

The Water-Food-Energy-Environment Nexus in the Context of Global Change: Farmer Livelihoods in the Ica Basin, Peru

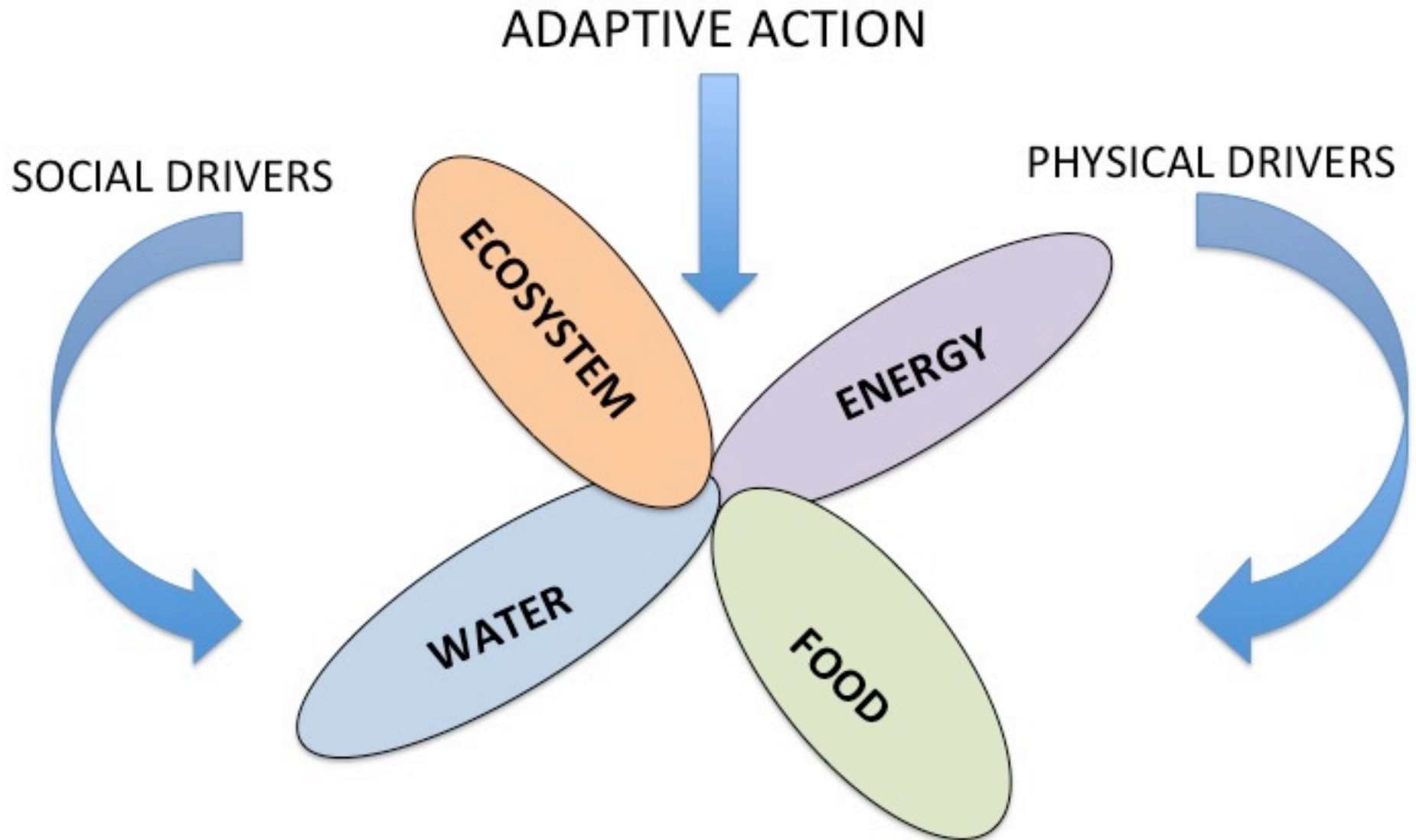
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The Human-Environment Security Nexus



Water Security

Availability of adequate quantities and qualities of water for societal needs and resilient ecosystems, in the context of current and future global change.

