Conductivity and turbidity measurements at the Oponono Pans.
Water Environment Division, DWA Field trip 13 - 15/4/1999
in conjunction with NNEP, MET

by Nicolas Clark & Kevin Roberts (1999)

Introduction

Concern has been expressed at a perceived deterioration in water quality of the pans making up the Oponono complex. Causes may include natural and accelerated siltation from higher up the drainage system and local impacts from trampling by cattle and fishermen. Siltation rates would need a large scale study but it was thought that the effects of trampling on water quality could be investigated more easily.

During a three-day field trip most of the pans were visited and measurements of conductivity and turbidity were made. This included the effects of localised disturbance of the pan substrate and samples of cores from the bottom of the pans.

Methods

Sampling was carried out at 17 sites (coordinates read from GPS) covering all the main pans as shown on Map 1.
Three types of measurement were made:

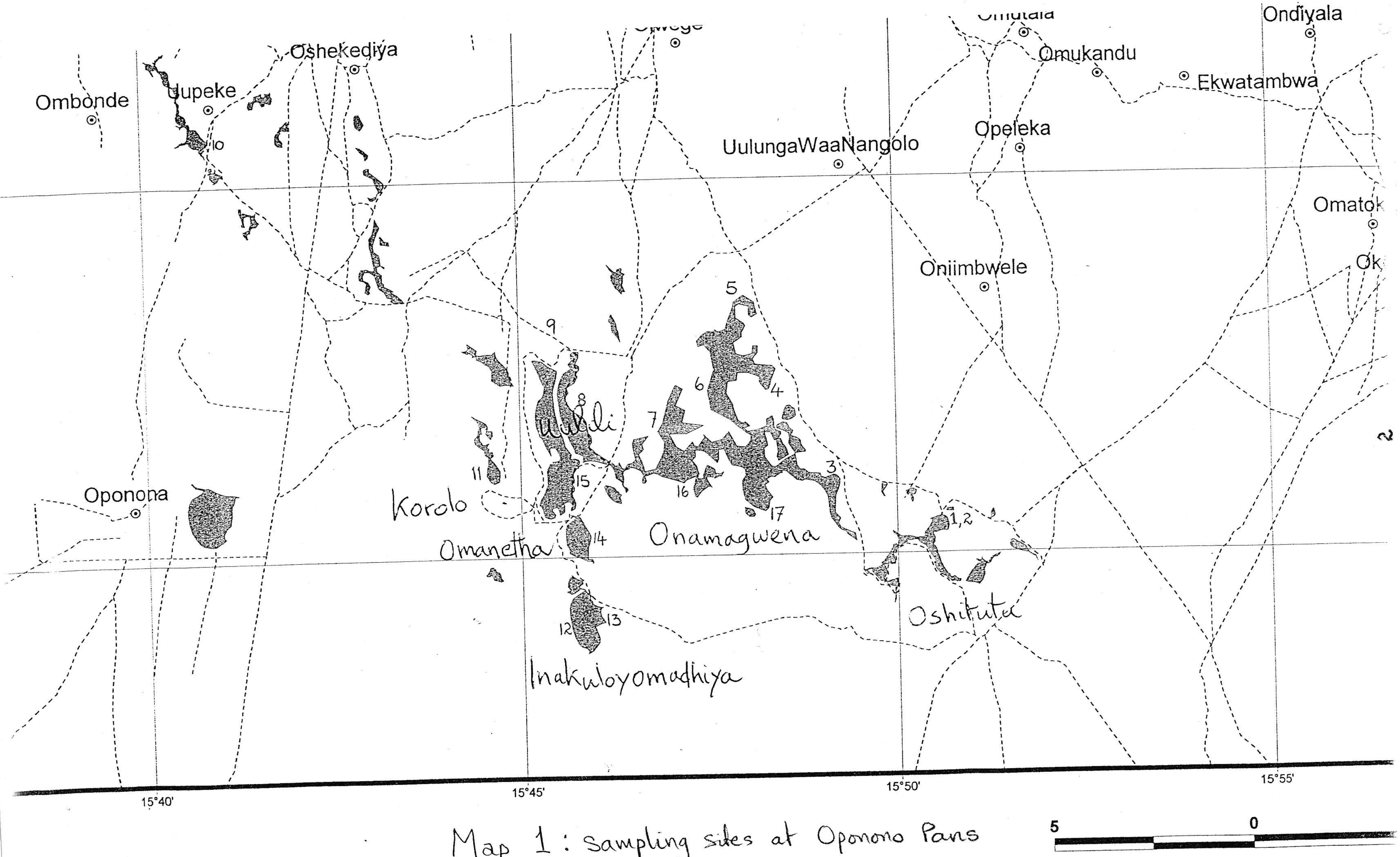
1. Turbidity and conductivity were measured using meters at each site. Wind conditions varied from offshore winds (generally on the east side) to onshore winds (generally on the west side).

