International Nitrogen Initiative

Latin America and the modern N cycle: a cross-road

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

GLOBAL CHANGE
IGBP International Geosphere-Biosphere Programme
Brazil Regional Office

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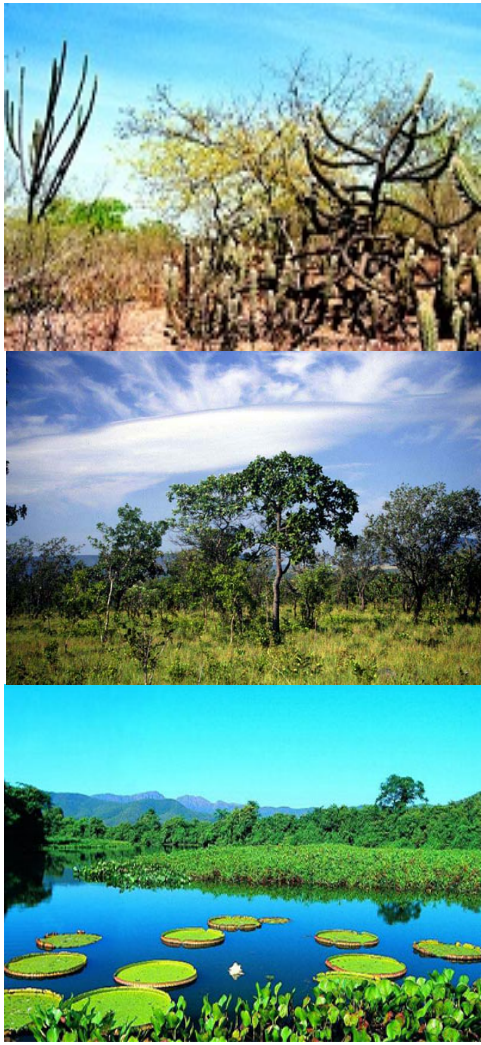
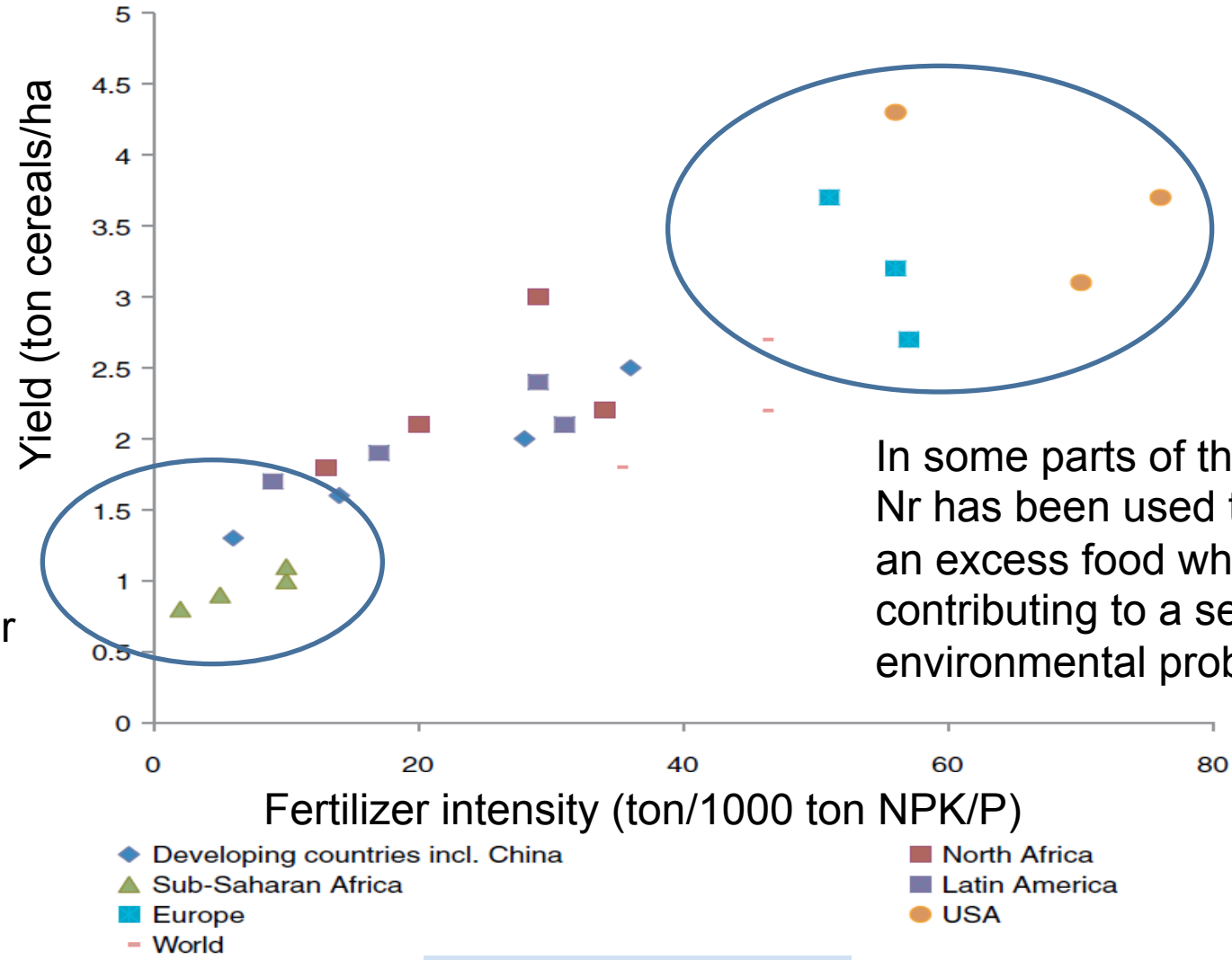
Changes in global N cycle

- Nitrogen is
- a key element for life on Earth,
- related to ecosystem functioning and many human activities,
- under strong pressure due to current global environmental changes.



