UNIVERSIDAD NACIONAL DE COLOMBIA

SEDE BOGOTÁ

FACULTAD DE INGENIERÍA

ÁREA CURRICULAR DE INGENIERÍA CIVIL Y AGRÍCOLA

DOCTORADO EN INGENIERÍA - INGENIERÍA CIVIL

Doctorado en Ingeniería

Ingeniería Civil

UNIVERSIDAD NACIONAL DE COLOMBIA

ORGULLOUN

Hydro-Economic Model Produced Water in Oil Extraction Process

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Doctoral Seminary
Doctoral Project Progress
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Outline

1. Motivation
   - Water supply: surface and groundwater
   - Water demand by sector
   - Hydrocarbon production
   - Water quality
2. Problem Description
3. Goals
4. What has been done - what remains to be done: Water, Economy and Industry
5. Methodology

1. Motivation

The availability of water resources and variability (Morón et. al., 2013)
Water supply in Colombia (Rodríguez et. al., 2015)

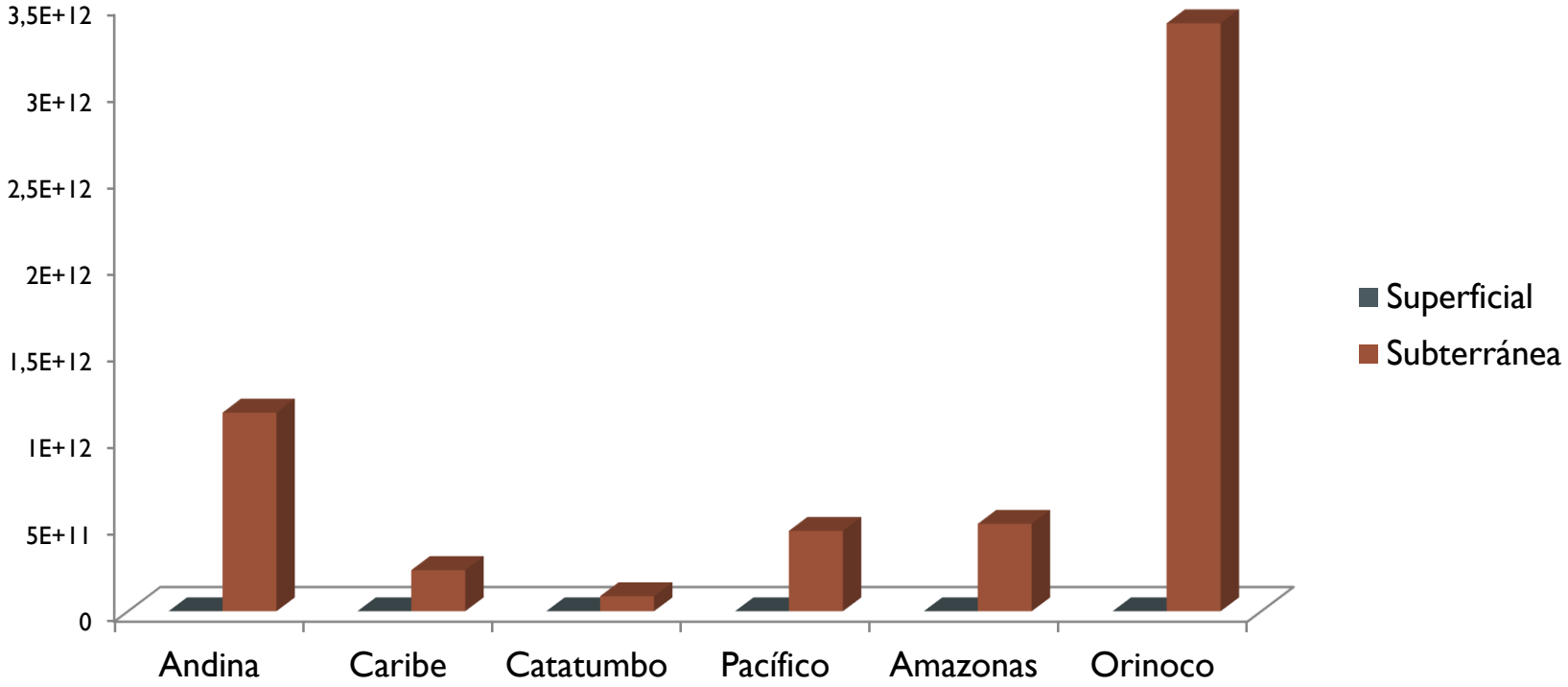
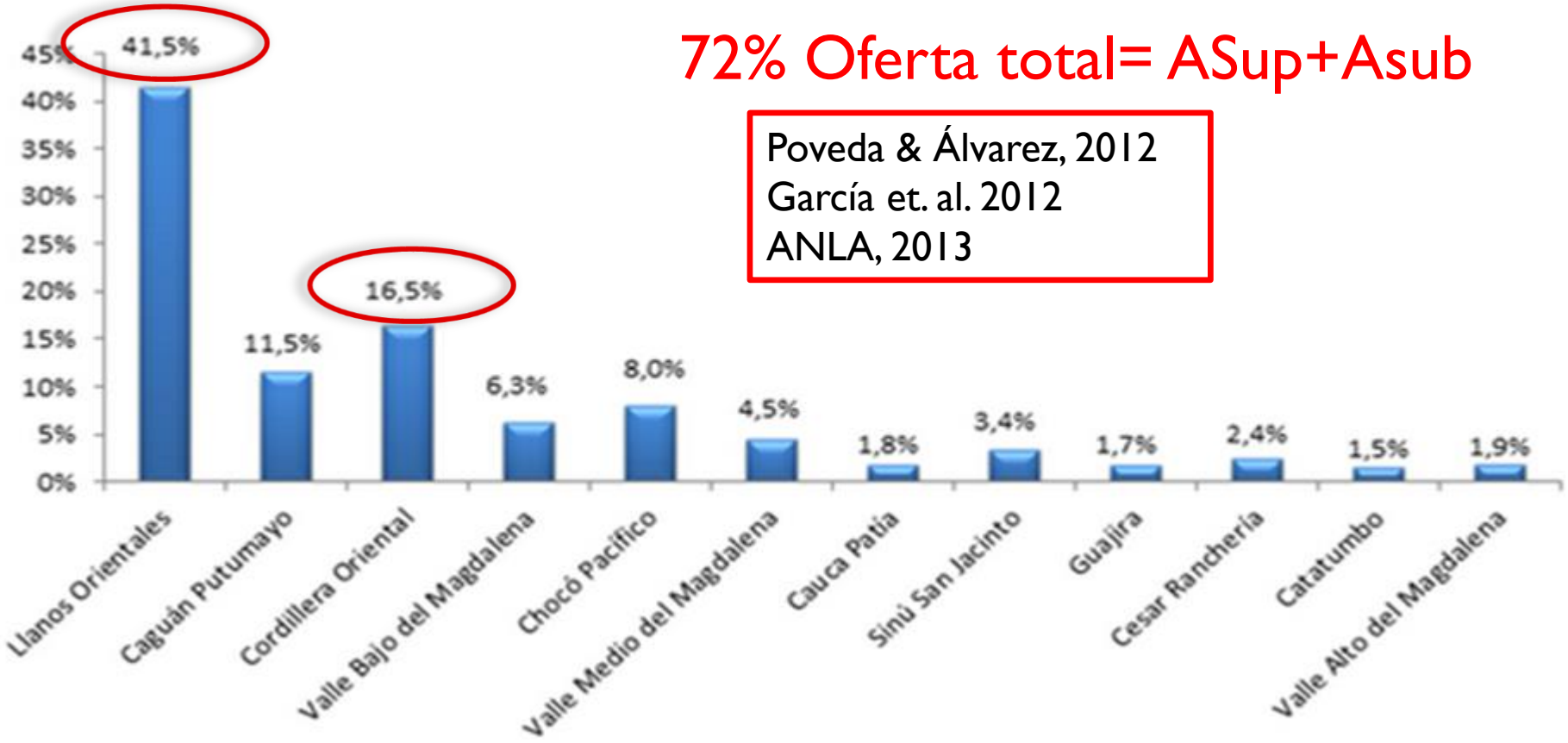


