Report Summary

Patrick Niemeyer, USDA-NRCS soil scientist, spent two weeks in East Timor at the request of the University of Hawaii at Manoa assessing the utility of the available soils maps. It was found that although soil delineations of two maps correspond to boundaries between soil types, the 1978 Portuguese soil map was the best map available for representing soils in East Timor. The soils map is completed at the 4th order of USDA soil survey. This makes the map useful for broad country-wide planning but of limited use in more site specific planning. Any projects that use the soil information provided by this map in the planning process will require on-site inspection to verify existing soils types. Steps should be taken to convert this map, along with its' associated data, to a digital, computer ready, version. The soils map should be made available to MAFF extension agents and associated staff. They should be trained to navigate using the soils map as well as other available maps and to identify soils on the map based on basic soil characteristics. In the future soil mapping of important agricultural and commercial lands should be updated at a more detailed mapping scale.

Trip summary

Patrick Niemeyer, Soil Scientist for the USDA Natural Resource Conservation Service, was sent to East Timor from May 21, 2004 to June 7, 2004 at the request of the University of Hawaii at Manoa for the purpose of verifying the quality of existing soil maps of East Timor. It is believed that a sufficiently accurate soil map will allow local agriculture extension services to transfer technology from one location in the country to other locations where similar soils occur. The same soil map can also be used in the planning and construction of buildings or roads.

To verify soil mapping, an area surrounding the city of Baucau in the Seical district was selected as the predominant study site. UH Manoa has fertilizer trials and other studies established in the area and it was decided to use these locations as the principal sites for investigation. Data collected from the soils investigation can be applied directly to these studies. The districts of Emera, Aileu, and Dili were also visited to see coffee growing areas and make basic soil observations.

The assignment required the examination of landscapes and soil pedons to check the accuracy of soil mapping with actual site observations. A global positioning system (GPS) was used in conjunction with a laptop computer to track and verify location. In this way, geomorphic features that relate to map unit boundaries were identified. Pedons were observed at 9 sites by digging one cubic meter pits to expose the soil horizons. Observations were also made at exposed road cuts, by boring with an auger, or by digging small holes with a shovel.

In addition to the field work, soil pedon data from a similar project was collected from MAFF and data tables for the digitized soils map were checked for accuracy. Availability of maps, aerial photos, and soils data was also assessed.

This assignment also provided a training opportunity for local UH and Ministry of Agriculture, Forestry and Fisheries (MAFF) staff members. East Timorese farmers also had an opportunity to learn about soils specific to their area. Participants included: Fernando Sousa, UH project support; Julio Correia, MAFF Soil Scientist; and Antonio Lopes, MAFF Agriculture Extensionist. At each location, farmers participated by asking questions, and providing information about soils and previous land use. With their help, we chose representative locations for pedon descriptions.

Short History of East Timor Soils Mapping

Soil mapping of East Timor was initiated in 1960 by the government of Portugal and published in 1978 as Os Solos de Timor (The Soils of Timor)[1]. The book portion of the publication contains a short section describing general geomorphology, geology, climate, vegetation and erosion in East Timor. It also contains approximately 550 soil pedon descriptions and their physical and chemical properties. Classification of these soils was completed at the soil great group** level using the approximate definitions proposed for the 1969 UNESCO/FAO Soils Map of the World[2]. The scale of this map is 1:100,000 and is covered on 10 map plates. Map units in this publication are defined as Associations and Complexes of Associations and delineated at a soil texture phase. Each soil association contains the following information: type and percentages of soils in the

map unit, location of map unit, parent material, geography, vegetation, climate, and a reference to pedons that are represented in the map unit and described in the publication. The more recently developed digital map of East Timor was made available through Australian Local Government Information Service (ALGIS) working with East Timorese counterparts under the auspice of the World Bank. The map was digitized using the original Portuguese map as a template. Soils have been converted from 1969 FAO group classification to the 1975 USDA Soil Taxonomy[3] great group classification. In the digitizing and reclassification process, some of the original map units were combined. The combined map units were usually those separated on the original map due to surface soil texture or rockiness but in some cases smaller map units with distinctly different soils have been incorporated into larger adjacent units.

