ETESP

Earthquake & Tsunami Emergency Support Project

Technical Paper

Sandy Sediments

(Update March 2006)

CONTENTS

1. INTRODUCTION

1.1. The Damage the Tsunami Inflicted

This section is limited to the "technical" damage to the soil properties through the effects of sedimentation and inundation by sea-water - that is if "damage" is the correct word since, in some cases or locations, soil has been improved. In the Meulaboh area the Dinas Pertanian staff reported that some lands had been improved by the deposition of sediments basically deepening the amount of soil on the site – often also improving the texture. However, in many areas the land was damaged by the deposition of sand.

1.2 Background

When it struck the shore the tsunami-wave did various things, including:

- Wreaked devastating physical damage – not the subject of this document
- Rapidly started to drop the sand-load along with any other marine sediments or debris it carried
- Picked-up and redistribute anything that lay in its path – including surface soil from exposed areas such as farms
- Redistributed the new material it had picked as the material settled out via sedimentation and continued to pick more material as it progressed inland
- Flooded the land and slowly doing less physical damage at is progressed inland – often up to 5km or so
- Flood water then infiltrated the soils and the longer the land was flooded then the greater the amount of infiltration
- Sandy and coarse textured soils infiltrated much more water much more quickly than heavier soils – this is a standard feature of soils and is determined by the particle size class (texture) of the upper or surface horizons
- Where floodwater became trapped, for example in low-lying places and in padi fields, the salinity of the flood water increased. The longer that water remained on a site the more saline it became – this was due to the salt solution concentrating as the water evaporated

This short technical or background paper was compiled after receipt and study of the atlas of maps compiled by ISRI (Indonesian Soil Research Institute) mapping various data derived from a survey during 2005. The mapping is discussed further in ETESP report "Digital Mapping Update march 2006". The ISRI map atlas, covering the NAD (Nanggroe Aceh Darussalam) area, presents maps showing:

- Salinity of tsunami deposits
- Depth of deposits
- Texture of the deposits, and
- A damage classification based on the above factors

Figure 1.1 Sample of ISRI Land Damage Map

The cooperation shown by ISRA in supplying ETESP Agriculture with a copy of these maps is greatly appreciated and acknowledged.

2. ADDITION to the MAPS by ETESP

2.1 Background

In discussions with other ETESP components one factor that has always been raised has been the presence of coarse textured or sandy deposits. The focus of these discussions always being how to deal with such material. Assessment of the status of salinity and soil reclamation carried out by ETESP Agriculture during 2005 and early 2006 concluded that:

- Depth of deposit, as such, was not particularly important in itself (Executive Summary, ETESP, 2005)
- In may areas where recovery was underway farmers were simply ploughing in and mixing deposits with the original soil, with the addition of fertilisers and organic manures
- Farmers were monitoring for themselves when the soil seemed to have 'recovered" by the growth of grass – if the growth was vigorous and green, and stayed green, then the soil was considered fit for resumption of cropping
- Non-sandy deposits should be thoroughly mixed in with the original soil by ploughing
- Sandy deposits to a depth of about 15cm should also be mixed-in via ploughing – paying attention to the texture of the resultant mixed soil and adding copious amounts of organic manure - plus fertilisers as required
- The detrimental effect of an increase in surface level in irrigation areas covered with sandy, or other deposits, must be considered since the increase in surface level could mean that the land is no longer under irrigation command and cannot be irrigated

2.2 Study of the ISRI Maps

The maps produced by ISRI represent a huge step forward in the documentation of the damage caused by the tsunami, previous data was all based on tables and list but there was no spatial representation of just where the damage existed. In theory, these maps will enable studies and reclamation programmes to be located where there is a need for them and the "size" or extent of the problem being addressed could at lest be seen.

In one respect, ETESP Agriculture, took a different view to one aspect of the mapping from ISRI – that of the problem caused by course (sandy) deposits. ISRI considered such deposits from the viewpoint of salinity. ISRI were totally correct in considering the reclamation of the sandy deposits as an easy task despite the fact that often the sandy deposits were very saline.

ETESP considered that the inherent properties of the sandy deposits were a greater problem then the high salinity because of the sediment having:

- low ability to retain moisture – low AWHC (Available Water Holding Capacity)
- low natural or inherent fertility
- low ability to retain added nutrients due to low CEC (Cation Exchange Capacity) – low fertility potential

The location of the deep, sandy deposits was not reflected in the "land-damage classification" map and ETESP made attempts to include this additional limitation or difficulty in using such affected areas.

