The Management of Electronically Collected Data within the Long-Term Ecological Research (LTER) Program - 1994

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An Update to the 1991 - 1993 Surveys

This report is meant to complement and update the original (1991) version and the 1992-93 updates, rather than supersede them. The objective is to point out differences in the observations and conclusions of the previous reports and, as a consequence, important points in those earlier documents will not necessarily be repeated here. It should be noted that although the cover of the original report indicated that the survey had been conducted in January 1992, the survey was actually conducted in the autumn of 1991.

Sources

The information used to construct the updated tables came from a variety of sources. The sources and their approximate timing were:

AND manual modification of hardcopy tables from 1993 update provided by Don Henshaw, 25 September 1994

CPR email message from Tom Kirchner, 3 November 1994

HBR email message from Cindy Veen, 3 November 1994

JRN email message from Barbara Nolen, 3 November 1994

KNZ email message from John Briggs, 8 November 1994

NTL manual modification of hard-copy tables from 1993 update provided by Barbara Benson, 25 September 1994

NWT manual modification of hard-copy tables from 1993 update provided by Tim Bardsley, Nel Caine, Don Cline, Brad Lewis, and Mark Losleben, 25 September 1994

PAL email message from Karen Baker, 4 November 1994

SEV manual modification of hard-copy tables from 1993 update provided by Doug Moore, 25 September 1994

VCR email message from Dave Krovetz, 20 September 1994; manual modification of hardcopy tables from 1993 update provided by Dave Krovetz, 25 September 1994

The responses from CPR and HBR indicated that there had been no changes since the previous update (1993).

The NIN site is no longer LTER, and entries for it were removed from the tables.

Caveats

In general, the qualifications and warnings appearing in this section of the original report apply here as well. Moreover, the fact that a particular variable is not measured electronically should not be construed as an indication that the variable is not measured. The electronic collection of data at a LTER site as reported here does not necessarily imply that those operations are supported wholly or in part by the LTER program. The meteorological station at CDR, for example, is operated by the University of Minnesota Experimental Station.

Most importantly, the information contained herein is based on my interpretation of the material that was provided to me and individuals at the sites were not given the opportunity to comment on those interpretations. Nevertheless, the primary purpose of this document is to provide a general reference for the site data managers and appropriate technical support personnel. The ultimate sources for detailed and truly up-to-date information are the contact people at the sites.

In addition, not all sites have responded to the survey each year and so the entries for some sites are more up-to-date than others. Specifically, no additional information has been provided for ARC, CWT, & LUQ since 1991, BNZ & CDR since 1992, and HFR & KBS since 1993.

Given that many of the hardware and software tools mentioned will eventually become obsolete, I have deleted entries from the appropriate tables if the source of the updated information indicated that a particular tool is no longer used. Such information will still be available in

older versions of the tables and this sort of periodic "house-cleaning" will help to keep the tables from becoming too unwieldy in the future. No entries were deleted from Table 9 (problems), however, because I believe this information is more useful as a quick reference if it reflects both past and present experiences. Obviously, if an individual site resolved all of its problems, it would be a most useful resource - something that wouldn't be apparent from a table in which past problems had been deleted!

Summary

Hereafter, all references should be understood to mean electronic collection and/or management of data. All tables follow the text and are organized so that the most universal variables or items are presented near the top of the table.

Variables

Climatological variables continued to be those most commonly measured by electronic means (Table 1). Air temperature, wind speed, and wind direction were monitored at all 17 of the sites included in the survey. Relative humidity was measured at all but one of the sites. Solar radiation, precipitation, and soil temperature were measured by at least 75% of the surveyed sites. Soil moisture and light were recorded by at least half of the sites. Recent additions to the list of variables being measured electronically are soil heat flux, snow temperature, snow depth, and snowmelt. Electronic technology continues to be the major tool used to collect climatological and micrometeorological data within LTER.

Hardware

Data loggers manufactured by Campbell Scientific Instruments (CSI) continued to be the most commonly used loggers within LTER (Table 2). Versions of these instruments were being used at 14 of the 17 sites, with the CR21X and CR10 microloggers being the most popular models.

The LTER program has acquired a great deal of experience with the various hardware options available for electronic data collection (Tables 3 through 8). CSI probes and/or CSI thermistors were employed by 14 of the sites (Table 3). Bill Bland (NTL) indicated that CSI 207 and HMP35C were enormously different probes. More specifically, the CSI HMP35C is a Vaisalla modified to include a 107 thermistor. Barbara Nolen (JRN) noted that many thermocouples include copper-constantin wires.

CSI Met-One wind speed and wind direction sensors were used by 10 of the sites (Table 4). Li-Cor radiometers were being used at 12 of the sites.

A wide variety of models and manufacturers were involved in electronic collection of precipitation, water depth, snowmelt, and soil/snow moisture data. Dave Krovetz (VCR) provided the following comment regarding water depth measurements:

"We are now using a lot of the Onset Dataloggers called HOBOs,which we modified to use as water level recorders. These are 2K (up to 32K now) self contained single channel loggers, running on an internal battery. We use them to log the pressure in an enclosed body of air in a vertical pipe in our wells. As water level rises, the pressure does too, etc. Equate pressure changes with level changes and get a water level time series. Costs about $225 - about 30 in the field now - everybody happy so far, John [Porter] and I await a "formal data set" from the summer's work. (Onset Computer Company, 536 MacArthur Blvd, Pocasset, MA 02559-3450, 508-563-9000 (contact: Scott Ellis))"

Time domain reflectometry (TDR) continued to be the up-and-coming technology for soil (and now snow) moisture measurements, given that 5 sites have acquired this capability; only 1 site reported use of TDR in 1991. Nine and 7 sites used CSI data storage modules and radiation shields, respectively (Table 8).

