

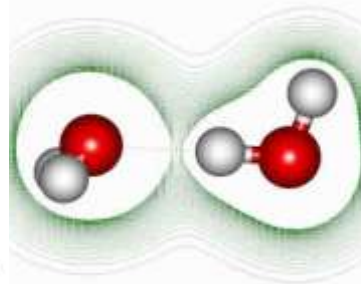
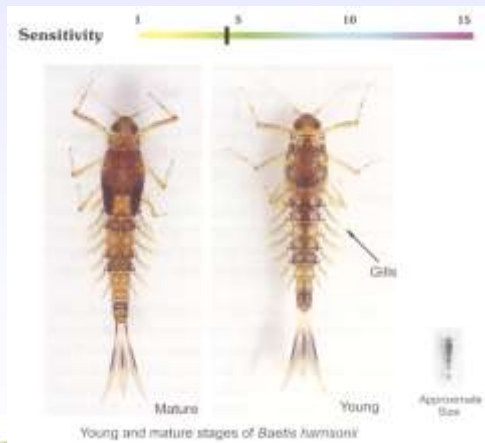
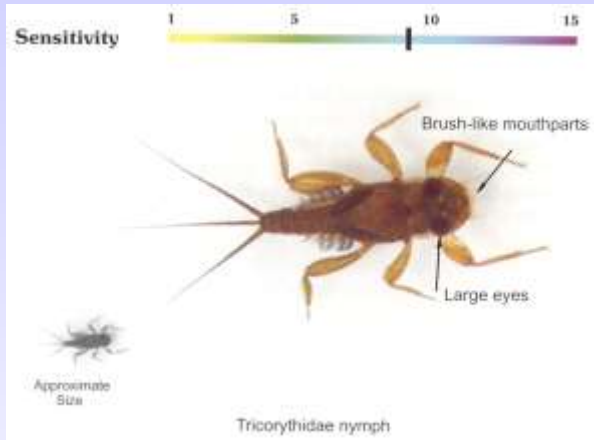
The environmental benefit of sound wastewater management

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WISA Wastewater Management Conference
East London
12 and 13 June 2007



AQUATIC ECOSYSTEMS: BIOTA, CHEMISTRY, FLOW AND HABITAT



ECOSYSTEMS ARE COMPLEX



- **Biota**
 - Riparian and instream vegetation
 - Fish
 - Invertebrates
 - Microbial systems
- **Water**
- **Substrate**
- **Interactions with catchment processes**

