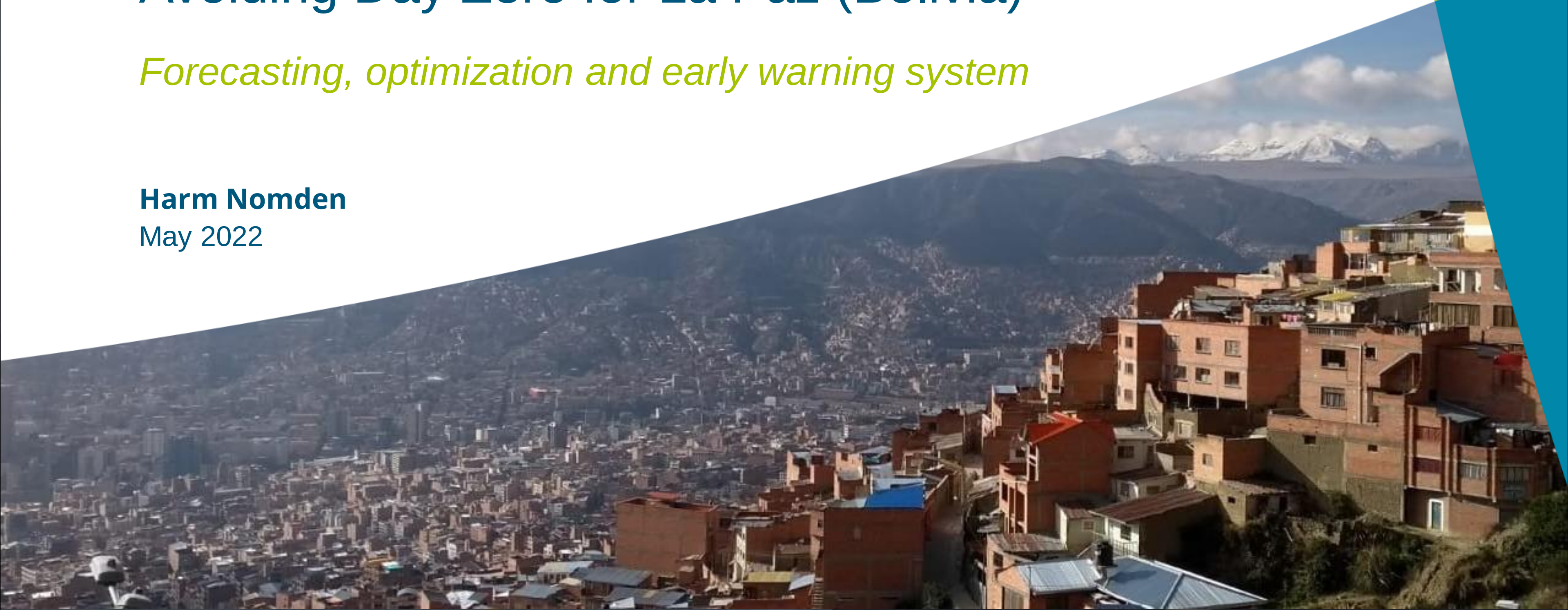
Avoiding Day Zero for La Paz (Bolivia)

Forecasting, optimization and early warning system

Harm Nomden
May 2022



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Avoiding Day Zero for La Paz (Bolivia)

Project manager: Michel Riemersma,

contact: michel.riemersma@rhdhv.com

Local project manager: Adrian Zamora

Team of water experts:
Harm Nomden (technical lead), Hidde Kats, Ric Huting, Thies Blokhuijsen, Wouter Engel, Björn Bolhuis, Raul Romero Vidaurre.

Team EPSAS (local drinking water company La Paz):
Tomas Quisbert, Seleny Humerez Espinoza, Wilson Yuque

Harm Nomden

Msc in Water Engineering & Management

10 years of experience in water-management in the Netherlands, Colombia, Bolivia, Myanmar and more.

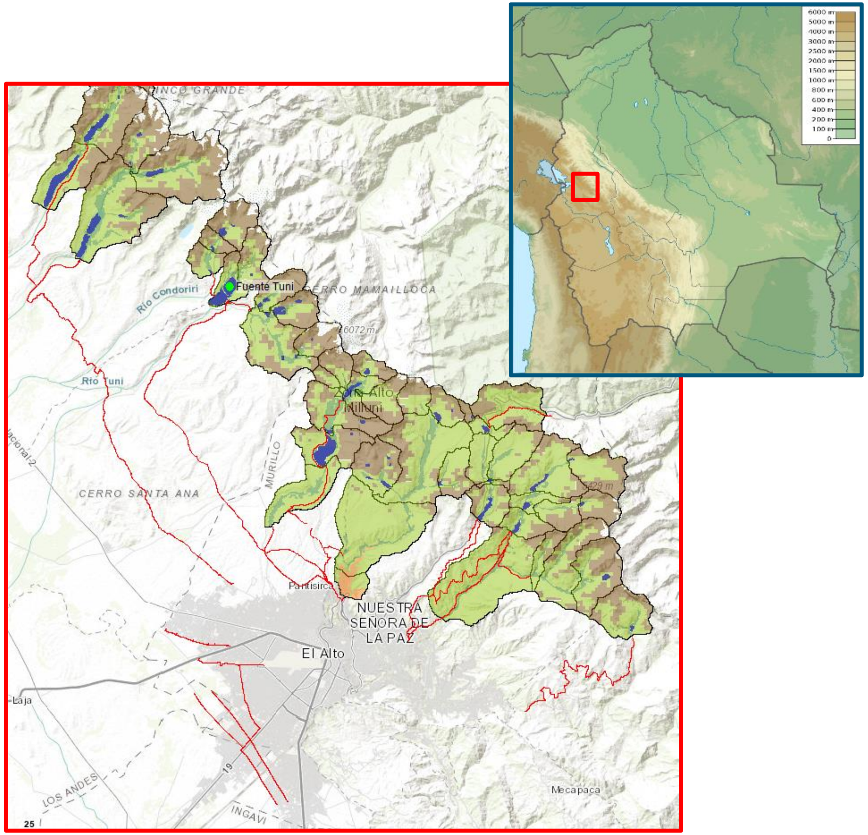
Since January 2022 working for **Sweco** (mainly North-Europe) as advisor watermanagement and data expert

