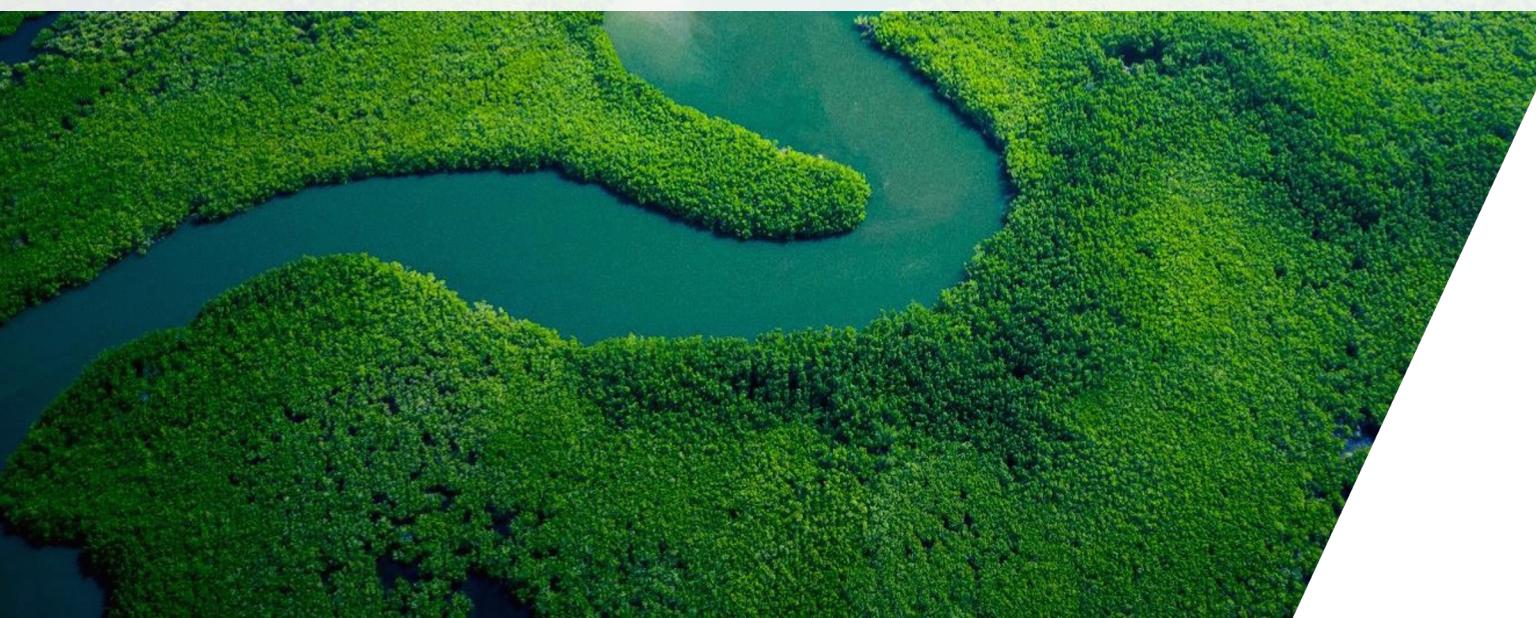




River Runner

Navigating and Indexing Hydrologic Data with Open Standards



Benjamin Webb
Software Developer
Internet Of Water

What is the Hydro Network-Linked Data Index (NLDI)?

- A RESTful web service for discovering indexed hydrologic information
- A river navigation tool providing geospatial representations of stream flowlines, catchments, and water monitoring locations
- An open-source project used by United States Geologic Survey (USGS)

How does the NLDI work?

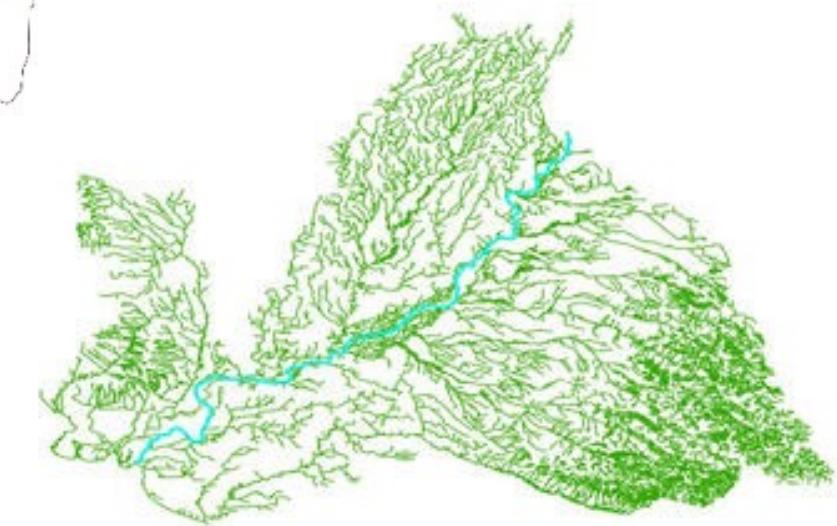
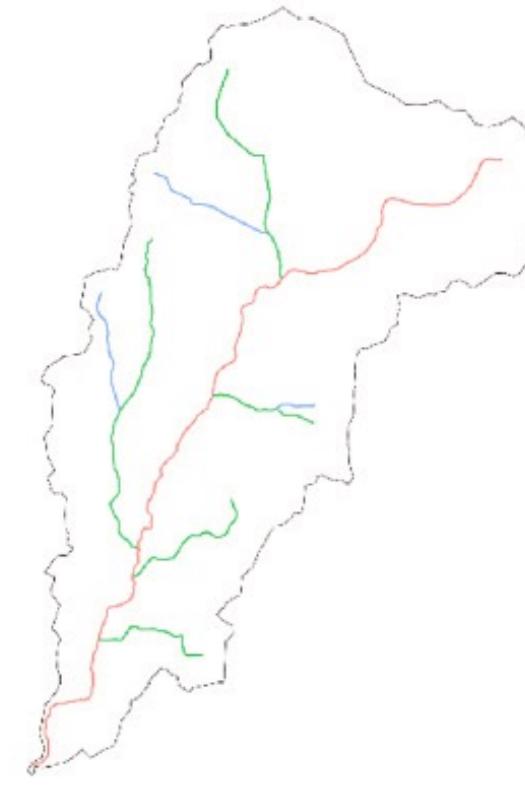
Value-Added Attributes (VAAs): a set of pre-calculated network characteristics of the NHDPlus High Resolution and Merit-Hydro

Community Contributed Features: a set of features provided by an organization that are indexed to the NHDPlus High Resolution

<https://www.usgs.gov/national-hydrography/value-added-attributes-vaas>

Stream Level

- A simple and logical stream routing system
- STREAMLEVE = 1 for all flowlines flowing into the ocean
- Flowlines feeding into Level 1 are assigned STREAMLEVE = 2



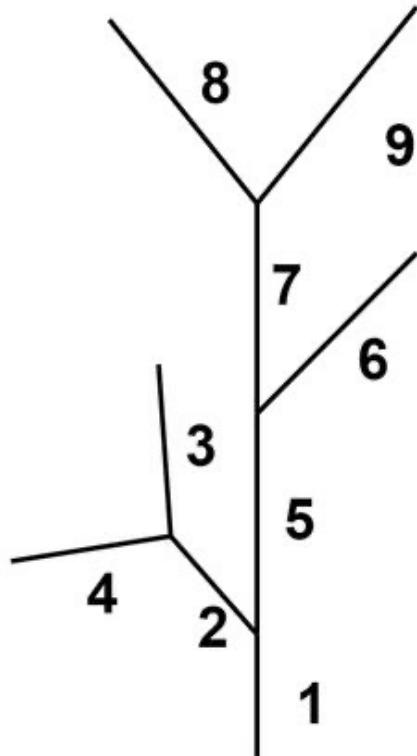
[from USGS Value-Added Attributes]

