Vertical Distribution of Biomass and Moisture in a Prairie Grass Canopy

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Introduction:

Numerical weather prediction and short-range climate prediction are based upon the propagation of atmospheric circulation models. Boundary forcing of these models includes energy transfer at the land-atmosphere interface. Estimates of this transfer are derived from a biosphere model, which is a temporal model of land-atmosphere processes. Among the significant parameters of a biosphere model are the temperature and the moisture distributions in soil and vegetation. These parameters also govern the radiobrightness signature of land, allowing the performance of a biosphere model to be validated and improved through satellite microwave radiometry.

While satellite microwave radiometry can be useful in developing a biosphere model, its applicability is limited to relatively homogeneous regions due to its low spatial resolution -- typically several tens of kilometers. One type of region which is both homogeneous and extensive is northern prairie. Our long-range objective is to develop a biosphere model for northern prairie that is linked to satellite radiometry. Our radiobrightness model for prairie will include assumptions about the vertical distribution of biomass and moisture for a typical grass canopy, since the radiobrightness of prairie is significantly influenced by emission, scattering, and absorption by various prairie grasses. The following experiment was designed as a possible prototype for the necessary characterization of wild grass.

Procedure:

The site of the experiment was a field at the Matthaei Botanical Gardens in Ann Arbor, Michigan. The grass was mature , and rather uniform in height throughout the field. The highest of the grass stems measured 94 cm when held upright. This part of the grass had turned brown and was leaning over at approximately at 30 angle. The green portion of the grass appeared at 52 cm above the ground and was almost vertical. Near the ground, dead grass formed a thatch which was pulled up and included in the measurements. The experiment was performed in August on a clear, hot day without any wind. Three research assistants were involved in the experiment. It took approximately 10 hours to get the grass samples.

The procedure consisted of placing four boards on the ground, marking out a one meter square patch as shown in Figure1. Each board was 25 cm wide and 2 cm thick. Two measuring sticks, connected by a string, were held upright on one end of the opposite boards. The string marked the proper cutting height (starting at 94 cm) across the patch. The grass was held from the top and then cut off at the level of the string using a pair of scissors. The measuring sticks were then moved along the boards with the string at the same height to cut the grass layer across the whole patch. The string was then lowered 2 cm and the procedure was repeated. The cutting at 2 cm decrements continued until ground (zero cm) was reached. All the measurement heights were taken from the bottom of the board. Each layer sample was stored in covered plastic containers.

The wet weight of the grass was measured immediately after the cutting. The volume of each sample was found by submerging the grass in a graduated cylinder. The smaller volumes were measured in one ml increments and the larger ones in 5 ml increments. The samples were then dried by baking at 40 C and the dry weights were recorded. The measurements are given in Table 1. Figure 2 shows the graphical representation of the data.

Conclusion:

While this method represents a viable means for the characterization of a grass canopy from the viewpoint of microwave studies, it has its limitations. For example; the uppermost parts of the grass stems were at angles which were not characterized; it is likely that the moisture in the canopy changed over the duration of the experiment (approx. 10 hours); and finally, the method is very labor intensive--three research assistants for 10 hours. If our biosphere model studies show significant sensitivity to diurnal and seasonal variations in canopy moisture, then using this method to characterize moisture variations will require a tremendous investment of project resources.