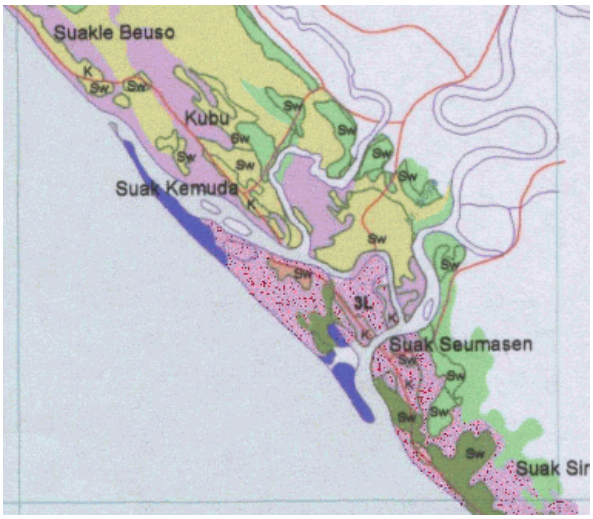
2.3 ETESP Map Edits

Using the hard copy of the "sediment texture" and "sediment depth" maps ETESP added a pattern to the digital copy of the "land-damage classification" map (Refer ETESP Digital Mapping, Update of March 2006).

A sample of the edits is shown as Figure 2.1. The dotted pattern was added to map units wherever there were coarse textured deposits deeper than 20cm recorded.

In addition each mapped polygon on the maps was measured via digitization to obtain the size or extent of each unit in hectares. An additional legend was compiled in MS Excel and added to the map images.

Figure 2.1 Deep Sandy Deposit Edits



3. USE of the DATA

3.1 ETESP Programme 2005/6

The areas affected all fall into the heavily damaged land category and, as such, will not be included in the immediate amelioration ETESP programme 2005 but they may well be included for the 2006 programme.

3.2 Possible Solutions and Future Landuse

If some of the areas covered with sand have to be utilised within reclamation or rehabilitation programmes the following suggestions are offered:

3.2.1 Move or Remove

When the coarse (sandy) material is over 20cm deep – and it can be well over 50cm – the site cannot be used as it is since there would not a suitable rooting zone for any crop planted due to the low AWHC and fertility status. In addition, as stated earlier, the additional material on the surface could mean the land was no longer under irrigation command. To ameliorate the site the deep sand has to be moved, removed or the land possibly abandoned for use under irrigation and Landuse / cropping pattern totally changed:

- It might be necessary to utilise heavy equipment, such as mechanical shovels, to collect the sandy material and load it onto trucks for removal from the site
- Another possibility, proposed by the ETESP Irrigation and Drainage component, is to use bulldozers or graders to move the sand to the edge of the effected field or site and build raised beds at the edges
- Economic analysis would need to be carried out to determine if either or neither of these proposals were economically feasible. If raised beds were built then these raised areas could, in theory, be developed in time to carry some form of crop or vegetation.

3.2.2 Mix-in with original Soil

When the deposit is only a few centimeters deep, say up to 15 – 20cm maximum, then consideration should be given to ploughing the deposit in and mixing it with the original soil. When this is done the texture of the original soil should be carefully considered and:

- If original texture is fine, say clay loam or clay, then mixing should not dilute the original soil texture much. At worst the surface texture might become sandy clay loam, which is a perfectly normal rooting medium for many plants
- If the texture is medium, say sandy clay loam, mixing should still be considered as, at worst, the topsoil texture might be reduced to sandy loam – an acceptable topsoil
- If, however, the original texture is a light sandy loam or loamy sand then careful thought needs to be given to the future use of the site and only crops that have low nutrient demand and reasonable tolerance to periods of drought should be grown. This is because, after mixing, the surface soil might have a texture of loamy sand or sand and such soils have low fertility, low fertility potential and low moisture retention capabilities
- A further consideration should be the planned use of the site, after mixing the sediment in with the original soil. If it is to be flooded rice cultivation then, when the mixed soil is “puddled”, the sand will settle out first and will be relocated to the bottom of the ploughed / puddled layer. This way the sandy material will be removed from the upper topsoil which is the main planting depth for wetland rice and the topsoil will more or less revert, texture-wise, to what it was before the inundation
- Whenever the sandy material is mixed in with the original soil copious amounts of organic fertiliser, compost or FYM, should be incorporated at the time of mixing as this will immediately help boost the fertility and the fertility potential by replacing many of the nutrients that will have been removed by leaching via the flood water or by a planned reclamation leaching programme.

