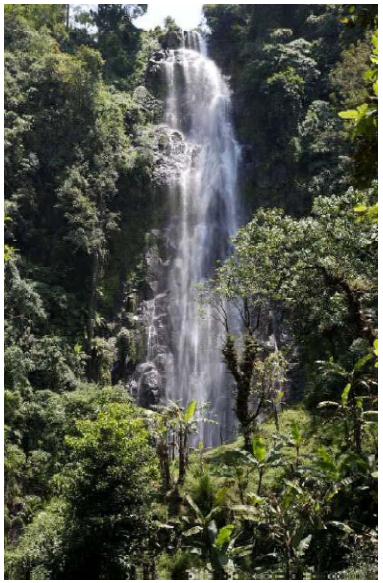

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Working Group 2 System Boundaries

Environmental Flows for sustainable bioenergy

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• River basins are complex, coupled social-ecological systems

• Temporal and spatial interconnectedness across scales:

- Socioeconomic and political interdependency
- Hydro-ecological interconnectedness

• Agricultural systems depend fundamentally on ecological processes and ecological services.

• Dams etc, and abstractions of water impact flow regimes in river basins

• 2030 projections: (De Fraiture et al. 2008)
- 30 million additional hectares crop land (biofuels)
- 180 km3 additional irrigation water withdrawals.

→ impact individual countries and regions could be highly significant for water resources

• Human activities → river basins are *closing* or *closed*

→ Closure depends on the definition of the flow that is committed to flushing, diluting, and sustaining ecosystems.

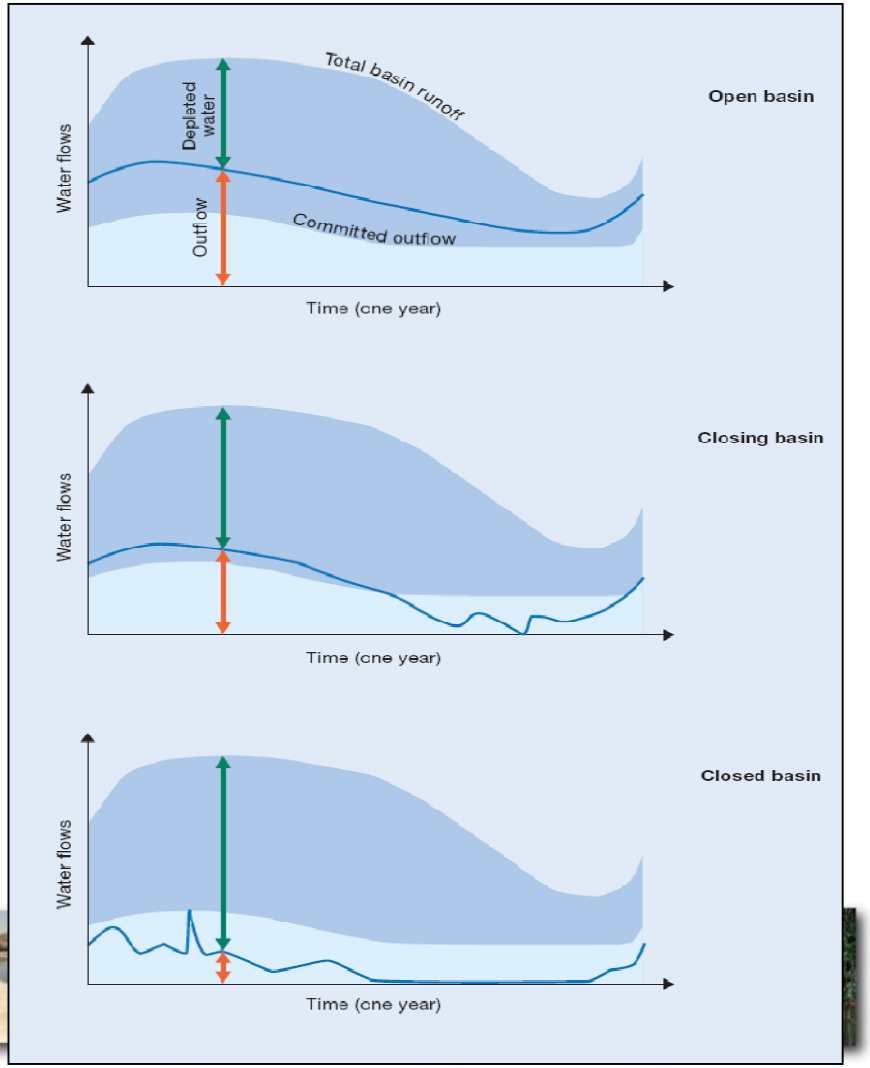
• Biofuel production may impact river basins

Direct or indirect impacts driven by:

- Expansion of arable land
- Intensification of agriculture (water use / pesticide/fertiliser use)
- Changes in crop production (in crop type and production methods, e.g. rainfed to irrigated).

