River Basin Development: a framework for case studies

(Francois Molle; draft document for discussion)

Background

For millennia has mankind developed its hydraulic knowledge, diverting or damming flows in order to allow better sanitation, transportation and productive use in agriculture. In most cases, water resource developments, even large scale ones, were based on relatively plentiful local resources: the magnitude of the diversion and the population density of the societies concerned were limited and these uses seldom had drastic impacts on other parties. It was only about three centuries ago that the concept of water basins came to the fore (Batchelor *et al.*, 1998), but it is only during the 20th century that this late recognition of hydrological and ecological entities gave way to more systematic scientific research on the interrelationships between land use, run-off and erosion, generally focusing on small scale and upland catchments. Furthermore, it was only very recently, in most cases during the second half of the second century, and in numerous cases during the last two decades, that river basins[1] became not only the focus of hydrological investigations, but also of a societal concern for an improved management of the most crucial resource for life.

As human societies develop, they also expand their infrastructure to tap and use water resources. *This gradual "anthropogenization" of river basins generates complexity*:

- Resource-wise, the growing interception of surface and underground water fluxes alters the natural hydrological regime, as reservoirs and return flows from uses determine changes in the resource base in terms of quantity, timing and quality. This also has critical implications on ecological equilibriums and dynamics and more generally on the environment.
- Society-wise, water users and the general population find themselves in a situation characterised by growing interaction and interdependence. When one's water use deprives someone else from the water he or she is expecting for his/her consumption or productive activities, social resources must be mobilised to define socially accepted patterns of water allocation and management: in other words, water becomes "everyone's business". With the emergence of water as a scarce and therefore valuable

[1] It is recognised that the boundaries of the basin are not strictly encompassing all relevant phenomena. Administrative boundaries rarely correspond to basins, aquifers may span over several basins, and transbasin diversions are also important options of macro-level water management.

resource, laws, politics and the structure of power within the society must also be factored in the analysis of the access to water resources.

- Economy-wise, with the growing commercialisation of agriculture and of intersectoral linkages, the different economic activities within the basin and their respective productivity in water use will be defined within the wider national and international economy. Economic alternatives offered to investors as well as to farmers, especially when faced with decreasing supply, critically shape the nature of change and are also largely governed by macroeconomic structures.

The definition of a sound management of water resources thus appears as a daunting challenge, as it requires not only an in-depth understanding of physical flows, human activities, socio-economic conditions, societal, political and cultural contexts, but also of how their interrelate with each other. In addition, as most river basins are quite large, the spatial heterogeneity of all these factors, as well as their scaling-up, are critical issues that need to be addressed.

While all river basins differ by their specific mix of characteristics, they also share commonalities. A scientific investigation must therefore strive to follow the (narrow) path that demarcates overly generalised framework (which only provide standardised options) from too unique-like descriptions (that do not allow lessons to be drawn for other situations).

Several conceptualisations have been offered in order to represent the changes occurring along time in a given basin (Keller *et al.*, 1998; Molden *et al.*, 2000; Turton and Ohlsson, 1999)[2]. They are generally based on linear descriptions of change[3] which distinguish successive phases of construction/supply augmentation, improvement of management, and demand management. These frameworks do not accurately describe all basin trajectories but they help emphasising that the main issues relevant to each basin, the problems faced, and the expectations of stakeholders will vary from one basin to the other, depending on its relative degree of 'evolution'. 'Closing basins', in particular, are water systems where there is less and less usable water leaving the system other than the necessary to meet minimum instream and outflow requirements. (Little of the regulated water is lost to unproductive evaporation in water bodies and fallow land, or flows out of the basin uncommitted, environmental requirements being considered). They are generally concerned with the following crucial issues:

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[2] See Molle (2002) for a critical review of such frameworks

[3] A sequential vision may help in resituating the evolution of a given basin, but should not be taken as a normative framework. Basins may not conform to such idealised trajectories and one should refrain from interpreting it as a unilinear idea of "progress" or of crisis generation. In reality, sub-areas within the basin may be at different stages and some steps may not exist (for example, allocative problems may be solved by the institutions adopted since the onset; in some basins scarcity has always been present (oasis), etc). In addition, saying that adjustments and new institutions are needed does not imply that the solutions selected are adequate.

☑ **Water resource development and management**, must be geared towards striking a balance between supply and demand. When, in a context where most accessible resources are already tapped, population and water use per capita increase, there is a need to improve management and efficiency in use (the amount of water depleted by a given use, or the economic return of a m^3 of water). This has implications from the farm level to the operation of reservoirs and cuts across technical, economic and organisational issues. In addition, it is necessary to ensure long-term sustainability and regulate the use of groundwater extraction.

☑ **Water allocation and water rights**; as users compete for scarce resources, the allocation of water becomes crucial, as it eventually defines who gets what and whether this is equitable and economically efficient. Here, again, several technical, legal, and political factors come into play. A growing water scarcity often cause conflicts and raises uncertainty in supply, and water entitlements or rights need to be increasingly formalised.

☑ **Environment;** ecological cycles and equilibria are threatened by over abstraction of surface waters or change in flow regime which affects in-stream environment, exacerbates saltwater intrusion, affects the productivity of land in estuarine areas, and reduces the capacity for diluting waste discharge. Irrigation may also mobilize salts and cause salinisation of land. Watershed degradation caused by poor land use, land clearing, inappropriate cropping techniques, or overgrazing is altering hydrologic factors and increasing the vulnerability of watersheds. Aquatic ecosystems are degraded by nutrient discharges (from sewage and fertilizers) which accelerate the eutrophication of water bodies. Degradation of wetland ecosystems is affecting important natural functions (hydrologic and ecological), which makes the productive resource base vulnerable.

