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Institutions for Agricultural Water Management in Water Scarce River Basins in Asia: Lessons from Five Case Studies[1]

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Introduction

This paper synthesizes key lessons from five case studies on institutional arrangements for river basin management in Asia carried out by the International Water Management Institute (IWMI) in collaboration with national research institutes. The case studies were part of a five country regional study financed by the Asian Development Bank to develop effective institutions for agricultural water management in water scarce river basins. The following river basins were selected for study: Fuyang basin (People's Republic of China); Singkark-Ombilin (Indonesia); Upper Pampanga (Philippines); East Rapti (Nepal) and the Deduru Oya (Sri Lanka). In 2001, two basins from Thailand: Mae Klong and Bang Pakong were included as additional sites. The overall objective of the study was to improve the management of water resources available for agriculture in river basins where there is growing inter-sectoral competition for water, and associated environmental, socio-economic and institutional issues due to rising water scarcity. The specific objectives of the study were:

- To carry out a detailed analysis of existing institutional arrangements for water resources management in selected river basins with a view to identifing the extent to which they constraint and facilitate decision making relating to agricultural water management, especially in the context of inter-sectoral competition for water.

- To apply and validate a conceptual framework for analyzing institutional arrangements for water resources management.

- To develop and initiate the implementation of policies and institutional strengthening programs that will lead to improved management in agriculture.

Three supplementary case studies were also conducted. Two of these were river basins from developed countries: Murray-Darling in Australia and Omonogawa in Japan. The main objective of these two case studies was to identify key elements of successful water resources management that may provide useful lessons to developing countries. The third study was of the Brantas basin in Indonesia. This case study was conducted in

[1] This paper is largely based on the paper presented by the author at the Final Seminar on the Five Country Regional Study on the Development of Effective Water Management Institutions, May 21-22, 2002, Kasetart University, Bangkok, Thailand.

cooperation with Jasa Tirta to document how an effective institutional framework and basin organization have been developed and installed to manage multiple-uses of water in a large river basin in a developing country

Methodology

The case studies focused on standard set of research questions and a common methodology. The key components of the methodology were a) compiling an inventory of the physical infrastructure relating to water resources in the river basin. *b) Water accounting, c) analysis of the prevailing socio-economic conditions in the basin d) Assessing the current performance of irrigated agriculture in the basin and e) analysis of the existing* formal and informal institutional arrangements for managing water resources in the river basin and documenting how different stakeholders are included or excluded in water resource development and benefit appropriation strategies.[2]

Physical Characteristics of the Basins

A working hypothesis of the study is that institutional needs change as river basins evolve and change over time from both from a bio-physical and socio-economic perspective. Figure1 illustrates the hypothetical development path of a river basin as defined by Molden and Sakthivadivel (2000). Three distinct stages in the development of water resources in river basin water can be identfied: (i) development or construction stage, (ii) transition stage where the emphasis is on managing supplies and water savings, and (iii) allocation stage in which the river basin has become "closed" in the sense that all available water has been allocated to various uses.

In the *development stage* water tends to be plentiful and low in value. Conflicts are few and the need for coordination among sectors limited. At the other extreme, in the *allocation stage* water is scarce and valuable with a high potential for conflicts among users, and controlling pollution and the declining water quality is a major problem. The major task at this stage is setting priorities for water allocation among key sectors: irrigation, domestic, industry and the environment.

Figure 2 categorizes the five selected river basins in terms of their development stages and highlights some of their salient features. The categorization is based on the results of water-accounting study conducted in each basin. The five sites chosen reflect full range of stages in the development of river-basins. A cross-site comparison of the five basins allows us to develop a perspective on the problems occurring at the various stages in the evolution of the river basin. East Rapti River basin in Nepal, an open basin, is relatively underdeveloped, but well endowed with water resources. Per capita water availability is estimated to be about 9000 m^3. There is a very large potential for further development of water resources. At the other extreme is the Fuynag basin in North China which is a closed basin. With an annual per capita water availability of about 400 $m^{3,}$ it is one of the

[2] Details of the Methodology and the research questions are outlined Samad and Bandaragoda (1999).

most water short regions in North China.[3] The other three basins fit in-between these two extremes (Figure 1) with varying stages of development and levels of water scarcity. The Upper Pampanga basin is relatively well–endowed with water, with per-capita water availability exceeding 3500 m^3. The Deduru Oya basin (1046 m^3 /per capita/annum) in Sri Lanka is seasonally water scarce, especially during the peak of the dry season when there is hardly any river-flow. It is also spatially water scarce especially in the mid-stream region of the basin that is predominantly in the drier region of the basin. Ombilin sub-basin located in the upper-reaches of Kuantan - Inderagiri river basin in West Sumatra, Indonesia is an "open basin". But, there is intense inter-sectoral competition for water and a high incidence of water related conflicts.

