

Environmental Flows

Principals, approaches, calculations

By

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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**”*

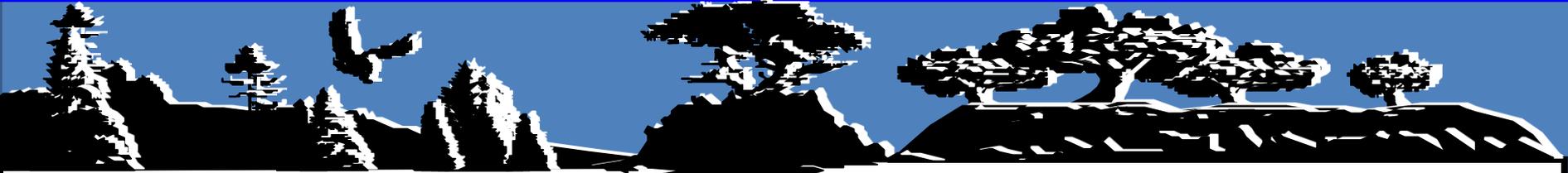


Definition of Environmental Flows

- 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.



HYDRAULICS
Velocity, Depth,
Substrate

ECOLOGY
Habitat types
Ecological processes
Indicator species

HYDROLOGY
Flows in m^3/sec



The Engineer

The Ecologist



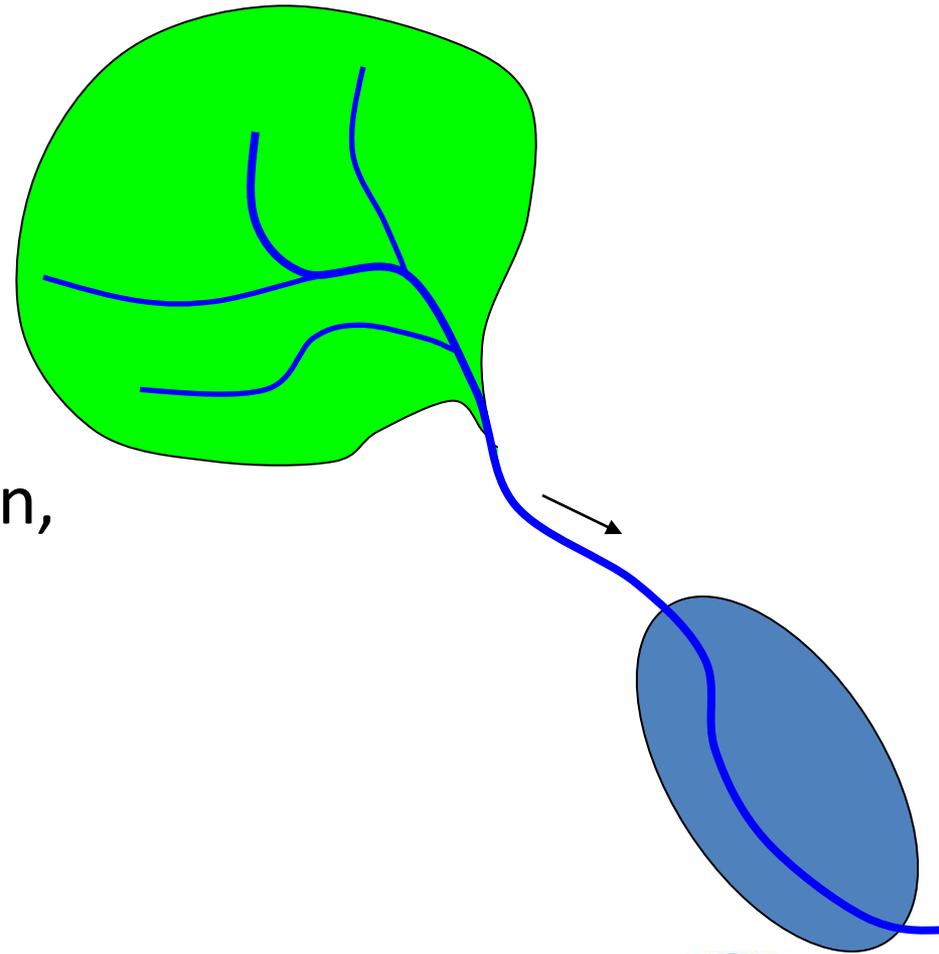
Environmental Flows and IWRM

- 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

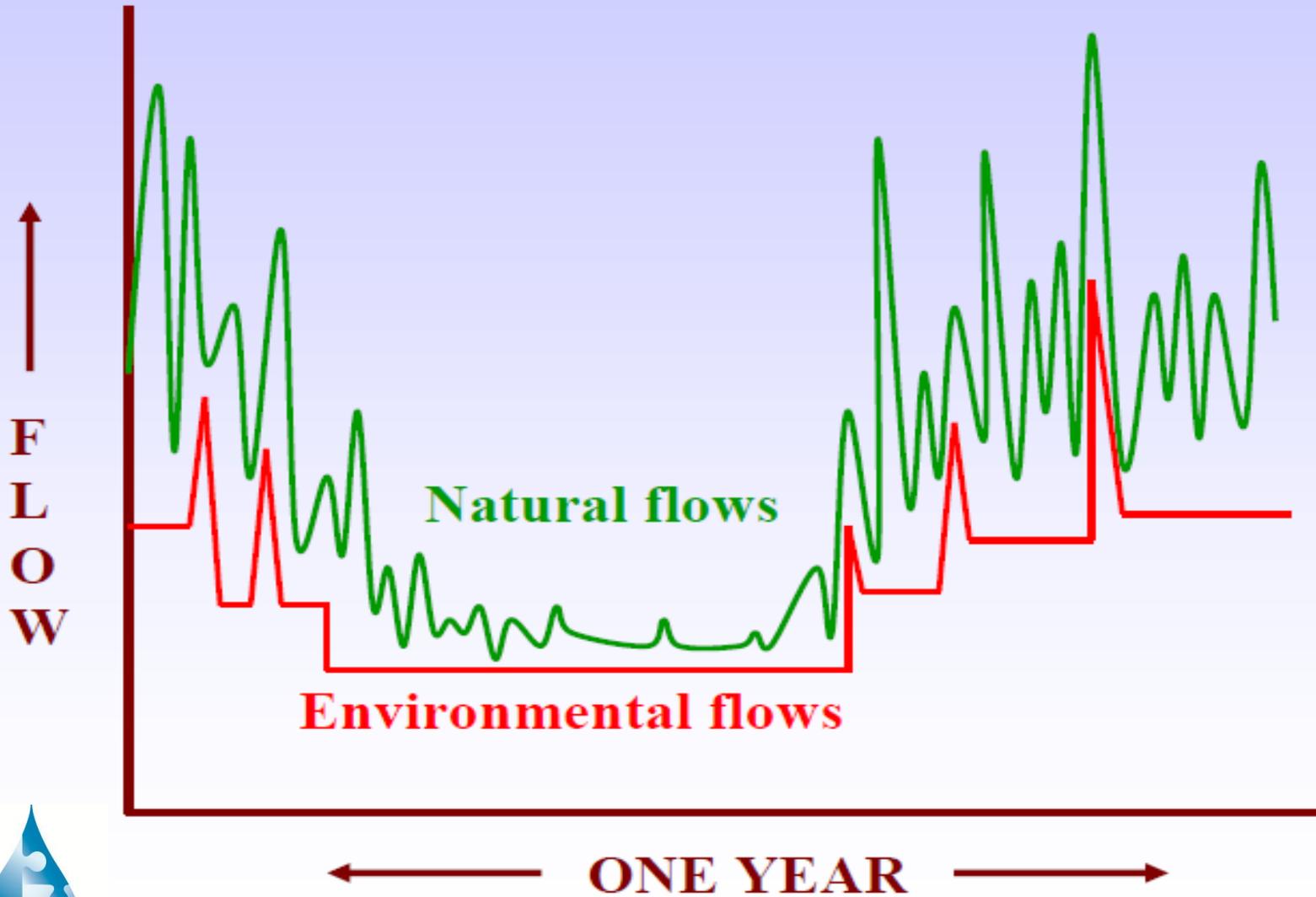
- Third, integrated water resources planning and management are facilitated by policies, laws, strategies, and plans that are **multi sectoral**, based on :
 - The allocation of water for **all uses**;
 - The protection of **water quality** and control of pollution;
 - The protection and **restoration** 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

