XCLIMATE WORKSHOP

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Date:    July 1, 1996                                          X-Roots Database:
                                                               "Biblio Cluster"
To:      X-Roots / LTER Climate Mini-Workshop Participants¹    "Catalog Cluster"
                                                               "Measure Cluster"
From:    C Bledsoe,  J Hastings, R Nottrott, Workshop Co-Organizers

Re:      Report of X-Roots/LTER Climate Mini-Workshop, May 16-17, UCDavis²,³

cc:      LTER Data Managers;  LTER PI's;   LTER Climate Committee;
         M Harmon (LIDET);  Lauenroth  & Hendricks (X-Roots Grasslands & Forests Workshops)
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[1] X-Roots/UCD (Bledsoe, Coman, Hartshorn, Hudson, Wagner, Wilson) X-Roots/UNR (Hastings, Uthiram), X-Roots/LTERNET (Nottrott), LTER (Greenland, Henshaw, Porter) Advisors/UCD (McCoy, Quinn).
[2] Relevant URL's: this report available from LTERNET Quick Finder http://lternet.edu/im/xroots/aclim.htm
Belowground Productivity X-Roots home page http://lternet.edu/about/research/syn_01.htm
Climate Committee standards document http://lternet.edu/im/climate/standard86.htm
[3] Comments on this report may be directed to Caroline Bledsoe, (cbledsoe@lternet.edu).

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Executive Summary

X-Roots is a cross-site, multi-disciplinary project designed to synthesize existing below-ground plant root biomass data from many sites (LTER and others), together with associated plant, climate and soils data in order to clarify controls on below-ground plant productivity. X-Roots, a three-year project (Sep 1994 - Aug 1997), was funded from a special NSF/DEB competition to enhance intersite and synthetic research, especially in the LTER Network.

When X-Roots found it more difficult than expected to obtain climate data in easily usable forms, the project asked for help from several more experienced LTER climate researchers, including David Greenland, Chair - LTER Climate Committee. Email and telephone discussions led to a small mini-workshop -- the X-Roots/LTER Climate Mini-Workshop which was held on May 16-17 at UC Davis. Workshop co-sponsors were the X-Roots Project (PIs Bledsoe and Hastings; co-PIs Nottrott and Chinn) and the LTER Network Office (subcontract to LTER Research Coordinator Bledsoe). Invited participants were David Greenland (U Oregon), Don Henshaw (AND site) and John Porter (VCR site). Jordan Hastings (MCM site) and Rudolf Nottrott (NET site) also represented those sites, and served as workshop co-organizers.

Workshop participants were involved in two main activities: (1) review of X-Roots progress to date, particularly database and related software development; and (2) deliberation on content and format of LTER climate datasets to facilitate their distribution and use in projects such as X-Roots. To focus the latter activities, participants were asked to prepare and bring climate datasets from their sites to the workshop.

On the workshop's first day, the overall structure of the X-Roots database was described, followed by a demonstration of the X-Roots bibliographic database (*" Biblio Cluster "*) which is used within the project to track data sources. Next, a prototype of the X-Roots measurement database (*" Measure Cluster"* , used to record quantitative data) was presented, utilizing sample data from the KBS site. This was followed by Greenland's discussion of the intersite CLIMDES ("CLIMate DEScription") project, which was funded in the same NSF/DEB special competition as X-Roots. On the second day, participants discussed desirable content and format for climate datasets; they also explored the current reality of these issues by importing their LTER climate datasets in forms suitable to X-Roots. The workshop wrapup was an extended discussion of data naming conventions, data source tracking, quality control, and metadata issues. Participants talked about the need to update climate datasets, which led to consideration of distributed datasets which would be accessible and on-line and query-able (e.g. SQL Server software, etc.). Finally, participants outlined several action items from the workshop.

The workshop was successful in many ways. A prototype X-Roots database was populated with climate data from five sites (AND, KNZ, MCM, SGS, VCR). X-Roots project members learned how additional site data can be obtained

from CLIMDES. Participants also outlined two possible standard formats, V-One (one variable) and V-Many (many variables), for distributing climate data. A decision was made to experiment with updating some of the CLIMDES datasets (current only to 1990),which will be useful for two reasons: to provide more recent data (e.g. LIDET project's litter bag decomposition studies began in 1990) and to gain experience with processes for updating centrally held data. Another experiment at formal database distribution will be made with the X-Roots bibliography, followed by the LTER All Site Bibliography, with results to be presented to the LTER Data Managers and LTER Principal Investigators at Fall 1996 meetings. Participants are encouraged by the X-Climate workshop which, beyond serving the immediate needs of X-Roots (and LIDET), may provide useful lessons for the LTER Integrated Network Information System currently in development. The following report summarizes our discussions and observations from the X-Roots/LTER Climate Mini- Workshop and is organized into 3 sections: Workshop Action Items, Major Workshop Topics and Appendices.