Figure 1. Comparativo water supply in Colombia. Source. Ideam. Water Study. 2010

- Average water yield in Colombia is 63 l / s-km^2 (Agua para el siglo XXI, Cepal. 2000)
- Global average performance: 10 l / s-km^2
- Performance Latin America: 21 l / s-km^2

Percentage Distribution of Groundwater in Colombia.



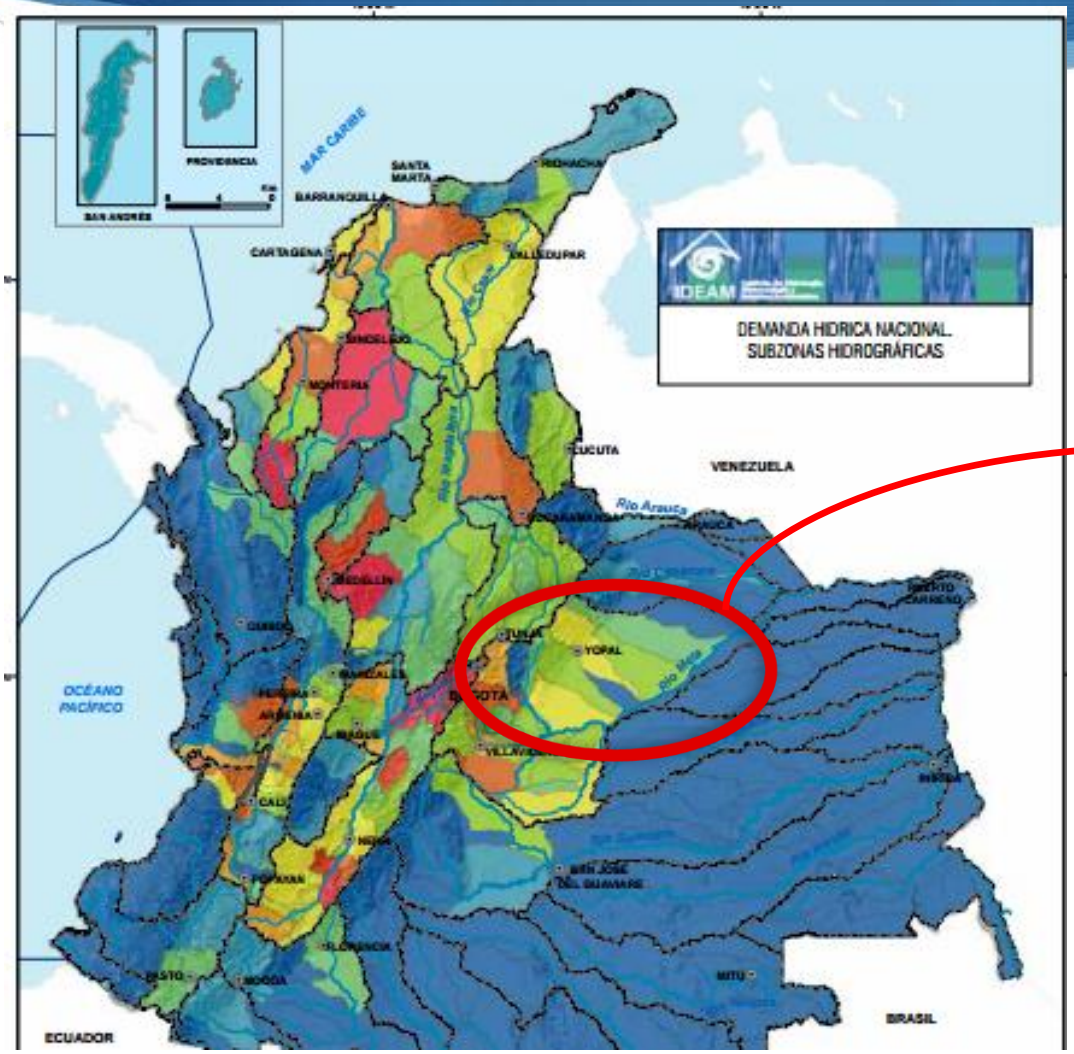
72% Oferta total= ASup+Asub

Poveda & Álvarez, 2012
García et. al. 2012
ANLA, 2013

Figure 2. Percentage distribution of groundwater in Colombia. Ideam. Estudio Nacional del Agua . 2010.

Strategic alternative to face decreases in flow rate variability

Water Demand by Departments



Total water demand
100-350 Mm3

Saldivar, 2013
Ramos & Rosado, 2015
Méndez Sayago, 2010

Figure 3. Water Demand by Departments in Colombia. Source. Ideam. Water Study. 2010

