ANDEX White Book
Chapter 7: Science Underpinning Sustainable Development

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The Central Andes of Colombia









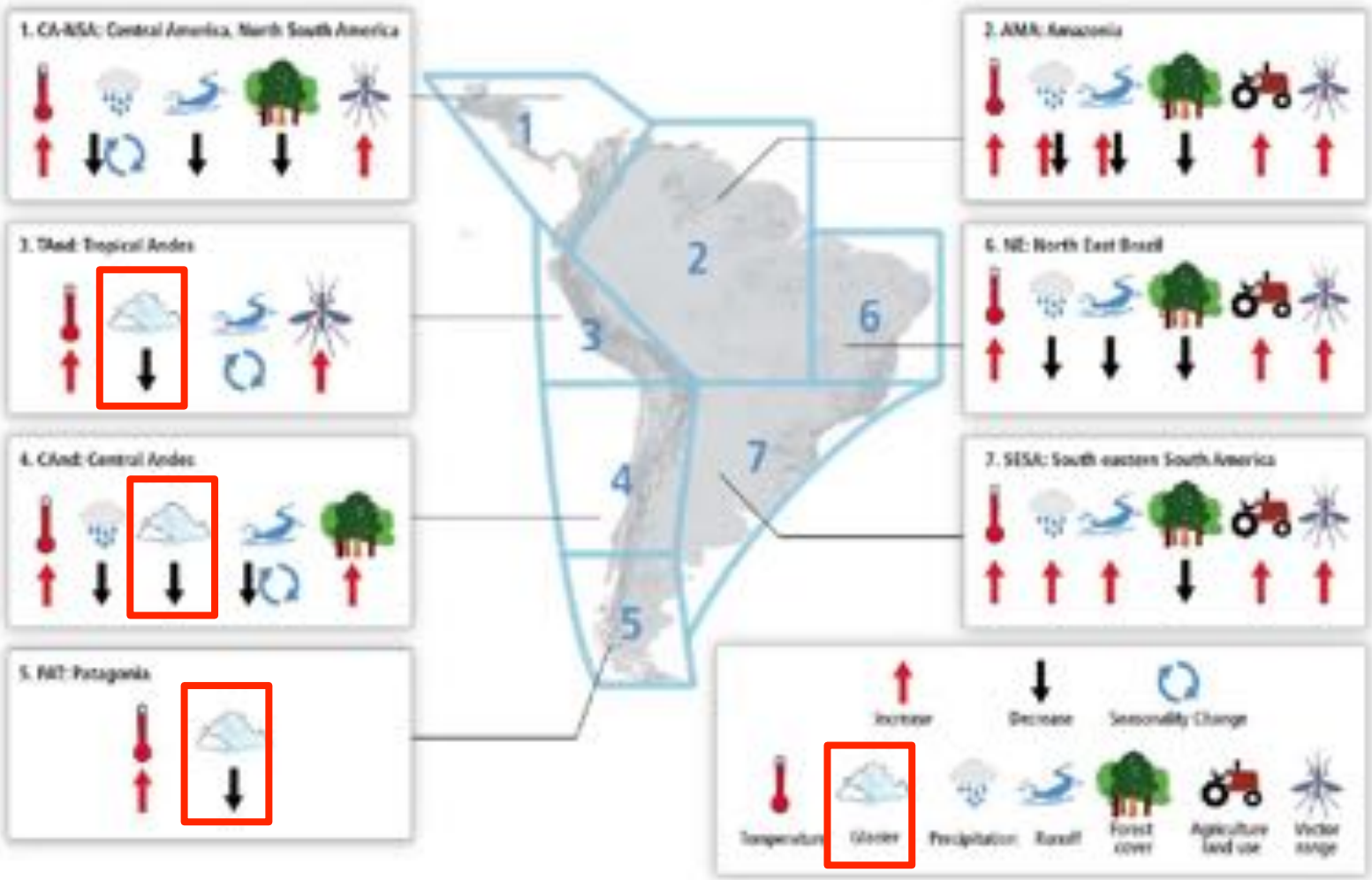
But, guess what? The Andes are a very crowded place +80M people

