Journal of Agrometeorology 3(1&2) : 175 - 178 (June-December 2001)

Distribution of soil moisture at the LASPEX-97 sites

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ABSTRACT

Depth profiles of soil moisture measured at LASPEX-97 stations were examined for the short-term and seasonal changes. The analysis suggested that although the hourly and day to day variation in soil moisture (volumetric) was within 1-2%, a remarkable change in the distribution of soil moisture was noticed at seasonal scale. Soil moisture profiles showed different characteristics for the different stations. The results were explained in relation to soil properties of the region concerned.

Keywords: LASPEX-97, Soil moisture, Soil properties

One of the objectives of the Land Surface Processes Experiment (LASPEX-97) was to characterize the spatial and temporal distribution of soil moisture variations. Soil moisture in the surface and sub-surface layers control the characteristics of boundary layer and coupling with upper atmosphere. Kobayashi *et. al.* (1993) observed that diurnal and day-to-day variations in soil moisture were perceptible only in the top ten centimeter layers and the seasonal variation was perceived only in the upper 1 m over Heihe Field Experiment (HEIFE) desert area. They also observed relatively wet layers located between 10 and 50 cm. Using General Circulation Model, Yang and Lau (1998) showed that following wet land surface conditions (enhanced snow and soil moisture), in the Asian continent during previous cold seasons, the summer monsoon becomes moderately weaker. Using the soil water budget model, Huang *et. al.* (1996) found that the annual soil moisture cycle was determined largely by evaporation. This paper discusses the depth profiles of soil moisture and its temporal variations observed during LASPEX-1997.

MATERIALS AND METHODS

Large variations in soil properties are observed over the Sabarmati and Mahi river basin. Soil properties of LASPEX sites are given in Table 1. Details of agroclimatic features of the sites can be seen in the paper of Pandey *et al.* (2001).

Measurement of soil moisture

During LASPEX-97, soil moisture measurements were carried out using neutron and capacitance probes. Occasionally when both the instruments did not function, conventional gravimetric method was used. Measurement procedure of soil moisture by capacitance or RF probe is described below as these observations are used extensively in this study.

Capacitance probe

The dielectric constant of water (80) is considerably greater than that of air (1) and solid components of soil ($\simeq 4$). The overall dielectric constant of a composite of these constituents is dependent on the properties of

Table 1 : Soil properties at different stations of LASPEX-97.

Station	Soil type	Bulk density (10^3 kgm^{-3})	Thermal conductivity (Wm^{-1}K^{-1})	Thermal diffusivity (10^{-6} m^{2}s^{-1})
Khandha	Clay	1.28	0.699	0.287
Arnej	Loamy clay	1.24	0.718	0.304
Derol	Sandy loamy	1.50	1.230	0.677
Anand	Loamy sand	1.50	0.944	0.508
Sanand	Clay loam	1.60	0.946	0.591

water present in the soil and is used to determine the proportion of water. Calibration is done by immersing the probe in a bucket of water (100% moisture condition) using a plastic tube. The specifications of this, and the neutron probes are given by Shekh *et.al.* (2001).

The input to calculate the soil moisture is the frequency reading (MHz) of sensor in water and air. The frequency reading in air is the average of readings taken before and after logging the readings. According to users manual (1994), if F_w , and F_a are the frequencies in water and air, and F is the frequency reading at any depth in a soil during the logging process, then Normalized Frequency (NF) is defined as

$$NF = \frac{F_a^{7.692} - F^{7.692}}{F_a^{7.692} - F_w^{7.692}} \quad \text{... (1)}$$

The corresponding water content expressed in volumetric percentage (VSW) is given by

$$VSW = 50.21\ (NF)^{12.73\ NF} \quad \text{... (2)}$$

The frequency of measurement for gravimetric method was one per month. For capacitance and neutron probes, 1-4 times a day depending on the availability of probe during intensive observational periods (IOP). Using these, the soil moisture profiles were estimated in terms of volumetric water content.

RESULTS AND DISCUSSION

Figs. 1 (a) to (e) show the depth profiles of volumetric water content and diurnal variation at Anand, Derol, Arnej, Khandha and Sanand sites respectively. Soil moisture did not exhibit hourly variation at any depth at all the stations except at Arnej at 60 cm depth (within 5%) though the profiles vary significantly from station to station. At the surface (0-5 cm), soil moisture was higher at Anand and Derol. In the deepest layer (80-90 cm), soil moisture was more at Sanand and Arnej whereas, it was low at Derol. At Anand and Derol, by and large, the profiles showed similar trend of wet upper (30-40 cm) layer and dry lower (40-90 cm) layer. At Khandha, a single observation of soil moisture profile was available. Over Sanand and Arnej, the layer (0-10 cm) shows increase in soil moisture with depth followed by a decrease up to 20-40 cm with a linear increase up to 80-85 cm. Thus at Arnej and Sanand, where the soil type was loamy clay/clay loam, the top layer was dry and the bottom layer was wet. The reverse trend in variation was observed at Anand and Derol sites where the soil type was sandy loam.