Workshop Action Items

(1) Climate Data Content: Support LTER Climate Committee's recommendations for content of climate data and limited metadata, organized by levels (Level 1=basic, Level 2= advanced, etc.(Appendix 1).

(2) Storage and Distribution Formats: Encourage LTER sites to adopt two formats for climate datasets, one for local storage, the other for general distribution. Content is standard for both, with local choice for format of storage datasets, but network-choice for format of distribution datasets.

(3) V-One & V-Many Formats: Recommend * two standard World-Wide Web formats (effectively "transfer protocols") for distribution datasets -- V-One and V-Many.

(4) Limited Climate Metadata with Data: Recommend * standardization and inclusion of codes for three critical pieces of metadata in all climate distribution datasets: climate site and station code; month and date code; and data element (A.K.A. "variable") code.

(5) Climate Glossary: Recommend * LTER Climate Committee to develop a standard glossary for climate data (Web-accessible via LTER Home Page) which would include: a) **climate site and station names** (keyed to geographical location, period of record, etc.), b) **data element dictionary** (including name, units of measure, calculation methods, etc.), c) **data-quality flags** (ways of marking missing data, questionable data, etc.) d) **list of variables by Levels.**

(6) Test Updating and Distribution Processes: Ask the X-Roots group and others (e.g. LTER data management persons -- AND/Henshaw, SGS/Wasser, VCR/Porter, NET/Nottrott, etc.) to undertake additional experiments with dataset updating and distribution processes. First, post-1990 climate data will be updated to CLIMDES for several sites (Henshaw, Nottrott, others). Second, Web- access to climate data using the V-One and V-Many protocols will be tested for CLIMDES from a few sites (Henshaw, Nottrott). Third, formal database distribution aspects of the X-Roots *Biblio Cluster* (which supports SQL-queries) will be tested with bibliographic entries from several sites (Hastings and Uthiram, an X-Roots summer intern). Finally, Web-enabled SQL-access to the LTER Personnel Directory will be tested, again using a portion of the *Biblio Cluster* (Nottrott).

(7) X-Roots WEB Page: Develop an X-Roots Home Page with access to an X-Roots Glossary, a sample of the *Biblio Cluster* , and with links to preliminary lists of sources of data (root biomass, soils, climate, etc.) (task to be done by X-Roots Group @ UCD).

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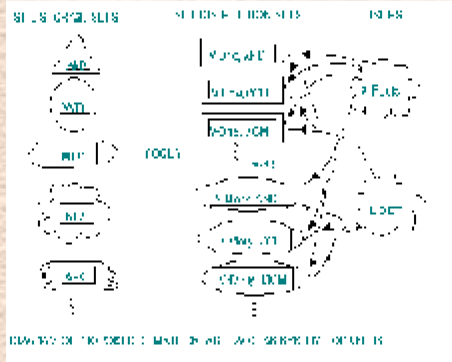
* Recommendations # 3, 4, and 5 are made to the LTER Data Managers' "Data Task" working group.

Figure. 1. Diagram of V-One and V-Many



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Major Workshop Topics

(A) Terminology

Workshop participants recognized the need for greater precision in terminology associated with data and information management topics. The X-Roots Group has initiated, for its use, a list of definitions which will be updated periodically; this list is available on the X-Roots Home Page (http://...........) and comments are welcome xroots@lternet.edu .These definitions, listed below, are used in this report.

Table 1. List of definitions used by X-Roots project.

data	quantitative, generally numerical or categorical, facts
information	qualitative, generally textual, descriptions and/or interpretations
variable	item of scientific interest, about which data and information are recorded
metadata	"data (and information) about data", which helps explain and/or qualify it
datafile	single, indivisible assemblage of data and information
dataset	group of closely associated datafiles, treated as a unit
database	organized and integrated collection of data and information on a topic
content	specific matter treated by data and information (e.g. climate variables of air temperature, precipitation, etc.)
format	format is the manner of organization of the data and information

In general, need for a glossary of many different types of terms was noted. Such a glossary should encompass not only broad semantics (as above), but also detailed terminology for the subject(s) at hand (discussed below, for climate particularly). As projects such as X-Roots and larger programs (the LTER Network) grow, a definitive language is increasingly important to clear, efficient communications.