—Scott et al., 2013



Food Security

“When all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”.

—World Food Summit, 1996

- Access
- Availability
- Use
- Stability



Energy Security

The uninterrupted availability of energy sources at an affordable price.

Long Term: Timely investments to supply energy in line with economic developments and sustainable environmental needs

Short Term: Ability of the energy system to react promptly to sudden changes within the supply-demand balance

—IEA (International Energy Agency)



Ecosystem Security:

To support the Earth's diverse ecosystems for their inherent value and the provision of ecosystem services

—RdeG

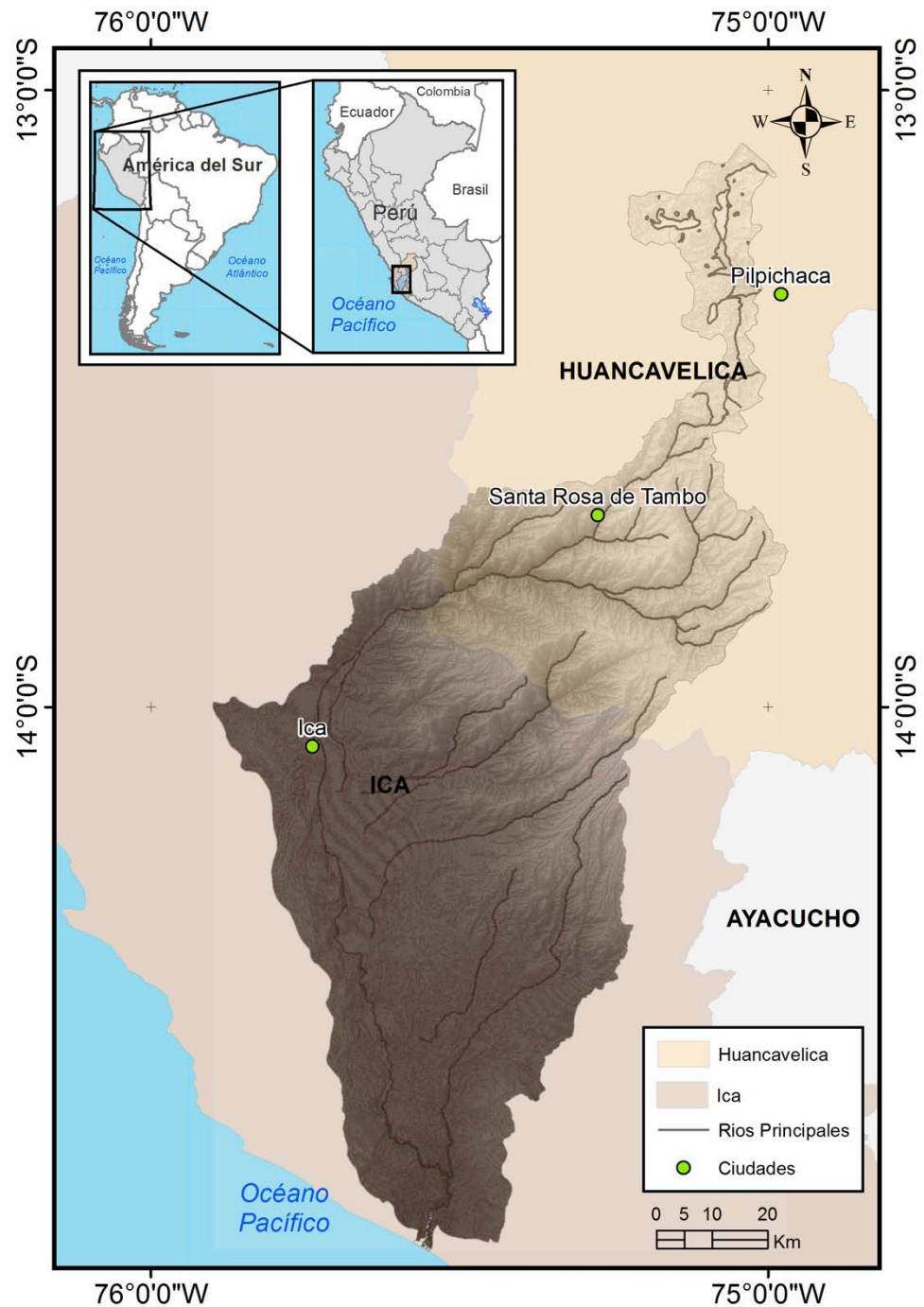


Ica Basin, Peru

Location: Andes-Pacific Watershed,
305 km south of Lima

Area: Natural basin: 7,876 km²
Extended Basin: 8,259 km²

Political Geography:
Ica and Huancavelica Departments



Ica Valley

- Extension of 37800 ha
- 1950: Cotton “white gold”
- 1969: Agrarian Reform
- 1990s: Neoliberal Reforms
- 2014: Agro-export driven economy, asparagus, table grapes, paprika, tomatoes

