Climate Monitoring Guide

Data acquisition, storage, and infrastructure

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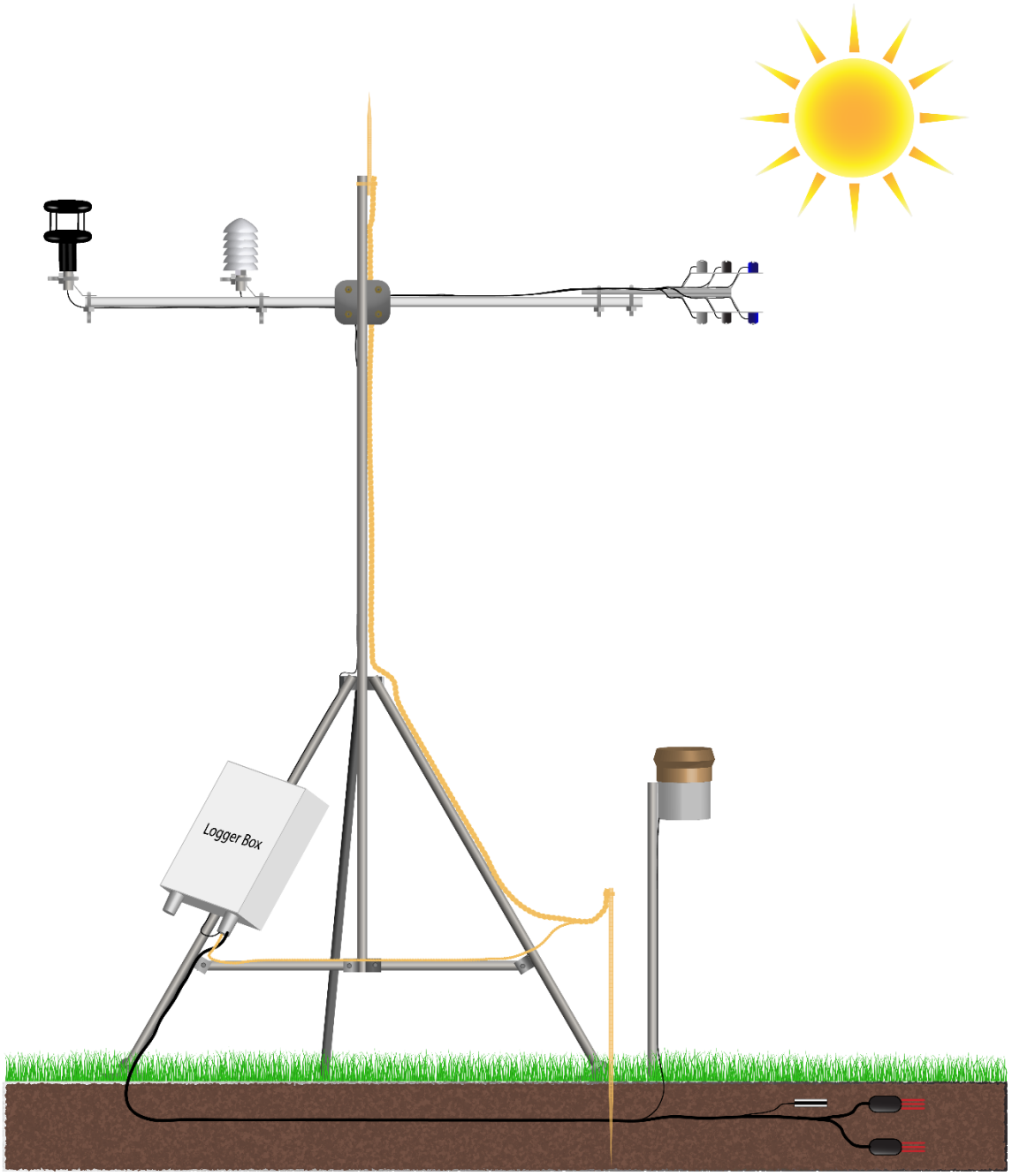

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1.1 Introduction

The goal of this chapter is to discuss climate station data access, acquisition and storage for climate stations.