Photo from Schoolmeester et al., 2016

White Book – Ch. 7

1. National policies towards sustainable development goals and climate change in the Andes (Mercy J. Borbor).
2. Exploring vulnerability drivers on the region. (MJB).
3. Linking science and policy: Is there an adequate stakeholder's dialogue? (MJB).
4. Development of scientific production and generation of public policies (MJB).
5. Air Quality (Joan Cuxart and Laura Gallardo).
6. Water Resources (Wouter Butyaert and G. Poveda).
7. Agriculture (TBA).
8. Human Health (G. Poveda)
9. Knowledge Gaps and Relevance.
10. Potential Activities.
11. Expected Outcomes.

Observed Impacts of Climate Change in Central and South America
5th AR IPCC, Ch. 27 (Magrin et al., 2014)



Social and Natural Sciences

1. National policies towards sustainable development goals and climate change in the Andes (Mercy J. Borbor).
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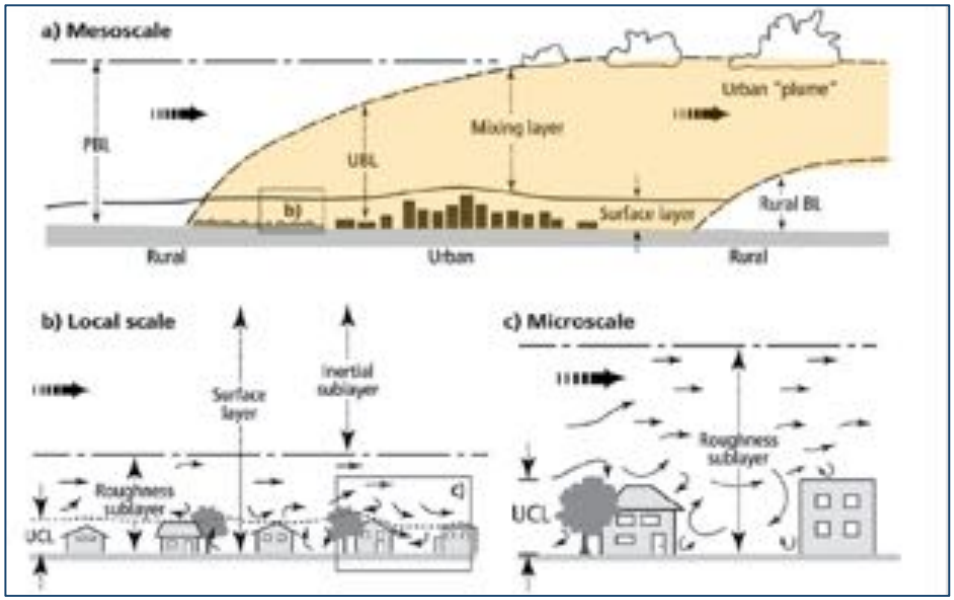
Poveda et al., (2018)

Air Quality

Relevant Processes Involving the Atmospheric Boundary Layer in the Andes: Urban and Rural



WUDAPT

An Urban Weather, Climate, and Environmental Modeling Infrastructure for the Anthropocene

J. Ching, G. Mills, B. Bechtel, L. See, J. Feddema, X. Wang, C. Ren, O. Brousse, A. Martilli, M. Neophytou, P. Mouzourides, I. Stewart, A. Hanna, E. Ng, M. Foley, P. Alexander, D. Aliaga, D. Niyogi, A. Shreevastava, P. Bhalachandran, V. Masson, J. Hidalgo, J. Fung, M. Andrade, A. Baklanov, W. Dai, G. Milcinski, M. Demuzere, N. Brunsell, M. Pesaresi, S. Miao, Q. Mu, F. Chen, and N. Theeuwes

BAMS, 2018

- Topographically-generated flows and the pollution in valleys.
- Relevance to agriculture in high valleys, in particular the impact of thermal surface inversions and the monitoring of evapotranspiration.
- (iii) Monitoring of the energy and matter exchange fluxes between the surface and the atmosphere.