2. Core samples were taken at seven sites (1,3,4,8,10,12,16). A plastic pipe 42mm diameter, 1.5m long and sharpened at one end was used to obtain samples of the substrate of the pan below about 50 cm water depth. The pipe was driven down into the substrate to a depth of between 30 and 50 cm. It was knocked in using a wooden mallet and removed using a winch attached by chain. Back on shore, water was drained from the top of the pipe and the core sample pushed out slowly using a rod and bung. Standard 2cm sections were cut from the core sample at regular intervals as it emerged. These were diluted in tap water to 300ml and the conductivity measured using a meter. The same dilution ratio was applied to the pan water of known conductivity to allow correction of the readings to micro Siemen units (approximately seven-fold dilution). Holes were also dug beside several pans to check sediment layers and conductivities.

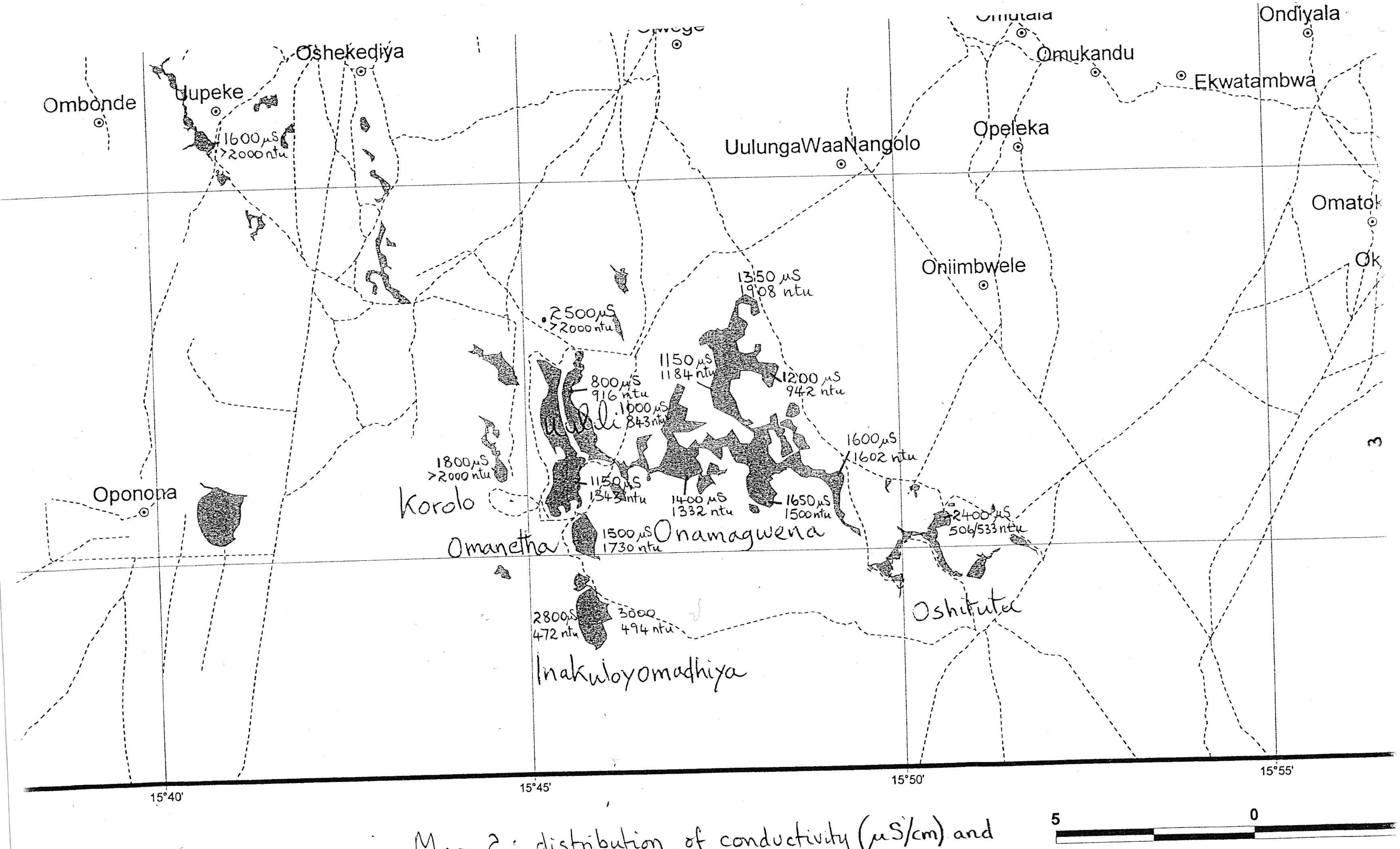
3. Trampling experiments were made at 9 sites (2,3, 4,11,12,14,15,16,17) where conditions were generally sheltered. These involved taking turbidity and conductivity measurements before the experiment began at between 50 and 80 cm water depth. Then either trampling by foot or digging with a shovel to about 10 cm depth of substrate for up to 10 minutes. Measurements were repeated during and after treatment.