(B) CLIMDES Project

The CLIMDES (CLIMate DESriptions) project, which is led by David Greenland, PI (U Oregon & AND site) has four goals: (1) to describe the climate and water budgets of 18 LTER sites; (2) to conduct a systematic time series analysis of temperature and precipitation records using the same methodology at all sites; (3) to compile projected climate change scenarios from a range of climate model experiments interpolated to LTER sites and regions and to discuss uncertainties associated with the projections; (4) to conduct a comparative climate analysis at all sites, including analyses of regional climates.

In support of its goals, CLIMDES undertook a compilation of LTER climate data for 18 sites for a nominal 30-year period ending in 1990. This work was performed by LTER graduate student Lynn Rosentrater, working with Greenland. CLIMDES data include air temperature (mean, mean min, mean max) and precipitation, primarily aggregated at the monthly time step, although some datasets include daily data as well. When the period of record at an LTER site was less than 30 years, data from nearby NOAA climate stations was typically substituted. Beyond its own analyses, CLIMDES intends to provide access to its LTER climate data via the Web in a standard format.

(C) Content and Format for Climate Datasets

Both content and format are important aspects of climate datasets. Content is increasingly being standardized across LTER sites, based on the Climate Committee's recommendations of "levels" of reporting for climate stations (see Appendix 1). Climate levels are described in detail in the Climate Committee's report (http://lternet.edu/im/climate/standard86.htm). Briefly, Level 1 is basic and expected of all LTER sites; there are 4 categories of statistical measurements : air temperature (° C, daily mean, daily mean max, daily mean min, monthly mean, monthly absolute max and min), precipitation (mm, daily total, monthly total), atmospheric moisture (R.H., daily mean, max, min, and monthly mean) and wind travel/wind speed (m/sec , daily mean and max and monthly mean). Level 2 has more variables : all the Level 1 variables plus 2 additional ones. Although not formally adopted by LTER, 2 additional variables are: wind direction (degrees from N), and global solar radiation (joules/cm^2). The variables for Level 3 and higher are not specified but might include specialized measurements such as UV-B, PAR, soil temperature, etc. on a project or site-specific basis (e.g. VEMAP, canopy microclimate data from the Harvard Forest tower).

Greenland stated that climate data are most frequently requested in the form of monthly statistics, followed by daily statistics. Data managers commented on the need for even shorter time steps (e.g. hydrologic modeling with 15 minute time steps!). On balance, workshop participants felt that the monthly time step was unnecessarily restrictive, and that daily data should suffice for most extra-site users. Thus a climate dataset standard needs to address both monthly and daily data.

Format of climate datasets varies widely across LTER sites based on site needs. Sites maintain data in a variety of database management systems (Oracle, FoxPro), statistical software packages (SAS), comma-delimited ASCII text files, etc. The same data often exist in multiple datasets and formats. However, for outside users, particularly researchers interested in multi-site data, it would be exceedingly valuable to have one (or a few) standard formats for dataset distribution. Distribution datasets are those intended for distribution to users outside LTER sites; these formats should be standardized for ease of use and inter-comparability. Distribution datasets and related metadata have also been called "export datasets" (see LTER Data Managers' Meeting Report for Fall 1994; gopher://lternet.washington.edu:70/11/newsletters/Reports/DMworkshops/1994. In the workshop we recommended two standard distribution datasets, referred to as V-One and V-Many (see Section D below).

Supporting both content and format requirements, a standard glossary of climate terms, methods, units, etc. should be developed, maintained, and made widely accessible to data users (e.g. via the LTERnet Web server). For example, it would be very useful to agree that "air temperature" data is always referred to by a specific code with the necessary modifiers, e.g. **MATMPM** for **M**onthly **A**ir **T**e**MP**erature **M**ean, **MATMPX** for **M**onthly **A**ir **T**e**MP**erature **M**a**X**imum, **MATMPI** for **M**onthly **A**ir **T**e**MP**erature **MI**nimum, etc. Along with this glossary, lists of standard measurements to be included at each "level" of reporting (see Appendix 1) should be specified; and each measurement variable should be assigned a standard abbreviation or code. Also, a system of "flags" should be adopted to indicate data completeness, quality control, etc. The glossary and associated lists should be updated regularly, as the Climate Committee deems appropriate.

