

# Environmental Flows

## Principals, approaches, calculations

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# Presentation Contents

- Definition of Environmental Flow
- Environmental Flow and IWRM
- Environmental Flows Methodologies
- Choosing the right method for EF
- Challenges for successful E-flows implementation
- How can an E-Flows assessment be incorporated into river basin management planning



# Definition of Environmental Flows

- Environmental Flows can be defined as *“the **water regime** provided within a river, wetland or coastal zone **to maintain ecosystems and their benefits**”*

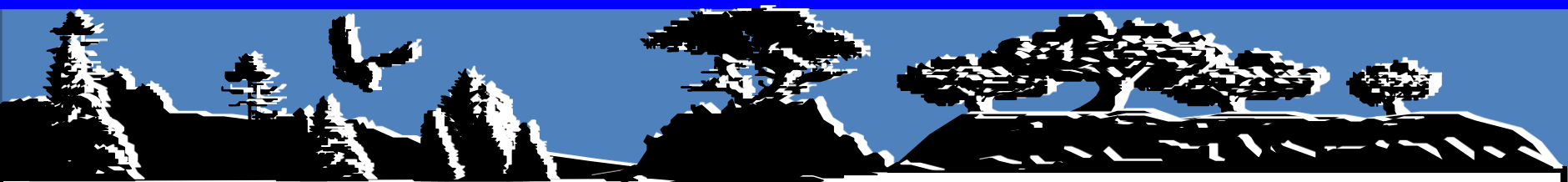


# Definition of Environmental Flows

- Despite the **growing recognition** of the value and importance of environmental flows, assessment of flow requirements to sustain environmental needs **still has a low priority** in water management
- A major obstacle for implementation is **lack of understanding** among stakeholders for the socio-economic cost and benefits associated with its implementation and a **lack of political will**



# What is the economic value of ecosystems?



## Total economic value of ecosystems

### Use

### Non use

#### Direct values

Outputs that can be consumed directly, such as fish, medicines, wild foods, recreation, etc.

#### Indirect values

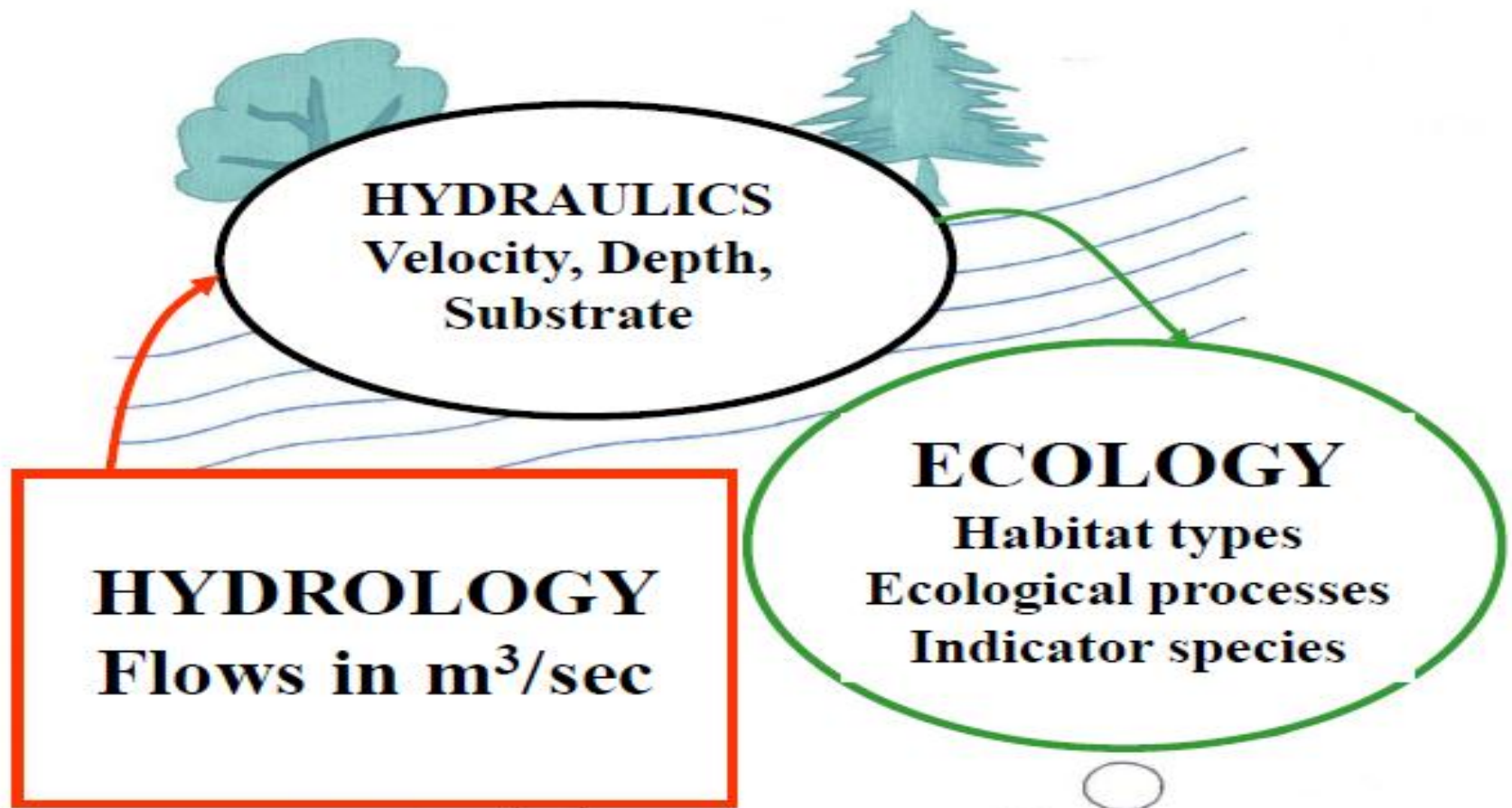
Ecological services, such as catchment protection, flood control, carbon sequestration, climatic control, etc.

#### Option values

The premium placed on maintaining resources and landscapes for future possible direct and indirect uses, some of which may not be known now.

#### Existence values

The intrinsic value of resources and landscapes, irrespective of its use such as cultural, aesthetic, bequest significance, etc.



