ENVIRONMENTAL ASPECTS OF TIDAL SWAMP LAND DEVELOPMENT FOR AGRICULTURE AND RURAL SETTLEMENT

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Abstract

There are an estimated 10 million hectares of tidal swamps in Indonesia suitable for agriculture. More than 500,000 hectares of them have been reclaimed for agriculture and rural settlements. Tidal swamps are land systems which are naturally susceptible to disturbances as basically they are sustained by a delicate hydrology. This calls for sound management strategies should these natural systems of low environmental constancy can be transformed into agro-ecological systems of high environmental stability. Such a transformation is the key to establish a sustainable agriculture and a habitable environment. To this end appropriate ecotechnologies supported by effective policy instruments are an absolute necessity.

Introduction

A keynote speech is expected to be broad enough to give executives something to comprehend and to get concern about, while sufficiently deep to keep scientific minds interested. This is obviously not easy to achieve, especially as the issues cover such a wide range of ambiguities and aspects like environment. Addressing environmental aspects of land development is supposed to discuss management strategies which permit the maximum number of non-deteriorative compatible uses of land. The meaning of such uses is relative as it depends on how the land responses to perturbation or human interventions. This response is the result of the interdependence and intercorrelation of the different land components.

Land in the sense of the total terrestrial phenomena can be differentiated into different biophysical systems according to a set of natural and artifactial attributes. A different system needs a different approach to develop and improve its benefit producing capacity while protecting it from detrimental disturbances. Thus the management strategy has to be compatible with the characteristics and behaviour of the system.

How then could an environment be defined in the context of land development? Especially in ecological context environment may be used synonymously with habitat (Monkhouse & Small 1978). De Santo (1978) describes habitat as that physical part of the community structure in which the organism finds its home. It is, therefore, the sum total of all the environmental conditions present in the specific place occupied by all the organisms of a particular community. But the term habitat basically implies adaptation of the
organisms to their biophysical surrounding (Stiegl er, 1976). This is the contrary of man’s attitude towards his environment. Using technologic devices and by creating socio economic institutions man attempts to manage his environment for the better in terms of meeting needs and desires. Creating, changing and modifying are always central of man’s actions.

One definition of environment is the whole sum of the surrounding external conditions within which an organism, a community or an object exists (Monkhouse & Small 1978). There is the term land which denotes a complex of surface and near-surface attributes significant to man (Mabbutt 1968). Chryst & Pendleton, Jr. (1958) describe land as the entire natural environment, all the forces or the opportunities that exist independently of man’s activity. Land comprises the physical environment, including climate, relief, soils, hydrology, vegetation, and the results of past and present human activities to the extent that these influence potential for land use (ILRI 1977).

Policy instruments, social and economic institutions, and traditional commitments play important roles in man’s existence. They determine entitlements to opportunities of sharing the uses and benefits of resources, including time and space. In essence the existence of people depend on the suitability of the land for the fulfilment of their needs and desires within the opportunities given by the biophysical constraints and by the operating socio economical and political forces.

Fundamentals of environment and environmental issues

If land attributes constitute environment, then environment is fundamentally an external system of processes. To clarify, soil fertility is generated by the processes of weathering and pedogenesis opposed by the deterioration processes of erosion, leaching and harmful accumulation of certain elements. Soils as entities are intimately associated with the systems of agriculture or rural settlements. So it would be more opportune dealing with soils as internalities of those systems. The processes that determine or influence soil fertility are the externalities. This is true also with the other land attributes, like local climate, relief, local waters, etc. Socio economical and traditional relationships within the local community are internalities, whereas the processes affecting them are externalities. Political conditions and policy instruments at the regional or national level are appropriately considered as externalities.
It is easier to understand and evaluate processes by their observable, or much better by their measurable, effects. Instead of processes one may choose using their effects on the land attributes or on the community as parameters of environment. By this way environments can be quantified and directly correlated to land use activities, whether to study the impacts of human activities on the environment, or the impacts of the environment on the habitants’ survival expectancy. An accelerated rate of erosion can be the result of man’s doing which increases the chance of incidence of erosion. This is the impact of land use on the system of processes (environment). It can be caused by an increase in rainfall erosivity as a phenomenon of the oscillating nature of atmospheric processes. This is the impact of the environment on land use. The reactions of land users to regional or national policies are one of the impacts of land use on the environment. A different land use supporting a different interest will react differently. It is positive if the reaction leads to an improved formulation of land use policies. The environment has a negative impact on the habitat if the policies stimulate inappropriate uses of land. In the words of Frohberg and Konijn (1981) the study of the environment requires the internalization of all externalities.

