

Water Resources and Irrigation Policy Issues in Asia

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Freshwater is a finite resource that is being continuously exploited to meet the requirements of an increasing population. The estimated average available water per capita worldwide decreased from about 40,000 cubic meter (m³) in 1800 to 17,000 m³ in 1950, 12,900 m³ in 1970 and 7,000 m³ in 1997. Although the present availability is still relatively high, it is rapidly decreasing – projected to be only 4,700 m³ by 2025. Moreover, there are large spatial and temporal variations in water availability. In some parts of Asia, water availability is less than the threshold level of 2,000 m³, below which an area is considered water-stressed.

Agriculture is the largest consumer of water. It accounts for about 84% of the total water use in Asia, 72% worldwide, and 87% in developing countries. The average irrigation water use efficiency is less than 40%. In predominantly rice-based cropping systems, water use efficiency is much less.

About 40% of the world's food production comes from irrigated land, which accounts for only 16% of the world's croplands. Asia, which has the highest population, also has the largest percentage of irrigated croplands. Expanding or even just sustaining the irrigation base is a key to food security and poverty alleviation in many developing countries of the region.

Although still relatively small in most Asian countries, the demand for water for industrial, municipal and environmental protection purposes continues to increase at a rate twice that of population growth. The proportion of water available for agriculture is projected to decline to 62% worldwide and 73% in developing countries

by 2020 (Barker and Associates 2000). Hence, the opportunities for expanding the irrigation base are limited. If food security is to be maintained, ways of increasing water productivity must be found.

Moreover, water is a very fragile resource. Its quality or state is easily modified by human activity to such an extent that it becomes less suitable for purposes it serves in its natural state. Many human activities, such as land use changes, influence the hydrologic cycle and can pollute available water.

In most of Asia, accelerated soil erosion is presently the most serious pollution problem. The sediment loads of major rivers are in excess of 50 tons per hectare (t/ha) per year, a rate more than five times the threshold level for the protection of terrestrial and aquatic ecosystems. Over 50% of the coral reefs of the Philippines, for example, have been seriously damaged by siltation.

WATER SUPPLY AND DEMAND CONSIDERATIONS

By and large, most countries in Asia (except for Singapore, Maldives and South Korea) are still not considered water-stressed. However, even in countries with high level of per capita water availability, large segments of the population are beset with water scarcity as a result of the large variations in the spatial and temporal distributions of rainfall and stream flow.

1. Water Supply Availability

Table 1 presents the average annual precipitation and internal renewable water resources (IRWR) of the five sub-regions of Asia according to the Information Systems on Water and Agriculture of

Table 1. Distribution of internal renewable water resources (IRWR)^a among Asian sub-regions

Sub-region ^b	Annual precipitation		Internal renewable water resources	
	m m	km ³	km ³	m ³ /inhabitant (1996)
Indian subcontinent	1,279	4,875	1,709	1,544
Eastern Asia	597	6,709	2,914	2,307
Far East	1,634	780	495	2,900
Southeast	1,877	3,640	1,768	9,062
Islands	2,823	8,444	4,707	15,953
Asia	1,194	24,448	11,592	3,825
World	-	110,000	41,022	6,984
Asia as % of world		22	28	

^a IRWR is the part of water resources generated from endogenous precipitation. It is computed by summing summer water flow and groundwater recharge and subtracting their common part.

^b Indian subcontinent includes India, Bangladesh, Bhutan, Nepal, Sri Lanka, and Maldives. Eastern Asia includes China, Mongolia, and North Korea. Far East includes Japan and South Korea. Southeast includes Thailand, Vietnam, Myanmar, Cambodia, and Laos. Islands include countries of the India and North Pacific Ocean from Malaysia, Indonesia, Papua New Guinea, and the Philippines.

the United Nations Food and Agriculture Organization (FAO) (FAO 2003). At first glance, it appears that the region is well endowed with water resources. While accounting for only about 16% of the world's land surface, it receives 22% of total precipitation and produces 28% of the world's renewable water resources. However, the region is home to 53% of the world's population and its IRWR is only about half of the world's average.

The available supply in the Islands is relatively high – 21,000 m³, 12,000 m³ and 3,000 m³ for Malaysia, Indonesia, and the Philippines, respectively. Singapore, which has a supply of only 170 m³, has to rely on Malaysia and Indonesia for additional water supplies. The Indian subcontinent, Eastern Asia, and the Far East are relatively arid, having much less water resources per person than the rest of Asia and the world. As early as 1996, South Korea's per capita water supply of about 1,500 m³ per year has already been below the threshold level of 2,000 m³. India and China are near this threshold. At an availability level of 114 m³ per inhabitant per year, the Maldives experiences chronic water scarcity. As increasing demands continue to outpace the development of new sources, more and more areas will become water-stressed.

2. Water Demand

Table 2 shows estimates of water withdrawal for agricultural, domestic, and industrial uses by the Asian sub-regions (FAO 2003). There are no available data for other uses.

On a macro level, it appears that the present demand for water in most Asian countries is still well within the available water supplies. The total water consumption in the Philippines in 1995, for example, was only about 13% of the total available supply. However, this is projected to increase to 44% by 2025. This rapid increase in demand has also been observed in Thailand where the total water use increased from about 17% of the total supply in 1990 to 22% in 2000. In the coastal areas of China, over 70% of the total surface and groundwater resources are already being utilized. Even water-rich Malaysia is experiencing occasional water shortages, thus forcing Singapore (which relies on Malaysia for additional supply) to seek additional water agreements with Indonesia.

At 92%, 90%, and 88%, respectively, the Indian subcontinent, the Islands, and the Southeast region have the highest percentage of water withdrawal due to agriculture. However, there are wide variations among individual countries in the share of agriculture over total water withdrawal:

Table 2. Regional distribution of water withdrawal

Sub-region	Annual water withdrawal by sector									
	Agricultural		Domestic		Industrial		Total withdrawal			
	km ³	% of total	km ³	% of total	km ³	% of total	km ³	% of total	m ³ /inhab	% of IRWR
Indian subcontinent	510.7	92	27.2	5	15.5	3	553.4	38	500	32
Eastern Asia	418.3	77	26.8	5	95.0	18	540.1	37	428	19
Far East	73.5	64	23.2	20	18.4	16	115.1	8	674	23
Southeast	82.1	88	3.9	4	7.0	8	93.0	6	476	5
Islands	127.9	90	10.4	7	4.3	3	142.6	10	483	3
Asia	1,212.5	84	91.5	6	140.2	10	1,444.2	100	476	12
World	2,310.5	71	290.6	9	652.2	20	3,253.3	100	564	8
Asia as % of world	52.5		31.5		21.5		44.4			

SOURCE: FAO's Information System of Water and Agriculture (FAO 2003).

Myanmar (90%), Vietnam (78%), Thailand (90%), Philippines (60%), Indonesia (76%), North Korea (73%), Malaysia (47%), South Korea (43%), and Cambodia (94%).

Irrigation accounts for the bulk of water use in agriculture. In the Philippines, for example, 72% and 27% of the total water use in agriculture are for irrigation and fishery, respectively.

In Asia where approximately half of the irrigated area is devoted to flooded rice production, the average water withdrawal per hectare of irrigated land is about 8,900 m³ per ha per year (0.89 m/year). China and India, which account for about 72% of the region's agricultural withdrawal, average 7,500 m³ and 9,200 m³ per ha, respectively. Other countries (e.g., Philippines, Malaysia, Japan, South Korea, Nepal and Sri Lanka) show much higher withdrawal rates ranging from 15,000 m³ to 31,500 m³ per hectare per year.

Table 2 also shows the total water withdrawal as percentage of the IRWR. A value of 25% or more (e.g., Indian subcontinent) indicates high pressure on water resources. A better indicator of the pressure on water resources is total renewable water resources (TRWR), which takes into account incoming or out-going flows (or water sharing agreements) across national boundaries. The countries with relatively high percentages of total withdrawal to TRWR include India (34%), South Korea (26%), Japan (21%), Sri Lanka (20%), China (19%) and North Korea (18%).

Irrigation places a heavy demand on water largely because of the very low water use efficiency

of the predominantly irrigated flooded rice of tropical Asia. This large wastage results in undesirable hydrologic side effects such as water logging and salinity problems (e.g., Indus Valley of Pakistan and Red River Delta of Vietnam).