**The Engineer**



**The Ecologist**





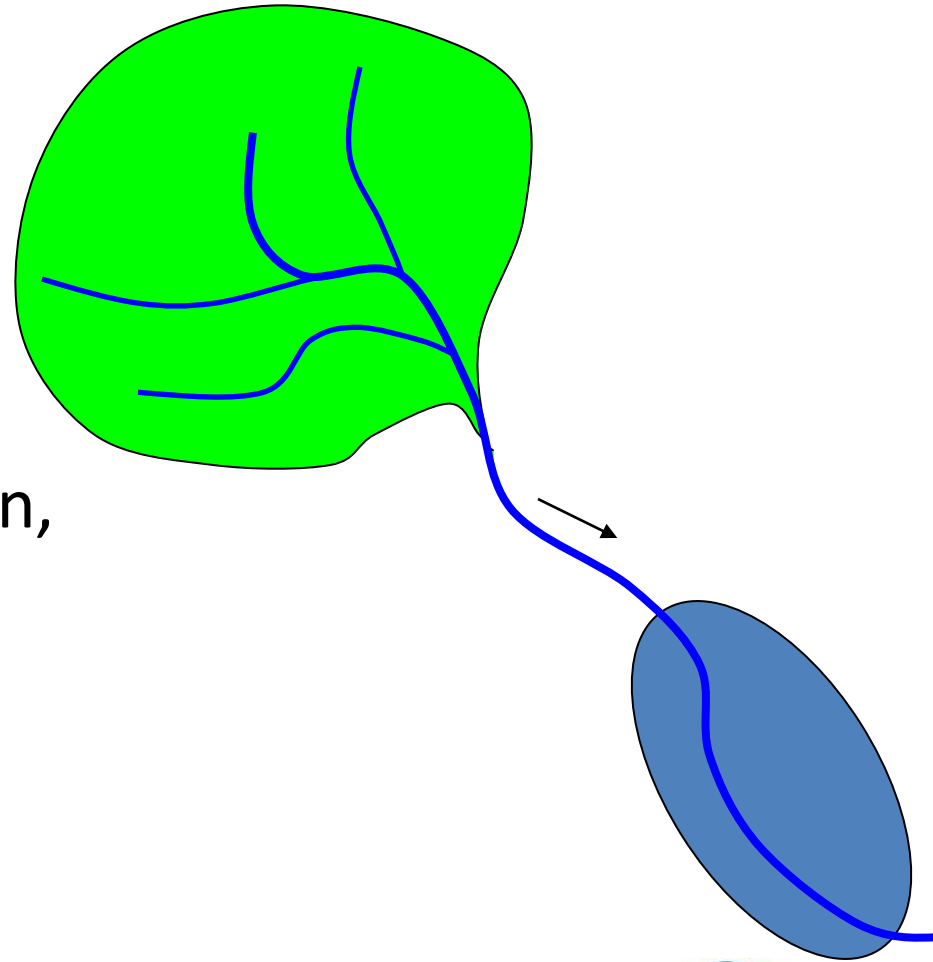
# Environmental Flows and IWRM

- The environment is linked to IWRM in three fundamental ways:
  - First, the **aquatic ecosystem** provides **habitat** for fish, invertebrates, and other fauna and flora.



# Environmental Flows and IWRM

- Second, the **design** and **operation** of hydraulic **infrastructure** for water supply, sewerage, irrigation, hydropower, and flood control often **affect ecosystems**





# Environmental Flows and IWRM

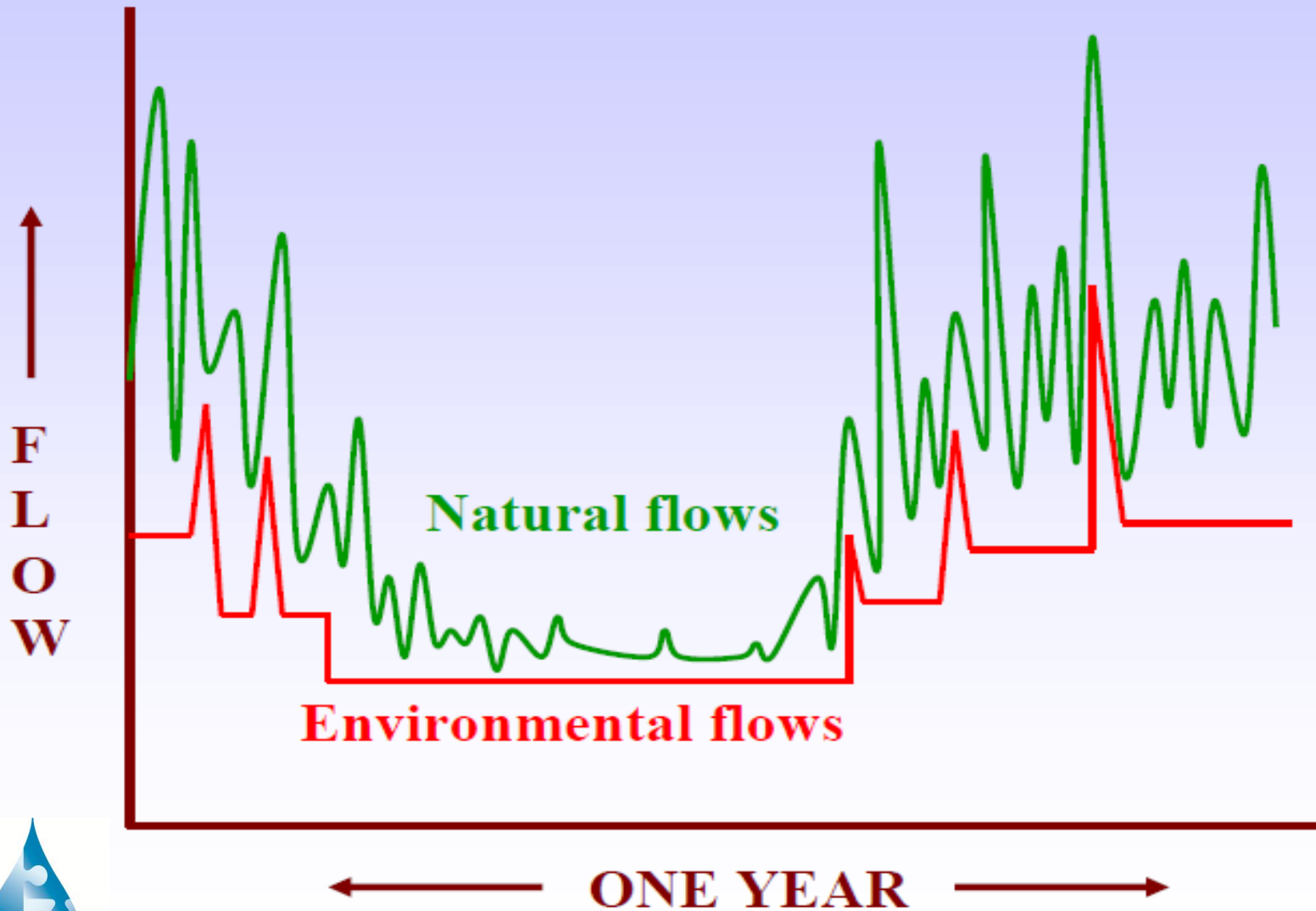
- Third, integrated water resources planning and management are facilitated by policies, laws, strategies, and plans that are **multi sectoral**, based on :
  - The allocation of water for **all uses**;
  - The protection of **water quality** and control of pollution;
  - The protection and **restoration** of lake basins, watersheds, groundwater aquifers, and wetlands;
  - Control and management of **invasive species**
- An important part of IWRM is about **balancing** water between **different users** including the **ecosystem**