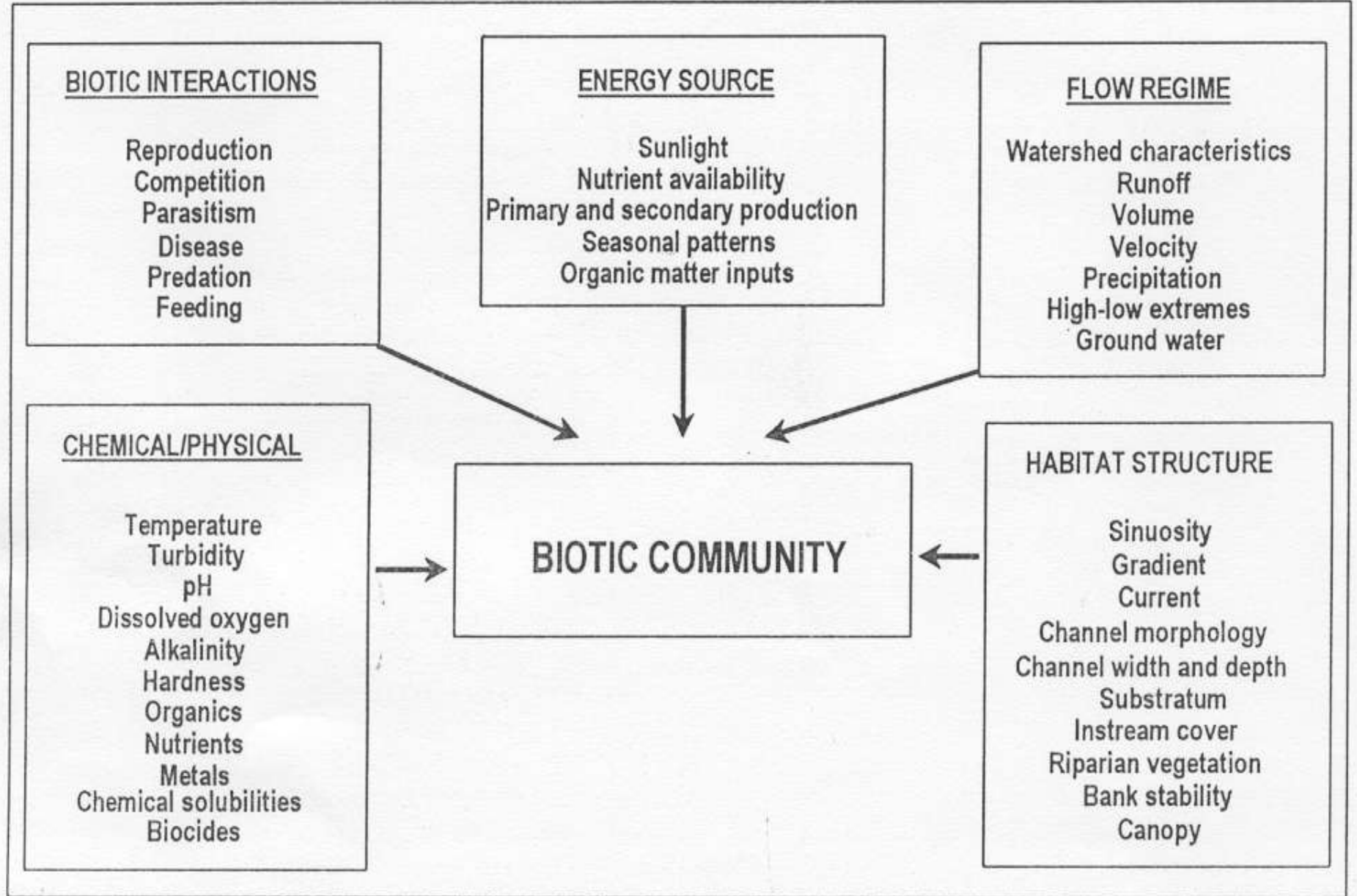


Figure 2.1 Some of the important chemical, physical and biological factors that influence and determine biotic communities [modified from Karr *et al.*(1986) cited by Rankin 1991].

The diversity in natural water chemistry, flows and habitats affects the ecosystem processes, functioning and diversity of organisms living in those water resources.

Water quality and pollution: Impacts on freshwater ecosystems

- Physical and chemical conditions
- WQ refers to degree of change from natural:
 - From point of view of ecosystem processes, functions and organisms (biodiversity)
 - Natural water contains a range of organic and inorganic particles which, under these conditions, do not pose a threat to organisms
 - Natural water quality is affected by both aquatic and terrestrial biotic interactions:
 - photosynthesis and respiration
 - leachate and other input from terrestrial environment
 - breakdown of complex organic matter: purification process
- (It is important to distinguish between water quality for human use and that for environmental use)

Water quality and pollution: Impacts on freshwater ecosystems

Pollutant types:

Temperature
Suspended sediments, turbidity
TDS, conductivity, salinity
pH and alkalinity
DO
Nutrients and eutrophication
Metals
Organic compounds (natural and synthetic: biocides, hormones etc.)