Today, other irrigation-related problems are becoming serious in the crop growing areas of China, Pakistan, Philippines, Thailand and Vietnam. Water tables or piezometric water levels are declining due to excessive pumping for irrigation (e.g., eastern, northern and central parts of Luzon and Visayas in the Philippines, and in Thailand and Pakistan). The dry season flows of major rivers (e.g., Yellow river in China, Indus river in Pakistan and Ganges river in India and Bangladesh) are decreasing due to massive water diversion for irrigation. Certain forms of irrigation (flood recession or inundation schemes) are adversely affecting wetlands and marshes, decimating the fish population.

In the agrarian countries of the region, the combined municipal and industrial use is estimated to be 50 to 100 liters per capita per day (lcpd). With urbanization and industrialization, this could increase dramatically. For example, the present use in big cities is now from 200 to 600 lcpd. In some of the more developed sub-regions, (e.g., Far East and Eastern Asia), the combined municipal and industrial use ranges from 23% to 36% of the total water use.

Increasing demand for urban and industrial use is forcing water authorities to over-pump critical aquifers. Many cities in Indonesia, China, Thailand

and the Philippines are now experiencing saltwater intrusion into their freshwater aquifers and land subsidence. As competition for water intensifies, urban and industrial demands take precedence over agricultural or rural uses, hence dispossessing farmers of their traditional sources of irrigation water. As a result of the El Niño episode of 1997, for example, the water traditionally used for irrigating large tracts of rice lands in Bulacan Province in the Philippines was diverted to meet the growing needs of the Metro Manila area, thus raising the issue of water rights and social equity in the allocation of basic resources.

3. Water Quality Considerations

It has been estimated that more than a billion people today do not have access to safe water for drinking. In Cambodia and Laos, for example, only about 25% of the rural population have access to safe drinking water. For many areas of Vietnam and Thailand, the percentage is still less than 50%.

To a large extent, the lack of access to safe drinking water is due to contamination of water sources by point and non-point pollutants that include sediments, wastewater from agriculture, industry and domestic uses, and solid wastes from industrial, urban and rural areas. Many of the developing countries of Asia lack financial resources to provide for adequate sanitation facilities, and the political will to implement laws or regulations governing illegal squatting in protected forest areas and in big cities. Many local government units are unwilling and unable to properly dispose of their garbage. It is estimated that because of pollution, less than half of the potential fresh water resource is suitable to meet human needs at present.

ISSUES IN WATER SUPPLY, QUALITY, AND DEMAND

There is a host of interrelated issues that must be addressed in the short and medium terms if a water crisis in the region is to be averted. Among others, these include: changing demand patterns; impact of climate change and watershed modifications on the water supply; low water productivity in agriculture; inadequate investments in water supply systems; moves toward decentralized and privatized water service and market mechanisms; the need to reduce non-revenue water; a sustained and expanded irrigation base; recycling of wastewater

for agriculture; access to water of the rural and urban poor; groundwater mining; international collaboration for managing shared water resources; protection of freshwater ecosystem, and the unfavorable environment for a comprehensive water resources policy and program framework.

1. Shifting Demand/Allocation Among Competing Uses

The shifting demand for water and the increasing conflicts among competing users are the result of population growth, urbanization, industrial-ization, and economic development. A vision for a desirable water world and a framework for action are imperative to meet the pressing needs for social and economic welfare and the development of the region.

A good example of a vision, including a strategy and framework for action, for a desirable water world is that prepared for Southeast Asia by the Southeast Asia Technical Advisory Committee (SEATAC) of the Global Water Partnership (World Water Council 2000). The countries involved are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

The vision of SEATAC is to ensure access of all inhabitants of Southeast Asia to safe, adequate and affordable water; provide sufficient water to ensure food security, and to spur and sustain the economies of the region; protect the water environment to preserve flow regimes, biodiversity and cultural heritage; and eliminate water-related health hazards.

The framework or strategy for action includes managing water resources efficiently and effectively; moving towards integrated river basin management; translating awareness to political will and capacities; and moving towards adequate and affordable water services. Managing water resources efficiently and effectively might entail a comprehensive review of policy and legislation so as to remove policy distortions and foster a policy environment in support of the vision; integrating and coordinating fragmented activities and responsibilities for water resources management; the treatment of water as an economic good; the development and adoption of appropriate technologies; and the enhancement of institutional capacity.

The irrigation base should be protected by employing water conservation technologies, such as farm level water management, soil moisture conservation measures, and cropping management techniques. Intra-country and regional cooperation in shared river basins should be strengthened for a more equitable and efficient management of water supply.

From the viewpoint of water resources, a river basin is an ideal planning and management unit. The concept of river basin management should be revisited when looking for solutions to water-related problems. The river basin is also the ideal unit to promote equitable sharing among conflicting water users.

At present, the more pressing water problem of the region is the efficient and timely delivery of water rather than limited supply. Unfavorable policies, such as high government subsidies, lack of infrastructure, and inadequate institutional capacity to deliver have impacted negatively on the water sector in some countries in the region. As a result, many existing water distribution systems for domestic use and irrigation are inefficient and fast deteriorating.

Political will goes a long way towards implementing reforms aimed at improving water delivery services and equitable water allocation. There is a need to instill awareness of the economic, social, and environmental values of water among different stakeholders.

Good governance requires an institution where committed leadership and empowered constituency exist. Government, the private sector, and the community should work together so that all water-related concerns and interests are addressed. Effective and efficient water resources management requires the development and strengthening of decentralized water-related institutions, supported by well-informed stakeholders.

2. Low Water Use Efficiency and Water Productivity in Agriculture

The bulk of available information in tropical Asia would indicate irrigation water use efficiencies in the order of 30% to 40% as against design assumption of 50% to 65% overall efficiency. The end result is low cropping intensity (less than 130% for Philippines, Pakistan and Cambodia) and very

low unit area productivity. In the Philippines, the low unit area productivity is partly due to the bias towards national irrigation systems (NIS) and communal irrigation systems (CIS), which are very difficult to manage, and have long water conveyance and distribution canals. The actual benefits from such irrigation systems are, on the average, less than half of those projected during design stage. David and delos Reyes (2003) estimated that only about a third of the potential gravity irrigation development is actually being realized (Figure 1).

There is now an increasing clamor to rationalize the use of public funds for large, gravity irrigation systems. As a result, there has been a search for more cost-effective and efficient irrigation technologies. The trend in much of Asia is now towards small-scale, privatized, farmer-controlled irrigation systems such as shallow tubewells, low-lift pumps and pressurized (drip, overhead, etc.) irrigation systems. Such systems are more efficient (50-90% water use efficiency), cost-effective, and allow farmers greater flexibility in their choice of crop-mix or farming systems. Much of the growth in irrigated areas since 1980 has come from tubewells.

From the viewpoint of equity in access to irrigation water and food security, there is still a need to maintain and build large gravity irrigation systems. To rehabilitate or develop such systems, greater emphasis should now be given to irrigation software (e.g., improved on-farm water management) and hardware (lined canals and more water control facilities) that minimize water losses.

It is imperative that agriculture should not only use irrigation water more efficiently but also reclaim, re-use or recycle wastewater for irrigation if the irrigation base for grain production is to be expanded on a sustainable basis. These issues on the efficient use and re-use of water, and a host of related issues must be addressed in the short and medium terms to avert an irrigation crisis in the region.

