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Macromodelling as a tool for water management in a megacity

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Peruvian-German research project "Lima Water – LiWa"

- Peru
  - SEDAPAL S.A.
  - Universidad Nacional de Ingenieria
  - Foro Ciudades para la Vida
  - FOVIDA
- Germany
  - ifak e. V. Magdeburg (Coordinator)
  - ZIRN, University of Stuttgart
  - IWS, University of Stuttgart
  - Leuphana University Lüneburg
  - Dr. Scholz & Dalchow
- Funding: BMBF
- www.lima-water.de

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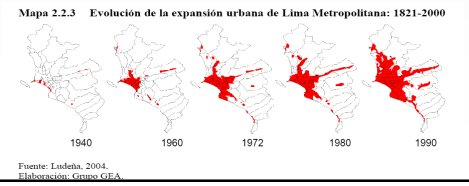
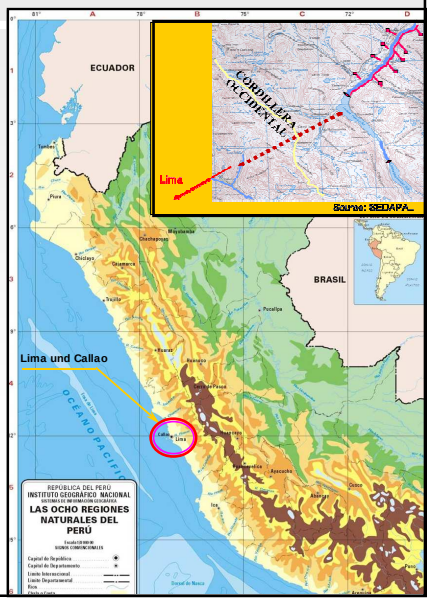
Urban growth centre Lima

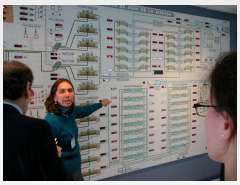
- Lima: Urban growth centre: 8 million inhabitants
- Significant population growth (2.1% p.a.), mainly in peri-urban settlements
- Desert region, only 9 mm rain p.a.
- Challenging boundary conditions for sustainable drinking water supply (demographic and geographic situation)
- Climate change leads to melting of glaciers in the Andean region





Situation of water supply and sanitation in Lima

Rio Rimac after abstraction

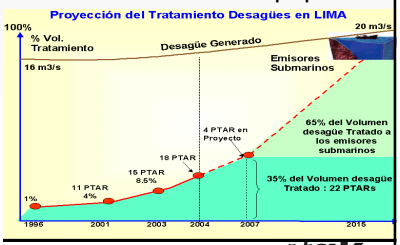


Control of supply network

Water lorries for 20 % of population

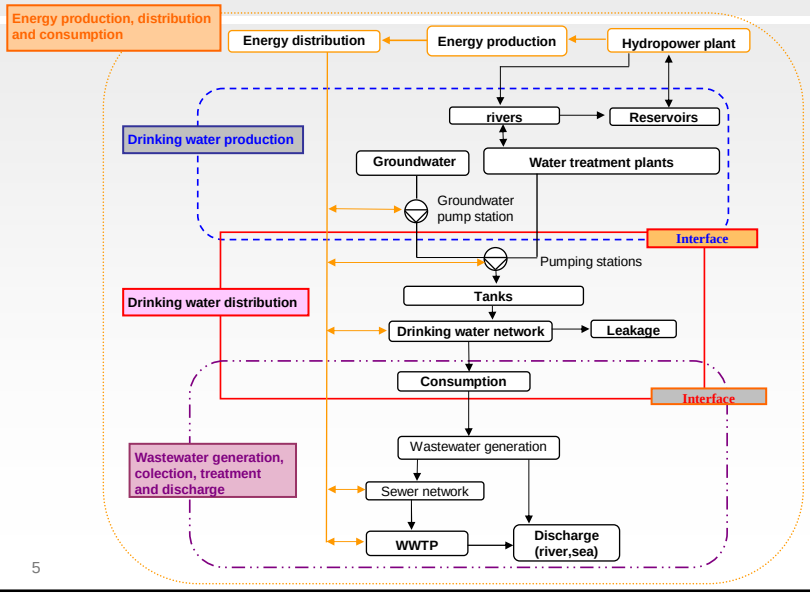
Projects on Ecological sanitation

La Chira WWTP (-> Sea outfall)