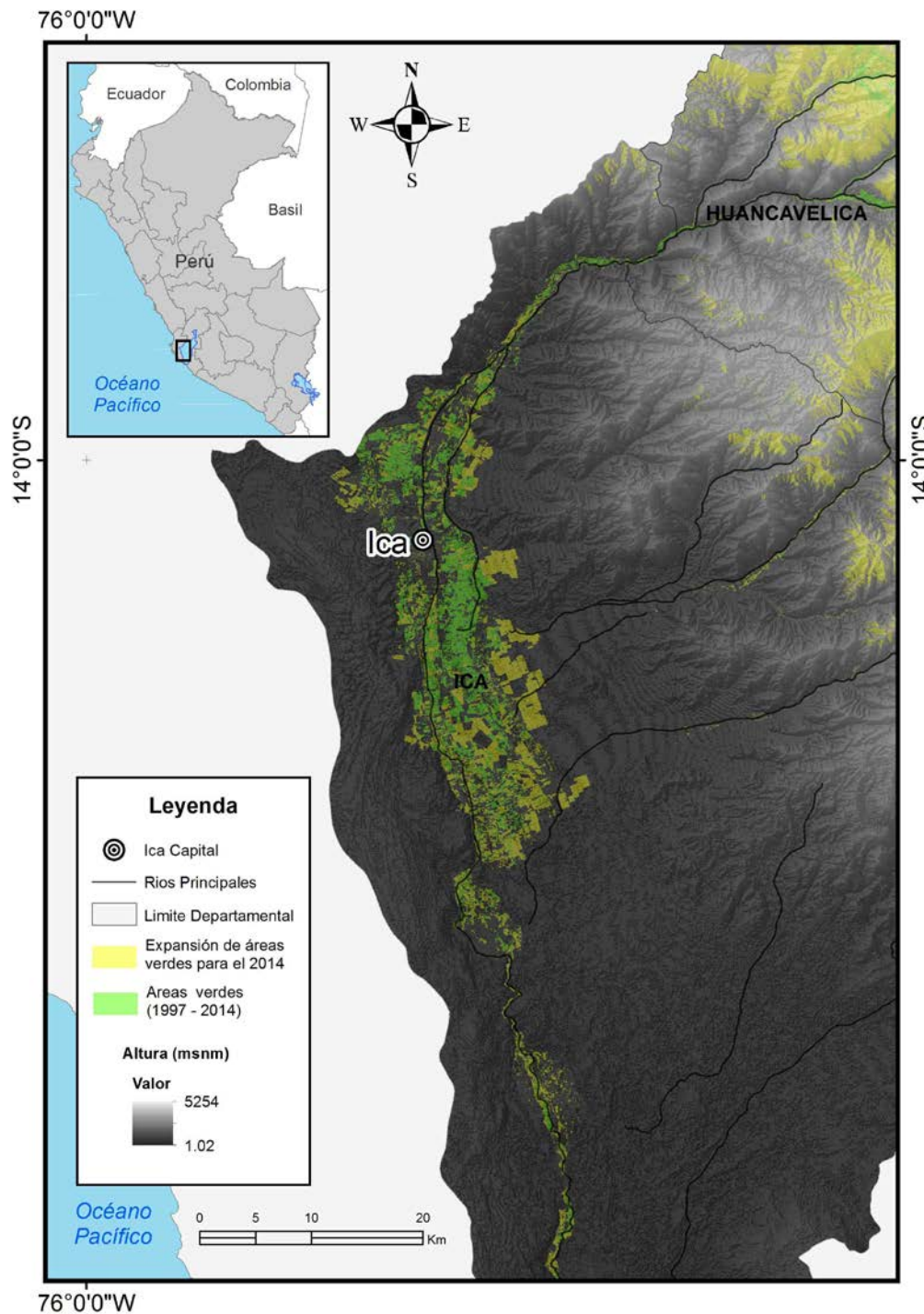


12,000+ Smallholders in the Ica Valley



