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# **Flood Management in South America**

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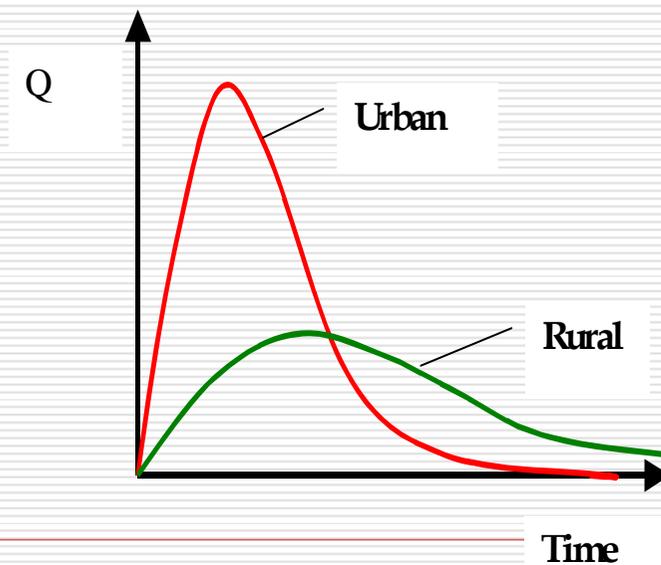
# Urbanization

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- High rate of urbanization increase in developing countries, mainly in Latin America where most of the countries are above 75% of Urban population.
  - High Population increase rate in the city limits;
  - Increase on the impervious areas and flow canalizations inside cities limits
  - Unregulated occupation by low income population in risk areas such: hill slopes and flood plains;
  - In January of 2004 in Brazil died 84 persons due to flood events.
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# Types of floods

- **Flood plain** are the natural floods in which the impacts are mainly due to the lack of the control of occupation of risk areas;
- **urban drainage floods** are mainly due to the increase of the peak and overland flow after the increase of the impermeable areas and flow velocity on the sewers.



# Flood Plains impacts

- population moves to flood plains after some years of low floods.
- When comes a high level flood the damage cost are high and created an economical problem;
- hill slope occupation
- flood plain risk areas occupation
- mainly by low income population



Normal  
Flow

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União da  
Vitória

1983 Flood

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# Main Causes

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- ❑ lack of land use regulation and enforcement;
- ❑ lack of prevention measures;
- ❑ indirect incentives: cities receives funds without repayment after a flood and do not need bidding to spend it
- ❑ bad management



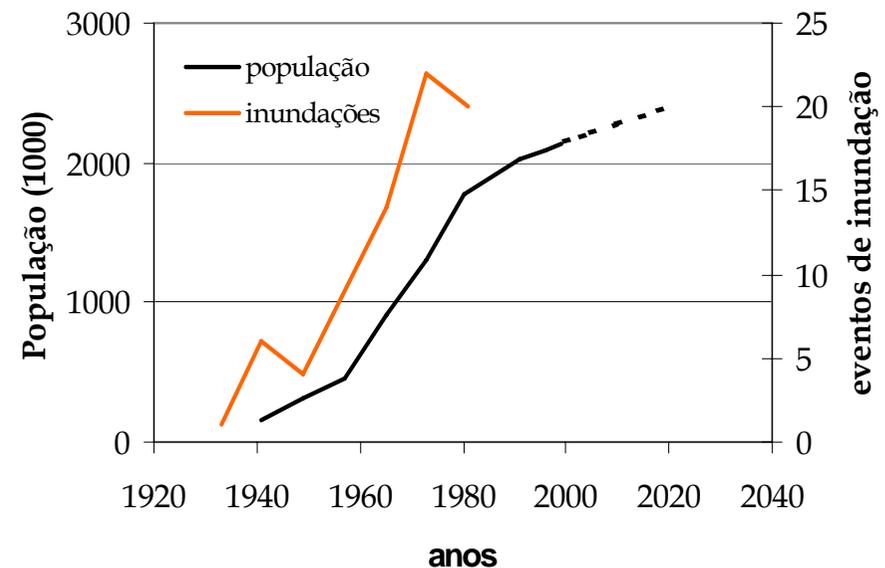
Santa Fé – Argentina

Floods inside the diques  
due to upstream  
entrance

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# Urban Drainage Floods

- Mainly due the increase of the impervious area and decreasing of concentration time by conduits and channels.
- Latin American urbanization was very high after 1970. For instance, Brazil increases its urban population from 55,9% (1970) to 82% (2000) in 30 years