— 1 — 2 — 3

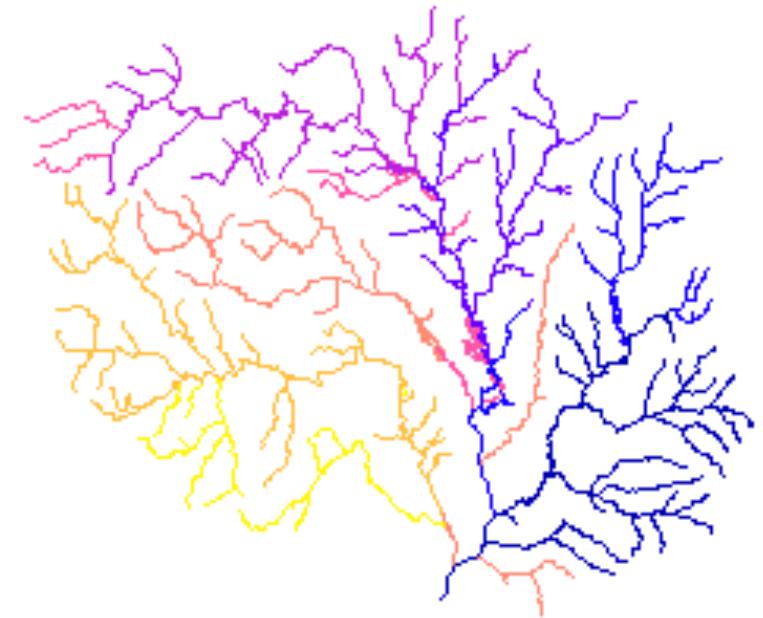
[from <https://doi.org/10.1016/j.envsoft.2023.105726>]

Hydrologic Sequence

- Unique sequence number that places each stream flowline in hydrologic order
- HYDROSEQ numbers increase from downstream to upstream

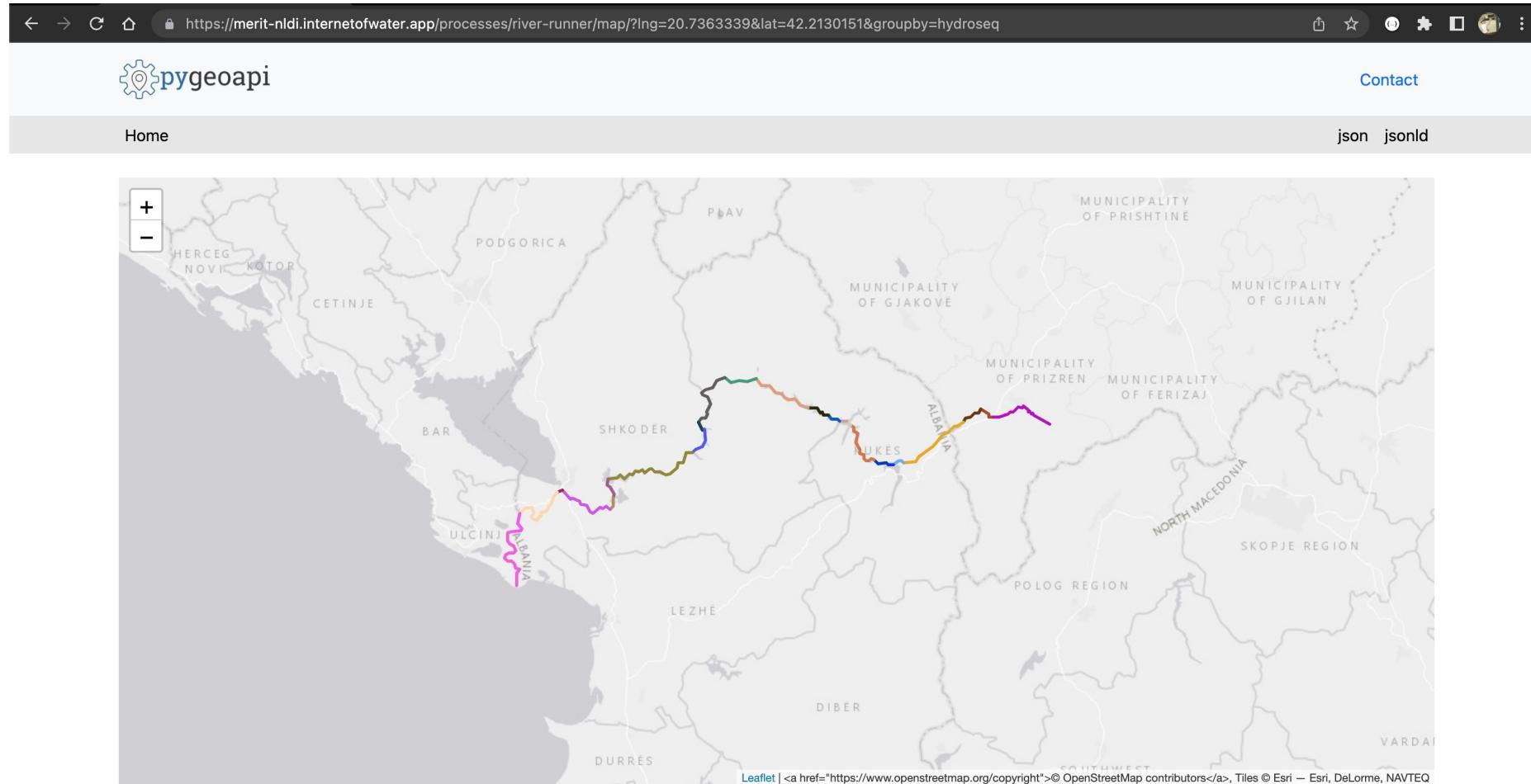


[from USGS Value-Added Attributes]



[from Advanced Network Attributes]

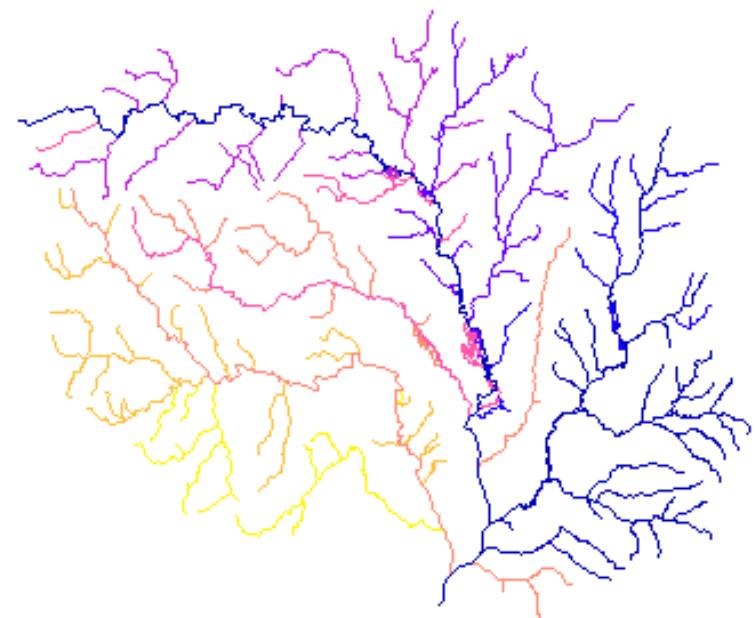
Value-Added Attributes in context – Hydrologic Sequence



<https://merit-nldi.internetofwater.app/processes/river-runner/map/?lNg=20.7363339&lat=42.2130151&groupby=hydroseq>