Results and Discussion

Coordinates of sample sites are listed in Table 1 and located on Map 1. The distribution of conductivity and turbidity levels is shown in Table 1 and on Map 2. Repeated samples at each site showed little variation with time or depth. The pattern of conductivities is not simple but may support the idea of a general flow of fresher water entering at the north west of the system and



Map 1: sampling sites at Oponono Pans



Map 2: distribution of conductivity (µS/cm) and turbidity (ntu) readings

Table 1 Opnono sample sites. Coordinates in degrees, mins and secs; turbidity ntu conductivity microSiemen/cm

Site	Name	Location	Southing	Easting	Turbidity	Conductivity
1	Oshituntu	west of point	18 09 44	15 50 32	506	2400
2	Oshituntu	east of point	18 09 44	15 50 32	533	2400
3	Onamagwena	east pan	18 08 53	15 49 14	1602	1600
4	Onamagwena	mid pan (E)	18 08 10	15 47 56	942	1200
5	Onamagwena	north pan	18 06 30	15 48 01	1908	1350
6	Onamagwena	mid pan (W)	18 08 06	15 47 26	1184	1150
7	Onamagwena	west pan (N)	18 08 22	15 46 53	843	1000
8	Uulili	east	18 08 22	15 45 59	916	800
9	Uulili	north channel	18 06 51	15 45 36	>2000	2500
10	Uupeke	east	18 04 20	15 40 58	>2000	1600
11	Korolo	west	18 09 05	15 44 30	>2000	1800
12	Inakuloyomadhiya	west	18 11 07	15 45 40	472	2800
13	Inakuloyomadhiya	east	18 10 36	15 45 59	494	3000
14	Omanetha	east	18 09 44	15 45 56	1730	1500
15	Uulili	south	18 08 57	15 45 45	1343	1150
16	Onamagwena	west pan (S)	18 08 58	15 47 14	1332	1400
17	Onamagwena	mid pan (S)	18 09 25	15 48 14	1500	1650

leaving at the south east into the Ekuma channel. The most southerly pan of Inakuloyomadhiya had the highest conductivity readings supporting the idea that it may act like a sump preventing further flow southwards. The north section of Uulili pan had the lowest conductivity indicating freshwater inflow. However a narrow channel directly north of the pan (site 9) showed high conductivity presumably due to localised evaporation.

Vegetation reflected these conductivity patterns with little vegetation in the more saline pans (sparse *Diplachne* grass in the water and *Sporobolus spicatus* grass around the edges) ranging to abundant vegetation in the fresher pans (abundant *Diplachne,* dense beds of the sedge *Cyperus articulatus,* and moderate growth of the floating grass *Oryzidium barnardii,* the sedge *Bolboschoenus maritimus*, and the floating legume *Neptunia oleracea*.)

Turbidity levels did not show a simple pattern. The higher conductivity pans such as Inakuloyomadhiya and oshituntu showed the lowest turbidity, while the sites in the north west (sites 9,10,11) showed highest levels. Pan water left in containers overnight showed the same turbidity reading in the morning indicating that no settling of silt occurred. One container left for one week, however, did show settling falling from a very turbid 1500ntu to a relatively clear 95ntu (tap water was found to be 0.6ntu).

Wind may be a factor in sustaining high turbidity and on the occasions when east (offshore wind) and west (onshore wind) sides of a pan were compared slightly higher turbidity and conductivity readings were obtained on the east side. For example at sites 1 and 2, 12 and 13, 17 and 3. It is assumed that deeper water in contact with the silty sediment is drawn up to the surface to replace water blown away from the east shore. No stratification of conductivity levels was observed, although temperature stratification occurs during the day with surface temperature being in the 30's $^{\circ}$C while the bottom water is in the 20's $^{\circ}$C. At night temperatures dropped to 17 $^{\circ}$C throughout the water column.