1.2 Data access/acquisition

As discussed briefly in **ICBCM_Climate_Station_2_Design.pdf** climate station data access will impact:

- Sensor and datalogger troubleshooting capability
- Data quality assurance and quality control
- Data loss

Choice of data-access strategies (on-site and/or remote access) should depend on:

- Site accessibility
- Staff availability
- Reporting requirements
- Data-loss thresholds

Example #1: If a climate station is located near a community office where project staff can regularly visit the climate station without the use of vehicle, **remote data access is not necessarily required**.

Example #2: If a climate station is located in a remote location and staff are not regularly available to visit the climate station, **remote access is required** (e.g., radio, cellular modem, satellite, WIFI).

Example #3: If a climate station located within a community where project staff can regularly visit the climate station with the use of a vehicle, **remote access should be considered** (e.g., WIFI booster)

1.2.1 On-site data access

On-site climate data storage serves as a temporary data storage location between site visits, which allows for data to be accessed and collected in-person by project staff using 1) a physical connection (e.g., USB cable, ethernet cable) between the project laptop and the site datalogger or 2) a data card swap, where the data-filled card (card A) is swapped for the empty data card (card B).

Common on-site data storage devices include:

- Datalogger internal memory – Low capacity (~4 MB)
- SD cards – Medium capacity (2 GB)
- microSD cards – High Capacity (32 – 256 GB)

1.2.2 Remote data access

On-site data storage and access (via site-visits) is mandatory, but remote data access is not. All climate monitoring projects should consider investing in remote data access, whenever possible, in order to perform daily data downloads and data checks because it:

- Permits quick data quality assurance and quality (QA/QC)
- Reduces, but does not eliminate, cost associated with site-visit (e.g., time, fuel, lodging)
- Reduces data-loss.

There are many remote data access solutions available for climate projects (Table 1).

Table 1. On-site and off-site data access solutions.

Onsite data access	Examples	Capacity and range capability
Internal datalogger memory	https://www.campbellsci.com/cr1000x	Low capacity (4 MB)
SD cards	https://www.digikey.ca/en/products/filter/memory-cards-modules/501?FV=-5|32440	Medium capacity (2 GB)
microSD cards	https://www.digikey.ca/en/products/filter/memory-cards-modules/501?FV=-5|15160	High Capacity (32 – 256 GB)
Remote data access		
WIFI	https://www.campbellsci.ca/cr6	~0.5 km
WIFI booster	https://www.ui.com/airmax/nanostation-ac/	~10 km
Radio	https://www.campbellsci.ca/narrow-band-uhf-vhf-radios	~40 km
Satellite	https://www.campbellsci.ca/tx325	Global
Cellular modem	https://www.campbellsci.ca/cellular-communications	Provide coverage
LoRaWAN	https://lora-alliance.org/	2 – 15 km

1.3 Data storage protocols and infrastructure

1.3.1 Data storage protocols

A common data storage/protection strategy is called the 3-2-1 rule, which goes as follow:

- Store three (3) copies of your data.
- Store two (2) copies of your data on different storage media (e.g., Blue-ray, SD card, DVD disk, microSD card, external hard-drive, internal hard-drive).
- Store one (1) copy in a location separate from the other two copies.

An example of the equipment and workflow necessary to satisfy the 3-2-1 rule is described in Scenario #1 (Table 2).

Scenario#1

Table 2. List of staff and equipment recommended for data acquisition and storage.

Equipment and staff	
Team member A	High quality personnel
Laptop	Copy 1
Card-reader	Data transfer
microSD card #1 (office #1)	Temporary data storage
microSD card #2 (office #2)	Temporary data storage
NAS #1	Copy 2
NAS#2	Copy 3

1. The datalogger has microSD card storage capability
2. On-site data is stored on a microSD card #1
3. Team member A performs a site-visits with a laptop and card-reader weekly.
4. Team member A safely removes microSD card #1 and transferred data to the laptop hard-drive
5. Team member A safely inserts microSD card #2
6. microSD card #1 and the project laptop are taken to the project office.
7. Data is transferred to NAS #1 (office #1)
8. Data is transferred to NAS #2 (office #2)