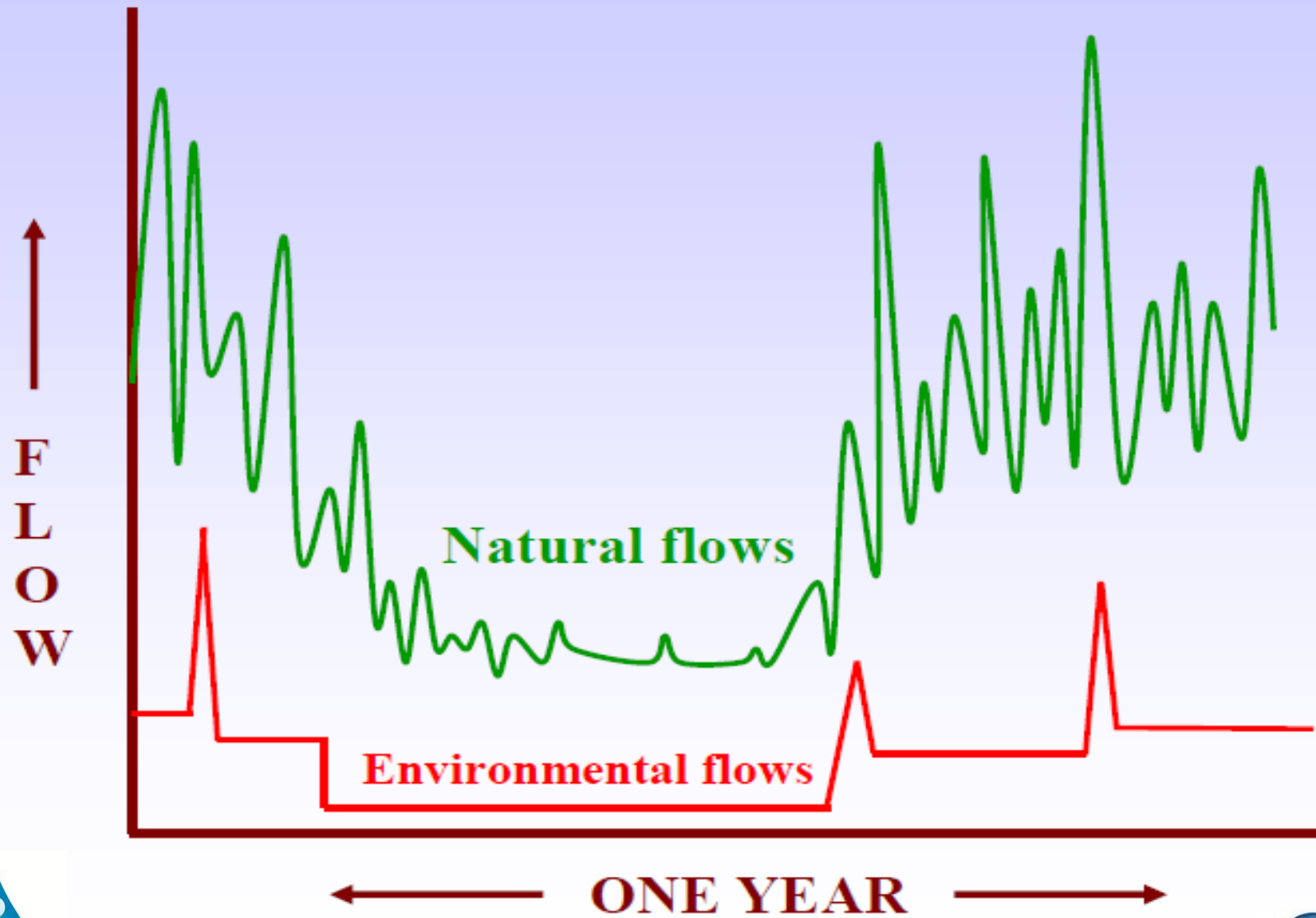
# Environmental Flow varies based on area type and land use



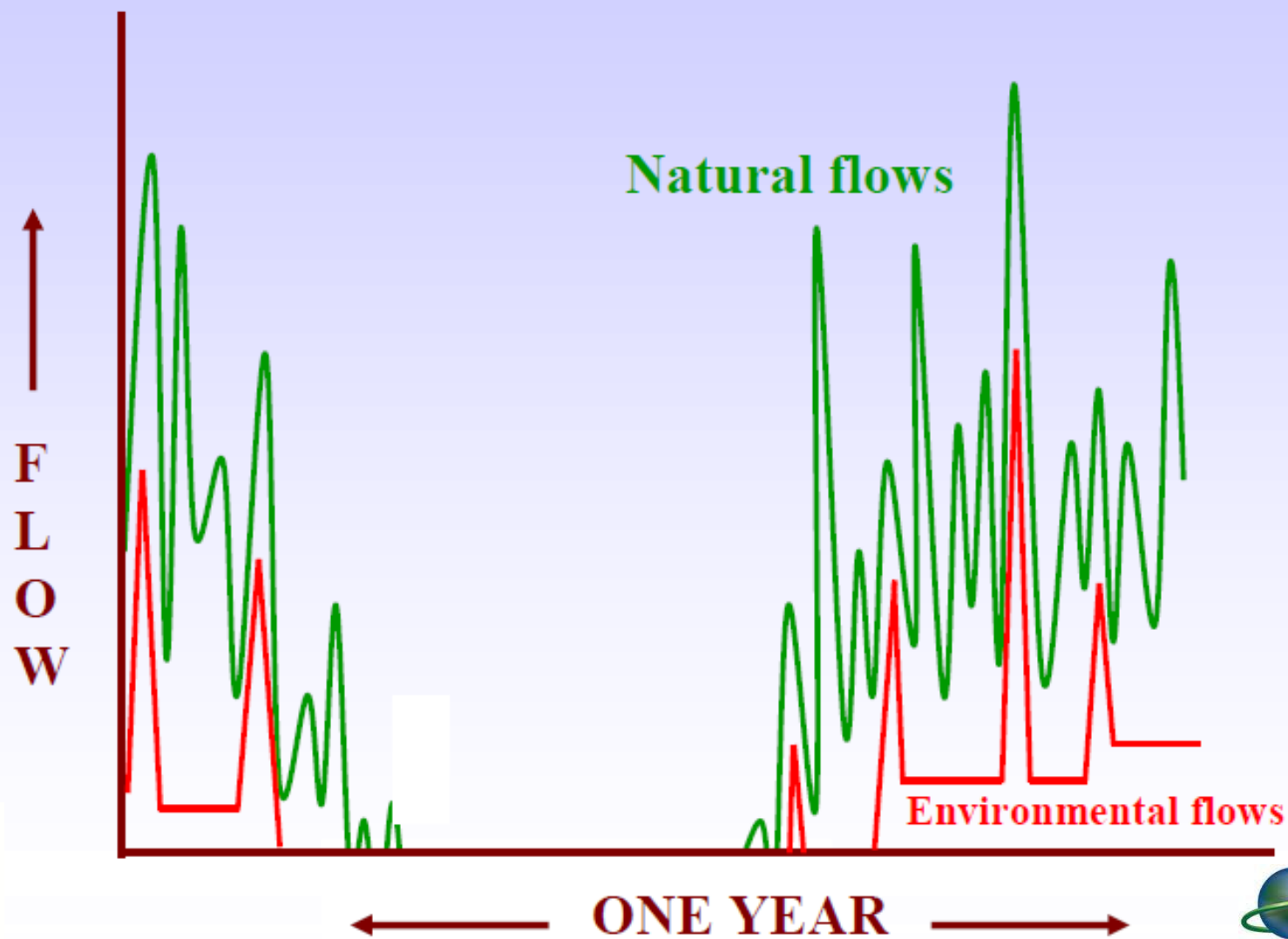
# RIVER FLOWING THROUGH A CONSERVATION AREA