The general picture emerging from the core sample results shown in Table 2 is one of a gradual increase in conductivity with depth of substrate. The actual values vary between sites as shown in Figure 1. The combined sites show a significant correlation whereby as soil depth increases conductivity increases exponentially as in Figure 2. The first 10 cm of sediment rarely reached conductivities of 2000 microSiemen/cm. Not until sediment depth was greater than 20 cm did very high conductivities around 9000 microSiemen/cm occur.

The implications of these data are that unless trampling of the substrate penetrates to considerable depths (at least beyond 10 cm) then the effect on overall conductivity levels of the pan water will be slight.

The trampling experiments were deliberately made to be an extreme example of such disturbance. The shovel was dug into the substrate underwater as deeply as possible and the water stirred up. A conductivity meter held at the site showed no change during these operations. Turbidity levels also showed no significant change.

Table 2 Oponono cores. depth cm, conductivity microSiemen/cm

Site	depth	Conductivity
1	34	9800
	28	18200
	12	3780
	2	3150
	water	2400
3	56	21700
	46	34300
	36	22400
	26	17850
	16	4900
	6	1820
	water	1600
4	35	6650
	25	2940
	20	2240
	12	1680
	7	1330
	2	1190
	water	1200

Site	depth	Conductivity
8	34	10150
	24	10150
	14	8400
	4	2520
	1	1610
	water	800
10	30	3150
	20	3290
	10	2590
	1	1540
	water	1600
12	40	5600
	30	2940
	20	2065
	10	1855
	1	1540
	water	2800
16	30	8750
	20	3640
	10	2100
	3	1960
	water	1400