Contact: harm.nomden@sweco.nl

Avoiding Day Zero for La Paz (Bolivia)

- The cities of La Paz and El Alto located at 3500-4000m above sea level.
- Drinking water supply is managed by EPSAS, the local drinking water company

- Challenges:
  1. **Growing water demand**: Growing number of inhabitants: 1.6 (2015) → 2.1 (2030) million;
  2. **Increasing stress on the system:** Climate change, water quality, operational costs;
  3. **November 2016 (after El Niño drought):** Water shortage during 6 weeks → heavy restrictions, protests, support from army;
  4. **Increasing complexity of the system**: from 14 to 26 reservoirs in 10 years time;
  5. **Continuous changes over time**: demand for monitoring and automatic forecasting and optimization increases;
  6. **Management: Limited number of experts.**



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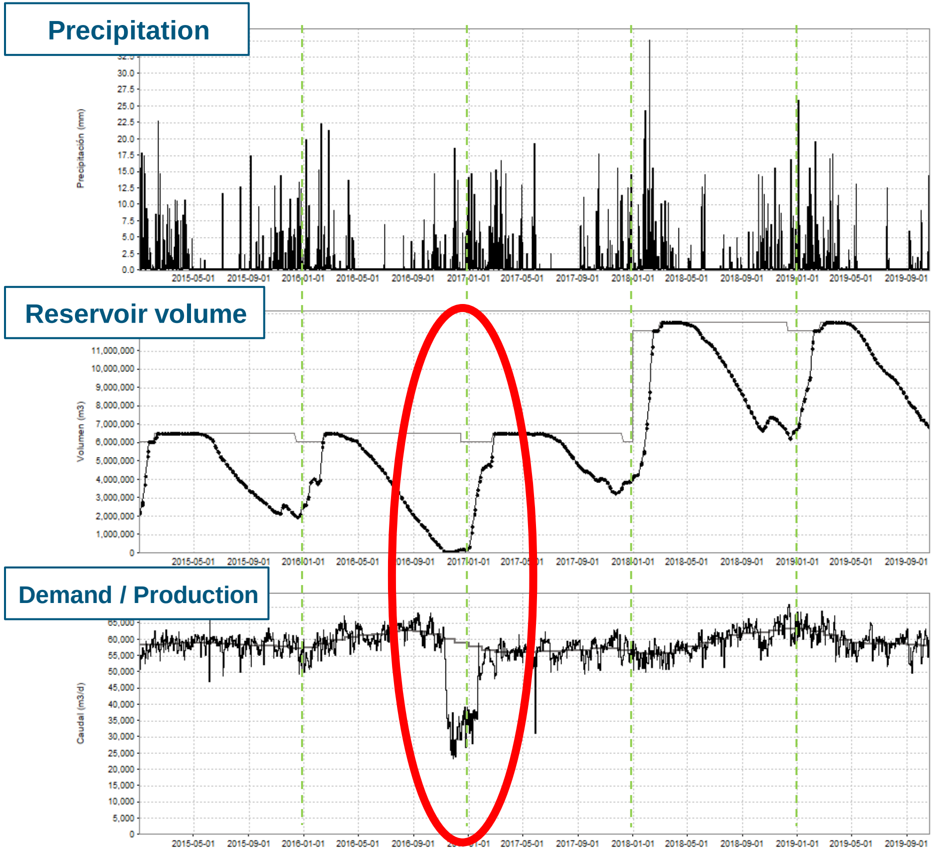

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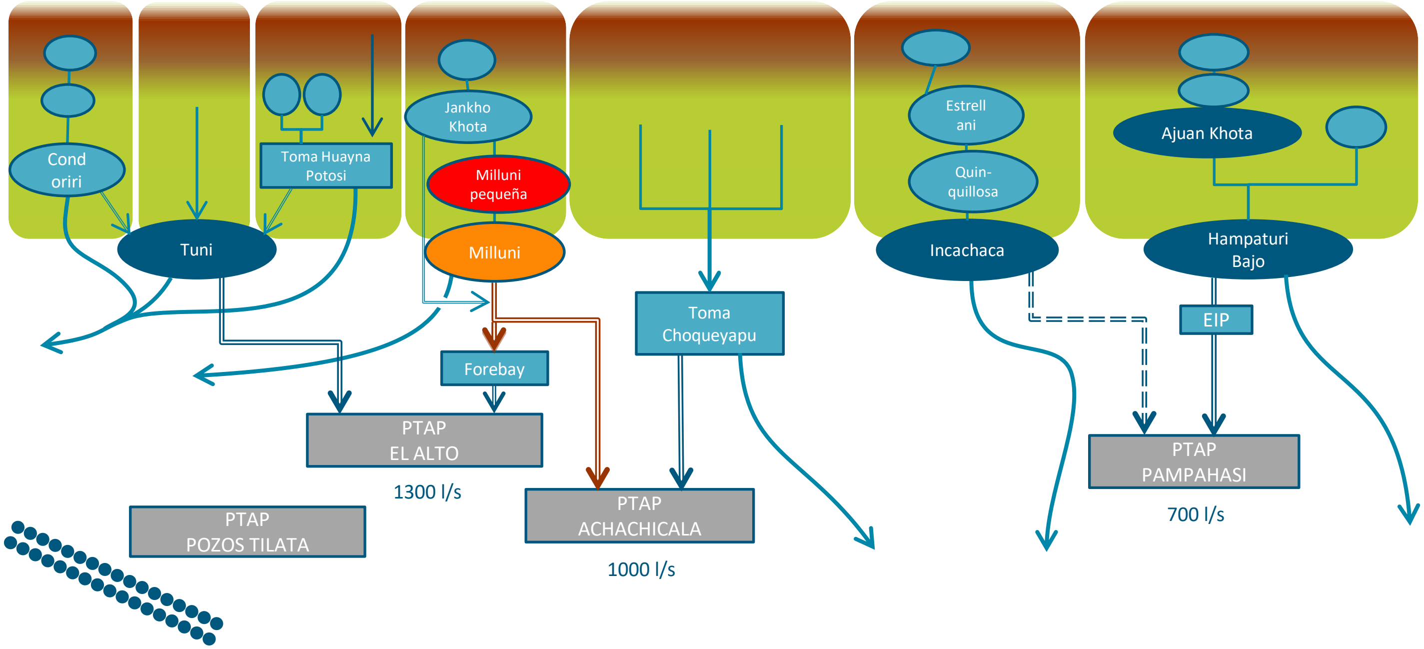
Supply Network EPSAS

