CHAPTER VIII. PROFILE SOIL MOISTURE

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A. INTRODUCTION

During the time since the Washita'92 project, 27 of the 42 raingage sites have been relocated. Relocation of these sites was necessary to accommodate landowner approval for construction of new site enclosures associated with the instrumentation of a Micronet system. At each Micronet site (42), measurements of air temperature, relative humidity, solar radiation, and soil temperature at 4 depths are electronically recorded, in addition to rainfall and soil moisture measurements. This work was completed in May 1994. During the relocation process it was necessary to remove the soil moisture access tubes from previous sites and install new ones at the present locations. All current Micronet sites are considered permanent and thus, for the near future the data stream should remain continuous. However, the process of relocation disrupted the continuity of soil moisture data being collected during this period of time. Also, a considerable number of new field calibrations must be performed at the new locations. The calibration work will be completed as soon as possible, in addition to the installation of permanent soil moisture and heat flux sensors. The number of soil profile moisture data collection sites for the April and October Washita'94 projects differ due to site relocations. Since the relocation work was completed in May 1994, a greater number of sites were accessed during October.

B. OBJECTIVE

The objective for this phase of the project was to measure profile soil moisture during both the April and October Washita'94 field and flight campaigns within the Little Washita River Watershed. A total of 24 Micronet sites were used for this purpose.

C. METHODS

Soil moisture measurements were obtained using a Resonant Frequency Capacitance (RFC) probe (Heathman, 1992). Model type is a Sentry 200-AP probe by Troxler Electronics Laboratories[1]. The RFC probe is designed to measure volumetric soil water content in both the saturated and unsaturated regions of the vadose zone. The technology is based upon the use of soil dielectric properties to measure soil moisture (Dean, et al., 1987; Bell, et al., 1987). The instrument primarily consists of a control unit and probe. The control unit stores probe calibrations (factory and field),

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[1]Trade names are given for convenience of the readers. No endorsement by the United States Deparment of Agriculture is implied.

measured data, and has computer downloading capability. The probe consists of two electrodes that measure the capacitance of the dielectric comprising the in-situ soil surrounding a 2 inch diameter vertical PVC access tube. Probe calibrations were determined using the techniques described by Van Bavel, 1961 and Bell, et al., 1987.

During the April and October Washita'94 projects 11 and 24 Micronet sites, respectively, were used to measure soil moisture. Site location and dates on which profile soil moisture measurements were made during the experiments are provided in table 1. Measurements were taken at 6 inch intervals to a depth of 45 inches beginning at 4 inches below the soil surface. Figure 1. shows the soil moisture profile data distribution at Micronet station 136 for two days in April and one day in October. Micronet 136 was in close proximity to Area 1, the largest and most active research field site during the project. The data shown represent approximate field calibrated values. A complete on-site calibration has not been made at site 136, however, using a nearby site calibration, with very similar profile characteristics, the values appear more representative than factory values. In support of figure 1. and the small difference in moisture values over a 5 month period, figure 2. shows soil depth vs probe frequency response which also indicates very little difference in values. Rainfall data prior to the time of soil moisture measurements suggest that these values should differ only slightly. Figure 3. shows the variation in soil moisture at 3 different locations on April 8, 1994.

Though not the subject of this writing, it should be noted that field experience with the RFC probe has shown that certain limitations exists. When working in very fine textured soils and very moist conditions the limits of factory calibration are exceeded. The probe frequency response will continue to increase with increasing moisture, however, the volumetric moisture reading will either exceed 100 percent or zero out. This can be quite frustrating and confusing for the user. A paper by this author and others that includes a discussion of this problem and a possible corrective measures is in progress.

D. PROFILE SOIL MOISTURE DATA BASE

The conversion of factory calibrated data to field calibrated data is continuing, as field calibration data is obtained for new and, when necessary, previous sites. To insure that field calibrations are representative and reliable, a broad range of moisture values are necessary at different locations throughout the watershed. Further field sampling and data collection should provide the data necessary to satisfy this requirement.

Field measurements are recorded and stored in the RFC control unit. At the lab the data are downloaded to a PC system and identified by filenames that indicate the time period of data acquisition. Using Monarch program software, the raw data are then converted to worksheet format in QPRO. Regression equations are used within QPRO to convert factory soil moisture values to field calibrated values. Eventually, these data files will be incorporated into a GIS data base system.

E. ACKNOWLEDGEMENTS

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F. REFERENCES

Bell, J. P., Dean, T. J. and Hodnett, M. G., 1987. Soil moisture measurement by an improved capacitance technique, Part II. Field techniques, evaluation and calibration. J. Hydrol., 93:79-90.

