Regional adaptation activities on river basin level
Alexandra Nauditt, ITT

The Impact of Glacier Retreat in the Andes Group
Workshop, UNESCO IHP, Santiago, 2015
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 scientific, 35 support)
- Students: 200 Msc and 35 PhD
- Budget: around 4.5 million Euro (3 million Third party fund)
IWRM Case Studies and Joint Projects
Learning from real life problems – „Natural Labs“

San Luis Potosi, MX
Closed Basin, Altiplano, floods and droughts, groundwater overuse

Limari, CL
Drought, basin vs field water use efficiency

Macacu, BR
Water Quality protection for urban drinking water supply

Paraiba do Sul, BR
Competing water demands under drought

Gondar, ET
Rain-fed agriculture in Ethiopian highland

Vu Gia Thu Bon, VN
Coordinated Reservoir Management, Floods and Droughts

Semarang, ID
Coastal Zone and Urban Watershed Management

Bagmati, NP
Integrated river basin development

Azraq, JO
Closed Basin, groundwater RAMSAR wetland destruction

Wupper, DE
Information Systems for multi-purpose river basin management

Eastern Nile
Transboundary River Basin Management

Gezira, SD
Optimisation of large scale irrigation

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

1. Environmental Monitoring
2. System Modeling
3. Management and Planning

- Storage
- Reservoir
- Source
- Discharge
- Treatment
- Distribution
- Collection
- Drainage
- Channels
- Field Irrigation
- Ecosystem
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:
Web based River Basin Information system to support drought management in Northern-Central Chile

Consortium:
Facultad de Agronomía, Universidad Católica de Valparaíso, 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 Modelling: Water Availability
Forecasting (rain-runoff), Water Demand and Allocation Modeling

Water use efficiency and Management of water related risks

Isotope and Geochemical tracer analysis
Ground Water level and quality monitoring
Discharge and Runoff monitoring
Water level monitoring

Water Resource Information and Irrigation Water management for mobile devices

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

Data Transfer

Stakeholders, Water Users and Institutions in the agricultural and urban sector
Information Transfer of Water Policy
Decision Support, Management and Training

Collecting Information

Field Measurements, Offline Data, Laboratory Data, etc.
Tools for drought assessment and management: Information is crucial for drought management

**Figure**: Data and information flow

**Components of Drought Information System**

- **Data**
  - Existing sensors / real-time data stations
  - Sensor connectors
  - Model connectors
  - Existing models
  - Data Center
  - Database connectors
  - Existing databases

- **Analysis**
  - Algorithms / Indicator threshold integration, drought impact calculation

- **Reporting**
  - Maps: visualization of spatial distribution of drought risk
  - Forecasts and scenarios
  - Knowledge, products and graphs to aid optional measures
  - Reporting
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 scarce 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
• Strong spatial and temporal variability of precipitation,
• average rainfall 120mm per year
• Pot Evapotranspiration
• > 1000mm
• Hydrological year May to April

Limarí Basin, Rio Grande (544km²) and Tascadero (242 km²), total size 11.696 km²,
<table>
<thead>
<tr>
<th>ID</th>
<th>Location</th>
<th>Elevation [m.a.s.l.]</th>
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<tr>
<td>9</td>
<td>GW borehole right tributary</td>
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<td>Gordito spring surface water</td>
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<td>11</td>
<td>Left tributary</td>
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<td>16</td>
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<tr>
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<td>Vega Larga left bank tributary</td>
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<td>Main River Gordito</td>
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<td>19</td>
<td>Left tributary</td>
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<td>Main river Gordito en la Tranca</td>
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<td>Las Cuevas before meeting Gordito</td>
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<td>GW spring right bank</td>
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<td>Rio Grande Las Ramadas</td>
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</table>
Stable Isotope values sampled seasonaly in stream waters spring, summer and autumn
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 homogeneity in conductivity => no contribution from deep groundwater
- Homogenous geochemical composition despite geothermal springs
Site appropriate 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 appropriate measures to obtain valuable information.

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 Valparaíso
CAZALAC

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Symposium and Professional Training

Understanding the role of Andean hydrology for water management: tools and concepts
17th – 20th November 2015
Santiago, Chile

Discharge measurements in the Cordillera, Chile (ITT)

The symposium and the training is supported by:

[Logos of supporting organizations]
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

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, parameters, 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.

Training Workshop

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<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
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<tr>
<td>Introduction to tools for hydrology assessment in mountainous catchments</td>
<td>Field Trip: Monitoring Climate and Discharge</td>
<td>Introduction to hydrological modelling approaches</td>
<td>Introduction to tools for hydrology assessment in mountainous catchments</td>
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<td>Lunch</td>
<td>Lunch</td>
<td>Lunch</td>
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<tr>
<td>Introduction to climate monitoring</td>
<td></td>
<td>Parallel working groups</td>
<td>Presentation of the results</td>
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<tr>
<td>Working group on field trip preparation</td>
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</table>

Set up of the climate station (ITT)
High elevation Andean region (ITT)
Gracias!

Danke  Obrigada

For more Information log on to:

www.basin-info.net/limari
www.hidro-limari.info
www.itt.fh-koeln.de


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)