Sources:

Sewage treatment works
Mining (e.g. acid mine drainage)
Various industrial effluents
Power stations
Dams and water transfers
Land-use practices: removal of/or changes in riparian vegetation and physical constructions
Increased evaporation
Irrigation return flows
Agriculture, including fish farms
Informal settlements, septic tanks
Construction sites and Litter

Water quality and pollution: Impacts on freshwater ecosystems

- Differences in species sensitivity and ecosystem sensitivities
- Loss of sensitive species and changes in species composition
- Absence of organisms at critical times
- Biological development: growth and reproduction, changes in lifecycles
- Physiological changes: respiration rates, histological damage, changes in various metabolic and cellular processes
- Endocrine disruption
- Bioaccumulation and bioconcentration
- Behavioural changes
- Reduced light penetration and impairment of visual cues
- Blocked gills and smothering of benthic organisms
- Eutrophication: stimulation of plant and algal growth

Overall impact results in changes in ecosystem processes (e.g. essential breakdown processes): loss of ecosystem goods and services

Water resource management is a balancing act:

ecosystem goods and services

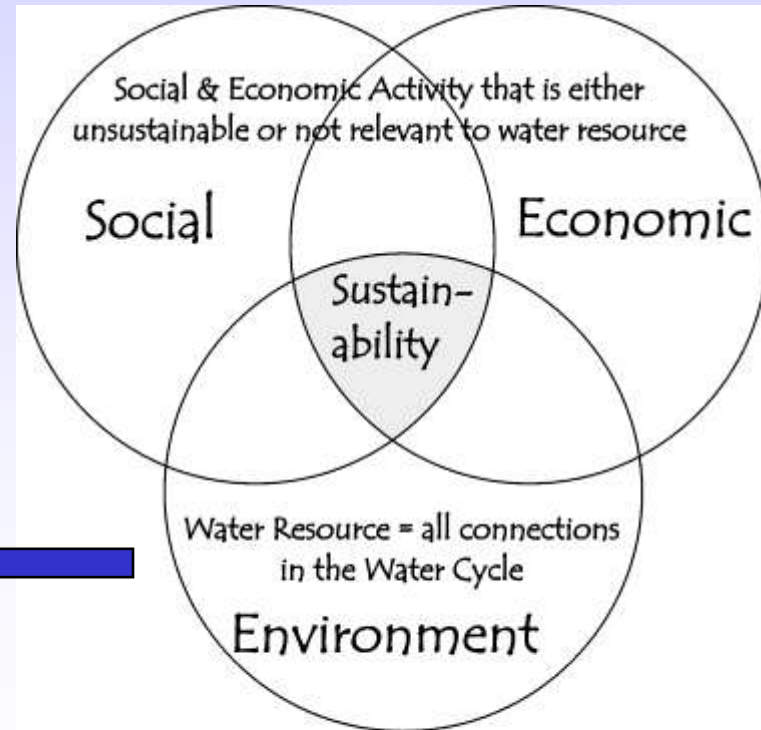


social and economic benefits

- water supply
- waste transport, processing & dilution
- natural products
- biodiversity
- flood control
- recreation
- aesthetic/spiritual needs



triple bottom line

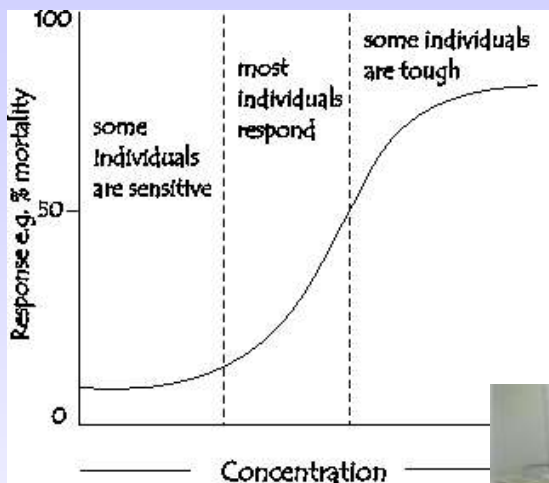


Water resource management is a balancing act:

- **Water resource use and protection: balancing long-term protection with sustainable use**
 - water resource protection assures long term resource use
 - generally resource use reduces ecosystem health
 - therefore resource use needs to be balanced with resource protection
- **Mechanisms for achieving this:**
 - Resource Quality Objectives
- **Environmental water quality: an integrated approach**
 - water resource quality objectives (RDM)
 - aquatic ecosystem water quality guidelines (RDM)
 - effluent discharge limits (license criteria) (SDC)