Reactive N – too much, too little...

In other world regions, lack of sufficient Nr to meet basic nutritional demands



In some parts of the world, Nr has been used to create an excess food while contributing to a set of environmental problems

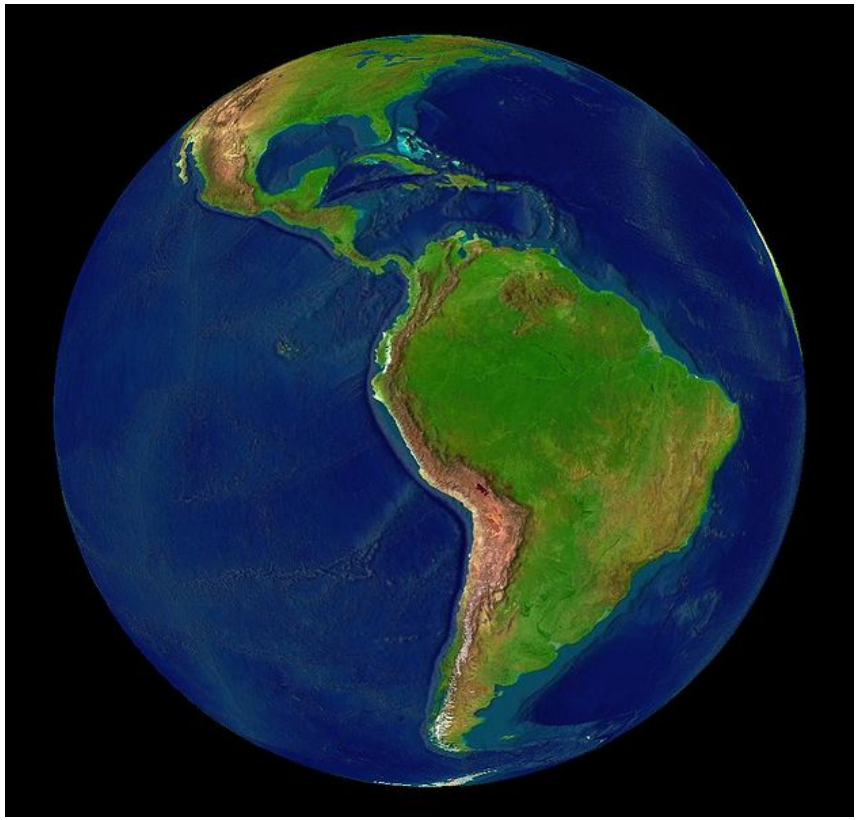
Erisman et al. 2011

Regional aspects of global N cycle

- Outside North America and Europe, little is known about the magnitude of N deposition or its impacts on ecosystems.

- Lack of long- term observations
- Large unknowns regarding the responses of diverse tropical and subtropical ecosystems to the input of reactive N.

Latin America and N Cycle



- This region a key player in the global arena for both **conservation and economic progress.**

- Due to the unique regional ecological determinants and simultaneous explosive socio-economic development

Diversity of landscapes

- Extremely high diversity of climate zones due to:
- its wide latitudinal (and temperature) range in the north-south direction
- contrasting precipitation gradients due to the presence of the Andes mountain range.

- This diversity of landscapes creates a myriad of habitats and biodiversity:
- tropical forests
- savannas
- unpolluted temperate forests

