A Regional Strategic Framework

for the

Reclamation of Salt-affected Soils

and

Agriculture Recovery

in

Tsunami-affected Areas

Outputs of a Regional Workshop

Held

31 March - 1 April 2005
Bangkok, Thailand

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Preamble

On 26 December 2004 a massive earthquake of magnitude 9.0 (on the Richter scale) occurred off the West Coast of Northern Sumatra, Indonesia, followed by a series of aftershocks that triggered tidal waves (tsunami) resulting in the loss of thousands of lives and the livelihoods of coastal communities in Southeast and South Asia, and as far away as Somalia. The countries hardest hit by the disaster are Indonesia, Sri Lanka, Maldives, India and Thailand.

Four months after the disaster the most pressing humanitarian needs for medical supplies, clean water, food, shelter and sanitation, have been taken care of and the priority for the affected communities now is to restart productive activities as soon as possible in order to regain their livelihoods, to secure food supplies as well as to recover from the psychological trauma caused by the tsunami.

The Food and Agriculture Organization of the United Nations (FAO) is actively involved in assisting these countries in the resumption of agricultural activities. A number of emergency assistance projects have been initiated to support the farming communities in the affected regions who lost their harvests, assets and subsequently the means to support their livelihoods and who are unlikely to meet the immediate food needs of their families without assistance. To evaluate the damages to agricultural lands and to plan appropriate interventions, successive assessment missions were undertaken in affected countries and four months after the disaster it is time to establish a regional assessment of the situation with respect to damages and to consolidate recovery plans for salt-affected lands and the agriculture sector.

One of the main impacts of the tsunami on the agricultural sector is related to salt contamination. This issue immediately received a lot of attention from key actors in agriculture, farmers and communities concerned about domestic water supply. This concern reflects an important fear within the agricultural sector and rural communities of facing a strong decrease in land fertility and high salt pollution resulting from sea intrusion. In that respect some alarmist opinions have been widespread about the high impact on soils and the many years required for reclaiming the land. Fortunately, this fear proved to be unfounded, or more precisely is founded on salinity problems that are far different. It is true that reclaiming salinized soils in arid countries can take years, but it is obvious that the nature, duration and type of impact are very different in this case.

In the tropical climate of the Indian Ocean, precipitation is quite abundant during the monsoon and provides an opportunity for salt leaching and soil cleansing. Immediately after the 26th of December FAO made the assumption that in most cases salt will be leached out after a few months of rain or irrigation, provided that the fields are properly drained. To enable stakeholders to monitor the recovery process and start cultivation again as soon as the top soil salinity has dropped below the threshold level for crop cultivation, FAO provided affected countries with electrical conductivity (EC) meters along with training to staff on monitoring salinity. Based on preliminary information obtained from the field so far, the Agriculture Department of the FAO has drafted a **framework for a reclamation action plan for affected soils**.

Resumption of agricultural activities and restoration of crop production in the affected areas is dependent on rehabilitation of damaged agricultural areas and infrastructure, reclamation of salt-affected soils, appropriate land use planning and the strategic adjustment of cropping systems.

Focussing on these issues, the FAO Regional Office for Asia and the Pacific convened a regional workshop to bring together interested parties involved in post-tsunami soil assessments and rehabilitation work. The workshop provided participants with an opportunity to share information, collectively assess initial findings related to rehabilitation needs and opportunities, share plans and proposals for future rehabilitation work, and develop mechanisms for collaboration and joint activities.

About 45 experts participated in the regional workshop representing six countries (see list in annex 4). A regional framework for agriculture was discussed and this report presents the outcomes of the workshop and the regional framework.

PART 1 Damage Assessment

1.1 Assessing Damage and Resilience of the Agricultural Sector

In general, the recovery of the agricultural sector depends on two major issues:

- The impact or damage to the agriculture capacity; and
- the capacity to recover or the resilience of the system.

Considering the damages, the tidal waves of the tsunami are physically similar to inland flash floods, with the additional aspects of salt water and sea sand deposit.

Tsunami related damages differ **by type**:

- Direct crop destruction by uprooting, salt poisoning, flooding, yield losses, etc;
- erosion and scouring, modifying the topography and removal of (paddy) bunds;
- fertility loss when the upper soil layer is washed away;
- salinity;
- sedimentation; and
- trash and debris accumulation.

Damages also differ **by intensity** depending on:

- The energy of the flood;
- the type of soil coverage and vegetation; and
- the hydraulic properties of the soil, including drainage capacity.

Resilience is a concept often applied to ecosystems after pollution. In the case of this disaster we speak about a human-agro-eco-system. The **resilience** of a system is its **capacity to recover** after having been affected by a disaster. For the agricultural sector, it refers to its capacity to re-embark on agricultural production. Two major factors determining the resilience of a system (among many) are:

- The **infrastructure capacity** to facilitate the return to a normal situation; and
- the **human capacity** to re-engage in agricultural activities.

Based on the above-mentioned factors, FAO proposed a simple classification system for assessing the damages and identifying appropriate courses of action for reclaiming the soil and restarting cultivation:

Extent of Damages	**Infrastructure Capacity**	**Farming/Human Capacity**
Determines the severity of the impacts (by type and intensity) at field level and the related efforts needed to restore production capacity.	Irrigation and drainage infrastructure — capacity to start the new cropping season with a reliable supply of water. Transport infrastructure — capacity to get access, etc. Support infrastructure, etc.	Determines the human capacity and skills to re-engage in agricultural activities and to undertake reclamation work to return to pre-tsunami production (systems).
← **Damage** →	← **Resilience** →	

1.2 Accounting for Differential Damage and Resilience

The effects of the earthquake and the subsequent tsunami vary strongly among countries. But variances in impact can be significant within a country or a province, or even within communities too. This is because of the differential damage caused, and also because of variances in resilience. Some regions, although badly affected, still have the support systems and access roads in place, whereas in others this regenerative power is badly affected. This applies to entire regions (like West Aceh), but

also to the community level where huge differences exist between households, depending on the number and skills of the deceased.
Differences among and within countries must be fully considered and reflected in the rehabilitation approaches:

- Where the damage is not severe, the immediate goal is to restore the pre-tsunami situation.
- Where damages are severe — and in the longer term in less damaged areas — the approach may include land-use planning (Integrated Coastal Area Management), land titling and commercialization and diversification strategies.

1.3 Accounting for Uncertainties, Household and Community Fragmentation

The human death toll was the most severe impact of the tsunami. For the agricultural sector this means a huge reduction in labour and support capacity. Many survivors are traumatized and in the worst stricken areas it will take a long time for farmers to return to their normal lives.
Social fragmentation and trauma at the family and community level will remain a major problem for many years. Many of the survivors are male heads of families, as many female heads of families were unable to withstand the waters and were washed away whilst trying to aid their children and elderly family members. The effects of large numbers of missing or deceased people on household and community decision-making processes and labour requirements have yet to be experienced. This situation presents a major challenge in the identification and implementation of appropriate interventions at the household and community level.

Official land tenure records and customary records held in the "communal memory" may have been lost — undoubtedly there will be disputes over the use and transfer of land previously owned by deceased community members.

1.4 Damage: Land

Land damages differ by type and intensity. In general, the closer the land is to the sea, the more damage has been reported, i.e. more and more sandy sediments, more scouring, longer inundation with saline water, etc. FAO proposed a technical framework in which 4 major land classes (A, B, C, D) were identified according to the severity of the damage and the resilience of the system. A short description can be found in appendix 3.

Salinization is a critical issue as it reduces or inhibits plant growth. Fields may have been covered by sea water for a prolonged period (days or weeks); others may have been covered by saline clay deposits. The degree of salinization depends on the duration of exposure to sea water and the soil type. Sandy soils have a high infiltration rate, resulting in contamination to a high depth in the soil profile. However, the capacity of sandy soil to fix and retain salt is limited and a minimum of fresh water will leach out salts from the profile. Clay soils are less sensitive, but in cases of prolonged inundation, the damages become progressively severe. Remediation will therefore require much more time and inputs.
Deposits can be saline and inundation may have caused sodicity problems. Sodicity affects plant growth because of limited nutrient uptake. Furthermore, sodic soils tend to be dispersive and easily eroded. Sodicity will be a bigger problem for non-rice crops and for crops on clay soils.
In the case of salinity, fresh water is a determining factor in resilience. Where there is no fresh water source (rain or irrigation) resilience is slow and resembles the salinity problems of arid regions.

1.5 Damage: Livestock

In many communities, almost all cattle, goats and poultry were either lost or killed. Many buffaloes appear to have survived, possibly because they were able to swim out of danger. Careful monitoring of livestock health status is required. Roving herds of ownerless cattle, buffaloes, goats and sheep may cause problems in the coming cropping season and will need to be returned to their owners. Restocking of backyard poultry and small ruminants (goats and sheep) will be required. Re-stocking of buffaloes has less priority as the majority of rice farmers use hand tractors for rice cultivation.

