Appendix: UsgsNwisGroundwater – USGS NWIS Groundwater Web Service Datastore

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Overview

The UsgsNwisGroundwater datastore corresponds to the United States Geological Survey (USGS) National Water Information System (NWIS) groundwater web service, as described on the following page:

http://waterservices.usgs.gov/rest/GW-Levels-Service.html

The following online query page is available for interactive queries:

http://waterservices.usgs.gov/rest/GW-Levels-Test-Tool.html

Although the USGS NWIS services are largely compatible with TSTool conventions, there are a number of limitations, which are discussed below.

The NWIS groundwater web service allows data to be retrieved as JavaScript Object Notation (JSON), tab-delimited (RDB), or WaterML 1.1 (with USGS extenstions, called WaterML 1.2). Each of these formats has features and limitations that are discussed in more detail in other documentation. The UsgsNwisGroundwater datastore is used with the `ReadUsgsNwisGroundwater()` command and the data files saved by the command are used with the `ReadUsgsNwisRdb()` and `ReadWaterML()` commands.

USGS NWIS and Standard Time Series Properties

The standard time series identifier for USGS NWIS time series in TSTool is of the form:

```
Location.DataSource.DataType.Interval~DataStoreName
```

More specifically, the identifier adheres to the following convention:

```
SiteNum.AgencyCode.ParameterCode.Day~DataStoreName
```

where identifier parts are described as follows:

- The `SiteNum` corresponds to a USGS site. The NWIS Mapper (http://wdr.water.usgs.gov/nwisgmap/), USGS Site Inventory (http://waterdata.usgs.gov/nwis/inventory) and other published information from the USGS can be used to determine site numbers.
- `AgencyCode` can be blank for USGS sites or is specified from the following list (for example, use `USGS` for the code): http://nwis.waterdata.usgs.gov/nwis/help/?read_file=nwis_agency_codes&format=table
- `ParameterCode` is taken from the parameter list available from the following list: http://nwis.waterdata.usgs.gov/usa/nwis/pmcodes

Ideally a parameter name could be used; however, the list of parameters is extensive, descriptions may change, and special characters like the period are used in descriptions and would interfere with the TSID convention. Consequently, a concise unique parameter name is not readily apparent, and the initial implementation uses the numerical parameter code. In the future, the text name may be allowed and a prefix may be used to indicate whether a code or name is used. The groundwater web service is constrained to the following parameter codes:

- 72019 - Depth to water level, feet below land surface
- 72020 - Elevation above NGVD 1929, feet,
- 62610 - Groundwater level above NGVD 1929, feet
- 62611 - Groundwater level above NAVD 1988, feet

- Interval defaults to `Day`. Finer resolution date/times are truncated to the day. In the future the datastore may be enhanced to allow the option to return time series in other intervals, including irregular.
- `DataStoreName` is the user-defined data store name from the configuration information.
- Data units are taken from the following:
  - WaterML `unitCode` in `variable` element
- Missing numerical values are internally represented as `NaN` and are assigned to any date/times in the period that do not have values.
  - WaterML `noDataValue` in `variable` element is checked and matching data values are handled as missing
- Data value flags, if encountered, are retained in the time series. However, because the USGS uses "A" for approved, it may be necessary to ignore this flag so that other flags stand out more when visualized.
- Data value `qualifiers` definitions are saved with time series and are available to use in time series visualization as flag definitions.
- Properties are extracted from the XML and saved as time series properties. For example, the time series property `siteName` is set from the following XML:

```
<ns1:sourceInfo xsi:type="ns1:SiteInfoType"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
        <ns1:siteName>CACHE LA POUDRE RIV AT MO OF CN, NR FT COLLINS,
CO</ns1:siteName>
```

Limitations

USGS NWIS data store limitations relative to TSTool standard features are as follows:

- Interpretation of USGS data is limited by WaterML limitations, as follows:
  - WaterML files from NWIS do not indicate the interval of the data. Day is assumed for the groundwater values web service; however, trying to read the WaterML file later will require that the interval is specified.
  - Some of the descriptions contain units, which may lead to confusion if time series are processed into different units.
- The USGS web service does not allow for all historical data to be returned. Specifying no period returns only the most recent value. Start and end dates must be specified to retrieve a longer period; however, there is no way to request the entire available period. Consequently, users must request a period of interest for their analysis and the browsing features of TSTool cannot list the available period (because doing so would require querying all data, which would be very slow). The USGS NWIS site web service may be utilized in the future to improve data browsing.

Datastore Configuration File

A data store is configured by enabling UsgsNwisGroundwater data stores in the main *TSTool.cfg* configuration file, and creating a datastore configuration file for each datastore. Configurations are processed at software startup. An example of the TSTool configuration file is shown below. Multiple data stores can be defined using the `[DataStore:DataStoreName]` syntax. For NWIS, this would allow, for example, accessing different versions of the web services.

```
# Configuration file for TSTool

[TSTool]

UsgsNwisGroundwaterEnabled = true

# Startup datastores (note that datastore name in config file takes precedence)

[DataStore:UsgsNwisGroundwater]

ConfigFile = "UsgsNwisGroundwater.cfg"
```

TSTool Configuration File with UsgsNwisGroundwater Data Store Properties

Properties for each datastore are specified in an accompanying data store configuration file (see below), which in the following example is located in the same folder as the TSTool configuration file and configures a data store named "UsgsNwisGroundwater".

```
# Configuration information for "UsgsNwisGroundwater" data store,
# for historical, manually recorded groundwater levels.
#
# Properties are:
#
# The user will see the following when interacting with the data store:
#
# Type - UsgsNwisGroundwaterDataStore (required as indicated)
# Name - data store identifier used in applications, for example as the
#     input type information for time series identifiers (usually a short string)
# Description - data store description for reports and user interfaces (short phrase)
# Enabled - whether the data store is enabled (default=True)
#
# The following are specific to the USGS NWIS groundwater data store:
#
# ServiceRootURI - web service root URI, including the server name and root path
# ServiceAPIDocumentationURI - web service API documentation URI, describing
#     the syntax, input, and output
# ServiceOnlineURI - web service interactive page to query data, typically
#     "drill down" or form based

Type = "UsgsNwisGroundwaterDataStore"
Name = "UsgsNwisGroundwater"
Description = "USGS NWIS Groundwater Values (historical manually recorded values) Web
Service"
Enabled = True
ServiceRootURI = "http://waterservices.usgs.gov/nwis/gwlevels"
ServiceAPIDocumentationURI = "http://waterservices.usgs.gov/rest/GW-Levels-Service.html"
ServiceOnlineURI = "http://waterservices.usgs.gov/rest/GW-Levels-Test-Tool.html"
```

UsgsNwisGroundwater Datastore Configuration File

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