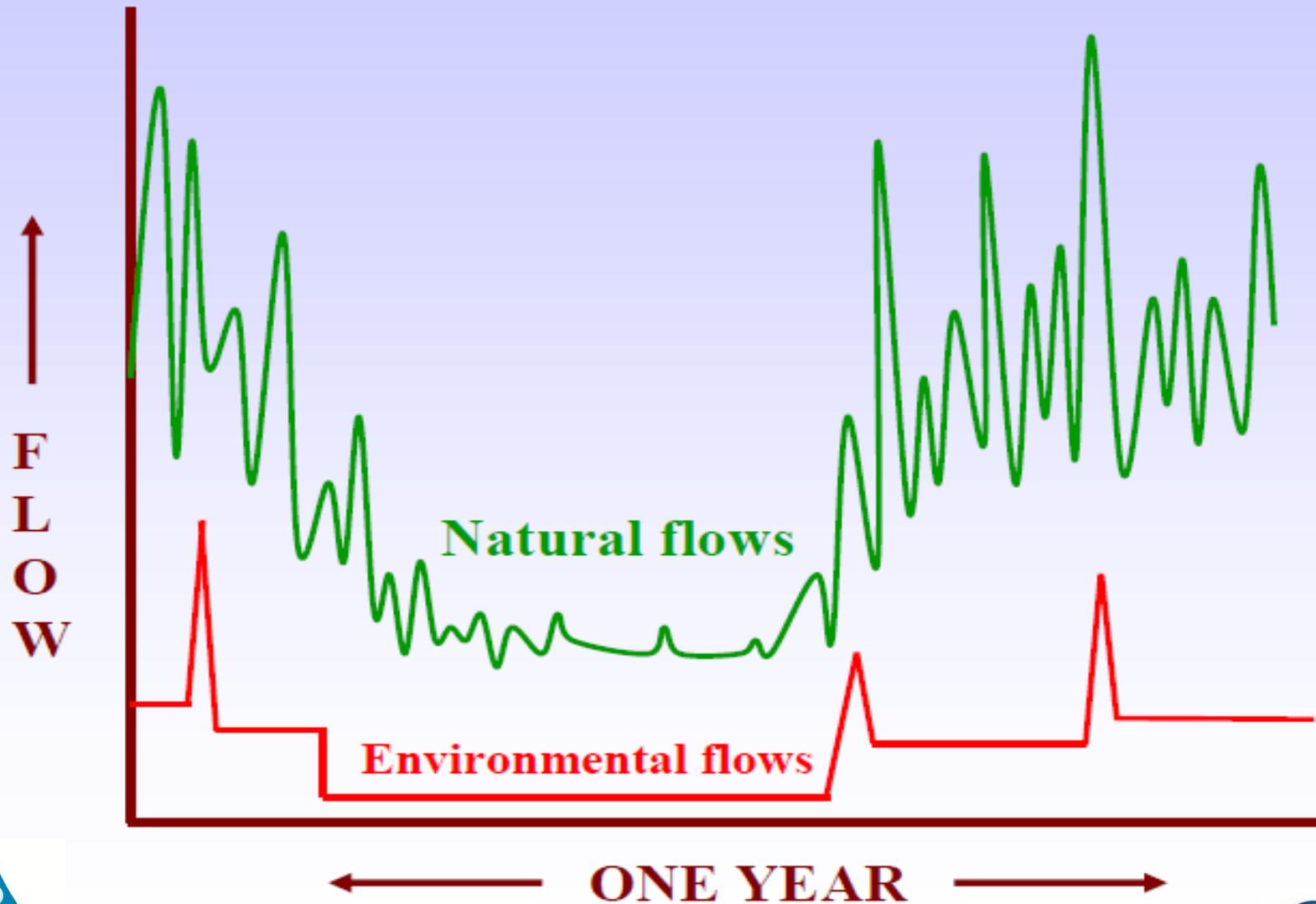


RIVER FLOWING THROUGH A CONSERVATION AREA

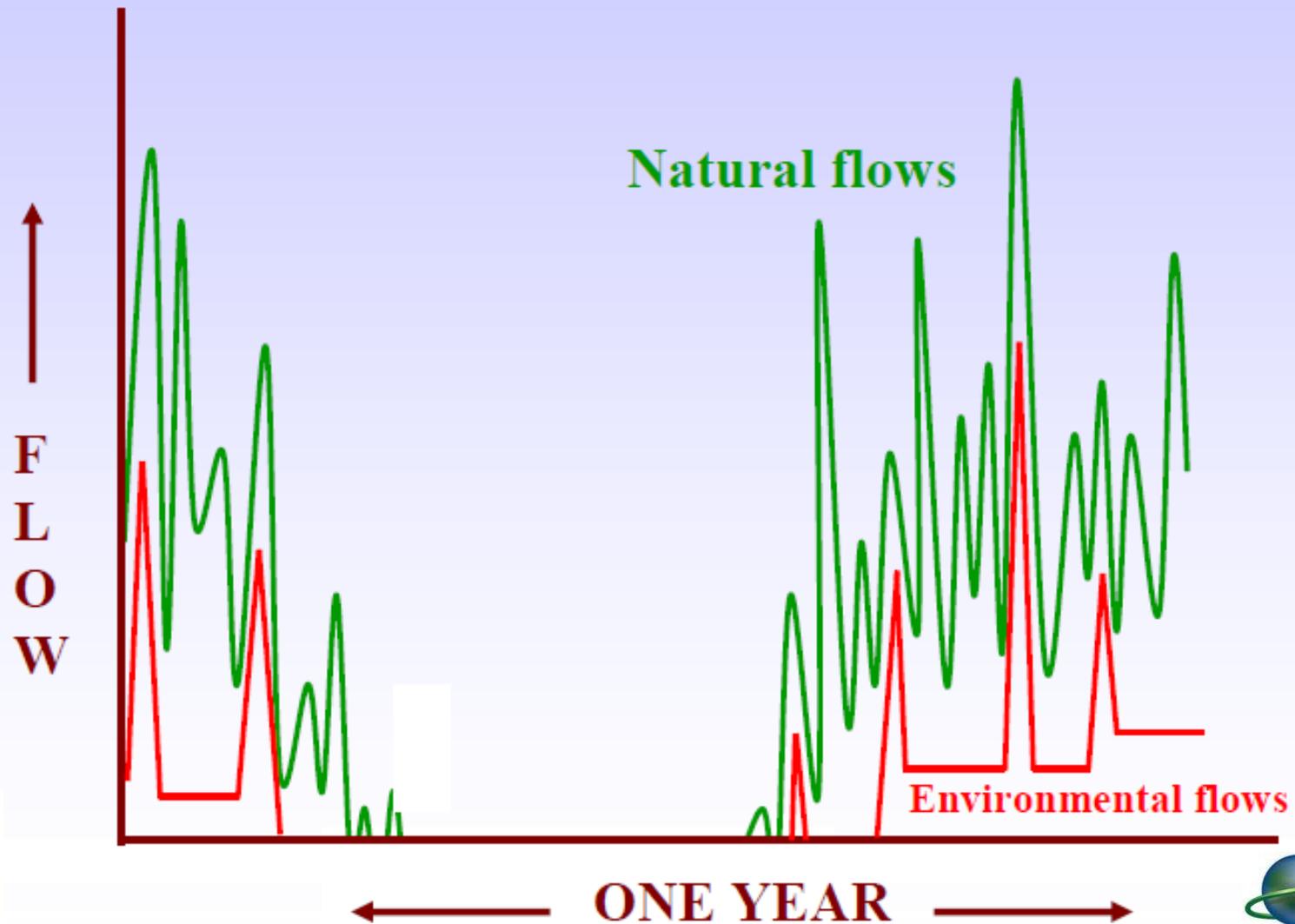


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RIVER FLOWING THROUGH AN URBAN AREA