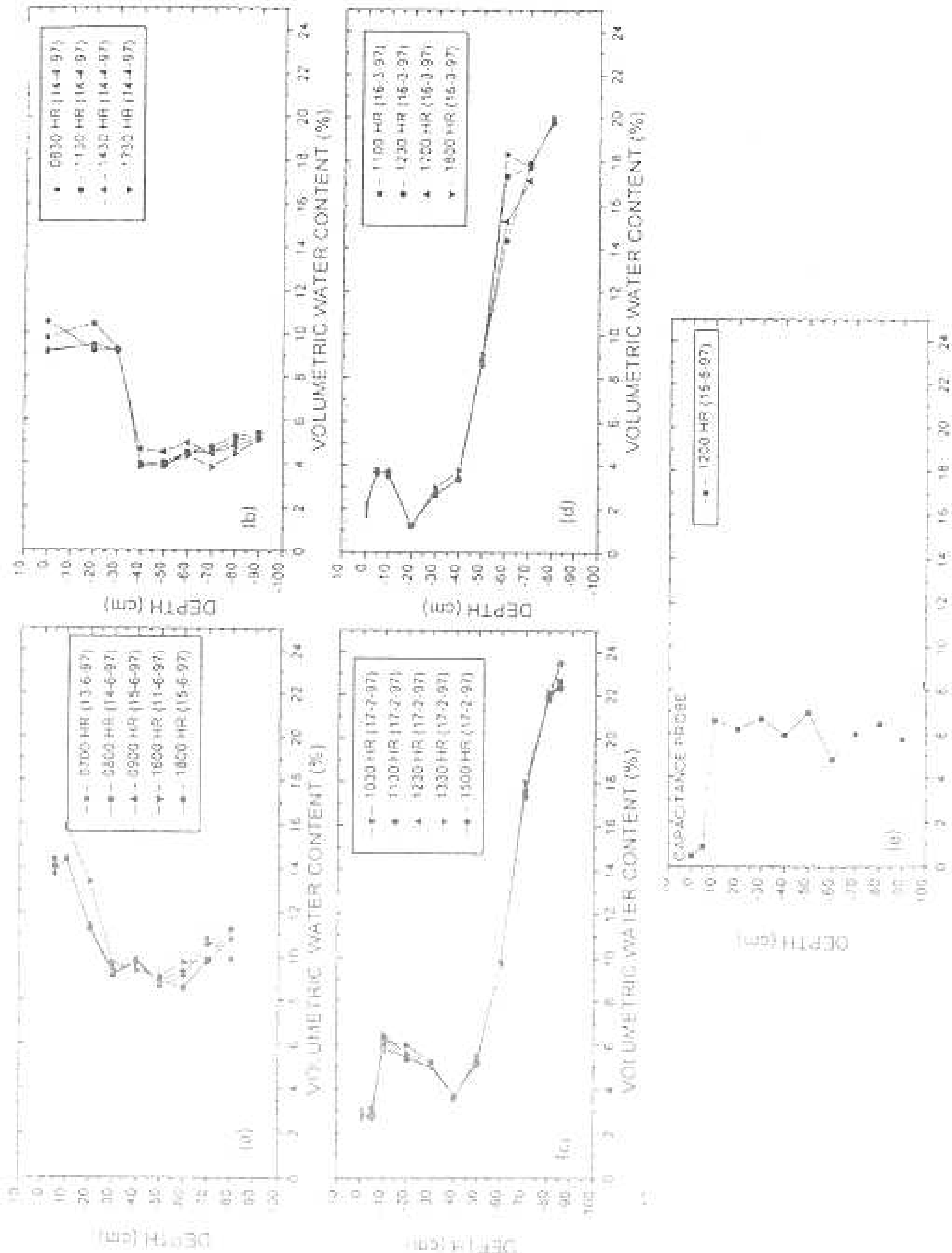

Fig. 1 : Depth profile of volumetric water content over (a) Anand (b) Derol (c) Sanand (d) Arnej and (e) Khandha.

Mean integrated soil moisture values for the upper 1 m depth were 10.5, 9.5, 8.0, 6.5 and 5.25% at Anand, Sanand, Arnej, Derol and Khandha sites respectively. The results are tentative since they are based on limited observations.

ACKNOWLEDGEMENTS

LASPEX-97 was sponsored by Department of Science and Technology, New Delhi (Govt. of India). Authors wish to thank Director, Indian Institute of Tropical Meteorology, Pune (IITM) for facilities provided for the work. Authors are thankful to Prof. A. M. Shekh, Gujarat Agricultural University, and his staff for providing necessary facilities at observational site. Thanks are due to the staff members of Boundary Layer and Land Surface Processes Studies Division of IITM for their assistance in collection of observations.

REFERENCES

Huang, J., van de Dool, H. M. and Georgakkos, K. P. 1996. Analysis of model calculated soil moisture over the United States (1931-1993) and application to long-range temperature forecasts. *J. Climate*, 9 (6) : 1350-1362.

Kobayashi, T., Shibata, S. and Nagai, H. 1993. Soil moisture behavior in the HEIFE Area. Proc. of International Symp. on HEIFE, Kyoto University, Kyoto, Japan (Nov. 8-11, 1993). pp. 131-140.

Pandey, V., Kumar, M. and Shekh, A. M. 2001. Agroclimatic features of LASPEX sites. *J. Agrometeorol.*, 3 : 39 - 55.

Shekh, A.M., Vernekar, K.G., and Keshavamurthy, R.N. 2001. The beginnings of LASPEX-97. *J. Agrometeorol.*, 3: 31 - 37

User manual, Capacitance Soil Moisture Probe. 1994. UMDI-101 (Issue A) 3/11/94, pp. 1-20.

Yang, S. and Lau, K. M. 1998. Influence of sea surface temperature and ground wetness in Asian summer monsoon. *J. Climate*, 11 (12) : 3230-3246.