Earth Science Information Partners (ESIP) EnviroSensing Cluster

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EnviroSensing Cluster

Primary objective

Provide sensor network resources for environmental sensor practitioners through a wiki page and regular monthly teleconferences

Primary activities

- Building a sensor and sensor data management best practices guide through community participation
- Monthly teleconferences
- Ongoing maintenance of the ESIP EnviroSensing wiki page and sensor network resource links

Sensor and sensor data management best practices

- Living document
- An open source, community supported resource that implements the 'Wiki Process'
- Scope of best practices guide
  - Establishing and managing a fixed environmental sensor network
  - On or near surface point measurements
  - Long-term environmental data acquisition
  - It does not cover remotely sensed data (e.g., satellite imagery, aerial photography, etc.)

Monthly teleconferences

- Monthly discussion forum open to the broader community
- Enlists presentations from sensor research projects and sensor manufacturers and software developers

Research program presentations 2015:

- Monterey Bay Aquarium Research Institute
  - Research product: Smart Open Sensors Consortium
  - http://www.mbari.org/
- Desert Research Institute
  - Research product: Acuity Data Portal
  - http://www.dri.edu/
- Heat Seek NYC
  - Research product: Heat Seek Temperature Nodes
  - http://heatseeknyc.com/

Sensor manufacturer / software developer presentations 2015:

- Aquatic Informatics
  - Software product: Aquarius
  - http://aquaticinformatics.com/
- Onset
  - Company products: HOBO Data loggers and HOBOware
  - http://www.onsetcomp.com/
- Kisters
  - Software product: WISKI system
  - http://www.kisters.net
- LI-COR
  - Company products: LI-COR instruments and Eddypro software
  - http://www.licor.com/

Sensor and Sensor Data Management Best Practices

http://wiki.esipfed.org/index.php/EnviroSensing_Cluster

Sensor, site, and platform selection

- Selection of sites, science platforms and support systems are interacting planning processes
  - Communication among PI's, techs, and information managers
- Data quality and longevity is ultimate goal
  - Robust and widely-used core systems and sensors
  - Standardize sensor and support hardware, software, designs
- Optimal siting for science objectives can be impeded
  - land ownership/permitting, seasonal weather patterns, logistical access, availability of services (e.g., power sources, communications), operating budget

Data acquisition and transmission

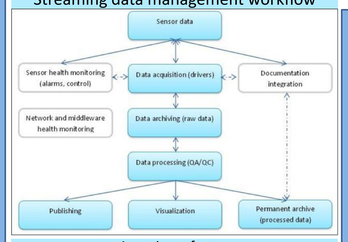
- Manual downloads of sensor data
  - May not be sufficient to assure data security
  - Does not allow direct control of devices
- Remote data acquisition considerations:
  - Collection frequency and need for immediate access
  - Uni- versus bi-directional transmission methods
  - Bandwidth requirements to transfer the data
  - Line-of-site communication or repeaters
  - Hardware and network protocols
  - Power consumption of the system components
  - Physical and network security requirements
  - Reliability and redundancy
  - Expertise
  - Budget

Sensor management, tracking, and documentation

- Documentation of field procedures and protocols:
  - Site visits, sensor tracking, calibration and maintenance activities, datalogger programs
- Sensor event tracking
  - Sensor event histories are essential for internal review of data, e.g., sensor failures, disturbances, method changes
- Integration of sensor documentation with the data
  - Associate data qualifier flag with each data value
  - Add a "methods_code" data column for easy user identification of methodology changes for a given sensor
- Communication between field and data personnel
  - Example field note database:

SiteID	Datalogger ID	SensorID	date time begin	date time end	category	notes	Note taker
					controlled vocabulary		

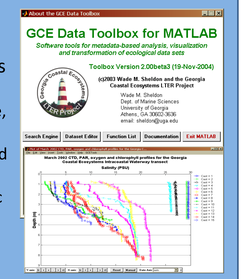
Streaming data management workflow

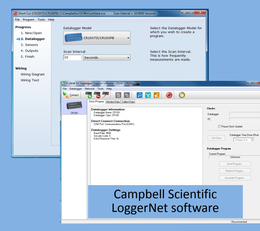


Aquarius software

Streaming data management middleware

- "Middleware" software packages and procedures
  - Enable communication and management of data between field sensors and a client such as a database, website or software application
  - Purposes include the collection, archival, analysis, and visualization of data
  - Middleware is often chained together into a scientific workflow to meet multiple functional requirements
  - Considerations:
    - Licensing, cost, interoperability of components
- Proprietary middleware / software
  - Campbell Scientific – LoggerNet
  - Aquatic Informatics – Aquarius
  - Vista Engineering – Vista Data Vision (VDV)
  - YSI – EcoNet
  - NexSens Technology – WQData Live
- Open source environments for middleware
  - GCE Data Toolbox (MATLAB required)
  - CUAHSI Hydrologic Information System (HIS)
  - DataTurbine Initiative





Sensor data quality assurance and quality control (QA/QC)

- Quality assurance – preventative measures
  - Routine calibration and maintenance
    - Anticipate common repairs and replacement parts
  - Design
    - Assure proper installation and protection
    - Sensor redundancy
  - Regular human inspection and evaluation of sensor network
    - Automated alerts; in situ webcams
- Quality control – checks in near real-time
  - Timestamp integrity (Date/time)
  - Range checks
  - Internal (plausibility) checks
  - Variance checks / Outlier detection
  - Persistence checks
  - Spatial checks / Correlations with nearby sensors

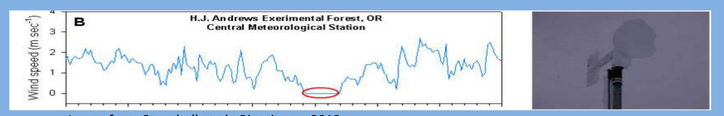
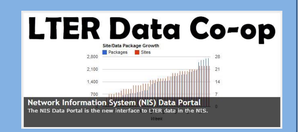


Image from Campbell et.al., Bioscience, 2013.

Sensor data archiving



- Archiving strategies
  - Create well documented data snapshots
  - Assign unique, persistent identifiers
  - Maintain data and metadata versioning
  - Store data in text-based formats
- Partner with cross-institution supported archives
  - Federated archive initiatives such as DataONE
  - Community supported, e.g., the LTER NIS
- Best practices
  - Develop an archival data management plan
  - Implement a sound data backup plan
  - Archive raw data (but they do not need to be online)
  - Make data publicly available
    - Assure appropriate QA/QC procedures are applied
  - Assign QC level to published data sets