A TEMPORARY RIVER (NO FLOW IN THE DRY SEASON)



Legislators & Managers

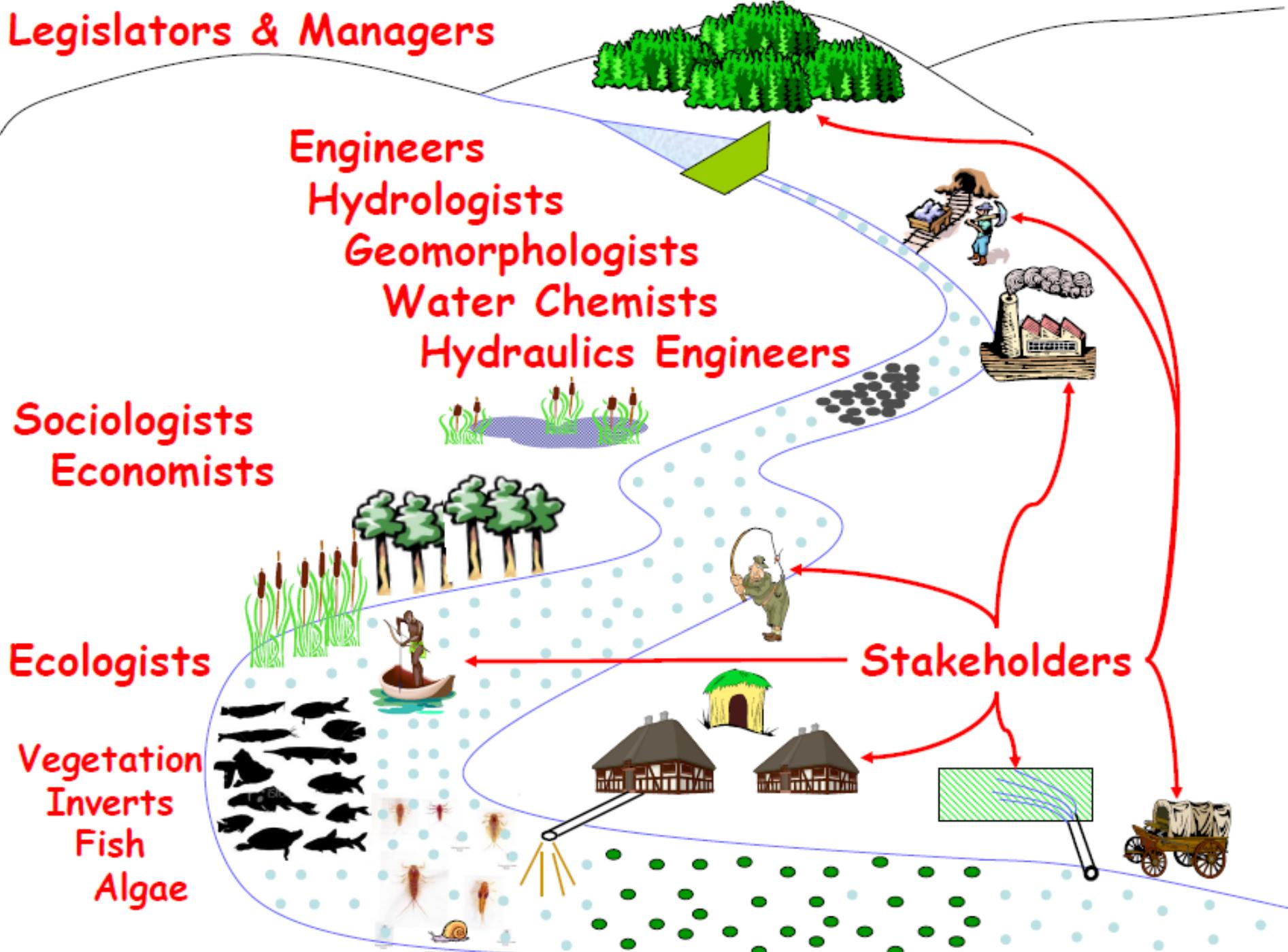
**Engineers
Hydrologists
Geomorphologists
Water Chemists
Hydraulics Engineers**

