



Public Works Research Institute



INTERNATIONAL WORKSHOP ON

WATER HAZARD AND RISK MANAGEMENT

***SOME EXPERIENCES OF
FLOOD MANAGEMENT IN ARGENTINA***

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ARGENTINA GEOGRAPHICAL LOCATION



GEOGRAPHICAL AND CLIMATIC CHARACTERISTICS



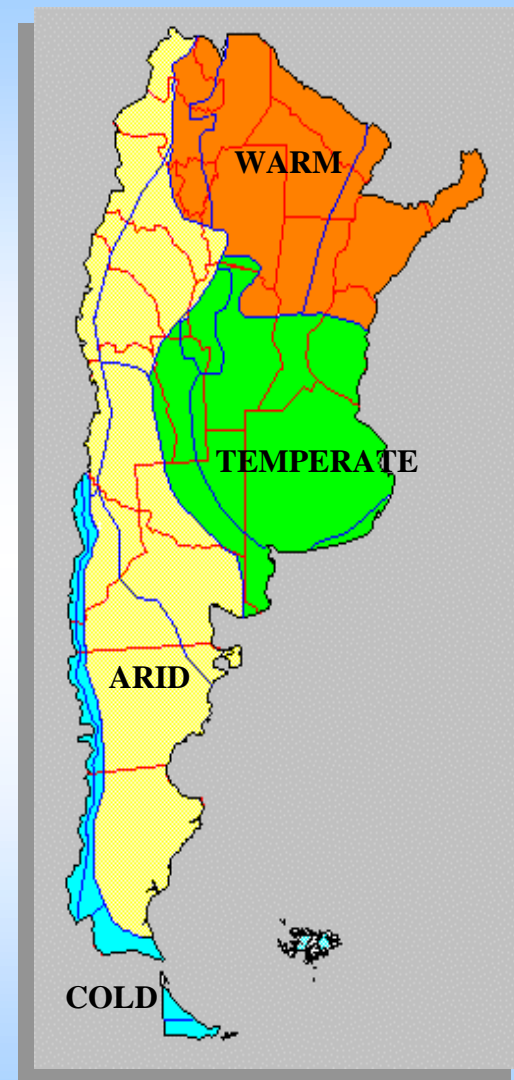
NOAA IMAGE



1500 Km

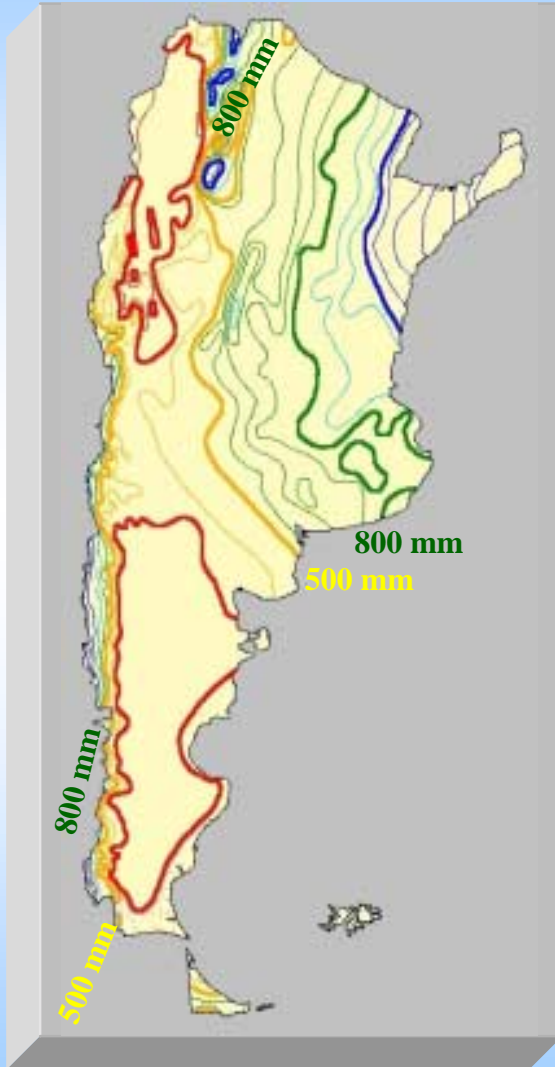
ALTITUDES

