8

The Closure of the Chao Phraya River Basin in Thailand: Its Causes, Consequences, and Policy Implications

françois molle

Introduction

Despite being a tropical country with a seasonal monsoon, Thailand has now joined a host of countries currently facing water shortages. With the exception of the southern region and some forest areas along the border, hydrologic data show that the annual average rainfall in Thailand varies between 1,100 mm and 1,600 mm. During the six driest months of the year, from December to May, the country relies chiefly on the water available in 28 main reservoirs. However, only 15% of the 200 billion m^3 (Bm^3) annual run-off remains trapped in the dams (ESCAP, 1991).

In an initial phase of development, when the population was still sparse and the means of abstracting water from waterways limited, water use was generally characterized by an open access regime, and the quantity of water available far exceeded the needs of the population. With growth in population, the expansion of the land frontier, the development of irrigation, and the sprawl of major cities, the ratio of supply to demand has become critical in some periods of the year in many of the 25 main Thai river basins. At present, many river basins are "closing", that is, most of the regulated water is eventually consumed and little water leaves the basins in the dry season. This is particularly the case of the Chao Phraya river basin, and of the rivers in the Northeastern region; the Mae Klong basin, on the western part of the Central region, is still an exception, with the average annual storage capacity of the Khao Lem

and Srinakarin dams exceeding downstream requirements by approximately 30%.

The Chao Phraya basin is the largest river basin in Thailand (160,000 km^2, or 30% of the area of the country), and is also the most important in economic terms, as it encompasses the bulk of the irrigated area as well as the Bangkok Metropolitan Area (BMA). During the twentieth century, the basin shifted from the status of an uncontrolled basin to a status of a highly developed basin, with multi-purpose storage dams, extensive canal infrastructure serving 2.9 million ha of irrigated land, a complex mix of economic activities, and sprawling urban areas. The agricultural potential of the basin cannot be fully realized, as the water resources available in the dry season only allow, on average, the irrigation of half the irrigable area. This deficit is compounded by the growing share allocated to the BMA and, within the agriculture sector, by the imbalances resulting from the growth of water use in the upper and middle parts of the basin, which reduce the share effectively allotted to downstream areas (the delta).

This chapter recounts the historical development of the Chao Phraya river basin over the second half of last century, and shows how supply and demand have evolved in parallel and how the society at large has coped with growing imbalances. This example serves to illustrate the consequences of "basin closure" in Thailand, and to discuss their policy implications.

The Evolution of Supply and Demand

Development of Water Resources

Early development of agriculture mostly relied on the diversion of small streams, and the use and control of the flood regime in the delta. The first two major storage dams, Bhumipol and Sirikit dams, were constructed in 1964 and 1972, respectively. After the completion of these two dams, approximately 12 Bm^3 (or km^3) of total run-off could be captured every year on average. This capacity was later incremented only marginally, with the construction of the Krasiew, Mae Ngat, Thap Salao and Mae Kuang dams, each with a capacity of approximately 0.25 Bm^3, but these resources were mostly committed to nearby irrigated areas that were expanded concomitantly.

Because of the high supply/demand ratio of the adjacent Mae Klong basin, some of its water started to be diverted in the 1980s to the lower part of the delta, as a way to boost dry season cropping (see Map 8.1). This use was further facilitated by the construction of pumping stations in the early 1990s, which gradually increased the flow into the west bank at low tide (up to 0.5 Bm^3/season at present). Now, the Mae Klong river is also contributing to the supply of the BMA[1] through a new canal designed to take its water down to the Thonburi area.

Groundwater resources have also been increasingly tapped. BMA's industries gradually increased their pressure on deep aquifers, to a level of 3 million m^3/day. Volumes abstracted for non-agricultural uses outside the BMA are relatively small (under 0.1 Bm^3/year). Irrigation, based on deep aquifers, has been developed in the middle basin (Sukhothai Project) in the 1980s, while shallow aquifers have also been gradually tapped wherever available (more on this later).