Dean, T. J., Bell, J. P. and Baty, A. J., 1987. Soil moisture measurement by an improved capacitance technique, Part I. Sensor design and performance. J. Hydrol., 93:67-78.

Heathman, G. C. 1993. Soil moisture determination using a resonant frequency capacitance probe. Presented at the 1993 International Summer Meeting, ASAE, CSAE, Spokane, WA, June 20-23. Amer. Soc. Agric. Eng. 2950 Niles Rd. Joseph, MI.

van Bavel, C. H. M., 1961. Calibration and characteristics of two neutron moisture probes. Soil Sci. Soc. Amer. Proc., 25:329-334.

Table 1. Micronet sites and days on which profile soil moisture data were collected during the Washita 1994 campaign.

SITE	JULIAN DAY 1994						
	95	98	103	104	277	278	279
RG122	Θ					Θ	
RG125	Θ			Θ	Θ		
RG130	Θ			Θ	Θ		
RG132						Θ	
RG133					Θ		
RG135		Θ	Θ			Θ	
RG136		Θ	Θ			Θ	
RG144		Θ					Θ
RG146		Θ	Θ			Θ	
RG149					Θ		
RG150	Θ			Θ	Θ		
RG151	Θ			Θ	Θ		
RG152					Θ		
RG154					Θ		
RG155							Θ
RG156		Θ	Θ				Θ
RG158							Θ
RG159							Θ
RG160		Θ	Θ				Θ
RG162					Θ		
RG163					Θ		
RG166							Θ
RG167							Θ
RG181					Θ		

Θ(theta) - soil moisture data obtained on this date.