# RIVER FLOWING THROUGH AN URBAN AREA



## A TEMPORARY RIVER (NO FLOW IN THE DRY SEASON)



**Legislators & Managers**

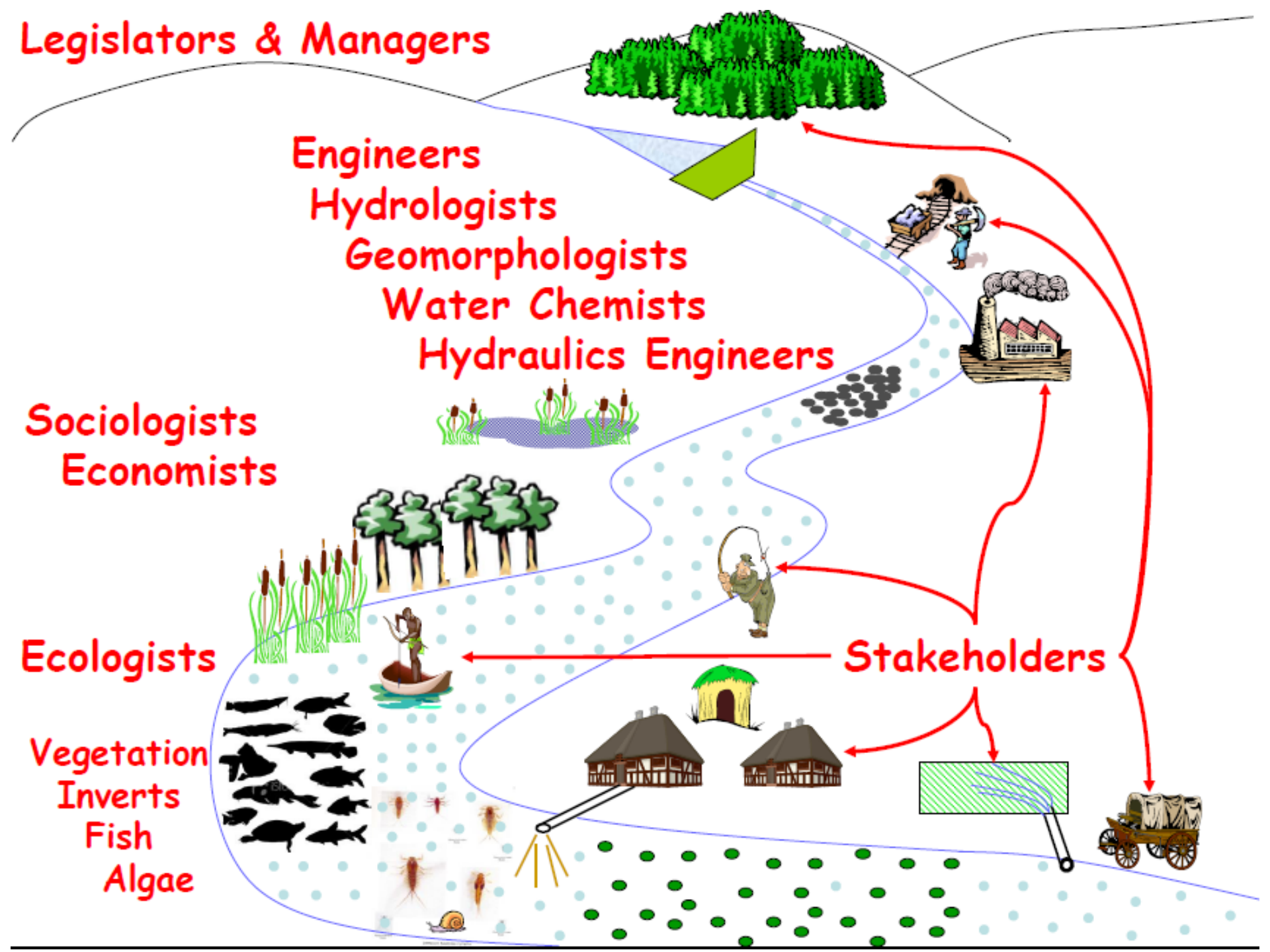
**Engineers  
Hydrologists  
Geomorphologists  
Water Chemists  
Hydraulics Engineers**

**Sociologists  
Economists**

**Ecologists**

**Vegetation  
Inverts  
Fish  
Algae**

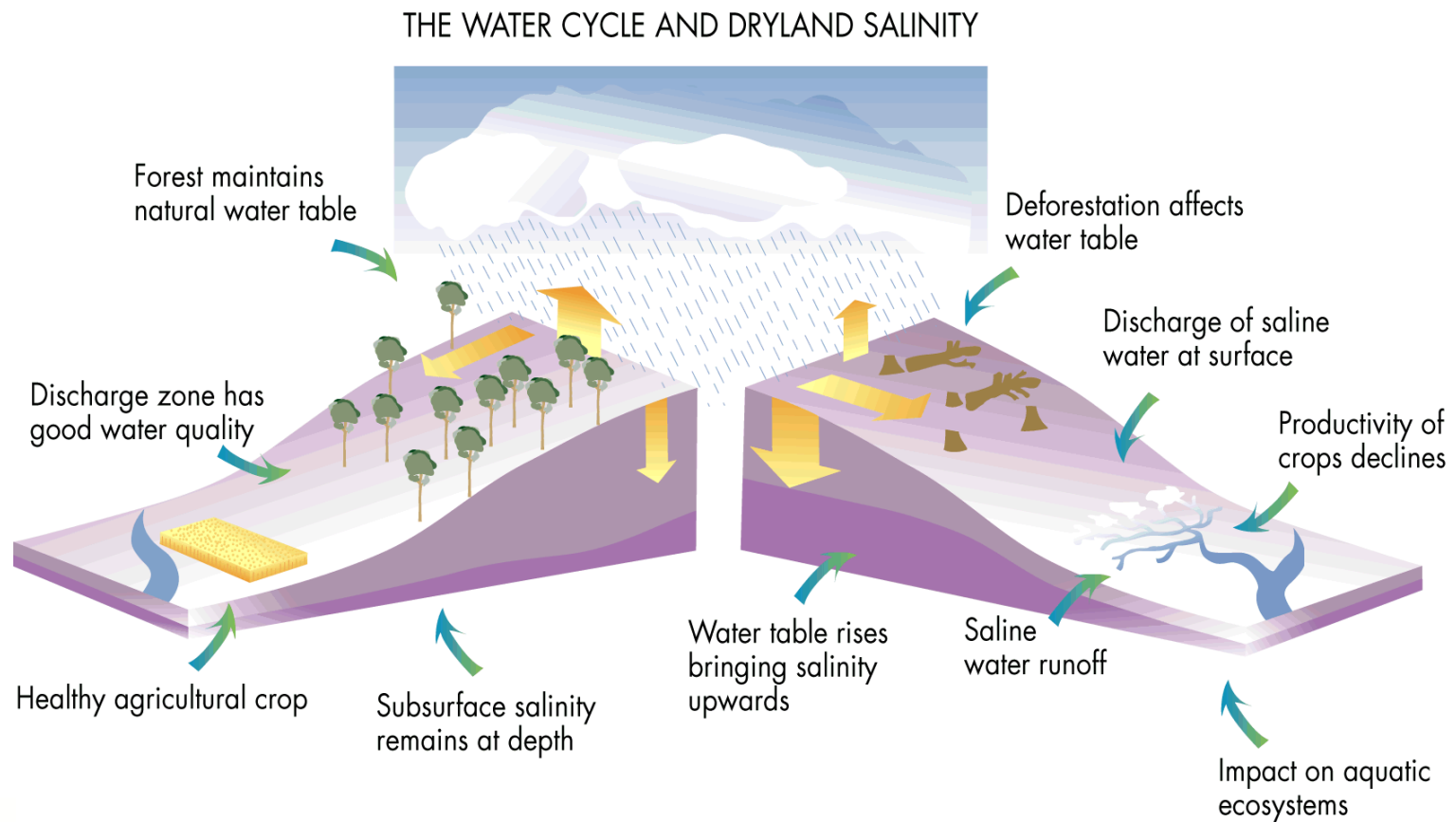
**Stakeholders**





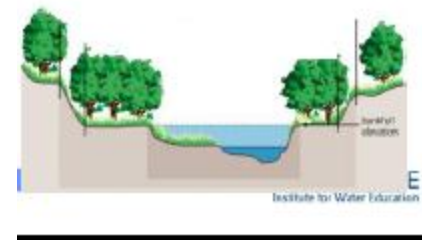
# In practice not so simple...

