SOCIAL AND ECONOMIC ASPECTS OF THE RECLAMATION OF ACID SULFATE SOIL AREAS

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Many participants in this symposium are intensively engaged in technical, scientific or managerial aspects of land use or land development in acid sulfate areas. It seems wise, therefore, to start with a discussion of the social and economic reasons for our work and the implications of our possible recommendations for the people and for the physical environment, before we concentrate on detailed scientific, technical and developmental aspects.

Changing an ecosystem needs to be approached with the greatest caution, to prevent social or economic damage to the families directly involved and to others nearby or elsewhere; and to prevent irreversible impoverishment of the natural diversity, which contains known and unknown resources.

After touching on the distribution and extent of the acid sulfate soils, I will discuss separately those in the salt-water and in the fresh-water zones. For the saline acid sulfate soils, the main problem is the question whether or not to protect and preserve them in their natural state. For the fresh-water acid sulfate soil areas, the main social and economic problem is to create an effective kind of development plan, that makes maximum use of the variability in the soils and the capabilities of the settlers, and that is designed for progressive change and improvement to correct for past mistakes.

1 Where people live

The world is a well-populated place. People are living in a great variety of places, but not in all places. Where people can move freely, for example within a given country, they tend to distribute in such a way that productivity of labor becomes similar in different places. The great differences in population density from place to place then reflect, at least in part, income opportunities at the level of available technology and resources. Large empty areas may thus be useless at present technology. For each area empty or almost empty of people, there is a reason: for example, no water in the Empty Quarter of Saudi Arabia. Many such reasons can be summarized under a few major terms. Non-use occurs because there is no available technology or because there are better opportunities elsewhere for the people. In the short run, there are other reasons as well: these can be found in history, politics and physical infrastructure. But the longer-term reasons lie in the unavailability of technology appropriate to the land and in the presence of alternative opportunities of economic activity for the people by whom the area could be reached. Attempts at colonization without recognition of these facts have caused great hardship and loss of development capital in several cases.

2 Occurrence and extent of acid sulfate soils

The world-wide extent of acid sulfate soils is about 13 million hectares: about one percent of the world's cultivated land. When the extent of the acid sulfate soils is compared with the extent of some of the world's other problem soils (Table 1), it is clear that peat soils or saline and sodic soils, for example, are far more extensive - and, incidentally, more persistent. Acid sulfate conditions constitute a problem that persists for a limited number of years, and that bedevils a small part of the earth's crust; a small part even of the total area of problem soils that the population of the world is faced with. Several of the other kinds of problem soils, however, mainly lie in areas that have other major problems as well and that are far away from great concentrations of people. The acid sulfate soils tend to occur under favourable climates for food production (Table 2), often near densely populated coastal areas or river plains (Figure 1), and their development would thus be of immediate interest.

Table 1. World distribution of some problem soils[1] (million ha)

Region	Type of soils			
	Acid sulfate soils	Peat soils	Planosols	Saline and sodic soils
Asia and Far East	6.7	23.5	2.7	19.5
Africa	3.7	12.2	15.9	69.5
Latin America	2.1	7.4	67.2	59.4
North America	0.1	117.8	12.3	16.0
Near and Middle East	0.0	0.0	0.0	53.1
Australia	0.0	4.1	49.3	84.7
Europe	0.0	75.0	4.0	20.7
World total	12.6	240.0	151.4	322.9

[1] Adapted from Beek et al. (1980), based on data from FAO/Unesco Soil map of the World

Table 2. World distribution of acid sulfate soils[1] (million ha)

Region	Length of growing periods (days)				Total
	< 90	90-180	180-300	> 300	
Asia and Far East	0.0	0.2	5.1	1.4	6.7
Africa	0.4	0.7	1.5	1.1	3.7
Latin America	0.0	0.1	0.8	1.2	2.1
North America	0.0	0.0	0.0	0.0	0.1
Other regions	-	-	-	-	0.0
World total	0.4	1.0	7.4	3.7	12.6

[1] Adapted from Beek et al. (1980), based on data from FAO/Unesco Soil map of the World. Growing period data according to FAO Agro-ecological Zones Project, Rome

In comparison with acid sulfate soils the extent of peat soils is larger (Figure 1). Some of the extensive, unused peat areas are enclosed by

