

Lecture note

River basin management

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by

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Lecture notes have been prepared on the following topics:

Aggregate water balances for basinwide planning

Case study: Kok River Basin

Case study: Lower Mekong Basin

Environmental management

Floods and drought

Glossary

Good governance strategies (example from Thailand)

Internet applications in river basin management

Paddy cultivation

Poverty alleviation

Project design

Public administration

Ramayana

Reporting

River basin ethics

River basin management

Sector planning and integrated planning

Socio-economics

Strategies for natural resources and environmental management (example from Thailand)

Technology management

UTM coordinates

Water demand management

Water resource economics

Water user associations

Each note is intended as a quick introduction of a subject prepared for professional practitioners who are specialists in other subjects.

The notes are 'public domain' and can be freely copied.

Suggestions and comments are most welcome!

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Glossary

- Catchment:** An area, delineated by watersheds, within which the surface runoff will flow towards a specific location. (A river basin is a catchment, but a catchment can also be a smaller part of a river basin). (Sometimes, a distinction is made between '*catchment*' and '*sub-catchments*')
- Conjecture:** An opinion or conclusion based on incomplete information
- Decentralization:** The allocation of decision-making authority to a lower (local) level (for example a commune council). **Deconcentration:** The implementation of central decision-making via local departments (for example a provincial department of a ministry)
- Drainage basin (according to the 2004 Berlin Rules on Water Resources):** An area determined by the geographic limits of a system of interconnected waters, the surface waters of which normally share a common terminus. (Basically the same as '*river basin*' and '*watercourse*')
- IWRM (integrated water resources management):** (as defined by Global Water Partnership): A process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems
- Opportunity costs:** The cost difference between one course of action and another (better or '*best*') course of action. In a wider sense: The implications of one course of action relative to alternative strategies. There is often an opportunity cost related to doing nothing
- Parochialism:** Narrow-mindedness (a polite word for self-interest)
- Riparian (country):** A country on a river bank; a country that is wholly or partly located within a river basin. (Same as a '*basin state*', in the terminology of the 2004 Berlin Rules)
- River basin:** An area that drains via a specific river; an area where the surface runoff flows towards and passes through the mouth of a specific river; for example, the Mekong Basin, the Nile Basin, etc.
- River basin management:** Management of water resources, water-related resources and water-related development in a river basin
- Sub-basin:** A river basin of a *tributary* (which is a smaller river that discharges into a larger river)
- Subsidiarity:** The principle that a higher authority should only make decisions that cannot reasonably be made at a lower level. According to this line of thought, the water allocation within a river basin must reasonably be made for the basin as a whole, and hereby by an authority that covers the entire basin. At the same time, however, the operation of an irrigation scheme within the basin may be better undertaken at the scheme level
- SWOT analysis:** A systematic identification and assessment of (mainly internal) strengths and weaknesses, as well as (mainly external) opportunities and threats
- Total Economic Value (TEV):** The full, immediate and long-term, direct and indirect value of a resource. TEV is used for valuation of wetlands and other natural resources, but is conceptually useful for other purposes. According to Pearce and Moran (1994), TEV comprises (1) direct value, such as timber production, fisheries, etc.; (2) indirect value, such as flood control, storm protection, soil conservation, etc.; (3) option value of a potential future use of the resource; (4) bequest value, representing that others might benefit from the conserved resource in the future; and (5) existence value, which is the value of the continued existence of a resource, irrespective of whether or not it will ever be used
- Watercourse (according to the 1997 UN Convention on the Law of the Non-navigational Uses of International Watercourses):** '*A system of surface waters and ground waters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus*'
- Watershed:** (1) A line in the landscape (e.g. a ridge) that delineates a catchment. The surface runoff on each side of the watershed will proceed towards different locations. (2) In American English, confusingly, a watershed is sometimes the same as a catchment or a drainage basin
- Watershed management** can cover management of wetlands and headwater areas; and/or management of land use within a catchment (or a river basin); and/or other tasks, as defined from case to case

1 Introduction

The present note deals with the river basin approach to water resources management.

It is no *'one-size-fits-all'*. What is useful and practical at one time and at one place may be less useful and less workable at a different time or a different place. Experience from elsewhere is valuable but must be considered with an open, yet critical mind.

2 Basics

Back in 1992, Agenda 21¹ stated that *'integrated water resources management, including the integration of land- and water-related aspects, should be carried out at the level of the catchment basin or sub-basin. Four principal objectives should be pursued, as follows:*

- (a) *To promote a dynamic, interactive, iterative and multisectoral approach to water resources management, including the identification and protection of potential sources of freshwater supply, that integrates technological, socio-economic, environmental and human health considerations;*
- (b) *To plan for the sustainable and rational utilisation, protection, conservation and management of water resources based on community needs and priorities within the framework of national economic development policy;*
- (c) *To design, implement and evaluate projects and programmes that are both economically efficient and socially appropriate within clearly defined strategies, based on an approach of full public participation, including that of women, youth, indigenous people and local communities in water management policy-making and decision-making;*
- (d) *To identify and strengthen or develop, as required, in particular in developing countries, the appropriate institutional, legal and financial mechanisms to ensure that water policy and its implementation are a catalyst for sustainable social progress and economic growth.*²

Since then, numerous efforts have been made or have been initiated to implement IWRM principles in connection with practical management efforts. These efforts have met with various challenges, depending on their starting point (i) relative to traditional sector planning and management; (ii) relative to national orientation towards ownership of the resource; and last, but not least, (iii) relative to the national institutional and legislative framework and established national planning practices.³

Water resources management and the related development process comprise three tracks⁴:

- an enabling environment of appropriate policies, strategies and legislation for sustainable water resources development and management;

¹ Agenda for the 21st Century (or Agenda 21) was passed by the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992, with participation by 179 countries

² Agenda 21, Article 18.9

³ Nielsen (Oct 01)

⁴ Jønch-Clausen (Jan 04)

- the institutional framework through which the policies, strategies and legislation can be implemented; and
- management instruments required by these institutions to do their job, such as water availability and demand assessments, economic instruments, information and monitoring, and conflict resolution.