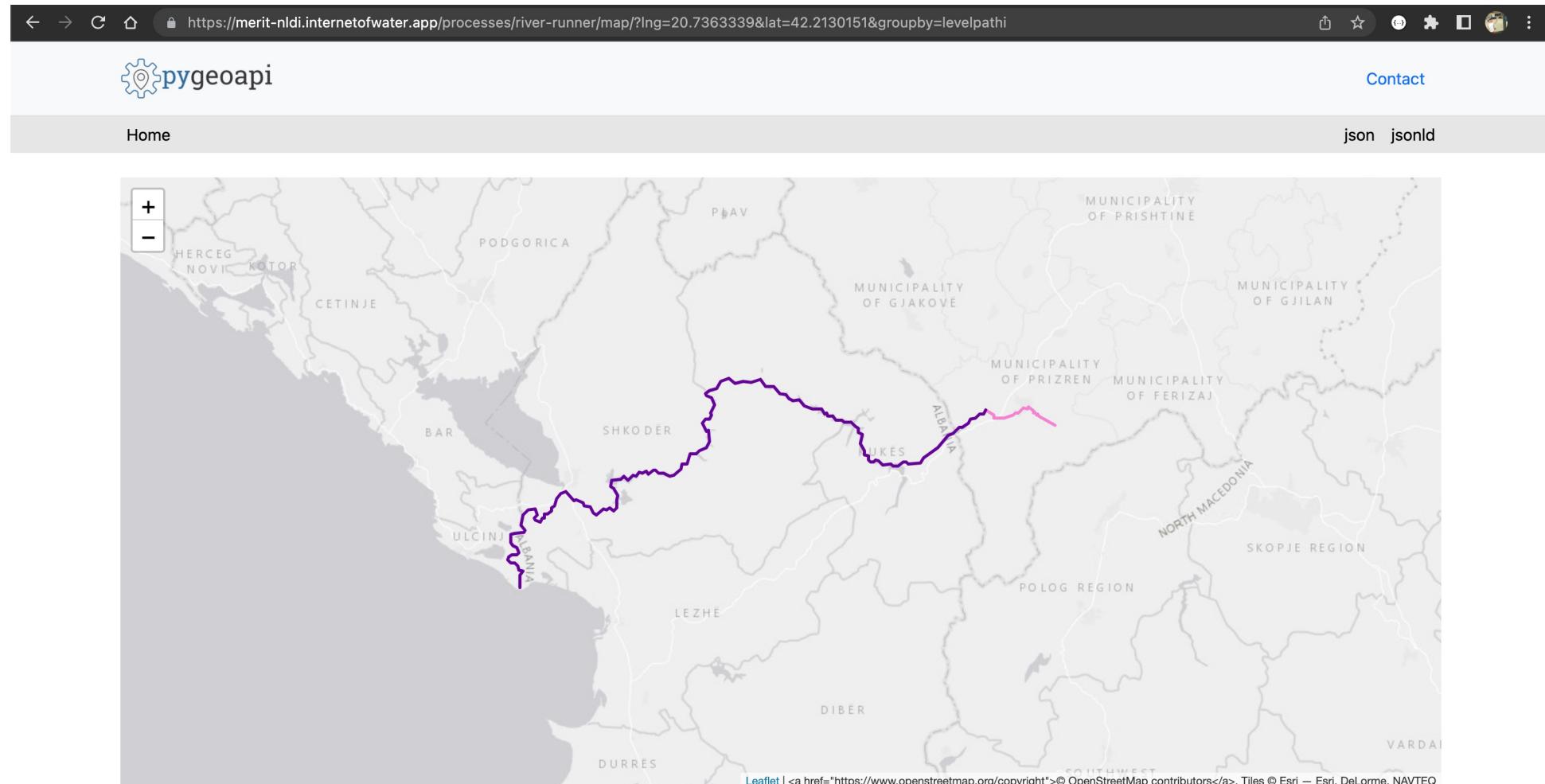
Level Path Identifier

- Unique identifier assigned to the set of flowlines that comprise a stream from its headwater to its mouth
- LEVELPATHI is the hydrologic sequence number assigned to the furthest downstream flowline on the stream level path



[from Advanced Network Attributes]

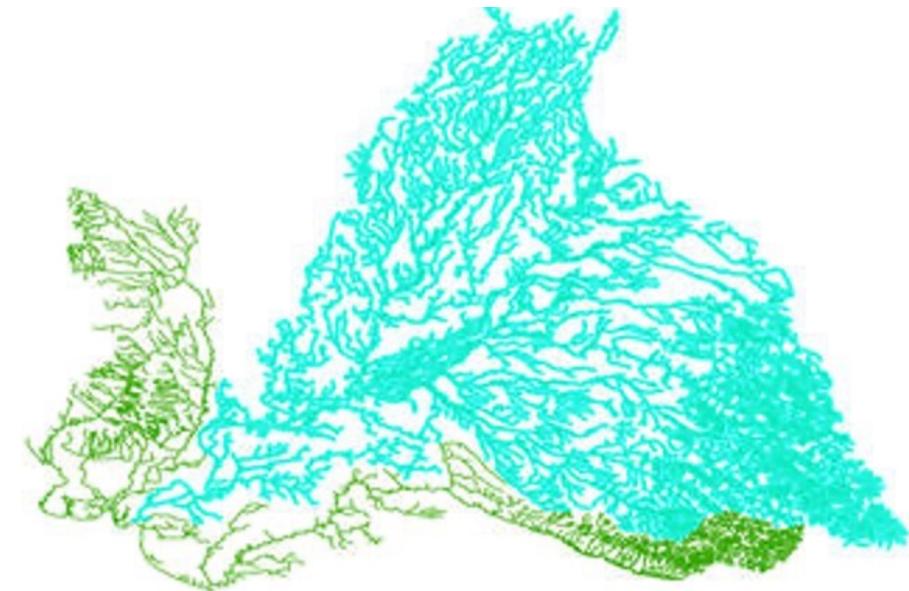
Value-Added Attributes in context – Level Path Identifier



<https://merit-nldi.internetofwater.app/processes/river-runner/map/?lng=20.7363339&lat=42.2130151&groupby=levelpathi>