Socio-Economic Characteristics

Table 1 gives the salient demographic features of the basin. The populations in all five basins are concentrated in rural areas. Fuyang river basin is the most densely populated basin and East Rapti the least. In Deduru Oya there is a heavier concentration of population in the more urbanized head and tail-end areas of the basin. The middle region of the basin is predominantly rural. High population growth has been reported in East Rapti and Upper Pampanga.[4] In Deduru Oya, there is an overall decline in the population growth rates, but there is evidence of an increase in population in the more urbanized area suggesting an increase in rural – urban migration.[5]

In all locations, statistics on employment specific to the basin are not available. Yet, employment data from the various administrative areas that fall within the basin indicates that overall, agriculture is the major source of employment for the inhabitants of the respective basins. The population dependent on agriculture varies from 40 percent in Deduru Oya to 79 % in East Rapti.

Incidence of Poverty

The least incidence of poverty is in the Fuyang basin with only six percent of the population living below the official poverty. In three other locations the incidence of poverty is high: Pampanga – 39%; East Rapti – 42% and Deduru Oya – 60%.[6] In the Deduru Oya basin, a few pockets of poverty have been reported from the principal urban center (Kurunegala). Poverty is more pronounced in the drier mid-stream area where there is acute scarcity of water, especially in the dry season. In the latter case, poverty is attributed to low agricultural productivity levels due to the scarcity of water.

[3] Wang and Huang, 2001.
[4] 2.7 and 2.9 % per annum in the two districts in East Rapti (Ghimire et al, 2000) and 2.9% per annum in Upper Pampanga (Orden et al, 2000).
[5] Comparable data on population growth rates for rht Fuyang basin and Ombilin are not available.
[6] Detailed information on poverty is given only in the Sri Lankan and the Nepalese case studies.

In East Rapti, poverty is more pronounced in the rural areas than in the urban centers. Besides locational effects, there are also a strong caste and ethnic dimensions to the poverty problem. Certain groups classified identified as “primitive” and leading mostly nomadic life-styles are among the worst affected. The incidence of poverty is reportedly high among the ethnically disadvantaged groups, especially among fisher communities. The poverty problem is aggravated due to decreasing fish population in the river due to over-fishing and mounting water quality problems due to the discharge of industrial effluents into the river.

Status of Irrigated Agriculture

Deduru Oya

In Deduru Oya basin water is scarce in the mid-stream region. This area has the highest concentration of small tank systems in the entire basin. Water scarcity has seriously affected irrigated agriculture in the small tank systems. Rice is the main crop cultivated under irrigation in both the wet and dry season. In some areas non-rice crops are grown in the dry season. In recent years there has been an increase in groundwater abstraction using diesel/petrol powered pump sets. These are primarily for non-agricultural purposes such as brick making. In some places water pumps are being extensively used to lift water directly from river for irrigation. Rice and other field crops are the main crops grown by river lift irrigation in the head and mid regions of the basin. In the tail–end areas vegetable cultivation is the dominant activity.

Farmers identified sedimentation and silting of tank beds, reduction of inflow in to the tanks due to blocking of natural water courses by encroachers, unplanned development activities in the tank catchments as some of the major hazards in the basin. Unregulated sand mining carried out in large scale was reported as the major cause of environmental degradation in Deduru Oya basin. It is the biggest commercial activity in the basin. Excessive sand mining has resulted in sea water intrusion, loss of natural ponds along the river, reductions in the ground water level and disturbed the stability of the bridges across the river

East Rapti

Agriculture is major source of livelihood of the population in the basin. Of the total economically active population of Makawanpur disttict, 82.7 percent, i.e. slightly more than national figure are involved in agriculture. In Chitwan, 75 percent of the population are engaged in agriculture. It is estimated that about 26% of the total land area in the basin are used for agriculture. On the total area cultivated some 18% are in the river valleys and inner plains. These are the major irrigated farming areas in the basin. The cropping intensity (CI) of these areas is between 200-300 percent. Cropping pattern in such areas with the year-round-irrigation facilities is: Paddy-Fallow-Paddy; Paddy-Wheat-Paddy; Paddy-Wheat-Fallow; Paddy-Legumes-Paddy; Paddy-Legumes-Fallow. However, in areas with seasonal irrigation facility the cropping intensity approaches up to 200 percent. The cropping pattern in such areas is: Paddy-Wheat; Paddy-Legume; Paddy-

Maize; Maize-Oilseeds; Maize-Maize; Paddy-Vegetables; Maize-Vegetables; etc. Livestock (improved breed of buffaloes and cows) and poultry farming is also very popular in the plain parts. In the hilly areas of the basin are largely rainfed. The dominant cropping pattern in the hilly areas is: maize-millet; potato-millet; maize-potato-fallow; maize-fallow. Nearly 75% of the holdings are less than 1 hectare. Land ownership in the basin is highly skewed. About 46% percent of the half the households own only 16 percent of the total available cultivable land. Some 6% households own approximately 26 percent of total cultivable land.

A significant development in over the last few years is the proliferation of groundwater development particularly in the plains. A major reason for the rapid spread of groundwater development is the generous government subsidy amounting to 60% of the investment cost of tube-wells. More recently the government has suspended the subsidy program. This in turn has slowed down the establishment of tubewells.

