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10-1989

Second Annual International LTER Workshop, Albuquerque, New Mexico, USA, October, 1989

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Long-Term Ecological Research:
International Workshop II
Oct. 2-4, 1989
Albuquerque, New Mexico, USA

Background

In September, 1988, an international workshop on long-term ecological research was conducted in Berchtesgaden, West Germany. The objectives of this workshop, consisting of about 30 participants from mostly northern hemisphere countries, were: (a) to identify important ecological questions, especially those at the regional and global scales, which were amenable to long-term research approaches; (b) to analytically define those conditions under which long-term research offered the only viable investigative approach; and (c) to consider the issues that would be involved in establishing coordinating mechanisms for international long-term ecological research programs. The workshop was successfully completed and a forthcoming book will provide the results to the research community.

Workshop II will build on the results of workshop I and on the professional contacts that were fostered during the first workshop. Specifically, the first workshop brought together scientists from various countries who began to identify common ecological processes being studied at two or more sites, who recognized that certain broad climatic phenomena were exerting similar influences on different ecological habitats, and who realized the necessity of much broader geographical comparisons and analyses if ecological principles were to be identified and tested. **Thus, the objectives of Workshop II will be: (a) to begin the formal development of international coordinating and networking of collaborative long-term ecological research at specific sites; (b) to facilitate the introduction of the newest technologies into these collaborative research efforts; (c) to identify initial working groups in three selected biomes; and (d) to develop specific plans for international collaborative long-term ecological research in each of these three biomes.** Long-term research questions identified during the first workshop in West Germany (see Appendix A) will provide a starting point for the objectives of Workshop II. **The research plans developed for the biomes will include the long-term ecological phenomena to be studied, the comparable data to be collected, the analytical techniques to be used in analyzing the resulting data, and the personal and technological methods to be used in designing the studies, collecting the data and sharing the information.**

Structure of the Workshop

This is considered as a "working" workshop, so the number of participants will be small and each will have very specific responsibilities. Moreover, there will be the implicit assumption that participation in the workshop will mandate subsequent collaborative efforts to secure funding for and participation in the identified long-term ecological research programs.

The results of the first workshop indicated that current ecological research in three biomes were particularly amenable to international collaborative investigations: arid to semi-arid grasslands and shrublands, temperate forests, and tundra-boreal forests. During the International Biological Program (IBP), there were some efforts toward international

collaboration in these biomes, but these efforts were largely post-facto comparisons of data. Furthermore, at that time many of the current measurement, analytical and communication technologies were not available, our concepts of global phenomena were much more primitive especially as they relate to ecological processes, and the use of models was not well developed. Subsequently we have recognized the necessity of planning international research projects rather than just comparing data. Also, we have learned that models are particularly effective at building collaborative research projects among scientists from various countries and ecological conditions. Thus, the design of the proposed Workshop II builds on the IBP, the first long-term ecological workshop, more sophisticated technologies, greater understanding of the linkages between ecological and climatic processes, some successes in developing and using ecological models and an additional decade or more of ecological research in three biomes.

One of the few successful international collaborative ecological research efforts has involved modelling of the boreal forest. Therefore, the first segment of the Workshop will be an analysis of this effort by Professor Shugart who has agreed to dissect the reasons for its success and how these reasons relate to the proposed international collaboration in long-term ecological research.

A second part of the plenary segment of the workshop will be a presentation from a representative of each of the three biomes on the ecological questions that are amenable to long-term ecological research. At this time we anticipate presentations to be given by participants from: [Mexico], arid; [Finland], tundra-boreal forest; and [Canada], temperate forest. In each case, the presentation will not be simply a description of current research, but rather will be an attempt to identify ecological questions or hypotheses that must be addressed in an international and long-term context. **We will strongly encourage and facilitate interactions between investigators before the workshop to develop presentations that will speed subsequent research plans.**

The last part of the plenary segment will consist of three presentations on technologies that will be integral to international long-term ecological research: (a) geographical information systems [GIS] coupled to simulation models; (b) remote sensing and data management such as the NASA First Integrated Field Experiment [FIFE]; and (c) new communication technologies for sharing data and analyses. Each of the presentations will be designed to anticipate the needs of the international long-term ecological research network. These three categories of technologies have been selected to address a series of spatial and temporal scales. That is, the GIS-model technology is particularly useful for studying site-specific processes and integration at the site level. Remote sensing and management of data from several integrated technologies are useful for expanding from the site to the region or continent. Finally, communication technologies should permit the sharing of the results from the first two technology categories and for ensuring the active continuation of the research projects.