In addressing environmental issues of land development for agriculture in conjunction with rural settlement such as Indonesia’s agriculture-based transmigration schemes, one should embark in the elaboration of the following principal questions:

a. What should be the optimal level of interaction between agriculture and the environment?
b. What should be the association of the rural settlement with agriculture for reaching and sustaining the optimal level of interaction between agriculture and the environment?
c. What should be the role of the policy instruments, and at what level they should be set, in the framework of questions one and two?

Optimization of the agriculture - environment interaction means that agriculture development is pursued through a management system which adopts ecological as well as economical principles. It has implications for both its ecological situation and its economical system. Such a management system needs the support of a compensative interdependence of agriculture and rural settlement. This means that agricultural productivity depends on the effective support of rural services, while in turn the efficacy of this support is encouraged by a profitable agriculture.
Policy instruments should act as conditioning factors of both the optimization and compensation processes towards equitable and sustainable results.

The first question is the most important, but finding the precise answer is extremely difficult. It confronts the two diametrically opposed human attitudes:

a. Desire of farmers as economic individuals to get the most profit out of their farming business;

b. Willingness of farmers coming forth from the ecological kinship all organisms share to comply with the capability limits of their habitat.

Both are the psychological products of sensations and perceptions, and primeval instinct of survival. They are therefore heavily biased by ethnological and sociological backgrounds. As such they are place and time dependent. Improved welfare, especially of formerly subsistent communities, often results in the prevalence of quick-profit-mindedness over conservation consciousness.

Another difficulty arises from the fact that impacts can be exported from one area to another. For example, erosion materials are exported by upstream areas and eventually imported as beneficial or detrimental deposits by their associated downstream areas. Chemical pollutants in waters may come from higher laying fertilized and pesticide sprayed crop lands. The importing lands may have different impact resistance and different interests to support than the exporting lands. An optimal level of interaction between agriculture and environment for a commanding land system may not be so when considered from its transmitted effects on the commanded land system.

The second question implies that farming is an integral part of rural activities. This postulates an agriculture-based rural economy, meaning strong agricultural linkages of all rural-based services and industries. The appropriate technologies should be those which can act as intermediary agents between the ecological condition faced by the entire rural community, the economic system the community lives on, and the community adherence by tradition to certain social values. Thus the answer to the second question will be the development of technologies which Carlstein (1982) calls them collectively ecotechnology. This is also one facet of the answer to the first question. Obviously ecotechnology is area specific and changes with time. Ecotechnology is a function of space and time.

From the operational point of view the third question is the most decisive, thus the most important from the executive angle. The elaborations on the first question have made it clear that it is hardly possible to set a universally valid ecological standard of optimal
interaction between agriculture and environment. There are also a complex of factors to be considered in designing ecotechnologies. In most cases optimum is a conceptual value rather than an actual one. Thus an optimal criterion relies heavily on policies drawn from perception and common sense.