3700 Km

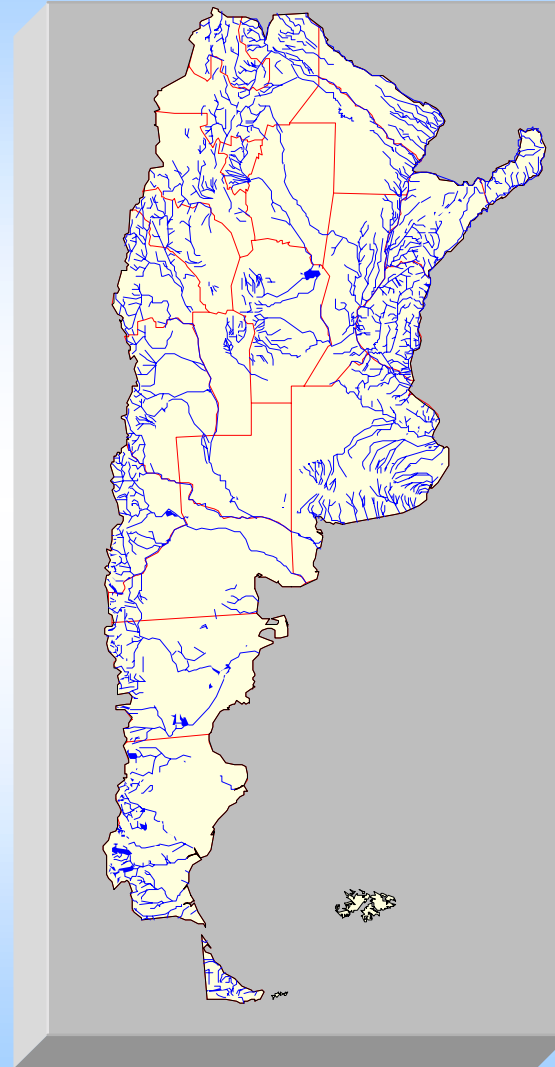


CLIMATES

HYDROLOGICAL CHARACTERISTICS

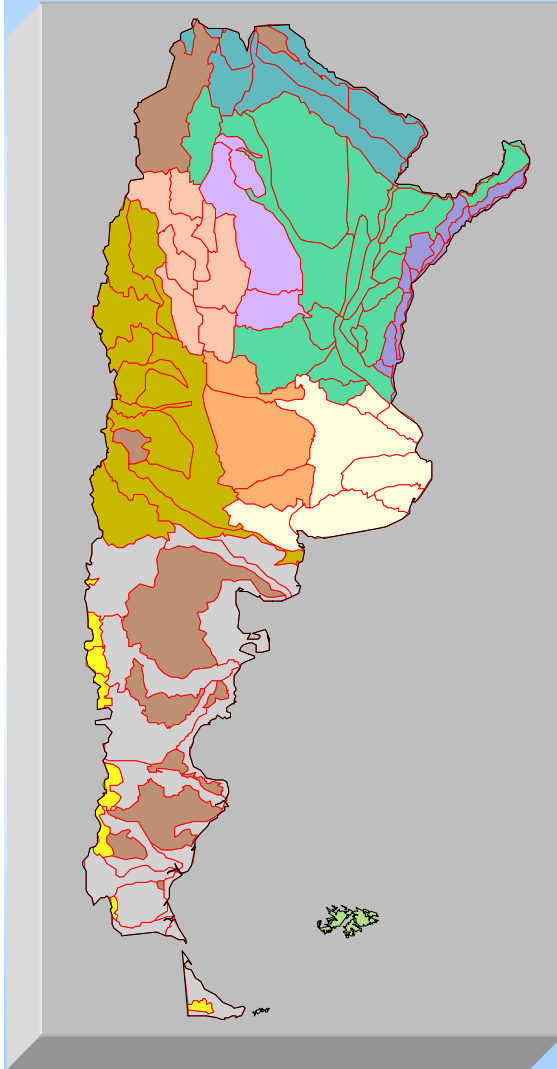


PRECIPITATION



RIVER NETWORK

SURFACE WATER AVAILABILITY

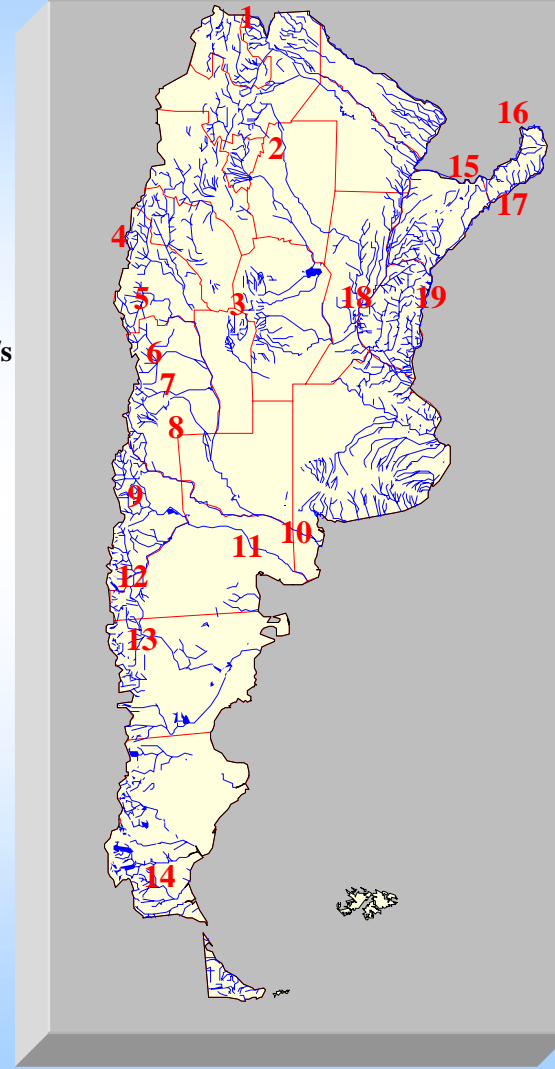


Mean Annual Flow $\approx 26.000 \text{ m}^3/\text{s}$

Spatial Distribution

Del Plata Basin	84%
Atlantic Watersheds	10%
Pacific Watersheds	5%
Endorheic Basins	1%