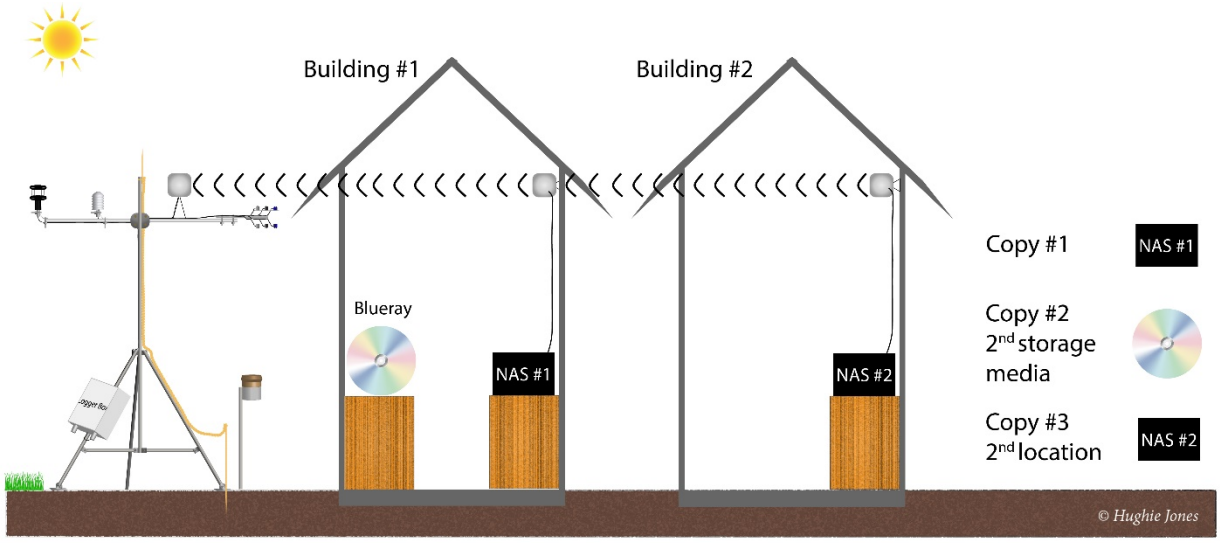

Fig. 1. Illustration of the 3-2-1 data protection rule. The illustration shows how data exists as 3 copies (NAS#1, NAS#2 and Blu-ray), where 2 copies are on different storage media (NAS and Blueray) and 1 copy is in a separate location (in building #2).

1.3.2 Data storage infrastructure

Device attached storage (DAS) devices and Network attached storage (NAS) devices are user-friendly and cost-effective solutions for storing and securing large volumes of project data (e.g., photographs, video, audio recordings, documents, climate data). In general, DAS devices are used by individuals to store data and NAS devices are beneficial for team collaboration.

Some advantages and disadvantages of NAS devices are listed in Table 3 and key components of NAS devices are listed in Table 4.

Table 3. Advantages and disadvantages in using network attached storage (NAS) devices for data storage.

Advantages	Disadvantages
Easy to setup and operate	Uses Linux operating and file system, which limits software accessibility
Centralizes files for easy collaboration	Centralized files are susceptible to human error and natural disaster (e.g., fire, flood)
Accessible from remote locations (internet)	Requires intermediate knowledge of computer systems
Compact in size	Network dependant
Affordable	Data transfer speed can be slow

Capable of cloud backup (e.g., Google drive, Onedrive)	

Table 4. List of key network attached storage (NAS) components.

Component	Example
NAS computer box (CPU and RAM memory)	https://www.synology.com/en-us/products/DS420+#specs
Hard-drives	https://www.seagate.com/ca/en/internal-hard-drives/hdd/ironwolf/
Ethernet cables (CAT5e or CAT6)	https://www.digikey.ca/en/product-highlight/b/bel-fuse/cat5e-and-cat6-ethernet-patch-cables?utm_adgroup=General&utm_source=google&utm_medium=cpc&utm_campaign=Dynamic%20Search_EN&utm_term=&productid=&gclid=CjwKCAjwnef6BRAgEiwAgv8mQbBdn4w72vp5_n0NnrUzmb6UbjF6nfm6XUzMFMv8cTCJACV-Bkd0qBoCxZoQAvD_BwE
Uninterrupted power supply	https://www.eaton.com/us/en-us/products/backup-power-ups-surge-it-power-distribution/backup-power-ups.html
Router	https://mikrotik.com/product/rb4011igs_rm