Water Demand Estimated by Sector

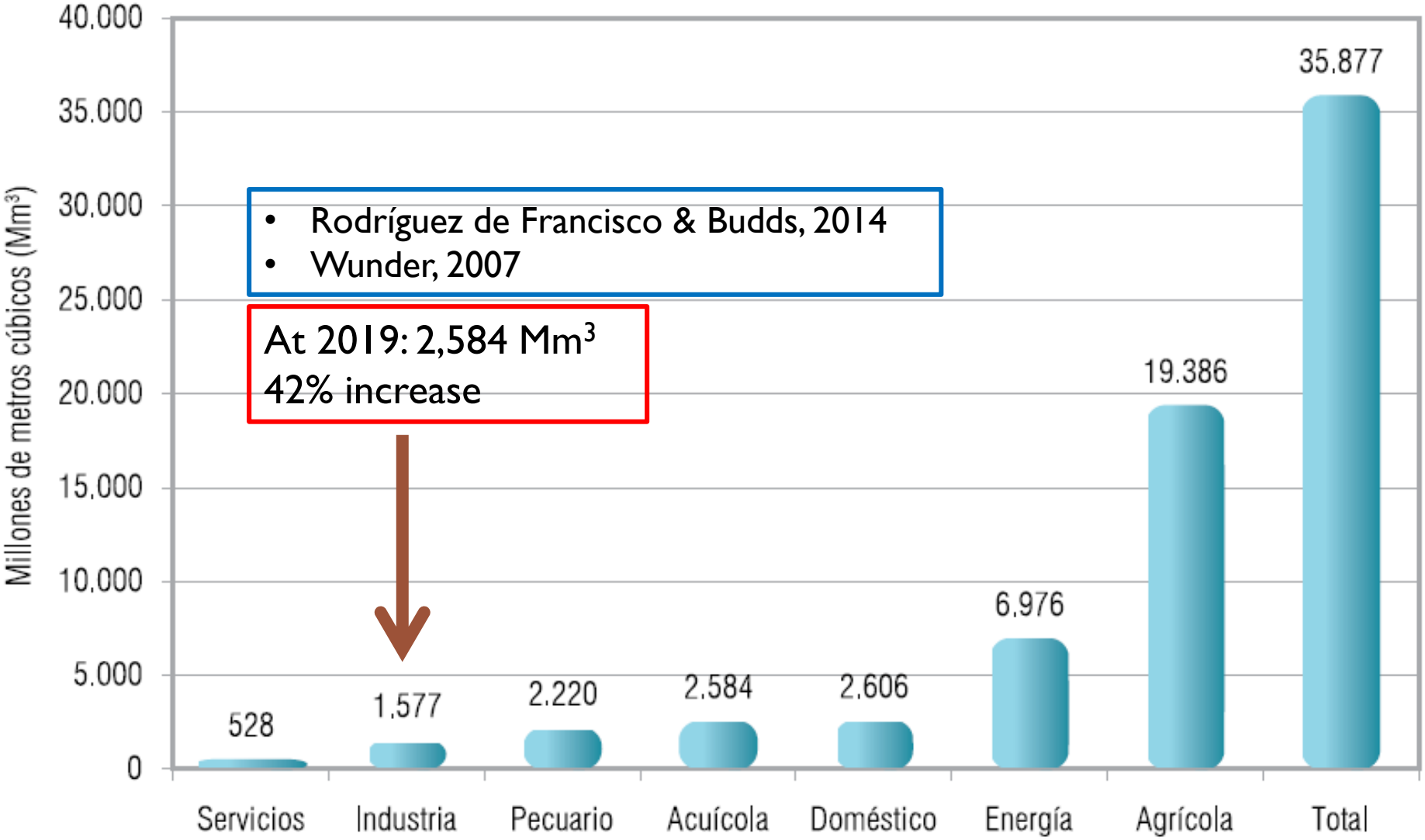
