WATER FLOW AND SEDIMENT TRANSPORT IN THE LOWER DANUBE RIVER

ROMANIAN RETROSPECTIVE and PERSPECTIVE

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Danube River Basin in Europe

- Second largest river basin in Europe:
  - catchment of 801,463 km^2
  - shared by 18 countries

Danube River

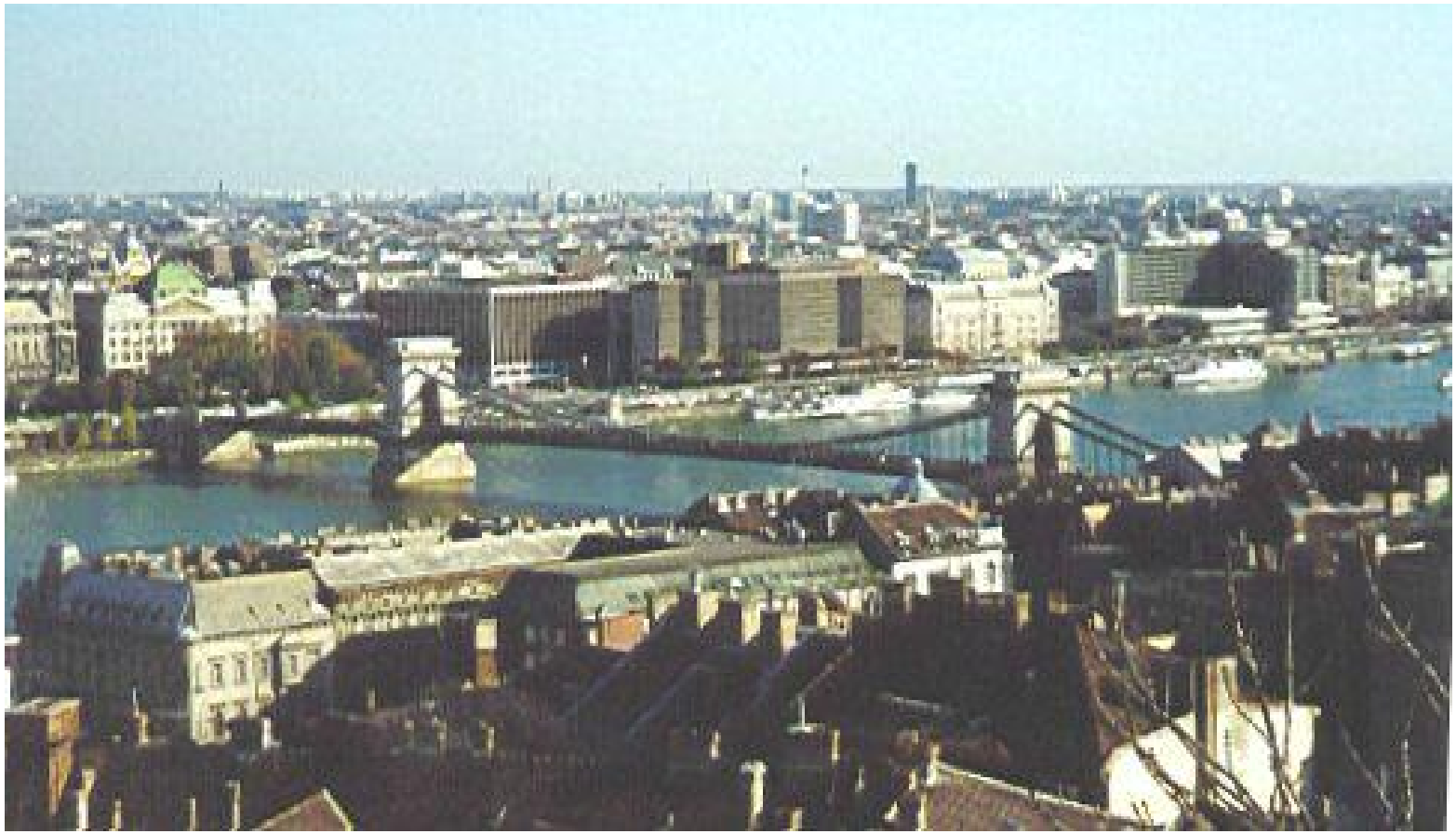
The " ***Great Blue Diagonal*** " of Europe

- Second longest river in Europe
  - 2857km-long in 9 riparian countries
  - Flows through 4 capital cities
    - Vienna
    - Bratislava
    - Belgrade
    - Budapest

  and other major cities in the region

Danube River at Vienna

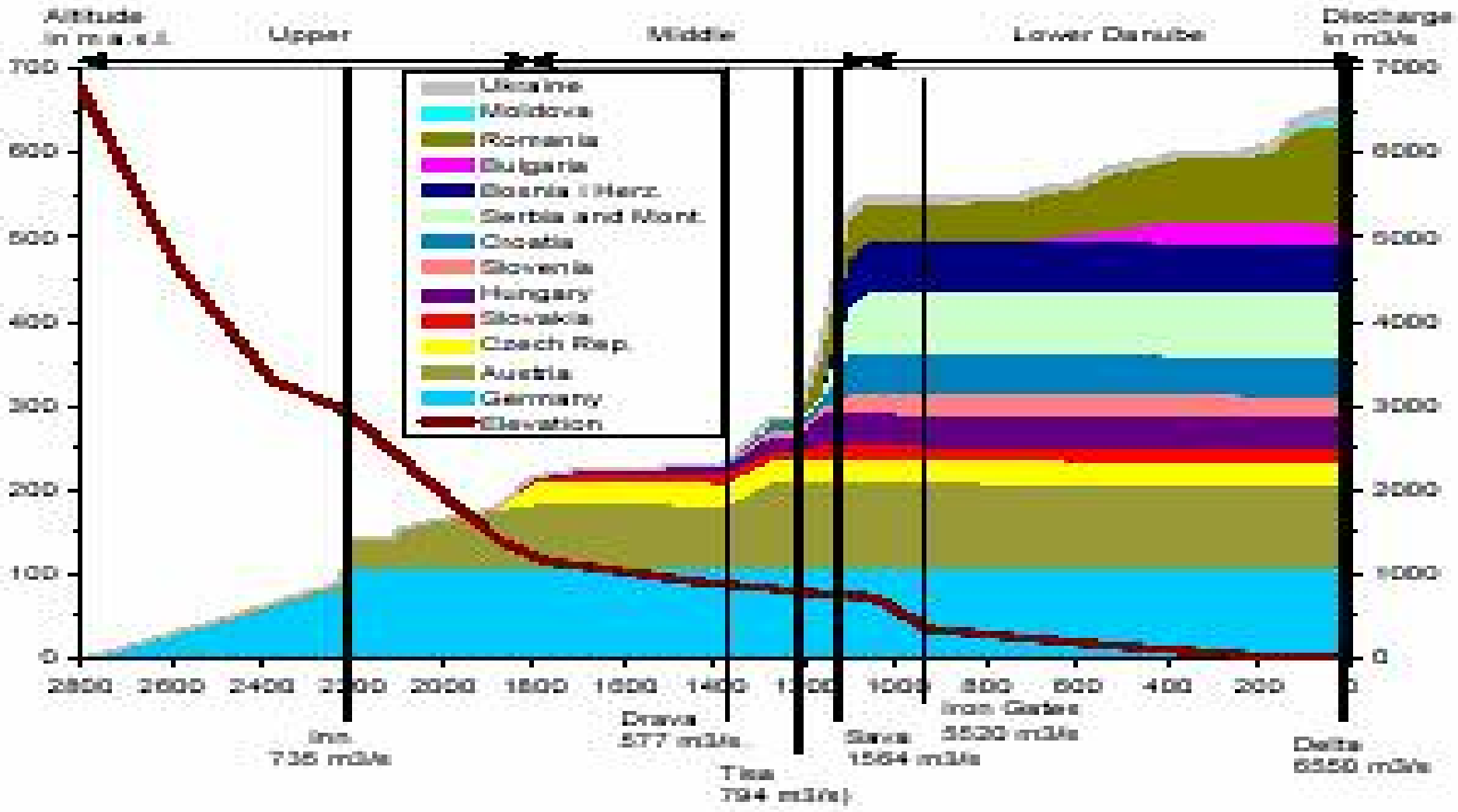
Danube River at Budapest



Danube River Network

Major tributaries

Tributary	Length (km)	Flow (m3/s)
Inn	514	135
Morava	352	110
Drava	893	577
Tisza	966	794
Sava	861	1564
Morava	430	232
Isker	368	54
Yantra	285	47
Jiu	339	86
Olt	615	174
Arges	350	71
Siret	559	240
Prut	950	110



Upper Danube **Middle Danube** **Lower Danube**

IMPORTANCE OF THE LOWER DANUBE RIVER

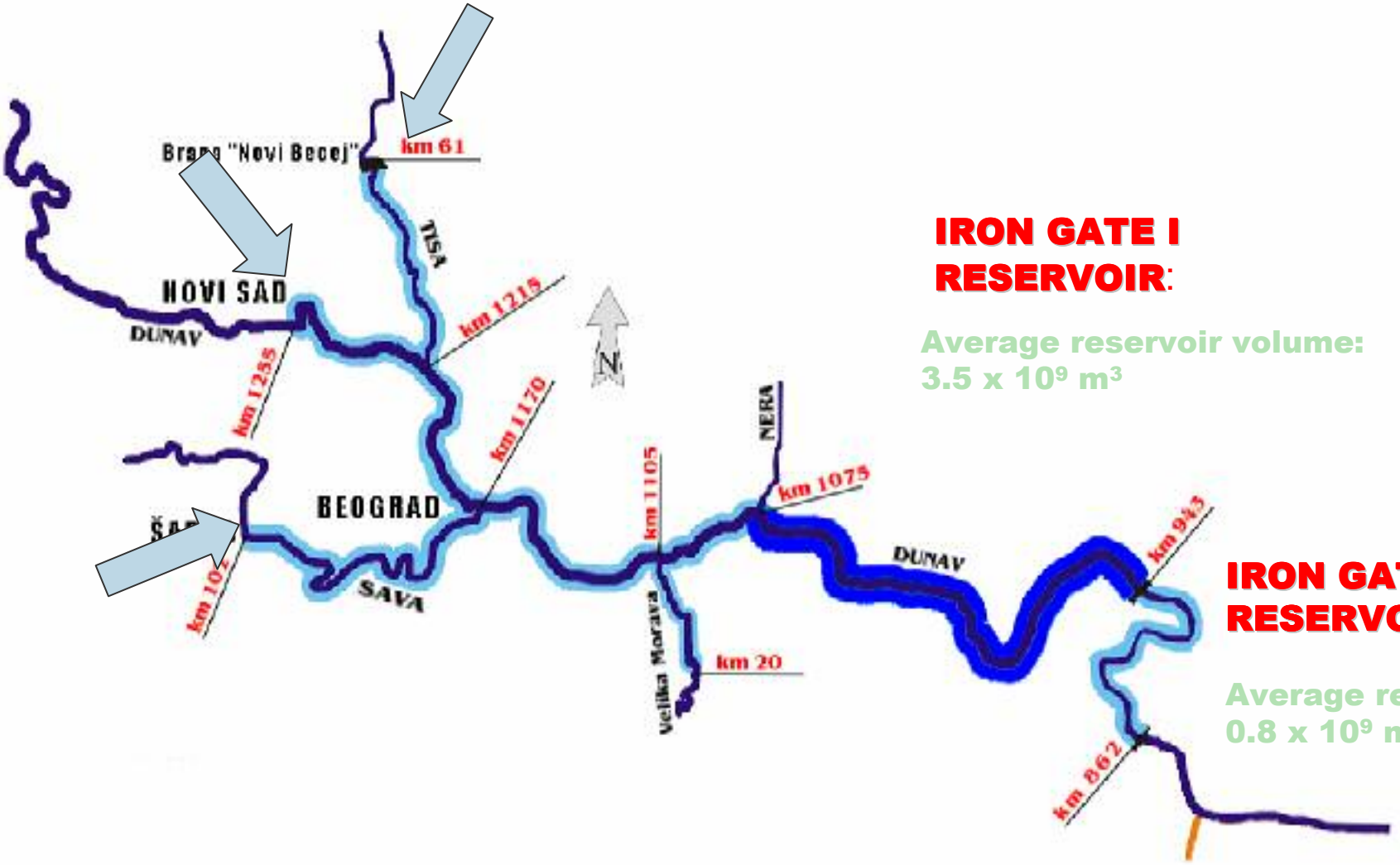
- Major international watercourse
- Multipurpose used by riparian countries
  - power generation
  - fluvial navigation
  - water supply
    - agriculture water(irrigation)
    - domestic water (drinking)
    - industrial water
- Fishing
- Tourism and recreation

