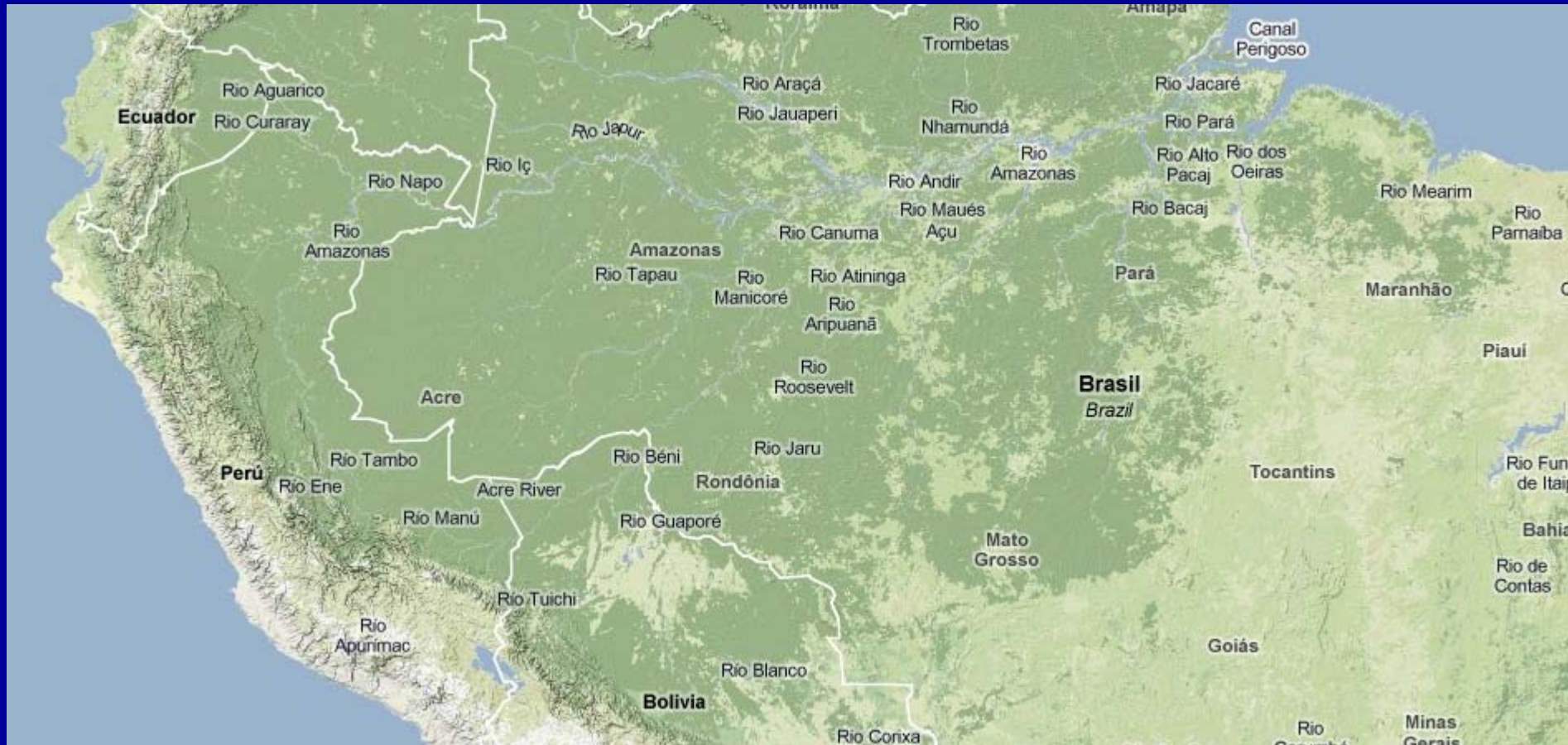


Climate Change and Peru

Rainforest in Peru



Peru's rainforest represents 20% of the Amazon

Deforestation in Peru

- Peru has ~255,200 square miles of tropical forests (~France)
- One of the lowest annual deforestation rates in the Amazon basin
- 580 square miles were cut down in 2005
- Other organizations put the average figure at around 970 square miles annually
- Much less than Brazil, 46,300 mi² annually
- Tropical deforestation causes about 18% of global greenhouse gas emissions.
- Peru accounts for < 1% of the world's emissions, but about half of Peru's emissions are due to deforestation

