INTEGRATED WATER MANAGEMENT FOR THE HUMID TROPICS[1]

L.K. Smedema[a] and W.J. Ochs[b]

[a] *Theme Manager, International Program for Technology Research in Irrigation and Drainage (IPTRID), World Bank, 1818 H. Street N.W., Washington D.C. 20433, USA*
[b] *Drainage Adviser, World Bank (Retired).*

Introduction: Difficult hydrological characteristics of the humid tropics

The humid tropical zone has some very distinct hydrological characteristics, which makes it almost mandatory to integrate irrigation and drainage. It is a very difficult climatic situation. This is illustrated by the fact that the agronomists distinguish for this zone between lowland and upland crops; in no other climatic zone such a distinction for cropping is based on hydrology.

The following graphs from the Mekong delta present some of the difficult hydrological characteristics which are typical of the humid tropical zone. There is a pronounced rainy season and also a pronounced dry season (Figure 1). During the dry season the water table drops. It starts rising at the beginning of the rainy season and almost immediately there are severe waterlogging problems and in many cases even flooding. During the dry period obviously the emphasis should be on irrigation, and during the wet period it should be on drainage. But much of the water for the irrigation needs to come from the wet season. This implies the need for storage or at least transfer of some of the water and also the need for integrated water management. Most of my presentation will be on hydrological integration. Obviously, institutional integration is required as well.

During the wet season river levels are high. This makes it difficult to discharge drainage water by gravity. Pumping could be a solution. That is something I'll come back to later.

In addition to the difficult hydrological context of the humid tropics, there is also the agricultural context which further complicates water management. This is the desire for crop diversification and intensified agriculture. In the old days, very often there was only cropping during the wet season. Most countries now desire year-round cropping, with intensities of 200% or more. Most countries in the humid tropical zone now want to diversify and eliminate this distinction between upland and lowland cropping. I think water management is a very important tool towards such diversified cropping.

I will illustrate the need for integration and also the problems of integration with two cases. One case is from the conventional large canal irrigation schemes of Eastern India and Bangladesh. The other case is the swamp development schemes of the Mekong and also Indonesia, which both have the feature of the multi-functional canal system.

[1] Text below is based on a tape recording of Dr. Smedema's presentation.

