SUSTAINABILITY UNIT

Return to RIEEA Local Environmental Modeling for High School Students - Full Intro and Lesson Units

SUSTAINABILITY UNIT

Overview/Background

- Students will explore how sustainability in self, school, and community contexts is related to environmental justice and health outcomes, and how land use plays a role in sustainability.
- The activities explore the following topics:
    - *Climate Change*
    - *Renewable Energy*
    - *Waste Management*
    - *Heat Island Effect*
- Create an iPlan map using the following indicators:
    - *Added Heat Advisory Days*
    - *Greenhouse Gas Emissions*
    - *Particulate Matter*
    - *Housing Units*
    - *Jobs*
- **iPlan Integration**: For this unit, iPlan is best implemented at the conclusion of Lesson 1. At the conclusion of lesson one, students should have a good understanding of the challenges of individual versus collective, corporate, or legislative action to reach sustainability goals. In Lessons 2 and 3, students will be able to model and reference iPlan scenarios directly related to content. This scenario can be run in either a rural or urban community; different outcomes and topics for discussion will play out depending on whether the scenario developed is urban or rural. If time allows, it would be beneficial to run two distinct scenarios to compare and contrast rural and urban communities. Specific ways to bring iPlan maps into discussions are listed as "iPlan Integration" throughout these lessons.

Unit at a Glance

- Objectives
    - Students will be able to explain what a carbon footprint is and how it can be used as a tool to assess personal habits for sustainability.
    - Students will be able to define sustainability, environmental justice, green/alternative energy, and greenhouse gas emissions.

    - Students will be able to explain how communities can employ land use or urban planning to meet sustainability goals.
    - Students will be able to describe the role alternative energy plays in climate change.
- List of Lessons
    1. Measuring Your Carbon Footprint
    2. Sustainable School Community Assessment
    3. First-Hand Analysis for Sustainability
- Subjects
    - Civics
    - Environmental Science
    - Human Geography
- Standards Connections
    - HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
    - HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
    - HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
    - HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
    - HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
    - SSHS.CVC.5.3: The role of political interest groups
    - SSHS.CVC.5.4: Participation of citizens
    - HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
    - HS-ETS1-2 Engineering Design: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
    - HS-ETS1-3 Engineering Design: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

    - CCSS.ELA-LITERACY.RI.11-12.7: Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.
    - CCSS.ELA-LITERACY.RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
    - CCSS.ELA-LITERACY.RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
    - CCSS.ELA-LITERACY.SL.9-10.1.C: Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.
    - CCSS.ELA-LITERACY.SL.9-10.1.D: Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.
    - CCSS.ELA-LITERACY.SL.11-12.4: Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
- Connections to Other Units
    - Measuring Your Carbon Footprint connects to Urban Planning and Civil & Environmental Engineering (lesson #1 in the Community Development and Water Systems unit)
    - Sustainable School Community Assessment connects to Food Sources, Food Sovereignty Exploration (lesson #3 in the Land Conservation unit)
    - Sustainable School Community Assessment connects to Wildlife Ecology Investigation (lesson #1 in the Ecology and Human Geography unit)
    - Sustainable School Community Assessment connects to Understanding Local Ecological Issues (lesson #3 in the Ecology and Human Geography unit)
    - Sustainable School Community Assessment connects to Urban Planning and Civil & Environmental Engineering (lesson #1 in the Community Development & Water Systems unit)

- First-Hand Analysis for Sustainability connects to Urban Planning and Civil & Environmental Engineering (lesson #1 in the Community Development and Water Systems unit)

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Lesson 1. Measuring Your Carbon Footprint

This activity explores carbon footprints and how choices made by individuals and families can contribute to climate friendly or sustainable living. The iPlan scenario is best run at the conclusion of this lesson as a tool to explore the dichotomy of individual choices versus collective, corporate, or legislative choices.

⏱️ Time Considerations ⏱️

This lesson includes classroom discussion and computer activities and can be done in 1-2 hours/learning periods. Please note that lesson components can be chosen to fit your class time, such as combining a discussion and computer activity one day, and then an outdoor walk and computer activity the second day. Extension activities will require additional class periods to complete this work.