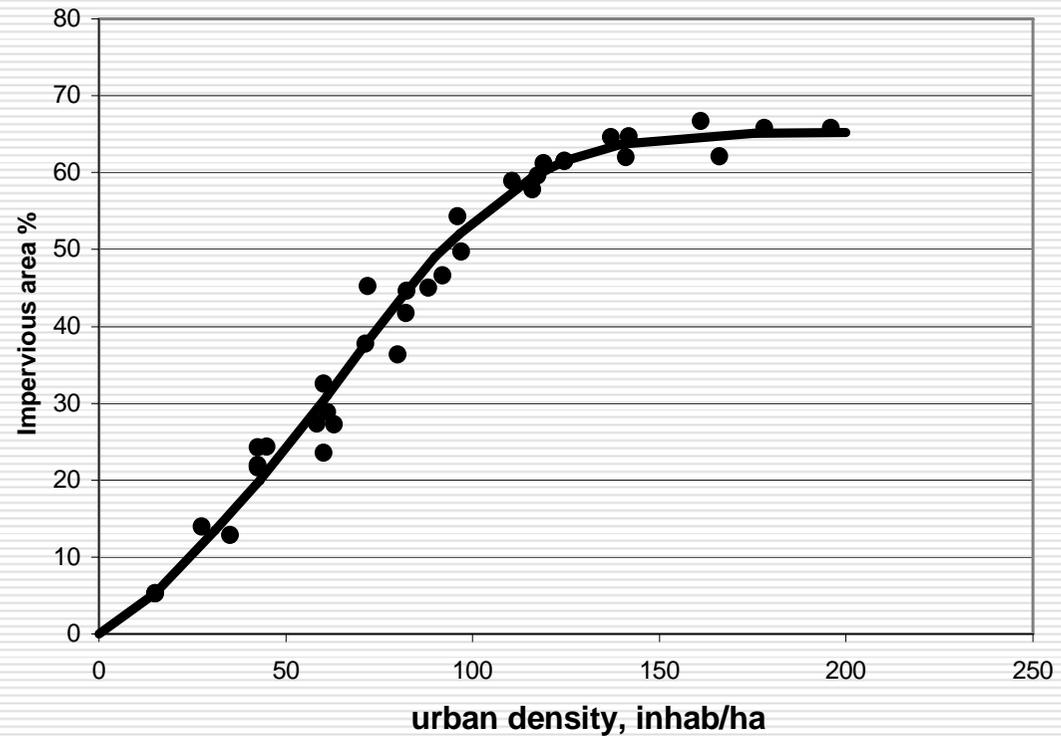


Belo Horizonte – population and flood increase

# Population increase and its relationship to impervious areas

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□ Curve obtained based on data from Curitiba, São Paulo and Porto Alegre, three major cities of Brazil