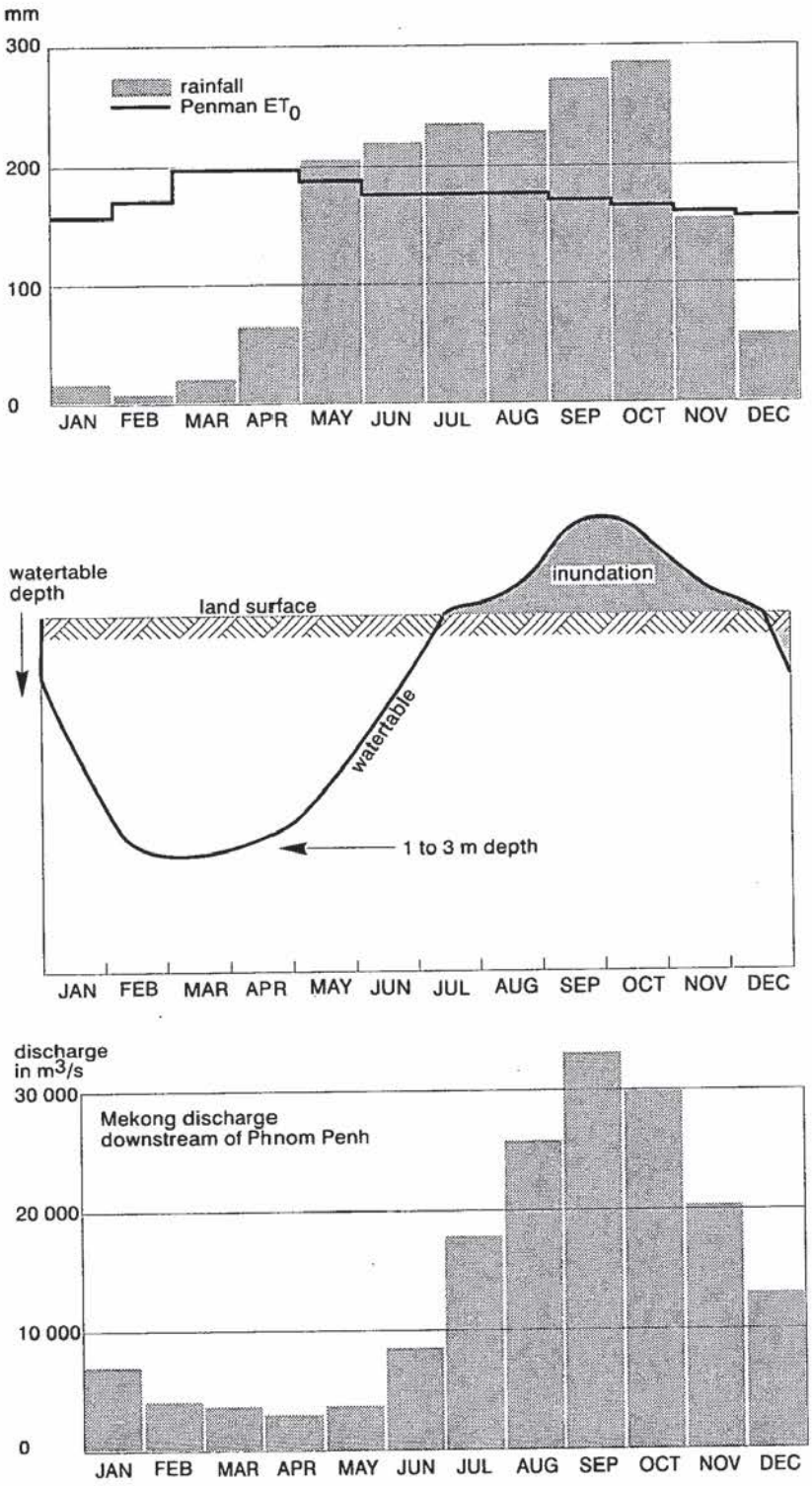

Figure 1. Natural water regimes in the Mekong Delta

Case 1 Canal irrigation schemes of Eastern India

Let us first consider the canal irrigation schemes of Eastern India and Bangladesh. An example is the canal irrigation scheme in the Krishna delta. It was developed around 1900 and during that period the conventional way to develop these deltas was by constructing a barrage and then cover the delta or the coastal lowland areas with an extensive canal irrigation system basically to use the dry season river flow, to spread the water over the land, so that during the dry season there could be cropping. One of the problems created by spreading that water over the land and not having a very good drainage system was the problem of waterlogging. No salinity, because we have about 1,200 mm of rain and my experience is that with more than 600-700 mm of rain there is no salinity problem. There is, of course, some coastal salinity here, but that is a different type.

This kind of irrigation development is very common in Eastern India. Most of it started early in the 19th century, but until recently the same type of schemes still continued to be developed (e.g. the Sharda-Sahayek scheme in eastern Uttar Pradesh, India, and the Ganges Gobadah scheme in Bangladesh, which were developed in the 1960's and 1970's).

I think the rationale of these schemes is sound enough: you have that river flow, so you use it and spread it over the land so that you can have some dry season cropping. There are also considerable problems related with this kind of schemes. The first is related to scale. These large systems require long development periods of 30-40 years. People establish practices which are based on the availability of a lot of water during the initial period. It is difficult to correct those practices later.

Also, these schemes are typical examples of public schemes, with public funding and public management. Nowadays we like to have a more private type of development. I am not going to say more about this issue, because I want to concentrate on the hydrological aspects.

Developing these schemes to spread water over the land requires building a lot of infrastructure. The infrastructure that has been built - not only the irrigation infrastructure, but also roads and railways - block whatever natural drainage systems there are. This has created a lot of waterlogging and flooding during the monsoon season.

Another feature is that under natural conditions, during the dry season the water table would drop, but with irrigation during this season this does not occur, so at the beginning of the rainy season there is much less storage capacity available. With irrigation , the water table remains high, so that part of the storage is not available. This leads to additional drainage problems, which can be avoided through cautious irrigation management.

In the case of Eastern India and Bangladesh, one should avoid the temptation to irrigate during dry spells in the rainy season, because in many cases this does more harm than good. Whatever is gained in yield by preventing drought, is lost by creating waterlogging problems. Of course, it is expensive as well to irrigate. There has been a High Level Commission in Uttar Pradesh which has looked into these problems. One of the recommendations this commission has made is to close the irrigation canals during the wet season. Another recommendation made by this High Level Commission is to irrigate with tubewells, not with canals. There is this groundwater which is a resource but can also be harmful. So why not exploit that groundwater, use the water for irrigation and at the same

time have the advantage of lowering the water table. I think that this is a very good example of integrated irrigation and drainage management.

Intermezzo: An example of a management intervention from Tanzania

The benefits of cautious irrigation management can be illustrated with an example from Kilombero Sugar Estate in Tanzania, which has basically the same climate as East India. Whenever there was a short dry spell during the wet season, the estate managers would start to irrigate. When shortly after they had irrigated and filled up the storage the next rain would come, this rainfall could not be accomodated; so they had created their own waterlogging problems. One of the recommendations I made - and of which I'm still proud - was not a physical intervention but a management intervention: I convinced the managers to risk some drought. So we did not irrigate some fields during that period and then we noticed that if the wet periods and the dry periods fell in a certain pattern, we could manage and maintain the water table at a reasonable level. So we solved the drainage problem by a management intervention.