**Sociologists
Economists**

Ecologists

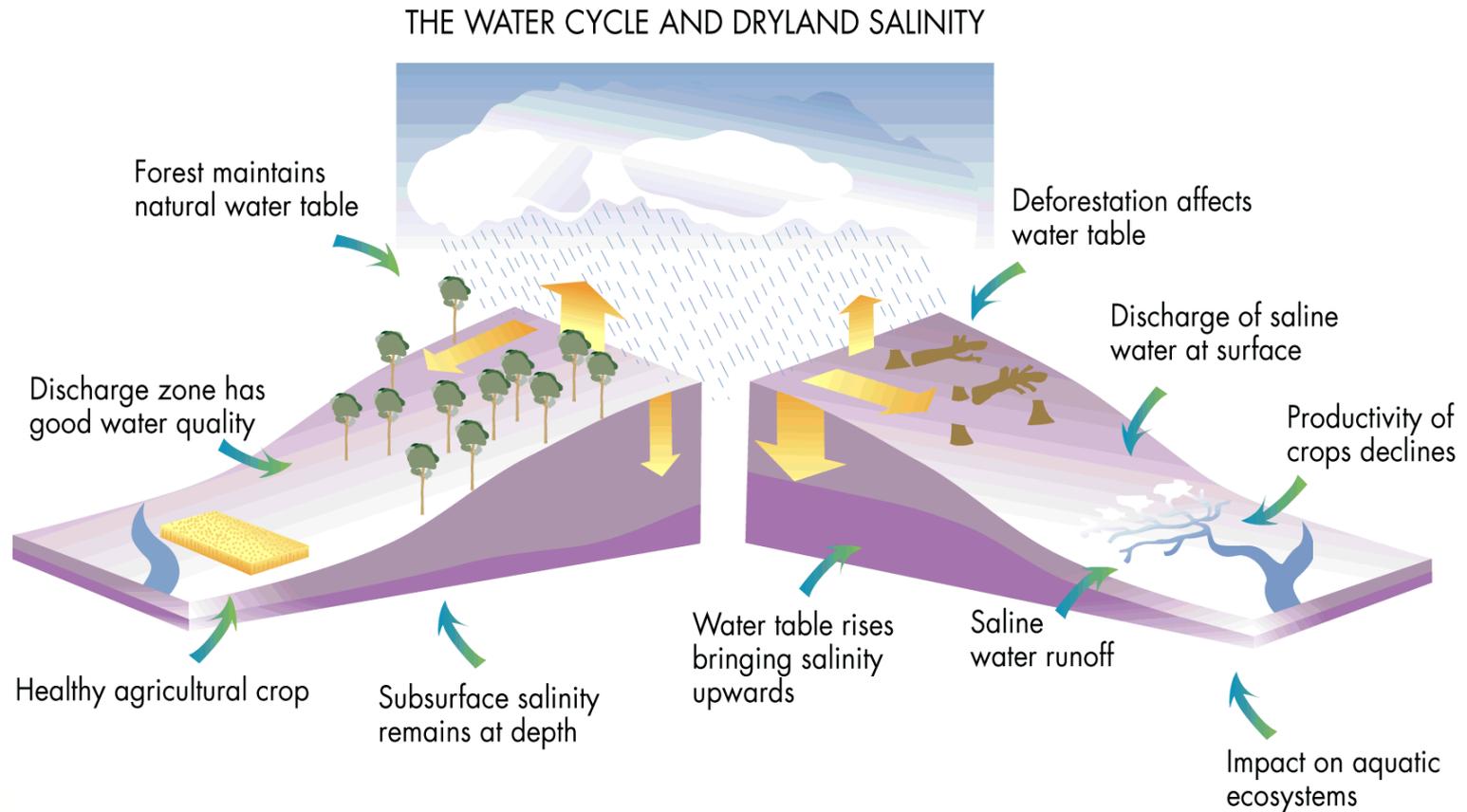
**Vegetation
Inverts
Fish
Algae**

Stakeholders



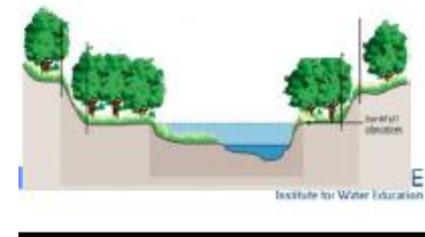
In practice not so simple...

