

**CHAPTER V. TIME DOMAIN REFLECTOMETRY (TDR)VOLUMETRIC SOIL  
MOISTURE MEASUREMENTS AND DATA SUMMARY SIR-C/X-SAR EXPERIMENT  
LITTLE WASHITA RIVER CATCHMENT 1994**

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**A. INTRODUCTION**

The measurements in this report were taken during the first part of the SIR-C/X-sar field experiment in the Little Washita River watershed during April of 1994. More detailed information is available from the author. This report is only to illustrate the type of measurements taken and to present an idea on the possible applications of it.

**B. TDR VOLUMETRIC SOIL MOISTURE MEASUREMENTS**

All the measurements were performed using two portable time domain reflectometry (TDR) (TRIME-P2 instruments, manufacturer IMKO) in "Area 1", of the measurement sites. Within this site 5 agricultural fields with different crops were sampled. The crops were:

Alfalfa/winter wheat	code 11
Corn field (almost bare)	code 12
Winter wheat	code 13
Rangeland	code 14
Oat (early growing stage)	code 15

Figure V-1 is a schematic representation of the site. In Figure V-1, the transects along which the measurements were performed are indicated. There were two long transects AT1 and AT2 and 5 cross transects (CT1..CT5). Measurements were made daily along the two long transects. On the cross transects, data were collected on only the first two days (April 6, 7). In general the measurements were taken walking the long transects from North to South. During the second week (April 12-16), measurements were also made on the oat field (code 15). The data is

summarized in Tables 1, 2, and 3. The calibration data for the TDR using laboratory measurements based on soil from “area 1” is summarized in Table V-4. Figure V-2 shows detailed field measurements taken at the rangeland plot (14) to investigate the effect of local topography.

### C. REFERENCES

Van Oevelen, P.J., 1998. Soil moisture variability: a comparison between detailed field measurements and remote sensing measurement techniques. Accepted for publication in Hydrological Sciences Journal.

Van Oevelen, P.J., 1994. Ground data collection report, Washita 1994 SIR-C experiment. Internal data report. Department of Water Resources, Wageningen Agricultural University.