3 The river basin as a management unit

Compliance with the recommendation in Agenda 21, to apply the river basin (or sub-basin) as the basic unit for planning, has certainly made life easier for the hydrologists and the water resources managers. At the same time, though, it has become apparent that not all problems have been solved in this way (should anybody have expected that). Rather, new challenges have emerged.⁵

Take, as one example, the quite common case where agriculture is the major water consumer, and at the same time an important economic sector that receives a high political attention. A shift from sector management to integrated management offers advantages, as demonstrated by comprehensive evidence, but may well, at the same time, raise a whole range of new context-related and process-related challenges and requirements, such as

- inconsistency with political and administrative sector boundaries and geographical boundaries. River basins seldom comply fully with provincial or national borders;
- inconsistency with an established (and sector-based) legal and institutional infrastructure;
- inconsistency with established (and sector-based) planning practices; and, in some cases,
- inconsistency with traditional water ownership (such as '*first come - first served*', or '*water as a free good available to anyone*').

Other practicalities of integrated management are

- conflicts of interest, e.g. between sectors, upstream/downstream, inland/coastal, urban/rural, or national/province/district level; and
- shifting priorities by key stakeholders in the course of the decision process.

The limitations of hydrological boundaries

A river basin delineation by hydrological borders (watersheds) is particularly useful for the purpose of water resource management, flood management, and water quality management. For other purposes, the delineation can be less stringent - also to assure that no area be left out from the patchwork of river (sub-)basins.

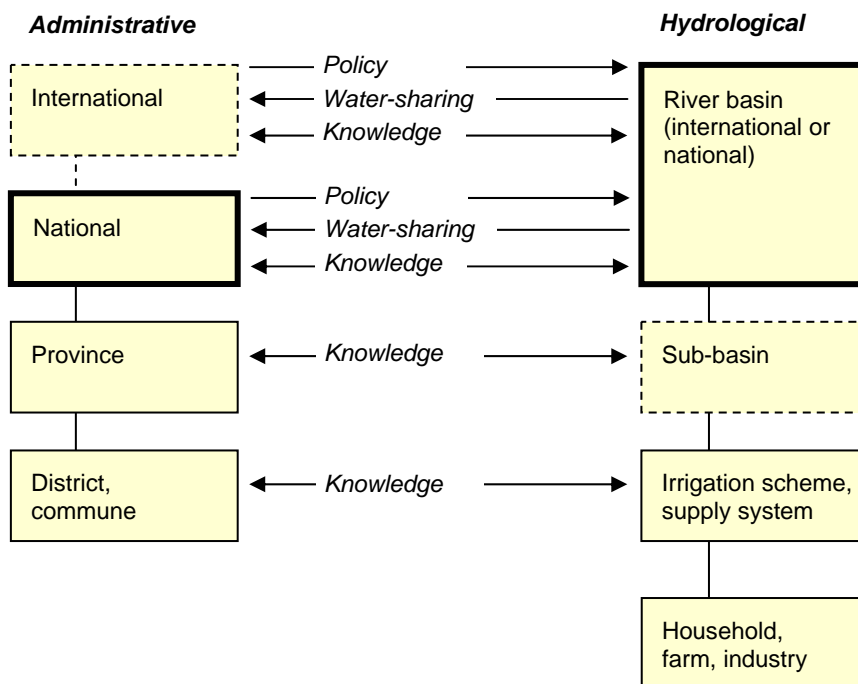
This is why the European Water Framework Directive applies the '*river basin district*' (rather than the river basin) as the main geographical unit. Mekong River Commission's Basin Development Plan applies '*sub-areas*' (rather than sub-basins). In both cases, and for the same reason, the areas are largely delineated by watersheds, but modified to cover the entire area to be managed - with due regard to national and other administrative borders.

⁵ Entire chapter quoted from Nielsen (Oct 01)

In the hydrological perspective, the river basin is the top management level. It interacts with other management levels by resource allocation (water-sharing), various regulation, and exchange of knowledge.

In the administrative perspective, the national level is the most important in terms of decision-making authority, as indicated in the figure below.

Figure 1: Levels of management



Good mutual knowledge-sharing between the levels is required for good decisions at any level.

4 Management tasks and modalities

4.1 Overview

Frank Rijsberman observes that *'the water challenge has two crucial dimensions; one is the aspect of service delivery comparable to that of other utility services and the other is the aspect of (renewable) natural resources management. Both aspects are important and they are linked in most every real life situation, but they should be recognized as distinct, with distinct solutions'*.⁶

In the present note, a distinction is made between

- supplies: Safe water and sanitation to households, water for production, hydropower, etc., as well as wastewater and solid waste disposal (possibly on a commercial basis);
- resource allocation: Water allocation and water-sharing (preferably IWRM-based);

⁶ Rijsberman, Frank (May 04), p. 4

- related services: Reservoir operation, flood and drought management, management of aquatic habitats and water quality, morphological management, navigation, ...; and
- water-related social and economic development (sector-wise and integrated).

