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Climate Variability and Ecosystem Response

Proceedings of a Long-Term Ecological Research Workshop

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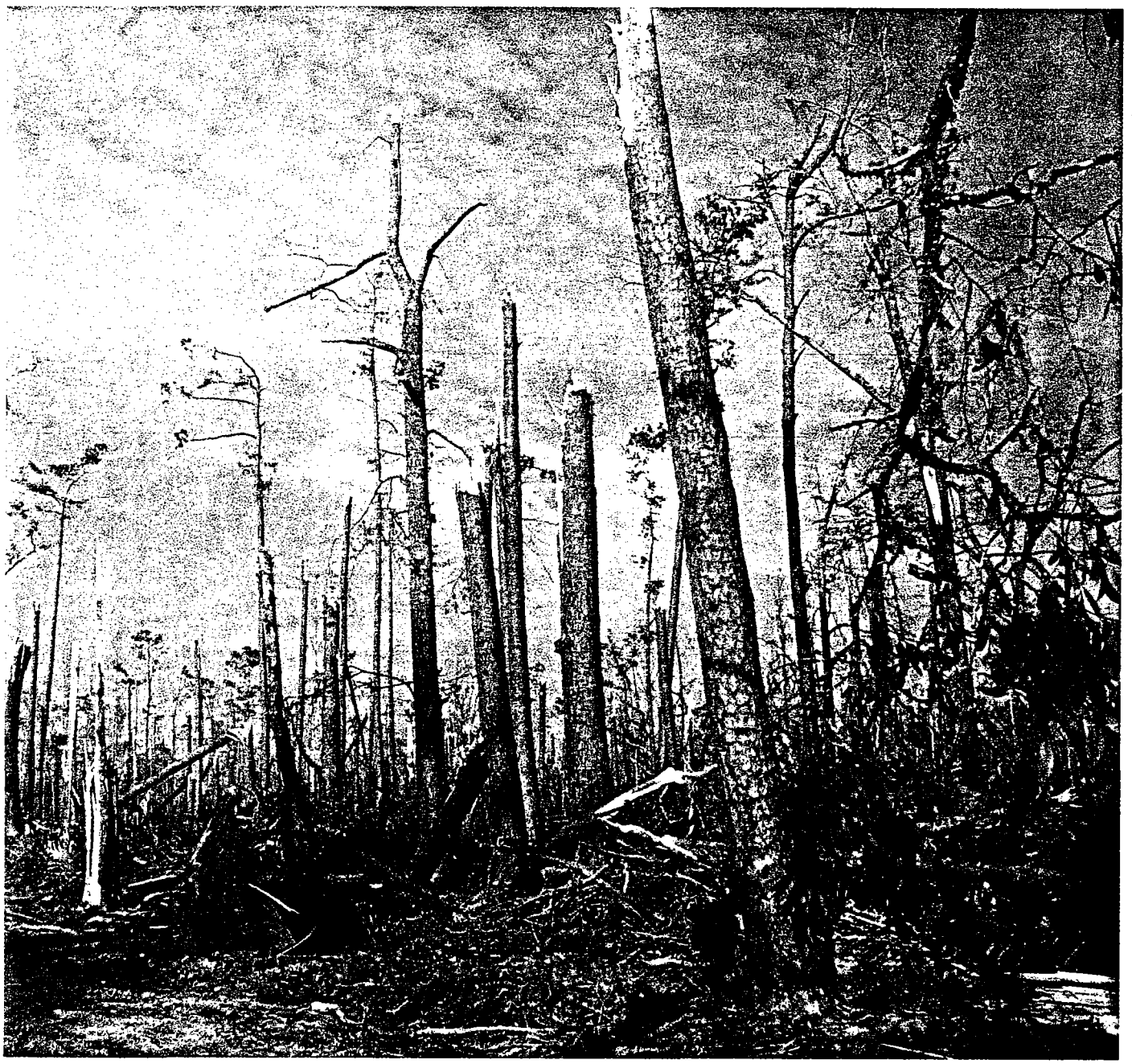

INTRODUCTION TO LTER WORKSHOP

ON CLIMATE VARIABILITY AND ECOSYSTEM RESPONSE

David Greenland and Lloyd W. Swift Jr.[1]

The Intersite Climate Committee of the Long-Term Ecological Research (LTER) Program, which is sponsored by the National Science Foundation, has the mission of facilitating investigations of the atmospheric environment in LTER ecosystems. The Committee has developed standards for meteorological measurements at LTER sites (Greenland 1986; Swift and Ragsdale 1985) and has summarized the climates at the first 11 LTER sites (Greenland 1987). This climate summary demonstrated the obvious: very different ecosystems have very different climates. This report, and discussions at the LTER Data Processing Workshop at Las Cruces in January 1986, suggested that moisture (including soil moisture) and climate variability were distinctive forcing variables at each site. The Climate Committee decided to defer investigations of water budgets and to concentrate first on climate variability. This decision recognized the LTER network's potential importance to research on the global climate change question and the growing public interest in that question.