Fuyang Basin

As noted earlier, Fuyang is one of the most water short basins in North China. Agriculture is the largest user of water. But the share of agricultural water has been declining over time- from 81% in 1993 to 75% in 1998. This is primarily due to growing domestic demand for water. Industrial water demand during the same period has increased by only 1 percent only.

The total design area under surface irrigation is about 430000 hectares. The actual irrigated area is substantially less than the designed area. In 1990s the actual area irrigated was only 41 per cent of designed irrigated area. Most of the surface irrigation system are managed by the government agencies, though contract management system was implemented in some periods With the decline in surface water supply and increasing demand of water for agriculture, domestic and industrial uses, groundwater exploitation increased rapidly. The groundwater irrigation investment was mainly financed by the local village and township with varying extent of government finance subsidies prior to the implementation of household production responsibility system (HRS) initiated in the late 1970s investment in groundwater was by local government agencies with financial assistance from government. Farmers contribute family labors for constructing groundwater irrigation system. These systems were under collective ownership. With the implementation of HRS investment in ground water was primarily by private individuals. There is evidence that in the past two decades that groundwater tables have fallen by more than 1 meter annually. Urbanization, industry and population growth has also led to increasing surface and groundwater pollution, which has further aggravated the water scarcity problem in the basin.

Main crops cultivated in the area under irrigation include wheat, corn, cotton, rice and some millet, soybean, peanut and horticultural crops. . With the modernization of agriculture since 1950s crops yield there has been a doubling of grain yield and a three fold increase in the yield of ginned cotton.

Ombilin River Basin

The major use of water varies among the three major rivers and lakes that constitute the basin. In the Ombilin river water is used for irrigation, industry, power generation, and domestic water supply. Irrigation and domestic water supply are the dominant uses of water in the other two basins

The development of Singkarak Hydro Electric Power Plant has reduce significantly the outflow of water from Singkarak Lake to Ombilin River which affecting the quantity of water flowing in Ombilin River. The reduced water flow in the Ombilin River has adversely affected farmers who rely on the river for irrigation water. Pump irrigation is being adopted by a very limited number of farmers in the last decade.
Marked seasonal fluctuations in the river flow is a major feature of the Ombilin River. For the owners and operators of water wheels, fluctuations in the water discharge of Ombilin River has caused several problems in system operation and maintenance (O&M). The inadequate and unreliability of irrigation water has adversely affected agricultural production in the basin. Rice yield has declined from an average of 4.2 tons per hectare earlier to 3.1 tons per hectare in 1999. Water quality is an emerging problem. This is mainly due to the discharge of effluence from a coal plant. This is causing serious health problems to people living downstream who depend on the river for water for domestic needs. Fish population in the river has declined due to the deterioration of water quality in the river. This has affected cash incomes of households dependent on fishing for their livelihood.

Existing Institutional Arrangements for Water Management

Management of water resources

In all five countries where the case studies were conducted there is an explicit recognition of the importance of considering the river basin as the unit for developing and managing water resources. Yet, none of the river basins studied were managed by formal river basin organization. The water resources were managed on purely sectoral lines by a multiplicity of government agencies with little inter-agency coordination.

In China, four major laws and some 30 state regulations provide the institutional framework for managing the country's water resources. The current laws and regulations water management, finance, water pricing, water withdrawal permit system, water saving, irrigation district management. Steps have been taken to formulate legislation to strengthen integrated watershed management, water allocation and efficiency issues within and across major river basins (Center for Chinese Agricultural Policy. 2000b).In principle, water allocation in the Fuyang river basin, should be done by the Hebei Province Water Resources Bureau in coordination with five prefectures within the basin. In practice, the provincial bureau has very limited power in allocating the water uses among prefectures and counties in the basin.

In West Sumatra. Indonesia, where water management is fragmented between a number of government agencies, a provincial water management committee (PTPA) was set up to coordinate the activities of the various agencies. The PTPA is supposed to be set up in all provinces. However, up until now this committee has not been formed in any of the six river basins located in West Sumatra.

In the Upper Pampanga basin, a number of government agencies are tasked with the administration of water in the basin.[7] Their interests and functions are administrative and regulatory in nature. Despite the presence of these agencies within the basin, it is still beset with problems and issues such as siltation of waterways, land conversion, water pollution, and lack of a coordinating body to promote effective water resource management in the basin. The situation is the same in Deduru Oya where some 20 sectoral departments and agencies are involved with water resource administration and management.[8] East Rapti is no exception with a multiplicity of agencies involved in water management. Although there has been recent attempts to make district (DDC) and village (VDC) development councils responsible for coordinating activities at the local level, they have not been very effective partly because it such functions were considered to be the responsibility of central line agencies and in part due to limited local capabilities.

In all basins, attempts have been at irrigation management reforms and introduce participatory irrigation management (PIM). China has introduced far reaching institutional reforms in the groundwater sector with de-collectivization of the ownership of the groundwater systems and transferring them to private ownership and management. The management of surface irrigation systems has been vested with the local government authorities. In the other locations lift irrigation – both river lift and groundwater systems- are managed by the individual owners, except in Nepal where the larger systems are managed by WUAs. The larger surface irrigation systems are under joint WUA-Agency management. In Sri Lanka, minor schemes are managed by largely by farmer organizations with some involvement of government agencies.

