REPUBLIC OF YEMEN
Sana'a University
Water & Environment Centre

الجمهورية اليمنية
جامعة صنعاء
مركز المياه والبيئة

Challenges in Applications of Integrated Water Resources Management Workshop
Monday 15 – Wednesday 17 March 2010
Water and Environment Centre, Sana'a University, Sana'a, Republic of Yemen

Transition towards adaptive management of water facing climate and global changes in Moroccan oases

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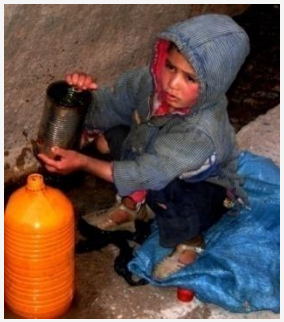
Outline

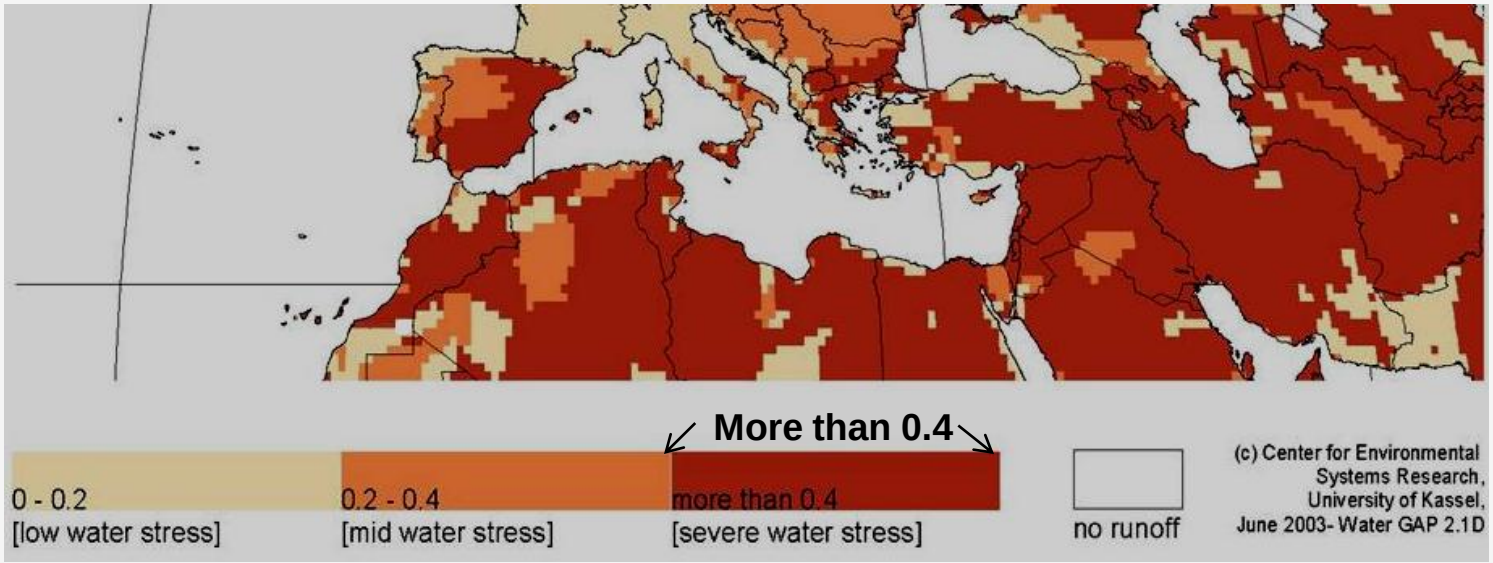
- What are the characteristics of water regime that is adaptive?
- Vulnerability and adaptation with respect to water resources
- Hydrologic implications of climate change for water resources
- Topics covered in a water resources assessment
- Viewing water resources from a services perspective
- Tools/models



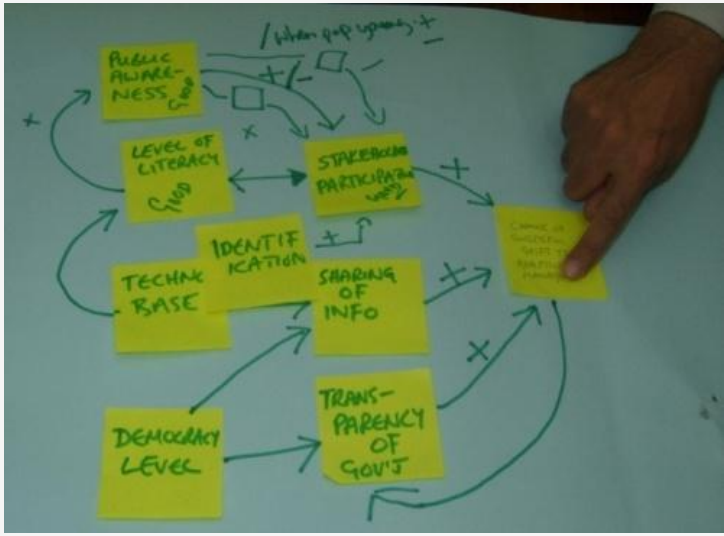
Withdrawal to availability Ratio (w.t.a.) (B2 scenario, HadCM3)

$$\text{w.t.a.} = \frac{\text{Annual Withdrawals}}{\text{Annual Availability}}$$

- the Share of Water Consumption to Water Availability
  - World: 1995: 8,4 % 2025: 12,2 %
- **But:**
  - South America: 2025: 1 – 2 %
  - Asia: 1995: 40 – 80 % 2025: 60 – 85%
  - North Africa: 1995: 95 % 2025: **130 %**
  - In some countries already more than 100% of the yearly water supply is consumed. This is unsustainable!



What are the characteristics of water regime that is adaptive?