Discussion of available soils maps of East Timor

The USDA Soil Survey Manual divides soil surveys into 5 orders. First order surveys are the most intensive and 5th order surveys the least intensive. The soil surveys available for East Timor were created at a scale of 1:100,000 (1 in. = .63 miles or 1 cm = 1 km) and can be classified as 4th order soil surveys. At this scale soil mapping is able to provide "general soil information for broad statements concerning land-use potential and general land management"[4]. Soil map delineations at the 4th order generally represent 2 or more soils (associations and complexes) and are very general. The map units in the Portuguese soil map of East Timor provide for anywhere from 2 to 7 dissimilar soil types in a soil association. Soil complexes in this mapping are a combination of 2 or more associations. This means a soil complex could be made up of from 4 to 14, or more, dissimilar soils. The digitized soils map of East Timor uses soil delineations or combined delineations from the Portuguese map but the multiple FAO soil types have been changed to a single USDA soil type. Conversion or translating between the FAO soil classification system and USDA Soil Taxonomy is not exact. For example, soil moisture regime dictates the classification of soil at the suborder level in the USDA system; the FAO system does not incorporate soil moisture regime at any level. Further complicating the issue of soil classification is that both the FAO and USDA soil taxonomy have been updated and changed significantly since these maps were created.

Findings

During the two week assignment we described nine representative soil pedons. These pedons were described using a standard USDA-NRCS method found in the Field Book for Describing and Sampling Soils[4]. A sample of about one kilogram was taken from each soil horizon for examination at the UH Manoa soils lab. The soils were then classified at the soil Great group level using the 1975 and 1998[5] editions of USDA Soil Taxonomy and the current FAO method of soils classification[*]. These classifications and classifications for the soil map units in which they are found are presented in Table 1. Both maps were correct in predicting the soil order four times. In only one case does the1975 USDA Great Group classification of a pedon match exactly to that of a map unit designation for the updated digital soil map. The current FAO classification of these same pedons matched the Portuguese map unit designations in two cases.

Table 1.

Pedon number	98 Soil Taxonomy Great Group Classification	75 Soil Taxonomy Great Group Classification	FAO Classification Great Group (current)	Pedon falls within these map units	
				1978 Portugues soils map (FAO Classification)	World Bank soils map (75 Soil Taxonomy)
04-TL-BS-**001**	Hapluderts	Chromuderts	Natric-Calcic Vertisols	AS	Haplaquepts
04-TL-Vaitobono-**002**	Hapluderts	Chromuderts	Calcic Vertisols	CN	Pelluderts
04-TL-Vaitobono-**003**	Hapluderts	Chromuderts	Calcic Vertisols	CN	Pelluderts
04-TL-Fatumaka-**004**	Calciudolls	Calciustolls	Haplic Kastanozems	AR	Xerochrepts
04-TL-Fatumaka-**005**	Argiudolls	Argiudolls	Luvic Phaeozoms	AR	Xerochrepts
04-TL-Watuwa-**006**	Ustifluvents	Ustifluvents	Chromi-Calcic Durisols	CZ	Calciustolls
04-TE-Bubuanakala-**007**	Endoaqualfs	Umbraqualfs	Humi-Umbric Nitosols	VR	Humitropepts
04-TL-Ostico-**008**	Hapludalfs	Rhodustalfs	Rhodi-Umbric Acrisols	VR	Haplustalfs-Tropudults
04-TL-Wautume-**009**	Calciudolls	Calciustolls	Chromi-Calcic Kastanozems	TCCZ	Calciustolls
AS-Orthic Solonchaks and Gleyic Solonetz					
CN-Pellic Vertisols, Calcic Vertisols, Luvic Vertisols, Vertic Calcarious Cambisols, Vertic Luvisols					
AR-Association is a variant of the Soil Association *VR VR=Chromic Luvisols, Ferric Luvisols, Rodic Ferrasols, Ferric Acrisols, Rendzimas, Calcarious Regosols, and Calcarious Lithosols*					
CZ-Calcarious Cambisols & Calcarious Regosols					
VR-Chromic Luvisol, Ferric Luvisols, Rodic Ferrasols, Ferric Acrisols, Rendzinas, Calcarious Regisols, Calcarious Lithosols					
TCCZ-Complex of soil associations Atc & CZ, Atc-Calcarious Fluvisol & Fluvicalcarious Kastanozems, CZ-Calcarious Cambisols, Calcarious Regisols					

Using GPS and a lap-top computer we used real-time tracking to follow our movement on screen across the digitized soil map. In this way we could test the trueness of the digitized soil delineations by relating them to geomorphic features that we could physically observe. Rock escarpments, slope changes, or vegetation changes are often indicators of changes in soil type. These type of features corresponded to the soils delineations represented on the computer screen in most instances. There were cases however where geomorphic features were not represented by, or did not correspond to,

digitized soil lines. Field checking of the paper copy of the Portuguese soil map was not possible as it was not available; however, later cross checking of the paper map with recorded GPS points and field notes showed a better relationship between observed soil changes and delineations found on the Portuguese map. Soil delineations and homogeneity of map units were also checked by digging small holes with a shovel or auger at points on landscapes where there was an obvious change in soil type or at random spots within a delineation. This process indicated that although the delineations of map units are accurate, soils within the units can be highly variable or do not correspond to the soils indicated by the map. This was true in most cases concerning the digitized soil map.

