

User Guide

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Domain: <https://npspd.erams.com/>

Non-Point Source Priority Dashboard



One Water Solutions Institute

Colorado State University

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EXECUTIVE MESSAGE

Catena Analytics offers powerful platforms for building accessible and scalable analytical tools and simulation models that can be accessed via desktop or mobile devices. Our team has spent the last decade developing the Environmental Resource Assessment and Management System (eRAMS), an open source technology that provides cloud-based geospatially-enabled software solutions as online services and a platform for collaboration, development, and deployment of online tools. Our services are used to assist with strategic and tactical decision making for sustainable management of land, water and energy resources. Thank you for choosing Catena Analytics and the eRAMS platform to meet your data, modeling, analysis and geospatial needs.

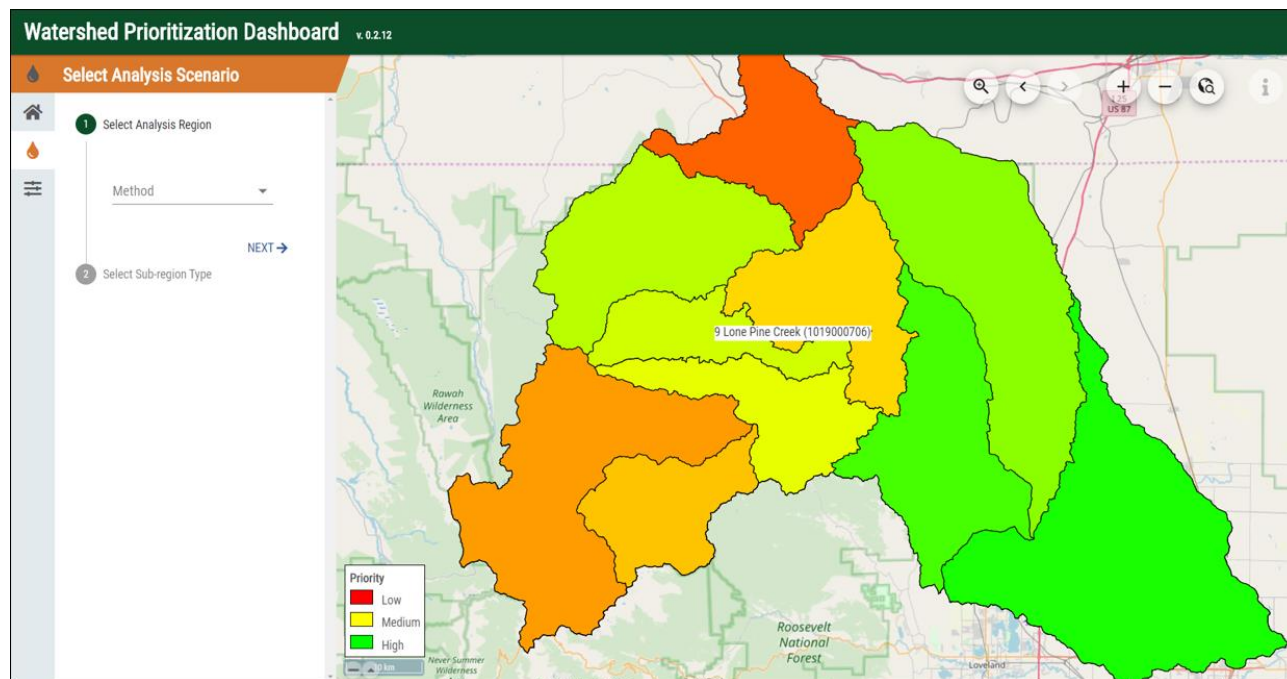
WHO SHOULD USE THIS GUIDE?

This guide is a tutorial to get you started using eRAMS and the [Non-Point Source Priority Dashboard](#). The guide provides instructions for commonly performed tasks and uses of the tool. This tool is intended for use by urban planners and water managers, academic groups, regulatory officials, consultants as well as state, local and federal agencies planning for the future of water resources.

NEED HELP?

After reviewing the guide and video tutorials, if you need additional assistance we are here to help! This guide is designed to provide instruction on commonly performed operations and answers to many frequently asked questions. If you find any aspect of the tool challenging or missing information from this guide, please engage an eRAMS expert to guide you through any hurdles. Contact us at: eramsinfo@gmail.com

INTRODUCTION



PURPOSE

This tool allows users to explore Colorado water systems and prioritize or rank particular watersheds or locations within them, based on a range of user-selected criteria to assist with decision making at the state-or-local level.

DESCRIPTION

The Non-Point Source Priority Dashboard (NPSPD) was developed to assist the Colorado Department of Public Health and Environment (CDPHE) prioritize watersheds for conservation, restoration, and preservation.

The NPSPD uses a Multi-Criteria Decision Analysis (MCDA) approach to assist with tactical decision making by allowing users to build customized analysis scenarios and identify critical watersheds in a specified region. Using a geospatial interface, a user can select from three pre-populated analyses with default values to reflect a variety of indicators including those identified by the U.S. Environmental Protection Agency (EPA) Healthy Watersheds Assessment Program and the CDPHE.

Users can customize the level of importance and either maximize or minimize the significance of numerous assessment criteria ranging from landscape and biological condition to water quality and contamination, to land use and climate change. Multiple analyses can be conducted and compared within the dashboard. Results and raw data can be exported as a spreadsheet and the interactive graphing features help visualize the model outputs.

SOFTWARE AVAILABILITY

Domain

<https://wpd.erams.com/>

Documentation URL

<https://erams.com/catena/tools/colorado-collaborative/watershed-prioritization/>

AUTHORIZED USE PERMISSION

The information contained in the Non-Point Source Priority Dashboard (the "Service") is for general information purposes only. Colorado State University's One Water Solutions Institute ("CSU-OWSI") assumes no responsibility for errors or omissions in the contents of the Service. In the Service (<https://wpbeta.erams.com>) you agree to hold neither the creators of the software platform nor CSU-OWSI liable for any action resulting from use or misuse of the Service. In no event shall CSU-OWSI be liable for any special, direct, indirect, consequential, or incidental damages or any damages whatsoever, whether in an action of contract, negligence or other sort, arising out of or in connection with the use of the Service or the contents of the Service. CSU-OWSI reserves the right to make additions, deletions, or modification to the contents of the Service at any time without prior notice.

GETTING STARTED

QUICK START

Click on the links below and follow this simple workflow to get started using the Watershed Prioritization Dashboard:

1. [Access the tool](#)
2. [Step 1 – Select Analysis Region\(s\)](#)
3. [Step 2 – Conduct Multi-Criteria Decision Analysis](#)
4. [Step 3 – Export Data](#)

SYSTEM REQUIREMENTS


A modern web-browser is required to connect and utilize the Watershed Prioritization Dashboard. Browser options include: Google Chrome v.69, Mozilla Firefox v.62, Safari v.11.1, and Microsoft Edge v.17.

USING THE TOOL


ACCESS THE TOOL

The Watershed Prioritization Dashboard can be accessed by visiting <https://npspd.erams.com/>. A token will be generated for each unique session conducted and a custom url will be generated to share the analysis or return to previously completed projects.

STEP 1 – SELECT ANALYSIS REGION(S)

With the Watershed Prioritization interface open, click the  icon (Watershed Prioritization icon) on the left dashboard.

Modify Base Layer (optional)

If you prefer to modify the base layer in the Watershed Prioritization interface, click the  icon (settings icon) on the right side of the dashboard and select “Back” or “Next” to toggle between available base layers (Figure 1). Options include: Open Street Map, USGS Imagery, USGS Imagery Topo, USGS Hydro-NHD, USGS Shaded Relief, and None.

