2017

Big World, Small Planet – Module 4: Wants Versus Needs: Pushing the Boundaries, Teacher Edition

Facing the Future, Western Washington University

978-1-940829-13-5

BIG WORLD, SMALL PLANET

Module 4: Wants Versus Needs: Pushing the Boundaries

Teacher Edition



A comprehensive guide to global issues and sustainable solutions

Facing the Future

BIG WORLD,

SMALL PLANET

A Comprehensive Guide to Global Issues

and Sustainable Solutions

Teacher Edition

Facing the Future

BIG WORLD, SMALL PLANET

Module 4: Wants Versus Needs: Pushing the Boundaries
Teacher Edition

ISBN 978-1-940829-13-5

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

About Facing the Future

Facing the Future is a program of Western Washington University. Facing the Future's mission is to create tools for educators that equip and motivate students to develop critical thinking skills, build global awareness, and engage in positive solutions for a sustainable future.

Facing the Future develops and delivers standards-based hands-on lessons, student texts, curriculum units, and professional development opportunities for educators. Facing the Future curriculum is in use in all 50 U.S. states and over 140 countries by teachers and students in grades K-12, in post-secondary education, and across multiple subject areas. Facing the Future reaches over 1.5 million students through its programming.

For more information, visit **www.facingthefuture.org**.

WESTERN WASHINGTON UNIVERSITY

The Facing the Future Program
Western Washington University
516 High Street, MS-9102
Bellingham, WA 98225
www.facingthefuture.org

Table of Contents

Table of Contents

Activities *continued*

To the Teacher

Here are a few comments about getting started with the Activity Guide.

1. **Teacher Edition Contents:** Some material is provided only in the Teacher Edition. In addition, the Teacher Edition also includes work papers to be copied and handed out to students when needed.

2. **Reading Assignments:** Activities note which pages should be read to prepare for that particular assignment. The unit schedule notes the pages that are required pre-reading for the activity to be done each day. It also lists recommended reading for each day of a 20-day unit. This recommended reading schedule spreads the reading over the 20-day unit and will have students prepared for each day's activities.

3. **Field Books:** Students will prepare Field Books at home after Day 1 of the unit. In the Field Books, students will record their work during the unit; write reflections on class activities; and describe daily observations of wild nature, using both sketches and text.

   The Field Books can be created using binders, 8-1/2" by 11" composition books, spiral-bound notebooks, or stacks of paper held together with brads or binder clips. Students will need to add pages from time to time; if you use bound or spiral notebooks, students will need tape or glue pages into their Field Book occasionally.

4. **Field Book Reflections and Discussion Questions:** Daily activities have Discussion Question and Field Book sections at the end. Discussion questions relate to the classwork. Field Book instructions include prompts for nature journaling, references to Think About It boxes in the day's reading assignment, and sometimes other reflection questions or activities.

   You may also choose to ask students to answer some of the Discussion Questions in their Field Book reflection pages instead of discussing them in class. You can also choose – or let students choose – which Think About It boxes you would like students to respond to in writing; there are probably more than you will want to assign on some days.

5. **Unit Schedule:** A proposed unit schedule is included. The schedule includes daily activities, reading needed for the assignment, text reading assignments, and a summary of Field Book activities and reflections.

6. **Academic Standards:** U.S. Next Generation Science, Common Core, and National Council for the Social Studies high school standards are provided. Middle school standards are available on the Facing the Future website.

Suggested Unit Schedule

Day	Recommended Reading	Required Pre-Reading for Activity	Activities	Field Book Reflections and Observations
1	Pages 1-5		Activity One ***Consumption Then and Now, Part 1*** Activity Two ***Set Up Field Book*** Activity Three ***Nature Journal*** ***Homework*** Activity Four Preparation Students collect print advertisements (please see activity for more details)	***Nature Journal*** See Activities 1 and 3 ***Think About It*** boxes, Pages 5 and 6
2	Pages 6-12 (through Causal Loop Diagram)	Pages 4-5 Activity Background Information section, page 62	Activity Four ***Advertising: What Are They Selling?***	***Nature Journal*** ***Think About It*** boxes, Pages 7 and 10
3	Pages 12-15 (up to Local to Global section)	Pages 8-12 (through the Causal Loop Diagram)	Activity Five ***Nature and the Materials Economy*** ***Homework*** Activity 7 preparation Students collect information on clothing they or their families own	***Nature Journal*** ***Think About It*** box, Page 11 Update ***Learning Links*** Page Update ***Questions*** Page
4	Pages 15-19	Pages 13-15 (up to Local to Global section)	Activity Six ***Ecological Footprint***	***Nature Journal*** ***Think About It*** boxes, Page 15 (two boxes)
5		Pages 15-19	Activity Seven ***Closet Connections*** Day 1	
6	Pages 20-21		Activity Seven ***Closet Connections*** Day 2	***Nature Journal*** ***Think About It*** box, Page 16 Update ***Learning Links*** Page Update ***Questions*** Page
7	Pages 22-23		Activity Eight ***Consumption Then and Now, Part 2***	***Nature Journal*** ***Think About It*** boxes, Pages 17 and 19
8	Pages 24-26	Review Pages 8-13 Read Pages 18-19, 24-26 Read Activity Background Section, page 73	Activity Nine ***Nature, the Materials Economy, and Feedback***	***Nature Journal*** ***Think About It*** box, Page 20
9	***Review*** Pages 1-26	Review Pages 1-21 Read Pages 20-26	Activity Ten ***Sustainability Skill Building: Decision-Making, Part 1***	***Nature Journal*** ***Think About It*** boxes, Page 21 (two boxes) Update ***Learning Links*** Page Update ***Questions*** Page
10	***Pre-Reading for Unit 2*** Pages 27-34	Review Pages 1-26	Activity Eleven ***Consumerism Reflections, Self-Assessment, and Commitments***	
11	Pages 34-41	Pages 27-29 (up to Understanding Climate)	Activity Twelve ***Climate Questionnaire*** Activity Thirteen ***Weather and Climate***	***Nature Journal*** New ***Learning Links*** and ***Questions*** Pages in ***Field Book***

Day	Recommended Reading	Required Pre-Reading for Activity	Activities	Field Book Reflections and Observations
12	Pages 35-41	Review Pages 29-32 Pages 36-41	Activity Fourteen ***"Beat the Heat" Climate Awareness Game***	***Nature Journal***
13	Pages 42-47	Critical Thinking Guidelines Page 22 Read Pages 35-41 Activity Background, Pages 85-89	Activity Fifteen ***Evaluating Claims: Climate Change Science and the Scientific Method*** Day 1	***Nature Journal***
14	Pages 48-52		Activity Fifteen ***Evaluating Claims: Climate Change Science and the Scientific Method*** Day 2	***Nature Journal*** ***Think About It*** box, Page 29 Update your ***Learning Links*** Pages Update your ***Questions*** Page
15	Pages 53-55	Pages 37-42	Activity Sixteen ***Carbon Footprint***	***Think About It*** boxes, Page 30
16		Review Pages 22-23 Review Earth Charter Principles, Page 45 Read Pages 48-55	Activity Seventeen ***Sustainable Skill Building: Sustainable Decision-Making, Part 2***	***Nature Journal*** ***Think About It*** boxes, Page 32
17		Review Pages 29-32, 38-39, 45-46 Review Field Book notes and work papers	Activity Eighteen ***Climate Change and Systems Thinking***	***Nature Journal*** ***Think About It*** box, Page 33 Update your ***Learning Links*** Pages Update your ***Questions*** Page
18		Review Pages 27-55	Activity Nineteen ***Effective Climate Change Communication*** Day 1	***Nature Journal*** ***Think About It*** box, Page 35
19		Review Pages 27-55	Activity Nineteen ***Effective Climate Change Communication*** Day 2	***Nature Journal*** ***Think About It*** box, Page 45 Update your ***Learning Links*** Pages Update your ***Questions*** Page
20		Review Pages 27-55	Activity Twenty ***Climate Questionnaire Revisited*** Activity Twenty-One ***Climate Change Reflections, Self-Assessment, and Commitments***	

Academic Standards

The following standards are addressed in this module.

Standard	Description
Next Generation Science Standards - High Schoool[i]	
Disciplinary Core Ideas	
HS-PS3.D	Energy in Chemical Processes: The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.
HS-LS1.C	The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
HS-LS2.B	Cycles of Matter and Energy Transfer in Ecosystems: Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Plants or algae form the lowest level of the food web.
HS-LS2.C	Anthropogenic changes (induced by human activity) in the environment – including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change – can disrupt an ecosystem and threaten the survival of some species.
HS-LS4.C	Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.
HS-LS4.D	Biodiversity and Humans: Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
HS-ESS2.A	Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (e.g., ice ages) to very long-term tectonic cycles.
HS-ESS2.C	Role of Water: The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.
HS-ESS2.D	Weather and Climate: Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.
	The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.
	Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
HS-ESS2.E	The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

Standard	Description
HS-ESS3.A	All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
HS-ESS3.C	Human Impacts on Earth Systems: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
	Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation
HS-ESS3.D	Global Climate Change: Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.
	Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.
HS-EST1.A	Defining and Delimiting Engineering Problems: Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
	Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
HS-EST1.B	Developing Possible Solutions: When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.
Science and Engineering Practices	
Constructing Explanations and Designing Solutions	Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
Engaging in Argument from Evidence	Construct an oral and written argument or counter-argument based on data and evidence. Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.
Developing and Using Models	Use a model based on evidence to illustrate the relationships between systems or between components of a system.
Obtaining, Evaluating, and Communicating Information	Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
Crosscutting Concepts	
Systems and System Models	Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales.
	When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
Cause and Effect	Cause and effect relationships can be suggested and predicted for complex natural- and human-designed systems by examining what is known about smaller scale mechanisms within the system.

Standard	Description
Stability and Change	Change and rates of change can be quantified and modeled over very short or very long periods of time. Feedback (negative or positive) can stabilize or destabilize a system.
Energy and Matter	Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
Patterns	Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
Connections to Engineering, Technology, and Applications of Science	
Influence of Science, Engineering, and Technology on Society and the Natural World	New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
Connections of Science to Nature	
Science Addresses Questions about the Natural and Material Worlds	Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
	Science knowledge indicates what can happen in natural systems – not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
	Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.
National Council for the Social Studies Thematic Strands[ii]	
Time, Continuity, and Change	Knowledge and understanding of the past enable us to analyze the causes and consequences of events and developments, and to place these in the context of institutions, values and beliefs of the periods in which they took place.
People, Places, and Environments	The study of people, places, and environments allows us to understand the relationship between human populations and the physical world.
	Learners develop an understanding of spatial perspectives and examine changes in the relationship between people, places and environments.
	Apply knowledge, skills and understandings to today's social, cultural, economic and civic issues: How do people interact with the environment and what are the consequences of those interactions?
Individual Development and Identity	Questions related to identity and development are central to understanding who we are. Who do individuals grow and change physically, emotionally and intellectually? Why do individuals behave as they do? What influences how people learn, perceive, and grow? How do people meet their basic needs in a variety of contexts? How do social, political, and cultural interactions support the development of identity?
Power, Authority, and Governance	Students study dynamic relationships between individual rights and responsibilities, the needs of social groups, and concepts of a just society. Become more effective problem-solvers and decision-makers.
Production, Distribution, and Consumption	People have wants that often exceed limited resources. Unequal distribution of resources leads to systems of exchange. Economic decisions are increasingly global. Students need to study interdependent world economy and role of technology in economic growth.
Science, Technology, and Society	Science, and its practical application, technology, influence social and cultural change and ways people interact with the world. Modern life, as we know it, would be impossible without technology and the science that supports it.
	Students think analytically about the consequences of change and how we can manage science and technology to increase benefits to all.