# Total Solids and obstructions

- ❑ Obstructions
- ❑ Garbage
- ❑ Lack of maintenance
- ❑ Bad design

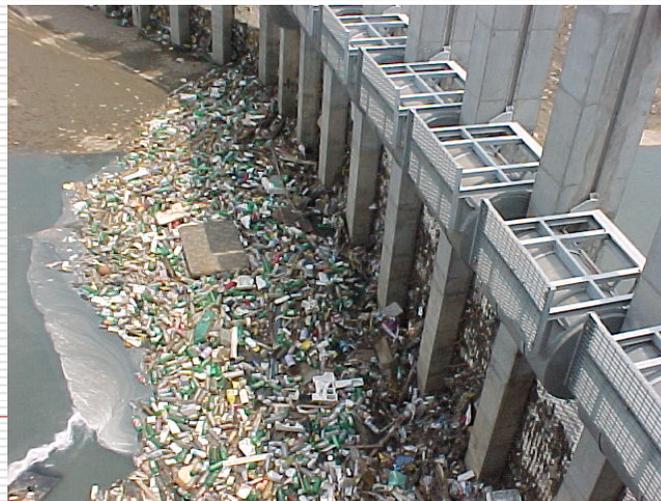
PORTO ALEGRE



BELO HORIZONTE



SÃO PAULO



# Erosion and Total Solids

- Stage 1 : increasing the city and high production of sediments;
- Stage 2 : Transition from sediments to garbage ;
- Stage 3: when the city is already constructed reducing the sediment and increasing the garbage.



# Urban Erosion

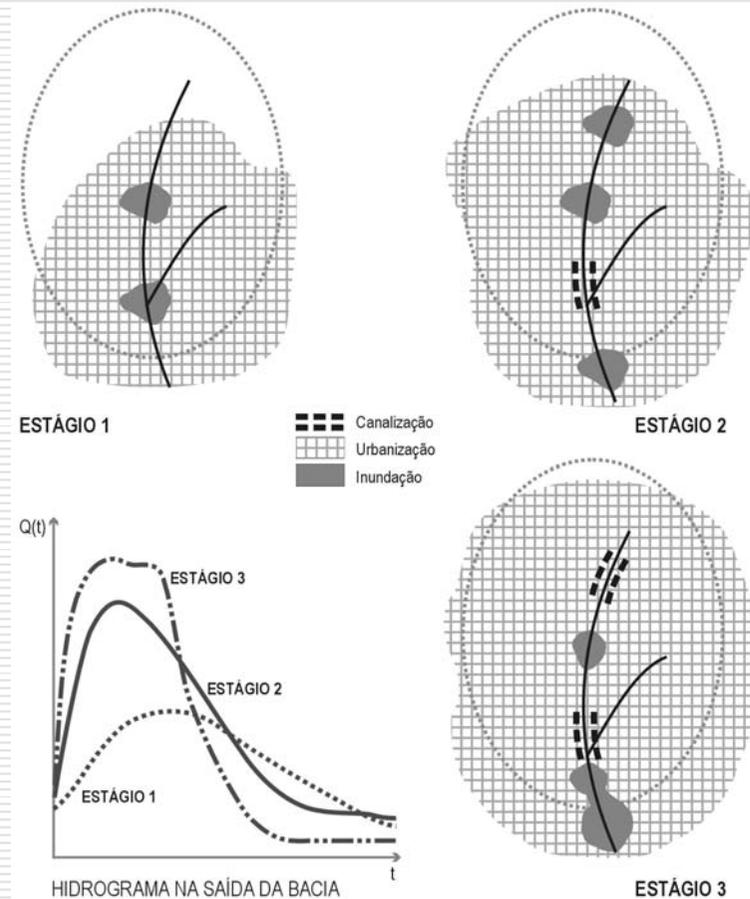
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# Urban Drainage Flood Management

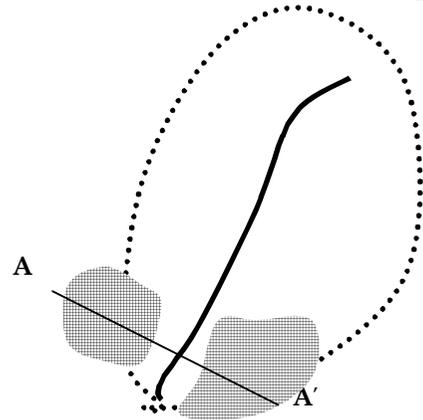
## Flood transference

- First stage: some floods areas
- Second stage: drainage canalization transferring floods to downstream;
- Third stage: floods again in downstream reaches due to the sequence of works;
- The society losses twice: high cost of the works and increases the floods