1.6 Resilience: Farming/Human Capacity

For returnee farmers, the loss of farm assets (cash, buildings, seed, livestock, tools, etc), cash income (vegetables, coconut, oil palm, peanuts, cocoa, rubber, etc) and support services (rented hand tractors, casual labour, agricultural inputs, local processors, markets, etc) will prevent many farmers from re-entering the agricultural production cycle and marketing their produce. The recapitalization of farm enterprises and the restoration of local support services is an immediate priority. The restoration of market linkages and physical access will also require forward planning in terms of rehabilitating infrastructure around community locations. Priority must be given to activities that strengthen the resilience of the farming system. A critical element is labour. The labour force has been drastically reduced and a lot of labour is currently needed in rehabilitation efforts.

1.7 Resilience: Infrastructure Capacity

As the sea water receded, many of the feeder and drainage channels for the rice growing areas were destroyed or severely silted and require major rehabilitation or reconstruction. Many freshwater sources have been destroyed or are contaminated with salt water.

Preliminary assessments clearly show the importance of infrastructure in dealing with the post-tsunami situation. For instance, road infrastructure is crucial for support services, while irrigation infrastructure is the key recovery factor in dry regions.

Constraints related to infrastructure may impede the carrying out of civil and field works (land levelling and watering) and the return to a normal situation.

1.8 Quantitative Assessment

All lands affected by the tsunami have been salinized. The extent of salt pollution is highly dependent on variables such as the duration of the floods, the nature of the soil, the presence of salt deposits etc. The following table gives an overview of the initial damages to agricultural lands caused by the tsunami considering countries and main areas. The damages are presented using the Land Damage Classification System developed by FAO (ranging from A (minor damage) to D (land completely lost). The table also gives the recovery rates from salinity for the different regions as assessed (March and April) and as predicted (End of May).

Affected countries	**Comments on Assessment** *Assumptions*	**Affected Area Per Class (ha)** A/B/C1	C2/D	Total	**Early March Situation** (%)	**Desalinized** (ha)	Not yet cleared	**Early April Situation** (%)	**Desalinized** (ha)	Not yet cleared	**End of May Predicted Situation** (%)	**Desalinized** (ha)	Not yet cleared
Indonesia (West)	50% classes A, B, C1; 50% classes C2,D	14 235	14 915	29 150	72	10 235	4 000	81	11 555	2 680	100	14 235	-
Indonesia (East)	100% classes A, B, C1	8 300	-	8 300	30	2 500	5 800	39	3 223	5 077	57	4 690	3 611
India (Islands)	*Damage assumed to be similar to Indonesia (West Coast)*	5 372	5 628	11 000	72	3 862	1 509	81	4 360	1 011	100	5 372	-
India (Mainland)	*Assumed to be Similar to East Sri Lanka with less rainfall*	8 782	-	8 782	30	2 635	6 147	33	2 924	5 858	40	3 513	5 269
Sri Lanka	90% classes A&B; 10% Class C	3 780	420	4 200	65	2 457	1 323	68	2 582	1 198	75	2 835	945
Maldives	100% of fields in classes A&B	1 900	-	1 900	80	1 520	380	87	1 645	255	100	1 900	-
Thailand	100% of fields in classes A&B	900	-	900	80	720	180	87	779	121	100	900	-
Myanmar	No significant damage to agricultural land	-	-	-	-	-	-	-	-	-	-	-	-
Total		**43 269**	**20 963**	**64 232**	**55**	**23 929**	**19 340**	**63**	**27 069**	**16 200**	**77**	**33 444**	**9 825**

1.9 Assessment Overviews Per Country

These overviews combine information presented by the workshop's participants and that already available mainly through the UN system.

1.9.1 Indonesia

- Agricultural land damages are widespread and severe. There are different types of damage, most of them occurring simultaneously:
  - Direct crop destruction by the waves, salt poisoning, uprooting etc
  - De-surfacing of the landscape as a result of erosion and sedimentation
  - Deposition of salted sediment and salt infiltration
  - Trash and debris accumulation, destruction of field bunds
  - Fertility depletion when the top soil is eroded.
- Infrastructure to support economic activity has been devastated and its repair is critical.
- Roads, irrigation and drainage infrastructure, markets, government offices, cars, etc have been washed away.
- As many as 92 000 farms and small enterprises (providing jobs to around 160 000 people) have been destroyed.
- More than 600 000 women and men in Aceh and Nias, about one fourth of the total working population, have lost their jobs.
- The support sector sustained heavy capacity losses, as many of the staff are among the deceased.

The effects of the earthquake and the resultant tsunami were more severe along the west than the east coast. The west coast, being closer to the epicentre, received the full impact of the tsunami. The damage was very severe along unprotected sections of the coastline and extended as far as six kilometres inland up river systems. Coastal towns and villages and roads and bridges were decimated. Damage to livestock populations and rice growing areas was severe with debris and layers of sediment of variable thickness, kind and origin deposited on the latter.

Along the east coast, the damage was more sporadic affecting small coastal areas exposed to the northerly wave action. Roads and power were not dramatically affected and, although there are pockets of severe damage, particularly to fish and shrimp ponds and livestock, the long-term effects are minimal.

1.9.2 India

India has been hit in two areas: Along the east coasts (mainly) of Andra Pradesh and Tamil Nadu and in the Andaman and Nicobar islands. The latter were close to the epicentre of the earthquake and have suffered severe damage to property, agricultural lands and the farming community. The extent of damage is not uniform in all the islands. Most affected islands are Car-Nicobar, and Hut Bay.

The overall extent of damage in the islands is as follows:
Number of villages affected = 68
Area affected = 11 000 ha
Number of people affected = 350 000 out of 550 000 (63.6 percent)
Almost one-third of the farming community has been affected.
There has been extensive damage to agricultural crops, building structures and houses and the establishments on the seacoast.

Along the east coasts of Andra Pradesh, Tamil Nadu and Kerala an estimated 8 720 ha. have been affected by sea floods. Damages are usually less severe than on the islands. The resilience, however, is lower because of the absence of precipitation (dry season).

1.9.3 Sri Lanka

The disaster has claimed an estimated 30 974 lives, 4 698 persons are missing, 23 176 are injured and more than 248 266 families are affected. About 117 300 houses have been damaged (as of 01 February 2005). The fishing community, its industries and others who lived close to the sea have suffered most. The damage to agriculture is also significant, especially if the numerous home gardens in the vicinity of dwellings are taken into consideration.

The affected paddy fields amount to an estimated acreage of 9 000 acres (3 630 ha) whereas other field crops (OFC) amount to 627 acres, 525 acres for vegetable farms and 315 acres of fruit trees.

- Heavy damages to 27 000 home gardens.
- In areas that received substantial rainfall EC_e and EC_w 1-5 dS m^{-1}.
- In areas that did not receive any substantial rainfall EC_e 6-25 dS/m and EC_w 5-15 dSm^{-1}.
- At the start of the *yala* season 65 percent of the affected area will be ready for cultivation, as far as salinity is concerned; 40 percent taking all agronomic problems into consideration.
- At the start of the *maha* season (September) 90 percent will be ready for cultivation, from a salinity and agronomic point of view.
- 10 percent of the problem area consists of a large rainfed paddy areas in low lying land between the coast and a lagoon (>400 ha in Mullaitivu).
- From a technical point of view salinity is not a major obstacle to re-engagement in crop production.
- Lack of experience and knowledge of how to cope with salinity is a major impediment to speedy re-engagement in crop production.

1.9.4 Maldives

- Maldives was very vulnerable to the tsunami, because:
  - The highest elevation in the country is 1.5m above sea level
  - The population is widely dispersed across very small islands that are often remote and inaccessible.
- Agricultural land, crops and home gardens (accounting for 50 percent of total damage) have been destroyed:
  - 112 agricultural islands affected
  - About 15 000 farmers affected
  - 73 percent of the agricultural area was affected
  - An estimated 370 000 fruit trees died as a result of salt accumulation near the plants.
- The tsunami-waves caused extensive beach erosion. Natural vegetation and crops were damaged and died from the direct impacts or from high soil salinity levels.
- The flood water has raised the water-table and salinized upper groundwater. Groundwater has become contaminated at places by leaking septic tanks and oil spillage.
- The flooding of wells caused high salinity levels in the surrounding groundwater.
- The seawater intruded laterally into the ground water aquifer, thereby salinizing the fresh water lens over some distance inland.
- It is estimated that monsoon rains will flush out enough salt from the fresh water lens to make well water safe for irrigation.
- Some of the farmers experienced the loss of their assets: Farm tools, agro-fertilizers and pesticides.
- Some of the inter-atoll cargo vessels were badly damaged and this has had a bad impact on the farmers in terms of marketing.

