EARTHQUAKE and TSUNAMI EMERGENCY SUPPORT PROJECT (ETESP)
Executive Summary
Soil and Land Reclamation








December 2005

Contents

1. INTRODUCTION

The Tsunami of 26 December 2004 inundated northern Sumatra and dumped vast amounts of sea-water plus sediments and debris on the land as well as virtually totally destroying a large proportion of the infrastructure - social and agricultural. Under ADB Grant Number 0002-INO the Earthquake and Tsunami Emergency Support Project (ETESP) was set-up to assess the situation and propose remedial measures to assist the area recover from this natural disaster. Uniconsult International Limited (UCIL) was awarded Package 3 – Agriculture Component and UCIL staff mobilised in early September 2005 to commence work. The Desalinisation and Soil Improvement Specialist mobilised in October 2005 and was tasked with assessing the situation with respect to soil damage and designing remedial interventions to enable the reclamation of the soil and farmland to allow agriculture to resume as quickly as possible.

2. WHAT WAS DONE

At the time the ETESP Inception Report was prepared very little data had been located about the soils, salinity and sediment problems brought about by the tsunami. However, there was limited information available relating to the extent and degree of damages – most of this data being available in the ADB GIS Mapframe system – these data have been consulted and used. Limited climatic data were reported in the Interim Report and these data have been used for further analysis and manipulation. Other data were made available through BPTP (Balai Pengkajian Teknologi Pertanian), including the raw data for a salinity survey done using an EM38 salinity probe. This dataset was compiled by the Soil Research Institute, Bogor 16123, Indonesia from a survey carried out by the institute and funded by the Australian Centre for International Agricultural Research (ACIAR). These data were studied, analysed and manipulated to produce salinity values for the soils to enable reporting and pinpoint missing data items. The sites were then visited to collect additional data to allow completion of the assessment.

3. WHAT AREAS WERE STUDIED and ASSESSED

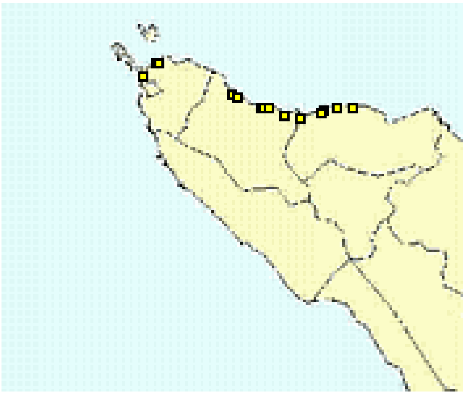
The salinity survey covered sites in Kota Banda Aceh and Kabupatens Aceh Besar, Pidie and Bireuen.

Table 1 Locations of Studies

Kabupaten / Kota	Kecamatan	No of Desa	Number of Sites
Banda Aceh	Kuta Alam	1	2
Aceh Besar	Lhoknga	1	3
	Darussalam	1	2
	Baitissalam	3	3
Pidie	Meureudu	1	1
	Triang Gadeng	2	3
	Panteraja	1	2
	Simpang Tiga	3	4
Bireuen	Samalanga	1	1
	Jeunieb	1	1
	Jeumpa	3	4
	Jangka	1	2
	Ganda Pura	1	2

Several transects were done at or near various villages and basic field notes were taken of how many days flood there had been, depth of sediment, farmer actions following the clearing of the flood and assessment of the status of land use and crop condition.

Figure 1 Location of Salinity Survey Sites



The spread of the sites along the north coast can be seen above, though the individual sites cannot be clearly seen. ETESP visited all of these sites to collect data on present salinity (December 05), water table depths, drainage status, crop or land condition and to collect GPS coordinates.

4. WHAT WAS FOUND

ETESP found that the data collected from the salinity survey had not been fully assessed or used and that no or very few interventions to improve the condition of the land had been put in place or designed, apart from supplying the farmers with standard inputs of seed, fertiliser and other agricultural materials. Any of these inputs of seed and fertilisers that were applied to salt damaged land were totally wasted as no crops grew where salinity existed. The assessment, findings, conclusions and recommendations following the ETESP study are presented below.

4.1 Problems

Salinity and Drainage

At some point "someone" said – "there is NO SALINITY problem" in Aceh and people / experts / advisers stopped thinking. However, there was, and still is in places, is a "chronic", low grade problem and it does involve salinity. Generally, soil EC values are less than 4dS/m and this falls in Salinity Class SC1, which is usually an easy problem to overcome – often without a reclamation programme. However, something that virtually everyone missed, or ignored, was the WATER TABLE levels which are horrendously high in many places. High water tables mean any soil drainage has to be "lateral" in nature and, as the Tsunami affected area is virtually flat and drainage lines and channels were blocked, damaged and not operating – often through long-term neglect and not just due to tsunami damage – land drainage was NOT operating.