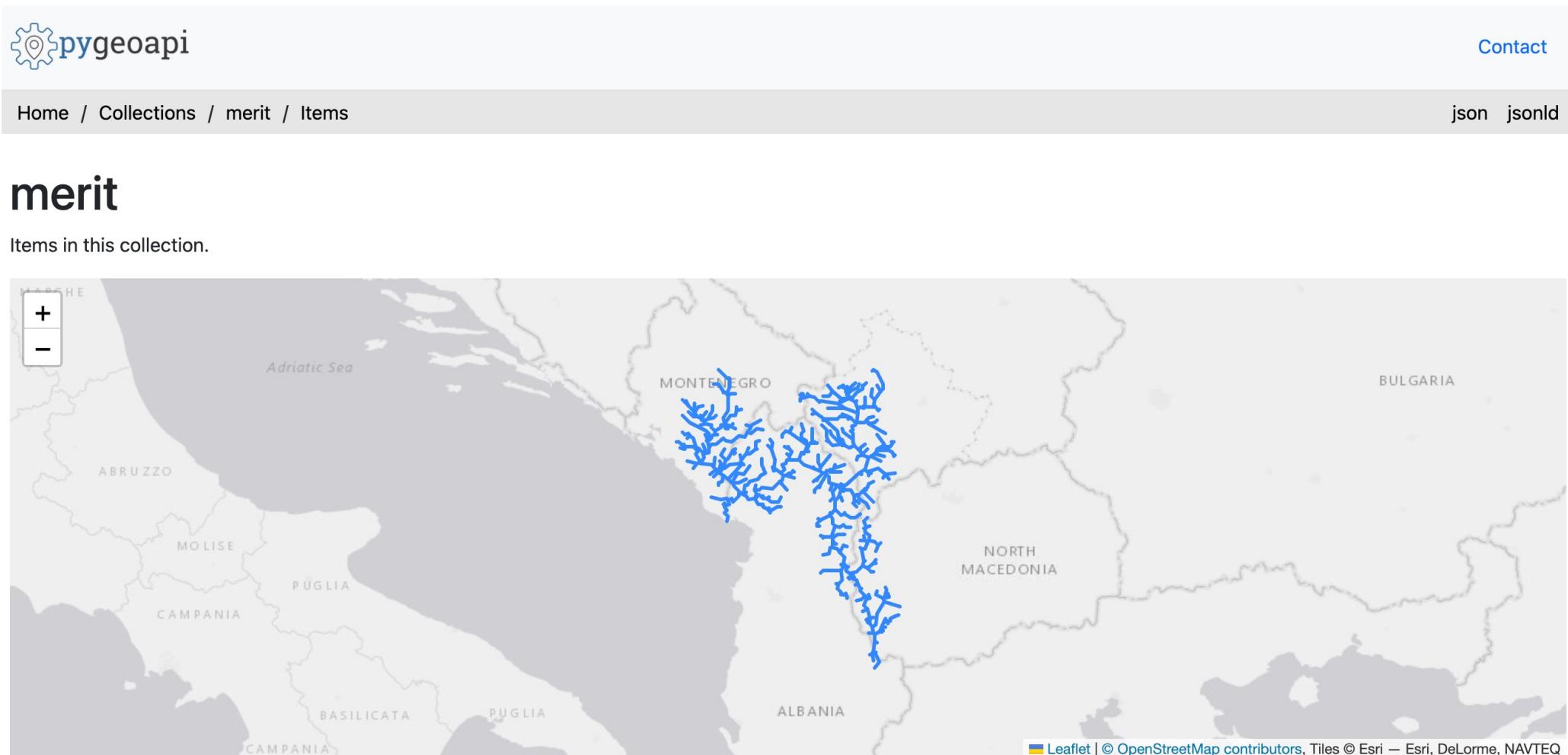
Terminal Path Identifier

- The Hydrologic Sequence of last or “terminal” flowline in any part of the network.
- TERMINALPA can be used to identify all the flowlines that flow to a terminal flowline.



[from USGS Value-Added Attributes]

Value-Added Attributes in context – Terminal Path



<https://merit-nldi.internetofwater.app/collections/merit/items/?limit=401&terminalpa=1420165>

... and many more VAAs



pygeoapi

Contact

Home / Collections / merit / Items json jsonld

merit

Items in this collection.

id	areasqkm	terminalfl	terminalpa	streamlev	comid	hydroseq	riverid	levelpathi	down_levelpaths	tocomid
654804	16.5883865444377	0	1420165	2.0	21006858	1420252	None	1420170	1420165	21008071
654805	0.114109510449158	0	1420165	3.0	21006859	1420260	None	1420260	1420170,1420165	21006851
654808	24.7182461602339	0	1420165	4.0	21006862	1420264	None	1420264	1420260,1420170,1420165	21006851
654878	9.21957347851557	0	1420165	1.0	21006932	1420406	None	1420165		21008161
654894	22.3808106832436	0	1420165	2.0	21006948	1420446	None	1420446	1420165	21006931
654906	9.26422794264064	0	1420165	2.0	21006960	1420448	None	1420446	1420165	21006941
654913	21.7103085043078	0	1420165	2.0	21006967	1420450	None	1420446	1420165	21006961
654921	152.708838752655	0	1420165	2.0	21006975	1420452	None	1420446	1420165	21006961
654927	32.8367221804796	0	1420165	3.0	21006981	1420251	None	1420251	1420170,1420165	21008071
654980	32.3782327243848	0	1420165	1.0	21007034	1420407	None	1420165		21006931
654986	26.8125545985071	0	1420165	1.0	21007040	1420417	None	1420165		21007031
654998	14.2822327979875	0	1420165	2.0	21007052	1420437	None	1420437	1420165	21007041
655002	76.3149698233607	0	1420165	2.0	21007056	1420408	None	1420408	1420165	21007031
...

Putting it all together



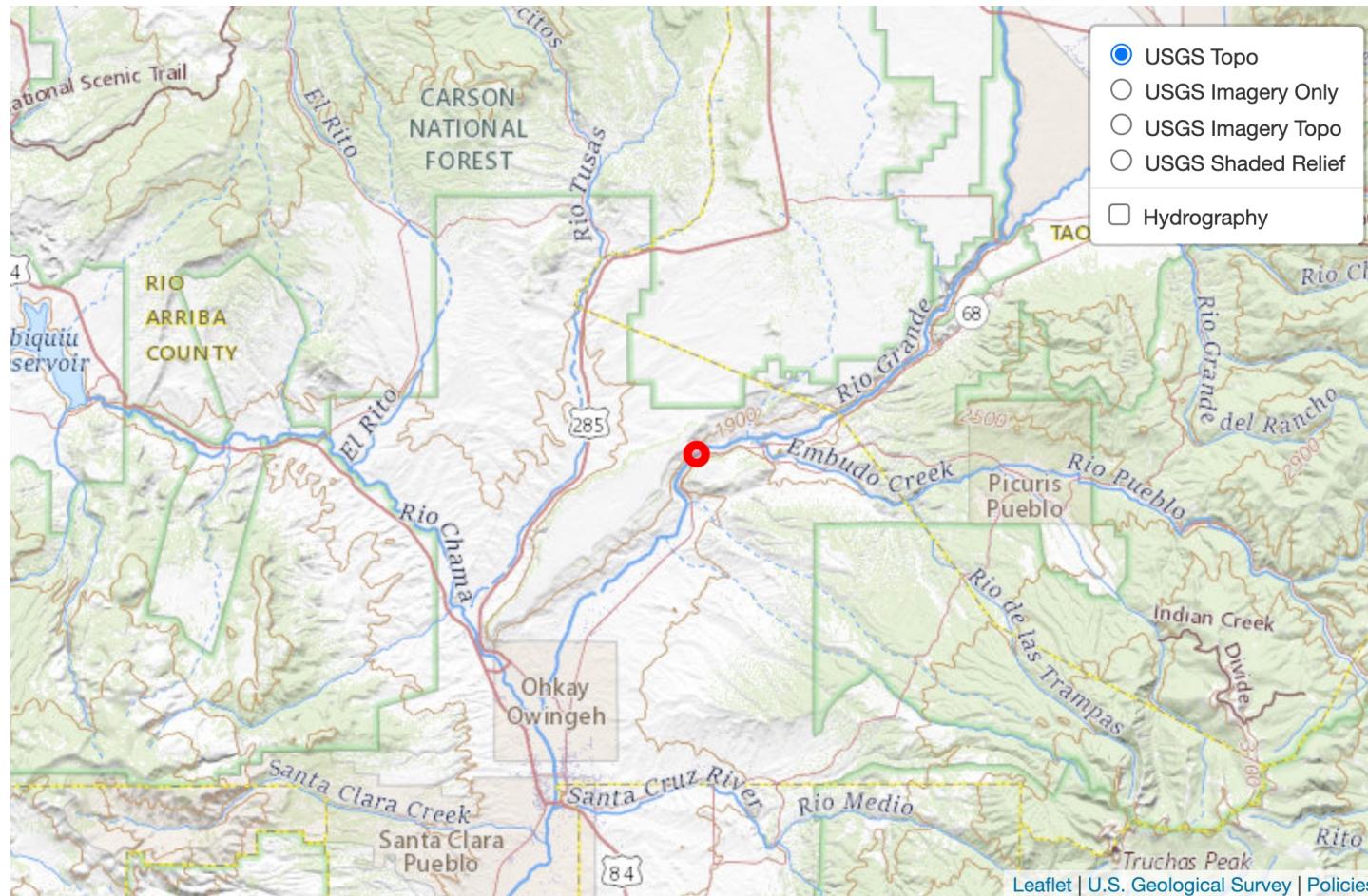
<https://river-runner-global.samlearner.com/?lng=20.7363339&lat=42.2130151>

