# EARTHQUAKE and TSUNAMI EMERGENCY SUPPORT PROJECT

# (ETESP)

## IRRIGATION SITES – LHAMNO, ACEH JAYA



**(March 2006)**

## CONTENTS

# VISIT TO ETESP IRRIGATION SITES, LHAMNO, KECAMATAN JAYA, ACEH JAYA

## 1. INTRODUCTION

### 1.1 Purpose of Visit

In March 2006 the Irrigation and Drainage Component of ETESP contacted the ETESP Soil Desalinisation and Improvement Specialist with a request if he could advise and assist them with possible soil problems on sites they were tasked with rehabilitating. The main problem causing concern to the engineers was the reported presence of sand sediments on the sites. In total there are over 20 sites but this initial visit, mainly to asses the situation and possibly develop a strategy or approach involved, was to four sites in the Lhamno area.

The sites were visited by the ETESP Soil Desalinisation and Improvement Specialist accompanied by the Team Leader plus various staff of the Irrigation and Drainage Component.

This “site visit” report has been compiled strictly from a technical point of view based on the rapid, eye-ball observations made during the visit, plus any information extracted from existing mapping, and the Soils Specialist has not considered any implications of or on the strategies, plans or intentions of the BRR, the ETESP (Earthquake and Tsunami Emergency Support Project, ADB), Dinas Pertanian or involved NGOs,.

Details collected by GPS during the visit have been appended to various maps as explained below.

**Figure 1.1 Location of Sites**


### 1.2. Location and Maps

The sites in question lie about one to one a half hours south of Banda Aceh by road and can be seen in Figure 1.1 The yellow “waypoint” markers indicate the upslope edge of the irrigated areas where the irrigation canals first discharge.

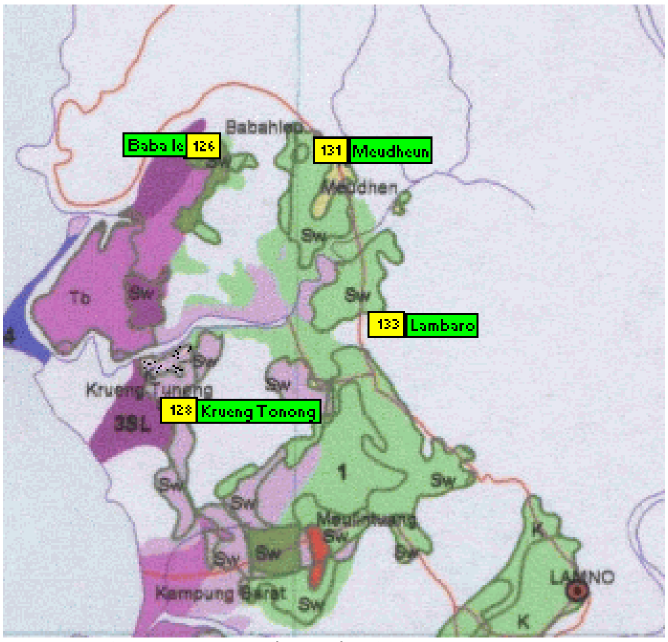
The maps used in this report are all compiled in digital format and are accessed using the GPS Software “OziExplorer”. The various maps are described in the ETESP background paper “Digital Mapping”.

The map in Figure 1.1 is extracted from the digital copy of the Bakosurtanal topographic series at a scale of 1:250,000. Other maps are:

- Bakosurtanal 1:50,000 scale
- Recent tsunami impact mapping by the Indonesian Soil Research Institute (ISRI) Bogor as used in Figure 1.2, and the
- Satellite image download from Google Earth

The above sources are gratefully acknowledged.

**Figure 1.2 Location of Sites Visited on ISRI Tsunami Damage Map**




*Source Map: ISRI Post-Tsunami Mapping 2005*

### 1.3 GPS Records

All routes followed were collected by GPS and are available as “plot” files, the purpose of this being to check the relative accuracy and agreement between the published maps and the GPS data. In general there was good agreement between the two. Several “waypoints” (**WP**s) were collected at significant points and the data are shown in Figure 1.3 below. Altitude data collected by GPS are not to be taken as accurate since it is known from experience that there can be significant differences between mapped altitudes and GPS derived data. However, differences between readings located relatively close together can be used – such as the difference of an irrigation off-take above the actual fields.

**Figure 1.3 GPS Data from Lhamno Sites**

| Name | Latitude | Longitude | Alt(m) | Description |
|---|---|---|---|---|
| 120 | 5 08 46.8 | 95 19 27.6 | 43.0 | Baba Ie - Turn off |
| 121 | 5 08 08.6 | 95 19 20.3 | 11.0 | Baba Ie - End of sealed track |
| 123 | 5 08 07.1 | 95 19 36.5 | 13.1 | Baba Ie - NE corner short of "spring", very wet + heavy vegetation |
| 124 | 5 08 29.7 | 95 19 22.8 | 15.8 | Baba Ie - Sluice + offtake with new BM (1) |
| 125 | 5 08 22.8 | 95 19 21.7 | 14.0 | Baba Ie - Bend in irrigation channel, split goes under road |
| 126 | 5 08 22.6 | 95 19 21.0 | 14.0 | Baba Ie - Irrigation channel at village coffee shop |
| 127 | 5 06 33.9 | 95 19 17.4 | 13.1 | Kreung Tunong, dam = sluice gate |
| 128 | 5 06 32.3 | 95 19 12.0 | 11.0 | Krueng Tunong - sliice gate + culvert at road crossing |
| 129 | 5 06 43.7 | 95 18 51.6 | 14.0 | Krueng Tunong - road between cabe beds & before kelapa |
| 130 | 5 08 43.7 | 95 19 56.6 | 41.1 | Meudheun - weir + offtake |
| 131 | 5 08 20.8 | 95 20 12.9 | 36.0 | Meudheun - footbridge over canal at top of irrigated area |
| 132 | 5 07 04.8 | 95 20 38.7 | 52.0 | Lambaro - Weir + offtake |
| 133 | 5 07 08.6 | 95 20 36.9 | 41.0 | Lambaro - end of canal with gates and canal split at top of area |
| 134 | 5 07 09.6 | 95 20 33.0 | 37.0 | Lambaro - bend in canal with exit path to road |
| 135 | 5 07 09.5 | 95 20 28.5 | 32.0 | Lambaro - footpath to irrigated area meets sealed highway |

**Table 1.1 Data Extracted from GPS Records and Maps**

| Site | Location | GPS | Head | Location | Altitude | Km from Ocean | Original Extent of Sawah mapped - Ha |
|---|---|---|---|---|---|---|---|
| Baba Ie | Off-take<br>Field | 16m<br>14m | 2m | Highway turn-off<br>Difference | 43 GPS<br>25 Map<br>18m | 1.5km | 34 |
| Krueng Tunong | Off-take<br>Field | 13m<br>11m | 2m | | | 1.25km | 85 |
| Meudheum | Off-take<br>Field | 41m<br>36m | 5m | | | 2.5km | Not applicable as no land apparently lost |
| Lambaro | Off-take<br>Field | 15.8m<br>14m | 1.8m | | | 4.5km | Not applicable as no land apparently lost |

## 1.4 Area of Land Originally Mapped as Sawah in Baba Ie and Krueng Tunong

The two following figures are extractions of the 1:50,000 map but are not presented at the same scale in the figures.

**Figure 1.4 Mapped Sawah Area Baba Ie**

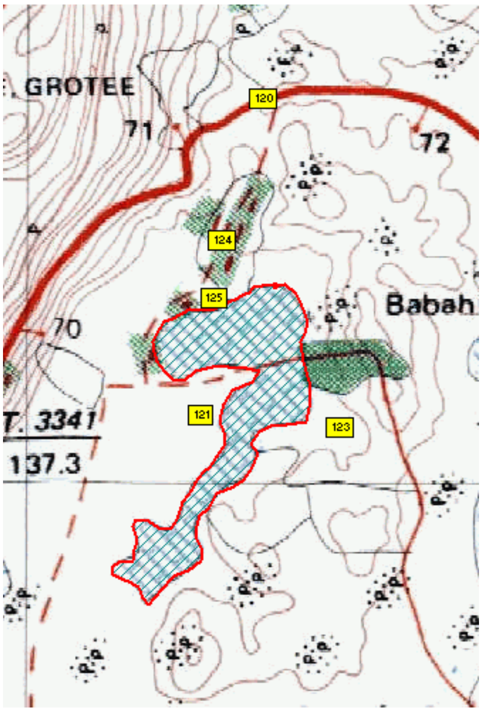
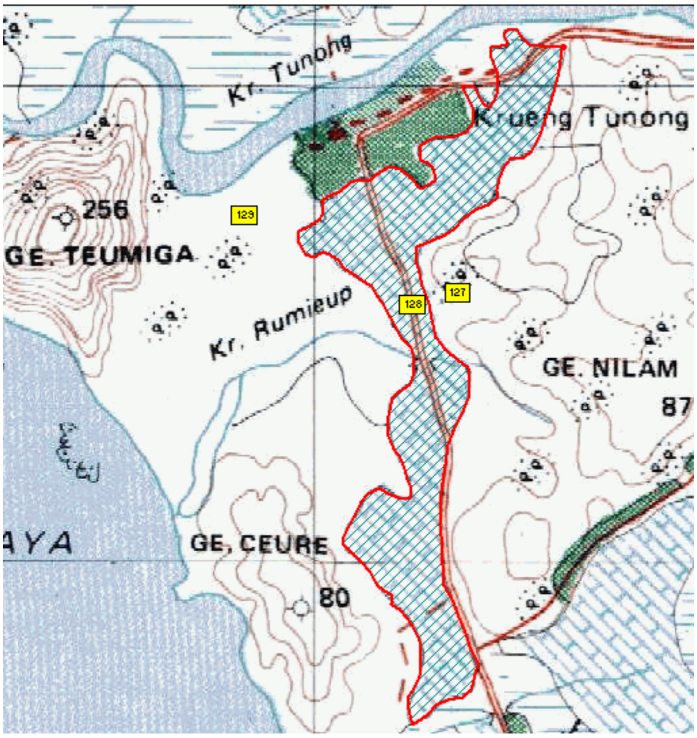



**Figure 1.5 Mapped Sawah Area Krueng Tunong**




The above areas are presented since there is every likelihood that the locations will, for ETESP interventions, be considered from the viewpoint of the whole village and not just the irrigated land. This means that dryland agriculture as well as irrigated agriculture needs investigating along with fisheries activities. Some of the land mapped as "Sawah" at Baba Ie was already being converted to "Tambak" in March 2006 and an integrated livelihoods approach is indicated. Similarly, at Krueng Tunong "Cabe" and "Kelapa" developments were being undertaken outwith the mapped "sawah" area.

# 2. TSUNAMI DAMAGE

## 2.1 Introduction

Along the west coastal strip there was generally devastating damage done by the tsunami and very few remnants of the previous buildings remain, usually only twisted metal and the foundations or heavier parts of buildings – such as steps and stairs constructed of concrete. The foundations of previous houses are in evidence on some of the sites visited which are close to the ocean. However, the physical damage caused to infrastructure in general is not the subject of this report. The only physical damage that is mentioned briefly is the obvious damage to the irrigation and drainage system, but this damage is not commented on since this comes under the competence of the engineers in the party.

The main emphasis and purpose of this visit was on the damage to the land:

- Salinity damage, and
- Sedimentation, in particular if the sediments were sandy

More detailed information on the possible or expected effects of the tsunami are presented in the ETESP report "Soil Conditions for Wetland Rice 2006" and the problems of sands in the ETESP report "Sandy Sediments" 2006.

## 2.2 Damage to the Land

Damage to the land was not quite as devastating as might have been expected at the locations close to the sea:

- Baba Ie was flooded to up to 5m depth but only for 15 – 20minutes, and
- Krueng Tunong also suffered a very short term flood of less than one day

The fact that the flood did not remain on the land for long means that a relatively small amount of salt water could have infiltrated.