3. Inadequate Investments in Water Supply Systems to Meet Future Demands

The cost of developing water supply systems has steadily increased during the past two decades. The cost of gravity irrigation development, for example, nearly doubled during this period. In the

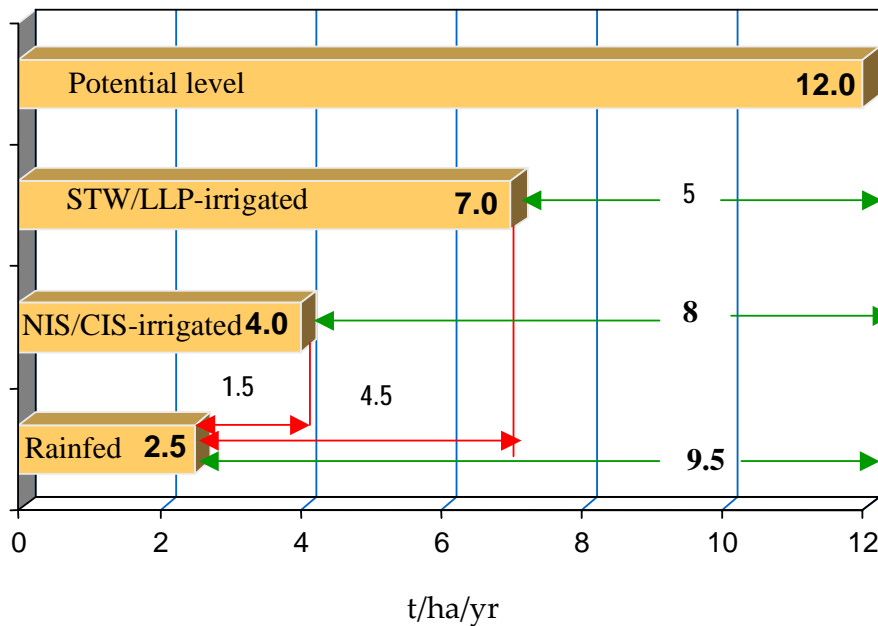


Fig. 1. Unit Area Productivity for Areas Served by Different Irrigation Systems

Philippines, the average investment cost per hectare (ha) for gravity irrigation is now more than US\$4,000 per ha. The developing countries of the region are investing less for the development of water supply systems.

From 1951 to 1980, the annual growth rate in irrigated areas in Asia averaged 2.1%. From 1980 to 1995, this slowed down to 1.3%. Table 3 shows the growth in irrigated areas of selected Asian countries.

4. Recycling Wastewater for Agriculture

Wastewater is normally filtered, disinfected, and mixed with freshwater, if necessary (to dilute the concentration of salts) to make it suitable for agricultural use. There are well-documented success stories in using wastewater for irrigation. The vitality of the crop agriculture sector of California is, in fact, mainly due to the sustainable use of wastewater for irrigation. However, most of the available technologies for wastewater treatment may still be prohibitive to the poor countries of the region. Nevertheless, with adaptive research and modifications, appropriate technologies are bound to evolve.

Countries in the region are now beginning to capture tail water runoff from irrigation to expand irrigation service areas. Irrigated rice-fish-livestock

farming systems based on multiple water use or re-use principles are beginning to materialize. Elevated poultry houses are built over fishponds; the poultry droppings fertilize the pond water. The pond water is regularly replaced with the wastewater being used for rice irrigation. On a somewhat smaller scale, the solid parts of wastewater from municipal landfills and feedlots are removed and sold as organic fertilizers or garden soils while the treated wastewater is used to produce high-value crops. Some countries (e.g., Pakistan) have embarked on long-term land drainage and reclamation projects designed partly to reclaim or re-use wastewater from irrigation.

5. Access to Water of the Rural and Urban Poor

Many societies consider access to water as a basic human right. Thus, most countries in the region have adopted a policy of enhancing the provision of water supply and sanitation at local levels. Some countries have established independent water districts with enabling acts and guidelines for community participation in the planning and implementation of community-based water resources development projects. Access to water by the poor, however, should not be at the expense of efficient and sustainable water service.

Table 3. Growth in irrigated area in Asian countries, 1980-1995

Country	Increase in total irrigated 1980-1995 ('000 ha)	Average annual growth (%)	Share of growth in Asia	Total irrigated area, 1980 ('000 ha)
India	11,622	1.8	0.48	38,478
China	4,390	0.6	0.18	45,467
Pakistan	2,520	1.1	0.10	14,680
Thailand	1,989	3.4	0.08	3,015
Bangladesh	1,631	4.9	0.07	1,569
Myanmar	556	3.0	0.02	999
Vietnam	458	1.7	0.02	1,542
Nepal	365	3.6	0.01	520
Philippines	361	1.7	0.01	1,219
North Korea	340	1.8	0.01	1,120
Indonesia	279	0.4	0.01	4,301
Cambodia	73	3.7	0.00	100
Laos	62	2.9	0.00	115
South Korea	28	0.1	0.00	1,307
Sri Lanka	25	0.3	0.00	525
Malaysia	20	0.4	0.00	320
Bhutan	13	2.7	0.00	26
Japan	-355	-0.8	-0.01	3,055
Asia	24,377	1.3	1.00	118,358

6. Towards Decentralization and Market Mechanisms

There is a need to rationalize the current arrangements for development financing in the water resources sector. This should aim to make resource allocation more demand-led and ensure that local government units (LGUs) and water districts wishing to improve and extend the supply and distribution of water and/or provide sanitation services within their areas of jurisdiction have access to adequate finance. The provision of long- and short-term finance for capital investment should match the demand for services within the context of decentralization of powers to the LGUs and the adoption of market-based instruments.

7. The Need to Reduce Non-Revenue Water (NRW)

There are high levels of non-revenue water in most developing countries. In the Philippines, for example, a great number of piped water systems of the Metropolitan Waterworks and Sewerage

System (MWSS) is suffering from more than 55% level of NRW. Moreover, only about 50% of the operation and maintenance costs of government-run irrigation facilities are recovered through irrigation service fees. The subsidy on the operation of government-financed irrigation systems discourages the efficient use of water. Hence, one effective policy measure in enhancing sustainable use of water is to reduce NRW.

8. Privatizing the Provision and Pricing of Water Service

In general, the government is a poor business manager. Studies in the Philippines and Pakistan reveal that one of the serious causes of inefficiency in water resources management is the direct involvement in the operation, financing, and ownership of the water supply of the public sector.

A better option is to encourage private sector participation to tap its potentials for commercial viability, operational efficiency, increased competition, and improved cost recovery.

9. Ensuring Institutional Capacity to Deliver

Capacity-building is an indispensable element in improving water services and in the sustainable development of water resources. There are four generally recognized basic elements of capacity-building: 1) fostering a favorable environment with appropriate policy, legal and macroeconomic framework; 2) institutional development including community participation; 3) human resources development and; 4) strengthening of management systems.

The problems associated with water supply and demand-population relationships are highly localized in nature. Hence, community participation is crucial to understanding local conditions. It is also vital to strengthening institutional arrangements and creating among local communities a sense of identification with or ownership of water resources development projects.

Many local waterworks and sewerage authorities, and LGUs in many areas of the region are capable of designing and constructing domestic water supply systems. However, they are not as adept at designing and maintaining sewerage facilities and in protecting water sources (e.g., watersheds and aquifers). Hence, there is a need for continuing human resources development. There is also a need to improve the management of water supply systems to minimize losses and pilferage.

10. Comprehensive Framework and Coherent National Strategy for Water Supply and Sanitation

Many countries lack a comprehensive water resources policy framework and a coherent strategy for water supply and sanitation. This partly stems from the fragmentation of water resources development activities and the lack of baseline information on water resources supply and demand. In Cambodia, for example, the mandate for irrigation development is claimed by three Ministries (Agriculture and Forestry, Water Resources, and Rural Development). In the Philippines, irrigation development is entrusted to the National Irrigation Administration (NIA), Bureau of Soils and Water Management (BSWM) and LGUs. This is because both countries still do not have a comprehensive water resources policy framework to guide the allocation, planning, and

development of water resources development projects.

11. Effect of Changing Climate and Man-Made Modifications on Water Supply

Watersheds are subject to continuing manipulations. Some are for land and water resources development such as irrigation, flood control, and power generation. Others are for purposes not directly related to water resources utilization but with undesirable hydrologic side-effects. The conversion of forest cover into urban areas or grasslands, for example, resulted in shifting hydrographs (increasing flood peaks, decreasing dependable stream flows) and water quality degradation. Land use transformations may also have adverse effects on the recharge and safe yields of shallow aquifers.

The traditional methods of protecting critical watersheds and aquifer recharge areas by reforestation and agro-forestation have to be augmented with mechanical methods in order to conserve as well as enhance vital land and water resources.

With its very large population dependent on agriculture, the Asian region is vulnerable to the negative impact on water resources and extreme hydrologic events of any significant climate change. It is therefore important to study the vulnerability of the different sub-regions or countries to the impact of climate change so that adaptive strategies to minimize such impact could be developed.