1.9.5 Thailand

About 900 ha of agriculture have been damaged by sea floods:

- Six provinces affected, +/- 1 080 farmers. 80 percent of affected agricultural lands were tree plantations (rubber, oil palm, fruit trees).

- Main characteristics of the affected soils: Coarse-textured beach and sea bottom sandy sediment; well-drained.
- Minor salinity problems, only in very few pockets water logging and perishing of plants.
- Shallow and surface water resources temporarily affected by salinity. Groundwater largely unaffected.

1.9.6 Myanmar

- Agricultural damage as result from the tsunami is negligible. Damages mainly concentrated on fisheries and seaside villages.
- Myanmar escaped from high damages and high number of casualties as the tsunami developed more in an east and west direction and mangrove forests protected the coastal zone.

PART 2: Framework Goal and Objectives

2.1 Framework Goal:

The rapid rehabilitation and improvement of sustainable agriculture based livelihood activities of the coastal communities affected by the tsunami on 26 December 2004 through enhanced and strengthened efforts to rehabilitate their affected land and natural resource base and the agricultural sector.

2.2 Framework Objective:

To support, strengthen and enhance assessment, emergency relief, and rehabilitation of coastal communities in the countries affected by the tsunami, in particular in the areas of rehabilitation of damaged agricultural areas and infrastructure, reclamation of salt-affected soils for resumption of crop production, appropriate land use planning and strategic adjustment of cropping systems, rehabilitation of irrigation and drainage systems and agricultural recovery, to ensure that these:

- Contribute to poverty alleviation, sustainable livelihoods and food security at household, local and national levels;
- are based on sound regulation, good governance and functional management institutions that ensure equitable development and safety within the different parts of the sector;
- use appropriate technologies with due recognition of the environmentally sustainable limits to managing and exploiting the natural resource base;
- are part of a holistic view of the coastal ecosystems and are managed according to the principles of integrated coastal area management, including the wider aspects of land tenure, land and water, fisheries and forestry, relocation of communities and equity;
- have a well integrated livelihood and sectoral approach that encompasses agricultural support services and institutions to spur agricultural development opportunities for the coastal communities.

Through:

- The development of guidelines on land reclamation measures and strategies for technically feasible rehabilitation and mitigation plans;
- the identification of needs, priorities and emerging issues at country level regarding the reclamation of tsunami-affected land and ecosystems and agricultural recovery;
- the promotion of key strategies for land resource assessment, land use planning and agricultural recovery; and
- mechanisms for coordination, exchange of information and technical co-operation among collaborating national, regional and international governmental and non-governmental organizations.

PART 3 Guiding Principles for Agriculture and Coastal Rehabilitation/Reconstruction

3.1 Guiding Principles

Agriculture recovery plans have been formulated and discussed in each affected country and are now ready for implementation. In this section we present the results of the discussions and exchange of information on the guiding principles for post-tsunami rehabilitation interventions.

We identified three overriding principles in tsunami interventions

I. **People centred approach —** dealing with people, their sensitivities, resources and livelihoods.
II. **Integrated approach —** implementing agro-economic and socio-economic interventions
III. **Acknowledging opportunities and threats —** Disasters provide both opportunities and threats that need to be addressed.

These three overriding principles can be subdivided into six guiding principles:

1. Conflict sensitivity
2. Building people's capacities
3. Integrated approach
4. Going beyond the status-quo
5. Subsidiarity
6. Risk-taking.

3.2 Discussion of Guiding Principles

3.2.1 People centred approach

- The most devastating effect of the tsunami has been on people; the death toll is enormous and the capacities of survivors along the coast have received a serious blow, both quantitatively as qualitatively.
- All assistance should thus be targeted towards rebuilding the lives, confidence, and dignity of the communities. This can only be achieved by considering the cultural features and the coping capabilities of the local communities. Strengthening the capacities of people as individuals or in groups is the daunting task of all interventions.
- Societies are constituted of — and people are organized in — ethnic, social, cultural groups. Interventions should not fuel new conflicts nor reactivate old ones.
- Women are central in society. The importance of including women in any consensus building at every stage of rehabilitation and reconstruction cannot be overstated. Specific efforts need to be made to support local women's NGOs and ensure women have a role in decision-making, implementation and oversight of programmes at community level.
- Vulnerable groups and people are more affected by disasters and should receive special attention.

3.2.2 Integrated approach

- The coastal zone accommodates a complex mixture of many activities including tourism, fisheries, agriculture and forestry. Agriculture and home gardening are major activities, but cannot be isolated from the others. Full consideration should be given to multi-sector (agri-fishery-industry) and multifunction activities (production-protection-environment).

3.2.3 Acknowledging opportunities and threats

- The strong global expression of solidarity after the December 2004 tsunami provides opportunities for improving the situation of affected populations, but the disaster also generated risks.
- Opportunities are related to development and reconstruction of more sustainable livelihoods for people living along the coast, e.g. better protected, more equitable, more profitable, more environmentally sound.
- The risks are associated with the enormous flow of money, the numbers of actors involved, etc. This makes control of the inputs and coordination of interventions more difficult, and increases the risk of waste and misappropriation of funds.

3.2.4 Six guiding principles

P1. Conflict sensitivity: The interventions should not exacerbate existing ethnic, social, or cultural conflicts or fuel new ones. At the local level, possibilities can be sought to overcome existing conflicts through the interventions. This principle obviously applies to the countries where civil war/unrest has been prevalent in the last decades, but also to countries where the social system is partitioning society.

P2. Building people's capacities
The result of the disaster will be felt long after fields have been cleaned of salts and debris. The human factor is central in this (as in all) catastrophes. The capacity of all actors in the agriculture sector has been severely affected (although it has not disappeared). The issue needs to be addressed in an energetic manner. The goal is not to restore the pre-tsunami capacities only. Capabilities of all actors/institutions should be strengthened to deal with hazards resulting from the disaster. Moreover, the rehabilitation of the sector requires a quick recovery of capacities to be able to embark on this process (from professional masons to district policy staff). Capacity building should be diversified and target different players essential for quick recovery. Support to the government and administrative structures (especially in agriculture), civil society institutions, private sector, research institutes, and farmers and farming communities should form an integral part of all recovery strategies.

P3. Integrated approach: A comprehensive and coordinated approach is required to tackle complexity within the agro-sector, multi-sector activities and multifunction of land use and the institutional set–up. Even within the recovery process of the agricultural system support to labourers, artisans, suppliers of inputs and traders is of equal importance as support to farmers and an integrated and comprehensive approach is needed.

P4. Going beyond the status quo:
Immediately after the disaster several voices expressed the need not to reconstruct pre-tsunami vulnerabilities or unsustainable situations (like over-capacity in fishing). The reconstruction phase needs to be much broader than simply replacing what existed before the tsunami. It is not desirable to restore vulnerability and poverty and, in cases of massive destruction, restoration of the previous situation is not even an option. It is critical, therefore, that the reconstruction plan aims to offer reliable opportunities for the diversification of livelihoods that are more profitable, reduce vulnerabilities and contribute to sustainable natural resource management.
Interventions should, through their strategies, target the reduction of inequity. While immediate efforts need to focus on approaches that recapitalize households that have lost their key productive assets, restoration of livelihoods should actively focus on people without capital as well. It is important to stress that most vulnerable groups are often overlooked as they fall out of easily visible interest groups. Interventions should try to get these invisible or less visible entities (i.e. women, landless, informal sector) on board.

P5. Subsidiarity: The rehabilitation strategy must be based on the principle of subsidiarity. This means that all interventions should respect the (developing) mandates and competences of government, civil society and private sector institutions. It also means that regional planning should be sensitive to local concerns and ambitions and that responsibility should be delegated to the lowest possible level where coherent planning can be guaranteed. It calls for a well-conceived distribution of roles and consequent responsibilities of the different actors involved. The subsidiarity principle should guide the reconciliation of bottom-up and top-down approaches, recognizing that each actor/tier of government has responsibilities of a different nature.

Combining P4 and P5 results in a **coordinated approach** that**:**

- Can work through and complement existing interventions, rather than duplicating or replacing them;
- recognizes the importance of moving smoothly through the three interrelated development phases — relief, rehabilitation and reconstruction — towards the development of a sustainable agriculture industry;
- builds partnerships by unifying and coordinating those activities that are already being undertaken by government, non-government agencies and donors;
- links interventions to achieve synergy (for example, linking local government capacity building programs to new social mobilization programs).

P6. Risk taking: Interventions should be rapid. In a situation of massive emergency needs, interventions for recovery of the baseline activities and food production/supply should be carried out immediately and rapidly, even if there are many technical uncertainties about damages and resilience. It is difficult in these conditions to ensure that all activities embarked upon will be a hundred percent effective and transparent. But the risk of not doing anything while waiting to get everything right is much higher than acting immediately with the knowledge that some interventions might not turn out to be as good as we thought. Therefore, adaptive management is needed in which risks are deliberately taken, but where there is continuous monitoring and modification of the management process. This reflection-in-action is critical in all phases of post-disaster management.