**Background of tidal swamp land development in Indonesia**

Except for the last few years Indonesia was constantly hard-pressed by rice shortage from domestic production to feed her fast growing population. Huge imports of rice became a major instrument of balance of the country’s national security and stability at the tremendous cost in foreign payments. Meanwhile Indonesia embarked on a big intensification program of boosting her domestic rice production from existing irrigated lands. The program became known as Bimas and later on stepped up by the Inmas and Insus programs, improved versions of the Bimas. Rice production has since been pushed up as fast and hard as the participating subsistent farmers can take. The at the start ambitious target of self-sufficiency in rice was pursued, and still is, at any cost including subsidizing input and output prices. Although the efforts have paid off handsomely at last, but intensification has its limits. Further increases should be sought in the expansion of cultivated land. These new lands will also provide reserves for future intensification.

The expansion of wet rice into upland areas, which used to be the common trend, requires the expansion of existing irrigation networks or construction of new ones. Either one is costly, especially if it is intended to bring new lands under cultivation. This will be the case of concomitant expansion of agriculture and resettlement of farmers to open up new areas, like Indonesia’s agriculture-based transmigration schemes. A different approach has to be followed should cost be saved. There are the tidal swamps where since unknown time the Bugis people have been producing rice with evidently sustainable yields. Their method is simple, utilizing tidal energy for intermittently inundating and draining their rice lands. Amazingly recent sophisticated research had come to the conclusion that periodical movement of soil water is quite effective in generating soil fertility. Intermittent irrigation on lowland rice is now a common practice in many countries.

Tidal energy is inexhaustible and free as long as the moon is still orbiting the earth and the seas are still full of water. As it is non-commercial or subeconomic its use is congruent with the world-wide campaign to create innovative production technologies to eliminate excess dependence on fossil energy. This means diversifying energy sources by
adding new and renewable or inexhaustible sources. It adds to its advantage if the source is locally available. Tidal energy also meets this criterion.

The history of tidal swamp development for agriculture in general and for wet rice in particular is inseparable from the professional and public careers of the late minister Sutami of Public Works. He got strongly impressed by the ingenuity of the Bugis tidal irrigation technique, more so because it was invented by illiterate farmers who of course never went to engineering schools. He then entertained the innovative idea of adopting the principles of that traditional technique. Before long he became an ardent advocate of this time-honored engineering novelty to be developed into a new irrigation system which in the future should become the tidal swamp equivalent of what gravity irrigation is now for uplands.

When fully developed the tidal irrigation system will be able to add to Indonesia’s arable land some 10 million hectares of tidal swamp land suitable for agriculture (Noorsyamsi et al. 1984). According to studies made by the Ministry of Public Works, the total investment cost in tidal irrigation is much lower compared with conventional gravity irrigation.

Comprising the costs of investigation and design, land clearing, construction of canal network and structures from main canal to farm level ditches, and overhead expenditures, the investment per hectare in tidal irrigation is around Rp 108 000 or equivalent to US$ 270 (at domestic prices and exchange rate of 1974). This is about 49% of the FAO standard at that time of US$ 600 for investment per hectare in conventional irrigation for lowland rice (estimated using figures stated in Anon. 1968, 1974).

The Bugis experience in Sungsang and Jambi, both in Sumatera, has proved that after the system has matured a wet rice crop can yield on the average 3 to 4 Mg (ton) ha\(^{-1}\). In other areas the local farmers also reclaimed part of their lands for other crops, such as cassava, pineapple, banana, coconut and other tree crops. For example, in the 35 year old resettlement area of Tamban in Central Kalimantan, home gardens of coconut have been successfully established. The more than 70 year old Serapat Area has developed into an organized settlement (Anon. 1968). These are indeed encouraging achievements in light of the simple reclamation technology the settlers were using.

These facts of great opportunities were enough for the late minister Sutami to set the highest priority in the development of tidal swamps. It soon became the Indonesian Government’s strongest policy instrument in agriculture development in Sumatera and
Kalimantan. While in Java and Bali it is the intensification policies of Bimas, Inmas and Insus. As a matter of fact the development of tidal swamps is the extensification counterpart of the intensification programs, and together they form the core instrument of resources development, physical as well as human, which is the essence of the agricultural development of Indonesia, of which transmigration schemes are important components.