12. Inadequate Water Resources Database

There are pressing needs to fully harness shallow aquifer utilization. However, the dearth of hydro-geologic information constrains such moves. For instance, the inadequate database on aquifer lithologic (i.e., depth, thickness and composition), hydraulic (i.e., hydraulic conductivity, transmissibility, storage coefficient and specific yield) and hydrologic properties (i.e., safe yield) is the primary reason for the under-utilization of groundwater resources in many Asian countries (e.g., Philippines, Cambodia and Indonesia). Equally important is the continuing assessment of surface water potentials for irrigation and other uses to properly identify and zone potentially irrigable areas by various modes of irrigation. Further, in-depth characterization of the water balance

parameters (i.e., rainfall, evapo-transpiration and incident solar radiation) of major crop-growing areas is badly needed.

Most countries of the region do not have databases of water resources with the required spatial and temporal resolutions for accurately assessing water resources, projecting future water supply and demand scenarios, identifying alternative development options, and evaluating the impacts of policies, plans and programs related to water resources. For example, information on streamflows and stream-flow quality (e.g., suspended sediment load, biological oxygen demand [BOD] and concentrations of heavy metals) is spotty in most countries of the region. There are also no reliable data on the impact of changing land use or human influence on stream-flow properties. The available information on important aquifer properties is inadequate for planning.

13. Groundwater Mining

Many Asian countries have good aquifers in the form of alluvial deposits. These are being recharged continuously from percolation from rainfall, and seepage from surface water bodies. As a result, groundwater irrigation has been the engine of growth of agriculture during the past three decades in the more arid Indian subcontinent and the Eastern sub-region. India, Nepal, Bangladesh, Pakistan and China use over 300 km³ of groundwater annually, nearly half of the world's annual use (Shah et al. 2003). In India, about 60% of the irrigated area was served by about 19 million wells in 2000. In Bangladesh, more than 80% of the irrigated areas is served by shallow tubewells. On the arid North China plains, groundwater was extracted from some 3.3 million tubewells to irrigate 14 million ha in 1997. In Pakistan, groundwater provides over 40% of the crop water requirement in the province of Punjab, which produces 90% of the country's food.

In Asian sub-regions which have abundant surface water, groundwater is still basically used for domestic and industrial water supply, except in the Philippines where shallow tubewell irrigation has become popular among farmers.

The rapid growth of groundwater irrigation resulted in a boom, propelling rural and regional economic growth, and ensured livelihood and food

security for the poor. It has been estimated that the contribution of groundwater to the Asian economy is about US \$25 billion - 30 billion annually. Over half of the population of South Asia is now directly or indirectly dependent on groundwater irrigation for livelihood. Hence, it is critical to sustain the groundwater boom experienced by these countries.

Groundwater mining or overdraft, which has been observed in countries relying on deepwell irrigation, poses as a threat. The solution to this problem lies in groundwater basin-wide management for long-term sustainable use. There are also observed water-logging and salinity problems in arid areas served by both shallow and deep wells. These must be addressed by regulated groundwater use, and conjunctive surface and groundwater use.

There are misconceptions even among technical people on the potential environmental impact of shallow tubewells (STW). One concern is that too many STWs will result in declining groundwater levels and cause groundwater mining and possibly land subsidence. Groundwater level decline should be differentiated from (1) temporary overdraft or (2) groundwater mining (sustained withdrawal beyond the aquifer's safe yield). Under temporary overdraft conditions, the mean annual groundwater abstractions are within the safe yields or recharge rates of the aquifers. Thus, the groundwater levels return to their normal levels at the end of the wet season. Under conditions of groundwater mining, the groundwater levels continue to subside as groundwater withdrawals are in excess of aquifer recharge rates.

The truth of the matter is that STWs operate by suction lifting and cannot extract water beyond the suction lifting range of about 7.5 m (below the ground surface). Hence, STWs can not possibly mine groundwater. The groundwater extracted by STWs is usually replenished during the wet season. This is more so in the wetter regions of Southeast Asia. Restriction over the number or siting of tubewells, however, may be necessary to keep the water level within the suction lifting range throughout the dry season and thus prevent partial crop failure due to water shortage as a result of temporary groundwater overdraft. The threshold level whereby STWs become inoperable should be defined for all major shallow aquifer systems. This

limit should not be allowed to be reached or exceeded, as the only alternative to sustaining groundwater irrigation is to shift to deep tubewells.

Deep wells can extract water beyond the suction lifting range and their unrestricted development may lead to groundwater mining and other adverse environmental side effects. Siting deep tubewells for irrigation in STW areas should only be allowed if their operation will not adversely affect the operation of STWs.

14. International Collaboration for Managing Shared Water Resources

The region is characterized, on the one hand, by a series of island countries with no shared water resources among them and, on the other hand, by shared river basins. Examples of shared rivers are the Mekong, Indus and Ganges.

The importance of river basin management in the equitable allocation of water has already been mentioned. The merit of international collaboration in pooling resources, expertise and information for managing shared water resources cannot be overemphasized. The lack of clear-cut agreements on the sharing and management of the waters of the Ganges river resulted in the costly and sub-optimal water resources infrastructures in Nepal and Bangladesh.

15. Fostering a Favorable Policy Environment

One of the requisites to ensuring an adequate water supply to meet future needs is the fostering of a favorable policy environment for the efficient use, optimum allocation, conservation and management of water resources. Many countries (e.g., Bangladesh, Philippines and Indonesia) fully subsidize the investment costs and, to a certain extent, the operation and maintenance cost of large gravity irrigation systems while privatizing or removing the subsidies for other irrigation schemes. Naturally, farmers will prefer the inefficient and costly but subsidized gravity systems. This is a case where an inappropriate policy precluded the judicious choice by farmers for more suitable mode of irrigation.

In some countries, the pricing and subsidy policies for agricultural products also preclude the judicious choice of crops by farmers. In Pakistan, for example, subsidy on imported wheat and

protection for sugarcane led to the irrigated cultivation of aromatic rice and sugarcane – two crops that consume more water per unit area per unit crop. This is in spite of the scarcity of irrigation water in the country.

The design of most gravity irrigation in Southeast Asia is tailor-made for rice monoculture, with inadequate attention to drainage. As a result, farmers cannot diversify their farming systems to take advantage of favorable conditions for the cultivation of other crops. Some countries put up tariff and non-tariff barriers to the entry of irrigation technologies (e.g., pump sets). In many countries, the incentives to irrigated crop production are not market-driven. Water lords or powerful interests control the allocation and use of irrigation and municipal water, to the detriment of the small people and fisherfolk. Most of the traditional community fishing grounds of the TonLe Sap, a huge lake in Cambodia, have been leased to big fishermen.

Generally, the existing policy environment does not reward the good water users, nor penalize its misuse. Some countries, however, are beginning to use legislative and budgetary allocation measures together with policy initiatives to support sustainable water resources development. Such measures include improved financing for the water resources sector, enabling act (the Clean Water Act in the case of the Philippines), deregulation, decentralization to LGUs, and privatization of water services.

16. Promoting Economies of Scale

In some developing countries, there are too many small water districts or local water authorities. In the Philippines, there are over 500 water districts (WDs) and 1,500 LGUs all mandated by law to provide water supply and sanitation services in the country. A big portion of these WDs and LGUs suffer from the lack of one or more of the following: water resources, physical facilities, human resources, or financial resources. One possible solution is to create economies of scale by grouping this unwieldy number of WDs and LGUs. Such cooperation or grouping may be able to enhance the technical feasibility, financial viability and operational efficiency of a country's water supply and sanitation systems.

SPECIFIC ISSUES IN IRRIGATION AND RECOMMENDATIONS

1. Poor Performance of Gravity Irrigation Systems and Irrigated Agriculture

Recent information points towards the poor performance of gravity irrigation systems. A review of the World Bank-supported large-scale irrigation projects by Plusquellec (2002) showed that the lower-than-expected performance was related to over-optimistic assumptions regarding efficiency. The impact of poor physical performance in terms of water distribution and concurrent poor construction standards on agricultural productivity, is often overlooked. This finding was confirmed by a formal evaluation of 21 irrigation projects by the Bank's Operations Evaluation Department (OED) up to 1990. For the 21 projects, the estimated average economic rates of return were 17.7% at appraisal, 14.8% at project completion, and only 9.3% at impact evaluation.