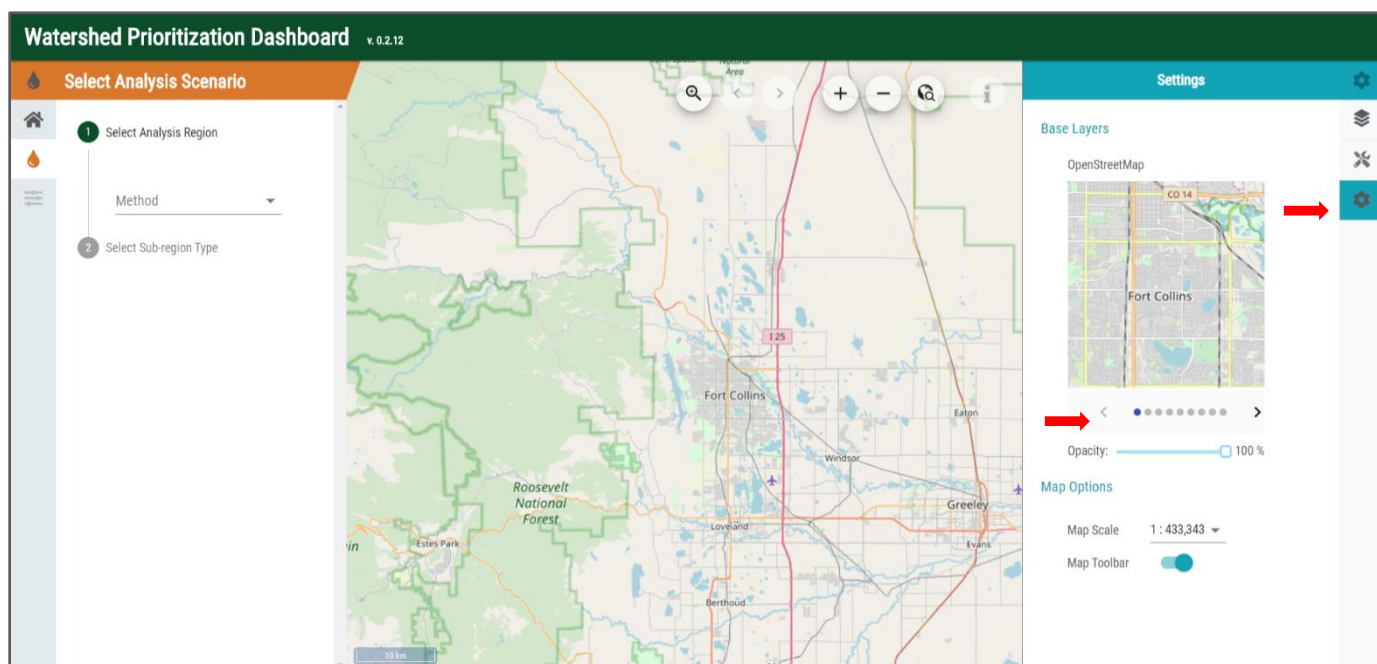


Figure 1: Modify base layer

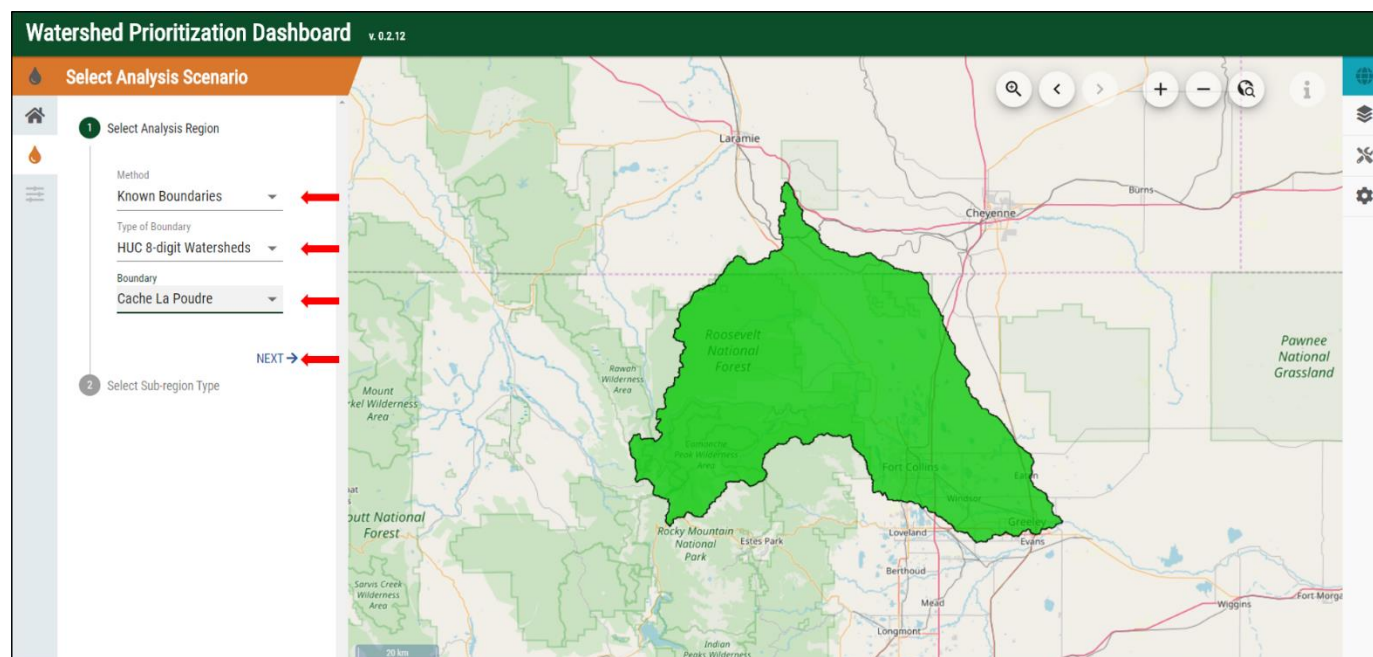


Figure 2: Select analysis region (method, boundary type, boundary)

View Watershed Data

Once a sub-region type is selected, all the sub-regions that fall within the analysis region are extracted. The geographic interface displays the extent of each sub-region. In addition, the raw watershed indicator data is also displayed in the corresponding analysis tabs. As such, there are several ways to view this data in its raw form which are described in greater detail below.

The geographic interface can be minimized by selecting the triangles in the lower left corner of the map (Figure 3). This will allow the data tabs to be maximized, making it easier to read and sort.

Hovering over any point on the interactive graph will display the corresponding data (Figure 4). The raw data can be exported as a .csv or excel file and the graph can be downloaded as an image or .pdf by selecting the horizontal bars in the upper right corner of the table (Figure 4).

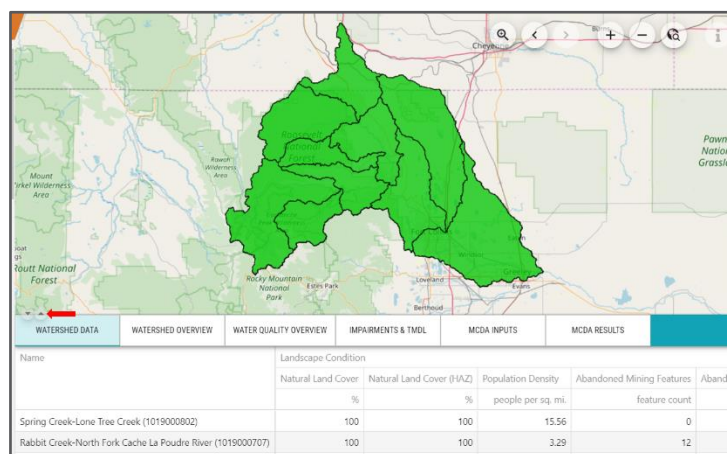


Figure 3: Collapse geographic interface (map)

Watershed Data

A table summarizing the watershed indicators for each of the MCDA categories and sub-categories is shown in this data tab. Each row is a single sub-region area and the interactive table allows user to sort the data any column by clicking the column header.