- "Adaptive management is learning to manage by managing to learn"

Bormann et al, 1993

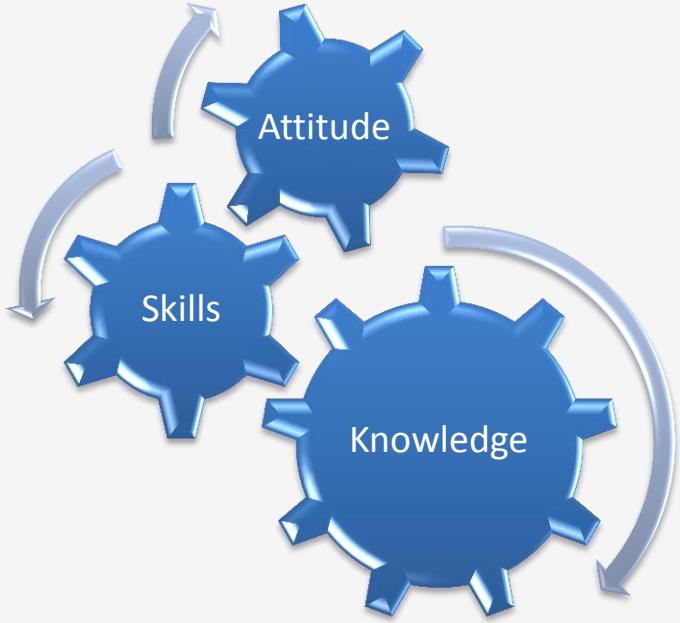
- scientific understanding will come from the experience of management as an ongoing, adaptive, and experimental process, **rather than through basic research or the development of ecological theory.**

Walters, 1986

- Adaptive management has as one goal to increase the adaptive capacity of the system.

What matters to AWM?

Ideally, a teaching programme for AWM addresses the three aspects of learning:

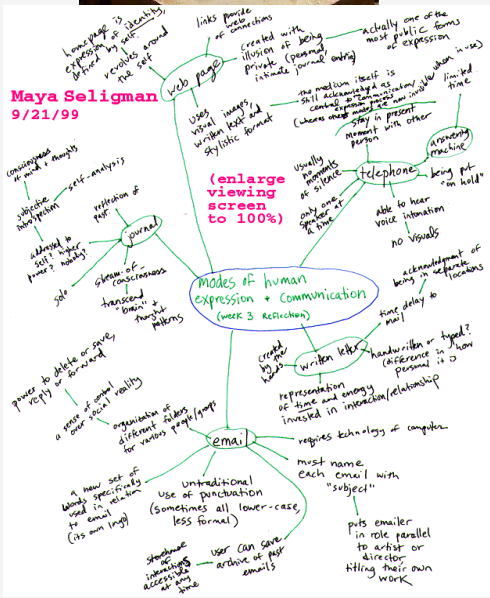


Water managers require not only new knowledge and skills, but also a shift in attitude in order to better respond to uncertainty and complexity.

Moving from risk assessment to risk management

- Most assessments of water risk have identified and assessed risk rather than implementing risk management

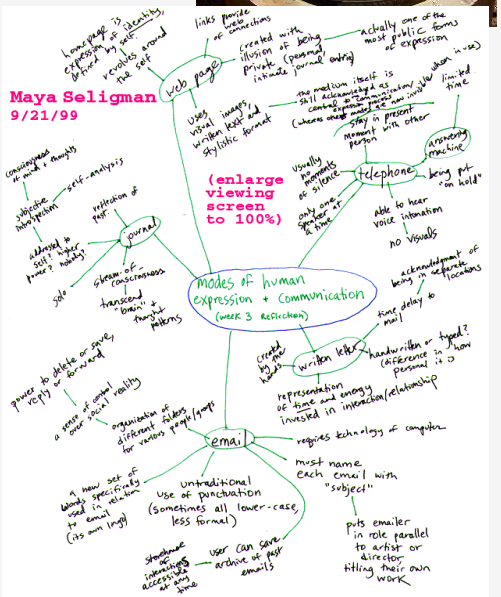
- To implement adaptation, assessments need to identify metrics for evaluation and monitoring and embed them into ongoing management processes



Effective Vulnerability & Adaptation Assessments

- Defining V&A assessment
  - Often V&A is **analysis**, not assessment
  - Why? Because the focus is on biophysical impacts, e.g., hydrologic response, crop yields, forests, etc.

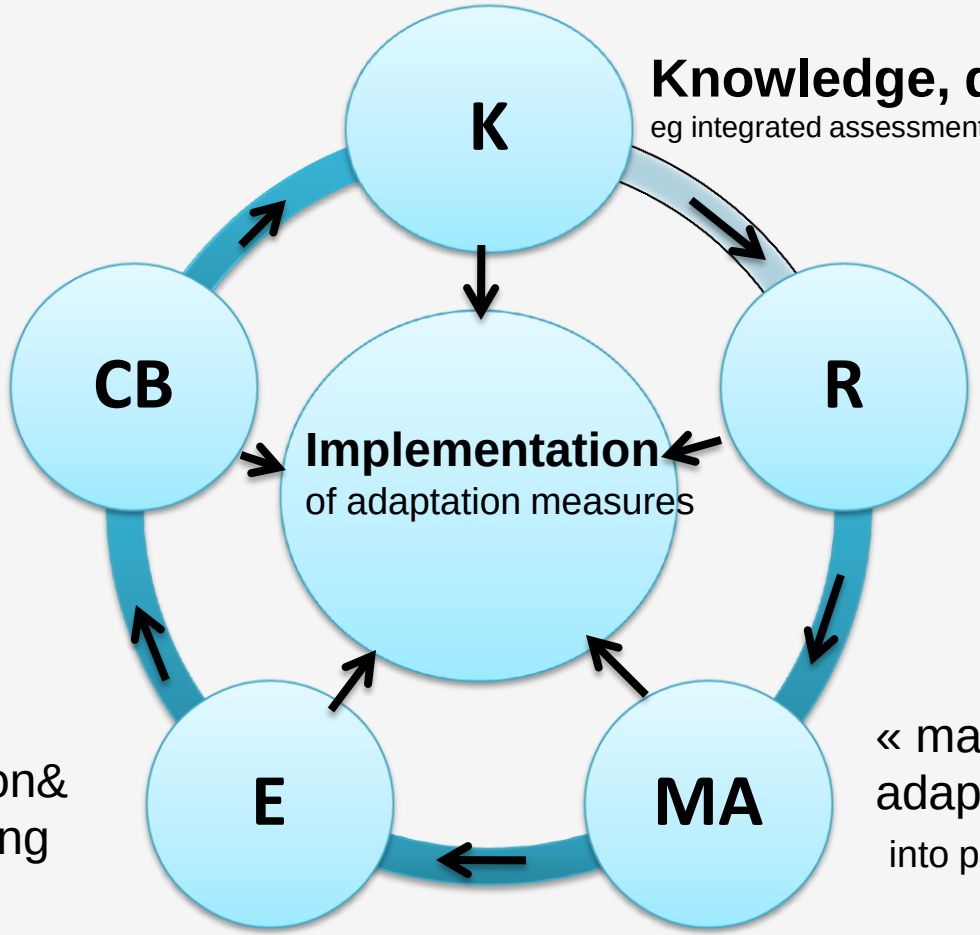
- However, **assessment** is an integrating process requiring the interface of physical and social science and public policy