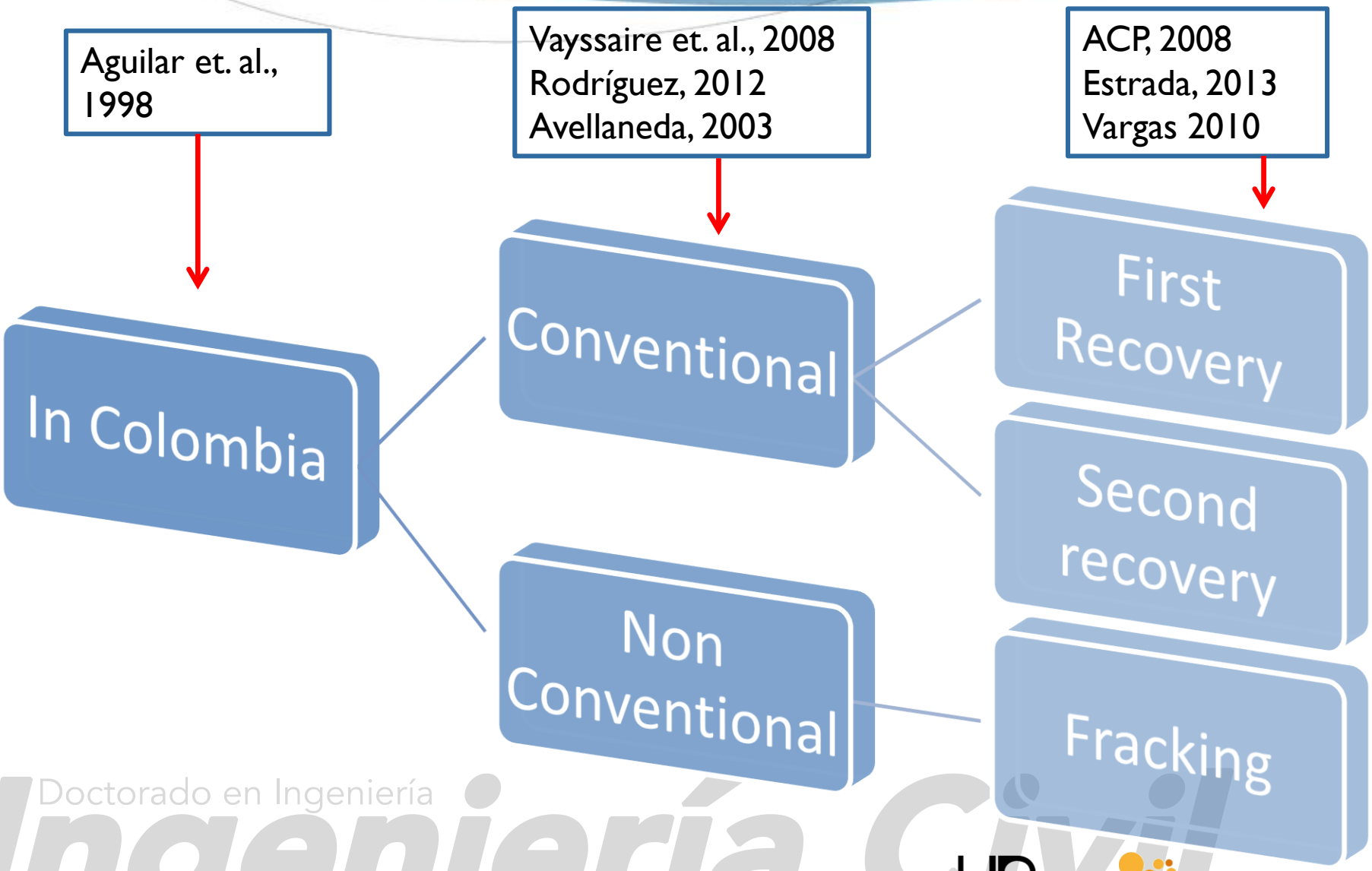
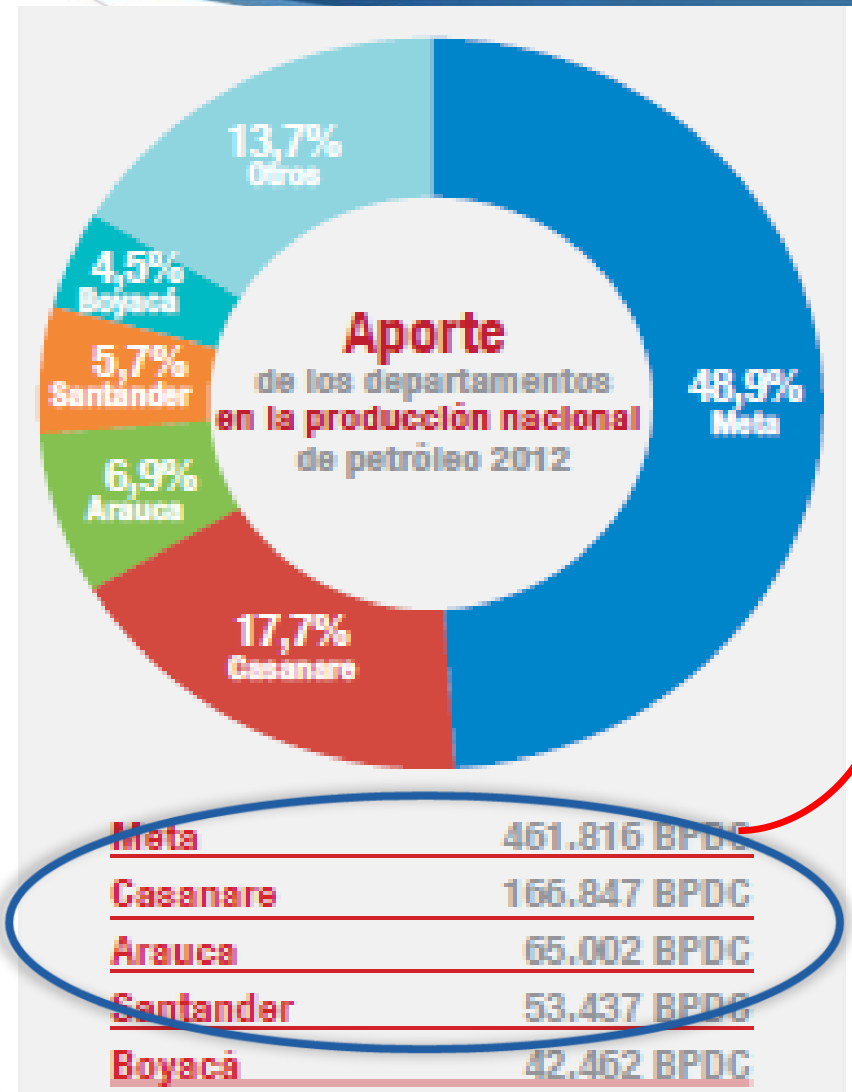