A soils map is only useful if staff has knowledge of basic soil science and knowledge of the available maps. The East Timorese MAFF and UH staff are familiar with many characteristics used to identify soil type. They have limited experience with identifying soils based on a method of soil taxonomy or by using a soil map. The hard copy of the Portuguese soils map could not be found at MAFF although the ALGIS unit said they have a hard copy available. The soil scientist at MAFF has the book portion of the soils map but not the maps. Topographic maps for the country are available at ALGIS but much of the MAFF staff is not familiar with locating themselves on these maps using GPS or triangulation with a compass.

Conclusions

Of the available soils maps of East Timor, the original Os Solos de Timor provides the most information and is the most detailed in its' delineation of soil map units. Overall delineation of map units appears to correspond to soil changes. As stated previously, a map at a scale of 1:100,000 supplies, "general soil information for broad statements concerning land-use potential and general land management". This map may be useful for broad-based planning and could be incorporated as part of any resource inventory of the country. It can be used for transferring agricultural technologies because it provides a loose basis for locating areas of potentially similar soils, but at the 1:100,000 scale the number of soil types identified in associations and complexes can be large or inaccurate. Selections based on this soil map must be verified by identifying similar soils at the new

site. MAFF staff members involved in this investigation are capable of identifying similar and dissimilar soils if given the necessary equipment and training. Their experience in the country can provide useful information concerning soils when selecting sites for transfer of new technology. If it is decided to update and improve on the existing Portuguese map, the East Timor ALGIS office has most of the aerial photos and topographic quadrangles required for this project.

Suggested Steps

- UH Manoa projects or MAFF can use the Portuguese map as a rough guide for identifying sites for technology transfer but must check the new sites for similar soils
- The soils map must be made available to MAFF staff
- MAFF extension agents should be trained to locate themselves on topographical maps and the soils map using GPS and triangulation with compass
- MAFF staff must be trained to use their knowledge of soils to identify similar or dissimilar soils as related to the soils map and be supplied basic equipment for this purpose
- The digital version of the soils map should be made to reflect the 1978 Portuguese map and the location of soil pedons described in this publication should be plotted on the digitized map. It may be possible to complete this through cooperation with USDA-NRCS Hawaii
- Digitizing of this map should initially be completed with the 1969 FAO soils designations with plans to update the map using the current FAO classification system
- Soils data available in Os Solos de Timor should be entered into an EXCEL spread sheet
- At some point, using the 1978 Portuguese map as a reference, important agricultural and commercial lands should be remapped at a scale of 1:24,000 or smaller

References:

1. Os Solos de Timor, Sacadura Garcia J., Carvalho Cardoso J., Memorias da Junta de Investigacaoes Cientificas do Utramar, No. 64, segunda seria, Lisboa, 1978

2. On-line resource, World Reference Base for Soil Resources, FAO, Rome, 1998 ISBN 92-5-104141-5, http://www.fao.org/docrep/W8594E/w8594e00.htm#Contents, accessed 6/22/04

3. Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys, Soil Conservation Service, U.S. Department of Agriculture, Agriculture Hand Book No. 436, December 1975

4.Soil Survey Manual, Soil Survey Division Staff, U.S. Department of Agriculure, Handbook, No. 18, October, 1993

5. Field Book for Describing and Sampling Soils, Version 2.0, National Soil Survey Center, Natural Resources Conservation Service, U.S. Department of Agriculture, September, 2002

6. Keys to Soil Taxonomy, Soil Survey Staff , U.S. Department of Agriculture Natural Resource Conservation Service, Eighth Edition, 1998

Notes:

*soils were classified without lab data, some of the classifications may change once lab data is received and applied

soil great group-UDSA Soil Taxonomy classification system levels are as follows: (general) Order>Suborder>Great Group**>Subgroup>Family>Series>Phase (exact)