Deforestation in Peru



Deforestation in Peru

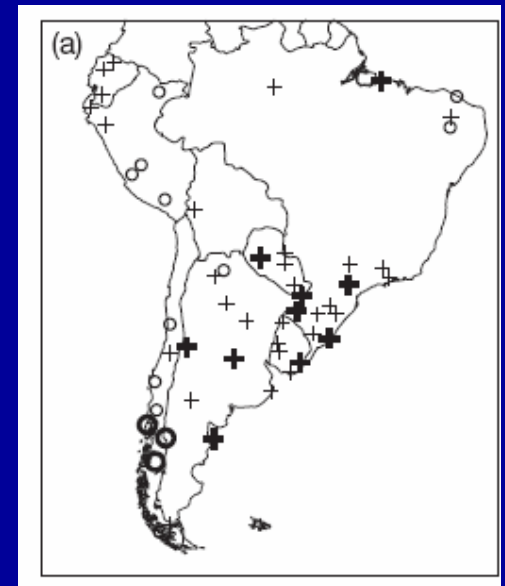
- Logging, mining, road building, oil and gas
- Slash and burn (agricultural land)
 - Farmers moving from highlands
 - Ownership of land after 5 years?
- 2007 annex US-Peru free trade agreement
 - Help regulate mahogany trade
 - Creation of Peru's Environment Ministry

Peru's Ambitious Plan

- In addition to already protected forests
- Protect 80% of primary forests
- Zero deforestation in 10 years
 - Just give us \$25 million a year!
 - Actually quite similar to other Latin American countries
 - Brazil wants \$20 billion

Past Decade and IPCC Pred.

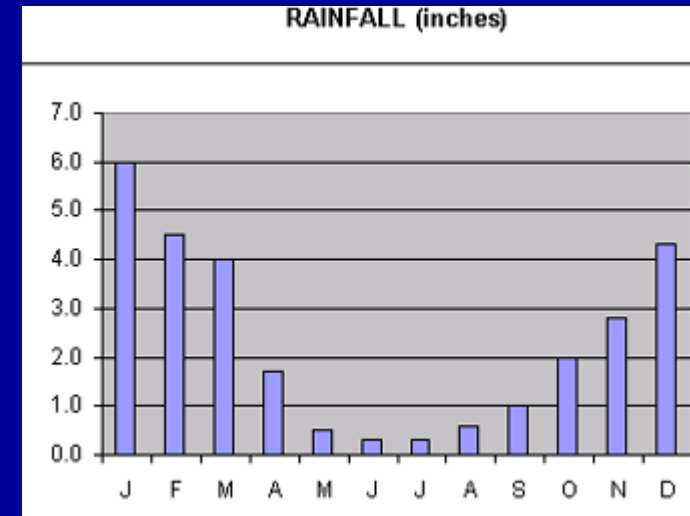
- Southern Peru
- Declining precipitation
- Increase in temperature
- Change in ENSO frequency
- Sea level rise



Trends in rainfall in (a) South America (1960-2000). An increase is shown by a plus sign, a decrease by a circle.

Consequences for Peru

- Peruvian climate dominated by monsoon (closely coupled to ocean-atmosphere interactions)
- Change in precipitation
 - Water stress for arid regions
 - Increased flooding followed by dry periods
 - Change in land use
 - desertification of farmland,
 - tropical forest replaced by savannas



Consequences for Peru

- Change in ENSO frequency
 - Fungal diseases in maize, potato, wheat and beans due to higher humidity and rainfall associated with ENSO events
 - Increased wind stress, hypoxia and deepening of the thermocline will impact fisheries (reduction of spawning areas and fish catches of anchovy)
 - Flooding of infrastructure and houses



Consequences for Peru

- Sea level rise
 - Peru OK
 - Increased erosion
 - Farmland destruction
 - “At least we’re not Buenos Aires!”