This plenary segment of the Workshop will provide a common basis for the three biome-specific working groups that will consume most of the workshop time. Each of the three working groups will consist of five scientists who are intimately involved in long-term ecological research and who have access to or control of a substantial dedicated research site. The tasks of each of these working groups will be as follows:

a. Identify one to a few research questions or hypotheses from Workshop I (Appendix A) that

are international in scope but regionally important and that require long-term ecological research for a resolution.

b. Plan the experimental approach, ensuring that the international comparisons and analyses are used to their greatest power.

c. Describe the technologies to be employed, both for scientific investigative and project communicative purposes.

d. Provide a plan for the analyses of the resulting data.

e. Establish the necessary coordinating structural components for the proposed study by the five sites, but do so in such a way that the structure could include additional sites and investigators in the future.

f. Propose a strategy for obtaining funding for the anticipated long-term ecological research project.

The workshop schedule provides an opportunity for the three working groups to have a common discussion of their plans. Thereafter, each group will refine its approach and plans.

Communication from the Workshop

Workshops represent a popular and common way for scientists to interact and advance the science of their discipline. Unfortunately, workshops work best if discussions involve small groups of individuals. Thus, a typical, cost-effective, and successful workshop can accommodate only a relatively small portion of the scientific community. Subsequent dissemination of the information usually occurs as reports, books, or word-of-mouth. These forms have significant delays (e.g., up to two years in the case of books), misrepresentations (possibly by word-of-mouth), as well as an inability by the rest of the community to participate in the process. Cost-effective technologies, such as telecommunications, can allow near real-time interactions with a large portion of a research community. We propose to add this component to this workshop to demonstrate its usefulness as well as communicate and receive feedback from scientists throughout the United States.

The importance of the international nature of this workshop dictates that most of the participants will come from outside of the United States. For example, only two U.S. sites are represented in each of the three biome types in spite of a larger number of possible candidates. We propose to include interactions from many scientists at a wider range of sites by telecommunications. Most universities have downlink capabilities allowing inexpensive reception of telecommunications. Fewer have uplink capabilities, i.e., transmitting video signals, and it is more expensive. We propose the following system:

On the last day of the workshop, after the small workshop groups have developed preliminary, long-term research plans, a one-hour telecommunications program will

transmit the elements of those plans. Any site that has downlink capabilities will be able to tune in to the presentation and prepare questions, responses, and alternatives. During a 1-2 hour period following the broadcast, the other sites can use conventional telephone and electronic mail to communicate their responses to the workshop group. A second hour of video transmission will follow immediately and answer questions, responses, as well as modify research plans suggested by other scientists. These presentations can be recorded and duplicated for additional audiences or for subsequent referencing. There can be additional conventional communication from the other sites if needed.

International Conference Preliminary Schedule
revised 8-14-89

Saturday, Sept. 30
Arrival of participants

Sunday, Oct. 1
Rest, research site visits

Monday, Oct. 2

8 - 8:30	Introductions
8:30-9:30	Great Plains Modeling Experience (Parton)
9:30-10:30	Boreal forest/Tundra presentation (Wein, Laine)
10:30-11	Break
11 - 12	Temperate Forest presentation (Heal)
12 - 1:30	Lunch
1:30-2:30	Arid/semiarid presentation (Safriel)
2:30-3:30	CO_2 Program/National Weather Analyses (Farrell)
3:30-4	Break
4 - 5	Working group formation & initial discussions
6 - 8	dinner

