


INDICATORS OF HYDROLOGIC ALTERATION (IAH):
basic principles and practical experiences

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Our goal:

A NEW TOOL FOR CHARACTERIZING STREAMFLOW REGIMES

quantifying hydrologic impacts caused by dam construction

This approach is applicable when working with dam operators or water managers to change the way water is being stored, released or diverted for human use

INDICATORS OF HYDROLOGIC ALTERATION (IAH)

1. Key concepts
2. METHODOLOGY
3. Application
4. Conclusions

IF THERE IS A DAM IN A RIVER WE HAVE TWO FLOW REGIMES:

upstream the reservoir we have the **natural regime**

And

Downstream the reservoir we have a different regimen : **altered regimes**

NATURAL REGIME

WATER uses:
Agriculture
Industry
Domestic use
Hydropower...

ALTERED REGIME

How can we assess the degree of hydrologic alteration?

We know that human land and water uses are substantially altering hydrologic regimes around the world

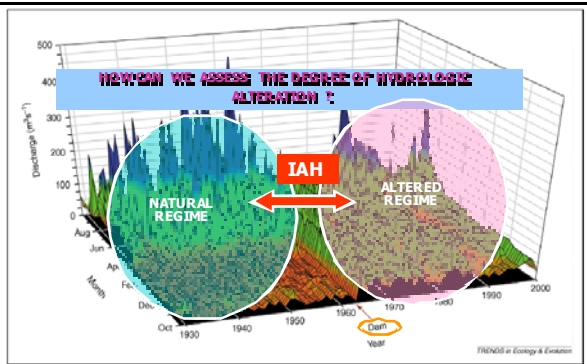


Figure 1. Hydrograph of the Green River, Utah, USA from 1929 to 2000. Before the Flaming Gorge Dam was completed in 1963 (arrow), the river experienced floods from spring snowmelt and droughts during autumn and winter. Damming increased the flow volume, causing both floods and droughts to become less frequent and smaller in magnitude. Data from US Geological Survey.

EVALUATIONS OF HUMAN INDUCED HYDROLOGIC CHANGES ARE NEEDED TO ADVANCED RESEARCH, SPECIALLY ON THE BIOTIC IMPLICATIONS OF HYDROLOGIC ALTERATION



GEN CANYON DAM, COLORADO, USA



Catchment land-use change and associated water resource development, lead to changes in one or more aspects of the natural flow regime

These changes result in declines in aquatic biodiversity and invasions by introduced or exotic species

Danube Delta

Major pressures on Danube:

- Pollution**
 - oxygen depletion
 - changes in species composition
 - biodiversity decline
 - fish mortality
- Structural interventions**
 - habitat loss
 - habitat fragmentation
 - biodiversity decline
 - loss of filtering capacity
 - hindrance of fish migration (eg. sturgeons)
 - alteration of natural flow dynamics
 - alteration of sediment balance
- Climate change**
 - floods & droughts
 - sp. displacement
 - biodiversity decline
 - disappearance of sp. & habitats
 - changes in community composition
 - invasive species

Danube Delta is a natural Reserve of the Biosphere. More than 300 sp of birds used the Delta in their migrations.

Danube is a very regulated river. The dams trapped more than the 90% of the sediments altering the dynamic of the Delta .

What are the biotic consequences of its alteration?

42,000 Dams in 140 Countries

New Zealand 86 Papua New Guinea 3
 South Africa 539 Albania 306 Zimbabwe 213
 Romania 246 Nigeria 45 Bulgaria 180 Ivory Coast 22
 Czech Republic 118 Congo (DRC) 16 Russia 91 Angola 15
 Yugoslavia 69 Namibia 13 Slovakia 50 Madagascar 10 Slovenia 30
 Cameroon 9 Croatia 29 Ghana 5 Mauritius 9 Bosnia-Herzegovina 25
 Burkina Faso 8 Ukraine 21 Ethiopia 8 Lithuania 20 Mozambique 8
 Azerbaijan 17 Lesotho 7 Armenia 16 Swaziland 6 Hungary 15 Georgia 14
 Sudan 4 Uzbekistan 14 Zambia 4 Kazakhstan 12 Botswana 3 Kyrgyzstan 11
 Malawi 3 Tadjikistan 7 Benin 2 Latvia 5 Guinea 2 Moldova 2 Mali 2 Senegal 2
 Seychelles 2 Sierra Leone 2 USA 6375 Tanzania 2 Canada 793 Togo 2 Gabon 1 Liberia 1
 Suriname 1 China 22,000 Uganda 1 India 4291 Japan 2675 South Korea 765 Thailand 204
 Malaysia 59 Chinese Taipei 50 Syria 41 Sri Lanka 46 Saudi Arabia 38 Philippines 15 Iraq 13
 Turkey 625 Indonesia 96 Algeria 107 Pakistan 71 Morocco 92 North Korea 70 Tunisia 72 Iran 66
 Cambodia 2 Bangladesh 1 Taiwan 1 Spain 1187 Laos 1 France 569 Italy 524 United Kingdom 517
 ~Brazil 594 Norway 335 Mexico 537 Germany 311 Argentina 101 Sweden 190 Chile 88 Switzerland 156
 Venezuela 74 Austria 149 Columbia 49 Portugal 103 Cuba 49 Finland 55 Peru 43 Cyprus 53 Greece 46
 ~Dominican Republic 11 Ecuador 11 Iceland 20 Costa Rica 9 Macedonia 18 Honduras 9 Ireland 16 Bolivia 6
 ~Belgium 15 Panama 6 Denmark 10 Uruguay 6 Netherlands 10 El Salvador 5 Luxembourg 3 Australia 486 Fiji 2