Also, lateral drainage is naturally slow and there are many structures acting as dams and stopping the lateral drainage making the situation worse. The above points are discussed as they apply in the various study areas. However, such problems can be overcome, interventions are indicated and the land can be reclaimed.

Salinity in Low Lying Places

Very few locations have been badly salinised and usually those that are badly effected are very low lying, close to the sea or coastline and adjacent to fish ponds. In some cases there is now active sea-water intrusion to these low lying sites. Such soils may not be reclaimable for agriculture but income generation can be restored via land use change with the development of, for example, fish ponds.

Sediments

The perceived large problems caused by depths of sediment appear to be unfounded in most cases. Many sites have been seen where farming has been restored following desalinisation after the sediments were thoroughly mixed in with the native soil, often with the addition of copious amounts of organic matter in the form of FYM or compost and, sometimes, mineral fertilisers. Most of the fine textured sediments would not have come from the sea but would have been topsoil material picked up by the tsunami wave as it crossed the land, these topsoil deposits would have been saline but only from the sea water that carried them.

Sandy, or coarse textured, sediments, which were found mainly close to the coast line, would most probably have originated from the sea-bed, would have been saline but, being sandy in nature, could not contain vast amounts of salt and salts are easily removed from sand by leaching. However, there is a problem in places by the depth of sand that has been deposited since sands have low water holding capacity, low inherent fertility and low fertility potential. Where there are deep deposits of sand these deposits may have to be manually removed and trucked away. Shallow sand deposits should be ploughed in just like other deposits and incorporated with the native soil.

5. RECOVERY and RECLAMATION

The recovery of the land is largely governed by the status of soil drainage and irrigation water supply. ETESP stated soon after the soil assessment programme commenced that the land would not and could not recover based on rainfall alone, as was being stated by some authorities.

The findings in the recent studies confirm the ETESP hypothesis and there is a very clear relationship between the current state of the land at the various locations and the existence and efficiency, if it is working at all, of any previously installed irrigation and land drainage systems (Refer ETESP Scenarios 1, 2 and 3). It has been found that, in the places studied, the worst effected areas are in Aceh Besar where there is little or no formal irrigation. In Pidie, there is more irrigation and the land is recovering in sites that fall within irrigation schemes (Refer ETESP Scenarios 4 and 5). In Bireuen, where there has been large scale development of irrigation, the land is largely recovering and this is described in ETESP Scenario 5. In Bireuen, farmers are now assessing if the land has recovered by the colour of the grass growing on their fields so self assessment of the soil and land is now happening.

In areas that have no, or damaged or inefficient, land drainage the land can be reclaimed but it will involve installing or repairing land drainage systems plus some reclamation leaching. ETESP Scenario 3 demonstrates this situation very clearly. However, the recommendation for reclamation leaching often involves doing the leaching during the driest part of the year when water tables are at their lowest, building raised beds for palawija cropping and only applying supplementary irrigation water as overhead irrigation until the full depth of soil that needs to be reclaimed has been reclaimed. Where there is good soil drainage then reclamation should not be required or, if it is required, it can be done even during the wet season – but raised beds would be suggested for the first season.

Tools have been created to calculate just how much water has to pass down through the soil in order to remove the salts and also the number of irrigations that have to be applied and just how much water will be required. The depths of water to reclaim even a moderately salinised soil to 60cm depth can be in metres – NOT mm or cm and there is no way the requisite amount of water can be supplied by rainfall alone. However, rainfall would be a bonus and help save irrigation water and, once reclaimed, the rainfall should be sufficient in most cases to supply the required leaching fraction over and above normal irrigation to keep the soils free of salt.

Recovery of the areas that are recovering would have been much quicker if better soil drains had been in place and if the drains that did exist had been in better state of repair following regular maintenance. All drains, field-drains, collectors and main drains should be inspected by a competent drainage engineer and necessary upgrading and repair carried out to help mitigate any future disasters of this nature. This would also help prevent natural salinisation that can occur.

6. ETESP SCENERIOS

The various scenarios of damaged areas, problems and suggestions for reclamation interventions are presented below, whilst much more detail is given in the individual reports for the area concerned.

