Nutrient and Sediment Yield

Indicator Names

- *Nitrogen Yield in Watershed*
- *Phosphorus Yield in Watershed*
- *Suspended Solid Yield in Watershed*

Indicator Category | **Stressor**

Subcategory | *Pollutant Loading Severity*

Available in RPS Tool files for all lower 48 states

Indicator Description

Background

The term *nutrients* can refer to several different elements or compounds that support plant growth but nutrient pollution is typically associated with excess *nitrogen and phosphorus* in the environment.[1] The term *sediment* broadly refers to any small solid particles that are transported into waterbodies, such as detached soil particles or plant matter.[2] Nutrients and sediment may enter waterbodies through a variety of mechanisms (surface runoff, wastewater discharge, atmospheric deposition, etc.).

What the Indicators Measure

These indicators quantify the average "yield" of nutrients and sediment from a HUC12 subwatershed* per year. A pollutant yield expresses the mass of the pollutant that is exported from a subwatershed over time on a per unit area basis (e.g., per acre or square kilometer).

- ***Nitrogen Yield in Watershed*** – average annual yield of total nitrogen from the HUC12, reported as kilograms of nitrogen per square kilometer per year. A map of HUC12 nitrogen yields is provided in Figure 1.
- ***Phosphorus Yield in Watershed*** – average annual yield of total phosphorus from the HUC12, reported as kilograms of nitrogen per square kilometer per year.
- ***Suspended Solid Yield in Watershed*** – average annual yield of total suspended solids from the HUC12, reported as megagrams of suspended solids per square kilometer per year. Suspended solids are a subcategory of sediment that are suspended in the water column of a river, lake, or other waterbody.

Relevance to Water Quality Restoration and Protection

Excess nutrients and sediment are among the most prevalent types of water pollution in the United States.[3] While some amount of nutrient and sediment input is necessary to sustain aquatic plant and animal populations and habitat, excessive amounts of either can cause harm.[4,5]

High levels of sediment can negatively affect water quality and aquatic ecosystems by decreasing water clarity, burying plants, and smothering bottom-dwelling organisms.[5] Excessive sediment inputs can also increase the costs of drinking water treatment.[6]

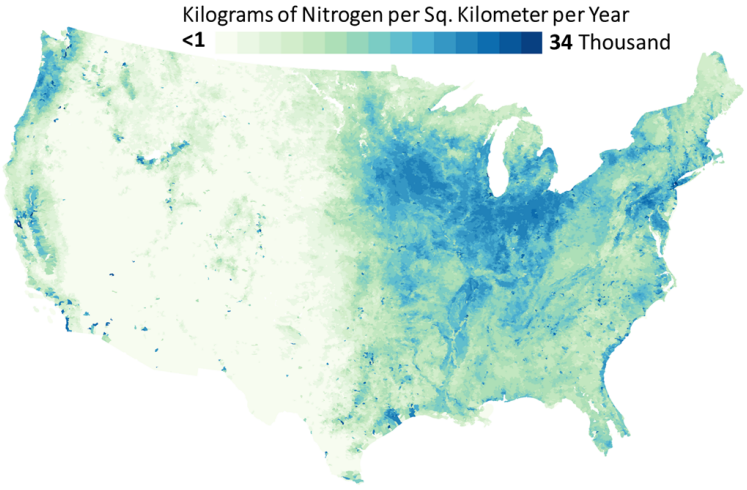

*Figure 1. Map of **Nitrogen Yield in Watershed** for HUC12s in the contiguous US.*

Nutrient pollution can degrade the environment and present concerns for human health.[4] Excessive nutrients can contaminate drinking water and significantly harm aquatic ecosystems through the impacts of eutrophication, the over-amplification of natural plant and algal growth.[4] Algae block light from aquatic plants by clouding the water and certain types of algae can be toxic to humans and animals. Eutrophication can also lead to aquatic oxygen depletion as the decomposition process that breaks down decaying algae uses up the available dissolved oxygen in the water. These low to no oxygen areas can harm or kill fish and other oxygen-dependent organisms that are unable to move to areas with more oxygen.[7]

Climate change can intensify the impacts of nutrient pollution by increasing water temperatures in some areas, which creates more favorable conditions for eutrophication.[8] Areas that experience more frequent and intense precipitation and runoff events may also face increased nutrient and sediment loading to waterbodies.

Some of the most well-known impacts of nutrient and sediment pollution occur in the Chesapeake Bay, Gulf of Mexico, and Great Lakes. Excessive nutrients and sediments in these waterbodies have significantly degraded water quality. Impacts to smaller lakes, rivers, and coastal waters are also common across the US. These cumulative impacts harm wildlife, damage human structures, and have significant economic costs.