Supply Network EPSAS: 2016 - 2017 - 2018 - 2019 - 2022 - 2025



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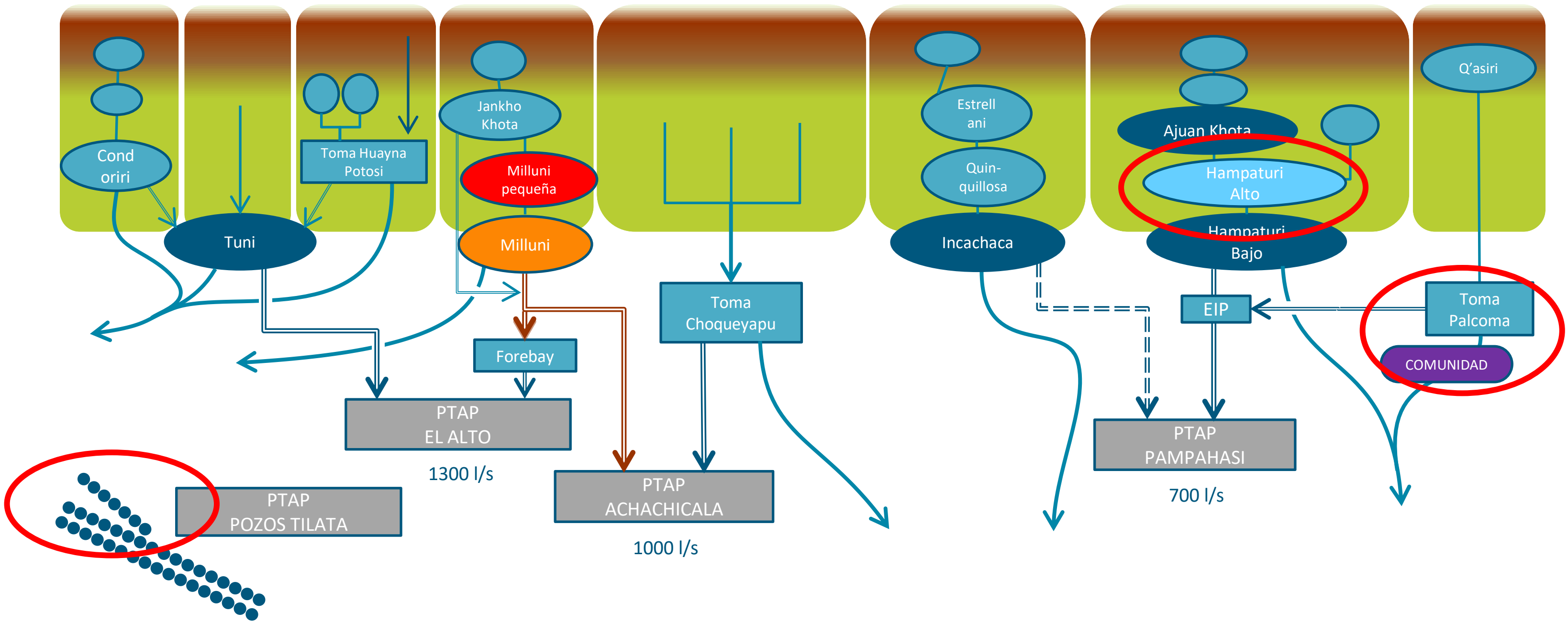

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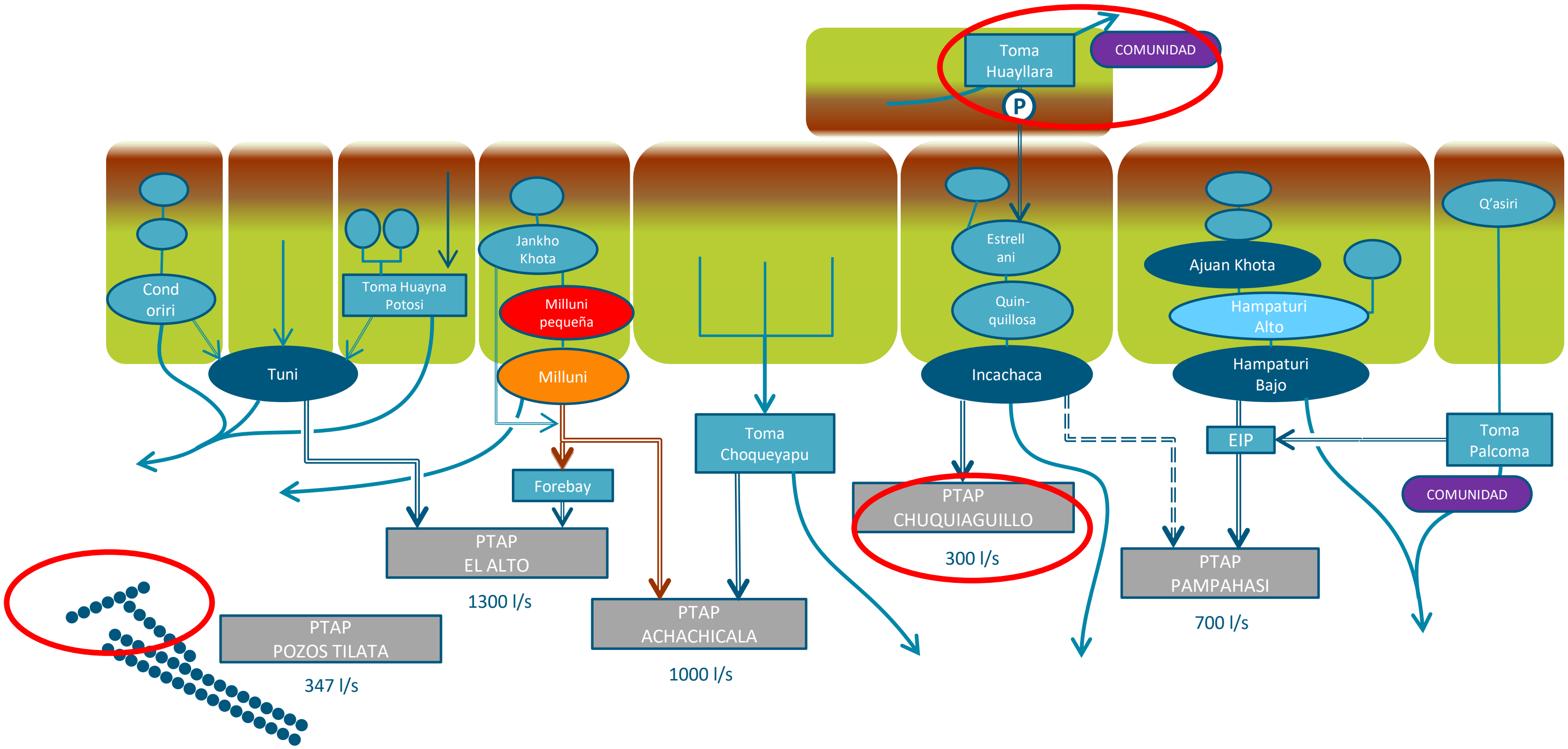