✳ Topics ✳

- Sustainable Living
- Green Energy

✏️ Materials ✏️

- laptops/tablets/Chromebooks
- notebooks
- pencils
- supplemental materials, such as data sheets and more, can be found here

💬 Vocabulary 💬

- *Carbon footprint:* A measure of the amount of carbon dioxide and other carbon compounds emitted due to the consumption of fossil fuels by a particular person, group, etc.

- *Climate change:* Climate change is a long-term shift in global or regional climate patterns. Often climate change refers specifically to the rise in global temperatures from the mid-20th century to the present and the effects thereof.
- *Equity:* The quality of being fair or impartial; fairness; impartiality.
- *Global hectare:* A biologically productive hectare with world average biological productivity for a given year.
- *Sustainability:* Fulfilling the needs of the current generation without compromising the needs of future generations.

🐝 Activities 🐝

Class Discussion: What is **sustainability**? How can individual choices and actions contribute to sustainable living?

- Ask students what sustainability is. In what context do we hear this word?
- Explain that sustainability is fulfilling the needs of the current generation without compromising the needs of future generations–it is the integration of environmental health, social **equity**, and economic vitality in order to create thriving, healthy, diverse, and resilient communities for this generation and generations to come. The practice of sustainability recognizes how these issues are interconnected and requires a systems approach and an acknowledgement of complexity.
- Explain that we need to think sustainably more now than ever before to save our communities from the most damaging effects of **climate change**.
- Allow students an opportunity to brainstorm ways or examples of individual actions that contribute to sustainability.
- Discuss collective action and how it contributes to sustainability.

Carbon Footprint Quiz: Introduce what a **carbon footprint** is and have students determine their individual footprint.

- Explain to students that sustainability happens at many different levels, with global agreements, national policy, statewide initiatives, community action, and individual action. This exercise will help students to evaluate their own lifestyle and household and come up with recommendations for change. One way that this can be done is through a footprint audit or quiz. The quiz we will take measures our carbon footprint.

    - The Carbon Footprint Quiz estimates the area of land and ocean required to support your consumption of food, goods, services, housing, and energy, and assimilate your wastes.
    - Your ecological footprint is expressed in "**global hectares**" (gha) or "global acres" (ga), which are standardized units that take into account the differences in biological productivity of various ecosystems impacted by your consumption activities. Your footprint is broken down into four consumption categories: carbon (home energy use and transportation), food, housing, and goods and services. Your footprint is also broken down into four ecosystem types or biomes: cropland, pastureland, forestland, and marine fisheries.
- Students take the Carbon Footprint Quiz.
- After all students have completed the quiz, use the following questions to have a brief discussion addressing what the quiz tells us.
    - What do young people have control over?
    - What areas of your life have the biggest impact?
    - What areas of your life are easiest to change?
    - How does the US compare to other countries?
    - How does carbon footprint affect sustainability?
    - What aspects of sustainability do we not have control over?
    - Who controls the choices we have?
    - How do our choices relate to equity?
    - In what ways does this relate to climate change and climate change impacts?
- **iPlan Integration:** Refer to your iPlan scenario: As you tried to decrease *greenhouse gas emissions* and *added heat advisory days*, how did that impact jobs and/or other community members' needs? Can municipal development help lower individuals' carbon footprints? If so, how?
- In student science notebooks, ask students to reflect on what, if anything, surprised them upon taking the quiz. What areas of their footprint do they have control over? Do individual actions matter?

Extension Activities

Research Activity:

- Have students research the history of measuring carbon footprints. Who created and promoted this tool?

- Research which individual choices are most or least impactful on a carbon footprint. Which collective actions might contribute more meaningfully to sustainability?

Reflection Activity: Ask students to reflect on what they might be able to change in their lives over the course of the next week or two to lower their carbon footprints. Ask students to reflect on the tension between policy change vs asking individuals, corporations or communities to make voluntary changes.

- Students can reflect on how easy or difficult it is to make those changes.
- Students can extend their learning to their households by asking family members to take the same quiz and then compare their scores.

Community Member Interviews: Students can interview someone in their family, school, or community who makes sustainable choices such as getting around without a car, eating vegan, or living in a tiny home.

