Empowering Tomorrow's Decision-Makers: EnviroAtlas and Ecosystem Services in the Classroom

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**EnviroAtlas** is an interactive, web-based tool that anybody can use to help inform decisions that impact the places where people live, learn, work, and play.

EnviroAtlas includes:
- Geospatial Data
- Analytic and Interpretive Tools
- Interactive Mapping Application
- GIS Toolboxes
- Educational Lesson Plans
- Guide for use in Health Impact Assessment
- Eco-Health Relationship Browser

*Developed through cooperative effort amongst multiple Federal agencies and other organizations.*
EnviroAtlas interactive tools allow users to discover, analyze, and download data and maps related to ecosystem services, or the benefits people receive from nature. Ecosystem services underpin most aspects of human well-being, including water, security, and the economy.

- EnviroAtlas Interactive Map - Discover and use hundreds of maps
- Eco-Health Relationship Browser - See the many linkages between ecosystem services and human health

Learn about EnviroAtlas Data - Spatial extents, organization, and approach
Data Matrix - Search and sort 300+ maps
Data Download
EnviroAtlas Educational Materials

- Three lesson modules, all with hands-on and outdoor portions
- Align with NGSS
- Have individual State Science Standards in Appendix of every lesson
EnviroAtlas Educational Materials

K-6
Exploring Your Watershed
Available online

4-12
Connecting ecosystems and human health
Available online

9-12+
Building a Greenway: Case Study
Available online

In development: 6 new mini lesson plans on Ecosystem Services
Lessons for all grades

Connecting ecosystems and human health

A lesson plan module that gets students outdoors, online, and thinking about connections
This lesson can be done with or without internet.

Suggested Grades: 4-12
Suggested Topics: human health, ecosystems, ecosystem services, systems, connections, interdependence

Key Concepts: Scientific literature shows that there are multiple linkages between the environment and human health outcomes.

Time Considerations
Prep Time: 30 minutes
Outdoors: up to teacher (at least 10 minutes recommended)
Eco-Health Relationship Browser: 50-70 minutes
Materials: computer(s), internet, speakers, notecards (optional)

NGSS Standards (State Standards in brackets): 4ESS3-1, 4ESS3-2, 5-ESS2-1, 5-ESS3-1, MS-LS2-2, MS-LS2-5, HS-ESS2-2, HS-ESS3-2, HS-ESS3-3, HS-ESS3-4, HS-ESS3-6, NGSS Science & Engineering Practices: 1, 4, 7, 8.

Learning Objectives
By the end of this lesson module, students will be able to:
- Define, describe, and explain ecosystem services.
- Describe characteristics of ecosystems, including local ecosystems on or near their school grounds (ecosystem type will vary based on outdoor availability near the school, such as: forested area, creek, pond, meadow, field, etc.).
- Describe the relationships of ecosystems in their local area and human health.
- Support their explanations with scientific evidence.

Key Words/Vocabulary
aesthetics   benefit   biodiversity   conservation
ecosystem   ecosystem services   habitat
human health   mitigation   recreation

Summary
This module follows the BSCS 5E model to promote student discovery and learning about the complex interactions between the environment, ecosystem services, and human health outcomes.

This module incorporates an outdoor lesson, an optional hands-on lesson, and a web-based tool developed by the US Environmental Protection Agency (EPA) called the Eco-Health Relationship Browser. The Eco-Health Relationship Browser is an easy-to-use, interactive tool that illustrates scientific evidence for linkages between human health and ecosystem services, which are the benefits that humans receive from nature. The tool links ecosystems (including urban ecosystems), ecosystem services, and human health outcomes.

Students are prompted first to explore the concept of ecosystem services, then to examine their own local environment outdoors and how it may contain ecosystem services, and finally to consider the relationships between ecosystem services and human health.

ECOSYSTEM SERVICES

Ecosystem goods and services, often shortened to ecosystem services (ES), are the benefits that humans receive from nature. These benefits underpin almost every aspect of human well-being, including our food and water, security, health, and economy.