At about the turn of the 1960s the Government called upon the cooperation of universities to work out technologies and execution strategies for the development of tidal swamps. Without any reliable knowledge and experience to start with, IPB, ITB and UGM plunged into the problem, urged by the gravity of the nation’s rice pressure. The working condition was far from idealistic by scientific standards. Investigations, pilot tests, result adjustments, monitoring, real-scale execution, and moving in of settlers were following each other in too short sequences, frequently even overlapping. As reclamation and settlement of the land went almost simultaneously, the results during the first years were understandably erratic and confusing, and therefore unreliable for any judgement. Through years of trials and errors, racing with time and the typical impatience of the bureaucracy when dealing with research, and not to a lesser degree moving against well meant warnings from expatriate colleagues, the three universities succeeded at last in having their pioneering job done. This for Indonesia unique government sponsored large-scale academic exercise has accomplished the putting on the ground of the foundation of tidal swamp land development. Many more still need to be done to improve and perfect the performance of the system to meet the acceptable demands of ecology, economy and society.

**Environment and development of tidal swamps as systemic phenomena**

Environmental aspects of tidal swamp land development will be discussed using the following data base:

a. The autochthonous changes in the land attributes brought about by the development, and their probably exportable impacts on neighbouring terrestrial or aquatic systems
b. The reactions of associated natural systems to changes occurring in the developed land, triggered off by the shift in the natural balance
c. The conditioning effects of human socio-cultural interrelationships on the development process, including competitive or conflicting interests, policy instrumentation and implementation, and availability of knowledge, skill and experience.
d. The concept of equitability and sustainability of developmental changes from a holistic view of land use planning. The analysis module is presented in Figure 1. For brevity the conditioning factors created by the human socio-cultural interrelationships have been left out. They are implicitly understood codefining constraints to development, directing reclamation, amelioration and correcting measures, and determining the kinds of anthropogenic features superimposed on the indigenous land attributes.

Tidal swamps are terrestrial - marine interface land systems. They are formed and maintained by the consociation of coastal hydrology as the intensity factor and coastal morphology as the conditioning factor. As hydrology is the dominant, active factor in the consociation, tidal swamps are intensively dynamic systems and highly variable in space and time.

Being interface systems between the two major resource systems of the earth, tidal swamps are ecologically usually highly productive, especially where the coastal hydrology is straightly connected with the inland hydrology. The coastal morphology influences the importance of the hydrology. It also influences the magnitude of the hydrology when seen from the other land components which are dependent on the hydrological conditions, like vegetation and soils. The terms importance and magnitude are adopted from environmental impact assessments. In this sense hydrology and morphology are genetic factors as well as attributes of tidal swamps. Vegetation and soils are attributes but not factors. The existence of vegetation is not a criterion of swamps (Amer. Geol. Inst. 1962), and so it is a facultative attribute. But vegetation, and soils, may be used as differentiae of swamps and to assay changes occurring in swamps.

Tidal swamps are delicate land systems because they are the products of a specific environment consisting of only a few genetic factors where hydrology dominates. As hydrology is prone to perturbation, the resistance of tidal land systems against disturbances are weak. But due to that same hydrology their resiliency or recovery potential is relatively fast, provided that the stress is not excessive. All important changes in tidal swamps are the results of or associated with changes in their hydrology, whether directional as drainage or recurring as cyclic hydration - dehydration.

One hydrology related phenomenon is the deposition of peat found in many areas of tidal swamps, varying in thickness from a few centimeters to several meters as well as in degree of decomposition ranging from highly fibrous to mucky. Another is the highly dispersed condition and low bearing capacity of the fine mineral sediments due to
prolonged water saturation. Tidal swamp soils may be characterized by the accumulation of surfuric material which upon intensified drainage undergoes oxidation forming strongly acid sulfudic compounds. Highly dispersed mineral soils and peats particularly the fibrous ones are liable to subsidence upon improved drainage, physical alterations, or chemical and biochemical decompositions. Subsidence modifies relief and elevation of the land, and these in turn affect the hydrology of the site. The modifying effect of subsidence on relief is stronger the more heterogenous the material is as different materials or different states the material is in have different potentials of subsidence. This means that the hydrological effect on the site is greater.