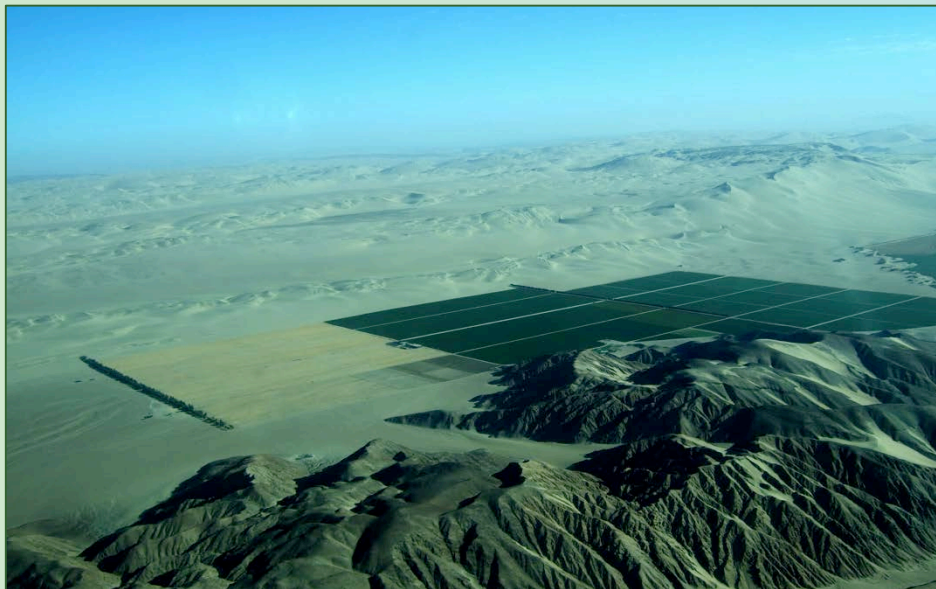
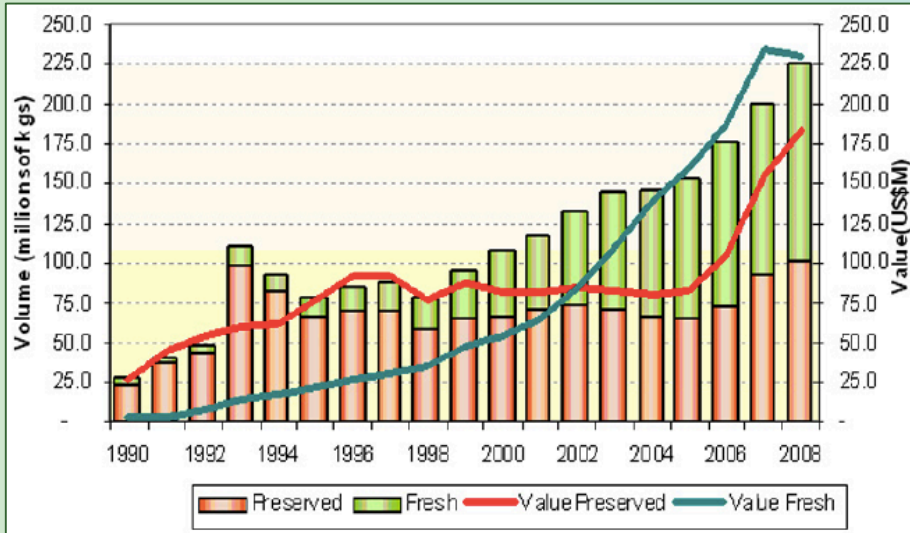
Agro-export expansion