The distinction is a question of ends and means - the supplies represent a major objective and justification of the resource management.

River basin management can comprise any or all of the tasks, but they require different institutional capabilities and different professional skills, and they can take place at different management levels. Some tasks can be undertaken by private utilities, while others are more suited for the public sector. (They also differ with respect to the scope for cost recovery).

Some of these tasks must, by necessity, take place within hydrological boundaries - at the river basin level. These include (i) over-all water allocation; (ii) water quality management; and (iii) flood and drought management. Other tasks can equally well (or sometimes even better) be undertaken at the national level or at a lower level.

The tasks can be roughly structured as indicated in the figure below.

Figure 2: Integrated management and sector management

	National level	River basin level	Lower level
Integrated (multi-sector)	National policy National knowledge base, over-all development strategies, and legislation	Resource allocation Basin-level knowledge base and integrated strategies	
Sector-wise	National policy National knowledge base, sector strategies, and legislation	Flood and drought management, water quality management, morphological management Basin-level knowledge base and sector strategies	Supply of safe water (and sanitation) Irrigation management Sewage and waste disposal

4.2 Management aims

River basin management can, from case to case, address a variety of aims, such as the ones listed below.

Social benefits:

- Basic access to water, sanitation - and electricity
- Livelihoods; reduced urban migration
- Reduced risk exposure (floods, drought)
- Cultural aspects of water availability

Income generation and livelihoods:

- Water efficiency and economic efficiency of production systems
- Timely and appropriate response to new (external) opportunities and threats - lower trade barriers, commodity prices, climate change, ...

Economic revenue:

- Value chains building on primary production: Agriculture, fisheries, hydropower, ...
- Value generated by tourism and navigation

Other benefits:

- Habitat conservation
- Peaceful relations within the basin
- Investment climate supported by good governance

Mekong River Commission: 'Meeting the needs, keeping the balance'

A suitable resource allocation serves the different demands in a balanced way:

- Sharing between competing uses - in-stream and off-stream
- Sharing within drainage area (including upstream-downstream water sharing)
- Allocation between groundwater and surface water withdrawals
- Balance between short-term and long-term costs and benefits - including sustainability of resource utilization

4.3 *Development needs and development potential* (including strengths and weaknesses, in SWOT terminology)

Development needs can include for example

- access to safe water and sanitation;
- water for production and livelihoods (agriculture, fisheries, related processing industries, and trade and distribution); access to markets; access to credit and technology;
- governance (policies, regulation, institutions, capacity, knowledge base)

The development potential can be influenced by aspects such as

- water availability (surface water & groundwater);
- soil suitability;
- storage potential;
- fisheries potential;
- land use, forests;
- tourism potential;
- hydropower potential;
- waterways (navigation) potential;
- exposure and vulnerability to floods and drought and saline intrusion;
- financial constraints (macro-scale and micro-scale);
- technological constraints;

- lack of knowledge (for example about groundwater potential and subsidence risk); and
- social barriers

4.4 Drivers of change

(or 'external forcings') (or opportunities and threats, in SWOT terminology)

Drivers of change in relation to river basin development can include for example:

- Urbanization;
- technological development (new technology, improved access to existing technology) (affecting the efficiency of production systems and the related competitive advantages);
- external infrastructural development;
- commodity prices, such as food and energy prices;
- tourism development; and
- climate proofing.

The drivers can represent opportunities as well as threats. The response is mostly a matter of adaptation (although some of the drivers can be managed to some extent).

4.5 Knowledge-building and knowledge-sharing

An important river basin management task, in its own right, is promotion of knowledge-building and knowledge-sharing. This will allow for better decisions about water-sharing and water-related development, and also for prevention of related disputes.

For example, knowledge is required about

- general (normal) water availability - rainfall, evaporation, storage, runoff;
- water demand for various purposes - offstream as well as in-stream;
- the efficiency and value generated by water-dependent production systems (agriculture, fisheries yields);
- water-dependent livelihoods;
- demand management options and effects (including subsidies and green taxes);
- river morphology (erosion and accretion);
- *'hot spots'* (assets with a particular vulnerability and exposure); and
- sewage discharges, diffuse pollution, water quality, and the state of aquatic habitats.

The knowledge should not only describe present conditions, but future conditions as well. Tools should be implemented for prediction of the impacts of specific interventions, such as withdrawals, flow regulation, sewage discharges, etc. This means that knowledge must be built about cause-effect relations that determine or influence the social, economic and environmental conditions in the river basin.

Operational weather forecasting does not need to be made at the basin level, but flood forecasting does. Also, water quality monitoring must take place at the basin level.