☑ **Livelihoods enhancement;** access to water is crucial for the livelihoods of many farmers and a reduction of their allotments or a significant rise in the price paid for this access may have severe financial consequences. More generally, water is vital for hygiene and domestic uses and obtaining access to proper sanitation is a basic prerequisite for a better quality of life. Poor sanitation, water pollution and uncontrolled waste discharges from urban, agricultural, mining and industrial development, impacts negatively on public health. Thus water is also at the core of broader concerns for poverty alleviation and food security.

These different dimensions implicitly highlight that any pattern of water resource management is likely to be a trade-off between different objectives, as water is expected to fulfil or contribute to competing purposes: food security and poverty alleviation through irrigation, health and hygiene, power generation, non-agricultural economic development, ecosystems services. More generally, and may be more crucially, it is apparent that in many cases equity and economic efficiency are contradictory objectives that call for a political mediation.

Since the majority of the population of most developing countries economies is still mainly agrarian, economic and social development will depend on how successful nations are in promoting sustainable management of their land, water and other renewable natural resources.

The overall challenges can be stated as: ***under conditions of increasing water scarcity, competition between uses, weak institutions, and environmental degradation, how can water basin resources be managed in an equitable, pro-poor, efficient and sustainable manner***.

The Comprehensive Assessment for Water Management in Agriculture, adopted by IWMI and its partners, makes provision for case studies on river basins to create a knowledge base for use by practitioners, planners, resource managers (at the local level), and by development agencies, policy makers, donors and researchers (at a broader level of generalisation), in addressing the complex issues of integrated water resources management within a basin perspective.

Rationale

The growing awareness of the interrelated nature of anthropogenic water uses and of the natural water cycle within a basin, together with the limitations of traditional approaches based on the augmentation of supply, have led to the emergence of widely popular concepts such as Integrated Water Resources Management (IWRM), or Integrated River Basin Management (IRBM). Since the Rio and Dublin Summits, a holistic and participatory approach recognising water both as a social and economic good has been advocated. While few oppose such general principles, there is evidence that real world situations rarely conform to these ideal frameworks. As a result, one needs to go beyond such general concepts and get on-the-ground understanding and knowledge about how societies have *effectively* dealt (or not dealt) with the problem of managing land and water resources at the basin level, and how coming challenges can be addressed.

The focus is therefore on documenting the development "trajectory" of river basins, showing how a particular society has grown, evolved and develop its productive activities within a given physical, climatic and ecological context, and how, in return, it has been affected and changed by these transformations. Such trajectories are marked by conflicts, shock events, crises, and compromises that need to be highlighted.

Why adopt a basin approach? A basin perspective allows us to integrate upstream and downstream issues, to understand the interrelatedness of competing uses and users, to integrate other natural resources and human interventions with the management of water resources (see footnote 1).

Why carry out *more* basin studies? Most of the existing basin-scale studies appear to be sectorial or discipline oriented (hydrology, agriculture, environment, etc) and are aimed at specific objectives. They lead to a series of different approaches, viewpoints, scales, and outputs. There is a need to carry out more comprehensive and comparable studies, that integrate the behaviour and concerns of all actors within a specific physical and societal environment.

Why carry out longitudinal studies? Most studies focus on the actual situation but do not provide a detailed picture of " how we got there". It is posited here that attitudes towards water, how it is shared and used, are historically grounded and that the past development of the basin, or its gradual *anthropogenisation*, must be reconstituted and factored into the analysis of both the present situation and future prospects. This is also why an *in-depth* approach of a few basins is preferred to an *in-breadth* analysis of a higher number of river basins.

Why focus on water-agriculture-environment relationships? It is commonly known that agriculture is typically the largest user of basin water resources, and as such contributes to the degradation and depletion of water resources. The impact of agricultural activities (deforestation, use of chemical fertilisers and pesticides, intensification etc) on environment (soil erosion, fertility decline, water pollution, salinisation, depletion of the natural water base of ecosystems, etc) is more and more prominent and has not been satisfactorily factored in the analysis of both benefits and costs, and the sustainability of agriculture. It has also been argued that solutions to scarcity and to the water-agriculture related environmental problems can be found in the way water is managed for agriculture.

Why undertake comparative basin case studies? As most existing studies are partial, they do not lend themselves easily to comparisons. By adopting a common protocol for the study of river basins in different physical and socio-cultural contexts, a more generic understanding of both the commonalities and the importance of site-specific conditions must arise.

Objectives, outputs and activities

OBJECTIVES

The main purpose of the basin case studies is to contribute to addressing IWRM challenges by generating, synthesizing and disseminating useful information and knowledge on basin level water management challenges, for use by practitioners, development agencies, planners, policy makers, and donors.

To achieve this goal, the project will include an in-depth analysis and comparison of the historical development and present status of a number of selected basins. The resulting knowledge is specifically aimed at improving the understanding of basin level processes and their interactions, and identifying trade-offs. This will form the basis for exploring, in a participatory manner, the alternatives and scenarios for the future sustainable management of water resources in the basin, and for deriving a set of contextualised options that may be used to address water management challenges.

This multi-disciplinary and comparative investigation is expected to yield several building blocks of knowledge, as well as methodological lessons, that will contribute to the

Comprehensive Assessment carried out within the framework of the Dialogue on Water, Food and Environment.