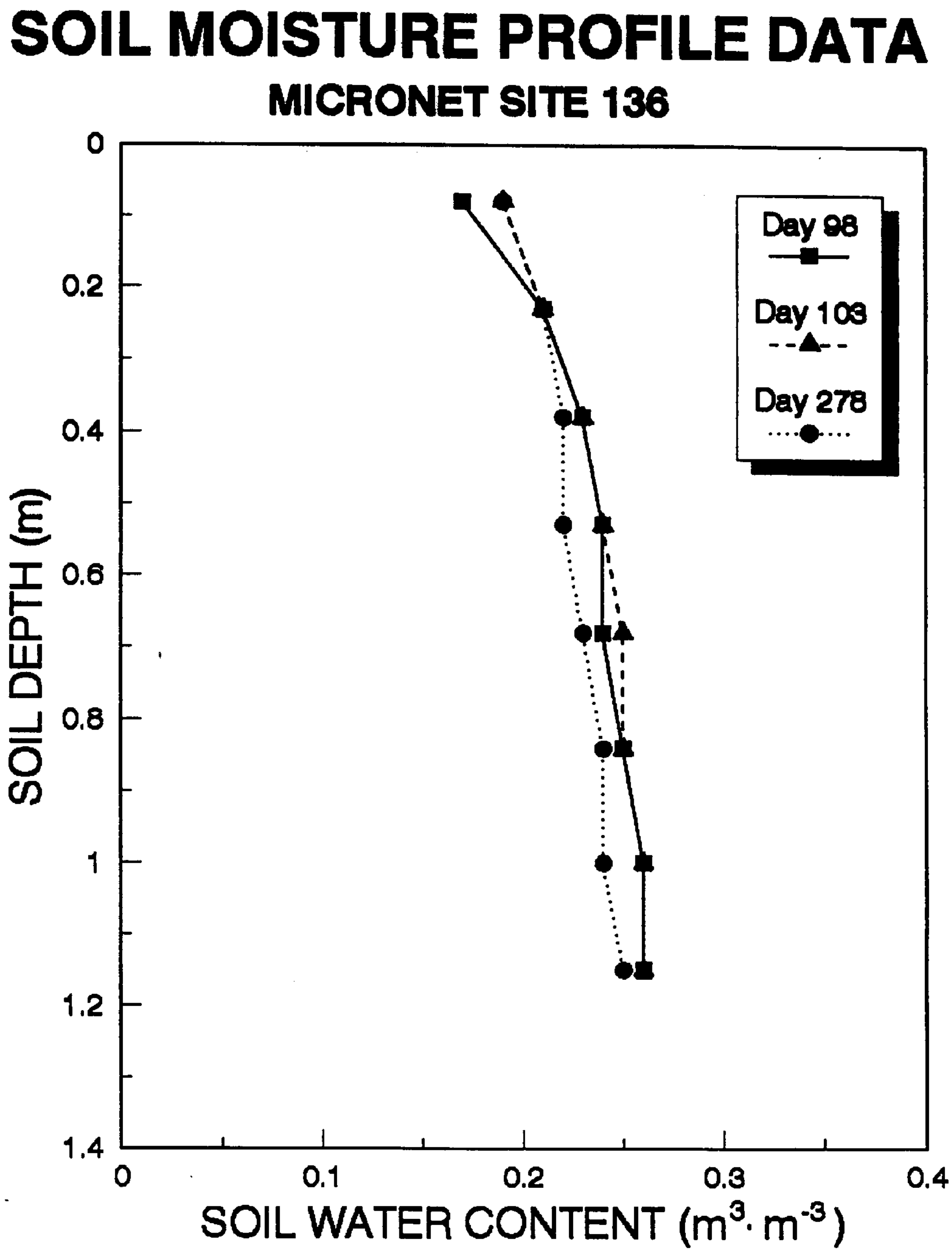

Figure VIII-1. Soil depth vs water content at site 136.

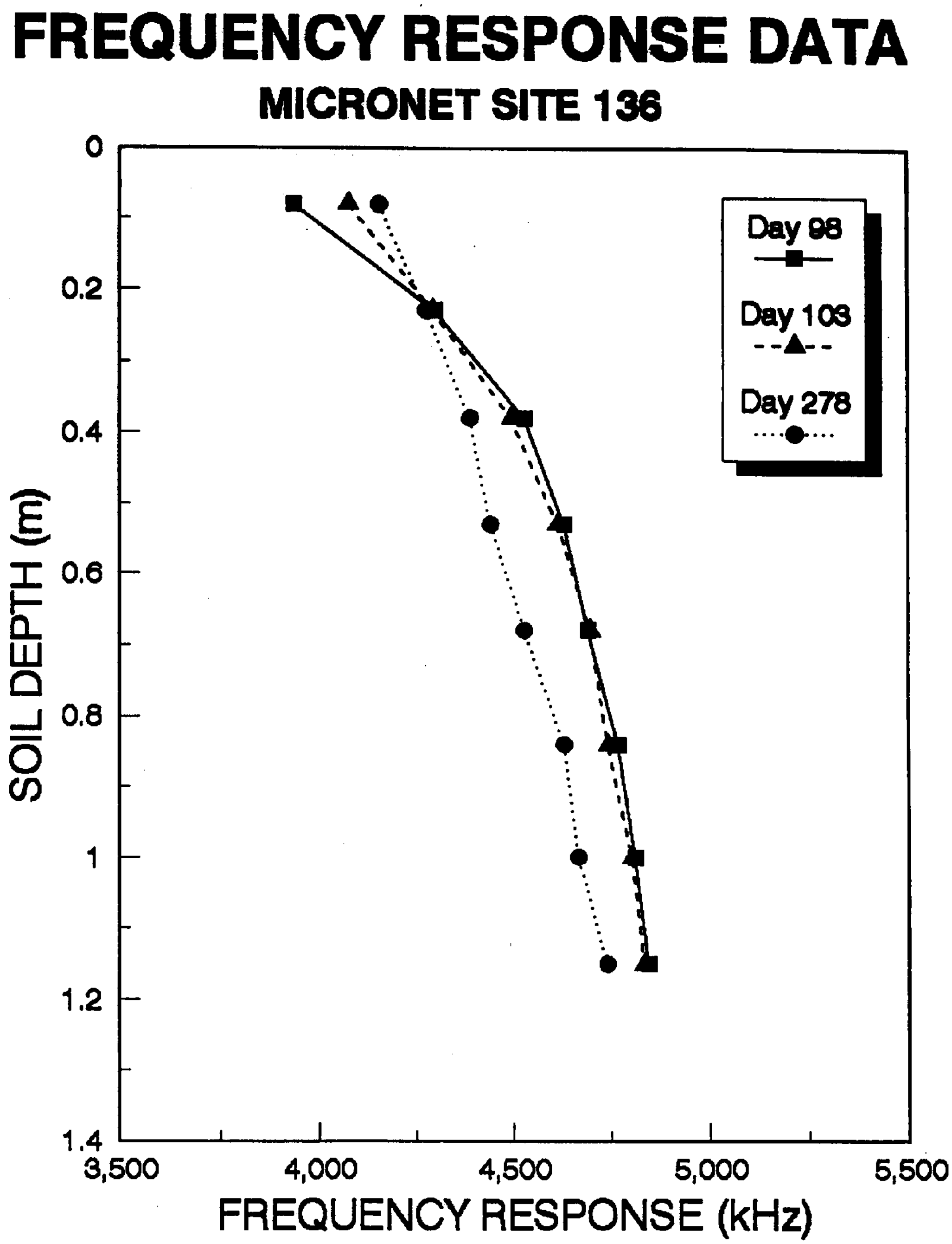

Figure VIII-2. Soil depth vs frequency response at site 136.