[7] National Irrigation Administration (NIA), National Power Corporation (NPC), Department of Environment and Natural Resources (DENR), Bureau of Soil and Water Management (BSWM), Philippine Atmospheric Geophysical Astronomical Service Administration (PAGASA)Local Water Utilities Administration (LWUA), National Electrification Administration (NEA), Bureau of Fisheries and Aquatic Resources (BFAR), Department of Public Works and Highways (DPWH).

[8] Department of Irrigation (ID),[1] Department of Agrarian Services (ASD), Irrigation Management Division (IMD), National Water Supply and Drainage Board (NWS&DB), Water Resource Board (WRB), Agricultural Development Authority, Forest Department, Inland Fisheries Development Authority, Coastal Conservation Department, and Geographical Survey and Mines Bureau of (GS&MB).

Water Rights

Deduru Oya

Water rights in the basin come within purview of national statutes relating to water. The Crown Land Ordinance of 1949 gives a person who occupies the land on the bank of any public lake or stream the right to use water in that lake or stream for domestic use, livestock or agricultural purposes provided it is extracted by manual means. The owners of private lands can extract ground water in their lands without any restrictions. There are no rules or regulations to control their water use. Water rights relating to irrigation are clearer. In ancient irrigation systems such as the small tanks systems have stipulated customary water rights. However, the in the more recently established major schemes, the tank, canal network and in some cases a specified area in the catchment is considered as government property.

East Rapti

In Nepal the Water Resources Act of 1992 and its by-laws in 1993 vests the ownership of all the water resources in the country with the government. A government license is required for the development of the water resources other than the water resources on the land of a landowner. However, development of water for individual and collective use for the drinking and irrigation does not require license. Water right in Nepal is available to people in following four ways:

- Natural right for developing water for limited purpose.
- Right acquired through license for developing water resource for specific purpose.
- Upper riparian has prior right compared to the lower riparian.
- Customary use right and prior appropriation right.[9]

Fuyang River Basin

According to the Water Law in China, there are two kinds of water right relating to both surface and groundwater: 1) collective property right- if a reservoir or a water body belong to rural collective organization, property right of water stored in these reservoirs and water pockets will also belong to the collective 2) State property – all other water bodies both surface and groundwater all belong to state. According to current regulations water users (including individuals and institutions) cannot draw water from any river, lake or groundwater resources without obtaining a water use license. The water resource management agencies at each level have the right to issue a license to the water user.[10] At present, water trading or transferring the water withdrawal permit or the water use right is prohibited. In the event of any violations, the water resources administration or any other relevant authority can revoke water withdrawal permit license and expropriate unlawful income.

[9] Kayastha, Ram Nath and Dhruba Pant (2001)
[10] Wang, Jinxia (1999) Summary paper on the basin.

Singarak-Ombilin

According to the Indonesian constitution, water is a "God granted resource" and should be used for the highest level of welfare of the people. Therefore, water is owned communally by all citizens. No individual ownership can be claimed over water. The idea also provides the basis for the state right to control—but not to own—water. This state right to control water is exercised by the government.

Upper Pampanga

In the Philippines the utilization of surface and ground water is governed by the Philippine Water Code through the National Water Resources Board (NWRB). All waters belong to the State and are not subject of any acquisitive prescription. The State may allow the use or development of waters by administrative concession through the issuance of Water Right to user. The Water Right is the privilege to appropriate and use water granted by the government through NWRB. The measure and limit of appropriation of water is Beneficial Use, the utilization of the right amount during the period that the water is needed for producing the benefits. Priorities in appropriation of water follow the priority in time principle except in times of emergency when the use of water for domestic purposes have better right over all other uses.

A Comparative Perspective of the Five River Basins

Commonality in the five basin studies

1. Explicit recognition of the importance of integrated water resource management

2. Explicit recognition of the river basin as the unit of management of water resources

3. Growing Scarcity of water and inter-sectoral competition for water.

4. In some countries, water for domestic and industry is given priority over allocations for agriculture.

5. The need for clearer definition of water rights.

6. Groundwater is emerging as an importance source of water. Given this trend groundwater management is becoming an important issue.

7. Water Quality issues and committing water for environmental purposes are major issues.

Major Problems in the Respective Basins and Proposed Solutions

Table 3 provides a check list of problems as reported in the various studies. There are four problems common to all five sites: (i) need for reliable data, (ii) inadequate planning, (iii) absence of well-defined water rights, and (iv) absence of mechanisms for integration of surface and ground water development and use. Other problems tend to vary from site to site although water inadequacy in the dry season is common to all sites.

Lessons from Case Studies on Advanced River Basin Management

The following paragraphs highlight some of the key lessons from the three supplementary case-studies of advanced river basin management i.e. Omanogawa basin in Japan, Murray Darling basin in Australia and the Brantas basin in Indonesia.