Consequences for Peru

- Temperature increase
 - Glacial retreat



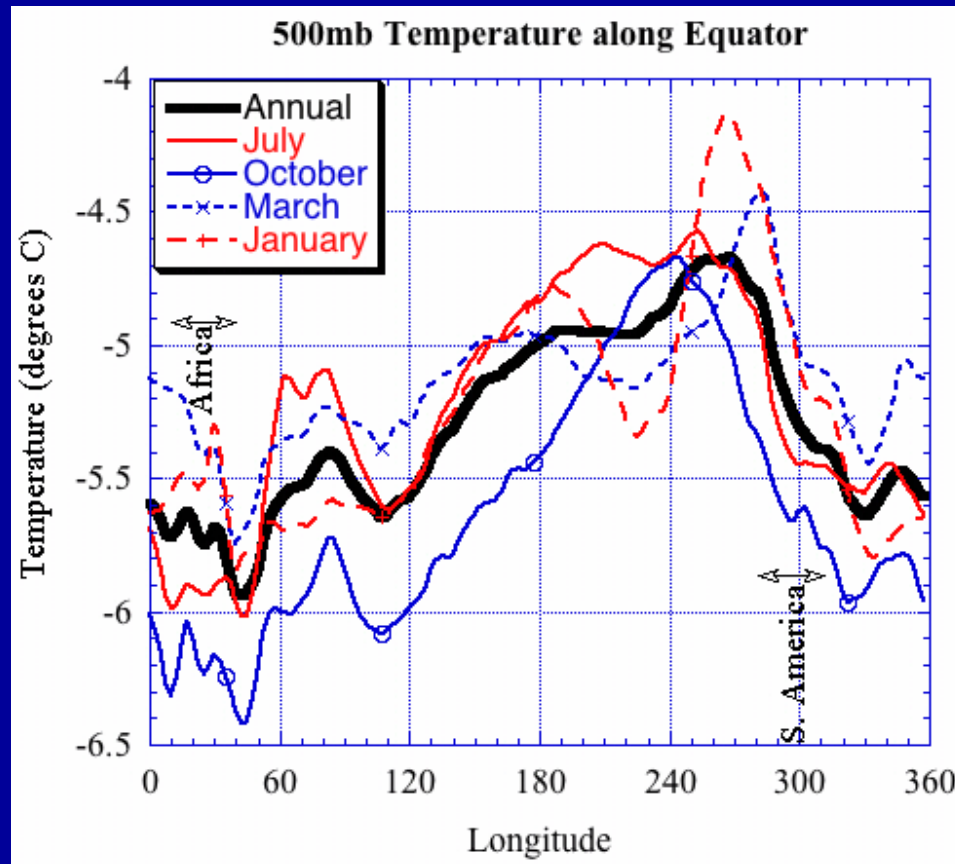
Tropical Glacier Retreat

- Tropics
 - 30N to 30 S
 - 70% of population
 - “Accumulation zone” for Earth’s energy
 - Important tests for climate models

Tropical Glaciers

- Cool air (~6.5 degrees per km)+ snow =glacier
- Tropical temperature varies little throughout the year (unlike extratropics)
- Seasonal variation in precipitation
- Tropics have low horizontal temperature variations (no strong Coriolis forces to balance P-T gradients, not so true away from the equator....)
- Temperature strongly implicated in glacial retreat

Temperature along Equator



The 1950-1995 climatological mean temperature along the equator at the 500mb level. This level is approximately at the altitude of the summit of Kilimanjaro. Results are based on the NCEP data set. Note that the annual mean equatorial temperature varies by only 1.5 degrees C over the entire globe.

Energy Balance

- How do glaciers melt?
 - Sublimation takes 8.5x more energy than melting
 - Air T, wind, humidity, cloudiness all effect ability of glacier to melt
 - Atmospheric conditions change the number of hours a day glacier surface is warmer than surrounding air (easier to melt)
- Fresh snow very reflective (and added mass)

Healthy Glaciers

- Accumulation zone
- Equilibrium line altitude
- Ablation zone
 - Climate change causes glacier to shrink
 - Reach new equilibrium size
- If equilibrium line reaches top of glacier, game over!
 - Chacaltaya and, the summit glaciers of Kilimanjaro [Moelg and Hardy,2004]

