Linking Watershed Management to River Basin Management by Water Outcomes: *Shaking the Tree*

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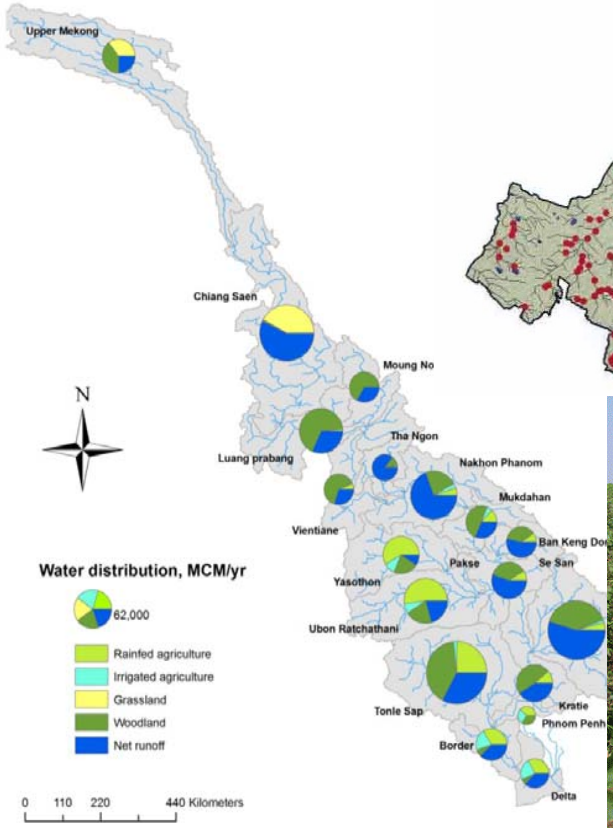
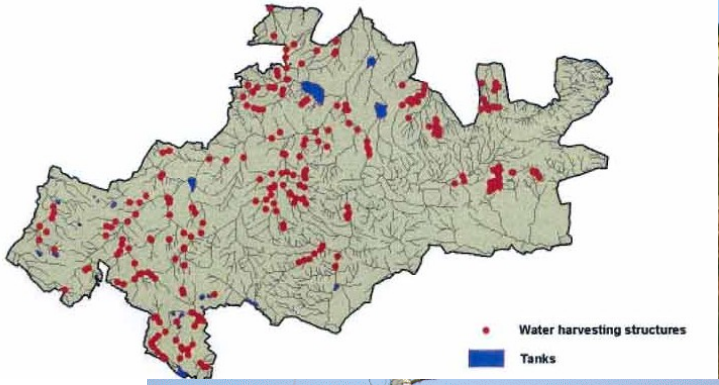
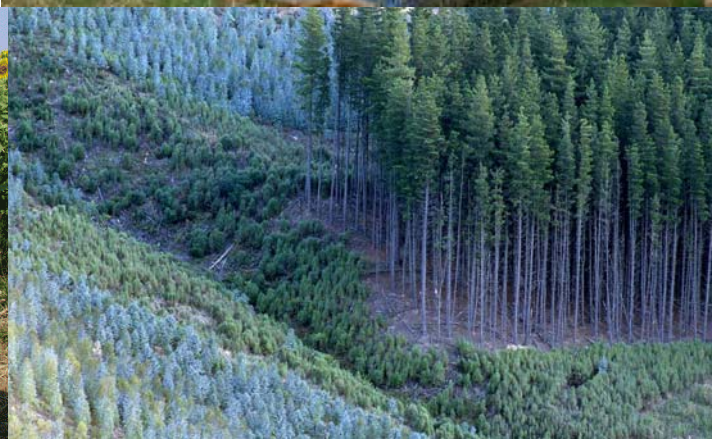