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

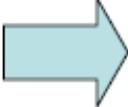
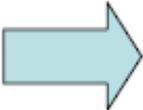
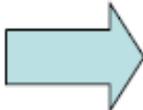
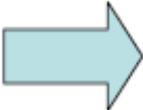


Environmental Flows: Adoption and Methods

- 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)

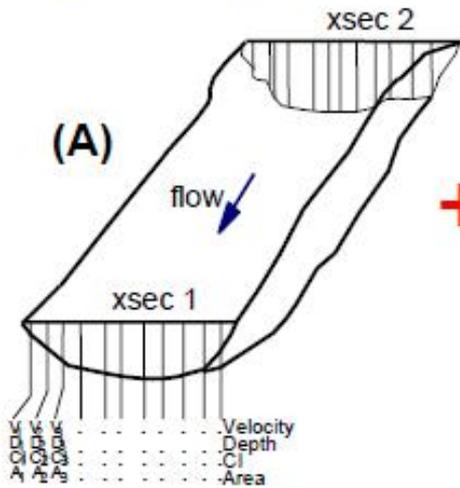




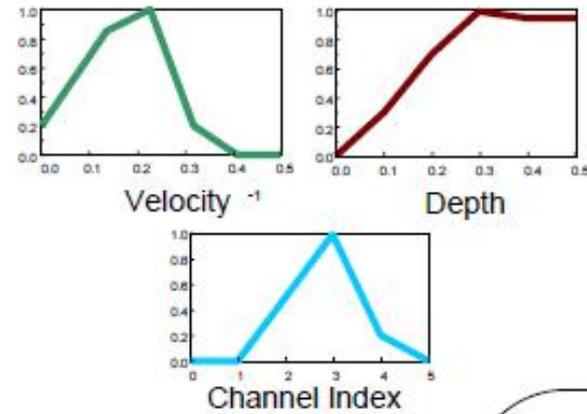
Habitat simulation methodologies



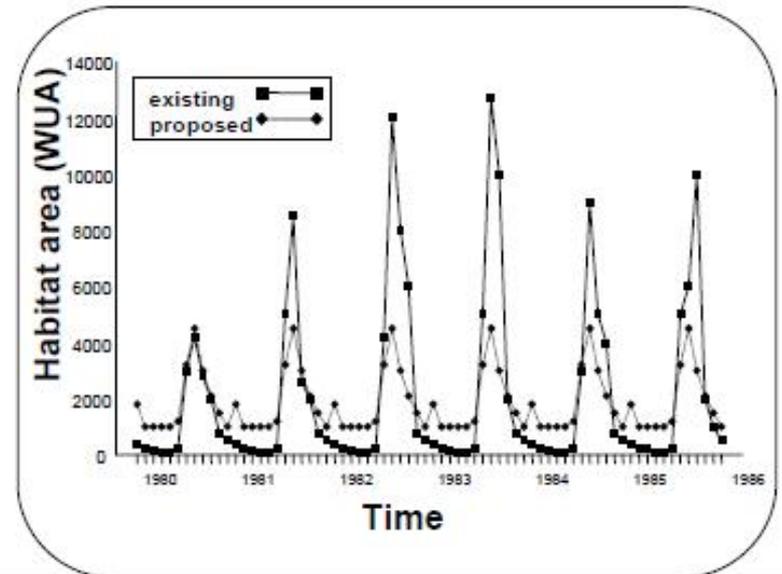
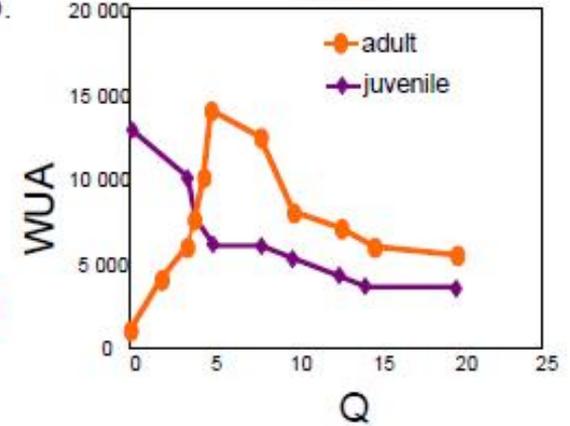
e.g. IFIM/PHABSIM



(B) Habitat suitability curves for target sp.