Omanogawa[11]

Omono Gawa is well endowed with water resources. Even in years of severe drought, such as 1994, a considerable volume of water is discharged by the river system. It is an urbanized basin with an urban population of about 70 percent of a total population of some 690,000 persons. Agriculture is a secondary activity. The younger generation find it less attractive as an occupation due to the limited income potential from agriculture compared to industry and the public and commercial sectors. The area under paddy cultivation has reduced over the past 20 years as the impacts of reduced consumption took effect, as the nation became more wealthy and reduced subsidies.

Omonogawa has a long history of water development and management initiatives that originate from the water users, specifically farmers, extending over one thousand years. In common with many countries, there are many institutions with interests in management of water resources. In Japan the Ministry of Construction has the predominant role in river basin development and management, a position that has been maintained for over 100 years. Although the role of the public sector is central to water resources management, farmer groups have a well-established role based on participatory development and management of natural resources for protection of agricultural water resources. In recent times, numerous land improvement district (LID) schemes have been undertaken in the basin. The LID system is recognized as one of the more successful innovations in the region to support user involvement in management of irrigation and water resource schemes. However, the LID system has grown out of a long experience in communal management of land and water resources. This experience has included many years of bitter and painful conflict among farmers concerning water allocation. The prevailing system for water management has been developed gradually by farmers themselves, subsequently being formalized by the Land Improvement Act, promulgated in 1949.

[11] This section is based on the report prepared by Makin et al (2001).

Individual LID management organizations are responsible for the daily operation, maintenance, and development of the irrigation and drainage systems. A noteworthy features that LIDs reinstated traditional forms of water distribution, originally superceded following construction of the main intake channel. The LIDs are also responsible for the quantitative measurement of water abstractions and also for water quality measurements. The LID can force municipalities or industrial users to construct and operate water treatment plants if discharges are not within the approved standards.

The Murray Darling[12]

The Murray-Darling river basin was chosen for study as it typifies a basin where the hydrological boundary extends over several administrative regions and the institutional arrangements are in place for effectively coordinating water management functions in a large geographical area. The basin is managed in a framework that involves the commonwealth (or Federal) government, four states and one territory. The framework involves layers of representative bodies that consist of a Ministerial Council, the Murray Darling Basin Commission, and series of high level groups interspersed with community representatives. These layers make up fora where strategies and policies are set out for sharing the water and managing the serious problem of water quality in the basin.
In Australia, water resources are largely under the jurisdiction of the states and territory governments. The Federal government participates in water and water resource management through other means such as legislative and executive capacity.

The Murray-Darling River Basin is managed by individual states but there are overarching bodies that coordinate many of the efforts of state and territory governments at the basin level. Rather than amending the Constitution, a Murray-Darling Basin Commission has been formed to manage inter-jurisdictional processes and conflicts in an organized manner. The Commission is the executive arm of the Murray-Darling Basin Ministerial Council which consists of ministers responsible for land, water, and environmental resources in each of the signatory or contracting governments. The Commission is an autonomous organization equally responsible to the governments represented on the Ministerial Council as well as to the council itself. The commission began with a mandate to manage water quantity that has gradually extended to include water quality issues and, to a limited extent, related land resource management issues. In the late 1980s, it was given a mandate to initiate, support, and evaluate integrated natural resources management across the Murray-Darling Basin.

Over the last decade or so, the Murray-Darling Basin Commission has become increasingly aware of the need for the benefits of community consultation. To this end, in 1986 it established a Community Advisory Committee that reports directly to the Murray-Darling Basin Ministerial Council. Today, virtually all commission programs involve a large degree of consultation. Most policy reforms are, at least, discussed with

12 This section is based on the report prepared by Young and McDonald,(2001).

the council and explored through transparent media and meeting-based processes. Draft policies and/or strategies are then released and finalized after a period of time.

The lessons from the basin can be summarized largely in terms of how conflict is managed. Managing resources sustainably required innovative mechanisms to be put in place that will encourage reform in an environment of cooperative federalism. The Murray-Darling Agreement is a prime example of institutional rules designed to manage conflict. The myriad constellation of committees and groups of officials works reasonably well despite the complexity of the arrangements. The key is the continuities created by ministers and their deputies sitting on various committees. Trust between individuals has grown up over the years. As well, in these settings, moral suasion works as a mechanism to encourage states to act in a manner consistent with the common good.

Brantas River Basin[13]

The Brantas river basin was selected for case study as an example of a single organization (Jasa Tirta I Public Corporation) managing multiple-uses of water in a large river basin in a developing country. Jasa Tirta Public Corporation was established in 1990 managing the Brantas basin fulfilling people's needs, The corporation also carries conservation, development, and utilization of the river and water sources, including giving information, recommendation, education, and guidance. In 1999 the name of Perum Jasa Tirta was changed into Perum Jasa Tirta I.

The guiding principle of the organization is "one river, one plan, and one integrated management." One river (basin) is a hydrological unit that covers several administrative areas managed as one unit. There should be one integrated, comprehensive, sustainable, and environmentally based concept of a development and management plan. One management system should guarantee an integration of policies, strategies, and program as well as implementation of the system for all of its reaches. The scope of river basin management covers watershed management, water quantity management, water quality management, flood control management, river environment management, water resources infrastructure management, and research and development.