- Advent of ground water extraction technologies
- Mild climate
- Abundant fertile desert soils
- Easy transport
- Cheap labor
- Legal and institutional support (tax breaks, international trade agreements, foreign investment)



Agro-export Industry

Asparagus exported from Peru, 1990-2008
MINAG-DGIA 2009



Surface Water and Groundwater Resources

Surface Water: Extreme variability with flowing water only in summer (November to March)--rainy season in the highlands. Months of Sept-Oct. supplemented with water from Choclococha System. Strong irrigation boards and committees along length of basin.

Groundwater: Clean, permanent supply. Requires infrastructure investment. Aquifer has 40% of Peru's water. Regulated by the *Autoridad Nacional de Agua*, but over-extraction has led to crisis.

Sources of Irrigation Water in the Ica Valley	Hectares	Number of Users	Water Demand
Surface Water	12,043	13,800	246 MMC
Mixed surface/subterranean	11,291	200	249 MMC
Subterranean Water	9200	6	138 MMC
Total in Ica Valley	32,534	14,006	633 MMC

Source: Bayer, D. 2010. Estudio hidrogeológico del acuífero Ica-Villacurí, INRENA.



Surface water irrigation

La Achirana Canal

- 53 km from bocatoma to end
- Constructed during Incan era
- Irrigates 16,971 ha
- 11,581 users
- Regulated by the JURLASCH

Rio Ica Canal

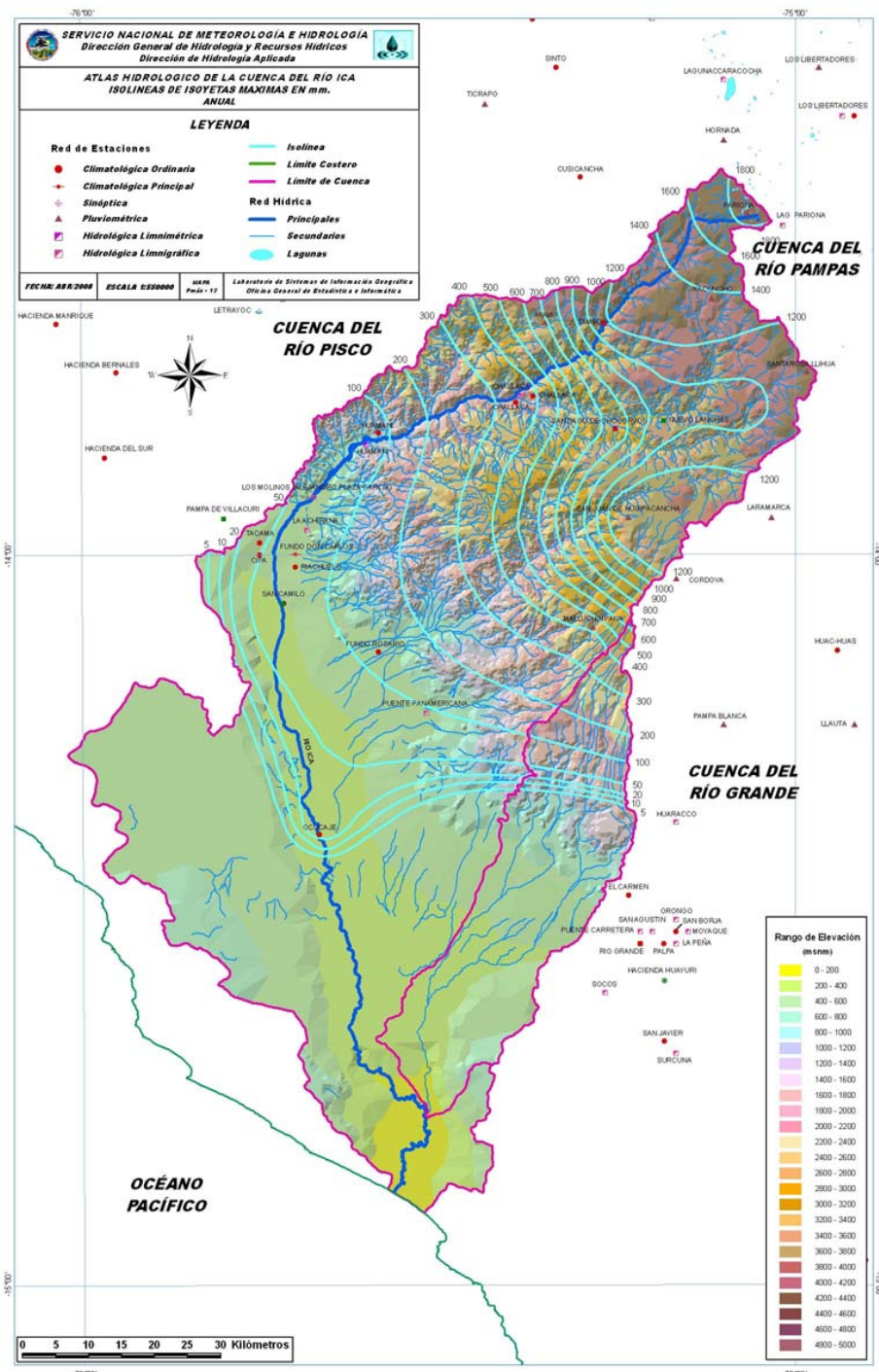
- Irrigates 16,800 ha
- 6,435 users
- Regulated by JUDRI