📚 Additional Resources 📚

- The Nature Conservancy: Understanding Your Carbon Footprint
- BBC News: Climate Change and Your Carbon Footprint
- The New York Times: Reduce your Carbon Footprint
- Carbon Tax Center: Carbon Pricing and Environmental Justice
- Center for Climate Justice: Lower Your Carbon Footprint? Sure...But Don't Stop There!
- Solar Energy Insights: State Per Capita Carbon Emissions

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Lesson 2. Sustainable School Community Assessment

This activity explores sustainability within students' school community–in what ways can a school community come together to make sustainable choices? An iPlan scenario should be run prior to starting this lesson and then revisited at the conclusion of this lesson.

⏱️ Time Considerations ⏱️

This lesson includes outdoor and computer activities that can be done in 2-3 hours/learning periods. Please note that lesson components can be chosen to fit your class time, such as combining a discussion and computer activity one day, and then an outdoor walk and computer activity the second day. Extension activities will require additional class periods to complete this work.

✳ Topics ✳

- Green Energy
- Systems Thinking
- Environmental Literacy

✏️ Materials ✏️

- laptops/tablets/Chromebooks
- notebooks
- pencils
- supplemental materials, such as data sheets and more, can be found here

💬 Vocabulary 💬

- *Bioswale:* Channels designed to concentrate and convey stormwater runoff while removing debris and pollution.

- *Food systems:* All the elements and activities related to producing and consuming food, and their effects, including economic, health, and environmental outcomes.
- *Green building:* A building that, because of its construction and features, can maintain or improve the quality of the environment in which it is located.
- *Green energy:* Energy that can be produced using a method, and from a source, that causes no lasting harm to the natural environment.
- *Sustainability:* Fulfilling the needs of the current generation without compromising the needs of future generations.
- *Urban planning:* The branch of architecture dealing with the design and organization of urban space and activities.

🐝 Activities 🐝

Class Discussion:

- Review **sustainability** and the 3 Es that drive sustainability: environment, equity, economy. How do they intersect?
- Discuss the role that institutions can play in sustainability and climate action; individual action is not enough. Actions must take place at the individual, institutional, community/city, state, regional, federal, and global level. State, regional, federal, and global actions are arguably the most important as they have the largest reach.

Walking School Sustainability Assessment:

- Take a walk around the school (both indoors and outdoors) and observe the site through the lens of sustainability. Systematically examine the building(s) and outdoor areas to determine the use of energy and resources and how sustainability could be improved. Think about the 3 Es of sustainability.
- Students should document in their notebooks all the evidence they observe of "good" sustainability practices and "poor" sustainability practices. Examples could include: **green building** practices such as: solar panels, passive solar, energy efficient heating and cooling, recycled materials, local foods composting, food services, **bioswales** and rain gardens, native plantings, impervious surfaces, energy efficient lighting, environmental curriculum or lack of, green cleaning products, old insulation, poor window seals, lack of natural light, oil heat, building temperature regulations, etc.

- After the walk, students compile a list of what they observed. This list should then be broken down into categories: **food systems**, stormwater mitigation, environmental literacy, **green energy**, etc. Use the following questions to have the students reflect, either individually in notebooks or in a discussion or both:
    - Where does our school do well? Where are we weak? What action can our class take to help enhance our sustainability practices?
    - Where and how extensively have energy and water conservation measures been used?
    - Are there ways to improve recycling practices? Reduce waste? Reuse materials?
    - Is solar possible? If so, where would it go?
    - Can our school collect and make use of greywater systems?
    - Can landscaping be improved with more native plantings, drought tolerant species, or plantings in general?
    - Is agriculture possible here?
    - How much pavement is there? Can that be changed?
    - How much tree canopy is there? Can more be added and how easy would that be?
    - Are there sustainability classes or clubs?
    - Is climate change woven into the curriculum? If not, how could it be?
    - Does **urban planning** have an affect on our school's sustainability?
    - Are there **urban planning** decisions that could be made to make our school community more or less sustainable?
- Debrief and compile a list of observations.
    - How would students rate the sustainability of the school?
    - Where is the school successful and where does it fall short?
    - Are there actions this class or students in this class can take to help improve campus sustainability?
- **iPlan Integration:** Refer to your iPlan scenario: Are there small scale planning decisions that our school or school district can make to help achieve some of our desired goals for sustainability? How much land does a school or school district own? Can some of it be rezoned to create lower greenhouse gas emissions, etc.? In iPlan, make some zoning changes to make more green space, how does that change levels of greenhouse gas emissions or numbers of heat advisory days?