Wastewater treatment

Interactions of the subsystems “drinking water”, “wastewater” and “Energy”



Water management in megacities

- Some tasks and responsibilities
  - Water supply to the population (quantity, quality)
  - Water supply to industry
  - Water supply for irrigation
  - Wastewater collection, treatment, discharge, reuse

  - Planning, maintenance of infrastructure
  - Exploring new options
  - Improved operation of the system
  - Interactions with other sectors, e.g. energy (generation, use conflicts)
  - Institutional framework
  - …

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Water management in megacities (systems approach)

- The underlying system
  - Dynamic, fast growing, complex, many subsystems
  - Numerous interactions (of subsystems and processes)
  - Need to increase resilience of the system, decrease vulnerability
- Present solutions
  - Often driven by particulate interests (e.g. private companies)
  - Overall approach often lacking

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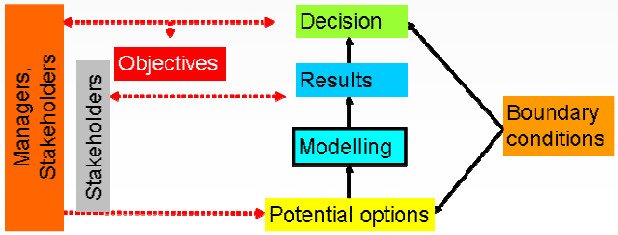
Water management in megacities: aided by macromodelling

- Solution approach
  - Modelling to cope with complexity
  - Participatory discussion and decision approaches, ensuring ownership
  - 2 Modelling approaches:
    - Detailed models, e.g. individual plants
    - Macromodelling: the entire water system within one model



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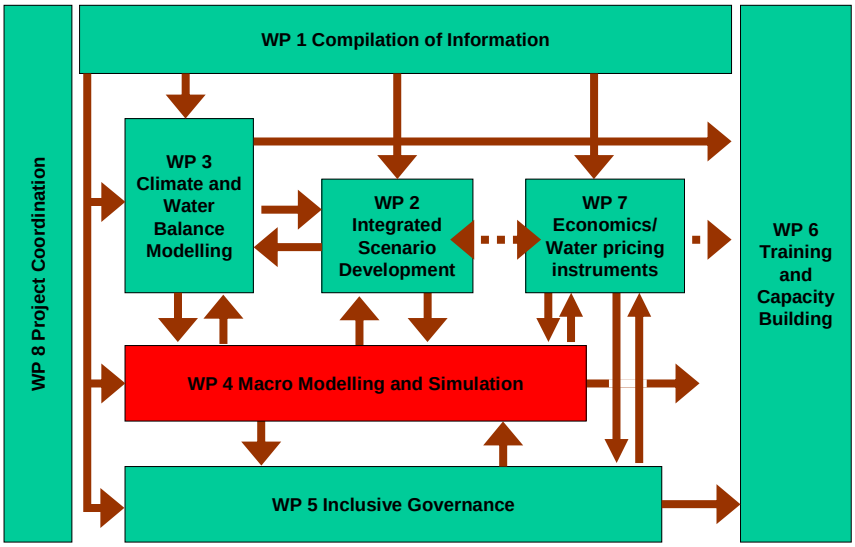
Macromodelling within the overall context of the LiWa project



Simulation environment for Macromodelling of water systems: LiWatool

- Planning and analysis of water systems on a global scale
- Includes water supply and wastewater systems, also treatment
- Due to system complexity: modelling of districts as units
- Water, pollution, energy, ressource fluxes, social levels, economic parameters, (Global Warming Potential)
- Based on ressource-flux modelling
- Modules easily adaptable and extendable -> high flexibility
- Quantitative and qualitative parameters
- Time series
- Financial information (capital and O&M costs, water tariffs)

- Modelling of scenarios (e.g. population growth, climate change) and options to act (variants), assessment of impacts of proposed options
- Representation by Sankey-diagrams, Export to Excel, html reports
- → Support of informed discussions and decisions