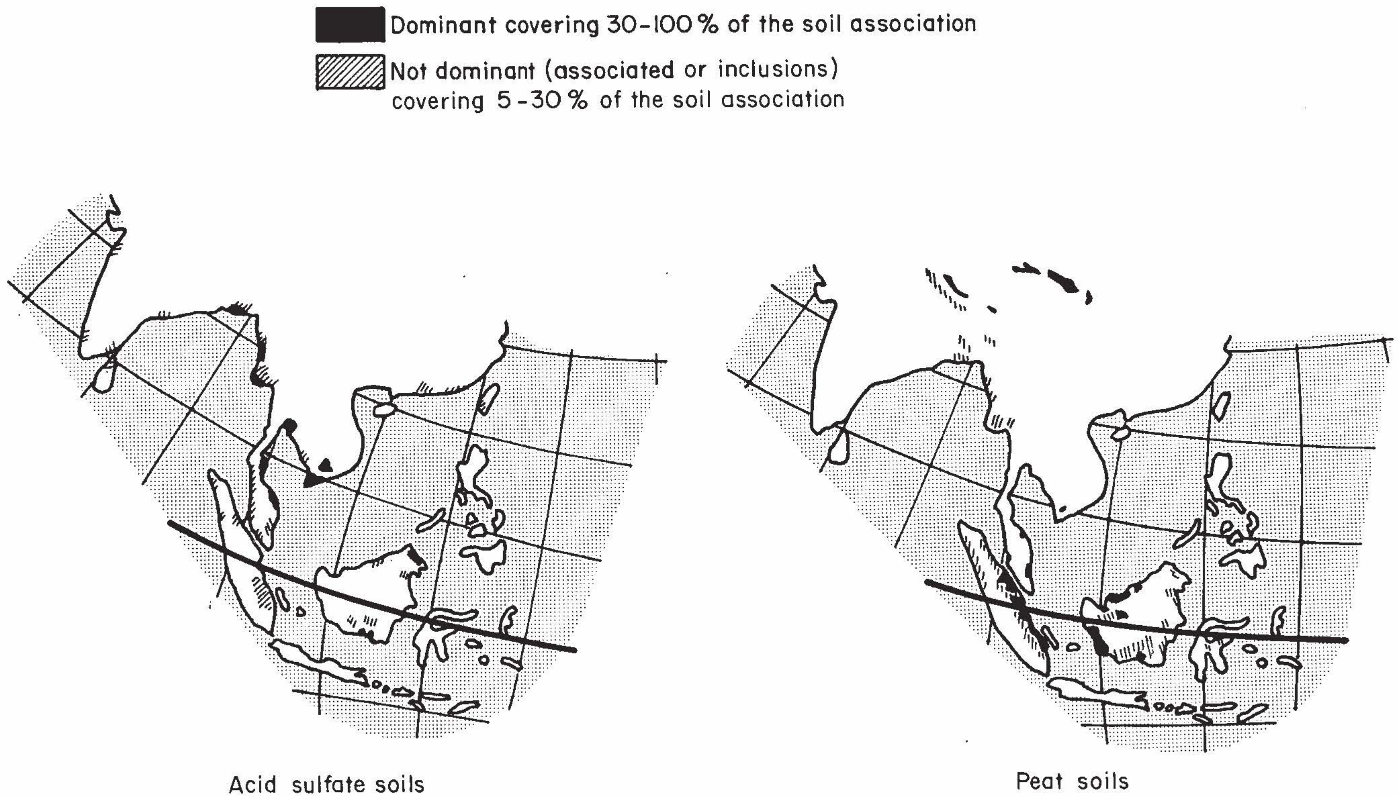

Figure 1. Distribution of acid sulfate soils and peat soils in South and Southeast Asia. Simplified from Beek et al. (1980). Data from FAO/Unesco Soil Map of the World.

acid sulfate margins. These, in turn, generally adjoin more intensively used, better land. In this geographic sense, acid sulfate soils are marginal. There are not yet any economically or even technically valid recipes for the reclamation of certain central, large peat areas. Practical possibilities exist for the development of some acid sulfate soils, and not yet for others. In this sense, too, we are working on the margin of the technically and economically possible. This implies the chance of failure, partial or total, in specific land development efforts.