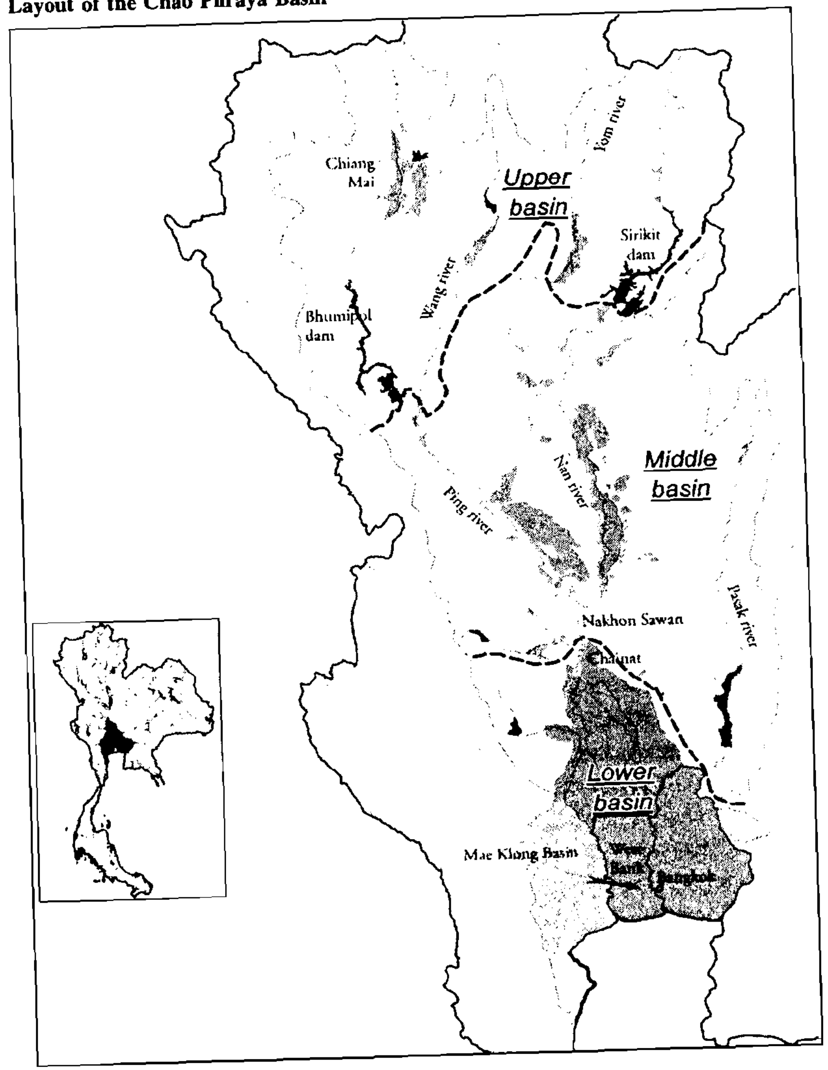
Apart from these regulated resources, supply by direct rainfall may have been altered in the basin. The decrease in precipitation is very limited in the upper part of the basin (Kwanyuen, 2000) but clear in the delta proper (Molle et al., 2001).

In sum, it appears that the mobilization of resources was first achieved through the construction of two large dams, later complemented by smaller reservoirs, with deep aquifers providing most of the water used by industries. Transbasin diversion, as well as deep and shallow aquifers, later added to these resources, while direct rainfall declined in some parts of the lower basin.

The Growth of the Effective Demand

This gradual increase in supply was paralleled by a spectacular growth of demand for water in all sectors. BMA's demand rose from 0.46 million m^3/day in 1978 to approximately 7.5 million m^3/day in 2000 (a 16-fold increase in 22 years), including a contribution of approximately 3 million m^3/day from underground water, most of which is used by industries (90% of which relies on the aquifer) (TDRI, 1990). The overdraft of deep aquifers in the BMA (sustainable rates are estimated at 1 million m^3/day), with its horrendous externalities in terms of land subsidence and flood damage, reduces the amount of surface water that has to be diverted to the capital, but shifting the pressure onto the aquifer.

Map 8.1
Layout of the Chao Phraya Basin



Irrigation originated in the valleys of the North, where traditional run-of-river irrigation (*Muang fay* systems) has been prosperous for at least seven centuries. Despite the early excavation of canals in the delta flats, and some attempts to establish gravity irrigation schemes (Ishii, 1978), the effective development of large-scale irrigation schemes and water control dates from the 1950s. The first phase of this development was the construction of the Greater Chao Phraya Project, with 400,000 ha of irrigated areas in the delta. The hydraulic network was designed to supplement water to wet season crops. With the advent of high-yielding varieties (HYVs) and the improvement of the on-farm infrastructure in some pilot areas, the idea of double-cropping gained momentum and, in the late 1970s, the government embarked upon a campaign aimed at fostering it. In less than 10 years, dry season cropping shifted from a status of initiative supported by public agencies, to one of an activity that needed to be controlled, and sometimes curtailed, over a command area of approximately one million ha.

The development of dry season cropping in the delta stirred the demand for irrigation infrastructure in other provinces. The large paddy areas of the lower reaches of the Ping and Nan rivers, located in the middle basin (see Figure 8.1), also needed to have their production stabilized through irrigation. This led to the development of additional areas (250,000 ha, 80% of the area with rice) in the late 1980s, and those concerned with these additional areas gradually requested water for dry season cropping. In the upper part of the basin, development followed a gradual increase from 0.47 million *rai* (0.0752 million ha) in the early 1950s, to 2 million *rai* (0.32 million ha) in 1980, and 5.6 million *rai* (0.896 million ha) in 1993 (JICA, 1997).

These investments were paralleled by the introduction, from the early 1980s onward, of an estimated 450 pumping stations fostered by the Department of Energy Development and Promotion (DEDP). These stations feed on the rivers and usually serve an area of 2,000 *rai* (320 ha); they are planned without real concern for the overall availability of water in the basin and with no coordination with the Royal Irrigation Department (RID). Another major newly irrigated area is the marginal uplands located along the trunk canals that delimit the irrigated delta, and that have also gained access to canal water with the technical and financial help of provincial authorities (including, RID regional offices). Along the western side of the delta, these areas now total, at least, 15,000 ha. In addition to these "official" areas, there are also some uncontrolled or semi-controlled cases of water abstraction by private pump owners along rivers and main canals.