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1 The Eco-Health Relationship Browser currently includes six ecosystem services that relate beneficially to human health issues, as reported in the scientific literature. The web tool highlights linkages that may be unfamiliar to the general population; it does not document well-known associations between public health and ecosystem "goods" such as food, fiber, and other materials. Terms to describe ecosystem services are not standardized and may vary slightly across reference materials.
<table>
<thead>
<tr>
<th>State</th>
<th>3rd Grade Science Educational Standards that apply to the EnviroAtlas “Exploring Your Watershed” Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>14. Collect information from a variety of sources to describe climates in different regions of the world.</td>
</tr>
</tbody>
</table>
| AK    | [3] SC3.2 organizing a simple food chain of familiar plants and animals (L)  
[3] SD2.1 identifying and comparing a variety of Earth’s land features (i.e., rivers, deltas, lakes, glaciers, mountains, valleys, and islands)  
[3] SE1.1 identifying local problems and discussing solutions (L) |
| AZ    | None. |
| AR    | Strand 2, PO 2. Describe science-related career opportunities.  
Strand 3, PO 1. Describe the major factors that could impact a human population (e.g., famine, drought, disease, improved transportation, medical breakthroughs).  
Strand 3, PO 2. Describe the beneficial and harmful impacts of natural events and human activities on the environment (e.g., forest fires, flooding, pesticides). |
| CA    | 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.  
3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.  
**NGSS Science & Engineering Practices (APPENDIX F):**  
1. Asking questions (for science) and defining problems (for engineering).  
2. Developing and using models.  
8. Obtaining, evaluating, and communicating information. |
| CO    | None. |
| CT    | NGSS (see CA above). |
| DC    | NGSS (see CA above). |
The EnviroAtlas Eco-Health Relationship Browser

Related Lesson Plan: “Connecting Ecosystems and Human Health”
The Eco-Health Browser

Ecosystems:
- Forests
- Urban Ecosystems
- Wetlands
- Agro-Ecosystems
- Drylands

Ecosystem Services:

Health promotional services
- Aesthetics & Engagement with Nature
- Recreation & Physical Activity

Buffering services
- Air Quality
- Water Quality
- Heat Hazard Mitigation
- Water Hazard Mitigation

30+ health outcomes:
- Asthma
- ADHD
- Cancers
- Cardiovascular diseases
- Heat stroke
- Healing
- Low birth weight
- Obesity
- Social relations
- Stress
- ... many more
Evidence-based associations

(500+ scientific articles!)

Example: 12 articles on the associations between Mental Health and Aesthetics & Engagement with Nature

The Eco-Health Browser
Lesson Plan

“Connecting Ecosystems and Human Health”

Grades 4-12
Grades 4-12: “Connecting Ecosystems and Human Health”
Grades 4-12: “Connecting Ecosystems and Human Health”

ADHD: Eco-Health Connections

Note: these are not all-inclusive. Some studies may have been left off due to space constraints.

ADHD / AESTHETICS & ENGAGEMENT WITH NATURE:
Several studies suggest spending time/exercising in green settings versus other environments has a positive effect on children with ADHD. Evidence 3: Access to green space, including gardens, parks, and playgrounds, was found to be related to fewer conduct, peer and hyperactivity problems in children (Fouri et al., 2014; n=6,384, United Kingdom). In ten-year-old children, the odds of hyperactivity or inattention problems were almost one and half times higher for children living further than 500m from urban green spaces than those within 500 meters (Markeyych et al., 2014; n=1,932, Munich, Germany).

ADHD / RECREATION & PHYSICAL ACTIVITY:
Children with ADD/ADHD experience reductions in symptoms following exercise in green environments. Evidence 1: Children with ADHD function 10% better after activities in green settings, when compared to activities indoors and activities in the built outdoor environment (Faber et al., 2001; n=46, USA).

ADHD / WATER QUALITY:
A pilot study was conducted to determine the effect of Manganese (Mn) levels in water on hyperactive behaviors in children exposed. Children who received water from a well with higher Mn concentrations (610 micro-g/L vs 610 micro-g/L) also had higher Hair Manganese (MnH) concentrations. MnH was significantly and directly associated with oppositional (defiance) and hyperactivity behaviors, two predictors of ADHD risk (Bouchard et al., 2007; n=46, Quebec).

ADHD / AESTHETICS & ENGAGEMENT WITH NATURE: Several studies suggest spending time in nature has a positive effect on children with ADHD, meaning that ADHD symptoms are reduced (Markeyych et al., 2014; n=1,932, Munich, Germany).

ADHD / RECREATION & PHYSICAL ACTIVITY: Children with ADHD experience less symptoms following exercise in green environments (Faber et al., 2001; n=46, USA).

ADHD / WATER QUALITY: One study found that children exposed to a chemical called Manganese in water showed more hyperactive behaviors (Bouchard et al., 2007; n=46, Quebec).
Grades 4-12: “Connecting Ecosystems and Human Health”

Indoor, Hands-on Portion with technology

Outdoor, Exploratory Portion

[Images of students engaged in activities]

bit.ly/EPAEnviroAtlasED
Available adaptations for varied classrooms

with and without internet

hands-on OR seated at desks

notecards for different grade levels

Grades 4-12: “Connecting Ecosystems and Human Health”
The EnviroAtlas Interactive Map

Related Lesson Plans: “Exploring Your Watershed” & “Building a Greenway Case Study”
epa.gov/enviroatlas

EnviroAtlas Interactive Map

What's New?

