

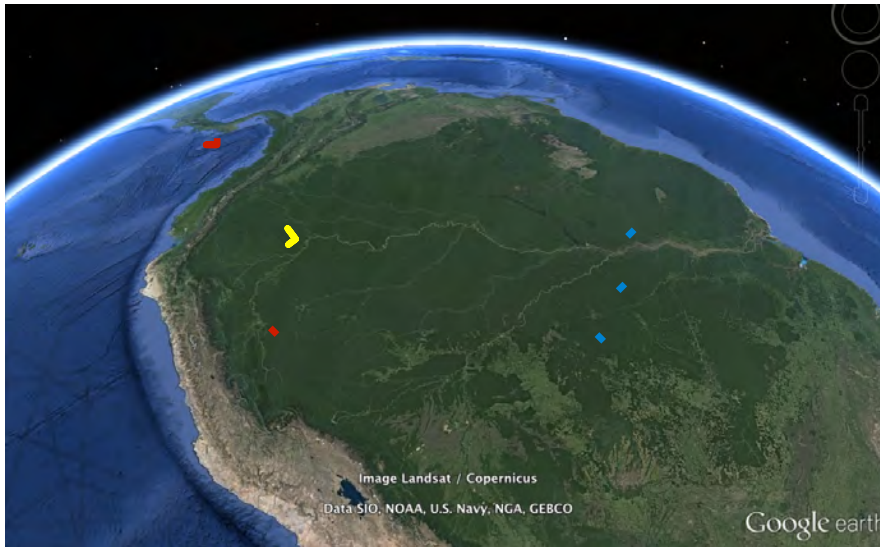
A Regional Hydrological Project for the Andes-Amazon System

Germán Poveda
Department of Geosciences and Environment
Universidad Nacional de Colombia
Medellin, Colombia



Amazonia has been studied in isolation from the the Andes

Diverse research programs (+25 years) devoted on the low-lying Brazilian Amazon
None in the non-Brazilian and upper Andean



Livros LBA

2015. *Biosphere, atmosphere and land use interactions in Amazonia*. Editores: Laszlo Nagy, Bruce Forsberg e Paulo Artaxo. Editora Springer. No prelo.

2014. *Cenários para a Amazônia: clima, biodiversidade e uso da terra*. Editores: Thaise Emílio, Filipo Luizão, e Manaus. Editora INPA, 191p. ISBN: 978-85-211-0126-0. Arquivos disponíveis online: <http://ciencias.inpa.gov.br/#/portal/lorio-216/>

2012. *Caracterização e gênese de solos em diferentes ambientes fisiográficos na região Sul do Amazonas*. Editores: Campos, M. C. C. PUC-Goias, Goiânia. 110p. Disponível para venda: <http://www.uev.br/lvco/edlorafilia/livro.asp?id=539>

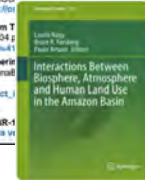
2011. *Atmosfera e Sociedade: aspectos multi e interdisciplinares da meteorologia*. Moura, Marcos Antonio Lima, Querino, Carlos Alexandre Santos; Santos, A. B. ed. Maceió-AL: EDUFAL, 2011. v. II.

2006. *Amazonia and Global Change*. Editores: Keller, M. M. Bustamante, J. Gash, and P. Silva Dias (Eds.). Geophys. Monogr. Ser. vol. 186, 566 pp., AGU 9781118670347; doi:10.1029/GM186. <http://fer>

2009. *Amazônia: Natureza e Sociedade em T* Diogenes Alves. Editora da USP (Edusp). 304 p. <http://www.edusp.com.br/estivro.asp?id=41>

2008. *Ciência e tecnologia: o caso do experie Amazônia (LBA)*. Tatiana Schor. Editora Annablume para venda: http://www.annablume.com.br/objeto/product_tak37

2004. *Sociedade, Território e Conflito: BR-1 UFPA, NAEA / UFPA. 297p.* Disponível para vi



Interactions between Biosphere, Atmosphere and Human Land Use in the Amazon Basin

Autores: Nagy, Laszlo, Bruce Forsberg, Paulo Artaxo (eds).