ACTIVITIES

The main activities of this initiative will be broken down according to the following steps:

- Review of available literature; improvement of the present document to be posted on IWMI's website (in particular the case study protocol), by feedback of potential partners;
- Identify potential case study contributions and determine the sample for the comparative study;
- Carry-out case studies (see methodology below)
- Synthesise and cross-analyse the different studies; develop a Rapid Basin Appraisal framework
- Disseminate results

OUTPUTS

The expected deliverable products are:

- A set of comparable in-depth longitudinal case studies, made available on the net
- A synthesis book with one appendix for each basin
- A "Rapid Basin Appraisal" methodology
- Scientific papers, MSc/PhD theses and students trained
- Basin level stakeholder conference (Capacity building of local partners for decision-making in water related issues through an improved understanding of basin development and management). Such consultation can be achieved through using mechanisms to be set by the Dialogue on Water, Food and Environment (national and local dialogues).

Methodology

1. GETTING STARTED

Basins case studies will be selected based on the following parameters:

- Information already available (on-going work)
- Basin size
- Climate (diversity of situations)

- Degree of basin development/closure
- Population density
- Representativeness
- The presence of severe poverty (and tradeoffs, poverty/environment/other uses in the context of large numbers of poor people)
- Complexity (existence of a mix of competitive uses, conflicts, etc)

However, since the intention is to build on existing or on-going research, it is recognised that the selection of basins will be greatly governed by the capacity of potential partners to associate themselves to the initiative and to endorse the common protocol. As it is expected that a sample of approximately 12 basins will eventually be adopted, the above parameters will be used to ensure that no situation of wide occurrence is left uncovered by the study.

The problems faced by small catchments and by large basins such as the Mekong basin, are too different to lend themselves to a comparative analysis. In addition, the type and precision of data that can be used for the analysis are also at variance. Therefore, the exercise will focus on "middle size" basins with a degree of anthropogenic pressure and inter-sectoral regulation needs: in other words, small upland catchments (typically of a few hundred km2 or less), as well as very large basins (Mekong River, Yellow River, etc), will not be considered and the case studies will preferably be chosen in the medium range (typically between 2,000 and 200,000 km2). *<Other research activities conducted by IWMI will also address small catchment and large basins but not within the comparative framework under consideration here. In particular, the Comprehensive Assessment provides for 'case studies' that are more focused in scope.>*

As it is recognised that they are faced with a particular range of (geo)political issues, it is also not intended to include international basins in the sample. However, this aspect might be addressed in a complementary activity of the CA. Likewise, emphasis is placed on developing countries, but the lessons drawn from basins in developed countries will also be considered in the literature review and factored in the analysis.

2. CASE STUDY METHODOLOGY

The case studies will document the historical development of the basin, characterise in more detail its present state, and develop *scenarios* of future development. The following protocol is not meant to straightjacket the implementation of the case study but, rather, to provide a common ground that will allow a degree of comparativeness. It is recognised that some of the issues will be either irrelevant or difficult to address in certain basins, while site-specific situations might on the other hand create the need for investigating additional aspects.

The basins will be analysed in a systemic manner, focusing on their different components as well as on their interrelationships, but a critical emphasis will be placed on the several

dimensions of physical, environmental, technical, institutional and societal *changes* within the basin.

Each basin 'comprehensive assessment' will be synthesised in a report that will draw along four main sections:
a) The natural setting
b) The historical transformations of the basin
c) The current situation
d) Prospective and scenarios

Appendix 1 provides a structured list of issues that have to be considered. This analysis will unfold along ***eight main lines*** of scientific problematics that are summarized in the following table. Questions and challenges related to each topic are indicated together with some general hypotheses that need to be tested. (further elements on themes 1 to 4 are also given in Appendix).

3. LITERATURE/EXPERIENCE REVIEW

Some of the issues require a wider collection of experience and literature review than what will be allowed by the case studies.

It is envisaged to commission specific syntheses, tentatively 2 or 3, which will complement the knowledge drawn from the case studies. They will widen some of the crosscutting issues and allow a sounder overall final synthesis. Topics likely to be addressed are:

* Basin management organisational patterns vs. context and governance: a typology of basin management alternatives will be set up, drawing in particular on experiences in developed countries. The importance of contexts, notably political and cultural, will be factored in a guideline for determining a set of recommended organisational options for a given context.

* International basins: conflicts and cooperation.

* Water sharing: the question of water allocation within basin (but also within irrigated schemes) will be addressed in more detail in a companion research project.