3 Reasons for development

Decisions on whether or not to develop given areas of acid sulfate soils, and on the direction which development should take, regrettably are often not based on their physical and chemical qualities. However, such decisions may be prompted by population pressure - in adjacent areas or further away - or by the need for employment possibilities or commodities which hopefully could be produced by the land.
The large acid sulfate areas along the northeastern coast of South America (Figure 2) generally lie between a strip of better land in the young coastal plain, toward the coast, and higher land further south. In Guyana, they have largely been developed into reservoirs: low-level seasonal lakes supplying irrigation water for sugar-cane and rice on the better land toward the coast. This extensive use, without any need for soil reclamation, was possible because there is a relative abundance of land compared with the small population. A similar situation occurs in some other parts of South America. The West African acid sulfate areas (Figure 2) are under a somewhat greater pressure for development.
The ratio of population to available, usable land is much higher in South and Southeast Asia. Thus, large areas of acid sulfate soils have been reclaimed by the people, partly without the benefit of scientific advice, particularly in the Central Plain of Thailand. In Indonesia and Vietnam, too, there are heavy pressures on land and urgent needs for land development. These pressures and needs constitute an important reason why the Second International Symposium on Acid Sulfate Soils was convened in 1981.

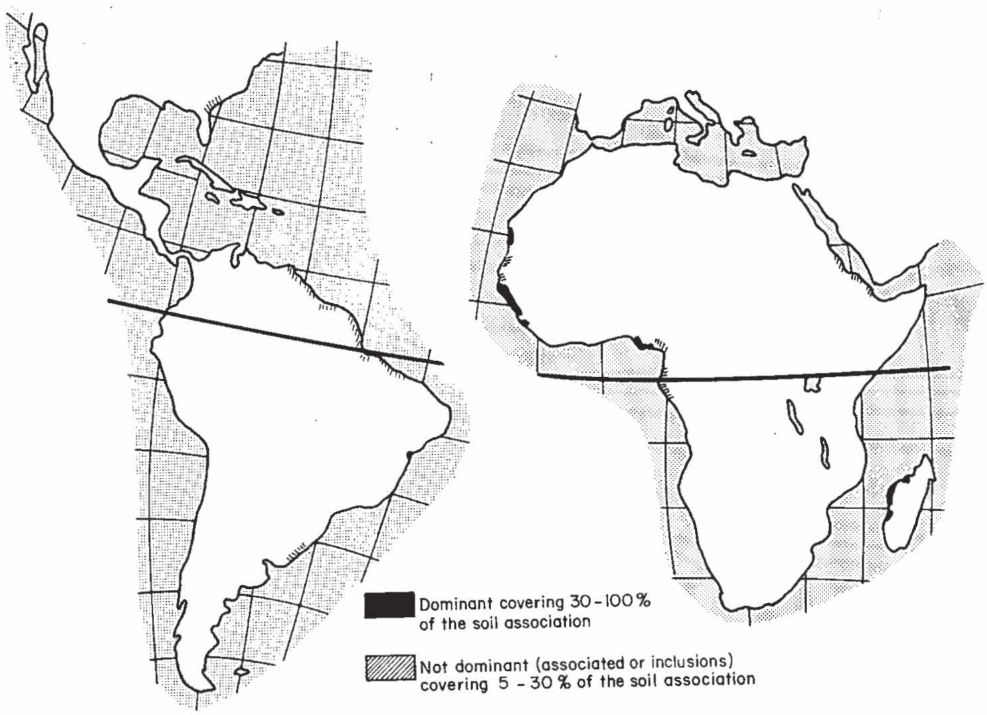

Figure 2. Distribution of acid sulfate soils in Africa and the Americas. Simplified from Beek et al. (1980). Data from FAO/Unesco Soil Map of the World.

4 Possible uses and their socio-economic implications

There is a variety of possible uses of acid sulfate soils:

- for all types of acid sulfate soils, and including some adjacent peat areas: nature reserve, or low-level irrigation water storage and flood protection;
- for inland, fresh-water areas: wetland rice, rubber, oil palm or pineapple;
- for areas closer to the sea, mainly with mangrove and some with a palm vegetation: biomass production for energy, or wood and bark production;
- for the saline areas adjacent to the coast: brackish-water fishponds, or salt pans in climates with a dependable dry season;
- for the salt-water edges: nurseries for fish, shellfish and other marine life. This brings us back to the first use mentioned: protection of the natural ecosystem.