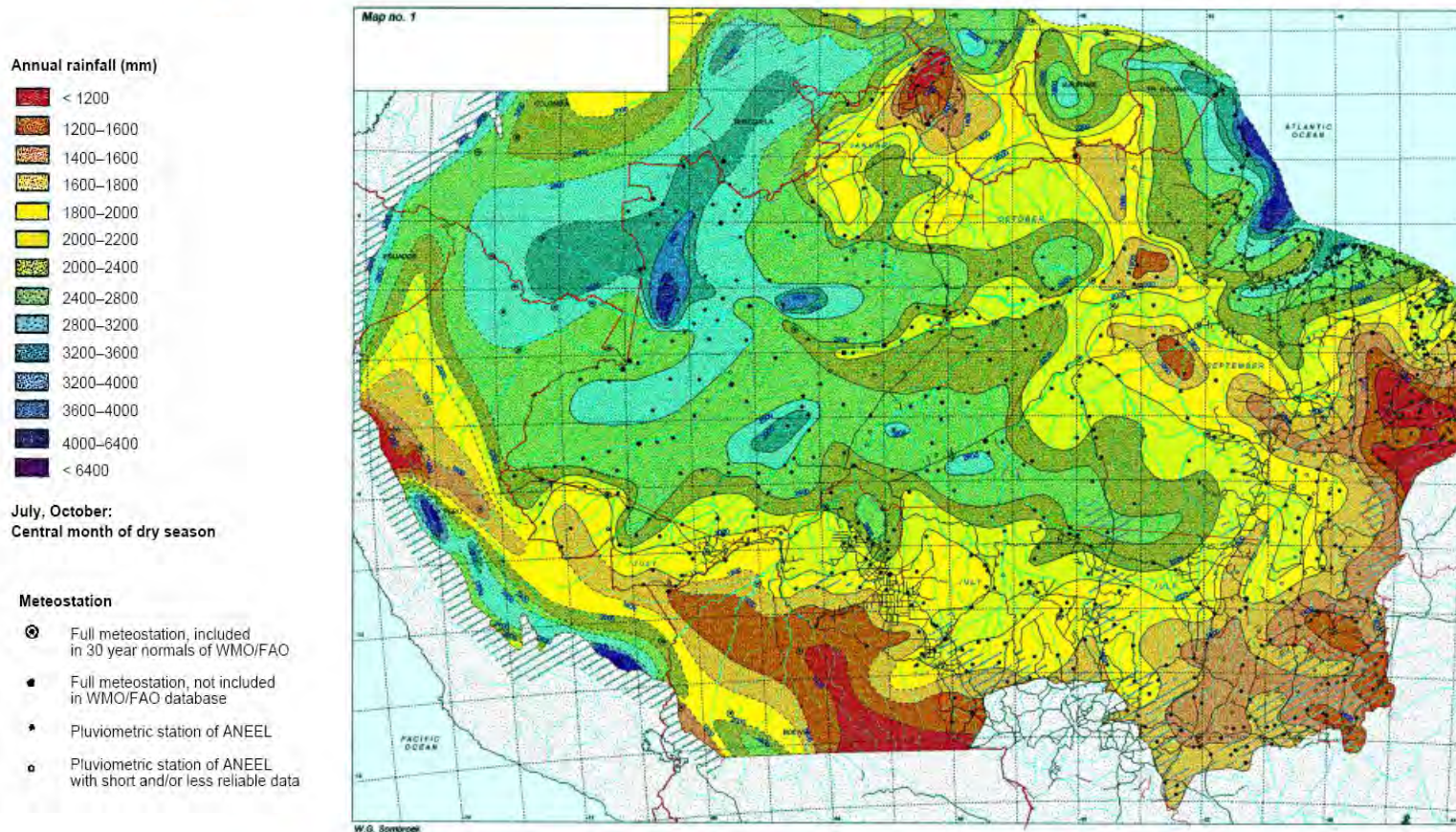
AMAZALERT

A research project on impacts of climate change and land use change in Amazonia

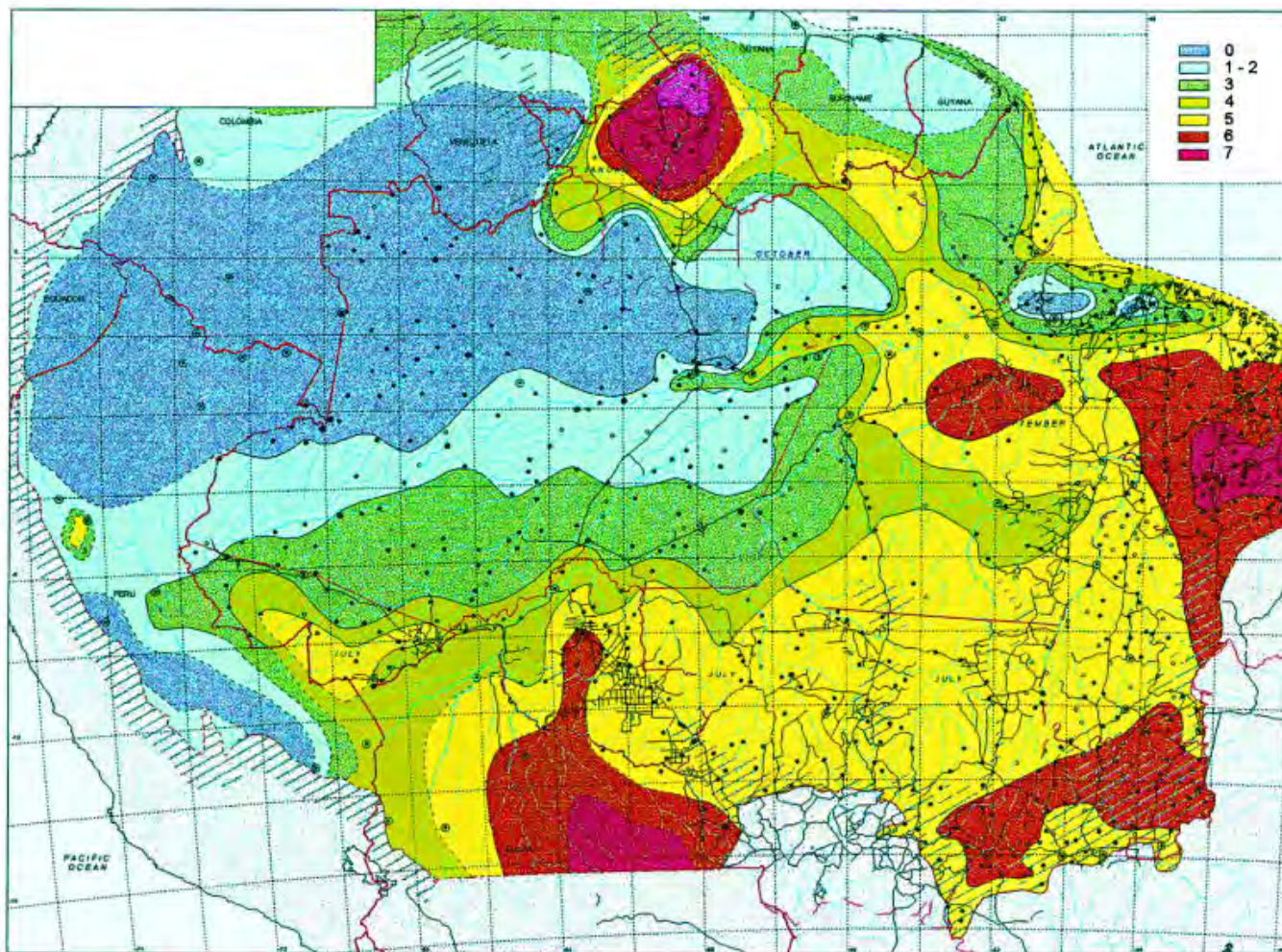
LBA Overarching Questions

- How does Amazonia currently function as a regional entity within the larger Earth system, in terms of Hydrology, Climatology and Biogeochemical Cycles.
- How changes in land use and climate will affect the biological, physical, and chemical functioning of the region's ecosystem.
- But...these fundamental questions can not be answered without considering Amazonia in its entirety from the headwaters in the high Andes, and the feedbacks with the low-lying Amazonia.

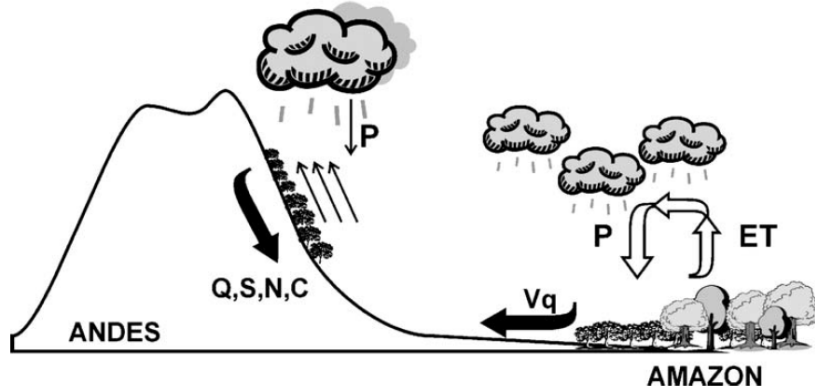
Wettest regions of Amazonia in Colombia, Ecuador, Peru (Water & Energy Budgets, Clouds, Carbon?)



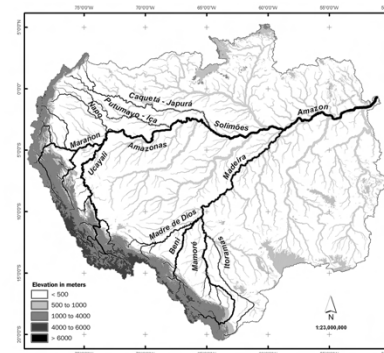