Tuesday, Oct. 3

8:30-9:30	GIS/Process modeling presentation (Schaller)
9:30-10:30	Data Mgmt/Networking presentation (Strebel)
10:30-11	Break
11 - 12	Communication technology presentation (Storch)
12 - 1:30	Lunch
1:30-3:30	Working groups
3:30-4	Break
4 - 5	Combined working session
6 - 8	dinner

Wednesday, Oct. 4

8 - 9:30	Telecommunication preparation
9:30-9:45	Move to studio
9:45-10:55	Telecommunication session I
11 - 12	Critique
12 - 1:30	Working Lunch
1:45-3	Telecommunication session II
3 - 5	Wrap up, Future Workshops/Plans
6 - 8	dinner

Thursday, Oct. 5
Continued interaction for those still here. Departure

note: This schedule seems very short considering what we want to do. Our working sessions must be very efficient!

Appendix A
Long-Term Ecological Research Questions

This report represents the efforts of a working group of the International Workshop "Long-Term Ecological Research: A Global Perspective" held in Berchtesgaden, West Germany, to identify important long-term ecological questions which might form the basis of studying ecological processes on a global basis. The specific objective was to "further define the rationale for long-term ecological research and identify important existing and emerging scientific questions which could most appropriately be addressed at long-term ecological research sites, particularly those related to environmental changes at the global scale." The working group addressed two related aspects; the scientific questions to be addressed at long term research sites and the networking of those sites.

International Networks for Studying Global Change

The working group represented many disciplines, study sites, and countries. Discussions soon revealed that research priorities and objectives differed markedly and a certain research program could not be forced on sites/countries with different priorities. However, there were concepts that were common to all. For example, all individuals recognized the benefits of long term research. Also, the fundamental approach was to explain or account for variation in the parameters measured. These may sound trivial but they form the basis for justifying a global network and extrapolating results to regional and global scales. Only a network of sites can represent the large spatial scales needed to document changes that occur at those scales. Each site can be located accurately so that rates of movement of environmental phenomena or the scale of influence of environmental phenomena can be quantified. We envision a global scale Geographic Information System (GIS) that could map and project results at appropriate large scales. The networking allows sites to work on a common time scale and synchronize efforts at quantifying responses to large scale environmental phenomena. For example, an *El Nino* event may cause very different responses among different ecological parameters at one site and among different sites. This results from the many interacting factors at a site and the site-specific nature of those interactions. However, the initiation of the responses may well be caused by the *El Nino* phenomena, a triggering effect, which could be common at all sites. The network could identify the scale of the triggering phenomena, the times of initiation and conclusion, and the types of ecological responses that were similar and dissimilar. For some sites it could separate the triggering response from the subsequent chain of events (succession of events) until a new triggering event occurred. Some regions may respond to certain types of triggering events while others may not. This may help to identify the significance of various types of constraints on systems, the regional extent of those constraints, and the sequence of ecological phenomena typical following changes in those constraints. Networking is essential for a rapid information transfer and facilitates early recognition of events that are common to large areas.

Functions of a Network: Goals

The issues of global and regional change impose on the ecology at all smaller spatial scales. Achieving the detection, understanding and prediction of global change and the prescription of human response to global change requires the formation of interactive, real time networks of ecologists around the globe. Explicit goals of international and regional networks are 1) to identify common patterns of change, 2) to develop regional and global syntheses of change and a mechanistic understanding of these changes, 3) to partition the variances between global and site specific forcing functions, and 4) to develop approaches to scaling up (and down) from local to regional

to global spatial scales. Networks will accelerate the rate of achieving these goals by reducing the time lags both for information transfer and the planning and conduct of appropriate long term ecological research.

Networks should be flexible and form around scientists studying similar systems on the one hand (e.g., those who study grasslands) to those studying markedly different systems (e.g., grasslands, lakes, urban ecosystems, coastal zones). These networks are essential when we consider the short times over which global change may occur, the need for implementation of new techniques, and the spatial scale and diversity of ecosystems involved in the problem.