Megadiverse countries

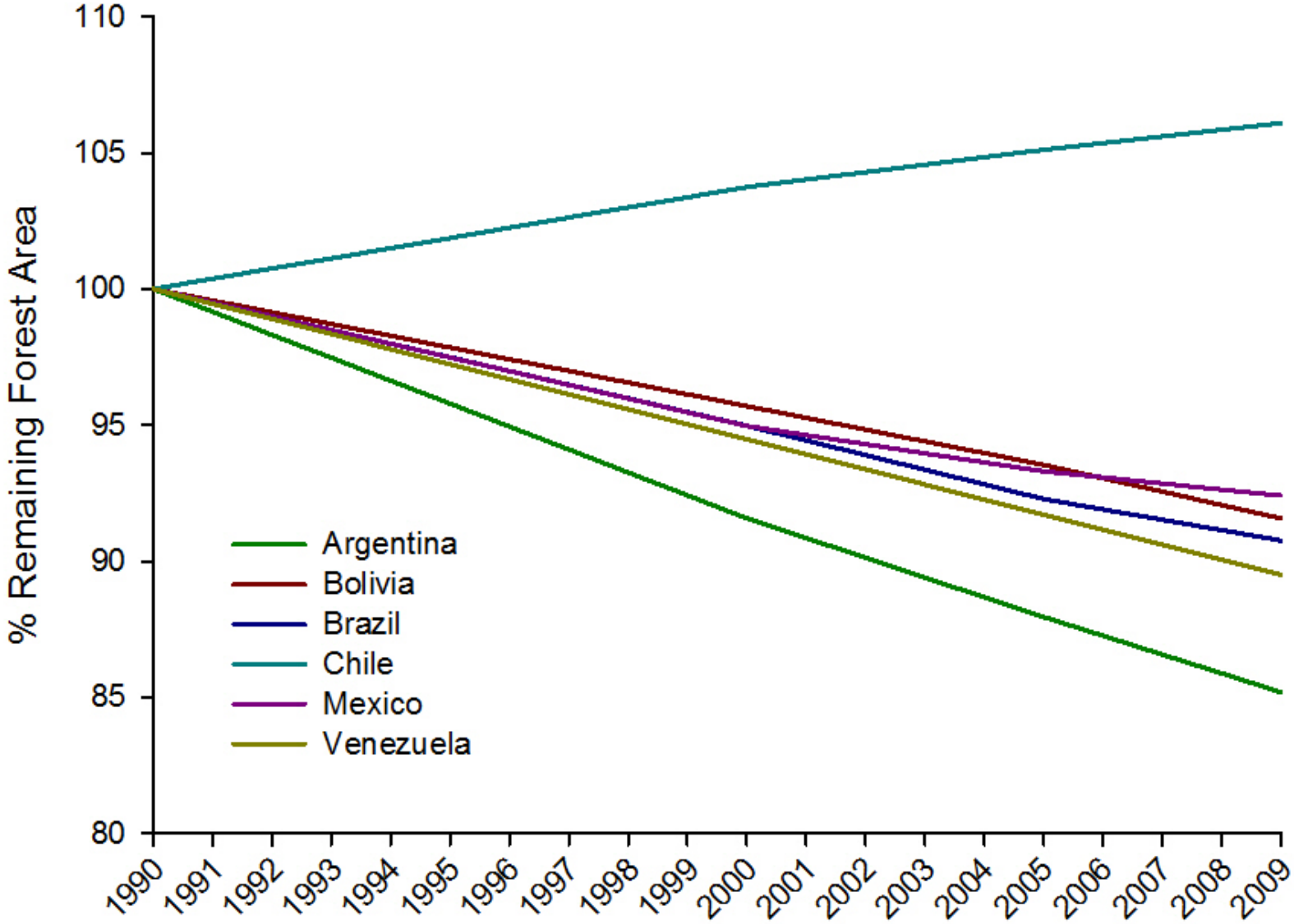
Latin America and the Caribbean is the region with the greatest biological diversity on the planet:
50% of the world's tropical forests
33% of its total mammals,
35% of its reptilian species,
41% of its birds
50% of its amphibians.

Recent changes

- The relatively political stability that LA has been experiencing in the last decades has allowed for unprecedented economic growth in the region.

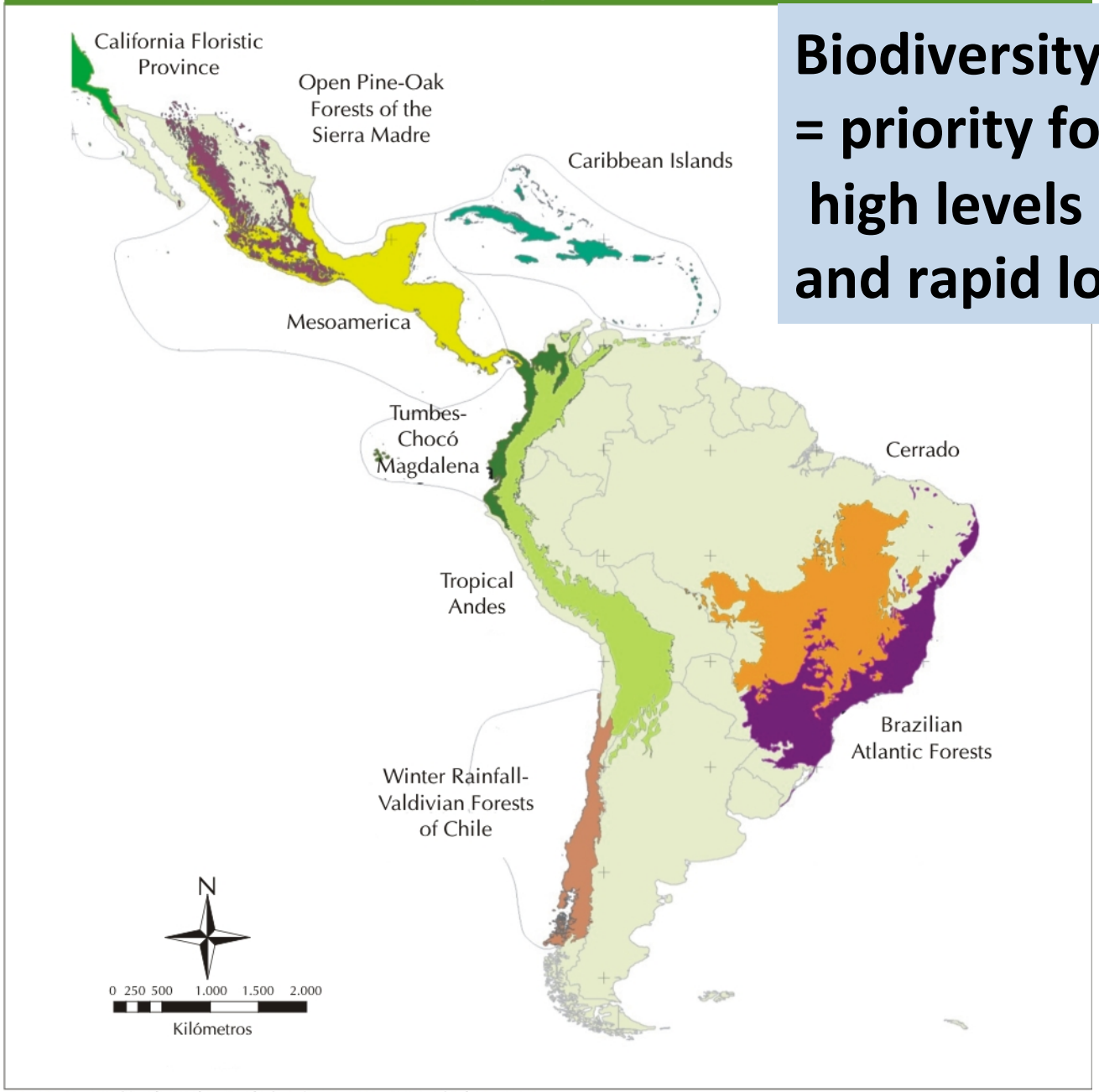
- The downside of this development:
  - rapid and intense loss of natural habitats due to biomass burning and land conversion, especially in its tropical zone,
  - coupled with a persistent and pervasive social inequality, particularly in urban areas.