- Better performance | Maps and tools load faster.
- Search data layers | New search bar allows you to search for a specific data layer.
- Create a sub-set of layers | Add maps to an Active Layer List to create a list of maps based on your interests.
- Filter data | Easily filter data by topic or data extent.
- Analytical tools | New change analysis and time series viewer tools are available.
- Mobile compatibility | The Map is now accessible on tablets and smartphones.
- Icons | Demonstrate map layer connections to ecosystem service benefit categories and display geographic extent (N or C) and data type.

Click on the map to launch the application.
**Updated December 2018**
400+ map layers with National and Community-level data
EnviroAtlas Interactive Map: National Data
EnviroAtlas Featured Communities

In Progress
Complete
EnviroAtlas Interactive Map: Community Data
Additional Context: EnviroAtlas Fact Sheets
EnvirosAtlas Fact Sheets

School Days Not Lost to Illness due to Ozone Removed

This EnvirosAtlas community map estimates the number of school days per year not lost to illness due to ozone removed by trees, summarized by census block group. This dataset identifies one of the adverse health effects that can be reduced by trees in a community. These data are estimated using the U.S. EPA’s Environmental Benefits Mapping and Analysis Program (BEAMAP).

Why is avoiding school days lost to illness important?

In 2012, roughly two thirds of school-aged children missed one or more days of school due to illness or injury. Respiratory illnesses result in an average rate of school days missed of 1 to 2 days per student per year depending on geographic region. Missing even one day of school has been linked to lower academic performance, particularly in math. Additionally, if a child cannot attend school because of an illness, the parent or guardian may need to stay home as well and miss a day of work.

Several studies have found an association between elevated ozone levels and school days missed. Young adults and children are especially sensitive to high levels of ozone, which can decrease lung function and exacerbate existing lung conditions such as asthma. Exposure to elevated levels of ozone can cause cough, throat irritation, and discomfort or difficulty breathing. An absence from school indicates the relative severity of the effects of ozone on children. However, students are generally not in school during the hot summer months when ozone levels are higher, so the full impact of ozone on school absences may not be reflected in this report.

Trees help reduce the potential adverse health effects of ozone by removing it from the air. Ozone air pollutants are typically in part through the leaf trunks (pores), through some gases are removed by the plant surface. Once inside the leaf, gases diffuse into intercellular spaces and may be adsorbed by water films to form acids or react with intercellular surfaces. The removal of gaseous pollutants is more permanent than the removal of particles because the gases are often absorbed and converted within the leaf interior. Healthy trees can remove significant amounts of ozone pollutants in cities, where it is often concentrated.

How can we use this information?

The map, School Days Not Lost to Illness Due to Ozone Removed (days/year), is one of two EnvirosAtlas maps that illustrate annual productivity losses avoided that are attributable to pollution removal by tree cover. Used in conjunction with near-road and overall tree cover data available in EnvirosAtlas, this map can highlight areas in which pollution removal by trees is likely to have the greatest benefits, and which may lack natural buffers for common air pollutants. EnvirosAtlas provides demographic data that can be overlain to visualize the distribution of sensitive populations relative to the health benefits of tree cover. This map can also be used with urban planning and local health data to aid in current and future decision-making processes, such as land development, public health programs implementation, or policy changes, which could involve changes to tree cover.

What were the data for this map created?

This map layer was derived from a high resolution community-level ozone map. The total amount of tree cover (m²) was determined for each census block group. The Tree pollution removal program was then run for each block group, assuming a local source value of 0.2 and utilizing the closest locally meteorological and pollution data. Percent of county-wide tree cover was derived from the most current (2014) national land cover maps. Local leaf on and leaf off dates were used to vary canopy cover daily based on the amount of tree cover classified as evergreen. Hourly estimates of pollution removal by trees were combined with atmospheric data to estimate annual percent air quality improvement due to pollution removal for several pollutants.

Selected adverse health effects avoided due to tree cover were calculated using BEAMAP. The BEAMAP model estimates health impacts and disabled days or excess costs based on the local population and change in pollutant concentration. For EnvirosAtlas, county-level multipliers of health impact per person per change in CO were calculated and then applied to the block group. The final values incorporated the block-group changes in pollutant concentrations from U.S. and U.S. Census Bureau age distribution data released from census tracts to each block group. For more information on these methods, see the layer’s metadata or the publications below.

How can I access these data?

EnvirosAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To find the EnvirosAtlas 1-meter land cover grid created for each community, enter land cover community in the interactive map search box.

Where can I get more information?