Watershed Overview

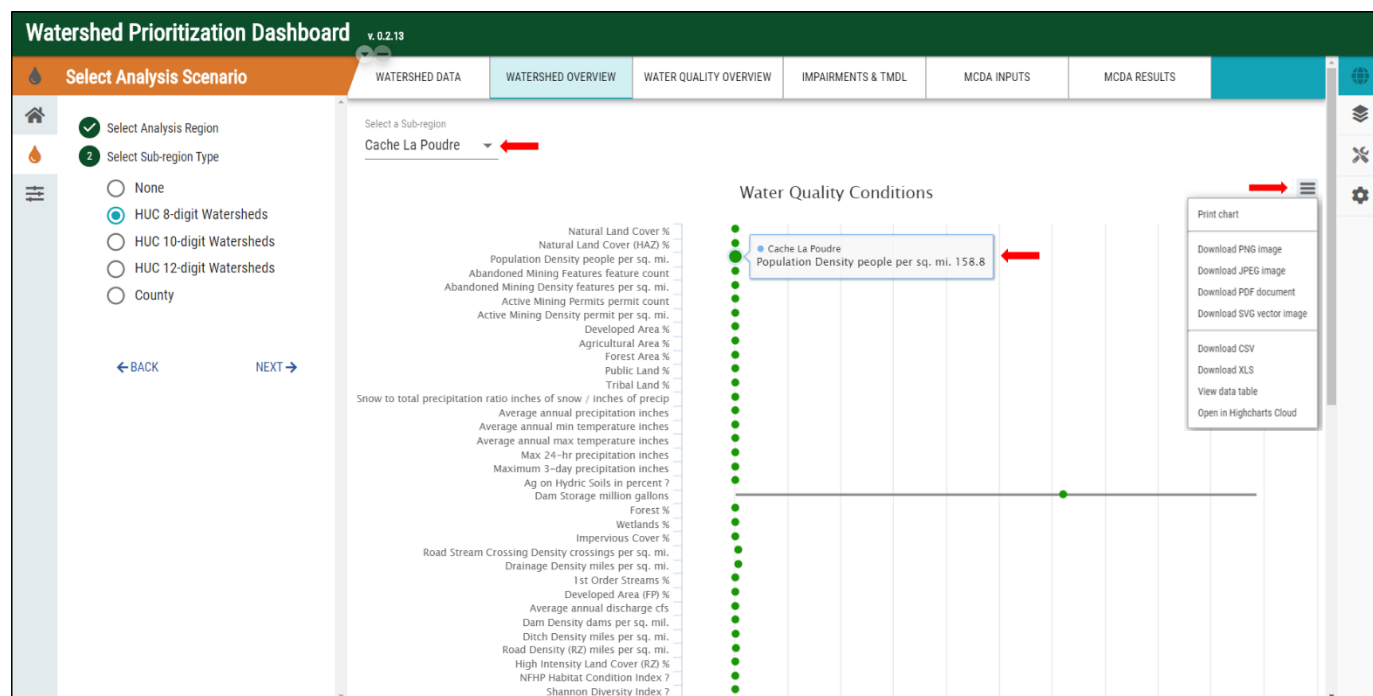


Figure 4: Select sub-region, display individual data points, export data

This table summarizes watershed conditions for the selected sub-region (excluding water quality and impairment data which are provided in stand-alone summary tabs). If multiple sub-regions are available, a user can toggle between them by clicking the carrot under the “Select a Sub-region” drop down menu (Figure 4). The table summarizes both statewide and sub-region data.

Water Quality Overview

This tab provides a table summarizing water quality conditions for the selected sub-region. If multiple sub-regions are available, a user can toggle between them by clicking the carrot under the “Select a Sub-region” drop down menu (Figure 4).

Impairments & TMDLs

This table provides the impairment data for the selected subregion which is summarized by distance (miles, acres) and count. The information is provided at the state-wide level as well as in the currently selected subregion.

STEP 2 – MULTI-CRITERIA DECISION ANALYSIS (MCDA)

Specify Analysis Type

The Non-Point Source Priority Dashboard (NPSPD) allows users to conduct a Multi-Criteria Decision Analysis (MCDA) by selecting from one of three priority categories. A detailed description of the categories is provided below.

Detailed descriptions of corresponding data sets can be found under the [Technical Discussion](#) section of this document.

EPA Healthy Watersheds

The U.S. Environmental Protection Agency (EPA) Office of Water created the Healthy Watersheds Program to protect high quality waters under the Clean Water Act. This program emphasizes technical analysis, tools and data to help identify priority watersheds within the nation's water systems. Through this program, the EPA developed a set of *indicators* or factors for describing, comparing and assessing watersheds within a specific area. This analysis helps users determine where the healthiest watersheds are and also, what their level of vulnerability might be.

In addition to the EPA indicators, the Colorado Department of Public Health and Environment provided several supplementary factors which are also included under the "EPA Healthy Watersheds" priority category.

Details for each indicator are available under the [Watershed Health Index](#) and [Watershed Vulnerability Index](#) sections of this document.

Protect

The Protect option of the MCDA analysis is based on the parameters of interest defined by the Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Division (WQCD). The default-selected indicators and their weights reflect the importance to the WQCD for identifying watersheds that are in need of protection (in good shape) with an emphasis on nonpoint source pollution concerns.

Restore

Selecting the Restore option of the MCDA analysis is similar to Protect. It is based on CDPHE's WQCD to identify watersheds in need of restoration (in poor shape) with an emphasis on nonpoint source pollution concerns.

Adjust Priorities

Once the MCDA has been selected, the indicators are pre-populated with default values based on the priority category selected. Users can adjust the level of importance and if they prefer can either minimize or maximize the priority of the selected criteria.

To customize an indicator's priority, click the arrow next to the indicator category to display the criteria included in each category (Figure 5A).

Select/deselect all criteria by clicking the box next to the indicator category (Figure 5B).

Select/deselect a criterion by checking the box next on the left side of the criteria name (Figure 5C).

Modify the level of importance by sliding the square along the blue line (Figure 5D).

Maximize/minimize the criteria by selecting the up (max) or down (min) arrow next to the ranking function (Figure 5E).

Run MCDA

Once any optional changes have been made to analysis type and/or the default indicator values, click "Run MCDA".

After the run is complete results of the analysis will be displayed in the "MCDA Results" tab. Users can review the selected inputs in table format under the "MCDA Inputs" tab. Multiple analyses can be performed and displayed simultaneously to compare results. Each run will be displayed in a separate column under the "MCDA Results" tab (Figure 6). Clicking the column header will sort the results.

Download Report

Once an assessment has been run, the "Download Report" button will be enabled. This will generate a pdf report of the data input, user MCDA input, and model result tables as well as map of prioritized watersheds/areas.