Recently published maps by ISRI (Indonesian Soil research Institute, Bogor) indicate that the damage to the immediate area around these two sites was:

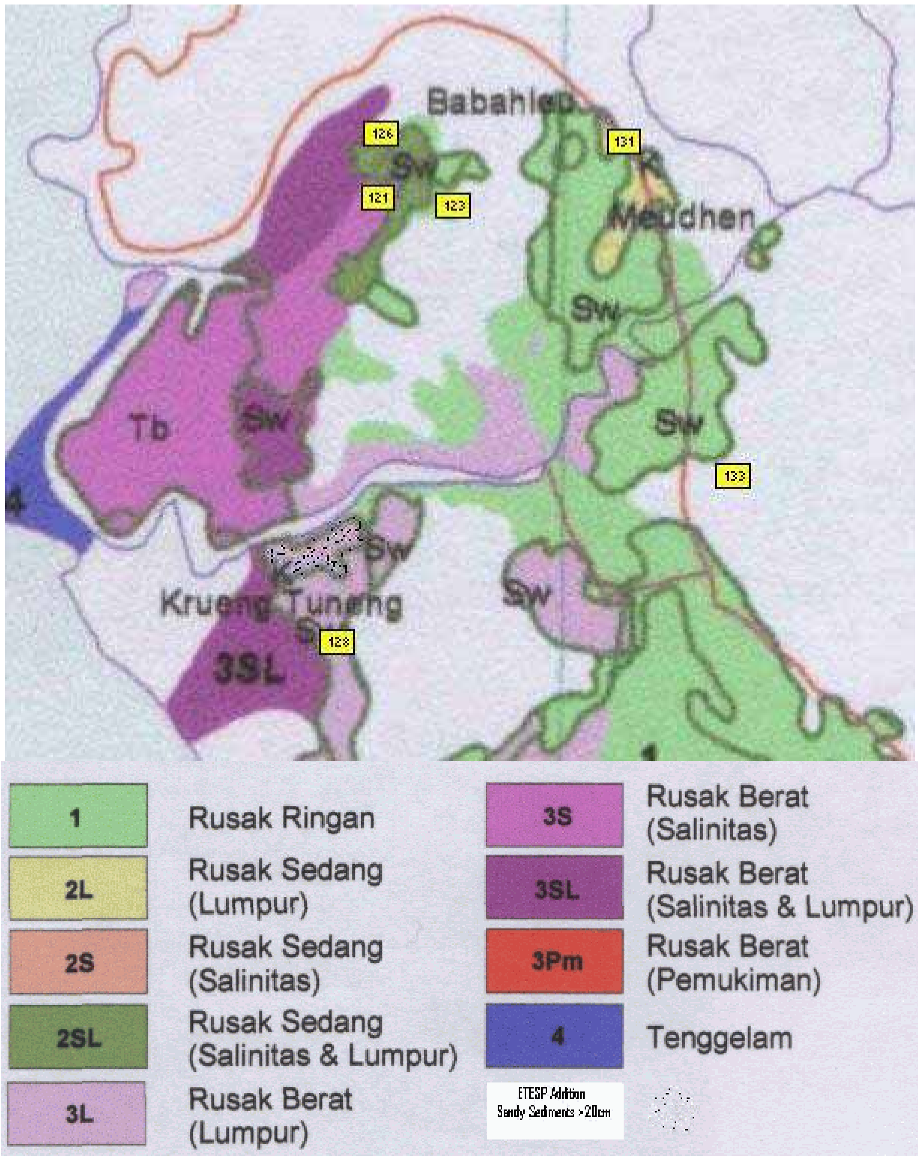
- Baba Ie; moderate to heavy due to salinity and sediment
- Krueng Tunong; heavy due to sediment

An extract of the IRSI map is presented as Figure 2.1 with GPS WPs superimposed.

NB ETESP has established that unless the sediments were <u>sandy</u> then depth of sediment cannot be considered as heavy damage.
*Refer ETESP Executive Summary, December 2006 and Tour report, February 2006.*

At the inland sites, Meudheun and Lambaro, the ISRI maps shows the cultivable land was only lightly damaged – coloured pale green – and would fit with the shallow, gentle flood that occurred.

**Figure 2.1 ISRI Soil and Land Damage Map**



### 2.2.1 Salinity Damage

With the very short duration of the floods (Section 2.2) the soils on these sites were not expected to show many signs of salinity damage. Field salinity determinations of EC (Electrical Conductivity) could not be carried out as a salinity meter could be obtained for use.

There was relatively good vegetative cover over most of the coastal sites, apart from some of the sand covered areas, and the vegetation was of mixed species off grasses and shrubs. In other recently visited areas the vegetative cover has been a reliable indicator as to whether there is a salinity problem or not. The inland sites were being or about to be cultivated.

The sand deposits would not have contained vast amounts of salt since sands have low absorption and adsorption capacities and, in any case, any salts would have been rapidly leached out of the sands due to their very free-draining nature.

It is concluded that there is not a significant salinity problem on these site and that the lack of vegetation on the sandy areas would be due to poor moisture availability for plant growth since sands have low available moisture holding capacity (AWHC). Available data (Section 3.2) appear to support low level of salinity damage

### 2.2.2 Sedimentation Damage

ETESP studies to date have shown that depth of sediment, in itself, is not as damaging as first thought. In fact, in some areas farmers and Dinas Pertanian staff have reported that many farms have been improved by the deposition of sediments. This “improvement” has resulted in areas of previously shallow soils being covered over by topsoil material relocated by the tsunami wave – the resulting, deeper soil then has more depth (root-zone) for plants to exploit in their search for nutrients and moisture.

However, depths of sand >20cm are considered to be a problem (ETESP Sandy Deposits, March 2006) since the sands have low AWHC, low fertility and the additional depth can result in the land being “out-of-command’ for irrigation.

There are sandy deposits on the coastal sites and these deposits have to be investigated further and their depths plus spatial distribution mapped out.

### 2.2.3 Damage to Irrigation Infrastructure

Weirs and off-takes were in better condition than some others seen of late by ETESP Agriculture with very little debris accumulation due to tsunami effects. Most damages would be accounted for by age and normal wear and tear plus a certain degree of neglect or poor maintenance over the years.

Upper reaches of irrigation supply channels seen were generally functioning to some degree but all would require some refurbishment and improvement to various degrees. The supply channel at Krueng Tunong was totally non-functional and needs reconstruction over its entire length. Very few in-field irrigation structures could be seen in the coastal sites and, it is assumed, these were either washed out or buried by the sediments.

The canals at both inland sites were functioning with water reaching the irrigated areas and in-field structures were still in place.

## 2.3 Why Soil Damage was Relatively Light

From a soils perspective the damage at these locations was relatively light in that the only damage that could be seen via casual inspection was the deposition of sand on the surface at the sites close to the coast. There will have been some salinisation but to a degree that has apparently not caused any great problem, or is it expected to cause a problem in the future. The areas had various factors in their favour:

- Location and
- Existence of drainage channels

### 2.3.1 Locations

As has been found in other areas, on both the north and west coasts, land at some distance from the shoreline normally suffered gentle flooding, any sediment would have comprised redistributed topsoil and, if the area had any irrigation infrastructure, the flood had an easy way to leave the area. Irrigation supply channels and drains would have acted as storm drains and helped the seawater escape from the site.

The coastal sites were at much more risk in that they suffered larger, deeper more ferocious flood and the flood would still have been carrying sand from the ocean which was subsequently dropped or deposited. Sand deposits were in evidence at both Baba Ie and Krueng Tunong.

Baba Ie

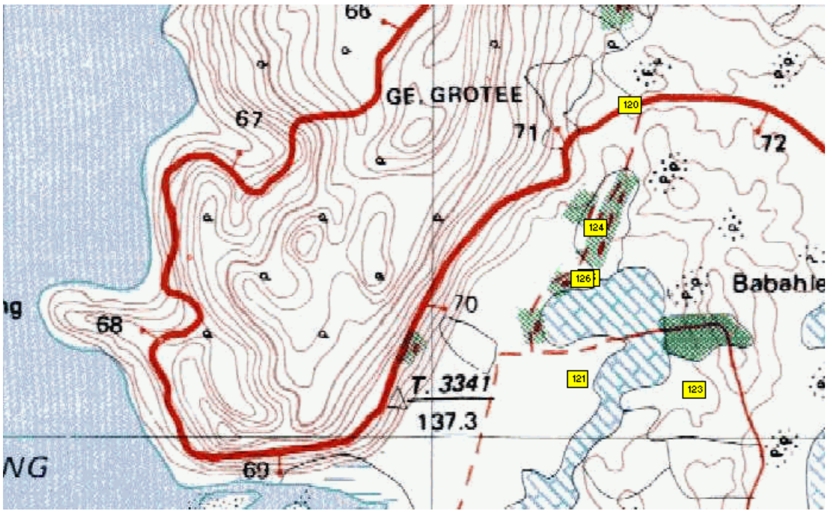
The main tsunami wave approached Sumatra from the west and in Figure 2.2 it can be seen that the Baba Ie location plus the surrounding area was shielded from the full force of the wave by the hilly headland.

Also it can be seen that the site does have some elevation, as evidenced by the contours on the map, meaning that the flood would have run-off and not been trapped as would have happened if the area had been flat.

Also, there were natural stream lines though these are not shown on the maps. One is the irrigation supply stream which virtually follows the road alignment in the NW of the site. There is another very indistinct flow line coming out of the eastern side around WP123 and is sourced in a spring.

Both these natural channels offered escape routes for the flood and also added fresh water to the site to assist with leaching any salts present.

**Figure 2.2 Site Protected by Headland**



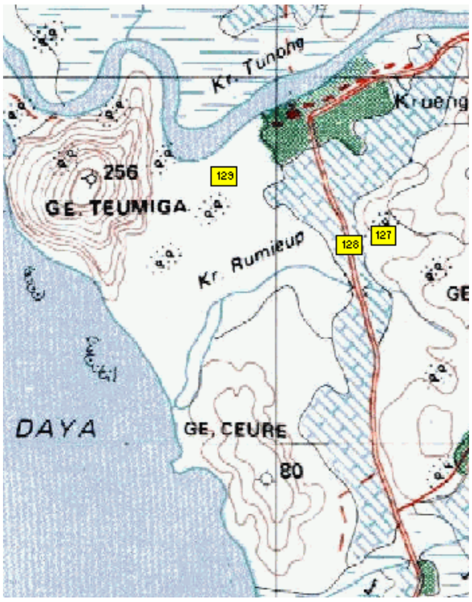

<u>Krueng Tunong</u>

To some extent this area was also shielded from the full force of the tsunami wave by the existence of hills right on the coast.

In addition as can be seen in Figure 2.3 the area is drained by one major river (Krueng Tunong) and two smaller stream lines (Krueng Rumieup and one unnamed).

It is suspected that the Krueng Tunong is now partially blocked and there seems to be quite major flooding along its course but, at the time of the tsunami, it offered a low point to which much of the flood would have flowed.