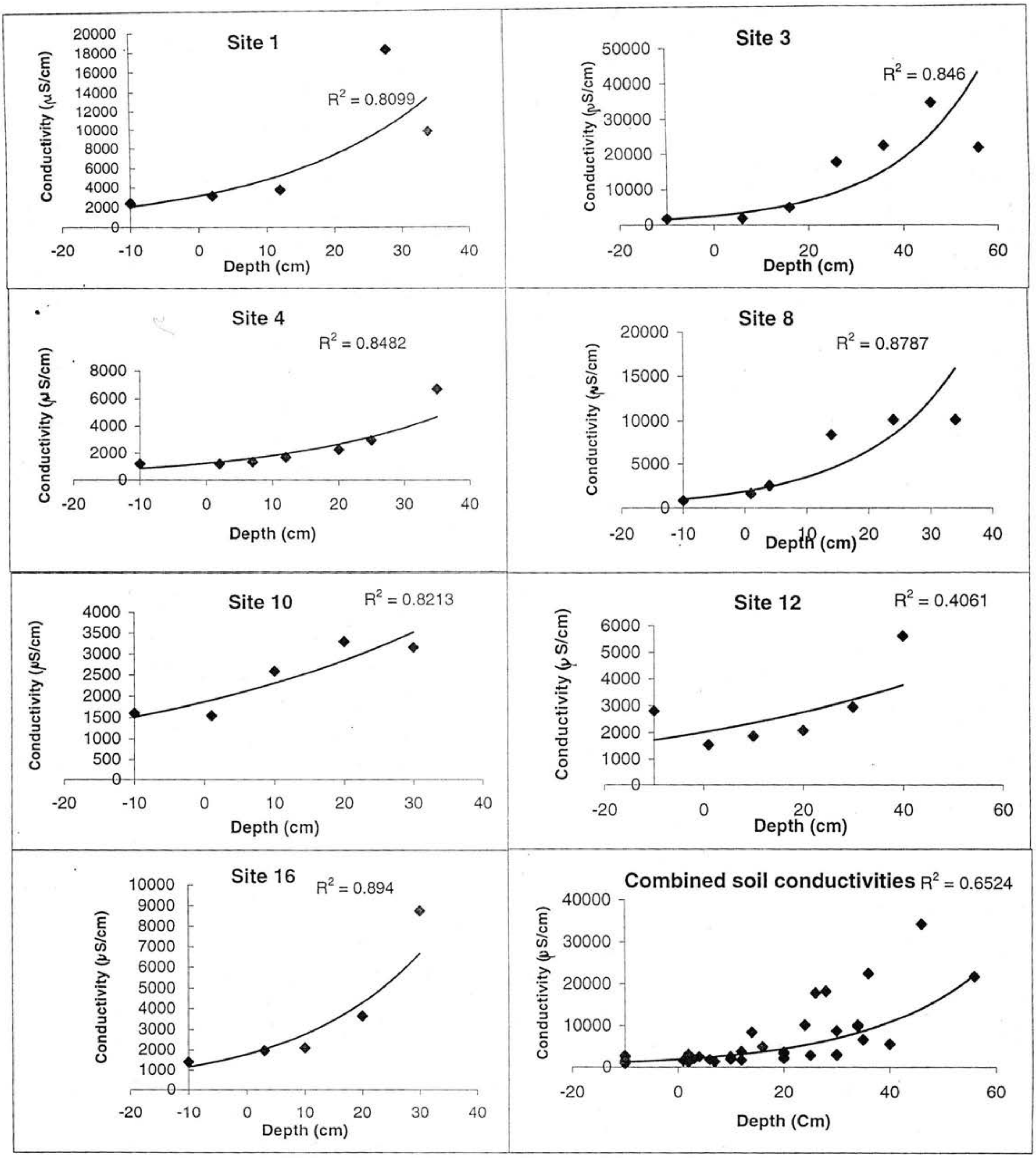


Figure 1. Change in core conductivity with depth at different sites.

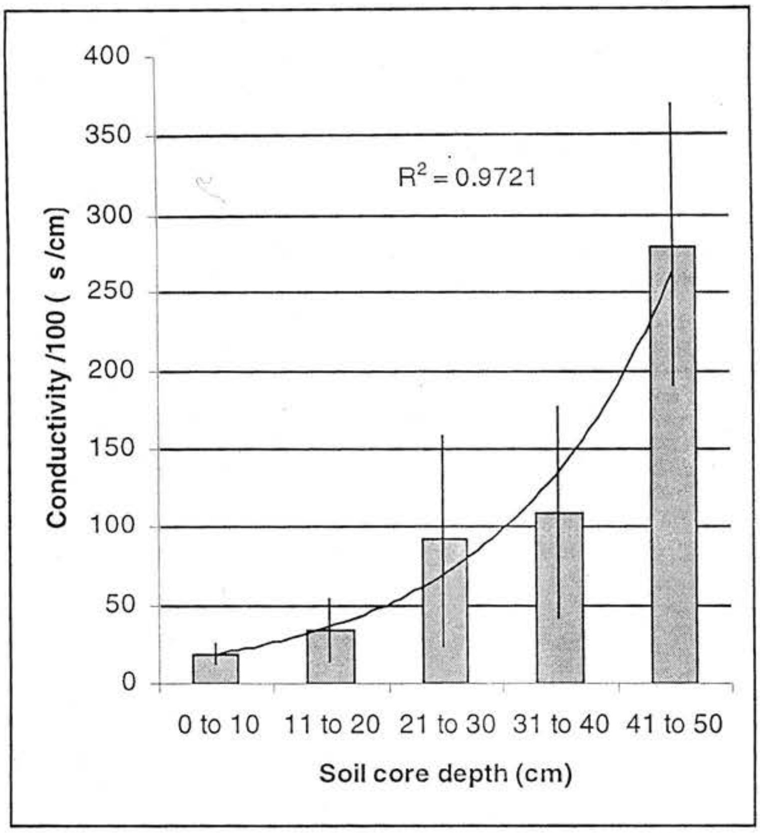


Figure 2. The combined core samples show that the conductivity of pan soils increased exponentially with depth down to 50cm.

Conclusions and Recommendations
In conclusion the results of this field trip indicated that the salts contained in the sediment immediately below the water column were in balance with levels in the water. It was not until sediment depths of well over 10 cm were reached that salt content became much more concentrated than the water. It seems therefore that trampling by people and cattle are unlikely to have a significant impact on conductivity levels of the water and the results of the trampling experiments seemed to support this. Evaporation rates are likely to be a much more significant factor in increasing salinities of the water. .

It is recommended that further conductivity readings should be made which will allow the patterns of water flow to be monitored over the season. More sites need to be located at the inflows (e.g around Uulili especially to the north and west) and the outflow (around Oshituntu). This could be done in conjunction with gauge plates to record water levels at strategic points.

The impacts of intensive agriculture and overgrazing on soil erosion and accelerated siltation rates in the Cuvelai needs investigation but this would be a large scale project. There is a need for some part of the Cuvelai system to be protected so that the natural system can be studied properly.

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