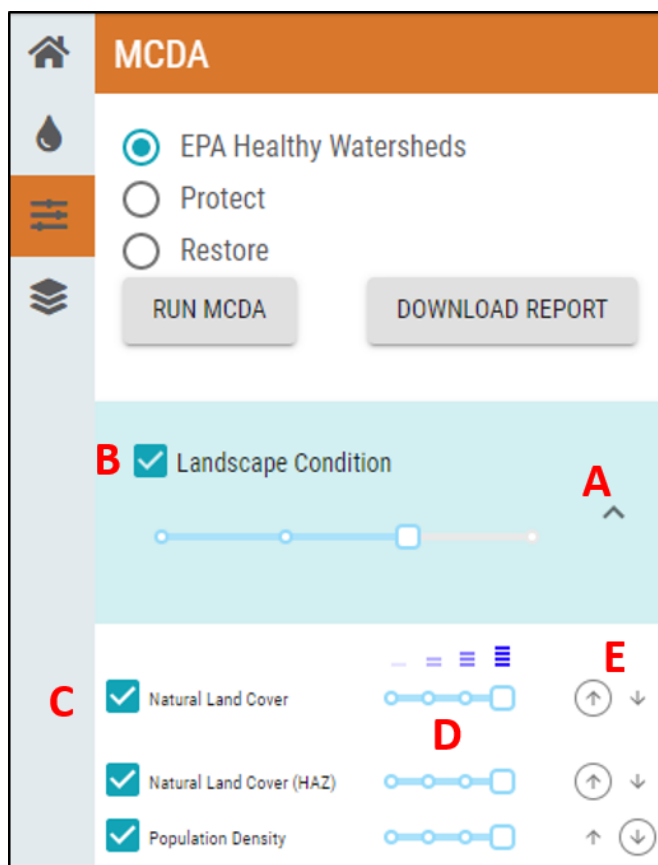


Figure 5: Adjust indicator and criteria priorities

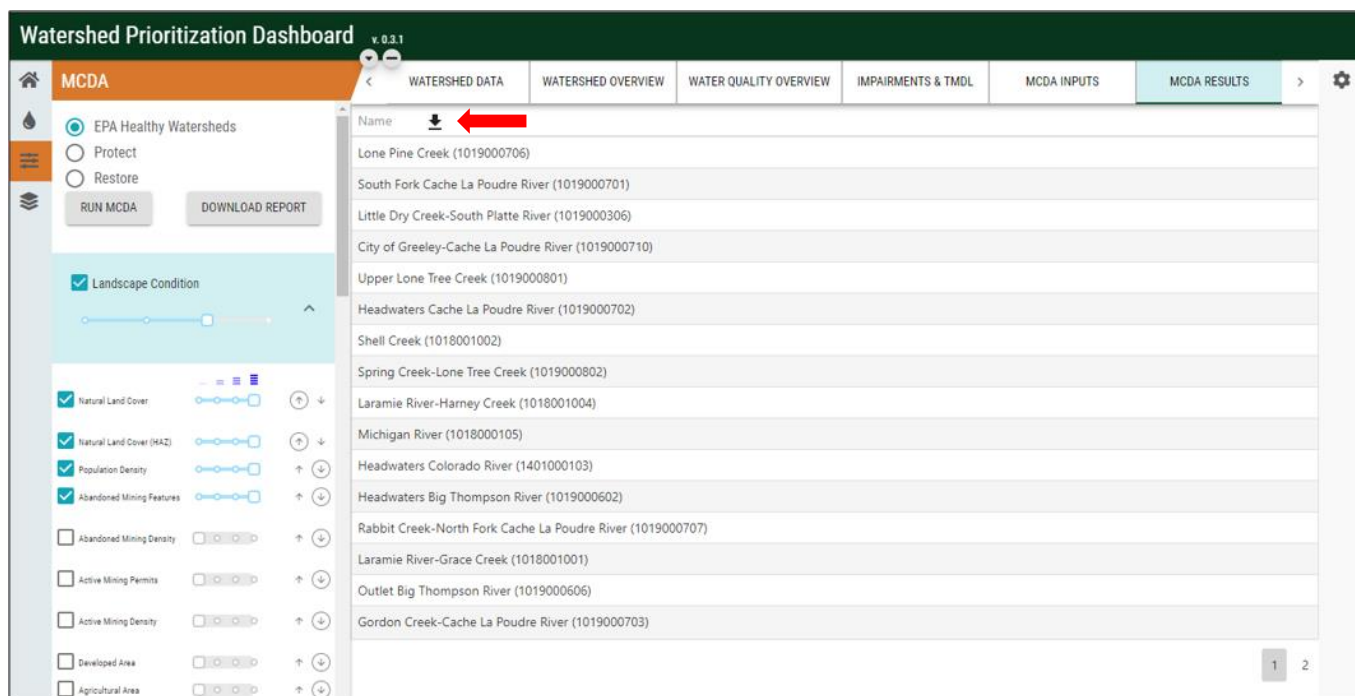


Figure 6: MCDA results and download link

STEP 3 – EXPORT DATA

Raw watershed/water quality data used in an analysis can be exported as a .csv or excel file and the corresponding graph can be downloaded as an image or .pdf by selecting the horizontal bars in the upper right corner of the table (Figure 4).

To download the MCDA results, click the arrow at the bottom left of the results tab. Users will be prompted to select the desired location for the file (Figure 6).

TECHNICAL DISCUSSION

The Non-Point Source Priority Dashboard contains a number of datasets that are processed to calculate watershed indicators. Many of these indicators are based on the EPA Healthy Watershed framework (U.S. EPA, 2011). This section discusses the technical details of each watershed indicator including data source, methodology, and assumptions. They are broken out by their inclusion in the Watershed Health Index (WHI) or the Watershed Vulnerability Index (WVI).

ADDITIONAL BOUNDARIES

Boundaries for more than just watersheds were necessary in the processing of some indicators. Specifically, the extents of floodplain and riparian zones were necessary.

Data Source

Floodplain, riparian and hydrologically connected zone extents were extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The `Estimated_floodplain_CONUS`, `WSIO_Riparian_Zone_tif` and `WSIO_Hydro_Connected_Zone_tif` were downloaded from the site above.

Methodology

Once downloaded the raster extent maps were projected to the same coordinate system as the analysis and then clipped to the state of Colorado. These raster were then converted into polygon (shape) layers for easier use in subsequent analyses using the ArcGIS Raster to Polygon tool in the Conversion package.

WATERSHED HEALTH INDEX

Landscape Condition

These indicators reflect the condition of the landscape and it's state relative to human modification (urban areas, agriculture, mining, etc.).

Percent Natural Land Cover

Data Source

Land cover data was taken from the National Land Cover Dataset (NLCD) for 2016 (Yang et al., 2018) produced by the USGS.

Methodology

The NLCD dataset was projected to a common coordinate system for processing and clipped the boundary of to the state of Colorado. It was then reclassified to reflect only those categories that are 'natural' verses non-natural (i.e. human influenced like developed areas, cropland). These definitions are available in Table 1. This resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Table 1: NLCD Land Use Classifications

NLCD Code	NLCD Title	Agriculture	Forest	Natural	Urban	Wetlands
11	Open Water	False	False	True	False	False
12	Perennial Ice/Snow	False	False	True	False	False
21	Developed, Open Space	False	False	False	True	False
22	Developed, Low Intensity	False	False	False	True	False
23	Developed, Medium Intensity	False	False	False	True	False
24	Developed, High Intensity	False	False	False	True	False
31	Barren Land (Rock/Sand/Clay)	False	False	True	False	False
41	Deciduous Forest	False	True	True	False	False
42	Evergreen Forest	False	True	True	False	False
43	Mixed Forest	False	True	True	False	False
51	Dwarf Scrub	False	False	True	False	False
52	Shrub/Scrub	False	False	True	False	False
71	Grassland/Herbaceous	False	False	True	False	False
81	Pasture/Hay	True	False	False	False	False
82	Cultivated Crops	True	False	False	False	False
90	Woody Wetlands	False	False	True	False	True
95	Emergent Herbaceous Wetlands	False	False	True	False	True

Percent Natural Land Cover (Hydrologically Connected Zone)

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

The same methodology in the [Percent Natural Land Cover](#) section was used except that the resulting layer was clipped to the hydrologically connected zone, see the [Additional Boundaries](#) section, prior to calculating zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Population Density

Data Source

Population data from the 2010 U.S. Census (U.S. Census) was used as the basis for this indicator.

Methodology

Total population for the smallest geographic area (block) was extracted for the given boundary (i.e. a single watershed). This was then divided by the total area of the block to get an average population density of that block. The intersected area between the watershed and current block was then multiplied by this initial population density to get an estimate of total population in the overlapping area. These populations for each of the intersection blocks was then aggregated for a total population of the boundary (watershed) then divided by the total area of the watershed for a final estimate of population density.

Abandoned Mining Features

Data Source

The results of a combined assessment effort by more than a dozen federal, state, and local organizations created the Abandoned Mines Lands Information Hub (www.erams.com/aml). The mining features in this dataset form the basis of abandoned mining in this analysis. Further information on the contacts for each agency can be found at <https://s3.amazonaws.com/erams-cdphe/ColoradoAMLContacts.pdf>.

Methodology

A sum of all the mining features within each boundary of interest (each HUC8, 10, 12 and county in the state) was calculated. No distinction was made between mine feature types (waste rock pile, adit, etc.) and no effort was made to cross-reference features in the datasets to prevent double counting (i.e. if EPA Mines and BLM Mines both have a feature for "Mine Name A" it would be counted twice). This is due to complex issues of land ownership boundaries that certain mines overlap multiple government agency boundaries resulting in entries in more than one of the datasets for a single mine feature.

Abandoned Mining Density

Data Source

See the section [Abandoned Mining Features](#).

Methodology

Density of abandoned mining features was calculated based on the sum of all mining features in each boundary of interest (each HUC8, 10, 12, and county in the state) divided by that boundary's area. The resulting indicator is a count of features per square mile. See the section on [Abandoned Mining Features](#) for more information on how the sum of features was calculated.

