Managing Sensor Infrastructure: A Sensor Extension for ODM2

Amber Spackman Jones, Jeffery S. Horsburgh, Juan Caraballo, Maurier Ramírez
Utah Water Research Laboratory, Utah State University

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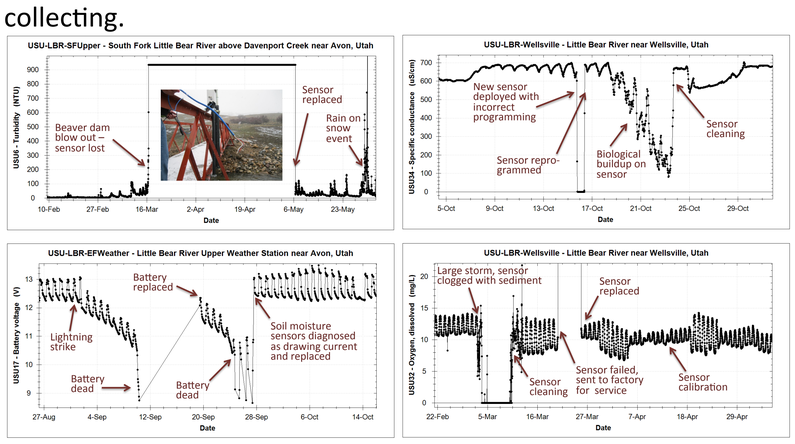
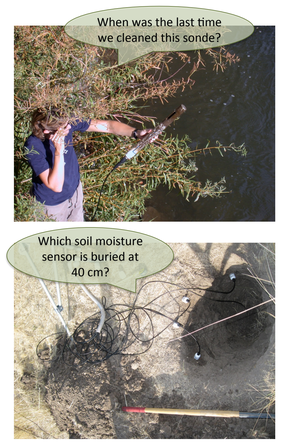
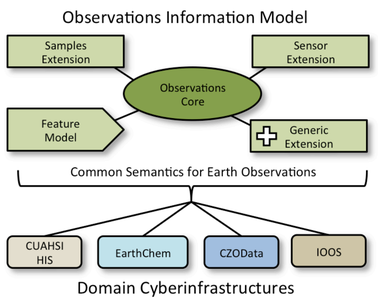
Background: The Observations Data Model (ODM) is a relational data model for storage and management of environmental observations data designed to capture consistent descriptions for unambiguous interpretation among users. ODM 1.1 was intended for publication of point-based hydrologic observations using the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) Hydrologic Information System (HIS). Because of its focus on data publication, ODM 1.1 does not provide all of the functionality needed to fully describe the data collection and management process for sensor and sample-based observations. We are working to develop a new version of ODM (ODM2) that better supports both management and publication of sensor and sample-based observations.

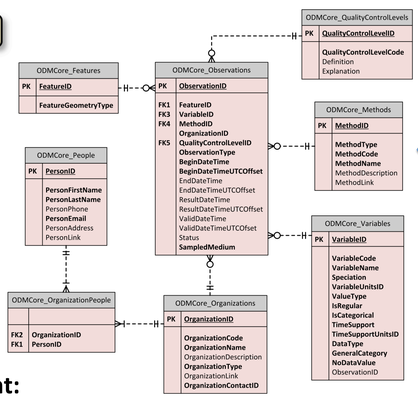
Motivation: Research sites conducting long term monitoring using *in situ* sensors need the functionality to track equipment, deployments, calibrations, and other events related to site maintenance and to link this information to the observational data that they are collecting.







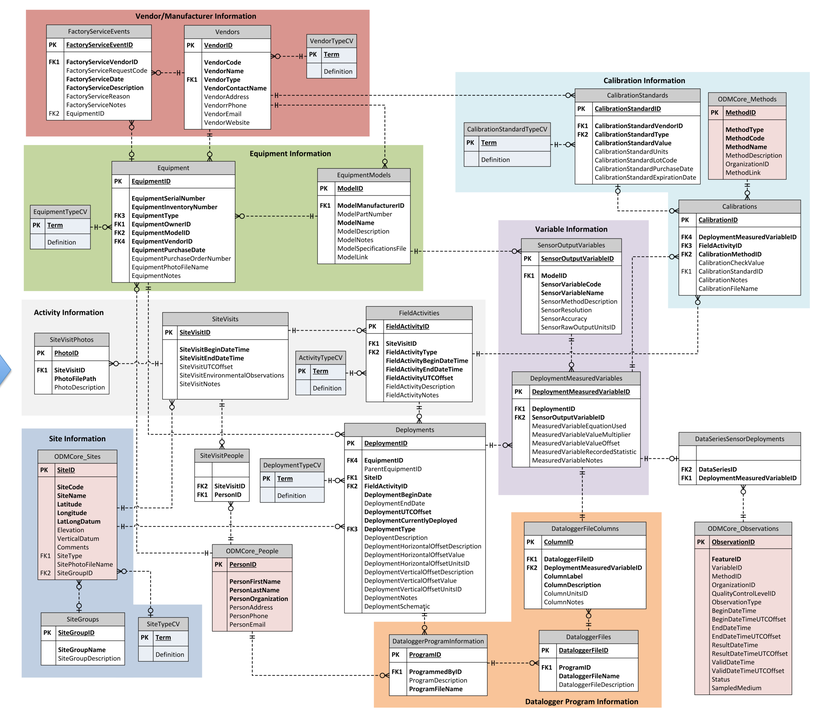
ODM2 Core: ODM2 consists of a core set of entities common to all types of observational data to describe location, observed variable, and time.