A second reason for the expansion of demand is the gradual development of on-farm infrastructures, notably in the peripheral part of the flood-prone area that grows traditional varieties of rice on uneven natural

land. These areas, when receiving some leftover water from the main canals in the dry season, have also been encouraged to expand the network of ditches, as well as the levelling and bunding of plots, so as to be in a position to grow dry season crops. This was eased by the relatively cheap and abundant supply of machinery and was financed by farmers and local public budgets (as in case of ditches). Large releases of water aimed at allowing farmers to grow a dry season crop following years with flood damage (such as, in 1995 and 1996) triggered significant expansion of on-farm facilities.

A last, more recent water requirement is the need to reserve some fresh water to dilute pollution and flush it out of the delta. In the lower west bank, for example, a discharge of approximately 10 cms is reserved for that purpose.

In sum, irrigated areas have spread all over the basin, and their potential, with regard to dry season cropping, now exceeds by far the available supply. The basin is now considered "overbuilt" by the World Bank, which funded all medium and large-scale infrastructures.

Spatial Distribution of Water Use

The gradual spread of irrigated areas in different parts of the basin has impacted on the allocation of resources. The use of the basin water has been first re-balanced by a stronger abstraction in the north: with the development of irrigated areas and population growth, the upper basin has significantly increased the share of the natural run-off that is locally stored and used. It is estimated that this has roughly curtailed dam inflow by an average of 2 Bm^3 (out of a total of 12 Bm^3) over the last 30 years. This trend has been compounded by the decline in direct rainfall in the southern part of the basin.

The stock available for agriculture downstream of the storage dams (middle and lower basins) has been affected by the lower dam inflow, and also by the growing share of water diverted by the BMA (as mentioned above), although this was compensated for by transfer from the Mae Klong basin. The major shift in allocation, however, has occurred between the middle and lower basins, with the former seeing its supply increased dramatically over the last 20 years. The share of dry season dam releases "diverted" by the middle basin, to the detriment of the delta, has moved from 5% up to 35% in recent years. The interpretation of this change is that water users in the middle basin have increased in area but, foremost, have found a way to get effective supply closer to their demand by diverting water from the rivers (and engaging in triple-cropping in recent years).

Last, water allocation within the delta has also been uneven, with priority being given to the western part (Molle et al., 2001).

Adaptations to Growing Water Scarcity

The conjunction of the overall decline in supply and the growth in demand defines a framework of growing scarcity that actors in the system have been responding to in many ways. This section provides an overview of the system's main adjustments to changing conditions.

Adjustments in the Farming Sector

Common knowledge sometimes suggests that the agriculture sector continues with its wasteful practices, despite the pressure on water resources, and is thus the main cause of the water shortage. Contrary evidence from the present case study shows that several far-reaching endogenous adjustments have been made in response to the closure of the basin, both by farmers and by the line agencies, RID, and the Energy Generation Authority of Thailand (EGAT).

A first set of adjustments concerns the efficiency in use. Most main and secondary drains have been equipped with regulators in order to better retain water in the dry season (they capture superficial and sub-superficial run-off), and little water is passed on to downstream areas. This was done by the RID, often at the request of local villagers. Farmers are commonly seen pumping along these drains, and such locations are often considered more convenient than irrigation-canal banks.

A major response to water shortage, like in many other places of the world, was the development of tubewells, driven by a need to access reliable water sources for both diversification and intensification. The boom in well drilling occurred in the early 1990s. A survey carried out in 1994 at the village level has inventoried 89,000 of them in the central plain, mostly in the upper Chao Phraya delta and the upper Mae Klong project (Kasetsart University and IRD, 1996). Local storage of water has also been enhanced by the digging of public reservoirs in swampy low-lying areas, which are sometimes used for dry season cultivation.

Tapping these secondary sources has been made possible by the boom in individual pumps. The statistics are sometimes contradictory but over 80% of farmers have one or more pump sets in the delta. A consequence of the wide dissemination of pumps (even in areas where it is possible to get irrigation water by gravity), has been an increase in efficiency. Particularly, since accessing water involves cost and farmers tend to limit pumping operations to avoid the loss of water at the plot level (Bos and Walters, 1990). The average efficiency of irrigation in the delta in the dry season (beneficial depletion by crops/net water diverted) has been estimated at 60% (Molle et al., 2001). When considering a larger scale, losses by infiltration appear to be reused either locally (shallow aquifers), or in the BMA (via the deep aquifers); and the amount of beneficial water depletion is even higher: 88% in the dry season.

Other adjustments in the farming sector include mechanization and diversification, but these dynamics must be traced back to other transformations of agrarian systems, particularly labor shortage, decline in average farmland, development of new markets, and the growth of non-agriculture sectors.

Breaking up Cropping Calendars

Another important response to water scarcity has been the increase in effective supply derived from the breakdown of formal scheduling. While in the past, dry season cropping was scheduled to start only in February (after a period of two months when water was cut to allow maintenance and the harvesting of sugar cane and floating rice), this calendar was challenged by a chaotic pattern of planting promoted by the farmers. Instead of waiting for hypothetical late deliveries, some of them decided to start growing their crops before the official beginning of the season, thus capitalizing on the residual wetness of fields and drastically reducing water requirements for land preparation.[2] This was made possible by a series of concomitant changes: (*a*) the shift from transplanting to wet broadcasting dealt away with the constraint of matching water supply with the time for transplants, which was fixed by the establishment of nurseries; (*b*) mechanization (in particular that of harvesting), which greatly eased the capacity to ensure proper operations when needed; (*c*) the use of shorter duration rice varieties (90 to 105 days instead of 120 days), allowing, in particular, triple-cropping; (*d*) the development of secondary water sources, including reservoirs excavated in public lowlands, tubewells, and gated drains, as well as that of individual pumping devices allowing to tap these sources. Farmers have thus, succeeded in increasing their effective supply in three respects: first, by broadening the time interval when supply is possible; second, by forcing the RID to release unplanned water (it is common knowledge that the RID ends up feeling compelled to deliver water to avoid the loss of standing crops); and, third, by tapping secondary resources and low canal flows. In addition, early and late cropping calendars made better use of residual field wetness as well as rainfall. All these gains, on the other hand, critically weakened the meaning and the proper definition of scheduling.