Another OED study in 1996 on the impact of investments in six gravity irrigation systems in Thailand, Myanmar and Vietnam showed that the economic rates of return not only fell short of appraisal projections by a substantial margin, but were all below 7%. These findings challenged the

common precepts about water management in the humid tropics – that the major threats to sustainability of irrigation investments arise from mismanagement by official agencies and distributive anarchy due to the opportunistic behavior of farmers. The gap between appraisal expectations and actual results cannot be attributed to decaying infrastructure or distributive wastages. Rather, it is due to falling paddy prices, excessively optimistic estimates of crop areas served, irrigation project design faults, and construction inadequacy.

Available information in the Philippines points to the same conclusion. Table 4 shows the cropping intensities in irrigated areas and yield levels in both irrigated and rainfed areas in 1990 and 1994. The cropping intensities were very low, averaging 129% and 122%, respectively. Further, the yields were also very low, accounting for only about two thirds of their potential levels. In 1998, average cropping intensity was 118% and the yield was relatively higher at 3.7 t/ha.

The results of a study on the actual maximum areas served over design areas of representative samples of national irrigation systems (NIS) and communal irrigation systems (CIS) show that, on the average, the maximum area irrigated is only 75% of the design area (Table 5). This means that

Table 4. Average yields in irrigated and rainfed farms and average irrigation intensities, in irrigated areas, 1990 and 1994

Year	Region	Irrigation intensity (%)	Irrigated area yield (t/ha)	Rainfed area yield (t/ha)
1990	CAR	99	2.75	1.76
	1	92	2.84	2.52
	2	105	3.46	1.86
	3	123	2.95	2.12
	4	134	3.00	2.05
	5	217	2.60	1.59
	6	151	3.16	2.14
	7	203	2.19	1.06
	8	151	2.73	1.51
	9	166	3.54	1.66
	10	133	3.51	2.21
	11	132	3.75	2.57
	12	156	3.61	2.19
1990	Average	129	3.10	1.99
1994	Average	122	3.38	2.11

SOURCE: Department of Agriculture.

Table 5. Summary statistics, 1965-1983 maximum irrigated areas as a percentage of design areas (After Ferguson 1986)

Category	Median	Mean
All systems	75.5	75.1
<i>By size</i>		
Small (less than 1,000 ha)	70.5	79.2
Medium (1,000 to 3,000 ha)	72.1	75.7
Large (greater than 3,000 ha)	76.8	72.8
<i>Vintage</i>		
Pre-NIA (before 1965)	92.6	94.0
Early NIA (1965 to 1972)	71.0	69.5
Recent NIA (1972 to 1983)	52.1	55.5

if irrigation facilities are designed and developed for 100 ha, only about 75 ha, on the average, will actually be irrigated. Larger systems seem to be less efficient than smaller systems. What is striking is the 20% decline in the ratio with vintage. Newer irrigation projects only served 56% of their designed

service areas in contrast with the high 94% served before 1965.

Table 6 shows the economic performance indicators for selected large gravity irrigation projects assisted by the International Bank for Reconstruction and Development (IBRD) and the Asian Development Bank (ADB). Time and cost overruns averaged 63% and 42%, respectively. Note that none of the sample irrigation projects was completed on time. This would imply a tendency to underestimate the duration of project construction and/or inefficiency in project implementation. As these projects have long construction periods, a time overrun of 60% would mean years of delay in project completion and realization of the streams of project benefits.

The reasons for the poor performance of gravity irrigation systems include an inadequate database for planning; inadequate institutional capacity and mechanisms for the development of large irrigation projects; design mistakes; poor quality of construction; inadequate and fragmented irrigated-agriculture support services; and the intractability of many of the interrelated socio-economic, institutional and technical aspects of managing medium and large irrigation systems.

Table 6. Performance indicators of selected World Bank and ADB-supported national irrigation systems projects

Projects	% Time overrun	% Cost overrun	ERR (%)		
			Appraisal	Completion	Evaluation
World Bank					
UPRIIS	43	105	13.0	14.0	8.9 (11.7) ^b
Aurora Peñaranda	88	44	17.0	8.6	2.6 (4.5)
Tarlac ISIP	69	33	15.0	13.0	n.a
MARIIS	56 ^a	-4 ^a	13.0	9.5	n.a
Upper Chico	90	-3	15.0	7.7	n.a
Jalaur	37	-2	20.0	20.0	n.a
ADB					
Cotabato	15	68	14.0	n.a.	n.a
Davao del Norte	30	177	17.2	18.4	n.a
Pulangui	87	25	18.0	11.0	n.a
Agusan del Sur	114	54	19.0	7.0	n.a
Angat-Magat	45	102	24.2	16.6	n.a
Laguna de Bay	63	42	14.2	2.0	n.a

^a Weighted average of three projects. SOURCE: World Bank (1991)

^b Figures in parenthesis estimated based on rice price at completion date

The measures to improve the performances of existing systems include: (1) focusing on smaller systems which are more efficient, easy to manage, amenable to privatization, cheaper to construct, and have shorter gestation periods; (2) streamlining, restructuring, and/or reorienting public institutions or agencies concerned for better performance; (3) integrating and planning the design and operation activities for the much needed interactions among designers, planners, operation and management (O&M) engineers and user-beneficiaries; (4) emphasizing more cost-effective O&M and rehabilitation activities; (5) enhancing regional and provincial capabilities for irrigation development activities; (6) effective monitoring of irrigation systems performance; and (7) implementing a system of greater accountability in the use of public funds for irrigation.

2. Sub-Optimal Use of Water

Irrigation places a heavy demand on water partly because of its sub-optimal use of water. In the predominantly rice-based cropping systems served by large gravity irrigation systems, the real water use efficiency is less than 20%. The water productivity of such irrigation systems is not more than half a kilogram of rice for every cubic meter of water used.

The large wastage in gravity-fed paddy irrigation has many adverse hydrologic and environmental side-effects. These include water logging, pollution from tail water runoff and reduced dry season flows of rivers feeding aquatic ecosystems due to massive water diversion for irrigation.

There is now an increasing clamor to rationalize and optimize the use of irrigation water. As a result, there has been a search for more cost-effective and efficient irrigation technologies. The trend now is towards the more efficient and cost-effective, small-scale irrigation systems. These systems give farmers a greater degree of control over their irrigation water and, hence, are more amenable to crop diversification and privatization.

The strategies for increasing water use efficiency of irrigated agriculture include crop diversification, modernization of existing gravity irrigation facilities, irrigation management transfer or devolving as much irrigation management activities to local government units and water users

groups as possible, developing improved crop varieties, manipulating cropping calendars, and improving on-farm water management and crop cultural practices. Modernization of an irrigation system involves upgrading or improving the system capacity to respond appropriately to service demands. It is not simply rehabilitation because it includes rectifying design shortcomings and it involves institutional, organizational and technological changes at all operational levels of irrigation activities.

3. Cost-Effectiveness and Suitability of Current Irrigation Technologies

Considering the tight financial situation and the demands for more public funds for the construction of other infrastructure and facilities, investments in irrigation system rehabilitation must be cost-effective.

There is a strong bias in favor of certain modes of irrigation in the allocation of funds and other resources for irrigation. To remove such bias, the criteria for allocation should be: (1) cost-effectiveness; (2) affordability (low unit area investment cost); (3) sustainability (full repair, O&M costs recovery); (4) efficiency in water use; (5) simplicity of O&M including on-farm water distribution and management practices for farmer-irrigators; (6) length of gestation period; and (7) potential for increasing unit area productivity.

One important implication of this policy initiative is the need to reassess the present irrigation development priorities (e.g., rehabilitation or modernization of existing gravity systems or the development of other modes of irrigation such as shallow tubewells [STWs], low-lift pumps [LLPs], small farm ponds, small inundation schemes and hand tubewells [HTWs]) in terms of the above criteria. Other implications include: (1) the need to delineate or zone areas according to the most suitable mode of irrigation (e.g., shallow versus deepwell areas); (2) greater participation of farmer-irrigators in the planning, development and O&M of irrigation facilities; and (3) removal of irrigation subsidies.