Tools for managing environmental water quality

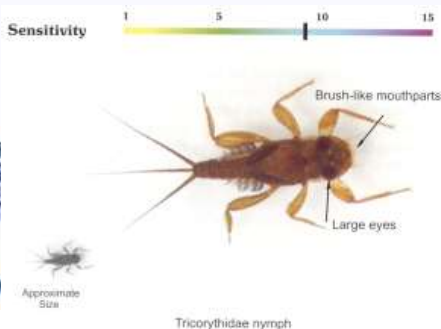
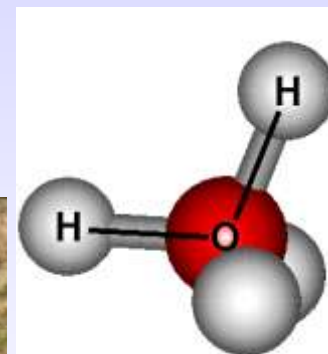
Water chemistry, living organisms and their interactions



Integration of data and maximizing information:

- > water physico-chemistry
- > biomonitoring
- > ecotoxicology

Concentration response relationship



Application in a site-specific case-study:

- The problem:
 - Environmental water quality management of a stream receiving various impacts and implications of change in industry discharge to water resource
- Industry ash dam
 - On water course: currently receiving discharge
 - Final effluent currently being discharged to river needs to be stopped: high TDS, considered transfer to ash dam
- Biomonitoring and chemical analysis of water and sediment
 - Impact by industry on the stream
 - Unidentified pollutant sources



Application in a site-specific case-study:

- Data available and approach:
- Surface water quality data
 - From the industry and DWAF
 - Ecological Reserve PES assessment
- Biomonitoring data
 - ASPT and habitat results related to flow patterns
- Groundwater quality data
- Toxicity data
 - TDS, other water quality constituents (fluoride, boron, sodium), effluent



Application in a site-specific case-study:

- Issues limiting data interpretation:
 - Lack of reference condition data: both for chemical characterization and biomonitoring
- Results:
 - Inorganic salts ($MgSO_4$, Na_2SO_4 , $NaCl$): EC and TDS
 - Nutrients (SRP, TIN)
 - Biotic indicators (ASPT): generally low scores`