Standard	Description
Global Connections	Analyses of the costs and benefits of increased global connections, and evaluations of the tensions between national interests and global priorities contribute to the development of possible solutions to persistent and emerging global issues. By interpreting the patterns and relationships of increased global interdependence, and its implications for different societies, cultures and institutions, students learn to examine policy alternatives that have both national and global implications.
Civic Ideals and Practices	High school students increasingly recognize the rights and responsibilities of citizens in identifying societal needs, setting directions for public policies, and working to support both individual dignity and the common good. They become familiar with methods of analyzing important public issues and evaluating different recommendations for dealing with these issues.
Common Core Language Arts[iii]	
CCSS.ELA-LITERACY. RH.9-10.4	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.
CCSS.ELA-LITERACY. RH.9-10.7	Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
CCSS.ELA-LITERACY. RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCSS.ELA-LITERACY. W.9-10.1.A	Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
CCSS.ELA-LITERACY. W.9-10.1.D	Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY. W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
CCSS.ELA-LITERACY. W.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY. W.9-10.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
CCSS.ELA-LITERACY. W.9-10.10	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
CCSS.ELA-LITERACY. SL.9-10.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
CCSS.ELA-LITERACY. SL.9-10.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
CCSS.ELA-LITERACY. SL.9-10.1.B	Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.
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.

Standard	Description
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.9-10.4	Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
CCSS.ELA-LITERACY. SL.9-10.6	Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

Unit 1

Introduction to Consumerism

Essential Questions For This Unit

1. *How can I make more sustainable consumer choices?*
2. *Where do the things that I use go at the end of their useful life?*
3. *Who made the things that I use? What is life like for those people?*
4. *How does my consumption of goods affect overall global sustainability?*

Introduction to Consumerism

In 1955, the economist Victor Lebow made this statement:

> *Our enormously productive economy... demands that we make consumption our way of life, that we convert the buying and use of goods into rituals, that we seek our spiritual satisfaction, our ego satisfaction, in consumption... We need things consumed, burned up, worn out, replaced, and discarded at an ever increasing rate.*[1]

It is not clear whether Mr. Lebow meant to encourage or simply recognize consumption as a driver of our economy. Either way, he correctly described the global economy today. For example, according to the World Bank, consumer spending has accounted for about two-thirds of the United States' economy since 2000, and similar patterns of consumption can be seen in many other developed countries including Sweden, Venezuela, India, and Great Britain.[2]

developed country:
A country that has an advanced technological infrastructure and in which average income is higher than average, compared with other countries in the world. Sometimes the term "More Economically Developed Country" is used to refer to countries in this category.

developing country:

A country that does not have an advanced technological infrastructure or in which average income is less than average compared with other countries in the world. Sometimes the term "Less Economically Developed Country" is used to refer to countries in this category. The poorest countries in the world are sometimes referred to as "Least Developed Countries."

Consider these 2015 global statistics:

- $247 billion was spent on beauty care products, including shampoo, cosmetics, and nail polish.[3]
- $39 billion was spent on ocean cruises.[4]
- $70 billion was spent on pet food.[5]

Everyone must consume resources like food and water in order to survive. We also use resources for personal enjoyment, such as with entertainment and leisure. **Consumption** refers to the use of goods and services – from eating at a restaurant to buying a t-shirt. When people purchase goods and services, we call these people **consumers**. Every time we buy groceries, get a haircut, or hire a plumber, we are acting as consumers.

Consumerism is related to consumption, but it describes a particular worldview related to our consumption patterns. Consumerism can be defined as "the cultural orientation that leads people to find meaning, contentment, and acceptance through what they consume."[6]

Examining our consumption patterns is important for sustainability. Everything we consume requires materials and energy from nature. In fact, since consumerism took hold a century or so ago, people have used more resources than we used in all the preceding years of human history. Consumption also affects our social and economic systems through business activities and employment. The impact of each individual's personal consumption patterns affects the broader economy, the environment, and society.

A New Consumer Society

A good definition of sustainability is a safe and just world for all species, forever. We can move toward the goal of sustainability by developing a sustainability worldview, which encompasses our knowledge, values, capabilities, and behaviors. Keep this idea of sustainability in mind as we look at the emergence of the consumer society.

Consumerism and Industrialization

Modern consumerism grew in parallel with the Industrial Revolution, beginning in the mid-1800s. By the 1920s, new factories produced mass quantities of standard products and established name brands. These new products began to replace locally made goods. Before long, large department stores and mail order catalogs offered these new goods to people across the country. Mass production brought costs down, allowing many people to own such items as washing machines, toasters, and refrigerators. As more people moved from farms to cities, buying food and clothing became more practical than making them at home. And mass production made manufactured goods more affordable.

The transition to an industrial economy caused a major change in the norms, habits, and values of people in developed countries. At the beginning of the Industrial Revolution, thrift and modesty were important values. As industrialization and modern consumerism expanded, values like individualism, appreciation for new things, and **conspicuous consumption** became more common.

conspicuous consumption:

Consumption of luxury items as a way to increase one's status or prestige. Buying and using more than one needs in order to keep up with current trends and styles.

Advertising and Media

As industrialization created new products and bigger businesses, advertising helped bring in new customers. For the first time, advertisements featured eye-catching images and persuasive language. Advertisers tapped into the emerging field of psychology, encouraging the belief that buying something would make the buyer more attractive, successful, or accepted.

Advertisers and manufacturers promoted a practice of **artificial obsolescence**. This practice encourages buyers to replace working appliances, clothing, cars, and other goods with newer, more fashionable ones. One advertising executive noted that artificial obsolescence called for redesigning products "entirely apart from any mechanical improvement, to make them markedly new, and encourage new buying, exactly as the fashion designers make shirts longer so you can no longer be happy with your short ones."[7]

Today, advertising is a big business – and children and teens are a major target. Children in the United States watch an estimated 40,000 commercials each year, and in the United Kingdom, children watch about 10,000 each year.[8] In 2013, advertisers spent $171 billion in the United States alone.[9]

Advertising is delivered in new ways with today's technology. Social media platforms and search engines track personal preferences and deliver ads targeted to the user's likely buying habits. Manufacturers develop games, also known **advergames**, which feature products and blur the line between advertising and games. Online shopping offers new goods with few clicks of a computer mouse. This method of shopping is rapidly replacing paper catalogs that are mailed to our homes. Advertisers are even using brain science to study how people's brains react to different advertising practices, using the results to design more and more persuasive ads.

Television and movies also influence consumerism. These forms of entertainment showcase lifestyles of wealth and luxury and standardize clothing and car choices. And both movies and television show characters using products, providing subtle influence through a practice known as product placement. This practice is actually a form of advertising in which manufacturers pay television and film companies to feature their products in movies or on TV programs. **Product placement** is the reason you may see your favorite actress sipping a popular soft drink or wearing a particular brand of athletic shoe in her next film.

Pervasive advertising aimed at children makes consumerism seem normal and inevitable – but it is not. Sweden, Norway, the United Kingdom, Greece, and the Canadian province of Quebec all limit advertising that is intended for children.

Think About It!

Some people own digital video recorders (DVRs), electronic tablets, or cable television boxes that let them watch television shows and movies any time they like, without advertising. From the standpoint of sustainability, what are the pros and cons of owning more electronic devices compared to avoiding the influence of advertising?

disposable income:

The money that a household or person has left after all mandatory taxes and fees owed to the government have been paid.

Technology and Change

Today, we are accustomed to change. New products, new movies, and new fashions come and go quickly. In the 1920s, people were not used to so much change; however, many aspects of everyday life did change quite drastically during that time. In developed countries, people began using electricity for lighting and powering appliances while automobiles became affordable for growing numbers of people. Movies and radio were new technologies that created a whole industry called the **entertainment industry**. At the same time, more people began working outside the home in factories and businesses – and began to enjoy more leisure time. These innovations had an important impact on women who began experiencing greater independence.

These inventions often allowed people to be better connected with one another and to enjoy a more comfortable way of life. However, these innovations – especially the speed of radio communication and the new speed of automotive transportation – also made life seem to be speeding up. This feeling of rapid change contributed to a new appreciation for novelty so that "new" meant "good" in a way it had not done before. This change in worldview helped convince people to buy new things and encouraged them to accept the idea of artificial obsolescence.

Today, the pace of change is even faster. Many goods that are in common use today had not even been invented a few decades ago. Technologies such as cell phones, personal computers, home gaming systems, and electronic tablets were unheard of just a generation ago. Today, new technology and new features often are available before an old device wears out. We are constantly being sold on the idea that "new is better." But is it?

Think About It!

Consider the following Earth Charter principles:

EC2. Care for the community of life with understanding, compassion, and love.

EC6. Prevent harm as the best method of environmental protection and, when knowledge is limited, apply a precautionary approach.

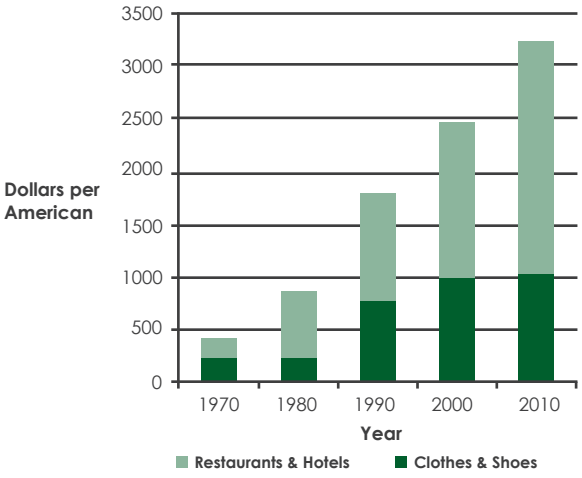
EC7. Adopt patterns of production, consumption, and reproduction and safeguard the Earth's regenerative capacities, human rights, and community well-being.[10]

How do these principles compare to the values promoted by consumerism? Keep these principles in mind as you read the rest of this unit. How do they influence your thinking about consumerism?

Consumerism Today

Today, people around the world buy more than ever. In the United States consumerism is an epidemic. For example, the chart on the next page shows what Americans spent on just a few items from 1970 to 2010.

Consumer Spending in the United States[11]



However, today consumerism is becoming a worldwide phenomenon, and many countries around the world have come to depend on increasing consumerism to spur economic growth. For example, the Chinese government is encouraging people in China to consume more, and by 2020, it is expected that domestic consumerism will account for about 60% of the Chinese economy.

As we consume more our expectations keep growing and we keep accumulating more things. Consider that the United States now has almost 50,000 self-storage facilities with 210 million square meters of storage space available (2.5 billion square feet or 90 square miles). Why do you suppose there are so many storage facilities in the U.S.? The reason is that many people in the U.S. no longer have enough room in their houses to store all of their possessions!

Consumer spending is on the rise worldwide. According to the WorldWatch Institute, "worldwide, private consumption expenditures – the amount spent on goods and services at the household level – topped $20 trillion in 2000, a four-fold increase over 1960 (in 1995 dollars)."

All that shopping takes time. For example, people in the U.S. spend as much time shopping as they spend on religious activities and community involvement: about two hours per week.[12]

Teens and Consumerism

The teen market holds great appeal to manufacturers. In 2007, $17 billion were spent marketing to kids – up dramatically from $100 million in 1983.[13]

Why are teens so attractive to advertisers? The reason is that teens spend a lot of money. An average of $960 is spent each year by or for each teenager in the U.S. – a total of $259 billion.[14] Here are some other reasons businesses focus on the teen market:

- They are the largest single consumer group.
- Teens in developed countries have a relatively large amount of **disposable income** compared to adults.
- Teens are quick to adopt new styles, technologies, and ideas.
- They are not yet set on specific brand choices.
- Teens influence their parents' and friends' purchases.
- Teens, as a group, shop a lot.

Think About It!

Do you think you and your friends are consumers? Are you part of consumerism? What is the difference? How do you feel about being targeted by $17 billion in advertising?

Producing and Consuming Goods

Consumption is part of a larger system called the materials economy. The **materials economy** includes all the steps involved in producing and consuming goods, including disposal.