Laguna Choclococha

- Formed by 3 lakes in the Andes-Atlantic Pampas Basin
- 53 km Inter-basin transfer canal to Lake Pariona, to Tambo River
- Regulated water, Sept-Oct
- Irrigates 40,000 ha, increasing production by 10,000 ha in Ica
- 150 Mm³, Extension needed
- Social conflicts Ica/Huancavelica





Ica Basin and the Integrated Ica Basin



Choclococha Inter-Basin Transfer System



Security Nexus Challenges in the Ica Valley

- Valley receives <math><1\text{mm}</math> of rain per year
- Over-extraction of aquifers, need to expand inter-basin transfers
- Agro-export production drives economy
- High power demands
- Extreme imbalance in socio-economic resource access
- Urban expansion, lack of basic services
- Air, water, land contamination
- Land degradation
- Global change



Livelihoods along the Gradient

Ica Valley, 400m

- >12,000 farmers own 1-10ha
- Small parcel size
- High cost of water, inputs
- Limited access to credit
- Uneven representation
- No market control



Santa Rosa de Tambo, 3000m

- Extreme topography
- Interrupted water supplies
- Marginalized from state
- Interventions from NGOs
- Erosion, kikuyo grass invasion
- Out-migration, elderly, children



Tinco, 3690m

- 2-hours walk from road end
- Elderly, children
- Livelihoods of cattle/dairy
- Malnutrition
- Terrace agriculture
- Meager economic flows



Pilpichaca, 4100m

- Subsistence livelihoods
- Herding alpacas, llamas
- No heating/cooking fuel
- Year-round cold temps
- Malnutrition
- Limited access



Government Programs, NGOs and Interventions



- *Cocinas mejoradas*
- Conservation for Ecosystem Services
- Climate Change adaptation
- Stakeholder dialogues for water conflicts
- Farming improvements
- Irrigation improvements
- Livestock support
- Women and child nutrition



Ica Nexus Conclusions

- Water, human flows down the mountain
- Extreme coastal-highland disparities
- Global change vulnerability
- Crisis management of proactive adaptation?
- Information, economic flows
- Environmental education, conservation
- Needs/Security Paradox



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