Two main kinds of acid sulfate soil areas can thus be distinguished, each having distinct development alternatives with very different socio-economic implications: the fresh-water and the salt-water zones.

4.1 The salt-water zone

The main socio-economic problems in the salt-water zone are those of choice. There are various development possibilities, each feasible when viewed by itself within a limited area. Each has a different impact on the local ecology and on the adjacent sea area, particularly in its fisheries aspect. These consequences need to be clearly considered and weighed before development decisions are taken.

The natural mangrove ecosystem, part of which occurs on potential acid sulfate soils, is ecologically and economically very important.

In The Philippines (Gonzales 1978), fish of more than 40 zoological families have been recorded from the mangrove area, as well as many species of prawn, crab and oyster. Milkfish and prawn fry are collected for rearing in ponds. The mangrove area is both a nursery and the start of a food chain for much marine life; the disappearance of a mangrove

fringe from a coast-line could have serious or disastrous consequences for fishing activities off-shore. The mangrove and nipa palm forest by itself also yields several products, for example in the Philippines: viscose rayon for textile fibers, tannin for leather manufacture, firewood and charcoal for fuel, thatch and shingles for roofing and walls, palm sap for vinegar and wine, timber for construction and furniture. The main alternatives to keeping the area as a mangrove ecosystem are salt pans, brackish-water fishponds, and wetland rice fields. All three uses require land reclamation measures, involving changes made by engineering, water management and chemical inputs. All three produce large amounts of acids during the reclamation period, part of which will reach the sea. Where extensive areas are to be reclaimed, the impact of this on adjacent coastal fringes will need to be estimated in order to determine a safe rate of reclamation.
At this point I would like to quote some words of Jose Janolo, secretary of the Department of Natural Resources in Manila, on the occasion of the international workshop on mangrove and estuarine area development, in 1977.

> 'We must .. respect our environment and treat it with consideration and care .. There is a very real danger that, in our eagerness to produce and develop .., we may be overlooking the limits of the ecosystem. Have we paused to consider that no technology can ever recreate an extinct species or reconstitute fundamental chemical-biological cycles? .. Our approach to the development of mangrove and estuarine areas .. must be based on an awe and respect for the complex multifaceted and interconnected, but finite environment of which we are all inhabitants.' (Janolo 1978)

Salt pans, rice fields or fishponds. If areas with saline acid sulfate soils are to be reclaimed, there are generally no great infrastructural problems. The main requirement is roads: for inputs and produce, as well as to get the people to services, and services to the people.
In Bangladesh, for example, there is a small potential acid sulfate area called the Chakaria Sunderbans. This was covered by mangrove and was saline, tidal and not yet acid. It was developed (reclaimed) by local

people for rainfed wetland rice and rapidly became extremely acid as soon as the tidewater was excluded by dikes. The rice gave very low yields and failed in some fields. Then the people, who mainly lived on the higher land nearby, changed their poor and failing rice fields into salt pans. In local spots, extremely acid water welled up through the soil into the salt pans. Such spots were isolated and made harmless by separate small dikes. Even though the salt pans are only productive for about 4 months per year, in the dry season, annual incomes per ha were higher than even from good rainfed rice land.

In the Philippines, where much of the acid sulfate area is of the saline type, many of the individual patches are also small, and occur within a few km from schools and markets. Even in this relatively favorable situation, where there is a good infrastructure and where effective procedures for land reclamation and management are known at least to some technical experts, as well as to the land users in some parts of the country, there may still be major socio-economic problems. On coastal acid sulfate soils in Sorsogon, for example, on the southern tip of Luzon Island, wetland paddy yields of about 250 kg/ha are reported. Some farmers keep operating at this level because they have no other opportunities and because they have relatively large holdings.

Rice farming on such land generally appears to be losing ground in two ways: by farmers abandoning the land and migrating to towns, and by conversion of the land into brackish-water fishponds. The latter is a major engineering operating that requires considerable financial resources, but can result in an economically viable production system.