Figure 3: Knowledge-sharing

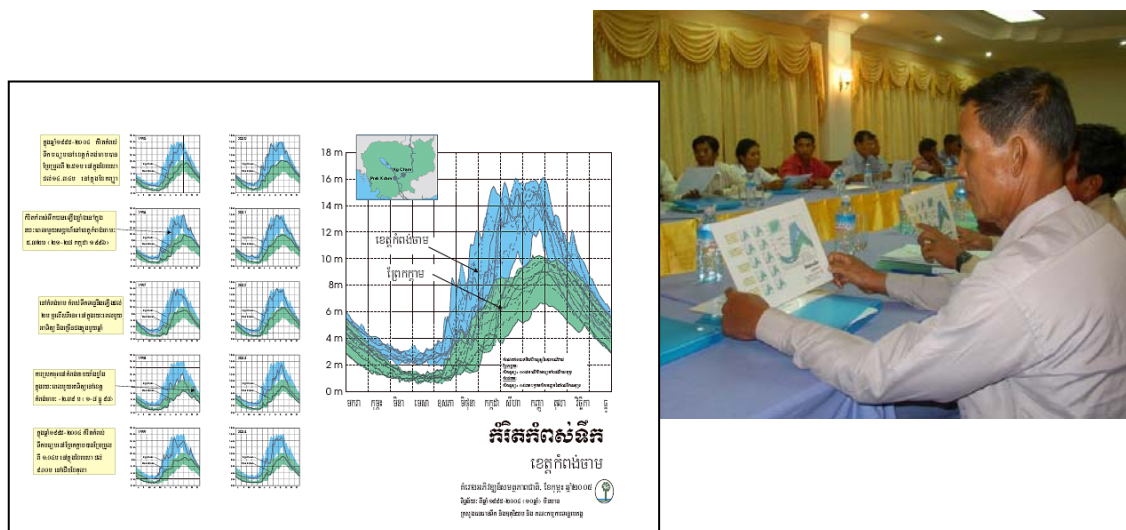


Photo from Kampong Cham Province, Cambodia, Apr 05. Water user group representatives (who are in charge of irrigation operation, but who had never in their life seen a rainfall statistics) are briefed about normal and extreme rainfall, drought and water level

5 Policies and plans

5.1 River basin policy

River basin policies provide a shared sense of direction and a tool for progress monitoring.

They can be problem-oriented or development-oriented or a combination. This distinction, however, is not important - all can be useful. Problem-oriented policies will normally take their starting point in the basin *'as it is'*. They may build on problem tree/logframe analysis or *'hot spot'* analysis. They have a shorter time horizon and can address important aspects such as for example

- poverty alleviation
- the Millennium Development Goals
- environmental conservation
- climate change

Development-oriented policies are less linked to present conditions and trends, and take a perspective of the basin *'as it could be'*. They may build on scenario analysis. They have a longer time horizon and can address attractive opportunities such as for example

- production efficiency development and diversification
- livelihood generation
- tourism development
- hydropower development
- pro-active environmental management

Long-term development strategies should reach beyond the concerns of today. Their formulation should be open-minded - and look ahead, as much as over the shoulder. The agenda of tomorrow can be qualitatively different from the agenda of today, and there is a risk that *'one cannot see the forest for all the trees'* - meaning that an attractive long-term development opportunity is overlooked because of overwhelming immediate development needs.

Policies can also provide guidance on implementation modalities and governance framework - that is, not only *'what to do'*, but also *'how to do it'*. This perspective can cover aspects such as

- legislation
- public participation
- public-private dialogue and partnerships
- deconcentration and decentralisation

There are important links between (a) water uses/water resources management and (b) land use/land management - which should be kept in mind also at the policy level.

The policies can set goals that can be quantitative (xx percent of population having access to safe water & sanitation, rice yield xx t/ha) or qualitative (improved access to safe water and sanitation, improved rice yield). This is a matter of taste - both can be useful - somewhat depending on the time scale (and national planning traditions).

5.2 River basin plans

Policies can be supported by strategies, elaborating the approach, and by action-oriented river basin plans.

Good strategies can contribute to a general governance aim of transparency and predictability. They can highly support the added value of an integrated approach to water resources management, by outlining the principles for achieving a balance between in-stream and offstream water uses, between various sectors, and between a short-term and long-term perspective. This is a step towards operationalisation of aims such as *'optimal'*, *'fair'*, *'equitable'* or *'reasonable'*.

In order to succeed, a river basin plan must have close interfaces with related explicit national policies, implicit preferences, and strategic development and investment plans.

In general, the road from a good idea to its implementation is much shorter if the idea is in harmony with some established national strategies and development goals.

This does not mean that a plan must in all ways passively adjust to existing plans. On the contrary, a positive interaction should be aimed at, in support of a mutually beneficial convergence. National planning can learn important lessons from the river basin level, and the other way around.

6 International river basins

Many large river basins extend across several countries. If so, the management becomes much more complicated due to different national political agendas and development priorities (as well as a variety of practicalities). At the same time, however, the potential added value of a basinwide approach is much larger than for river basins that are located in one single country.

Not surprisingly, international river basin organisations have a much weaker political support than national ones. The countries are autonomous. As a starting point, they can - and do - make their own decisions. They can choose to allocate some part of their authority to a joint river basin organization, or they can operate a joint river basin organization without much authority, but which undertakes various planning and monitoring functions, develops a shared knowledge-base, and facilitates the decision process.

Water-sharing is an important task within any river basin, and also in international ones. International water-sharing is a professional discipline in its own right, with a comprehensive literature. The sharing can build on different principles (or a combination), such as:

- *'fair and equitable water allocation'* - a vague concept suited for soft negotiations between upstream and downstream countries;
- *'historical rights'* - or status quo - a convenient way in basins where the water is already fully utilized - but still open to interpretation, because the water availability can change from year to year - so it can become a matter of sharing a deficit, as much as sharing an available amount of water;
- *'optimal allocation'* - a clear economic perspective, aiming at maximising the size of the cake, and assuming that the (bigger) cake can be shared in good faith among the countries - which is not always easy.