Active Mining Permits

Data Source

Permitted mines locations in Colorado were extracted from the Colorado Division of Reclamation, Mining and Safety's website (<https://mining.state.co.us/Reports/Pages/GISData.aspx>). The link to permitted mines was used to download the "Permitted_Mine.zip" file containing the shapefile for mine locations.

Methodology

The "Permitted Mine" layer from DRMS was used to select active mines. Active mines in this analysis were defined as any mine with a "StatusDesc" of: Active, Application In Review, or Temporary Cessation, which encompasses all current mines, those that are about to become active and those temporarily closed but still under development. These 'active' mine permit locations were then filtered by their location into the boundaries of interest (each HUC8, 10, 12, and county in the state) and summed for a total count of all active mining permits.

Active Mining Density

Data Source

See the section [Active Mining Permits](#).

Methodology

Density of active mining features was calculated based on the sum of all mining features in each boundary of interest (each HUC8, 10, 12, and county in the state) divided by that boundary's area. The resulting indicator is a count of features per square mile. See the section on [Active Mining Permits](#) for more information on how the sum of features was calculated.

Developed Area

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only urban/developed categories as defined in Table 1. This resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Agricultural Area

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only agricultural categories as defined in Table 1. This

resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Forest Area

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only forest categories as defined in Table 1. This resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Tribal Land

Data Source

Colorado land ownership was extracted from the Colorado Natural Heritage Program (CNHP). In this dataset is a section for tribal land ownership.

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the land ownership data was projected, clipped to Colorado and reclassified to reflect only the tribal ownership. The resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Climate

Snow to Total Precipitation Ratio

Data Source

Snow Telemetry (SNOTEL) monitoring stations in the state of Colorado provide the basis for snow to total precipitation data. These stations are maintained by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service database (SNOTEL, 2019).

Methodology

Precipitation data from SNOTEL for snow (Snow Water Equivalent, inch, Start of Day Values) and total precipitation (Precipitation Accumulation, inch, Start of Day Values) were summed for each water year (October 1st to September 30th) for each monitoring station. An annual snow to total precipitation ratio was then calculated for each station. If multiple stations existed within a single boundary (watershed or county) an average of their annual snow to precipitation ratio was calculated. The ratio for the last year of record (2018) was taken as the final value for this analysis.

Average Annual Precipitation

Data Source

Parameter-elevation Regressions on Independent Slope Model (PRISM) climate was used to calculate climate data statistics. This data is maintained by the Oregon State Climate Group under the Northwest Alliance for Computational Science and Engineering (PRISM Climate Group, 2019).

Methodology

The geometric centroid of the boundary of interest (each HUC8, 10, 12 and county in the state) was intersected with the PRISM grid cell extents. Then daily climate data for that grid cell was extracted from 2008-01-01 to 2018-12-13.

These daily precipitation values were annualized (summed per year) to come up with a dataset of annual precipitation (in inches). This dataset was then averaged to determine a 10-year average annual precipitation value.

Average Annual Minimum Temperature

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Precipitation](#) for how a PRISM grid cell was selected. These daily minimum temperature values were then annualized (the minimum value per year) to come up with a dataset of annual minimum temperatures (in degrees Celsius). This dataset was then averaged to determine a 10-year average annual minimum temperature.

Average Annual Maximum Temperature

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Precipitation](#) for how a PRISM grid cell was selected. These daily maximum temperature values were then annualized (the maximum value per year) to come up with a dataset of annual maximum temperatures (in degrees Celsius). This dataset was then averaged to determine a 10-year average annual maximum temperature.

Maximum 24-hour Precipitation

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Precipitation](#) for how a PRISM grid cell was selected. These daily precipitation amounts annualized (the maximum value per year) to come up with a dataset of annual

maximum precipitation (in inches). The 2018 value for annual maximum precipitation was then kept and recorded.

Maximum 3-day Precipitation

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Precipitation](#) for how a PRISM grid cell was selected. These daily precipitation amounts were then summed on a running 3-day total. The largest 3-day total for 2018 was kept and recorded.

Hydrology

Agriculture on Hydric Soils

Data Source

Agricultural extent on hydric soils was extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The Percent Agriculture on Hydric Soils summary "PUNITAGHYDRIC_NHDPv2_WBD" was downloaded from the site above. This includes a percent summary of agricultural lands on hydric soils per HUC12 watershed.

Methodology

The percent agriculture on hydric soils within each HUC12 level (PAGHYD80) were summed to the HUC10 and HUC8 levels. Weighted averages of the HUC12 levels were taken to approximate county level percent agriculture on hydric soils, as a higher resolution dataset was not available at this time.

Dam Storage Ratio

Data Source

Dam Data was extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The National Inventory of Dams summary "NIDams_NHDPv2_WBD" was downloaded from the site above. This includes count of dams per HUC12 watershed as well as storage volume.

Methodology

Dam counts (NIDamCount) and storage volume (NIDamMGAL) were summed from HUC12 level to the HUC10 and HUC8 levels. Weighted averages of the HUC12 levels were taken to approximate county level dam information as a higher resolution dataset was not available at this time.

Forest Remaining

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only forest categories as defined in Table 1. This resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Wetlands Remaining

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only wetland categories as defined in Table 1. This resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Impervious Cover

Data Source

Imperviousness data was taken from the National Land Cover Dataset (NLCD) for 2016 (Yang et al., 2018) produced by the USGS.

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD imperviousness data was projected, clipped to Colorado. This resulting raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Road-Stream Crossing Density

Data Source

See the section [Road Density](#) for road data and the section [Drainage Density](#) for stream data.

Methodology

The road and stream layers were clipped to Colorado and intersected to generate a layer of crossing locations. These locations were then minimized based on their location (removed duplicate crossings due to multiple road segments on top of one another) using the "Delete Identical" tool in the Data Management package of ArcGIS with input set to 'shape' so that only duplicate locations would be removed, and not duplicate road/stream intersection (i.e. same road and stream segment intersecting multiple times).

Drainage Density

Data Source

The [USGS National Hydrography Dataset \(NHD\)](#) was used for the stream drainage network. This was downloaded from [The National Map \(TNM\)](#) viewer for the state of Colorado.

Methodology

The stream network layer was then projected to a common coordinate system for the boundaries of analysis (HUC8, 10, 12, and counties) and then clipped to the state of Colorado. Once clipped, this layer was intersected with the various boundaries using the ArcGIS "Identity" tool in the Analysis package to cut stream segments at the analysis boundaries (so that excess length outside the boundary would not be included in calculations for segments that intersected those boundaries). Then each new stream segment's length was calculated. Once completed, the new layer was spatially joined to each of the set of boundaries and the length of stream segments (excluding FType = 336, canals and ditches and FType = 420, underground conduits) within a boundary were summed for a total length of streams (in miles) per watershed/boundary.

Percent Developed Area in the Floodplain

Data Source

For developed area data source, see the section [Percent Natural Land Cover](#). For floodplain extent data source, see the section [Additional Boundaries](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only urban (developed) categories as defined in Table 1. This resulting raster was then clipped to the floodplain area and then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Average Annual Stream Discharge at Outlet

Data Source

Discharge data for stream monitoring stations from the USGS National Water Information System (NWIS, 2019), U.S. EPA WQX/STORET Water Quality Data Portal (Water Quality Data Home, 2019), and Colorado Decision Support System of the Colorado Department of Water Resources (CDSS Rest Services) were used to calculate stream discharge conditions.

Methodology

Data for each of the monitoring stations contained within the boundary of interest (each HUC8, 10, 12 and county in the state) was extracted from its respective database. Discharge data for each station was then checked if it occurred in the last 10 years (2008-01-01 to 2018-12-31) and sorted into annual arrays of discharge data. The 2018 annual average dataset was then calculated for each station. The station with the largest annual average (i.e. largest stream/river in the boundary of interest) was selected as the representative 'outlet' of the watershed. This annualized value was then recorded.

Geomorphology

Dam Density

Data Source

See the section [Dam Storage Ratio](#) for dam data.

Methodology

See the section [Dam Storage Ratio](#) for dam methodology.

Ditch Drainage

Data Source

See the section [Drainage Density](#) for stream data.