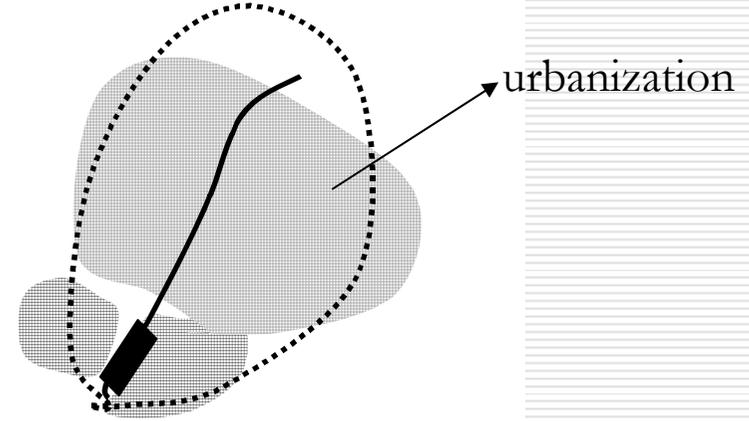
# Flood Plain Management

Before urban development

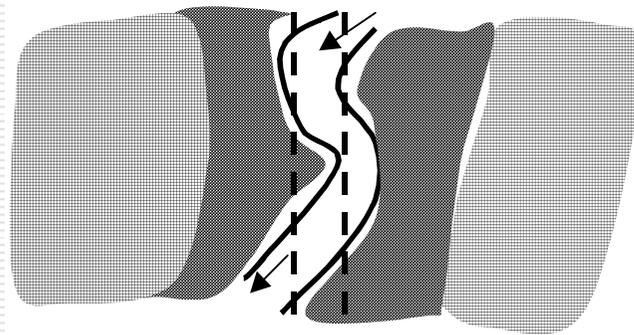


(a) Basin view before urban development

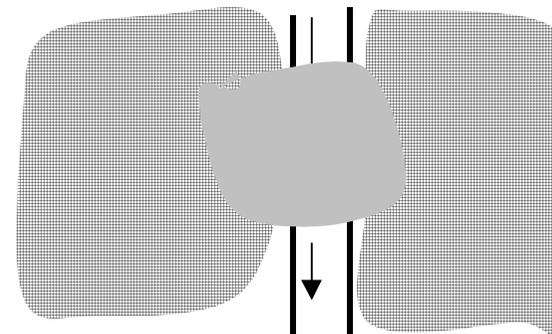
Future scenario



(b) second stage: new urbanization upstream



(c) local view of flood areas and nearby urbanization in the first stage



(d) second stage: occupation of flood areas and flood due to upstream developments