Food Production Systems and Food Security

CEPAL, 2017

Food Production Systems and Food Security

Tons of work to do toward Understanding and Modelling

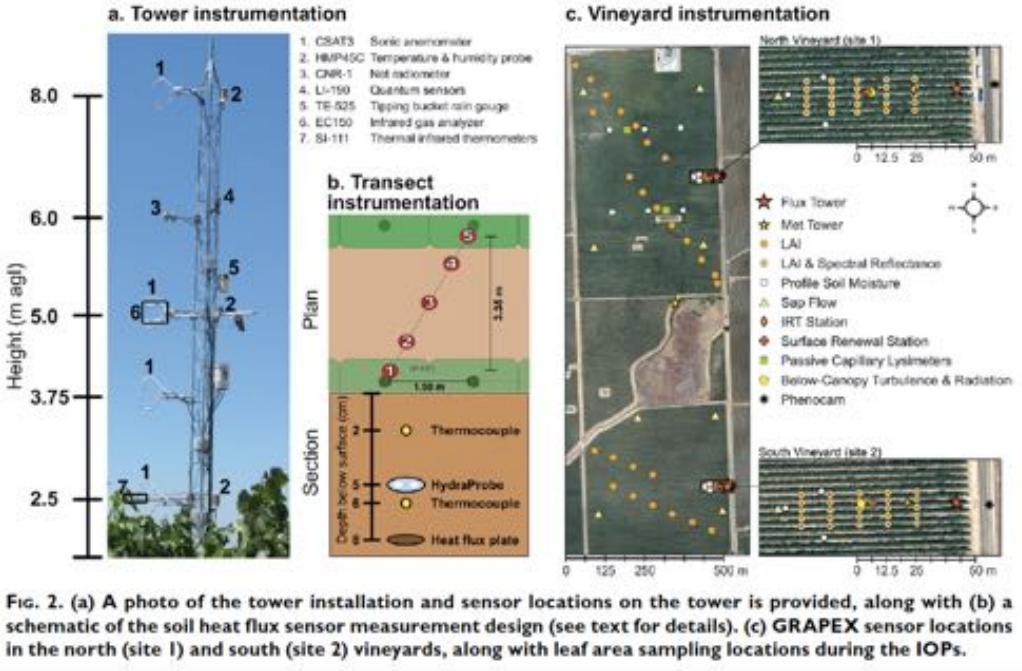
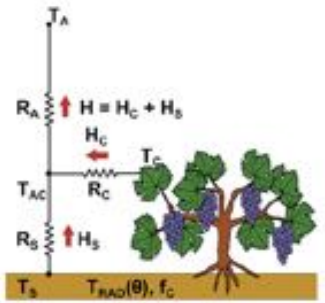


FIG. 2. (a) A photo of the tower installation and sensor locations on the tower is provided, along with (b) a schematic of the soil heat flux sensor measurement design (see text for details). (c) GRAPEX sensor locations in the north (site 1) and south (site 2) vineyards, along with leaf area sampling locations during the IOPs.

Surface Energy Budget:
SWR, LWR, SHF, LHF



Sensible heat flux module

System, soil (S), canopy (C) budgets

$$RN = H + LE + G$$
$$RN_S = H_S + LE_S + G$$
$$RN_C = H_C + LE_C$$

Two-source approximation

$$T_{RAD}(\theta)^4 \approx f_C(\theta) T_C^4 + (1 - f_C(\theta)) T_S^4$$

Temperature constraint

H_C, H_S, RN_C, RN_S, G

PT, PM, or LUE R_C model

LE_C

Residual

$LE_S = RN - H - G - LE_C$

Iterative energy balance solution

THE GRAPE REMOTE SENSING ATMOSPHERIC PROFILE AND EVAPOTRANSPIRATION EXPERIMENT

William P. Kustas, Martha C. Anderson, Joseph G. Alfieri, Kyle Knipper, Alfonso Torres-Rua, Christopher K. Parry, Hector Nieto, Nurit Agam, William A. White, Feng Gao, Lynn McKee, John H. Prueger, Lawrence E. Hipps, Sebastian Los, Maria Mar Alsina, Luis Sanchez, Brent Sams, Nick Dokoozlian, Mac McKee, Scott Jones, Yun Yang, Tiffany G. Wilson, Fangni Lei, Andrew McElrone, Josh L. Heitman, Adam M. Howard, Kirk Post, Forrest Melton, and Christopher Hain