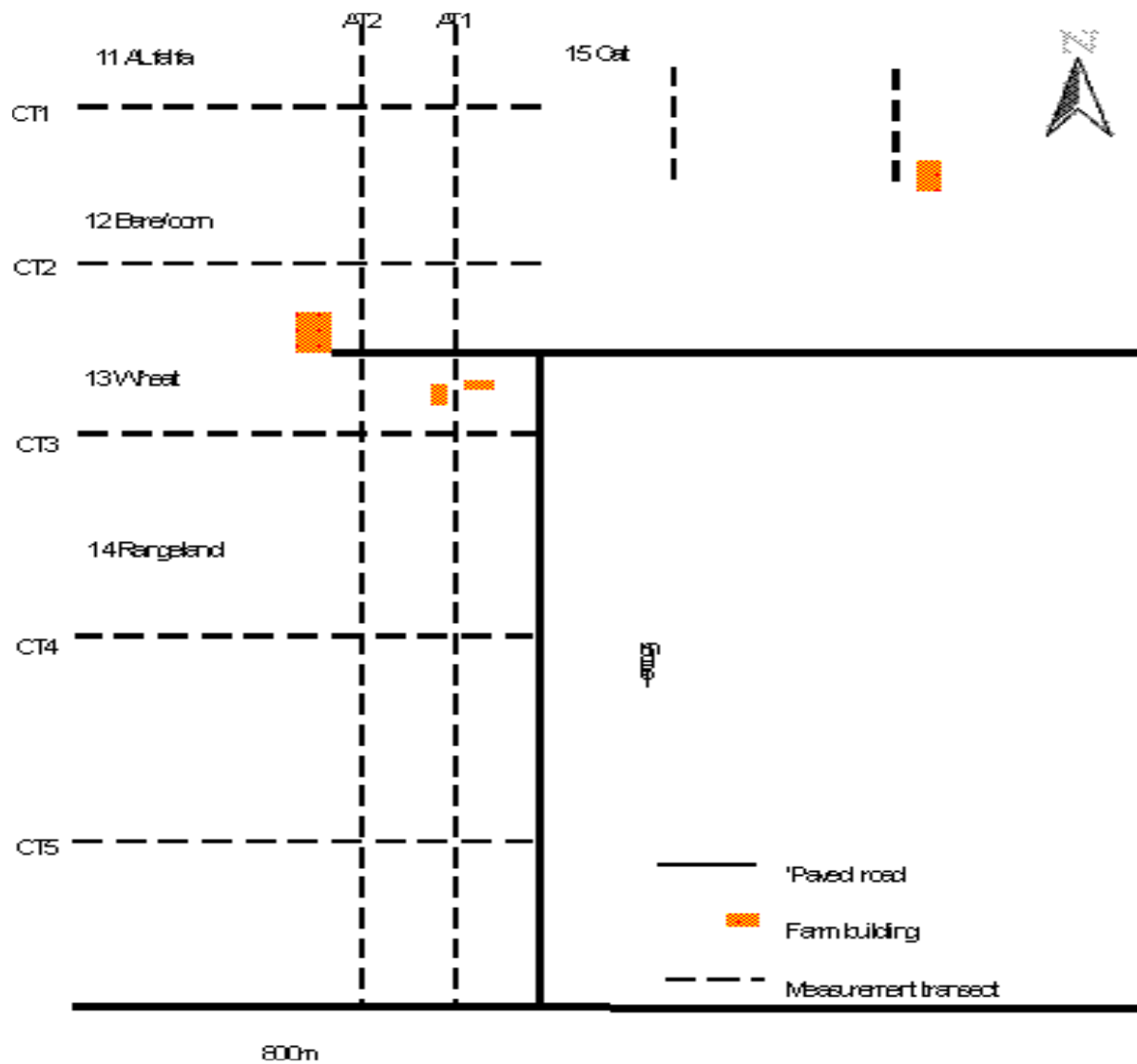


Figure V-1. Schematic representation of area 1 showing the measurement transects. (Van Oevelen 1994)