Although the conversion to fishponds appears to be economically sound, there is a major social danger. The conversion requires capital and unrestricted access to saline tidewater for every pond operator. Both these aspects carry the seeds for increasing social disparity, the rich getting richer and the poor being pushed out from the land. Such developments could be prevented by public canals open to tidewater, and by access to sources of medium-term credit for the poor farmer with little land.

4.2 The fresh-water zone

The potential acid sulfate soils in a fresh-water environment seem to constitute a less varied and less valuable natural ecosystem than the saline ones. The reclamation and use of fresh-water acid sulfate soils generally raise greater technical and infrastructural problems, as well as economic and social ones, than the acid sulfate soils in the saline coastal fringe. The individual areas are generally more extensive. In many, there is little or no tidal range to assist drainage and irrigation. There is no salt water to help speed up the removal of acids. Acid drainage water will need to be removed without damage to land downstream. Provision of access and services is generally more difficult and expensive. Known, technically sound procedures of reclamation for wetland or selected dryland crops are not necessarily economic even at low labor costs.

Because of the extent of the 'empty' areas, their large-scale colonization requires infrastructure locally, in the new land, since established services on the old land may be too far away. Similarly, a new network of social connections, support and organization needs to grow or to be developed in large, contiguous colonization areas.

Acid sulfate soil areas are not necessarily homogeneous throughout: they may vary in severity over short distances, and especially along rivers there generally are strips of land without acid sulfate problems. For the most severe acid sulfate soils there do not yet seem to be effective and economically feasible reclamation methods. For the less severe kinds there are practical development possibilities. Some of these have been found by scientists, but several have been developed by the people living and farming on the edges of the acid sulfate areas or within them.

Farmers in the Mekong Delta, for example, developed a system of shallow, broad drains at close intervals throughout the extent of the rainfed wetland rice fields on acid sulfate land. The first rains of the wet season wash much of the acid out of the surface soil into the drains. There it is immobilized by reduction or it is removed toward the rivers. By the time sufficient rain has fallen to raise the water level to the land surface, most of the acid has been removed from the upper few cm and the rest has been immobilized by reduction locally. Reported paddy yields under this system are about 2.5 t/ha, compared with a previous average of about 0.5 t/ha.

5 Failures and successes

5.1 Holland in the last three centuries

In the year 1641, a famous Dutch engineer who became known by the name of Leeghwater (Empty-the-water) devised a plan to drain the largest lake in the Netherlands, 4 meters deep and with a clayey bottom. The task was too great for the windmills existing at that time; two centuries later, in 1848, the Dutch state undertook the work with English steam engines. The drainage was a success - the colonization by farmers was a disaster. Acid sulfate soils covered part of the empoldered lake bottom, and two generations of farmers abandoned the land or went destitute trying to wrest a living from their farms.

Seen in a perspective of centuries, acid sulfate soils are a temporary phenomenon. In the natural, permanently wet state, the acid in them is hidden in the form of pyrite and the soils can exist essentially unchanged for long periods. After drainage, extreme acidity develops, precluding most of the relatively easy development possibilities of swamp areas with better soils. After several decades of leaching by rainfall or irrigation, if drainage has been maintained, much of the acid has been removed and the soil may have become moderately suited for some uses. After a century, it may even become good agricultural land: the former Dutch lake now is a prosperous area.

5.2 Settlement scheme

A more recent example is a polder developed shortly before 1960 in Guyana, South America, to the west of Georgetown. There, the colonists were rice farmers. After a few years, 90 percent of them had abandoned the land again: an enormous economic loss and a social disaster.

At present, there are colonization schemes planned and under execution in acid sulfate areas. People in the planning-and-development investment sector now think of 'socio-economic' aspects of such schemes. We technicians, and planners as well, firmly believe that we will never make mistakes as bad as our predecessors made. But can we bear the responsibility for the chance that they will become similar failures, with consequent social disruption? We should realize that the term 'social' or, worse, 'socio' is not a mere appendix to embellish 'economic'. Its basic meaning is linked with 'together' - not with provision of things from above. Let us examine a kind of organization and planning that may increase the chances of social and economic success.