IMPORTANCE OF THE LOWER DANUBE RIVER

man-made structures and works

- **Iron Gates 1 and 2 great systems for**
  - **power generation**
  - **fluvial navigation**
  - **flood attenuation**
- **Great rail-road bridges at Giurgiu- Russe and Calafat (future)**
- **Embankments for flood protection**
- **Intakes for water supply**
- **Sand mining**

IRON GATES I (1972) and II (1985) – Romania and Yugoslavia



IRON GATE I RESERVOIR:

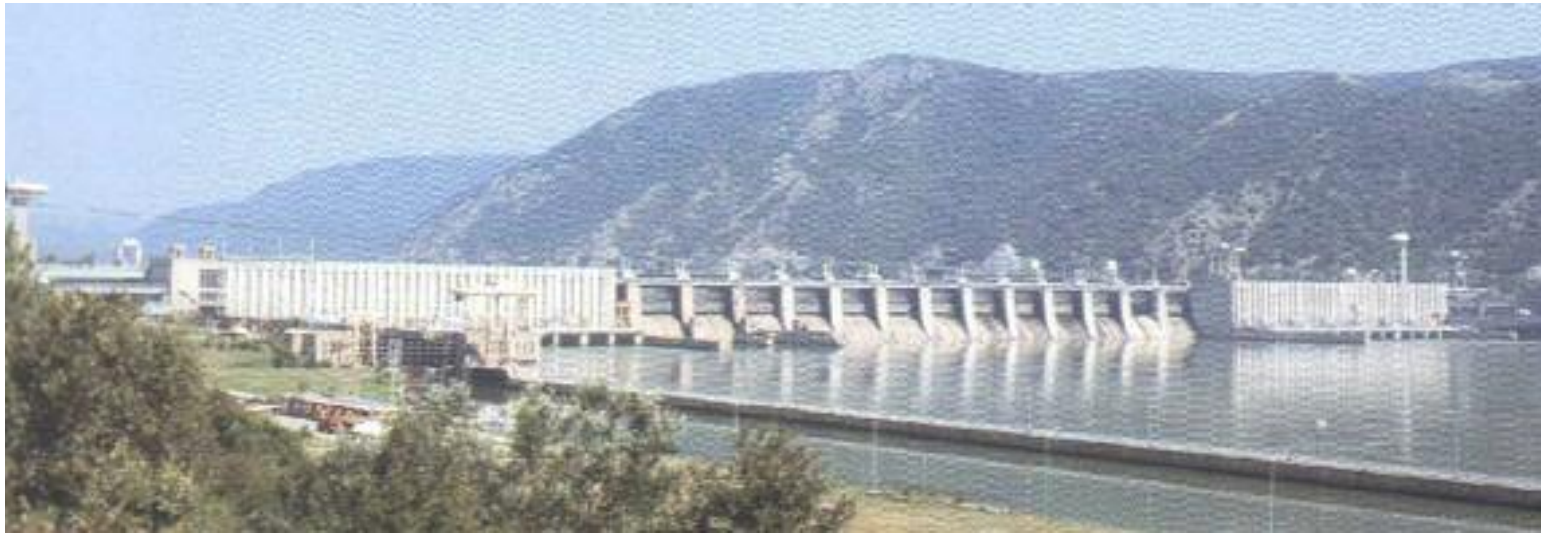
Average reservoir volume: 3.5 x 10^9 m^3

IRON GATE II RESERVOIR:

Average reservoir volume: 0.8 x 10^9 m^3

IRON GATE I

1972



The Iron Gate I system consists of two symmetrical parts, each comprising:

- **a navigation lock**
- **an overflow concrete dam (1278 m long with 14 spillways)**
- **a non-overflow earth dam**
- **a hydropower plant (6 turbines)**

IRON GATE II

1985

The Iron Gate II system consists of two dams:

- **an overflow concrete dam on the main Danube channel (1003 m long)**
- **an overflow concrete dam on the Gogos branch**
- **a hydropower plant (20 turbines)**
- **a navigation lock**

ROMANIAN RETROSPECTIVE

SCIENTIFIC & PRACTICAL INVESTIGATION in the Lower Danube River – ROMANIAN RIVER REACH

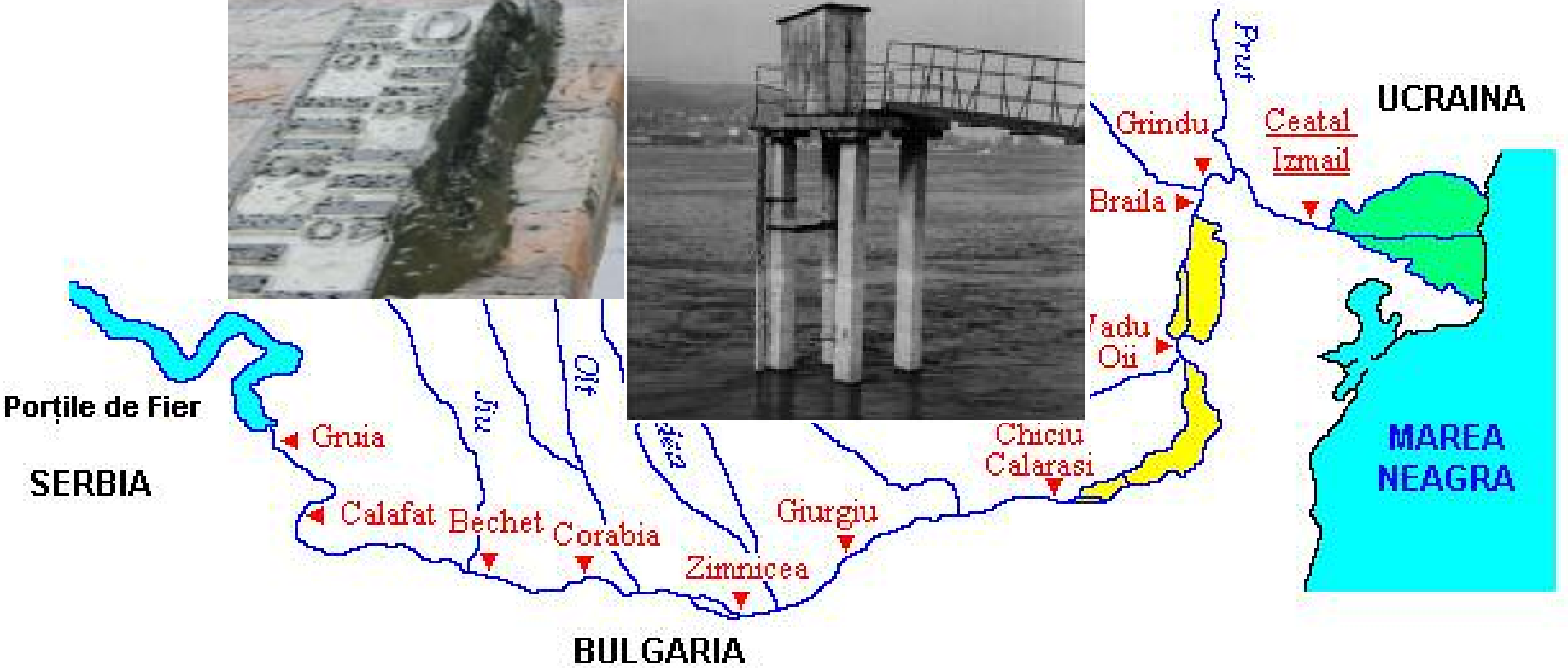
OBJECTIVES:

- Evaluation of hydrological & hydraulic regime:
  - water flow regime
  - sediment transport regime
- Evaluation of river processes & morphological changes:
  - thalweg changes
  - cross-sectional changes
- Determination of water & sediment quality

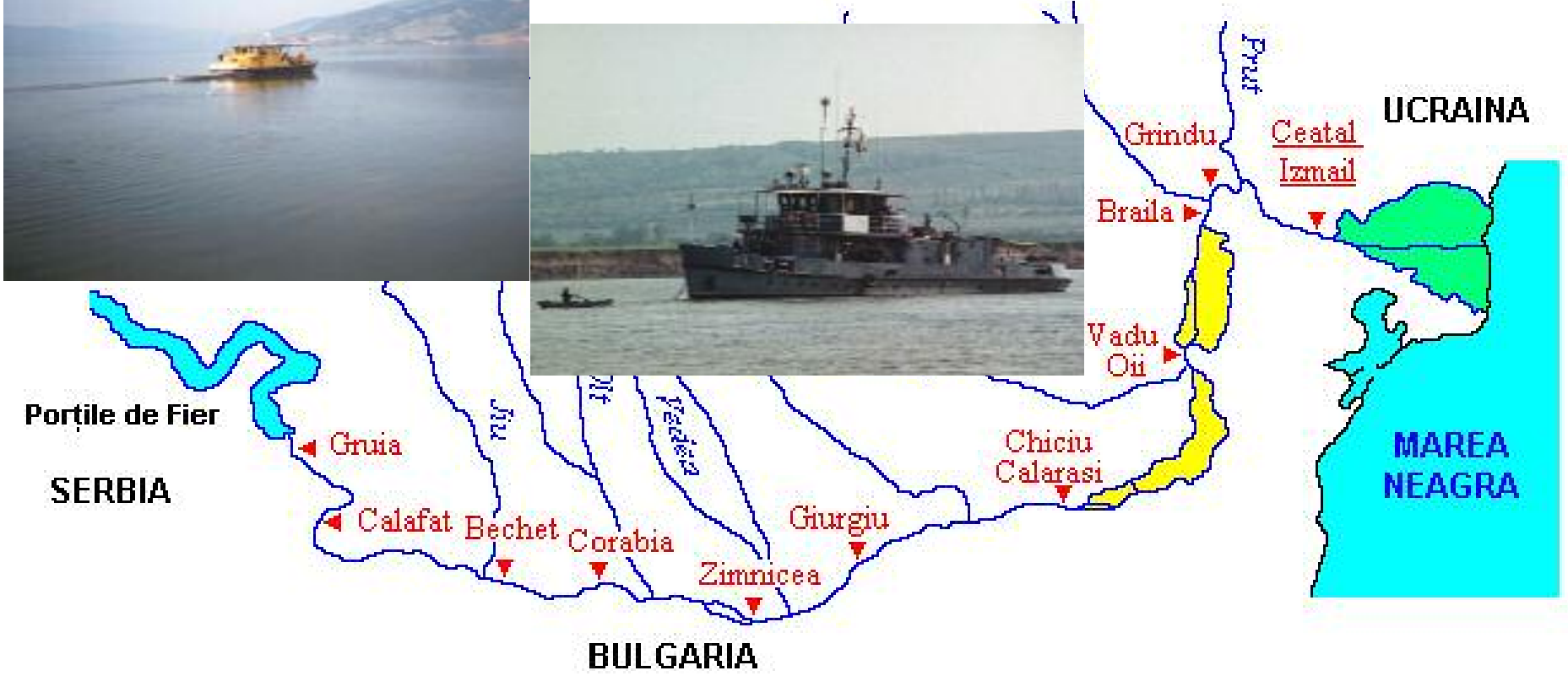
MEANS:

- Field data
  - collected at permanent hydrometric stations
  - during periodic field campaigns
- Laboratory data

Permanent Hydrometric Stations in the Lower Danube River in Romania



Periodical Field Measurement Campaigns
along the Lower Danube River in Romania



Type of Data Collected in the Field

- Physical properties of water and sediment
- Hydraulic flow parameters
  - Water level and discharge
  - Flow velocity and depth
- Sediment (bottom & suspended) data
  - Sediment discharge and turbidity
  - Sediment size distribution (granulometry)
- Bathymetric data
  - River geometry (long & cross profiles)

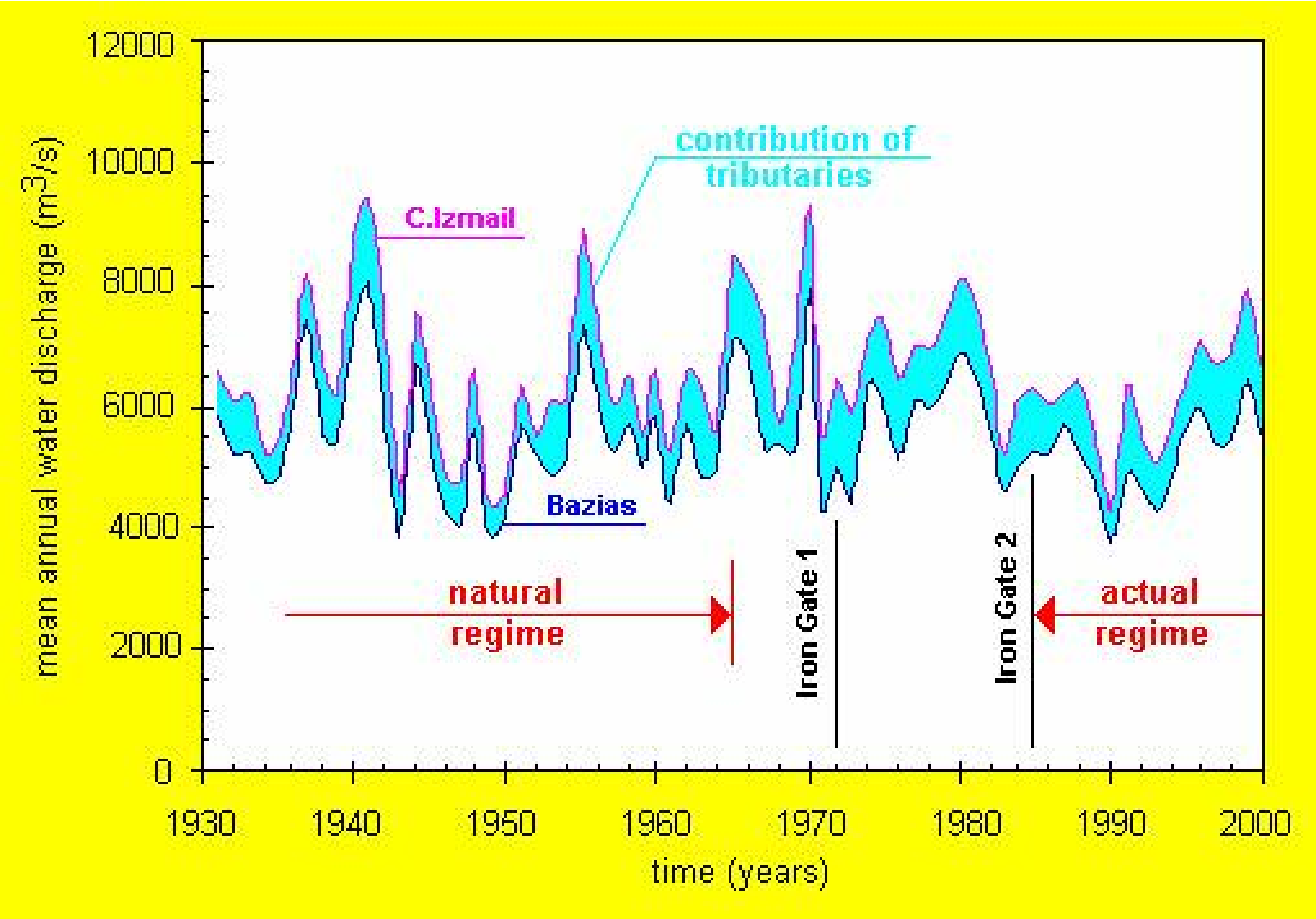
WATER – SEDIMENT REGIME
(history – based on field information, data)

- Up to year 1965 – **"NATURAL REGIME"**
  (UNDISTURBED)

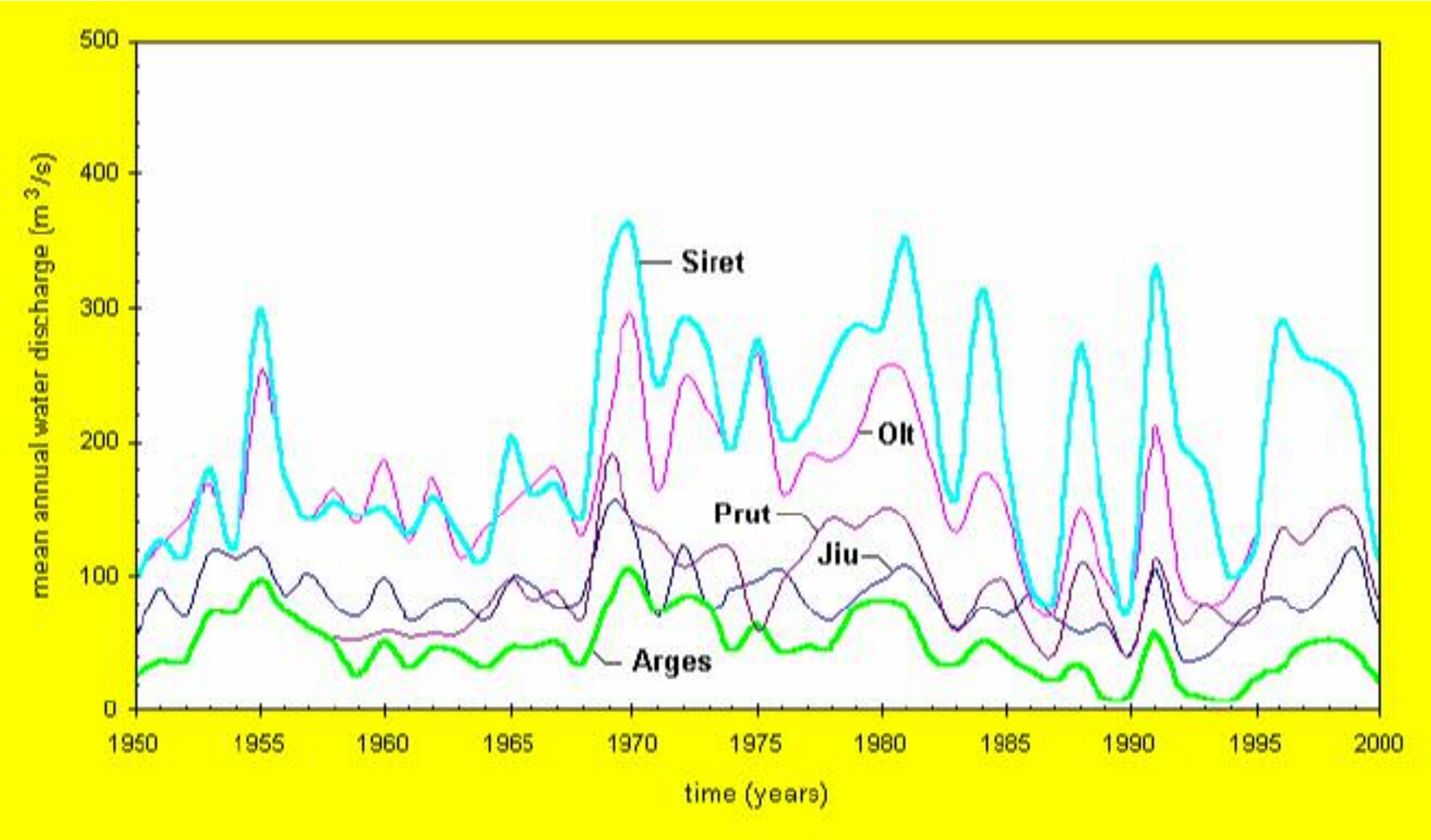
- From 1965 to 1985 – **"TRANSIENT REGIME"**
  Great changes in time due to:
  * natural causes (climate)
  * anthropic works & activities

- From 1985 to present – **"ACTUAL REGIME"**
  (DISTURBED)