**In situ impacts on land capability**

Two clues akin to each other towards a sound land management are hydrology and subsidence. All major processes in tidal swamps are controlled by hydrology, including subsidence. Subsidence generates a feedback mechanism in hydrology. Under continuous waterlogging which creates an anaerobic condition sulfidic material predominates. When aerobic condition prevails the sulfidic material is oxidized to surfulic compounds and at the same time liberates ferric iron. Physical alterations and chemical and biochemical decompositions of soil materials are enhanced by desaturation of the soil or by the activation of soil water movement. Upon strong and prolonged desiccation peats become irreversibly hydrophobic. They can still recover after a certain period of rewetting if the water stress was not excessive. Drainage increases the danger of soil acidification. But by the same token drainage provides the opportunity of lessening the risk of developing strong acidity during the progress of reclamation by leaching the sulfates.

Self-restoration of soil pH during hydro-reclamation of tidal swamp soils had been observed in the Jelapat resettlement area in South Kalimantan.

When first mapped in 1971 a large part of the area was covered by acid sulfate soils. Five years after full-scale hydro-reclamation no more acid sulfate soils could be detected apart from a few scattered spots (P4S-UGM Test Farm Team 1976). Conformably the content in water soluble sulfates in the surface and subsurface layers decreased. There were the disadvantages of decrease in the organic matter content and the leaching of N, P and K. Base saturation also decreased in consequence of enforced leaching. A decrease in peat thickness was indicated too.
Contradictory to the fact, the results of the first soil survey had led to the conclusion that several hundreds of years will be needed to free just the upper 20 cm of soil from pyrites if only natural rainfall is used for leaching and the leachate is discharged by gravity drainage only (Driessen & Soepraptohardjo, 1974). This might be correct but it is irrelevant to the problem solving. This sharp contrast of prediction and fact proves three things. First, the prediction was made without being aware of the potential of tidal energy for hydro-reclamation. Second, the system of hydro-reclamation which has been applied is effective. The disadvantage on soil fertility should be accepted as a calculated risk which will be taken care of in the next phase of amelioration.

Figure 1. Analysis module for addressing basic environmental issues of tidal swamp land development

Third, the disappearance of acidity is most likely not just a straightforward result of leaching, but more fundamental processes are involved in the alleviation of acidity. The most ready explanation is the subsequent reduction in deeper soil layers of the eluviated...
acids to less acid compounds. The reduction is enhanced by the presence of readily decomposable organic matter. The other processes which might be active are the neutralization of the acids by bases released during the acidolysis of aluminosilicate minerals or by bases and alkalinity brought in from surrounding sources by the rising tide, the transformation of the strongly acid sulfates to the weakly acid carbonates by CO₂ from the soil biological activities, and the complexolysis of Fe³⁺ and Al³⁺ by organic ligands forming metalo-organic chelates. Complexolysis liberates OH from the Fe and Al hydroxides which mitigates the imbalance of OH against H in the soil solution. Pyrite is rapidly oxidized by Fe³⁺ in solution, thereby reducing the iron to Fe³⁺, but ferric iron is generated again from ferrous iron by the bacteria Thiobacillus ferrooxidans (Dent, 1986). The chelation of Fe³⁺ may play a significant role in retarding this catalytic oxidation of pyrites.

Furthermore, the formation of chelates facilitates the leaching of excess plant absorbable Fe and Al so that toxic accumulation of these elements can be restrained. In these respects the chelation activity of organic molecules is far more important than their ability to enhance reduction and to create a strong anaerobic soil condition. One tends to postulate that peat and its decomposition products are greatly instrumental in the hydro-reclamation of acid sulfate soils.