Methodology

See the section [Drainage Density](#) for methodology for assessing the miles of ditches in each watershed/boundary. However, all FTypes except FType = 336 (canals and ditches) were excluded to calculate the ditch drainage.

Road Density

The [USGS National Transportation Dataset \(NTD\)](#) was used for the road locations (USGS NTD, 2019). This was downloaded from [their website](#) for the state of Colorado.

Methodology

The road network layer was then projected to a common coordinate system for the boundaries of analysis (HUC8, 10, 12, and counties) and then clipped to the state of Colorado. Once clipped, duplicate road segments were removed using the ArcGIS 'Unsplit Line' tool in the Data Management package. Road layers were then clipped to the riparian zone, as defined in [Additional Boundaries](#) section, in the state of Colorado so calculate this riparian-zone only watershed indicator. Then the layer was intersected with the various boundaries using the ArcGIS "Identity" tool in the Analysis package to cut to segments at the analysis boundaries (so that excess length outside the boundary would not be included in calculations for segments that intersected those boundaries). Then each new stream segment's length was calculated. Once completed, the new layer was spatially joined to each of the set of boundaries and the length of road segments within a boundary were summed for a total length of roads in riparian zones per watershed/boundary.

High Intensity Land Cover

Data Source

See the section [Percent Natural Land Cover](#).

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only urban high intensity development (Developed, High Intensity) as defined in Table 1. This resulting raster was then clipped only to the riparian zone,

see the [Additional Boundaries](#) section, and then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Biological Condition

Shannon Diversity Index

Data Source

Biological population data for benthic macro-invertebrates was provided by the Colorado Department of Public Health and Environment (CDPHE). This data served as the basis of these calculations.

Methodology

Each observation of biologic data, already calculated as a Shannon Diversity Index (SDI) value from CDPHE, was extracted for each monitoring location in the boundary of interest (HUC 8, 10, 12, county). The SDI values within the period of analysis (2008-01-01 to 2018-12-31) were averaged for a final SDI value.

Macro-Invertebrate Multimetric Index (MMI)

Data Source

See the section [Shannon Diversity Index](#).

Methodology

Similar to the [Shannon Diversity Index](#), MMI was calculated as the average of any observations within the period of record for monitoring locations in the boundary of interest (HUC 8, 10, 12, county).

Hilsenhoff Biotic Index (HBI)

Data Source

See the section [Shannon Diversity Index](#).

Methodology

Similar to the [Shannon Diversity Index](#), HBI was calculated as the average of any observations within the period of record for monitoring locations in the boundary of interest (HUC 8, 10, 12, county).

Water Quality

Current Concentration

Data Source

Water quality data for stream monitoring stations from the USGS National Water Information System (NWIS, 2019) and U.S. EPA WQX/STORET Water Quality Data Portal (Water Quality Data Home, 2019) were used to calculate water quality conditions.

Methodology

Data for each of the monitoring stations contained within the boundary of interest (each HUC8, 10, 12 and county in the state) was extracted from its respective database. Data for each parameter of

interest, show in Table 2, was then checked if it occurred in the last 10 years (2010-01-01 to 2018-12-31) and sorted into annual arrays of water quality data. The 2018 annual dataset was then processed for its current value according to the statistic for each parameter listed in Table 2. These statistics were recorded for the boundary of interest as indicators of current conditions.

Table 2: Water Quality Parameters (Any)

Water Quality Parameter		Statistic	Units
Full Name	Abbreviation		
Nutrients and Related			
Ammonia	NH3	Average	mg/L
Chlorophyll a	Chlor. a	Median	ug/L
Nitrate	NO3	Median	mg/L
Nitrite	NO2	Median	mg/L
Sulfate	SO4	Median	mg/L
Total Nitrogen	TN	Median	mg/L
Total Phosphorus	TP	Median	mg/L
Pathogens			
Escherichia Coli	E. Coli	Median	#/100 mL
Physical Parameters			
pH	pH	Min and Max	Standard Units
Temperature	Temp	Median	Degrees Celsius
Metals			
Arsnic (Total)	As-T	Median	ug/L
Cadmium (Dissolved)	Cd-D	85 th Percentile	ug/L
Copper (Dissolved)	Cu-D	85 th Percentile	ug/L
Iron (Dissolved)	Fe-D	85 th Percentile	ug/L
Iron (Total)	Fe-T	Median	ug/L
Lead (Dissolved)	Pb-D	85 th Percentile	ug/L

Manganese (Dissolved)	Mn-D	85 th Percentile	ug/L
Mercury (Dissolved)	Hg-D	85 th Percentile	ug/L
Mercury (Total)	Hg-T	Median	ug/L
Nickel (Dissolved)	Ni-D	85 th Percentile	ug/L
Selenium (Dissolved)	Se-D	85 th Percentile	ug/L
Silver (Dissolved)	Ag-D	85 th Percentile	ug/L
Uranium (Total)	U-T	Median	ug/L
Zinc (Dissolved)	Zn-D	85 th Percentile	ug/L

Impairments

Table 3: Water Quality Parameter (Impairments)

Water Quality Parameter		In Stream Dataset	In Waterbody Dataset
Full Name	Abbreviation		
Nutrients and Related			
Ammonia	NH3	True	True
Dissolved Oxygen	DO	True	True
Chlorophyll a	Chlor. a	False	True
Sulfate	SO4	True	False
Total Phosphorus	TP	True	True
Pathogens			
Escherichia Coli	E. Coli	True	False
Physical Parameters			
pH	pH	True	True
Sediment	Sediment	True	False
Temperature	Temp	True	True
Metals			

Aluminum (Total)	Al-T	True	False
Arsenic (Total)	As-T	True	False
Macroinvertebrates	Bugs	True	False
Cadmium (Dissolved)	Cd-D	True	False
Chlorine	Cl	True	False
Copper (Dissolved)	Cu-D	True	True
Iron (Dissolved)	Fe-D	True	True
Iron (Total)	Fe-T	True	True
Lead (Dissolved)	Pb-D	True	True
Manganese (Dissolved)	Mn-D	True	True
Mercury (Dissolved)	Hg-D	True	False
Mercury (Fish tissue)	Fish-Hg	False	False
Nickel (Dissolved)	Ni-D	True	False
Selenium (Dissolved)	Se-D	True	True
Silver (Dissolved)	Ag-D	True	False
Uranium (Total)	U-T	True	False
Zinc (Dissolved)	Zn-D	True	False

Supporting vs. Impaired: Streams

Data Source

Stream classifications for the state of Colorado were extracted from the Colorado Department of Public Health and Environment (CDPHE)'s website for water data (<https://www.colorado.gov/pacific/cdphe/clean-water-gis-maps>).

Methodology

Stream data from above contains attributes for stream classification ("Ag", "AQLife", "Rec", "WS") and stream impairment ("ImpAnalyte" where 5 indicates a 303(d) impairment, 4b is on the monitoring and evaluation list (M&E), and 3b is a TMDL). The assessed stream lengths (miles) were calculated and compared to impaired stream lengths for each boundary of interest (each HUC8, 10, 12, and county in the state). This ratio of impairment verses assessment (%) was taken as the comparison of supporting verses impaired streams where a higher value (closer to 100%) means most of the

streams are impaired and a lower value (closer to 0%) means most of the streams are supporting their use classifications.

Supporting vs. Impaired: Waterbodies

Data Source

Waterbody classifications for the state of Colorado were provided by CDPHE in a similar format to that of the stream data (section [Supporting vs. Impaired: Streams](#)).

Methodology

Waterbody data from above contains attributes for classification ("Ag", "AQLife", "Rec", "WS") and impairment ("analyte" where 303(d) impairment and M&E impairments are listed per water quality parameter). The assessed waterbody sizes (acres) were calculated and compared to impaired waterbody sizes for each boundary of interest (each HUC8, 10, 12, and county in the state). This ratio of impairment versus assessment (%) was taken as the comparison of supporting versus impaired waterbodies where a higher value (closer to 100%) means most of the waterbody areas are impaired and a lower value (closer to 0%) means most of the waterbody areas are supporting their use classifications.

Miles of Impairment

Data Source

See the section [Supporting vs. Impaired: Streams](#).