% Remaining Foresta Area in Latin America



MAP 2.7

Latin America and the Caribben: Biodiversity *Hotspots*



Biodiversity hotspots in LA = priority for conservation high levels of endemisms and rapid loss of habitats

Source: Prepared by the authors with data from Mittermeier and others, 2004.

Changes in N fluxes

- Two particular aspects of the development in Latin America are resulting in substantial changes of N fluxes both in anthropogenic and natural environments:

1. Land use changes and intensification of agricultural activities

2. Remarkable urbanization pace with the expansion of megacities

Land use changes...

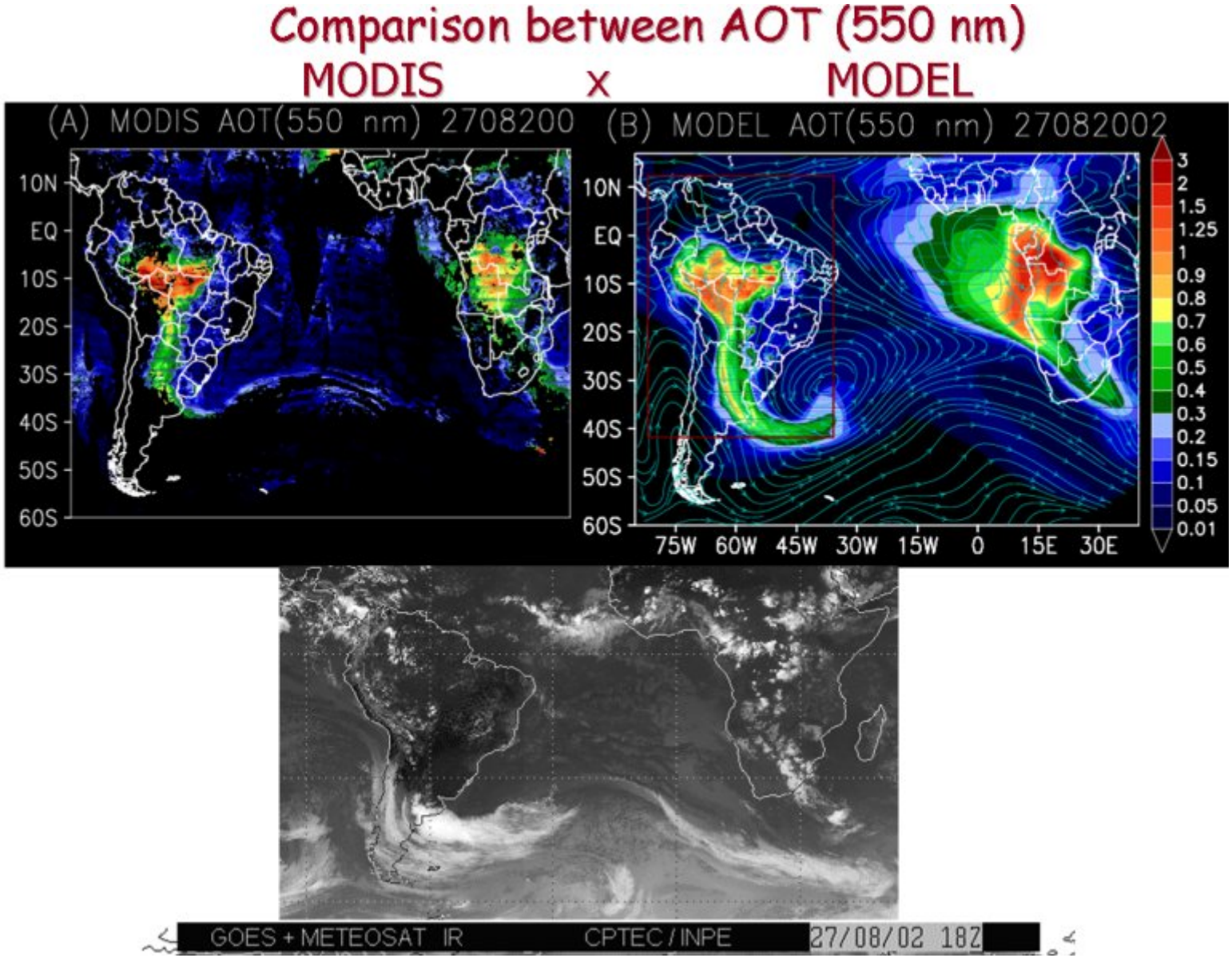
- Conversion of tropical forests = decreases natural nitrogen stocks (these ecosystems present highest rates of biological nitrogen fixation).