🪁 Extension Activities 🪁

Interviews:

- Have students interview a local green/sustainable building company. What benchmarks do they use for achieving sustainability? What motivates them?

Field Trip:

- Have students tour a local LEED certified building. What practices do they see in a LEED Gold, Silver, or Platinum building that are in their school or lacking in their school?

Data Analysis:

- Measure and compare runoff at the site of a rain garden or bioswale and a traditional impervious surface.
- Measure and compare the temperature of a site with green space and one with asphalt or concrete.
- Track where your school's food comes from and determine its associated carbon footprint.

Civic Engagement: Research and develop a sustainability action plan for your school and present it to decision-makers (i.e., school administrators, school committee members, town council members, etc.).

📚 Additional Resources 📚

- Sustainable Schools: Sustainability Assessment Questionnaire
- National Wildlife Federation: Certified Sustainable School Campus

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Lesson 3. First-Hand Analysis for Sustainability

This activity explores the concept of sustainability in the context of larger community planning efforts–it specifically asks students to reflect deeper on the ways equity and justice play out in our sustainable planning decisions. For this lesson, an iPlan scenario should have already been run (as part of lessons 1 and 2). However, for this lesson new scenarios can be run that compare and contrast two communities (e.g., urban versus rural, or climate justice community versus non-climate justice community) to explore more systematic connections between planning and sustainability.

⏱️ Time Considerations ⏱️

This lesson includes computer activities and can be done in 3-4 hours/learning periods or during a half-day field trip. Please note that lesson components can be chosen to fit your class time, such as combining a discussion and computer activity one day, and then an outdoor walk and computer activity the second day. Extension activities will require additional class periods to complete this work.

✳ Topics ✳

- Systems Thinking
- Urban Planning
- Civil Engineering

✏️ Materials ✏️

- laptops/tablets/Chromebooks
- notebooks
- chart paper and/or poster board
- pencils
- supplemental materials, such as data sheets and more, can be found here

💬 Vocabulary 💬

- *Climate resiliency:* Successfully coping with and managing the impacts of climate change while preventing those impacts from growing.
- *Climate mitigation:* Refers to efforts to reduce or prevent emission of greenhouse gasses.
- *Environmental justice:* The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies, and the effort to address systemic, structural, or historical inequities in the distribution of negative environmental effects.
- *Regional planning:* Addresses planning issues that cross local jurisdictional boundaries, like transportation or watershed protection. In other examples, regional planning offers a holistic approach to the interconnected systems and dynamics that shape physical and cultural landscapes.
- *Sustainability:* Fulfilling the needs of the current generation without compromising the needs of future generations.

🐝 Activities 🐝

Classroom Discussion: Introduce this lesson by asking your students the following questions:

- What is **sustainability**?
- What makes for a sustainable community?
- What experiences have students had in sustainable communities?

Research Activity and/or Homework: Read local histories ahead of time to ground students in the historical context.

Outdoor Activity: A walking tour is one of the best ways to understand sustainability as it relates to city or **regional planning** and equity. Going for a walk allows students to see how a particular place has evolved in the past and how it may change and become more sustainable in the future. Be sure to have the students bring their notebooks to take notes.

- A walking tour works best in a more dense area or an area where there are a lot of unique land features, people, development, and/or traffic. If you have access to bikes, that is another way to do

this exercise. Choose an area that has some historical buildings, some new buildings, a diversity of building types, a variety of land uses, and ecosystems.