Dam Management

The Bhumipol and Sirikit dams are multi-purpose reservoirs but were initially designed as important sources of energy for the country. As such, their management had been entrusted to EGAT. In 1972, dams made up one-third of the Thai energy generation capacity and, therefore, water releases were mostly dictated by the national requirements in electricity. As a consequence, releases were sometimes made in times when the demand of downstream users was low and the water going through the turbines was eventually "lost" to the sea (that is, the discharge was in excess of the 50 m^3/s required to control salinity intrusion). In the 1970s, an average of 3 Bm^3 of dam stocks were lost every year in this manner.

With the increasing demand for water, EGAT's management came under growing scrutiny as the wastage of huge amounts of water repeatedly triggered the wrath of NGOs and other observers. At the same time, the structure of the Thai energy generation sector was gradually modified, with hydroelectricity producing now no more than 5% of the total energy. With a contribution of Bhumipol and Sirikit dams at around 1% each, EGAT was able to better attune its releases to downstream requirements. In the 1990s, the water wasted to the sea was brought down to approximately 5% of the yearly average dam inflow (Molle et al., 2001).[3] In other words, the basin is closing off.

Dam management also refers to inter-annual regulation, which demands that carry over stocks be kept at the end of the dry season, in order to cope with possible low precipitations during the next rainy season(s). A lack of concern for such regulation leads to increasing the risk of shortage in the system but is a way to gamble short-term political gains in years of limited stocks:[4] conflicts between technical criteria (security of the system) and political criteria (farmers' demands should be met if there is water in the dams), have been increasingly apparent. The resulting mismanagement of carry over stocks largely explains why the low rainfall years of 1994 and 1999 have paved the way to water crises, leading to the rationing of water supply to the BMA. This can be interpreted as a last ditch strategy to avoid passing on the effective water deficit to agricultural users by raising supply through mobilization of water that should normally be kept for ensuring the security of the system. The (immediate) effective supply is raised at the expense of (mid-term) security.

Social and Institutional Induced Changes

The growing independence and "individualization" of farmers in their quest for access to water also reverberated on overall patterns of water management. The development of farmers' pumping capacity has discouraged whatever regulation improvements the RID would have otherwise been pushed to achieve, and strengthened a pervasive individualistic concept of gaining water access.

However, the imbalance between supply and demand has also sometimes induced changes in the collective behavior of farmers. Innovations, for example, have emerged to solve the problem of water sharing along a given lateral canal, when the inflow by gravity is not possible and pumping from the main canal is needed (Molle et al., 2001a). Pumping at the head of a lateral is achieved by a group of farmers using their own low-lift axial pumps (*tho phayanak*), and is generally paralleled by a synchronized second lifting operation at the ditch or plot level, which requires some degree of collective action and agreement. Such arrangements, however, are generally ad hoc and localized. More formal organizational structures, such as Water User Groups or Water User Associations, the establishment of which had failed in the past, were not revitalized by the new challenges posed by a growing pressure on resources, as farmers did not see them as possible vehicles for improved participation. (The reasons for this lie outside their scope; more on this later).

Not meeting the demand for water also recently triggered unprecedented protests from those located at the tail end of the water supply scheme, threatened to be deprived of water in years of abundant supply. The relative demand rose because those tail-enders, who in "normal" seasons conform to the obvious reality that they will not get any water, also wanted to benefit from these deliveries. In fact, they strongly interceded with local politicians, and district and provincial heads to obtain a rotation that would allow them to grow a second crop, while those at the head were about to start their third crop. This shows that equity, as a social construct, is not static and circumstances may depart from what is acceptable at a given point in time. Such shifts in social norms may also be facilitated by a general context of political decentralization and democratization at the local level, where more space for negotiation is being opened (Arghiros, 1999).

Pressure on water resources has also altered the role and power of the RID as water manager. The decline in its authority was brought about not only by the development of farmers' pumping capacity, growing access to secondary water sources (breakdown of scheduling), and uncontrolled diversion (breakdown of allocation), but also by the growing role of politicians in mediating conflicts and special requests for water. Local patronage networks are regularly activated to obtain extra supplies in times of shortage and risk of crop loss.