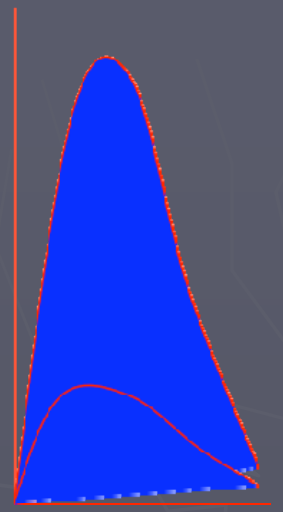


Introduction: Watershed Functions and Water Outcomes

- Watersheds will be manipulated to tackle environmental, social and economic challenges such as food security and climate change
- Every land-use decision is a water-use decision. The water cycle and land management are inextricably linked.
- Better focus needed on natural, economic and social linkages between different water users within the same river basin at the interface between watershed management and river basin management.
- Water outcomes of watershed management are key to this focus
  - The link between watershed management and the water cycle is complex:
    - numerous and simultaneous processes;
    - spatial variability of processes;
    - spatial heterogeneity of the watershed characteristics;
    - scale effects; and
    - non-linearities
  - **There are things that we know that we know !**

Mean surface runoff

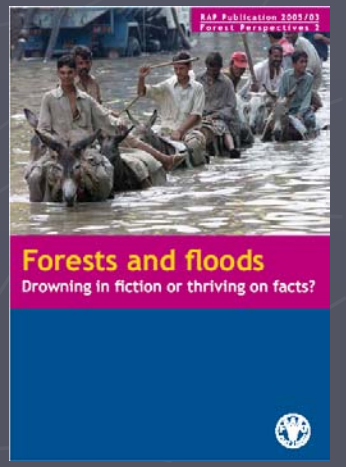
- Important watershed variables that affect hydrology: **land cover** and **soil infiltration capacity**.
- Evaporation from forests in dry and wet condition: Decreased runoff from areas under forests as compared with areas under shorter crops.



Dry Season Flows

- Low flow generation from uplands is one of the most important watershed issues in Southeast Asia.
- **In tropical areas afforestation tends to lead to a reduction in base flows because of increased ET** and **deeper roots** than other land cover types. A reduction in forest cover increases yields and dry season flows.
- Long-term impact: how management and land use practices affect infiltration.

Peak Flows



- Deforestation is blamed for having a tremendous negative impact on watershed functions. Reforestation is a popular DRM action
- Available evidence: Deforestation has little impact on large floods (rainfall, soil saturation).
- **Localized flooding:** forests can minimize runoff. But no evidence that a loss of trees significantly contributes to severe widespread flooding.

Groundwater recharge

- linked with base flows.
- Key factors are soil infiltration capacity and ET.
- Planting highly evaporative vegetation cover (forests) or trees with deep roots (such as Eucalyptus) reduces groundwater recharge.
- Water tables may rise as a result of decreased ET after forest removal.

Soil erosion and landslides

- Forests effective in reducing some erosion (understorey vegetation and litter and root network)
- little effect on large landslides on steep terrain (which contribute the bulk of the sediment load in many areas)
- There is much silt already in the river system that will continue to flow down

Water quality

nutrients, pathogens, pesticides, salinity, heavy metals and thermal property.

Observable impact of land use on:	Watershed size [km^2]		
	small 0,1 – 10	medium 10 - 100	large 100 and up
Sediment load	x	-	-
Pathogens	x	-	-
Nutrients	x	x	x
Salinity	x	x	x
Pesticides	x	x	x

Summary

Folklore	Reality
• Afforestation increases water yield. • Vegetative cover reduces large floods. • Planting trees reduces erosion . • Erosion is caused by grazing and shifting cultivation. • Sponge effect	• Afforestation may decrease water yield. • Vegetative cover has little effect on large floods. • Planting trees may increase erosion. • Erosion may be caused by variations in climate and vegetation or spot sources. • Roots are pumps

- **It's complicated, it depends (sorry!)**

- **Scale** is critical to effectiveness and penetration of management interventions. As basins increase in size effects can become less clear:
  - 'offset' effects such as de-synchronization.
  - Impact can also become more pronounced as effects accumulate.
- Effects of changed land use are not confined to small watersheds and can affect main basin flows (Lacombe yesterday)

Future watershed management and water outcomes

Afforestation to combat climate change

- Planting of new forests and replanting old forests for carbon sequestration (for example UN-REDD+ program).
- Potential to exacerbate water stress, which will also increase as a result of climate change.