7. SALINITY DATA

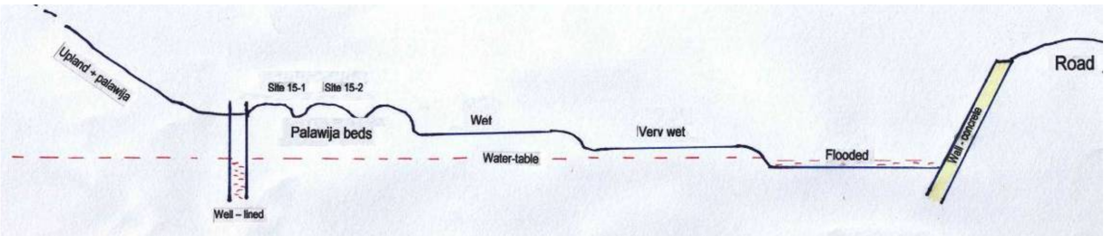
Appendix 1 contains a summary table of salinity data extracted from the various reports whilst Appendix 2 contains facts and figures regarding water required for leaching.

Scenario 1 Sloping land with no irrigation or drainage

The soil is considered slightly to moderately damaged with salinity levels of 2-4dS/m (Salinity Class SC1) with reclamation normally being attempted by the farmer without guidance. But, the farmers are only having limited success and that is normally only on the highest parts of their farm. The main problem with such sites is a high water table and restricted drainage. Water tables at highest part of farm are at 50-75cm with salinity of 0.25-0.50dS/m (Class C2) and the water table is usually at the surface on the lower parts of the farm.

The water on and in the land just cannot escape from the site as there is no active drainage system and the natural stream lines have been blocked, often by man-made structures such as roads and concrete irrigation channels.

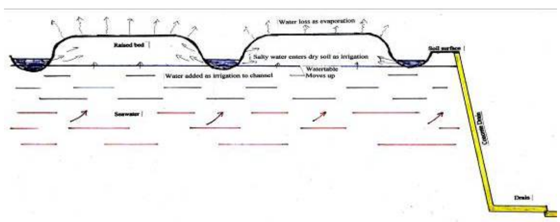
Cross Section of typical location



Problems

1. High water table which gets closer to the surface as the level of the land falls towards the natural stream lines
2. The land in the lower-slope positions is flooded since the water table is actually at the surface
3. Man-made structures, such as roads, urban and agricultural drainage ditches and irrigation channels, acting as dams and blocking the drainage
4. Inappropriate, surface flow irrigation methods are being utilised and these are perpetuating the salinity
5. No in-field or on-farm drainage and natural stream lines are no longer active

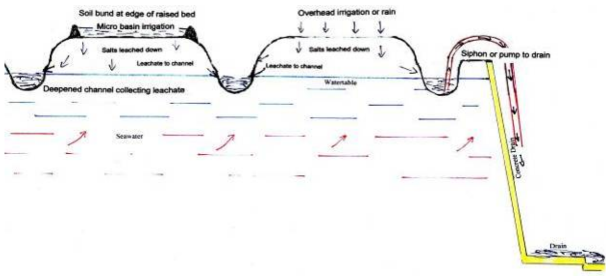
Surface Irrigation Perpetuating Salinity



Immediate actions

1. Install in-field & on-farm drainage, these can be farmer-installed with guidance and instruction
2. Clear, unblock and restore natural drainage lines and ensure they connect to the local river or drain
3. Deepen in-field furrows so they can act as drains to remove any saline leachate produced – the farmer can implement this
4. Apply irrigation as overhead and not surface-flow, this will better enable soil leaching – use watering cans or appropriate, low-cost technology with piped or pumped supply
5. Use salt tolerant varieties and, for the immediate future, only grow palawija on raised beds with overhead irrigation techniques.

Overhead Irrigation Giving Desalinisation



A palawija cycle must be built into the cropping calendar to allow annual leaching and desalinisation

Possible reclamation problems and effects

1. Engineering difficulties bypassing man-made structures requiring minor to medium civil engineering inputs
2. Increasing salinity and flooding downstream as the saline leachate is removed from the sites and drained to local rivers
3. Development of soil acidity under palawija cropping, this is a known problem with some of the soils of the region and soil pH must be monitored. Soils with this possible problem should have large amounts of organic matter (FYM, compost) added to assist remove the aluminium from the soil and hence reduce the acidity. Liming materials may also be required. These soils will revert to neutral when flooded for padi in future.
4. Farmers might show some resistance to having to grow palawija rather than padi but, with selection of high value, marketable crops income generation could be considerably enhanced

Conclusions and Recommendations

These soils can be easily and rapidly reclaimed and brought back into production with relatively low costs and most of the intervention done by the farmer. In puts such as seed and fertilizer should not be supplied, or applied to the farm, until the salinity level is lowered via the above actions. Even then, salt tolerant varieties of crop should be utilised and, if palawija, soil pH must be monitored.

Scenario 2 Level, low lying close to the coast and still flooded with drainage

The soil is considered to be moderately to heavily damaged and still flooded. Surface water salinity of 1.5-2.0dS/m (Class 3) and surface soil salinity of 4.63dS/m (SC2). However, previous irrigation systems are now acting as drainage systems and could be utilised to drain and reclaim this land if some refurbishment was done, channels cleaned and deepened to improve the outflow of the main drains or channels into the sea plus preventing or reducing tidal effects.