**Figure 2.3 Krueng Tunong Protected by Coastal Hills**

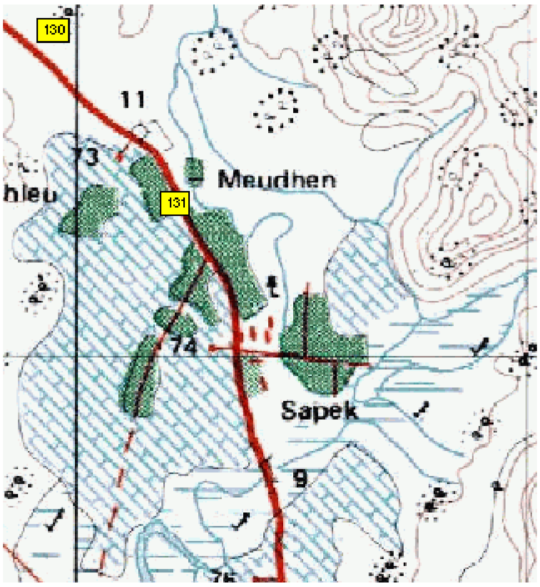



<u>Meudheun</u>

Being on the edge of the hills (Figure 2.4) Meudheun suffered very little flooding, a shallow flood which cleared very quickly due to:

- Irrigation channels
- Drainage channels
- River running down the NE edge and
- Major river south of the area

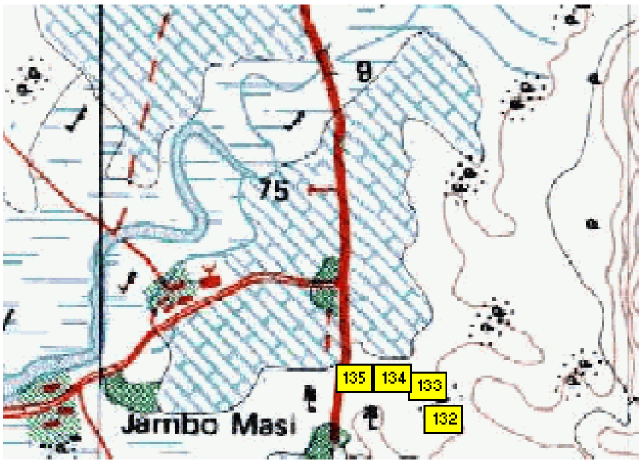
**Figure 2.4 Meudheun Site**




<u>Lambaro</u>

The irrigated area of Lambaro lies to the north of the waypoints in figure 2.5 and there is natural drainage from the hills in the east down to the major river which lies to the north west. Accordingly, the shallow flood had an easy escape and did not remain on the site.

**Figure 2.5 Lambaro**



# 3 FINDINGS and RECOMMENDATIONS

## 3.1 Introductory Summary

The situation as of mid-March 2006 is summarised in Table 3.1 below with detail presented later.

**Table 3.1 Summary for the Sites in General**

| No | Item | Findings | Problems and Amelioration Requirements |
|---|---|---|---|
| 1 | Salinity damage | No obvious signs of salinity damage | As and when a salinity meter is available, or when any soil sampling is done, the salinity (EC in dS/m) of the soil should be measured to confirm there is no problem<br><br>Some values as reported by the survey carried out by Lotti are given in Table 3.2 below but there is some doubt as to the veracity of the values quoted |
| 2 | Sediment damage | There are sandy deposits over much of the coastal sites | The first and most important requirement is to carry out a rapid survey to establish the depths and distribution of the sandy deposits<br><br>Thin (5 – 15cm) layers of sand are no problem and should just be ploughed in and mixed with the original soil<br><br>Sands deeper than 15 or 20cm depth are a problem since:<br>• sands offer very low moisture reserves for plant growth and survival (low AWHC)<br>• sands offer very low reserves of nutrients for plant growth<br>• sands have very high infiltration rates and any irrigation water would pass to depth very rapidly, this is no good for wetland rice<br>• in some areas the additional depth of sediment on top of the original soil could mean that the irrigation supply is no longer able to supply irrigation water to the land – the land could be too high and "out-of-command" |
| 3 | Irrigation system | The systems are in need of refurbishment starting with the settlement pond, then the irrigation supply canal right down to the in-field water distribution channels | • Clear all debris from the intake and monitor the intake for accumulation of additional debris in the future – clear on a regular basis<br>• Clear and repair the entire length of the irrigation supply canals and, in some cases, totally re-construct<br>• Ensure that the irrigation canal is able to command the land that can be irrigated – that is either raise the canal or lower the level of the land to be irrigated<br>• Re-establish terraces or bunded fields with accompanying water supply channels to distribute the water |
| 4 | Drainage system | There are drainage system quoted as existing but these were not seen or inspected | • Check, clear and rehabilitate the full length of any existing field and collector drains.<br>• Construct in-field drains to ensure any salts that are present are leached to depth and removed from the location. This will ensure any existing salinity is removed and that in future salinity will or should not build-up – drains should be excavated to 75 – 100cm depth<br>• All drains should be protected by earth bunds to prevent irrigation or rainfall water flowing straight off the land into the drains |
| 5 | Rain fed areas adjoining the irrigated areas | Create field bunds around all plots or fields | • Since irrigation supply is limited in the areas all efforts must be made to retain any water that enters the fields via precipitation. All fields and plots must have earth bunds constructed along the edges to ensure any water landing on the soil infiltrates or enters the soil and cannot run-off and be lost to drainage<br>• Some simple water-harvesting techniques could be considered where soil conditions allow<br>• Thin coverings of sand or sandy soils can actually be of benefit in rain-fed areas since any rainfall (precipitation) landing on the sand will infiltrate rapidly and add to the reserves of moisture in the soil |

If all the above interventions and tasks are done the land will be rehabilitated – however, it will not be fully ready for irrigated use. Further specific soils and drainage investigations will have to be undertaken to establish the suitability of the recovered land for irrigated use.

## 3.2 Salinity

As stated in previous sections of the report no obvious salinity problems appear to exist. The only data that are available are shown in Table 3.2 below – these data are extracted from the Lotti survey of the sites and the full data set is presented in Appendix A. There is some uncertainty as to the actual unit in which the data were reported but the values shown below are not particularly different form values reported in other sources. However, as a precaution, it would be advisable, as and when a survey is undertaken to establish the depths and distribution of the sandy sediments, to collect soil samples from pre-determined parts of the location. The sampling should be designed to ensure overall coverage – and have those samples analysed as indicated in section 3.7 below.

**Table 3.2 Salinity Data**

| Scheme | Overall / mean Salinity dS/m | Overall Salinity Class | Mean or range Sediment dS/m | Mean or range Soil Salinity dS/m |
|---|---|---|---|---|
| Baba Ie | 2.1 | Very slightly saline | 0.8 – 2.0 | 3.5 |
| Krueng Tunong | 2.6 | Very slightly saline | 1.0 – 3.8 | 0.7 – 4.5 |
| Meudheun | 2.2 | Very slightly saline | 1.7 | 2.7 |
| Lambaro | 2.6 | Very slightly saline | 2.6 – 3.2 | 1.2 – 2.6 |

*Source: Refer Appendix A and ETESP report "Irrigation LabData, February 2006"*

## 3.3 Sediments

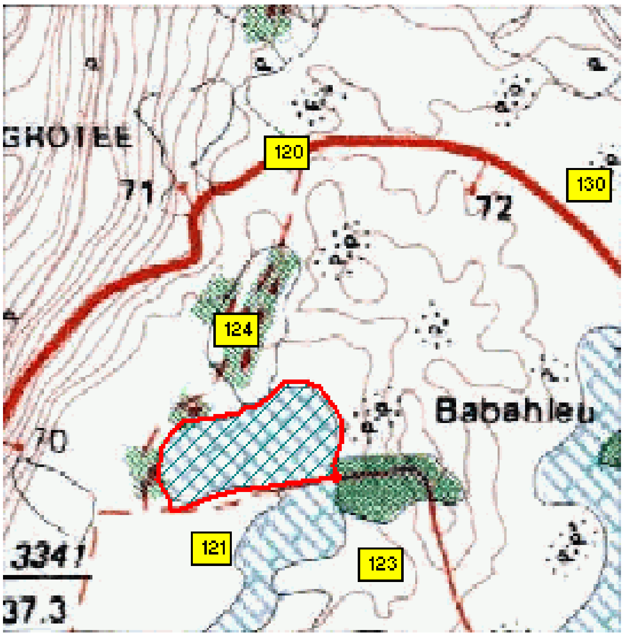
The only sediment damage noted within the locations was the presence of sands on the surface over quite large areas of the two coastal sites.

Before other interventions are installed it would be very advisable to have a rapid survey carried out by a soil surveyor to map the distribution and depths of these sandy deposits. This does not need to be a formal soil survey with full profile descriptions but the aim could be accomplished by an auger survey or chisel-pits making note of depths of natural horizons or layers defined by soil colour and / or soil texture. Suggested numbers of points to be described are detailed in Tables 3.3 and 3.4 below, this table is one of the ETESP tools and the calculations are based on size of area and density of sites required to achieve various reliability levels of mapping. Possible areas to be surveyed have been estimated by digitizing the land previously (pre-tsunami) mapped as cultivable.

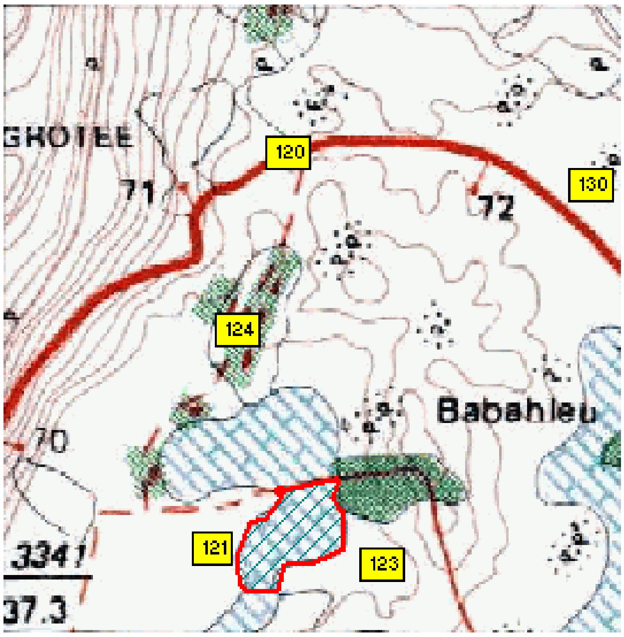
### 3.3.1 Baba Ie

The track used to divide the area N and S on the map was not seen in the field. The total area that might possibly be irrigable totals about 15 ha and has been rounded to 20ha for estimating the number of inspection sites.

**Figure 3.1 Area Measurement Baba Ie**




Area to North of the mapped track 15 ha




Area to South of the mapped track 8 ha

The total area of land mapped as originally being "sawah" is shown in Figure 1.4 and the area in hectares in Table 1.1

**Table 3.3 Suggested Number of Survey Points Baba Ie**

| Survey Level Routine Soil Survey | Map Scale | Area of 1cmx1cm of map | Target observation density (FAO Min) | Target observation density (FAO Low) | Target observation density (FAO Mid) | Target observation density (FAO High) | Survey Area Extent | Number of Sites for the survey | Number of Sites for the survey | Number of Sites for the survey | Number of Sites for the survey |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1: | Ha | Sites / Ha | Sites / Ha | Sites / Ha | Sites / Ha | Ha | FAO Min | FAO Low | FAO Mid | FAO High |
| Extremely detailed | 1000 | 0.0100 | 10 | 25 | 50 | 100 | 20 | 197 | 493 | 985 | 1970 |
| Extremely detailed | 1500 | 0.0225 | 4 | 11 | 22 | 44 | 20 | 88 | 219 | 438 | 876 |
| Extremely detailed | 2000 | 0.0400 | 3 | 6 | 13 | 25 | 20 | 49 | 123 | 246 | 493 |
| Very detailed | 2500 | 0.0625 | 2 | 4 | 8 | 16 | 20 | 32 | 79 | 158 | 315 |
| Very detailed | 5000 | 0.2500 | 0.40 | 1 | 2 | 4 | 20 | 8 | 20 | 39 | 79 |
| Detailed | 7500 | 0.5625 | 0.20 | 0.5 | 1 | 2 | 20 | 4 | 10 | 20 | 39 |
| Detailed | 10000 | 1.000 | 0.10 | 0.25 | 0.5 | 1.0 | 20 | 2 | 5 | 10 | 20 |

*Based on: FAO Soil Bulletin No 42, Soil Survey Investigations for Irrigation, 1986*

ETESP would suggest aiming to map at 1:2500 or 1:2000 scale and employing the FAO "Mid Category" of reliability. This would require between 150 and 250 rapid soil observations but a skilled, experienced soil surveyor could reduce this number considerably by using a phased approach. That is, at first do a reduced density, say 50 observations, to check if these observations would allow boundaries to be drawn. Any boundaries drawn would then be checked by doing intermediately located spot observations. This process would be continued until a reliable map could be produced. Inexperienced field surveyors would be advised to initially do a higher level of observations than indicated for an experienced operator. A suggested proforma for data recording is presented below Section 3.6.