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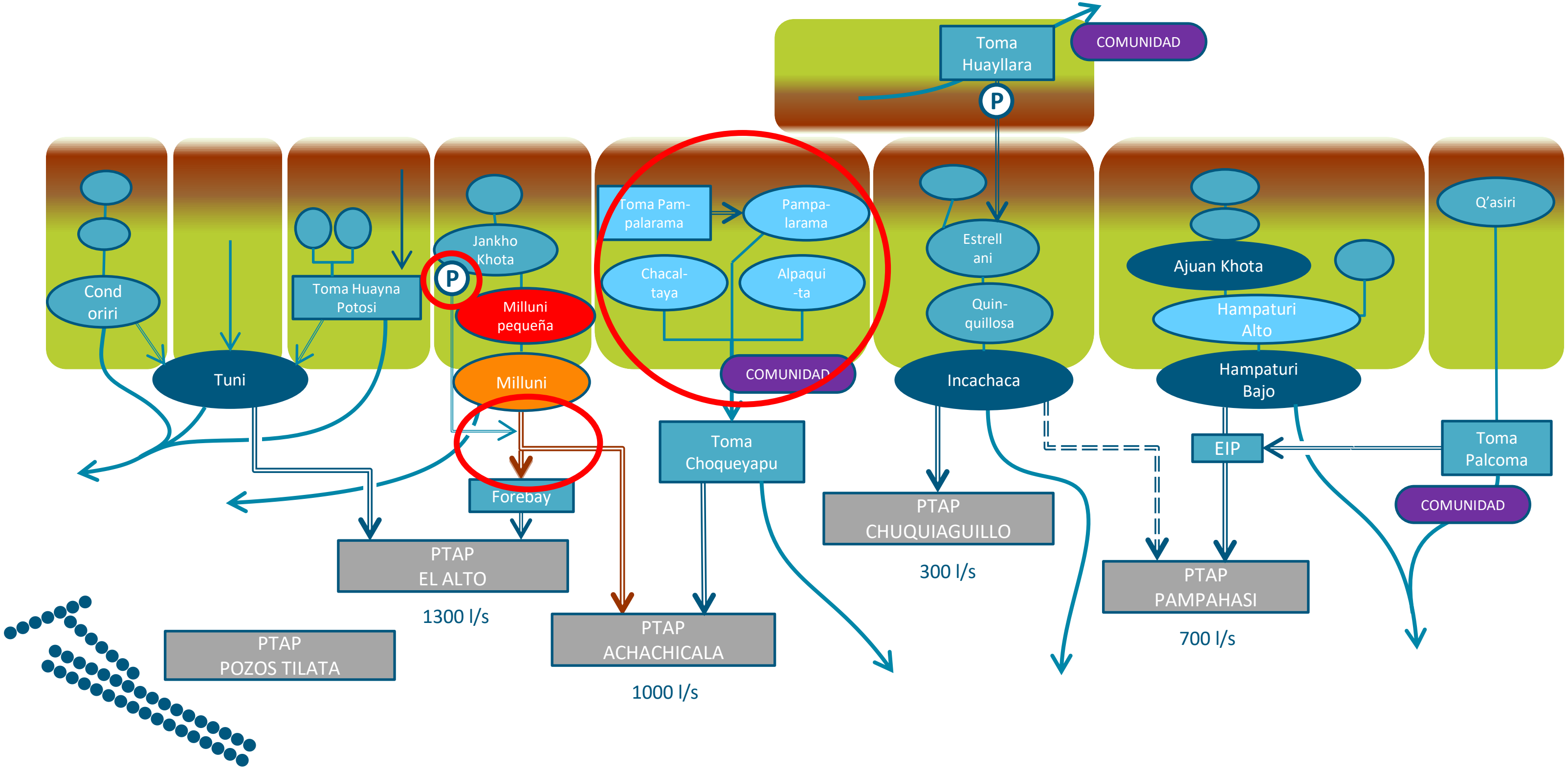