Figure 7.2 Stages of basin occupation and impacts

# Flood Management Sustainable Solution

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- Urban drainage: (a) New developments can not increase the natural flow; (b) Flood Management of the urban drainage basin; (c) induce the infiltration on source control measures and damping in the major drainages; (d) Recovery of the natural flow paths
  - Flood Plains: non-structural measures such as urban zoning; protection of slopes; and flood warning
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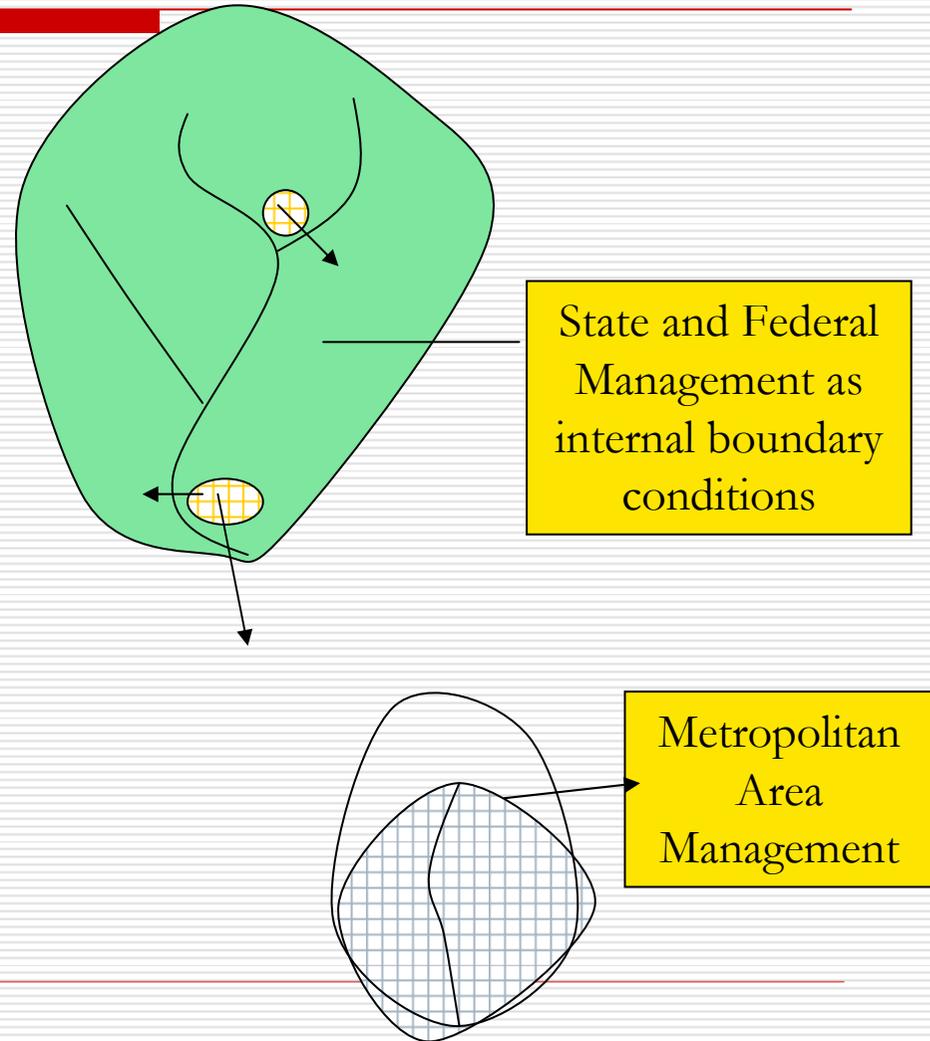
# Management solutions

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- For new developments is important to implement parks for space reserve since it is required 1 to 2% of basin area for urban drainage damping the peak flow to the channels capacity;
  - In flood zoning there is a need to give economical value for the flood plains through environmental compensation for private owners;
  - For public areas there is a need for implementation of public facilities in order to avoid invasion
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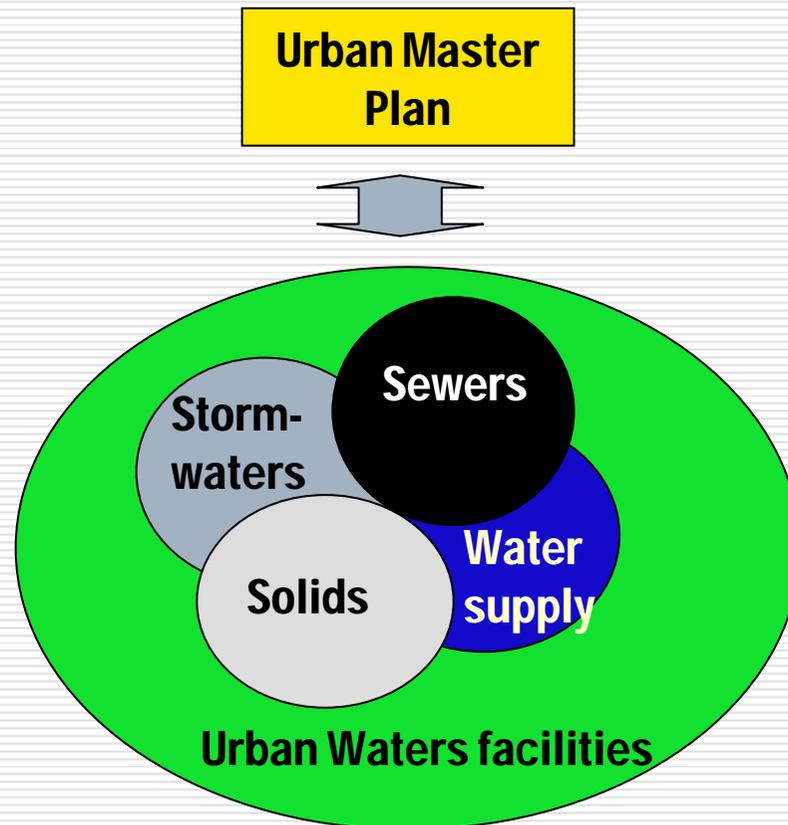
# How to move to it ?