BAMS, 2018

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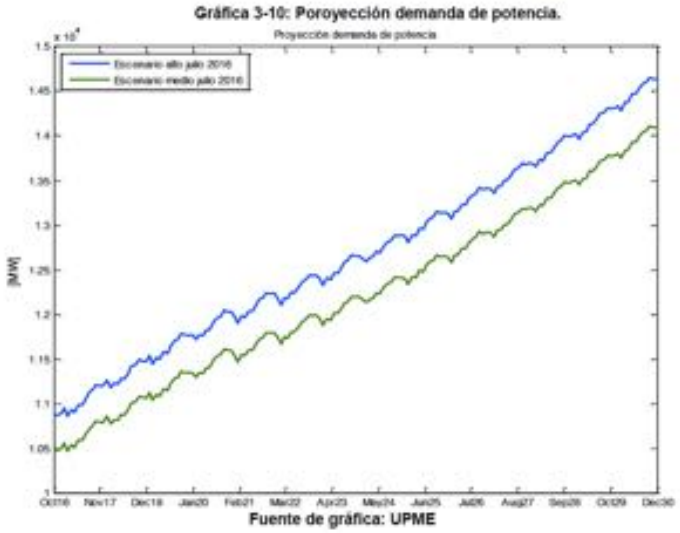
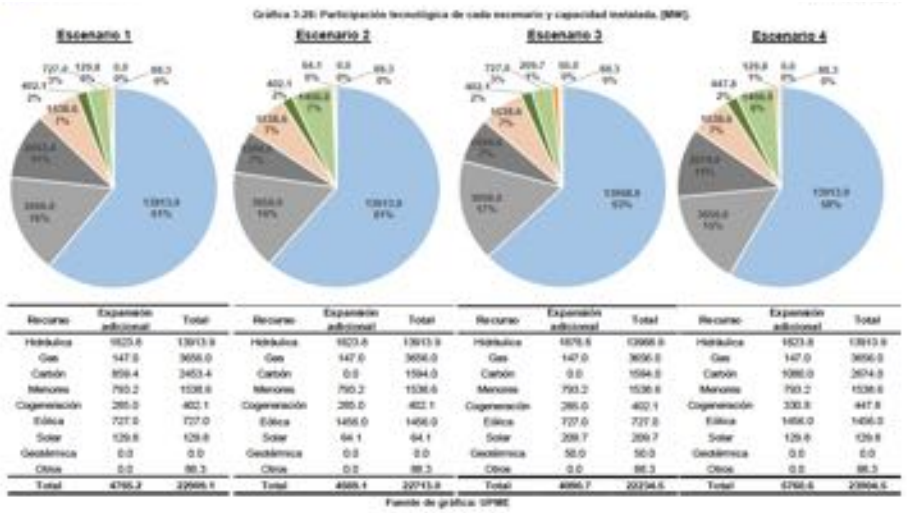
Water Resources- Hydropower

Country	Area	Population	Installed Hydropower Capacity (MW)	Hydropower Generation
Colombia	1,250,000 km^2	49,500,000	11,726 (2017)	54,915 GWh (2017)
Ecuador	257,217 km^2	16,144,363	4,409 MW (2016)	15.59 TWh (2016)
Peru	1,280,000 km^2	32,400,000	5,385 MW (2017)	33,400 GWh 2017)
Bolivia				
Argentina				
Chile	756,102 km^2	17,948,141	7,055 MW (2016)	20.8 TWh (2016)

Colombia-
Projection of Electricity Demand



Future Electricity Sources
(Blue: Hydropower)