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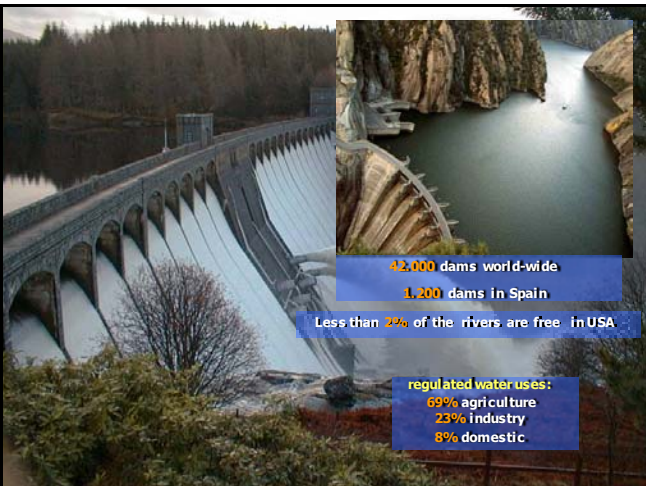


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1. KEY CONCEPTS

Which characteristics of natural flow regime are biologically relevant?



1. INDICATORS OF HYDROLOGIC ALTERATION: Key concepts

THOSE LINKED TO THE INTEGRITY OF FRESHWATER ECOSYSTEMS



those aspects of the flow regime linked to the integrity of freshwater ecosystems

LATERAL AND LONGITUDINAL CONNECTIVITY

ACCESS TO RIPARIAN AREAS AND FLOODPLAINS

NATURAL FLOW

HIGH MAGNITUDE FLOODS

Based on Bain & Bartholomew

those aspects of the flow regime linked to the integrity of freshwater ecosystems

LATERAL AND LONGITUDINAL CONNECTIVITY

ACCESS TO RIPARIAN AREAS AND FLOODPLAINS

FLUVIAL ECOSYSTEM

CHANNEL FORM HABITAT COMPLEXITY PATCH DISTURBANCE

LIFE HISTORY PATTERNS SPAWNING RECRUITMENT

CRITICAL CONDITIONS

DISPERSAL AND REPRODUCTIVE TRIGGERS

NATURAL FLOW

HIGH MAGNITUDE FLOODS

VARIABILITY

BASE FLOWS - DROUGHTS

INFLEXION POINTS

SEASONALITY

THE NATURAL FLOW REGIME INFLUENCES AQUATIC BIODIVERSITY VIA SEVERAL INTERRELATED MECHANISMS

Why do these flow components influence on the ecosystem?

Magnitude
General availability of water in freshwater ecosystems

Variability
Shapes geomorphological and ecological processes, and it's a source of biodiversity, habitat heterogeneity and vitality of river systems

Duration
Critical aspect specially in extreme events: floods and droughts, close linked with *tolerance thresholds of native species (capacity to recover from disturbance)*

Seasonality
Life-history strategies are synchronized with long-term flow patterns

Rate of change
Adaptation capacity of different species

1. INDICATORS OF HYDROLOGIC ALTERATION: Key concepts

KEY CONCEPTS !

Which is the ecological meaning of natural flow regime?

Which characteristics of Natural Flow Regime are biologically relevant?

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Which characteristics of Natural Flow Regime are biologically relevant?

Magnitude
General availability of water in freshwater ecosystems

Variability
Shapes geomorphological and ecological processes, source of biodiversity, habitat heterogeneity, vitality of river systems

Duration
Droughts, floods, closed

Seasonality
Flow patterns

Rate of change
Adaptation capacity of different species

FLOW REGIME	FLOW REGIME
Magnitude	Availability
Variability	Diversity
Duration	Tolerance threshold
Seasonality	Synchronous
Rate of change	Adaptation capacity

1. INDICATORS OF HYDROLOGIC ALTERATION: Key concepts