The feedback mechanism in hydrology generated by subsidence may create constraints to the progress of reclamation, including the physical ripening of the mineral soil material, the chemical and biochemical ripening of peat, and the removal of acidity and toxicity produced by acid sulfate weathering or the arrest of the acid sulfate weathering itself.

Since many intricate reactions take part during hydro-reclamation, a seemingly slight deviation in water control may cause a steep drawback to the progress of land capability augmentation. It stands to reason that a thorough understanding of the soil behaviour under tidal hydrology is imperative. This calls for a high research priority in dynamic pedology.

The urgency of such a research is illustrated by the opposite case of Sei Puntik, also in South Kalimantan, to the previously mentioned case of Jelapat. Due to an inapt design of the reclamation works in Sei Puntik built during the Japanese occupation in the Second World War, the acid sulfates have persisted ever since and got even worse recently. It can be noted that in contrast with the Jelapat soils the Sei Puntik soils are practically destitute of peat.
Exported impacts

Basically resettlement areas are selected at a distance from indigenous villages with the purpose of establishing new growth poles. As yet no observations on transmitted impacts on existing cultivated lands or dwelling sites were seen necessary. In addition, if there were muddy or acid effluents from the new settlements they were presumably of limited significance as the effluents will get greatly diluted by the time they enter the big estuaries before flowing with high tide into neighbouring villages.

Reactions of associated natural systems

The reactions taking place at the air - land and sea - land interfaces are the most pertinent. The first interface reaction can be assessed at the change in the microclimate. The second one is assessable at the magnitude of sea water intrusion. The parameters of microclimate were air and soil temperatures, and air relative humidity. The assessment was based on the importance and magnitude of the changes when forest or bush vegetation was converted into tree crops, natural grass, wet rice crop, or dwelling compounds. The importance of change is signified by the degree of numerical change in the parameters relative to the values of forest or bush land as base. The magnitude of change is indicated by the meaning of the numerical change for the site quality or suitability for a specified use. The parameters of sea water intrusion were water and soil salinity in EC. As soluble sulfates contribute to the increase in EC a higher EC signifies a greater salinity only if it coexists with a pH which is close to neutral or slightly alkaline.

Table 1 shows the microclimate characteristics of the Kotabaru Area in South Kalimantan and of the Terentang Delta in West Kalimantan under different land uses. It can be concluded that the importance of change is rather apparent but the magnitude is small. The changes are more notable in the air relative humidity and soil temperature. Generally the importance of change is bigger in the Terentang Delta than in the Kotabaru Area but the magnitude of change is the same in both areas. Using the Leopold scoring of importance/magnitude, each on a scale of 0 to 10, the change in microclimate when reacting upon the changes in land use can be marked 8/4 and 6/4 for the Terentang Delta and the Kotabaru Area, respectively.

As a whole the problem of water and soil salinity are of minor importance since estuarine flats within the normal reach of saline or brackish water intrusion are basically
avoided for resettlements. Some salinity incidents may occur during an abnormal dry season. The commencing of the heavy rains of the wet season after it prevent the building up of salinity.

Sea water intruding areas of acid sulfate soils is beneficial rather than harmful. In the Teluk Batang Area of West Kalimantan, where the land is beyond flooding by the incoming high tide, the intruding sea water through the canal walls has a strong neutralizing effect on the subsoil acidity, or preventing the potential acidity to emerge. Aluh-Aluh in South Kalimantan, which is periodically affected by sea water seepage, has one of the comparatively productive soils. Through their long experience the indigenous farmers have developed a specific cropping system.

They begin planting their crops after the salinity recedes which normally occurs at the start of the rainy season after sufficient rain has fallen.

They leave the land fallow when the sea water intrusion becomes too strong which will usually come when the dry season advances towards its peak. The farmers have a certain way or feeling to predict the commencement of such an intolerable salinity.