Increasing agricultural productivity to enhance food security

- Rainfed farming covers 80%of the world's croplands and produces more than 60% of cereals.
- 25% of the increased water requirement needed to attain the MDG hunger reduction target will be coming from irrigation.
- 75% attributed to water investments in rainfed agriculture.

We must recognize, account and plan for these impacts on the hydrological cycle and distribution of all costs and benefits for all users in the basin.

- Climate-proofing crops:
  - field levelling, field bund construction, soil water conservation measures, farm ponds
  - increased abstraction and use of groundwater for irrigation
- The increase in areas under horticulture and forestry

Will contribute to increasing water depletion

New planning approaches are required which:

(1) take account of changed flow conditions

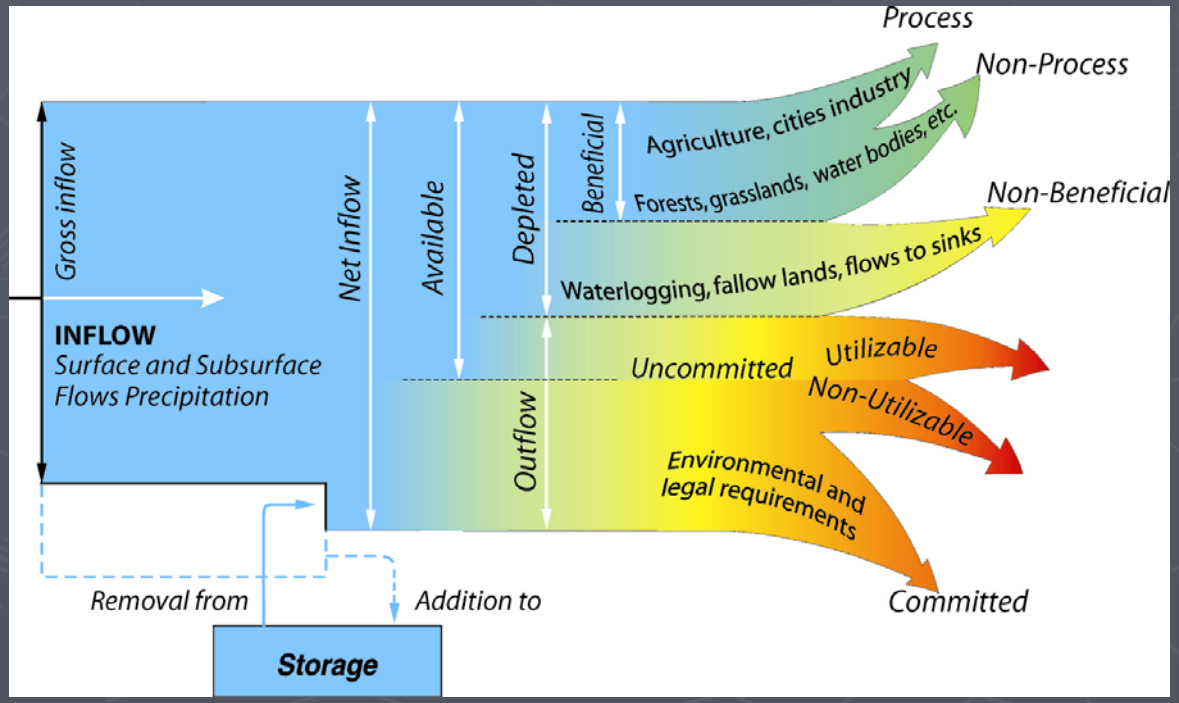
(2) take account of all externalities (not just positive: PES ....)

(3) contribute to the maintenance of agreed minimum downstream flows for environmental and other purposes.