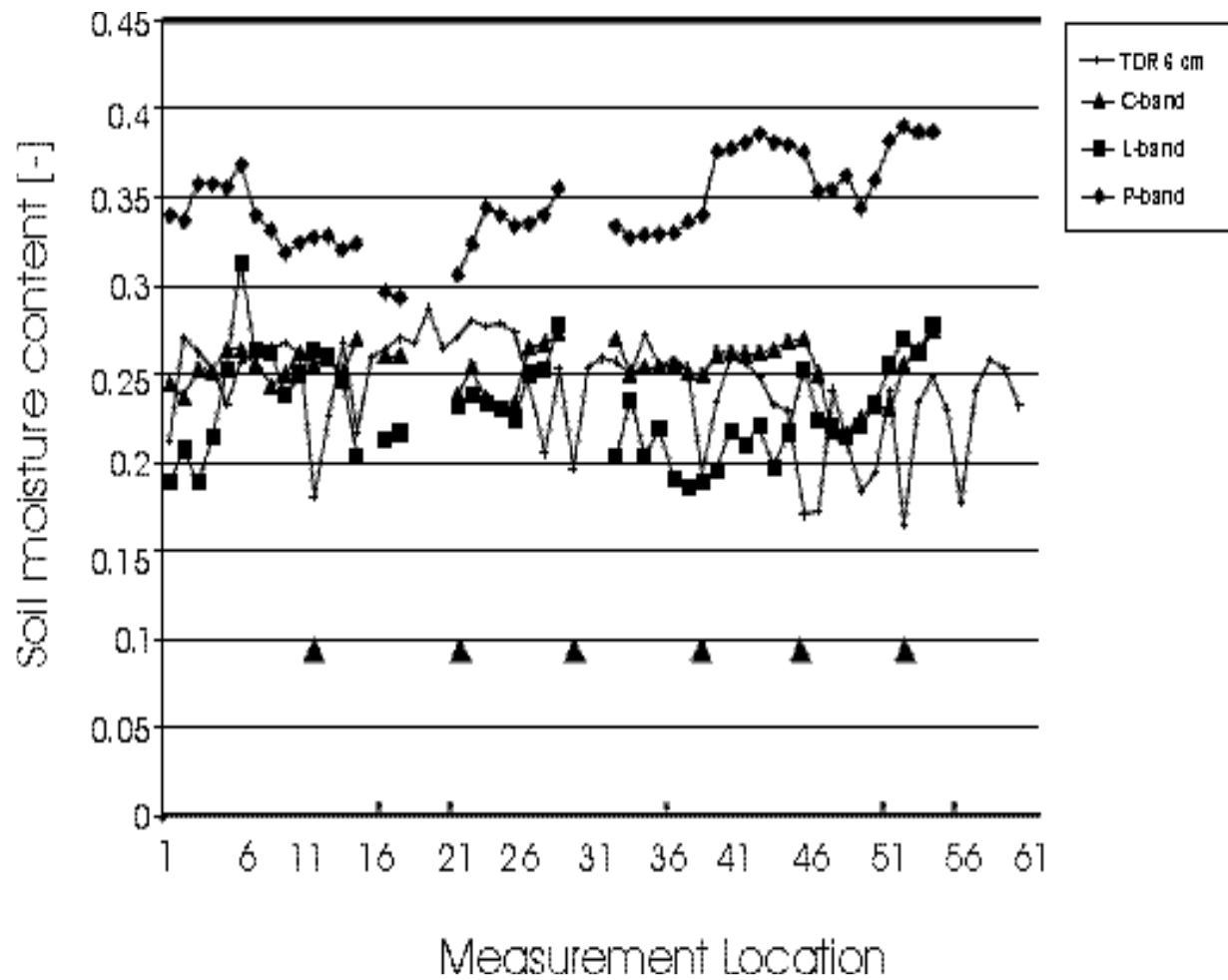


Figure V-2. Soil moisture measurements over a transect in rangeland (code 14) to detect the effect of terracing. The arrows indicate the location of the measurement points on top of the terrace ridge

Table V-1. Volumetric soil moisture measurements along transects AT1 and AT2

Date	6 April		7 April		9 April		11 April	12 April	12 April	13 April	14 April	15 April	16 April
Ser.nr.->	AT1	AT2	AT1	AT2	AT1	AT2	AT1	AT1	AT1	AT1	AT1	AT1	AT1
Distance	25m	25m	25m	25m	25	25	25	50	50	50	50	50	50
Field nr 11	Alfalfa/Wheat field												
Mean	24.52	13.74	16.91	8.73	15.77	11.82	27.65	28.11	27.06	25.87	24.72	21.24	20.44
St. Dev.	6.46	4.14	4.90	2.26	5.06	4.15	3.05	2.04	2.46	2.60	2.78	5.39	6.14
Field nr. 12	Bare/Corn field												
Mean	32.54	26.06	21.35	20.58	24.39	26.73	28.88	27.63	25.78	25.05	25.06	21.05	23.29
St. Dev.	4.33	9.19	9.25	7.91	4.77	6.27	2.46	3.66	5.56	2.04	2.98	8.31	9.55
Field nr. 13	Wheat field												
Average	15.59	11.51	10.97	8.51	11.38	7.77	23.57	23.30	20.11	20.07	14.90	16.23	12.77
ST. Dev.	6.45	3.61	6.15	5.96	5.71	2.95	6.27	2.48	2.28	2.09	1.91	2.96	2.83
Field nr. 14	Rangeland												
Average	28.53	27.19	25.66	25.92	22.79	23.31	NA	28.43	NA	26.81	26.15	26.89	26.07
Std. Dev.	4.34	5.63	3.75	4.66	4.96	3.91	NA	1.36	NA	2.51	2.32	2.51	2.60

Table 2: Volumetric soil moisture measurements along the cross transects (CT1-CT5) in fields 11-14

Date	d=25 7		d=25 7		d=25 6	d=50 7		d=50 6
Ser. #	AT2 1502		AT2 1502		AT1 1502	AT1 1437		AT2 1437
Field	CT1	Field	CT2	Field	CT4		Field	cT5
111	17.7	121	30	141	28.4	24.6	141	27.3
112	10.7	122	30.6	142	30.9	25.9	142	28.3
113	20.4	123	31	143	30.4	27.3	143	27.5
114	21.8	124	26.1	144	26.2	26.8	144	28.1
115	15	125	29.5	145	31.4	23.2	145	29.2
116	10.9	126	25.8	146	19.6	28.7	146	31.7
117	5.6	127	32.9	147	34.7	28.5	147	29.8
118	7	128	27.4	148	34.5	27.7	148	27
119	6.3	129	28.6	149	32.2	29.9	149	27.6
1110	5.7	1210	9.6	1410	33.7	30.1	1410	29.7
1111	9.8	1211	28.2	1411	33.5	27.8	1411	31.7
1112	12.7	1212	30	1412	31.2	26.6	1412	24.9
1113	8.1	1213	22.5	1413	21.2	17.3	1413	17.7
1114	11	1214	20.1	1414	22.1	17.8	1414	30
1115	18.5	1215	17.5	1415	27.3	24.1	1415	32
1116	-	1216	11.2	1416	27.6	22.1	1416	25.5
1117	10.4	1217	27.6	1417	23.4	21.9	1417	30.8
1118	6.6	1218	10.4	1418	19.3	28.4	1418	29.6
1119	8.6	1219	13.6	1419	23.2	19.9	1419	30.2
1120	6.9	1220	9.8	1420	12.7	23.3	1420	31.1
1121	-	1221	7.2	1421	10	9.6	1421	32.5
1122	-	1222	11.2	1422	-	25.4	1422	30.0
1123	-	1223	5.7	1423	-	19.1	1423	24.3
1124	-	1224	5.1	1424	-	22.2	1424	27.9
1125	-	1225	6.7	1425	-	14.7	1425	14.4
1126	-	1226	5.1	1426	-	22.1	1426	-
1127	-	1227	-	1427	-	24.7	1427	-
1128	-	1228	-	1428	-	21	1428	-
1129	-	1229	-	1429	-	19	1429	-
1130	-	1230	-	1430	-	-	1430	-
1131	-	1231	-	1431	-	-	1431	-
1132	-	1232	-	1432	-	-	1432	-

