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Integrated river basin Management

From Concepts to Good Practice

Briefing Note 8

Transboundary Water Sharing

Developing and allocating reasonable and equitable water shares across boundaries

This note is one in a series explaining the attributes and practical application of integrated river basin management. The purpose of the Briefing Note series and the issues and aspects that are covered are outlined in the mini-guide.

This note discusses:

- International law and principles on sharing
- Volumetric and benefit sharing
- Setting and managing water shares

Case studies are also presented to illustrate different sharing options and allocation methods, including the use of evapo-transpiration.

Contents

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Introduction

Transboundary water sharing is fundamental to all river basin organizations. Whether a river basin is international (involving two or more countries) or national (involving two or more internal states, provinces, or prefectures) sharing water resources still refers to achieving reasonable and equitable allocation of water among the various administrative bodies in the basin.

Each of the member-countries or government agencies within a basin organization, or the stakeholders that occupy the river basin, will have its own interpretation of what is fair and reasonable and each will have sovereign or specified rights that it will want to see protected.

Internationally, the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses provides the most detailed principles on water utilization and sharing, protection of sovereign rights, and conflict resolution. These principles, which relate to reasonable and equitable utilization and sharing, are equally applicable to internal or national river basins and to international basins. The full text of Part II of this UN Convention appears in the annex.

In the context of water resources, *reasonable* means sensible, not asking too much. *Equitable* meaning fair, just, not favoring anyone more than another.

This is a relatively new principle of international water law: new at least in the sense that it has taken quite a long time to become accepted. As part of a major effort to codify international water law, the principle was first widely discussed in Chapter 2 of the Helsinki Rules, adopted by the International Law Association in ___. [[year]] This was then adopted by the UN Convention in 1997.

What Does "Equitable and Reasonable Utilization" Mean in a River Basin Setting?

While economists may caution that *equitable sharing* does not necessarily result in the economically efficient allocation of the resource, water management professionals argue that the principle has the ability to achieve a **realistic and pragmatic balance of interests among the basin partners**. Ultimately what is needed is a complementary mix of mutual interests, protection of sovereign rights, solutions to satisfy the most reluctant partner, and a large amount of mutual trust, respect, and confidence. The strict application of an economically efficient allocation approach is unlikely to satisfy all parties.

Equitable sharing does not stand alone as a principle. The right of a country to a reasonable and equitable share of the water resource base is accompanied by the complementary principle to not cause appreciable harm to the other countries in the basin. Again, mutual trust and respect cannot transpire if one partner causes unacceptable harm to another.

Accordingly, what needs to be considered is not what might be reasonable and equitable use for a particular country, but what is reasonable and equitable in relation to *all* parties in the basin. This key principle complements the larger principle that countries have a right to participate in the beneficial use of a shared river, plus a complementary obligation to cooperate. This principle was also discussed in the context of data and information sharing in Note 4. Diagrammatically, this principle can be represented as a triangle of mutually dependent obligations (figure 8.1).

Although beneficial use refers to the use of water for the economic and social benefit of a country, the resource itself and the aquatic and riverine life that depend on it for survival must also be considered.

Thus before any bulk sharing of the basin's resources among the basin partners is decided, the share for the environment – in terms of both the quantity and quality of flows – must be debated and allocated, either before the consumptive use sharing, or as another component of the bulk sharing process. Establishing the needs for environmental sustainability is discussed in more detail in Note 5.

The discussion above illustrates that there is no exact definition for reasonable and equitable sharing. rather, this is determined by what the basin partners agree to as a suitable compromise. The UN Convention gives some guidance as to how to go about developing the debate and how to facilitate open discussion about the full range of economic, environmental, and social issues. The Convention states that the relevant factors to be considered when debating reasonable and equitable utilization are:

- Geographic, hydrographic, hydrological, climatic, ecological, and other factors of a natural character
- The social and economic needs of the watercourse states concerned
- The population dependent on the watercourse in each watercourse state
- The effects of the use or uses of the watercourses by one watercourse state on other watercourse states
- Existing and potential uses of the watercourse
- Conservation, protection, development, and economy of use of the water resources of the watercourse and the costs of measures taken to that effect
- The availability of alternatives of comparable value to a particular planned or existing use.

The term **"existing and potential uses"** in the fifth bullet above is an important issue. "Existing use" implies some legitimacy of the principle of prior appropriation – yet such a principle is not necessarily reasonable or equitable. Hence the need for pragmatic compromises to water sharing, based on the merits of particular situations, and the critical importance of mutual trust and respect, are even more evident.

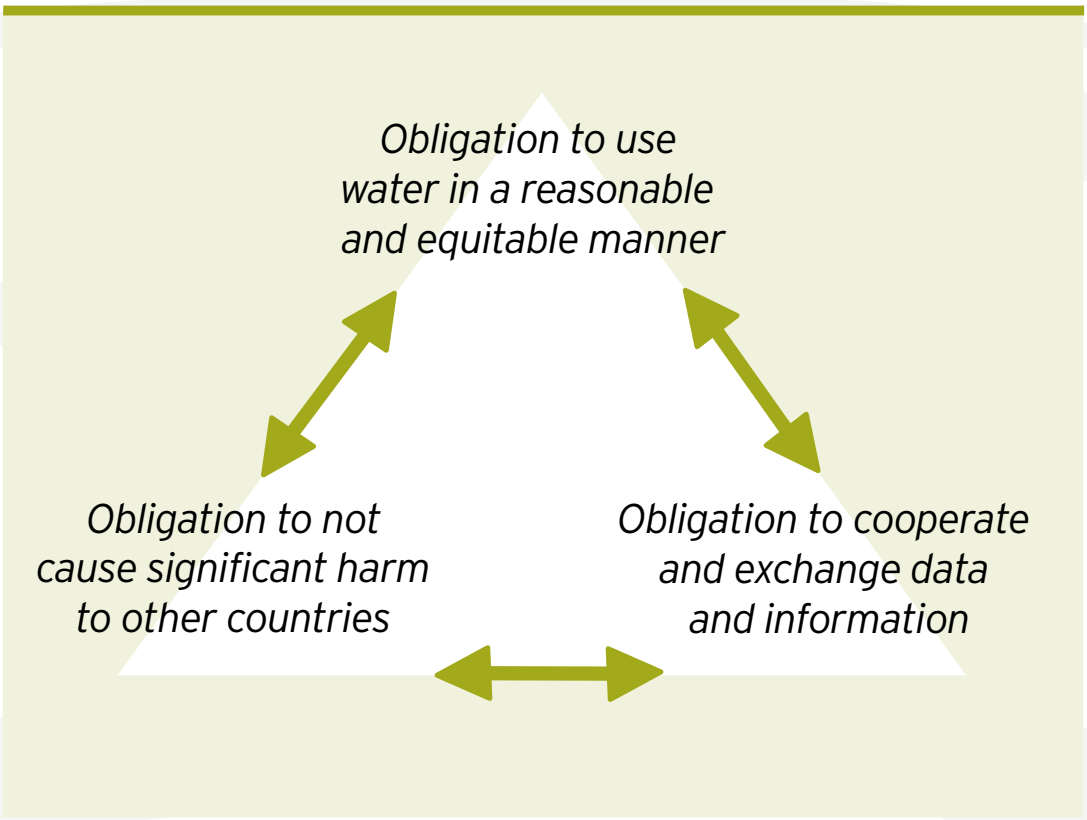
Another key issue is the sharing of *benefits*, rather than the sharing of water *volumes*. Recently, this approach has been encouraged because it is more likely to achieve positive results faster, compared to attempting to define specific volumetric water shares. This approach is discussed in more detail below in reference to the Mekong River Commission.