To learn more about BEAMAP and how they can be used to support research, planning, and policy efforts, visit these respective websites. There are numerous resources on the relationships among trees, ecosystem services, and human health and well-being. A selection of some of these resources is listed below. In-depth information on the relationships between trees and human health and well-being can be found in EPA’s EnvirosAtlas and EnvirosHealth Relationships Resource. For additional information on data creation, access the metadata found in the drop-down menu for each map layer listed in the EnvirosAtlas table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnvirosAtlas Team.

Acknowledgments

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Selected Publications


“Exploring Your Watershed”
Grades K-6
Virtual Demo/Video
K-6: “Exploring Your Watershed”

Indoor, Hands-on Portion

Outdoor, Exploratory Portion

Mapping Portion
K-6: “Exploring Your Watershed”
K-6: “Exploring Your Watershed”
Available Adaptations for varied classrooms

Internet/ Self-Directed:
With and without internet, with and without self-guidance for students

K-6: “Exploring Your Watershed”

ESL:
(Sentence Frames and answer choice)

K-3:
(Teacher Script, Coloring Page, Word Search, and Comic Strip)
Teacher Handout: Exploring Your Watershed \n
Exploring Your Watershed: K-3rd grade Teacher Script

These materials are part of the EPA Report EPA-640/R-11/490a.

1. Set up the lab kits so that each group has the following supplies at its work station:
   - Bucket
   - Cloth towels or rags for drying bucket at end of lesson
   - Spray bottle
   - Washable marker(s)
   - Wax Paper
   - EnviroAtlas maps printed and placed in sheet protectors
   - Handouts: Coloring Page/Word Search/Comic Strip
   - Crayons (if using the coloring page)


2. Assign the students to groups of 3-4 each.
3. Have the students identify themselves as Partner #1, Partner #2, Partner #3, and Partner #4.
4. Read the following script:

**WAX PAPER EXERCISE**

SAY: Today we are going to learn about watersheds. A watershed is an area of land where water collects and flows to streams, rivers, and eventually to the sea.

US Environmental Protection Agency | May be reproduced for educational purposes only
“Building a Greenway: Case Study”
Grades 9-Undergraduate
Indoor, Hands-on portion with technology and maps

Collaborative, decision-making portion

9-12+: “Building a Greenway: Case Study”
9-12+: “Building a Greenway: Case Study”

Other Maps to Consider

These maps were not presented by the Parks and Recreation Department, but may be useful in considering the best plot route for the city of Canton.

Figure A1. Percent tree cover, overlaid with population twice below the US poverty level.

Figure A2. Demographic allocation of population.

Figure A2 shows the demographic allocation of population for the Canton area. This means that the population is distributed to depict where people may actually live. In the demographic map above, the darker colors represent areas where more people live and the lighter colors are where fewer people live.
Available adaptations for varied classrooms

- with and without Internet
- student roles in case study
- various extension activities

9-12+: “Building a Greenway: Case Study”
“I’m excited that these educational materials are free and easily available to students, teachers, and schools. Best of all, the educational resources are also aligned with the State Science Standards.”
—Delaine Machado, K-5 ESL teacher

“I didn’t realize that protecting the environment meant protecting the people that I love.”
—7th grade student from Durham, North Carolina
CONCLUSION

• **EnviroAtlas** is a powerful, robust, high-tech tool (that’s free!).
• We’ve built some K-12+ lesson plans that leverage **EnviroAtlas** (also free!).
• We hope you feel more confident and comfortable using EnviroAtlas and the lesson plans.
Access EnviroAtlas Educational Materials
epa.gov/enviroatlas/enviroatlas-educational-materials

Building a Greenway: A Case Study
This interdisciplinary learning module promotes student discovery using available maps and data, engaging students to be collaborative decision-makers. This case study is intended for secondary education, undergraduate, and community education/engagement programs.

Connecting Ecosystems and Human Health
This engaging 4-16 lesson plan module introduces students to the connections between ecosystems and human health by using an interactive web-based tool and a hands-on activity.

Exploring Your Watershed
This K-6 interactive lesson-plan module encourages students to explore their local watershed through a hands-on lab, an outdoor exploratory session with maps, and an EnviroAtlas web-mapping session that can be completed with or without internet. This lesson plan is now available in Spanish.
IMPACT
December 2016-July 2018

2,564 Total Participants

• **1,159** Elementary students
• **203** Middle School students
• **229** High School students
• **973** Teachers, educators, and professional staff

72% of students from low-income/low resource schools

• **3** formal training workshops
• **17** formal Conference Presentations (NSTA, ESA, NCSE, EENC, etc.)
• **17** non-formal presentations (Science Nights, STEM Expos, Earth Fairs, etc.)
• **54** classroom visits
Questions?

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Contact the EnviroAtlas Team