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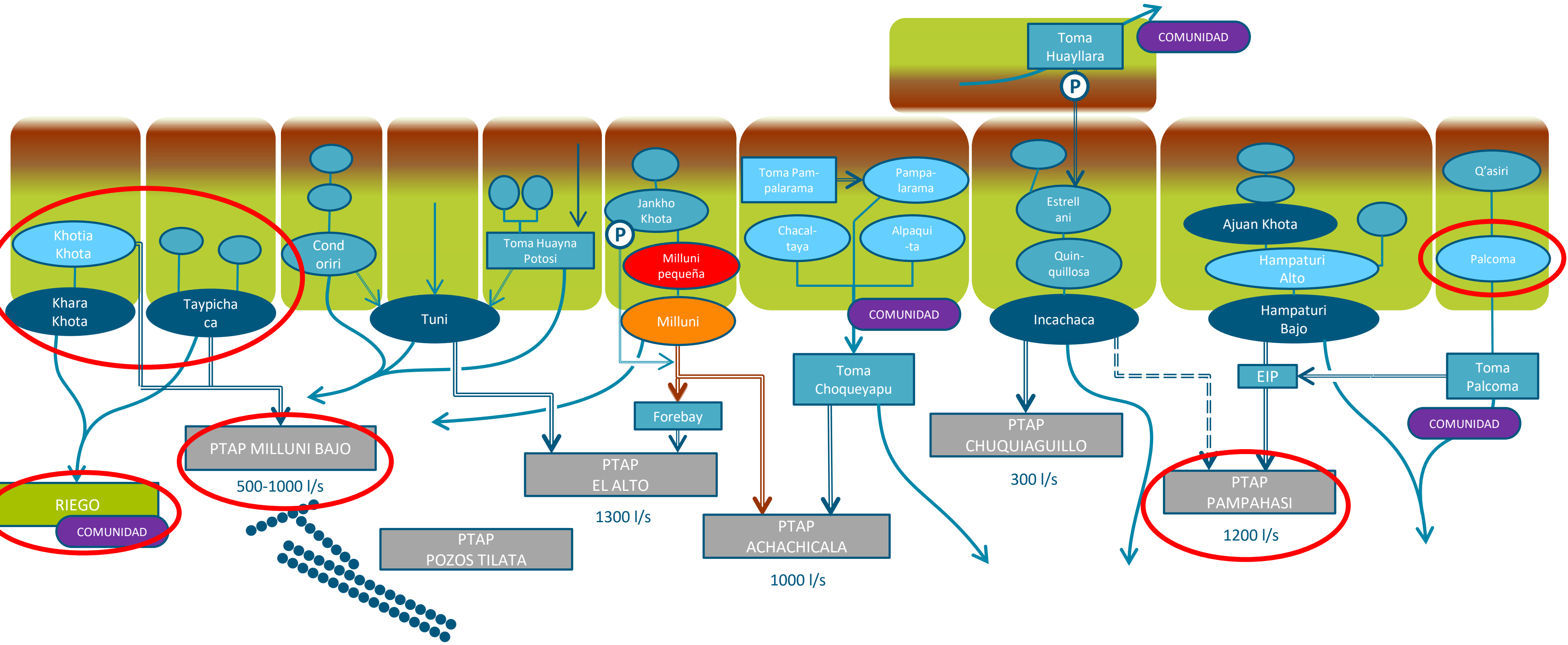

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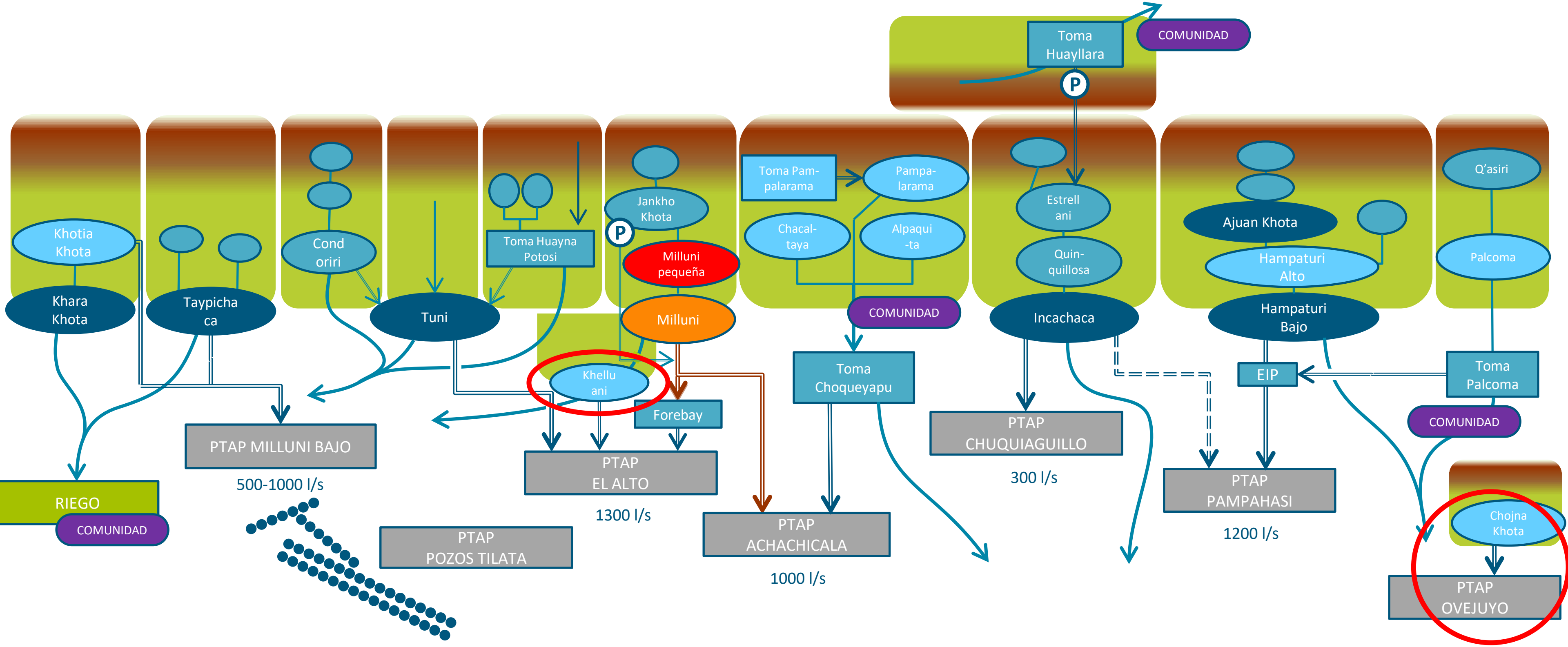