> Pragmatism – after all facts and information have been openly discussed in an atmosphere of mutual trust and respect – has the best chance of producing enduring water sharing arrangements that satisfy environmental, social, and economic needs.

Despite all these attempts to achieve fair and reasonable sharing of the basin's resources, conflicts will arise. It is an important function of a basin organization, or an agency responsible for basin-wide water resource management issues, to be able to bring disputes to the negotiating table, and through agreed processes, achieve an acceptable result. Note 12 discusses the important role of dispute resolution.

figure 8.1

MUTUAL OBLIGATIONS AMONG PARTIES IN A RIVER BASIN



How are Some RBOs Dealing with Water Sharing Issues?

The discussion that follows centers on basin-wide issues. It does not deal with how each member-state or province allocates its water share and licenses water to particular users within a state or province; rather, it addresses issues to the point of accountability where each state or province must report to the river basin organization or relevant agency responsible for basin-wide water sharing. (This is generally referred to as the *accountability level* of integrated river basin management.)

The three practical examples are reviewed:

- The Mekong River Commission (MRC), a relatively new organization just coming to terms with how to share water resources among four countries (Cambodia, the Lao People's Democratic Republic, Thailand, and Vietnam)
- The Murray-Darling Basin Commission (MDBC), established almost 90 years ago in Australia and including water shares and the monitoring of those shares for most of this time
- The Tarim Basin Water Resources Commission (TBWRC), a new basin organization in China that uses a different approach than the MRC.

The Mekong River Commission

The Mekong River Commission is fundamentally different from the MDBC and the TBWRC in that it is an international basin organization, not a domestic one. As such, the organization must maintain strong respect for the sovereign rights of each member-country to develop its own natural resources. The MRC's role is to develop rules for the protection of the basin's rivers and to set broad rules for the use of the remaining water after these environmental needs have been met, in accordance with the principles set out in the agreement. The specific rules to control water usage are still to be defined; a range of options must be considered before agreement is reached. It may turn out that specific annual volume quotas for each country are not developed; rather, agreement may be reached on sharing rules and procedures, which the MRC would then use to evaluate any projects and proposals submitted by a country. The Ministerial Council would then need to consider the evaluation and decide whether the project makes reasonable and fair use of the water.

The MRC does not intervene with respect to how each country distributes water that is within the agreed usage rules and procedures. Rather, it monitors water usage to ensure that actual diversions are within the agreed rules for any particular project and that environmental flow obligations are being met. It thus has more of a coordinating and planning role, as compared to more traditional arrangements, where the basin partners did not autonomously manage their water use and the RBO had more direct management and control over water usage.

The Legal Agreement. Articles 1 to 3 of the MRC agreement provide the basis for cooperation among the four countries (Cambodia, Lao PDR, Thailand, and Vietnam):

- Article 1 – "To cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the basin including, but not limited to, irrigation..."

- Article 2 – "To promote, support, cooperate and coordinate in the development of the full potential of sustainable benefits to all riparian countries and the prevention of the wasteful use of the basin's resources, with emphasis on joint or basin-wide projects that are determined through formulation of a basin development plan..."

- Article 3 – "To protect the environment, natural resources, aquatic life and conditions, and ecological balance of the basin from pollution or other harmful effects resulting from any development plans and uses of water and related resources..."

The terms of these three Articles must be considered before any project can be investigated or studied. With regard to sharing water in the basin, the overriding issue is covered in Article 3, which states that no development can proceed if it impacts the environment beyond what is agreed to as the *level of ecological sustainability*. Thus as discussed, **before water sharing for consumptive use among basin partners can realistically occur, the flow regime requirements for the environment must be established.**

Volumetric Water Sharing. The MRC agreement has avoided the specification of volumetric shares for each country in its legal agreement. As a proxy, the agreement incorporates rules and procedures that define which types of projects need to be submitted for review and debate, and what are the broad criteria for assessing whether a particular project is acceptable. Schedules to the agreement are to be framed that will precisely define the notification, assessment, and recording for projects.

To have sought to include specific volume shares for each country in the 1995 agreement could have caused the agreement to be delayed for many years – or even decades – because it probably would have been impossible to agree on what reasonable and equitable shares would be before the new institutional arrangements had been finalized.

Different processes are required for reviewing projects if, for example, they require water in the dry or wet season; they are on the main river or on tributary streams within the member-countries; or they divert water outside the basin (an inter-basin diversion).

In addition, the agreement states that *acceptable minimum flows* must be determined for the main stream and that any development projects must not infringe upon these flow levels. The minimum agreed flow regime must maintain the agreed level of ecological or environmental health. To set this level, significant information about all aspects of the natural resource base of the basin must be known. This issue is discussed in detail in Note 5. The MRC has chosen to develop its environmental flow regime requirements as part of the basin development planning studies underway, rather than carrying out a separate review of the characteristics and health of the basin's natural resources and then determining flow regime requirements in advance of any planning studies.