At one time a serious salinity problem had arisen in one half of the Tabunganen Area just behind the aforementioned Aluh-Aluh Area. It was caused by an intermeddling in technical design matters by the local administration, constructing an access waterway by connecting one part of the canal network directly with the sea.

The appearance of plant pests and diseases are the natural reactions of the biological system to the perturbed steady state of equilibrium, caused by the change of an established natural system into a developing cultural system. As long as those malignancies are still manageable they have to be accepted as reasonable risks of achieving a higher carrying capacity of the land. They are the consequences of and the challenges to development. This holds true also for the previously mentioned problems of subsidence, irreversible water repellent of peat, acid sulfate weathering, and salinity.

**Human socio-cultural interrelationships**

Whatever the reason had been behind the said Tabunganen case of the blundering intermeddling in technical design matters, it exhibited clearly the great potential of political powers in generating an adversity of unpredictable consequences to the environment. This case pronounced a self acknowledged prerogative of the local political
instruments to favour a certain interest group while negating the fact that fundamentally land is a national asset.

The physical problems commonly manifesting in new tidal land settlements in Indonesia stemmed from the inconsistent observance of the technical operation timetable. The various line departments involved in the projects were concerned in their respective targets only. Coordination at the operational level was weak and still is, although at the executive level coordination has been endorsed with handsome ceremony. Besides, each department had different budget liquidity terms so that they were compelled to proceed with their own work schedules. This was the frequently raised argument for not being able to follow correctly the present activity sequences for the best physical results. The presence of farmers even when they were just working their home garden plots to make living more bearable in an area of wet and soft ground, interfered by their large numbers with the smooth progress of reclamation.

Another problem came from the fact that the resettled farmers had not been duly prepared for working a quite different type of land than what they were accustomed to on their former farms, or what they used to see in the region they had lived in before. Reorientation and retraining of transmigrants prior to moving them to the new settlements were much neglected. The incompatibility of traditional skill with the conditions of the land to be worked is another source of detrimental impact on the environment.

**Holistic view of tidal swamp land development**

It has never been the intention of the speaker to bring out an ecological accounting matrix. The core question was not what will be the balance of gains and losses when, say, a mangrove system is converted into an agricultural system. If an assessment was done on an ecological accounting matrix, a mangrove forest clearing may get a maximum Leopold mark of 10/10 like in the case of the Kotabaru Area of South Kalimantan (P4S-UGM Ecological Team, 1976-77 b). This means that a mangrove forest clearing will practically denude that area of that type of forest because the existing total size is very limited, hence a maximum mark of importance.

As the existence of an adequate size of mangrove forest determines the quality of the area to support near-shore fishery, the magnitude mark denoting the impact of clearing is also maximum, i.e. 10. A clearing of primary forest in the same area got a Leopold mark
of 8/8 as the total forest reserve in that area was small and the forest consisted for the greater part of valuable timber.

The greatest weakness inherent in such a system of assessment is that it is confined to that particular area. It has no criterion of minimum size of land as the valid term of the assessment. The smaller the land being assessed the higher the impact mark will be. Every assessment will then come up with a quasi-scientific recommendation that not a single plot of a natural ecosystem should be allowed to be converted into an agro ecosystem, even if the latter system has a higher producing capacity and provides more opportunities for better living. The assessment gives no room for considering alternate benefits.