ODM2 Extensions: Additional metadata can be provided via extensions to the core to support particular types of observations.

Extensions Under Development:

- **Sensors:** describe monitoring equipment, deployments, and *in situ* time series.
- **Samples**: capture sample hierarchy and analytical methods.
- **Features:** detail the physical feature(s) from which an observation is made.
- **Annotations:** provide qualifiers or comments to variables or observations.
- **Provenance**: describe data versioning and processing.



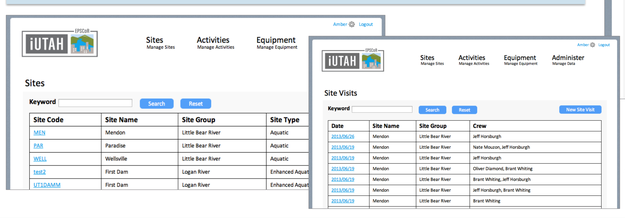
Linkage to ODM2 Core: The connection between the Sensors Extension and the ODM2 Core provides linkages between observations, equipment, and events associated with the observations. The linking tables are Methods, Observations, People, and Sites.

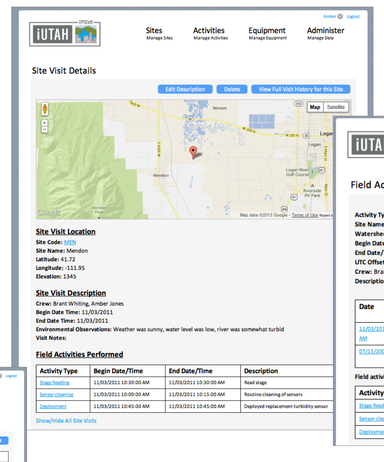
Sensors Extension. The Sensors Extension permits information about individual sensors, deployments, and the associated time series to be recorded and managed.

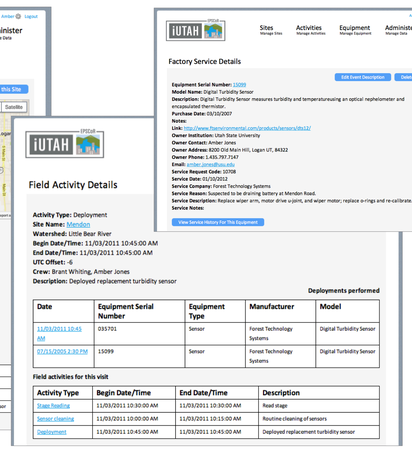
Table Descriptions

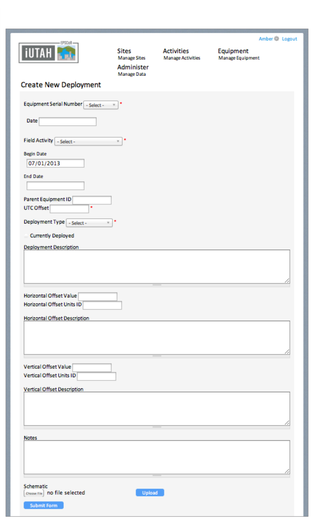
- **Equipment** contains attributes of individual sensors and other pieces of field equipment while **EquipmentModels** describes attributes of equipment of the same type.
- **Deployments** provides information about the sensor deployment in space and time.
- **SiteVisits/FieldActivities/Calibrations** record activities of field crews and sensor calibrations.
- **Vendors** provides information on equipment manufacturers and suppliers and **FactoryServiceEvents** records sensor servicing by the manufacturer.
- **SensorOutputVariables** contains information on a specific variable being measured by a sensor. It is linked to the specific deployment through **DeploymentMeasuredVariables**.
- **DataloggerProgram** tables allow for tracking of programs, files, and each variable recorded in the file.
- **Controlled Vocabularies** are used for types of equipment, deployments, sites, vendors, activities, and calibration standards.

Web Interface: Field technicians and other researchers can use the web interface for the Sensors Extension to add and edit sensors, sites, and field activities such as calibrations and deployments. The interface can be used to address questions such as what sensors are deployed at a site, the deployment history or factory service history of a sensor, and the history of field activities performed at a site.



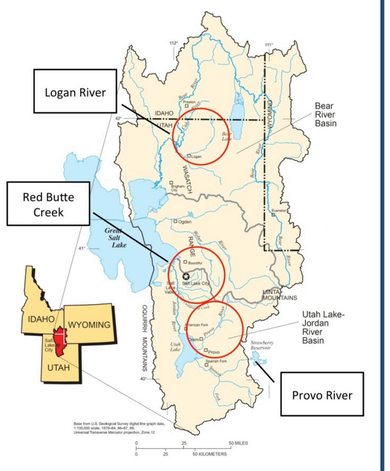






OPEN SOURCE CODE REPOSITORY:
The web application for the Sensors Extension is available in GitHUB
https://github.com/UCHIC/ODM2Sensor

Implementation: The iUTAH (innovative Urban Transitions and Aridregion Hydro-sustainability) network of aquatic and terrestrial sensors is being used as a test case for the Sensors Extension. The ODM2 Sensors Extension and associated tools will be useful for similar large scale and long term monitoring networks. See http://data.iutahepscor.org.



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Contact Information
Amber Spackman Jones, (435)797-7147, amber.jones@usu.edu
Jeffery S. Horsburgh, (435)797-2946, jeff.horsburgh@usu.edu
Juan Caraballo, (435)797-0045, juan.caraballo17@gmail.com
Maurier Ramírez, (435)797-0045, mauriel.ramirez@gmail.com