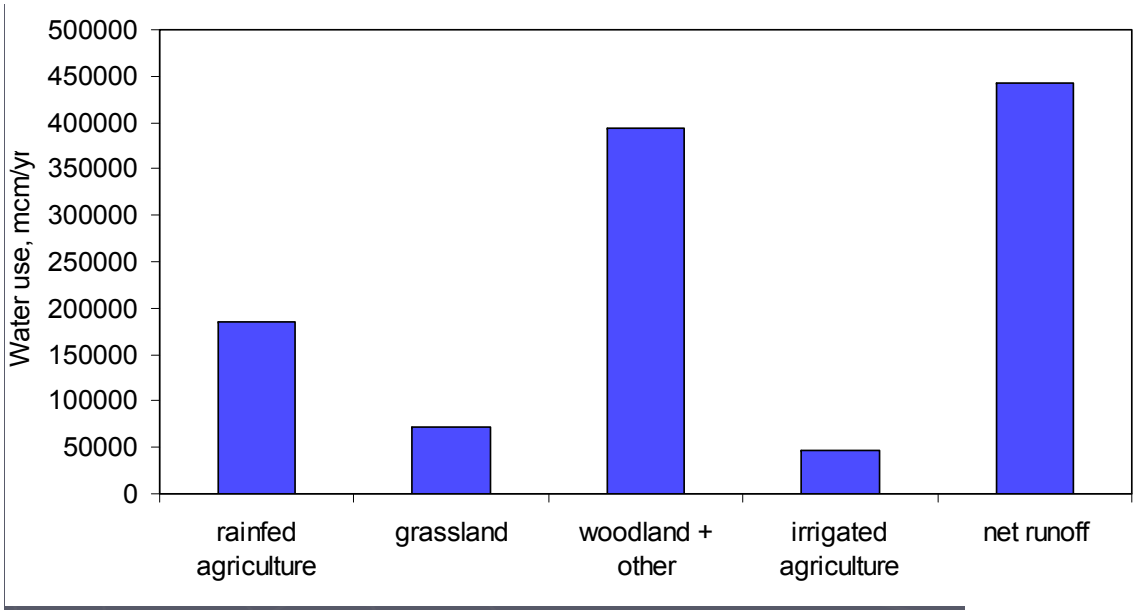
Watershed management has to be, also, about a pie in the sky!