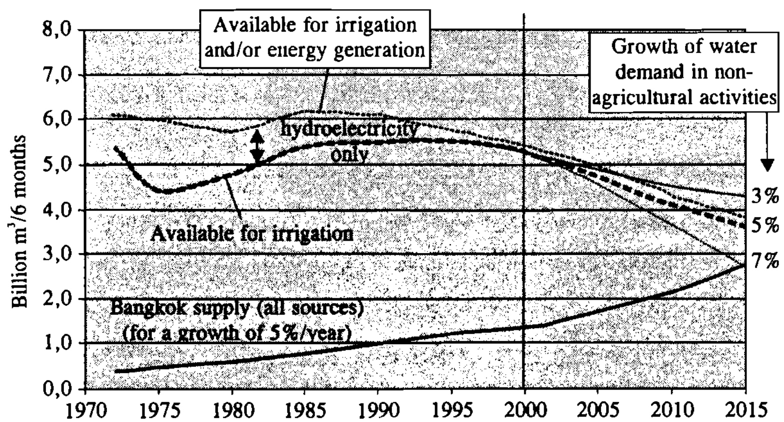
Other formal aspects of institutional change can be mentioned, despite their limited impact. This includes the appointment of the "Dry Season Cropping Promotion Committee," chaired by the Ministry of Agriculture, to plan dry season cropping and water allocation (nowadays only a subcommittee continues to meet yearly to achieve some degree of coordination between agencies); the enactment of pieces of legislation, such as the 1992 Factory Act and the Enhancement and the Conservation of National Environmental Quality Act (Environment Law), passed in a bid to control industrial pollution (but there are several flaws in the laws and little enforcement capacity, see Wongbandit, 1997). There is a well recognized need for innovative, integrated management and policies at present, which is demonstrated by the intense ongoing debate on the reform of the water sector.

Water Balance and Perspectives

These examples of responses show that, despite the decline in dam inflow and the growth of the amount of water diverted to the BMA, several counterbalancing realignments have occurred. Figure 8.1 attempts to quantify the impact of these changes on the available water stock for the dry season (Molle et al., 2001). It presents an average picture of long-term trends, which does not take into account the high

year-to-year variability (and in particular masks the drought period of 1991–1994). The balance was made considering the changes in supply (including groundwater and diversion from the Mae Klong basin) and in non-agricultural demand (including energy generation), the closing term being what is left for use in the dry season for agriculture. This term, in its turn, includes a share that is released exclusively for energy generation, and a larger one, which is used for both energy generation and dry season cropping. It can be seen that the available water increased in the 1980s as a result of improved dam management in the wet season, offsetting the decline in dam inflow. At the same time, the volume used *only* for energy generation in the dry season also decreased, stabilizing the average volume available for irrigation at around 5.5 Bm^3. In the late 1990s, however, the gains from dam management were all realized and the amount of water for dry season agriculture set on a declining trend.

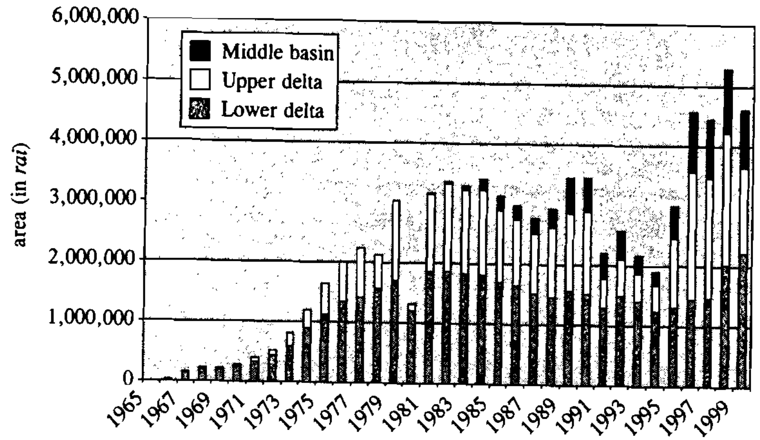
Figure 8.1
Evolution of Available Water Stock for Dry Season Cropping



How did the cropping area vary during the same period? It can be seen from Figure 8.2 that the average cropping area first reached around 3,200,000 *rai* (500,000 ha) in the 1980s (i.e., roughly 50% of the total project area). This can be taken as an indication that since the inception of dry season cropping, the dam water stocks have been insufficient to allow the full expansion of double-cropping. This is, however, only partially true, as the insufficient capacity of irrigation canals and the poorly developed on-farm level largely accounted for that situation.

Therefore, the non-realization of the full potential was not perceived as a result of insufficient resources. This situation was to radically change in the last two decades.

Figure 8.2
Growth of Dry Season Rice Cropping in the Chao Phraya River Basin



The apparent contradiction between Figures 8.1 and 8.2 is that despite the double squeeze on water supply due to the reduction in dam inflow and the growing diversion by the BMA, the cropping area has been on the rise (the 1991–1994 dry period is atypical). It is, therefore, hard to identify a situation of crisis and declining supply when more people than ever have been growing rice in the past six years. Several reasons explaining this situation have been mentioned earlier. They include the facts that secondary water sources have been tapped, irrigation efficiency has improved, shorter rice varieties and direct seeding have been introduced, and mechanization has now spread.[5] The two main factors, however, were the better control of dam release (see Figure 8.1) and the deregulation of calendars, the latter with its series of gains, as commented earlier.

Despite such spectacular achievements in the diversification of water sources and expansion of water supply, the pressure on water resources stemmed from the fact that the relative demand grew faster than the effective supply (all savings considered). This was due to the expansion of irrigated areas, on-farm infrastructure, pumping facilities, flexibility in cropping operations, access to water, and willingness to grow rice (especially in periods of higher prices).