Number of consecutive months with rainfall less than 100 mm/month



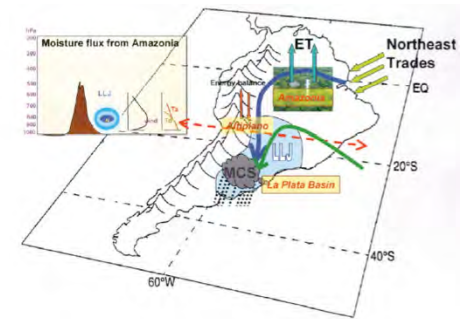
- Thirteen percent of the Amazon River basin is located in the Andes.
- Nine of the main rivers in the basin flow from the Andes (McClain & Naiman, 2008).
- The Andes and Amazon conform a coupled system exhibiting hydro-climatological feedbacks.



Poveda *et al.*, Paleo-3, (2006)



(McClain and Naiman, 2008)



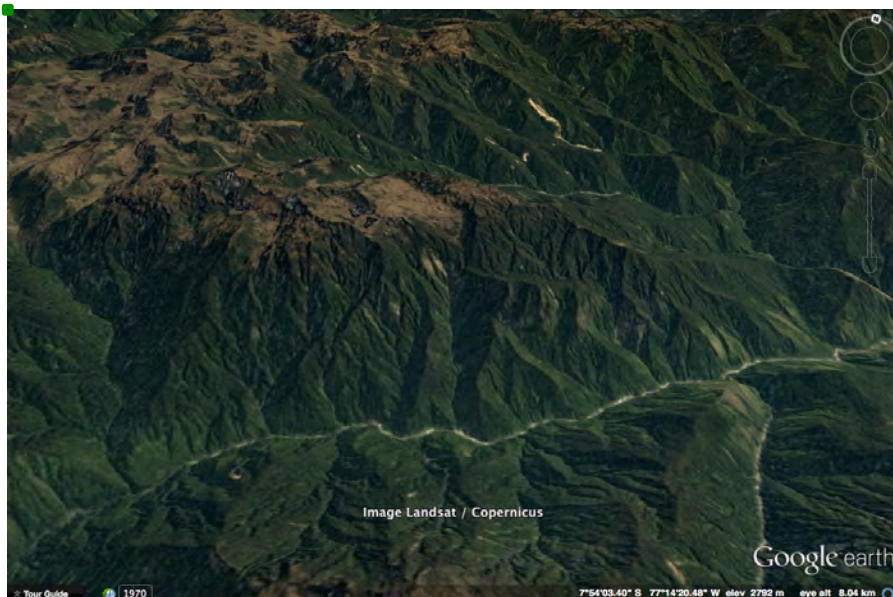
(Marengo *et al.*, 2004)

The mountain range acts as a barrier for winds influencing the movement of air masses over the basin

Tropical Glaciers of Andes: Headwaters of the Amazon River Basin



Andes: Headwaters of the Amazon River Basin (2) Strong Topographic, Climatic, Ecological Gradients



Fate of Páramos, Yungas, Punas, & Cloud Forests?