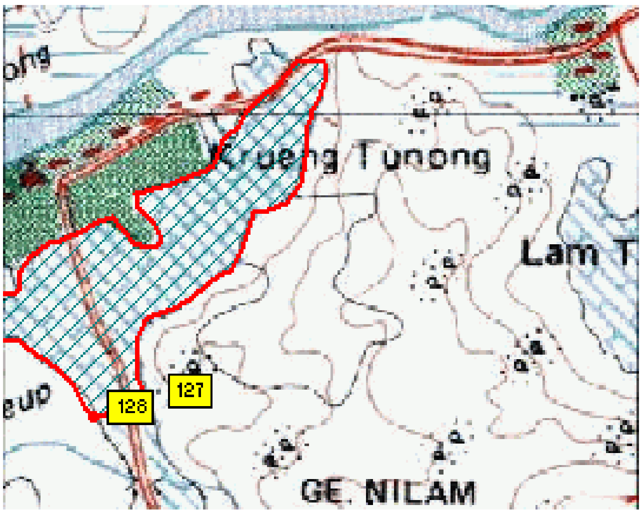
As and when a soils investigation is done bulk soil samples from 0-25cm, 25-50cm, 50-75cm and 75-100cm could be collected from say 5 – 10% of the sites, ensuring that all parts of the location are sampled, and sent to the laboratory for the analyses suggested in Section 3.7 below.

If it is determined that there is an area of land that has to have the sand moved or removed then the spoil would have to be dumped somewhere. Near the coast "tambak" development is already being undertaken and correlation with the contractor doing this development might help to locate a suitable place for sand disposal – the obvious use would be to build some form of protection bund between the agricultural area and the sea. Consideration could then be given to planting coconut on the bund.

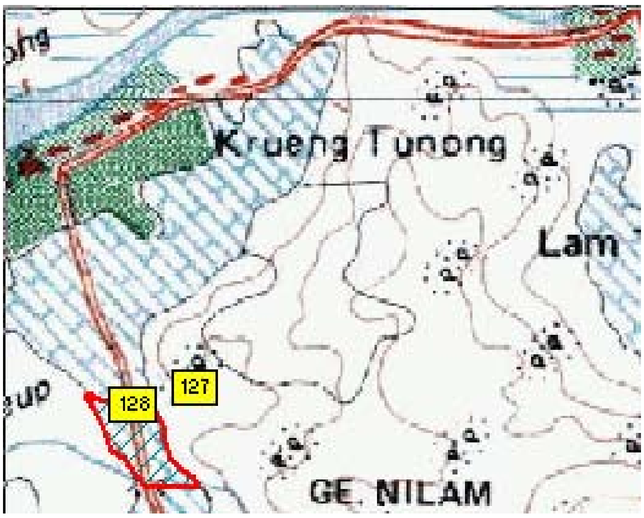
### 3.3.2 Krueng Tunong

Without current, up-to-date topographic mapping it is again not easy to estimate the cultivable land so, as in Baba Ie, the area of land previously mapped as 'sawah" has been measured. This time one block running northwards to the main river and a second block running southward to the minor stream line have both been measured. The total area from this exercise is about 40 ha and this has been used to calculate numbers of possible soil inspection sites (Table 3.4).

**Figure 3.2 Areas Krueng Tunong**




Area N of existing canal 40 ha




Area S of existing canal 5 ha to first stream

The total area of land mapped as originally being "sawah" is shown in Figure 1.45and the area in hectares in Table 1.1

**Table 3.4 Suggested Number of Survey Points Krueng Tunong**

| Survey Level Routine Soil Survey | Map Scale | Area of 1cmx1cm of map | Target observation density (FAO Min) | Target observation density (FAO Low) | Target observation density (FAO Mid) | Target observation density (FAO High) | Survey Area Extent | Number of Sites for the survey | Number of Sites for the survey | Number of Sites for the survey | Number of Sites for the survey |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1: | Ha | Sites / Ha | Sites / Ha | Sites / Ha | Sites / Ha | Ha | FAO Min | FAO Low | FAO Mid | FAO High |
| Extremely detailed | 1000 | 0.0100 | 10 | 25 | 50 | 100 | 40 | 400 | 1000 | 2000 | 4000 |
| Extremely detailed | 1500 | 0.0225 | 4 | 11 | 22 | 44 | 40 | 178 | 444 | 889 | 1778 |
| Extremely detailed | 2000 | 0.0400 | 3 | 6 | 13 | 25 | 40 | 100 | 250 | 500 | 1000 |
| Very detailed | 2500 | 0.0625 | 2 | 4 | 8 | 16 | 40 | 64 | 160 | 320 | 640 |
| Very detailed | 5000 | 0.2500 | 0.40 | 1 | 2 | 4 | 40 | 16 | 40 | 80 | 160 |
| Detailed | 7500 | 0.5625 | 0.20 | 0.5 | 1 | 2 | 40 | 8 | 20 | 40 | 80 |
| Detailed | 10000 | 1.000 | 0.10 | 0.25 | 0.5 | 1.0 | 40 | 4 | 10 | 20 | 40 |

ETESP would suggest aiming to map at 1:2500 or 1:2000 scale and employing the FAO "Mid Category" of reliability. This would require between 300 and 475 rapid soil observations but a skilled, experienced soil surveyor could reduce this number considerably by using a phased approach. That is, at first do a reduced density, say 100 observations, to check if these observations would allow boundaries to be drawn. Any boundaries drawn would then be checked by doing intermediately located spot observations. This process would be continued until a reliable map could be produced. Inexperienced field surveyors would be advised to initially do a higher level of observations than indicated for an experienced operator.

As and when a soils investigation is done bulk soil samples from 0-25cm, 25-50cm, 50-75cm and 75-100cm could be collected from say 5 – 10% of the sites, ensuring that all parts of the location are sampled, and sent to the laboratory for the analyses suggested in Section 3.6 below.

The final areas to be checked (surveyed) will depend on the current topographic mapping being planned by the Irrigation and Drainage engineers as this will establish land which is in or out of command. The areas may then be further trimmed depending on calculations of water supply and the area that can be reliably irrigated.

In this location there is a higher or elevated area between the land which would be considered for irrigation and the ocean, this higher area is already used for dryland cultivation with chili and coconut being planted. Any sand to be cleared form the irrigation area could be used to build-up and protect the inland edges of this elevated area.

## 3.4 Drainage

To operate efficiently with reasonable guarantees of salinity not building-up in an irrigation system the following system of drains is normally required:

- In-field drains
- Collector drains, and
- Main drains

On these locations drains have not been seen and these should be constructed to obtain maximum efficiency of the installation. As suggested in ETESP report "Soil Conditions for Wetland Rice" in-field drains should be excavated to 100cm depth to allow full desalinisation and reclamation of the entire root zone for rice.

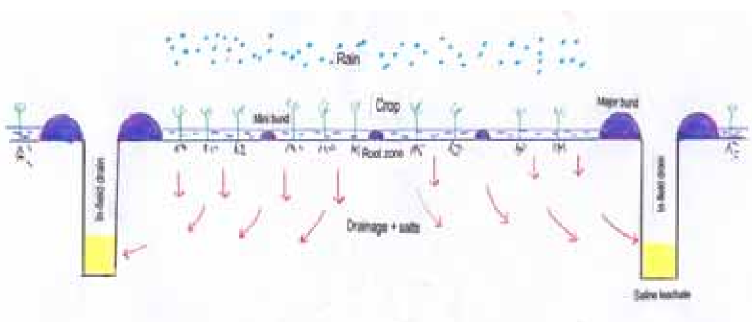
<u>In-field Drains</u>

In-field drains are drains that are dug at intervals in a network that covers all of the irrigated or cultivated area. More detail on the subject can be found in ETESP "Scenarios" – Scenario No 6, Update of March 2006.

These drains are excavated to approximately 100cm depth in the soil and they must NOT be lined in any way. Grass may well grow on the edges and sides of the drains and this would help stabilize them but vegetation has to be kept under control or it can block the flow in the drains.

There was no obvious existing in-field drainage system seen on these sites.

**Figure 3.4 In-field Drains Cross Section**




In-field drains have to have bunds installed along their length to prevent surface water (rainfall or irrigation) from flowing directly into the drain instead of infiltrating into the soil.

Further comment on drains is outwith the capability of the Soil Specialist and is a task for a Drainage Engineer.

## 3.5 Rain-fed Areas

Pre-tsunami it is reported that there was land under rain-fed cultivation at these locations. Since there has been sand sediment added to the soils the overall soil texture will have been diluted to some extent – that is soils will, overall, be sandier than they were (for example, sandy clay loams now being sandy loams). Sandier soils have poorer AWHC and nutrient reserves than finer textured soils so care will have to be taken that crops to be planted are suited to the soils as they now exist and will grow on these soils.

Similarly, the fertility status and fertility potential should be considered and further agronomic and soils technical inputs might be in order once the full details of the soils in the area have been determined and suitable inputs of organic manures and mineral fertiliser applied.

To help boost moisture reserves in the rain-fed areas bunds should be constructed around plots or fields to ensure that any precipitation that does land on the field remains there and does not run-off and be lost in the drainage. Similarly, if there are some non-sandy surface soils that are out of command for irrigation the moisture reserves could be improved by installation of simple water-harvesting interventions.

## 3.6 Soil Fertility

Appendix A presents the available data on soil analyses and fertility that are known fro these sites.

The summaries from the sheets for the various areas are presented below, but note that the comments on "iron precipitation" and "Acid sulphate" risk are experimental to some extent:

### 3.6.1 Baba Ie Fertility

| | |
|---|---|
| **Fertility:** | Inherent fertility: considered to be moderate to low with Org-C, Exch Ca and Exch K moderate whilst Total-N, Exch-Mg and TEB are all low. Organic manures and fertilisers indicated |
| **Potential:** | Fertility potential: or ability to retain added fertilisers is rated low with CEC of 13.1 noted, though the figures are not really representative since there is no subsoil data for one site |
| **Deficiencies:** | Deficiencies: overall it appears as though magnesium (Mg) could be deficient. Use of dolomitic limestone or mineral fertilisers with Mg indicated |
| **Salinity** | Reclamation leaching probably not needed if good water management exists along with functioning drainage system, but check for change after civil works complete to check condition |
| **Reaction:** | Reaction: at the time the samples were taken was neutral. Exch H and Al both low |
| **Iron precipitation:** | Little or no risk of iron precipitation with root damage and drain clogging |
| **Iron Toxicity:** | No or only slight risk of iron toxicity to rice |
| **Acid Sulphate:** | Slight to moderate risk of acid sulphate conditions existing, as / if soils dry monitor for smell of $H_2S$ and monitor for dropping pH values |

### 3.6.2 Krueng Tunong Fertility

| | |
|---|---|
| **Fertility:** | Inherent fertility: considered to be moderate to low with Org-C moderate as are Exch Ca and TEB whilst Total-N is low as is Mg but K is rated as high. |
| **Potential:** | Fertility potential: or ability to retain added fertilisers is rated low with CEC ranging from 8.8 to 25.7 with an average of 14.7me/100g. Application of organic manures would boost CEC and overall fertility |
| **Deficiencies:** | Deficiencies: overall it appears as though magnesium (Mg) could be deficient. Use of dolomitic limestone or mineral fertilisers with mg indicated |
| **Salinity** | Reclamation leaching not required, but check ECe after civil works complete to check for change in condition |
| **Reaction:** | Reaction: at the time the samples were taken was neutral with an overall pH of 7.12 whilst Exch-H and Al are both very low as is Al saturation |
| **Iron precipitation:** | Little or no risk of iron precipitation with root damage and drain clogging |
| **Iron Toxicity:** | No or only slight risk of iron toxicity to rice |
| **Acid Sulphate:** | Slight to moderate risk of acid sulphate conditions existing, as / if soils dry monitor for smell of H2S and monitor for dropping pH values |

### 3.6.3 Meudheun Fertility

**Fertility:** Inherent fertility: considered to be moderate as Org-C, total-N, C:N ratio, Exch Ca, Mg and K plus TEB are all rated moderate.