What then, are the perspectives for the future? The slopes of the extrapolated trends shown in Figure 8.1 are, of course, quite dependent on the projected increase of water use in the BMA. The figures show that with no new water resources development, the decline over the next 15 years is bound to be very significant, even with reasonable annual rates of 3% or 5% (it also shows that the continuation of the pre-economic crisis 10% rate would have had catastrophic consequences). In other words, there is a need to anticipate a significant reduction of the water available for irrigation in the dry season.

The Problems Posed and Policy Implications

Several possible transformations are likely to be brought about by the trends mentioned above. The pressure for change will partly depend on the overall evolution of the economy. An optimistic (pull) scenario is that this situation would be paralleled by a sustained growth of non-agriculture sectors, wherein the demise of agriculture would have less economic consequences. A pessimistic (push) scenario is one of an agrarian crisis in which rural stagnation cannot be avoided. In all cases, pressure is likely to build up and responses will follow three main lines: supply augmentation, conservation, and allocation. The selection of a specific portfolio of options will depend on the perception of their relative financial and political costs by decision makers (Molle, 2002a). At that stage, adjustments will heavily depend on the provision of policies by the government because local users and managers have already achieved most of the improvements that were feasible at their level (although organized pressure/interest groups still have an important role to play). In addition, the growing interdependence of water users at the basin level makes it necessary to design new modes of management at that level.

A solution through more water resources development is the preferred option of consultants and concerned line agencies (Pal and Panya, 2000; JICA, 1997). They merely interpret the actual situation as a deficit in supply, and propose the construction of a few more storage dams as well as water transfers from the Mekong or Salaween rivers for which, feasibility studies have already been carried out. These solutions are costly, run into opposition from NGOs and local populations, and are not favored by development banks.

A second solution is to give priority to demand management, which includes measures for both water conservation and reallocation towards more economically beneficial uses. Saving water is a popular issue since it is widely held that farmers are both "guzzling" water and using 70% of all water resources, from which one can easily deduce that a small improvement on their part would be enough to rebalance demand and supply. However, as shown earlier, the pressure over water resources in the Chao Phraya basin has translated into the improvement of both the local and overall efficiency in water use, which defines the closure of the basin. Crop—water productivity (kg/m^3) has been improved by shifting calendars and reducing evapotranspiration. Return flows have been tapped to such an extent that only 12% of dam releases is now lost to non-beneficial use in the dry season (non-beneficial evaporation or outflow to the sea in excess of environmental needs). Interestingly, all these adjustments have taken place despite the fact that water is free, which is discordant with the motto "water is wasted because it is not priced" (Molle, 2002).

Others advocate that, in such a situation, emphasis must be placed on the maximization of net benefits, including shifting water to uses that have a higher economic efficiency (Wichelns, 2002). This includes both encouraging crops with a higher water productivity ($/m^3), and reallocating water to non-agricultural activities. Diversification has been the object of large-scale governmental projects, but Siriluck and Kammeier (2000) have shown that these have met with mixed results. In effect, it can be shown that the development of cash crops is primarily dictated by market conditions, as well as constrained by factors such as labor or capital availability, or soil suitability. Evidence of the dynamics of diversification in the delta (Kasetsart University and IRD, 1996) points to the fact that farmers display great responsiveness to market changes and opportunities (a point definitely confirmed by the recent spectacular development of inland shrimp farming [Szuster et. al., forthcoming]), and it is not clear whether policies have been very effective in enhancing these opportunities. Contrary to widespread belief, farmers do not need to have their water priced to shift to other productions. They will increasingly do so if the uncertainty on water and commodity prices is lowered, and if markets are available.

Few gains can be expected from intersectoral reallocation of water. This is because, contrary to situations where water rights are locked up in low productivity agricultural uses, such as in the western U.S., non-agriculture sectors have always received priority in Thailand.

The lack of water is not significantly constraining the development of non-agriculture sectors, and agriculture is actually being allocated the share of water remaining after other sectors are served (in addition, most industries rely on deep aquifers and do not directly compete with agriculture).

What, then, are the prospects for soothing the pressure on water basins, if increasing supply is costly and problematic, and demand management unlikely to yield significant water savings and economic gains? The establishment of basin level institutions is widely viewed as a panacea, but ongoing pilot basin organizations suggest that they tend to be conceived as mere consultative institutions, with a preponderant weight of officials. The crux of the matter and the challenge for the Thai administration are to establish a basin level mode of water management, where dry season water entitlements are defined in a multi-leveled process, down to the bulk allocation to groups of users under a main or secondary canal, with the involvement of users' representatives. While such an arrangement may seem a matter of goodwill, it has in reality far-reaching and multifaceted implications. First, allocation requires that users are known and registered, and that free-riders are prevented from accessing water. At present, this is not administratively and legally possible (riparian users have rights to reasonable use), and even the control of the diversion to RID irrigation areas, for example, in the lower Ping, is problematic. Second, managers must have the technical capacity to deliver the agreed upon discharges at different points in the network. At present, technical constraints in managing water in the Chao Phraya basin do not allow such control on water flows and significant modernization is required to upgrade this capacity. Third, establishing a process of collective decision making means that groups of users are federated in higher hierarchical levels, with corresponding representatives. There is no such structure at the moment. Fourth, the partnership of users and irrigation officials must be sealed by some degree of reciprocal dependence, which in practice means that members of the field staff are to be selected and paid by the groups of users. Such a reform of the role and structure of the Irrigation Department is not visible at the moment. And fifth, such an overall reform obviously needs a strong commitment and support from the administration, and from politicians, that remain to be seen.