Effective V&A Assessments

- To be valuable, the assessment process requires
  - Relevancy
  - Credibility
  - Legitimacy
  - Consistent participation
- An interdisciplinary process
  - The assessment process often requires a **tool**
  - The tool is usually a **model** or suite of models
  - These models serve as the interface
  - This interface is a bridge for dialogue between scientists and policy makers

The adaptation cycle



Warrick 2000, 2006

adaptation can be viewed as a *dynamic process* that evolves over time, involving five major pre-conditions for encouraging implementation

What is our rationale ?

- Knowledge
  - Technical capacity is limited
  - Capacity is developed but not sustained
  - The complexity of research as a social process is not well appreciated
- Policy Support
  - Water, Climate and development linkages are poorly understood
  - Policy processes and instruments necessary for effective “mainstreaming” are not fully understood

How do we get there?

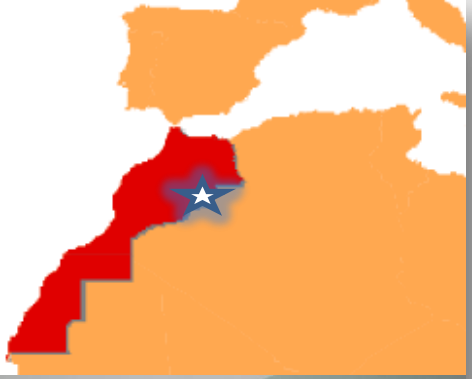
Action Research as a key vector for generating new knowledge

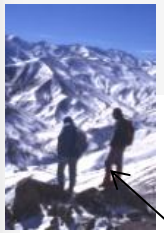
- Practical and participatory
- Stakeholders are co-learners – knowledge and skills of stakeholder are brought to bear on the problem
- Encourages learning by doing
- Brings both users and people generating the knowledge together
- Part of a social process
- Education and Research that seek to change behaviour

Outcome areas

- Positive improvements in knowledge, attitudes and motivations
- Testing adaptation strategies
- Shared learning
- Informed policy processes
- An increased level of community participation and involvement in the area.
- Changes in behaviour, policy and practice.
- Ongoing integrated activities to improve water quality and monitoring of those activities