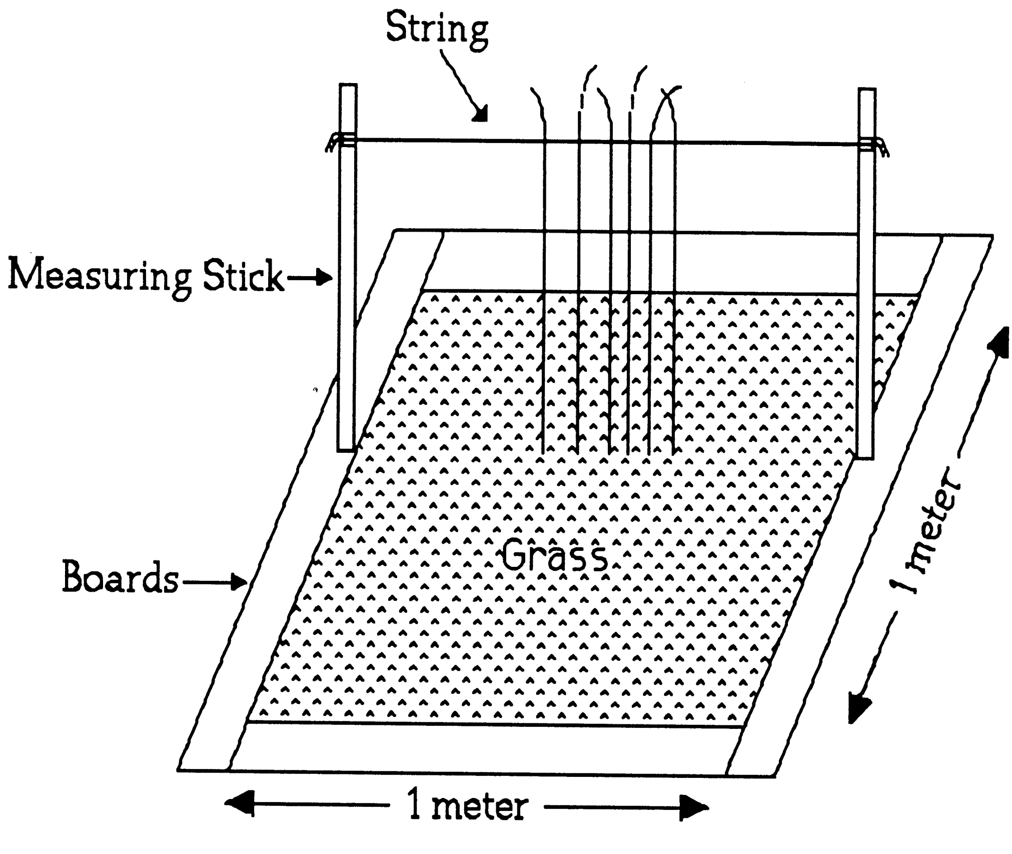

Fig. 1. Experimental Setup

Table 1. Data obtained from the field experiment

Height above ground (cm)	Wet grass weight (gm)	Dry grass weight (gm)	Grass Volume (ml)
2	116.30	79.65	171.00
4	122.60	56.61	188.00
6	30.85	14.36	40.00
8	54.56	22.91	68.00
10	59.80	23.96	73.00
12	48.80	21.23	60.00
14	43.14	19.33	60.00
16	7.10	15.80	50.00
18	39.17	17.79	55.00
20	29.29	13.35	45.00
22	29.03	13.17	45.00
24	23.07	11.39	35.00
26	16.23	8.35	20.00
28	17.03	9.05	20.00
30	13.26	6.98	21.00
32	12.25	6.76	20.00
34	7.10	4.01	13.00
36	6.83	4.05	12.00
38	3.78	2.21	7.00
40	3.24	2.46	7.00
42	3.18	2.41	6.00
44	2.93	2.21	6.00
46	2.14	1.80	4.50
48	1.84	1.64	4.00
50	1.42	1.30	3.00
52	1.98	0.89	5.00
54	0.84	0.76	1.50
56	1.47	1.26	4.00
58	0.85	0.78	2.00

Table 1. contd.

Height above ground (cm)	Wet grass weight (gm)	Dry grass weight (gm)	Grass Volume (ml)
60	1.40	1.28	3.00
62	0.90	0.81	2.00
64	1.00	0.87	2.00
66	0.89	0.75	2.00
68	0.79	0.67	1.00
70	0.52	0.47	1.00
72	0.69	0.51	1.50
74	0.56	0.52	1.00
76	0.58	0.47	1.00
78	0.28	0.21	0.50
80	0.27	0.16	0.50
82	0.46	0.28	0.50
84	0.19	0.00	0.50
86	0.14	0.00	0.50
88	0.17	0.00	0.50
90	0.03	0.00	0.00
92	0.07	0.00	0.00
94	0.02	0.00	0.00