A Convention on the Law of the Non-navigational Uses of International Watercourses was passed by the UN General Assembly in 1997. It uses words as *'equitable'*, *'reasonable'*, *'optimal'* and *'sustainable'* in connection with water utilization. It is not yet in force, due to lack of ratification, but still, it is widely used as a guideline for international water-sharing. It may be replaced as a major guideline by the Berlin Rules on Water Resources, prepared in 2004 by the International Law Association (ILA). These rules provide an elaboration of *'equitable and reasonable use'*. Please refer to the extract attached as Appendix B.

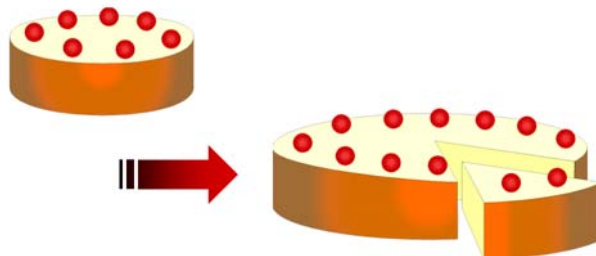
In the same line of thought, Global Water Partnership, in its basic definition of integrated water resources management (IWRM) points at *'... co-ordinated development and management ... in order to maximise the resultant economic and social welfare in an equitable manner ...'*

In this connection, it must be remembered that

- (i) *'optimal'* and *'equitable'* are two basically different considerations. In many cases, what is *'optimal'* is not *'equitable'*, and what is *'equitable'* is not *'optimal'*. (Using the water for paddy cultivation could be *'equitable'* but far from *'optimal'*, while using the water for golf courses could be *'optimal'* but far from *'equitable'*). Furthermore,
- (ii) what is *'optimal'* for the river basin as a whole may be less than optimal for many sub-basins in that river basin. For example, maximising the economic benefits (or the

livelihoods) in a river basin could require that water is allocated to a certain part of the basin, to the disadvantage of other parts.⁷

So, while increasing the size of the cake, it must be considered how to share it. There is a strong interaction between the '*optimal*' and the '*equitable*' perspective - and the interaction can be positive or negative.



The cross-border collaboration becomes easier when it build on '*shared values*', which are overlaps between the policies and development priorities of the riparians. Often, some uncontroversial '*win-win*' schemes can be identified, which can serve useful purposes in their own right, but with important side benefits such as confidence-building and consolidation of collaboration modalities.

Knowledge-building and knowledge-sharing are important tasks of any river basin organisation, including the international ones.

Conflict prevention and resolution are other tasks that can, sometimes, provide attractive benefits at a marginal cost. Some conflicts are caused by lack of knowledge - for example of the impacts of a planned intervention - and may possibly be prevented from materializing if such knowledge is produced and made available to the decision-makers.

Legislation/guidance on international water-sharing

1966: The Helsinki Rules on the Uses of the Waters of International Rivers, by the International Law Association (ILA)

1997: Convention on the Law of Non-Navigational Uses of International Watercourses, approved by the United Nations General Assembly (but not yet ratified)

2004: The Berlin Rules on Water Resources, by the International Law Association (ILA)

⁷ The word '*optimal*' occurs 4 times in the 1997 UN convention but only once in the 2004 Berlin rules

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- Jønch-Clausen, Torkil (Jan 04): Integrated Water Resources Management (IWRM) and Water Efficiency Plans by 2005 - Why, What and How? Global Water Partnership
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- Rijsberman, Frank (May 04): The water challenge. Copenhagen Consensus Challenge Paper

Websites

- Asian Development Bank (ADB) Water for All: www.adb.org/Water/
- Capacity Building for Integrated Water Resources Management (CapNet): www.cap-net.org
- EU Water Framework Directive (WFD): ec.europa.eu/environment/water/water-framework
- Food and Agriculture Organization of the United Nations (FAO): www.fao.org/
- Global Water Partnership (GWP): www.gwpforum.org
- International Network of Basin Organizations (INBO): www.inbo-news.org
- Intergovernmental Panel on Climate Change (IPCC): www.ipcc.ch
- International Water Management Institute (IWMI): www.iwmi.cgiar.org
- Network of Asian River Basin Organizations (NARBO): www.narbo.jp
- UN Environment Programme: www.unep.org
- UNESCO Water: www.unesco.org/water/
- UN World Water Assessment Programme: www.unesco.org/water/wwap/
- US Climate Change Science Program: www.climatechange.gov
- Waterencyclopedia: www.waterencyclopedia.com
- Wikipedia: www.wikipedia.com
- World Water Council (WWC): www.worldwatercouncil.org

... and many more! A Google search on '*river basin*' gave 4 mio. hits (Dec 08)!