Typical site previously used for padi

Problems

1. High water table and flooding by very saline water which is influenced by tidal action via the existing channel
2. Deep sediments deposited by the tsunami which, to date, have not yet been mixed in with the original soil due to flooding restricting access to the land
3. High salinity surface water and moderately salinised surface soil giving unsuitable environment for cropping
4. No current cultivation and cannot be any cultivation until the land is drained and salt tolerant seed is made available

Sites like this are on almost flat alluvial plains with no obvious high points, still totally or partially flooded, no cropping at all and covered in grasses which are being browsed by buffalo etc. and are close to the coast. But, at least one location, there was an operational drainage channel. Refer the photos below. However, local information was that this was, in fact, a previous irrigation system. The in-field water-flow in this channel was fairly fast and there was an outlet into a major channel which was obviously linked to the sea. This drain or channel was flowing - but very slowly. This drainage system was governed by tidal movement and the local estimate was that there is presently between 50-100cm of sludge, sediment and rubbish in the channel or drain.

Existing badly silted-up channel

Drainage entering main channel

Immediate Actions

Deepen and clear all existing channels on, around and above the site, ensure all sediment and garbage is removed. Much of this can be done by the farmers under supervision and within the "cash-for-work" scheme.

Cut tidal effects in the main channel by clearing the river / channel mouth and install flood gates to protect the channel. These activities will NOT be low cost and will involve major civil engineering.

Restore irrigation water supply with an upgraded distribution system. This task will not be low cost and will involve civil engineering expertise – but could be incorporated into the ETESP irrigation programme.

Use highly saline tolerant rice varieties as such sites will probably be at risk of re-salinisation from sea-water ingression.

Possible reclamation problems

Sea level continues to rise and inundation could well be an on-going problem, even if tidal gates are installed.

If highly salt tolerant varieties cannot be located locally for immediate use then they must be located and imported before any planting is done (Thailand has knowledge).

Conclusions and Recommendations

These sites can be reclaimed but at considerable cost due to relatively major civil engineering interventions.

If reclamation proves too expensive then a change of land-use is indicated and the immediately obvious use is to construct fish pods

No seed, fertilizer or other inputs should be supplied or applied until reclamation has been completed. If reclamation is not to be attempted then a change in land use has to be made or the land abandoned to agricultural cropping.

A follow up visit to the original site with this scenario showed water being rapidly drained from the site since drains had been cleared and / installed as necessary.

Scenario 3 Rain fed area with no active drainage though drainage installed

Level areas previously used for rain-fed rice but out-of-command of local irrigation systems and having the remnants of a soil drainage system. Soil salinity level about 4-6dS/m (SC2) and water table at 30-50cm with salinity level of 0.3-0.6ds/m (C2). Farmers have tried cropping but crops failed and sites now abandoned. Such sites can be quite badly damaged with the surface water virtually stagnant with algae etc growing and water is not passing into the existing drainage canal.

Raised bund above the soil drain

Problems

High soil salinity that, if anything, is getting worse due to evaporation of the saline water from the surface concentrating the salts.

High water table that should not be there since there is a soil drain at the edge of the field but it is NOT collecting and removing water from the field.

Surface water all over the site gives an unacceptable, anaerobic root zone for palawija and the site is far too saline for padi. The site is so wet and stagnant that algae and other water plants are growing.

Water is not entering the existing drain and it is suspected that there might be a plough pan formed over years of puddling with oxen.

Immediate Actions

Clear the drain that passes through the site and also ensure it is cleared down-stream so that any effluent collected can be removed from the site. At the same time deepen the drain to below the rooting depth for palawija (50-60cm). Most of the on-farm work can be done by the farmers under guidance and through the "cash-for-work" scheme.

Refurbish the full length of the drain where it leaves the farmland and until any effluent that it carries can be safely and environmentally acceptably be removed from the area and into a local, natural stream line or functioning, large drain.

Establish, by digging, examining, describing and sampling soil profile pits in several locations within the site to establish if there is a restriction to drainage due to a plough pan. If there is a restriction deep plough or rip to at least 50cm depth to break or rupture any pan or restriction.

Construct palawija beds and follow Scenario 1 using palawija cropping with overhead irrigation, when required, as the cropping system until salinity is reduced.

Much of the damage to such drains is not due to tsunami effects but is due to long-term neglect and lack of maintenance of the drain.

Badly damaged and blocked drain

Refurbishment will be mainly a civil engineering task and relatively expensive to implement but very necessary if not essential – not only for agriculture but also for social reasons.