- Prepare a tour route ahead of time and develop some mini-lessons to implement along the way, such as calculating residential densities in several sites, brainstorming traffic-calming strategies, and the art of making observations.
- Explain to students that they will be observing the local environment firsthand to see how it has evolved in the past and how it may become more sustainable in the future.
- Be sure to move slowly to allow information about the local environment to be observed. Some questions that can be asked along the way include:
    - Can you see opportunities for ecological restoration? Improved street design? New development?
    - When was this place built? What clues tell us that?
    - What was this place like 100 years ago? 300 years ago? 1,000 years ago?
    - What might this place be like in 10, 20, or 100 years from now?
    - Try to imagine how a certain street or block may look in the future. What sustainability or planning strategies could help reach those goals?
    - How does this place feel to you? What specific features make it feel that way? How would you change them if you could?
    - Who do you observe using this place? What are they doing? Are there any people that might not feel comfortable here?
    - How are people using particular spaces? Which groups may feel welcome? Which groups may not feel welcome?
    - What kinds of people live, work, and play here? What clues tell us this?
    - How big are the lots? How big are the houses? How are the buildings positioned on the lots?
    - How wide are the sidewalks? Are there sidewalks? Bike paths?
    - How are the streets designed? How wide are the streets? Are there features that make it more or less pedestrian or bike friendly? Are there ways to make it more pedestrian friendly or bike friendly?
    - Where is the nearest park or open area? Is it accessible to people?
    - Are there opportunities to make more green space?
    - What elements of the original ecosystem remain? Can any habitat be restored or created to increase biodiversity or mitigate climate change?
    - Where is the nearest waterway? How would water drain in this place?

    - Are there elements that give the place historic or cultural significance?
    - Is there any evidence of **climate mitigation**?
- **iPlan Integration:** Refer to your iPlan scenario: using your first-hand analysis, ask yourself many of the same questions of your modeled scenario. How do the answers to those questions make you want to change your plan? If you change your plan in response to those questions, how do your social or economic indicators change? How do stakeholders' opinions change?

Reflection Activity: Once the walking tour is complete and all the questions are addressed, lead the class through a formal debrief/reflection activity.

- Key areas to discuss include:
    - **Climate resiliency** and **climate mitigation**
    - Equity and **environmental justice**
    - Sense of community
    - The role of transportation
- After the discussion, ask students to write about the walking tour. They can be asked to write four (4) paragraphs, each one addressing a topic above.
- Finally, invite students to do a mapping exercise to reimagine this place. What makes for their version of a utopian sustainable community? Students should work in teams and use chart paper and/or poster board to complete this phase of the assignment.

Class Presentations: Once the posters are complete, each student team presents their vision of a sustainable community to the class.

- How does the utopian version they created for themselves in the absence of stakeholders compare to the map(s) they created in iPlan?
- What steps could be taken to bring more stakeholders onboard to their utopian vision?

Extension Activities

Community Leaders:

- Invite an expert in sustainable planning to speak to the class. Some organizations to reach out to are Rhode Island School of Design, University of Rhode Island, Providence Sustainability Office, etc.

- Students can interview a family member or community elder and learn their story of their community.

Research Activity: Review historical archives of your community through the lens of sustainability.

Field Experience: Tour a LEED-certified building or sustainably-designed school. Rhode Island's newer and recently renovated schools are required to have sustainable features.

📚 Additional Resources 📚

- Going Green: Sustainable Cities Around the World
- City of Providence: Sustainable Providence Plan
- City of Providence: Climate Justice Plan
- City of Boston: Climate Action Plan
- Public Square: A CNU Journal: Designing Cities for Climate Change and Sustainability
- Digi: 6 Traits of a Sustainable City (With Examples)

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SUPPLEMENTAL MATERIALS

In an effort to further support your implementation of these lesson units, we have created a Google folder with examples of student data sheets, vocabulary lists, detailed lesson notes, and more. The materials in this folder, entitled Supplemental Materials for iPlan Lesson Units (RIEEA), were developed by the Rhode Island Environmental Learning Council when they piloted the lessons in classrooms across the state. You are free to use any of them as they are, or with your own modifications.

- *Supplemental Materials for Sustainability Unit*

Please note that some units have many supplemental materials, whereas others do not. If you create or find other materials that you would like to share with others, please email them to info@rieea.org with the subject line: "iPlan Supplemental Materials suggestion". Please be sure to specify which unit and lesson they are meant for, and we will add them to the relevant folder.

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