**Potential:** Fertility potential: or ability to retain added fertilisers is rated low with CEC of 12me/100g. Application of organic manures - FYM and / or compost – would help boost fertility and fertility potential

**Deficiencies:** Deficiencies: overall it appears as though magnesium (Mg) might be slightly deficient. Use of dolomitic limestone or mineral fertilisers with Mg indicated

**Salinity** Reclamation leaching probably not needed if good water management exists along with functioning drainage system, but check for change after civil works complete to check condition

**Reaction:** Reaction: at the time the samples were taken was neutral and both Exch H and Al rated as low whilst Al saturation is very low. No problems from precipitation of iron, which is rated as high, would be expected

**Iron precipitation:** Little or no risk of iron precipitation with root damage and drain clogging

**Iron Toxicity:** No or only slight risk of iron toxicity to rice

**Acid Sulphate:** Slight to moderate risk of acid sulphate conditions existing, as / if soils dry monitor for smell of H2S and monitor for dropping pH values

### 3.6.4 Lambaro Fertility

**Fertility:** Inherent fertility: considered to be moderate as Org-C, Total-N, C:N ratio, Exch-Ca and TEB all moderate, though Mg is low and K high

**Potential:** Fertility potential: or ability to retain added fertilisers is rated low as CEC is only 12me/100g. Addition of organic manure or compost would boost CEC and fertility

**Deficiencies:** Deficiencies: overall it appears as though magnesium (Mg) could be deficient. Use of dolomitic limestone or mineral fertilisers with Mg indicated

**Salinity** Reclamation leaching probably not needed if good water management exists along with functioning drainage system, but check for change after civil works complete to check condition

**Reaction:** Reaction: at the time the samples were taken was neutral with overall pH 6.9 whilst Exch-H and AL both very low. Risk of iron precipitating and harming rice roots or clogging drains considered minimal

**Iron precipitation:** Little or no risk of iron precipitation with root damage and drain clogging

**Iron Toxicity:** No or only slight risk of iron toxicity to rice

**Acid Sulphate:** Little or no perceived risk of acid sulphate conditions existing

## 3.7 Final Interventions

Once the items detailed in sections 3.2 – 3.5 have been addressed and interventions applied the sites would be almost ready for normal agricultural activity.

The recommended final interventions comprise:

1. Shallow depths of sand and other sediments should be thoroughly mixed in with the original, underlying native soil by ploughing. The first ploughing might be easier to achieve with the soil dry – that is not flooded as for puddling and padi preparation.

2. If available, large amounts of organic composts and manures should then be incorporated into the soil / sediment mixture by further ploughing. Mineral fertilisers can also me added at this time if planting is planned in the immediate future

3. If the soil is to be used for padi then it should be puddled following the normal procedures used by the farmer. One point to bear in mind is that when the soil texture has been diluted by ploughing-in sand the sand will settle out first when the soil is puddled – this means that the resultant top layer of soil may have a texture very similar to the original soil of the site

4. A first crop should then be planted and progress monitored carefully to enable good feedback to the extension service (ETESP has compiled a very simple format for monitoring in a way that gives feedback when the collected data are added to the monitoring form on computer)

The only other intervention that ETESP would suggest at this time should be considered for the inland sites where survey and sampling is not expected to be done. After the first harvest is gathered and an estimate of the quality and quantity of the harvest made – how close to the expected yield was this harvest to the pre-tsunami norm? If the yield is depressed to any great extent then soil sampling should be considered and the samples subjected to normal laboratory analyses for:

- Soil Reaction with pH (water) and Exchangeable H (hydrogen) and Al (aluminium)
- Soil EC – in dS/m
- Exchangeable-Ca (calcium)
- Exchangeable-Mg (magnesium)
- Exchangeable-K (potassium)
- Exchangeable-(sodium)
- Total-N
- Organic carbon
- Available-P, and
- CEC – Cation Exchange Capacity

These routine soil analyses could be carried out by ISRI, Bogor and there is a commercial laboratory based on the Department of Agriculture at the university in Darussalam. However, the competence and reliability of this laboratory is not known though attempts are being made to investigate capabilities. Once obtained the laboratory data should be entered into the ETESP tool (Excel spreadsheet) "ETESP Lab Data Summary Ver 4". This tool applies ratings to the level of the various nutrients and also presents a summary indicating fertility level, any possible deficiencies and obvious risk factors presented by the chemical status of the soil.

**Figure 3.5 Suggested Soil Description Collection Form**

| | | | |
|---|---|---|---|
| **SITE NUMBER:** | | **Topo Map No:** | |
| **Survey Area** | | **Topo Map Scale 1:** | |
| **Coords:** | deg min sec **N** | (GPS) | deg min sec **E** |
| **Altitude:** | masl | GPS / Altimeter / Map | |
| **Obs. Type:** | Profile Section | Chisel / Auger | Auger |
| **Date:** | (d)/ (m)/ (year) | **Surveyor:** | |

| MICRORELIEF | | SURFACE CONDITION | | SURFACE LITTER | | SURFACE COVERING STONES & GRAVEL | |
|---|---|---|---|---|---|---|---|
| **Amplitude** | **Type** | **Moisture** | **Hardness** | **Type** | **cm** | **Freq** | **Type** |
| (Cm) | Landshaping | Dry | Loose nr | | | none | Sand |
| < 25 | Sand | Sli Moist | Soft ND | | | rare | Fine gravel |
| 25 - 50 | Undulations | Moist | Sli Hard | | | few | Coarse gravel |
| 50 - 100 | Gulley | Wet | Mod Hard | LITTER | | common | Stones |
| 100 - 200 | Rills | Flood | Hard | **Decomposition** | | many | |
| >200 | Mound | nr | Very Hard | | | abundant | |
| nr | Terrace | ND | Extr Hard | | | nr | |
| ND | Bench | **Cracks**: nil few common many nr | | VEGETATION CATEGORY | | PRESENT LANDUSE | |
| **Notes:** | Cattle Poachin | **Cracks**:vf fine med cs vcs nr ND | | Grassland | | None | |
| | Vegetation | **Soil Cap:** nil broken exten nr ND | | Shrubland | | Grazing | |
| | ⇐Other | **Lichen:** Yes / No | | Wetland species (Reeds) | | Wetland | |
| | nr | **Algae:** Yes / No | | Other: | | Other: | |

| HORIZON No. | DEPTH (cm) From - To | MUNSEL COLOUR Dry | MUNSEL COLOUR Moist | TEXTURE Field / hand Texture | MOTTLE Num | Size | Cont | Colour |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 - | ________/_______ | ________/_______ | | | | | |
| 2 | - | ________/_______ | ________/_______ | | | | | |
| 3 | - | ________/_______ | ________/_______ | | | | | |
| 4 | - | ________/_______ | ________/_______ | | | | | |
| 5 | - | ________/_______ | ________/_______ | | | | | |
| 6 | - | ________/_______ | ________/_______ | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **SUMMARY** | Dominant Topsoil Colour: | Dominant Subsoil Colour: | | | | |
| | Dominant Topsoil Texture: | Dominant Subsoil Texture: | | | | |
| | Depth of sand: cm | Sampled: YES / NO | 0 - 25 | 25 - 50 | 50- 75 | 75 - 100 |

Notes/ Comments / Diagram

nr = not recorded
ND Not Determined or No Data

# 4. SUGGESTED ROUTINE FOR FUTURE INVESTIGATIONS

## 4.1 PREPARATION and DATA RECORDING

1. Site visits such as carried out for the schemes in the Lhamno area should be done
2. New topographic mapping should be compiled to be available for use on the site visit if possible
3. During the site visit the area should be rapidly inspected by walking the length of the irrigation supply canal, visiting the weir and off-take plus noting the point where the canal discharges into the top end of the scheme
4. GPS tracks of all canals followed, access roads used and, if possible, alignment of drains should be taken
5. GPS waypoints of all points of interest or importance should be taken
6. All GPS data can then be downloaded on to the digital copies of relevant mapping

## 4.2 INTERVIEWS, OBSERVATIONS and MEASUREMENTS

1. Local farmers should be interviewed to establish just what happened when the tsunami struck; how deep was the flood, how long did the flood last and did the inundation do obvious physical damage?
2. Local farmers should be interviewed to establish what area, hectarage, was under irrigation before the tsunami?
3. What was the cropping pattern, for example – padi, how many crops per year and if only 1 or 2 crops why?
4. What is the local perception or knowledge of the depth of sand deposited on the agricultural land?
5. A walk-about within areas with reported sand deposits should be attempted and, if possible and equipment is available, rapid checks of sand depth should be made in a few locations
6. The status of the vegetation of the site should be noted, if there is good vegetative cover of mixed species then indications are that salinity damage is not serious
7. Similarly, if a salinity meter is available the salinity of the soil at a few locations within the site should be measured in the field
8. The salinity of all water that can be seen or accessed should be measured by salinity meter in the field
    - standing or flood water
    - drainage water
    - ground-water
    - well water, and
    - irrigation water

## 4.3 PLANNING and SURVEY

1. Where there are no sand deposits rehabilitation of the irrigation and drainage systems could be scheduled as soon as the programme allows, but areas with sand must await the findings of soil survey investigations and the sand depth map
2. In areas where there are proven sand deposits a survey should be planned to map at the scales discussed earlier in this report (1:2,000 to 1:2,500), or at scales that the engineers decide would suit irrigation planning
3. During the soil investigations 5 – 10% of the sites should have soil samples taken and sent to the laboratory for the soil analyses as suggested in section 3.7 above. The analyses will confirm the need for reclamation leaching and allow a check on the existing data compiled by the ETESP Agriculture from the Lotti data plus pinpoint obvious nutrient deficiencies
4. Once the sand depth / distribution map is compiled decisions have to be made if sand deeper than 15 – 20cm is to be moved, removed or a decision made to abandon using the land for irrigated agriculture

## 4.4 SAND REMOVAL and LAND PREPARATION

1. If sand is moved or removed it must be disposed of in an environmentally acceptable manner. In some cases the sand may be pushed to the side to form protection banks or bunds that could be of value for planting such crops as coconut. In other areas the sand might be removed and spread over the surface of areas that are sandy and already cultivated with suitable crops, the extra depth might be a useful addition to the root zone. In some cases there may be no place locally to use for sand disposal – consideration then needs to be made of the economics of trucking the sand to another location or abandoning the land as far as irrigation is concerned
2. In areas with non-sandy sediments, plus those with shallow sandy sediments and where the deep sand has been removed, the sediment must now be incorporated into the underlying soil by ploughing – the initial ploughing should be done with the land dry and be to as great a depth as can be achieved. Large tractors with specialized ploughs, such as moldboard, may be required and agricultural engineering expertise should be employed. The addition of organic manures and fertilisers is recommended at this time
3. After dry-ploughing, land to be used for irrigated rice should then be puddled following the techniques normally used by farmers but again puddling should be to as great a depth as possible and thoroughly done. Where the sediments are sandy the sand fractions will move to the bottom of the puddled zones since sand settles out more quickly than silts and clays – there is every chance that after a few seasons the land will display surface characteristics not too dissimilar to the state pre-tsunami