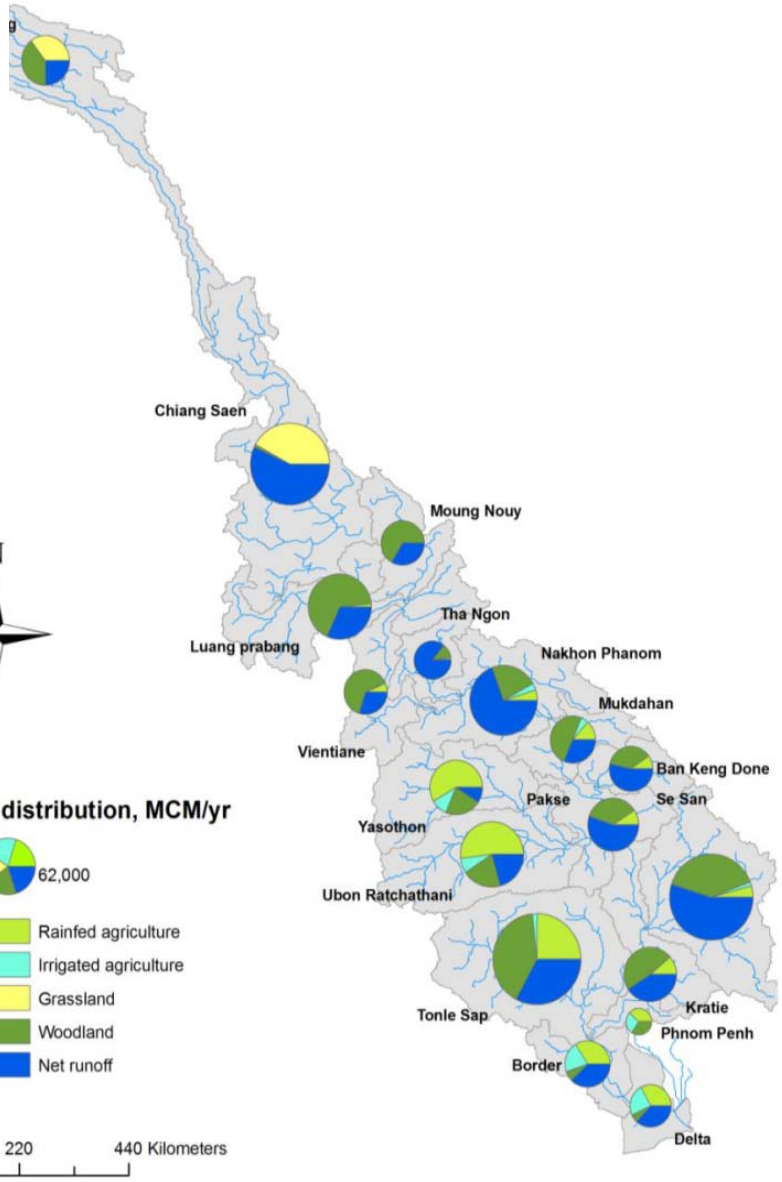
- Water-use accounting

Knowledge of the current status of water resources and trends in demand and use is a precondition for successful water management.



Source: Molden and Sakthivadivel, 1999





Simple water-use accounting of the Mekong Basin

(Challenge Program for Water and Food, CSIRO)

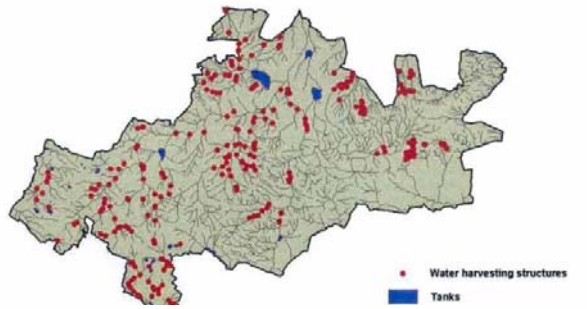
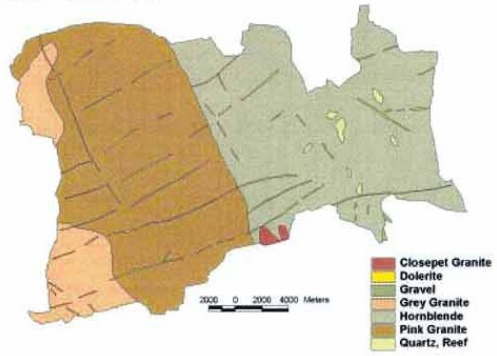


Figure 9. Geology of Kalyandurg mandal



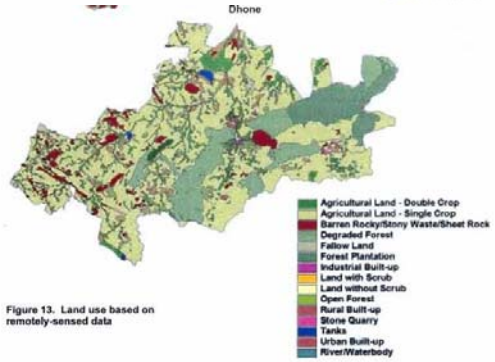
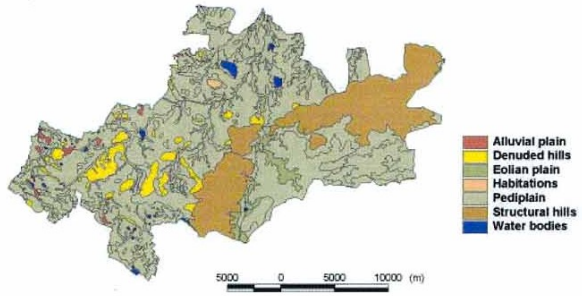


Figure 13. Land use based on remotely-sensed data



ANDHRA PRADESH RURAL LIVELIHOODS PROGRAMME WATER AUDIT

- Inflows to many tanks have declined in recent years, with a severe impact on the utility (inc. recharge), biodiversity and cultural value of the tanks and on reliability of domestic water supplies.
- Communities' belief:

i) Decline in rainfall

ii) Deforestation in the tank catchment area

Water audit

- Water harvesting created upstream along drainage lines in the tank catchment areas in recent years.
- Recharge captured locally and small contribution to base flow captured by downstream structures.