(D) Distribution Dataset Formats: V-One and V-Many

Workshop participants agreed that LTER sites are frequently asked for climate data in one of two formats (see Table 2

& Figure 1). In the workshop, these climate datasets were identified simply as "type A" and "type B"; here we adopt the more meaningful names, V-One and V-Many. V-One is a slight modification of the format recommended by the LTER Climate Committee based on Level 1 content constrained by an 80 column telnet screen width. Basically, each V-One dataset is a separate file, representing a single variable (in this case climate attribute), with multiple lines in the file for successive years; each line presents twelve monthly measurements for the variable. Thus a minimum of four (Level 1) and up to six (Level 2) files are required for a useful complement of datasets from a single site. V-Many is a generalization of V-One to accommodate multiple variables in a dataset or file. This is accomplished by interposing an additional column for month (or, conceptually, even finer time scales), so that time is strictly vertically in the file. Variables are arrayed across each line. In this manner, a single file could represent many variables (4, Level 1; 8, Level 2, etc.) for a single site over an extended period of time.

Some users prefer V-One format because they are interested in monthly data which can, if necessary, easily be turned into yearly means; V-One is "spread-sheet friendly". Examples of V-One users include X-Roots, LIDET (Harmon et al.) , the Forest-Gap Modelers Group (Urban et al.). Other users request data in V-Many format because this data is readily imported into database programs and statistical software. V-Many is "database friendly". V-Many can also be easily queried using SQL and is easily scalable to daily or finer time steps.

Table 2. Characteristics of V-One and V-Many, with examples .

Data are taken from Davis CA (code assigned as DVS) for a particular climate station (code assigned as 003). There are 2 examples of V-One files, one for monthly mean air temperature for 3 years, a second for monthly precipitation for one year. There is one example of a V-Many file for 4 variables for part of one year.

V-One Characteristics:
*one variable
*rows = time (years), columns = time (months)
*easy to view
*has a spreadsheet "look and feel"
*difficult to aggregate yearly data
*easy to aggregate monthly data
*1-8 small files, each containing a single variable
*codes (site, climate station, variable name)

V-Many characteristics:
*many variables
*rows = time (years, then months), columns = variables
*many variables to view
*has more of a database "look and feel"
*easy to scale time steps from year to month to day
*more complex
*one (or several) larger files with many variables
*codes (site, climate station)

V-One

DVS 003 MATMPM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	45.0	50.0	53.0	58.0	64.4	70.9	74.5	73.4	70.6	63.2	53.0	45.7
1991	44.1	50.5	52.2	59.3	65.0	70.2	73.4	72.4	71.3	64.1	53.8	46.6
1992	46.8	49.0	51.6	55.4	63.4	72.3	76.7	75.4	69.6	62.3	52.2	44.8

DVS 003 MPRECIP

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	4.20	2.58	1.80	1.30	0.37	0.15	0.03	0.04	0.22	0.99	2.36	3.28

V-Many

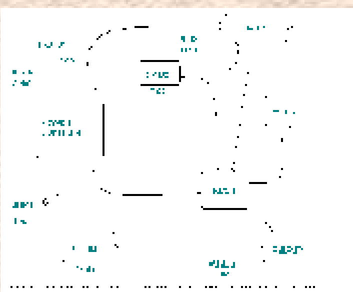
DVS 003

Year	Month	MATMPM	MATMPI	MATMPX	MPRECIP
1990	Jan	45.0	37.2	52.7	4.20
1990	Feb	50.0	40.3	59.6	2.58
1990	Mar	53.0	41.3	64.7	1.80
1990	Apr	58.0	44.4	71.5	1.30

(E) X-Roots Database Model

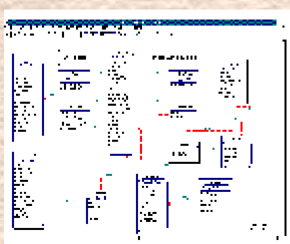
Over the past 18 months, the X-Roots "DataTeam" (Hastings lead, Coman, Hudson, Nottrott, Uthiram and Wagner) has developed an entity-relationship database model (Fig. 2) and explored mechanisms for distributed data access for the X-Roots project. The "EcoTeam" (Bledsoe lead, Hartshorn, Wilson) has interacted with the DataTeam throughout this process. Both teams learned new vocabulary and new ways of thinking during the process. **This interaction has been absolutely essential to the successful development of a model which meets the needs of both developers and users.** The somewhat "messy" evolution of this model was reviewed at the workshop, culminating in its present model as three main "clusters" (groups of tightly-related tables): *Biblio Cluster* , *Catalog Cluster,* and *Measure Cluster*.