PART 4 Salinity and Sodicity: Reclamation of Land and Water Resources

Damage to agricultural land and losses in fertility has multiple causes: Debris, sedimentation, erosion, salinization of land and siltation of irrigation feeder and drainage canals, removal of bunds, disturbance of land levelling. Damages are highly variable and location specific. As such, detailed local assessments to determine the extent and nature of the damage and methods of land reclamation should be conducted and plans should be tailored accordingly.
The FAO salinity assessments resulted in an overview of the problems related to land damages/losses. For a more comprehensive discussion of the criteria used in the development of the aforementioned classification system the reader is referred to PART 1 or the MoA-FAO framework for rehabilitation of the tsunami-affected agricultural areas in Aceh, Indonesia. Notwithstanding the general conclusion that salinity problems have decreased tremendously as a result of natural conditions and (over)irrigation, salinity and sodicity remain important issues to be monitored at least for the near future.
This part of the framework will mainly deal with salinity and sodicity management (4.1- 4.4). Other reclamation strategies at field level are either complementary or mitigate other land damage problems, caused by the tsunami (4.5).
Some reclamation interventions are targeting only single effects whereas others have multiple objectives. For instance, restoration of bunds and field levelling are useful in preparing the land for rice cultivation for the next season, but a more immediate effect is capturing precipitation and/or spreading irrigation water to allow uniform leaching of salt.

4.1 Comprehensive Assessment System

Apart from the now-completed FAO assessments, a detailed assessment of salinity/sodicity of soils affected by the tsunami has not been undertaken to date. Whilst an assessment of soil-pH and electrical conductivity (EC) (as carried out in previous FAO assessments) are an effective means of evaluating salinity, these attributes may not indicate a potential sodicity hazard. A comprehensive assessment system is proposed to address this gap and to be able to continue monitoring salinity and sodicity problems. This system should consist of the following:

- A simple **field-based guideline** for assessing the presence of **salinity and sodicity** (and acid sulphate materials) that will enable extension staff, field workers and farmers to assess the presence of these conditions. This would include current methods used in the field, namely pH and EC measurements, along with visual estimates of turbidity associated with clay dispersion as an indicator of the presence of sodium (and possibly Mg^{2+}). A draft field-based guideline is presented in appendix 1.
- Assessment of sediments through a **simple field guide** to determine the presence of **pyritic materials**. Significant sediment deposition has occurred, with depths ranging from 5 to over 20 cm. These sediments consist of a mix of sand, silt, clay, organic matter and primary/secondary minerals. Because of the marine origin of these sediments they may contain pyritic materials that could generate significant acidity when exposed to an oxidizing environment. A draft technical field guide is presented in appendix 2.
- **Comprehensive training** of extension staff, field workers and farmers. This should be commenced as soon as possible. The training should deal with the field-based guidelines for **assessing salinity, sodicity and acid sulphate materials**. The initial efforts in assessing salinity/sodicity/acid sulphate materials at the field level should focus on land Classes B and C1 as it is assumed that Class A soils are either currently under production or will be brought back into production this coming wet season. In addition, capacity building within the national agricultural research and extension services in the analysis and assessment of salinity/sodicity may be required.
- **Permanent monitoring sites**. These should be set up to initially undertake a comprehensive assessment of soil chemical, physical and biological properties. These monitoring sites would then be routinely sampled in order to assess the efficacy of rehabilitation over the next five years.

These sites would provide valuable data and information on the pace of rehabilitation and associated changes in productivity. The sites would provide baseline data on the effects of the tsunami and the impact of interventions. Such monitoring sites should be selected in each of the affected countries and information generated from these monitoring sites should be shared amongst all parties through a **communications network**. This data would have significant scientific value and provide insight into the processes of rehabilitation.

4.2 Rehabilitation of Land and Water Resources

4.2.1 Soil reclamation

Dominant agricultural activities in the tsunami-affected area were lowland paddy (both rainfed and irrigated) and home gardens. In the former, surface flushing may be effective in dissolving deposited salts. Most efforts will be needed to recover fields with crops other than paddy (maize, peanuts, etc), as soil properties are of lesser importance to paddy than to other crops. In all field-based rehabilitation activities an **adequate drainage system** is a critical component of the overall reclamation process as this network will transport soluble salts from the field. Thus, a high priority should be given to repairing damaged drainage systems and making them functional. If drainage infrastructure has to be constructed, a comprehensive assessment of the costs/benefits associated with the rehabilitation process should be made before deciding on rehabilitation of these areas. (Re-)constructing drainage infrastructure is expensive and any decision to undertake major works should be the responsibility of the local or national government. Guidelines for the rehabilitation of drainage systems (as developed by FAO) should be applied to these systems.

Along with effective drainage, **land levelling** is critical in the reclamation of salt-affected soils and efficient irrigation management. Lands affected by salt intrusion should be levelled prior to the commencement of surface flushing. This can be achieved using sophisticated laser levelling devices (if appropriate and feasible) or simpler grader systems that can be tractor-mounted.

The **steps in the reclamation** of salt-affected soils can be summarized as follows:

- **Leaching/surface flushing** of salts will require the presence of an adequate drainage system on soils of both light and heavy texture. It is assumed that this will effectively be achieved through natural rainfall in many parts of the region and will allow the majority of salt affected soils to be brought back into production before or within the coming wet season.
- Reclamation of **saline-sodic and sodic soils** is often more problematic. Comprehensive soil chemical testing should be undertaken prior to any intervention to ascertain the nature of the problem. Such analysis would include an assessment of the exchangeable sodium percentage (ESP), sodium adsorption ratio (SAR), electrical conductivity (EC) and pH. Rates of gypsum or phosphogypsum — necessary to allow effective displacement of sodium from the exchange complex — can be estimated on the basis of these assessments. Drainage is essential in this form of rehabilitation to either leach or flush the salt from the soil.
- **Management of acid sulphate soil**. There is a possibility that sediments deposited or exposed by the tsunami may be of an acid-sulphate nature. Management options for these soils/sediments are:
    a. Keep these soils/sediments flooded at all times and avoid the development of oxidizing conditions. This is an option for shrimp ponds, but not for paddy.
    b. If these soils have been exposed to oxidizing conditions through drying, liming materials should be applied in order to neutralize the acidity generated.

4.2.2 Reclamation of water resources

Contaminated open and shallow tube wells can be reclaimed through natural flushing that will occur during the next wet season or by pumping and monitoring the EC. The EC of water for agricultural and drinking purposes should be below 2 dS m^{-1}.

Intrusion of ocean water is a threat from excess pumping, and can cause ingress of salinity, particularly in locations where the aquifers are highly permeable.

In areas with interlayered contaminated fresh and saline water aquifers, there is a need to clearly identify in what ways the aquifers were contaminated by the recent tsunami in the light of historical salinity, before taking remedial action. Reclamation of groundwater can be problematic in such areas.

4.3 Improvement of Soil Quality and Production Systems

Along with the rehabilitation of salt/sodic soils affected by the tsunami there is a need to enhance the productivity and sustainability of these production systems. This can be achieved through a number of on-farm based activities. In order to effect the implementation of improved management strategies, the provision of basic farming tools and equipment needs to be undertaken as soon as possible.
Proposed activities are:

Increasing soil organic matter: Addition of organic matter materials will assist in accelerating the reclamation process for saline-sodic and sodic soils in addition to the supply of nutrients to the developing crop:

- As there was significant debris of an organic nature deposited on the surface after the tsunami, this material could be composted and used as a soil conditioner. This would have a positive effect on the chemical and physical properties of the soil. This could also include the incorporation of animal manures and other household composted materials.
- The growing of green manure crops and their subsequent incorporation into the soil will assist in improving soil properties. There are a range of crops that could be used as green manures. (See for example FAO World Soil Resources Report 76: Green manuring for soil productivity improvement (1994)).

Use of salt-tolerant crops and varieties: Crops and varieties that tolerate high salt levels may form an intermediate strategy in the reclamation of salt affected soils. There are a number of salt-tolerant rice genotypes. The use of these **salt-tolerant genotypes** should be viewed as an intermediate step in the reclamation of saline soils, to be combined with normal leaching/flushing. Another option in regions with a distinct monsoon regime is a **delayed planting** and cultivation of varieties with shorter growing periods to allow for leaching without losing the planting season.

Training of extension staff: In order to implement these strategies, comprehensive training of extension staff and farmers will be required. Training should include the above-mentioned field assessment of saline/sodic soils and reclamation methodologies, including drainage, crop production technologies and management. This requires the development of comprehensive training modules. An effective means of achieving this could be through the Farmer Field School (FFS) concept developed by FAO.