## complex biophysical linkages (Brand 2003)



# Some key Points

- Flow is a “**Master Variable**”
- Must consider **variations** for wet, dry and average years
- **Spatial** and temporal **variability**
- Importance of **adaptive** management


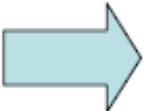
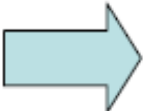
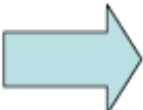


# Environmental Flows: Adoption and Methods

- In 2003, a survey revealed the existence of **207** individual methodologies EF Calculations
- They fall into **four** discrete groups:
  - **Hydrological** index methods,
  - **Hydraulic** rating methods,
  - **Habitat** simulation methods,
  - **Holistic** methodologies



# Categories of environmental flows methodologies and examples

1. Hydrologic 
  - Tennant
  - $Q_{90}$
2. Hydraulic rating 
  - Wetted perimeter method
3. Habitat simulation 
  - IFIM
  - PHABSIM
4. Holistic methods 
  - Building Blocks Methodology (BBM)

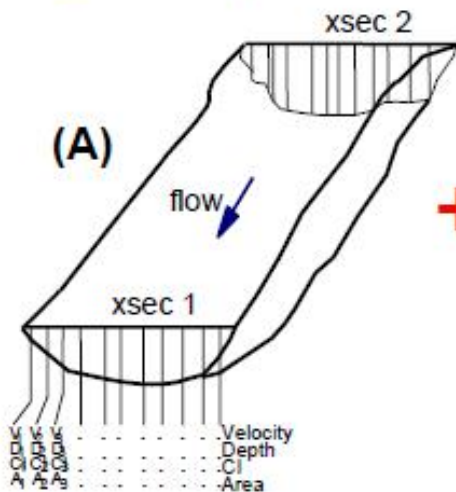




# Habitat simulation methodologies

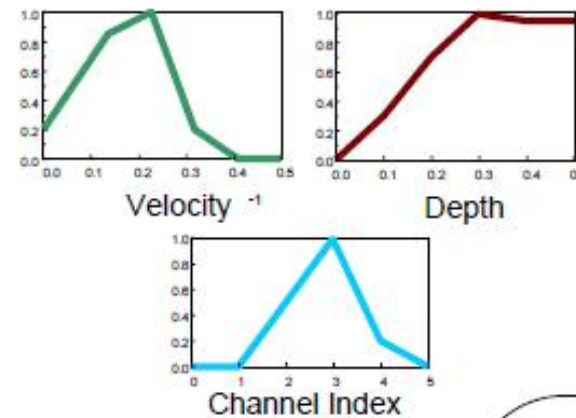


e.g. IFIM/PHABSIM



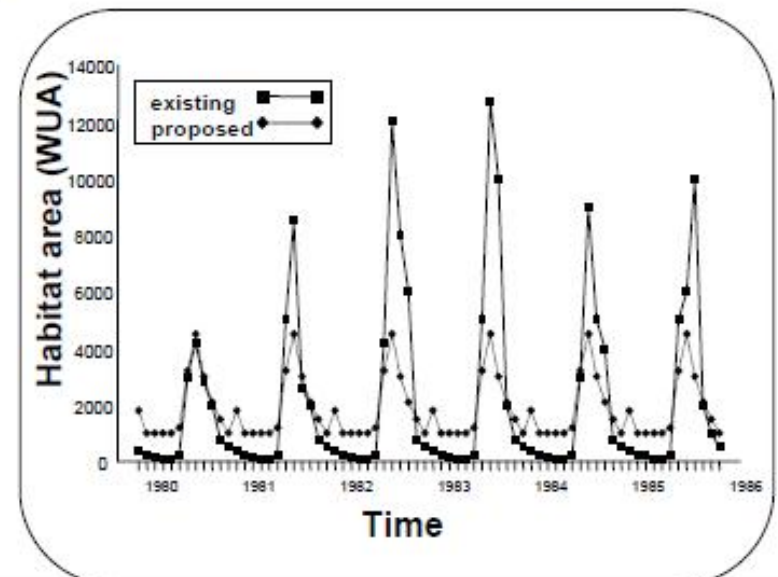
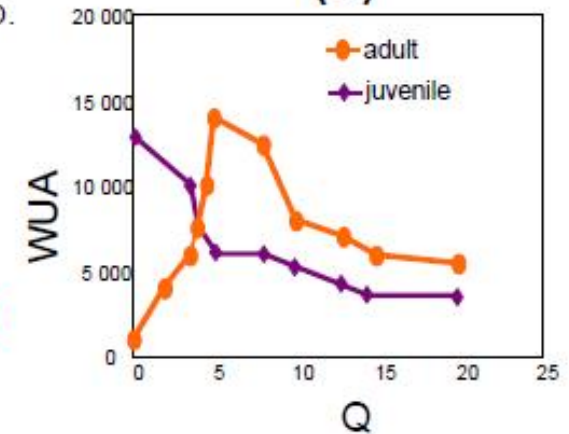
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(B) Habitat suitability curves for target sp.



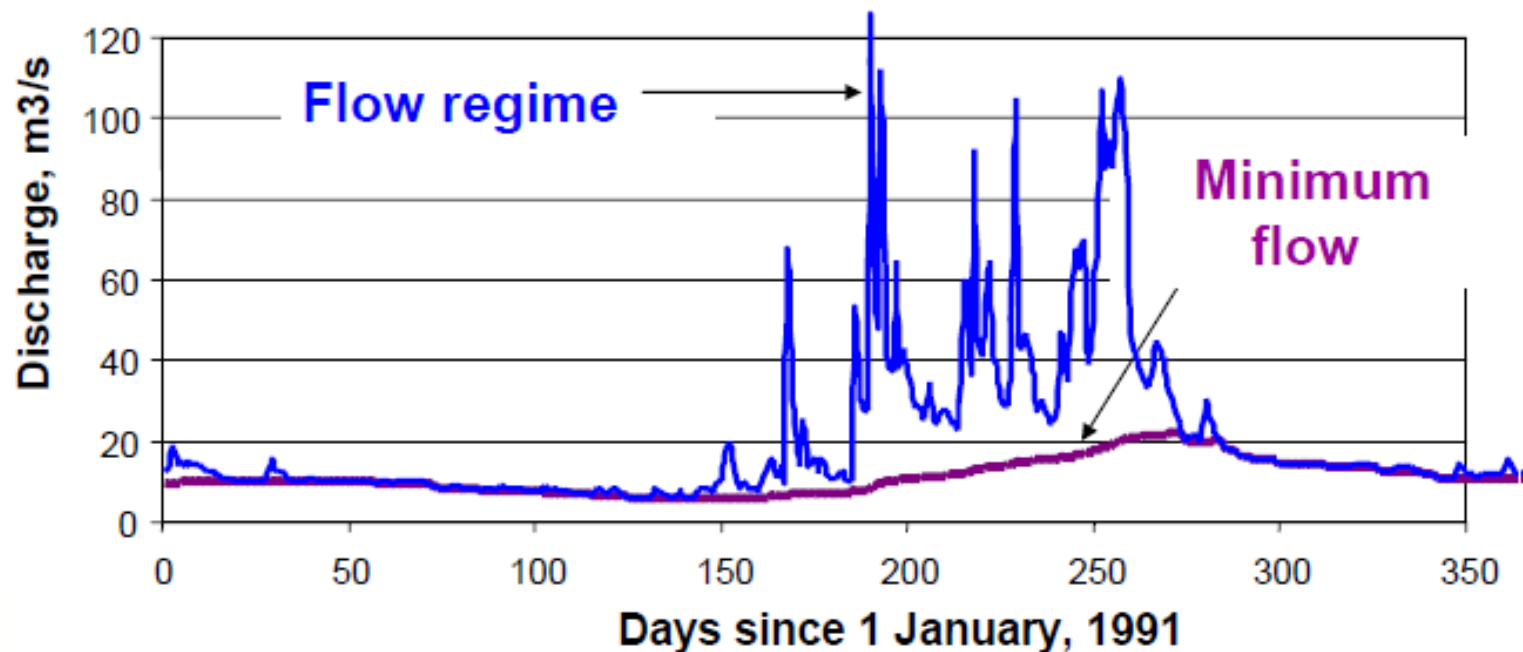
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(C)