Kilimanjaro

February 17, 1993



www.philippegatta.fr

February 21, 2000

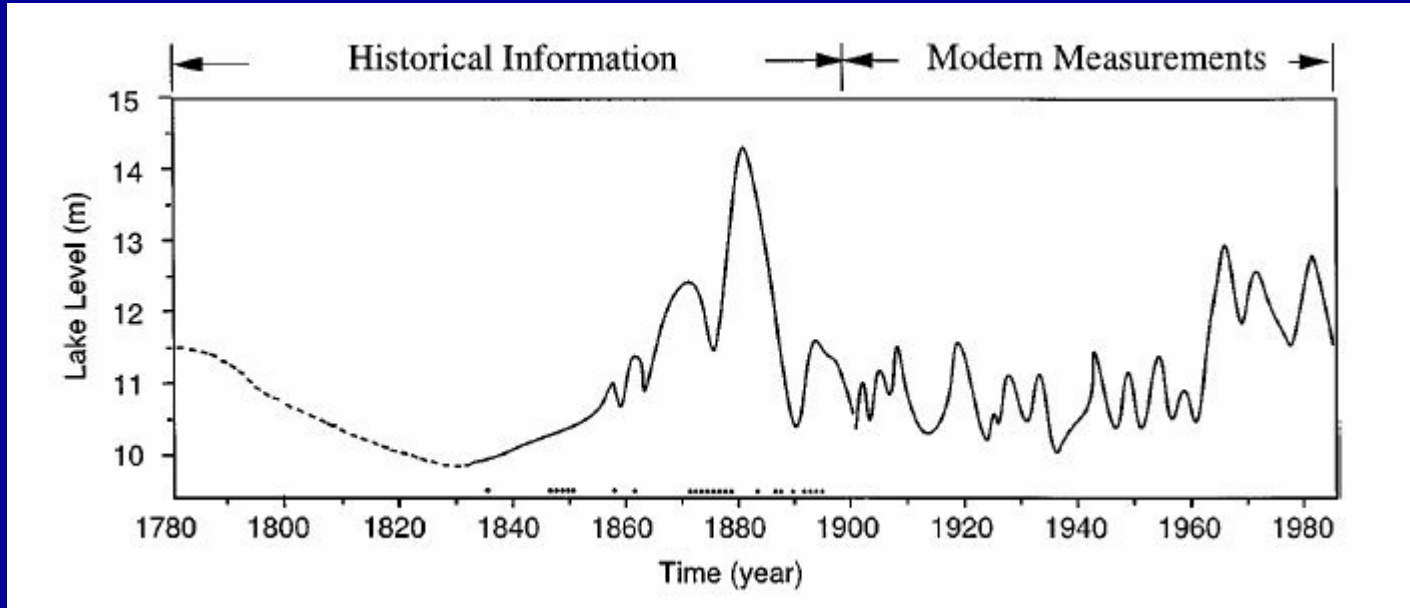


Kilimanjaro

- Kilimanjaro's glaciers are retreating, is it due to warmer temperatures or decreased precipitation?
- Retreat began in late 19th century (before anthropogenic warming) with shift to drier conditions
- Cited by climate skeptics as evidence that global warming isn't the cause of glacial retreat.

“A new study in the March issue of *International Journal of Climatology* further debunked alarmist claims that global warming is causing a retreat of the famous alpine glacier atop Africa's Mount Kilimanjaro.”

Lake Victoria



Lake Victoria level data, after Nicholson and Yin (2001). The lake acts somewhat like a huge rain gauge, so that lake level is a proxy for precipitation. Data before 1840 is not based on individual year level measurements, but historical reports of general trends.

- Wet-dry shifts are common throughout the record

Kilimanjaro

- Early observations saw glacier shrinking from wet decade around 1880
- Glacier had been around for 11,000 years (likely seen similar shifts in precip)
- Still debate among scientists about cause of Kilimanjaro glacier retreat

“Kilimanjaro may be a photogenic spokesmountain “no matter what the climatic agenda” but it is far from ideal as a laboratory for detecting human-driven warming. The debate over it obscures the nearly universal agreement among glacier and climate experts that glaciers are retreating all over the world, probably as a result of the greenhouse-gas buildup “

Peruvian Glaciers

Qori Kalis



1978



2004

Quelccaya Ice Cap-largest ice mass in tropics

2006 ice fall

Peruvian Glaciers

Yanapaccha



Acute Problems

- 11 April 2010 a large volume of ice (500x200m) broke off of a glacier on the flanks of Hualcan
- The ice fell into a lake, creating a 75 ft wave of water that spilled into the Chucchu River and traveled downstream
- Glacial outburst floods

Long-Term Effects

- ~1/4 of Lima residents have no water service
- A “stressed” condition between 2015 and 2025 may impact the availability of water supply to 60% of Peru’s population
- Water supply very important for agriculture

Food Security

- 31% of economically active population work in agriculture
- 34% of farmlands are irrigated
- 1 in 6 Peruvian children are chronically malnourished
 - 1 in 3 in rural areas



Hydroelectric Power

- The Mantaro river generates 40% of the country's electricity and powers 70% of the industry
- Decreased intermittent runoff means more fossil fuels burned for energy
- More fossil fuels=warmers climate...
“Environmentalists and indigenous groups condemn plan for six dams in Peruvian Amazon”

What can Peru Do?

- Transbasin water transfers (Hello LADWP)
- Regulate growth and building in floodplains
- Crop simulation models (when to plant drought resistant or faster growing crops)
- Peru and rest of Latin America is poor

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