4.4 Information and Experience Network

As mentioned already under 4.1, an exchange network should be established amongst the countries affected by the tsunami. This network would allow for the **exchange of information** between countries regarding progress with respect to reclamation of salt affected soils and methodologies used to reclaim these soils. The network would also serve as a **central repository** of information that would be generated from established permanent monitoring sites. FAO or another organization should coordinate the network.

4.5 Other Land Reclamation Measures

4.5.1. Cleaning of trash and debris

Removal of trash and debris is the first step in field reclamation. Depending on the gravity of the damage this will be done on an individual or collective basis. The removal of tree trunks requires a capacity beyond that of the individual farmer and should be done either through heavy equipment (which is rarely available) or collective works.

4.5.2. Dealing with sedimentation

The practical options for dealing with sediment deposits are:

- **Physical removal** (a difficult option for small farmer communities as 10 cm of sediment over a hectare is equivalent to 1 000 m^3 of sediment, weighing 1 500 tons). It might be an option for home gardens, but not for larger fields;
- **mixing** the sediment with the underlying soil (NB: hand tractors can only reach down to 20 cm).

The issue of deposit is variable and options/solutions may vary depending on the nature and the depth of the deposit. From preliminary observations and discussions with farmers it seems that only in one case strong interventions are required: A high depth of sand over clay soil (see table below).

Deposit	Soil	Options
Sand	Sand	mix deposit with soil
Clay	Clay	mix deposit with soil
Clay	Sand	mix deposit with soil — this is likely to increase fertility
Sand	Clay	Options depend on depth of sediment layer: ▪ Up to 5(10) centimetres: There should be no problem mixing the sand with the soil; ▪ more than 10 centimetres can cause fertility problems, and farmers will have to weigh two options: Invest in removing the top sand layer or try to accommodate it within the soil profile by deeper ploughing.

Table 4.1 Options for dealing with deposits on different soils

The removal of deposits raises the issue of where and how far to dump the deposit and the costs of removal and transportation. Assuming the deposit is dumped at the side of the field, this represents a section of 2.5 m^2 along the periphery of a 1 hectare (100 x 100 m) field (10 percent of the total area).

4.5.3 Levelling and bunding

Paddy fields needs to be levelled especially in many cases of class B and most of class C since the local topography has been modified by erosion, scouring and sedimentation. Farmers also need to reconstruct paddy field bunds that have been washed out, particularly those parallel to the wave front. These activities have priority where salinity/sodicity occurs (4.2.1), but have to be carried out before cultivation in all cases.

PART 5 Diversification and Commercialization of Agriculture Systems Affected by the Tsunami

5.1 Opportunities for Diversification and Commercialization Activities

It is generally accepted that pre-tsunami conditions were not ideal in many regions. The severity of the disaster — waves washing away everything and everybody in their path — makes rehabilitation a tremendous task. After the first shock, communities and supporting organizations will have to rebuild livelihoods in the coastal zones. These should not necessarily reflect pre-tsunami situations. Partly because they cannot be achieved (for example in lands of Class C2 and D) and, during rehabilitation an effort should be made to look beyond the previous situation to overcome the vulnerabilities of the pre-tsunami farming system.

As part of these overall **risk management strategies** (extensively dealt with in national frameworks and not repeated here) **diversification and commercialization** (D&C) of agricultural systems are suggested paths to follow. The framework presented here elaborates on the important issues in D&C that should be taken into consideration and expands on the scope for regional cooperation. Country-specific policies are developed in national frameworks.

In order to introduce and enable the growth of sustainable diversified and commercialized agricultural systems, strategies should focus on:

- **Recovery before growth:** Re-establishing livelihoods is the over-riding objective in the rehabilitation and reconstruction phases. Immediate efforts should focus on approaches that recapitalize households that have lost their key productive assets, before attempting improved diversification and commercialization.
- **Household income and asset accumulation**: Re-establishing and improving household production and reconstructing and strengthening the private sector — through development of processing, markets, small enterprises, other businesses and financial services — will lead to improved incomes and asset accumulation, which could in turn enable households and communities to improve buffering of their livelihoods against the numerous risks currently existing in the tsunami-affected areas.
- **Support services:** Improvements in public services and infrastructure will have the twin benefits of reducing vulnerability (for example through improved transport and communications, and through social protection schemes) and improving skills (which in turn improve their ability to manage productive activities or find employment).

Many enabling factors are required to enable resource-poor farmers to shift from subsistence farming to diversified or commercialized farming. Even when these elements are present, the transition is generally slow and risky and very much determined by the degree of market liberalization and the degree of peace and order existing in the area. A number of inter-related key-factors that, in general, enable the development of diversification and commercialization activities are:

- Access to markets and market information
- Post-harvest processing facilities
- Road access
- Trade and input suppliers
- On- and off-farm mechanization
- Community cohesion and the presence of organized farmer groups
- Secure land ownership/tenure
- Supportive policy
- Local and national political system or strong state (next to strong civil society)
- Peace and order.

A very rough and simple overview of the possibilities for D&C of the farming systems in the various affected areas is presented to support the tailoring of regional strategies:

- Maldives, south-west Thailand and south-east India have vibrant market economies and support service industries. Many of the enabling factors required for D&C were not adversely affected by the tsunami and can be quickly rehabilitated.
- The farming systems in the southern coasts of Myanmar and Sri Lanka and the eastern coast of Sumatra are in the early stages of D&C. As above, many of the D&C enabling factors were not adversely affected and can be quickly rehabilitated.
- The farm systems on the north-east coast of Sri Lanka are mainly subsistence-focused and the prevailing peace and order situation will limit future D&C opportunities.
- The farm systems on the north-west coast of Sumatra were mainly subsistence-focused and the prevailing peace and order situation over the last two decades has prevented D&C activities. Many of the D&C enabling factors that were present before the tsunami have been seriously affected and massive rehabilitation efforts are required.

5.2 Critical Factors to Consider in the Promotion of D&C Activities

The critical factors that need to be considered during the difficult process of establishing an enabling environment for a sustainable D&C farm system are:

- **Identification of crop/livestock systems** for the various agro-ecological zones — In order to fast-track the difficult process of farmer adoption, applied research and extension processes can be combined in simple small farm (single factorial) experiments.
- **Economic analysis of profitability and risk** — Every D&C intervention promoted must be evaluated in terms of profit.
- **Risk minimization strategies** — It is extremely important to identify all risks associated with the existing farm system before introducing D&C activities. In addition, it is critical to develop risk minimization strategies for new D&C activities, particularly in the formative investment and development stages.
- **Input and market analysis** — Comprehensive studies on existing and projected local, national and, where appropriate, international product demand, quality standards and supply chains is vital for the sustainable development of a D&C farm system.
- **Environmental impact** — The environmental effects of the D&C intervention need to be assessed.
- **Labour and mechanization** — Rural-urban migration trends, ageing rural populations, timeliness of cultivation and harvest, product quality demands, reluctance by investors to depend on rural labour markets, all have contributed to the degenerating farm power and labour situation. Mechanization using hired or shared machines becoming the norm even in subsistence farm systems. D&C strategies should be sensitive to these trends.
- **Support services** — Inputs and, more importantly, information flows to small farmers come from many sources. The messages being provided must be technically correct and economically sound.

5.3 Scope for Regional Cooperation

Most of the D&C policies and strategies will be developed at the national level, or lower. However, there is scope for regional cooperation.

At the regional level cooperation should take the form of:

- **Sharing information** and lessons learned through a regional website and occasional workshops;
- publication of case study papers identifying **"the good and the bad"**;
- the implementation of **action-research pilot projects** that field-test country specific processes and technical interventions involved in the establishment of D&C interventions in the tsunami-affected areas; and
- **capacity building** in appropriate D&C message identification and delivery. A regional Training of Trainers program, using experiential learning approaches, could be developed in this respect.

PART 6 Integrated Coastal Area Management (ICAM) in Tsunami-Affected Areas

6.1 Rationale for Adopting an ICAM Approach in Tsunami-affected Areas

- Tsunami-affected areas were by definition coastal areas, characterized by complex and diverse coastal eco-systems and land and water management systems. There are **strong linkages and interactions** between sea, coast, mangroves and dunes and fisheries activities, areas of habitation and agricultural areas, in particular aquaculture, plantations, irrigation and drainage systems, and hinterland agricultural systems and watersheds. The resource base and economic activities of coastal households were distributed across landscape units that strongly interacted with each other.
- ICAM does not only refer to the adoption of an **integrated approach** for land use planning or eco-system management, but also to a **consultation and decision-making process** involving all stakeholders in tsunami-affected areas, and to a comprehensive analysis and planning on the basis of the livelihoods of affected communities.
- **Regional workshops** convened by FAO on the tsunami and on forestry and fisheries also called for the adoption of an ICAM framework for rehabilitation and long-term reconstruction of tsunami-affected areas.
- Governments in several affected countries are now debating changes in coastal land use (forest buffer belts, relocation of housing, etc) that call for the adoption of an ICAM approach. In the past, governments in tsunami-affected countries have, to varying degrees, indicated the necessity of moving towards ICAM, but also that adoption of ICAM principles in policy and practice was **still weak or non-existing**. ICAM initiatives are now being developed in Indonesia, India and Thailand.