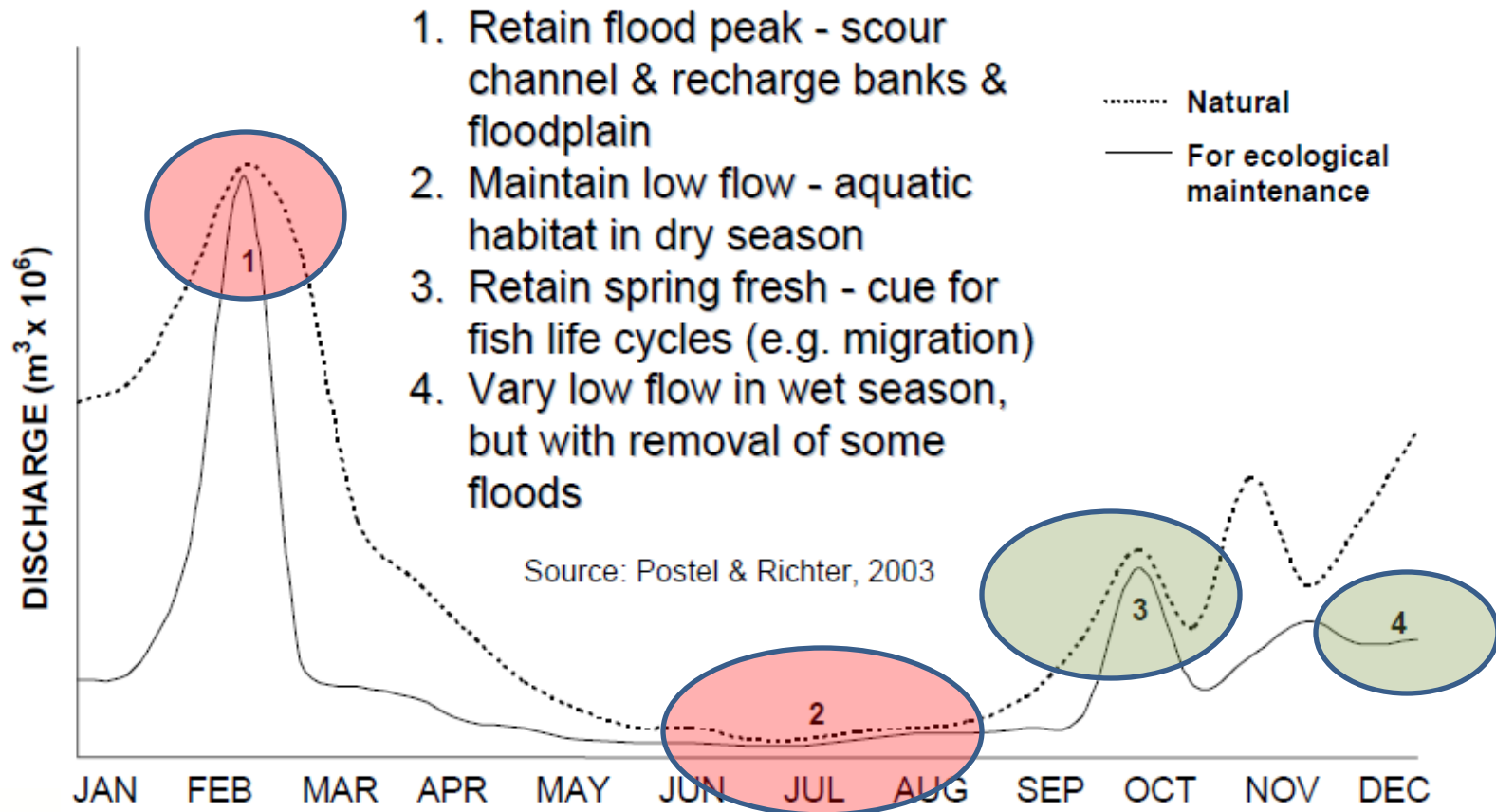
# Shift from minimum flow to flow regime:

- \* magnitude, frequency, duration, timing, rate of change
- \* flow components (low flows, freshes, floods)