- Legislation to control the output from the cities: Federal or State legislation to enforce it in the Basin and a Fund to finance the cities implementations. It is interface of the Basin Water Plan and city management.
- Implementation by the cities through Urban Drainage and Flood Management Master Plan



# Integrated Urban Waters management

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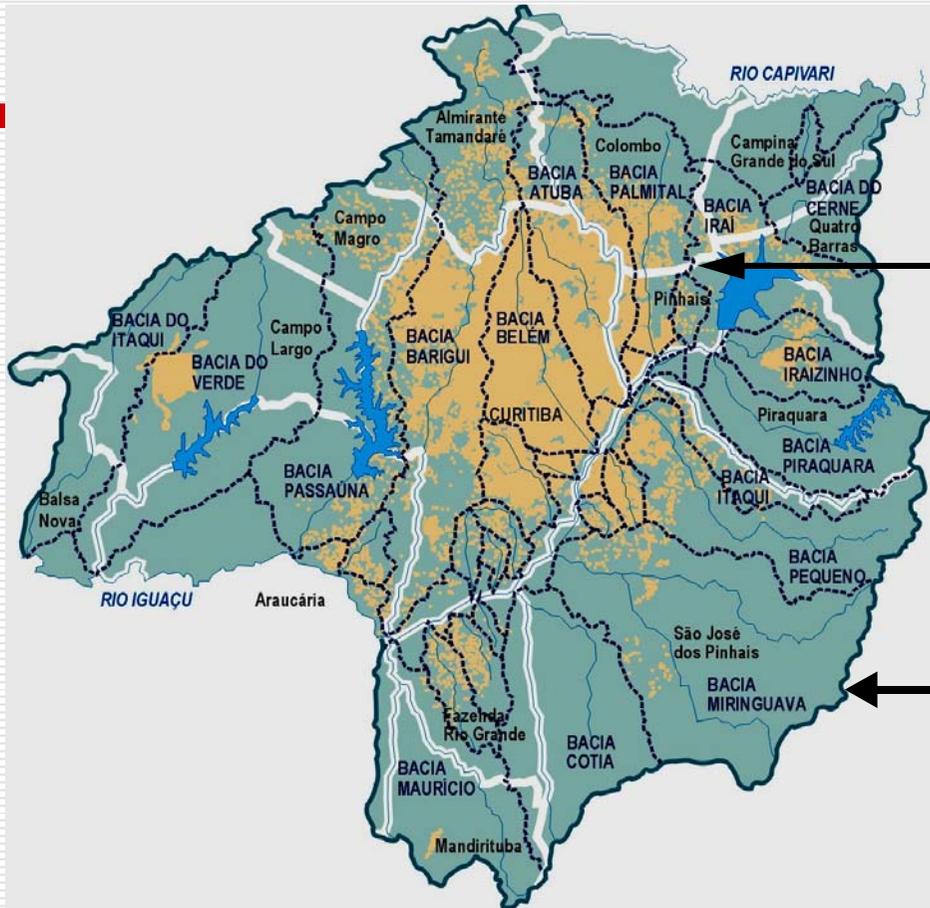
# Scenarios