More than just a visualization

- The NLDI is both a river navigation tool and a service to discover indexed information
- Data can be indexed to a Flowline in a Basin
- Able to navigate Upstream Tributaries, Upstream Mainstem, Downstream Mainstem, and Downstream Diversions

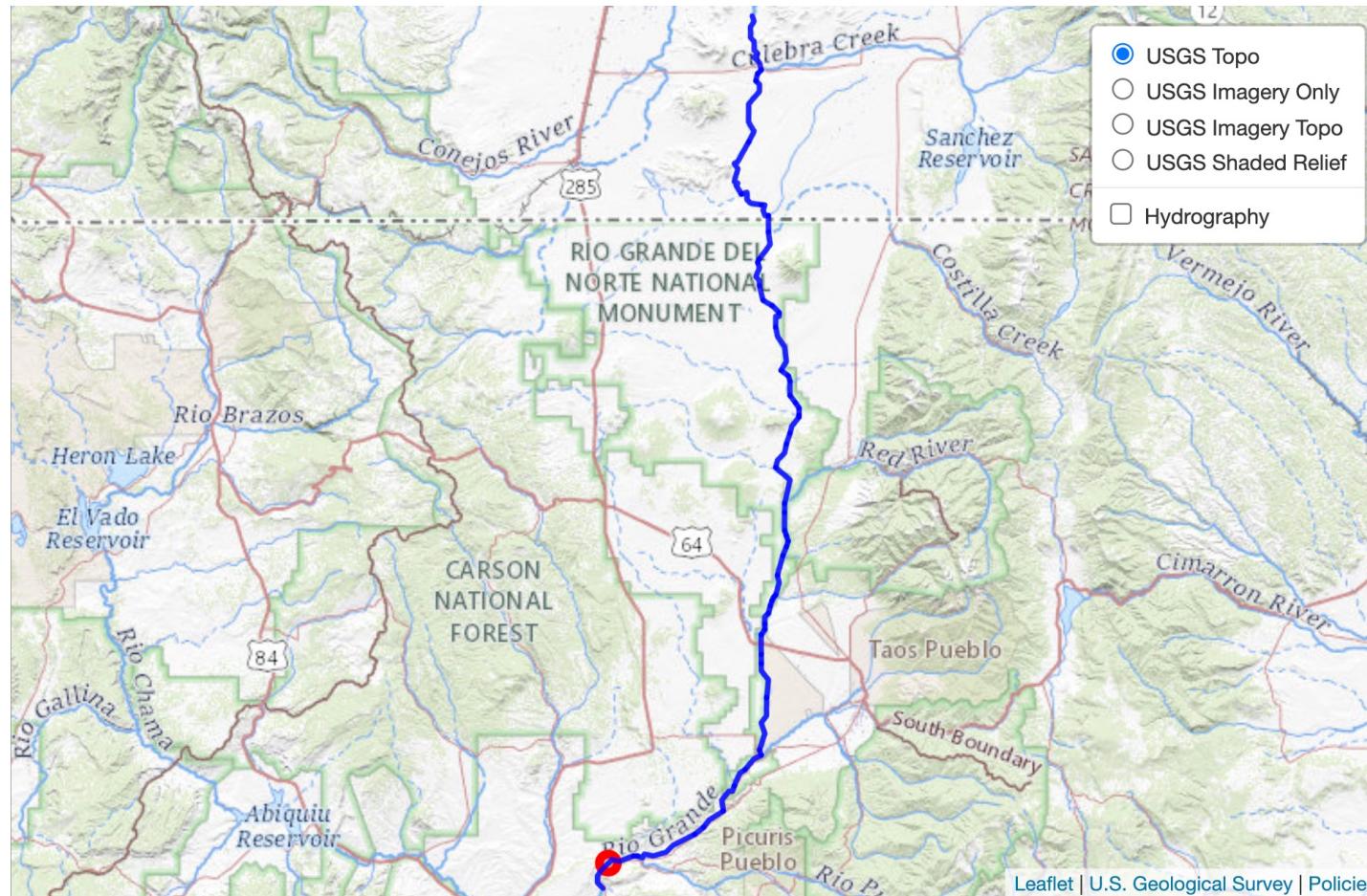
What does this look like?

Starting with an NWIS Site



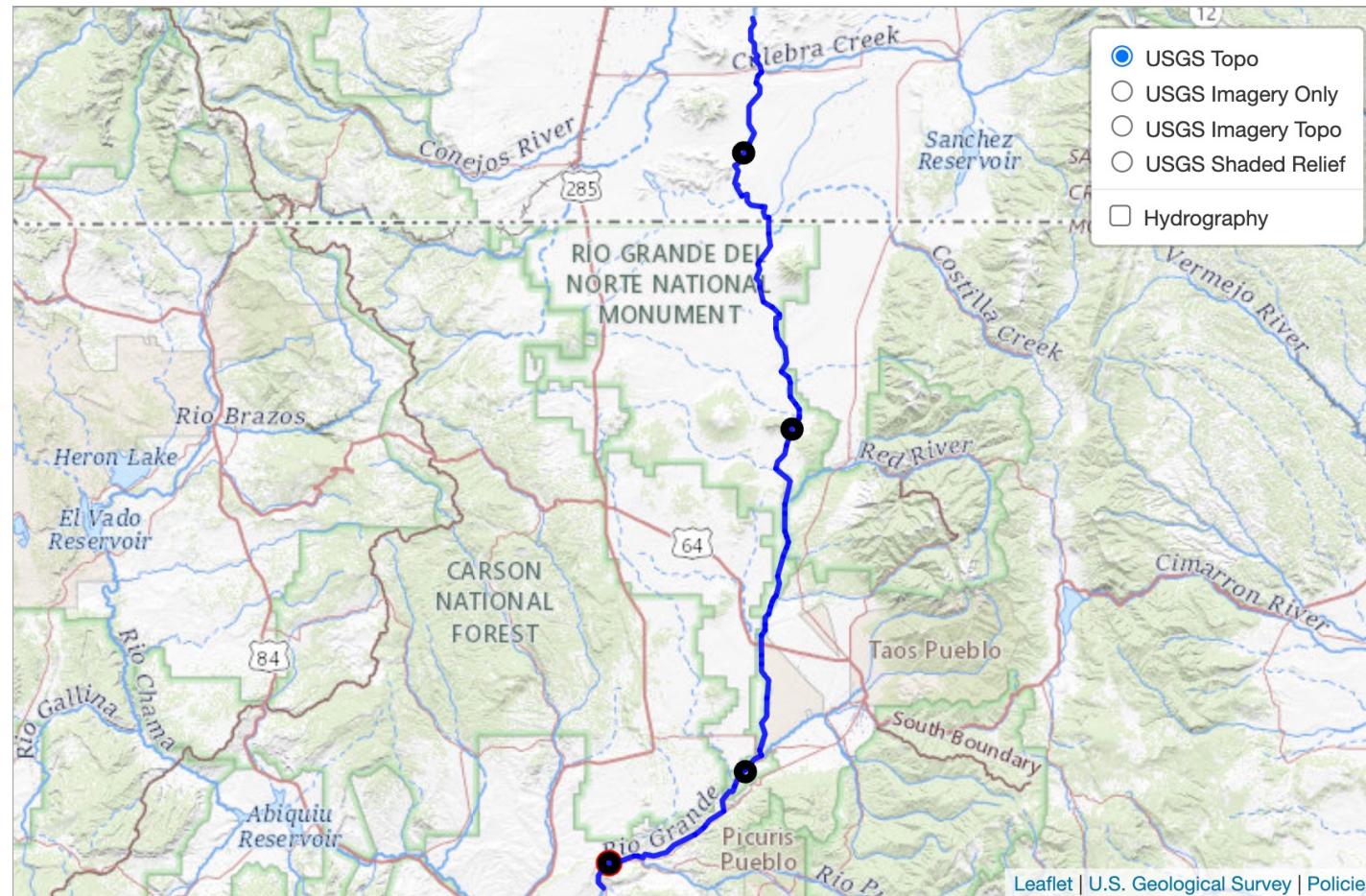
<https://labs.waterdata.usgs.gov/api/nldi/linked-data/nwissite/USGS-08279500>