Appendix A: Thoughts to share

Institutions

- 1 Integrated management is a useful supplement, rather than a replacement of existing sector management - with its wealth of expertise
- 2 Similarly, river basin management is a useful supplement, rather than a replacement of management at other (higher or lower) levels of administration
- 3 Involve and/or build on existing institutions (including existing coordination bodies) and existing planning procedures
- 4 Develop clear roles, clear rules, and capable and resourceful bodies that collaborate with each other
- 5 Pursue interaction and harmony between management levels (basin level, national level, sub-basin level, province level, community level, and irrigation scheme level)
- 6 Prefer de-central decision-making where this is reasonable - considering the scale of the decision, and subject to practical (capacity and knowledge-base) constraints
- 7 Build confidence between actors, and maintain creditable and functional conflict resolution modalities
- 8 Practice knowledge-building and knowledge-sharing, within and among river basins
- 9 Promote revenue generation and cost recovery, in pursuit of financial sustainability

Goals and policies

- 10 Maintain a sense of direction towards in clear (although perhaps utopian) goals - that may be independent from what is realistic in the short term. Example: *'Safe water for all'*
- 11 Apply a holistic, integrated approach covering the entire basin and spanning across sectors
- 12 Note and exploit the powerful long-term synergies between economic growth, natural resource management and environmental preservation. Promote sustainable and transparent resource utilization - water, hydropower, forests, minerals, habitats, etc.
- 13 Seek balance between stakeholder interests: Upstream/downstream, instream/offstream, and local versus national interests (for example in connection with re-settlements)
- 14 Apply livelihood generation as a progress indicator in its own right (along with national economic growth, safe water and sanitation, poverty alleviation, etc). Pay particular attention to rural livelihoods
- 15 Prefer small steps to big ones when the choice is open. There is always a risk of unexpected side effects
- 16 Involve the private sector with its powerful development agenda and potential. Apply gentle regulation to achieve a balance between immediate and long-term benefits, and between private and public development priorities
- 17 Note the strong links between water resource management and land management. Apply zoning of land use, with a view to land use potential, soil quality, access to water, habitat conservation, cultural assets, flood risk, pollution, and infrastructure
- 18 Consider the potential for development of tourism and recreation
- 19 Make regular reviews and updates of the development agenda, in timely response to new knowledge, new challenges, and new opportunities

Management

- 20 Practice openness, dialogue and active stakeholder involvement throughout the formulation and implementation of development goals and policies
- 21 Promote gender mainstreaming
- 22 Reduce corruption and self-interest; pay attention to the powerless and minorities; promote transparency and predictability throughout the public administration
- 23 Don't rely on perfect knowledge about the future. Base decisions on the *'best available knowledge at the time when the decision must be made'* - possibly involving the concept of *'Total Economic Value'*
- 24 Promote basinwide, real-time data management (flood levels, storage, forest fires, etc)

Appendix B: ADB's 25 IWRM elements

Entire appendix is quoted from ADB (Nov 06)

What is IWRM? Integrated water resources management (IWRM) is now recognized across the world as the process to promote the coordinated development and management of water, land and related resources in river basins, to maximize the economic benefits and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

The following 25 elements are widely accepted to be important in introducing integrated water resources management (IWRM) in river basins. Incorporating these elements into institutional reforms, development strategies, and investment projects will make a significant difference for IWRM in the basin. Improvements may also be needed in the enabling environment at the national level.

<i>IWRM element</i>	<i>Typical interventions/criteria</i>
1 River basin organization	Build capacity in new or existing RBO, focusing on the four dimensions of performance (stakeholders, internal business processes, learning and growth, and finance) under the Network of Asian River Basin Organization's (NARBO) benchmarking service
2 Stakeholder participation	Institutionalize stakeholder participation in the river basin planning and management process including active participation of local governments, civil society organizations (academe, NGOs, parliamentarians, media), and the private sector, and an enabling framework for meaningful stakeholder participation in project specific planning decisions
3 River basin planning	Prepare or update a comprehensive river basin plan or strategy, with participation and ownership of basin stakeholders, and application of IWRM principles in land use planning processes
4 Public awareness	Introduce or expand public awareness programs for IWRM in collaboration with civil society organizations and the media
5 Water allocation	Reduce water allocation conflicts among uses and geographical areas in the basin with participatory and negotiated approaches, incorporating indigenous knowledge and practices
6 Water rights	Introduce effective water rights or entitlements administration that respects traditional or customary water use rights of local communities and farmers and farmer organizations
7 Wastewater permits	Introduce or improve wastewater discharge permits and effluent charges to implement the polluter pays principle
8 IWRM financing	Institutionalize models whereby all levels of government contribute budget to IWRM in the basin
9 Economic instruments	Introduce raw water pricing and/or other economic instruments to share in IWRM costs, stimulate water demand management and conservation, protect the environment and pay for environmental services
10 Regulations	Support the development and implementation of a legal and regulatory framework to implement the principles of IWRM and its financing in the basin, including tariffs, charges, quality standards and delivery mechanisms for water services
11 Infrastructure for multiple benefits	Develop and/or manage water resources infrastructure to provide multiple benefits (such as hydropower, water supply, irrigation, flood management, salinity intrusion, and ecosystems maintenance)
12 Private sector contribution	Introduce or increase private sector participation in IWRM through corporate social responsibility (CSR)-type contributions