Main issues	Challenges, questions	Hypotheses
1. Basin development trajectories	Do river basins follow similar paths of development? What have been the different types of adjustment to water scarcity and water quality degradation, and do they happen in a similar sequence? If not, what factors account for the differences? Do policies only respond to conflicts and degradation, or can they be preventive? How do local responses and global response, notably by the state, shape trajectories? Can a generic framework of historical basin development be designed?	Options are not selected only based on economic costs but reflect the distribution of agency and power among actors, their selective interests, and more generally the political economy context, notably the state/citizenry relationships. Individual or community local responses are of great importance. Some general and common aspects of political economies and relative costs of alternative responses create some widely shared commonalities but no deterministic description is possible.
2. Water productivity	What techniques and strategies have been implemented to improve water productivity? What specific conditions enabled them and to what extent can they be transferred to other settings? What is the particular relationship between local water uses and basin level water use? Is there significant scope for end-use efficiency gains? What would be the impact of specific localised water savings? Is there scope for eliciting water savings through pricing? What has been the evolution of water productivity within the basin ($/m^3) and in each sector? What have been the main (endogenous and exogenous) contributors to these changes? What is the scope for gains?	Technical options are conditional upon a series of factors: techniques may or may not be appropriate, cost-effective, and may have scale-dependent side-effects depending on the context. Micro-irrigation may not be a solution. Closing or closed basins might, by definition, have little scope for overall water savings at the basin level; users often respond to water scarcity by local adjustments. Water conservation policies may have a more reduced scope than commonly believed. Volumetric pricing is hard to implement, demand is inelastic at low range prices, and savings may not be real savings at a wider scale. Crop intensification and diversification, and non-agricultural development raise the productivity of water use.
3. Water allocation and rights	Are there water rights at different levels (community, project or basin level, national legislation)? Do formal and informal, local and administrative rights enter in conflict? What is the resulting degree of equity? What has been the impact of state intervention in water resources management over the years? What is the actual allocation pattern and what is the weight of the different stakeholders? How have the shares of sectorial water uses evolved and what has been the impact on agriculture?	Legal pluralism is a common situation. Changes in allocation or in rights must consider the existing bundle of rights. Equity is a social construct. Allocation in large-scale systems is generally a top-down process and bulk allocation is loosely defined. Inter-sectoral reallocation is enforced centrally and often does not hinder non-agricultural development. Ag-non-Ag transfers are a common feature and generate adjustments in the Ag sector.

Water allocation (cont.)	How can basin-level water rights be secured and formalised, and is this important to the improvement of management? What are the official and effective allocation mechanisms in public irrigated schemes? How does this process fare in terms of economic efficiency, equity among users, and resilience (how does it cope with inter-annual variability)?	Formal prescriptive rights backed by law may be desirable but they are difficult to establish and enforce since they demand physical, socio-political and legal pre-requisites that are rarely encountered in practice. They are also often ill-adapted to specific local situations. Generation/modification/re-definition of rights must rest strongly on informed negotiation between actors. Official "hydraulic equity" and effective access to water often differ starkly. The development of conjunctive use makes equity goals more complex. The variability of water stocks creates difficulties for the definition of users' entitlements.
4. Equity and distribution of benefits: poverty alleviation, socio-economic categories of actors	To which categories of people have accrued the benefits of public interventions in the water sector and what is the distribution of these benefits? Did they increase income and mitigate poverty? Did the change in access to water generate gender-sensitive impacts? Can a methodology be designed to better link local and global economic changes, include induced uses and indirect benefits of water, and provide a more comprehensive picture of benefits and costs (impact assessment)? How are interventions and project outputs influenced by the strategies and underlying rationale of dominant decision-makers and funding agencies?	Some categories of people, within the beneficiaries, may have been gradually sidelined. Multipliers effects, backward and foreward linkages, multifunctionality and induced uses (e.g fisheries) or benefits must be taken into consideration. By doing so, the cost/benefit common picture is radically altered and a more comprehensive impact assessment is obtained. Putting decision-making for investments in context shows that objectives and modes of rationality may differ, and that they significantly impact on the outcomes of projects.
5. Agriculture vs. environment	What has been the impact of water resources development upon environment (water quality, fauna, wetlands, salinisation, etc) and pre-existing activities? What are the tradeoffs between irrigated/rainfed agriculture and environment and how can we address them? Can we estimate, quantify, and value environmental uses, and how can we ensure they are considered in the allocation process? What awareness and environmentalist forces exist in the basin? What is the perception by users?	Agricultural and water resources development have been detrimental to nature. Environmental degradation has also crucially altered pre-existing livelihoods. More water needs to be reserved for environmental needs in some basins. Commensuration of values is not always possible. Better information is necessary to allow sounder negotiations between stakeholders with different value judgments. Environmental concern is linked to the standard of living and cultural values.

6. Food production and security	What has been the change in population, food production, consumption and security within the basin, for both food producers and non-producers? What is the share of food consumed produced in the basin? Does this have impact on livelihoods? What are the relationships between water and food security?	Irrigation raises food production and household income and therefore contributes to food security. The basin scale is only partly relevant for analysing issues of food security.
7. Institutions for basin level management	What are the formal/informal institutions and organisations that contribute to manage water resources at the basin level? What is the contribution of users and civil society as a whole? How does this relate to the socio-political context e.g. processes of decentralization or devolution)? What is the scope for enhancing participation, defining services and establishing rights? To what extent is current management 'integrated'? What type of basin level coordination is suitable in the particular context of the basin? What are the criteria for such choice?	Several types of institutional settings may be established for managing resources at the basin-level. Distinguish functions and structures. The state regulatory role seems necessary to address scarcity at the basin level, but centralisation may not always be the best solution and contextual options must be designed.
8. The basin within its wider economic and political context	What are the relationships between the basin economy, notably agriculture, and the wider national and international context? How do basin boundaries overlap with administrative/political structures and other decision-making units? Are basin boundaries relevant to analyse processes?	The basin is part of the national economy and sectorial linkages have spatial implications on the basin. Political decision-making often does not correspond to basin boundaries.

4. OVERALL SYNTHESIS

Upon completion of the studies a synthesis will be made in order to extract generic knowledge and a range of contextual options for basin management. This synthesis will draw on the different case studies but also on the available literature.

Because of the very nature of this comparative study, there is no focus on a particular aspect of river basins (for example a problem-oriented comparison on environmental degradation or institutional change would lead to a selection of basins relevant to the more narrow focus adopted). The comprehensive nature of the present analysis will lead to a more global understanding of how processes are contextualised and the overall synthesis/comparison will run along the ***eight main lines*** mentioned earlier and summarised in table 1.