Query Upstream Mainstem



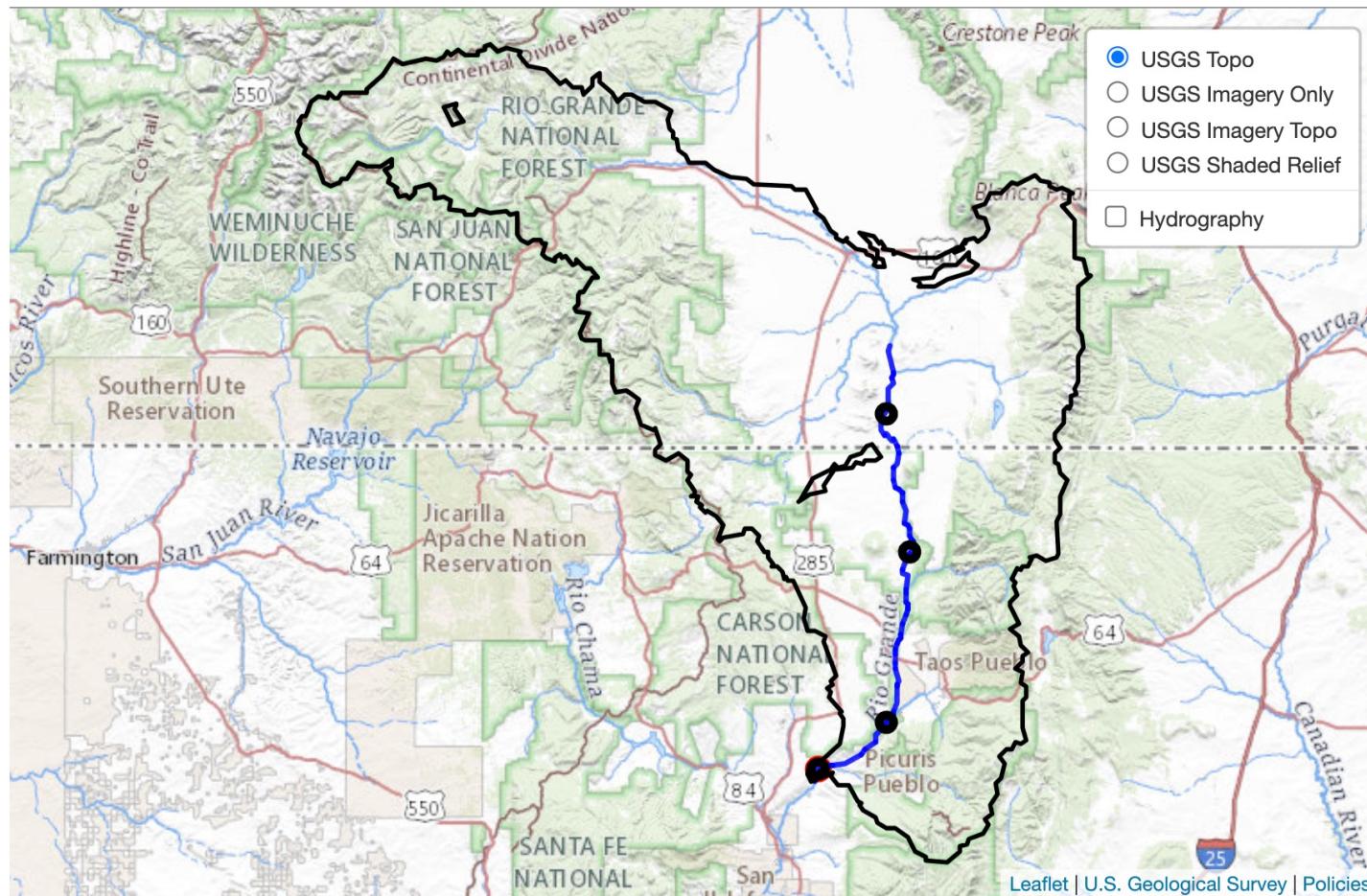
<https://labs.waterdata.usgs.gov/api/nldi/linked-data/nwissite/USGS-08279500/navigation/UM/flowlines?distance=150>

Query NWIS Sites on Upstream Mainstem



<https://labs.waterdata.usgs.gov/api/nldi/linked-data/nwissite/USGS-08279500/navigation/UM/nwissite?distance=150>

Query Basin of NWIS Site

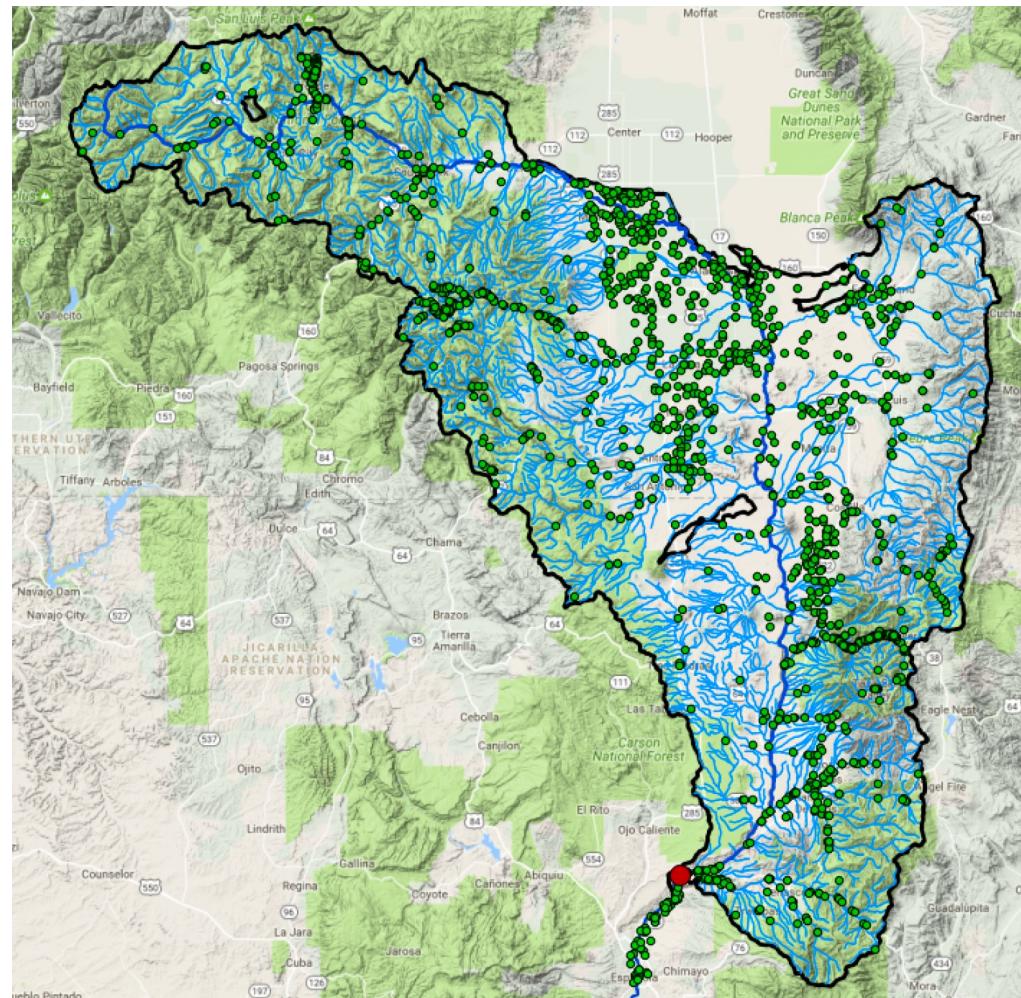


<https://labs.waterdata.usgs.gov/api/nldi/linked-data/nwissite/USGS-08279500/basin>