- Long-distance transfer of N through biomass burning

Fires in South America

- Rapid land use changes = changes in natural fire regime (season and frequency of burning)
- Between 5% and 9% of the global burned areas occurs in South America
- Brazil concentrates 63% of the total fires, followed by Argentina with 21%
- ~70% of burned areas in Brazil occurs in the Cerrado (savannas of Central Brazil)

Transboundary air pollution



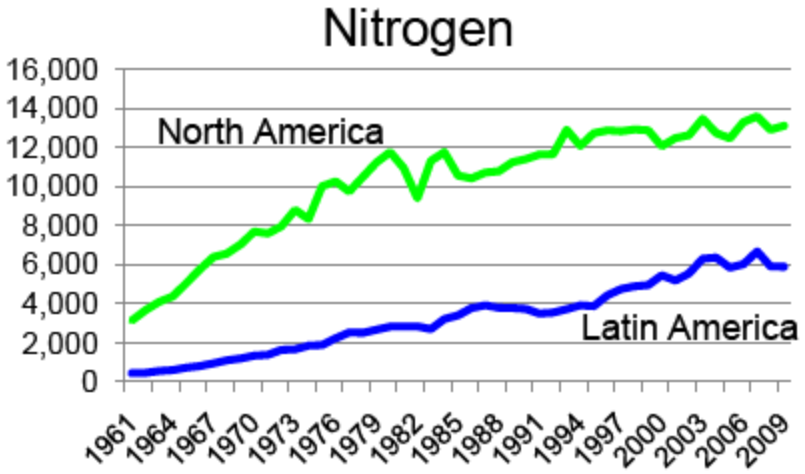
Besides N transfer....source of black carbon

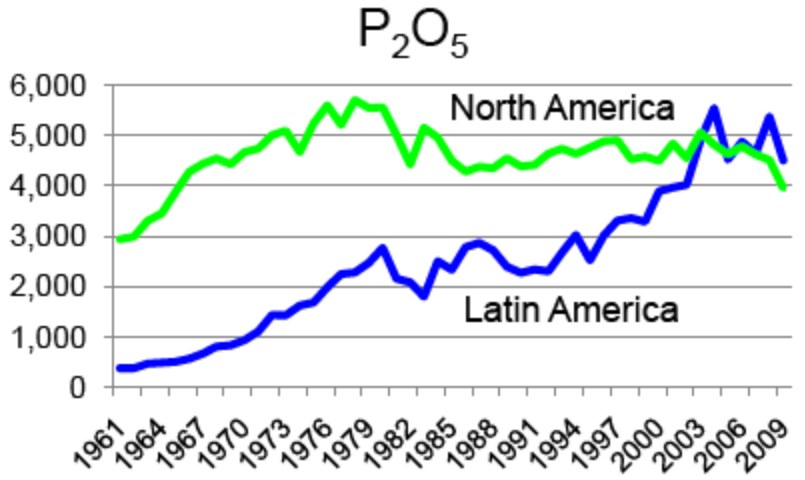
- Black carbon emissions = regional “hotspots”
- The largest sources of black carbon are Asia, Latin America, and Africa.
- 42% open biomass burning (forest and savanna burning)

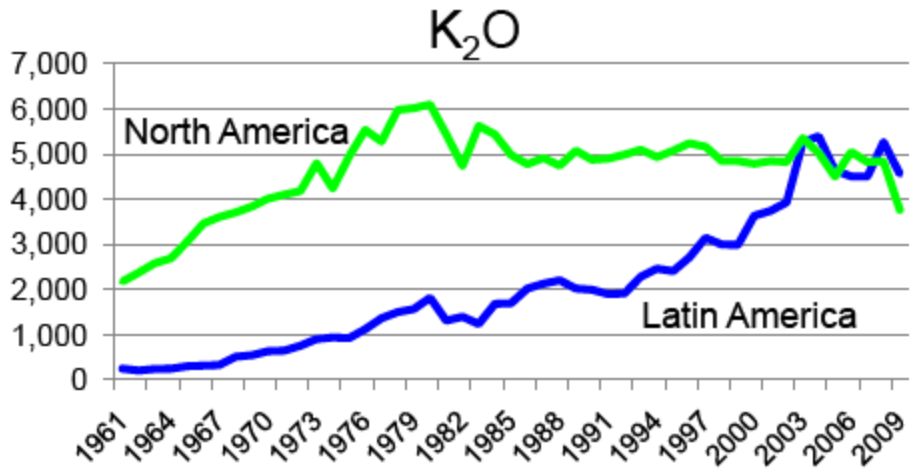
Fertilizers and Land use changes...

- At the same time, the use of N-fertilizers in agricultural areas in LA has reached an unprecedented rate, in absolute amount (kg) as well as the intensity of use (kg/ha).