The MRC must weigh some important considerations initially:

- What is really meant by environmental sustainability? What natural resource and social parameters must be taken into account?
- What level of impact on these parameters can be tolerated from new development proposals and the water used by them?
- Can water be taken without limit in the wet season (when the monsoons bring huge flows down the river systems) without affecting the environmental health of the basin?
- When does the critical dry season begin, when severe limitations can be imposed on the impacts that a new project may cause? Since the current flow levels in the dry season can cause problems with salinity intrusion, fish breeding, and so on, can water be taken for development in this dry period without severely affecting environmental values and health?

To reiterate, the MRC approach to water sharing is not to develop specific annual shares of water for each country; rather, it is to develop rules and procedures to review and assess the impacts of basin-wide and national projects, measured against a set of environmental, hydrologic, and social indicators.

More specifically, the MRC approach uses linkages between three main work programs to deliver a *basin development plan* that will share the benefits and meet the requirements of ecological sustainability (figure 8.2).

figure 8.2

MAJOR WORK PROGRAMS UNDER THE MRC APPROACH

PROGRAM	RESPONSIBILITIES
ENVIRONMENT PROGRAM Provides the data and environmental response assessments (level of environmental impact for various levels of development and water use) to the Water Utilization Program.	• To collect data and information about the nature and extent of the basin's natural resources • To analyze data to determine trends and resource problems • To determine options for maintaining various levels of resource health for various development options • To assist in determining acceptable minimum flow regimes against which to assess projects
WATER UTILIZATION PROGRAM Uses the information from the Environment Program to develop, among other things, environmental flow rules and regimes that reflect an agreed balance between economic development and environmental protection.	• To develop technical and procedural rules for sharing data and information, for notifying projects and assessing them, and for resolving differences as to whether or not projects are acceptable • To develop a water-related knowledge base, and a suite of modeling and analytical tools to support the implementation of the rules and procedures relating to water sharing • To develop an acceptable environmental flow regime, based on information provided through the Environment Program
BASIN DEVELOPMENT PLAN Uses all the rules, procedures, modeling, and analytical tools developed under the Water Utilization Program, as well as the environmental flow rules and indicators, to assess the acceptability of a range of basin-wide development scenarios and to agree on a package of development that best meets the needs of the basin partners.	• To develop various water-related planning scenarios for each of the major sub-basins within the lower Mekong Basin incorporating all aspects of development, resource use, and rehabilitation • To test these scenarios against the rules, procedures, indicators, and agreed ecological values for the basin • To agree on acceptable development scenarios and prioritize sub-basin plans and particular projects within the agreed scenarios • To oversee implementation

Sharing benefits rather than sharing water volumes is arguably the most modern or mature river basin approach, but it is by no means any simpler to reach agreement. Benefits ultimately need to be seen in the broadest possible way, such as ecosystem services. This gets back to addressing the issues of an agreed mix of mutual interests, protecting sovereign rights, satisfying the most reluctant partner, and maintaining mutual trust, respect, and confidence. In this context, one partner may feel that sharing benefits will not be acceptable unless it is given the opportunity to sell some of the water from within its boundaries, and thus accrue benefits through water sales or transfers. For example, a partner that has large volumes of the basin's water resources within its boundaries but only limited areas of suitable land for development may wish to sell some of the water it might otherwise never utilize because of lack of opportunity.

Thus sharing benefits and sharing water resource volumes may be issues that need to be discussed openly and fairly if basin partners are to maintain mutual trust, respect, and confidence. Two approaches are described below.

The Murray-Darling Basin Commission

The Initial Water Sharing Agreement. In the early 1990s, the Murray-Darling Basin Commission (MDBC) in Australia set out to follow a path of sharing the water, not the benefits of the basin. After more than a decade of debate, the agreement came to include specific water shared along with the sharing of certain benefits.

It is relevant to consider the situation in the river basin around 1900, when the states of Australia agreed to form a federation. Each state retained the right to develop its

own natural resources. So all the rivers within each state, irrespective of whether they flowed into the main stem of the River Murray, could be developed as each state wished. However, the main stem River Murray passes through three states; the upper two states share the river as a common border. Thus how the water resources of the River Murray were to be shared became an issue on the first day of the federation.

The two upper states jointly wanted to build one or two large dams to develop large irrigation schemes along the rich flood plains of the river. The lower state was more concerned with preserving river flows for navigation purposes. At the time, there was little road or rail infrastructure. The lower state was able to provide shallow draft shipping to secure much of the inland agricultural transport business to the major seaboard port of Adelaide.

Finally an agreement was reached that a major dam could be built in the headwaters, but a series of compensatory weirs and locks would be built in the lower state to maintain navigation rights and river traffic loads – even though major reductions in the flow downriver would occur because of water storage in the dam. This agreement was legalized and became the first River Murray Waters Agreement (later amended to the MDB agreement).

In terms of water sharing, the lower state was allocated a specific annual volume, broken up into specific monthly flows, calculated to provide an agreed level of irrigation and navigation benefits that were seen as reasonable and equitable after all the weirs and locks were constructed. The two upper states each had to contribute half of this monthly requirement. The two upper states were then free to share equally the remaining resources held in the new dam (plus use their own tributary water). Thus the volume of water available to the two upper states was not a fixed annual share; it varied with the amount of water held in storage at the start of each water year. A detailed accounting system was developed to record how much water was used and how much passed to the lower state. Over the long term, through this sharing arrangement, each state has been receiving about one third of the available resources –even though the sharing rules were not based on the specification of proportional volumetric shares to all three states; *only* one share was set for the lower state.

The principles behind this sharing arrangement still apply some 90 years later, even though additional mainstream dams have been constructed. Any extra water is shared in approximately equal proportions. In addition, downstream flow for commercial navigation in the lower state has ceased to be an issue. It has been replaced by recreational and environmental needs and more water for the irrigation sector.

Modernizing the Water Sharing Agreement. Over the last 10 years, and by mutual agreement within the MDBC institution and its member-governments, unlimited water use on the tributary streams within the basin by each state is no longer permitted, even though this remains a state right under the country's constitution. The very high levels of development on all these streams has led to severe reductions in flows and large increases in both urban and agricultural pollution in the River Murray. As a result, the lower state is receiving poor quality water and little more than its entitlement or allocation flow, and no flushing flows for improving the water quality.