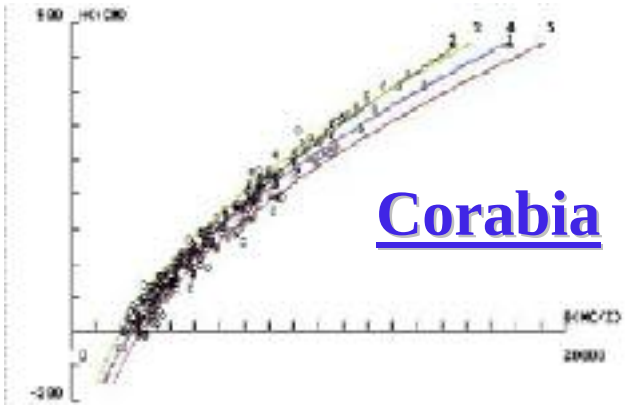
Water flow regime – Danube River



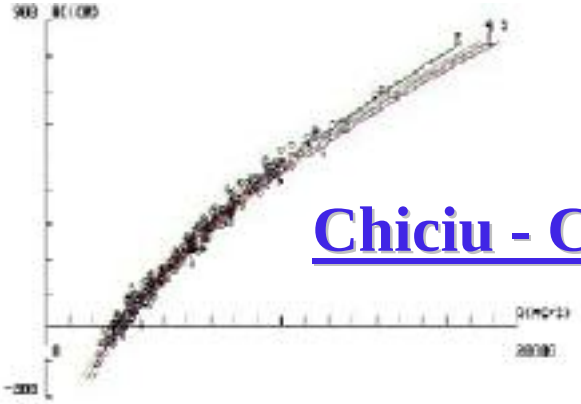
Water flow regime – Tributaries



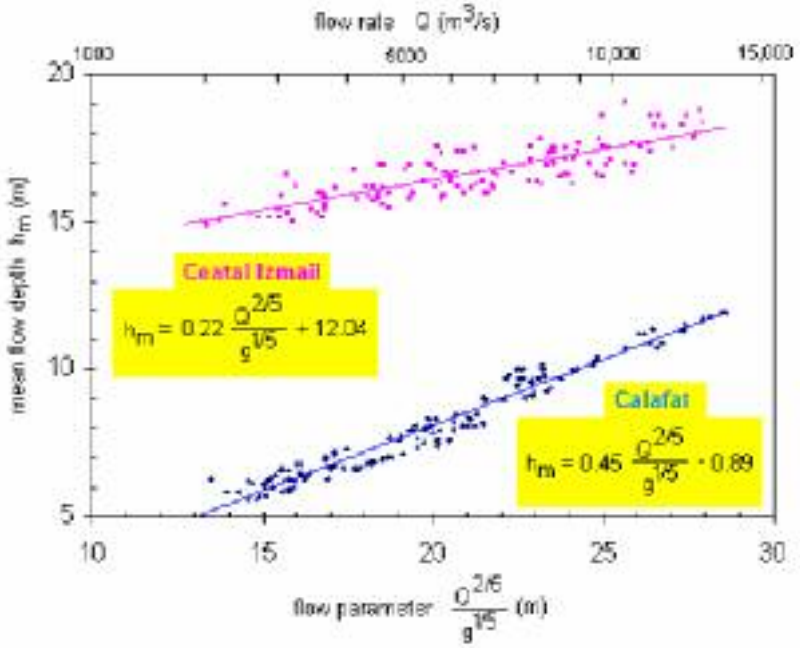
Discharge Rating Curves



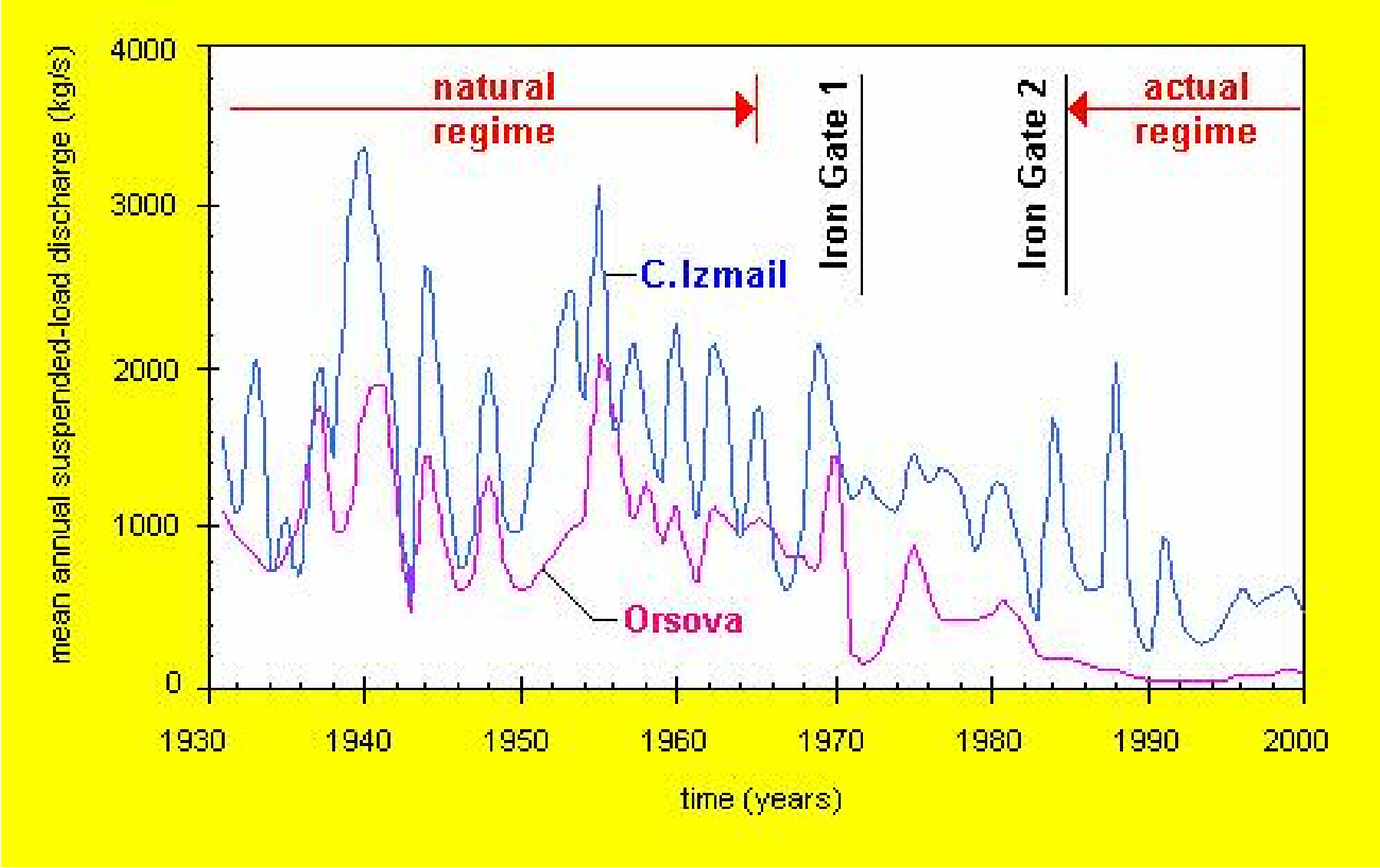
Corabia



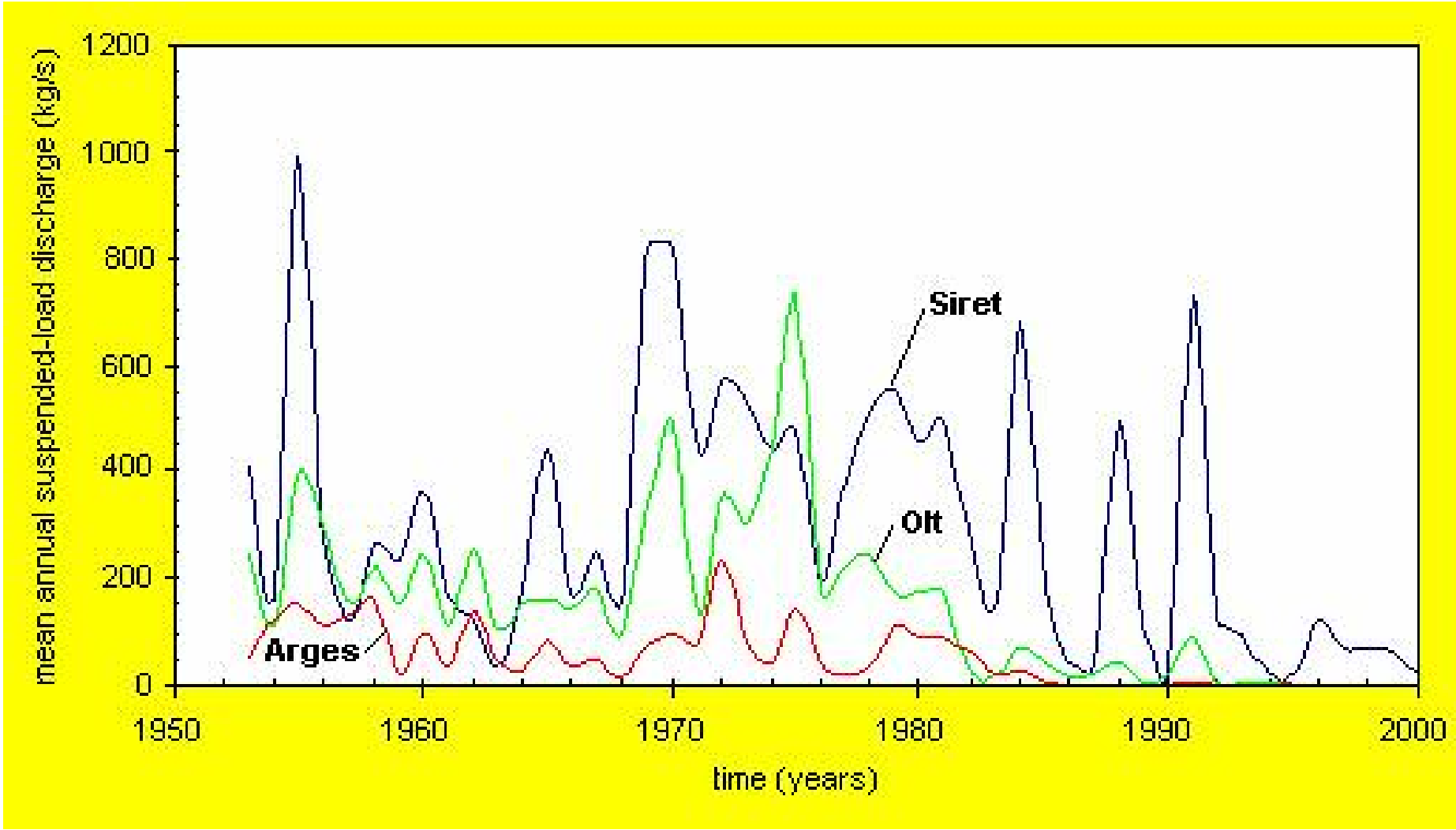
Chiciu - Calarasi



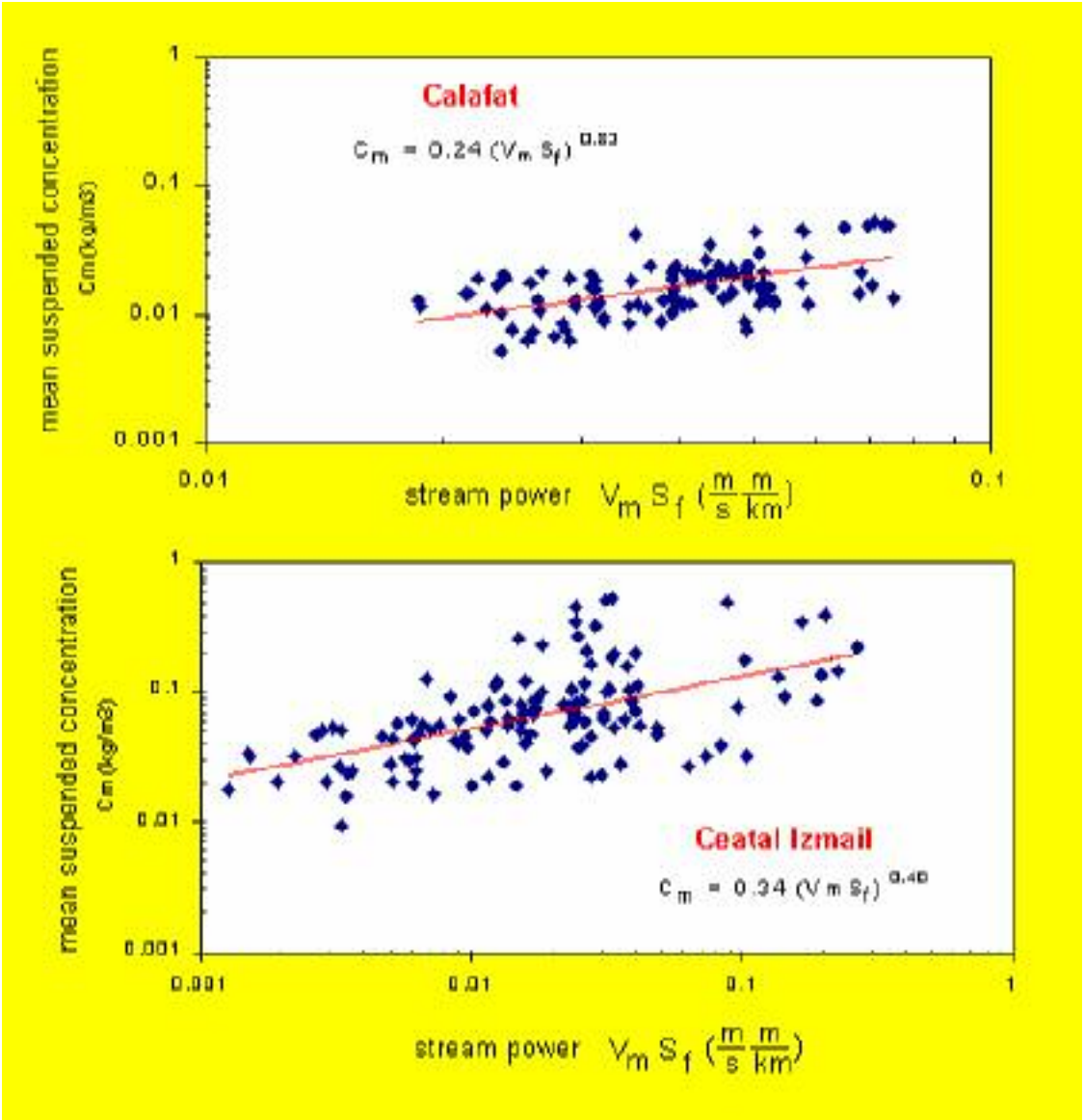
Sediment transport regime – Danube River