Figure 2. Simplified diagram of X-Roots model, showing 3 Clusters with related tables.



The main purpose of this model is to categorize and structure the wide variety of data and information required by the X-Roots project with sufficient detail to allow information technologists to build what root biologists actually need to study controls on below-ground productivity as measured by root biomass. A secondary purpose is to permit manipulation of these varied data on an ad hoc basis in workshop settings. Since the model is being developed with resources from several sources (X-Roots, Cal-EPA, LTER, etc.), the model has "generic" aspects to allow its use by diverse groups. This "generic" aspect has added considerably to the development time, but the resulting model should be much more robust and complex (Fig. 3).

Figure 3. Preliminary diagram of X-Roots model developed using X- Case commercial software.



The first cluster developed by X-Roots, hence the most advanced at present, is the "Biblio Cluster", which contains three main types of bibliographic information. The CITATION table records essential facts about citations from scientific literature: authors, title, abstract, etc. The CONTACT table contains information about people and/or organizations, both generally and as involved with citations specifically, i.e. as authors, editors, contributors, etc. The KEYWORD table (actually a complex of tables) provides ways of indexing and referencing citations via a hierarchy of key words and phrases. All three tables are interlinked via many-to-many relationships. Although the *" Biblio Cluster "* is implemented as a Visual-Fox application, it was first developed in MS Access software by Siva Uthiram, an LTER summer intern working with Bledsoe and Hastings (Figure 4). Currently, X-Roots is using the Visual Fox application for its bibliographic data entry (Figure 5). A future test of *Biblio Cluster* will be to link two current LTERnet databases, the All Site Bibliography and the Personnel Directory (essentially linking the CITATION and CONTACT tables, although more complex in execution).

Figure 4. Initial development of Biblio Cluster , a Microsoft Access software application.

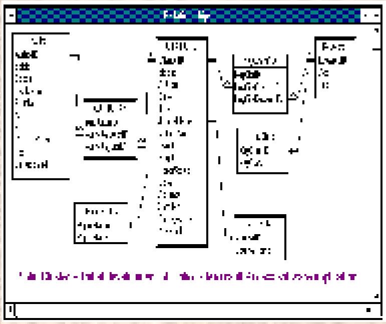
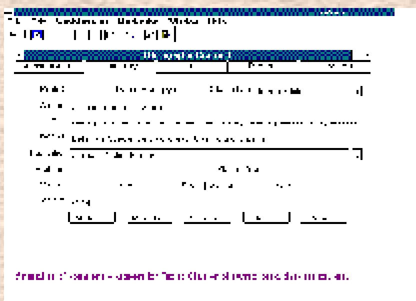


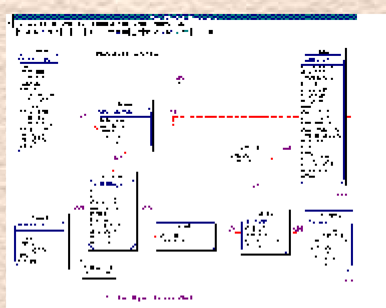
Figure 5. Snapshot of data entry screen for Biblio Cluster, showing tabs, data fields, etc.



The second cluster is the *"Catalog Cluster"* which has only been outlined at present; a prototype is planned for late Summer 1996. This cluster is designed to track original data which is contained in datasets and to relate these DATASETS to CITATIONS and PERSONS. In many cases, machine-readable datasets are **not** available and the only way to obtain root biomass data has been to find citations to published articles, then to "mine" published journal articles for data.

The third cluster, under active development at present, is the *Measure Cluster* (Fig. 6). At the workshop, Hastings demonstrated a prototype of this cluster, adapted specifically to climate data (Figure.7) for the first X-Roots Agroecosystem workshop. The central feature of the *Measure Cluster* is a dual table structure: RECORD and MEASURE (hence the name). Each RECORD entry tabulates the occurrence of "real data" taken from a CITATION or DATASET; MEASURE contains the (set of) data value(s) themselves. RECORD is directly linked to LOCATION and CONTACT, identifying where the data apply, and who reported it. A timestamp, showing *when* the data apply, is also carried in RECORD. MEASURE is linked to ATTRIBUTE and METHOD, detailing what was measured, and *how* . Thus the metadata about each measurement -- who, what, where, when, and how -- are explicitly recorded in database tables.