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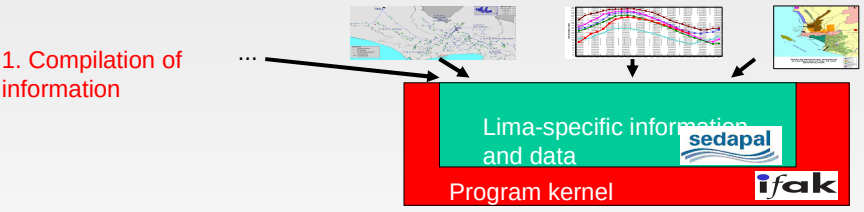
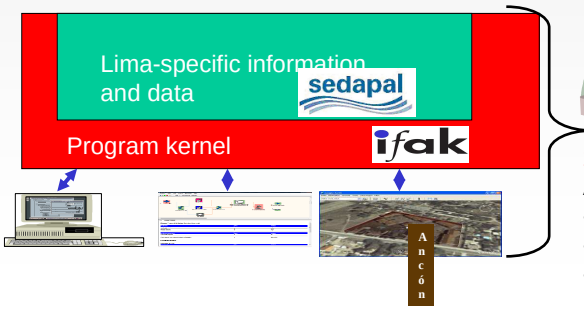
Development of LiWatool
in close cooperation with the water company

1. Compilation of information





2. Application of program:
Assistance
- In planning
- In discussions
- In decisions

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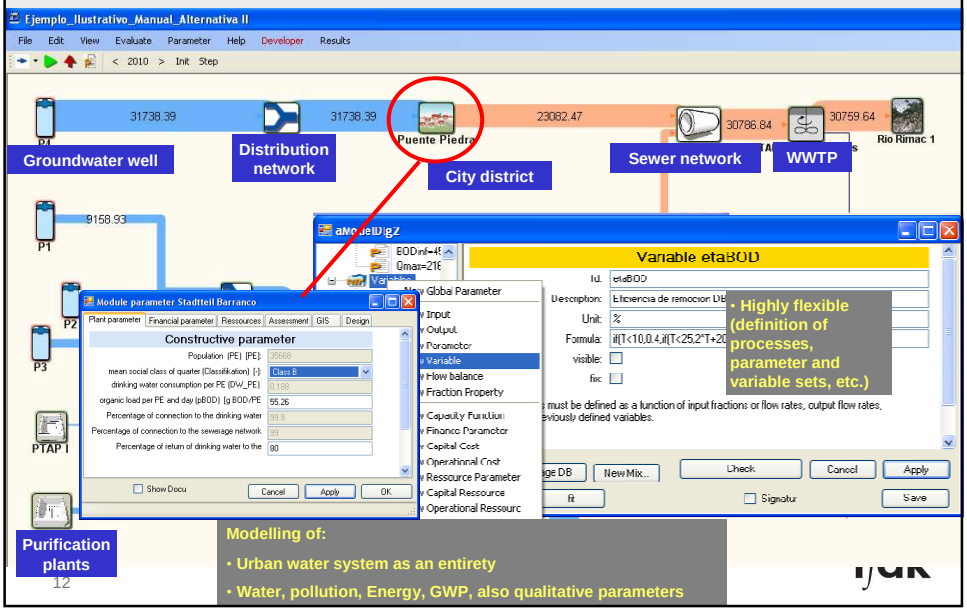
"LiWatool" – Macro-modelling system (1)