<i>IWRM element</i>	<i>Typical interventions/criteria</i>
13 Water education	Introduce IWRM into school programs to increase water knowledge and develop leadership among the youth, including responsibility for water monitoring in local water bodies
14 Watershed management	Invest to protect and rehabilitate upper watersheds in collaboration with local communities and civil society organizations
15 Environmental flows	Introduce a policy and implementation framework for introducing environmental flows and demonstrate its application
16 Disaster management	Investments in combined structural and nonstructural interventions to reduce vulnerability against floods, droughts, chemical spills and other disasters in the basin
17 Flood forecasting	Introduce or strengthen effective flood forecasting and warning systems
18 Flood damage rehabilitation	Investments in the rehabilitation of infrastructure after floods
19 Water quality monitoring	Initiate or strengthen basin-wide water quality monitoring and application of standards
20 Water quality improvement	Invest in structural and nonstructural interventions that reduce point and non-point water pollution
21 Wetland conservation	Invest to conserve and improve wetlands as integral part of the river basin ecosystems
22 Fisheries	Introduce measures to protect and improve fisheries in the river
23 Groundwater management	Institutionalize and strengthen sustainable groundwater management as part of IWRM
24 Water conservation	Institutionalize a policy and implementation framework to promote efficiency of water use, conservation, and recycling
25 Decision support information	Improve on-line publicly available river basin information systems to support IWRM policy, planning, and decision-making, including dissemination of "tool boxes" and good practices

Appendix C: International water-sharing

Extracts of the 2004 Berlin Rules on Water Resources of the International Law Association

CHAPTER III - INTERNATIONALLY SHARED WATERS

Article 10 - Participation by Basin States

1. Basin States have the right to participate in the management of waters of an international drainage basin in an equitable, reasonable, and sustainable manner.
2. Basin States shall define the waters to which an international agreement regarding the management of waters of an international drainage basin applies; such an international agreement may apply to all or part of the waters of an international drainage basin or to a particular project or use, except that a use by one or more basin States shall not cause a significant adverse effect on the rights of or uses in another basin State without the latter State's express consent.

Article 11 - Cooperation

Basin States shall cooperate in good faith in the management of waters of an international drainage basin for the mutual benefit of the participating States.

Article 12 - Equitable Utilization

1. Basin States shall in their respective territories manage the waters of an international drainage basin in an equitable and reasonable manner having due regard for the obligation not to cause significant harm to other basin States.
2. In particular, basin States shall develop and use the waters of the basin in order to attain the optimal and sustainable use thereof and benefits therefrom, taking into account the interests of other basin States, consistent with adequate protection of the waters.

Article 13 - Determining an Equitable and Reasonable Use

1. Equitable and reasonable use within the meaning of Article 12 is to be determined through consideration of all relevant factors in each particular case.
2. Relevant factors to be considered include, but are not limited to:
 - a. Geographic, hydrographic, hydrological, hydrogeological, climatic, ecological, and other natural features;
 - b. The social and economic needs of the basin States concerned;
 - c. The population dependent on the waters of the international drainage basin in each basin State;
 - d. The effects of the use or uses of the waters of the international drainage basin in one basin State upon other basin States;
 - e. Existing and potential uses of the waters of the international drainage basin;
 - f. Conservation, protection, development, and economy of use of the water resources of the international drainage basin and the costs of measures taken to achieve these purposes;
 - g. The availability of alternatives, of comparable value, to the particular planned or existing use;
 - h. The sustainability of proposed or existing uses; and
 - i. The minimization of environmental harm.
3. The weight of each factor is to be determined by its importance in comparison with other relevant factors. In determining what is a reasonable and equitable use, all relevant factors are to be considered together and a conclusion reached on the basis of the whole.

Article 14 - Preferences among Uses

1. In determining an equitable and reasonable use, States shall first allocate waters to satisfy vital human needs.
2. No other use or category of uses shall have an inherent preference over any other use or category of uses.

Article 15 - Using Allocated Water in Other Basin States

1. Allocation by agreement or otherwise to one basin State does not prevent use by another basin State to the extent that the basin State to which the water is allocated does not in fact use of the water.
2. Use of a water for purposes of this Article includes water necessary to assure ecological flows or otherwise to maintain ecological integrity or to minimize environmental harm.
3. Use of water by a basin State other than the one to which the water is allocated does not preclude the basin State to which the water is allocated from using the water when it chooses to do so.

Article 16 - Avoidance of Transboundary Harm

Basin States, in managing the waters of an international drainage basin, shall refrain from and prevent acts or omissions within their territory that cause significant harm to another basin State having due regard for the right of each basin State to make equitable and reasonable use of the waters.

Appendix D: River basin organisations

Randomly selected and by order of alphabet

Mekong River Commission (MRC)

www.mrcmekong.org

The Lower Mekong Basin is the Cambodian, Laotian, Thai and Vietnamese parts of the Mekong Basin. It has a population of some 62 mio. people and an area of 606,000 km². (The entire basin includes parts of Myanmar and of the Yunnan Province of China as well, and has an area of 795,000 km²). Most people earn their living from farming, typically harvesting one annual crop, except in the Delta, where 2 or 3 crops can be grown each year. Rice is the predominant crop. The basin is water-rich, but its production systems and ecosystems are sensitive to irregularities.

The Committee for Co-ordination of Investigations of the Lower Mekong Basin was established in 1957. It functioned until 1975, when the Khmer Rouge took power in Cambodia and Viet Nam was reunited. In 1978, its work was resumed by an Interim Mekong Committee with participation by Laos, Thailand and Viet Nam.

Today, Mekong River Commission (MRC) is a regional organisation formed by Cambodia, Laos, Thailand and Viet Nam. Its mandate is laid down in the Mekong Agreement from 1995. Its work is supported by National Mekong Committees in each member country. The Mekong Agreement includes principles for intra-basin and inter-basin water-sharing.