## 4.5 FURTHER SOILS and DRAINAGE INVESTIGATIONS

1. The above actions and interventions should rehabilitate the land, or determine if the land can be rehabilitated or should be abandoned as far as irrigated use is concerned, however
2. Soil physics studies including AWHC, infiltration rates and possibly hydraulic conductivity might be required before efficient use of the rehabilitated water resources can be ensured and the maximum area irrigated with sufficient drainage installed

## 4.6 MONITORING

1. Monitoring, as suggested in the ETESP report “Soil Conditions for Wetland Rice”, should be carried out

# 5. ETESP Soil Desalinisation and Improvement Reports and Tools

## 5.1 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

## 5.2 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

ETESP, Sandy Sediments, FEBRUARY 2006

ETESP, Soil Conditions for Wetland Rice, MARCH 2006

## 5.3 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 20$^{th}$ – 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

## 5.4 ETESP Soil Desalinisation and Improvement Tools

| File name and date | Purpose |
|---|---|
| ETESP<br>ECe from EM38 data.XLS<br>OCTOBER 2005 | Calculate soil salinity (ECe) values from raw data collected by EM38 salinity device when no calibration information provided |
| ETESP<br>Leaching Water Requirements.XLS<br>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:<br>• Textural class of soil<br>• Initial salinity of the soil (dS/m)<br>• Target salinity wished to be achieved (dS/m) |

| | |
|---|---|
| ETESP<br>Irrigation Leaching Progress.XLS<br>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:<br>• Soil textural group, or<br>• AWHC (Available Water Holding Capacity)<br>• Estimate of water application efficiency, or use default values<br>• Size of irrigation gift as mm of water |
| ETESP<br>Survey Density.XLS<br>DECEMBER 2005 | 1. Correlate the scale at which to map surveys of various types from reconnaissance to very detailed level<br>2. Determine observation density (Sites / hectare)<br>3. Calculate the total number of sites for surveys at various reliability levels<br><br>Requirements:<br>• Survey area extent in hectares (ha)<br><br>Also presents various map and mapping information |
| ETESP<br>Labdata summary.XLS<br>Version 4<br>FEBRUARY 2006 | Enter standard laboratory data and obtain ratings as to the level of all the various nutrients and chemical properties.<br><br>Also calculate weighted mean vales for topsoil and subsoil plus obtain automatic simple summary of:<br><br>• Inherent fertility<br>• Fertility potential<br>• Possible nutrient deficiencies<br>• Salinity status, and<br>• Reaction<br><br>Also experimental estimate of possible perceived risks |
| ETESP<br>Site Monitoring tool.XLS<br>March 2006 | Enter field data for specific sites or villages making note of :<br><br>1. <u>Locational information</u><br>• Kabupaten<br>• Kecamatan<br>• Desa<br>• Farmer or Land-owner, and<br>• Geographic coordinates<br><br>2. <u>Soil, land and crop features</u><br><br>• surface soil textural group<br>• soil salinity<br>• soil acidity<br>• irrigation water quality (salinity)<br>• status of drains, plus<br>• estimate (%) of the actual pre-tsunami crop yield<br><br>to monitor land reclamation progress and get information on further interventions possibly required |
| ETESP<br>Soil Conditions Database tool.XLS<br>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:<br><br>• surface soil textural group<br>• soil salinity<br>• soil acidity<br>• irrigation water quality (salinity)<br>• status of drains, plus<br>• estimate (%) of the actual pre-tsunami crop yield<br><br>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<br>Auger Description Form<br>MARCH 2006 | Simple pro-forma for recording data collected during soil investigations to establish depths and distribution of sandy sediments |

# APPENDIX 1 LABORATORY DATA

**Table A.1 Lotti Data with ETESP Additions**

| Scheme | Site | Soil or | Depth | Text | PSC (%) | | | EC | pH | | pH | $H^+$ | $Al^{3+}$ | Fe | S | C | N | C/N | Exchanageable me /100g | | | | | BS (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| / Desa | No | Sediment | cm | | Sand | Silt | Clay | dS/m | H2O | KCl | Diff | | | ppm | (ppm) | (%) | | | Ca | Mg | K | Na | CEC | |
| Baba Ie | BI ES | Sediment | 0 - 35 | S | 94 | 5 | 1 | 0.8 | 7.8 | 7.1 | 0.7 | 0.12 | 0.19 | 15 | 87.7 | 3.04 | 0.17 | 18 | 10.44 | 1.25 | 0.52 | 1.37 | 14.36 | 95 |
| Baba Ie | BI ES | Soil | 35 - | C | 37 | 16 | 47 | 3.5 | 6.7 | 6.1 | 0.6 | 0.40 | 0.23 | 69 | 107.1 | 1.89 | 0.22 | 9 | 8.58 | 0.64 | 0.36 | 0.83 | 11.84 | 88 |
| Baba Ie | BI 3 | Sediment | 40 - | LS | 87 | 10 | 3 | 2.0 | 6.8 | 5.2 | 1.6 | 0.38 | 0.22 | 13.9 | 140.8 | 1.41 | 0.16 | 9 | 5.25 | 2.25 | 0.72 | 1.09 | 10.19 | 91 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Krueng Tunong | KT A1 | Soil | 40 - | SiC | 10 | 45 | 45 | 0.7 | 7.1 | 6.2 | 0.9 | 0.24 | 0.17 | 19 | 120 | 5.53 | 0.32 | 17 | 8.05 | 2.69 | 0.2 | 2.36 | 15.85 | 84 |
| Krueng Tunong | KT H1 | Sediment | 0 - 12 | S | 94 | 1 | 5 | 1.0 | 7.3 | 6.3 | 1.0 | 0.41 | 0.17 | 14.8 | 127 | 1.43 | 0.22 | 7 | 9.14 | 1.55 | 1.08 | 2.86 | 15.95 | 92 |
| Krueng Tunong | KT H1 | Soil | 12 - | SCL | 47 | 18 | 35 | 3.1 | 7.1 | 6.5 | 0.6 | 0.12 | 0.18 | 218.1 | 247.7 | 2.64 | 0.24 | 11 | 8.26 | 1.29 | 0.68 | 1.6 | 12.66 | 93 |
| Krueng Tunong | KTG1 | Sediment | 0 - 38 | S | 95 | 1 | 1 | 3.8 | 7.0 | 6.3 | 0.7 | 0.02 | 0.18 | 14.5 | 209.9 | 1.34 | 0.15 | 9 | 9.02 | 1.52 | 1.23 | 2.94 | 36.13 | 41 |
| Krueng Tunong | KTG1 | Soil | 38 - | SL | 73 | 16 | 11 | 4.5 | 7.0 | 6.4 | 0.6 | 0.18 | 0.22 | 20.5 | 217.2 | 1.39 | 0.19 | 7 | 8.21 | 1.97 | 0.8 | 2.49 | 15.18 | 89 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Lambaro | LB9 | Soil | | SCL | 62 | 12 | 26 | 1.2 | 7.3 | 6.4 | 0.9 | 0.01 | 0.39 | 26.5 | 350.3 | 1.97 | 0.41 | 5 | 5.25 | 1.34 | 0.42 | 1.28 | 9.87 | 84 |
| Lambaro | LD1 | Sediment | 0 - 20 | LS | 85 | 3 | 12 | 3.2 | 7.2 | 6.5 | 0.7 | 0.18 | 0.22 | 21.4 | 328 | 1.42 | 0.13 | 11 | 8.94 | 1.38 | 1.17 | 1.87 | 13.43 | 99 |
| Lambaro | LD1 | Sediment | 20 - | SCL | 51 | 22 | 27 | 2.6 | 6.6 | 6.0 | 0.6 | 0.15 | 0.26 | 68 | 182.2 | 1.99 | 1.00 | 2 | 5.85 | 0.96 | 0.87 | 1.19 | 10.54 | 84 |
| Lambaro | LDI | Sediment | 0 - 20 | SL | 83 | 9 | 8 | 3.2 | 7.2 | 6.5 | 0.7 | 0.18 | 0.22 | 21.4 | 328 | 1.42 | 0.13 | 11 | 8.94 | 1.39 | 1.17 | 1.37 | 13.43 | 96 |
| Lambaro | LDI | Soil | 20 - | C | 31 | 21 | 49 | 2.6 | 6.6 | 6.0 | 0.6 | 0.15 | 0.26 | 68 | 182.2 | 1.99 | 0.21 | 9 | 6.85 | 0.98 | 0.87 | 1.19 | 10.54 | 94 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Meudheun | M3 | Sediment | 0 - 7 | S | 92 | 7 | 1 | 1.7 | 7.7 | 7.1 | 0.6 | 0.01 | 0.38 | 18 | 279 | 1.67 | 0.22 | 8 | 8.83 | 1.92 | 0.75 | 1.93 | 14.49 | 93 |
| Meudheun | M3 | Soil | 7 - | CL | 44 | 23 | 34 | 2.7 | 6.5 | 6.0 | 0.5 | 0.46 | 0.20 | 68.7 | 187.6 | 2.63 | 0.30 | 9 | 6.34 | 1.22 | 0.3 | 0.91 | 9.71 | 90 |

Original EC data were reported in an unconventional unit, micro-mmhos / cm as opposed to the older but conventional unit of milli-mmhos/cm. The conversion to the presently accepted international dS/m unit has been done on the assumption that the data were reported in the unit quoted in the report.

## Table A.2 Processed Data for Baba Ie

Kabupaten: Aceh Jaya  Chemical Characteristics of - Deposits  Baba Le Aceh Jaya

Scheme: Baba Le  *(Refer below for Original & Mixed Soil Data)*

Sample Type: Sediment

| Index No | Site | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BL ES | S | 0 - 35 | 0.81 | 7.8 | 7.1 | 0.70 | 0.12 | 0.19 | 15 | 87.7 | 3.04 | 0.17 | 18 | 10.44 | 1.25 | 0.52 | 1.37 | 14.36 | 13.58 | 9 | 4 | 1 | 95 | 8.35 | Mg deficient with P inhibition | 2.40 | Mg sli deficient |
| | | | Rating | Non Sal | Sli Alk | ND | ND | V Low | V Low | Mod / OK | Low | High | Low | Mod | High | Low | Mod | High | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 2 | BL 3 | LS | 0 - 40 | 2.00 | 6.8 | 5.2 | 1.60 | 0.38 | 0.22 | 13.9 | 140.8 | 1.41 | 0.16 | 9 | 5.25 | 2.25 | 0.72 | 1.09 | 10.19 | 9.31 | 22 | 7 | 2 | 91 | 2.33 | Ca sli deficient | 3.13 | OK |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | Low | Mod / OK | Mod | Mod | Low | Mod | Mod | Mod | High | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya  Chemical Characteristics of - Original Soil  Baba Le Aceh Jaya

Scheme: Baba Le  *(Refer below for Mixed Soil Data)*

Sample Type: Original Soil

| Index No | Site | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BL ES | C | 35 - | 3.50 | 6.7 | 6.1 | 0.60 | 2.00 | 4.00 | 75.00 | 111.00 | 10.00 | 0.11 | 91 | 4.00 | 2.00 | 1.00 | 3.00 | 15.00 | 10.00 | 13 | 7 | 27 | 67 | 2.00 | Ca sli deficient | 2.00 | Mg sli deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | High | High | High | Mod | V High | Low | Poor | Low | Mod | High | V High | Mod | Mod | ND | V Low | High | High | | | | |
| 2 | BL 3 | False data | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya  Chemical Characteristics of - Soil Sediment Mixture  Baba Le Aceh Jaya