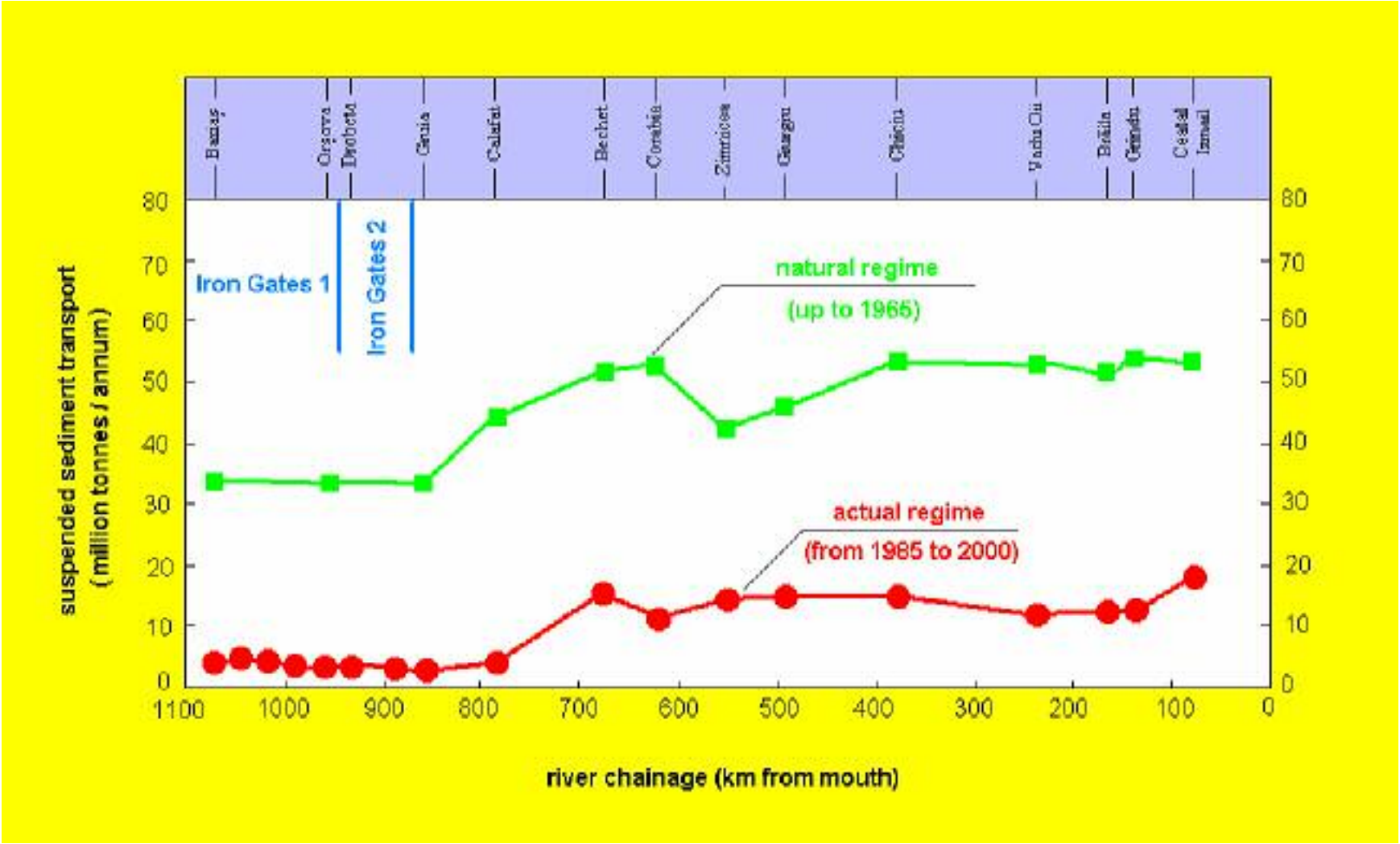
Sediment transport regime – Tributaries



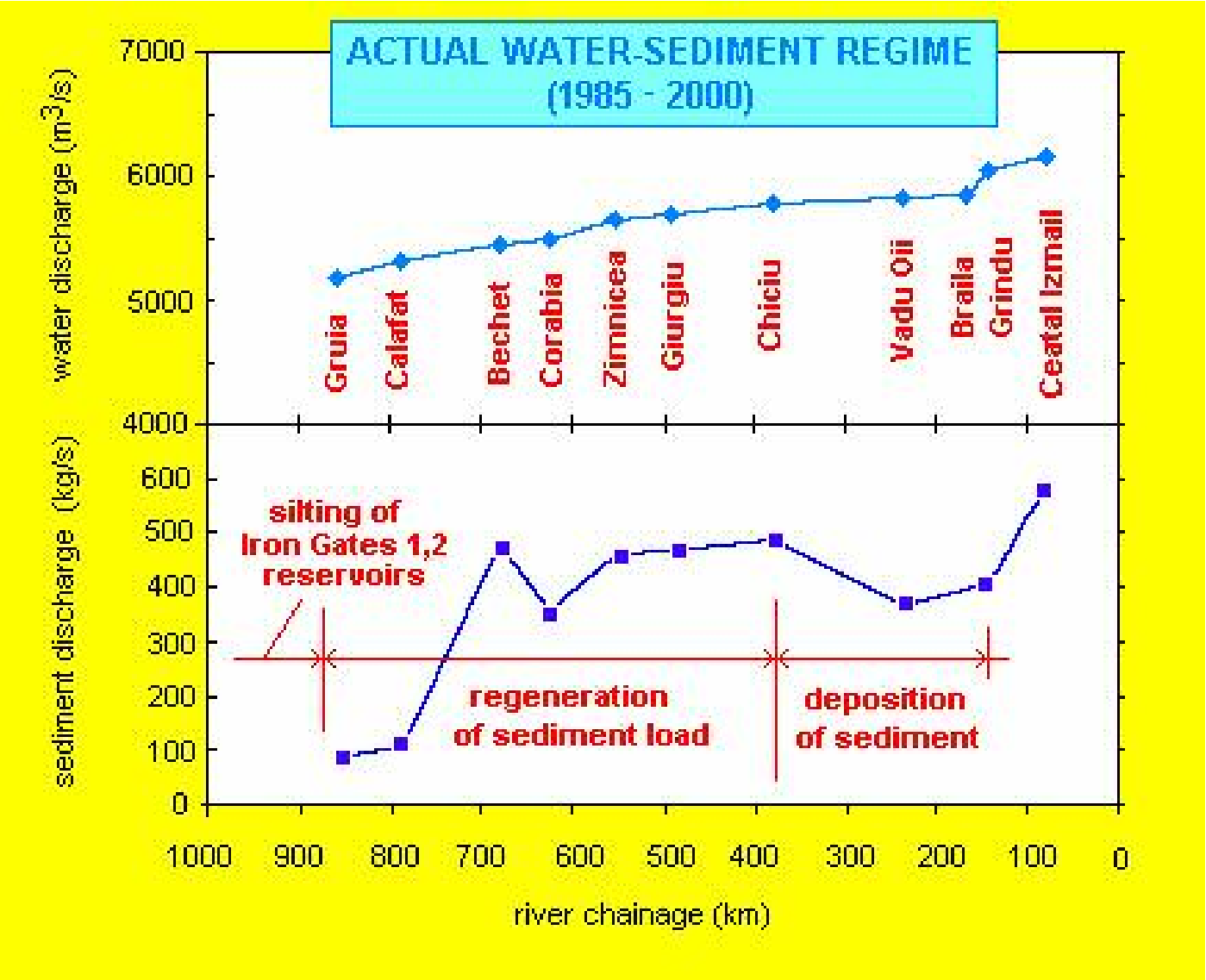
Sediment transport equations



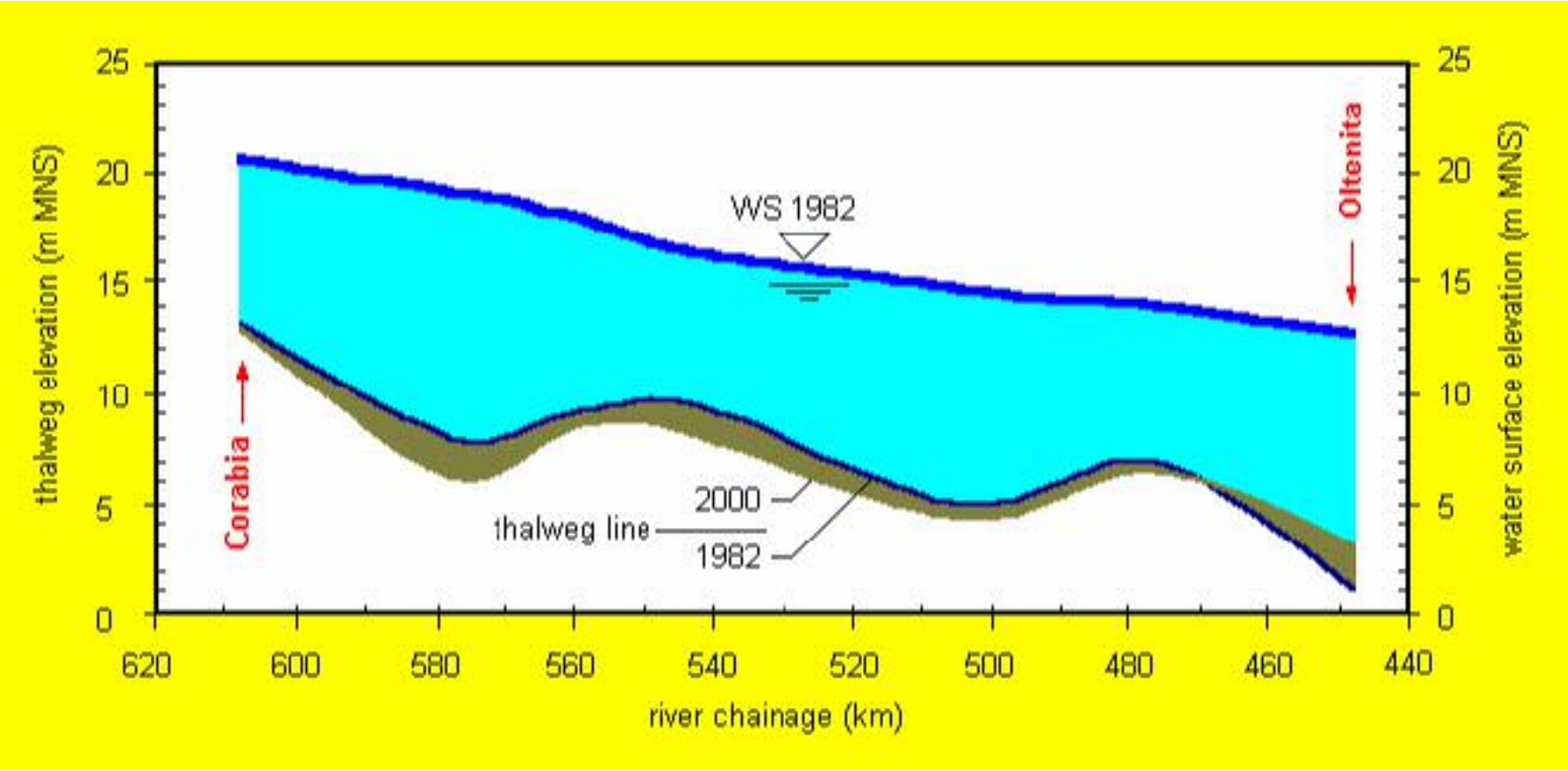
Natural – Actual Sediment Transport Regimes