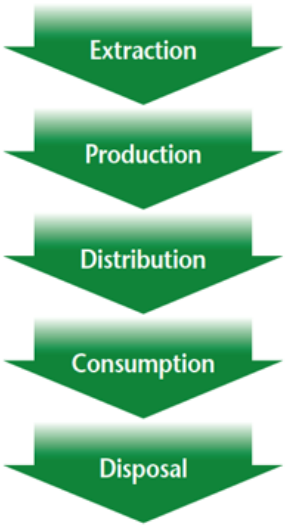
One way to envision this system is as a series of sequential steps. This sequence is sometimes called a "take-make-waste" process because materials and energy are used in one step after the other, usually ending with the product being thrown away. Let's look at this approach to get a feel for the steps involved in the traditional manufacturing and purchasing process. At each step along the chain, there are environmental, economic, and social considerations.

Extraction

Extraction is the removal of resources from a natural environment. Extraction can refer to harvesting; for example, trees are harvested to make lumber. Extraction can also refer to mining, such as coal that is mined from deep inside mountains or below the Earth's surface. Water use is also considered a form of extraction; it involves the removal of a natural resource from the environment for human consumption.

Extracting materials requires energy to find, harvest, refine, and transport materials. Extracting also often creates large amounts of waste, since the desired raw material must be separated from other materials. Jobs in the extraction industry, such as logging and mining, often pay relatively well but may have very dangerous working conditions.

Steps in the Materials Economy



Production

Production is the process by which raw or recycled materials are turned into manufactured goods. Production requires natural resources, energy, and human labor. Factory operations usually generate waste and pollution, including greenhouse gas emissions. However, a growing number of companies now have strong sustainability goals, including:

- reducing or eliminating facility waste
- purchasing 100% renewable energy
- requiring their materials and energy suppliers to meet sustainability standards.

In addition to environmental concerns, factories need to offer safe working conditions and pay a living wage to workers.

Distribution

The **distribution** of a product describes the journey it takes from the place where it is manufactured to the place where you can purchase it, usually moving the manufactured product from a factory to a warehouse or store by truck, train, ship, or air. It also includes advertising and marketing to sell the product, as well as operating retail stores or online distribution centers where people can buy the product. Many companies are becoming more aware of the waste generated by packaging and are substituting single-use plastic packaging for recyclable materials. In the U.S., 51% of packaging was recycled in 2013. Paper and steel packaging had the highest levels of recycling at over 70% each. Only 15% of plastics were recycled.[15] Many goods are manufactured overseas in countries that may have different environmental laws and worker safety and pay practices than the United States.

Consumption

The act of buying and using things is known as **consumption**. This is the most visible step of the materials economy and it drives the whole system – from the extraction of natural resources to the eventual disposal of consumer goods. Without buyers, there would be no extraction, production, distribution, or disposal. We can decide whether to make a purchase; if we do choose to buy something, we can "vote with our dollars" for companies that protect the environment and workers while contributing to a healthy economy.

Disposal

After a product has been consumed, the last step of the materials economy is **disposal.** Disposal traditionally means throwing something away, but it also includes **recycling, repurposing,** and **upcycling**. About 34% of U.S. waste was recycled in 2013, up from just 6% in 1960. The most readily recycled materials are paper and cardboard, yard waste, and metals.[16]

recycle:
To reprocess a material that has already been used or that is considered waste so that it can be used again.

repurpose:
To use something that has already been used or is considered waste for a new purpose.

upcycle:
To process or repurpose a discarded object or material to create something that is higher value than the original object.

Recycling, repurposing, and upcycling all save materials, energy, and pollution compared to creating new goods out of unused materials. Recycling also keeps materials out of landfills, which take up a significant amount of space and can leak hazardous materials into the environment. Some cities now charge for waste collection by weight in "pay as you throw" programs. These programs often cut waste by 44% and increase recycling rates.[17] Cutting waste is important: the world generates 1.3 billion tons of waste each year; the U.S. created about a quarter of that amount. China, Brazil, Japan and Germany are also big contributors.[18]

The Materials Economy as a System

All of the steps in the materials economy – together with their impacts – form a system with consumption as the driver. Let's use a causal loop diagram to examine relationships in the take-make-waste system. A **causal loop diagram** shows the relationships between the components, or parts, of a system. A **system** is a group of components in which the parts work together as a unified whole to accomplish some purpose.

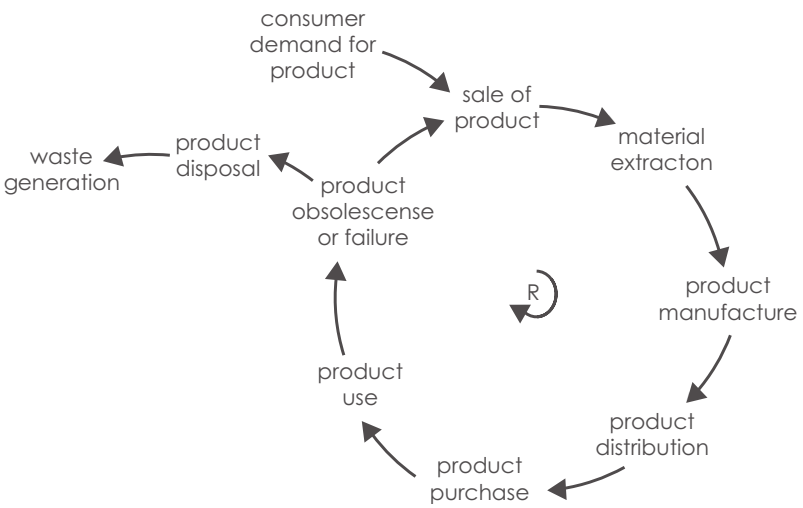
The materials economy system is driven by consumer demand for products. As consumers buy more products, manufacturers buy more raw materials to meet the demand for their products. These raw materials must be extracted from nature. The products then follow the sequential steps of the materials economy.

The figure on the next page shows a causal loop diagram representing this system. Note that disposal is not part of the cycle in the traditional take-make-waste sequence; once products are thrown away, they are removed from the cycle. The "R" in the center tells us that this is a reinforcing loop: an increase in the amount of one component leads to an increase in the next component. Each sale leads to more material extracted, more products manufactured, and so on, through product disposal and waste generation. In addition to the relationships shown in the diagram, each component could also include arrows pointing out of the circle to represent each step's relationships with the environment, the economy, and society. These impacts have been left out to keep the diagram simpler.

Think About It!

Watch the video, "The Story of Stuff," posted online at (http://storyofstuff.org/movies/story-of-stuff/). How do the ideas presented tie in with your understanding of sustainability?

Take-Make-Waste Causal Loop Diagram



Think About It!

What will consumption look like in the future? How can human consumption support sustainable societies, economies, and environments? Can you think of ways consumption might positively impact people or places? On the other hand, what might be negative consequences of consumption?

Consumption and the Big Ideas of Sustainability

Interconnectedness

One of the most fundamental big ideas of sustainability is interconnectedness, which helps us understand how different elements work together as a whole. Recognizing interconnections can help us understand how our choices may have bigger impacts than we realize.

With consumerism, we rarely see all the effects of our buying decisions. Materials are extracted from faraway locations, factories producing goods may be located on a different continent, and the landfill where our used goods go may be miles away. Before we decide to make a purchase, we can think about these interconnections. Where do the materials come from? Were the workers who made the product paid a fair wage? What happens to it at the end of the product's useful life? When we think of a purchase as part of an interconnected system, we are better able to look for products that contribute to a safe and just world for all, forever.

Nature Connection

The big idea of nature connection calls upon us to remember that our entire economy and society operate within nature. We cannot use more materials or energy than nature can provide, nor can we generate more waste than nature can transform or absorb. We can observe nature's patterns and learn from them.

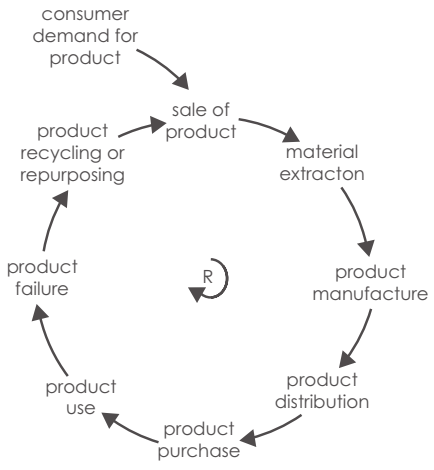
Learning from Nature: Cycles and Flows

Earth provides a variety of materials that are essential to life, including water, oxygen, nitrogen, and carbon. Life depends on these materials being reused, because – with the exception of occasional meteors – Earth is a **closed system** with respect to matter. Fortunately for living things, Earth is the ultimate recycler: these materials are used over and over again.

What does a closed system mean for consumerism? Earth provides a continual flow of fresh materials for life through recycling and reuse. There is no need to continually extract new materials, creating waste in the process. And nature throws nothing away. All materials stay within the cycle. In contrast, humans usually go back to Earth whenever we need something, rather than reusing what we have. And when we are done, we toss it into a heap, never to be used again. We believe those things can be gone forever. But where is "away" is a closed cycle? Our take-make-waste industrialized economy is learning to adopt nature's practices through recycling and reusing materials.

With cycles in mind, let's redraw the materials economy causal loop diagram shown above. The figure below shows products staying in use as long as they work – or can be repaired. This practice means that fewer raw materials will be needed. Because this loop is a reinforcing one, we need less of each component as a result: less material extraction, less manufacturing, and so on. There would then be lower impacts on the environment, economy, and society as a result. The second key difference is in product disposal. The first diagram showed used goods leaving the loop when they were discarded. The revised diagram shows used products being repurposed or recycled, staying within the cycle.

Sustainable Materials Economy Causal Loop Diagram



biodegrade:

To slowly break down by biological means, such as by bacteria, fungi, or chemical processes.

Sustainable Products

Some businesses have tried to move their practices closer to nature's practices through "green" products. Green products may be made from natural, rather than synthetic, materials; use recyclable packaging; or **biodegrade** when they are disposed of. Some companies have pledged to use as much as 100% renewable energy in their manufacturing processes, while others strive to produce zero waste. Fair trade products offer safe working conditions, living wages, and fair businesses practices to protect farmers, factory workers, and artisans around the world.

ecological footprint:

The impact that a person, community, or organization has on the environment. Ecological footprints are expressed as the amount of land that would be required for a person, community, or organization to continue using natural resources at the present rate.

Many of these products are more beneficial to the environment, the economy, and society than traditional products. It can be challenging to understand which products are really beneficial, though, since there are no clear, standard definitions for terms like "green," "natural," or "free trade."

Respect for Limits

The idea of limits helps us recognize that Earth has a finite capacity to supply clean air, fresh water, food, waste recycling, and biodiversity. Respecting these limits means balancing our own wants and needs with those of other people and species, now and in the future.

Ecological Footprints

Humans, like all living things, need to consume resources to live. But let's look at what can happen when we consume more than what we really need, a phenomenon called **overconsumption**.