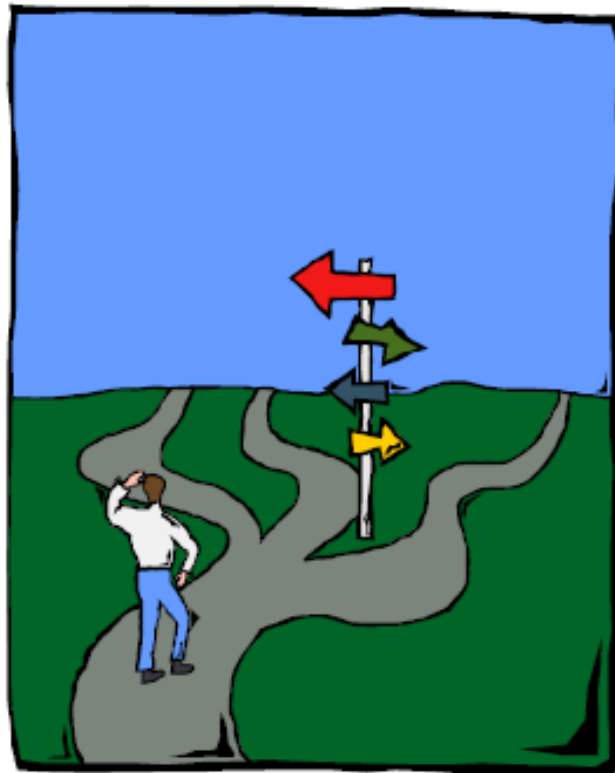




# Holistic Methodologies: natural flow paradigm



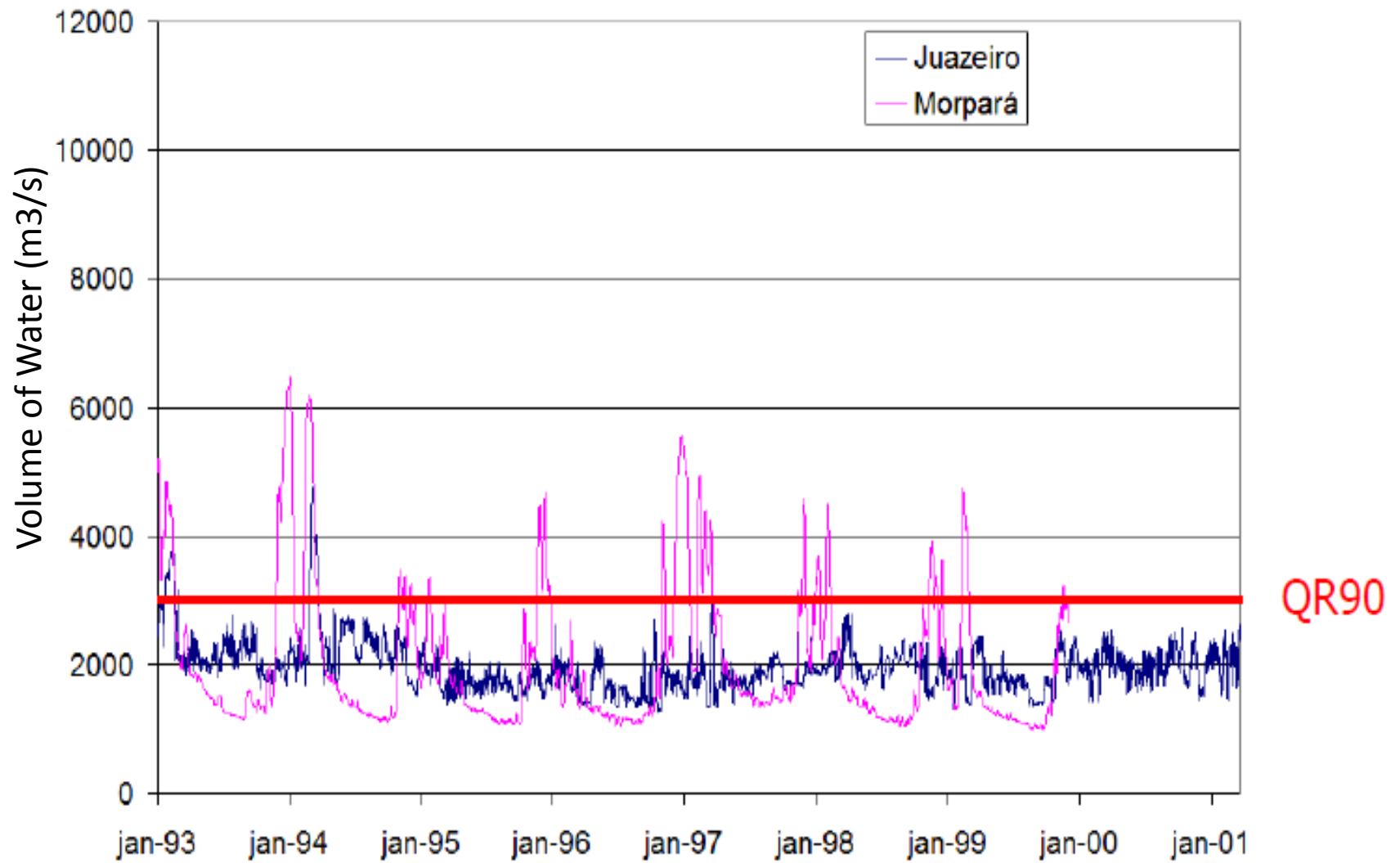
# Choosing the right method



# Hydrological methodologies: strengths and deficiencies

- Simple, rapid, inexpensive desktop approaches
- Low data needs, primarily flow data
- Suitable for water resource planning purposes
- Potential for regionalization for different river ecotypes
- Simplistic, inflexible, low resolution output
- Direct ecological links absent or limited
- Dynamic nature of flow regime seldom addressed
- Suitable for low controversy situations





# Habitat simulation methodologies strengths and deficiencies

- High resolution habitat-flow relationships for target species
- Generate alternative e-flow scenarios for different species
- Advanced technical support
- Focus on target species, not whole ecosystem
- Not applicable for some ecosystem components
- Limited links with characteristics of flow regime
- Output restricted to flow-hydraulic habitat relationships
- Resource intensive relative to output
- Poor links with biological responses to flow change



# Holistic methodologies strengths and deficiencies

- Whole-ecosystem focus
- Generates alternative environmental flow scenarios for different ecological and social conditions
- Use of interdisciplinary expert judgment in structured, consistent process
- Usable in data rich and data poor contexts (use of available techniques and understanding)
- Explicit links with characteristics of flow regime and with biological and social responses to flow change
- Reliant on expert judgment
- Difficulties in reconciling opinions of different experts
- Moderate to high resource demands







# Environmental Flows Methodology

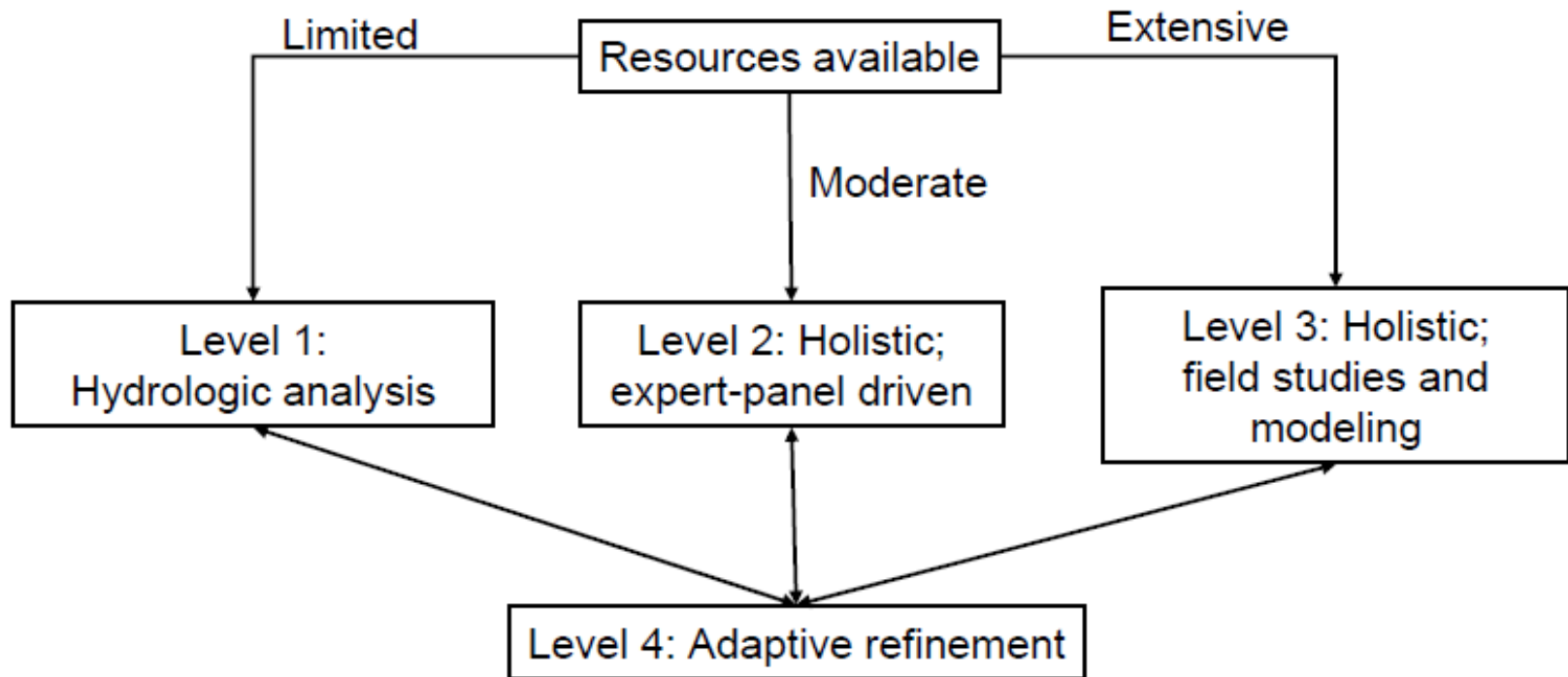


- The process emphasized three main aspects to the approach and methodology employed
  - awareness raising and education
  - field assessments
  - Scenario building and multi stakeholder dialogue workshops.