Figure 6. Measure Cluster -- Preliminary diagram showing relationships among metadata and measurements.



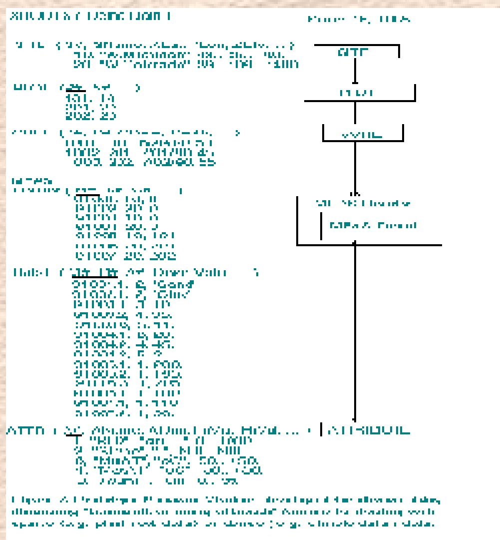
Each row in the MEASURE table represents a single datum. Further, each row in MEASURE has a corresponding row in RECORD, so in the nominal case, two database rows are required to entable each measurement. Some economy can be obtained when measurements are made in parallel at a single point in space and time, and reported by a single person or group, as is common for climate. In this case, multiple MEASURE "detail" rows are linked to a common RECORD "master" row. Nonetheless, the definitive structure of the *Measure Cluster* is a long, thin cord of interlinked

MEASURE and RECORD rows, growing rapidly as the database is built. (This structure is colloquially known as the "beanstalk" or "string of beads"). By contrast, the ATTRIBUTE, CONTACT, LOCATION and METHOD tables are short, squat and relatively static. These tables encode the "standards" chosen for site locations, variable names, etc. (c.f. topic A above).

The "beanstalk" structure is not intuitive, nor directly amenable to the types of analysis which are common in scientific research. However, because it can be efficiently queried and "dumped" into an endless variety of spreadsheets, it is cogent and useful. Conversely, the beanstalk can also be easily "loaded" from spreadsheets, such as V-One and V-Many. Thus, the *Measure Cluster* database is one mechanism by which climate datasets from different sites, with different contents and formats, can be assimilated and subsequently transformed into standard distribution datasets, for FTP or Web access.

At the workshop participants successfully imported climate data from various sites and formats and began loading them into a prototype *Measure Cluster* (Figure 7). The X-Roots DataTeam will work with Greenland, Porter and Henshaw to refine this prototype and test it on additional climate data.

Figure 7. Prototype Measure Cluster developed for climate data, illustrating beanstalk or string of beads feature for dealing with sparse (e.g. plant root data) or dense (e.g. climate data) data.



With data modeling now "essentially complete", and several prototype implementations of various aspects of the total X-Roots database made, construction of a permanent database in Visual FoxPro software has begun. Altogether over 25 tables will be involved, including numerous tables to link among many diverse types of data and extensive metadata. This has been a large undertaking , however, we are making substantial progress. A working version of the X-Roots database with all three clusters will be implemented by Fall 1996, a more complete version by early 1997. X-Roots and derivative databases will be used in two X-Roots workshops (Grasslands, Winter 1997; Forests, Winter 1998) and by other projects (e.g. the SOLA [Science On-Line Antarctica] workshop, September 1996 ; an ecotoxicological database project for California EPA, also September 1996). Beyond database design, implementation, and loading, a great deal of work remains to be done on various analysis and display functions needed for the X-Roots workshops. To date, the X-Roots development effort has focused on database issues, not on output datasets and their ancillary manipulation and graphics issues. Output issues will be undertaken during Summer and Fall 1996.

(F) Access to Current LTER Climate Datasets:

Prior to the workshop, we explored access to climate data from both LTER and other sites. For LTER sites, Nottrott downloaded some on-line climate data from KNZ and KBS sites. The data were readily available but nonstandard formats, codes and meaning of terms made the task more difficult than expected. For other sites, we located data in the literature on root biomass, then attempted to find climate data for these sites. For example, we obtained corn root data from a California site, then contacted the experiment station for weather data. We also explored several CD-ROMs of climate data, but found that the data were not organized so that we could easily find specific sites. The LTER network also has experienced these sorts of impediments to effective data sharing and integration.