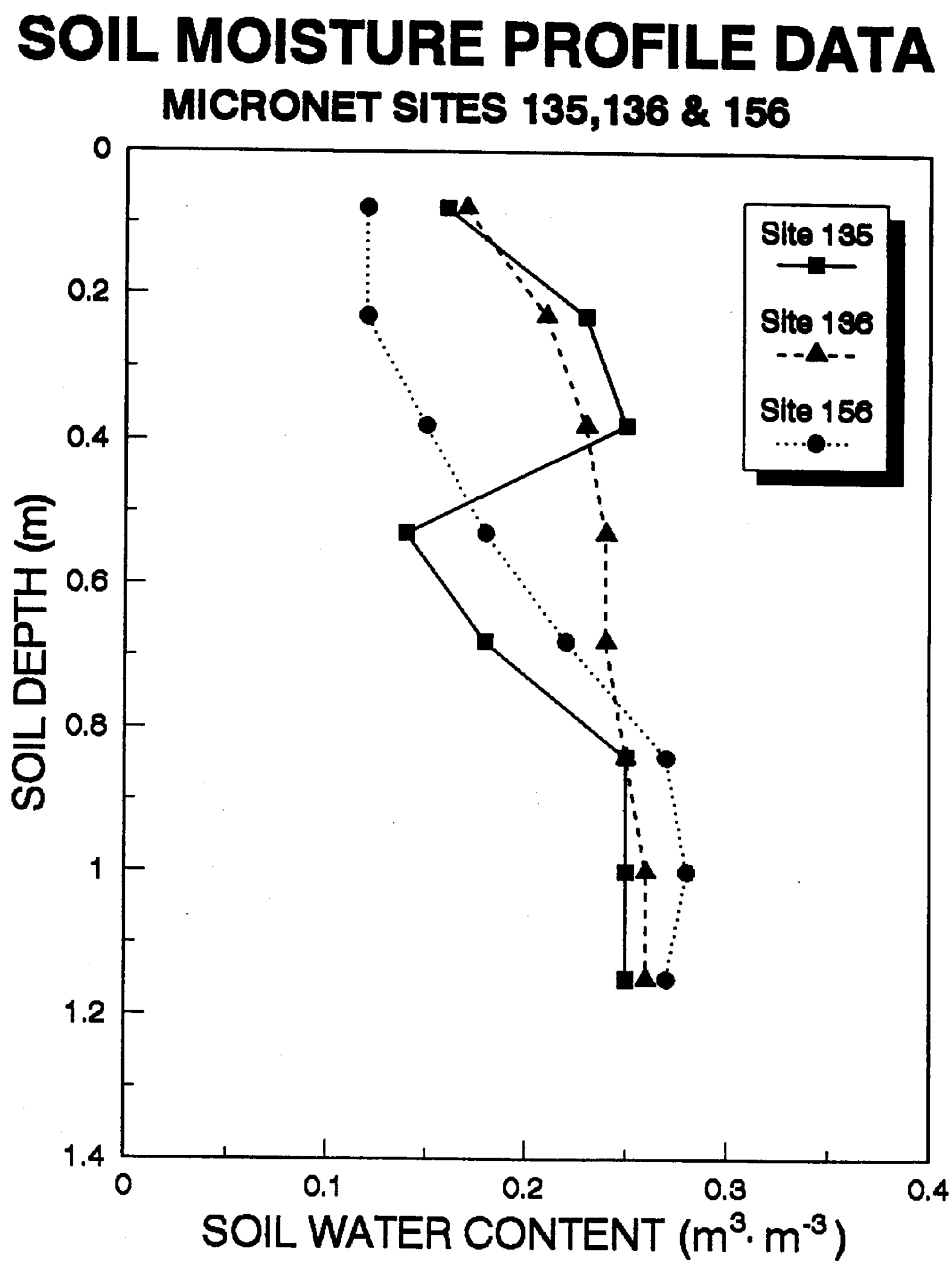

Figure VIII-3. Soil depth vs water content at sites 135, 136, and 156 on April 8, 1994.