Scheme: Baba Le  *(Refer below for Mixed Soil Data)*

Mixed: Deposit and Original Soil  *(Depth range based on theory that mixing is done to twice the depth of original sediment)*

| Index No | Use Index No | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | SCl | 0 - 70 | 2.15 | 7.25 | 6.60 | 0.65 | 1.06 | 2.10 | 45.00 | 99.35 | 6.52 | 0.14 | 54.40 | 7.22 | 1.63 | 0.76 | 2.19 | 14.68 | 11.79 | 11.02 | 5.14 | 13.99 | 80.62 | 5.18 | Mg sli deficient | 2.20 | Mg sli deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Mod | High | High | Low | V High | Low | Poor | Mod | Mod | High | V High | Low | Mod | ND | V Low | Mod | V High | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Mean for mixed soils | | | 2.2 | 7.25 | 6.60 | 0.65 | 1.06 | 2.10 | 45 | 99 | 6.52 | 0.14 | 54.40 | 7.22 | 1.63 | 0.76 | 2.19 | 14.7 | 11.8 | 11.0 | 5.1 | 14.0 | 80.6 | 5.2 | Mg sli deficient | 2.20 | Mg sli deficient |
| | Ratings for mixed soils | | | Non Sal | Neutral | ND | ND | Mod | High | High | Low | V High | Low | Poor | Mod | Mod | High | V High | Low | Mod | ND | V Low | Mod | V High | | | | |

**Fertility:** Inherent fertility: considered to be moderate to low with Org-C, Exch Ca and Exh K moderate whilst Total-N, Exch-Mg and TEB are all low. Organic manures and fertilsers indicated

**Potential:** Fertility potential: or ability to retain added fertilisers is rated low with CEC of 13.1 noted, though the figures are not really representative since there is no subsoil data for one site

**Deficiencies:** Deficiencies: overall it appears as though magnesium (Mg) could be deficient. Use of dolomitic limestone or mineral fertilisers with mg indicated

**Salinity** Reclamation leaching probably not needed if good water management exists along with functioning drainage system, but check for change after civil works complete to check condition

**Reaction:** Reaction: at the time the samples were taken was neutral. Exch H and Al both low

**Iron pptn:** Little or no risk of iron precipitation with root damage and drain clogging

**Iron Toxicity:** No or only slight risk of iron toxicity to rice

**Acid Sulphate:** Slight to moderate risk of acid sulphate conditions existing, as / if soils dry monitor for smell of H2S and monitor for dropping pH values

## Table A.3 Processed Data for Krueng Tunong

Kabupaten: Aceh Jaya Chemical Characteristics of - Deposits Krueng Tunong Aceh Jaya

Scheme: Krueng Tunong *(Refer below for Original & Mixed Soil Data)*

Sample Type: Topsoil

| Index No | Site | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | KTC | S | 0 - 60 | 0.47 | 6.5 | 5.8 | 0.70 | 0.13 | 0.23 | 22.2 | 177.7 | 1.54 | 0.15 | 10 | 5.92 | 0.72 | 0.61 | 0.46 | 8.75 | 7.71 | 8 | 7 | 3 | 88 | 8.22 | Mg deficient with P inhibition | 1.18 | Mg deficient |
| | | | Rating | Non Sal | Sli Acid | ND | ND | V Low | Low | Mod / OK | Mod | Mod | Low | Good | Mod | Low | High | Mod | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 2 | KTG 1 | S | 0 - 38 | 3.80 | 7.0 | 6.3 | 0.70 | 0.02 | 0.18 | 14.5 | 209.9 | 1.34 | 0.15 | 9 | 9.02 | 1.52 | 1.23 | 2.94 | 36.13 | 14.71 | 4 | 3 | 0 | 41 | 5.93 | Mg sli deficient | 1.24 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | V Low | Mod / OK | Mod | Mod | Low | Mod | Mod | Mod | V High | V High | High | Mod | V Low | V Low | V Low | Low | | | | |
| 3 | KTH 1 | S | 0 - 12 | 0.97 | 7.3 | 6.3 | 1.00 | 0.41 | 0.17 | 14.8 | 127 | 1.43 | 0.22 | 7 | 9.14 | 1.55 | 1.08 | 2.86 | 15.95 | 14.63 | 10 | 7 | 1 | 92 | 5.90 | Mg sli deficient | 1.44 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | V Low | Mod / OK | Mod | Mod | Mod | Mod | Mod | Mod | High | V High | Mod | Mod | V Low | V Low | V Low | V High | | | | |
| 4 | KTD 1 | LS | 0 - 36 | 0.45 | 7.5 | 6.5 | 1.00 | 0.25 | 0.18 | 34 | 88 | 2.52 | 0.14 | 18 | 5.04 | 1.03 | 0.69 | 1.39 | 10.69 | 8.15 | 10 | 6 | 2 | 76 | 4.89 | OK | 1.49 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | V Low | Mod High | Low | Mod | Low | Mod | Mod | Low | High | High | Low | Mod | V Low | V Low | V Low | High | | | | |
| 5 | KTA 1 | SL | 0 - 40 | 0.40 | 7.7 | 6.9 | 0.80 | 0.01 | 0.22 | 12 | 55 | 0.87 | 0.09 | 10 | 6.44 | 0.95 | 0.27 | 1.29 | 12.25 | 8.95 | 8 | 2 | 2 | 73 | 6.78 | Mg sli deficient | 3.52 | OK |
| | | | Rating | Non Sal | Sli Alk | ND | ND | V Low | Low | Mod / OK | Low | Low | V Low | Mod | Mod | Low | Low | High | Low | Mod | V Low | V Low | V Low | High | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya Chemical Characteristics of - Original Soil Krueng Tunong Aceh Jaya

Scheme: Krueng Tunong *(Refer below for Mixed Soil Data)*

Sample Type: Original Soil

| Index No | Site | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | KTC | ND | ND | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | KTG 1 | SL | 38 - | 0.45 | 7.0 | 6.4 | 0.60 | 0.18 | 0.22 | 20.5 | 217.2 | 1.39 | 0.19 | 7 | 8.21 | 1.97 | 0.8 | 2.49 | 15.18 | 13.47 | 13 | 5 | 1 | 89 | 4.17 | OK | 2.46 | Mg sli deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | Mod / OK | Mod | Mod | Low | Mod | Mod | Mod | High | V High | Mod | Mod | ND | V Low | V Low | V High | | | | |
| 3 | KTH 1 | SCl | 12 - | 0.31 | 7.1 | 6.5 | 0.60 | 0.12 | 0.18 | 218.1 | 247.7 | 2.64 | 0.24 | 11 | 8.26 | 1.29 | 0.68 | 1.6 | 12.66 | 11.83 | 10 | 5 | 1 | 93 | 6.40 | Mg sli deficient | 1.90 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | V Low | Ext High | Mod | Mod | Mod | Good | Mod | Low | High | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 4 | KTD 1 | SiCl | 36 - | 0.67 | 7.5 | 6.5 | 1.00 | 0.40 | 0.18 | 5.2 | 101.2 | 2.68 | 0.15 | 18 | 5.78 | 0.35 | 0.5 | 1.02 | 10.39 | 7.65 | 3 | 5 | 2 | 74 | 16.51 | Mg deficient with P inhibition | 0.70 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | V Low | Mod / OK | Mod | Mod | Low | Mod | Mod | V Low | Mod | High | Low | Mod | V Low | V Low | V Low | High | | | | |
| 5 | KTA 1 | SiCl | 40 - | 0.70 | 7.1 | 6.2 | 0.90 | 0.24 | 0.17 | 19 | 120 | 5.53 | 0.32 | 17 | 8.05 | 2.69 | 0.2 | 2.36 | 15.85 | 13.30 | 17 | 1 | 1 | 84 | 2.99 | Ca sli deficient | 13.45 | K deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | V Low | Mod / OK | Mod | V High | Mod | Mod | Mod | Mod | Low | V High | Mod | Mod | ND | V Low | V Low | V High | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya Chemical Characteristics of - Soil Sediment Mixture Krueng Tunong Aceh Jaya

Scheme: Krueng Tunong *(Refer below for Mixed Soil Data)*

Mixed: Deposit and Original Soil *(Depth range based on theory that mixing is done to twice the depth of original sediment)*

| Index No | Use Index No | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 2 | | | 2.13 | 7.00 | 6.35 | 0.65 | 0.10 | 0.20 | 17.50 | 213.55 | 1.37 | 0.17 | 8.12 | 8.62 | 1.75 | 1.02 | 2.72 | 25.66 | 14.09 | 8.59 | 4.34 | 0.97 | 64.72 | 5.05 | Mg sli deficient | 1.85 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | Mod / OK | Mod | Mod | Low | Mod | Mod | Mod | High | V High | High | Mod | V Low | V Low | V Low | Mod | | | | |
| 3 | 3 | | | 0.64 | 7.20 | 6.40 | 0.80 | 0.27 | 0.18 | 116.45 | 187.35 | 2.04 | 0.23 | 8.75 | 8.70 | 1.42 | 0.88 | 2.23 | 14.31 | 13.23 | 9.95 | 6.07 | 1.24 | 92.58 | 6.15 | Mg sli deficient | 1.67 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | V Low | V High | Mod | Mod | Mod | Mod | Mod | Low | High | V High | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 4 | 4 | | | 0.56 | 7.50 | 6.50 | 1.00 | 0.33 | 0.18 | 19.60 | 94.60 | 2.60 | 0.15 | 17.93 | 5.41 | 0.69 | 0.60 | 1.21 | 10.54 | 7.90 | 6.50 | 5.63 | 1.71 | 74.93 | 10.70 | Mg deficient with P inhibition | 1.10 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | V Low | Mod / OK | Low | Mod | Low | Mod | Mod | Low | Mod | High | Low | Mod | V Low | V Low | V Low | High | | | | |
| 5 | 5 | | | 0.55 | 7.40 | 6.55 | 0.85 | 0.13 | 0.20 | 15.50 | 87.50 | 3.20 | 0.21 | 13.47 | 7.25 | 1.82 | 0.24 | 1.83 | 14.05 | 11.13 | 12.36 | 1.73 | 1.43 | 78.49 | 4.89 | OK | 8.48 | OK |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | V Low | Mod / OK | Low | High | Mod | Good | Mod | Mod | Low | High | Low | Mod | ND | V Low | V Low | High | | | | |
| | Mean for mixed soils | | | 1.0 | 7.28 | 6.45 | 0.83 | 0.20 | 0.19 | 42 | 146 | 2.30 | 0.19 | 12.07 | 7.49 | 1.42 | 0.68 | 1.99 | 16.1 | 11.6 | 9.4 | 4.4 | 1.3 | 77.7 | 6.7 | Mg sli deficient | 3.27 | OK |
| | Ratings for mixed soils | | | Non Sal | Neutral | ND | ND | Low | V Low | High | Mod | Mod | Low | Good | Mod | Low | High | High | Mod | Mod | V Low | V Low | V Low | High | | | | |

**Fertility:** Inherent fertility: considered to be moderate low with Org-C moderate as are Exch Ca and TEB whilst Total-N is low as is Mg but K is rated as high.