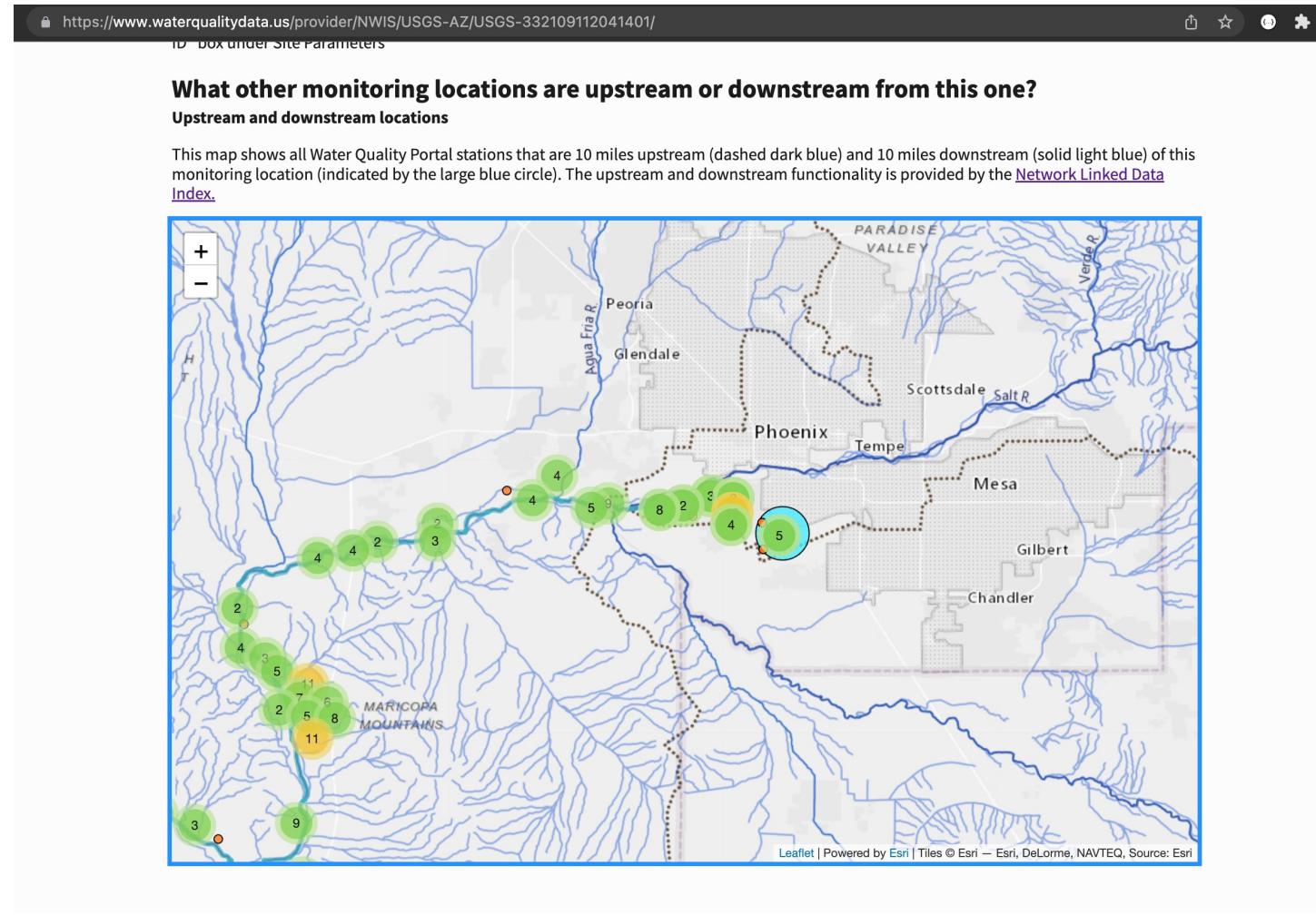
Query Upstream Water Quality Portal Sites

Combining NLDI Queries

1. [NWIS site](#)
2. [The Basin of NWIS site](#)
3. [Upstream Mainstem](#)
4. [Upstream Tributaries](#)
5. [Upstream WQP Sites](#)