It is important to understand that such a reform is unlikely to bear spectacular fruits in terms of irrigation or economic efficiency, although a better water supply certainly contributes to a better application of water at the plot level, as well as encourages investments at the farm level. Its main benefits would be to stabilize water uses and "rights," to bring the users into the decision making process of allocation and to instill a service oriented practice of water management. At the end, the prospect of capitalizing on the process of seasonal bulk entitlements to define more formal water rights is far-fetched, particularly because it is not realistic to envisage individual rights in the particular context of smallholder agriculture. A consequence is that the amount of water allocated to agriculture is set to decline—as it is given the lowest priority, to the benefit of cities, without concrete compensation to agriculture—unless supply is augmented. On the other hand, this gradual decline can be seen as a way to elicit new improvement in productivity, and to progressively downsize irrigated agriculture. This, of course, can be criticized on a number of points, but the experience of the last two decades (as well as of neighboring Malaysia, where the demise of agriculture is already well advanced) shows that a strong economic growth can make this transformation a pull process rather than a push one (Molle and Srijantr, 1999).

Conclusion

This chapter described the development of both supply and demand in the Chao Phraya basin and its gradual closure. It provided insight on how it adapted to changing circumstances: water scarcity induced changes in the agricultural sphere (agricultural techniques; calendars or varietal choice; individual pumping capacity to access secondary sources of water), in social organization (new arrangements to cope with varied patterns of water shortage; shifts in farmer/agency relationships), water management (dam management; blurring of cropping calendars and dissolution of scheduling; intra-basin reallocation; undue use of carry over stocks) and politics (political interference; generation of policy—reform proposals). In contrast to the common picture that water shortages and crises are provoked by wasteful practices, this case study suggests that significant endogenous adjustments are made in response to water scarcity, and that crises may be ascribed to the propensity of managers/politicians to reduce the pinch of water scarcity by increasing supply at the expense of security in future supply.

Basins, where competition over water is highest, are thus, also most probably those in which the scope for efficiency gains is the most limited. This critically weakens the prospect that significant gains can be achieved through demand management, in particular by economics-based tools. This points to a common overestimation of the potential impact of exogenous policy reforms on water use efficiency and productivity, both because the scope of these policies is reduced, and because their efficacy in particular contexts is debatable. In the present case, reform proposals are based on a misunderstanding of water use within the basin, on the lack of recognition that diversification to cash crops is first and foremost governed by market conditions, and on the fallacy that intersectoral water allocation is an economic constraint (Molle, 2001).

While the Chao Phraya basin is undoubtedly nearing closure, it can still be described as "immature." Centralized intervention is needed to design or enable institutional reforms that tend to be postponed. However, the main potential gains of these reforms are to be envisioned in terms of equity, control over further growth in demand, empowerment of users in water management and in the negotiation on seasonal entitlements. This, in the long run, should be conducive to a growing formalization of rights in the basin. It was pointed out that such a wide reform had far-reaching implications with many prerequisites to be met.[6] The crux is now whether the combined logics of both politicians and administrators can be conducive to the institutional changes needed. Although the theory of Hayami and Ruttan (1985) on induced institutional change suggests that endogenous adjustments would result from the increasingly conflicting, and complex interactions within river basins, it seems that emerging initiatives have, up to now, been mostly driven by exogenous pressure, and it is not clear whether they are also endorsed by insiders. In other words, changes are on the way, but their nature, time frame and impact are neither mapped out, nor likely to meet the expectations of those committed to reforming the Thai water sector.

NOTES

1. With a discharge of 5–10 m^3/s, planned to be raised up to 45 m^3/s within 10 years.
2. It can be shown that a rice crop planted on November 15 consumes 25% less water than when planted in February (Molle et al., 2001).
3. The year 1996 constitutes a horrendous counter-example of this trend (several billion m^3 dumped to the sea) and shows that EGAT should now not be allowed to release water in excess of downstream uses without consultation with the other stakeholders.

4. While engineers spend much time refining "rule curves," "thresholds" and other management guidelines, in practice, these parameters are seldom well understood by users (see Sakthivadivel et al., 2001, for a Sri Lankan case), and they are often vague enough to be subject to pressure and interpretation by politicians.
5. Part of the increase is also due to the non-recording of triple-cropping of rice in the early 1990s.
6. An example in point is the recent policy implemented in Pakistan "aimed at ensuring transparency, equity, and efficiency to ensure cost recovery for the irrigation service," but which ended up being a demonstration of "how an inappropriate policy can jeopardize the sectoral performance." (Prathapar et al., 2002).

REFERENCES

Arghiros, Daniel. (1999, July 5-8). *Political Reform and Civil Society at the Local Level: The Potential and Limits of Thailand's Local Government Reform.* Paper presented to the 7th International Conference on Thai Studies, University of Amsterdam, the Netherlands.