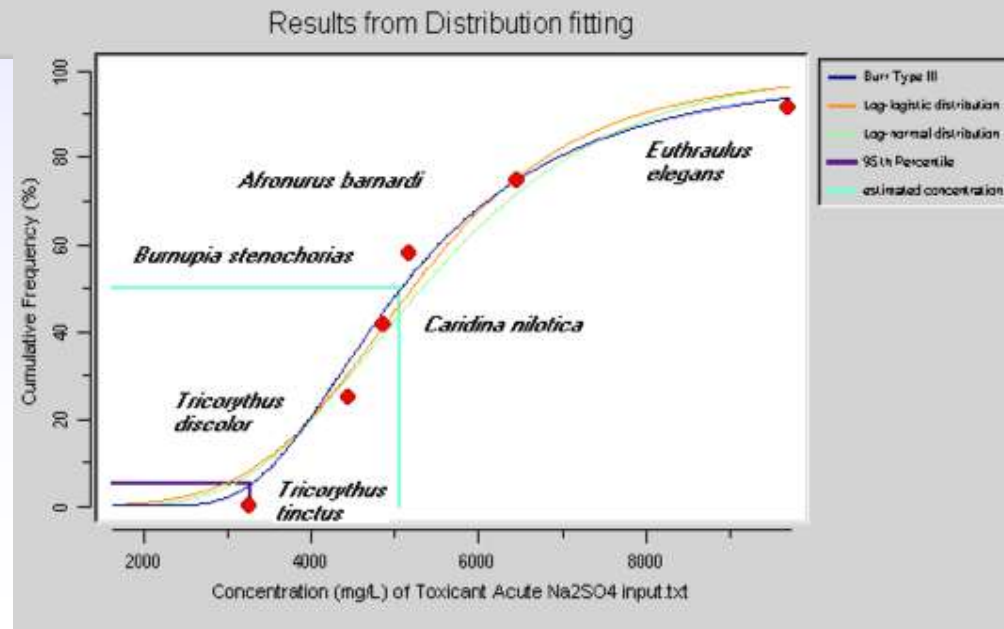
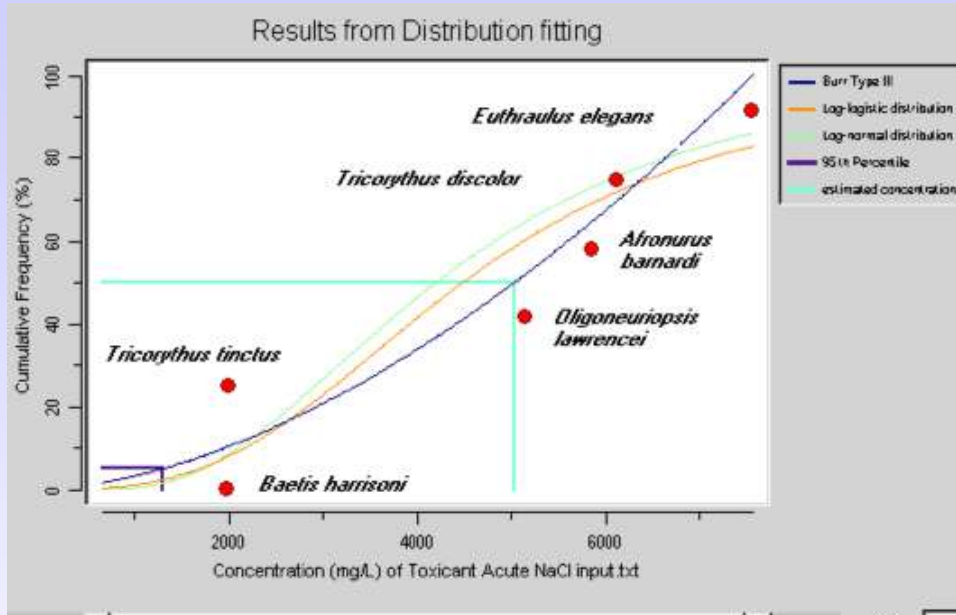
upstream dam (95%TDS)	downstream dam (95%TDS)	Downstream most point in stream (95%TDS)
Poor (416mg/L)	Poor (1220mg/L)	Fair (592mg/L)
fair - poor		

Application in a site-specific case-study:

- Ecotoxicology:
- Link between the water chemistry and biomonitoring results
- Data available:
 - UCEWQ database
 - Indigenous invertebrates species
 - TDS values (as well as nominal concentrations) for NaCl and Na₂SO₄
- Species Sensitivity Distributions
 - BurriOz
 - Generation of different levels of %species protection: derive trigger values for different levels of ecosystem classification



Application in a site-specific case-study:



Application in a site-specific case-study:

Ecological Class	% Species protection	TDS values (mg/L)
Natural	99	283
	95	328
Good	90	356
Fair	85	378
	80	397
Poor	75	415
	70	433
	50	507

Application in a site-specific case-study:

Implications for effluent management:

- Discharge to ash dam likely to result in increase to groundwater TDS levels, with subsequent consequences to surface water
- Result: > 50% species loss
- Decision made?
 - To treat high TDS concentration effluent rather than releasing to environment and risking further environmental degradation

Acknowledgements

- Water Research Commission
- DWAF
- Amatola Water
- Unilever
- Other industrial partners: Sasol, RBM
- Staff and students of UCEWQ and IWR

COURSE ANNOUNCEMENT:
Introduction to managing environmental water quality
13 to 17 August 2007