NPK Consumption
North America x Latin America







Source: http://www.fertilizer.org/ifa/Home-Page/STATISTICS; Heffer, P. 2009. Medium-Term Outlook for World Agriculture and Fertilizer Demand 2008/09-2013/14. 77th IFA Annual Conference, 25-27 May 2009, Shanghai, China

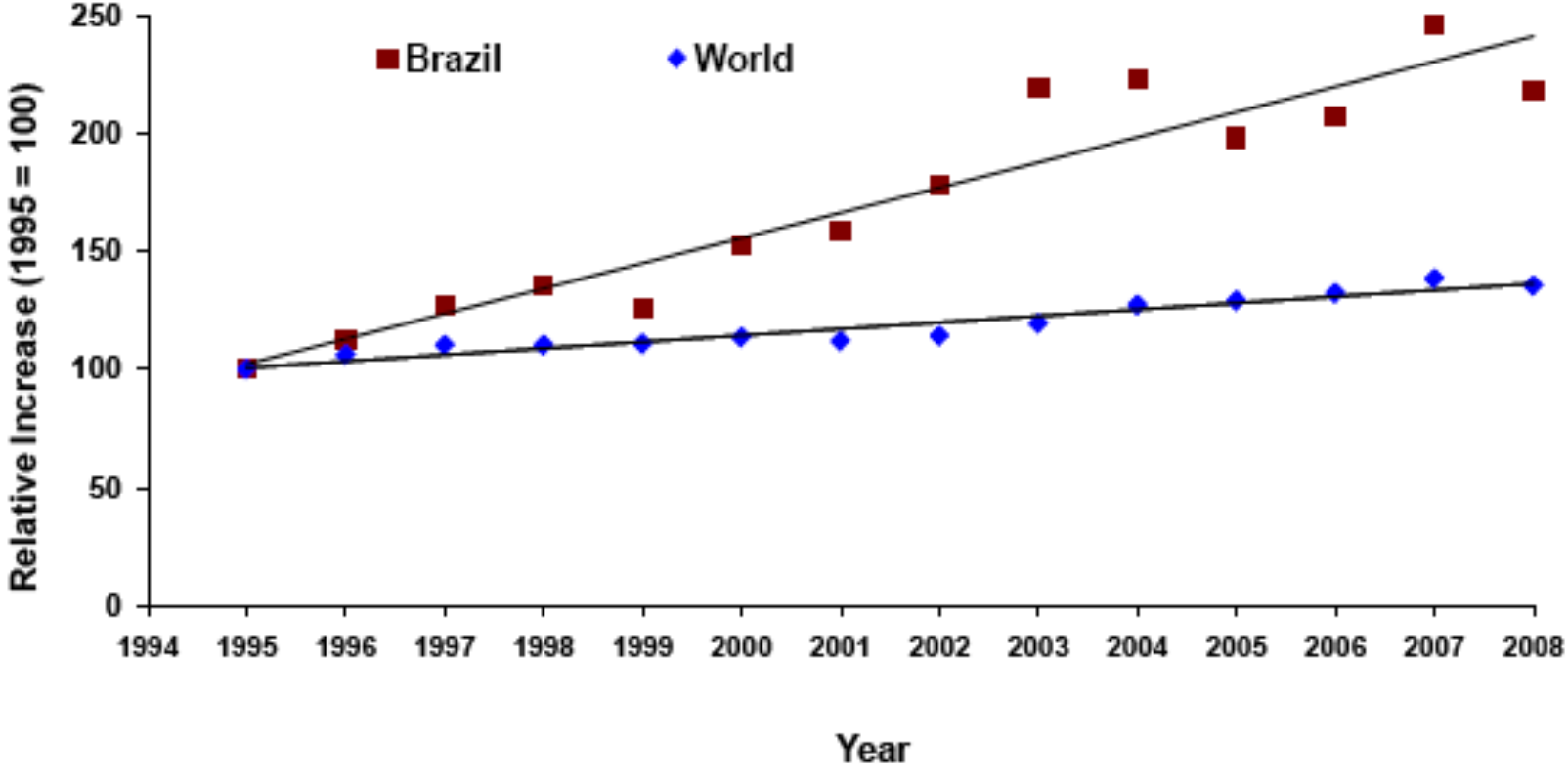
IPNI

Regional asymmetries

- The **use of nitrogen fertilizers is uneven** among different Latin American countries due to economic and social factors

- Argentina consumes 60% of the fertilizer in the Southern Cone Countries
- Brazil: maize, soybean and sugar cane= use 56% of the N, 71% of the P_2O_5 and 75% of the K_2O
- USA: wheat, maize, soybean = use 63% of the N, 58% of the P_2O_5 and 66% of the K_2O

Relative Increase in Fertilizer Use (1995-2008)



Source: ANDA / IFA

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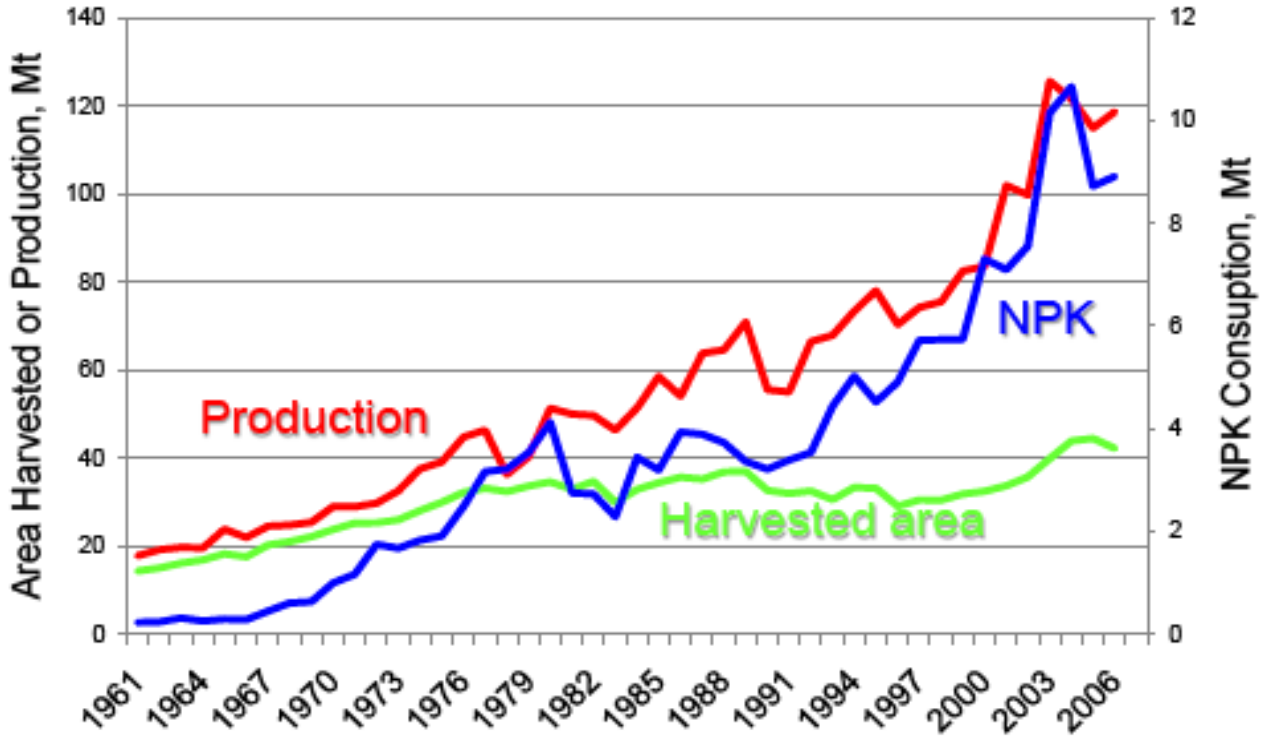
Intensification of agriculture