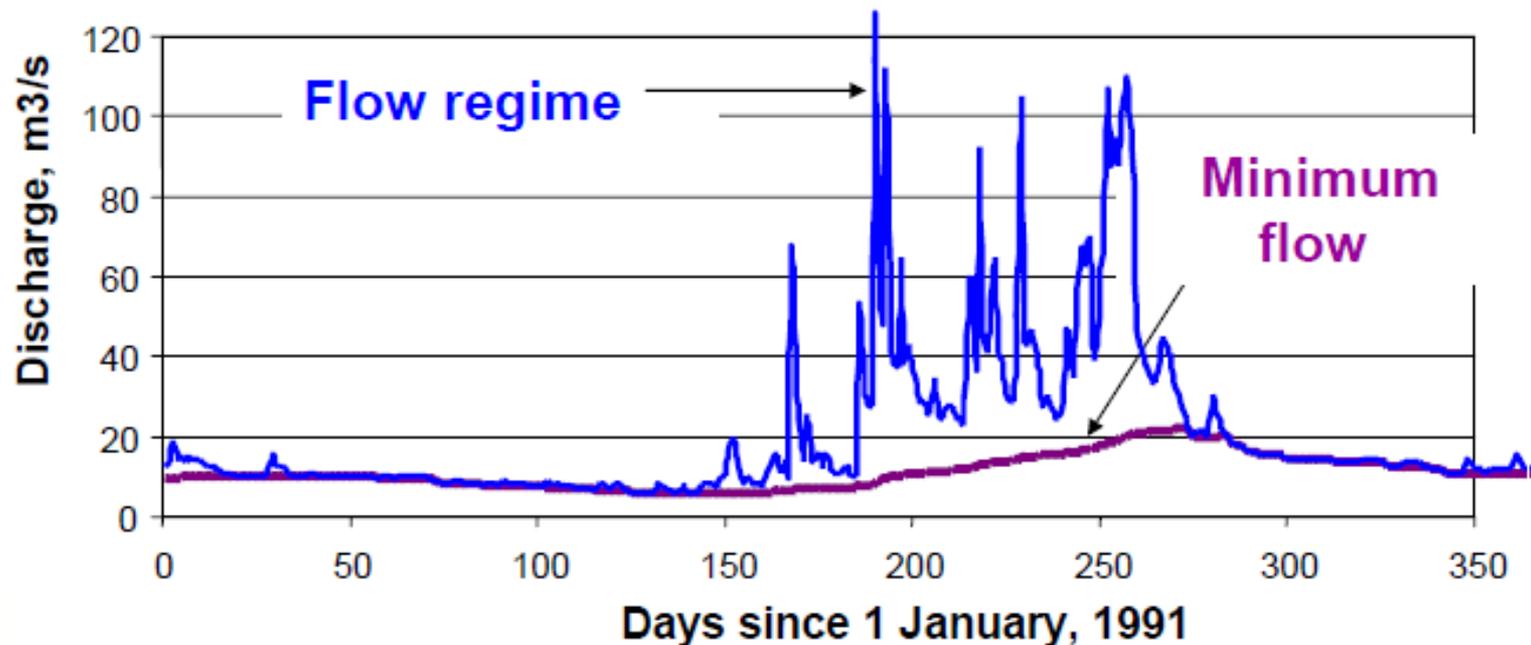


(C)

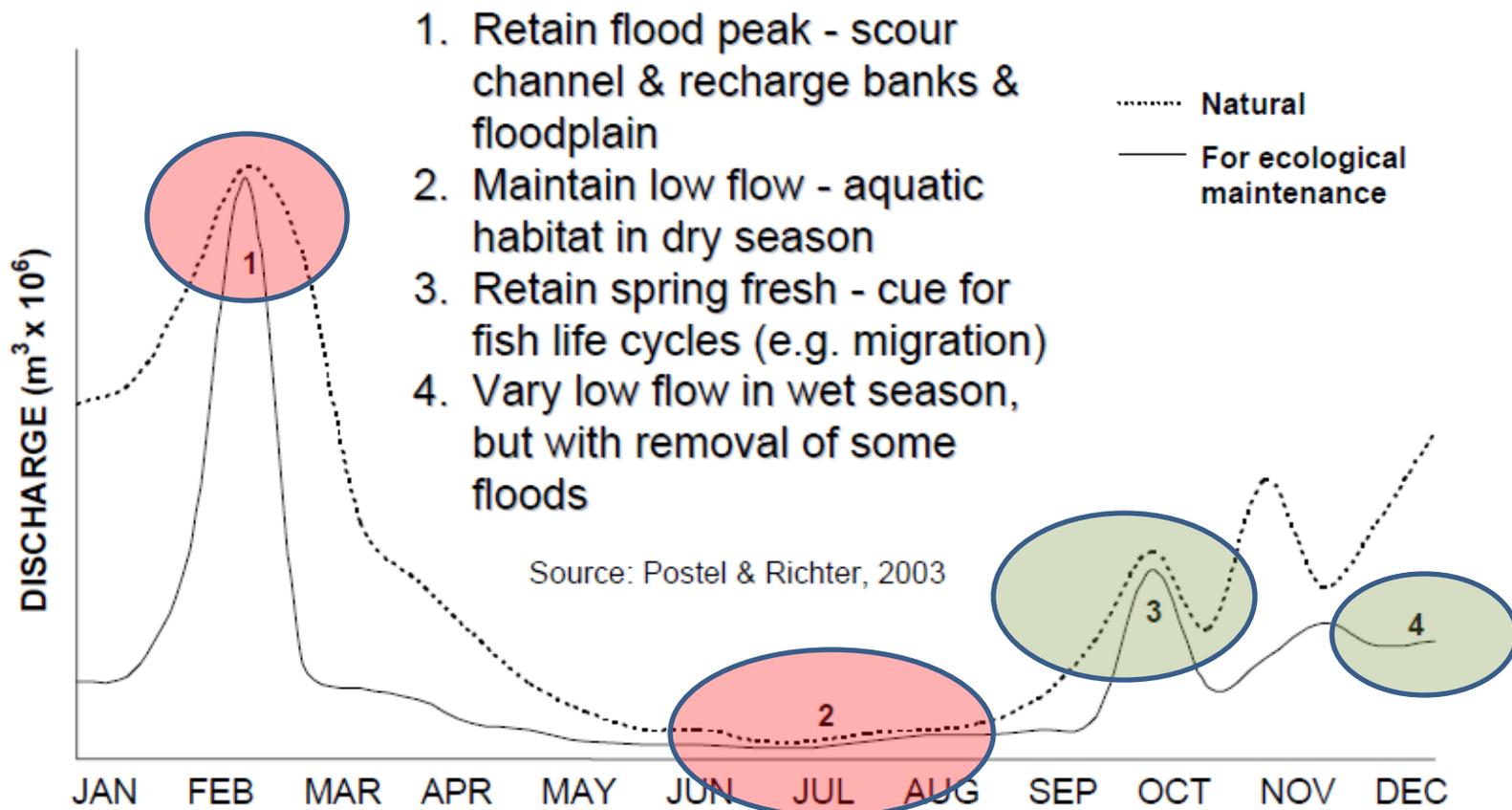


Shift from minimum flow to flow regime:

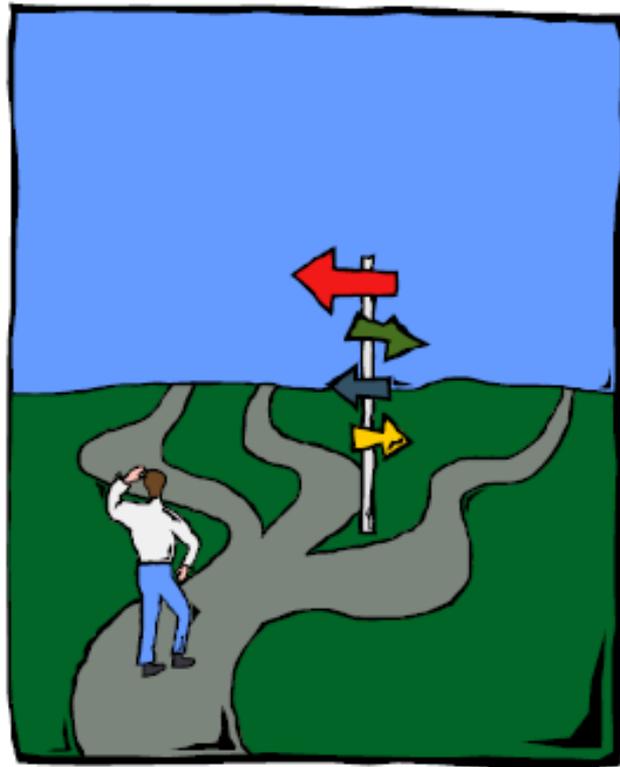
- * magnitude, frequency, duration, timing, rate of change
- * flow components (low flows, freshes, floods)