4. POSSIBLE CROPS TO CONSIDER

The crops to consider first and foremost would be those that the local farmers would have grown on sandy or coarse textured areas before the tsunami. The following crops are presented with the known criteria that will be of importance. The main things to be considered are:

- Does the crop have tolerance to periods of drought? These soils have low AWHC!
- Does the crop have high or low nutrient demand? These soils are inherently infertile!
- Does the crop have a tolerance or even preference for lighter textured soils?
- Does the crop have some tolerance to salinity? These soils are invariably close to the coast and will have some salinity – residual from the tsunami flood, from sea-water ingress, from wind-blow of sea water and even from lateral drainage from cultivated areas upslope

Some possible crops are listed in Table 4.1

Table 4.1 Possible Crops for Coarse Textured Soils

Crop	Preferred Soil	Tolerance to drought	Tolerance to salinity (dS/m)	Nutrient Demand	Suitable	Data Source
Ground nut	Medium to coarse	Medium	3.2 – 6.5	Medium	Yes	Bookers
Soybean	Medium to coarse	Medium to low	5.0 – 10.0	Medium to low	Yes	Bookers
Coconut	Medium to coarse	Low	2.5 – 10.0	Low	Yes	Bookers
Oil Palm	Medium to coarse	Low	1.0 – 2.5	Medium to high	No	Bookers
Water Melon	Medium to coarse	Not determined	2.5 – 10.0	Low to medium	Possibly	Bookers

Bookers: Bookers Tropical Soil Manual, 1991

The above statement on suitability should be further checked with agronomists and farmers.

5 CONCLUSIONS and RECOMMENDATIONS

The ISRI maps are a good starting point when trying to determine where the deep, coarse textured sediments exist, the ETESP addition further aids this task.

1. Where sandy or coarse textured sediment occur they should easily be de-salinised, often via rainfall alone, since the coarse texture allows rapid leaching and the low CEC means there is not actually a great deal of salt to be removed.
2. Where the sandy or coarse textured sediment is only a few centimeters thick it should be mixed into the original soil by ploughing whilst, at the same time, copious amounts of organic manures should also be ploughed-in.
3. Where the depth of sediment is 20cm or more consideration has to be given to moving or removing the sandy cover to allow access to the original soil. However, if the economics of these actions are not favourable then perhaps the land has to be abandoned to agriculture.
4. If the land is to be used fore padi, wetland, rice then puddling will also help to move the coarse material away from the surface and depositing it further down the profile.
5. Consideration must be given to the selection to less demanding crops as and when cropping can be resumed on sites with coarser textured topsoils.

6. ABBREVIATIONS and GLOSSARY

(Simple metric units and chemical element symbols not included*)*

asl	Above sea level
ASP	Aluminium Saturation Percentage
AWC / AWHC	Available water capacity (amount of water held in soil at suctions low enough for root uptake, = MC% FC – MC% WP)
BS%	Base saturation percentage
C	Clay (finest mineral particles in soils, < 2um in diameter, important store for some nutrients and water, make soils sticky & heavy to work)
CEC	Cation exchange capacity
CL	Clay loam
cm	Centimetre
EC	Electrical conductivity
Exch	Exchangeable (for cations)
FYM	Farmyard manure
GIS	Geographical information system
GPS	Global positioning system
ha	Hectare
Horizon	Soil layer
ID	Imperfectly drained (soil)
Imperfectly drained	Soils in which most large pores drain their water soon after rain or irrigation for much of the year, but remain filled for long spells in summer Identified by moist or wet feel, and grey or brown colours and many grey, rust or orange mottles.
In situ	In original position or place (Latin)
L	Loam (Mixed soil with substantial quantities of all three particle size classes, i.e. clay, silt and sand)
LS	Loamy sand
MD / MWD	Moderately well drained (soil)
Munsell	System of standard soil colour notation, operated by matching soil against standard charts. Colour described by 'hue' (Spectral composition, red, yellow, blue, green); 'value' (dilution with white), & 'chroma' (darkness)
NA	Not applicable / Not applied
ND	No data / Not Determined
NS	Not sampled (in soil profile descriptions)
OC	Organic carbon
OM	Organic matter
P	Phosphate
PD	Poorly drained (soil)
PM	(Soil) Parent Material
Pptn	Precipitation, rainfall
pH	Measure of acidity - alkalinity
Si	Silt (intermediate sized mineral particles in soils, 2 - 50 um in diameter, important store for plant available water, make soils slippery & vulnerable to surface erosion and capping, aka Z, Zi)

7 REFERENCES and ETESP REPORTS

7.1 References

Booker 1991
Booker Tropical Soil manual, Longmans, London 1991

ISRI 2005
Indonesian Soil research Institute, Bogor, Atlas, Peta Lahan Pertanian, Terkena Dampak Tsunami, Propinsi Nanggroe Aceh Darussalam 2005, Departemen Pertanian 2005

7.2 ETESP Soil Desalinisation and Improvement Reports

7.2.1 Technical Data Reports

ETESP Agricultural Component, Desalinisation & Soil Improvement, Mobilisation Report, OCTOBER 2005, Updated FEBRUARY 2006

ETESP, Banda Aceh Kota, Kuta Alam, Data Assessment and Soil Reclamation, NOVEMBER 2005