• This will affect water use and quality

From Moll e et al 2007



Water related impacts of biofuel production:

- Effects on aquatic system
  - Streamflow reduction and regulation;
  - Wetland degradation;
  - Water quality.

streamflow has been called the 'master variable'

- Effects on terrestrial system
  - Changes in the water table;
  - Changes in runoff due to land use changes;
  - Moisture recycling.

• Determining how much water can be allocated to consumptive human uses without the loss of ecosystem services:

Environmental water flows (EF):

"Quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihood and well-being that depend on these ecosystems"

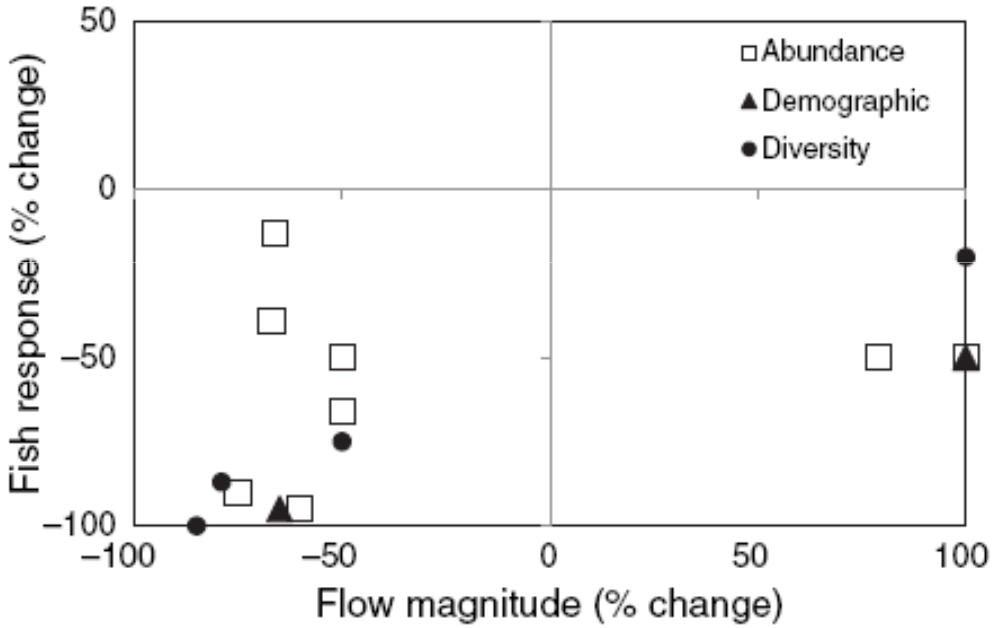
(Brisbane Declaration)

• Find a compromise between productive uses and some protection threshold.

"ENVIRONMENTAL FLOWS ARE LIKELY TO BE DIFFERENT FROM NATURAL FLOWS AND SELDOM TO BE 'MINIMUM' OR 'AVERAGE 'FLOWS'"




- Relation between flow alteration and (negative) ecological responses broadly acknowledged. Data between degree of alteration and response is limited.