Possible reclamation problems

Civil engineering inputs will have to be used to ensure that the drainage is safely disposed of and does not flood other areas and create problems downstream if the drain begins to flow carrying saline leachate.

It may not be economically possible to refurbish the full length of the drain due to expense or lack of relevant civil engineering skills and availability. Similarly, if safe disposal of the saline leachate cannot be guaranteed then the work should not proceed.

Inability to install / supply irrigation water could be a problem, but the ground-water can be used and the quality of the ground-water should improve with time as the salinity of the area is reduced. Also, the rainfall is relatively good (about 1700mm/annum) and, in the past, was good enough for rain-fed rice to be grown.

Conclusions and Recommendations

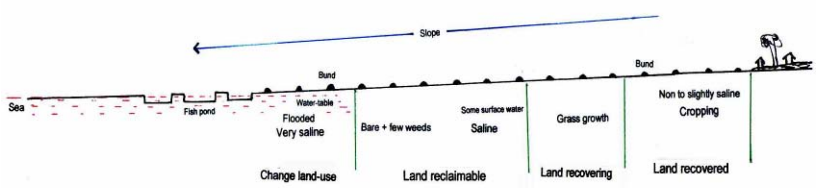
There are no insurmountable reasons as to why such sites cannot be reclaimed and brought back into production. However, the reasons for the present lack of flow from the fields to the existing drains must be established and remedial measures taken.

No seed, fertilizer or other inputs should be supplied or applied until reclamation has been completed or at least underway. After reclamation it is strongly recommended that saline tolerant varieties of crops should be ustilised to ensure there is no future crop yield reduction or failure due to any salinity build up – this is possible if the deep subsoil is also salinised to some extent and capillary rise can resalinise the topsoil.

Scenario 4 Lower slopes of irrigation schemes, close to fish ponds

This scenario is found mainly in the Pidie and Bireuen areas and is associated with the lower slope positions of irrigation schemes, near the coast and where fish ponds already exist.

Cross section from village on high ground to fish ponds and the sea



Drainage Ditch / Collector Drain

The irrigation schemes have an operational water supply system and some basic drainage channels – though what the farmers call drainage is really overflow systems that remove excess irrigation water from one irrigated field to the next field down-slope.

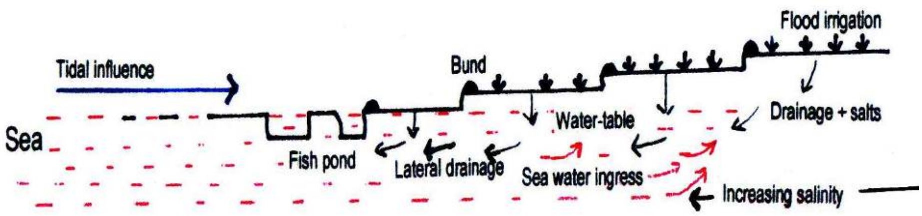
However, there is often a larger drainage channel running directly down-slope at the opposite side of the field from the inlet for the irrigation water, hence there is some drainage of the land.

Problems

There is a progression of salinity increase down-slope with the soils at the top of the slope already back in production (Scenario 5) and the soils at the lowest points being badly flooded and very saline. There are at least two possible reasons for the salinity of these lower slope sites:

- Tidal influence and sea water ingress via the water-table, and
- Accumulation of salts in the lower slopes due to the sub-surface, lateral or sideways drainage of the soils further upslope. This is a natural phenomenon and is to be expected in any irrigation scheme, in particular where there has been inadequate provision of soil drainage

Salinisation of low lying site from the sea and irrigation



Salinisation is happening from the sea plus from the land and, for the worst affected areas, there is probably no way to reclaim the land and land-use should probably be changed to construction of fish ponds.

Immediate actions

A decision has to be made as to where the land-use should be changed to construction of fish-ponds and where reclamation should be carried out. One indicator or guideline should be the severity of the flooding on the surface and, also, if there is tidal influence – that is, does the flood increase and decrease with the tide? If there is obvious tidal influence then the land-use should be changed.

Where there is no tidal influence, but the land may still be flooded, then the drainage should be increased immediately – this can be done by installing drainage ditches across the slope (on the contour) and ensuring any drainage collected is discharged into the collector drain down the edge (down-slope) of the irrigated area leading to the fish ponds and the sea.

In the areas further upslope, where the land is recovering and grasses are starting to grow, the drainage should be increased as suggested above and this will speed up the recovery process. Diagrams are presented in Scenario 5 of such drains.

Possible reclamation problems and effects

With the installation of drains there will be an immediate increase in the amount of water, mainly saline, draining off the land trying to find its way to the sea. All channels downstream and the outlet to the sea must be unrestricted or increased flooding at the shoreline will happen.