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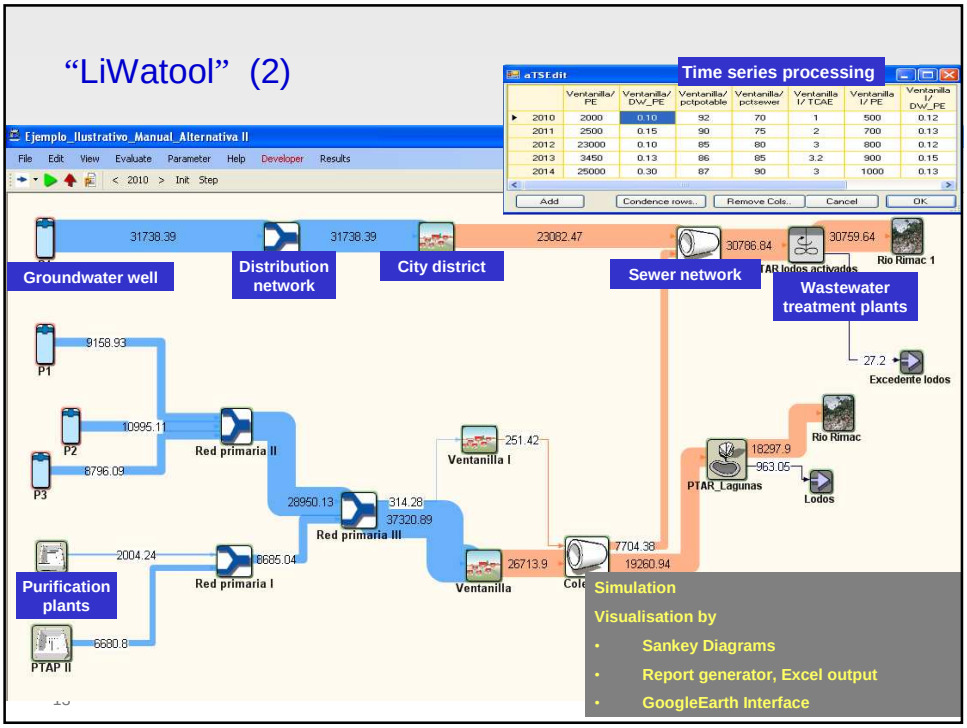
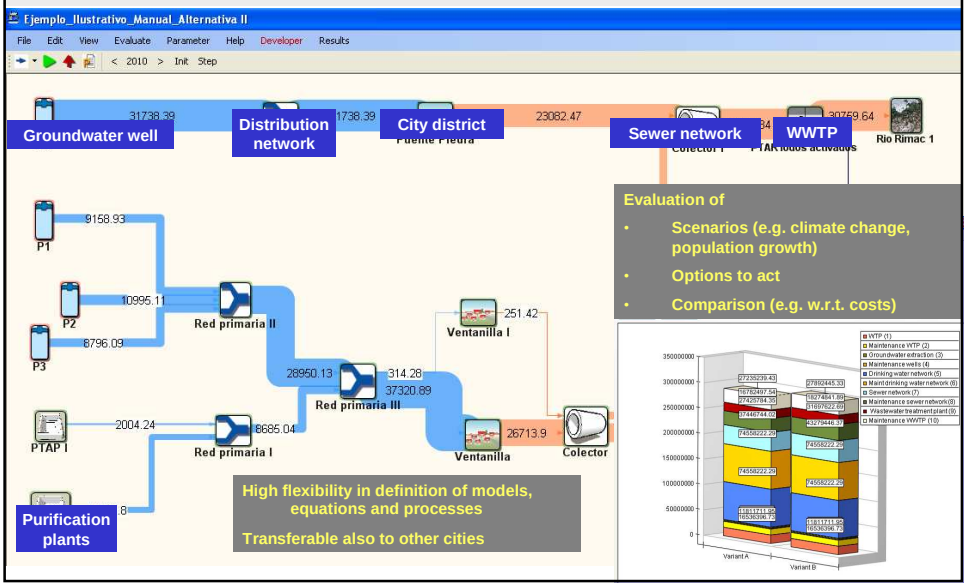
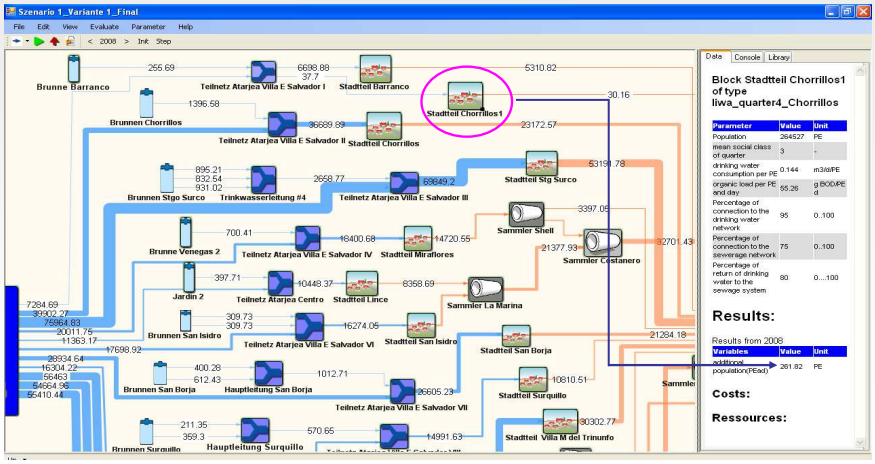
“LiWatool” (2)