A quick assessment of the different modes of irrigation using the above criteria was carried under Philippine setting by David and delos Reyes (2003). The results are shown in Table 7. When the available

Table 7. Comparative assessments of the different modes of irrigation in terms of different performance indicators

Indicators	Modes of Irrigation ¹			
	STW	SWIP	CIS	NIS
Quantitative indicators				
Rice yield level	3.9	3.2	3.2	3.2
Cropping intensity	183	125	125	125
Unit area productivity	7.2	4.0	4.0	4.0
Average investment cost	15	180	70	100
Cost effectiveness (ERR, %)	77		13.6	8.1
Average gestation period	1 week	1 year	1.5 years	5 years
Qualitative indicators (a rank of 1 is most desirable)				
Sustainability	1	2,3	2,3	4
Amenability to privatization	1	2,3	2,3	4
Crop diversification	1	2,3	2,3	4
Degree of farmer's control	1	2,3	2,3	4

¹STW – Shallow Tubewell including Low-Lift Pump (LLP); SWIP – Small Water Impounding Project; NIS – National Irrigation System or large gravity irrigation system; CIS – Communal Irrigation System or small to medium-size gravity irrigation system.

SOURCE: David and delos Reyes 2003

data permit, a given criterion was broken down into its basic indicators. Agronomic performance, for example, was broken down into cropping intensity, yield level and unit area productivity. When quantitative information was inadequate, qualitative ranking was resorted to.

In many instances, the technical and economic feasibilities of STWs, LLPs and HTWs demonstrate that there are better alternatives to large gravity irrigation systems. Collectively called minor or small-scale irrigation, these modes of irrigation would meet most of the criteria for priority investments in irrigation development in many Asian countries. The investment per unit area for an STW in the Philippines, for example, is less than one fifth the average cost of constructing large gravity irrigation systems.

Many of the alluvial plains and valleys of the region are criss-crossed by natural waterways which could serve as water sources for LLPs. In some places, there are also opportunities for inundation schemes and small reservoirs for combined irrigation and fishery purposes. The development of these modes of irrigation is also well within the capabilities of small communities. Where

technically feasible, these modes of irrigation could be more economically viable and sustainable alternatives compared to larger scale gravity systems. Also, they have very short gestation periods and higher water use efficiency. They are simple to operate and maintain. They give farmers greater control over their crop production environment, including the choice of crops and cropping systems.

In spite of the advantages of the different minor irrigation technologies, these did not attract many users due to: (1) total neglect of minor irrigation support services by agencies concerned; (2) lack of baseline information on shallow aquifer characteristics, dependable flows of streams and rivers, and hydrology of potential areas for inundation schemes (e.g., swamps, marshes and wet season waterlogged flood plains); (3) lack of benchmark information on suitable well development and well drilling techniques; (4) lack of affordable and suitable drilling rigs; and (5) unavailability of cheap pump sets.

4. Subsidy, Sustainability and Irrigation Service Fees

One overriding issue in irrigation development

today is sustainability. It is directly related to the issues of subsidy, cost-effectiveness, efficiency and cost recovery. To achieve efficiency and sustainability, irrigation subsidies must gradually be removed. This implies that irrigation investments and O&M must be fully recoverable.

The present policy on subsidy is biased towards large gravity irrigation schemes. The national and local governmental units subsidize their construction and part of their O&M costs. Most countries (e.g., Bangladesh and Philippines) give very little subsidy to the development of minor irrigation schemes.

The heavy subsidy on large gravity irrigation systems has been the primary disincentive to the judicious choice of irrigation technologies. Such inequity in subsidy increases farmers' demands for gravity irrigation systems relative to the more cost-effective irrigation technologies and discourages private sector participation in irrigation development. Obviously, such a policy cannot be sustained.

Many countries (e.g., Philippines, Malaysia, Indonesia, and Bangladesh) subsidize the O&M of large irrigation systems to supplement irrigation service fees (ISF). The rationale for this policy is to prevent the deterioration of irrigation facilities and expensive rehabilitation work which is usually the end-result of cumulative O&M neglect.

In the Philippines, the level of O&M subsidy is about the same as the total ISF collection. The actual ISF collection averaged only 50% of the total amount collectible. It is interesting to point out that this was about the same percentage of the service area actually irrigated in the dry season. The level of ISF collection seems to be correlated with the quality of irrigation service or irrigation system performance.

The cropping intensities in many gravity-fed, rice-based irrigation systems are in the order of 95 to 140%. Even during the wet season, a significant percentage of the irrigation service area cannot be served with supplemental irrigation water. Thus the limited money available for irrigation O&M is spread thinly over an unrealistically large irrigation service area. One way of reducing O&M cost or increasing O&M allocation per unit area is to reduce the irrigation service areas down to realistic levels. This will enable irrigation authorities to focus their repair, O&M and rehabilitation on smaller but

manageable service areas.

Irrigation authorities should redouble their efforts toward equitable, adequate and timely delivery of irrigation water and improved delivery of irrigated agriculture support services for higher yield and cropping intensity. Re-delineating the irrigation service areas down to realistic levels will go a long way towards increasing the dependability of water supply and in improving irrigated agriculture support services. Strengthening water users associations (WUAs) by giving them better incentives to take control over the repair, and O&M of secondary and tertiary canals will also help reduce O&M costs and improve ISF collection.

The policies governing ISF rates should be carefully reviewed. In some countries the rates are way below the amount required for adequate O&M. In others, farmers are exempted from the payment of ISF in times of poor harvest. The same farmer-beneficiaries, however, are not charged higher fees during periods of good harvest.

5. Irrigated Agriculture Support Services and Functions

A study in many Asian countries by Anden and Barker (1973) showed a yield gap of 87% between experimental or demonstration farms and farmers' fields (Figure 2). This gap has been attributed to the production constraints shown in the chart.

The experience in many Asian countries also showed that irrigation brings rice yield up to a level of about 3 t/ha. Yields beyond this level pretty much depend on how well the above-mentioned production constraints are circumvented by the farmers. There is a considerable margin for yield improvement in irrigated areas associated with proper management of soil and fertilizer, water, pests, seeds and seedlings.

Studies also revealed significant interactions among these production constraints. The quality of water management, for example, is known to influence the level of farm inputs, such as fertilizer as well as the incidence of weeds and pests. Hence, production constraints should be viewed in terms of their functional relationships. Most of the serious rice production problems in irrigated areas arise from the inability of those concerned to appreciate the cause-and-effect relationship among water management, dynamics of important soil properties, and control of weeds and insect pests. Coordination

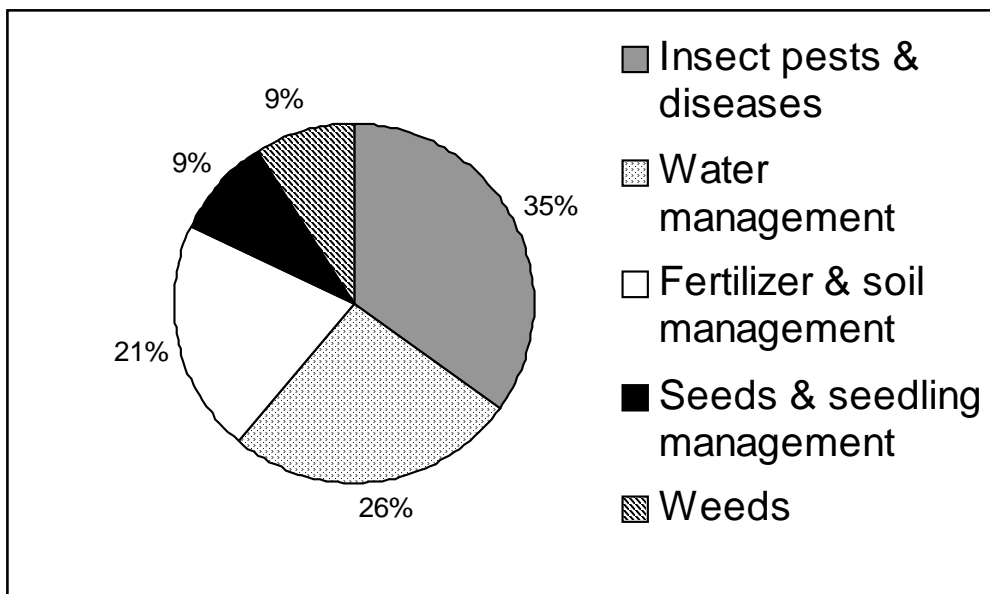


Fig. 2. Percentage contribution to the rice yield gap of the various production constraints

and harmony in policy instruments aimed at optimizing the benefits from irrigation development are lacking.