Vanishing glaciers in the Colombian Andes^{47 48}



1946



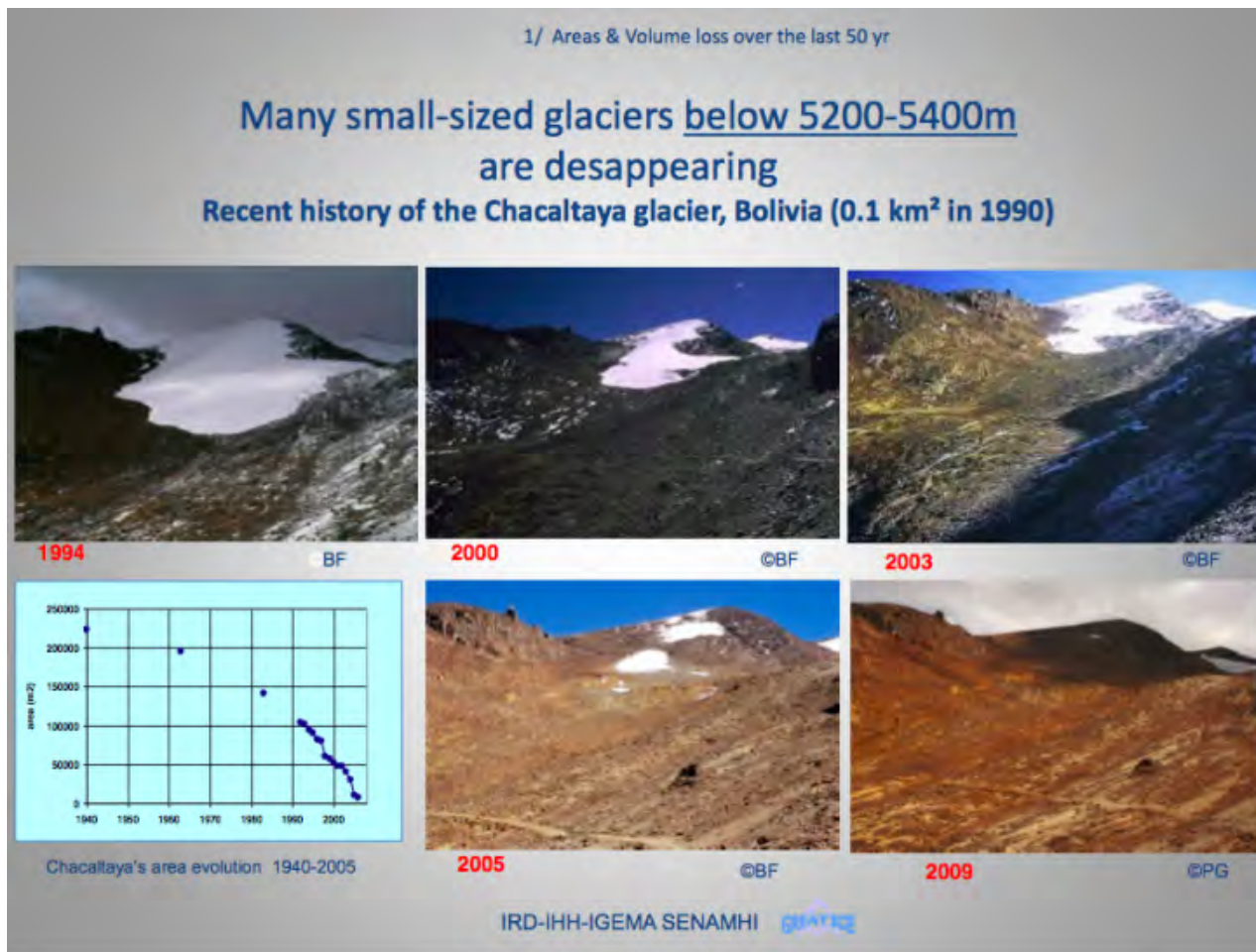
2006



2021?

Photos: (from left to right): Erwin Kraus (1946, reprinted with permission from Diego Samper Editores); Oliver Hill / Roberto Ariano (2006), and; Photoshop editing courtesy of John French (2006).

All Andean Glaciers are Disappearing



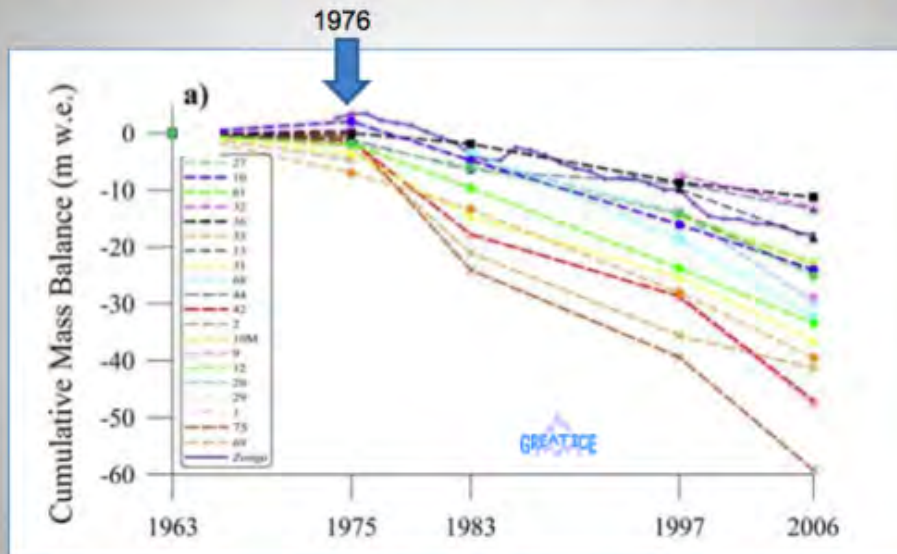
Depletion of Andean Glaciers

1/ Areas & Volume loss over the last 50 yr

Bolivia 16°S: depletion of glaciers in the Cordillera Real

Aerophotogrammetric analysis of 20 glaciers: loss of 40-50% (in area & volume)