“LiWatool” (3)



Analysis of scenarios and variants: Example: Effects of leakage reduction



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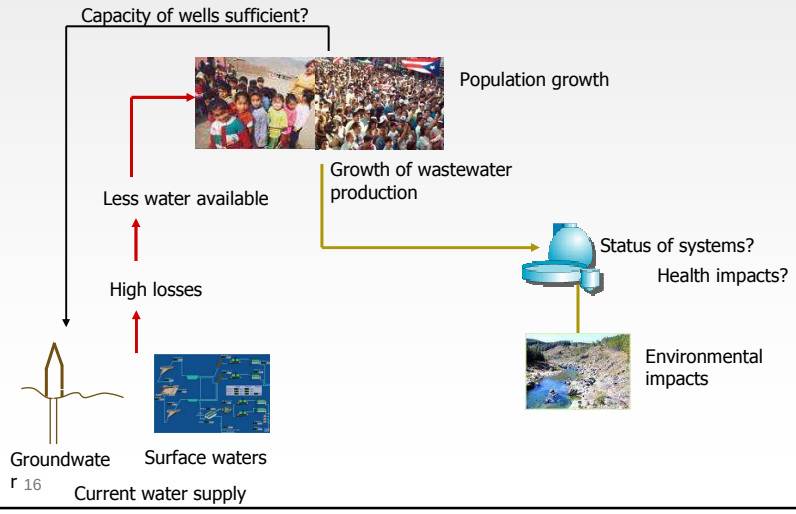
Example of Scenario analysis

Scenario: Analysing population growth as predicted



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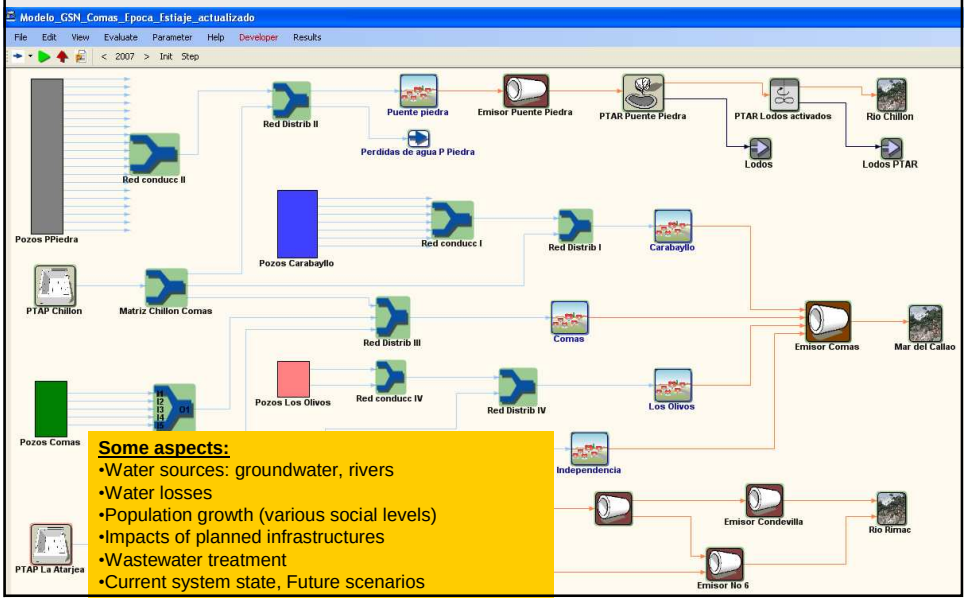
Application of LiWatool for Northern Service District of Lima



Some aspects:

- Water sources: groundwater, rivers
- Water losses
- Population growth (various social levels)
- Impacts of planned infrastructures
- Wastewater treatment
- Current system state, Future scenarios