Holistic Methodologies: natural flow paradigm



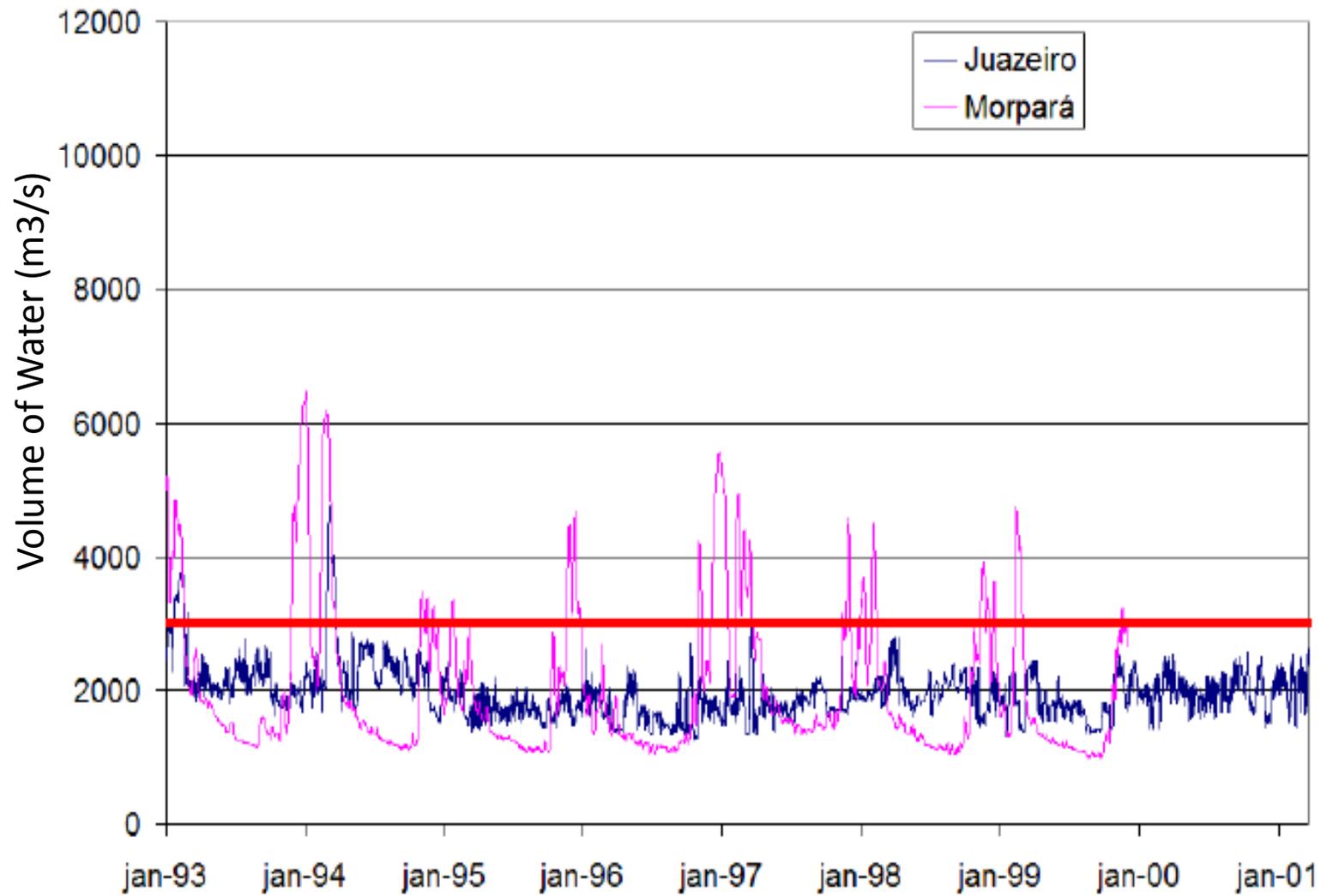
Choosing the right method



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





QR90



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

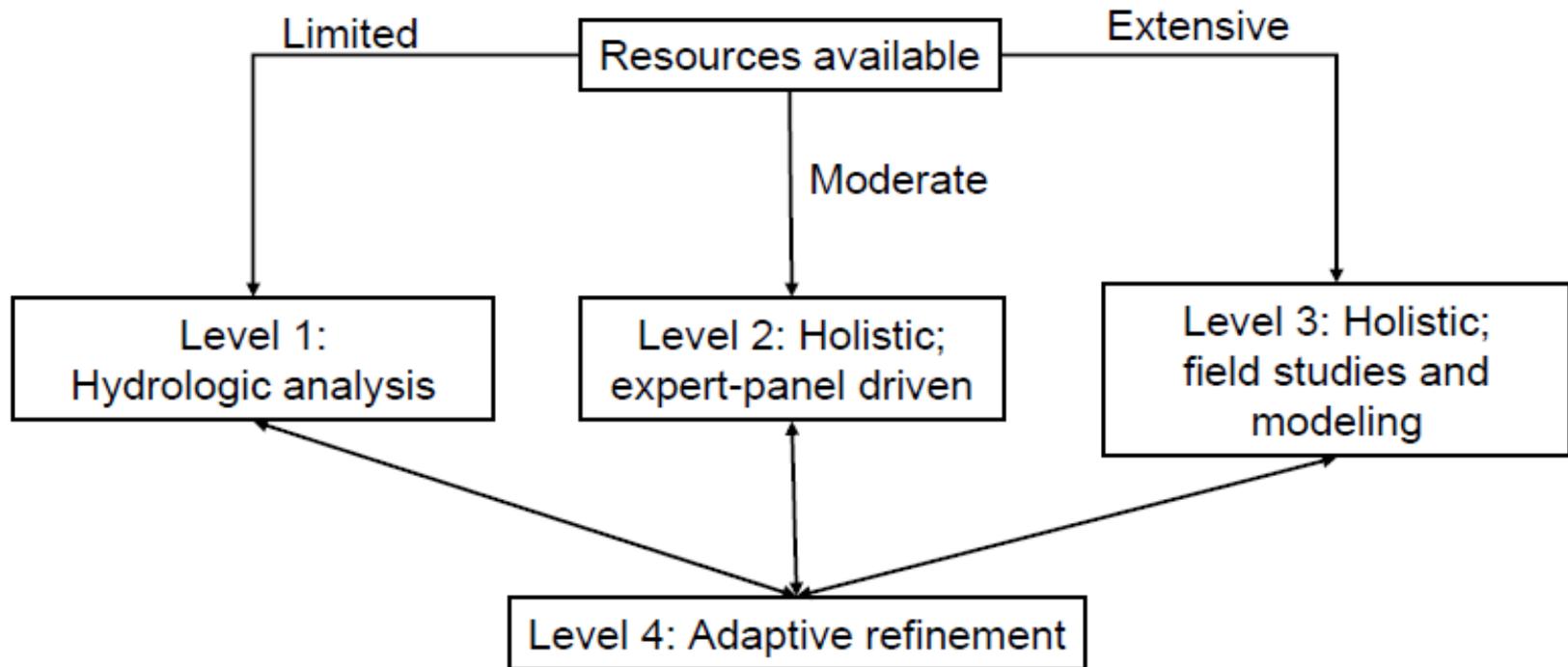


- The process emphasized three main aspects to the approach and methodology employed
 - awareness raising and education
 - field assessments
 - Scenario building and multi stakeholder dialogue workshops.