The management system adopted by the organization is based on the application of corporate principles. The organization engages in consultancy services as part of its resource mobilization strategy. A large share of its revenue is derived from government grants. Fees collected from water uses are an important source of finance. However, on the basis of political decision the agricultural sector - the largest user of water- is exempted from water fees. Public, private, and community participation are considered as important aspects in effective water resources management. Stakeholders are involved at each decision-making level through coordination forums. Roles of the key stakeholders are defined as follows:

[13] This section is a summary of the report of Sunaryo (2001).

- Government as the owner of the water resources and its infrastructure, plays the role of controlling and regulating at the national and regional level and exercising its public authority;

- The River Basin Management Agency has a concession to manage water resources and its infrastructure, including receiving contributions and rendering water resources services; while

- Society acts as users that have the right to receive services and participate in decision-making, but are expected to use water efficiently and take part in sustaining the environment.

Key Generic Lessons

- The study has shown that there are clear stages to river basin development. The development responds to the changing pattern of demand for water over time linked to population growth and economic development.

- There is no single organizational model of water policy and water resources management that applied universally. A country's ability to adopt new policies and institutions is highly contextual and is dependent upon the overall state of the economy, political system, legal system, cultural background and its physical resource base would circumscribe the policies and actions in the water sector. These parameters would also contribute towards determining the style and content of water resources management in any river basin (Bandaragoda, 2005)

- There is a clear need to focus on improved data collection and transformation of these data into useful management information. This information needs to be broadly shared with stakeholders.

- There is an urgent need for clearly defined water rights. Without clear understandings about water rights and effective enforcement, the poor and disadvantaged groups are vulnerable to losing access to water

- Administration of a water surplus basin does require positive management – to ensure drainage and flood control structures are operated and maintained correctly. Also even in water surplus basins, during times of drought there needs to be a well documented and effective system available to manage adjustments of water allocation to ensure basin scale impacts are minimized.

- Water quality issues can be dealt with effectively when the sectors involved are able to monitor and evaluate compliance of the other sectors.

- Water management agencies focused on agricultural water management, such as the LIDs in the Omono Gawa basin, have a major role to play in the management of

water resources. With appropriate delegated authority and support these agencies can be highly effective.

- The need to build up on traditional institutional arrangements which are time tested and adapted to local conditions and needs.

- There is a clear need design effective mechanisms for stakeholder consultations and enlist their cooperation in implementing programs for developing and managing water resources. Well-designed stakeholder driven institutions are more likely to have positive outcomes.

- The lessons from the case study of advanced river basin management (Japan and Australia) suggests that formal "river basin organizations" or creation of large public bureaucracies are not essential for managing water-scarce river basins. Other arrangements, including various kinds of committees and networks, can often work just as effectively. But there needs to be a clear legal framework, including clarity on water rights, and a regulatory framework to make such arrangements work.

- The "success stories" Murray-Darling, Omonogawa, and Brantas, suggest that institutional development for river basin management is a slow process taking decades and cannot be done overnight.

Table 1. Salient socio-economic features in the selected river basins

Characteristics	Fuyang (China)	Indragiri-Ombilin (Indonesia)	Upper – Pampanga (Philippines)	East-Rapti (Nepal)	Deduru Oya (Sri Lanka)
Total population(million)	15.6	0.7	1.5	0.6	1.0
Population density (pers/sq. km)	686	396	450	212	378
No. of Urban centers	4	4	3	3	22
No. of villages	9092	400	325	na	2807
Urban population (%)	28		36	25	10
Rural population (%)	72		64	75	90
Per capita availability of water (m^3)	868	NA	3630	9034	1046
Urban household having piped water (%)	97	NA	27	36	21
Rural households having piped water (%)	77	NA	NA	NA	09
% employed in agriculture	67	59	61	79	40
Proportion of population living below national poverty line(%)	6	NA	39	42	60

Table 2. The Agricultural Sector in Five River Basins

Characteristics	Fuyang (China)	Ombilin (Indonesia)	East Rapti (Nepal)	Upper Pampanga (Philippines)	Deduru Oya (Sri Lanka)
No. of surface irrigation schemes	3	184 (river lift)	214	37	3,600
No. of groundwater irrigation schemes	185,527	14	2,445	9	2,453
Surface irrigated area (ha)	150,000	32,180	32,388	98,222	47,150
Groundwater irrigated area (ha)	875,000	-	7,743	25,135	1,515
Main irrigated crops	Wheat, corn, cotton, rape-seed	Rice, mungbean, groundnut	rice, maize, wheat	Rice, vegetables, corn, onion.	rice, chili vegetables.
Annual cropping intensity (%)	155	Na	Na	156 – surface 200 – ground water	133-165% - surface 180-300 – groundwater
Comparison of current crop yields with yield 10 years ago	Decline in yield of all major crops	no change in yield of major crops	no change in yield of major crops	Drop in rice yield by 14-21%	Current yields of major crops are higher
Reasons for yield change	Water scarcity, institutional constraints	Not relevant	not relevant	Climatic changes, pest outbreak	Improved agronomy, better prices
Responsibility for O&M – groundwater systems	Individual farmer		WUAs		Smaller systems – WUAs; larger systems WUAs & Irrigation Agency
Responsibility for O&M-surface irrigation system	Local govt. authority	River lift systems (water wheels) – individual owners	WUAs & Irrigation agency	Irrigation Associations (WUAs) & Irrigation agency	Individual owners
Multiple use of irrigation water	Yes	Yes	Yes	Yes	Yes