Figure 4. Water Demand Estimated by Sector in Colombia. Source. Ideam. Water Study. 2010

Production of Hydrocarbons



Contributions of Hydrocarbons



Extraction: 1500 barrels of oil per day

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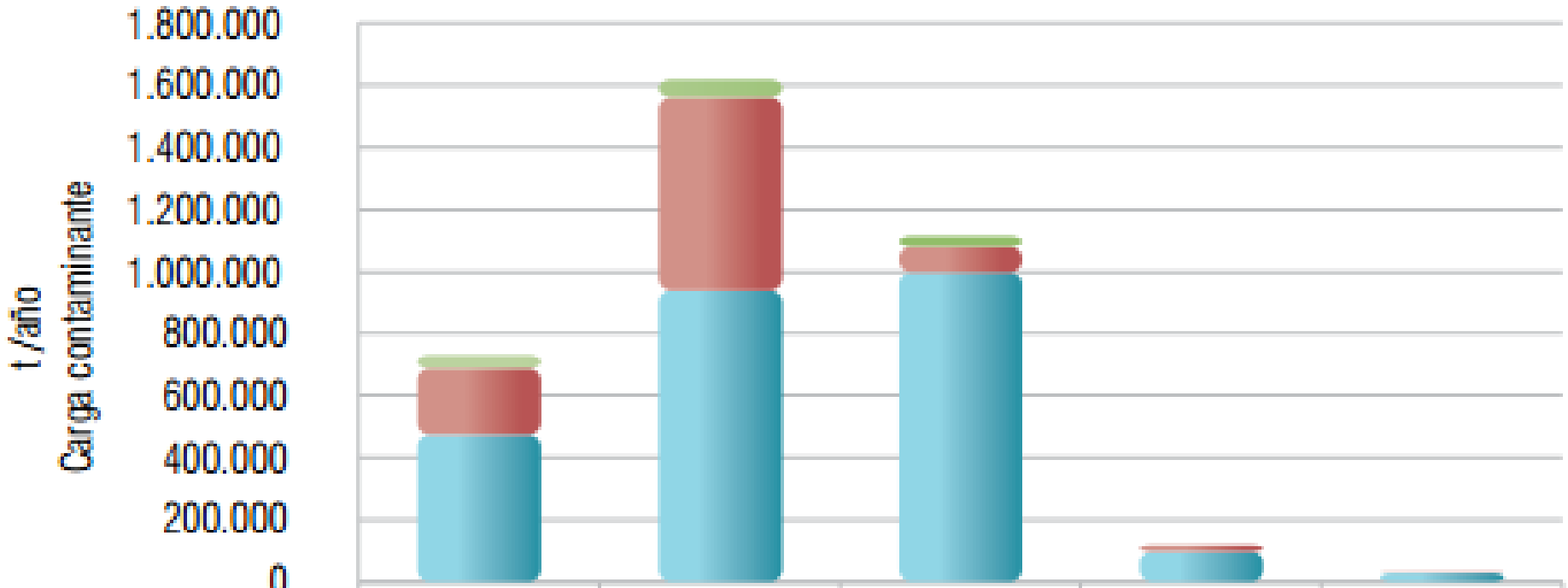
It produces 15000 barrels of water per day

Figure 5. Contributions of Hydrocarbons In Colombia. Colombia Energía. Edition 4. May 2013