The MDBC member-states have therefore agreed to limit diversions in all tributary streams, and in some cases, prohibit any new diversions. This has caused great conflict between farmers who use the water (and seek compensation for water allocation reductions) and environmentalists who want to reverse the decline in the health of the River Murray. The difficult question is just where is the acceptable balancing point between losses from the level of economic productivity because of water reductions and the consequential improvements in environmental health.

The MDBC initially was responsible only for water sharing along the mainstream of the River Murray. Currently, the

MDBC has several coordinating and planning roles in water sharing across all tributary streams of the basin. These responsibilities are highlighted below.

- To determine annual volumes for water consumption from the River Murray and related resources specified in the agreement
- To advise each of the three riparian states of the available water
- To control releases from the headwater dams and weirs in accordance with water orders from each state
- To monitor each state's diversions and operate a system of water accounts to detail how the water is used against what is available
- To monitoring and audit the water quotas that have been set for each tributary or sub-basin stream within each member-state (five states/territories divert water from the basin and some twenty sub-basins each have a cap or quota controlling diversions)
- To reviewing the effectiveness of the various water permitting systems in each state to ensure that the agreed targets and quotas in each sub-basin are being met.

Since the water shares of the River Murray resources and the water quotas for the tributary streams have been clearly established and agreed, the role of the MDBC is primarily to monitor and report on: water use during the year, compliance with the agreed quotas, and trends in resource behavior and health. That is, the Commission assesses whether the reduced level of water usage established by the introduction of quotas on the tributary streams has achieved the required level of resource rehabilitation.

It is important to note that the MDBC does not become directly involved in the issuance of water licenses or permits within the states. By agreement, it is confined to planning and coordination at the basin and at member-state levels. Hence its accountability ends at the point of ensuring the states' compliance with the broad basin-wide policies for basin sustainability. The system for water allocation and licensing/permitting in the Murray-Darling Basin can be summarized as follows:

The MDBC:

- Sets quotas for three states for water diversions from the main stream (the River Murray), as specified in the MDBC agreement
- Manages major dams and weirs on the main stream to release water to meet water orders lodged by the states that are within these state quotas
- Maintains an ongoing water account for each state to record progressive water usage throughout the year
- Sets quotas for water use on the tributary or sub-basin streams, after agreement by the Ministerial Council of the Commission on the method to be used to determine the quotas
- Audits each year whether each state has maintained water use for each sub-basin within the quota.

The member-state agency:

- Submits water orders (perhaps weekly) to MDBC for diverting water from main stream
- Manages its own water usage on each tributary or sub-basin stream and provides a year-end summary to MDBC to compare usage with the quota limit
- Issues licenses and permits to all water users within the state (that is, the River Murray mainstream and all the tributary or sub-basin streams within its state boundaries)
- Collects relevant information to ensure that licensees are complying with license conditions, including information that may be requested by MDBC.

The Tarim Basin Water Resources Commission

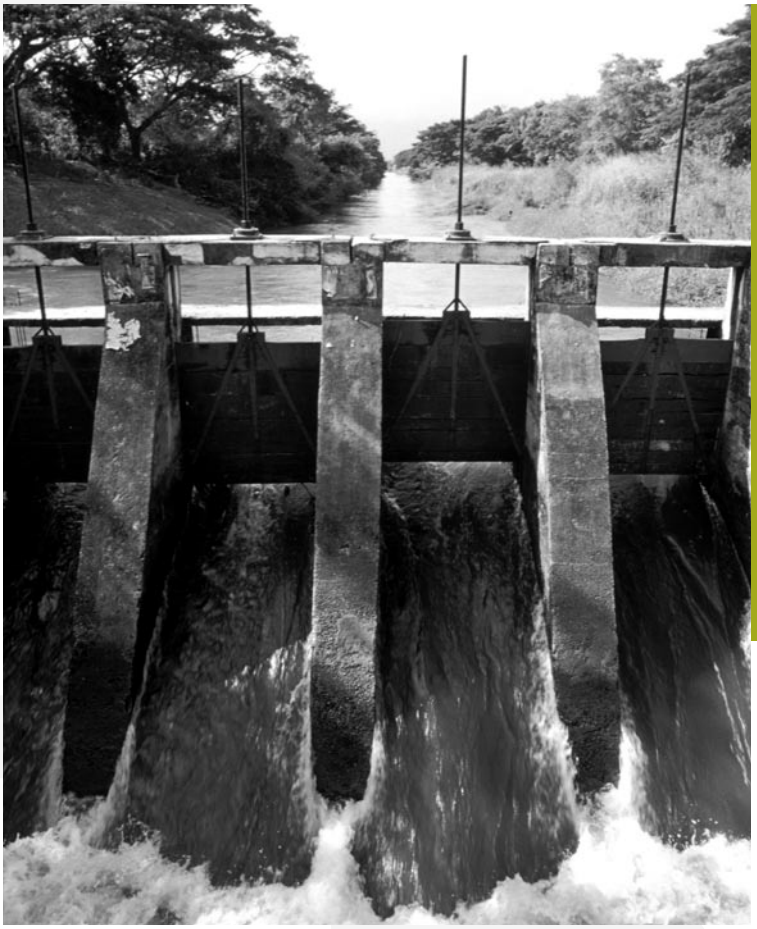
The Tarim Basin Water Resources Commission (TBWRC) provides a different example of how to share the water resources of a river basin. TBWRC is new basin organization created for the Tarim River Basin about five years ago. It is the first in China to have a set of regulations that cover all the key elements of integrated river basin management. Previously, the basin organizations in China operated like regional branches of the central government's Ministry of Water Resources, with no direct participation from the provinces within the particular basin. In addition, they

had more specific task-oriented roles and responsibilities, such as flood control, defining water shares, and pollution abatement, rather than covering all aspects of integrated river basin management with a high level of stakeholder involvement.

The Tarim Basin is wholly located within one province, the Xinjiang Autonomous Region, in western China. This region occupies almost one-sixth of all of China and has large areas of desert and highly fragile lands. The Tarim River rises in very high mountains in southwestern China and passes quite quickly down into the desert areas. The densely populated oases divert as much water as possible to maintain intensive development in what would otherwise be very unproductive areas. The Tarim River finally ends by discharging into a large inland lake. In its passage through the lower half of the basin, it provides valuable groundwater and flood overflow watering for an essential Green Corridor of vegetation that keeps desert areas at bay and protects important transport routes. The Government of China has declared the Green Corridor to be an area of national heritage.