Methodology

Stream segments with any water quality parameter impairment ("ImpAnalyte" with a 5, see the [Supporting vs. Impaired: Streams](#) section for more details) were selected and their length (miles) summed for each boundary of interest (each HUC8, 10, 12, and county in the state). Segment lengths outside the boundary (i.e. a stream segment that overlaps 2 counties) were broken at the boundary and the new length within the boundary of interest was used for summation.

These lengths were summed for any impairment, any category of impairment (Nutrient, Metal, Temperature, Sediment, Pathogens) and any of the individual parameters of impairment shown in Table 3.

Acres of Impairment

Data Source

See the section [Supporting vs. Impaired: Waterbodies](#).

Methodology

Waterbodies with any water quality parameter impairment ("analyte" with a 303(d), see the [Supporting vs. Impaired: Waterbodies](#) section for more details) were selected and their size (acres) summed for each boundary of interest (each HUC8, 10, 12, and county in the state). Waterbody areas outside the boundary (i.e. reservoir that straddles multiple watersheds) were broken at the boundary and the new area within the boundary of interest was used for summation.

These areas were summed for any impairment, any category of impairment (Nutrient, Metal, Temperature, Sediment, Pathogens) and any of the individual parameters of impairment shown in Table 3.

Number of Impairments

Data Source

See the sections [Supporting Vs Impaired: Streams](#) and [Supporting vs. Impaired: Waterbodies](#).

Methodology

The count of impairments was handled slightly different than their extents. Each unique stream segment and waterbody within the boundary of interest was checked whether it contained an impairment of any kind (metal, temperature, etc.). If so, that was counted as 1 impairment within the boundary, this way stream segments impaired for more than one parameter were not double counted.

Miles of TMDLs

Data Source

Stream segments with TMDLs for the state of Colorado were provided by CDPHE in a similar format to that of the stream data (section [Supporting vs. Impaired: Streams](#)).

Methodology

Stream segments in the above database only exist for TMDL locations, i.e. every segment has a TMDL. As such, any segment within the boundary of interest (each HUC8, 10, 12, and county in the state) had their length (miles) summed. Segment lengths outside the boundary (i.e. a stream segment that overlaps 2 counties) were broken at the boundary and the new length within the boundary of interest was used for summation.

These lengths were summed for any TMDL, any category of impairment (Nutrient, Metal, Temperature, Sediment, Pathogens) and any of the individual parameters of impairment shown in Table 4Table 3.

Table 4: Water Quality Parameters (TMDLs)

Water Quality Parameter	
Full Name	Abbreviation
Nutrients and Related	
Ammonia	NH3
Dissolved Oxygen	DO
Nitrate	NO3

Pathogens	
Escherichia Coli	E. Coli
Physical Parameters	
pH	pH
Sediment	Sediment
Metals	
Aluminum	Al
Cadmium	Cd
Copper	Cu
Iron	Fe
Lead	Pb
Manganese	Mn
Selenium	Se
Uranium	U
Zinc	Zn

Acres of TMDLs

Data Source

Waterbodies with TMDLs for the state of Colorado were provided by CDPHE in a similar format to that of the stream data (section [Supporting vs. Impaired: Streams](#)).

Methodology

Waterbodies in the above database only exist for TMDL locations, i.e. every waterbody has a TMDL. As such, any waterbody within the boundary of interest (each HUC8, 10, 12, and county in the state) had their size (square miles) summed. Waterbodies outside the boundary (i.e. a lake that overlaps 2 counties) were broken at the boundary and the new area within the boundary of interest was used for summation.

These areas were summed for any TMDL, any category of impairment (Nutrient, Metal, Temperature, Sediment, Pathogens) and any of the individual parameters of impairment shown in Table 4Table 3. However, there are very few waterbody TMDLs in Colorado and only the following parameters are present: dissolved oxygen, copper, total recoverable iron, mercury, and pH.

Number of TMDLs

Data Source

See the sections [Miles of TMDLs](#) and [Acres of TMDLs](#).

Methodology

The count of TMDLs was handled slightly different than their extents. Each unique stream segment and waterbody within the boundary of interest that included a TMDL of any kind (metal, temperature, etc.) was counted as 1 TMDL. This way stream segments with TMDLs for more than one parameter were not double counted.

Infrastructure

CAFO Permitted Capacity

Data Source

Confined Animal Feeding Operation (CAFO) data for the state of Colorado was provided by the Colorado Department of Public Health and Environment (CDPHE)'s based on permitted and registered CAFOs.

Methodology

CAFOs within the boundary of interest (HUC 8, 10, 12, or county) were combined to calculate a total count of animal units (standard unit of measurement for livestock) for the area.

WWTF Discharge

Data Source

Wastewater treatment facility (WWTF) data from CDPHE's Reg. 85 monitoring dataset of qualified WWTFs were summarized.

Methodology

The design capacity from WWTF within the boundary of interest (each HUC8, 10, 12 and county in the state) were summed and recorded for the total permitted capacity of WWTF in the boundary.

Count of Drinking Water Intakes

Data Source

Drinking water intake locations for the state of Colorado were provided by the Colorado Department of Public Health and Environment (CDPHE)'s with a memorandum of understanding that only a summary of the locations, not their actual locations be made available. As such, this tool and dataset are that summary.

Methodology

Each drinking water intake within the boundary of interest (each HUC8, 10, 12 and count in the state) were summed for a total count of intakes. Note that these intakes do not reflect volume of water diverted, as there is a mix of large and small intakes across the state.

Municipal Drinking Water Intakes served by this area

Data Source

See the section [Count of Drinking Water Intakes](#)

Methodology

The contributing area (drainage area) of water to each drinking water intake was processed for each boundary of interest (HUC8, 10, 12 and county in the state) to come up with a total count of how many municipalities are served by water from a given location. Note that this count does not reflect volume of water diverted and only accounts for each unique municipality (i.e. a single municipality may have multiple intakes that draw water from a single HUC8 which is counted as a single municipality in this indicator).

WATERSHED VULNERABILITY INDEX:

Land Use Change

Change in Human Use

Data Source

Land cover data was taken from the National Land Cover Dataset (NLCD) for 2011 and 2016 (Yang et al., 2018) produced by the USGS.

Methodology

Similar to the methodology in the [Percent Natural Land Cover](#) section, the NLCD data was projected, clipped to Colorado and reclassified to reflect only human use areas (the combination of agricultural and urban categories as defined in Table 1). The resulting rasters were then subtracted from each other (NLCD 2011 minus NLCD 2016) to create a raster of changes from historic where positive values indicated increases in that type of land cover and negative values indicated losses in that type of land cover. This difference raster was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state).

Change in Human Use (Riparian Zone)

Data Source

See the section [Change in Human Use](#).

Methodology

The same methodology in [Change in Human Use](#) section, was used except that the resulting layer was clipped to the riparian zone, see the [Additional Boundaries](#) section, prior to calculating zonal statistics (average) for each of the zones of interest were calculated.

Change in Developed Land

Data Source

See the section [Change in Human Use](#).

Methodology

Similar to the methodology in [Change in Human Use](#) section, NLCD rasters for developed land (urban category in Table 1) were processed for their differences since 2011 and then zonal statistics (average) for each of the zones of interest were calculated.

Change in Crop Land

Data Source

See the section [Change in Human Use](#).

Methodology

Similar to the methodology in [Change in Human Use](#) section, NLCD rasters for developed land (agriculture category in Table 1) were processed for their differences since 2011 and then zonal statistics (average) for each of the zones of interest were calculated.

Change in Natural Land

Data Source

See the section [Change in Human Use](#).

Methodology

Similar to the methodology in [Change in Human Use](#) section, NLCD rasters for developed land (natural category in Table 1) were processed for their differences since 2011 and then zonal statistics (average) for each of the zones of interest were calculated.

Projected Change in Impervious Cover

Data Source

The 2016 (present day) dataset for impervious cover was taken from NLCD (Yang et al., 2018), see the section [Percent Natural Land Cover](#) for more information. The projected imperviousness dataset was taken from Integrated Climate and Land Use Scenarios (ICLUS) dataset from the US EPA (US EPA, 2009) which was updated to version 1.3 in 2010. Of this dataset, the ICLUS A1 imperviousness was used to estimate impervious cover in 2050.