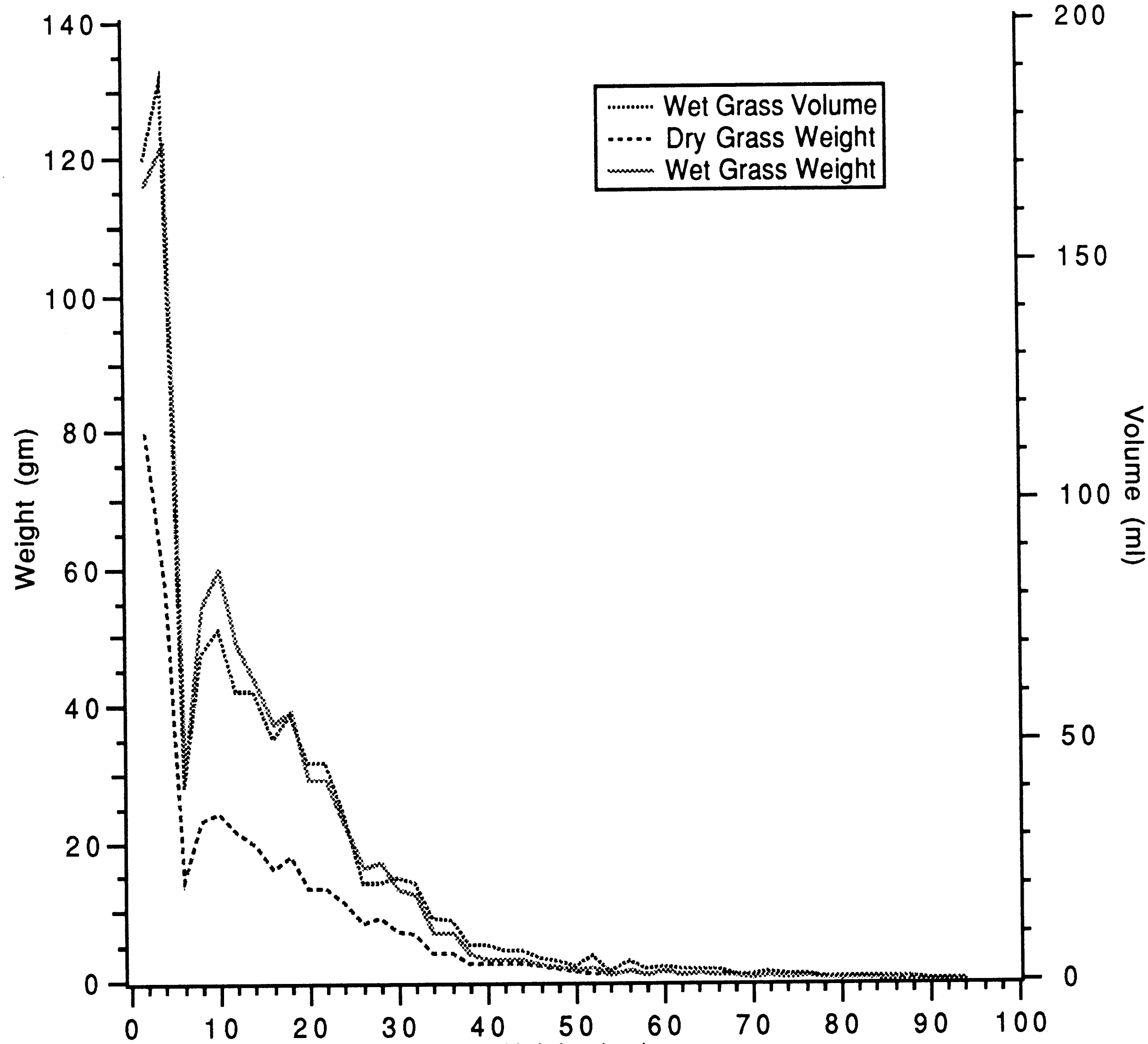

Fig. 2. Grass volume, dry weight and wet weight vs. height