Case 2 The multifunctional canal systems in the Mekong Delta

The second case which I would like to discuss is what I call the multifunctional canal systems [combined irrigation and drainage functions]. An example is the Mekong delta, where during the French period the entire delta was completely covered by canals. The French did it, I am told, for defense and strategic reasons to improve the accessibility, but now it is used as infrastructure for water management. The canal system is completely open and hydraulically connected. There are no structures in the canals. The system serves three water management functions.

The first function is flood control. The primary canal is just for conveyance. At the secondary canal the spoil is used to build low embankments. These low embankments are only meant to stop the flood at the beginning of the season. During the full flood season they are overflowing.

The second function is irrigation. The irrigation water is pumped from the secondary canal into the tertiary canals and then sometimes again from the tertiary canals on to the fields. In some cases near the sea there is also tidal irrigation. During high tide the water comes high enough to let the water in the field.

These tides, of course, can also be used for drainage, which is the third water management function. The pumps used in the Mekong are a reversible type. They can be used for pumping the water from the tertiary canals onto the field, but also for draining the fields by pumping into the tertiary canals.

What is important from this development - which is completely different from the conventional schemes that were discussed earlier - is that here pumping has become a very important tool for water management. Instead of relying on elevated [= above field level] systems for irrigation by gravity, the canal system is only used for conveyance and storage.

Once you have the water near the fields, you manage it by pumping. That is a development which has spread after World War II. It has revolutionized the water management in these lowlands, as shown in Figure 2. Traditionally, there was only a deep water rice crop during the wet season. Now, with low dikes to prevent early flooding, one can have a crop that starts with the early rains preceding the rainy season. With lowlift pumps and bunds around the fields, one can dispose of drainage water, get an early crop and then on the residual moisture a second crop after the rainy season. With complete flood protection - this is still far away and there are many environmental problems related to it - and good surface drainage, it is possible obtain three crops a year. For rice-growing in the humid tropics a surface drainage system alone is adequate, but cultivation of upland and perennial crops in these lowlands requires subsurface drainage as well.

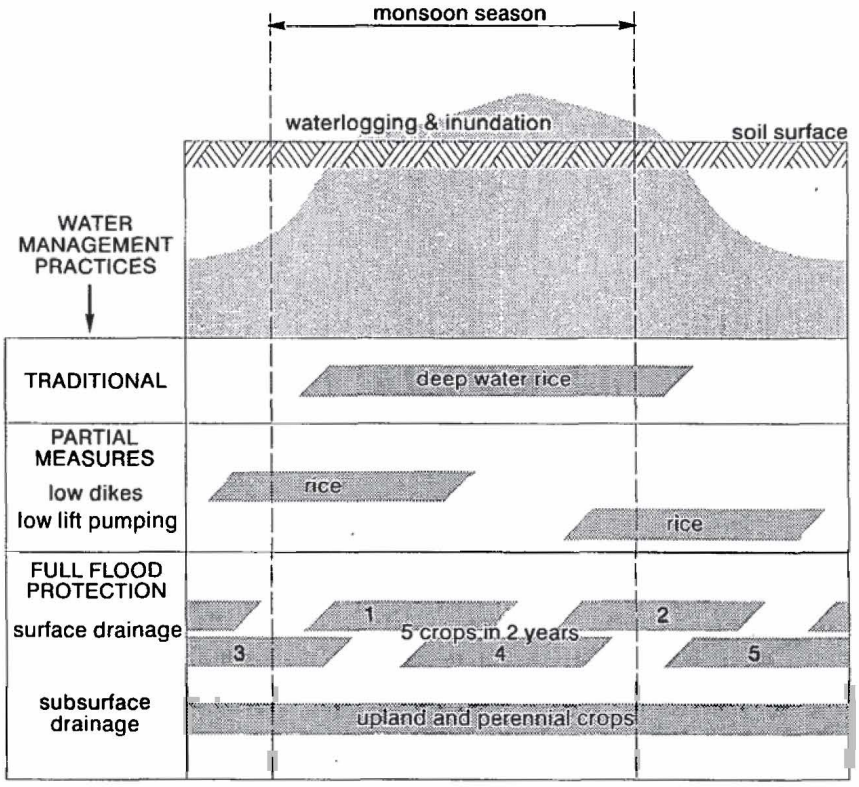

Figure 2. Water management and agricultural development stages in humid tropical lowlands

Time does not allow to present the Indonesian swamp development case, but basically it is the same. An open canal system, no structures, except in some cases a few flapgates. I noticed, both in Indonesia and also in the Mekong, that most flapgates are not functioning properly. There seems to be a need for more attention to the design of flapgates, because they are very useful in this kind of multi-functional canal system.

Discussion

A remark from the audience indicated that tubewells in coastal areas may be dangerous, as they will pump saline water at a certain moment. Another point was made that rice growing in deltaic areas is not normally the problem, but the second crop is the problem. Moreover, it was mentioned that general conclusions from average rainfall/evaporation data may be misleading. It was also mentioned that canal irrigation cannot be left out completely in many areas, especially not in situations where aquifer conditions are not favourable for tubewells.