Bos, M.G. and Walters W. (1990). Water Charges and Irrigation Efficiencies. *Irrigation and Drainage Systems*, 4 (3) 267–68.

Economic and Social Commission for Asia-Pacific. (1991). *Assessment of Water Resources and Water Demand by User Sectors in Thailand.* Bangkok: ESCAP.

Hayami, Yujiro and Ruttan, V.W. (1985). *Agricultural Development.* (Revised and expanded version). Batlimore: John Hopkins University Press.

Ishii, Yoneo. (Ed.) (1978). *Thailand: A Rice-growing Society.* Honolulu: The University Press of Hawaii.

Japan International Cooperation Agency. (1997). *The Study on the Kok-Ing-Nan Water Diversion Project in the Kingdom of Thailand.* Tokyo: JICA & Sanyu Consult and Nippon Koei Co.

Kasetsart University and Institut de Recherche pour le Développement (IRD) (1996). *Identification of Agricultural and Irrigation Patterns in the Central Plain of Thailand: Prospects for Agricultural Research and Development* (DORAS Project). Bangkok.

Kwanyuen, Bancha. (2000, December). Comparative Study of Rainfall Change in the North of Thailand. In *Proceedings of the International Conference on The Chao Phraya Delta: Historical Development, Dynamics and Challenges of Thailand's Rice Bowl* (pp. 369–78). (Volume 1). Bangkok: Kasetsart University.

Molle, François. (2001). *Water Pricing in Thailand: Theory and Practice.* (DORAS Project) (Research Report no. 7). Bangkok: Kasetsart University. Also available online at http://std.cpc.ku.ac.th/delta/ conf/Acrobat/ Papers_Eng/pricing.pdf

——. (2002, June 15-17). *To Price or Not to Price? Thailand and the Stigma of "Free Water"*. Paper presented at the Conference on "Irrigation Water Policies: Macro and Micro Considerations", Agadir, Morocco.

——. (2002a). *Development Trajectories of River Basins: A Conceptual Framework* (Draft Research Paper). Colombo: IWMI.

Molle, François and Srijantr, Thippawal. (1999). *Agrarian Change and the Land System in the Chao Phraya Delta* (DORAS Project, Research Report no. 6). Bangkok: Kasetsart University.

Molle, François, Chompadist, Chatchom, Srijantr, Thippawal and Keawkulaya, Jesda. (2001). *Dry-season Water Allocation and Management in the Chao Phraya Basin* (Research Report no. 8). Bangkok: Kasetsart University.

Molle, François, Ngernprasertsri, Nittaya, Sudsawasd, Savakon and Chompadist, Chatchom. (2001a). *Patterns of Social Interaction and Organisation in Irrigated Agriculture: The Case of the Chao Phraya Delta* (DORAS Project, Research Report no. 9). Bangkok: Kasetsart University.

Pal and Panya Consultants. (2000). *Final Report on Chao Phraya Basin Water Management Project* (Executive Summary). Bangkok.

Prathapar, S.A., Ul Hassan, Mehmood, Mirza, Z.I. and Tahir, Zubair. (2002). Constraints on Enforcement of Water Policies: Selected Cases from South Asia. In *Water Policy Reform: Lessons from Asia and Australia. ACIAR Proceedings No. 106* (pp. 209–23). Canberra: Australian Centre for International Agronomic Research.

Sakthivadivel, R., Loeve, Ronald, Amarasinghe, Upali and Hemakumara, Manju. (2001). *Water Scarcity and Managing Seasonal Water Crisis: Lessons from the Kirindi Oya Project in Sri Lanka* (Research Report no. 55). Colombo, Sri Lanka: International Water Management Institute.

Siriluck, Sirisup and Kammeier, H. Detlef. (2000, December). Government Policy and Farmers' Decision-making: The Agricultural Diversification Programme for the Chao Phraya River Basin, 1993–2000. In *Proceedings of the International Conference on "The Chao Phraya Delta: Historical Development, Dynamics and Challenges of Thailand's Rice Bowl"* (pp. 63–96). Bangkok: Kasetsart University.Also available online at http://std.cpc.ku.ac.th/delta/conf/prog_list.htm

Szuster, Brian W., Molle, F., Flaherty, Mark S. and Srijantr, Thippawal. (forthcoming). Socio-economic and Environmental Implications of Inland Shrimp Farming in the Chao Phraya Delta. In F. Molle and Thippawal Srijantr (Eds.), *Thailand's Rice Bowl: Perspectives on Social and Agricultural Change in the Chao Phraya Delta.* Bangkok: White Lotus.

Thailand Development Research Institute. (1990). *Water Shortages: Managing Demand to Expand Supply.* Bangkok: TDRI.

Wichelns, Dennis. (2002). An Economic Perspective on the Potential Gains from Improvements in Irrigation Water Management. *Agricultural Water Management*, 52 (3), 233–48.

Wongbandit, Amnat. (1997). Legal Aspects, annex G. In Binnies and Partners (Overseas) Ltd. (Ed.), *Chao Phraya Basin Water Resources Management Strategy* (p. 74). Bangkok.

Molle François.

The closure of the Chao Phraya river basin in Thailand : its causes, consequences and policy implications.

In : Shivakoti G. (ed.) Asian irrigation in transition : responding to challenges. Londres : Sage, 2005, p. 206-225.
ISBN 0-76-1933-506