At the workshop, participants supplied climate data. Greenland brought a subset of CLIMDES data for SGS, MCM, AND, KNZ and VCR, Henshaw brought AND data (and LIDET data), Porter brought VCR data, Hastings brought MCM data, and Nottrott acquired KNZ data. Climate data was stored in different formats -- e.g. AND climate data in FoxPro-for-Windows, KNZ and MCM data in ASCII, VCR data in SAS. Working with the X-Roots DataTeam, all these datasets were exported to ASCII files and then loaded into an X-Roots prototype database. Acquiring the measurement data was relatively straightforward; capturing the associated metadata was more complicated, and begged the questions of standard terminology (cf. Section A above). These metadata issues could not be resolved at the workshop.

(G) Distribution Experiments

At the end of the workshop, we discussed our desires for implementation of distribution datasets which can be queried from a central database, specifically the X-Roots database (a Visual Fox application which supports SQL queries to sites which have SQL servers for their datasets). Three follow-on experiments were discussed. ONE: A few sites could try updating the CLIMDES dataset assembled by David Greenland. TWO: Some tables from the All Site Bibliography could be moved to a few sites, then an SQL query could try access to all the tables (the centralized tables at LTERNET as well as a few distributed tables at sites with SQL servers). THREE: climate datasets for a few sites could be reformatted as V-One and V-Many and, subsequently tested access on the Web. Various workshop participants are interested in these experiments. We also hope other LTER data persons may join these experiments; contact Nottrott, Hastings or Bledsoe if interested.

APPENDICES

1. Climate Glossary

Climate Glossary (or dictionary, to be developed; LTER's Climate Committee would be a logical group), then placed on LTERNET's Home Page)

1.1 Codes for Site Names and Climate Station Names

Codes for Site Names and Climate Station Names (To be elaborated ......)