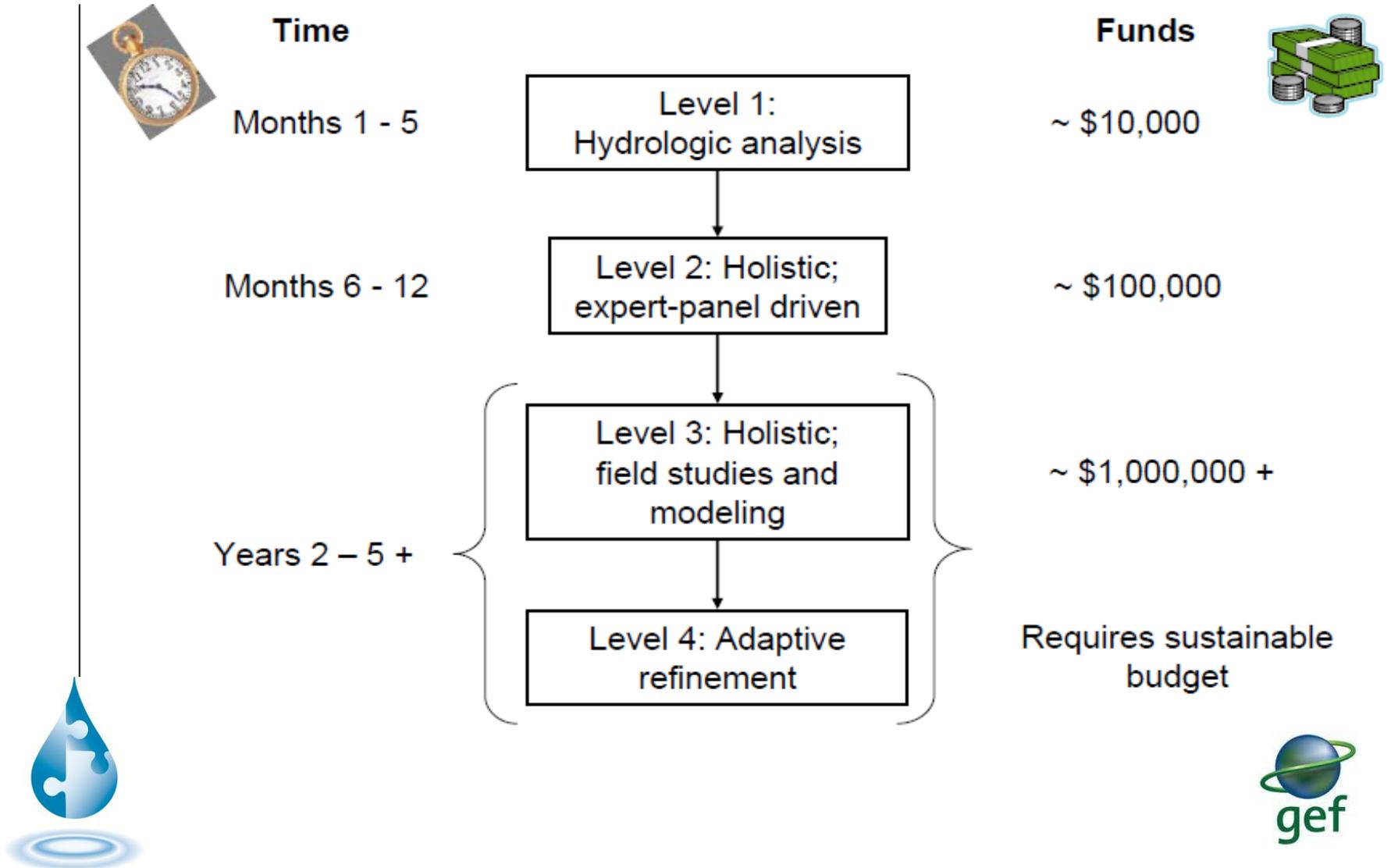
| Method | Resources | Time | Confidence | Resolution | Status |
|-----------------|-----------|------------------|---------------|---------------|-----------------|
| Desktop - rapid | Low | 2 days – 2 weeks | Low | Low | Planning guide |
| Intermediate | Medium | 8 weeks | Medium | Medium | Preliminary 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



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Resilient nations.