Table 3: Key water-management issues

Issues	Basins				
	Fuyang	Deduru Oya	East Rapti	Singkarak-ombilin	Upper Pampanga
Water Scarcity	Acute (quantity-wise)	During dry season scarcity in the middle reach (spatially and temporally)	Scarcity during the dry season (spatial)	Scarcity in terms of depth of flow	Scarcity during dry season and flooding during wet season
Inter-sectoral competition	Very high, agriculture worst affected	Competition between drinking water and agriculture	Competition between environment and irrigation	Competition between hydropower and irrigation (trans-basin diversion)	Competition between industry, drinking and agriculture (especially groundwater)
Environmental issues	Groundwater decline in quantity and quality; degradation of the quality of surface water	Seawater intrusion; sand-mining; waste from hospital and rice mills; siltation of tanks	Ecological health of flora and fauna affected; watershed degradation; O&M	High surface water treatment cost; watershed degradation;	Rubber factory; duck and fish rearing and small-scale industrial pollution
Water resources development/ conservation/ allocation	Water conservation and increasing productivity are increasingly adopted	Potential for water resources development exists; performance of irrigation system low	Potential for conjunctive use of groundwater at low cost exists; very low use of surface water and groundwater	Allocation of basin water and participation of stakeholders important	Efforts are expended to conserve surface water and rainwater; better irrigation management
River flow and reservoir status	Flow over the years decreased rapidly; reservoir levels are decreasing	River management is poor; siltation of tanks has reduced the capacity	No storage structure along the river; run-of river scheme; quite large variation in river flow	Trans-basin diversion; lake level decreasing; depth of flow in the river is low	Flooding and drought occur alternately; huge uncommitted outflow
Groundwater status	Large-scale extraction of groundwater; water table declining fast; groundwater contamination	Very limited groundwater; quality of groundwater bad at middle and tail reaches	Very limited groundwater is used; good quality groundwater available	Not much groundwater is in use	Groundwater is on the increase; competition for groundwater exists