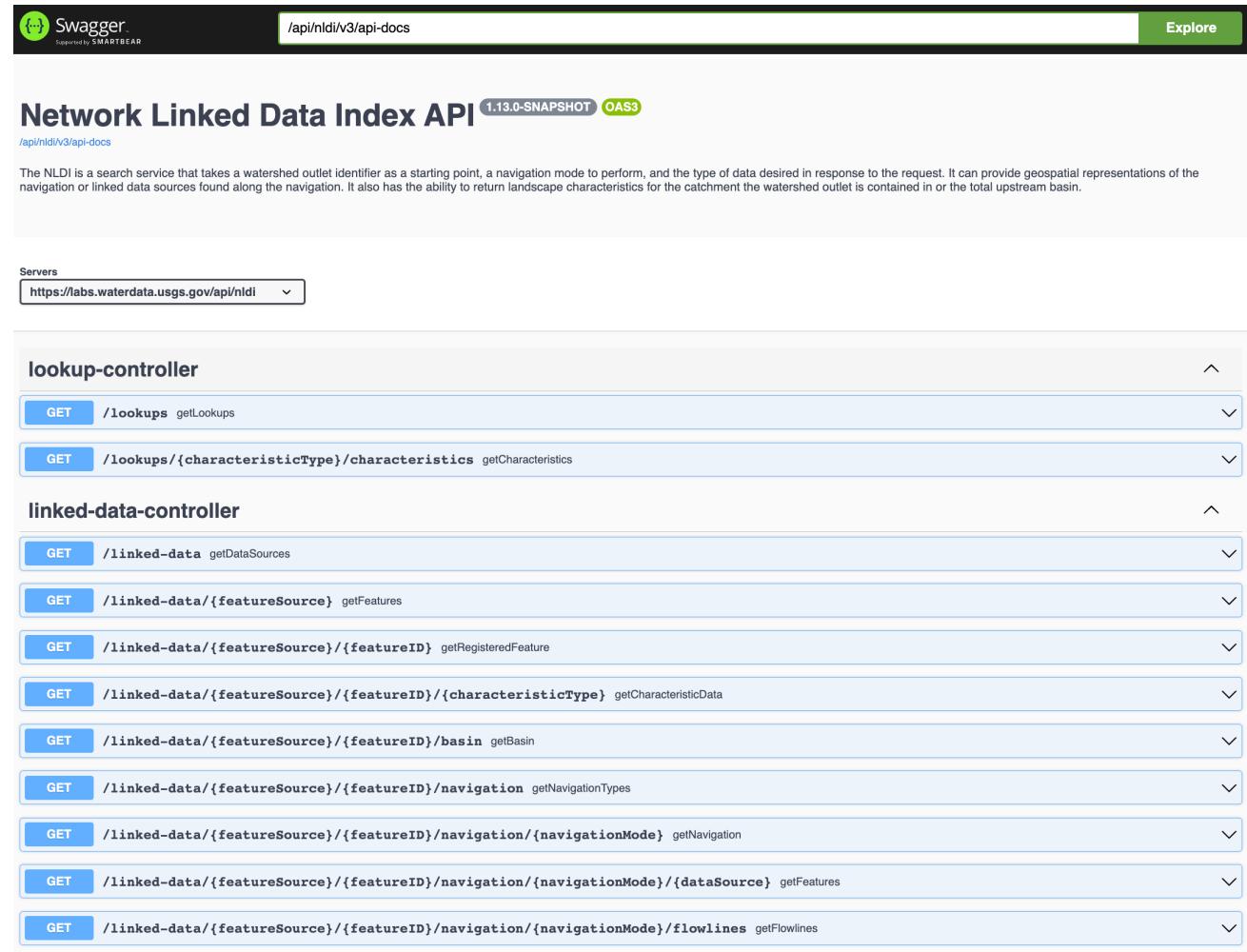


NLDI in National Water Quality Monitoring



Current state of the CONUS NLDI

- The US NLDI is implemented in Java with an OpenAPI Document
- Can index any data to the NHDPlus HR
- Open Sourced on GitHub



The screenshot shows the Swagger UI interface for the Network Linked Data Index API. At the top, it displays the title "Network Linked Data Index API" with version "1.13.0-SNAPSHOT" and "OAS3". Below the title, there is a brief description: "The NLDI is a search service that takes a watershed outlet identifier as a starting point, a navigation mode to perform, and the type of data desired in response to the request. It can provide geospatial representations of the navigation or linked data sources found along the navigation. It also has the ability to return landscape characteristics for the catchment the watershed outlet is contained in or the total upstream basin." A dropdown menu labeled "Servers" is set to "https://labs.waterdata.usgs.gov/api/nldi". The main content area is divided into sections: "lookup-controller" and "linked-data-controller". The "lookup-controller" section contains two GET methods: "/lookups" (getLookups) and "/lookups/{characteristicType}/characteristics" (getCharacteristics). The "linked-data-controller" section contains nine GET methods: "/linked-data" (getDataSources), "/linked-data/{featureSource}" (getFeatures), "/linked-data/{featureSource}/{featureID}" (getRegisteredFeature), "/linked-data/{featureSource}/{featureID}/{characteristicType}" (getCharacteristicData), "/linked-data/{featureSource}/{featureID}/basin" (getBasin), "/linked-data/{featureSource}/{featureID}/navigation" (getNavigationTypes), "/linked-data/{featureSource}/{featureID}/navigation/{navigationMode}" (getNavigation), "/linked-data/{featureSource}/{featureID}/navigation/{navigationMode}/{dataSource}" (getFeatures), and "/linked-data/{featureSource}/{featureID}/navigation/{navigationMode}/flowlines" (getFlowlines).

<https://labs.waterdata.usgs.gov/api/nldi/swagger-ui/index.html#/>

Future direction of the CONUS NLDI

- The NLDI is being rewritten in Python
- Updated OpenAPI Document that enumerates indexed data
- Extending the NLDI beyond the continental US to include Alaska

Swagger
Supported by SMARTBEAR

Network Linked Data Index API - Python 0.1.0 OAS 3.0
<https://nldi.internetofwater.app/api/nldi/openapi?f=json>

The NLDI is a search service that takes a watershed outlet identifier as a starting point, a navigation mode to perform, and the type of data desired in response to the request. It can provide geospatial representations of the navigation or linked data sources found along the navigation. It also has the ability to return catchment the watershed outlet is contained in or the total upstream basin.

Terms of service
United States Geological Survey - Website
CC-BY 1.0 license

Servers
<https://labs.waterdata.usgs.gov/api/nldi - Network Linked Data Index API>

nldi NLDI home

GET / getLandingPage

GET /openapi getOpenAPI

GET /linked-data getDataSources

GET /linked-data/hydrolocation getHydrologicLocation

comid NHDPlus Version 2 COMID

GET /linked-data/comid/position getComidByCoordinates

GET /linked-data/comid/{featureId} getComidById

GET /linked-data/comid/{featureId}/basin getComidBasin

GET /linked-data/comid/{featureId}/navigation getComidNavigationOptions

GET /linked-data/comid/{featureId}/navigation/{navigationMode} getComidNavigation

GET /linked-data/comid/{featureId}/navigation/{navigationMode}/{dataSource} getComidNavigationDataSource

GET /linked-data/comid/{featureId}/navigation/{navigationMode}/flowlines getComidNavigationFlowlines

wqp Water Quality Portal

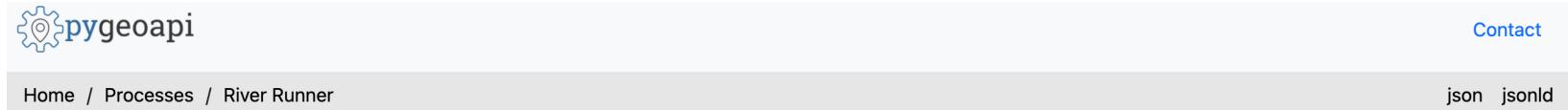
huc12pp HUC12 Pour Points

nwissite NWIS Surface Water Sites

<https://nldi.internetofwater.app/api/nldi/openapi?f=html>

Current state of the Global NLDI

The Global NLDI cannot index related hydrologic data and only supports downstream flowlines as a OGC API – Process via pygeoapi.



The screenshot shows the pygeoapi interface for the 'River Runner' process. At the top, there's a logo for 'pygeoapi' with a gear icon. To the right are links for 'Contact', 'json', and 'jsonld'. Below the header, the title 'River Runner' is displayed, followed by a brief description: 'A process that takes a set of coordinates in the world, and returns the largest flowpath from it to its terminal flowpoint.' Underneath, there are two blue buttons labeled 'rivers' and 'river-runner'. A table below lists the input parameters:

Id	Title	Data Type	Description
bbox	Bounding Box	object	Boundary box to begin a river runner query
lat	Latitude	number	Latitude coordinate of a point
lng	Longitude	number	Longitude coordinate of a point
lating	Latitude and Longitude	object	Lat and Lng coordinates in order [lng,lat]
id	OGC Feature Identifier	number	Identifier of starting feature
sorted	Sorted	string	Sort features by flow direction
sortby	Sort By	string	Property by which to sort features
groupby	Group By	['string', 'list']	Properties by which to group features
properties	Properties	['string', 'list']	Properties to retain

Future direction of the Global NLDI

- Capacity to add querying by Upstream Mainstems, Upstream Tributaries, and Downstream Diversions
- Capacity to explore indexing of data to the river network
- Cover river name gaps from Natural Earth
- Extending the community of practice to index data globally

Further Reading

- **US NLDI Intro:** <https://waterdata.usgs.gov/blog/nldi-intro/>
- **US River Runner:** <https://river-runner.geoconnex.us/>
- **US NLDI Feature Source:** <https://www.sciencebase.gov/catalog/item/60c7b895d34e86b9389b2a6c>
- **Global NLDI Intro:** <https://ksonda.github.io/global-river-runner/>
- **Global River Runner:** <https://river-runner-global.samlearner.com/>
- **Global NLDI Feature Source:** <https://www.sciencebase.gov/catalog/item/614a8864d34e0df5fb97572d>



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Contact our team at
internetofwater@lincolninst.edu