RIVER BASINS

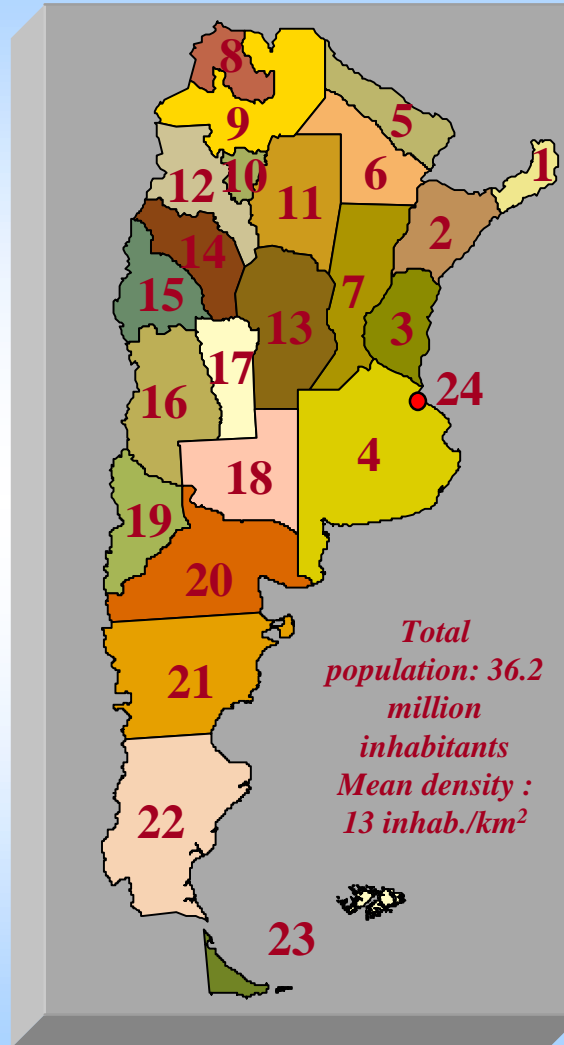


Mean annual flow (m^3/s)

1. Río Bermejo	320
2. Río Juramento	15
3. Río Tercero	30
4. Río Jachal	10
5. Río San Juan	60
6. Río Tunuyán	30
7. Río Diamante	35
8. Río Atuel	35
9. Río Neuquén	300
10. Río Colorado	130
11. Río Negro	1000
12. Río Limay	700
13. Río Chubut	50
14. Río Santa Cruz	700
15. Río Paraná	11800
16. Río Iguazú	920
17. Río Uruguay	2300
18. Río Paraná	16000
19. Río Uruguay	4700

RIVER NETWORK

POPULATION



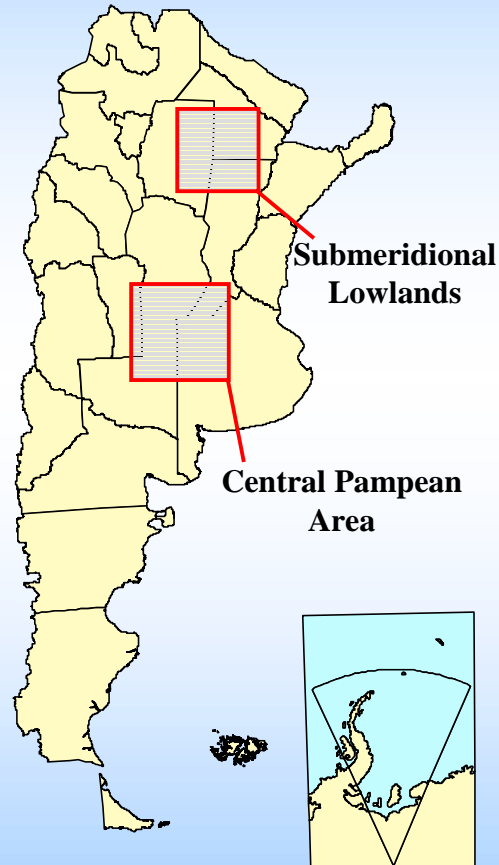
- 1- Misiones
- 2- Corrientes
- 3- Entre Ríos
- 4- Buenos Aires
- 5- Formosa
- 6- Chaco
- 7- Santa Fe
- 8- Jujuy
- 9- Salta
- 10- Tucumán
- 11- Santiago del Estero
- 12- Catamarca
- 13- Córdoba
- 14- La Rioja
- 15- San Juan
- 16- Mendoza
- 17- San Luis
- 18- La Pampa
- 19- Neuquén
- 20- Río Negro
- 21- Chubut
- 22- Santa Cruz
- 23- Tierra del Fuego,
Antártida e Islas del
Atlántico Sur
- 24- Ciudad Autónoma de
Buenos Aires

Total
population: 36.2
million
inhabitants
Mean density :
13 inhab./km²

POLITICAL DIVISION

FLATLANDS FLOODING (1)

Flatlands Areas



- Very low slope. Landscape with low energy for water runoff.
- Lack of defined basin limits.
- Lack of organized drainage structure and defined waterways,

consequently:

- Strong predominance of vertical variables (infiltration, evaporation) over horizontal variables (runoff).
- Excess rainfall stored in shallow surface areas and drainage generated on accumulation of water and creation of hydraulic gradient.