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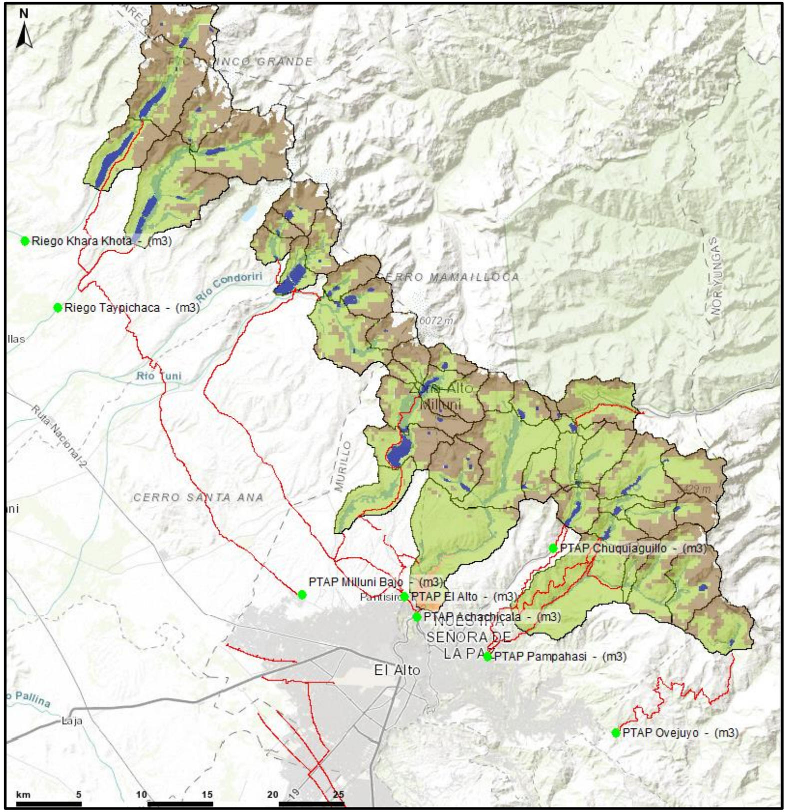
Water Efficiency & Early Warning EPSAS (La Paz, Bolivia)

Objectives Operational System:

- Monitor/forecast status of the catchments;
- Monitor/forecast water availability each reservoir, each catchment and each treatment plant;
- Monitor transported volumes of water;
- (Optimize) transport or use of water.
- Forecasts based on ensemble of historical data

Using:

- Historical meteo-stations and data + 50 new stations
- Hydrological modelling (custom-made)
- Optimization software + Delft-FEWS



Hydrological modelling

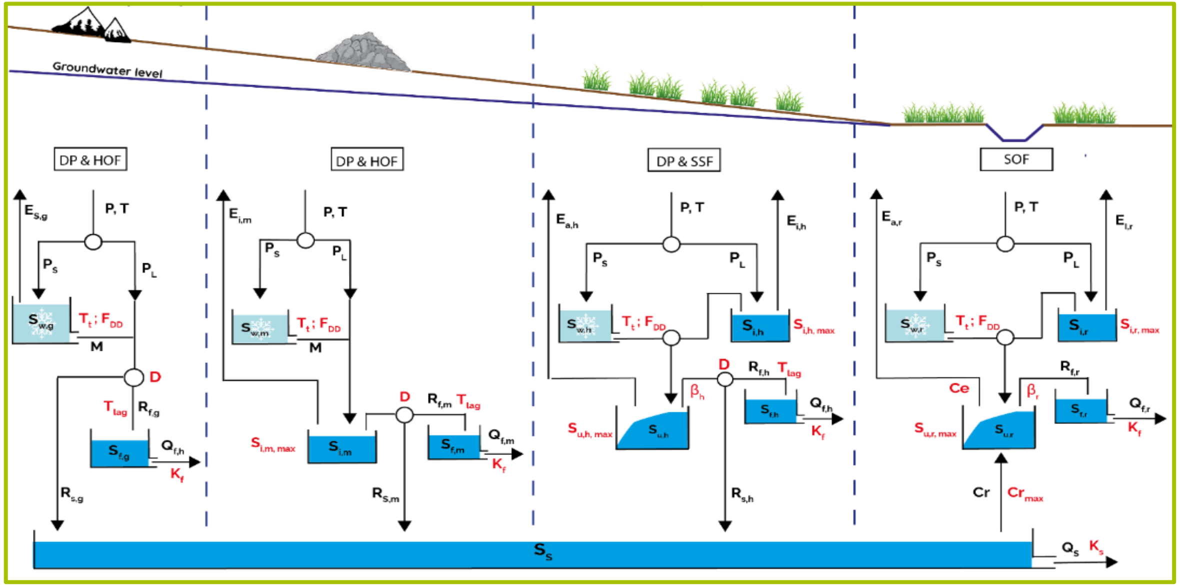
- Semi-lumped / semi-distributed hydrological model using **Hydrological Response Units**
- FLEX-Topo (Savenije, 2010)

Glaciers

Morraine rock

Hillslope

Wetlands



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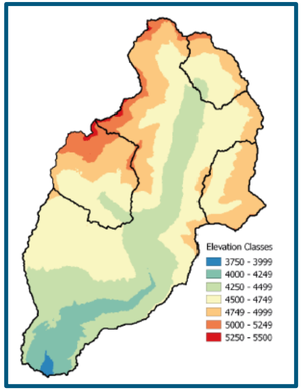
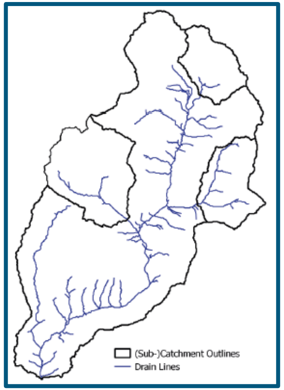
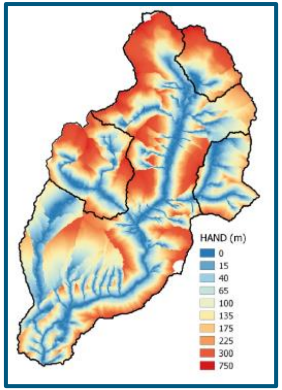
Elevation