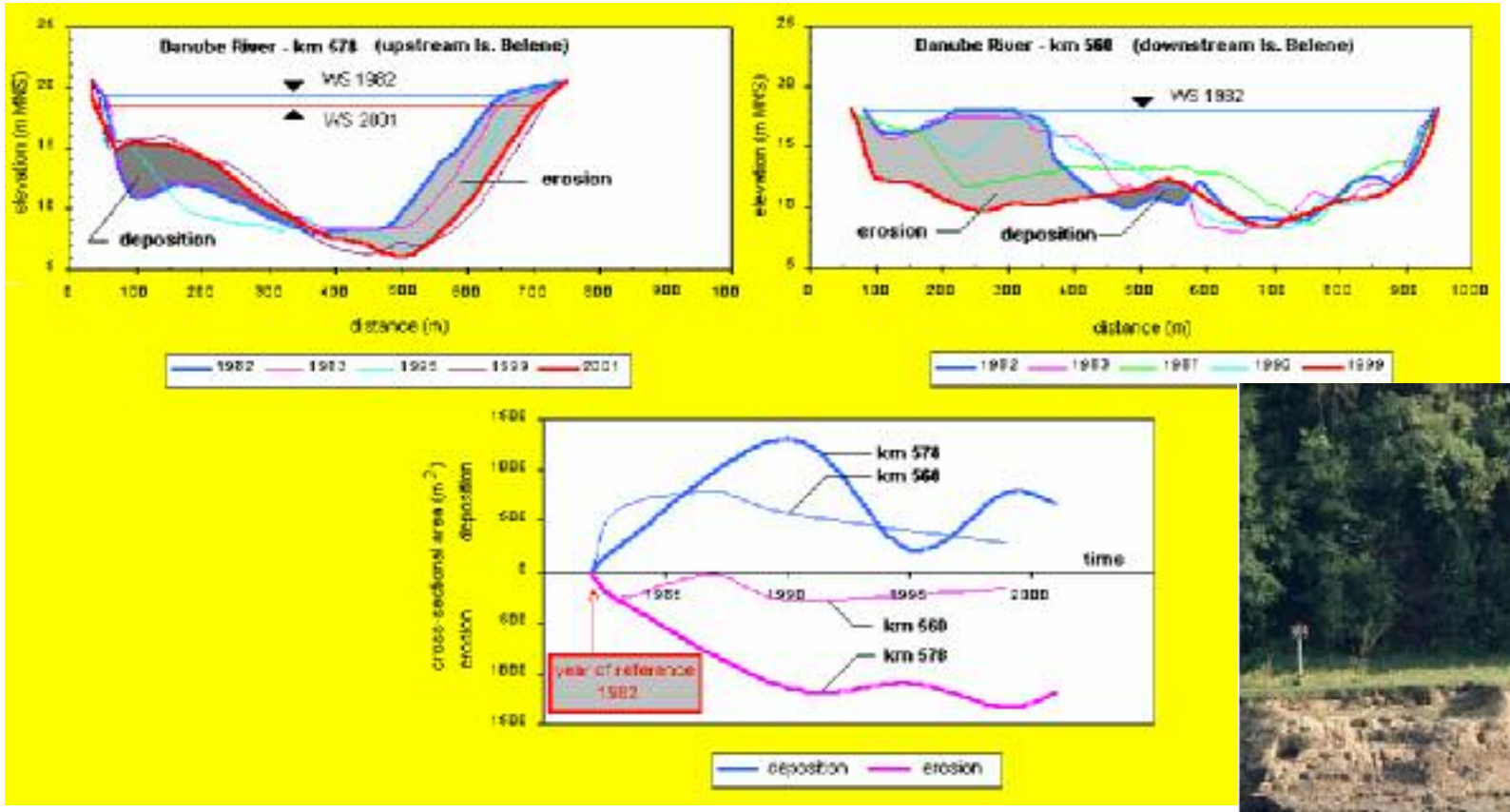
ACTUAL WATER – SEDIMENT REGIME



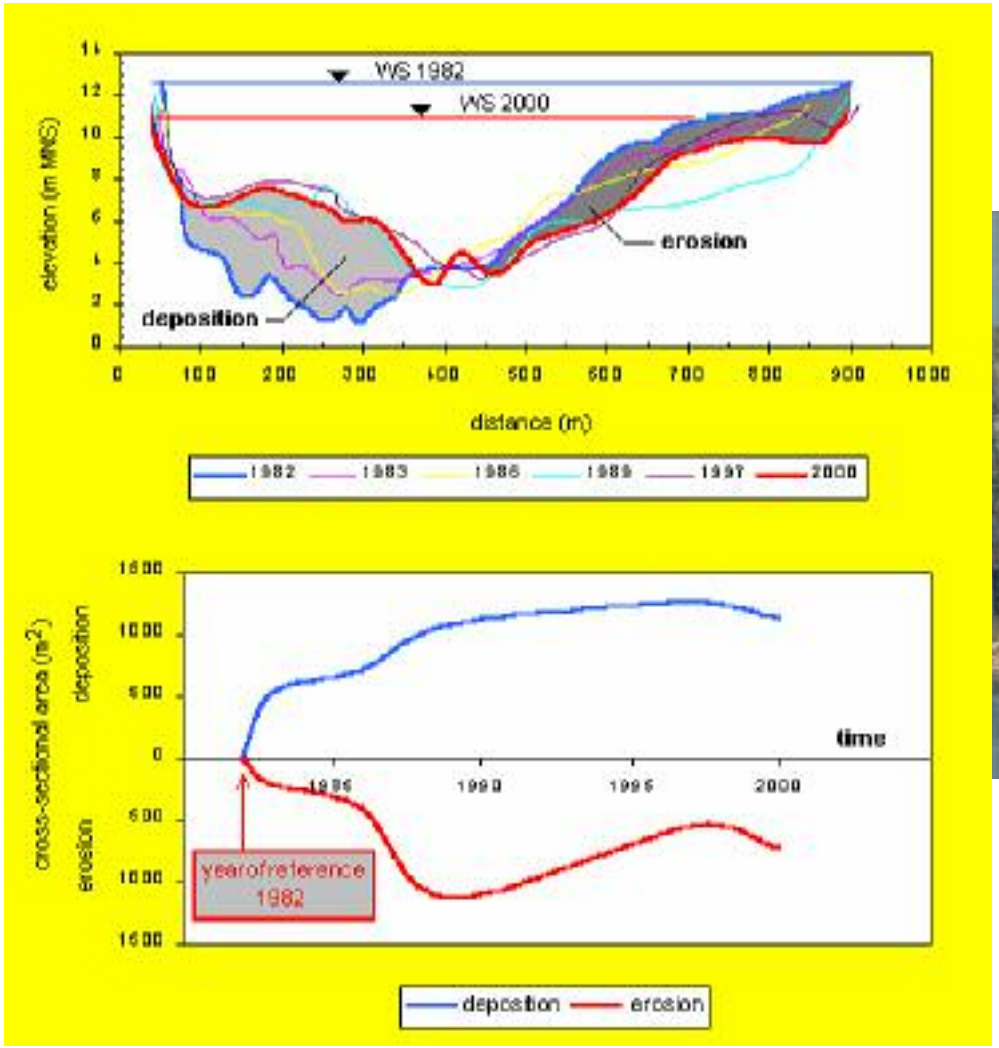
Morphological River Bed Changes thalweg degradation & aggradation



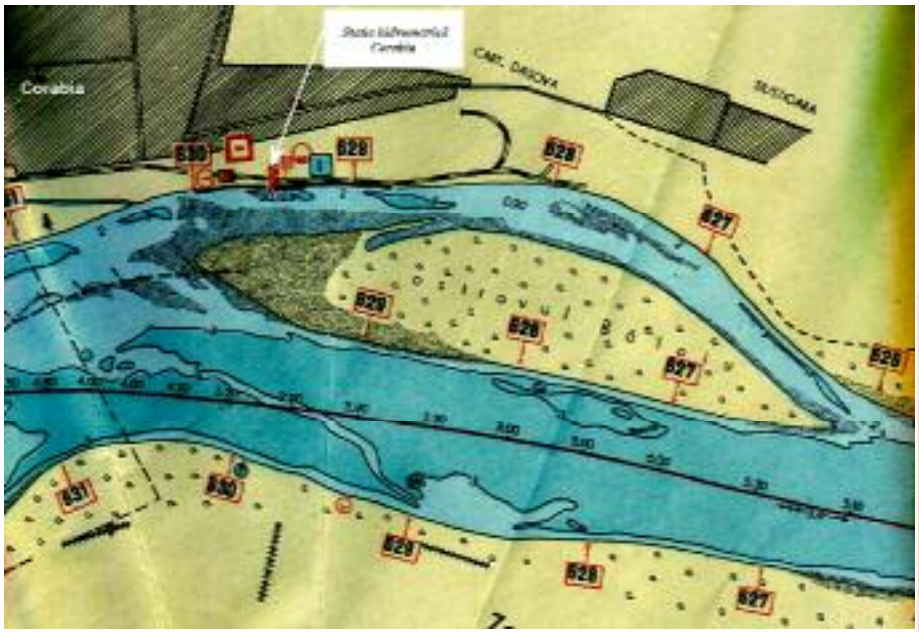
Morphological River Bank Changes high bank erosion (terrace)

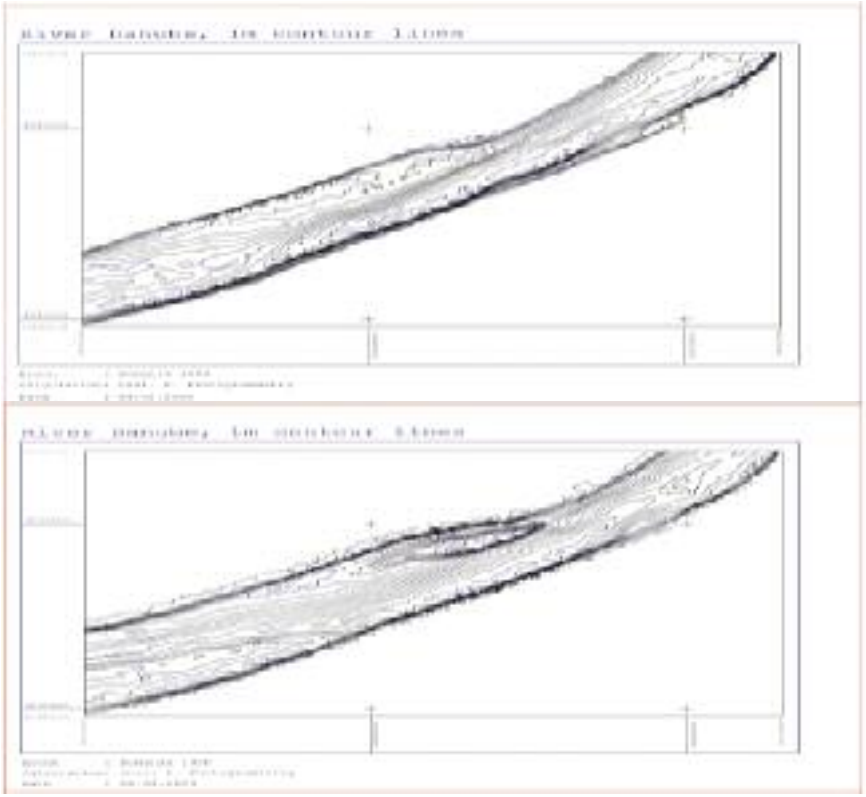


Morphological River Bank Changes flat bank erosion (flood area)