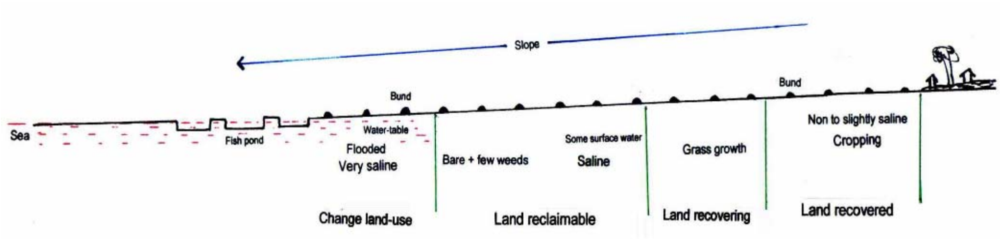
Conclusions and Recommendations

The services of an experienced soil / land drainage engineer should be used to design and oversee the installation of the suggested drains and, in the worst effected areas, no seed, fertilizer or other inputs should be supplied or applied until reclamation has been completed or at least underway.

Scenario 5 Flat to very gently sloping wetland-rice areas within irrigation

This scenario is found mainly in Bireuen plus other places where there are large, well established irrigation systems. Cropping has re-commenced in these areas and the combination of irrigation and even minimal drainage has lead to leaching of the salts and reclamation of the land. Farmers are monitoring the recovery themselves and start to cultivate when there is strong, green growth of natural grasses on their fields.

Cross section from village on high ground down-slope through padi area



The situation of this scenario is depicted on the right hand side of the diagram where the lower captions read "land recovered" and "Land recovering".

Very little intervention is now needed on this scenario but, if there had been a more comprehensive drainage system, this land could have been back in production much sooner.

Problems

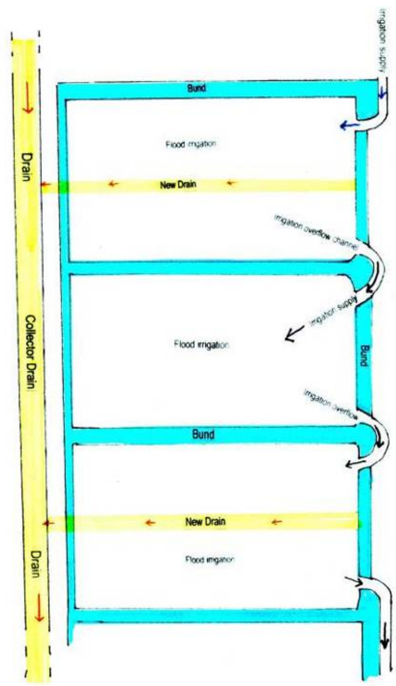
Land is this category no longer has a problem of any great significance, but there is an increase in salinity as one progresses down-slope away from the village on the high ground – this is because the first land to be leached would be the highest land and the saline leachate would have drained laterally down slope and added to the salinity of the lower slope sites. As long as there is sufficient rainfall plus continued application of irrigation water the land will continue to recover as the salts are leached out further and further down the slope.

Immediate actions

Consideration should be given to improving the existing drainage system to ensure there is no future build-up of salinity through normal irrigation of the land. In addition, a study of the water management and irrigation applications should be carried out to ensure that sufficient water is applied to ensure that there is an adequate "leaching fraction" being applied to ensure leaching occurs. If there were ever to be another disastrous tsunami and vast amounts of salt water were again dumped on the field the improved drainage system would speed up the recovery process.

Additional drains should be installed on the contour; right across the width of the padi fields and disgorge into the existing collector drain. The field drains should be deep enough to ensure that the bottom of the drain is below the maximum rooting depth of the crop (rice) being grown and, generally should be somewhere between 60 – 75cm deep, whilst the existing collector drains are already about 100cm deep.

New field and existing collector drains



Field Drain

Possible reclamation problems and effects

With the installation of drains there will be an immediate increase in the amount of water, some of it possibly saline, draining off these upper slope sites and trying to find its way down-slope to the sea. All channels downstream and the outlet to the sea must be unrestricted or increased flooding at the shoreline will happen.

Drainage Ditch / Collector Drain

Conclusions and Recommendations

Although land falling into this category is largely recovered, or recovering, improving the drainage network system can only be of benefit for the immediate and long-term future and will help ensure there is little or no build-up of salinity with continuing irrigated agriculture – however, good water management will also be important. Land in this category should receive all available inputs, especially improved seed, as soon as possible to help boost agricultural output.