ETESP, Aceh Besar Kabupaten, *Lhoknga, Darussalam and Baitissalam*, Data Assessment and Soil Reclamation, DECEMBER 2005

ETESP, Pidie Kabupaten, *Meureudu, Triang Gadeng, Panteraja and Simpang Tiga*, Data Assessment and Soil Reclamation, DECEMBER 2005

ETESP, Bireuen Kabupaten, *Samalanga, Jeunieb, Jeumpa, Jangka and Ganda Pura*, Data Assessment and Soil Reclamation, DECEMBER 2005

ETESP, Executive Summary, Soil and Land Reclamation, DECEMBER 2005

ETESP, Soil and Land Reclamation Scenarios, DECEMBER 2005, Updated March 2006

ETESP, Interpretation of Laboratory Data for ETESP Irrigation Component, FEBRUARY 2006

7.2.2 Background Technical Papers

ETESP, Background Paper, Annual & Monthly Rainfall, OCTOBER 2005

ETESP, Background Paper, Soil Acidity and Aluminium, DECEMBER 2005

ETESP, Digital Maps, FEBRUARY 2006, Update MARCH 2006

ETESP, Sandy Sediments, FEBRUARY 2006

ETESP, Soil Conditions for Wetland Rice, MARCH 2006

7.2.3 Site Visit and Tour Reports

ETESP, Site Visit Report – BRR Area at Lhoong: Kemukiman Cot Jeumpa, DECEMBER 2005

ETESP, Site Visit report, BLANG KREUNG SITE, DECEMBER 2005

ETESP, Tour Report, Field Tour Report NAD Areas, Feb 20th – Feb 24th 2006, FEBRUARY 2006

ETESP, Site Visit Report, Visit to Oxfam Sites Calang, MARCH 2006

ETESP, Site Visit Report, Visit to Red Cross Site, Aceh Besar, MARCH 2006

ETESP, Site Visit Report, Lhamno Irrigation Sites, Aceh Jaya, MARCH 2006

7.3 ETESP Soil Desalinisation and Improvement Tools

File name and date	Purpose
ETESP ECe from EM38 data.XLS OCTOBER 2005	Calculate soil salinity (ECe) values from raw data collected by EM38 salinity device when no calibration information provided
ETESP Leaching Water Requirements.XLS NOVEMBER 2005	Calculate the depths and volumes of water that have to be applied and pass through a selected depth of soil to achieve desalinisation. Information required includes: • Textural class of soil • Initial salinity of the soil (dS/m) • Target salinity wished to be achieved (dS/m)

ETESP Irrigation Leaching Progress.XLS NOVEMBER 2005	Determine how many irrigation gifts have to be applied to achieve de-salinisation of various depths of variously textured soil. Information required includes: • Soil textural group, or • AWHC (Available Water Holding Capacity) • Estimate of water application efficiency, or use default values • Size of irrigation gift as mm of water •
ETESP Survey Density.XLS DECEMBER 2005	1. Correlate the scale at which to map surveys of various types from reconnaissance to very detailed level 2. Determine observation density (Sites / hectare) 3. Calculate the total number of sites for surveys at various reliability levels Requirements: • Survey area extent in hectares (ha) Also presents various map and mapping information
ETESP Labdata summary.XLS Version 4 FEBRUARY 2006	Enter standard laboratory data and obtain ratings as to the level of all the various nutrients and chemical properties. Also calculate weighted mean vales for topsoil and subsoil plus obtain automatic simple summary of: • Inherent fertility • Fertility potential • Possible nutrient deficiencies • Salinity status, and • Reaction Also experimental estimate of possible perceived risks
ETESP Site Monitoring tool.XLS March 2006	Enter field data for specific sites or villages making note of : 1. <u>Locational information</u> • Kabupaten • Kecamatan • Desa • Farmer or Land-owner, and • Geographic coordinates 2. <u>Soil, land and crop features</u> • surface soil textural group • soil salinity • soil acidity • irrigation water quality (salinity) • status of drains, plus • estimate (%) of the actual pre-tsunami crop yield to monitor land reclamation progress and get information on further interventions possibly required
ETESP Soil Conditions Database tool.XLS March 2006	Enter field collected on the site form, or data collated and analysed from the data on the site form into a format that will be the first stages of a dbms / GIS compilation: • surface soil textural group • soil salinity • soil acidity • irrigation water quality (salinity) • status of drains, plus • estimate (%) of the actual pre-tsunami crop yield The data are stored against the official Dinas selected villages that qualify for ETESP inputs. This collation will allow monitoring land reclamation progress within kecamatan and kabupaten and get information on further interventions possibly required
ETESP Auger Description Form	Simple pro-forma for recording data collected during soil investigations to establish depths and distribution of sandy sediments