Methodology

Similar to the methodology in [Change in Natural Land](#) section, 2016 NLCD raster for imperviousness was subtracted from the 2050 ICLUS raster for imperviousness and then zonal statistics (average) for each of the zones of interest were calculated.

Protected Lands

Data Source

Protected lands were extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The summary of the USGS protected Areas Databased of the United States (PADUS 2.0) "protection_NHDPv2_WBD"NIDams_NHDPv2_WBD" was downloaded from the site above. This includes multiple assessment summaries for protected lands, but based on similar criteria

for assessment of water quality impacts of protected lands, GAP criteria 1 and 2 were the best fit for our assessment.

Methodology

Protected area (GAP1and2 in percent) were summed from HUC12 level to the HUC10 and HUC8 levels. Weighted averages of the HUC12 levels were taken to approximate county level protected lands as a higher resolution dataset was not available at this time.

Climate Change

Change in Snow to Total Precipitation Ratio

Data Source

See the section [Snow to Total Precipitation Ratio](#) for snow to total precipitation ratio data.

Methodology

See the section [Snow to Total Precipitation Ratio](#) for snow to total precipitation calculation information. A regression was fitted to the average annual snow to total precipitation ratios and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in snow to total precipitation ratio per year (inch/inch/year). Where a positive value indicates increasing snow-to-precipitation ratios (i.e. more snow fall) and a negative value indicates a decrease in snow-to-precipitation ratios (i.e. more liquid water).

Change in Average Annual Precipitation

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Precipitation](#) for how average annual precipitation was calculated. A regression was fitted to the annual data and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in average annual precipitation per year (inches/year). Where a positive value indicates increasing average annual precipitation (i.e. wetter) and a negative value indicates a decrease average annual precipitation (i.e. drier).

Change in Annual Mean Temperature

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Mean Temperature](#) for how annual mean temperatures were calculated. A regression was fitted to the annual data and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in mean temperature per year (degrees Celsius/year). Where a positive value indicates increasing mean temperature (i.e. warmer) and a negative value indicates a decrease mean temperature (i.e. cooler).

Change in Annual Minimum Temperature

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Minimum Temperature](#) for how annual minimum temperatures were calculated. A regression was fitted to the annual data and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in minimum temperature per year (degrees Celsius/year). Where a positive value indicates increasing minimum temperature (i.e. warmer) and a negative value indicates a decrease in minimum temperature (i.e. cooler).

Change in Annual Maximum Temperature

Data Source

See the section [Average Annual Precipitation](#).

Methodology

See the section [Average Annual Maximum Temperature](#) for how annual maximum temperatures were calculated. A regression was fitted to the annual data and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in maximum temperature per year (degrees Celsius/year). Where a positive value indicates increasing maximum temperature (i.e. warmer) and a negative value indicates a decrease in maximum temperature (i.e. cooler).

Hydrologic Change

Change in Average Annual Discharge

Data Source

See the section [Average Annual Stream Discharge at Outlet](#).

Methodology

The same methodology for extracting and summarizing annual discharge as described in the section [Average Annual Stream Discharge at Outlet](#) was used. A regression was fitted to the annual discharge for the representative monitoring location and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in average annual discharge (cubic feet per second per year or cfs/year).

Change in Peak Discharge

Data Source

See the section [Average Annual Stream Discharge at Outlet](#).

Methodology

The same methodology for extracting and summarizing annual discharge as described in the section [Average Annual Stream Discharge at Outlet](#) was used. However, instead of calculating an annual average value, an annual maximum or peak discharge was calculated. Then a regression was fitted to

the peak discharge for the representative monitoring location and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in peak discharge (cubic feet per second per year or cfs/year).

Change in Time to Peak of Discharge

Data Source

See the section [Average Annual Stream Discharge at Outlet](#).

Methodology

The same methodology for extracting and summarizing annual discharge as described in the section [Change in Peak Discharge](#) was used. However, once the annual maximum or peak discharge was calculated, the day of its observation was recorded. These were then used to fit a regression and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in time to peak discharge (days/year).

Change in Low Flow Discharge

Data Source

See the section [Average Annual Stream Discharge at Outlet](#).

Methodology

The same methodology for extracting and summarizing annual discharge as described in the section [Average Annual Stream Discharge at Outlet](#) was used. However, once the most recent year of data was available, a 7-day low flow for that year was calculated. The representative low flow value was then calculated for each year and a regression was fitted to it where the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in low flow (cubic feet per second per year or cfs/year).

Water Quality Change

Change in Current Concentration

Data Source

See the section [Water Quality](#).

Methodology

The same methodology for extracting and summarizing statistics of water quality parameters was used as is described in the section [Water Quality](#). A regression was fitted to the annual statistic (i.e. annual median total nitrogen) and the slope of this regression was calculated using Sen's Slope Coefficient, to quantify the change in water quality per year (units/year), where units are defined in Table 2.

Water Use

Domestic Water Use

Data Source

Domestic water use data was extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The Water Use summary "DWDbyHUC" was downloaded from the site above. This includes a summary of domestic water use in millions of gallons per day per HUC12 watershed.

Methodology

Domestic water use (IWD_MGAL) was summed from HUC12 level to the HUC10 and HUC8 levels. Weighted averages of the HUC12 levels were taken to approximate county level water use information as a higher resolution dataset was not available at this time.

Agriculture Water use

Data Source

Agricultural water use data was extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The Water Use summary "AgW_Demand" was downloaded from the site above. This includes a summary of agricultural water use in millions of gallons per day per HUC12 watershed.

Methodology

Agricultural water use (AWD_MGAL) was summed from HUC12 level to the HUC10 and HUC8 levels. Weighted averages of the HUC12 levels were taken to approximate county level water use information as a higher resolution dataset was not available at this time.

Industrial Water Use

Data Source

Industrial water use data was extracted from the [EPA EnviroAtlas](#) website's [Environmental Dataset Gateway Download Locations](#). The Water Use summary "IndustrialWD" was downloaded from the site above. This includes a summary of industrial water use in gallons per day per HUC12 watershed.

Methodology

Industrial water use (INDGAL) was summed from HUC12 level to the HUC10 and HUC8 levels. Weighted averages of the HUC12 levels were taken to approximate county level water use information as a higher resolution dataset was not available at this time.

Wildfire

Previous Wildfire Extents

Data Source

Previous wildfire and wildland fire extents for 2015 and 2016 (the latest available at this time) were extracted from the LANDFIRE program's website (LANDFIRE Program, 2019).

Methodology

Once the extents of previous wildfires were extracted, their proportion (zonal statistic) within each of the boundaries of interest (each HUC8, 10, 12, and county in the state) were calculated as a percent.

Mean Wildfire Risk

Data Source

Wildfire risk index was based on the risk assessment map by Dillon (2018) with the U.S. Forest Service. This risk index ranges from no risk (0 – water) to very high risk (5).

Methodology

The wildfire risk map ranges from low risk (1) to very high risk areas (5). It also includes categories for non-burnable areas (6) and water (7). For the purposes of this assessment, the non-burnable and water areas were ignored during calculations. The resulting risk raster map (1-5) was then used to calculate zonal statistics (average) for each of the zones of interest (each HUC8, 10, 12, and county in the state) for an average (mean) wildfire risk.

High or Very High Wildfire Risk

Data Source

See the section [Mean Wildfire Risk](#).

Methodology

Similar to the [Mean Wildfire Risk](#) calculation, this zonal statistic only incorporated the percent area of the original risk map that were high (4) or very high (5). Once this new raster of high/very high risk (1) and other (0) was created, zonal statistics (average) were used to determine the percent area of the high/very high risk category within each of the zones of interest (each HUC8, 10, 12, and county in the state).

GLOSSARY

NLCD: National Land Cover Dataset

NRCS: National Resource Conservation Service (part of USDA)

WHI: Watershed Health Index

WVI: Watershed Vulnerability Index

US EPA: United States Environmental Protection Agency

USDA: United States Department of Agriculture

USFS: United States Forest Service

USGS: United States Geological Survey

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