(Soruco, 2008)



Cumulative mass balance of 20 glaciers in the Cordillera Real

Soruco, A., Vincent, C., & Francou, B., 2009. Glacier decline between 1963 and 2006 in the Cordillera Real, Bolivia. *Geophysical Research Letters*, vol. 36, L03502, doi:10.1029/2008GL036238

Tropical Glaciers and Paramos: Water factories



Glaciers



Paramos



Tropical Mountain Forests



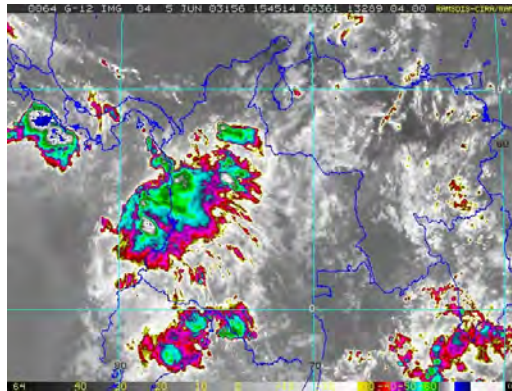
Photo: Peter Bunyard

Deforestation in the Andes: Socio-Environmental Risks and Vulnerability



Deforestation in Andes
photo Paul Salaman

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COLUMBIANO

16 N° 11 2011 12 página 16 con contenido: http://www.elcolumbiano.com. Correo electrónico: editorial@elcolumbiano.com. ISSN 1122-8862. Teléfono: 010249 9440000. Bogotá, D.C., 11 de 2006

Tragedia invernal deja 11 muertos

- DESASTRE EN Buenaventura, el peor de la década en el Valle.
- 37 DESAPARECIDOS y casi 900 damnificados, la cifra oficial.
- PRESIDENTE LÓPEZ visitó la zona y prometió reubicación.

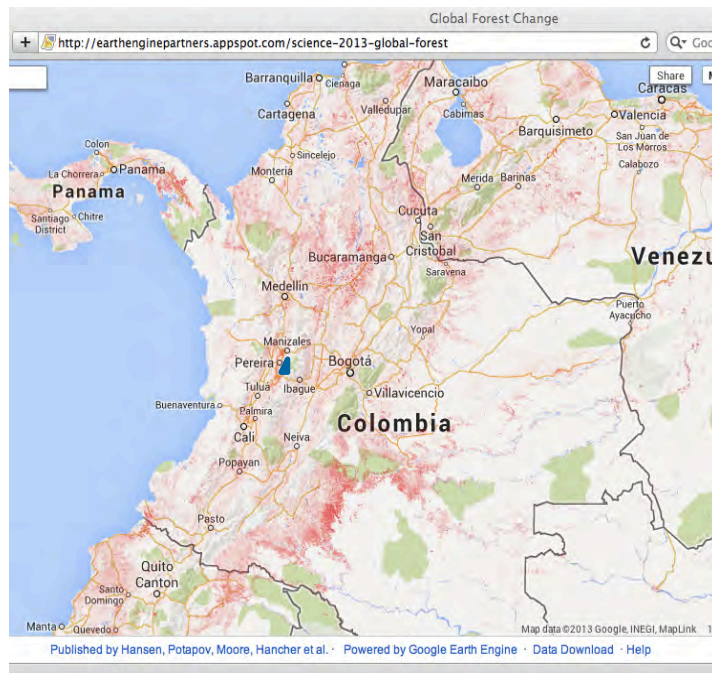
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Colombian Amazonia: Under threat by strong deforestation



Mining



Agriculture & Cattle Ranching



"The Road to Pave the Colombian Amazon"