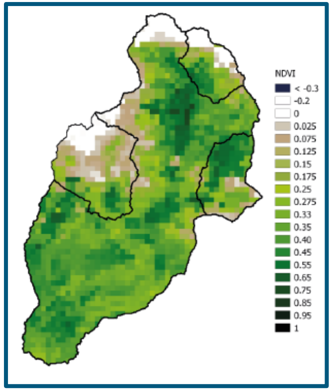
Rivernetwork



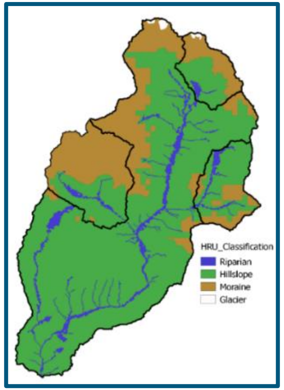
HAND



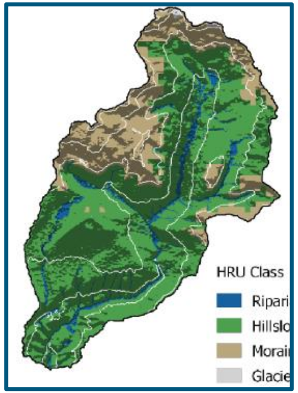
NDVI



HRU's

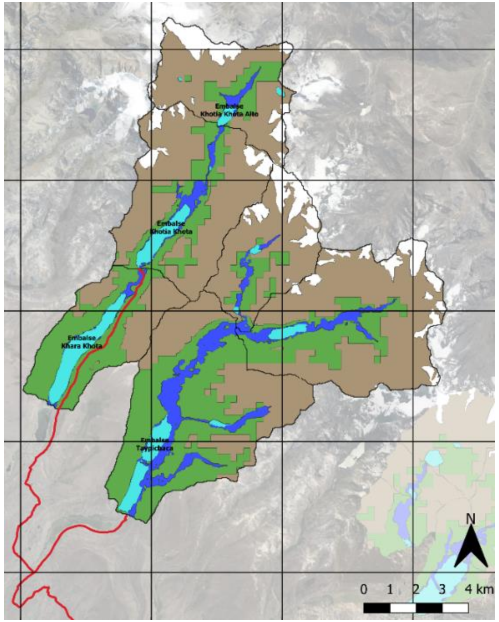


HRU's + elevation + irradiance

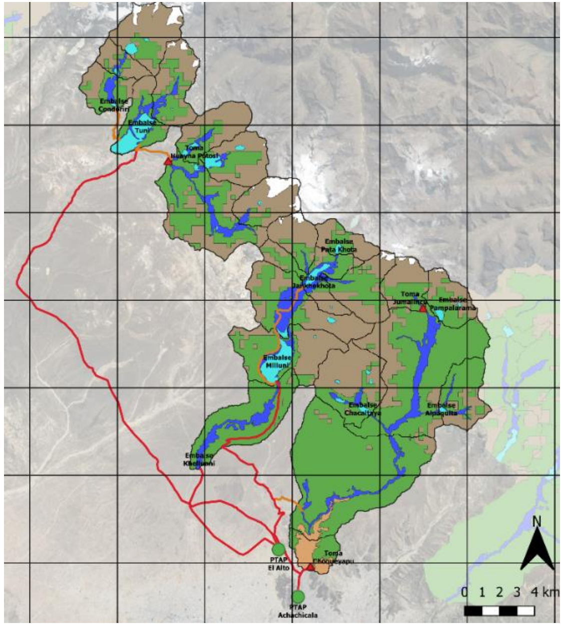


Hydrological modelling

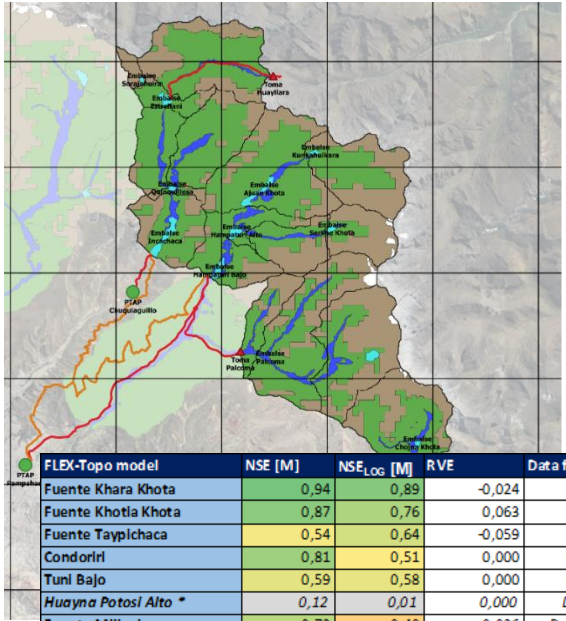
Territorial Unit Multi-purpose



Territorial Unit West



Territorial Unit East



- Using historical data 20 rainfall stations
- 49 subcatchments divided over 9 catchments
- Calibrated at 13 locations on monthly run-off

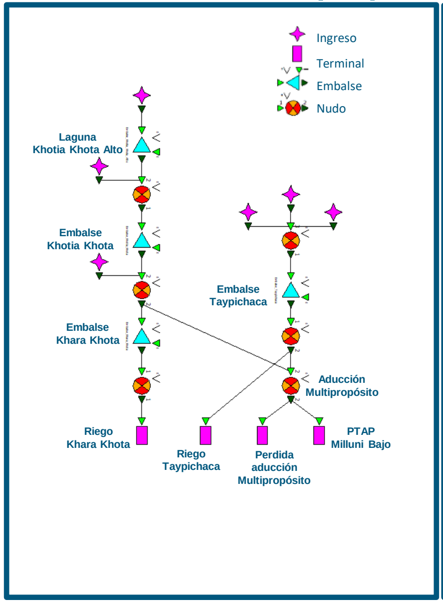
FLEX-Topo model	NSE [M]	NSE_{LOG} [M]	RVE	Data for calibration
Fuente Khara Khota	0,94	0,89	-0,024	Based on model results (monthly)
Fuente Khotia Khota	0,87	0,76	0,063	Based on model results (monthly)
Fuente Taypichaca	0,54	0,64	-0,059	Based on model results (monthly)
Condoriri	0,81	0,51	0,000	Limited discharge measurements (daily)
Tuni Bajo	0,59	0,58	0,000	Limited discharge measurements (daily)
*Huayna Potosi Alto **	*0,12*	*0,01*	*0,000*	*Limited discharge measurements (daily)*
Fuente Milluni	0,72	0,40	0,026	Derived from reservoir balances (monthly)
Río Choqueyapu (Kaluyo)	0,74	0,72	-0,010	Extensive discharge measurements (daily)
Fuente Incachaca	0,78	0,63	-0,041	Derived from reservoir balances (monthly)
Fuente Hampaturi	0,86	0,80	-0,010	Derived from reservoir balances (monthly)
*• Hampaturi Bajo ***	*0,76*	*0,70*	*0,147*	*Derived from reservoir balances (monthly)*
*• Ajuan Khota ***	*0,78*	*0,27*	*-0,124*	*Derived from reservoir balances (monthly)*
Fuente Palcoma & Chicani	0,72	0,77	-0,078	Limited discharge measurements (daily)
Average	**0,76**	**0,67**		