5.3 Spontaneous colonization

There is a gradual, organic process of land development and homesteading going on in some areas with spontaneous colonization, for example, on Palawan Island in the Philippines (James 1978) and in the tidal swamp land of Kalimantan and Sumatera in Indonesia (Collier 1979).
In the latter, a few Buginese settlers first dig a short section of main canal from a river, then a smaller cross canal serving land on both sides. As clearing proceeds and an economic base becomes established, family members or friends arrive, first stay with the original settlers and work on their land, then start clearing a section of land for themselves under the leadership of the original settler on the canal. Progressively, the main canal is extended and further cross canals are dug. Where problems arise, certain sections can be left unused: meanwhile, they are being drained by the presence of the canals and may in due course become usable. Such local, temporary failures can be absorbed by the social structure that has developed, and do not destroy the local economy. The new people arriving learn the methods of development and farming appropriate to the area from the earlier arrivals. They tend to stay even if there are partial failures because of their investment in money, working time and effort. As the cultivated area expands, there is time for concurrent development and improvement of local services and for the emergence of an effective social organization.

5.4 A Comparison

When we observe developments in large, one-shot reclamation and settlement projects by governments, a very different picture emerges. Total costs per hectare may be similar (or higher), but the rate of abandonment or other failures is higher than in the spontaneous settlements. Settlers in government projects tend to come from very different places. Those who become neighbors generally do not know each other, and all are new in the area, with no local support or experience to draw on. There is no social network or structure; the services provided by government are supposed to keep the people together and active until an economic basis and a social structure have evolved that will stabilize the new community.

This comparison does not intend to show that spontaneous migration would constitute an adequate answer to the economic and social ills of government-organized settlement. Often, the pioneer settlers are social leaders, independent souls, and belong to the relatively rich. The people resettled in government projects mainly belong to the poor, and had very few resources to draw on in their original location. Nevertheless, they should never be uprooted and transplanted, with government credit and fertilizer, into a social vacuum.

6 Development centered on farmers' capabilities

We need to use and adapt the strengths and valuable aspects out of the spontaneous migration experience to improve the government-stimulated programs. The people can protect themselves by their own active participation against some of the mistakes that politicians, planners and we scientists may make.

There is some recent experience with broad overall plans that have wide meshes, gaps, to be filled in later. Only a few of these meshes are filled in detail at the start. This kind of plan-structure allowing small-scale mistakes and progressive improvements would need physical space to correct such mistakes: a frontier situation would be desirable.

In a frontier situation, when there is enough land ready for development between presently used and undeveloped areas, small-scale experiments can be made on different kinds of acid sulfate soils at limited cost, both by the farmers and by scientists on farmers' fields. Successes can be immediately applied on similar land, while failures hold up the advance of part of the reclamation frontier: a gradual and organic process, rather like the tide coming in on a flat beach, successive waves claiming more of the area: then here, then there, and with occasional long delays in certain places.

The settlers for a given project should not be appointed all at once. The first wave of settlers will need to be chosen very carefully. These pioneers should be selected primarily on their capabilities of management, innovation and farming. If possible, they should be chosen with the participation of the villages in which they live. The settlers for a given stretch of frontier should preferably come from villages near to each other and they should be prepared to work together. As more settlers gradually arrive, they find older as well as more recently established settlers in the new area, with a range of practical experience on how to reclaim and use the land.

The willingness to settle in the new land at first may have to be stimulated by considerable direct assistance, but will tend to increase with time, as information about the progress of reclamation filters back from the settlers to the villages of origin. This will increase the chances of success and decrease the amounts of public money that will need to be used for direct assistance. Thus, more resources are available for adequate development of the general infrastructure such as roads, main drains or main irrigation structures.

The crucial aspect in the reclamation of acid sulfate soils is mobilizing the strength of the community of people, creating the possibility for a broad base of experience. If the people moving into areas of new development are strengthened, not weakened, in their technical abilities, their social organization and their mutual support; if they have a stake in the development of the land rather than just being planted there with government credit and fertilizers, they will not sell their borrowed ploughs and roof-sheets and go, but they will jointly make a success of the development even of acid sulfate soils. Our present task is to help in shaping the technical tools for reclamation, making maximum use of the varied experience of the practical farmers.

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