Eleven of the 15 sites then in the LTER network attended a workshop on Climate Variability and Ecosystem Response. Ten sites are represented by papers in this volume. Each site was invited to examine its longest time series of climatic data for temporal variability and to comment on the relation of that variability to ecosystem responses. The variability of many data sets was characterized by multiyear climatic periods punctuated by strong and dramatic responses to specific weather events. All sites found duration of record and spatial representativeness to be limiting factors in assessing variability.

The workshop was held in August 1988 at the Mountain Research Station of the University of Colorado, the field headquarters for the Niwot Ridge-Green Lakes Valley LTER site. The keynote address on Global Warming and Ecosytem Response was given by Dr. Stephen Schneider of the National Center for Atmospheric Research. Following this and formal presentations of papers, the authors and Dr. Gary Cunningham from the Jornada LTER site met as the LTER Climate Committee to review the research and our understanding of climate variability and ecosystem responses of the LTER sites. The discussions reported in the overview chapter concluded that recognition and utilization of time and space scales are keys to understanding response phenomena.

The papers in this volume represent a variety of ecosystems, environments, and approaches to our topic. This variety represents one of the riches of the LTER program, although it makes standardization and generalization difficult. The volume starts with information from three forest sites. Federer examines the record at the Hubbard Brook Experimental Forest in New Hampshire in order to determine whether real variation in the climate can be deduced from existing records. A powerful statistical technique, the Z-T extreme event analysis, is employed by Swift and others to determine the uniqueness, or return period, of extreme events in streamflow and precipitation data from the Coweeta Hydrologic Laboratory in North Carolina. Viereck and Adams infer effects of climate warming on vegetation patterns from data on spatial variation in microclimate and related plant successional development at the Bonanza Creek Experimental Forest.

Aquatic ecosystems were represented by the North Inlet South Carolina and the Northern Lakes Wisconsin LTER sites. Michener and others show impacts of chronic and acute climate events upon the estuary ecosystem and how the scale of climatic variability affects productivity. This paper was written before the North Inlet site was severely impacted by Hurricane Hugo in September 1989. At the Wisconsin site, Robertson demonstrates how historical data for fresh-water lakes can be used as a measure of longer term climatic change. Predominantly agricultural landscapes were addressed by Wendland and by Crum. Wendland summarizes the history and quality of Illinois weather observations that supported the former Illinois Rivers LTER site. Crum found little or no indication of climate change in 100-year temperature and precipitation records and was able to relate corn yield to midsummer precipitation at the Kellogg Michigan LTER site.

Three sites represented landscapes where extreme climates limit vegetation cover. Greenland describes a marked variation in the temperature and precipitation record on the alpine tundra at the Niwot Ridge-Green Lakes Valley Colorado site, but this variation was not well correlated to obvious ecosystem responses. In contrast, Kittel reports that climate variability

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in the shortgrass steppe ecosystem at the Central Plains Experimental Range site in Colorado is well related to ecosystem function. The final site paper, by Hayden, describes how storm events at the Virginia Barrier Island site move and reform coastal terrain and influence vegetation distribution. The latter point was a good demonstration of the contrast between time and space scales, which must be recognized in any attempt to relate climate variability to ecosystem response.

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Nine papers describe studies of climate variability and ecosystem response. The studies were conducted at LTER (Long-Term Ecological Research) sites representing forest, agricultural, and aquatic ecosystems and systems in which extreme climates limit vegetational cover. An overview paper prepared by the LTER Climate Committee stresses the importance of (1) clear definitions of terms, (2) use of appropriate temporal and spatial scales, (3) development of new and more useful indices of climate, and (4) opportunities to take scientific advantage of differences and similarities among LTER sites.

Keywords: Climate, climatic variability, Long-Term Ecological Research.

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