Basin characteristics





UNESCO- MAB

Altitudinal difference

Meteorological variability

Water source: snow/rain

Interbasin water transfert: water import/export

Land use: agriculture/forest

Fish and wlidlife

Seasonality discharge

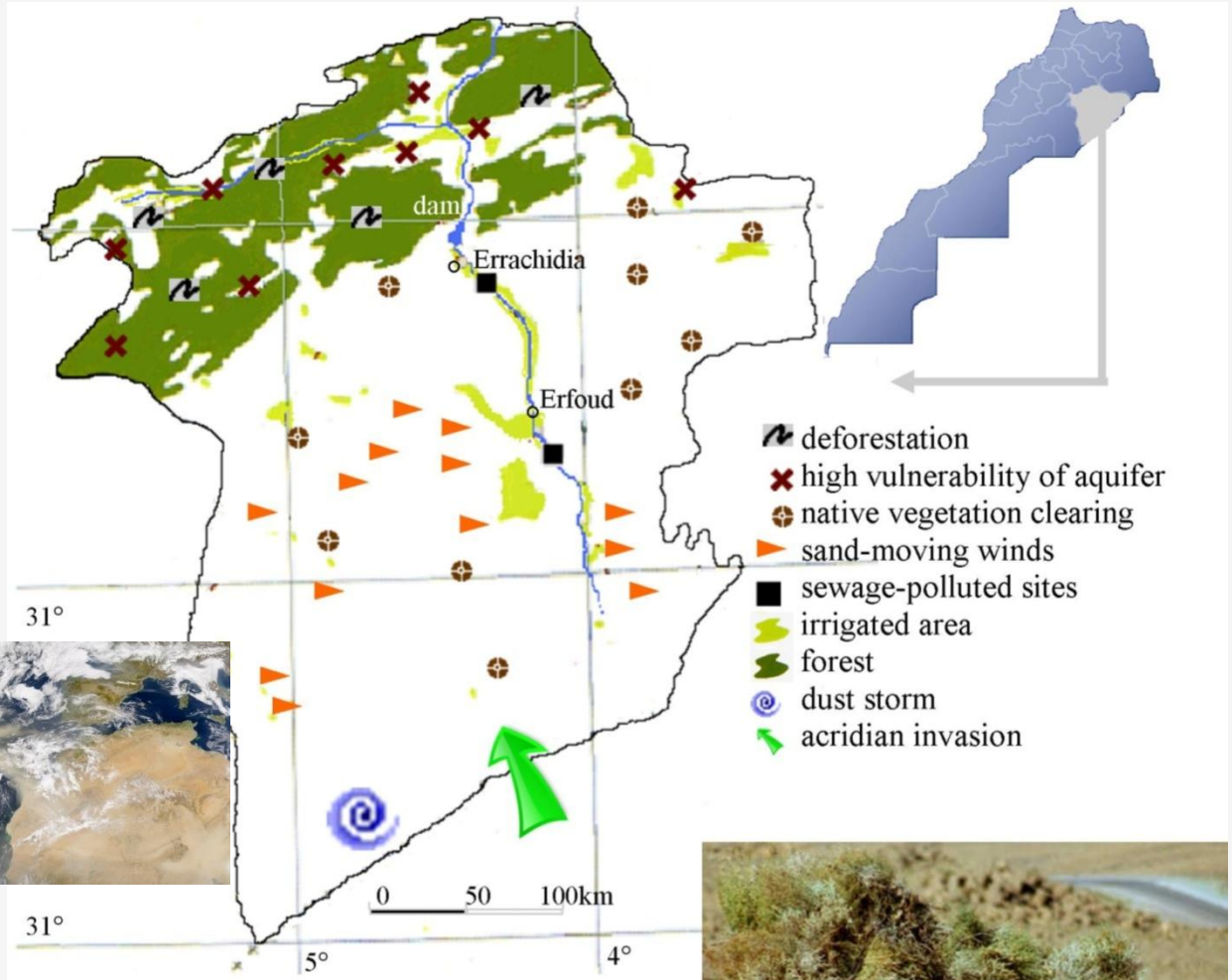


Fig. 22 A- Major global threats to the surface/ groundwater system in Oases. The scope and intersections of the numerous forcing and system impacts require an interdisciplinary and systematic research approach.

B- Women carrying firewood on their backs . A common sight in the rock desert of Morocco. The xerophytes they gather are enough to bake bread and cook for one week.

Socio-economic vulnerability

- Who/what is vulnerable against what?
- What are vulnerable groups or functions?
- Identify indicators
- How would you gather the data?

Key vulnerabilities and issues for resilience

Environmental Vulnerability Index (EVI)[1] For Tafilalt Basin

- The calculation of the EVI is based on 50 indicators of environmental vulnerability, outcomes.

- The indicators are divided into five subcategories:
  - meteorological events;
  - indicators for geological events;
  - indicators for Basin characteristics,
  - indicators for biological factor
  - indicators for anthropogenic factors.

- The indices are rated on a scale of 1–7, with 7 being the most vulnerable and 1 being the least.

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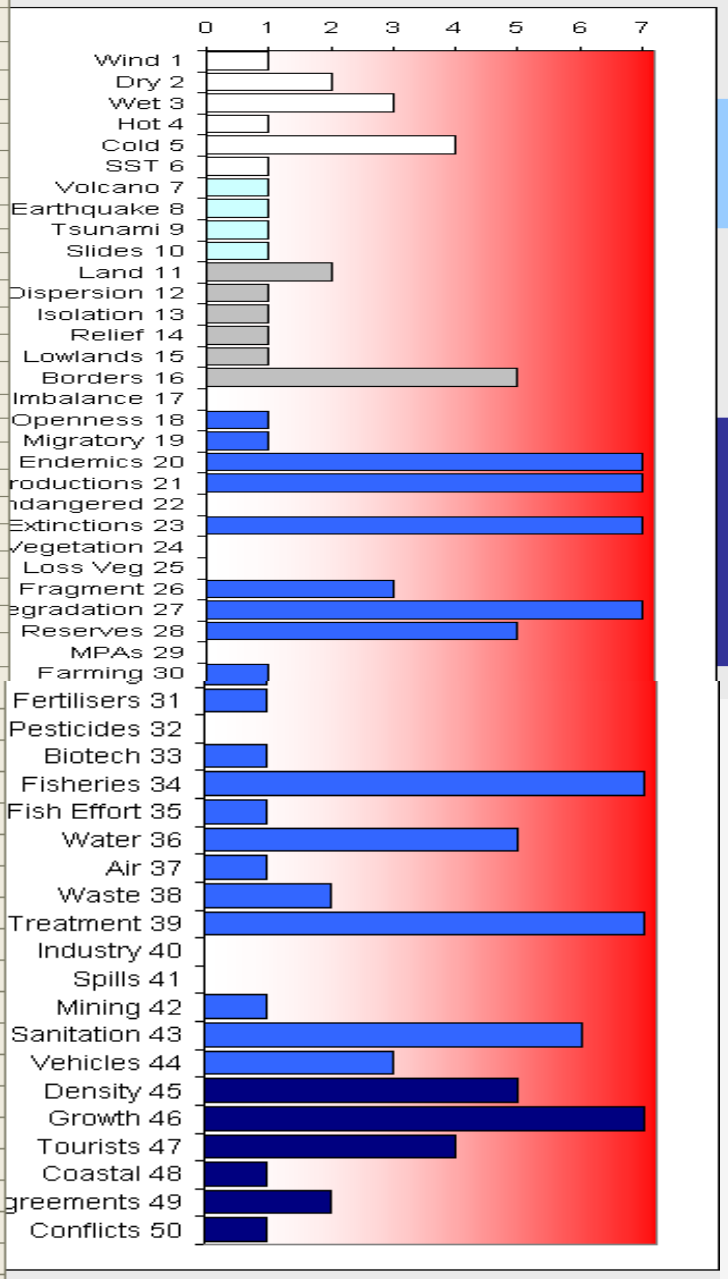
1. developed by the South Pacific Applied Geosciences Commission (SOPAC),