To conclude: There is both **a necessity and an opportunity** to introduce ICAM in tsunami-affected areas. For reconstruction planning of the most affected areas — classes C and D — it is estimated that an ICAM framework will be a necessary basis from the outset.

6.2 Issues to Consider in ICAM

Several important issues should be considered in implementing ICAM: Those are related to:

- Time scale;
- policy issues (short- and long-term planning); and
- technical and social issues.

6.2.1 Time scale

- ICAM is the accepted framework for long-term planning and thus naturally relates to reconstruction and development planning.
- However, emergency support and rehabilitation are on-going: The issue is therefore how to inject ICAM principles at this stage, wherever required.
- The situation is very dynamic and communities and other stakeholders will make their own decisions: There is a need to monitor trends and status and feed the outputs back into the management of reconstruction programs.

6.2.2 Policy issues (short- and long-term planning)

- As a result of the tsunami, governments are now encouraged to take decisions on land use planning, mostly related to safety considerations and zoning of coastal areas (buffer zones, housing). These decisions could have important implications for affected populations and may affect agricultural and other lands.
- ICAM should be used as the proper framework for planning options, not only as a framework for agro-ecosystem management, but also as a participatory consultation and coordination process with all stakeholders.
- In this context, issues related to land tenure are very important.

- ICAM is not only a question of proper strategy, but also a question of tactics: Emergency and reconstruction support should be carried out on the basis of management units that include all populations linked by natural and social processes. Such support should also be offered to populations that have welcomed displaced persons and populations that may react negatively if they are excluded from the reconstruction process and see no benefits accruing to them. ICAM can be a useful framework for sound social and political reconstruction tactics. The introduction of ICAM can be a platform for different stakeholders with their different perspectives to meet and find out what needs to be done before making guiding principles:
    - Communities that want to use the land and other resources;
    - Government agencies that want to plan reconstruction and regulate resource use; and
    - Technical experts, environmentalists, etc.
- ICAM can offer a proper unit to evaluate and discuss compensation to affected parties related to changes in the resource base and land use — (agriculture, industry settlement, business companies).
- Legal aspects related to regulation of land use should be based on a proper investigation of affected parties, actual potential benefits, etc.
- ICAM is a long-term process which will demand capacity building at different levels — central government, district, NGOs, stakeholder, etc.
- At the same time, capacity building is needed now to influence emergency and immediate rehabilitation planning in the direction of ICAM. However, long-term planning and emergency interventions seem to be difficult to reconcile.

6.2.3 Technical issues

- Two major types of coastal systems can be considered: Deltaic complexes and sandy shore complexes. Both are subject to strong tidal influence and water and salt flows should be properly assessed.
- In deltas, reclamation and drainage activities may impact downstream users. Groundwater tables may also be affected by leaching or subject to increased pressure. Salinity of lagoons and their links to the sea may be affected.
- In order to develop ICAM strategies, damage assessments should be carried out that focus on extent and type of area affected (i.e., mangrove forests/ beach forests/ agricultural land/ aquaculture/other uses).
- In the context of tsunami-affected areas, appropriate units of analysis for ICAM would include the hinterland watersheds. Their linkages with the coastal strip (through temporary re-allocation of water for leaching, movement of agriculture upstream, etc) make their inclusion necessary and appropriate.
- Land zoning and other regulatory instruments should be developed. Land zoning and regulation are necessary because previous land use was not always appropriate or sustainable (certain types of aquaculture, conversion of mangrove forests to other uses, etc.).

6.3 Projections for the Future

The objectives to be achieved in ICAM by 2005/2006:

- Reconstruction programs in tsunami-affected have started **implementing ICAM**;
- **Capacity** (at national, local and community level) to implement the ICAM principles has been developed;
- Some **operational models** are available for further application;
- Major **mistakes, conflicts and damages** to fragile eco-systems have been **avoided** thanks to taking into account an ICAM perspective in short and medium-term rehabilitation.

Short- and long-term activities and priorities to achieve these goals and full-swing ICAM in 2010 are:

1. Review of, contribution to, and liaison with officers involved in the preparation of national reconstruction plans so that they **include or take into account ICAM** (role of FAO);
2. **Monitoring of natural resources use**:
    a. At micro level (representative communities);
    b. at macro level (Remote Sensing/GIS); and

    c. using available monitoring information from emergency and rehabilitation programs;
3. Real scale **action-research projects** supported by regional or international institutions paired up with reconstruction programs targeting areas that are:
    a. Particularly affected;
    b. particularly complex; or
    c. of particular environmental value;
4. Development of ICAM **training curricula** and training of ISO/NGO trainers to introduce ICAM in community-based needs assessment and planning;
5. **Informal networking** among national, regional and international institutions, broadening the network to include, in addition to institutions present at the workshop, other interested parties: AIT/Prince of Songhkla University, UNEP, National/Regional Water Partnerships etc. FAO can take the lead in this regional network.

6.4 Scope for Regional Cooperation

- *Short-term:* An **informal network** to support activities 4 and 5 (tutorials, guidelines, advocacy).
- *Medium-term:* **GIS/remote-sensing platform** for natural resources assessment and monitoring.
- *Long-term:* **Regional Centre** for Integrated Coastal Area Management.

PART 7 Coordination and Networking

Some elements of this section were already introduced in the sections on the strategies. The aim here is to present a coherent and workable outline for structuring the informal regional networks that are proposed.

What is being proposed is informal networking among national, regional and international institutions, broadening the network to include, in addition to institutions present at the workshop, other interested parties, including AIT/Prince of Songhkla University, UNEP, National/Regional Water Partnerships etc. FAO can take the leading role in the network. Scope for regional cooperation:

- **Short-term:** An informal network to support activities on tutorials, guidelines, advocacy, etc.
- **Medium-term:** GIS/remote-sensing platform for natural resources assessment and monitoring.
- **Long-term:** Regional Centre for Integrated Coastal Are Management.

The two informal networks to strengthen coordination and collaboration of national, regional and international agencies involved in rehabilitation and management of salt-affected soils in tsunami-affected areas are on:

1. Soil reclamation/rehabilitation and management, and
2. Integrated Coastal Area Management (ICAM). Activities of the networks may be supported through FAO associated regional or other programmes.

The major identified objectives and roles of the networks include:

- Facilitate the exchange of information between countries regarding progress with respect to reclamation of salt affected soils and methodologies used to reclaim these soils;
- identify, share, and disseminate existing and emerging knowledge and technical information on integrated coastal area management and reclamation of salt affected soils;
- share information on region-specific strategies, directions and policies for rehabilitation and future management;
- assist in the development of technical guidelines with support from the participating members;
- serve as a central repository of information that would be generated from established permanent monitoring sites;
- function as a clearing house and peer review mechanism to discuss proposed interventions and research activities;
- explore inter-sectoral linkages between agriculture, forestry, fisheries and rural development in a collaborative approach to policy, planning and implementation; and
- capacity building in soil reclamation, diversification and commercialization of agriculture systems, and ICAM.

PART 8 Activities in 2005

The workshop identified the following priority/short-term activities:

1. Analyze the distribution of affected agricultural land using the remote sensing and GIS technologies: An interactive GIS-based map presenting the level of damages consisting of several layers of thematic maps including land use before and after the tsunami, classification of land damages and land suitability post-tsunami.

2. Classify the levels of soil damage and reassess crop suitability.

3. Appraise socio-economic conditions (especially tenure system, land/man ratio, and household structure).

4. Identify, develop and refine soil rehabilitation technologies.

5. Evaluate the dynamics of soil properties under the natural and treated (rehabilitated) conditions.

6. Disseminate the results to various users including farmers, government/policy makers, academicians and the public.

7. Monitor natural resources use at micro (representative communities) and macro levels (Remote Sensing/GIS) with available monitoring information.

8. Prepare and disseminate various practical guidelines, maps, policy papers, as well as technical reports.

9. Assist in restoring the legal framework for land tenure, titles and rights, redistribution of lands, solution for inheritance of missing owners.

10. Formulate policy recommendations for providing/distributing supplies and technical assistance to enable the community to implement agricultural recovery.

11. Seek opportunities for real scale action-research projects supported by regional or international institutions paired up with reconstruction programmes targeting particularly affected areas with complex environmental values.