A methodological appraisal will also draw lessons from the approach used and derive lessons and improved frameworks for future comprehensive basin case studies: most particularly, a "*Rapid Basin Appraisal*" methodology will be derived from the study.

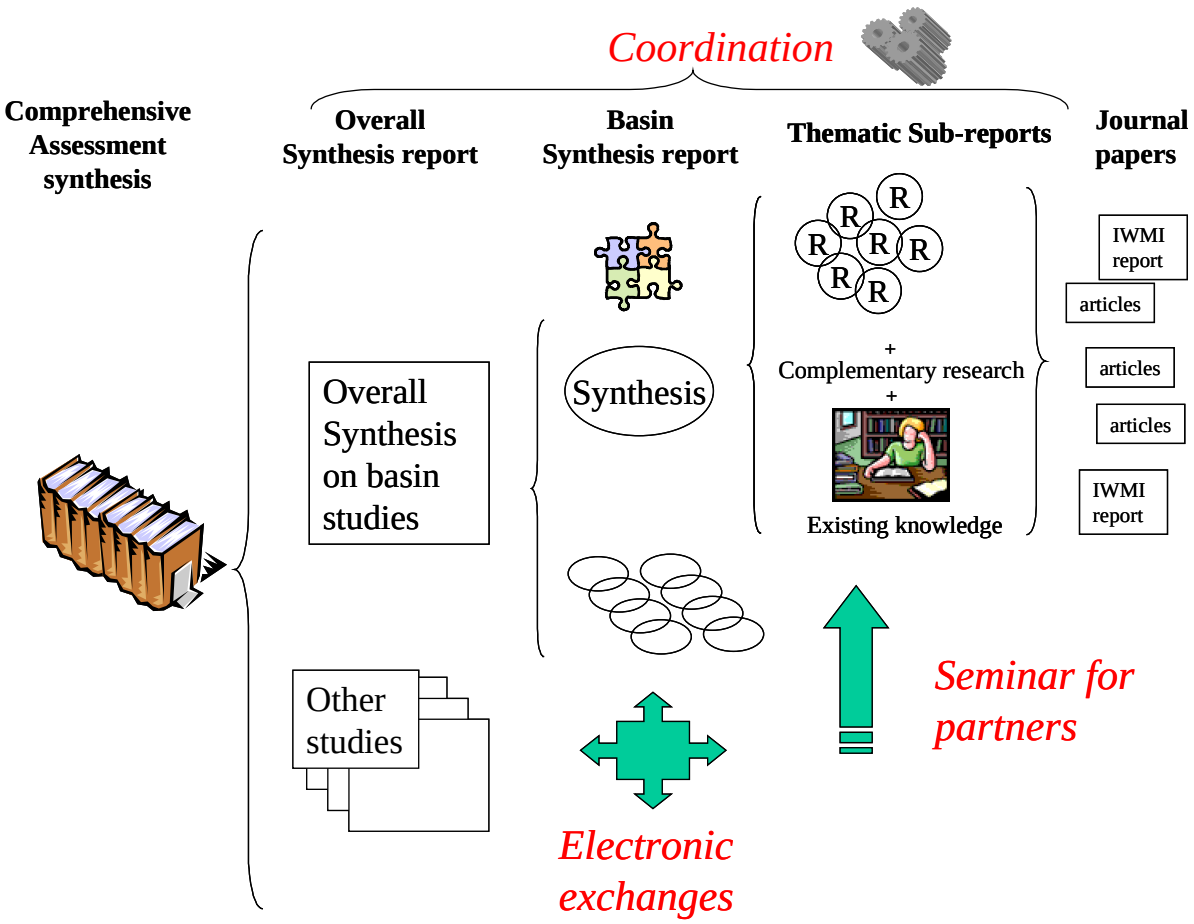
5. COORDINATION

Each basin study will build upon existing literature, expert knowledge (commissioned thematic reports), and complementary research activities. Output includes CA research reports, working papers and journal articles, as well as an overall Synthesis Report (see figure below).

The teams working in the different basins are to meet in 2003 for a first exchange, presenting some pieces of knowledge on their own basin, learning from other and improving the common methodology. When a report/paper is produced in a given basin (e.g. impact assessment in Walawe basin), it is circulated electronically to other team members. Partners are also expected to meet at a final meeting sometimes at the end of 2004.

The basin syntheses will serve as building blocks for the general synthesis of the comparative study. This report, in turn, will be a component of the final Comprehensive Assessment.

All documents will be made available on the internet. Basin syntheses will also be printed and widely disseminated.



6. DISSEMINATION

The different deliverables of the projects will be made widely available through scientific publications, websites, presentations at the Kyoto and Montreal Water Forums and other conferences.

In each of the basins considered in the study, a final workshop will also be organised to ensure that findings are discussed with and communicated to local partners.

Appendix 1: Issues to be addressed in the basin assessment

The following categories of issues are not intended to be the basis of a descriptive exercise. It is a mere list of points that need to be factored into the analysis, as long as they are relevant to the basin considered. For each of the 4 sections, syntheses are needed and indications are given in italics, including links to eight main problematics that are summarised in Table 1 and that will serve as the structure of the overall synthesis.