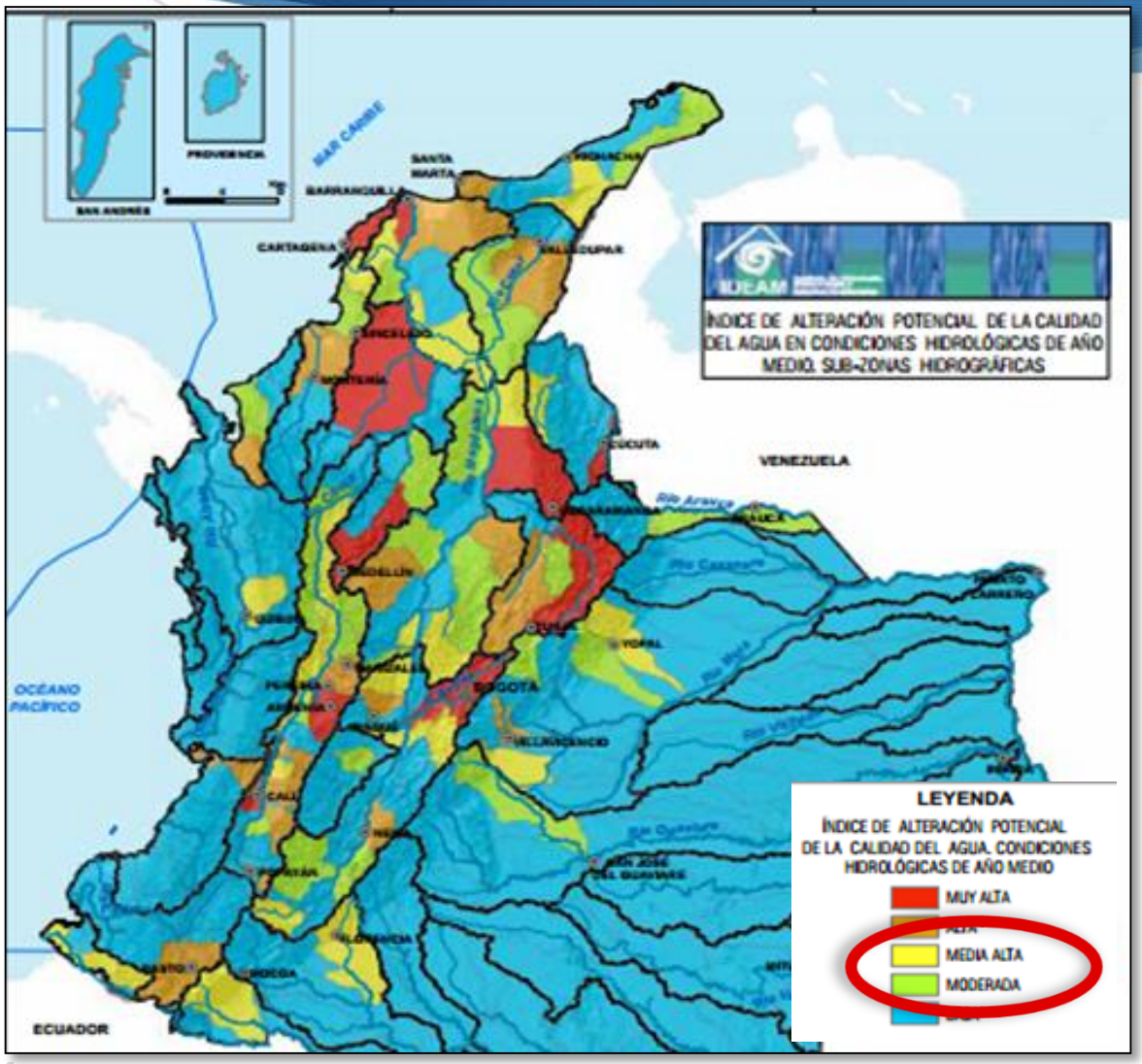
Water Quality - Sector



	DBO	DQO	SST	NT	PT
CAFETERO	41.253	53.926	33.290		
INDUSTRIAL	213.273	625.906	84.714	19.868	2.209
DOMÉSTICO	474.857	938.372	996.825	96.852	27.152