Table 3: Volumetric soil moisture measurements on field 15 (oat)

Field 15	d=50m 12 april	d=50m 12 april	d=50m 13 april	d=50m 13 april	d=50m 14april	d=50m 14april	D=50m 15april	d=50m 15april	d=50m 16april	d=50m 16april
1	20.2	27.1	27	26.5	22.1	20.7	29.1	21.7	21.8	22.3
2	22.3	27.2	11.2	23	11	25.5	13.8	26	6.4	27.3
3	16.6	26.9	13.3	25.5	9.5	25.9	7	28.4	5	27.9
4	18.5	27.4	12.9	22.5	14.4	26.1	11.4	29.3	10.7	26.9
5	21.4	24.7	21.5	23.5	18.2	24.6	18	26.1	17.2	18.9
6	29.5	29.3	24.2	20.7	19.9	22	27.5	22.2	29.7	19.5
7	22.1	22.6	19.7	23.4	18.7	20.1	21.7	18.8	24.9	16.5
8	23.8	20.8	25.1	19.5	19.6	12.9	24.4	18.2	25.8	11
Average	21.8	25.75	19.36	23.08	16.68	22.23	19.11	23.84	17.69	21.29
St. Dev.	3.61	2.65	5.75	2.14	4.24	4.16	7.42	3.95	8.78	5.59
Tot. Avg.	23.78		21.22		19.45		21.48		19.49	

Table 4: TDR calibration worksheet and data

TDR	Can Weight Wet [g]	Dry [g]	Delta [g]	Cylinder Weight Wet [g]	Dry [g]	Delta [g]	Vol. Moisture Content [-]	Moisture Content [%]
1	1.4	156.4	154.1	2.3	1,011.00	996.13	14.87	1.89
2	7.4	92.27	85	7.27	964.95	888.92	76.03	9.67
3	27.6	152.3	132.8	19.5	1,334.70	1,163.81	170.89	21.73
4	28.4	161.9	139.7	22.2	1,446.60	1,248.24	198.36	25.23
5	30.4	156.8	132.1	24.7	1,474.10	1,241.89	232.21	29.53
6	30.6	188.4	155.3	33.1	1,469.00	1,210.91	258.09	32.82
7	32.5							
8	1.4	76.1	74	2.1	870.20	846.19	24.01	3.05
9	4.1	86.1	81.9	4.2	874.90	832.22	42.68	5.43
10	4.7	91.8	86	5.8	923.60	865.25	58.35	7.42
11	13.5	90.6	83	7.6	1,050.90	962.75	88.15	11.21
12	9.8	116.7	106	10.7	956.90	869.16	87.74	11.16
13	8.5	96.04	87.4	8.64	1,035.50	942.34	93.16	11.85
14	25.7	141.3	123.6	17.7	1,329.80	1,163.22	166.58	21.19
15	21.9	133.5	117.1	16.4	1,241.70	1,089.16	152.54	19.40
16	18.5	111.6	99.6	12	1,097.00	979.04	117.96	15.00

Meas.	TDR	Regression		x=measured vol. soil moisture				
1.89	1.40	Multiple R	0.97023429					
9.67	7.40	R <sup>2</sup>	0.94135445					
21.73	27.60	Adjusted R <sup>2</sup>	0.93684326					
25.23	28.40	Std. Error	2.77908240					
29.53	30.40	Observations	15					
32.82	30.60							
3.05	1.40	<i>Analysis of Variance</i>						
5.43	4.10			<i>df</i>	<i>SumofSquares</i>	<i>Mean Square</i>	<i>F</i>	<i>Signific. F</i>
7.42	4.70	Regression		1	1611.62644	1611.626446	208.670731	2.19527E-8
11.21	13.50	Residual		13	100.402889	7.723298989		
11.16	9.80	Total		14	1712.02933			
11.85	8.50							
21.19	25.70							
19.40	21.90							
15.00	18.50							
		<i>Coefficients</i>	<i>Std Error</i>	<i>t Statistic</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	
		Intercept	-1.440971986	1.38037639	-1.0438979	0.314223621	-4.4230932	1.54114923
		x1	1.127693799	0.07806573	14.4454398	8.36908E-09	0.959043076	1.296344522