An **ecological footprint** allows us to quantify human impacts on the planet. An ecological footprint calculation determines the amount of productive land and water needed for all **ecological services.** A footprint includes farmland, pasturage, and fishing grounds to provide food, forested area for lumber and paper, and forested area needed to absorb carbon emissions. It takes into account lakes,

ecological services:

Any beneficial process that is the result of a naturally functioning, healthy ecosystem. Sometimes the term ***ecosystem services*** *is used to refer to such a process.*

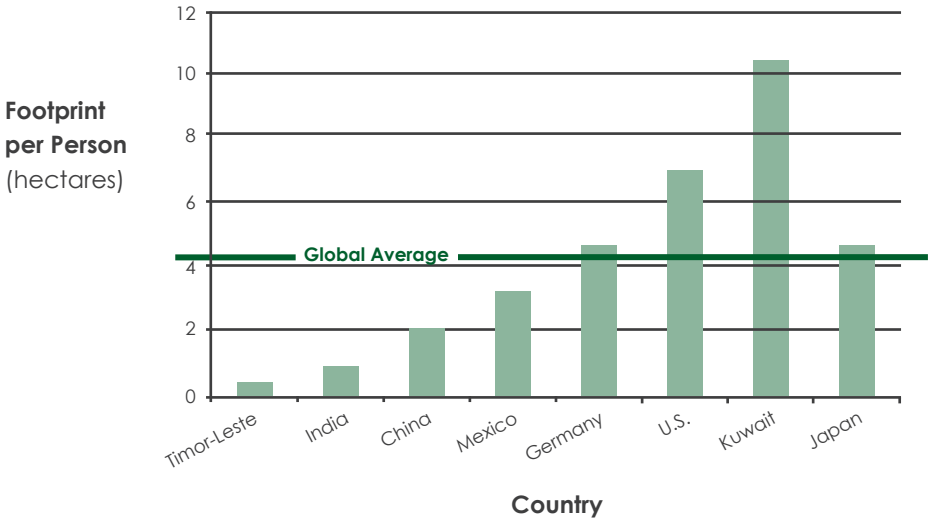
overconsumption:

A condition in which a natural resource is used at a faster rate than it can be renewed by natural processes; consuming something in excess or at a rate that is unhealthy.

rivers, and aquifers to meet freshwater needs. It includes all the area necessary to provide energy and jobs and to dispose of wastes, and it also includes all the area needed to support the infrastructure of our lives, such as homes, highways, hospitals, schools, and shopping malls.

For many countries, the biggest contributor to their ecological footprint is the forest land needed to absorb carbon emissions; farmland is often the second-largest contributor. The figure below shows the size of footprints from selected countries, including the smallest, largest, and average footprints. Ecological footprints are measured in hectares; one hectare is about the size of two and a half football fields.

Ecological Footprints



Source: World Wildlife Fund, Zoological Society of London, and Global Footprint Network.[19]

All together humans are using resources faster than the planet can replenish them. This phenomenon is called **ecological overshoot**. Each year, Earth Overshoot Day marks the day on which people have used the amount of resources that Earth can regenerate in a year. Earth Overshoot Day was on August 13 in 2015; it occurred in early October as recently as 2000. Another way to look at overshoot is to consider that it would take 1.6 Earths to meet humans' wants and needs.[20]

ecological overshoot:

A situation that occurs when a population uses natural resources at a rate that exceeds the long-term ability of the environment to regenerate.

Think About It!

Can you think of ways that your lifestyle would contribute to an ecological footprint in each of the categories described above? Compared to other people in the world, do you think you have a relatively small or large ecological footprint?

Local to Global

This idea reflects the links between our local actions and global impacts. The idea also reflects the understanding that all humans share values, goals, and rights, regardless of race, religion, or nationality.

Population

Population is a hotly debated sustainability issue. Some people argue that none of the major issues facing humanity today would be significant without the pressure of population. Others argue that population growth does not necessarily undermine sustainability if we are able to limit our individual impacts on the planet and carefully manage our natural resources. Either way, human population has been growing rapidly. It took nearly all of human history for the global population to reach one billion around 1800. As of 2015, world population was over 7 billion people. However, the world population growth rate has been steadily decreasing and is expected to continue to slow down over the next several decades.

Think About It!

What is driving the trend of overconsumption? Can the rate of human consumption continue to grow as it has in the past? Can the Earth support our consumption and provide us with everything we want?

Peace and Collaboration

Peace and security are fundamental needs, along with food, water, and shelter. If humans are to survive and not go extinct, we must learn to live together peacefully and work together constructively.

The Collaborative Economy

When we think about consuming and buying, we generally assume those actions mean owning something. But there is a new approach that turns the idea of ownership upside down: the collaborative, or sharing, economy. In the sharing economy, people can choose to rent or borrow items rather than buy them. Owners

Think About It!

What goods do you own that you could share? What items could you borrow instead of buy? How would you feel about borrowing or renting rather than owning?

can earn some money through rental fees, and renters pay less than they would have if they had bought the item they need. This idea can work well for seldom-used goods like home repair tools, some sports equipment, or even books. Some people rent out their cars during low-use times, such as while they are traveling and their car would just be sitting in an airport's parking lot. The environment benefits from the sharing economy because fewer goods are needed. Less energy and fewer materials are used, and less waste and pollution are produced. Also, because the exchanges take place locally, people can meet more of their neighbors and community members.

There are some potential problems with the sharing economy, though. In many communities, the sharing economy is not highly regulated, so there are fewer safeguards for consumers. As a result, concerns have been raised about safety, especially with ride- and lodging-sharing services. Other concerns include the impacts on traditional businesses that must compete with lower-cost sharing economy businesses as well as possible loss of taxes paid to cities.

Equity and Justice

The big idea of equity and justice reflects the understanding that all people should have equal access to opportunities and resources. At the same time, the impacts of unsustainable behavior should be distributed justly.

Living Wages for Workers

Think about these two questions:

- Why does one pair of jeans cost under $20 and another pair cost over $300?
- What does the price of jeans have to do with sustainability?

The answer to the first question may have many factors. Think about the five steps in the materials economy. Each step could include different labor practices, materials, energy, and shipping costs.

The second question considers equity for workers. Think about the sewing factories in which jeans are manufactured. A sewing factory should, at a minimum, provide fair wages to workers, maternity leave, retirement benefits, protection from hazardous materials used in manufacturing, and safe exits in case of fire or other emergencies. It might cost a factory in Bangladesh $0.90 per pair of jeans to meet these requirements and pay a worker. Between $0.15 and $0.20 of the total cost of a pair of jeans manufactured in this factory would pay for a safe working environment. To remain competitive and to meet consumer demand for lower prices, some factories try to cut costs associated with providing worker benefits and safe working conditions. That factory in Bangladesh could lower the cost of a pair of jeans by $.0.70 by removing these safeguards.[21]

In contrast, operating a safe factory and paying workers in the U.S. adds $31 to the cost of jeans, with $12 of that amount going to the workers. Other costs include shipping, retail store expenses, advertising, and profits. For example,

profits from premium jeans might total 40%-50% of the purchase price. Even with much higher worker pay and protections for workers in the U.S., only a small fraction of the cost of these high-end jeans goes to the people that make them.[22]

Of course, most of us cannot or would not pay hundreds of dollars for a pair of jeans. And affordable goods help many people. At the same time, it's important to consider whether low-priced goods can offer a living wage to the people who made the goods. Products that are priced too low may cause other people somewhere in the world to live in poverty. As a Bangladeshi factory owner says, "I try and teach my customers – every cheap product has a cost."[23]

Equity

Consumer spending on goods like electronics, up-to-date fashions, and expensive cosmetics is not available to everyone. In fact, luxury items like expensive beauty care products can cost more than people living in the deepest poverty spend in a year. There is an enormous gap between the standards of living of people living in the deepest poverty and people who have the most wealth. Globally, the people with the least disposable income, on average, live in the African countries of Burundi, Eritrea, and the Democratic Republic of Congo. These people have an average of $100 to $200 to spend on all goods, including food, clothing, and all other necessities besides housing. The people who have the most money live in the European countries of Switzerland and Norway spend an average of over $30,000 per year.[24]

Think About It!

How does consumerism affect the functioning of society? What parts of society does it affect? Are those functions improved or degraded by consumerism?

Health and Resiliency

Sustainability is fundamentally a concern for the health and well-being of people and the environment. Well-being contributes to resiliency. **Resiliency** refers to the ability of an individual or community to continue to function under changing conditions.

Community Engagement

One of the most powerful ways communities and societies stay resilient is through strong relationships. These relationships are fostered through involvement in local government, schools, spiritual communities, neighborhoods, volunteer organizations, and local businesses.

While community involvement benefits many people, consumerism focuses on individual wants and needs. Long work hours and long commutes take people away from time spent in the community. Consumerism focuses on what we have, rather than on who we are or what we do. Getting involved in school or community groups builds relationships, trust, and a sense of belonging. Building these relationships takes time and commitment but results in more effective and resilient communities.

Universal Responsibility

A sustainability worldview helps us take personal responsibility for our actions and contribute to creating a safe and just world for all, forever.

Hidden Costs of Consumption

Consumption can have negative effects that are not measured. Many processes involved in making, using, and disposing of consumer products involve costs that are not paid by either the manufacturers or the consumers of those products. One example of a process that can have unmeasured negative effects is air pollution. Smog and particulate matter can cause respiratory problems such as asthma as well as cardiovascular diseases. The human cost associated with long-term illness is hard to quantify, but these diseases also have a monetary cost for individuals, businesses, and governments that pay into health care systems.

These hidden costs associated with the materials economy are known in economics as externalities. **Externalities** are the external effects that accompany a process or activity.

Externalities are often unforeseen or unintended and may take the form of benefits or costs. Benefits – or positive externalities – could include security, satisfaction, or improved nutrition. Costs – or negative externalities – could include environmental degradation or wage inequity.

Because externalities are hidden, companies sometimes do not account for them when setting the price of a product or service. When the purchase price of a good is less than its true cost due to hidden negative externalities, the manufacturers will produce more of it and consumers will buy more of it. In this way, negative externalities help to encourage the overproduction and overconsumption of goods.

So why aren't these externalities included in the purchase price of a product? For one thing, companies and consumers benefit from low prices. Consumers who buy these products pay far less for them than they would if all costs were included. If a company did want to include these hidden costs in the price of a product, it would be hard to compete with other companies that exclude these costs.

Another problem is that it can be difficult to put a price on externalities. Exactly how much would it cost to remediate air pollution from a textile factory in Mexico? What is the cost of unsustainable deforestation given that forests, if logged sustainably, can be a renewable resource that provides other benefits, like air quality, tourism, recreation, and quality of life? What are the economic repercussions when employees are sick because they do not have health care? Because it can be difficult to calculate exact values for these costs, often we do not know how great the costs are or who ends up paying them.

Think About It!

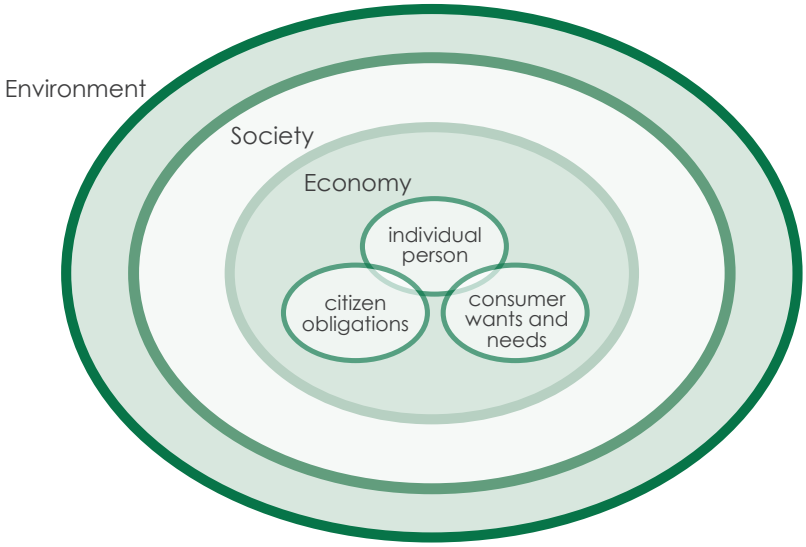
What hidden externalities might be associated with each of the following goods or services? Think about benefits and costs.

- *You purchase a hamburger from a fast-food restaurant*
- *You purchase a soccer jersey with your favorite player's name and number on the back*
- *You post a video to a social media account*
- *You pay someone to fix your bicycle when it gets a flat tire*
- *You purchase some fruit that from a farmer in your community*

Responsibility and Nested Systems

In many cases, sustainability problems come about because we do not understand nature's systems or because we cannot see the effects of our choices. Thinking about nested and overlapping systems can help. The figure below shows how our personal wants and needs fit within broader systems. When we "zoom in" in our own wants and needs, we may only see ourselves as an individual. When we "zoom out" a little, we can see that we are citizens as well as consumers. We can "zoom out" even further to see that both our consumer and citizen aspects are part of our broader economy, society, and ultimately, our environment. Keeping in mind our place in these nested systems can help us place our choices in a broader– and more sustainable – context.