**Potential:** Fertility potential: or ability to retain added fertilisers is rated low with CEC ranging from 8.8 to 25.7 with an average of 14.7me/100g. Application of organic manures would boost CEC and overall fertility

**Deficiencies:** Deficiencies: overall it appears as though magnesium (Mg) could be deficient. Use of dolomitic limestone or mineral fertilisers with mg indicated

**Salinity** Reclamation leaching not required, but check Ece after civil works complete to check for change in condition

**Reaction:** Reaction: at the time the samples were taken was neutral with an overall pH of 7.12 whilst Exch-H and Al are both very low as is Al saturation

**Iron pptn:** Little or no risk of iron precipitation with root damage and drain clogging

**Iron Toxicity:** No or only slight risk of iron toxicity to rice

**Acid Sulphate:** Slight to moderate risk of acid sulphate conditions existing, as / if soils dry monitor for smell of H2S and monitor for dropping pH values

**Table A.4 Processed Data for Meudheun**

Kabupaten: Aceh Jaya Chemical Characteristics of - Deposits Meudheun Aceh Jaya

Scheme: Meudheun *(Refer below for Original & Mixed Soil Data)*

Sample Type: Sediment

| Index | | Texture | Depth | EC | pH | pH | pH | Exchangeable | | Fe | $SO_4$ | Org C | Total N | C:N | Exchangeables | | | | | | Saturations | | | | Cation Ratios | | Cation Ratios | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | meq / 100g | | | | | | Mg | K | Al | BS | | | | |
| No | Site | | Range | dS/m | H2O | KCl | diff | H | Al | ppm | ppm | % | % | | Ca | Mg | K | Na | CEC | TEB | Sat% | Sat% | Sat% | % | Ca/Mg | Rating | Mg/K | Rating |
| 1 | M3 | S | 0 - 7 | 1.75 | 7.7 | 7.1 | 0.60 | 0.01 | 0.38 | 18 | 279 | 1.67 | 0.22 | 8 | 8.83 | 1.92 | 0.75 | 1.93 | 14.49 | 13.43 | 13 | 5 | 3 | 93 | 4.60 | OK | 2.56 | Mg sli deficient |
| | | | Rating | Non Sal | Sli Alk | ND | ND | V Low | Low | Mod / OK | Mod | Mod | Mod | Mod | Mod | Mod | High | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya Chemical Characteristics of - Original Soil Meudheun Aceh Jaya

Scheme: Meudheun *(Refer below for Mixed Soil Data)*

Sample Type: Original soil

| Index | | Texture | Depth | EC | pH | pH | pH | Exchangeable | | Fe | $SO_4$ | Org C | Total N | C:N | Exchangeables | | | | | | Saturations | | | | Cation Ratios | | Cation Ratios | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | meq / 100g | | | | | | Mg | K | Al | BS | | | | |
| No | Site | | Range | dS/m | H2O | KCl | diff | H | Al | ppm | ppm | % | % | | Ca | Mg | K | Na | CEC | TEB | Sat% | Sat% | Sat% | % | Ca/Mg | Rating | Mg/K | Rating |
| 1 | M3 | CL | 7 - | 2.70 | 6.5 | 6.0 | 0.50 | 0.46 | 0.20 | 68.7 | 187.6 | 2.63 | 0.30 | 9 | 6.34 | 1.22 | 0.3 | 0.91 | 9.71 | 8.77 | 13 | 3 | 2 | 90 | 5.20 | Mg sli deficient | 4.07 | OK |
| | | | Rating | Non Sal | Sli Acid | ND | ND | Low | Low | High | Mod | Mod | Mod | Mod | Mod | Low | Mod | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya Chemical Characteristics of - Soil Sediment Mixture Meudheun Aceh Jaya

Scheme: Meudheun *(Refer below for Mixed Soil Data)*

Mixed: Deposit and Original Soil *(Depth range based on theory that mixing is done to twice the depth of original sediment)*

| Index | Use | Texture | Depth | EC | pH | pH | pH | Exchangeable | | Fe | $SO_4$ | Org C | Total N | C:N | Exchangeables | | | | | | Saturations | | | | Cation Ratios | | Cation Ratios | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | meq / 100g | | | | | | Mg | K | Al | BS | | | | |
| No | Index No | | Range | dS/m | H2O | KCl | diff | H | Al | ppm | ppm | % | % | | Ca | Mg | K | Na | CEC | TEB | Sat% | Sat% | Sat% | % | Ca/Mg | Rating | Mg/K | Rating |
| 1 | 1 | | | 2.22 | 7.10 | 6.55 | 0.55 | 0.24 | 0.29 | 43.35 | 233.30 | 2.15 | 0.26 | 8.18 | 7.59 | 1.57 | 0.53 | 1.42 | 12.10 | 11.10 | 12.91 | 4.13 | 2.34 | 91.50 | 4.90 | OK | 3.31 | OK |
| | | | Rating | Non Sal | Neutral | ND | ND | Low | Low | High | Mod | Mod | Mod | Mod | Mod | Mod | Mod | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Mean for mixed soils | | | 2.2 | 7.10 | 6.55 | 0.55 | 0.24 | 0.29 | 43 | 233 | 2.15 | 0.26 | 8.18 | 7.59 | 1.57 | 0.53 | 1.42 | 12.1 | 11.1 | 12.9 | 4.1 | 2.3 | 91.5 | 4.9 | OK | 3.31 | OK |
| | Ratings for mixed soils | | | Non Sal | Neutral | ND | ND | Low | Low | High | Mod | Mod | Mod | Mod | Mod | Mod | Mod | High | Low | Mod | ND | V Low | V Low | V High | | | | |

**Fertility:** Inherent fertility: considered to be moderate as Org-C, total-N, C:N ratio, Exch Ca,Mg and K plus TEB are all rated moderate.

**Potential:** Fertility potential: or ability to retain added fertilisers is rated low with CEC of 12me/100g. Application of organic manures - FYM and / or compost - would boost fertility and fertility potential

**Deficiencies:** Deficiencies: overall it appears as though magnesium (Mg) might be slightly deficient. Use of dolomitic limestone or mineral fertilisers with Mg indicated

**Salinity** Reclamation leaching probably not needed if good water management exists along with functioning drainage system, but check for change after civil works complete to check condition

**Reaction:** Reaction: at the time the samples were taken was neutral and both Exch H and Al rated as low whilst Al saturation is very low. No problems from precipitation of iron, which is rtaed as high, would be expected

**Iron pptn:** Little or no risk of iron precipitation with root damage and drain clogging

**Iron Toxicity:** No or only slight risk of iron toxicity to rice

**Acid Sulphate:** Slight to moderate risk of acid sulphate conditions existing, as / if soils dry monitor for smell of H2S and monitor for dropping pH values

**Table A.5 Processed data for Lambaro**

Kabupaten: Aceh Jaya    Chemical Characteristics of - Deposits    Lambaro Aceh Jaya

Scheme: Lambaro    *(Refer below for Original & Mixed Soil Data)*

Sample Type: Sediment

| Index No | Site | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LD 1 | LS | 0 - 20 | 3.20 | 7.2 | 6.5 | 0.70 | 0.18 | 0.22 | 21.4 | 328 | 1.42 | 0.13 | 11 | 8.94 | 1.38 | 1.17 | 1.87 | 13.43 | 13.36 | 10 | 9 | 2 | 99 | 6.48 | Mg sli deficient | 1.18 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | Mod / OK | Mod | Mod | Low | Good | Mod | Low | High | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 2 | LB 9 | ND | ND | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Ldi | SL | 0 - 20 | 3.20 | 7.2 | 6.5 | 0.70 | 0.18 | 0.22 | 21.4 | 328 | 1.42 | 0.13 | 11 | 8.94 | 1.39 | 1.17 | 1.37 | 13.43 | 12.87 | 10 | 9 | 2 | 96 | 6.43 | Mg sli deficient | 1.19 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | Mod / OK | Mod | Mod | Low | Good | Mod | Low | High | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya    Chemical Characteristics of - Original Soil    Lambaro Aceh Jaya

Scheme: Lambaro    *(Refer below for Mixed Soil Data)*

Sample Type: Original Soil

| Index No | Site | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | LD 1 | SCl | 20 - | 2.60 | 6.6 | 6.0 | 0.60 | 0.15 | 0.26 | 68 | 182.2 | 1.99 | 1.00 | 2 | 5.85 | 0.96 | 0.87 | 1.19 | 10.54 | 8.87 | 9 | 8 | 2 | 84 | 6.09 | Mg sli deficient | 1.10 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | High | Mod | Mod | V High | Ext Poor | Mod | Low | High | High | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 2 | LB 9 | SCl | | 1.18 | 7.3 | 6.4 | 0.90 | 0.01 | 0.39 | 26.5 | 350.3 | 1.97 | 0.41 | 5 | 5.25 | 1.34 | 0.42 | 1.28 | 9.87 | 8.29 | 14 | 4 | 4 | 84 | 3.92 | OK | 3.19 | OK |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | Mod High | Mod | Mod | Mod | Mod | Mod | Low | Mod | High | Low | Mod | ND | V Low | V Low | V High | | | | |
| 3 | Ldi | C | 20 - | 2.60 | 6.6 | 6.0 | 0.60 | 0.15 | 0.26 | 68 | 182.2 | 1.99 | 0.21 | 9 | 6.85 | 0.98 | 0.87 | 1.19 | 10.54 | 9.89 | 9 | 8 | 2 | 94 | 6.99 | Mg sli deficient | 1.13 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | High | Mod | Mod | Mod | Mod | Mod | Low | High | High | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Kabupaten: Aceh Jaya    Chemical Characteristics of - Soil Sediment Mixture    Lambaro Aceh Jaya

Scheme: Lambaro    *(Refer below for Mixed Soil Data)*

Mixed: Deposit and Original Soil    *(Depth range based on theory that mixing is done to twice the depth of original sediment)*

| Index No | Use Index No | Texture | Depth Range | EC dS/m | pH H2O | pH KCl | pH diff | Exchangeable H | Exchangeable Al | Fe ppm | $SO_4$ ppm | Org C % | Total N % | C:N | Exchangeables meq / 100g Ca | Mg | K | Na | CEC | TEB | Saturations Mg Sat% | K Sat% | Al Sat% | BS % | Cation Ratios Ca/Mg | Rating | Cation Ratios Mg/K | Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | SCl | | 2.90 | 6.90 | 6.25 | 0.65 | 0.17 | 0.24 | 44.70 | 255.10 | 1.71 | 0.57 | 6.46 | 7.40 | 1.17 | 1.02 | 1.53 | 11.99 | 11.12 | 9.69 | 8.48 | 2.05 | 91.82 | 6.29 | Mg sli deficient | 1.14 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | High | Mod | Mod | High | Mod | Mod | Low | High | High | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Rating | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 3 | SCl | | 2.90 | 6.90 | 6.25 | 0.65 | 0.17 | 0.24 | 44.70 | 255.10 | 1.71 | 0.17 | 10.20 | 7.90 | 1.19 | 1.02 | 1.28 | 11.99 | 11.38 | 9.82 | 8.48 | 2.05 | 94.83 | 6.71 | Mg sli deficient | 1.16 | Mg deficient |
| | | | Rating | Non Sal | Neutral | ND | ND | V Low | Low | High | Mod | Mod | Low | Good | Mod | Low | High | High | Low | Mod | V Low | V Low | V Low | V High | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Mean for mixed soils | | | 2.9 | 6.90 | 6.25 | 0.65 | 0.17 | 0.24 | 45 | 255 | 1.71 | 0.37 | 8.33 | 7.65 | 1.18 | 1.02 | 1.41 | 12.0 | 11.2 | 9.8 | 8.5 | 2.1 | 93.3 | 6.5 | Mg sli deficient | 1.15 | Mg deficient |
| | Ratings for mixed soils | | | Non Sal | Neutral | ND | ND | V Low | Low | High | Mod | Mod | Mod | Mod | Mod | Low | High | High | Low | Mod | V Low | V Low | V Low | V High | | | | |

**Fertility:** Inherent fertility: considered to be moderate as Org-C, Total-N, C:N ratio, Exch-Ca and TEB all moderate, though Mg is low and K high

**Potential:** Fertility potential: or ability to retain added fertilisers is rated low as CEC is only 12me/100g. Addition of organic manure or compost would boost CEC and fertility

**Deficiencies:** Deficiencies: overall it appears as though magnesium (Mg) could be deficient. Use of dolomitic limestone or mineral fertilisers with Mg indicated

**Salinity** Reclamation leaching probably not needed if good water management exists along with functioning drainage system, but check for change after civil works complete to check condition

**Reaction:** Reaction: at the time the samples were taken was neutral with overall pH 6.9 whilst Exch-H and AL both very low. Risk of iron precipitating and harming rice roots or clogging drians considered minimal

**Iron pptn:** Little or no risk of iron precipitation with root damage and drain clogging

**Iron Toxicity:** No or only slight risk of iron toxicity to rice

**Acid Sulphate:** Little or no perceived risk of acid sulphate conditions existing