<b>Water Facility</b>	<b>Developed countries</b>	<b>South America</b>
Water supply	Covered some risk of water sources	Covered in most of the countries and high risk for water sources
Sewers	High control	5-15% of waste treated
Stormwater & Solids	Mainly sediments and quality control	Lack of any control
Flood plains	Mainly non-structural measures	Lack of any control

# Curitiba

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- Flood Control was a Project inside of PROSAM, program funded by the World Bank;
  - Flood Control planned stages were:
    - ↓ Emergencial actions
    - ↓ Iguaçu Flood Plain control
    - ↓ Urban Drainage Metropolitan Area
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Urban development  
master plan



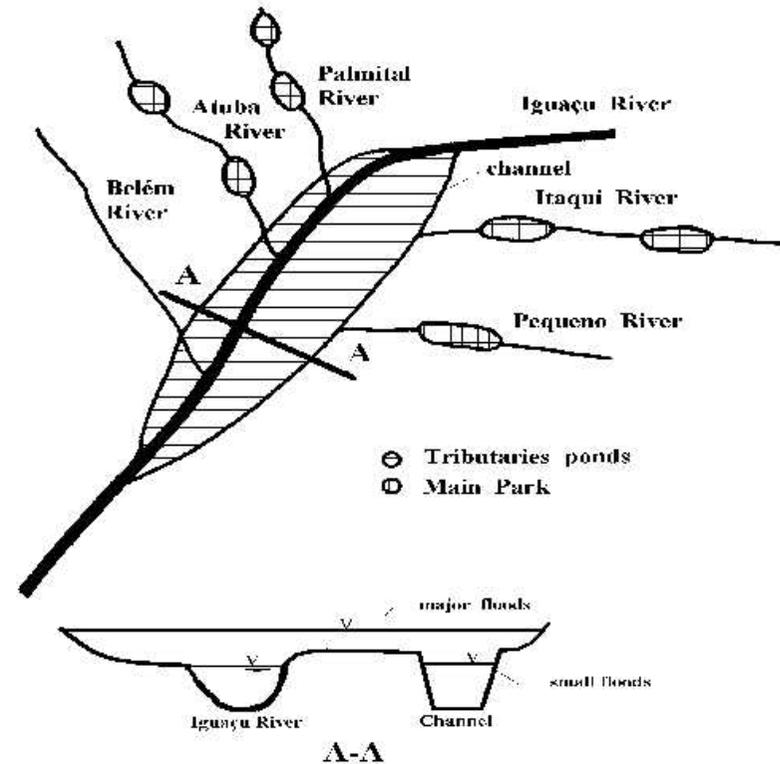
Urban drainage  
and stormwater  
management



Integrated water  
resource catchment  
plan

# Strategic Management

- Iguaçú flood plain has an important pressure for occupation
- If the river had its conveyance increase the population will move to plain as illegal development and with urbanization it could increase the floods again in the future
- The plan was to develop a parallel channel to protect the flood plain from invasion and reserve space and park development;
- Reserve space in parks at the tributaries



# Flood Plain and park

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- Areas used for sand extraction
- Park with 21 km<sup>2</sup> is in development



# Areas planed and developed

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# Urban Flood Management of Porto Alegre

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- Non-structural measures for urban drainage:  
since 2000 the new development can not increase natural flow;
  - Urban Drainage Plan for six basins;
  - Review of the flood control dike system (increase flow of internal basins)
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# FLOOD PLAIN MANAGEMENT

- Porto Alegre Metropolitan Area has about 3 millions inhabitants;
- Jacui/Guaiba lagoon and River Delta has a basin of about 85.000 km<sup>2</sup>;
- Dikes constructed in 1970
- 35 years without major floods; major floods before 1967.
- Red line shows the existing dike;
- Green area has its rainfall pumped to the river system