1.2 Data Dictionary:

```
LEVEL ONE,   VARIABLE NAMES AND DEFINITIONS:  (To be elaborated.....)
The following variable names will be used for the following defined variables:
          .........Mean monthly minimum air temperature. This is the average of the minimum
temperature
of all of the individual days of the month.
          .........Mean monthly maximum air temperature. This is the average of the maximum
temperature
of all of the individual days of the month.
          .........Mean monthly air temperature. This is the average of all the daily mean
temperatures of
the month. The mean temperature of the day is calculated from ( MATMPI+MATMPX)/2 except for those
LTER sites which record continuous or semi continuous records in which case MATMPM is calculated
as
the mean of 24 hourly records of temperature - the records being taken on the hour.
          .........Total precipitation recorded for the month.
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        .........Atmospheric moisture
        .........Wind travel/wind speed

LEVEL TWO,   VARIABLE NAMES:  The following variable names will be used for the following
defined variables:  (to be elaborated.....).
        ......wind direction
        .....global solar radiation

LEVEL THREE,   VARIABLE NAMES: Although variables are not defined for Level 3 and beyond, if
the following optional variables are chosen, we recommend the following codes:  .....(to be
elaborated...)

UNITS AND METHODS:  Temperature measurements are in deg C,  precip is in mm. Measurement
methods follow those outlined in the Climate Committee Met Observations Standards Document
(which,
in turn, follow pretty closely the protocol of U.S. Cooperative Weather Observers). The LTER
Climate
Committee Standards document can be found at  http://LTERnet.edu/im/climate/standard86.htm.
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1.3 Data Quality Codes:

Data Quality Codes (to be elaborated, the following is a draft.)

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Each data entry should  be accompanied by a data quality code. The following codes are based, in
part, on
the suggestions of Lloyd Swift (CWT) and, in part, on the practice of some State Climatologists.
        Q       Questionable data
        E       Estimated value
        9999    Missing data
                          __      A two digit field indicating the number of days missing of
missing
data in the monthly computation. Normally we would take 25 days of data as the minimum number
needed before the whole month becomes missing.  Codes are  needed for incomplete data (......)
and  T for
trace of precipitation.
        .....   to be continued.......
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2. Agenda for X-Roots / LTER Climate Mini-Workshop and List of Participants

X-Roots / LTER Climate Mini-Workshop, UC Davis, May 16-17, 1996
Co-Leaders: Caroline Bledsoe, Jordan Hastings, Rudolf Nottrott

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PARTICIPANTS
LTERClimate & DataMgers:        David Greenland, Don Henshaw, John Porter
XRoots EcoTeam:                 Caroline Bledsoe, Machelle Wilson, Tony Hartshorn
XRoots DatabaseTeam:            Jordan Hastings, Harvey Chinn, Rob Coman, David Hudson,
                                Rudolf Nottrott, Siva Uthiram, John Wagner
XRoots Advisors:                Jim Quinn, Mike McCoy
Guests:                         Julie Yamamoto, CAL EPA

MEETING LOCATIONS                         Thurs           Fri
Conference Room (145 Hoagland)          8:30-12         3-5 pm
Computer Lab (120 Veihmeyer)            1-5 pm          8:30-3 pm

LOGISTICS SCHEDULE
WED             Arrivals (Nottrott noon, Henshaw 1pm, Porter 4pm), informal dinner in Davis
THURS           Arrivals (Hastings,Uthiram 9am, Greenland 10am)
                Meetings 8:30-5, dinner/BBQ at Bledsoes' walnut orchard
FRI             Meetings 8:30-5 depart(Henshaw 5pm;Greenland 7pm;Hastings,Uthiram 6pm)
SAT             departures (Porter 10:30am, Nottrot 11:20am)
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AGENDA

Thursday May 16
8:30-9:45       Introductions/Overview of XRoots
                1. X-Roots: the project, ecological aspects, interests in climate data - Bledsoe
(15')
                2. X-Roots: database aspects, design, progress - Hastings et al. (15')
                3. Brief statements by participants on their workshop interests & objectives
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                4. Experiments in sharing cross-site data == X-Roots + LTER + LIDET, Bledsoe
9:45-10:00      Break
10:00-11:00     Development of an LTER ASC = "All Site Climatography"?!!!
                MiniWorkshop Goals - Bledsoe/Hastings/Nottrott
                Climate data - a user's perspective -Nottrott/Bledsoe
11:00-11:50     Current status: meteorological databases
                1.  Greenland's current NSF Project for LTER Climate Data
                2.  CONTENT of climate data - Greenland
                3.  FORMAT of climate data - Hastings
12-1:15         Lunch @ UCD Pub at the Silo
1:30-2:30       Hands-on Demo: X-Roots "BIBLIO CLUSTER" as a model for metadata entry, storage,
                and maintenance (Visual Fox application- Hudson/Wagner/Hastings);
                15' on evolution, 30' test drive, 15' appraisal/recommendations
2:30-3:30       Hands-on Demo: X-Roots  " MEASURE CLUSTER"  as a model for storing both sparse
                (roots, soils) and dense (climate) data.  The "beanstalk" and the "Buddha"
database
                models. Speeding input of data mined from a citation into a database and then
analyzing
                that data (dBIII appln-Hastings/Wagner/Hudson);
                15' on evolution, 30' test drive, 15' appraisal/recommendations
3:30-3:45       Break
3:45-5:00       Hands-on Demo:   Importing Climate Data into the Xroots Data Structure
                Case Study 1: McMurdo Antarctic Dry Valley LTER - Hastings

Friday May 17

8:30-9:00       Discussion of Thursday's activities/Agenda revision?
9:00-10:45      Hands-on Workshop:   Importing Climate Data into the Xroots Data Structure
                Case Study 2:   Andrews Old Growth Forest LTER in OR - Henshaw
                Case Study 3:   Virginia Coast Barrier Islands LTER in VA - Porter
                Case Study 4:   Konza Tall Grass Prairie LTER in KS - Nottrott
                Case Study 5:   MUIR and NSCD Soils Data on CDROM - Hartshorn
                Case Study 6:   Assembled Root Data - Wilson
                Case Study 7:   Assembled Climate Data - Greenland
10:45-11:00     Break
11:00-12:00     Discussion of next steps in cross-site comparisons (Greenland, discussion leader)
                Content - what are the key variables? Are these readily available?
                Formats - can a loader overcome incompatible formats?
                Anticipated uses of data in synthesis and modeling
12:00-1:00      Pizza in the computer lab (no dripping on the keyboard !!)
1:00-3:00       Hands-on Workshop, continued:
                Populating and tweaking root, soils, decomposition, and climate data entry and
exit
                Facets of the prototype
                XRoots/XClimate database
                Queries and Foxfire report generation - Coman
                Excel graphical analysis and output - Uthiram, Wilson, and Hartshorn
                Informal survey of output option wish-list
3:00-5:00       Workshop Wrap-up & Adjournment
                Synthesis & workshop products
                Working schedule and next steps
                Review & sign-off of draft report outline for LTER Data Mgrs.
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