Five major tributary streams drain the headwaters. These come together about a third of the length down the system to form the main stem of the Tarim River. The prefecture governments on each of these tributaries have heavily developed the water resources. By the mid 1990s, little water was reaching the lower river and the health and areal extent of the Green Corridor was being severely impacted.

A new basin organization was formed to achieve sustainable use of the basin's water resources. It was given a contemporary set of regulations that established the Tarim Basin Water Resources Commission (TBWRC) and made all government administrations within the basin equal partners through membership to a Board of Commissioners or Standing Committee. The regulations specifically gave TBWRC the role of managing the sharing of the basin's water resources. The general provisions require that a range of practices and approaches be followed to ensure



that economic development is integrated with ecological and environmental protection; that water should be used in a planned and efficient manner; and that a coordinated system of payment for water consumed should be introduced. This includes both a water supply charge for the volume of water actually diverted for use and a water resources fee to cover part of the cost of managing the water resources of the basin. The actual level of fees and charges that are to be collected must take into account *ability to pay* issues. In practice, the regional government will continue to provide large subsidies to the bulk water suppliers and to TBWRC.

Setting Water Shares. The Agreement requires *fair and reasonable* sharing of water resources among the *economic* partners in the basin, as well as a reasonable share

to protect the basin's environment. In this context, the Commission prepares and reviews a comprehensive master plan of the basin. It also reviews and determines the annual gross water quota, the annual limits for water usage, and the annual water use plan of the various prefectures and other concerned parties.

A specific annual volume or quota has been set for each prefecture on the basis that if diversions are maintained at this level, then sufficient water will pass downstream every year to maintain the Green Corridor in an acceptable environmental condition. Extensive monitoring is needed to establish whether the desired improvements in resource health are taking place or whether further adjustments in quotas need to be made. These could be either quota reductions to provide more water for the environment, or quota increases if actual environmental rehabilitation exceeds expectations. Making detailed assessments and responding honestly to these findings are important roles for a basin organization, as the overriding objective for any RBO is to find the most acceptable balance between economic development and environmental protection. There is no point in causing excessive economic strain through reductions in water use if this makes the environment healthier than the agreed level.
The quotas have been set with about a 10 percent reduction in recent annual usage. This provides a big incentive to improve water use efficiency, which is currently low. In this way, overall productivity can be maintained, even though water diversions have been reduced. The quota volumes need to be clearly specified in an agreement that also specifies the conditions and rules regarding how the quotas can be used, along with the monitoring, reporting, and auditing requirements. This agreement is to be signed by all parties (the basin organization and the respective states or provinces). All these aspects are very important so that all parties are aware of the rules and procedures in the event there is a dispute concerning the compliance of quotas.

The quota agreement may also specify some reporting requirements relating to how water is consumed by the various users within each state or province. It may also include reporting requirements pertaining to the permitting process (for example, whether water use efficiency issues are being incorporated in the permits/licenses). However, as mentioned earlier, nowadays it is uncommon for a basin organization to intrude into the actual water permitting process within states or provinces. Typically, a quota agreement would have provisions along the following lines:

- Purpose
- Definitions
- Parties to the agreement
- Roles and responsibilities
- River system covered by the agreement
- Annual long-term quota
- Transitional arrangements to reach quota
- Annual water regulating method (how hydraulic structures are to be operated)
- The water regulating plan for the year
- Permanent and temporary transfer of unused annual allocation
- Monitoring and reporting
- Monthly diversions within quota
- Reporting requirements relating to internal water use
- Water quality issues
- Performance indicators
- Asset management requirements
- Billing and charging for water resource management activities
- Customer liaison requirements
- Registering of complaints and disputes
- Dispute resolution
- Assessing quota effectiveness
- Developing analytical tools
- Hydrological, social, and environmental models

What Traditionally Have Been the Problems with Water Shares or Allocations in the Agriculture Sector?

In the past, when water was plentiful, the control of consumptive use in the irrigation sector was not based on the volumes of water diverted but on the area under irrigation. That is, a farmer had what was known as an *area water license* and was able to divert as much water in a year as he desired, provided that the water was used only in the area defined in the license. This is still common practice in many developing countries, where water may still be plentiful and where the areas irrigated by each farmer are quite small: for example, 1 to 3 hectares. In the latter case, a refined system to precisely measure volumes of water diverted on an individual farm basis is simply not practical.

But this approach does not promote efficient water usage. There is no incentive for farmers to use water more efficiently. In essence, they are free to use water almost indiscriminately provided it is within the defined fixed area. This in turn creates large drainage flows leaving the farm, either through increased flows to groundwater or through the surface drainage systems.