The Individual's Place in Broader Systems



Think About It!

Which of these products could meet the needs listed above? Which really only satisfy wants? Which could go either way? How do you decide?

- *New shoes*
- *A lock for the house front door*
- *The newest smart phone*
- *Lunch at a fast food restaurant*
- *A $200 pair of jeans*

Why We Buy

Wants and Needs

Consumerism focuses on wants rather than needs. People have always looked for ways to make life more pleasant and more convenient. However, sometimes we confuse the things we need with the things we want. For example, in many developed countries there have been trends in recent years of consumers buying bigger houses, more appliances, newer electronics, and more vacation travel. These trends do not reflect actual needs but rather they reflect people's wants. In what ways do you think these trends are pushing Earth's boundaries?

What are human needs? The psychologist Abraham Maslow developed the following list of eight fundamental human needs:

1. Physical health
2. Safety
3. Belonging and love
4. Self-esteem
5. Intelligence and understanding
6. Beauty
7. Development of the self
8. Spiritual fulfillment[25]

Recall that advertising is often designed to deliberately tap into these needs. Some ads make us question whether we are safe, desirable, or accepted. Others more directly imply that we will be able to meet our deepest human needs if we only buy the products the ads promote.

In addition to the external pressures to consume, like advertising and the media, we also experience internal pressures. Here are some of the internal pressures that influence our consumption habits:

- ***Self-Image and Desire for Belonging:*** Many of our purchases are intended to develop our self-image. Other times, we choose possessions to signal that we belong to a certain group or subculture. This might mean staying on top of – or avoiding – fashion trends or wearing particular brands or styles to identify with a group.

- ***Emotions:*** We may choose to go shopping to soothe sad feelings, celebrate accomplishments, or cure boredom. Trying to meet these emotional needs through consumption usually results in focusing on wants rather than needs, while minimizing more authentic life experiences.

- ***Inner Rewards:*** Brain scientists tell us that the experience of shopping actually makes us feel better – but only for a little while. Our brains reward us when we learn something new. In our modern world, many of our experiences are routine or repetitive. So for some of us, scouring a mall for a new shirt or pair of shoes is enough to trigger a reward. One way to shift this reward system is to bring other sources of surprise and delight into our lives. Unpredictable experiences like spending time in nature; making art, music, or handicrafts; or playing sports can create small, irregular learning experiences that provide ongoing satisfaction.[26]

- ***Avoiding the Big Picture:*** Shopping malls are designed to create a pleasant experience. But malls are removed from the rest of the world. Getting the goods at a mall reveals nothing of a product's origins or ultimate disposal. We experience only the enticing world of buying – which is just one step in the total materials economy. Being able to ignore the upstream and downstream impacts of our buying decisions makes it much easier to say "yes" to a new purchase.

Think About It!

What is the difference between a want and a need? Can something be both? How do you decide when to fulfill a desire for something you want, but do not need?

Think About It!

Reread the quote by Victor Lebow at the beginning of this module. Do you believe we have made consumption our way of life, as the quote suggests?

Look at the definition of consumerism presented earlier. Can consuming goods lead to "meaning, contentment, and acceptance"? How does consumerism compare to the Earth Charter values listed above?

Does Buying Make Us Happier?

Americans report about the same level of life satisfaction today as they did forty years ago, even though many of us have more possessions. However, people with strong consumer drives are often less happy than others. A focus on goals that are satisfied outside of ourselves takes time away from more satisfying inner goals like relationships, community involvement, and personal growth. Some goals that require fulfillment outside of ourselves include acquisition of more money, possessions, or praise. Focusing on money and material goods can increase stress and decrease well-being.[27] Systems thinker Donella Meadows wrote, "people need identity, community, challenge, acknowledgment, love, joy. To try to fill these needs with material things is to set up an unquenchable appetite for false solutions to real and never-satisfied problems."[28]

Sustainability Skill Building: Decision-Making

Making decisions on sustainability issues requires us to think in complex ways, face uncertainty, assess risk, account for missing information, and acknowledge our emotions. Sustainability issues often involve **wicked problems**. Wicked problems are hard to define and even harder to solve. Solutions to wicked problems are complex because the results may lead to new problems. With wicked problems, sometimes the best we can do is work towards a "more good, less bad" outcome and avoid a "more bad, less good" outcome.

We can gain factual knowledge by reading books or talking with experts. We also need to use our own life experience. For example, you may learn facts about nutrition in a biology textbook. Your informal knowledge could include the way you feel if you drink too many sodas. Knowledge, critical thinking, and good sense contribute to good judgment.

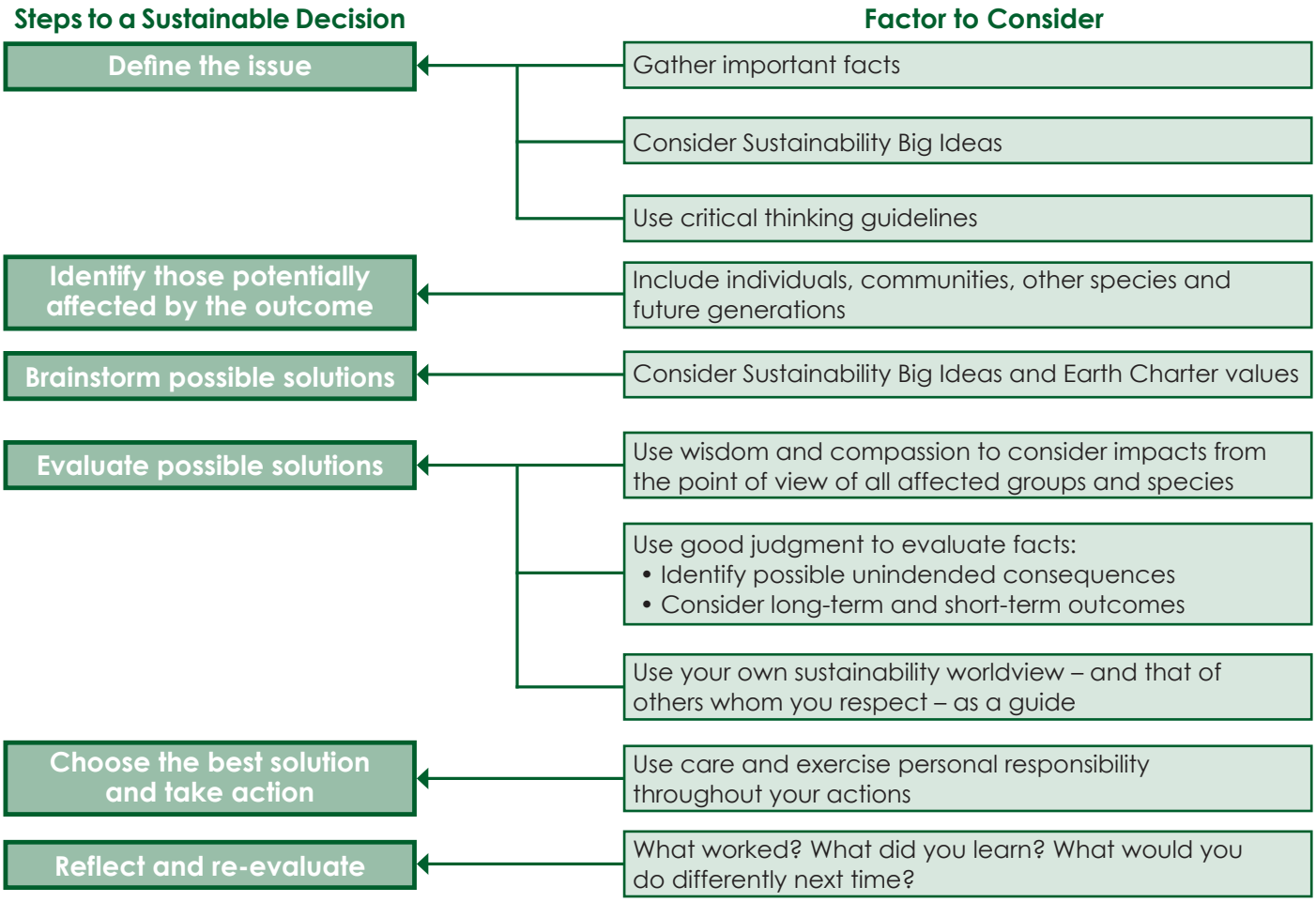
Critical thinking skills include:

1. Making sure that facts are accurate.
2. Asking good questions.
3. Recognizing assumptions that we, and others, make.
4. Deciding if the source can be trusted.
5. Analyzing conclusions.
6. Seeing issues from multiple points of view.
7. Using evidence to explain your point of view and make decisions.[29]

Where good judgment relies mainly on logic, wisdom calls for compassion and empathy. We act wisely when we consider how actions affect others, including the community and the environment, as well as oneself. A wise perspective also considers long-term benefits as well as short-term ones.[30] When we combine wisdom and judgment, we are more likely to make decisions that support sustainability.

A sustainability worldview supports good decision-making. Knowledge contributes to good judgment, values support wisdom, intention helps make choices, and all of these elements guide behavior. A general approach for making good sustainability decisions is outlined below.[31]

Decision-Making Flow Chart



Pathways to Progress: Consumption

In response to growing concerns about overconsumption, people around the world are undertaking a variety of actions to improve the well-being of people, places, and economies. The following are just a few examples.

Voluntary Simplicity

The voluntary simplicity movement has captured the imagination of many people wanting to find satisfaction and enjoyment in relationships, community, and relaxation rather than in things. Material needs are met simply, without a focus on **materialism**. Value is based on rich experiences and relationships. Freedom and contentment come from a clear understanding of the value of money and possessions – and the limits to their worth.

> **materialism:**
> *The tendency to view material possessions or things as more important than spiritual values.*

Support a Local Economy

Local living economies are rooted in the belief that local businesses can uniquely meet the needs of consumers in a community. Because local business owners live within the community where their goods are produced, they have an incentive to produce goods in ways that are mindful of employees and environments. Consumer support of local businesses also allows money earned within a community to stay within that community rather than going to the large multinational corporations that produce many of the world's products. In fact, buying goods and services at locally-owned businesses creates two to four times more economic benefit to the community than buying at a large, corporate-owned business.[32]

A movement is building to support and sustain local communities through purchasing locally-made goods. The Business Alliance for Local Living Economies (BALLE), is spearheading this movement. Over 34,000 socially-responsible businesses are already part of BALLE's North American network to create and sustain local living economies.[33]

Business Accountability

Many companies are now evaluating their entire **supply chain** to be sure sustainability is taken into account. Large companies can use their buying power to influence their suppliers to reduce their environmental impacts or ensure fair labor practices. Investors in large companies are increasingly asking for assurance that their investments are bringing about a better world. Large companies also often voluntarily prepare Corporate Sustainability Reports to inform investors and customers about their sustainability practices; these reports are often available on the corporate websites.

What You Can Do

There are many things you can do to address consumption. These solutions can range from the personal to the structural:

- ***Value experiences:*** Find value in being and doing rather than in having. Focus on relationships, community involvement, and experiences rather than on material goods to give your life meaning and enjoyment.

- ***Decide if it's a want or a need:*** Buy what you need and challenge yourself on wants. When you go to a store, make a shopping list and stick to it. Avoid impulse purchases.

- ***Share:*** See if you and your family can share items you use infrequently. Maybe you know someone who already owns something, so you do not need buy it. Several software applications are available to help potential sharers find one another.

- ***Do your research:*** Learn more about companies that sell the products you buy. If a company that creates products you like does not have a commitment to social responsibility, consider contacting them to encourage them do so. These resources can help:

    - Fair Trade USA for information about clothing, sporting goods, body care, and food at http://fairtradeusa.org/products-partners.
    - Free2Work for information about clothing and electronics at http://www.free2work.org.
    - Environmental Working Group for information about food, cleaning products, body care, sunscreen, and more at http://www.ewg.org/consumer-guides.