FLATLANDS FLOODING (2)

Socio - economic aspects

- Low population density.
- Extensive agriculture and cattle raising.
- Low development of an ordered network of canals.
- Unplanned use of space.
- Deficient roads network.

Anthropological actions

- Inadequate agricultural actions.
- Unplanned canals transfer damages downstream.

FLATLANDS FLOODING (3)

Political - institutional aspects

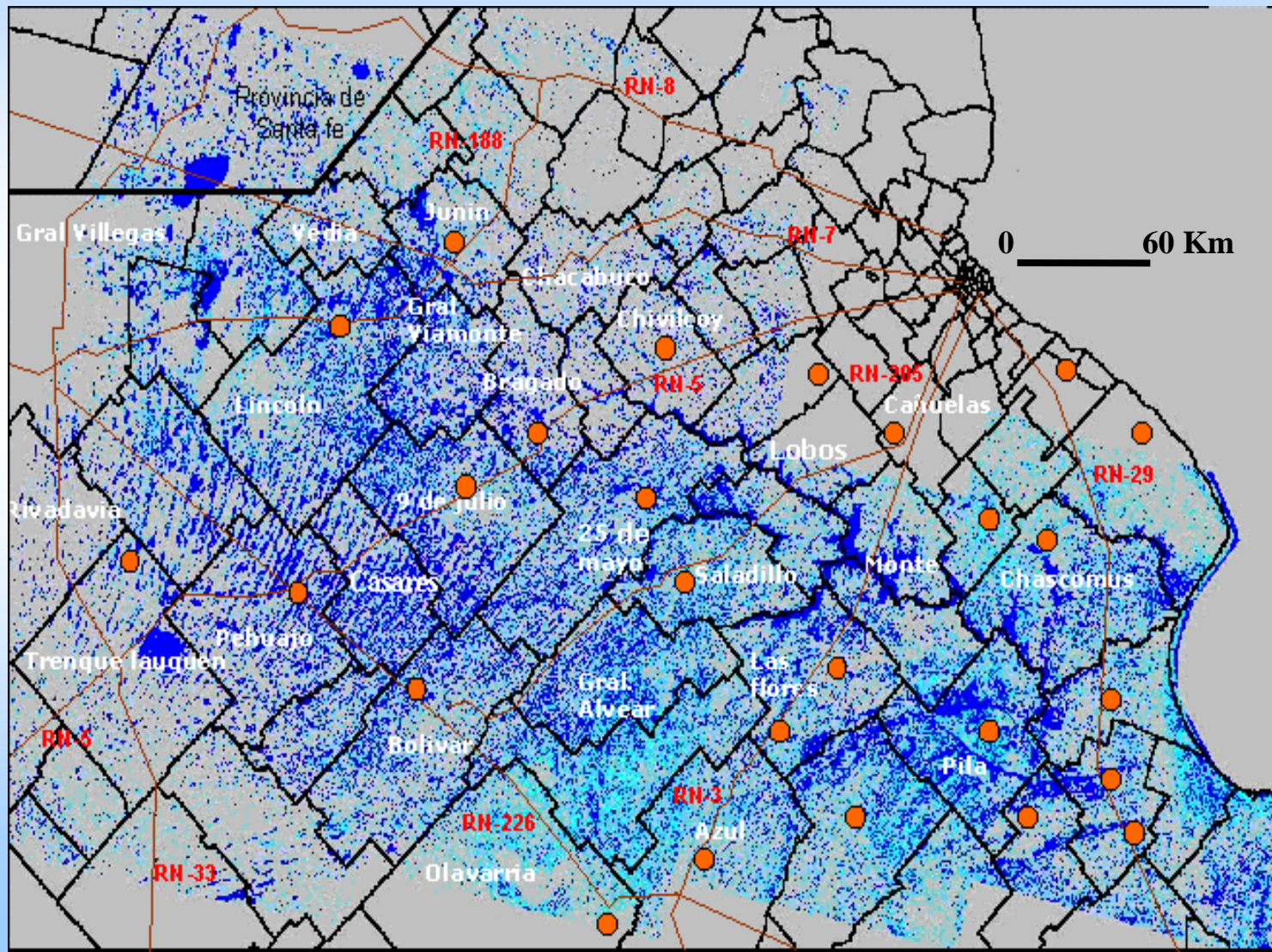
Argentina has a federal organization.

National Constitution mandates that the provinces are the owners of natural resources and, therefore, they do the planning and management of their water resources.

- Lack of a long – term active policy for flood management.
- Each province works in finding its own solution.
- Absence of planning for the whole hydrological system as a single system.