Tafilalt watershed

ENVIRONMENTAL VULNERABILITY INDEX



	SCORE	DATA%
EVI	288	84
CLASSIFICATION:	Vulnerable	
ASPECTS OF VULNERABILITY:		
Hazards	2,63	84
Resistance	2,38	100
Damage	4,43	70
LEGEND FOR INDICATOR TYPES:		
Weather & Climate		
Geology		
Geography		
Resources & Services		
Human Populations		
POLICY-RELEVANT SUB-INDICES:		
Climate Change	2,00	92
Exposure to Natural Disasters	1,91	100
Biodiversity	3,07	74
Desertification	2,78	82
Water	4,80	77
Agriculture / Fisheries	2,93	74
Human Health Aspects	4,00	83

ISSUES OF GREATEST ENVIRONMENTAL VULNERABILITY:

- the indicators with the highest scores were mostly anthropogenic in origin or could be traced to some man-made influence

- the valley's vulnerability could to a large extent be controlled by vigilant management of the watershed's resources

Water Resources from a Services Perspective

- Not just an evaluation of rainfall-runoff or streamflow
- But an evaluation of the potential impacts of global warming on the goods and services provided by freshwater systems

What are Ecosystem Services?

Ecosystem Services are the direct and indirect benefits that people obtain from ecological systems (MA2005). e.g., food, water supply and disease regulation help maintain our physical health, and non-material ecosystem services help maintain our psychological well-being.

What is Economic Valuation?

Economic Valuation is the assignment of direct and indirect costs and benefits from a human point of view (Tietenberg 2006).

Freshwater Ecosystem Services

what services a watershed provides ?

Extractable; Direct Use; Indirect Use

	Har-vest. biota	Water for ag., urban, indust.	Recre-ation, aesth. beauty	Trans-port	Clim. regu	Regen. of soil fertility	Nutr. cycl-ing	Flood/ drought mitig.	Water purifi-cation	Ero-sion con-trol	Habitat / biodi-versity
Upper Rivers	√	√	√		√		√	√		√	√
Lower Rivers	√	√	√		√	√	√	√	√	√	√

Cultural service: Imilchil legend

Chants et danses de l'Atlas, 1952 Institut du monde arabe , Paris

The town of Imilchil represents a symbol of Berber culture, known for its festival, officially known as *Betrothal Festival* .

The legend goes that two young people from different tribes fell in love, but were forbidden to see each other by their families. The grief led them to cry themselves to death, creating the neighbouring lakes of **Isli** (his) and **Tislit** (hers) near Imilchil. The families decided to establish a day on the anniversary of the lovers' death - when members of local tribes could marry each other. Thus the Imilchil Marriage Festival was born

Isli

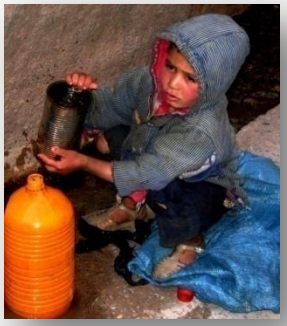
the festival is rich with music, dancing, feasts, and colorful clothing. The celebrations attracts many tourists to the area, and though contributing to local **economy,** the marriage *moussem* is the **big social gathering of the year.**

There are fears that the rituals can be affected by the foreigners.

Tools included in the project activities

- Tools for strategy development
- Tools for participatory learning and action:
- Tools for assessing:
- Tools for working with stakeholders:
- Tools for monitoring:

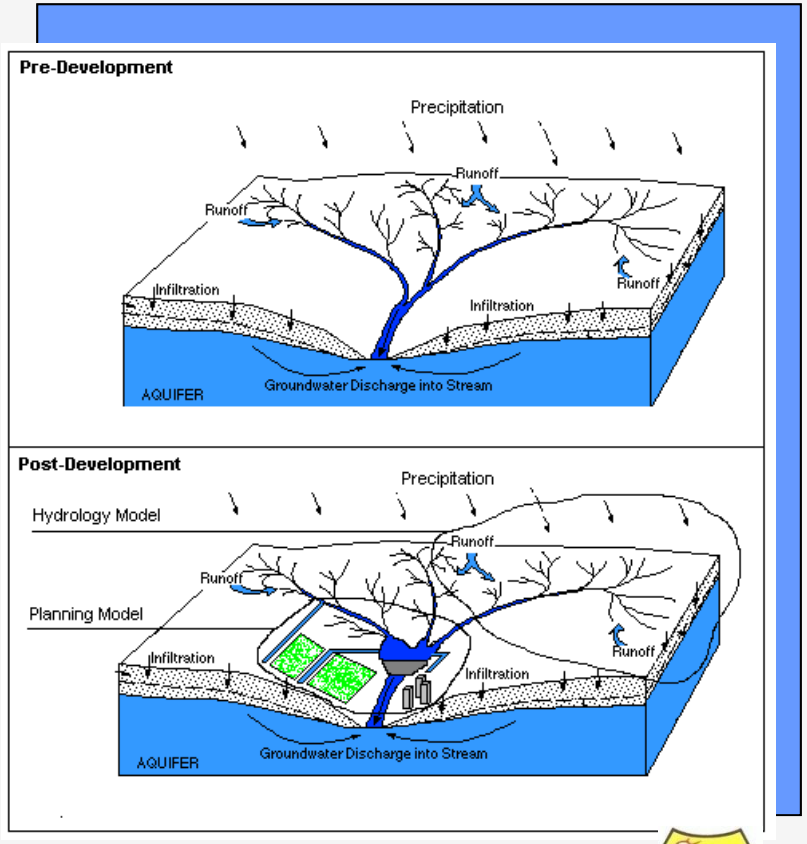
– WEAP INVEST CRiSTAL



Physical Hydrology and Water Management Models

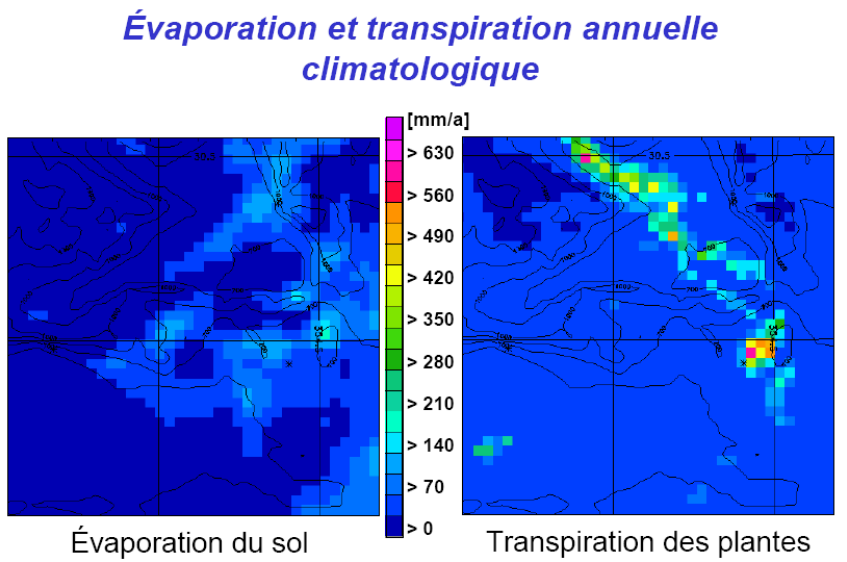
Water **E**valuation **A**nd **P**lanning system

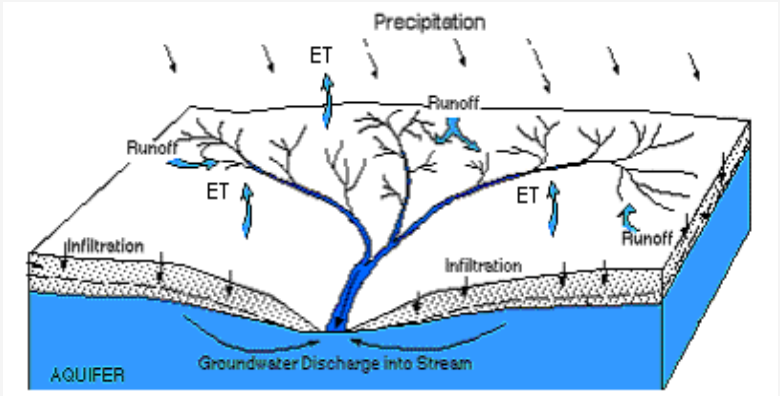
- **WEAP** advantage: seamlessly integrating watershed hydrologic processes with water resources management
  - Can be climatically driven



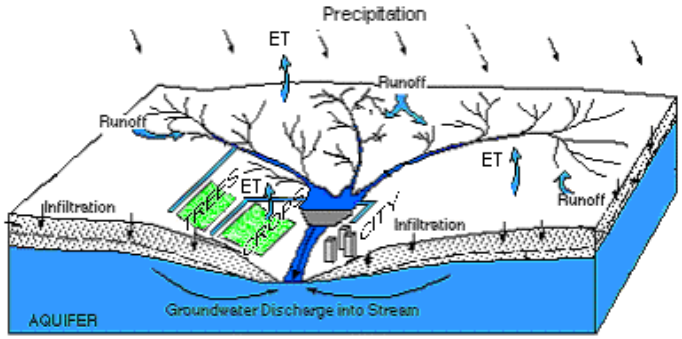
Hydrology Model

- Critical questions
  - How does rainfall on a catchment translate into flow in a river?
  - What pathways does water follow as it moves through a catchment?
  - How does movement along these pathways impact the magnitude, timing, duration, and frequency of river flows?





Planning Model



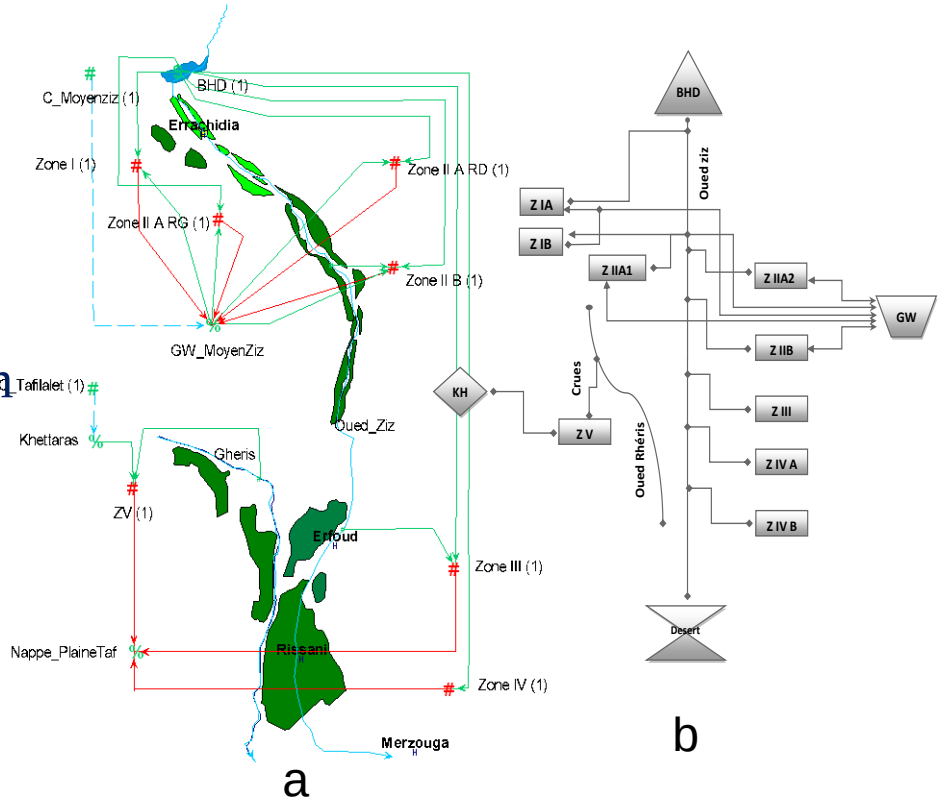
Critical questions

How should water be allocated to various uses in time of shortage?