Morphological Changes alluvial island formation





Morphological Changes
alluvial bar formation - dredging

ROMANIAN PERSPECTIVE via INTERNATIONAL PROJECTS

Phare - CROSS-BORDER COOPERATION
Romania - Bulgaria

MONDAN PROJECT

MONDAN PROJECT

Integrated cross-border monitoring system for the Lower Danube River

Proposed by

Romanian Ministry of Environment and Water Management
and
Bulgarian Ministry of Transport and Communication

MONDAN PROJECT

- Project type: Bilateral – Danube River from Timok to Calarasi-Silistra
  (Improvement of infrastructure)
- Framework: **EU – Phare**
  Cross Border Cooperation Romania – Bulgaria
- Authority: Ministry of Environment and Water Management – RO
  Ministry of Transport and Communications – BG
- Contribution: ICPDR Vienna
  Danube Commission Budapest

MONDAN PROJECT

- **Project Type:** Structural – improvement of monitoring systems (hydrometric network)
- **Project Duration:** 3 years (2005-2007) in 3 phases:
  * Phase 1 – 2005
  * Phase 2 – 2006
  * Phase 3 – 2007
- **Estimated Cost:** 6,8 MEuro

OVERALL OBJECTIVES

- To promote co-operation between Romania and Bulgaria in the field of:
  - Environmental protection
  - Fluvial navigation and transportation
- To join and harmonize the hydrologic and hydrometric experience in both countries with current international requirements, including the WFD
- To improve the existing monitoring systems in the Lower Danube River
- To develop a reliable working tool for water management policy-makers, decision takers and investors in the Lower Danube River

PROJECT GOALS (1)

- **Development of an advanced integrated monitoring system for the Lower Danube River, along the Romanian – Bulgarian reach**

- **Modernization of existing surveillance and hydrometric systems, including:**
  - **Modernization of 14 hydrometric stations, from which**
    - **8 in Romania**
    - **6 in Bulgaria**
  - **Development of 3 new stations in Bulgaria**
  - **Collection of field data, including:**
    - **hydrological data**
    - **sedimentological data**
    - **morphological data**
    - **water-sediment quality data**

- **Acquisition of 2 new specialized vessels for hydrometry, survey and research**

Romanian – Bulgarian Danube River Reach

PROJECT GOALS (2)

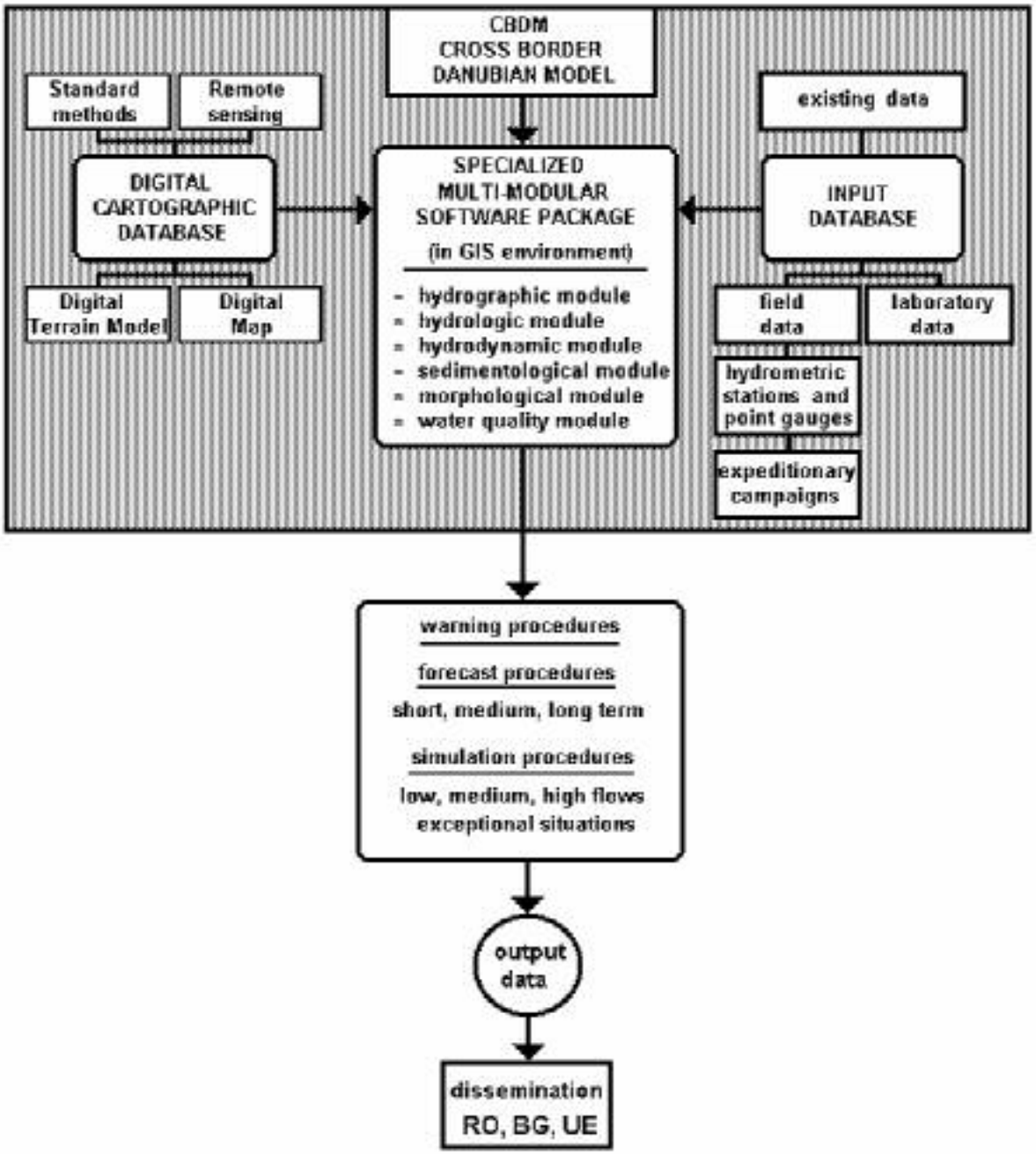
- **Implementation of a Cross-Border Danubian Computer Model (CBDM) for the Lower Danube River, with advanced modules for:**
  - **Water flow dynamics**
  - **Sediment transport**
  - **Morphological river changes**

  aiming to provide hydrologic and morphologic warning and forecasts during:
  - **Low flows**
  - **High flows**
  - **Exceptional events (floods)**
  - **Accidental pollution**

- **Implementation of advanced technologies and techniques:**
  - **Digital cartography**
  - **Geographical Information System (GIS)**
  - **GPS and DGPS**

MONDAN PROJECT

COMPUTATIONAL STRATEGY



IHP – Regional Hydrological Co-operation Programme of the Danube Countries

PROJECT SEDAN

SEDAN PROJECT

Modeling of
erosion, transport and sedimentation processes
in the Danube River and its major tributaries

Proposed by

IHP - Romanian National Committee
within
National Institute for Hydrology and Water Management, Bucharest

SEDAN PROJECT

- Project type: Regional – Danube River Basin
- Framework: **IHP UNESCO**
  Regional Hydrological Co-operation Program
  of the Danube Countries
- Authority: IHP-UNESCO Paris
  UVO ROSTE Venice
- Contribution: ICPDR Vienna
  IAD Vienna
  Danube Commission Budapest

SEDAN PROJECT

- Coordinating country: Romania
- Cooperating countries: Danube countries
  (IHP National Committees)
- Project Duration: 5 years (2005-2009) in 3 phases:
  * Phase 1 – 1year (2005)
  * Phase 1 – 2 years (2005-2006)
  * Phase 2 – 3 years (2007-2009)
- Estimated cost: 2,0 MEuro

SEDAN PROJECT – Background

Previous actions:

⇩2003 – Sofia and Venice

⇩2004 – Bucharest, Brno, Paris and Vienna

Next actions:

⇩2005 – Vienna, Passau and Belgrade

SEDAN PROJECT

Contribution of the IHP Danube Countries to ISI International Sedimentation Initiative

GEST Project

Global Evaluation of Sediment Transport

SEDAN Project

Case Study (Pilot-project) for Europe (Danube River Basin)

OVERALL OBJECTIVES

- ⇩ To promote co-operation between Danube countries
- ⇩ To join and harmonize the Danube countries experience
- ⇩ To improve the actual level of knowledge in the field of river modelling (flow and sediment)
  Particular view on erosion, transport and sedimentation processes in the Danube River Basin
- ⇩ To develop a reliable working tool for water management policy-makers, decision-takers and investors in the Danube River Basin
- ⇩ To contribute to International Sedimentation Initiative (ISI – GEST Project)

PROJECT GOALS (1)

To develop and use a Sediment Databank (SEDAT) for the Danube River and its major tributaries, including:

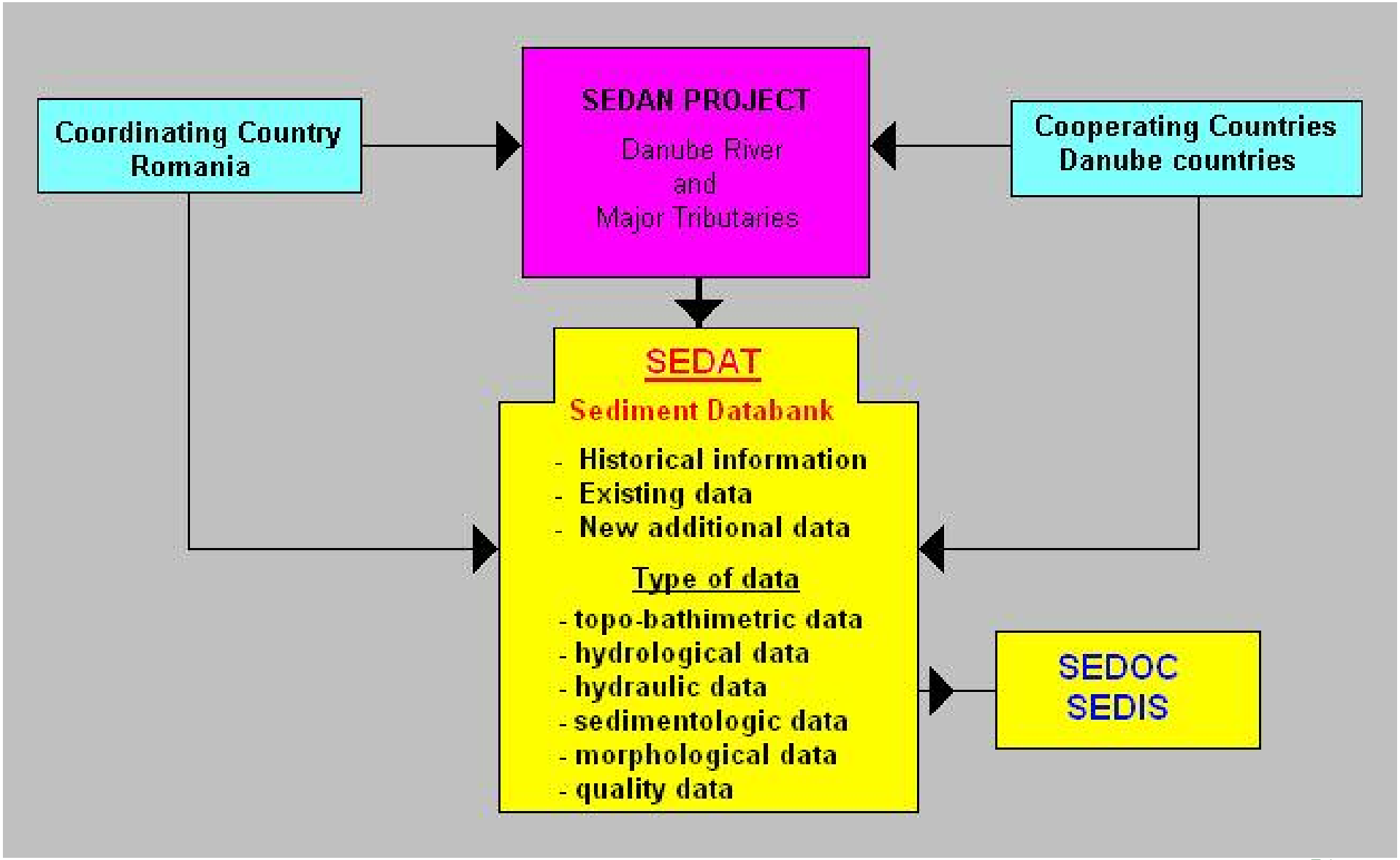
- **hydrological data**
- **sedimentological data**
- **morphological data**
- **quality data**

Type of data & information:

- **historical data**
- **existing data (from 1985 to 2000 or more)**
- **new collected data**

!!! SEDAT - freely accessible for Danube countries !!!

SEDIMENT DATABANK - SEDAT



PROJECT GOALS (2)

To establish the Current Budget and Balance of Sediment (SEDBUD & SEDBAL) In the Danube River and its major tributaries:

- **Suspended load**
- **Bed-load**
- **Total load**
- **Sediment granulometry**

!!! SEDBUD & SEDBAL - freely accessible for Danube countries !!!

PROJECT GOALS (3)

To develop and use a Danubian Computer Model SEDMOD with advanced modules for:

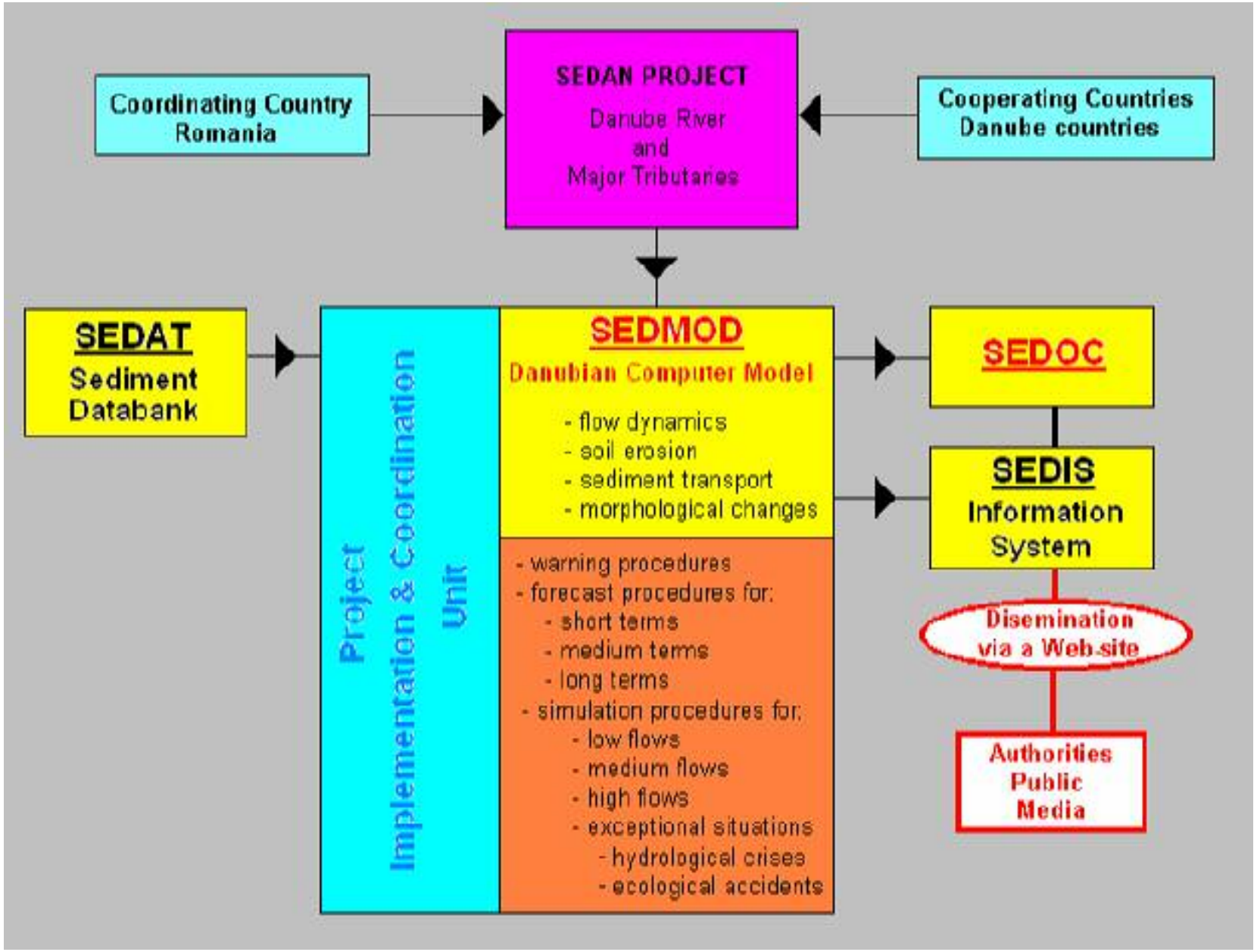
* **water flow dynamics,**
* **sediment erosion and transport,**
* **morphological river changes,**

aiming to provide:

* **warnings**
* **improved forecast procedures** — Short, medium, long term
* **calculation-simulation procedures** — Low, medium, high flows

applicable to the Danube River and its major tributaries.

DANUBIAN COMPUTER MODEL - SEDMOD



PROJECT GOALS (4)

To develop and use an Information System (SEDIS) for sedimentation-morphological status of the Danube River and its major tributaries,

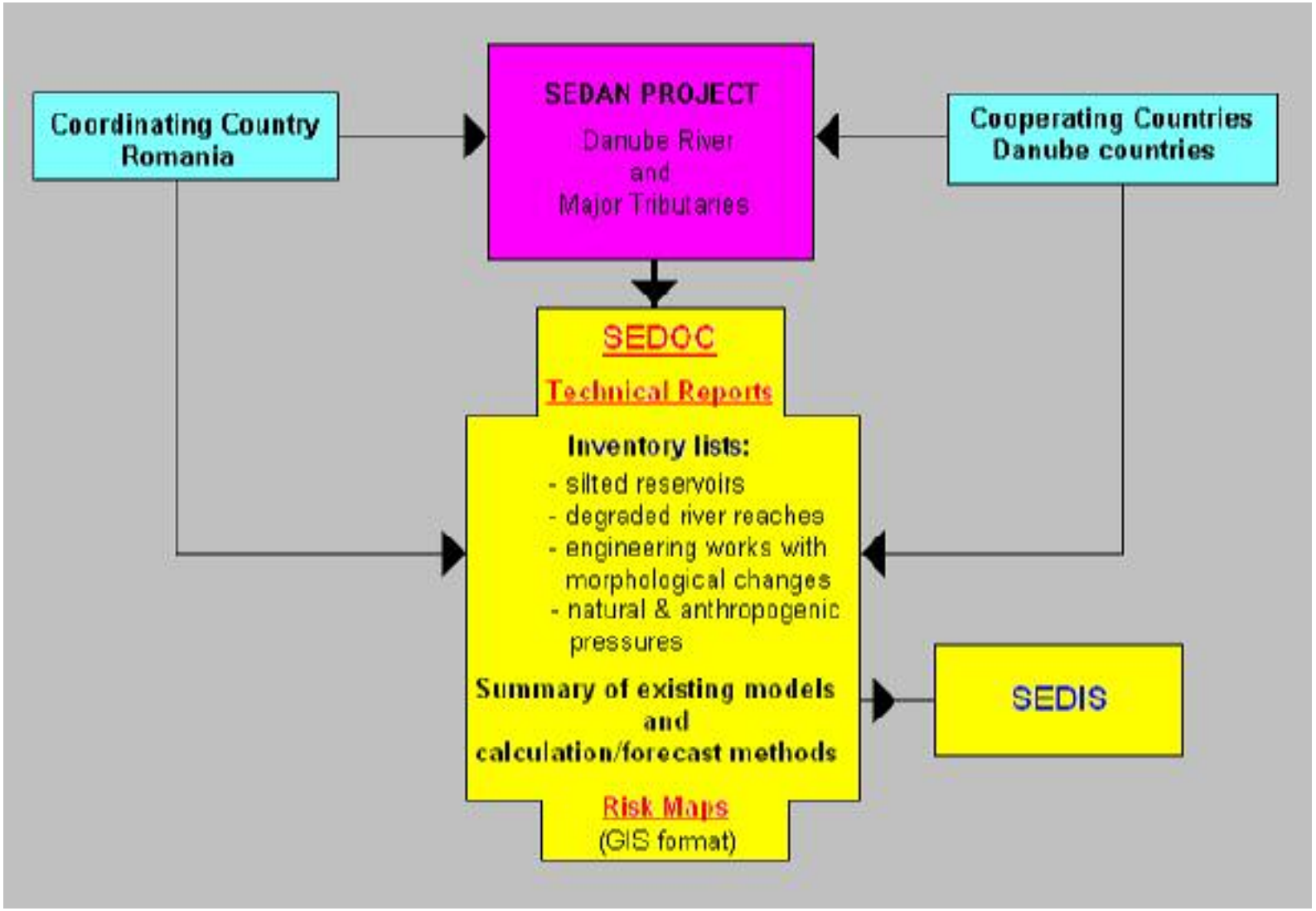
Dedicated web-site for wide dissemination for authorities, public and media:

- **Information**
- **Data**
- **Warnings**

EXPECTED PRACTICAL RESULTS

- Project Implementation & Coordination Unit **PICU**
- Technical reports and scientific papers
- Training programmes for specialists from Danube countries
- Workshops and meetings

PROJECT OUTPUTS



FINANCING & BANKABILITY

- Estimated total amount: 2.0 MEuro
- Sharing between Danube countries: 0.8 MEuro
  from which:
  - contribution of Romania: 0.3 MEuro
  - contribution of other countries: 0.5 MEuro
- Needs for external support: 1.2 MEuro


Thank You
Very Much