FLATLANDS FLOODING (4)

Central Pampean Area



FLATLANDS FLOODING (5)

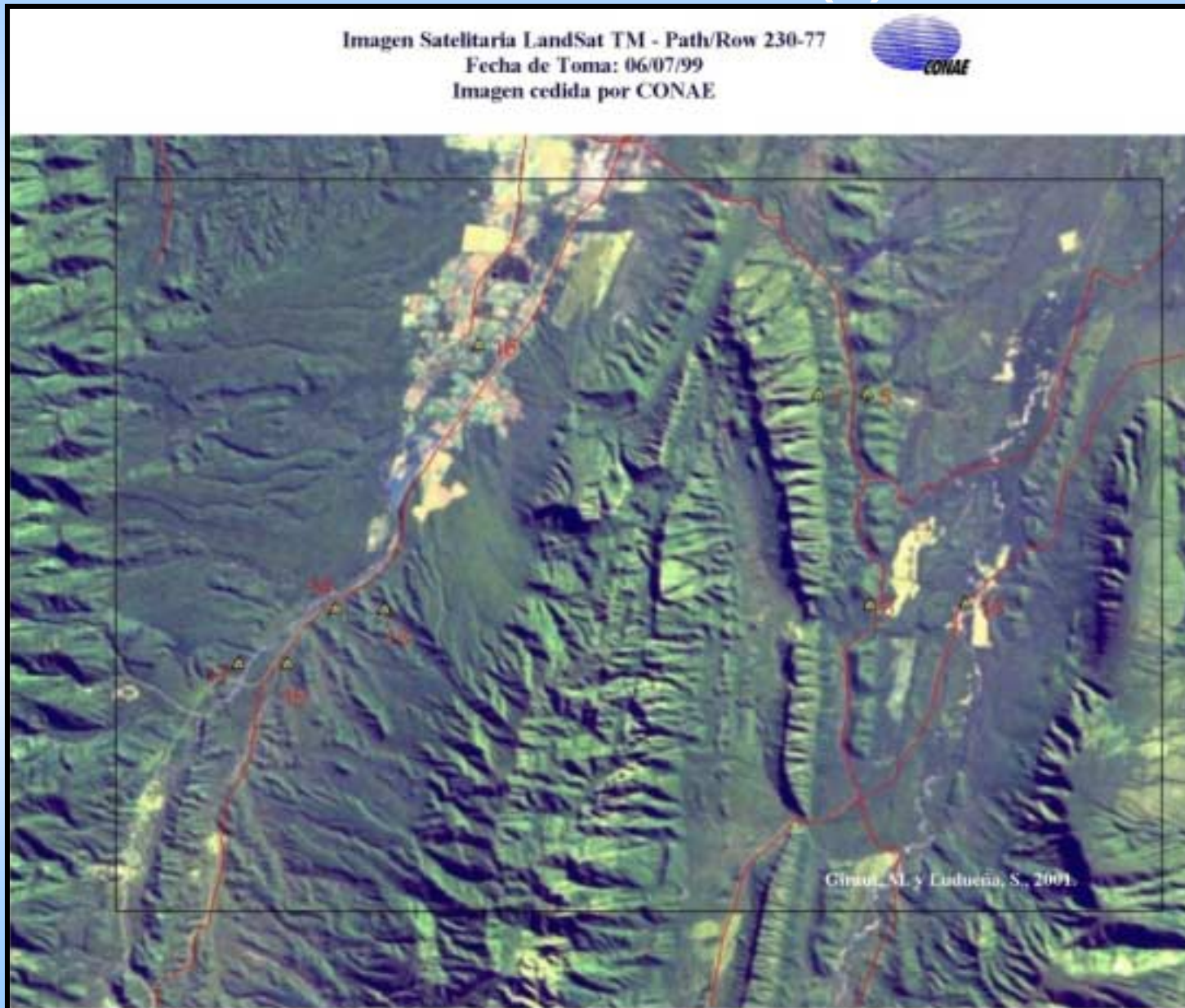


FLASH FLOODS (1)

North - Western Areas

- Generally arid or semi – arid regions
- Intense rainfall
- Snowmelt
- Geomorphological characteristics:
 - Steep slopes
 - Fragile soil structure → significant erosion
- Flash floods and mud/rock – slides
- Great damages to urban and transport (road, railways, bridges) infrastructure
- Environmental impact
- Human losses !!

FLASH FLOODS (2)



FLASH FLOODS (3)

Imagen Satelitaria LandSat ETM - Path /Row 230-77

Fecha de Toma: 14/04/01

Imagen cedida por CONAE



Girault, M. y Ludueña, S., 2001.