< Note: the list below is not meant to be a 'road-map' or check-list that must be translated systematically into heavy data collection. Rather, it may be useful in emphasising some aspects that might otherwise be glossed over in the case studies. The analysis carried out in each basin will first define what are the system components and themes that must receive emphasis, but is also intended to be comprehensive (the lack of salience of a given issue is in itself an interesting information when put into context)>

[A] The setting: physical and ecological environment

[Description of the natural/physical setting, including climate with its possible evolutions over time. It is important to stress the climatic constraints to rain-fed agriculture, the suitability and potential of the different landforms, the availability and accessibility of groundwater]

- Physical and climatic setting
  - Rainfall, ET, temperature, etc. (including possible evolutions of rainfall)
  - Soil, geology, topography, landform and their suitability for agriculture
  - Drainage network, flood regime, mean and probable seasonal flows, sediment load, erosion, etc (including possible evolution of the hydrological regime, natural or from human activities)
  - Risk analysis (drought, floods, pollution)
  - Past extreme events
  - Underground water resources
- Main ecosystems
  - Forests, grassland, wetlands; agricultural ecosystems
  - Riverine and estuary ecosystems
  - Wildlife and biological resources

[B] The basin historical development

The history of the basin can be described in two ways, either by looking at the changes over time in the different categories shown below, or, preferably, by periodizing history. Describe the evolution of 'society' within the basin and how it has developed its productive activities. Focus on agrarian change; show the link the basin history with the wider national political, economic and social transformations. Historical land and water resources development must be described, showing how supply and use have evolved, and how the society has responded (or not) to water problems.

- Demography, population changes
  - Early settlements, evolution of birth rate/mortality & growth rates
  - Sex ratio, age pyramid, life expectancy,..
  - Migrations (internal and international, long term and seasonal)
  - Ethnicity, linguistics (common and specific languages)
- Political, institutional and macro economic context
  - Political evolution, reforms, shock events (wars, famines, independence, etc)
  - Development and relative importance of economic sectors (in the basin and nationwide)
  - Main infrastructures: roads, railways, power generation, etc.

- Land use ; Water resources development, supply and demand

  Expansion of the land frontier
  Expansion of rainfed and irrigated areas
  (all sizes; "official" or not; Characteristics and maintenance status) and other uses
  Drainage works
  Reservoirs, canals, tubewells, etc.
  Flood protection, dikes
  Hydro-power; navigation
  Transbasin diversions
  Water treatment and desalinisation

- Agrarian change

  [examine agrarian transformations, including changes in:]
  Land use; cropping techniques and calendars, yields, input use intensity, mechanisation
  Farm size, land tenure, land market
  Credit
  Labour force in agriculture (by gender)
  Marketing, price system
  Crop/husbandry linkages
  Farm, off-farm and overall income composition (by source, amount and gender)
  Rural-urban linkages
  Cost/return of main farm activities
  Social relationships in rural areas; differentiation; political power, control over resources

- Water resource allocation and management

This section examines how water has been managed and allocated along time. It must be linked with the three above issues to offer an understanding of how the different responses to water scarcity, flooding or water quality degradation have been shaped by the context of the political economy of the basin/country. Appendix 2 and Molle (2002) provide further insight on this point.

Efficiency in use
Allocation rules (formal and actual), between sectors and within irrigated areas
Legal environment and regulation
Changes in supply, use, demand, and water balance
Societal responses to water scarcity, at the local and state levels

- Impact of development: health and environment

This section addresses the environmental and health impact of land/water resource development interventions. It will bring a clearer vision of the corresponding externalities and costs that must be considered in the impact assessment (see next point). Some methodological guidelines are given in Appendix 3.

Impact on ecosystems (biodiversity)
Soil degradation (erosion, salinisation, water-logging)
Impact on mangroves and other wetlands
Surface and underground water quality deterioration, health
Incidence and prevalence of water related and other infectious diseases
Quantification of costs (externalities)

- Impact of development: food and poverty and overall socio-economic effects

This section addresses the economic and social impact of land/water resource development interventions. Some methodological guidelines are given in Appendix 3.

Changes in food production and security; household and basin level
Policy driving forces and rationale in the decision-making for investments

Economic impact of land/water resource development project, including all the induced uses of water beyond irrigation, backward and forward linkages of agricultural production; taxes and subsidies from production to consumption and import/export (if any)
Distribution of benefits/costs among different segments of population; equity, poverty alleviation
Changes in income distribution; proportion of households with incomes below poverty line
Gender issues
Access to sanitation and drinking water

[C] A basin analysis: current situation

[This section is the "end point" of the preceding one but describes in more detail the current situation (notably with regard to water management), that will serve as a starting point for the next prospective section.]

- Social structure, political/power structure
  - Macro-sectoral policies; decentralisation policies
  - Relationships between the power structure and access to water
  - Political life, civil society (NGOs present and active in the basin, etc); governance
- Socio-economic stratification, poverty and health
  - Income distribution and sources; farmers typology
  - Gender issues
  - Food production and security
  - Proportion of households with incomes below poverty line
  - Access to sanitation and drinking water
  - Incidence and prevalence of water related and other infectious diseases
- Water uses, water flows within the basin and water accounting
  - Relative importance of different water uses: hydropower, agriculture, livestock, fisheries, domestic uses, industry, wild life, environment, navigation, recreation & aesthetics,..
  - Efficiency, consumptive use and water productivity of different uses
  - Surface water-underground water relationships and use
  - Relative Water Supply and demand/supply analysis
  - Water balances and accounting
  - Hydronomic zones
- Water pollution and environmental issues
  - Pollution sources (agri., industrial, urban, natural source)
  - Water treatment and re-use in agriculture
  - Watershed dynamics, run-off, erosion, siltation
  - Salinisation, water logging, eutrophication
  - Nutrient transport and cycling
  - Water needs for pollution dilution and environmental services
  - Impact on livelihoods

The next three points review the situation regarding water management, allocation and institutions. The analysis must be put in context and stress the scope for improvements, which are the most feasible options within the context considered, and what changes are likely to be easier to bring about or to emerge.