Next steps

- Completion of macromodel of entire Lima water system
- More detailed analysis of water tariffs
- Alternatives (e.g. reuse of treated wastewater for irrigation)
- Program extensions
  - Drinking water reservoirs
  - Integration of optimisation methods (reservoir operation, energy production)
  - More detailed consideration of capital and operational expenditure
- Transferability to other megacities

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THANKS FOR YOUR ATTENTION
Project „LiWa“
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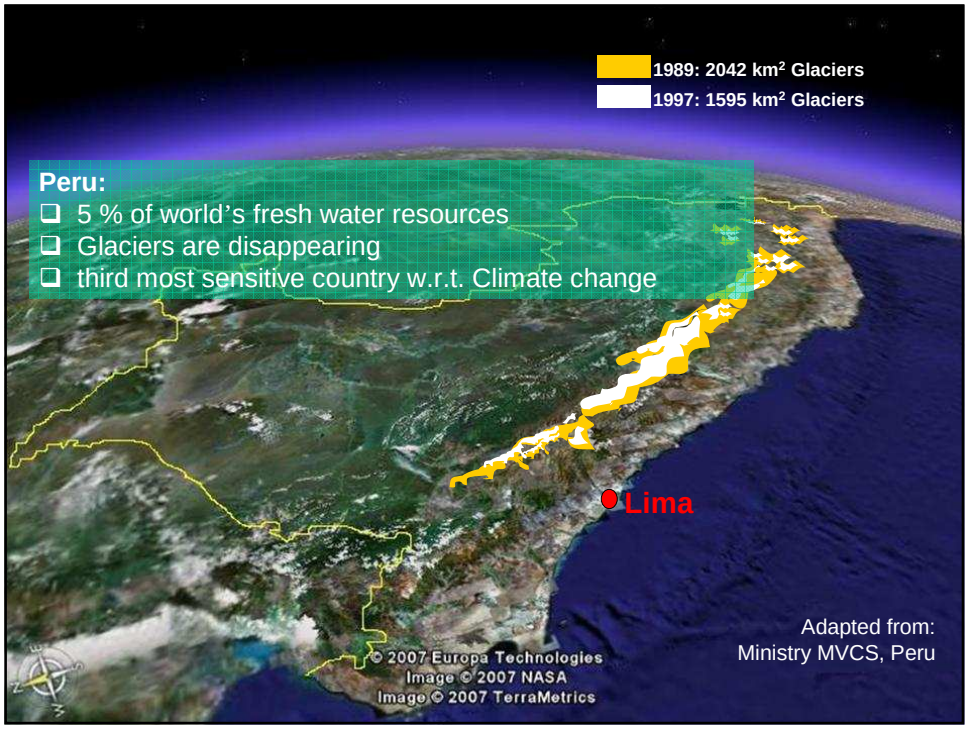
LiWa


1989: 2042 km² Glaciers
1997: 1595 km² Glaciers
Peru:
5 % of world’s fresh water resources
Glaciers are disappearing
third most sensitive country w.r.t. Climate change
Lima
Adapted from:
Ministry MVCS, Peru
© 2007 Europa Technologies
Image © 2007 NASA
Image © 2007 TerraMetrics

Geographical Information: GIS (Google Earth)

Visualisation of results

- Result files in Excel and generation of http reports

Microsoft Excel - Ejemplo_Ilustrativo_Manual_Alternativa I_docu.xls

	A	B	C	D	E	F	G
1							
2	Global Parameters						
3							
4	Name	Unit	Value				
5	yearly cost of	?/year	12000				
6							
7	Time series						
8							
9		Ventanilla PE	Ventanilla DW_PE	Ventanilla pctpotable	Ventanilla pctsewer	Ventanilla I TCAE	Ventanilla I PE
10							
11							
12	2010	5000	0.1	85	75	1	500
13	2011	6000	0.09	86	80	2	600
14	2012	7000	0.1	87	85	3	700
15	2013	8000	0.13	88	85	3.2	800
16	2014	9000	0.12	89	90	3	900

Globals / Parameters / Results for all blocks / Flows (2010) / Flows (2011)

Comparison of alternatives (under financial aspects, according to water company's cost structure)