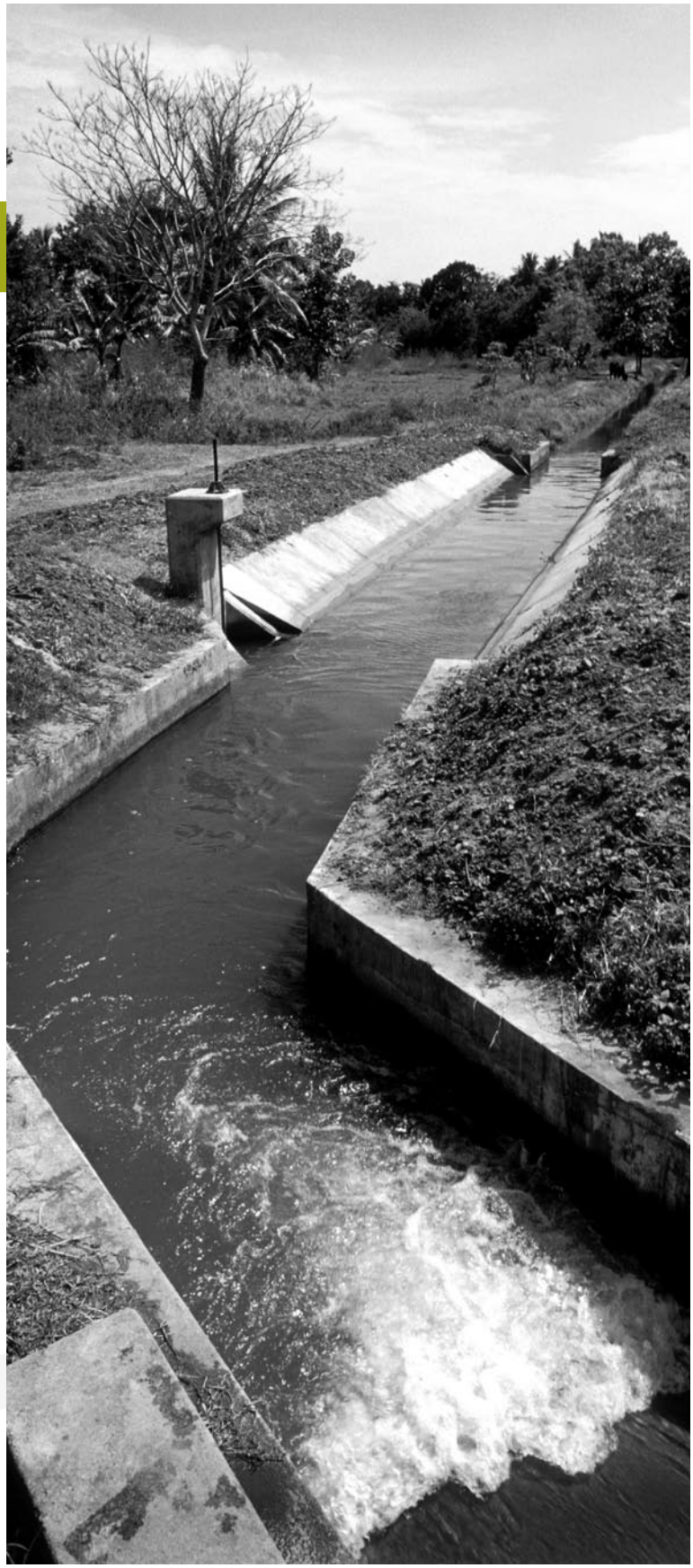
Such drainage results in large returns to the river system (for consumptive re-use downstream or by chance, to satisfy environmental needs) or large losses into wastelands and other non-ecologically beneficial water surfaces and swamps, or both. Those responsible for river operations in such circumstances become to expect these return flows, so they become part of the water balance and satisfy some of the demand when the releases from reservoirs are determined.

In many countries however, water is not plentiful; the prevailing scenario is water scarcity. This circumstance has driven new approaches to water allocation. It is now common to allocate a farmer a *fixed annual amount of water*, which can be used anywhere on a farm (provided there are no environmental or soil condition constraints) *rather than an unlimited water supply tied to a fixed area*. In addition, the economic value of water and the true costs of supplying it are now more carefully considered. Farmers are being asked to pay substantially higher water charges to cover a greater percentage of these costs.

What Happens to Water Allocations When On-farm Water Efficiencies Improve?

If a farmer is now constrained by a fixed diversion volume and he is also paying more for the water he uses, it is unlikely that he will continue to allow large quantities of water to drain off his farm. How will this shortfall downstream (either for consumptive use or to satisfy environmental needs) be met? In the case of river systems supplemented by dam storages, will river operators need to release more water to offset this reduction in return flows? If so, the volume of water available for allocation for consumptive use in the dams each year must be reduced, as a greater portion of the stored water will be required to meet the needs downstream. Once on-farm water efficiencies improve and drainage or return flows are significantly reduced, annual water allocations to farmers need to be smaller. This concept is often difficult for farmers to accept and is met with much resistance.

In the cases of the Murray-Darling and Tarim River Basins, certain annual volumes must be delivered downstream. In the MDBC case, the legal monthly components of the annual allocation of the most downstream state must be met. In the TBWRC case, a downstream variable flow regime is required to meet agreed environmental needs. If the return flows in the basin are reduced or are likely to be, because of higher water efficiencies on farm or within the irrigation distribution systems, then the MDBC and the TBWRC need to set annual diversion quotas for the upstream states or prefectures at a level that takes these reductions into account.



What Can Be Done to Offset Reductions in Water Allocations?

The problems outlined above bring the concept of evapo-transpiration (ET) back into focus. ET is evaporation from water and ground surfaces, and transpiration by plants. To offset some of the reduction to their water quotas, farmers will need to readjust their irrigation practices to utilize more of the non-beneficial evapo-transpiration (NBET) or non-beneficial water usage.

To explore this concept further, consider the Tarim Basin. As mentioned, this basin is a closed system with no outlet to the sea. Five tributary streams or sub-basins in the headwaters all join to form the Tarim River. It is useful to think of each sub-basin as a "black box." That is, every drop of water that enters the black box must again leave; what goes on within the box is irrelevant.

The only water entering the Tarim Basin is precipitation (mostly in the form of snowfall in the high mountains). As the basin is landlocked, water leaves only in the form of evapo-transpiration. It is useful to divide the ET into three components:

- Consumptive use (CU) related to human activity in irrigated agricultural, municipal, and industrial uses
- Beneficial ET (BET) from trees and green areas along rivers and in and around oases
- Non-beneficial ET (NBET), mostly in low lying areas with high water tables (including areas of salinization) and non-ecologically beneficial water surfaces.

The overall goal in the basin should be to maximize CU and BET and to minimize NBET. To prevent any further deterioration of the trees and green areas along the rivers, BET must be maintained at existing levels, so any increases in CU must be offset by corresponding equal decreases in NBET. More-over, to rehabilitate the Green Corridor downstream, an increase in BET is required. This increase, coupled with any increases in CU, therefore demand even larger reductions in the NBET.

The overall amount of NBET in the Tarim Basin is large, partly because of the local desert conditions. With proper planning, water allocations, and management, it has been possible to significantly improve water use (CU) and increase BET in the basin.

At the sub-basin level, the "black box" concept is also relevant. Figuratively, if the black box is placed in the floor of the sub-basin, including all areas of human activities and excluding the mountain areas, the inputs to each sub-basin would be surface water (SW) and groundwater (GW) inflows. (Precipitation directly on the sub-basin away from the mountains is very low and can be neglected.) The outputs are also SW and GW outflows, plus the amount of ET leaving the sub-basin (CU, BET, and NBET).

The TBWRC is supporting the government's goal to rehabilitate the downstream Green Corridor and has set a desired level of river health. This is to be achieved by allowing an improved flow regime to reach the lower river. Each sub-basin therefore needs to be managed to increase SW outflows. (GW inflows and outflows are small and can be neglected.) At first, this meant reducing the level of consumptive use (CU). Because NBET is so large, integrated land and water management plans have since been developed to sustain current development – and also allow for new development through significant reductions in the NBET within the sub-basins.