- Water planning and allocation
  - Management actors: users, Water User Groups, basin authorities, administrations, water suppliers, etc. (their role, power, attitudes, interrelationships, etc)
  - Priority in use, water rights or entitlements, legal framework
  - Formal and effective allocation processes (normal and deficit years)
  - Water sharing across political (e.g. provincial) boundaries
  - Satisfaction of human basic needs
  - Responses to extreme events

Conflicts and conflict solving
Equity
Political interventionism

- Current water management
  Patterns of water distribution
  Flood management, risk management
  Mitigation of pollution, environmental services
  * Water management *in irrigated areas*: case studies or overall assessment
    Allocation, irrigation efficiency, water productivity
    Conjunctive use in agriculture and farmers' strategies
    Performance
    Equity
    O&M responsibilities and costs; financing

- Regulation and incentives
  Taxation and subsidies, water pricing, markets, and policies for domestic, industrial and agricultural use.
  Past and on-going policies for the irrigation sub-sector.
  Laws; law enforcement

☑ Indicators

The current situation will also be typified with the use of indicators. Although indicators provide, by definition, extremely aggregated viewpoints on a system (and therefore obscure diversity and heterogeneity which are crucial drivers of its dynamic), their comparison across case studies may highlight contrasts and yield some interesting hints for interpretation. They refer to present conditions but, data allowing, they may also be computed for different points in time and used to describe historical changes. Most of these indicators are commonly utilised and include the following list (<*additional work is needed to single out a set of indicators that will have to be computed in each basin*>).

Water use

- Water availability per person (l/day/capita)
- Water diverted per person (l/day/capita)
- Water consumed (depleted) per person
- Water use per sector
- Aquifer use rate (current abstraction/safe yield)
- Water quality index

Water accounting at the basin level

- Regulated water (% rainfall and % run-off)
- Depleted fraction (specify by crop and use); Process fraction
- Beneficial utilization per available water and gross inflow
- Percentage of green and blue water (controlled and uncontrolled) depleted
- Non-committed outflow
- Rainfall/ET (year); Rainfall/depleted depth by crop

Water productivity

- Deflated gross margin per unit of water consumed by major crops
- Deflated gross margin per unit of water diverted by major crops
- Deflated value per unit of water in hydropower generation

Socio-economic

- Household income per capita (poverty level) by occupation and by area (irrigated or not)
- Gini coefficient of income distribution
- Prorated purchasing power
- Average farm size
- Average and CV of yields for main crops; yield gap
- Percentage of landless in the agriculture sector
- Household access to potable drinking water/sanitation
- Food security (percentage of food produced by the household); percentage of food consumed in the basin that is produced in the basin

[D] Trends, scenarios, prospects

[This section must explore, qualitatively and/or quantitatively, the possible evolutions of the basin, the options available]

Based on a thorough understanding of the present situation, constraints, trends, and trajectories solutions for the future must be explored. Scenarios can be mediated through the use of simulation models, if available, but they can also be based on more qualitative analyses of trends.

At this stage, it is necessary to involve stakeholders within the basin in order to get their input on their perception of:

- current problems (their cause, impact and possible solutions);
- conflicts;
- trade-offs (e.g. agri./nature; social equity/econ. effi., etc)
- trends in water balance, markets, population, land use, etc
- interactions (e.g. upland/lowland)
- current allocation;
- current distribution;
- potential for PIM;
- values, risk ;

These elements must be factored into the analysis of scenarios, but these must be made compatible with overall objective constraints:

- Projected demand and supply (by sector) and balanced supply/demand ratio
- environmental flow requirements
- Physical constraints of the distribution network
- Satisfaction of basic human needs

Societal choices must be considered in the definition of scenarios which, in particular, must address the following issues:

- Scope for water conservation (based on water accounting, hydronomic zones and analysis of water management in the basin, identify measures that can bring more overall water conservation);
- Allocation choices and priorities: are the current mechanisms used to allocate water among agriculture, industry, nature, etc. suitable to cope with future challenges? What

are the existing customary or formal rights and how are they taken into account in the prospective?