* HUC12s are subwatershed delineations in the National Watershed Boundary Dataset. HUC12s are referenced by their 12-digit Hydrologic Unit Code.

These indicators can used to identify priority HUC12s for nutrient and sediment management. An assessment of priority HUC12s may include additional indicators that describe potential sources of nutrients and sediment, such as cropland, impervious cover, or livestock populations, to pinpoint HUC12s that combine high nutrient or sediment loads with pollutant sources that can be the focus of management planning and action.

Processing Method

These indicators are derived from U.S. Geological Survey (USGS) Spatially Referenced Regression On Watershed Attributes (SPARROW) model results. The USGS has developed regional SPARROW models that provide estimates of average annual nitrogen, phosphorus, and suspended solid loads (mass per year) across the contiguous US based on circa-2012 landscape and point source conditions.[9] The SPARROW models are calibrated to sampled concentrations of nitrogen, phosphorus, and suspended solids in surface waters.

SPARROW model results include nutrient and suspended solid loads generated within very small drainage areas, called "catchments" (Figure 2). HUC12 values of nutrient and suspended solid yields were calculated for the RPS Tool from these incremental catchment loads by overlaying catchments with HUC12 boundaries, summing the catchment loads per HUC12, and dividing by the total HUC12 area. If a catchment spanned two or more HUC12s, the load was divided according to the proportion of the catchment area in each HUC12.

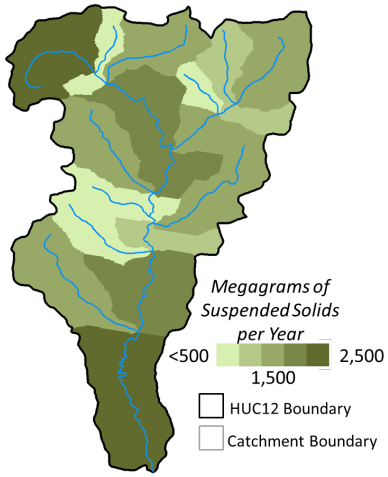

Figure 2. Example map of SPARROW model results. Displayed are incremental suspended solid loads for catchments within an example HUC12.

Limitations

- These indicators depict *average* annual nutrient and suspended solid yields based on circa-2012 landscape and point source conditions. Yields in any given year may differ due to hydrologic variability or changes in pollutant sources within a HUC12.
- SPARROW models are calibrated to water quality monitoring data and have been reviewed and evaluated by USGS modeling staff. However, error and uncertainty are inherent in all models.
- SPARROW estimates of nutrient and suspended solid loads are not available for some areas due to input data and model limitations. The indicator values may only represent nutrient and suspended solid loading in a portion of a HUC12 rather than the entire HUC12 area.
- These indicators measure nutrient and sediment pollution that is generated within the boundary of a given HUC12. Additional nutrient and sediment pollution can occur from upstream sources.

Links to Access Data and Additional Information

HUC12 indicator data can be accessed within the EPA Restoration and Protection Screening (RPS) Tool, in downloadable data files, or as a web service. Visit the EPA RPS website for links to access the RPS Tool, HUC12 indicator database, and web service.

The SPARROW model data used to calculate these indicators can be accessed from the USGS SPARROW Mapper website.

References

[1]EPA. 2021. Nutrient Pollution: The Issue. Accessed December 9, 2021.

[2]EPA. 2021. CADDIS Volume 2: Sediments. Accessed December 9, 2021.

[3]EPA. 2017. National Water Quality Inventory: Report to Congress. EPA 841-R-16-011.

[4]Conley, D., et al. 2009. Controlling eutrophication: nitrogen and phosphorus. *Science*. 323(5917): 1014-1015.

[5]Bilotta, G., et al. 2008. Understanding the influence of suspended solids on water quality and aquatic biota. *Water Research*. 42(12): 2849-2861.

[6]Dearmont, D., et al. 1998. Costs of water treatment due to diminished water quality: A case study in Texas. *Water Resources Research*. 34(4): 849-853.

[7]NOAA. 2021. Hypoxia. Accessed December 10, 2021.

[8]Glibert, P. 2017. Eutrophication, harmful algae and biodiversity—Challenging paradigms in a world of complex nutrient changes. *Marine Pollution Bulletin*. 124(2): 591-606.

[9]USGS. 2019. Spatially Referenced Models of Streamflow and Nitrogen, Phosphorus, and Suspended-Sediment Loads in Streams of the Midwestern United States. Scientific Investigations Report 2019-5114.