6. Water Rights and Water Pricing

Many countries have no coherent policy guidelines and regulations on water rights, water pricing and water control. Water rights policies and regulations should be reviewed with the end in view of making these fair, effective, and doable. Such policies and regulations should consider resource capabilities, such as dependable surface water supplies from rivers and safe yields from aquifers as well as demands for water from competing users. There should be provisions for trading or selling water rights for economic efficiency and equity.

Irrigation water prices should be set, at the very least, at full O&M cost recovery with the ISF going to public or private entities managing the irrigation system.

7. Irrigation R&D and Technological Base for Planning, Design, Development, and Operation of Irrigation Systems

Support for irrigation R&D in the region has always been inadequate, despite the fact that the bulk of available information worldwide shows very high rates of return of irrigation and irrigated agriculture research. Thus the problem of alternative choice

of technologies for more efficient and cost-effective irrigation systems has never been adequately addressed. Likewise, the non-structural solutions to water resources development projects, such as proper pricing of water to reflect its full cost, protecting aquatic ecosystems, managing demand, promoting multiple-use concepts, devising cost-saving measures, and developing water-saving technologies, have not been given adequate emphasis.

In addition, the very limited research in irrigation and irrigated agriculture is under-funded, incorrectly focused, fragmented, crop-oriented, and rarely takes into account the socioeconomic constraints faced by farmers. Thus, most of the results are inconclusive and are of little relevance to real irrigated farming situations. The most pressing challenges in irrigation today are to boost irrigation water productivity, manage ground and surface resources for sustainable use, reduce the cost of irrigation development, formulate sound design criteria, and generate technologies for improved construction of irrigation facilities. These imply technological solutions for meeting the increased demand for water.

Considering that the region has a large and rapidly growing population but with very limited lands to exploit and, as such, must depend on continuing expansion of irrigation for sustained

agricultural growth, there is a very strong case for increasing public investments in irrigation and water management research. In fact, with intensified and correctly focused R&D efforts, the wastage of huge financial resources for the development of inefficient irrigation infrastructures could have been avoided.

The very high and still escalating cost of gravity irrigation development and rehabilitation is, in part, due to the lack of research leading to the development of more accurate, efficient and cost-effective gravity irrigation systems. Specifically, research efforts should aim to develop irrigation software (e.g., suitable irrigation methods, on-farm water management packages for diversified crops, and improved irrigation systems operation and maintenance). Along with relevant socio-economic and policy concerns, these productivity-enhancing research agenda deserve higher priorities.

The following weak points of the research system on water resources planning and development, irrigation and irrigated agriculture must be addressed immediately:

- a. weak planning, programming, prioritization, and packaging;
- b. weak management, accountability, and coordination;
- c. inadequate regular funding;
- d. inability of agencies concerned to effectively monitor, evaluate and coordinate the research activities of various agencies and institutions;
- e. highly fragmented efforts; and
- f. weak linkages with extension services.

Intensive and diversified irrigated agriculture will require irrigation, good quality seeds and other inputs, suitable farm mechanization, primary processing (e.g., drying and storage) of farm products, and secondary and tertiary processing of farm products and by-products (e.g. food and feed processing). This vertical integration of activities in crop agriculture (from intensive and diversified irrigated agriculture to suitable farm mechanization to agro-processing and development of related agribusiness) offers the best opportunities for increasing farm incomes, generating employment and livelihood for the rural poor, and bringing women and other underprivileged groups into the

mainstream of agricultural development.

There are no easy and uniform pathways or processes for the effective transfer of irrigation technologies from R&D centers to farmers' fields. The irrigated crop subsector is not homogeneous. Each country has many different agro-ecological zones with varying water supply conditions, crop mixes, and farm groups with different needs and farming constraints. The intervening processes or linkages between research and extension include monitoring of existing as well as newly developed technologies; identification, evaluation, suitability assessment and adaptive modification of promising technologies; and eventual packaging of mature technologies for dissemination. These processes are, in fact, indispensable parts of an effective research and extension system. Only by strengthening these vital linkages can research and extension services be made sensitive to the changing needs of farmers. The testing, suitability assessment, modification and packaging of technologies must be location-specific and specific problem-oriented to conform to the needs of different farming groups and agribusiness concerns.

8. Institutional Arrangements/Mechanisms

Figure 3 shows the essential irrigated agriculture activities, support services and functions. An assessment on the adequacy of existing institutional mechanisms and arrangements would most likely reveal critical gaps and overlaps in many Asian countries.

In countries like Cambodia and Laos, there are crucial shortages on technical manpower at all levels. Yet in Cambodia, there are three separate ministries looking at irrigation development. Far-reaching institutional reforms are urgently needed to (1) fill the void and strengthen essential support services and functions, and (2) reorient existing organizations for stronger linkages and greater synergy in the areas of policy analysis; planning; programming; monitoring; research and development; extension; credit and marketing; and inputs supply.

The lines of responsibilities and accountabilities for these services and functions are not clearly defined in many of the countries of the region at present. The essential support services and functions that urgently need strengthening in many South and Southeast Asian countries include:

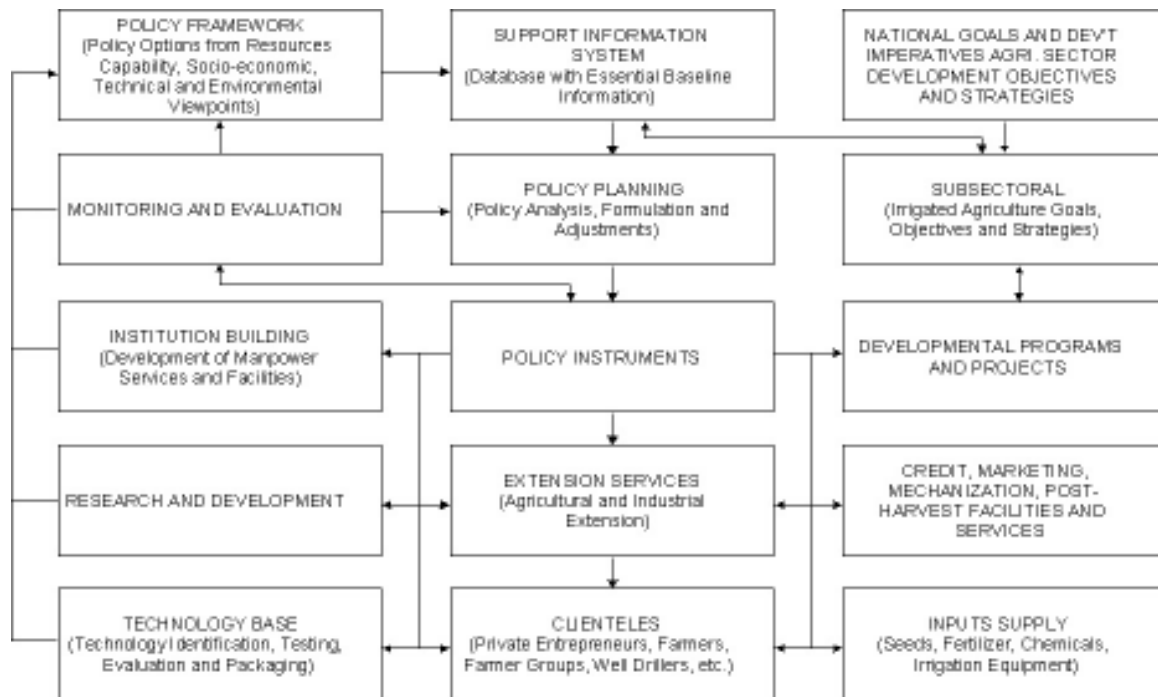


Fig. 3. Essential services and functions for accelerated transformation to irrigated agriculture

- a. policy formulation, planning, programming and monitoring at the upstream level;
- b. research and technology generation, technology identification and packaging, institutional development, packaging of credit and marketing facilities, and resources capability assessment at the midstream level; and
- c. extension and technology demonstration at the downstream level.

The needed institutional changes may include establishing new institutions and/or restructuring, strengthening, downsizing and dismantling existing institutions as well as enhancing the participation of the private sector in irrigation development activities.