- ***Sleep on it:*** Let your brain cool down – wait until the next day to make significant purchases. You may find that you don't need – or want – the item after all.

- ***Redefine cool:*** 81% of teens get ideas about what to buy from peers, 68% from fashion magazines and ads.[34] Can you and your peers decide for yourselves what's cool outside of influence from advertisers? How can sustainability fit into your choices?

- ***Make it last:*** When you do decide to buy something, consider how long it will last. Search out goods that will last a long time, and recycle them when they can no longer be used.

- ***Buy local:*** Support locally-owned retail stores rather than chain stores. Try to find stores that are located close enough to your home that you could get to them by walking, bicycling, or taking the bus. Shopping close to home can save time and money spent on driving.

Youth Profile

Jessica Assaf

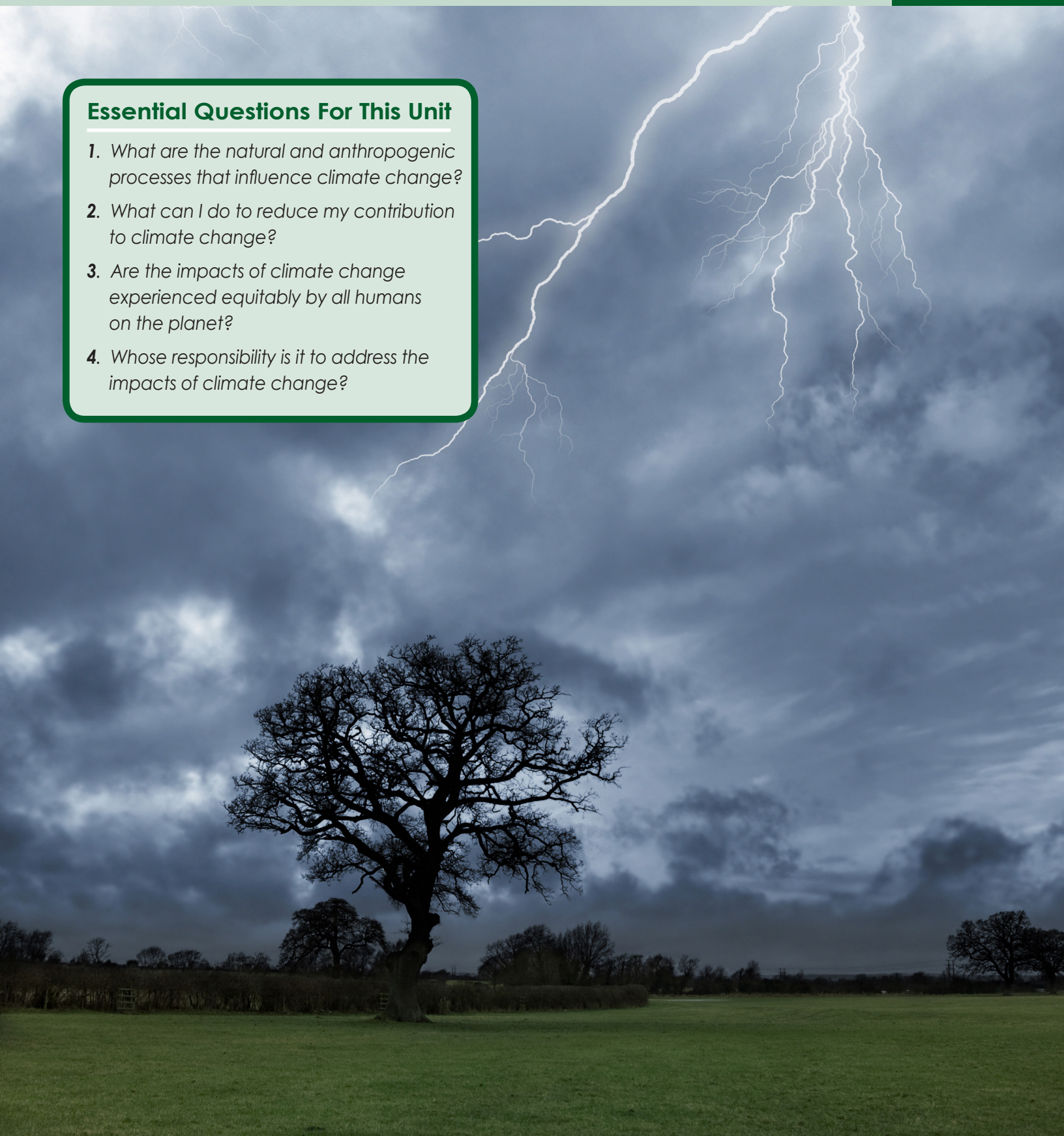
One way to change how consumer products are made is to campaign for structural change.

When a teenager from California learned that some makeup products actually had toxins in them that could lead to cancer and other illnesses, she decided to take action to make sure that they were taken off store shelves. Jessica Assaf worked with the Teens for Safe Cosmetics campaign to create Operation Beauty Drop, which placed large bins in malls for teens to drop off beauty products that contained toxins. Those toxic beauty products were sent back to manufacturers with a petition signed by teenagers demanding the products be made with safer chemicals. Jessica and her friends urged their local senators to pass a bill in California requiring manufacturers to inform the Department of Health Services if their products contained toxins. The bill became law in 2007. As a result, cosmetics manufacturers are now required to label products sold in California if they contain chemicals known to cause birth defects and cancers.[35]

Jessica Assaf

Unit 2

Climate Change



Essential Questions For This Unit

1. *What are the natural and anthropogenic processes that influence climate change?*
2. *What can I do to reduce my contribution to climate change?*
3. *Are the impacts of climate change experienced equitably by all humans on the planet?*
4. *Whose responsibility is it to address the impacts of climate change?*

Introduction to Climate Change

In Canada, Inuit elders of Nunavut have seen the winds becoming stronger and more unpredictable, the ice growing thinner where they fish for food, and the snowpack retreating earlier and earlier in the spring. Meanwhile in the island nation of Kiribati in the middle of the Pacific Ocean, islanders notice signs of sea level rise. Consequently, they are being forced to move their homes further inland. They are also building sea walls – human-made structures intended to block waves before they hit the shoreline – to prevent the shoreline from washing away. Farmers in Kiribati have had salt water seep up from the ground and into their wells, contaminating the fresh water they rely on for drinking and growing food.[36]

Indigenous – or native – peoples can often tell us a great deal about the land they live on since their communities have been living on that particular piece of land for hundreds, if not thousands, of years. For some, the land has become intertwined with their identity and culture. The examples above reveal how ecological knowledge – derived from thoughtful observation – may be passed down over generations in order for a community to live off the land sustainably. However, over the last few decades, indigenous communities in Nunavut, Kiribati, and elsewhere around the world have noticed unusual changes in their natural environments.

Scientists have also observed what indigenous peoples have been keenly aware of for decades – Earth's climate is changing.

Weather and Climate

Before we can examine why our climate is changing, we should first understand what we mean when we use the term climate. Many people think of climate and weather interchangeably. While the two are related, climate and weather are not the same thing.

Weather refers to short-term atmospheric conditions. These conditions include temperature, humidity, cloudiness, brightness, visibility, atmospheric pressure, wind, snow, and rain. For example, a weather report might include a prediction of cloudy skies with a chance of rain.

Climate, on the other hand, refers to long-term typical atmospheric conditions. Instead of offering a daily report, climate describes the expected atmospheric conditions of a region averaged over a longer period of time, ranging from years to decades. For example, the climate of a desert might be described as generally hot and arid. To evaluate the planet's overall climate, we should consider trends in average global temperatures, general wind patterns, and frequency and intensity of storms.

Think About It!

Have you noticed unusual weather in your area? What has changed? What evidence can you look at to decide if the changes you have seen are because of short-term weather conditions or long-term climate patterns?

Understanding Climate

The Greenhouse Effect

Earth's climate is affected by the composition of our atmosphere, particularly the concentration of chemicals in the atmosphere known as **greenhouse gases**. Naturally occurring greenhouse gases in the atmosphere such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) make up a very small portion of the atmosphere. Most of our atmosphere consists of nitrogen (N_2) and oxygen (O_2). However, small changes in the amount of greenhouse gases in the atmosphere have a significant impact on the planet's climate.

The impact of greenhouse gases is linked to Earth's relationship with the sun. Sunlight is a form of radiant energy. When radiation from the sun reaches Earth, it passes right through the atmosphere. Some of this energy is reflected back into space by clouds, but the majority is absorbed, warming the planet. Earth then sends some of this heat back into space as infrared radiation.

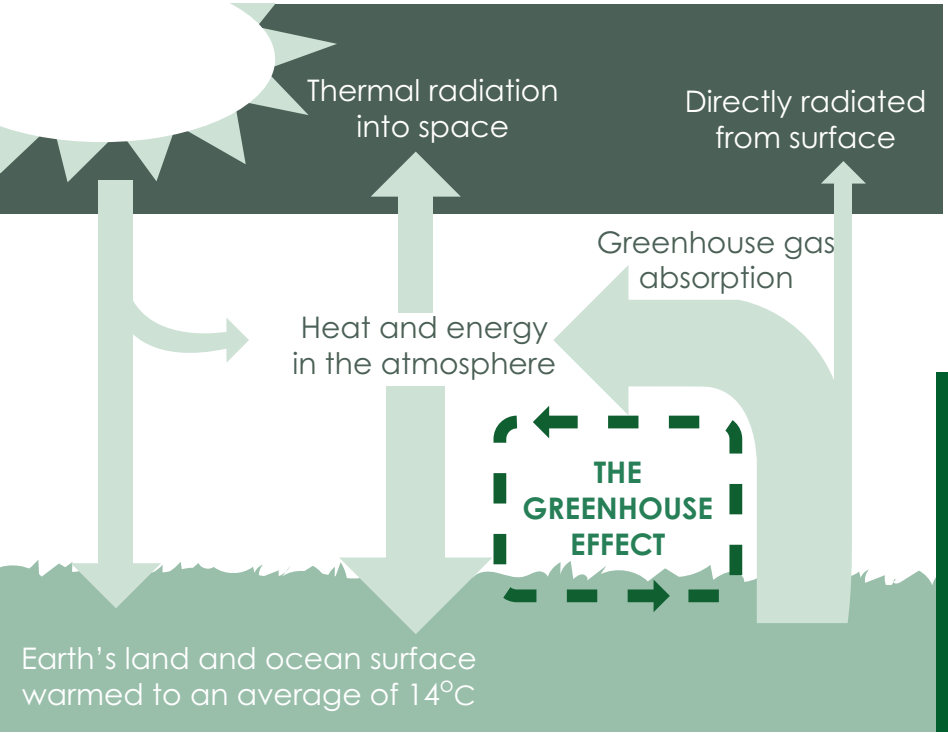
greenhouse gases:
Gases that trap heat in the atmosphere, which makes Earth warmer.

Here is where greenhouse gases come into play. Greenhouse gases trap some of the outgoing infrared radiation. A greenhouse allows sunlight to enter but then traps heat to maintain a warmer temperature inside the structure. In the same way, greenhouse gases help keep our planet warm and make conditions on Earth suitable for life. This phenomenon is called the greenhouse effect.

anthropogenic:
Any process that refers to the influences that humans have on natural systems.

The greenhouse effect is essential to life. In fact, the greenhouse effect – caused by gases that represent less than 0.05% of the atmosphere – warms Earth by about 33°C (59°F). Without the greenhouse effect, Earth would be so cold that all of its water would freeze. Our planet is the only one in our solar system with this kind of atmosphere.

When the greenhouse effect increases, overall temperatures on Earth rise in association with an increase of the greenhouse effect. The composition of greenhouse gases in the atmosphere can be altered by natural and **anthropogenic** activities.