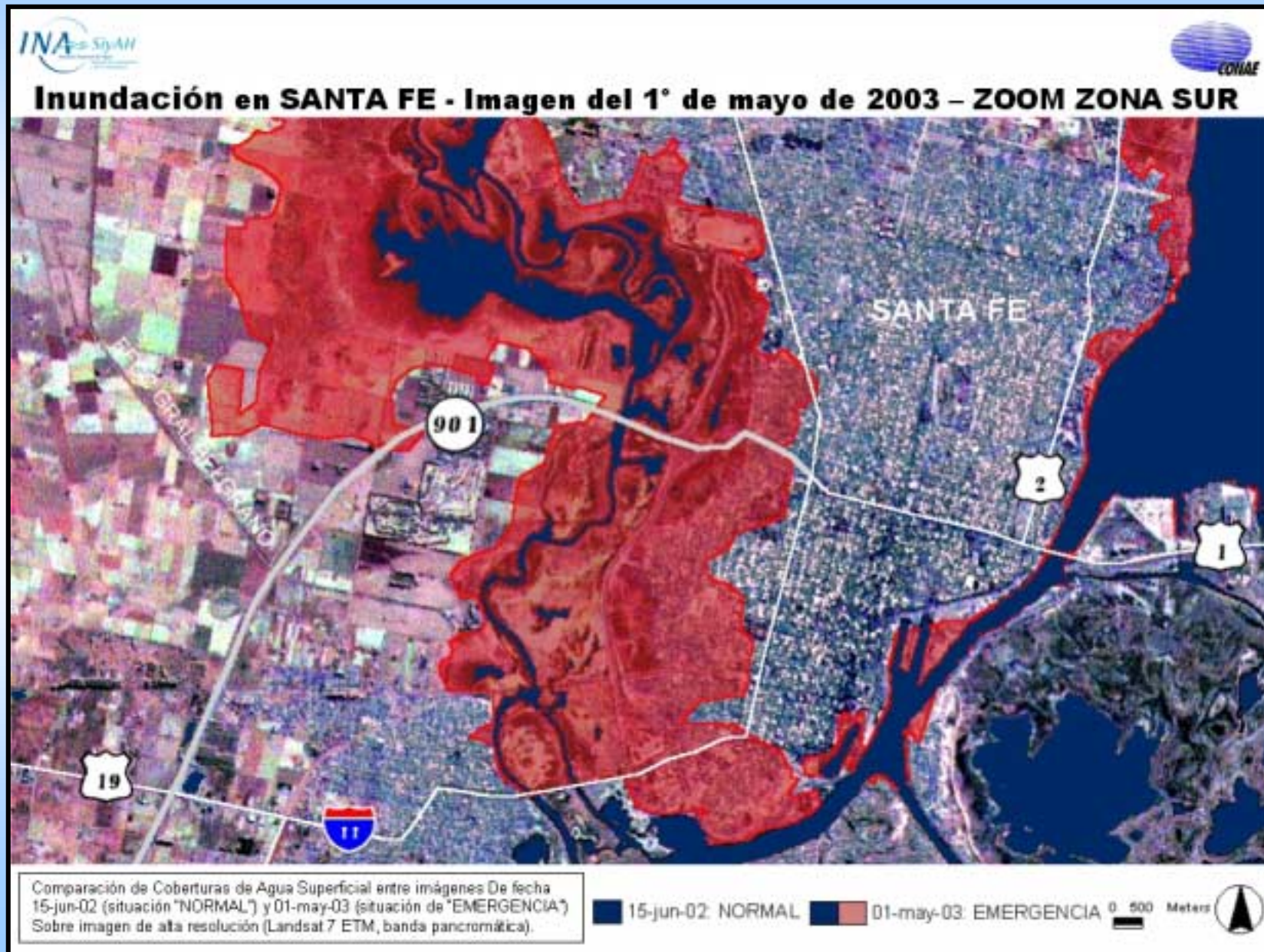
URBAN FLOODING (1)

- Recurring flooding of highly urbanized, metropolitan areas throughout Argentina.
- Flood damages exacerbated by high – density urbanization (69% of population resides in urban centers larger than 50,000 inhabitants).
- Majority of urban centers located on flood – prone low lands or large river flood plains.