How can these operations be constrained to protect the services provided by the river?

How should infrastructure in the system (e.g., dams, diversion works) be operated to achieve maximum benefit?

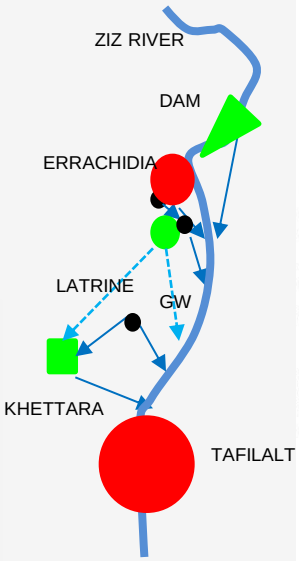
How will allocation, operations, and operating constraints change if new management strategies are introduced into the system?

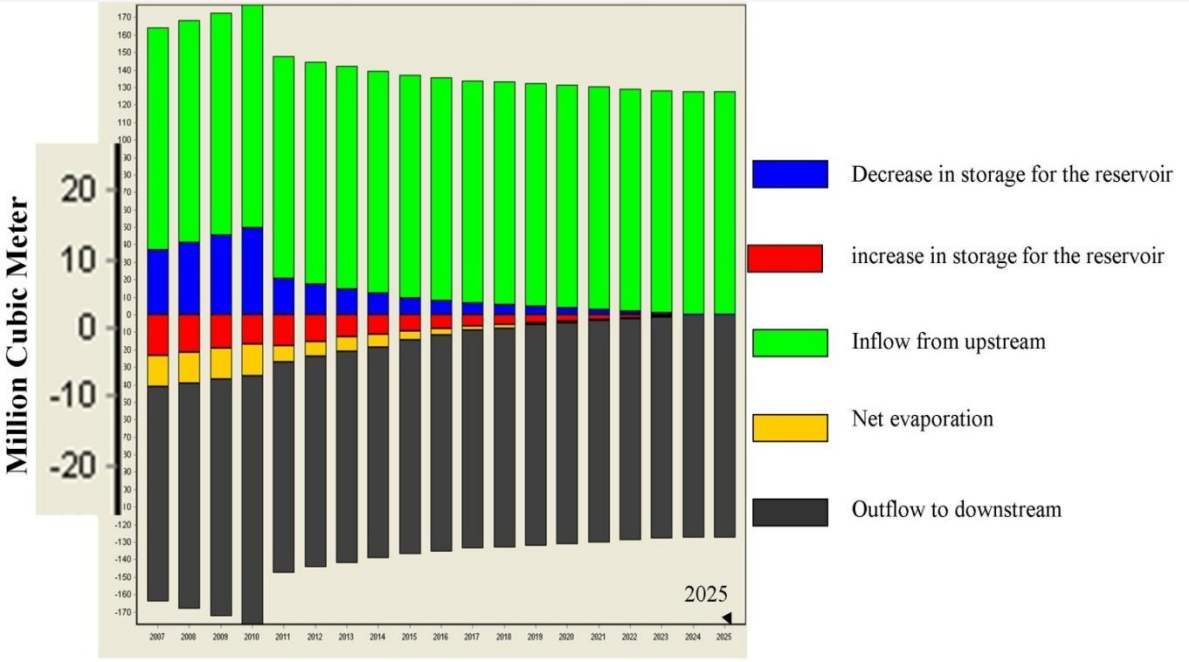


WEAP a) conceptual Model for water management and irrigated area in Tafilalet, b) Water distribution in main parts of the Ziz oasis

BHD: Barrage Hassan Addakhil; KH: Khettaras; Z: Zone, GW: Groundwater

WEAP Hydrology Model Applied: The Ziz Basin





Inflows and outflows per year simulated with WEAP for the 2025 scenarios in the Ziz basin

- Decrease in storage for the reservoir
- Decrease of net evaporation
- The data show that the reservoir will be totally filled by the year 2025.
- The effects of land use changes and climate changes on storage are also evident. More groundwater is extracted under the combined land use and climate change scenario because of increased evaporative demands for agriculture. Furthermore, under the Water for Food scenario current rates of withdrawal are unsustainable.

Synergism & Trade-offs

synergism is defined as a situation in which the combined effect of several forces operating on ecosystem services is greater than the sum of their separate effects

Trade-offs, in contrast, occur when the provision of one ecosystem service is reduced as a consequence of increased use of another ecosystem service

(adapted from Begon et al. 1996).

InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs

InVEST 1.003 Beta can map

Biodiversity

Avoided reservoir sedimentation

Hydropower production

Water purification: nutrient retention

Carbon seq & storage

Managed timber production

Crop pollination

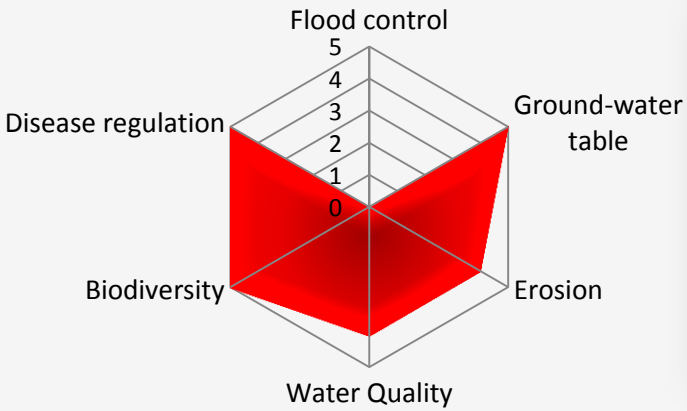
Project Goals:

- Generate preliminary monetary economic values of green infrastructure and associated ecosystem services in Tafilalt oases
- Identify associated uncertainties and data gaps
- Create web-based tool

The project team collected valuation data and local market and demographic data. Where possible, the valuation data were transferred to the region and adjusted to current (2010) dirhms for the region's land uses and their associated ecosystem services. These data were then incorporated into INVEST.