MRC is supporting water-related development towards '*an economically prosperous, socially just and environmentally sound Mekong river basin*'. At times, its work has been adversely influenced by a limited overlap of priorities among its member countries and a low decision-making capacity.

Murray-Darling Basin Authority (MDBA)

www.mdba.gov.au

MDBA was formed in December 2008, replacing the Murray-Darling Basin Commission (MDBC) which was formed in 1988. Actually, the MDBC was taken over by the federal government in response to a lengthy and severe drought that had endangered the national water security.

Its origin is based on a delicate water-sharing dialogue that goes back for more than a century. The Murray-Darling Basin Agreement was signed in 1992 and promulgated in 1993, replacing an River Murray Waters Agreement from 1915 (and amended in 1987). The mandate of MDBA is laid down in the 2007 Water Act, amended in 2008.

The Murray-Darling basin (1,061,469 km²) covers parts of the Capital Territory, New South Wales, Queensland, South Australia, and Victoria. The basin is water-poor but is intensely cultivated and irrigated.

One of the main tasks of MDBA is to prepare a basin plan for withdrawals of groundwater and surface water. MDBA is also involved in policy advice, monitoring, and knowledge-building. Much of the water-related development is managed at the state level or the federate (or central government, or Commonwealth government) level.

Nile Basin Initiative (NBI)

www.nilebasin.org

The Nile is the world's longest river, draining parts of 10 countries: Burundi, Rwanda, Tanzania, Kenya, Zaire, Uganda, Ethiopia, Eritrea, Sudan, and Egypt. Its basin (3.1 mio. km²) covers 10 percent of Africa's area and includes regions that vary from water-rich (upstream, in the south) to extremely dry (downstream, in the north). The basin features Lake Victoria (67,000 km²), the second-largest freshwater lake in the world, and the Aswan Dam and Lake Nasser (1970, 5,250 km²), the world's largest artificial lake. The Kanat El Salam Canal (2001) diverts water from the Delta into Sinai via a culvert under the Suez Canal. The Sheikh Zayed Canal (scheduled for completion in 2017) will divert water for irrigation from Lake Nasser towards northwest via the Toshka depression.

The Nile Basin Initiative (NBI) was formed in 1999 by the riparian states excluding Eritrea. It is managed by the Nile Council of Ministers of Water Affairs, supported by a Technical Advisory Committee with one representative from each member country, and a Secretariat located in Entebbe, Uganda. The NBI conducts knowledge-building and water-related investment preparation programmes, including irrigation, hydropower development and fisheries. Due to the size of the basin, and its diversified development agendas, a main part of the water-related development is structured under two separate action

programmes, one for the Eastern Nile region and one for the Equatorial Lakes region. The Shared Vision Programme develops a shared knowledge base and expands the institutional framework for basinwide water resources and environmental management.

International Commission for Protection of the Rhine (ICPR)

<http://www.iksr.org>

The Rhine Basin (185,000 km²) covers parts of Switzerland, France, Germany, Luxemburg and The Netherlands, and small parts of Italy, Liechtenstein, and Belgium.

ICPR was founded in 1950. It promotes shared vision and coordinated action within hydropower, flood protection, water quality, biodiversity and floodplain ecology, and groundwater protection. The Convention on the International Commission for the Protection of the Rhine against Pollution (Bern Convention) was signed in 1963 by the riparian countries. EU joined as a contracting party in 1976. A Rhine Action Programme (RAP) was launched in 1987. A new Convention on the Protection of the Rhine was signed in 1999 and entered into force in 2003. Apart from the Convention, the basin is managed in accordance with the EU Water Framework Directive (2000).

A separate body, The International Commission for the Hydrology of the Rhine Basin (CHR) is an organisation of scientific institutes of the riparian states that undertakes collaboration and provides policy advice.

The Central Commission for Navigation on the Rhine (CCNR) has participation by Germany, Belgium, France, The Netherlands, and Switzerland. Mandated by the Vienna Congress in 1815 to secure navigation on the Rhine, it is the world's oldest existing international organisation. Its work is based on the Convention of Mainz (1831) and the Convention of Mannheim (1868). Its secretariat was moved to Strasbourg (France) as a consequence of the Treaty of Versailles (1919).

Since 1992, the Rhine has been linked with the Danube to form the 3,500 km Rhine-Main-Danube Waterway connecting the North Sea and the Black Sea.

Tennessee Valley Authority (TVA)

www.tva.org

TVA was formed under president Roosevelt in 1933 in connection with his '*New Deal*' programme for recovery from the Great Depression. It is a federally owned corporation. Shaped around the Tennessee River, it covers most of Tennessee and parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina and Virginia.

From the onset, TVA had a sharp focus on regional socio-economic development, rather than water-sharing and regulation. Its aim was pursued via hydropower production, together with flood control and navigation, as well as agricultural development. Its power production capacity was strongly expanded during the 2nd World War. Today, the Authority is financially self-supporting. It operates 29 hydroelectric dams and one pumped-storage plant, as well as 11 coal-fired and 8 combustion-turbine sites, 3 nuclear plants, 16 solar power sites, a 2 MW wind power site, and one 4 MW plant fuelled by methane from sewage treatment. There are 34 flood control dams, and a 1,045 km waterway on the Tennessee river. TVA has an ombudsman⁸ and its own police force.

⁸ Ombudsman: An independent official responsible for investigations of complaints