EL ESPECTADOR

Domingo 05 De Febrero, Última Actualización: 1:03 Pm

Noticias Opinión Economía Deportes Entretenimiento Vivir Mujer Te



La carretera con la que quieren pavimentar el Amazonas

Medio Ambiente - Hace 5 horas

-

Some Research Questions & Advances

Typical Afternoon Storm over Medellin

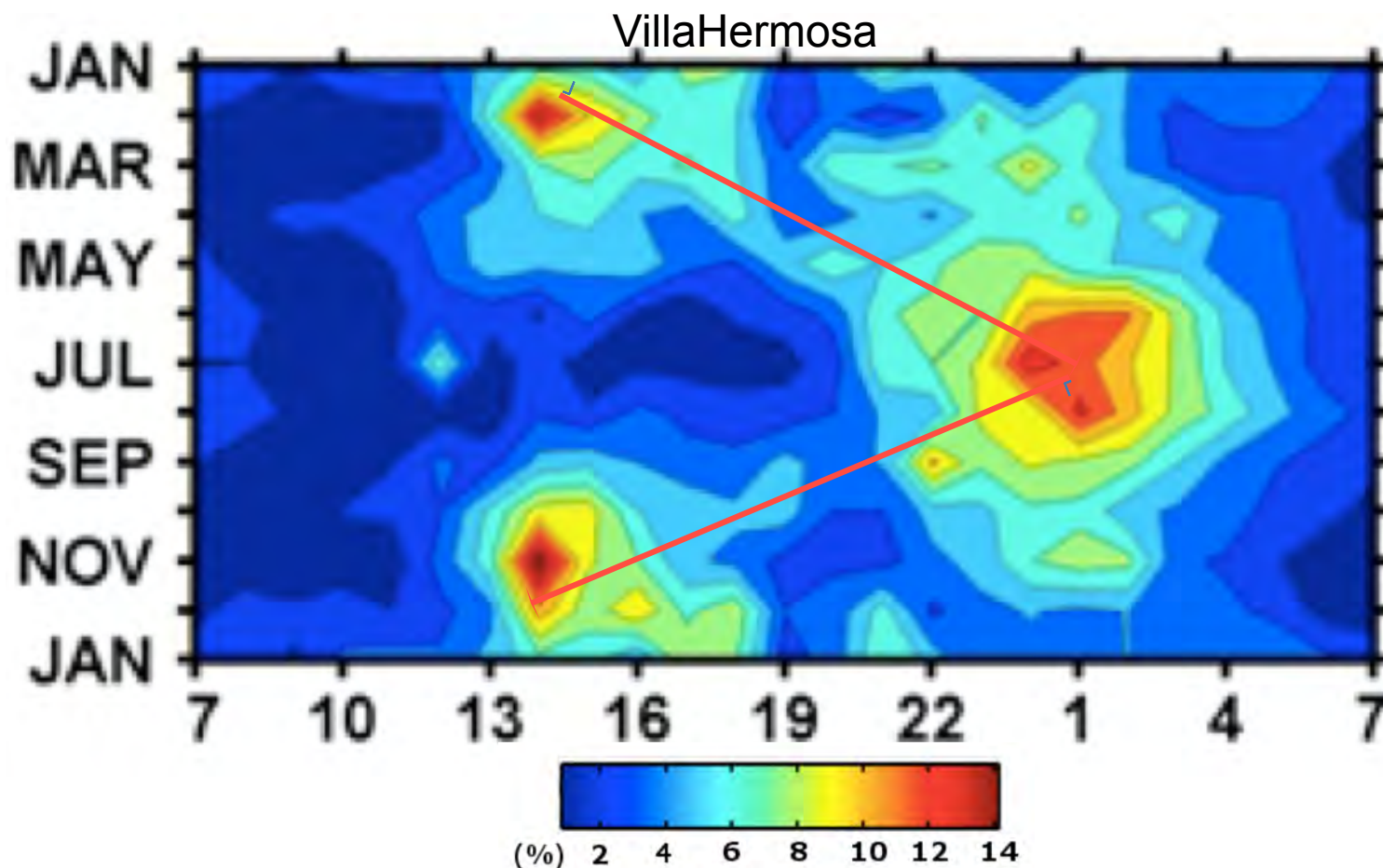


Photo Courtesy: Prof. José F. Jiménez

Diurnal Cycle of Rainfall – Tropical Andes of Colombia: Shifting phase with the annual cycle

Afternoon Peak: September-October to April-May

Midnight-dawn Peak: April-May to September-October



- What is the spatial variability of the annual cycle of hydrological variables:
P, E, Ep, R?