Water audit

1) water-related participatory assessments that produce outputs suitable for GIS analysis;
2) water auditing that combines terrestrial and remotely-sensed data;
3) modeling for assessing the impact of water harvesting structures on downstream water resource availability;
4) decision trees that use social, and institutional information along with physical information for targeting project interventions and activities;
5) a simple GIS-based participatory assessment methodology for M&E of rural water supplies.

(Batchelor, Calder, Sharma, DFID)

Upstream Downstream Linkages

- Facilitating and encouraging linkages between users can substantially influence the magnitude of the land impacts on water resources.
- There are a variety of mechanisms that can be used to solidify social, economic and institutional linkages:
  - Regulatory instruments (such as legal land use restrictions)
  - Subsidies and taxes towards certain objectives
  - Flexible property or use rights
  - Education and awareness building
  - Organizational development

Upstream-downstream → Upstream-upstream-downstream

From accounting to allocation

- Trends towards increased green water as well as blue water use underscore the need for good allocation mechanisms.
- Basin managers must recognize that conducting rainwater harvesting, planting forests or intensifying agriculture in one part of the basin will affect users in another part of the basin (particularly if the basin is closing or closed)
- Good allocation mechanisms based on sound water accounting will ensure that any reallocation of water is deliberate, and allow for the costs and benefits to be accurately weighed.

A Handbook for Integrated Water Resources Management in Basins

wh

Global Water Partnership

INTERNATIONAL NETWORK OF BASIN ORGANIZATIONS

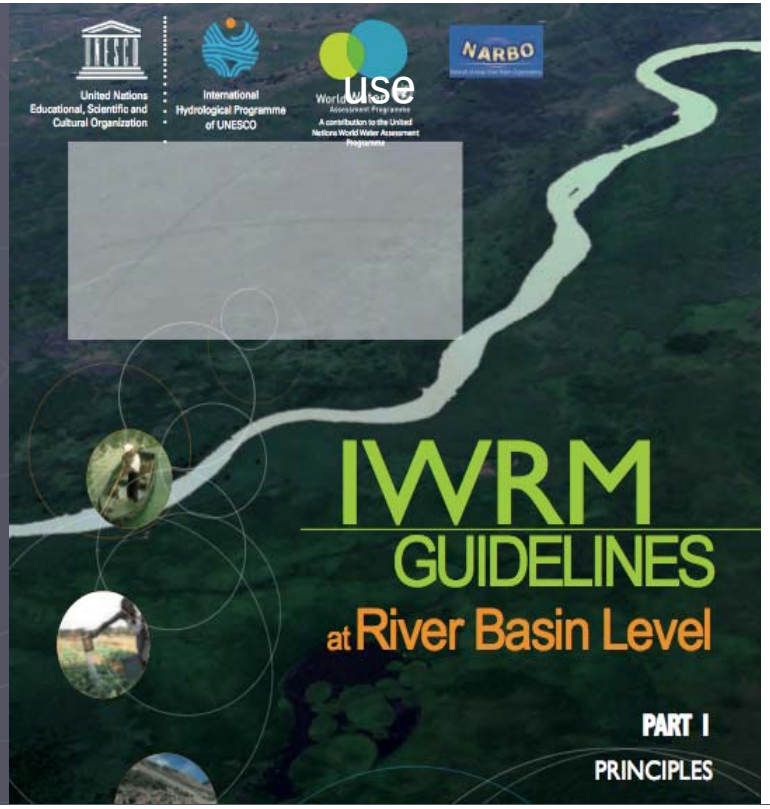
9.1 Organising collaborative basin information systems