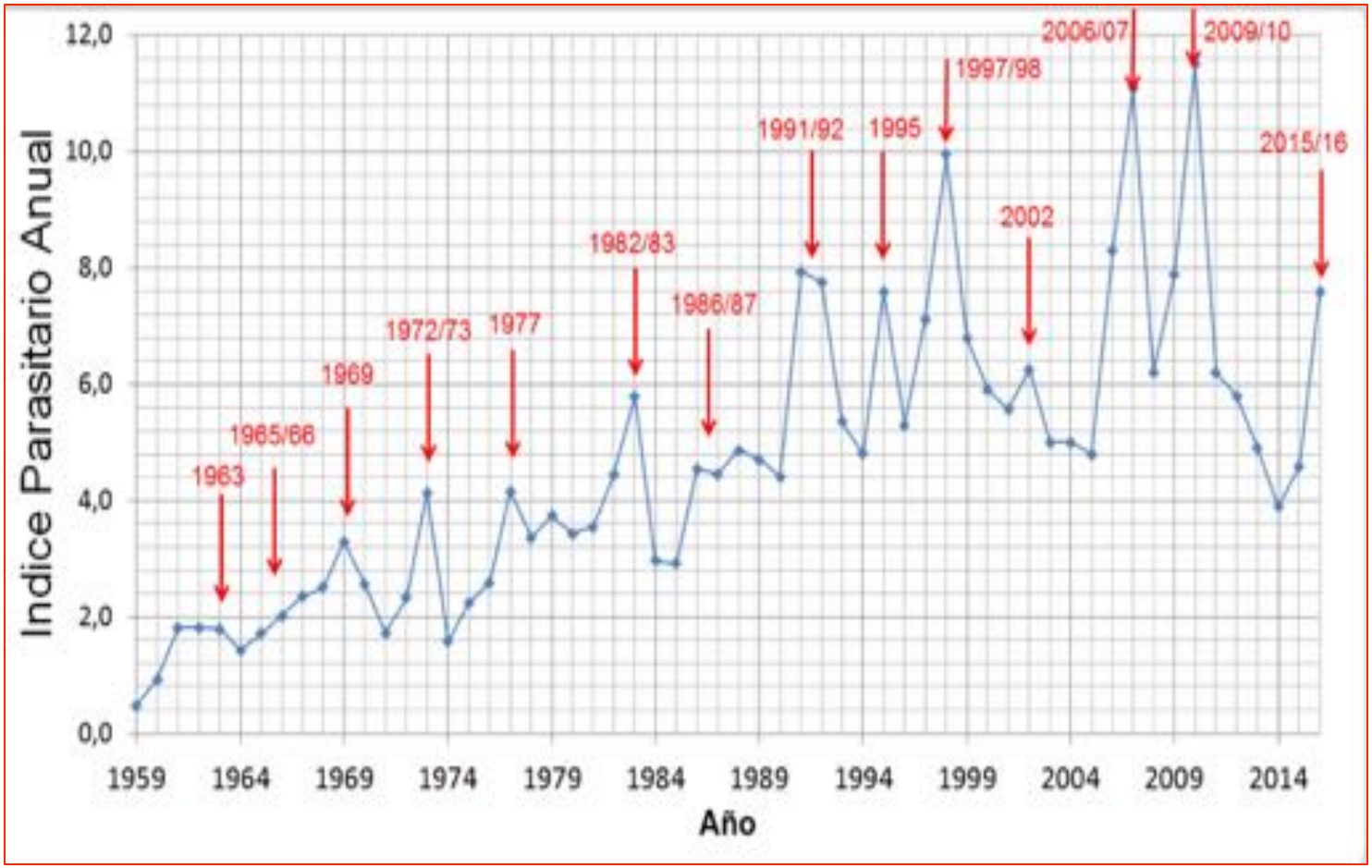


UPME, 2016)

- High Installed and Future Potential Capacity.
- Cheaper source of electricity.
- Clean and Renewable Energy (provided no deforestation).
- Environmental concerns of large dams and reservoirs.
- Dependence og climate variability (ENSO) and climate change.