Problems and Solutions

It continues to be evident that the vast majority of problems and difficulties experienced at a particular site are experienced by a number of other sites, although some site-specific problems were apparent as well (Table 9). More than 2/3 of the surveyed sites have experienced (or have taken action to minimize) deterioration of equipment and sensors, deleterious effects of extreme temperatures, power reductions and losses, impacts from animals and insects, and human errors. More than 1/2 have reported problems associated with deleterious effects of condensation and moisture penetration, as well as dirty sensors. Approximately 1/2 of the sites have reported problems associated with measurement of relative humidity, reading of magnetic tapes, wind speed sensor bearing failure, and broken/cut wiring. Approximately 1/3 have reported communication problems, exceeding of data storage capacity, poor contacts/shorts/fused switches, and software/programming problems.

Tim Bardsley (NWT) provided a diagram of a modified TDR probe design that eliminated some problems of previously used probes. This involved housing the actual probes within stainless steel or aluminum rods (~3/32-in diameter, threaded at upper end, pointed at lower). A hard, insulated block is glued in place at the upper end with the centrally located probe threaded in. The probe itself is soldered to a male BNC connector that has been threaded into a circular ~ 1.5-in diameter, 1-in thick circular aluminum block on the upper portion of the housing. The external wiring consists of a coaxial cable with the copper center soldered to the connection

unit of a female BNC connector. It is important that a good connection is made between the aluminum sheath and the BNC connector.

Brad Lewis (NWT) reported that problems interfacing MRC (Measurement Research Corporation) temperature probes with CSI data loggers were resolved by modification of both hardware (manufacturing an electronic circuit) and software. Campbell Scientific Instruments was very cooperative during the resolution of this problem.

Karen Baker (PAL) listed the following problems (solutions in parentheses): data transmission problems (cycle redundancy checks), connectors dislodged by elephant seals (repositioned battery), deterioration of wind vanes/anemometers (replacement), frosting of radiometers (ventilator blowing air), magnetic tape jam (upgraded RS232 line to PC), and battery failure (real-time display of battery power).

Doug Moore (SEV) provided the following comments: "We have worked out a program and altered wiring so that the Campbell DC111 modems do not answer incoming calls on the first ring as they are defaulted to do. This is important where a single telephone line is used for both downloading data and voice communications. Any number of rings can be programmed in before the modem will be allowed to answer. The only catch with this setup is that if the program is lost on the datalogger it is not possible to contact that datalogger until the program is restored. A second catch is that it may be necessary to call ahead to warn persons answering the phone that a call to the datalogger will be coming in. We have a station where this is the case during the summer but during the winter the location is deserted.

"We are now able to directly access our field dataloggers from the UNM campus over X-terminals (DEC or Sun) using a software package called DesqView which allows us to bring up the Campbell Term and Telcom windows from the PC at the Sevilleta field station which is collecting the data from the field via telephone or radio communications. This was not as straightforward as we had envisioned it. Neither Campbell nor DesqView were very helpful in helping us resolve the software incompatibility that popped up. Greg Shore had to expend a considerable amount of time to overcome this incompatibility."

It should be noted that the initial report did list some solutions to common problems and the original survey responses contained additional information.

Storage, Transfer, and Archival

Twelve of the 17 sites listed internal memory/solid state/RAM as being used for field storage of electronically collected data (Table 10). Data storage packs or modules were used by nearly 50% of the sites. Twelve of the 17 sites use magnetic tape and/or solid state technologies for transfer of data from the field site to the laboratory.

Sixteen of the 17 sites listed more than one storage medium for electronically collected data (Table 11). All of the sites reported computer hard disk, floppy diskette, and/or magnetic tape as being storage media. Optical devices again appeared to be the "rising star" for data storage - 1/3 of the sites use optical media for storage.

Nearly half of the sites archive/store data in more than a single format, with ASCII being used at 14 of the sites.

Quality Assurance/Quality Control (QA/QC)

The vast majority of sites used either redundant measurement systems or inspection of equipment and data (or both) as field QA/QC tools (Table 12). A variety of custom and commercial software or programs were used in the laboratory for additional quality control of the electronically collected data. In general, such software performed range/mean checks, outlier searches, and/or flagged data. All but 3 of the sites reported visual inspection of data (e.g., in graphical format) as being a component in their quality control programs.

Contact and Source Personnel

The following list is based on the responses for the current year only. It includes the names of respondents. It should be considered incomplete since not all respondents provided information on sources.

AND Don Henshaw

CPR Tom Kirchner

HBR Cindy Veen

JRN Barbara Nolen

KNZ John M. Briggs

NTL Barbara Benson, Tim Kratz, Bill Bland

NWT Tim Bardsley, Nel Caine, Don Cline, Rick Ingersoll, Brad Lewis, Mark Losleben

PAL Karen Baker, Chuck Stearns, Anthony Amos

SEV Douglas Moore

VCR Dave Krovetz

Conclusions and Recommendations

The comments found in this section of the original report and the updates are, for the most part, still valid. It is suggested that the data managers at each of the sites keep their copies of this and future updates with the original report and survey responses. One solution is to keep these in a 3-ring binder that also contains the various items comprising the LTER Data Management History and Reference File.