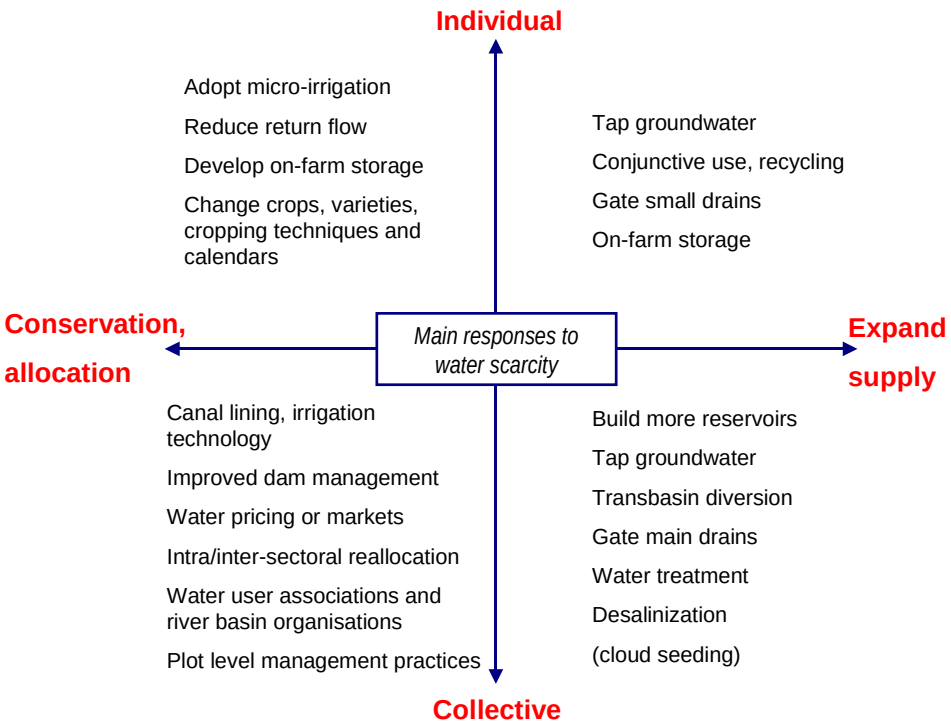
- Possible institutional/policy changes (RBO, PIM, etc.) within the actual context and what reforms are necessary/possible to enable them. What kind of river basin institution(s) are needed and what must be their role?
- Possible technical innovations
- Feasibility, costs and impact of new interventions: it is necessary to adopt a political economy framework that look into options not only in terms of economic and technical feasibility, but also in terms of political risk, actors strategies, and (see Molle, 2002).
- Environmental needs and sustainability. Green/blue water trade-off
- Implications in terms of risk for all stakeholders (see World Commission on Dams, 2000)
- Impact on equity, efficiency, poverty, food security and livelihood strategies: scenarios must particularly investigate the impact on the poorer strata of the society

Appendix 2: (Guidelines Theme 1,2,3) Local and overall adjustments to water scarcity

As demand grows in a river basin, water shortages begin to occur. These shortages are often spatially distributed and may occur during dry spells or in excessively dry years. This prompt users, managers, and in some instances policy makers, to adjust their behaviours and strategies. These adjustments are extremely varied and come under three different categories: (a) augmenting supply; (b) conservation of water (increase efficiency in use); (c) reallocation of water. The following figure synthesises some of the main strategies and distinguishes between those that are implemented by individuals and those that are collective (including intervention of public entities).

It is apparent that some of these adjustments are technical (e.g. drill a well or close a drain), while others are managerial (e.g. improve dam management) or institutional (change in allocation, priority or rights).

The latter case needs some more detailed description because it refers to the way scarce (and therefore valuable) resources are shared among users, which eventually determines how equitable and economically efficient the allocation is, and what strategies the different categories of actors will have to implement based on their own lot. Thus, allocation is best described as a political process, which needs to be documented in all its technical, social and political dimensions. It also includes legal changes and the establishments of new organisational levels, such as Water Policy Boards or River Basin Organisations.



Appendix 3: (Guidelines Theme 4) Studies of impact of water resource development

The overall impact of public interventions, especially in water resources development and irrigation, is a point of much controversy. Some maintain that its "toll" is high in terms of environmental impact (salinisation, destruction of wetlands, effluent discharge, etc) and low cost effectiveness. Others emphasise their crucial role in ensuring food production and in raising rural incomes. The case studies will bring new elements to the debate by investigating all the benefits and costs of the past interventions. While classical cost-benefit studies tend to focus on the changes in added value generated by irrigation, several dimensions must be given due consideration:

1. *Multi-use of water*

It is increasingly recognized that water in irrigation schemes generates multi-faceted benefits, beyond its use in crop production. First, a part of seepage water is used by trees and other vegetation situated near homesteads or along canals, which provide fruits, shade, raw material for construction or handicraft, medicinal products, aesthetics and other amenities. The water depleted by this vegetation is termed 'non-process beneficial use'. Second, water is also used for domestic purposes, enhancing hygiene, fisheries, cattle, duck raising, recreation, etc., all uses that can be valued and that add to the benefits induced by water. Studies in the Kirindi Oya well exemplify these points (Renwick, 2000; Renault *et al.* 2001; Meinzen-Dick *et al.*, 2001).

2. *Surface/underground linkages*

With the development of tubewells and pumping facilities, part of the water lost by infiltration is reused and this must be properly accounted for in the analysis.

3. *Linkages effects*

Apart from farmers themselves, many other activities thrive on the development of irrigated agriculture. Backward linkages include input providers, machinery makers, sellers and importers, and forward linkages refer to post-harvest activities, storage, transportation, retail markets, exports, etc.

Bhattarai *et al.* (2002) gives a few examples of (rare) studies that have attempted to measure multiplier effects. In one case regarding New South Wales, Australia, it was found that one dollar worth of output generated in irrigated agriculture created more than 5 dollar worth of value added to the regional economy in the form of other related goods and services and employment.

4. *Distribution of benefits*

Beyond the calculation of the 'average' benefit accruing to the 'average farm', it is necessary to investigate how the different socio-economic strata have benefited from the investments, and how these may have altered their status.

5. *Environmental impacts*

Because of the focus of the CA and of the lack of attention generally given to environmental impacts, it is necessary to document the positive and negative consequences of the projects on the environment.

Batchelor et al. 1998.

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APPENDIX 5: CANDIDATE BASINS

1. China (Yellow river)
2. Chao Phraya (Thailand)
3. Uda Walawe (Sri Lanka)
4. Central Valley (Jordan)
5. Merguellil (Tunisia)
6. Iran (Zayandeh Rud)
7. Lerma-Chapala (Mexico)
8. Olifant (South Africa)
9. Lower Volta (Burkina Faso-Ghana)