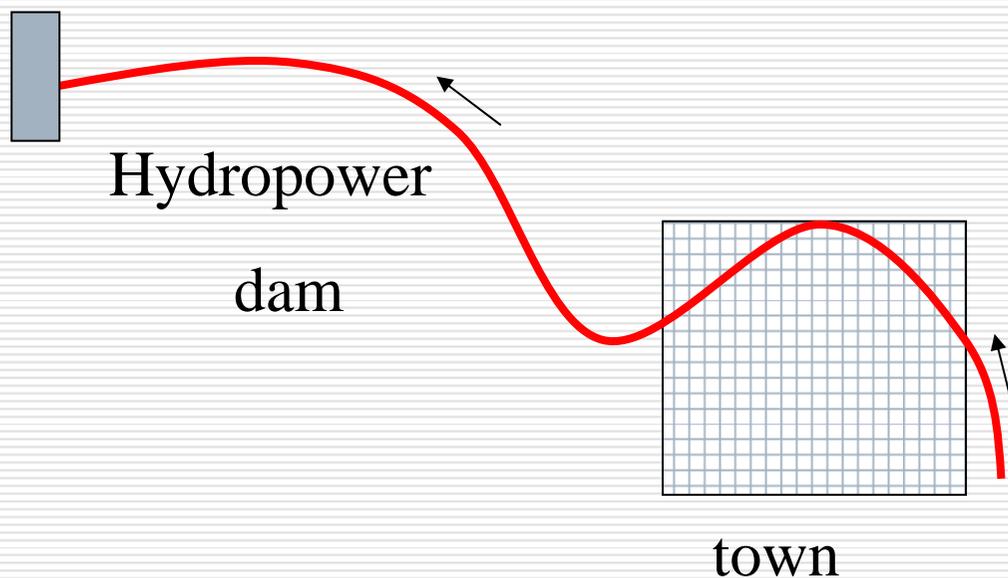


# Porto Alegre strategic management evaluation

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Description	US \$ billions
Cost of existing stormwater network	1,1
Cost of the existing stormwater network + the control of the floods	1,4
Cost as the stormwater would be sustainable constructed	0,50

# União da Vitória Flood x hydropower conflict



1. Population blame dam after 83 flood;
2. The Power Company describe it as 1000 year flood;
3. 1992 occur another major flood and population was very mad about and did not believe;
4. After negotiations, non-structural measures and knowledge about the floods the relationship between the company and population is normal.



# Brazilian National Program on Flood Management

- Proposal asked by the City Ministry in Brazil
- Proposal developed and discussed in the govern in 2004;
- First phase of implementation is starting in May/05

- Legal instrument based on the Water Law;
- Inter-ministerial will start the regulation discussion and proposal;
- Capacity building at govern level and funding agencies
- Technical manual and documents to support the Urban Water Plans and related actions

# Brazilian National Program concepts

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- *Legislation* : from the water law any change on quantity or quality requires permit
- *Regulation*: Cities will need the permit and the requirement will be the development of the Urban Sanitary and Flood management Plan

- Four classes of cities:
    - A - > 500 K (30 cities)
    - B - < 500 and > 100 K (192)
    - C - < 100 and > 20 K
    - D - < 20K
  - Starting with class A and moving to the others
  - US \$ 7,3 billions in 24 years – investing 0,2 GDP
- Total cities > 5 000.

# Activities underway

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- Technical documents: development of manuals; books and publications for capacity building;
- Capacity building: federal govern and many course through the country

- Term of reference for three cities and development of the Plan with Ministry follow up;
  - Still in discussion in the govern the legal aspects
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# Conclusions

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- ❑ Urban development and the present flood management are the main source of the problems;
  - ❑ Costs of channel improvements are increasing the floods and its cost is up to 1000% greater than storage control;
  - ❑ institutions issues such as: legislation (land occupation), capacity building and law enforcement are the more important actions in the management plan;
  - ❑ Interdisciplinary and integrate view of the city environment is the main tool for management;
  - ❑ need to build a sound institutional framework to deal with the Basin Water Management which usually are based on national and State govern management and the Integrated Urban Management which has been a municipality management.
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