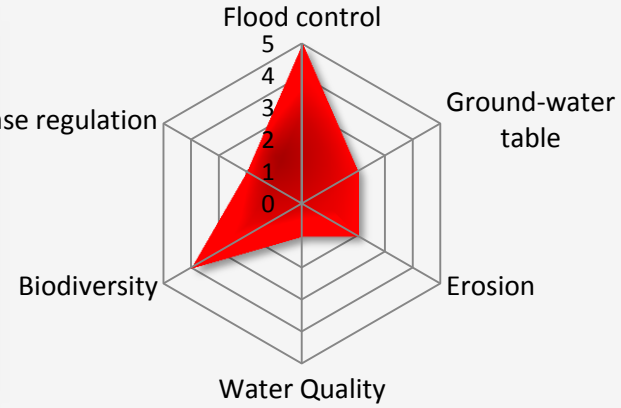
Key vulnerabilities and issues for resilience

Pre-dam (< 1970)



Hassan Dakhil Dam

Post-dam (present)



The area has undergone rapid change since the dam construction. Known thresholds in the system include

- ***groundwater contamination***
- ***salinization***
- ***Some of the ecosystem services provided by the Ziz are lost, such as***
- ***disease regulation,***
- ***Extend of active floodplain***
- ***biodiversity,***
- ***water quality and waste removal,***

Main Messages

•Trade-offs are inevitable in all decisions, at all scales, pertaining to land use, development and ES. Future programmes need to arm decision-makers (at all scales) with the information, knowledge and skills to make informed decisions based on an awareness and analysis of such trade-offs.

•There is an inadequate understanding and appreciation of the importance and value of ES, resulting in many avoidable negative trade-offs. Consequently, there is an urgent need for better research and communication of that research to these agencies.

• Major decisions in the next 50–100 years will have to be made on the current use of nonrenewable resources and their future use. Important specific trade-offs are those between agricultural production and water quality, land use and biodiversity, water use and aquatic biodiversity, and current water use for irrigation and future agricultural production.

social learning and capacity building issues:

In the rural area there is a need to enhance social learning and capacity building through a range of activities aimed at:

- training of stakeholders at several levels, in particular local village population, under consideration of high illiteracy and lack in education, including language barriers.
- adapted training and education programmes for stakeholder communication, e.g. using existing UNESCO and FAO techniques.
- interpret scientific approaches and modelling tools in a way understandable to managers.

CRISTAL

COMMUNITY-BASED RISK SCREENING TOOL – ADAPTATION & LIVELIHOODS

OBJECTIVE

Assist users in making adjustments to improve a project's impact on adaptive capacity.

APPROACH:

(a) Draw on environmental impact assessment model;
(b) Use the sustainable livelihoods framework to enable users to focus on elements of coping and adaptive capacity at the community level;

STRUCTURE: Focus on four framing questions divided into two modules:

MODULE 1 — SYNTHESIZING INFO ON CLIMATE & LIVELIHOODS

Q1: WHAT IS THE CLIMATE CONTEXT?

- What are the anticipated impacts of climate change in the project area?
- What climate hazards are currently affecting the project area?
- What are the impacts of these hazards?
- What are the coping strategies used to deal with these impacts?

Q2: WHAT IS THE LIVELIHOOD CONTEXT?

- What resources are important to local livelihoods in the project area?
- How are these resources affected by current climate hazards?
- How important are these resources to coping strategies?

MODULE 2 — PLANNING & MANAGING PROJECTS FOR ADAPTATION

Q3: WHAT ARE THE IMPACTS OF PROJECT ACTIVITIES ON LIVELIHOOD RESOURCES THAT...

- Are vulnerable to current climate hazards?
- Are important to local coping strategies?

Q4: HOW CAN PROJECT ACTIVITIES BE ADJUSTED TO REDUCE VULNERABILITY AND ENHANCE ADAPTIVE CAPACITY?

- How feasible is it to implement these changes in terms of...?
  - Local priorities/needs
  - Project finances
  - Institutional capacity
  - A supportive policy framework
  - Risks associated with future climate change

Major Achievements and lessons learned

- Enhanced multidisciplinary and multi-institutional research at the filed-site level.
- Shift from commodity-based research to SES research.
- Active involvement of stakeholders.
- Strong training and AWM capacity programs.
- NGOs were found to play a determinant role in disseminating at all levels of lessons learned aquaculture, sanitation facilitaties & ecohealth, irrigation and water hervesting, tourism and flood
- Role-playing games are taken seriously and meet stakeholders' interest.

AWM, a SWOT Analysis

STRENGTHS	WEAKNESSES
• Water management is the main subject of State Secretary of Water (Responsible for water management at the political level.) • Strong social cohesion	• Too many Organisations and institutions responsible for IWRM in the basin: • Information to the public are not given concerning water level, floods, access to water, water reserve and hydrological data
OPPORTUNITIES	**THREATS**
• Through AM, uncertainties could be addressed and restoration goals are more likely to be achieved. • Data exchange on a national level is needed.	• If there is not an ongoing training after the project has been finished the results are not sustainable.

Ouzoud the Hight Atlas Morocco

Closing Remarks: Challenges for Water Management

- Sustainable management of water resources cannot be realized unless current water management regimes undergo a **transition** towards more adaptive water management.
- To cope with **uncertainties**, adaptive management is needed as a systematic process for improving management policies and practices by **learning from the outcomes** of implemented management strategies.
- A key element is the active **involvement of stakeholders** in the process of developing, implementing and monitoring of river basin management plans.

Thank you