So even though most basin organizations control bulk or high-level water use through volumetric allocations or quotas set in terms of gross volumes that may be diverted by a state, province, or prefecture, **the important issue is how the individual states and the specific water users in these states use water, seek efficiency gains, and attempt to reduce NBET.** The basin organization needs to be aware of the reductions in NBET, not only because it is responsible for integrated water resources management coordination in the basin but also to ensure that these reductions return to the river basin water system and do not contribute to more CU.

Examples of this practice can be found in Colorado, California, and some other western states in the United States. While the water right is set in terms of the gross amount of water that can be diverted, it also includes how much can be used consumptively and how much must be returned through the drainage systems. In some parts of Australia, while rights are also based on gross diversions, there are specific drainage licenses for some large irrigation schemes, which regulate the water quality issues in any return flows and some also have a quantity component. These stipulations may relate only to a few months of the year, such as during times when rice fields are cleared – when the drainage water may be an important benefit for downstream users.

The river basin organization needs to set quotas carefully, taking account of the CU, BET, and NBET as well as future needs, particularly in terms of the BET. The RBO should also help identify ways to reduce NBET to achieve the greatest level of basin productivity consistent with the agreed levels of environmental protection. Its role is not simply to set annual quotas and monitor compliance.

How Can Water Use Be Monitored?

In terms of monitoring water use, the prime task of the RBO is to assess whether each member-state or administration complies with the quota agreement that has been endorsed and signed by all. Similarly, in those basins where a RBO does not exist, the agency responsible for managing water allocation and use should also be responsible for the compliance monitoring. Monitoring should be undertaken not only of compliance with the annual quota volumes (or a percentage thereof in times of drought) but also of compliance with the conditions relating to how and when water can be taken; with measurement practices for withdrawals; and with drainage or return flows requirements. The RBO should also report on land and water management practices and water efficiency statistics. These are particularly important for basin sustainability.

The monitoring and assessment of basin sustainability is covered in detail in Note 14. This issue is discussed briefly below to complete the picture.

Relevant data and information need to be collected to establish whether progress is being made and at what rate. While the development of a package of sustainability indicators and a related monitoring program are critical roles of a RBO, these are of little value without good, adequate data.

Monitoring bulk diversions such as annual water quotas is relatively simple. Many technical means of measuring water flow are readily available. But monitoring where this water goes, for what purpose is it used, and how productive is its use are far more complex issues. Yet the collection and compilation of information is costly. Many RBOs and member governments, agencies, and departments simply do not have the funds to collect all the necessary data. Hence the need for open sharing of data among all members. This will make the best use of available data and information – and perhaps more importantly, resources – so that limited funds can be used to obtain new information on resource behavior that was not previously measured.

One of the new technologies being used to assess water use efficiency for irrigation enterprises is thermal infrared imagery. Traditionally, indicators of irrigation performance were based on measurements of physical parameters (flow rates, yields, irrigation depths, canal seepage) at field, sub-project, project, or wider scales. Often, more than 50 indicators were specified by traditional mathematical formulae, but rarely were data sufficient to give a full or meaningful picture of irrigation performance. This is not surprising, as it is easier to define a mathematical formula for an indicator of performance than to actually spatially and temporally measure the data within reasonable costs. The advent of remote measurement for such fundamental parameters as evapo-transpiration and biomass formation has greatly improved effective measurement of key parameters in the irrigation sector. Spatial coverage is available at the various scales needed – field, project, basin – and temporal coverage is vastly superior at minimal cost, compared to the traditional system of extensive field measurement of data. Management tools such as remote sensing can now that tell system operators how uniformly water is being distributed, how productively it is being used, and where it is being wasted.

In the Tarim and Murray-Darling River Basins, this tool has greatly improved the accurate measurement of performance in areas relating to sustainable agricultural productivity. Remote sensing is already used for assessments at the broad irrigation district scale but the recent advances in thermal infrared imagery are making it possible to more readily obtain irrigation efficiency data at the farm level.

How Can Partners Move Forward with Transboundary Water Sharing: A Few Key Points

There is no single magic formula to define how the water resources within a basin should be shared. On the contrary, the expectations of each of the basin partners, and the establishment of trust, respect, and compromise regarding what is perceived as reasonable and equitable among all parties, must be achieved primarily through principled pragmatism. Sometimes impetus for the collaboration arises through a catalyst, such as a joint piece of infrastructure or an agreement to create and/or share water-related data and information. The process of water and benefit sharing proceeds from there.

The different approaches adopted by the three commissions – MRC, MDBC, and TBWRC –are summarized below.

- The MRC has adopted a set of principles and procedures for sharing water through the evaluation of projects. Once agreed ecological limits are not breached, the projects are endorsed. In other words, the process is based on the sharing of benefits rather than the creation of specific water entitlements, quotas, or volumes shares for each member country.

- The MDBC has allocated a specific water share for the lower state in the basin. The upper two states along the River Murray can equally share the water that is left (which varies from year to year depending on climate and runoff). The three states along the main river can trade water with one another if this achieves higher benefits.

- The TBWRC has developed specific water shares or quotas for each of the five prefectures within the basin, on the basis that, over the long term, if annual diversions are held at these levels, the volumes of water flowing to downstream areas will restore the Green Corridor to an acceptable level of health.

ANNEX

Principles of Reasonable and Equitable Utilization.

United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses.
(Adopted by the UN General assembly May 1997.)

Part II – General Principles.

Article 5 – Equitable and reasonable utilization and participation.

1. Watercourse States shall in their respective territories utilize an international water course in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits there from, taking account the interests of the watercourse States concerned, consistent with adequate protection of the watercourse.

2. Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to cooperate in the protection and development thereof, as provided in the present Convention.

Article 6 – Factors relevant to equitable and reasonable utilization.

1. Utilization of an international watercourse in an equitable and reasonable manner within the meaning of Article 5 requires taking into account all relevant factors and circumstances, including;

- Geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character,
- The social and economic needs of the watercourse States concerned,
- The population dependent on the watercourse in each watercourse State,
- The effects of the use or uses of the watercourses in one watercourse State on the other watercourse States,
- Existing and potential uses of the watercourse,
- Conservation, protection, development and economy of use of the water resources of the watercourse and the costs of measures taken to that effect;
- The availability of alternatives, of comparable value, to a particular planned or existing use.