→ Fish negatively impacted by flow alteration

From Poff & Zimmerman 2010

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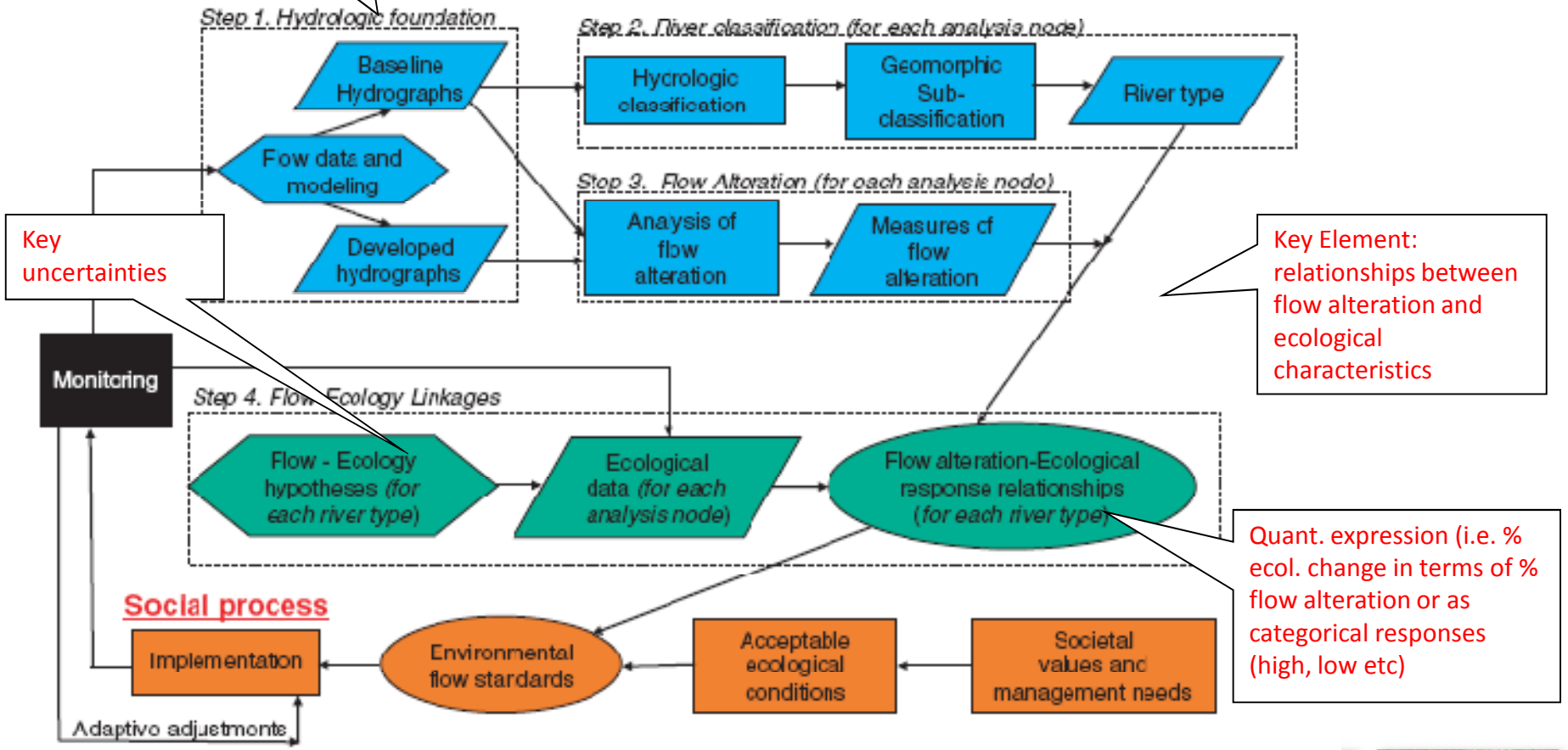
Assessing environmental flows

- Lots of methods and approaches to determine Environmental Flow:
  - from prescriptive to interactive approaches
  - from bottom-up to top-down approaches
- Most recent effort: *ELOHA* (Ecological Limits Of Hydrologic Alteration)
  - grounded in the premise that increasing degrees of flow alteration from baseline condition are associated with increasing ecological change.
  - classifying rivers into groups according to ecologically meaningful streamflow characteristics

Daily…weekly or monthly flow time-series during a common time period



(From Poff et al. 2010)

Key message EF approach

• constrain human-induced alteration of water flows and water quality within 'sustainability boundaries' (sensu Sustainability Boundary Approach, Richter 2009)

→ EF standards need to be *dynamic* in setting *:*
- recognizing interconnectedness of system is vital → ecosystem approach / IWRM

- reflect temporal and spatial variability in environmental requirements (ecosystem perspective)
- reflect temporal and spatial variability in water use requirements (social perspective)

→ EF standards need to be *adaptive* in definition *:*

- reflect latest understandings of micro- and macro scale dependencies, flow-ecology relationships and interactions with other environmental factors like habitat structure

- reflect changing societal needs and values over time

EF in relation to biofuel production

- EF integral aspect of water governance system & water management plan
  - biofuel production as part of full spectrum water-associated values and benefits
  - EF's fully part of allocation & prioritization schemes → account for cumulative effects all uses
- EF tools and data requirements:
  - feasible and effective EF methods to determine sustainability boundaries
  - ELOHA is example, but quite costly and elaborated → simple indicators?
  - hydrological monitoring at production sites? → water level / abstraction volumes?
- Degree of impact related to crop types and production methods.
  - water productivity of crop types, some crops may improve water balance
  - water efficiency of production process
  - specific water impacts more sensitive in context biofuel production?
    - → complex industrial processing, use specific chemicals?
    - → water quality > water quantity impact? → link EF to Envir Qual Standards
- Ultimately setting flow standards is *socio-political* decision but experts needed to indentify 'thresholds of potential concern'

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Thank you for your attention

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Appendix