Amazonia is a quilt, rather than a sheet

Hydrological Regionalization of Amazonian-Major Sub-basins

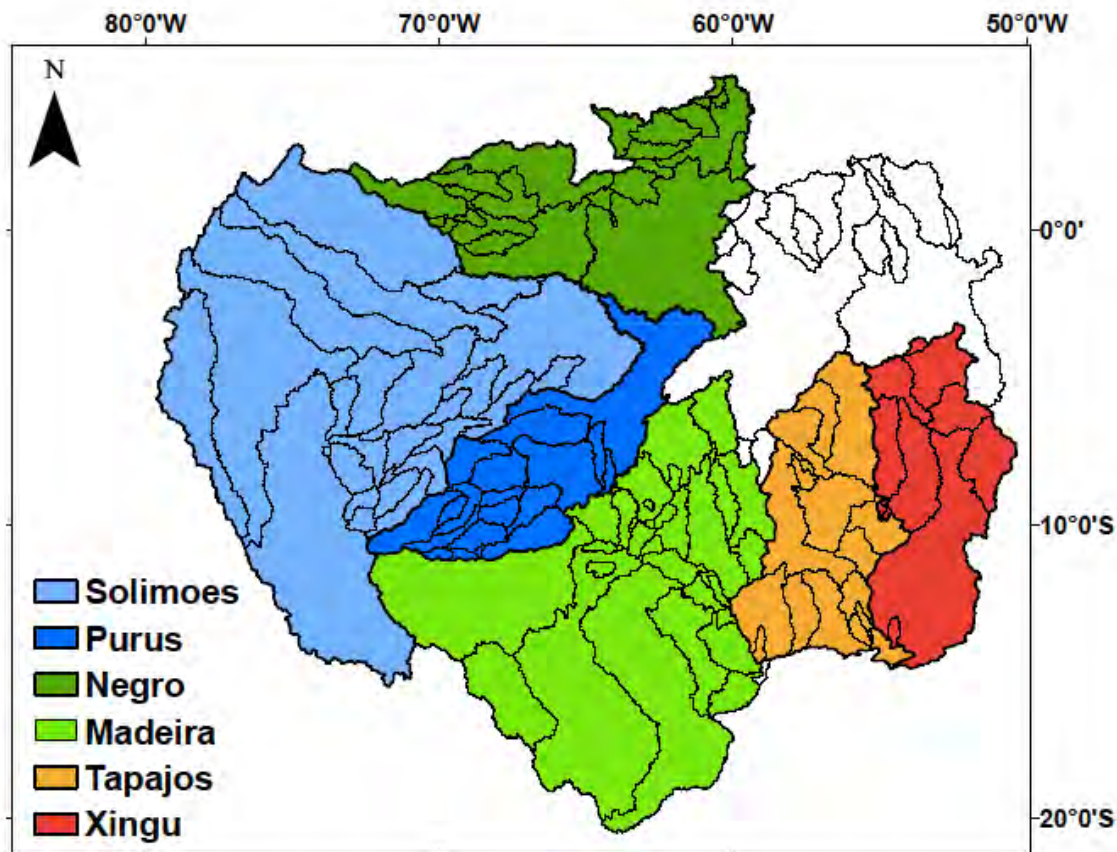
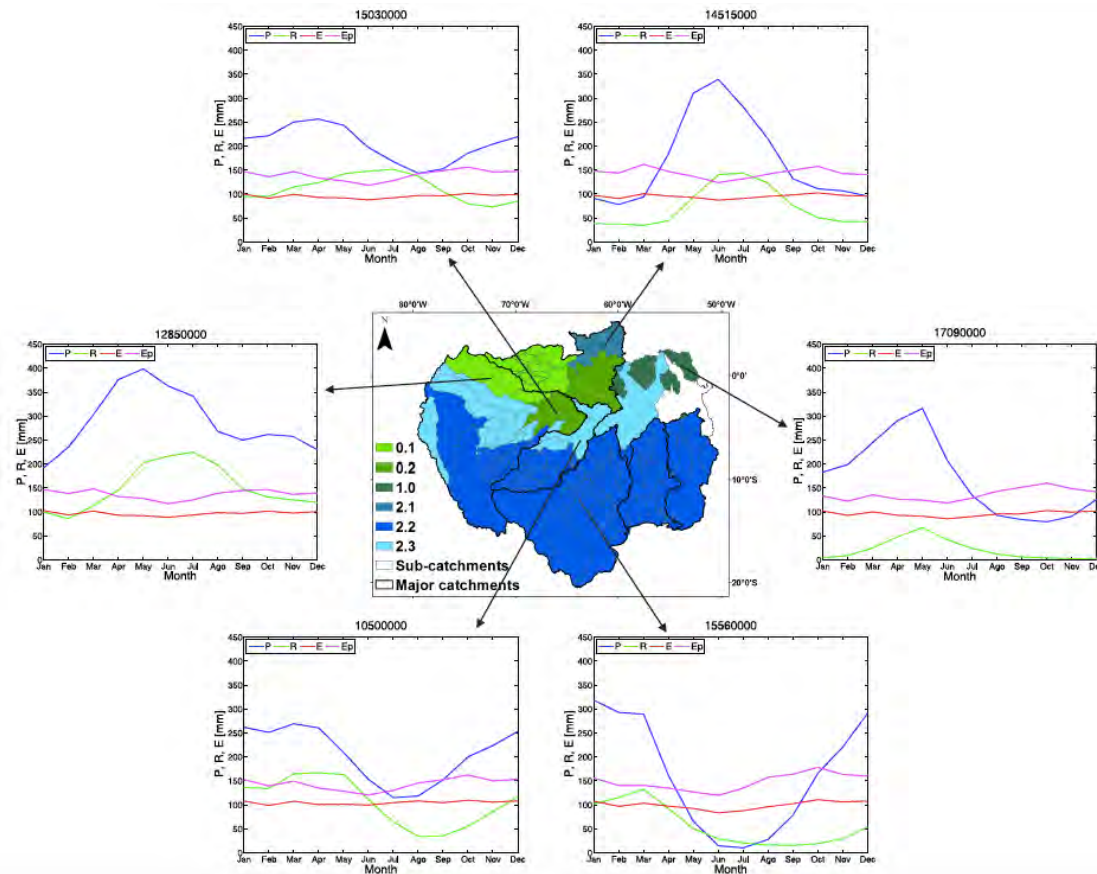


Figure 3-2: Location of the 146 sub-catchments and the 6 major river basins within Amazonia

Regional Distribution of Hydrologic Regimes

P (blue), Ep (purple), R (green), & E (red)



Spatial Variability of the Water Year

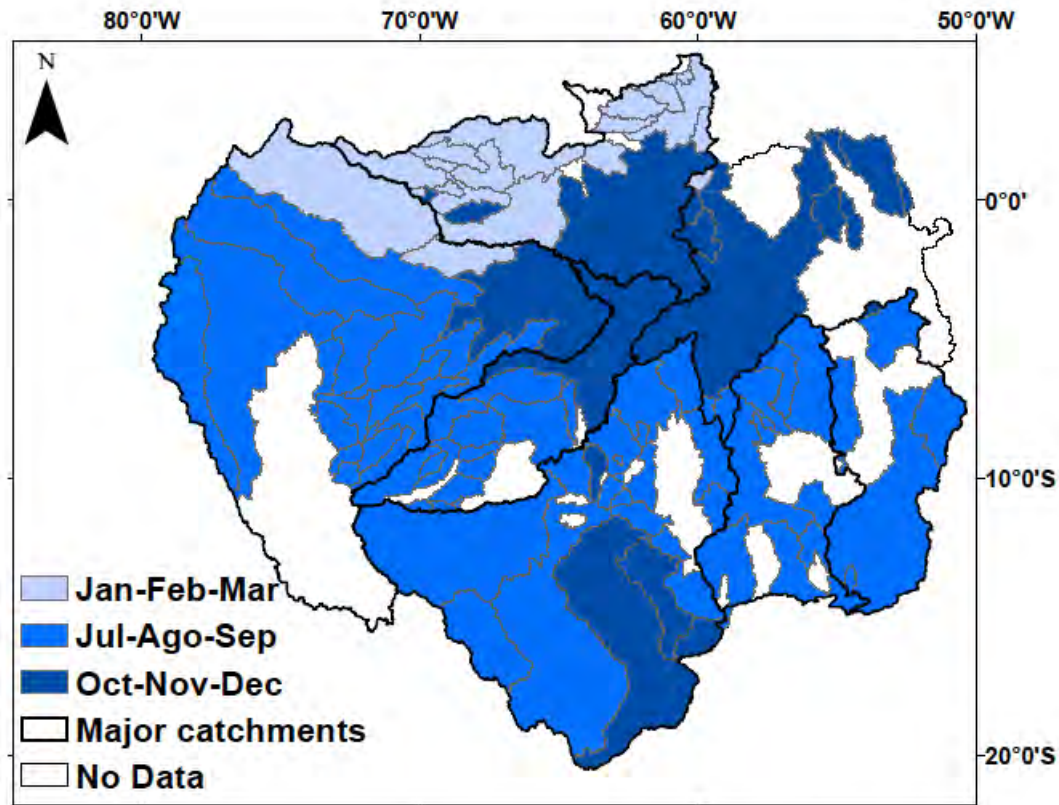
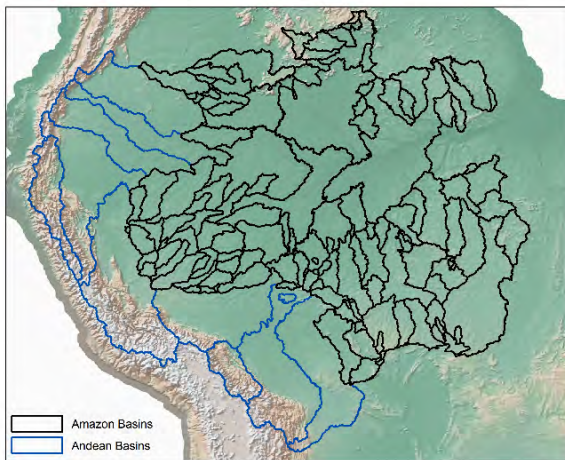