The Carbon Cycle

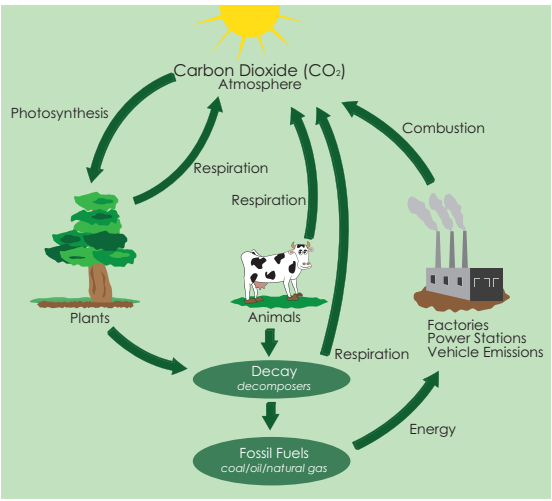
Earth's systems include many material cycles in which matter is exchanged through living things, the atmosphere, and Earth's crust. The water cycle is the most familiar of these cycles. Carbon also forms a cycle. Carbon is an essential element found in all living things. Carbon can form stable compounds with many other elements, making it an ideal foundation for the different functions needed to sustain life.

One carbon compound that is essential for life on Earth is carbon dioxide, or CO_2. Carbon dioxide is a colorless, odorless gas that is formed when a carbon atom bonds with two oxygen atoms. They use the carbon for growth and then release the oxygen into the atmosphere. Animals and plants release CO_2 through respiration as a byproduct of converting food into energy. When organisms die, they also release CO_2 and other carbon compounds as part of the

Think About It!

Are there ways that warmer temperatures could help some organisms, including humans? What examples can you think of?

The Carbon Cycle



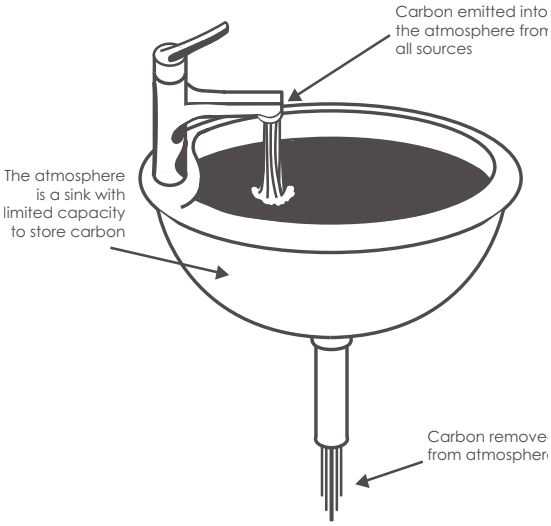
decay process. There are a number of ways that carbon can be removed from the atmosphere. Plants absorb CO_2 during photosynthesis and then use the carbon for growth. Carbon dioxide also is absorbed into the soil and oceans, and carbon is found in many rocks and minerals. However, some carbon stays in the atmosphere as CO_2 and methane (CH_4); both are powerful greenhouse gases.

Carbon Sources and Sinks

In the carbon cycle, carbon can be stored in sinks and released from sources. A **carbon sink** holds an amount of carbon dioxide or other carbon compounds that can be increased or decreased. A carbon sink is similar to the sink in a bathroom. If you allow too much water run into the bathroom sink, it will not drain out quickly enough and the sink will overflow.

By far the largest carbon sink is Earth's crust, where many rocks contain carbon.[38] Living things are carbon sinks, storing carbon as long as they live. **Fossil fuels** – coal, oil, and natural gas, which originally formed from ancient algae, trees, and plants – also are carbon sinks. The atmosphere also is a carbon sink – one that we do not want to fill too full. Breathing is a **carbon source**: as people and other living things exhale, they transfer carbon from their bodies to the atmosphere. Volcanoes and wildfires are other natural carbon sources.

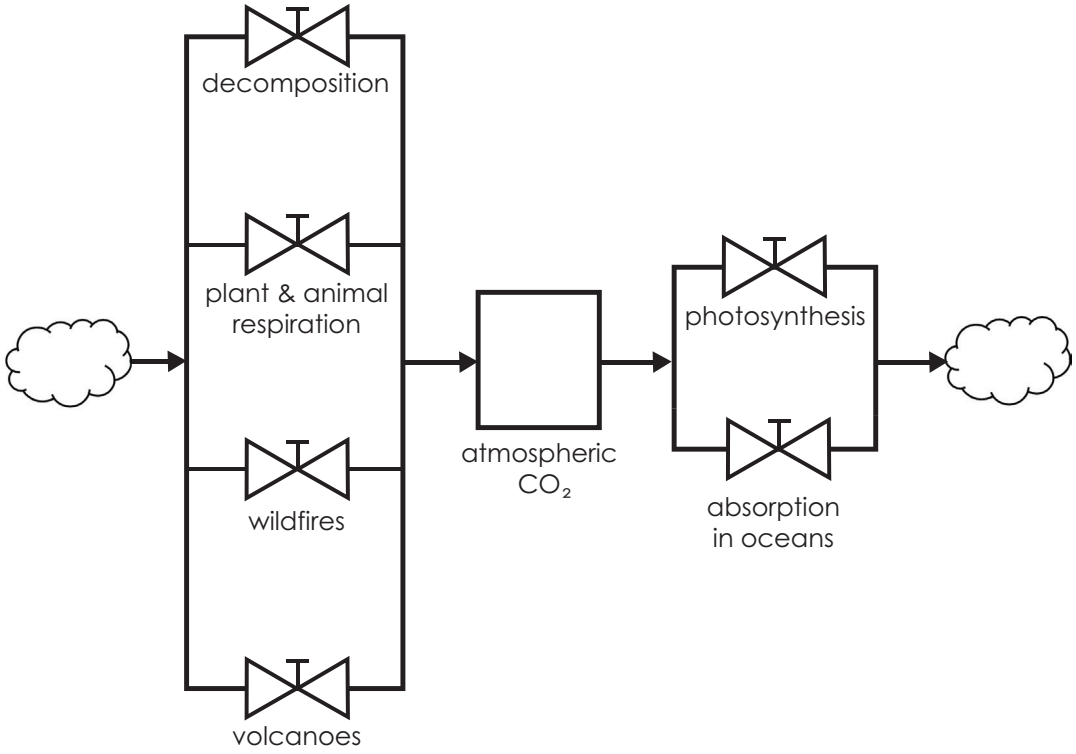
The Carbon Sink



Systems Thinking and the Carbon Cycle

Systems thinking gives us a more formal way to study how carbon sinks work. In systems thinking, we use **stock and flow diagrams** to address the same idea. A system is a group of components in which the parts work together as a unified whole to accomplish some purpose. Systems thinking helps us recognize how interconnections between system components contribute to the way the whole system functions. With this understanding, we can better understand the situation and identify solutions.

Stock and Flow Diagram of Atmospheric Carbon Dioxide



Stock and flow diagrams are one of the tools of systems thinking. These diagrams let us consider multiple inflows and outflows – and even multiple sinks. **Stocks** are like sinks: they represent stored quantities that can increase or decrease over time. The stocks are represented by rectangles. **Flows** are actions or changes that affect the amount of the stock, like water flowing into a sink through a faucet or flowing out through a drain. Flows are represented by the valve symbols. The cloud symbols represent any factors outside the part of the system we are currently studying. Let's look at a stock and flow diagram representing atmospheric carbon.

From the diagram, we can clearly see that CO_2 flows into and out of the atmosphere. Imagining the bathroom sink again, we can see that opening or closing any of the "faucets" that flow into the atmosphere would affect contributions to atmospheric CO_2. Opening or closing the drain would affect the amount of CO_2 that would be removed from atmospheric.

Think About It!

Which of these systems might act like a sink with flows filling and draining them?

- *A savings account*
- *The number of cars on a freeway*
- *Your health*
- *Your grades at school*

What is Climate Change?

Climate change refers to a significant shift in Earth's overall climate over an extended period of time. At various points throughout Earth's history, global climate patterns have shifted dramatically. Understanding how Earth's climate has changed in the past will help us better understand the changes we are witnessing today.

Natural Causes of Climate Change

A variety of natural processes may affect our climate. Over a very long time (thousands of years), the shape of Earth's orbit around the sun slowly changes, as do the tilt and direction of Earth's axis. These changes affect the amount of sunlight that reaches Earth, thereby affecting climate. Changes to the sun's intensity also affect climate; reduced intensity of sunlight has resulted in cooling on Earth. Volcanoes emit ash particles, which can temporarily cause climate cooling by blocking sunlight from reaching Earth.

Past Climate Shifts

Earth's climate gradually cycles between **glacial periods** and **interglacial periods**. Glacial periods, or ice ages, occur when Earth's average temperature is cooler and significant portions of the planet are covered by ice. During these periods, CO_2 levels are lower. Interglacial periods occur between glacial periods and are characterized by warmer temperatures and higher CO_2 levels.

Think About It!

For more information on natural causes of climate change, please see the U.S. Environmental Protection Agency's website. They offer a short slideshow and graph at (https://www3.epa.gov/climatechange/science/causes.html).

In the past, the cycling between glacial and interglacial periods was the result of natural phenomena. Changes in Earth's orbit or in the sun's energy affect the amount of sunlight that reaches Earth, thereby affecting climate. Volcanoes emit ash particles; ash blocks sunlight, temporarily causing climate cooling. In the early days of Earth's history, carbon dioxide levels were extremely high due to widespread volcanic activity. As Earth aged and volcanic activity decreased, CO_2 levels dropped.

Reconstructing Climate History

Through a variety of methods, scientists have formed a fairly accurate reconstruction of how Earth's climate has changed over time. Since scientists are unable to go back in time and measure temperature or climate composition directly, they assess climate indirectly by examining evidence of climate's impact on the planet.

Ice cores taken from ancient glaciers provide a window into Earth's climate past. Gas bubbles trapped in the ice can be analyzed to determine the exact air composition at the time the bubbles were formed. Ice cores from the Russian Vostok Research Station in East Antarctica have allowed scientists to determine CO_2 levels in the atmosphere over 400,000 years ago.

Scientists are piecing together climate history from ice cores and other sources. Soil and rocks give clues to glacier growth and retreat. Fossilized pollen can even provide clues, pointing to regions where certain plants and trees lived. Because plants and trees require certain temperature ranges and weather conditions to survive, these fossils can provide clues about ancient weather patterns.[39] Tree growth rings and coral growth bands give clues about past rainfall patterns. Trees' rings will appear closer together when the tree experiences water stress. Similarly, bands in coral shells vary in thickness based on the surrounding water temperature and other environmental conditions.[40]

Think About It!

Where do you get information about climate change?

- *What have you heard about climate change on the news?*
- *What have you heard about climate change from people you know?*
- *How do you evaluate these facts and opinions?*

Climate Change Today

Today we have the ability to track and analyze climate data with more sophistication than ever before. Over the past 50 years at the Mauna Loa Observatory in Hawaii, scientists have measured daily atmospheric compositions and temperature variations. We can use satellite images to measure the seasonal ice cover on Earth's surface and analyze how it changes. We can also measure the rise in sea levels and the concentration of CO_2 in oceans.[41]

This information helps us understand the link between atmospheric gases and temperature. We can use this knowledge to decipher recent trends and predict likely future weather and climate patterns.

Evidence of a Warming World

Earth's climate has experienced fluctuations in the past. However, recent warming trends are occurring at a rate that would not be expected from natural events alone. The Intergovernmental Panel on Climate Change (IPCC) is the leading group of scientists from around the world that reviews and analyzes climate research; their work reviewed over 9,200 scientific studies and was reviewed by over 1,000 experts.[42] The IPCC states that "human influence on the climate system is clear… Warming of the climate system is unequivocal."[43]

In the last one hundred thirty years, Earth's overall measured surface temperature has risen 0.85°C (1.53°F). Each of the last three decades has been warmer than the one before. Oceans, land, and the atmosphere have all warmed. While this temperature increase does not sound like much, even small changes in Earth's climate can greatly impact environmental conditions.[44]

Retreating glaciers and melting polar ice are visual evidence of a warming climate. The additional volume of liquid water that results from this melting contributes to rising sea levels. Shifting weather patterns provide additional evidence that the climate is changing. Wind and precipitation patterns have changed in many regions during the past century, resulting in increased rainfall in some places and droughts in others.[45]

Today, the climate is not just changing: it is changing quickly. The historical record shows Earth cycling in and out of ice ages many times. Typically, these cycles last about 5,000 years, with temperatures shifting about 5°C (9°F). In the current warming trend, Earth has warmed 0.7°C (1.2°F) over the past century. This rate of warming is six times faster than historical rates.[46] A faster rate of change means that humans and other species have less time to prepare for different conditions.