9.1.1 Establishing basin information systems for good governance

In order to manage water resources at the basin level, it is important for decision makers to have easy access to comprehensive, representative and reliable information, at all relevant levels, on:

- the quality and quantity of both surface and groundwater resources, as well as seasonal and yearly fluctuations;
- biotopes and aquatic environments, and their degrees of sensitivity;
- water use (withdrawals), particularly for irrigation, industry and drinking water, and pollution sources (discharges), whether point or non-point;
- the risks of recurrent extreme phenomena, such as floods, droughts and accidental pollution; and
- social and economic indicators, for example costs, prices, taxes.

IWRM And Land use changes



Quantifying water response to land-use changes

It will become vital to account for accelerated urbanization and changes in land use as the population increases (due to changes in demographics and social and economic activities within the basin) and their impact on the river basin management. They will result in changes in runoff patterns, water use patterns and water quality. Excessive urbanization and population growth will also constrain options for water management, such as limiting land available for water controlling facilities. Such changes can increase flood risks, reduce freshwater ecosystems, reduce river flow, deplete springs, and aggravate water quality or ground subsidence due to over-abstraction. Disaster management requires coordination of housing and urban policy with the water sector.

Informal and formal natures of water economies

Source: Tushaar Shah

Informal	Formal
Self-supply predominates	Service providers dominate
Vast numbers of tiny, primary water diverters from nature	Very few, but large primary diverters of water from rivers, lakes
Water institutions: local, fragmented, informal	Water institutions: few, formal, legal bodies
Intermediation in water services low or absent	Very high degree of intermediation in water provision
Even if water is scarce its free…	Even if water is plentiful, it costs money…

Irresponsive institutions
Autonomous adaptation
Planned adaptation
Mitigation

Socio-economic development,
IWRM
Planned adaptation

- Formalize land use planning/management to formalize ET Mgt
- Governance-based
- Policy, incentives
- Lateral approaches

Is distributed governance sufficient?

The river basin is a necessary venue to promote equitable sharing among conflicting water users:

- upstream
- downstream
- watersheds among each other
- the environment

Facilitated **dialogue** can bring affected water users together:

- Outcomes
- Benefit Sharing
- Governance
- Financial incentives
- Support

But use common sense:

•The issue is not each and every local action/decision/conflict

•Questions of density

•Assessment often requires back-of-envelope calculations

►Good accounting is essential in highlighting the potential unintended impacts of watershed changes and allowing managers to calculate the what is often a reallocation of water from one user or use to another.

►Accounting helps clarify linkages between users in the basin and can be used as a source of information when facilitating dialogue between users.

Some questions

- Plan and allocate rainwater or ET or infilltration at the watershed scale?
- Payment for Environmental Services, or user or polluter pays principles?
- **Efficiency, equity and risks trade-offs.** Strategic balance of water investments at the appropriate scale for small farmers, rainfed agriculture and larger investments and irrigation.

- New skills and data needed to properly design and implement landscape or community-level approaches to water harvesting and delivery systems for integrated water management (Rockstrom, 2007):
  - important processes, especially runoff/ET/infiltration
  - water availability and use at the meso-scale.
  - skills and capacity of basin managers in designing and implementing an integrated management plan

- Many tools now available
- Much knowledge available: no excuses

Key Messages

- Watersheds are both providers and the biggest consumers of water
- Developing linkages between upstream and downstream water users and among watersheds requires a clear picture of possible impacts of land uses on water quantity and quality at the scales at which these are relevant
- Sound accounting and auditing and waterfootprinting needed in watershed management and interventions that change land use to better understand hydrologic consequences at basin scale in all basins
- Micro interventions and community-based projects can have macro cumulative impacts, so require as much scrutiny as “big” projects
- Watershed or rainfed programs may result in a massive reallocation of water. A water policy framework for ILWRM at the meso-scale must deal with planning and allocating ET (“rainwater”) at watershed scale