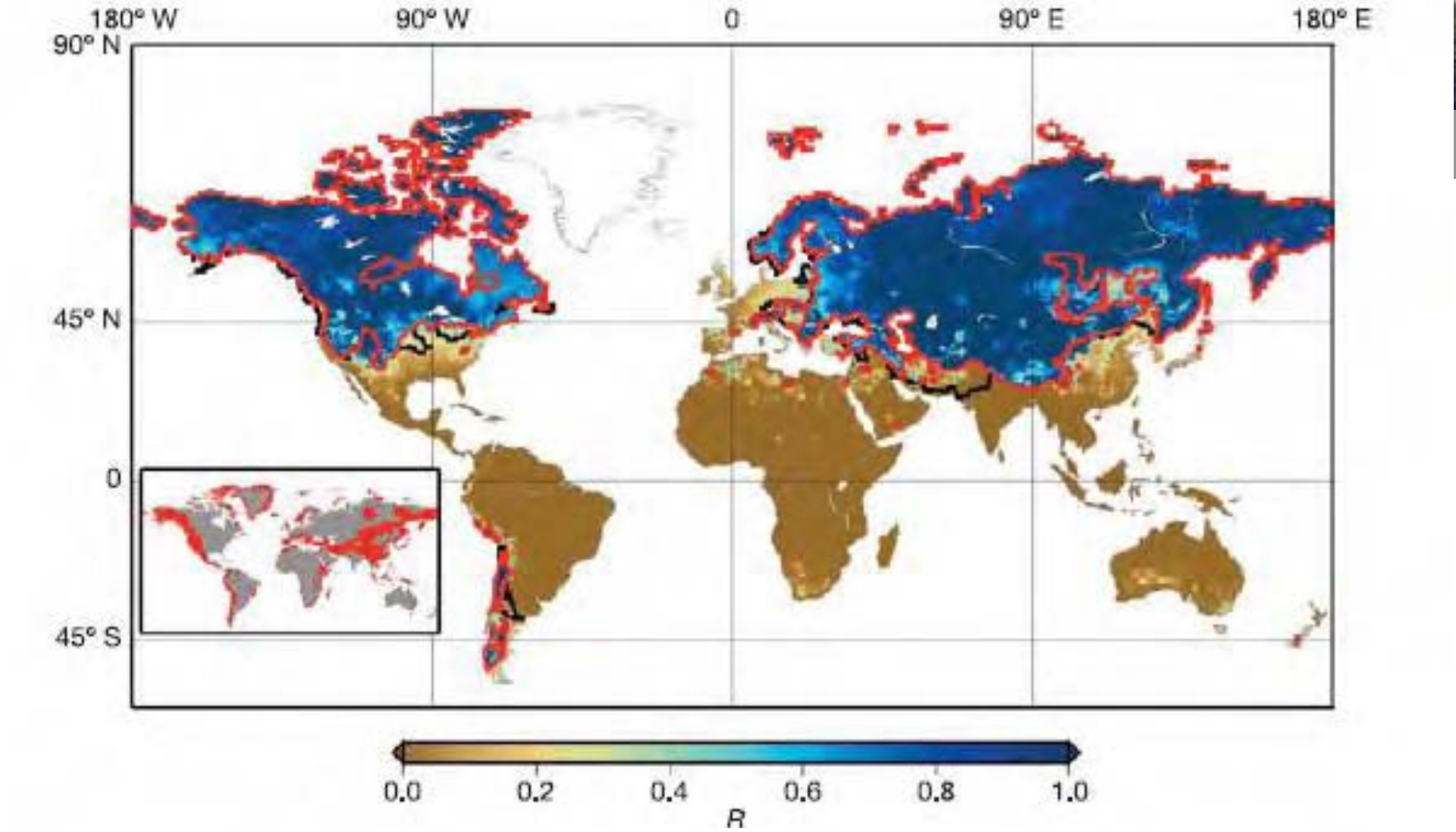

Fig: Regions with snowmelt dominated streamflow are highlighted with red lines. The black lines indicate areas where water availability is dependent on snowmelt generated upstream while runoff generated within these areas is not snowmelt-dominated. Barnett et al. (2005) highlight the vulnerability of the Andean, Himalayan and Hindu Kusch subbasins to climate variability and change as well as the complexity of these hydrological systems (Barnett et al., 2005) approximately one-sixth of the world's population lives within this combined snowmelt-dominated, low-reservoir-storage domain.

Characteristics of cryospheric mountainous arid and semiarid regions

- Large drought prone agricultural areas are supplied with water from mountainous headwater catchments as from the Himalayan „Third Pole“, the Andes or the Rocky Mountains (Colorado River)
- One sixth of world population is living in these regions (Singh et al., 2006; Barnett et al., 2005)
- Contribution to stream runoff in Central Chile:
  - Snow melt
  - ablation of glaciers and rock glaciers and other melting permafrost and ground ice (Arenson&Jakob 2010)
  - Groundwater of different ages (Vogel et al. 1971; Fritz et al., 1981)