2. In the application of Article 5 or paragraph 1 of this Article, watercourse States concerned shall, when the need arises, enter into consultations in a spirit of cooperation,

3. The weight to be given to each factor is to be determined by its importance in comparison with that of 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 7 – Obligation not to cause significant harm.

1. Watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States.

2. Where significant harm nevertheless is caused to another watercourse State, the States whose use causes such harm shall, in the absence of agreement to such use, take all appropriate measures, having due regard for the provisions of Articles 5 and 6, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation.

Abbreviations and Acronyms

BDP	Basin Development Plan
BET	Beneficial Evapo-transpiration (ET)
CU	Consumptive Use
DSF	Decision Support Framework
ERS	Environmental Resources Study
ET	Evapo-transpiration
GW	Groundwater
IRBM	Integrated river basin management
KRA	Key Result Areas
LWMP	Land and Water Management Plans
MDBC	Murray-Darling Basin Commission
MRC	Mekong River Commission
NBET	Non-beneficial Evapo-transpiration (ET)
O&M	Operation and maintenance
OMVS	Organisation pour la Mise en Valeur du Fleuve Senegal
RBO	River basin organization
SMART goals	Goal that are S (Specific), M (Measurable), A (Achievable), R (Realistic), and T (Time-based)
SW	Surface water
SWOT analysis	Analysis of Strengths, Weaknesses, Opportunities, and Threats
TBWRC	Tarim Basin Water Resources Commission
TQM	Total Quality Management
WSC	Water supply corporation
WUA	Water user association
WUP	Water Utilization Program

References

WEB SITES

Water Resources Management
Sectors and themes including:
Coastal and marine management
Dams and reservoirs
Groundwater
Irrigation and drainage
River basin management
Transboundary water management
Water and environment
Water economics
Water supply and sanitation
Watershed management
Information and access to the respective Web sites can be found at:
http://lnweb18.worldbank.org/ESSD/ardext.nsf/18ByDocName/SectorsandThemes

Dams
Benefit Sharing from Dam Projects, November 2002
http://www-esd.worldbank.org/documents/bnwpp/2/FinalReportBenefitSharing.pdf

Good Dams and Bad Dams: Environmental Criteria for Site Selection of Hydroelectric Projects
http://essd.worldbank.org/essdint.nsf/90ByDocName/WorldBankSafeguardPolicies404NaturalHabitatsGoodDamsandBadDamsEnvironmentalCriteriaforSiteSelectionofHydroelectricProjects/$FILE/Good+and+Bad+Dams+final.pdf

Groundwater
GW-MATE: Groundwater Management Advisory Team Briefing Note Series.
The overall structure of the series is as follows:
Notes 1 and 2 – Broad introduction to the scope of groundwater management and groundwater system characterization
Notes 3, 4, 5, 6, and 7 – Essential components of management practice for major aquifers with large groundwater storage under stress from intensive water-supply development for irrigated agriculture and/or urban water-supply
Note 8 – The protection of potable groundwater supplies
Notes 9, 10, and 15 – Planning national and regional action for groundwater resource management
Notes 13 and 14 – Management of smaller-scale water supply development in the rural environment
The remainder of the series (Notes 11,12,16, and 17) deals with a number of specific topics that pose a special challenge.
http://lnweb18.worldbank.org/ESSD/ardext.nsf/18ByDocName/SectorsandThemesGroundwaterBriefingNotesSeries

The Murray-Darling Basin
Murray-Darling Basin Initiative
http://www.mdbc.gov.au/

The Living Murray Initiative
http:/www.thelivingmurray.mdbc.gov.au/

Heartlands Initiative
http://www.ciw.csiro.au/heartlands/partners/index.html

Toolkits

Benchmarking, Rural Water Supply and Sanitation for Multi-Sector Projects, Gender, Hygiene and Sanitation, Private Sector Participation, Small Towns
http://www.worldbank.org/html/fpd/water/toolkits.html

Global Water Partnership IWRM Toolbox
http://gwpforum.netmasters05.netmasters.nl/en/index.html

Water Demand Management

Building Awareness and Overcoming Obstacles to Water Demand Management, Guideline for River Basin and Catchment Management Organizations, IUCN
http://www.gwpforum.org/gwp/library/River_basin_management_guideline_26Oct2004.pdf

Water Resources and Environment Technical Notes

The overall structure of the series is as follows:

A. Environmental Issues and Lessons
B. Institutional and Regulatory Issues
C. Environmental Flow Assessment
D. Water Quality Management
E. Irrigation and Drainage
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Water Supply and Sanitation

http://www.worldbank.org/html/fpd/water/index.html

OTHER SOURCES

Barrow, C. J. 1998. "River Basin Development Planning and Management: A Critical Review." World Development 26 (1): 171–86.

Boisson de Chazournes, Laurence, and M. A. Salman Salman. 1999. "International Watercourses: Enhancing Cooperation and Managing Conflict." Technical Paper 414F, World Bank, Washington, DC.

Bruning, Stephen D., and John A. Ledingham. 2000. Public Relations as Relationship Management: A Relational Approach to the Study and Practice of Public Relations. Mahwah, NJ: Lawrence Erlbaum Associates.

Chenoweth, J. L. 1999. "Effective Multi-Jurisdictional River Basin Management: Data Collection and Exchange in the Murray-Darling and Mekong River Basins." Water International 14 (4): 368–76.

Chenoweth, J. L., H. M. Malano, and J. F. Bird. 2001. "Integrated River Basin Management in the Multi-jurisdictional River Basins: The Case of the Mekong River Basin." International Journal of Water Resources Development 17 (3): 365–77.

Crano, William D., and Gary W. Silnow. 1987. Planning, Implementing and Evaluating Targeted Communication Programs, A Manual for Business Communicators. New York: Quorum Books.

Creech, Bill. 1995. The 5 Pillars of TQM: How to Make Total Quality Management Work for You. New York: Plume Books.

Dinar, Ariel, and D. Marc Kiljour. 1995. "Are Stable Agreements for Sharing International River Waters Now Possible?" Policy Research Working Paper 1474, World Bank, Agriculture and Natural Resources Department, Agricultural Policies Division, Washington, DC.

Dinar, Ariel, and Donna Lee. 1995. "Review of Integrated Approaches to River Basin Planning, Development and Management." Policy Research

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