12. Review contribution of ICAM and include ICAM approach in all activities.

13. Develop ICAM training curricula and training of ISO/NGO to introduce ICAM in community-based needs assessment and planning.

14. Appraise alternative livelihoods and markets in order to identify potential farm related and non-farm activities and assess their market viability.

15. Establish informal networking among national, regional and international institutions, broadening the network to include, in addition to institutions present at the workshop, other interested parties.

Appendix 1. Assessing salinity and sodicity in the field

Saline soils contain very high proportions of soluble salts (Na^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}) in both the soil solution and on clay particles. Many plants either fail to grow in saline soils or their growth is retarded significantly. However, there are a few plants (salt tolerant) that are able to tolerate and grow effectively on saline soils. Tables of salt tolerant field crops, vegetables and fruits, grasses and forages, woody crops, ornamental shrubs, trees and ground cover etc. are available in the literature for guidelines (Tanji, 1996). Where you have a crop growing on soils that are saline they often exhibit water stress symptoms (rolled and / or drooping leaves) even though the soil is wet.

A convenient way of measuring soil salinity in the field is to measure the electrical conductivity (EC) of a 1:5 soil to water solution with a conductivity meter. The meter must be correctly calibrated according to the manufacturer's instructions before use.

Sodic soils contain a higher than desirable proportion of exchangeable sodium percentage (ESP) on the clay particles. When in contact with water, sodic soils disperse into tiny fragments, which block soil pores on drying. They are difficult to manage, are often hard-setting and susceptible to erosion and waterlogging. Sodicity can be simply estimated by the degree of cloudiness of a sample placed in water.

A saline soil can also be sodic and dispersion is prevented by the concentration of salt. This soil can disperse once the salts are leached out. To accurately identify an area of sodic/saline-sodic soils it is recommended that samples be sent to a laboratory to test for ESP. In addition, requests should also be made to the laboratory to quantify the amendment required (e.g. gypsum) for reclamation of the respective sodic or saline-sodic soil. This should follow the implementation of a reclamation plan for sodic or saline-sodic soils.

Visual indicators of salinity:

- The species that occupy these areas are often salt tolerant and may include couch grass (*Cynodon* species) and halophytes.
- Where you have a crop growing on soils that are saline they often exhibit water stress symptoms (rolled and / or drooping leaves) even though the soil is wet.

Soil Properties

- Saline soils often exhibit a fluffy surface.
- Whitish salt crusts are often observed on top of mounds, aggregates or slightly elevated areas in the field when the surface is dry.

Visual indicators of sodicity:

- Poorer vegetation than normal, few or stunted plants and trees.
- With respect to a growing crop, variable height growth is often observed within the field along with yield variations at harvest.
- Symptoms of water stress not long after a rainfall or irrigation event.
- Poor penetration of rain or irrigation waters into the soil due to surface crusting.

Soil Properties

- Hard-setting surface horizon often observed in soils with a sandy loam topsoil.
- Surface crusting.
- Soapy feel when wetting and working up for texture assessment.
- $pH > 8.5$.
- Cloudy water in puddles that may form on the soil surface.
- Shallow rooting depth.

A field test for sodicity:

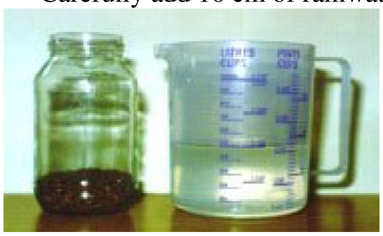
Sodicity is generally identified in the laboratory by measuring the ESP level in the soil. In the field we measure the problem caused by the sodium. That is, the cloudiness or turbidity caused by soil dispersion.

Test the surface and the subsoil separately to best assess the problem.

- Take a clean bucket into the field and collect samples from both the surface 0 – 10 cm depth interval, according to standard procedures.
- Collect samples randomly from a minimum of 5 locations over a uniform 1 – 2 ha representative area of the field.
- Spread the soil from the bucket into a thin layer on a clean plastic sheet. Place in a well-ventilated location to allow it to air-dry, which may take several days.
- If necessary break the air-dry soil down into pieces of 1 cm diameter, and mix the soil thorough in the bucket before commencing the test.

Measuring sodicity using the turbidity test.

- Place 2 cm of air-dry soil in the bottom of a clean glass jar with a lid.
- Carefully add 10 cm of rainwater or distilled water to give a 1:5 ratio of soil to water.



- Gently pour this water down the side of the glass jar without disturbing the soil at the bottom.
- Place the lid on the jar and invert the jar slowly and gently once and then return it to its original position (avoiding any shaking). Then let stand for 4 hours, with no vibrations or bumping.

Estimating the turbidity (soil sodicity) in a 1:5 soil/water suspension:

1. Clear or almost clear — non-sodic.
2. Partly cloudy — medium sodicity.
3. Very cloudy — high sodicity.

- A white plastic spoon or spatula that reflects light when placed in the centre of the suspension can help identify the level of turbidity.

Estimating turbidity using a spatula or white plastic spoon visibility:

1. Plastic spatula visible — not sodic.
2. Plastic spatula partly visible — medium sodicity.
3. Plastic spatula not visible — high sodicity.

Testing for salinity:

- After assessing sodicity, completely stir the whole soil sediment in the jar for 15 seconds and then let it stand for a further 15 minutes.
- Measure the electrical conductivity (EC) of the solution in deci-Siemens per metre (dS m^{-1}) and record the value. For sandy or loamy soils, if the EC > 0.4 dS m^{-1} the soil is classified as saline. For clay soils, if the EC is > 0.7 dS m^{-1} the soil is classified as saline.

- Using the pH meter measure the pH of the solution. Soils with a pH > 8.5 are sodic, whereas those with a pH < 8.5 may or may not be sodic.

Using a moist soil sample to assess sodicity:
Add distilled or demineralised water to a small portion of soil, manipulate the soil with your thumb and finger to form a soil bolus. Carefully place the bolus into a clean glass beaker with distilled water. The formation of cloud after 10 minutes around the soil indicates the possible presence of sodicity.

Appendix 2. Assessing the presence of acid sulphate materials in the field

(Adapted from Facts Land Series L61 Queensland Department of Natural Resources, Mines and Energy).

Acid sulphate soils (ASS) are soils and sediments that contain iron sulphides, commonly pyrite (FeS_2). When exposed to air due to drainage or disturbance these soils produce sulphuric acid (H_2SO_4), often releasing toxic quantities of iron (Fe), aluminium (Al) and heavy metals.

Release of acid and metals from these primary minerals can cause significant harm to the environment, engineering structures and human health.

Identification of acid sulphate soils.

A number of landscape features can indicate the presence of acid sulphate soils and highlight areas which may require further investigation. Laboratory analysis of soil samples is necessary to confirm the presence of acid sulphate soils.

Elevation
Acid sulphate soils are commonly found less than 5 m above sea level, particularly in low-lying coastal areas. Mangroves, salt marshes, floodplains, swamps, wetlands, estuaries and brackish or tidal lakes are ideal for the formation or presence of acid sulphate soils.

Vegetation
Species that commonly indicate the presence of acid sulphate soil areas include mangroves, marine couch, tea-trees (*Melaleuca spp.*) phragmites (a tall acid tolerant grass species), and she-oaks (*Casuarinas spp.*).

Soils
In their undisturbed, waterlogged state, ASS may range from dark grey mud to grey sand or peat. Initially, they have a pH close to neutral (6.6 – 7.3), but may become very acidic when exposed to air ($pH<3$). When disturbed, the soils may smell of rotten eggs (hydrogen sulphide gas).

ASS symptoms
A number of indicators provide evidence of problems associated with the disturbance of ASS.

Vegetation
Stunted or dead vegetation, acid scalds and poor vegetation re-growth in previously disturbed areas are indicative of the impacts of acid sulphate soil exposure. *Salinity may cause similar symptoms*.

Water bodies affected by acid sulphate soil runoff can be altered over time to favour plants that are more acid tolerant. Water lilies, rushes and sedges can dominate water bodies preventing light penetration, killing bottom-dwelling vegetation, which then decays and reduces dissolved oxygen in the water.

Jarosite
Jarosite is a yellow mineral and is the most conclusive field indicator that iron sulphides in acid sulphate soils are oxidizing and forming sulphuric acid. Jarosite requires very acidic conditions ($pH<3.7$) to form.

Water quality
When sulphuric acid reaches a water body, the water can become highly acidic ($pH<4$). Clear blue-green water indicates the presence of soluble aluminium and iron. Soluble iron has a greenish colour. When aluminium from the soil moves into water, it can cause suspended particles in the water to

clump together and drop to the bottom of the water body. This results in clear blue-green water with a deceivingly healthy looking appearance.

Fish kills
Fish kills may be associated with acid sulphate soil exposure. Sudden changes in acid, aluminium, iron or oxygen levels in the aquatic environment can kill fish and may also kill crustaceans and oysters.