Source: Bandaragoda 2005

Figure 1 Basin Development Stages

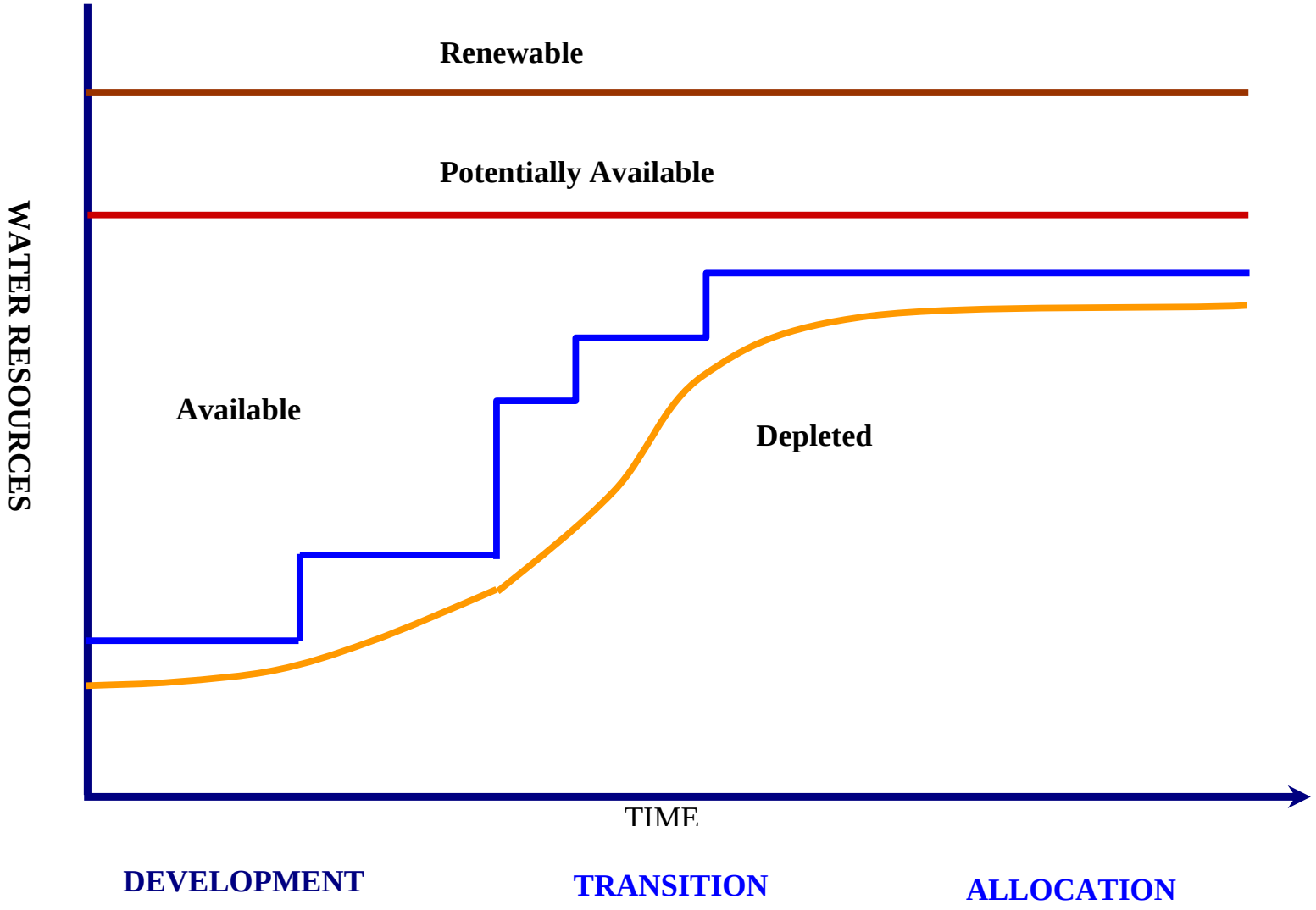
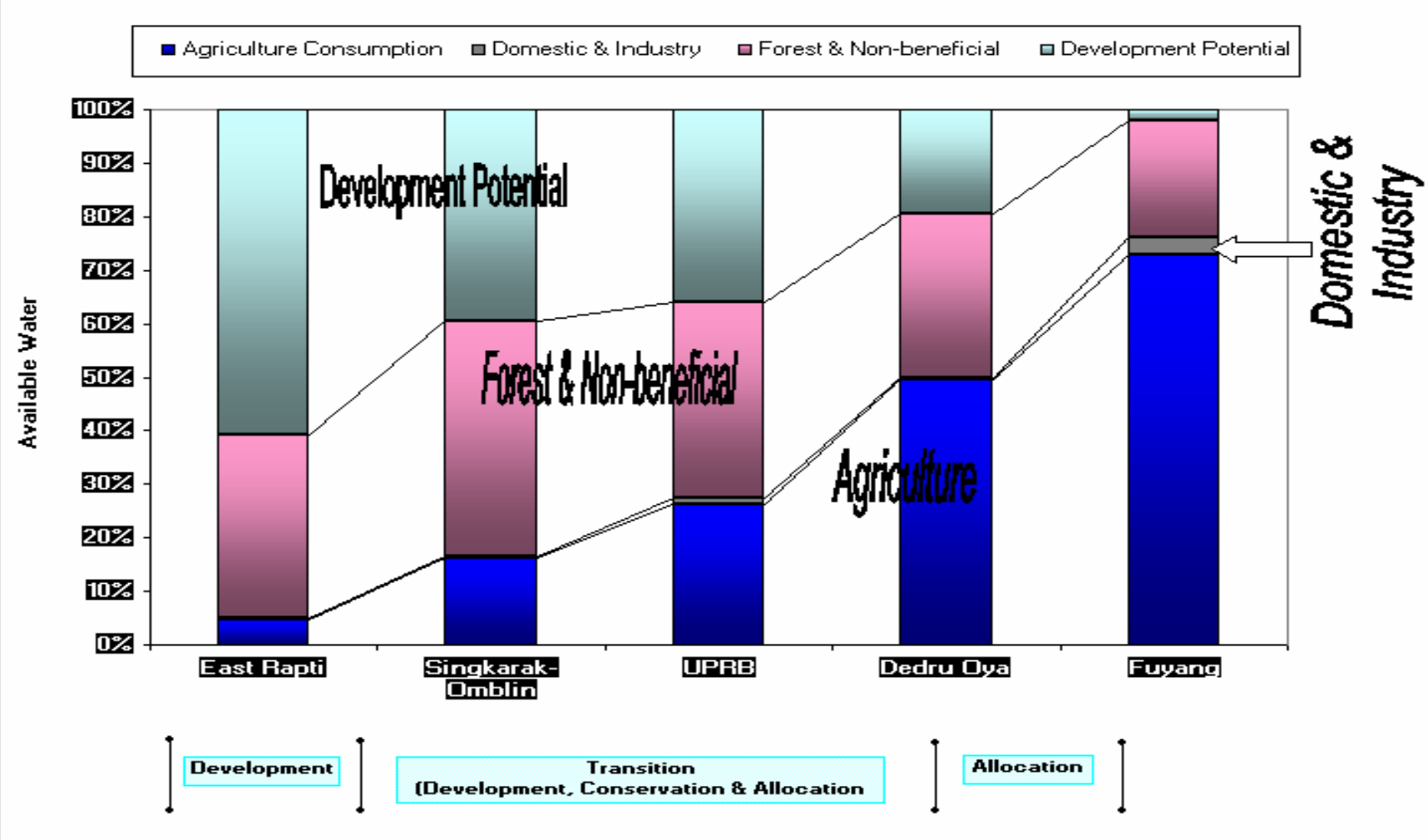


Figure 2 Development Stages of the Five Basins and Sectoral Water Use



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