9. Public Sector’s Capacity to Develop and Improve Irrigated Agriculture

Efforts to accelerate the pace of irrigation development and improve in the performance of irrigated agriculture suffered periodic setbacks partly because of inadequate monitoring and ineffective policy planning on the part of the public sector. Examples of policies and policy instruments

that had negative impacts on irrigation development include the following:

- a. emphasis on large, multipurpose irrigation systems, leading to neglect of small irrigation systems;
- b. heavy bias towards irrigation hardware at the expense of irrigation software and collection of essential baseline information;
- c. non-tariff barriers to the importation and trade in irrigated agriculture production inputs;
- d. heavy subsidy on gravity irrigation investment, repair, and operation and maintenance;
- e. highly fragmented institutional arrangements for the development of irrigation facilities and delivery of irrigation support services; and
- f. under-investment in the development of irrigated agriculture technologies aimed at increasing irrigated agriculture productivity and enhancing production incentives.

Strengthening the capability for irrigation sub-sector policy planning both in terms of staff number and technical depth is urgently needed in most Southeast and South Asian countries.

Policymakers, planners and technical staff should be supported with improved information and information systems (preferably an irrigation sub-sector monitoring and evaluation system with expanded technically-based analytical support). Effective formulation of appropriate design criteria, design philosophy, and an irrigation policy as well as routine adjustments in policies and policy instruments would require such information.

Irrigation policy options should initially consider broader policy guidelines in the utilization of water resources as embodied in national and sectoral development plans. Next would be the sectoral development objectives and strategies, resources development potentials, ongoing development activities, and constraints to harnessing the full benefits from irrigation development.

In formulating specific policies and policy instruments, various options are weighed in terms of: economic, environmental and social impacts; sustainability of long-term resources use; and practicality of implementation. Hence, wider consultation among stakeholders should be carried out in performing the tasks of packaging irrigation programs, projects and other policy instruments.

Monitoring and evaluation are two important functions that are indispensable to the national management process. Strategic monitoring is useful in formulating policies and policy instruments. This activity rightfully belongs to the public sector. Operational monitoring is for assessing the progress of implementation and impact of projects, programs and other policy instruments. It is useful for mid-course correction and other intervention measures for timely, effective and efficient implementation and coordination of irrigation development activities.

Inappropriate policy and policy instruments prevented the timely introduction of more appropriate irrigation technologies; imposed added costs on irrigation facilities and services; and allocated scarce public resources to activities and technologies were either unnecessary, unsustainable or inefficient. These precluded the increased participation of the private sector in irrigation development despite the fact that such participation would have enhanced commercial viability, operational efficiency, increased competition and cost recovery.

The public sector should devolve to the private sector as much essential irrigation services, functions and activities as possible. As the experiences in many Asian countries (e.g., India, Bangladesh, Korea, Taiwan, and Thailand) have shown, the private sector is more efficient and effective than the public sector in promoting certain irrigation development activities. This devolution will enable the public sector to focus its resources and energy on enhancing the incentives for irrigated agriculture production and promoting more productive investments in agriculture.

10. Role of Farmers and Water Users Organizations

As a matter of policy, governments of the region encourage greater farmers' participation in the planning and implementation of irrigation development activities. Many countries promote ownership and control of minor irrigation facilities. In some countries, the O&M of larger irrigation systems are handled by commercially oriented public utilities that enter into explicit contractual obligations with user associations. This arrangement should be pilot tested in the other countries of the region.

The recent initiative in Asia's irrigation sector is the irrigation management transfer (IMT) program. Its basic premise is that giving direct control of irrigation system management to water users groups and LGUs would enhance the sustainability of irrigation and the productivity of agriculture. However, despite the program's widespread popularity, there is little evidence of its positive impact on agricultural performance. Rather, the main impact has been the gradual decline in government financing of irrigation systems O&M. There is no evidence either of any adverse impact on the O&M of irrigation systems. It seems that with the program, water groups increase their stake or participation in the O&M of irrigation systems.

In the Philippines, the Local Government Code of 1991 and the Agriculture and Fisheries Modernization Act (AFMA) of 1997 devolved to the LGUs and water users groups the implementation of locally-funded communal irrigation systems and the management of secondary and tertiary canals of large irrigation systems. The transfer is moving at a snail's pace

as the irrigation authority prioritized for transfer the problematic and poorly performing irrigation systems.

As a result, many local water groups and LGUs were reluctant to accept the transfer to avoid increased financial burdens. They also lack technical expertise to address the technical problems besetting the poorly performing systems. This experience stresses the urgency and importance of recognizing and addressing jointly the technical and management constraints to improved irrigation performance.

11. Farming Systems Diversification

There are excellent opportunities and potentials for increasing food production and alleviating poverty through farming systems diversification. However, unfavorable policy environment, development strategies and allocation of resources across policy environments and other constraints preclude the development of these potentials. A classic example of an unfavorable policy is the concentration of public funds for irrigation development on gravity irrigation systems designed for rice monocultures.

Other constraints are the inadequate irrigation support services (e.g., very limited irrigation facilities, failure to inject good quality seeds into farming communities on a timely basis, and lack of processing and market facilities) for crops other than rice. It is, therefore, imperative that such constraints be addressed to enable farmers to take advantage of the opportunities for increased food production and poverty alleviation.

SUMMARY

At first glance, it appears that Asia is well endowed with water resources. While accounting for only about 16% of the world's land surface, it receives 22% of its precipitation and produces 28% of its renewable water resources. However, the region is home to 53% of the world's population and its internal renewable water resources (IRWR) is only about half of the world's average.

The available supply in the Islands sub-region is relatively high – 21,000 m³, 12,000 m³, and 3,000 m³ per person per year for Malaysia, Indonesia and the Philippines, respectively. Singapore, which has a supply of only 170 m³ per person per year has to rely on Malaysia and Indonesia for additional water supplies. The Indian sub-continent, Eastern Asia

and the Far East are relatively arid, having much less water resources per person than the rest of Asia and the world.

South Korea's per capita water supply of about 1,500 m³ per year is already below the threshold level of 2,000 m³. India and China are near this threshold.

On a macro level, it appears that the present demand for water in most Asian countries is still well within the available water supplies. The increases in demand to expand the irrigation base and to meet increasing requirements for domestic and industrial uses are expected to outpace the development of new water sources.

The countries in the region that have relatively high percentages of total withdrawal to IRWR include India (34%), South Korea (26%), Japan (21%), Sri Lanka (20%), China (19%) and North Korea (18%). A value of 25% or more (e.g., Indian subcontinent) indicates high pressure on water resources.

About 84% of the total water withdrawal of the region is for agriculture. At 92%, 90% and 88%, respectively, the Indian subcontinent, the Islands and the Southeast region have the highest percentage of water withdrawal for agriculture. There are, however, wide variations among individual countries in the share of agriculture over total water withdrawal (90% for Burma, 78% for Vietnam, 90% for Thailand, 60% for the Philippines, 76% for Indonesia, 73% for North Korea, 47% for Malaysia; 43% for South Korea and 94% for Cambodia).

Irrigation accounts for the bulk of water use in agriculture. This is due to the large irrigation base and the fact that approximately half of the irrigated area is devoted to flooded rice production.

Although still relatively small in most Asian countries, the industrial, municipal and environmental demands for water continue to increase at a rate twice that of population growth. The proportion of water available for agriculture is projected to decline to 62% worldwide and 73% in developing countries by 2020. Hence, the opportunities for expanding the irrigation base are limited. If food security is to be maintained, ways of increasing the productivity for water must be found.

There is a host of interrelated issues that must be addressed in the short and medium terms if a

water crisis in the region is to be averted. Among others, these include: changing demand patterns; impact of climate change and watershed modifications on dependable water supply; low water productivity in agriculture; inadequate investments in water supply systems to meet future demands; the trend toward decentralized and privatized water service and market mechanisms; the need to reduce non-revenue water; sustaining and expanding the irrigation base; recycling wastewater for agriculture; access to water of rural and urban poor; groundwater mining; the need to strengthen international collaboration for managing shared water resources; protection of freshwater ecosystems; and unfavorable environment for a comprehensive water resources policy and program framework.

The specific issues in irrigation that are more pressing were discussed. Among these are: the poor performance of irrigation agriculture; the sub-optimal utilization of irrigation water; the low water productivity; suitability and cost-effectiveness of current irrigation technology, sustainability and subsidy; adequacy of irrigated agriculture support services and functions; the weak R&D and extension services; inadequate institutional arrangements and mechanisms; and the roles of the different stakeholders in irrigation development. Suggestions on how to address these issues were given.

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