Iron staining
A by-product of the oxidation of acid sulphate is the production of rust-coloured iron stains and oily-looking bacterial scum. When acid water mixes with water of a higher pH, the dissolved iron in the water precipitates as a rust-red scum, which can smother and kill vegetation and aquatic organisms. During iron scum formation, oxygen is removed from the water, resulting in low dissolved oxygen levels. This can be a potential cause of fish kills.

Field Testing Procedures for Actual Acid Sulphate soils and Potential Acid Sulphate Soils.

The methodology described below is taken from the website of the Queensland Department of Natural Resources and Mines. They have an excellent website that comprehensively addresses acid sulphate soils. The procedure below can be modified according to specific field conditions and should be used as a guide in the field assessment of acid sulphate sediments. For further details and information visit the following website: **http://www.nrm.qld.gov.au/land/ass/what_are_ass/index.html**

Field pH (pH_F) is a good indicator of actual acid sulphate soils. If $pH_F < 4$, the soil or sediment is considered to be an actual acid sulphate soil. However, the pH_F test by itself does not provide an indication of potential acid sulphate soils (PASS). The pH_F test should always be used in conjunction with the pH_{Fox} test where a 30% hydrogen peroxide (H_2O_2) solution is added to a soil/sediment sample. If the $pH_{Fox} < 3$, then it is considered to be a potential acid sulphate soil. It should be noted that field pH tests are useful exploratory tools, but are indicative only – they cannot replace quantitative laboratory analyses.

There are some cases where a positive field test result may be misleading, as has been found with highly organic or peat soils. Alternatively, the presence of sea shells and other carbonaceous material may result in an increase in pH_{Fox} even if sulphides are present.
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Field pH test (pH_F) (from Ahern *et al*. 2004)

1. Calibrate battery powered field pH meter according to manufacturer's instructions.
2. Prepare the test tubes in the test tube rack. Make sure the rack is marked with the depths so there is no confusion about the top and bottom of the profile. Use of separate racks for the pH_F and pH_{FOX} tests is recommended as contamination may occur when the pH_{FOX} reactions are violent. As the soil:water paste is inclined to stick to the walls of tubes, it is best to use shallow, broad test tubes as this makes cleaning easier.
3. Conduct tests at intervals on the soil profile of 0.25 m or at least one test per horizon whichever is the lesser. In the case of sediments, it is suggested that samples be collected from the constrasting layers.
4. Remove approximately 1 teaspoon of soil from the profile/layer. Place approximately ½ teaspoon of that soil into the pH_F test tube and place ½ teaspoon of the soil into the pH_{FOX} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics. For example, **DO NOT** take ½ teaspoon of soil from the 0–0.25m depth or that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.
5. Place enough deionised water (or demineralised water if deionised water is not available; never use tap water) in the pH_F test tube to make a paste similar to 'grout mix' or 'white sauce', stirring the soil:water paste with a skewer, strong tooth pick or similar to ensure all soil

‘lumps’ are removed. **DO NOT** leave the soil samples in the test tubes without water for more than 10 minutes. This will reduce the risk of sulphide oxidation - the pH_F is designed to indicate the existing pH of a soil in the field; any oxidation subsequent to the soil’s removal from the ground will not reflect the true field pH. In some instances, in less than 5 minutes, monosulfidic material may start to oxidise and substantially affect the pH_F results.

6. Immediately place the spear point electrode (preferred method) into the test tube, ensuring that the spear point is totally submerged in the soil:water paste. Never stir the paste with the electrode. This will damage the semi-permeable glass membrane.
7. Measure the pH_F using a pH meter with spear point electrode.
8. Wait for the reading to stabilise and record the pH measurement.
9. All measurements should be recorded on a data sheet.

Field pH peroxide test (pH_{Fox}) (from Ahern *et al*. 2004)

It is recommended that a 30% hydrogen peroxide (H_2O_2) solution be used in the pH_{FOX} test. 30% H_2O_2 is highly corrosive and care should be taken when handling and using the peroxide. Safety glasses and gloves should be worn when handling and using peroxide. All chemical bottles should be clearly labelled and Material Safety Data Sheets (MSDS) should be kept with the chemicals at all times. Appropriate health and safety precautions should be adhered to. Peroxide should be kept in the fridge when not in use.

1. Adjust the pH of the hydrogen peroxide to pH 4.5–5.5 before going into the field. This can be done by adding a few drops of dilute NaOH stirring and checking the pH with the electrode regularly until the correct range is reached. NaOH is highly caustic so safety precautions must be exercised. NaOH can raise the pH quickly or slowly, so the pH needs to be monitored. Recheck the pH after allowing the peroxide to stand for 15 minutes. **DO NOT** buffer a large quantity of hydrogen peroxide at one time. Only buffer the amount to be used in the field for about a month. This must be kept in a fridge, well labelled with only small quantities to be taken into the field at any one time. This will ensure the longevity of the peroxide. Further, over time, the pH of the peroxide that has already been buffered may change. It is important to check the pH of the peroxide in the morning before departing to the field. Having a small quantity of NaOH in the field kit is recommended so the peroxide can be buffered if required.
2. Calibrate battery powered field pH meter according to manufacturer’s instructions.
3. Prepare the test tubes in the test tube rack as for pH_F test. Make sure the rack is marked with the depths/layers so there is not confusion about the top and bottom of the profile. Use of separate racks for the pH_F and pH_{Fox} tests is recommended as contamination may occur when the pH_{Fox} reactions are violent. It is important to use heat-resistant test tubes for the pH_{Fox} test as the reaction can generate considerable heat (up to 90°C). It is recommended that a tall, wide tube be used for this test as considerable bubbling may occur, particularly on highly sulfidic or organic samples.
4. Conduct pH_{Fox} tests at intervals on the soil profile of 0.25 m or at least one per sediment layer.
5. From the teaspoon of soil previously collected for the pH_F test, place approximately ½ teaspoon of the soil into the pH_{Fox} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics. For example, **DO NOT** take ½ teaspoon of soil from the 0–0.25 m depth or sediment layer that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.
6. Add a few millilitres of 30% H_2O_2 (adjusted to pH 4.5–5.5) to the soil (sufficient to cover the soil with peroxide) and stir the mixture. **DO NOT** add the peroxide to the test tube in which the pH_F test was conducted, that is, the pH_{Fox} test tube should not have any deionised water in it. Beakers can be used, however glass is usually easily broken when conducting field work, and when multiple tests are being conducted it is difficult to handle large beaker sizes efficiently. **DO NOT** add more than a few millilitres at a time. This will prevent overflow and wastage of peroxide. A day’s supply of peroxide should be allowed to reach room temperature prior to use (cold peroxide from the fridge may be too slow to react).

7. Rate the reaction of soil and peroxide using a four point scale. Extreme, vigorous, slight, no reaction.
8. Ideally, allow approximately 15 minutes for any reactions to occur. If substantial sulphides occur, the reaction will be vigorous and may occur almost instantly. In this case, it may not be necessary to stir the mixture. Careful watch will be needed in the early stages to ensure that there is no cross contamination of samples in the test tube rack. If the reaction is violent and the soil:peroxide mix is escaping from the test tube, a small amount of deionised water (or demineralised water; not tap water) can be added (using a wash bottle) to cool and calm the reaction. Usually this controls overflow. **DO NOT** add too much deionised water as this may dilute the mixture and affect the pH value. It is important to only use a small amount of soil otherwise violent reactions will overflow and the sample will be lost.
9. Steps 6 to 8 may be repeated until the soil:peroxide mixture reaction has slowed. This will ensure that most of the sulphides have reacted. In the lab this procedure would be repeated until no further reaction occurs, however in the field, best judgement is recommended. Usually one or two extra additions of a few millilitres of peroxide are sufficient.
10. If there is no initial reaction, individual test tubes containing the soil:peroxide mixture can be placed into a container of hot water (especially in cooler weather) or in direct sunlight. This will encourage the initial reaction to occur. When the sample starts to 'bubble', remove the test tube immediately from the hot water and replace into test tube rack.
11. Wait for the soil:peroxide mixture to cool (may take up to 10 minutes). The reactions often exceed 90°C. Placing an electrode into these high temperature situations may result in physical damage and inaccurate readings. Check the temperature range of the pH meter and probe to see what temperature is suitable. Note that a more exact pH is achieved if a temperature probe is also used, however this may be impractical in some field situations.
12. Use an electronic pH meter (preferred method) to measure the pH_{Fox}. Place a spear point electrode into the test tube, ensuring that the spear point is totally submerged in the soil:peroxide mixture. Never stir the mixture with the electrode. This will damage the semi-permeable glass membrane.
13. Wait for the reading to stabilise and record the pH_{Fox} measurement.
14. All measurements should be recorded on a data sheet.

References

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