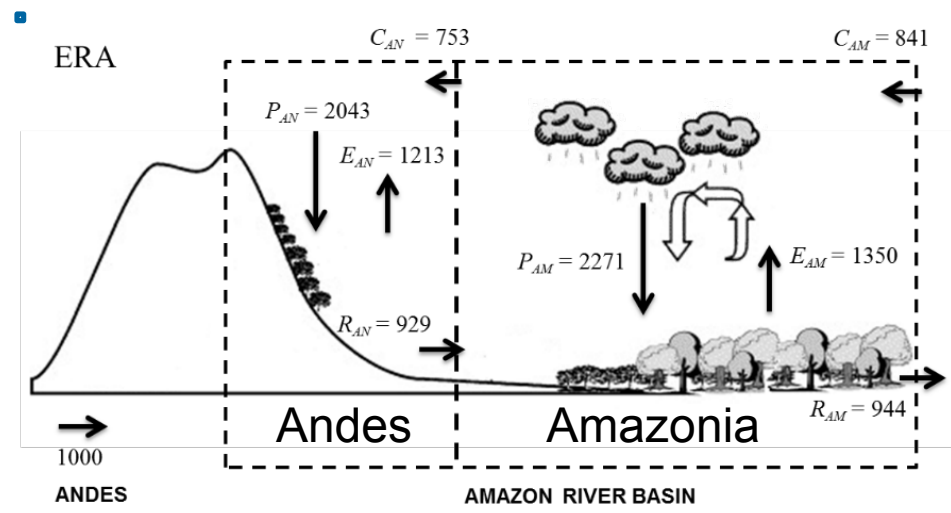
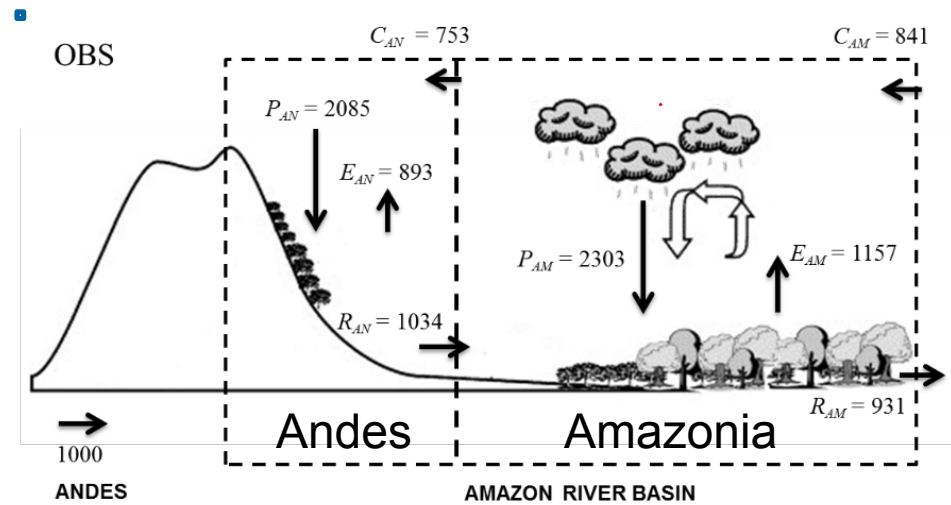
Figure 3-4: Starting month of the water year in 115 sub-catchments in Amazonia

- **Surface & Atmosphere Long-Term Water Balances For the Andes-Amazon system**

Components of Surface and Atmosphere WB – Observations & Reanalysis in Andes and Amazonia



Higher runoff per unit area in the Andes sub-region than in low-lying Amazonia for both datasets.



Recap

1. The Andes-Amazon demands a systemic approach towards understanding, modelling and predicting their hydro-climatological and biogeochemical couplings and feedbacks.
2. Impressive research has been developed on the low-lying Brazilian Amazonia, but the upper low-lying (non-Brazilian) and Andean Amazonias are virtually unknown.
3. Lots of fundamental issues and questions remain unexplored in the latter regions. Venezuela, Colombia, Ecuador, Peru and Bolivia need to take the lead in facing this challenge.
4. A recommendation from this 29 GEWEX SSC to WCRP and the countries: The creation of a Regional Hydrological Program for the Andes-Amazon system.
5. Tons of work to be done.