Human Health

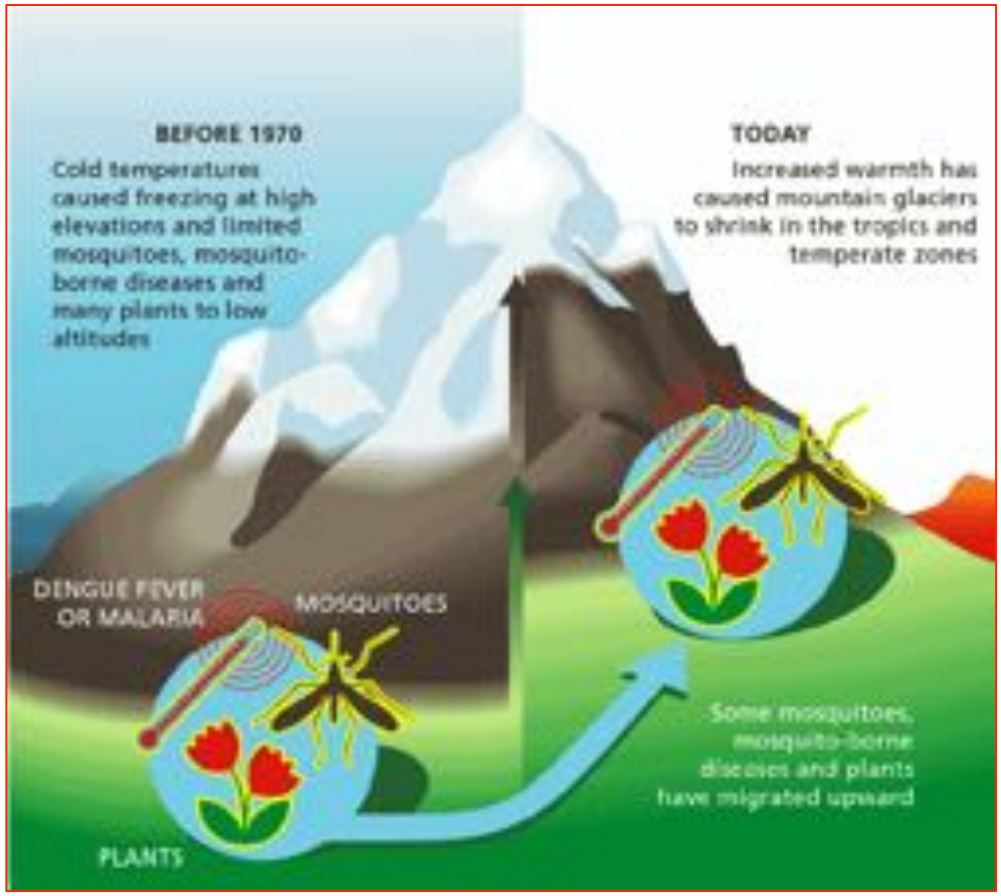
Transmission of Malaria in Colombia
Increasing Trend (Climate Change?) +
Outbreaks during El Niño



Poveda (2017)

Human Health

Mosquito-borne Dengue (a urban disease) is migrating to higher ground due to global warming



Epstein, *Sci. Amer. 2001*

Knowledge Gaps and Relevance

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- What are the Impacts of Climate Variability, Climate Change and Deforestation on Water Resources (mean and extremes), Air Quality, Agriculture, Human Health and other sectors (Human Settlements, Industry, Infrastructure, Biodiversity,…)?

- Do the Andes merit having their own RCPs (Representative Concentration Pathways or Scenarios) towards adaptation and mitigation of climate change?

- How to develop the transdisciplinary studies and to optimally link social and natural scientists towards the sustainable development of Andean societies?

- How to link natural and social scientists with stakeholders and decision-makers?

- How to integrate the traditional and ancient knowledge of Andean indigenous populations toward sustainable development?

Potential Activities

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Expected Outcomes

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Thank you!