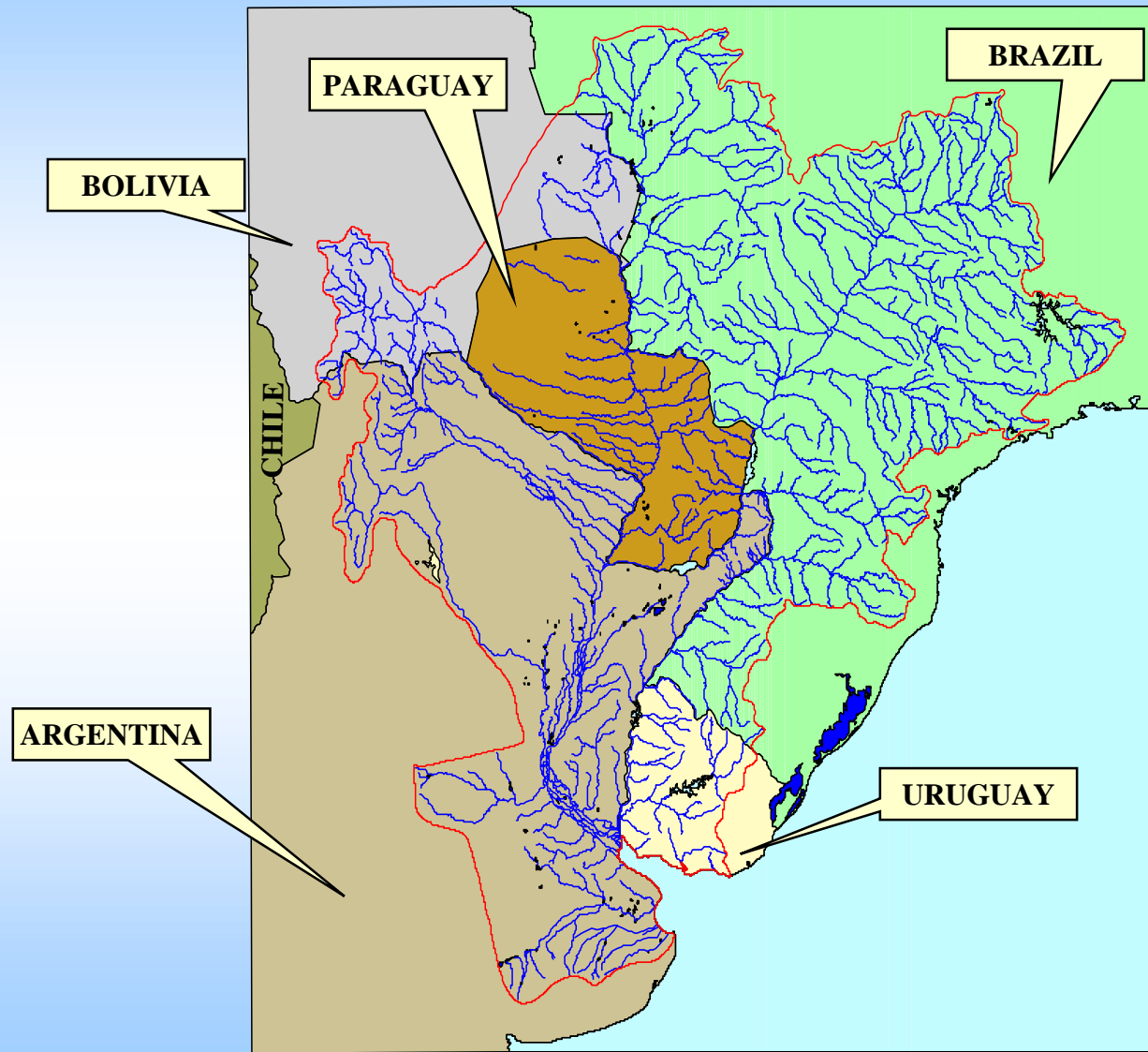
URBAN FLOODING (2)

- Urbanization reduces natural drainage through “impermeabilization”, thus increasing peak flows.
- Lack of urban planning regulation or its enforcement has led to uncontrolled settlement of predominantly low – income dwellers in flood – prone locations.
- Under – funding and deterioration drainage infrastructure.
- Obsolete stormwater drainage practices.
- Severe lack of technical information and standards.
- Financial policy for cost recovery of drainage management, operation and management is needed.
- Problems for solid waste collection, inadequate disposal practices and uncontrolled dumping .

URBAN FLOODING (3)



LARGE RIVERS FLOODS (1)



LA PLATA RIVER BASIN

LARGE RIVERS FLOODS (2)

Paraná – Paraguay River Basin (2.6 million km²)

- Wide range of natural resources.
- The most developed agricultural and industrial zones on South America.
- Some of the largest hydroelectric dams in Latin America.
- Extensive riverine and terrestrial transportation network.
- Generates about 89% of GDP of countries.
- Population: 100 million people.
- More than 1/3 of Argentina (79% of its inhabitants).

LARGE RIVERS FLOODS (3)