* Limited discharge measurements, linked precipitation station located far away

** Doubts about individual reservoir balances (specifically flow between reservoirs). Calibrated on catchment level.

Optimization

Territorial Unit Multi-purpose



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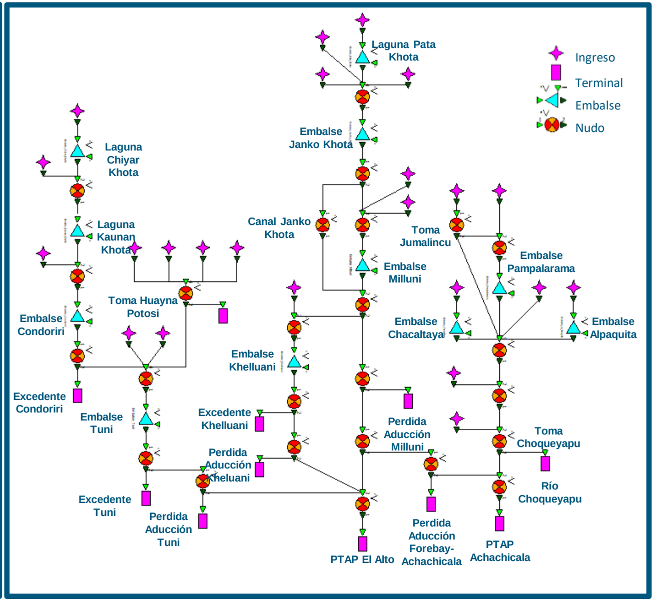

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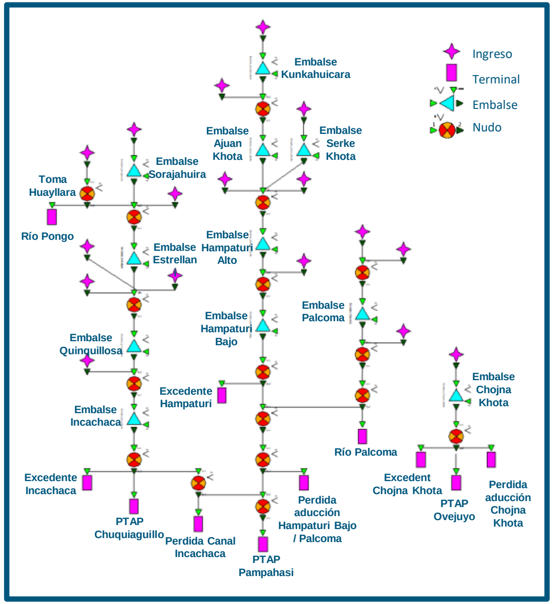
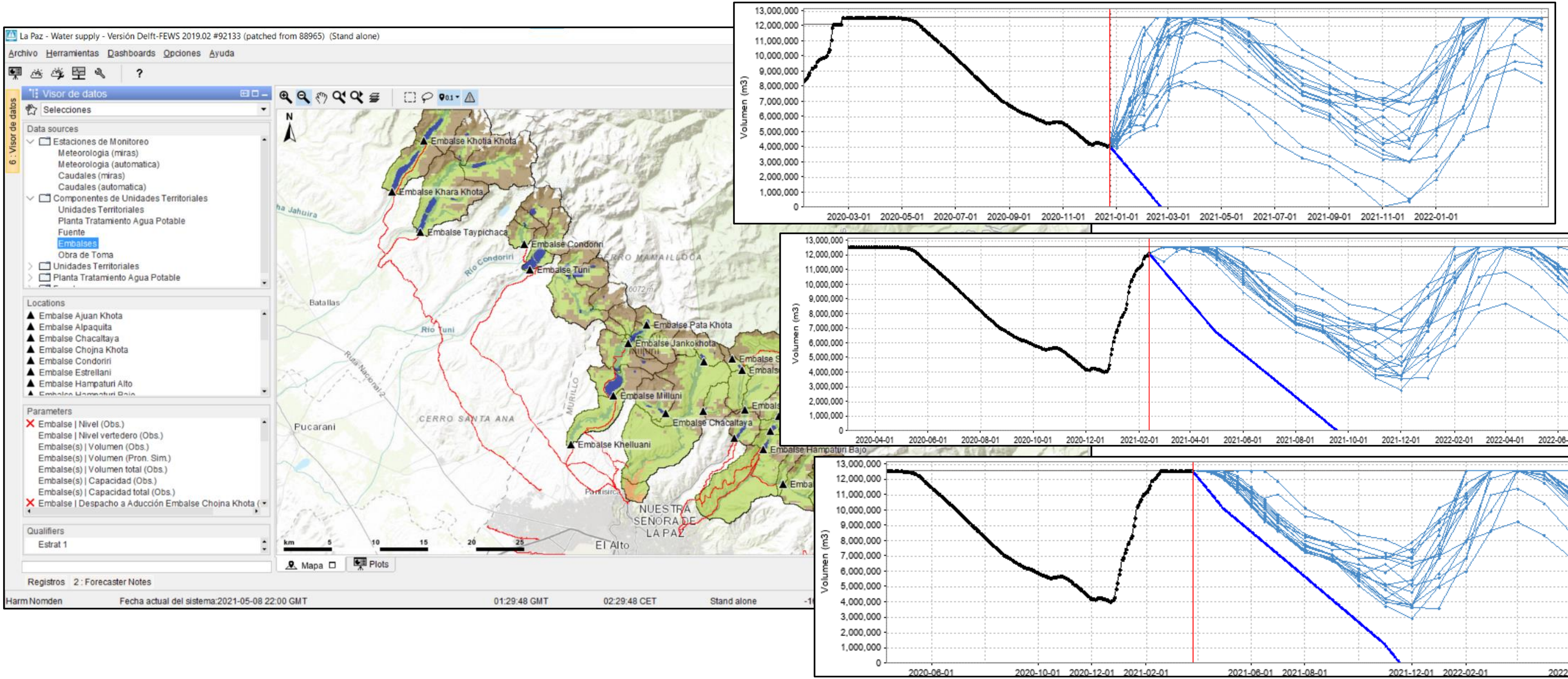


- Meteorological ensemble-forecasting
- Goal optimization using RTC-Tools 2.0 (developed by Deltares)
- Priorization of goals, multiple strategies (costs vs water security) and more.

Delft-FEWS: Operational system



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Thank you!

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