Table 1. Changes in Microclimate of Kotabaru Area and the Terentang Delta in Response to changes in land cover as exhibit by air and soil temperatures, and air relative humidity

<table>
<thead>
<tr>
<th>Microclimate parameters</th>
<th>Land cover</th>
<th>Kotabaru South Kalimantan</th>
<th>Terentang West Kalimantan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dry season</td>
<td>Wet season</td>
</tr>
<tr>
<td>Air temp. °C</td>
<td>Forest</td>
<td>31.1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bush</td>
<td>-</td>
<td>28.4</td>
</tr>
<tr>
<td></td>
<td>Rubber</td>
<td>30.2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Coconut</td>
<td>30.2</td>
<td>28.6</td>
</tr>
<tr>
<td></td>
<td>Grass</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Wet rice</td>
<td>30.2</td>
<td>28.5</td>
</tr>
<tr>
<td></td>
<td>Dwelling</td>
<td>-</td>
<td>29.4</td>
</tr>
<tr>
<td>Soil temp. °C</td>
<td>Forest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bush</td>
<td>-</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td>Coconut</td>
<td>-</td>
<td>26.0</td>
</tr>
<tr>
<td></td>
<td>Wet rice</td>
<td>-</td>
<td>27.0</td>
</tr>
<tr>
<td>Air relative humidity %</td>
<td>Forest</td>
<td>78.2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Bush</td>
<td>-</td>
<td>79.5</td>
</tr>
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<td></td>
<td>Rubber</td>
<td>81.0</td>
<td>-</td>
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<tr>
<td></td>
<td>Grass</td>
<td>80.5</td>
<td>-</td>
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<tr>
<td></td>
<td>Wet rice</td>
<td>80.4</td>
<td>82.5</td>
</tr>
</tbody>
</table>

* Predicted for the annual average. P4S-Ugm Ecological Team (1976-77 a, b)

If such an assessment should be followed it must embark on the total land assets of the country. No one needs to have mangroves in every conceivable place. Where will we put our harbours, our industries, our sea side resorts, our brackish water fish ponds? The fundamental issue has to be what will be the effects of land development, through its impact on the environment, on the development itself. This is the concept of sustainability of development. Sustainability of development will be assured by the appropriate choices...
of management systems which take into account resource management actions, implementation tools, and institutional and organization arrangements. It has been stated by Almeida et al., as cited by Soemarwoto (1984), that in developing countries environmental degradation often results from the lack of development. Soemarwoto further said that under such conditions environmental amelioration can only occur with development. Even if the development would cause negative impacts the overall effects could still be positive.

The other basic issue is how large a mangrove forest is needed and where it should be kept, maintained, or preserved, whether for ecological or for economical reasons, and where it can be given away for conversion.

This is the concept of land use planning for equitability. In a recent FAO environmental study on the management and utilization of mangroves in Asia and the Pacific, several recommendations for better balancing the interests of production with the continuing productivity of the ecosystem have been put forward. It stressed on the formulation of land use plans upon interdisciplinary research covering environmental impact assessment and socio economic studies on which to base integrated development programs in forestry, fisheries and agriculture (Cerescope 1983).

Fig. 2 is a basic model of environment management which combines the fulfilment of environmental protection or compensation with the secured productive and well balanced performance of resources. The model illustrates how environmental aspects should be treated in supporting development. It should be clear already by now that we are not concerned with environmental aspects of perturbations, but we are duly aware of environmental facts which upon understanding them the smooth progress of the overall development depends.

There are two exclusive activities concerning the perpetual utilization of renewable resources. One is called preservation which aims at keeping the original structure of the resource systems intact in order to perpetuate their natural functions. The other is conservation which means the protection of the resource systems from degradation while performing their anew functions at a higher level of proficiency in meeting the diversified and increasing demands of the population. There are parts of the country’s tidal swamp lands where preservation will be sensible. But there are other parts which under objective as well as subjective considerations prescribe land development, so that there conservation will be the right answer to environmental issues. It is a matter of intelligent land use
planning for the purpose of the optimal allocation of resources among the different sectors of interest on a national scale.

This is again a policy matter as optimization of use of resources is a concept of national security and survival. It must be stressed that such a land use planning is crucial. Without a judicious control enforced by a governmental act land use allocations will become a power struggle among competing or conflicting interests. The first to suffer under such a struggle will be the environment. Environmental deterioration will lead to a more agitated struggle for seizing better lands still remaining.

References


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