Figure 6. Water Quality by Sectors in Colombia. Source. Ideam. Water Study. 2010

Alteration Potential Water Quality



DBO: 13%

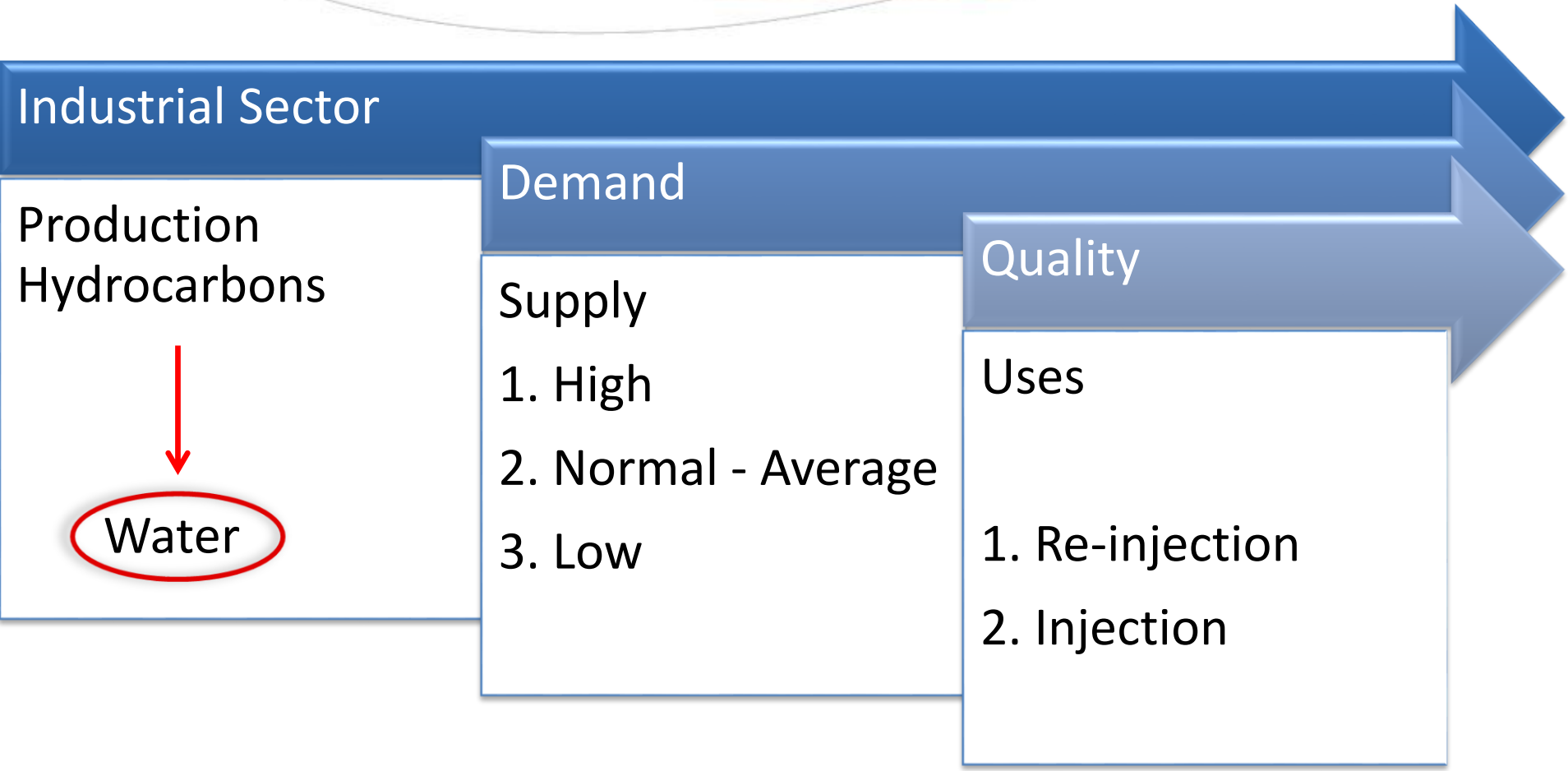
DQO: 32%

SST: 11%

NT: 16%

Figure 7. Alteration Potencial Water Quality. Ideam. Water Study. 2010

2. Problem Description



3. Main Goal

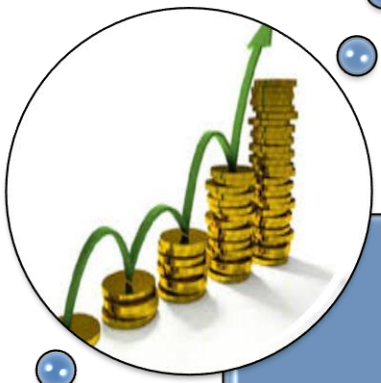
Development of a hydro-economic model (second generation)

Optimize the use of water resources in the hydrocarbon industry

Guidelines help establish control in the provision of water produced

4. What has been done and what remains?

Hydrocarbons Industry



Economic Models

Water

Water

Governance → Sustainable Use (Cyted, 2003; Bossel, 1999; Gleik et. al. 1996)

↓

→ Socio-economic development by Regions (Cepal, 2004)

→ Systemic Research Water Management (Dourojeanni et. al., 2002)

Comité Técnico Asesor para América del Sur (1985)

Contribution in Water Resources: Mining, Energy and Hydrocarbons (Pizarro, 2012)

Water Governance Crisis

Experiences

↓

Appropriation of International Contexts

Lack of coordination between sectors and institutions

Dispersal policies

High Dynamics Standards Entities

Low participation of relevant sectors

Ignorance or breach of rules

Misperception: Abundance of water

Disinterest on uses and risks

Economic Models

They are seeking to optimize resources → Offer / Demand analysis (Domínguez et. al., 2008)

- Multidimensional Approach (Haurou, 2009)
- Environmental, Economic, and social (Hommes & Umaña, 2005)

Indicators

- Nature and ownership of water
- Water rights
- Water markets (redeployment)

CALVIN	California	WAS	Río Jordán
	Minimize costs during periods of scarcity		Water allocation Water systems