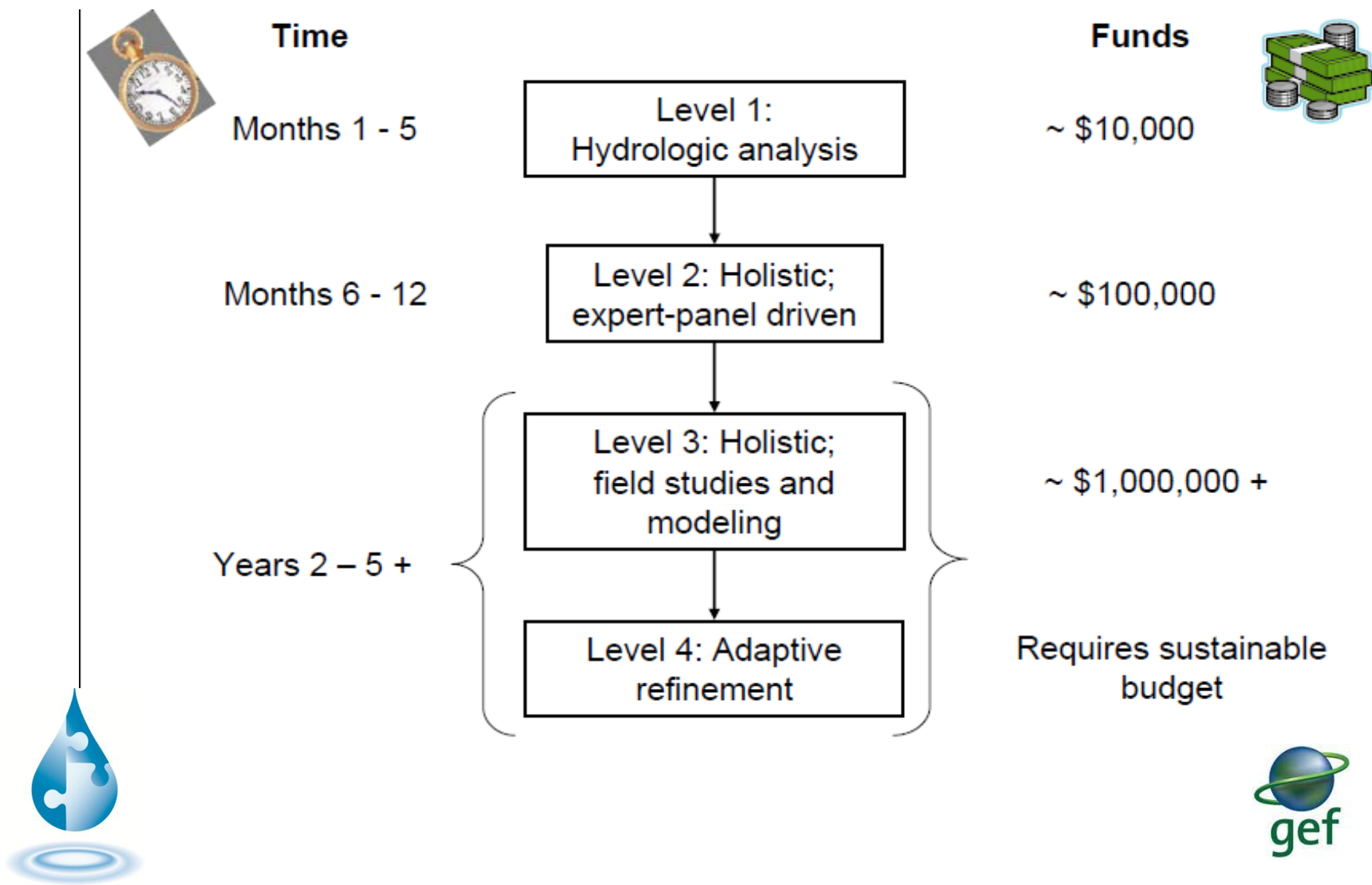
Table 1. Levels of Environmental Flows Assessments (EFA) - implications					
Method	Resources	Time	Confidence	Resolution	Status
Desktop - rapid	Low	2 days – 2 weeks	Low	Low	Planning guide
Intermediate	Medium	8 weeks	Medium	Medium	Preliminary EFA
Comprehensive	High	32 weeks	Medium / High	Medium / High	Full EFA

(Source: Tharme, 2007. E-Flows Scenarios Workshop, Udon Thani)

# Choosing the Right Method



# Choosing the Right Method



# Challenges for Successful E-flows Implementation

- Development of **policy and legislation** on resource protection, which would legitimize sustainable use.
- Establishment of **national research programmes** to increase the knowledge base and identify links between ecosystems and flows.
- Use of the **best available knowledge** from focused short-term research to answer immediate management questions and move ahead despite limited knowledge.



# Challenges for successful E-flows implementation

- Use of **structured, transparent** processes for options **assessment** and decision-making,
- **Learning by doing**, through the **monitoring** of the outcomes of the chosen option.
- Use of **strategic adaptive management** by adjusting management plans where indicated by monitoring results.



# How can an E-Flows assessment be incorporated into river basin management planning?

- *Understanding **stakeholder needs** and increasing awareness*
- *Setting **legislation**, standards and **guidelines***
- *Understanding **river use** and addressing tradeoffs*
- *Increasing **inter-sectoral** communication and coordination*
- *Setting **goals** and **monitoring** results*
- *Implementing **research** programmes*





# ***Are there any regional conventions on environmental flows?***

- **No**, there is no regional convention that deals specifically with environmental flows.
- **However** there are **treaties**, such as the Mekong River Agreement, which sets up the framework for cooperation between riparian States in all fields of the basin's sustainable development for the protection of ecosystems.
- **Sub national** agreements, such as the Murray Darling Basin Initiative in Australia



# What is the best way forward with transboundary E-Flows Assessments?

- *Transboundary **commitment** and legislation*
- *Addressing **imbalances** and **responsibilities***
- *Develop **research** and **monitoring** Programs*



# Conclusions

- Environmental flows is a **multi disciplinary** process that is take into consideration all the ecosystem needs as well as human needs
- Application of Environmental Flow **Restore** over-allocated rivers and consequently **improve** the functioning of downstream wetlands
- Flow **assessment** can also aid in finding the required **reduction** in **pollution** levels



# Conclusions

- Assessing rivers with (currently) **sufficient** water can reveal the **maximum** possible **abstractions**
- Even when there seems to be plenty of water the altered distribution over the year may have an impact on the fauna and flora of the ecosystem, the **Temporal distribution** of flow is also of great importance
- Environmental Flow **is not only** allocation of certain quantity over time, but it also require maintaining **certain quality** of this flow



# Thank you