Research Questions

The individuals of the working group identified specific questions being addressed at their sites. These questions were categorized and generalized into the following three groups: **Climatic Change/Land Use Change: Influence on Systems; Ecosystem Change: Influence on Climate; and Within System Characteristics: Influence on System Change.** The working group also identified a number of givens or assumptions that would be important in the working of a network and the extrapolation of results required for addressing long-term questions;

1. A network of sites with known abiotic conditions (yearly climate) will allow quantification of trends and processes not possible with even detailed studies on individual sites.
2. General climatic trends and process information is both determined by the network and transmitted promptly and accurately throughout the network.
3. Land use changes will be monitored in all areas of the region or globe, most probably by agencies using remote sensing techniques. Individual sites cannot address the extent of land use change.
4. Long-term experiments are vital in order to represent cumulative effects and unusual events.
5. In conjunction with a network of major research sites, other monitoring networks, and individual studies will fill gaps and add depth to the research network.

Climatic Change/Land Use Change: Influence on Systems.

* How can the biological productivity and utility of ecosystems to humans be maintained within acceptable ranges of variability with the expected disruption from invasion and extinction of taxa and guilds associated with climatic change?

* What is the effect of climate change (more frequent droughts, different precipitation amounts, patterns) on production, production practices, and land cover that makes these lands more susceptible to wind and water erosion?

* How do large scale changes in current regimes affect temporal behavior of regional ecosystems?

* What proportion of variance or what temporal patterns are caused by local phenomena versus large scale (e.g., climatic) phenomena?

* To what extent is land use change driven by: 1) man-induced change, 2) climatic change, 3) atmospheric inputs of anthrogenic origin?

* How are couplings of nutrients and toxicants in ecosystems affected by patterns of change in climate and land use?

* What will be the consequences of changes associated with climate change on: 1) species shifts, species composition, 2) carbon-energy flow (organic matter dynamics), 3) genetic evolution/adaptation from pesticides, metals, climate, 4) availability of nutrients, toxins, salts and mycorrhizal associations, 5) major changes at system boundaries and feedback mechanisms, 6) vegetation structure?

* Will certain arthropod herbivores become significant pests on agricultural or natural vegetation due to climatic change?

* Can we sustain productivity in a changing environment?

* How and to what extent will airborne pollutants, fertilizers, etc., (large scale influence) affect the natural material fluxes and cycles in ecosystems?

* Will different types of climatic change (i.e., drought, flooding, altered frequency of extreme events, etc.) result in very different spatial changes in systems? What portions of ecosystems are most susceptible to what types of climatic change?

* What are the proper scales for measuring different aspects of climatic change?

Ecosystem Change: Influence on Climate

* What is the effect of changes in cropping patterns and practices on the need for external nutrients, carbon fixed or lost from systems and loss of other nutrients to the atmosphere (e.g., nitrogen)?

* What are the feedback mechanisms and magnitude of influence between current climate, effects on natural and managed systems, and subsequent changes in climate resulting from altered trace gas emissions, energy budgets, etc.?

* At what places in the world are the largest changes in vegetation likely to occur, from the point of view of feedback effect to world climate? Here, a change is large if a) it involved a structural change in vegetation which would affect albedo, roughness or evapotranspiration, b) it is expected over an area of at least 100,000 km^2, c) it is in part of the world important to climatic energy budgets, i.e., an area where much solar radiation is received.

Within System Characteristics: Influence on Change

* To what extent do past changes have an effect on present ecosystems? Is it predictive?

* To what extent are disturbance-induced changes in species composition and productivity accommodated (ameliorated) by structural and functional adjustments within the system?

* Is the stability or resilience of the system proportional to the degree of spatial heterogeneity at the site level, at the landscape level?

* How does increasing biological uniformity between ecosystems because of invasions and/or local extinctions affect temporal behavior of populations and communities?

* What are directions of change in exploitable populations and how does this affect material cycles and trophic networks?

* What is the minimum description of vegetation which, taken along with a description of climate, allows us to predict albedo, roughness and evapotranspiration for areas aggregated over 100 x 100 km? That is, what is the minimum number of groups into which plant species can be aggregated for this to be possible and what are the groups?

* How do changes in site heterogeneity occur? What role does heterogeneity play in within site dynamics, change?