APPENDIX 1 Salinity of the Soils

Banda Aceh **Kuta Alam**	**Site**	**Overall soils salinity EM38 dS/m**	**Rhoades estimate O – 90cm EM38 dS/m**	**ETESP Average salinity EM38 dS/m**	**BPTPP lab salinity Nov 05 EM38**	**Conclusions**
BPTP	20-1	3.02	2.75	2.50	3.80	Situation not improved, no drainage Scenario 1
BPTP	20-2	3.27	3.52	2.50	3.80	Situation not improved, no drainage Scenario 1
Aceh Besar	**Site**	**dS/m**	**dS/m**	**dS/m**	**Dec 05**	**Conclusions and Recommendations**
Nusa	**15 – 1**	**2.15**	**2.50**	**1.80**	**2.25**	**Situation not improved, no drainage** **Scenario 1**
Nusa	**15 – 2**	**2.15**	**2.50**	**1.80**	**2.25**	**Situation not improved, no drainage** **Scenario 1**
Nusa	**15 – 3**	**2.00**	**2.10**	**1.90**	**3.22**	**Situation worse, no drainage** **Scenario 1**
Miruk Taman	**16 – 1**	**2.15**	**2.40**	**1.90**	**2.35**	**Situation not improved, provisional drainage** **Scenario 1**
Miruk Taman	**16 - 2**	**2.05**	**2.30**	**1.80**	**2.25**	**Situation not improved, no drainage** **Scenario 1**
Suleue	**17 – 1**	**2.05**	**2.10**	**2.00**	**5.00**	**Situation worsening, drains NOT working** **Scenario 2**
Blang Kreung	**18 – 1**	**4.30**	**4.80**	**3.80**	**4.63**	**Situation not improving, flooded** **Scenario 3**
Lampeudaya	**19 - 1**	**2.75**	**3.00**	**2.50**	**4.93**	**Situation worsening, flooded** **Scenario 3**
Pidie	**Site**	**dS/m**	**dS/m**	**dS/m**	**Dec 05**	**Conclusions and Recommendations**
Meuraksa	6 – 1	4.90	4.60	5.20	1.04	Salinity is falling, Improve drainage for recovery Scenario 4 – reclaimable area
Raya	4 – 1	0.61	0.62	0.60	0.24	Has irrigation supply but no real drainage Scenario 5 – land largely recovered
Cot Leue Rheng	5 – 1	10.04	10.47	9.60	7.26	Salinity is still high, tho' site has irrigation /and drainage Scenario 4 – change land use area
Cot Leue Rheng	5 - 2	6.45	ND	5.50	2.20	Salinity fell but still too high to give acceptable yield. Scenario 4 – reclaimable area
Reudup	7 – 1	1.61	1.92	1.30	1.47	Salinity unchanged as no drainage Has irrigation but basically Scenario 1
Reudup	7 – 2	2.08	2.15	2.00	ND	Same as 7-1 above
Seukee	1 – 1	1.75	1.89	1.60	3.93	Salinity increased no drainage system. Scenario 4 – change land use area
Seukee	1 – 2	1.22	1.13	1.30	ND	As 1-1 above
Seukee	2 – 1	0.34	0.17	0.50	2.61	Salinity increased has high water table Scenario 4 – change land use area
Tungoe (Cot Jaja)	3 - 1	0.46	0.51	0.40	10.70	Salinity increased, site is 60% flooded, Scenario 4 – change land use area
Bireuen	**Site**	**dS/m**	**dS/m**	**dS/m**	**Dec 05**	**Conclusions, Recommendations and Scenario**
Kuala Jeumpa	8 – 2	2.15	2.51	1.80	ND	Soil recovered, no leaching intervention required Scenario 5, upper slope
Bate Tomoh	9 – 1	1.39	1.38	1.40	0.25	Soil recovered, no leaching intervention required Scenario 5, upper slope
Lapang Timu	11 – 2	4.45	5.00	3.90	0.35	Soil well recovered, no leaching interventions required Scenario 5, upper slope
Kuala Jeumpa	8 – 1	2.10	2.40	1.80	0.45	Soil well recovered, no leaching interventions required Scenario 5, mid to upper slope
Lapang Timu	11 – 1	1.83	1.86	1.80	0.51	Soil well recovered, no leaching interventions required Scenario 5 with "road dam" as found in Scenario 1
Meulik	14 – 1	1.25	1.50	1.00	0.67	Soil well recovered, no leaching interventions required Scenario 5, upper slope but with marketing problems
Jangka Alue'u	12 – 1	2.06	2.31	1.80	1.55	Soil recovering or stable but drainage and leaching required Has irrigation but basically Scenario 1
Jangka Alue'u	12 – 2	1.88	2.08	1.70	1.56	Soil recovering or stable but drainage and leaching required Has irrigation but basically Scenario 1 to Scenario 4
Teupin Keupula	13 – 1	1.52	1.24	1.80	2.57	Salinity actually increased, drainage and leaching required Scenario 1 to Scenario 3 since irrigation not open
Cot Geureundong	10 – 1	1.46	1.62	1.30	2.69	Salinity actually increased, drainage / leaching required Scenario 4 type situation