- **Almost 10% of the world´s crops are harvested in Latin America.**
- Irrigation is used on 12.5% of the arable land.
- Yield improvement accounts for 75% and increase in area for 25% of the total gain in production.
- **Latin America is a net exporter of meat with a projection that exports will grow in the next years.**

Trend to intensification

Brazil: Cereal and oilseeds production, area harvested, and fertilizer consumption, Mt



Source: http://faostat.fao.org/ and http://www.fertilizer.org/ifa/Home-Page/STATISTICS

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Consequences

1. Large amounts of N are being exported from **LA as it has become a net exporter of food, fiber and bioenergy for the rest of the world**.
2. In some parts of the continent, as in subtropical grasslands, agricultural development is leading to **depletion of natural stocks of N.**
3. Conversely, in other regions, excess of **N is exported to pristine ecosystems.**

Changes in N fluxes

- Two particular aspects of the development in Latin America are resulting in substantial changes of N fluxes both in anthropogenic and natural environments:

1. Land use changes and intensification of agricultural activities

2. Remarkable urbanization pace with the expansion of megacities

Urbanization in Latin America

During the last 50 years the process of urbanization in Latin America has been remarkable:

- Population living in urban areas:
- 1950 - < 41%
- Presently - ~ 75%
- Faster urbanization in Latin America than in Northern America and Europe.

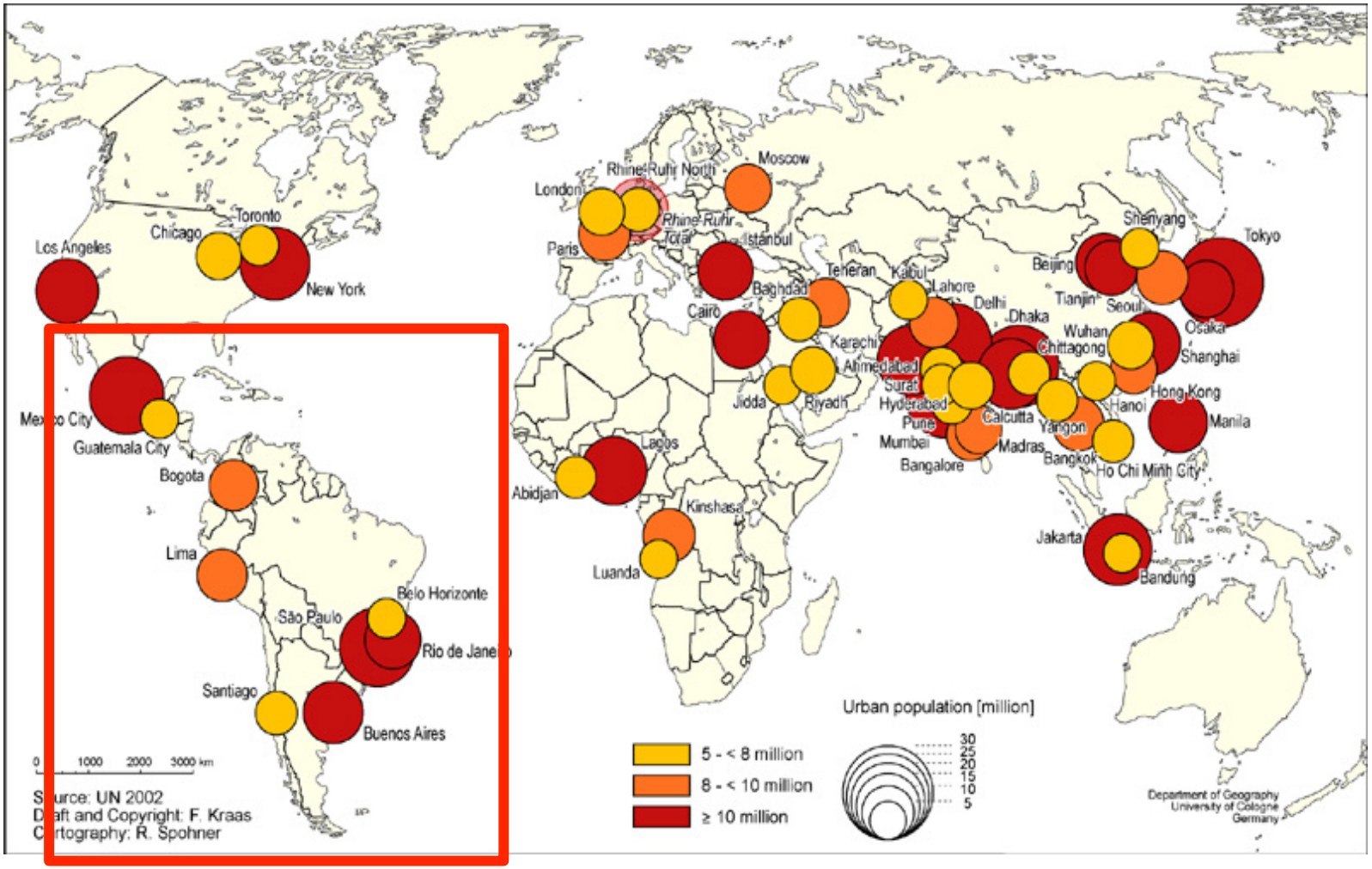
Despite the rapid growth in urbanization in Asian and African countries:

their % of people living in urban areas is still half of that for Latin America.

Latin American Megacities

- Urban systems in Latin America are characterized for their gigantic cities.
- For the year 2000, the region concentrates three of the largest cities in the world (São Paulo, Mexico City and Buenos Aires)
- Even though it concentrates only 13.7% of worldwide urban population.

Megacities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Wuhan
Shanghai
Chittagong
Dhaka
Delhi
Lahore
Kabul
Teheran
Baghdad
Cairo
Karachi
Ahmedabad
Surat
Hyderabad
Pune
Mumbai
Bangalore
Calcutta
Madras
Yangon
Bangkok
Hanoi
Hong Kong
Manila
Ho Chi Minh City
Jakarta
Bandung
Jidda
Riyadh
Lagos
Abidjan
Kinshasa
Luanda
Guatemala City
Bogota
Lima
Belo Horizonte
São Paulo
Rio de Janeiro
Santiago
Buenos Aires
0 1000 2000 3000 km
Source: UN 2002
Draft and Copyright: F. Kraas
Cartography: R. Spohner
Urban population [million]
5 - < 8 million
8 - < 10 million
≥ 10 million
30
25
20
15
10
5
Department of Geography
University of Cologne
Germany

Wastewater

- Urban population of Latin America = approximately $340x10^6$ persons connected to sewers, generates $52x10^6 m^3$/day of wastewater (WHO/UNICEF,2000).

- **Only 6% of this wastewater receives secondary treatment** before being discharged into surface waters or reused directly in agriculture or aquaculture .

Wastewater x future water supply

- Latin America and the Caribbean holds:
- > 30 % of all the planet's available freshwater
- ~ 40% of its total renewable water resources.

- At the same time, the effects of climate change are causing drought throughout the region = concerns about water resources.

- **There is a need to reduce pollution levels in rivers, lakes and along the coasts.**

Air pollution

- In addition to water pollution, **air pollution in urban centers creates high costs for society**.

Studies in Colombia, Peru, Guatemala, and El Salvador - cost of outdoor air pollution is ~ 1% of national GDP.

Pan American Health Organization - > 100 million people in Latin American cities are exposed to levels of air pollution that exceed the recommended standards.

Latin America and N cycle

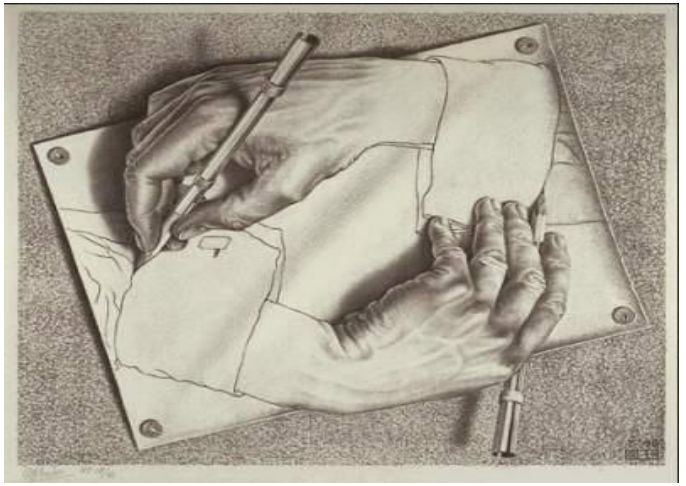
In spite of these critical issues, empirical measurements of N deposition or processes are extremely scarce:

Data feeding to **global and regional circulation models lack spatial distribution information** in this region.

Difficulties to evaluate and project **how human activity is altering nitrogen pools and turnover at regional and global scales**.

What is needed...

1. To establish a **research agenda** emphasizing the complex, and coupled, **socio-ecological dimensions of N cycle** alterations.
2. To identify and produce **detailed spatial information** regarding the production and the fate of Nr to formulate **regionally appropriate policies.**



Latin America is now at a crossroads

- Production of the major agricultural commodities, reasonable and planned urbanization

Conservation of its natural ecosystems and associated goods and services.

Concluding remarks

- The health of the inhabitants and the ecosystems of this region will be determined by the path taken in the coming years.

Social equality is a key component in order to achieve the equilibrium of economic progress, sustainability and conservation.