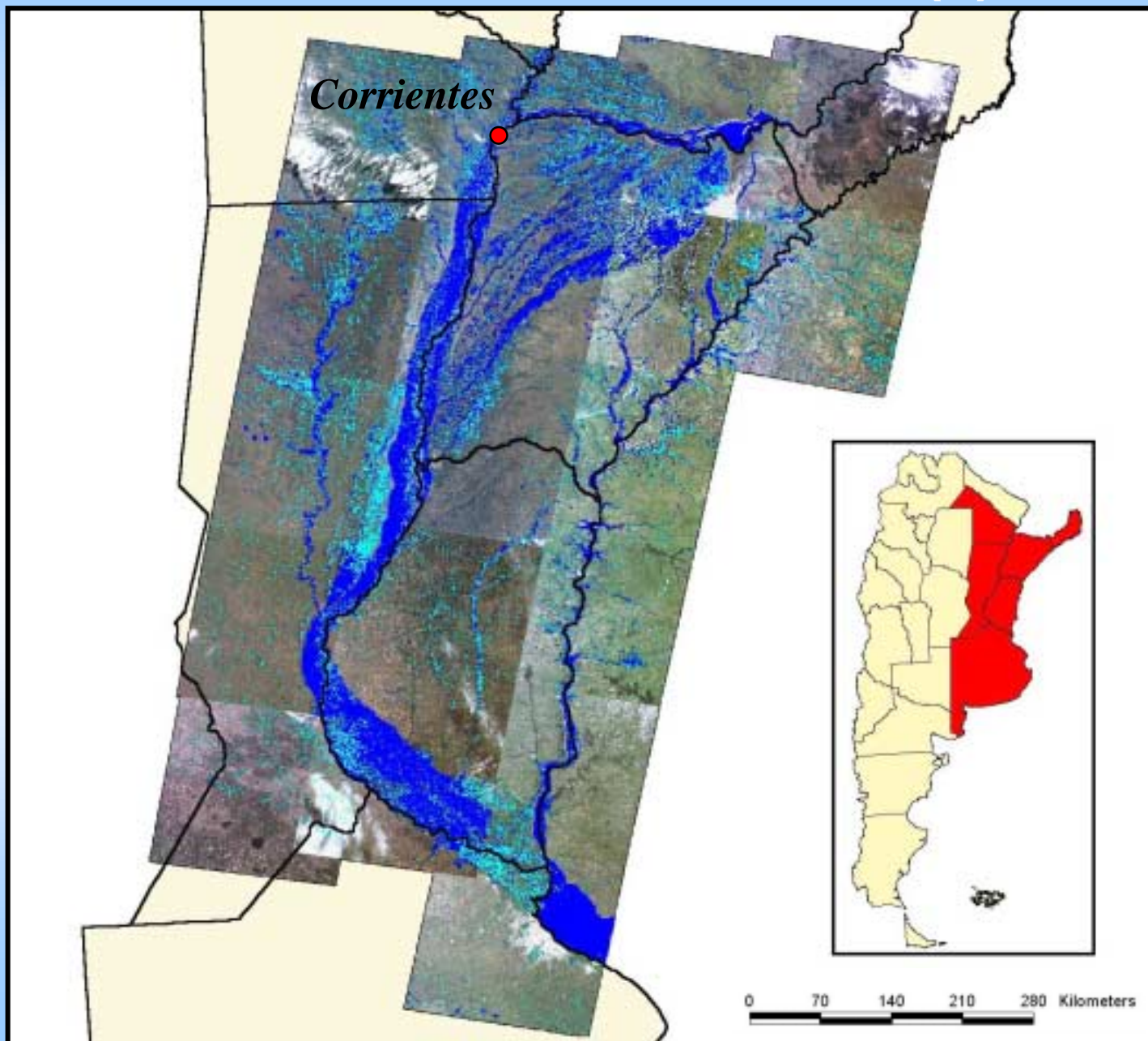
Paraná River Basin

- Paraná river flood plain width:
 - 13 km after confluence with Paraguay river
 - 56 km between Rosario and Victoria cities
 - 60 km Paraná Delta
- Precipitation almost throughout the year (mean annual 200 mm in the western Andes mountain range; 2,000 mm in southeastern Iguazú basin)
- High river flows begin in October/November and peak between February and June/July
- Floods in two of every three years at the city of Corrientes

LARGE RIVERS FLOODS (4)

- Substantial changes in the region's climate:
 - Extra – regional influence
 - Global warming
- 5 of the most severe floods since 1982
- Most notable events between November, 1982 and July, 1983 (peaks exceeded 50,000 m³/s)
- 85,000 houses and buildings damaged
- 3.6 million ha inundated
- Economic costs U\$S 1.8 billion

LARGE RIVERS FLOODS (5)



FLOOD MANAGEMENT EXAMPLE (1)

1- Relief rescue operations

- Evacuation of affected population
- Provision of shelter, food and blankets
- Fortification of river defenses
- Shoring up of dikes and other embankments

2- Flood Emergency Rehabilitation Project, in order to restore normal economic activity

- Rehabilitation of essential infrastructure (transport, energy, flood defenses, education and health, housing, water supply and sewerage)

FLOOD MANAGEMENT EXAMPLE (2)

3- New strategy to cope with flooding:

- Improved coordination of flood – related actions within and among the provinces
- “Structural measures” (long – term investments in defending most important assets, replacing present “emergency reactions”)
- “Nonstructural measures” (combination of actions for “living – with – floods”, including flood warning and civil defense measures in lesser priority areas)
- Classification of areas by flood risk
- Master Plan for flood – zone areas in each province (definition of defense works and areas of expansion)

FLOOD MANAGEMENT EXAMPLE (3)

Structural Measures

- Fortification of flood defenses in areas with strong economic and greatest vulnerability
- Raising of bridges, improving of existing and construction of new drainage channels, embankments and pumping systems
- Construction of a network of shelters, equipped with emergency supplies, in areas without defense works
- Improvement of housing conditions

FLOOD MANAGEMENT EXAMPLE (4)

Nonstructural Measures (“living – with – floods” strategy)

- Adaptation to floods of resident of rural areas and small communities
- Capture of their benefits (rich silt deposits, topsoil nutrients, nutrients for fish development, recharge of aquifers, seeding of sandbars)
- Early Flood Warning System: New data collection, computational equipments and communication systems
- National flood protection law. Comprehensive local rules concerning land and water use and related environmental matters. Land use restrictions
- Classification of areas according to vulnerability to flood risk. Private flood insurance

*“Nature is blamed for failings that are Man’s,
and well – run rivers have to change their plans”*

**(from the poem “Water” by Sir Alan P. Herbert,
included in the book “Floods”, by Roy Ward, 1978)**