APPENDIX 2 Number of Estimated Irrigations for Reclamation

Banda Aceh	Location	Site	Salinity (dS/m) Nov 05	Reclaim Leach Needed	Soil depth to recover (mm)	Depth of water table (mm)	Soil PSC	Leaching water required (mm)	No of 100mm "Gifts"	Water to be applied (mm)
Kuta Alam	BPTP	20-1	3.80	Yes	500	320	H	129	4-5	450
Kuta Alam	BPTP	20-2	3.80	Yes	500	320	H	129	4-5	450
Aceh Besar	**Location**	**Site**	**Salinity (dS/m) Dec 05**	**Reclaim Leach Needed**	**Soil depth to recover (mm)**	**Depth of water table (mm)**	**Soil PSC**	**Leaching water required (mm)**	**No of 100mm "Gifts"**	**Water to be applied (mm)**
Lhoknga	Nusa	15-3	2.00	Yes	300	100	M	Flood*	ND	ND
Darussalam	Miruk Taman	16-2	2.05	Yes	600	400	M/H	113	5	500
Baitissalam	Suleue	17-1	2.05	Yes	600	300	M	150	4-5	450
Lhoknga	Nusa	15-1	2.15	Yes	600	750	M	325	10	1000 +
Lhoknga	Nusa	15-2	2.15	Yes	600	750	M	325	10	1000+
Darussalam	Miruk Taman	16-1	2.15	Yes	600	300	M	71	4	400
Baitissalam	Lampeudaya	19-1	2.75	Yes	300	0	M/H	Flood*	ND	ND
Baitissalam	Blang Kreung	18-1	4.30	Yes	300	0	M/H	Flood*	ND	ND
Pidie	**Location**	**Site**	**Salinity (dS/m) Dec 05**	**Reclaim Leach Needed**	**Soil depth to recover (mm)**	**Depth of water table (mm)**	**Soil PSC**	**Leaching water required (mm)**	**No of 100mm "Gifts"**	**Water to be applied (mm)**
Triang Gadeng	Raya	4 – 1	0.2	No	600	750	H	120	5 – 6	550
Meureudu	Meuraksa	6 – 1	1.0	+/-	600	750	H	208	6 – 7	650
Panteraja	Reudup	7 – 1	1.5	Yes	600	750	H	735	18	1800
Panteraja	Reudup	7 – 2	1.7	Yes	600	750	H	850	20 – 21	2050
Triang Gadeng	Cot Leue Rheng	5 - 2	2.2	Yes	600	750	H	220	6 – 7	650
Simpang Tiga	Seukee	2 – 1	2.6	Yes	600	750	H	261	7 – 8	750
Simpang Tiga	Seukee	1 – 1	3.9	Yes	600	750	H	393	10 – 11	1050
Simpang Tiga	Seukee	1 – 2	3.9	Yes	600	750	H	393	10 – 11	1050
Triang Gadeng	Cot Leue Rheng	5 - 1	7.3	No*	0	0	H	0	NA	NA
Simpang Tiga	Tungoe	3 - 1	10.7	No*	0	0	M	0	NA	NA
Bireuen	**Location**	**Site**	**Salinity Dec05 (dS/m)**	**Reclaim Leach Needed**	**Soil depth to recover (mm)**	**Depth of water table (mm)**	**Soil PSC**	**Leaching water required mm**	**No of 100mm "Gifts"**	**Water to be applied (mm)**
Jeumpa	Batee Tomoh	9 1	0.25	No	NA	NA	H	0	NA	NA
Ganda Pura	Lapang Timu	11-2	0.35	No	NA	NA	H	0	NA	NA
Jeumpa	Kuala Jeumpa	8–1	0.45	No	NA	NA	H	0	NA	NA
Jeumpa	Kuala Jeumpa	8–2	0.45	No	NA	NA	H	0	NA	NA
Ganda Pura	Lapang Timu	11–1	0.51	No	NA	NA	H	0	NA	NA
Samalanga	Meulik	14–1	0.67	No	NA	NA	H	0	NA	NA
Jangka	Jangka Alue'u	12–1	1.55	Yes	600	*750*	H	86	4	400
Jangka	Jangka Alue'u	12–2	1.56	Yes	600	*750*	H	87	4	400
Jeunieb	Teupin Keupula	13–1	2.57	Yes	600	*750*	M	143	6 – 7	650
Jeumpa	Cot Geureundong	10–1	2.69	Yes	600	*750*	H	149	5 - 6	550

NA not Applicable as reclamation leaching not required
ND Not determined until flood cleared and salinity re-determined
No No reclamation, change land use*
Flood Can be calculated once the site has been drained*