AGRO-HIDRO-ECONÓMICO	Río Maipú - Chile
	Effects of Water Rights

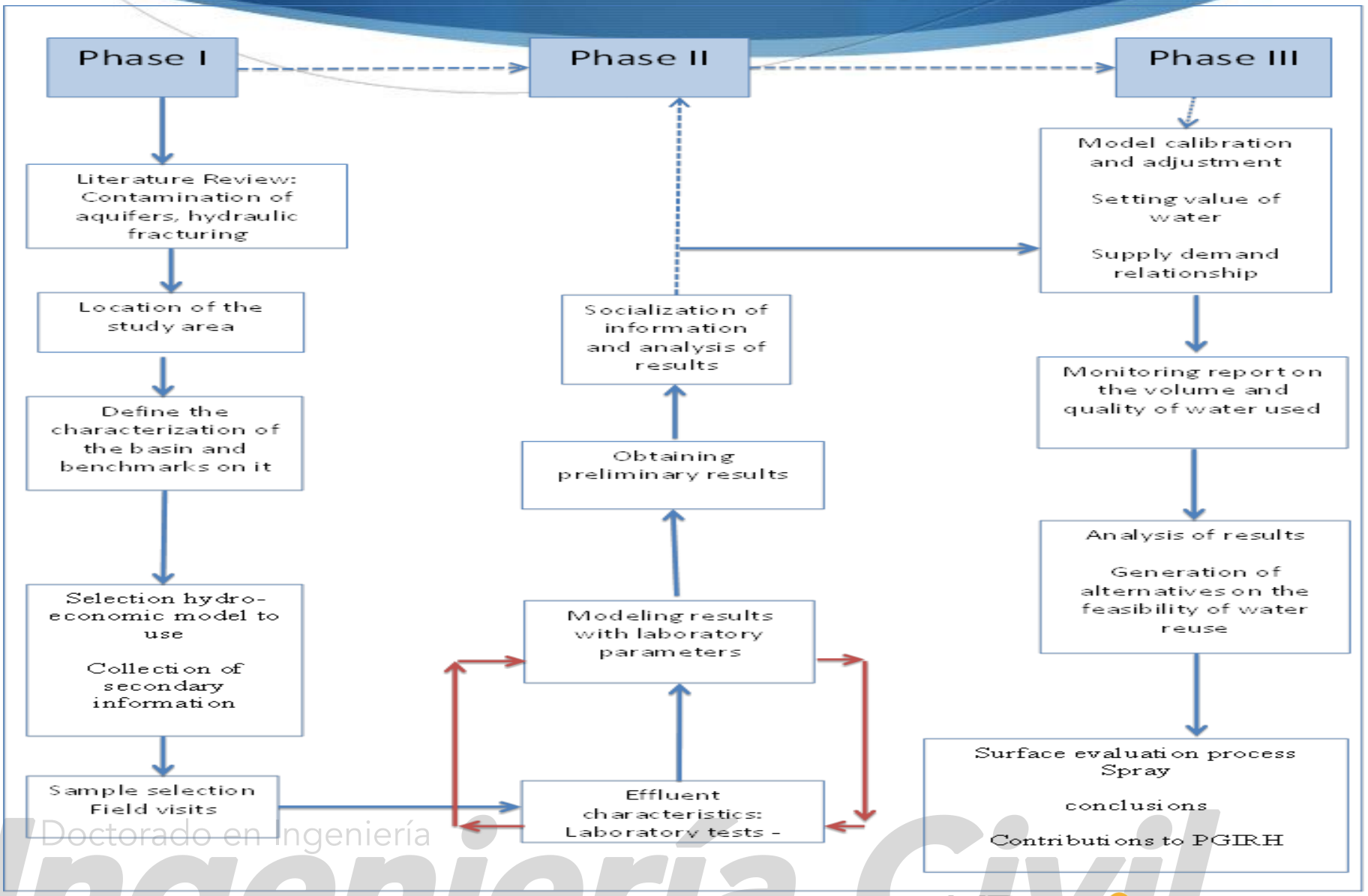
Then I Can Contribute In

- Sectoral water allocation
- Impact and management of droughts
- Economic instruments for water management

- Adaptation of demand (saving policies and disposal, maintenance)
- Conflict resolution, watershed management, sustainability

- Water quality (surface and underground)
- Demands and future projections
- Policy / regulation

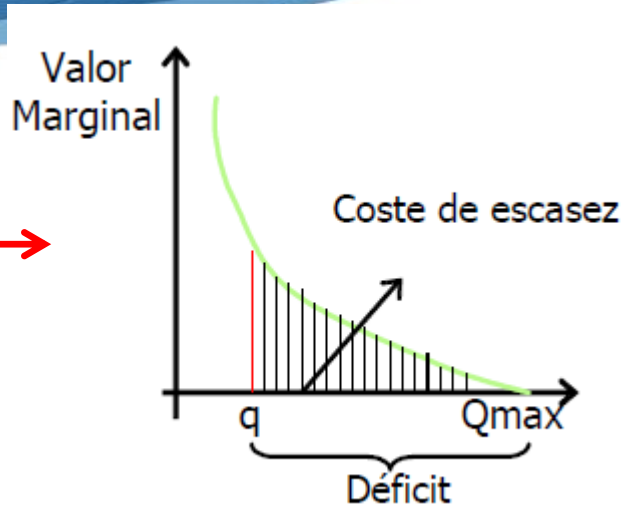
Methodology

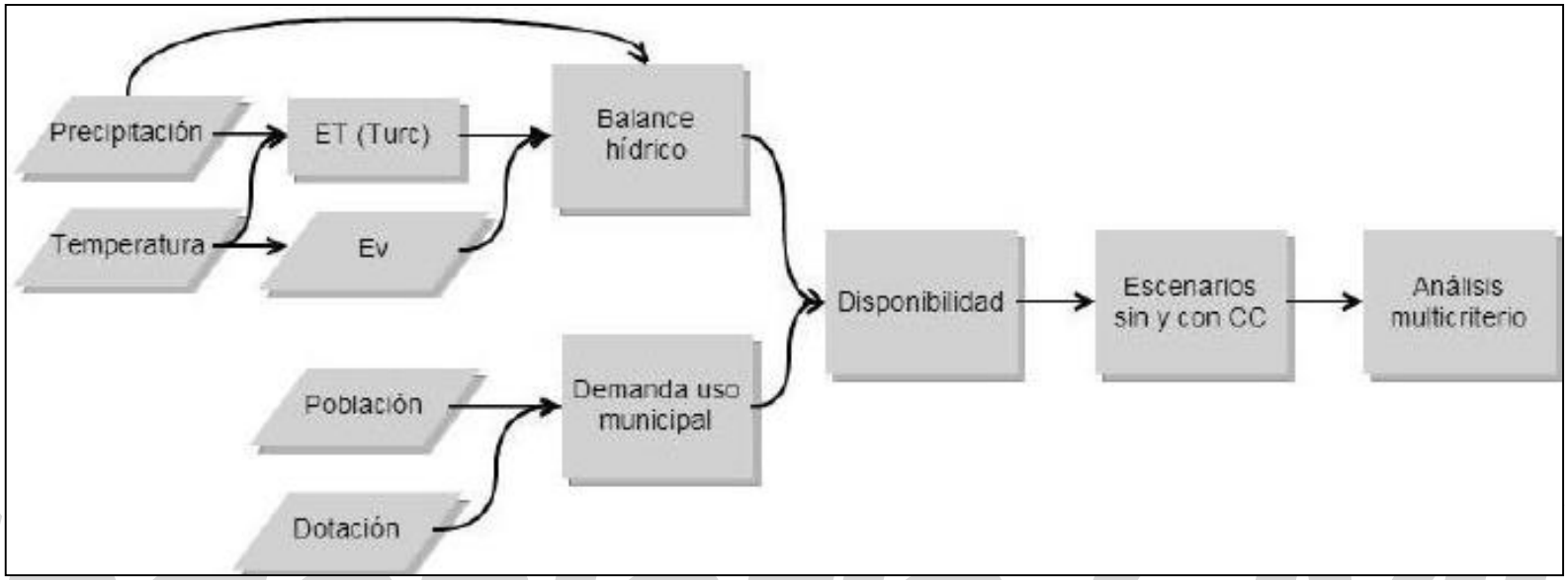


Methodology – Phase II

Modular: independent systems - Input
Holistic Systems of equations
General balance: Integration and Interaction

Ratio of annual water supplied and its marginal value or monthly





Pulido-Velazquez et al., 2011.

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