Effects of Rising Temperatures

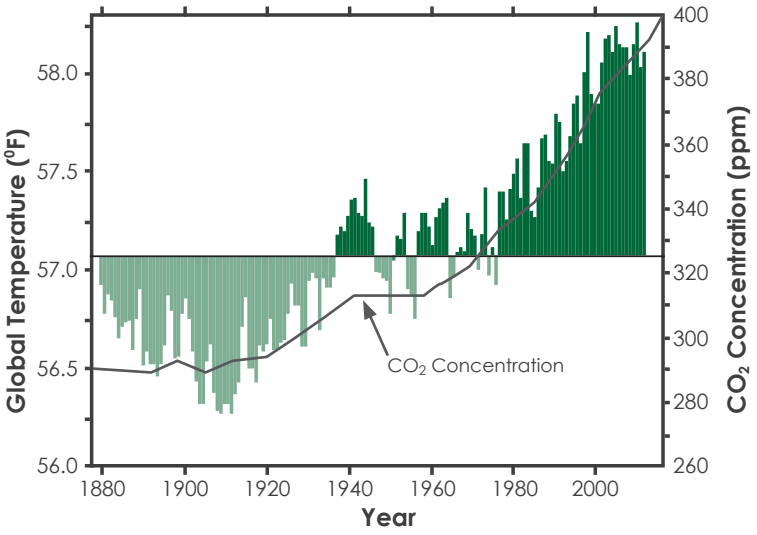
The steady increase in Earth's average temperature is having varied and complex consequences. Different locations around the planet are affected in different ways. Some regions may experience drought and extreme heat while others may experience heavy rainfall and flooding. Sea level may rise because polar ice caps may melt. Changing temperatures can affect ecosystems, requiring species to migrate to find regions that meet their temperature and weather needs. While average temperatures rise for the planet as a whole, some areas could experience more snow, more rain, and lower temperatures. Bigger temperature increases would cause stronger and more wide-ranging effects.[47]

Carbon Dioxide and Climate Change

Carbon dioxide is the most abundant greenhouse gas. Scientists have observed a close correlation between variations in atmospheric CO_2 levels and average global temperatures over thousands of years. There has been a sizeable increase in CO_2 levels beginning in the mid-1700s with the start of the Industrial Revolution. As CO_2 concentrations have increased, so has the overall average temperature on Earth's surface.

The amount of CO_2 in the atmosphere is measured in parts per million. This measurement is similar in concept to percentages, which can be thought of as parts per hundred. Scientists consider a concentration of 350 parts per million, or 0.035%, to be a safe level.[48] The following chart shows the trends in atmospheric CO_2 and global temperatures.

Global Temperature and Carbon Dioxide

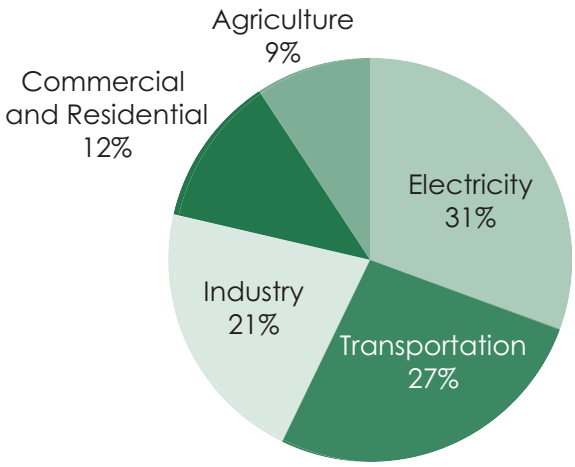


Source: Globalchange.gov[49]

The Human Element: Driving Forces

It is not accurate to say that all of the changes we see in our climate today are caused by human activity. However, scientific research tells us that natural causes are not enough to cause the warming we see today.[50] Our choices related to lifestyle and consumption have an impact on Earth's atmosphere. Humans burn fuels for energy, cut down trees for timber and to clear forests for farmland, and till soil and use chemicals for farming. These greenhouse gas emissions and other human factors are considered by scientists "extremely likely" to be the most significant cause of observed global warming since the mid-1900s.[51] The figure below shows the human activities that contribute to climate change in the United States.

U.S. Contributors to Climate Change[52]



Fossil Fuels and Climate Change

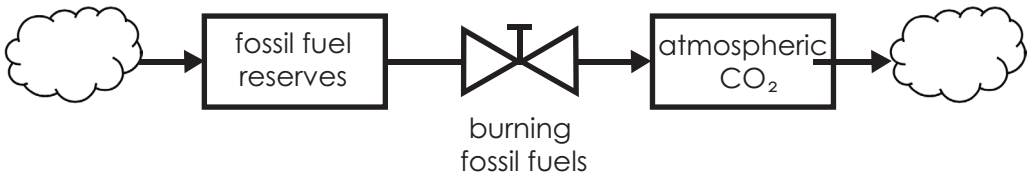
Fossil fuels – coal, oil, and natural gas – are used to generate electricity, power industry, heat homes and other buildings, and fuel transportation. Today, fossil fuels meet 84% of energy needs worldwide.[53] These fuels are made up of chemical compounds called **hydrocarbons**, which consist of hydrogen and carbon.

When the fuels are burned, hydrocarbons are converted to CO_2. Thinking back to the carbon cycle, we see that burning fossil fuels pulls carbon out of a very long-term, stable carbon sink and releases it into the atmosphere as CO_2. The sink model described above tells us that adding carbon dioxide emissions is like filling up the "sink" of the atmosphere. We know that the more carbon there is in the atmospheric sink, the hotter the planet becomes.

The figure on the facing page shows a stock and flow diagram for fossil fuel combustion. Fossil fuel reserves and the atmosphere are stocks that serve as carbon sinks. Burning fossil fuels is an action, or flow, that moves carbon from storage in fossil fuel, or hydrocarbon, reserves into the atmosphere. We can imagine turning the valve to increase or decrease the flow of carbon from fossil fuel reserves to the atmosphere.

Fossil fuel combustion causes 65% of greenhouse gas emissions worldwide.[54] Coal emits more greenhouse gases for the amount of energy generated than any other fossil fuel, followed by oil, then natural gas. In order to limit climate change, experts recommend that at least two-thirds of known **fossil fuel reserves** should not be burned.[55]

Fossil Fuel Combustion Stock and Flow Diagram



Other Drivers of Climate Change

Water Vapor

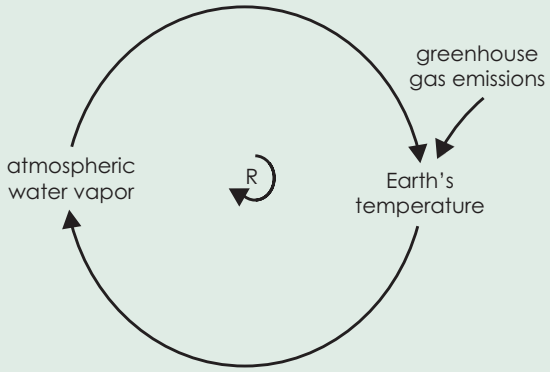
Water vapor may seem harmless, but as a naturally occurring greenhouse gas, it can further intensify the greenhouse effect. As Earth's temperature rises as a result of increasing levels of greenhouse gases, more water evaporates from oceans, rivers, and lakes. Also, as the air temperature goes up, the atmosphere can absorb more water vapor. But water is a stronger greenhouse gas than CO_2. For each degree of warming that leads to increased water vapor in the atmosphere, the added water vapor will cause an additional two degrees of warming.[56]

Systems Thinking and Water Vapor: Feedback Loops

We have seen that water vapor is a greenhouse gas. We have also seen that increased warming leads to increased water vapor in the atmosphere – which leads to increased warming. This kind of consistent cause-and-effect relationship is a good clue that there is a **feedback loop** in the atmospheric system. **Feedback** refers to an information flow that feeds back into the system, causing further changes. A feedback loop exists when changes in an element of a system cause further changes to other system elements. Those changes ultimately cycle back to affect the original element: A affects B, then B affects A.

The figure below shows this relationship in a **causal loop diagram**. A causal loop diagram is a systems thinking tool that represents cause and effect relationships. In this causal loop diagram, we see that Earth's temperature goes up because of greenhouse gas emissions. Rising temperature allows the amount of water vapor in the atmosphere to increase. This additional water vapor will cause further warming. The "R" in the middle of the circle tells us that changes in this cause-and-effect loop reinforce one another: an increase in any element causes an increase in the next element in the cycle. The greenhouse gas emissions cause a change in the feedback loop by increasing Earth's temperature but are not affected by the feedback loop. For this reason, greenhouse gas emissions are shown outside the loop.

Water Vapor Feedback Loop



Other Chemicals

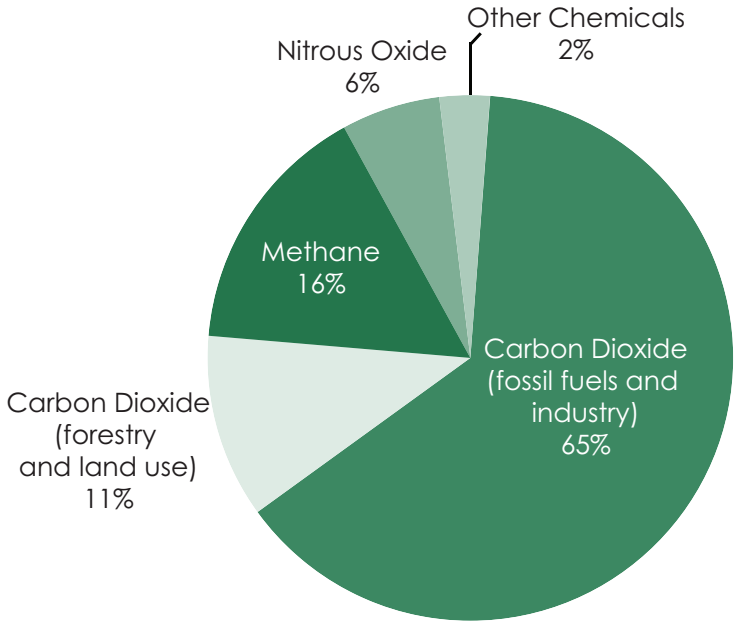
Nitrous oxide, or N_2O, is a by-product of the industrial production of agricultural fertilizers and is released into the air when those fertilizers are applied to soils. Nitrous oxide's **global warming potential** is almost 300 times greater than CO_2's warming potential.[57]

Methane is the main component of natural gas. CH_4 emissions primarily come from the extraction, distribution, and storage of fossil fuels. Livestock also produce methane. CH_4 is released as a by-product of the digestive processes of animals like cows, sheep, and goats; it is also stored in animal manure. Landfills also release CH_4, where it is a by-product of the decomposition of organic waste. Over one hundred years, methane results in twenty-five times more warming than CO_2.[58]

The previous two gases are found in the atmosphere naturally; human activities are increasing the amount found there. Humans have also invented a handful of new chemical compounds proven to act as greenhouse gases. These chemicals were invented to replace earlier ones used in refrigeration, air conditioning, and fire extinguishers. The earlier chemicals had

global warning potential:
A measure of how much heat a greenhouse gas traps in the atmosphere.

Global Greenhouse Gas Emissions by Gas



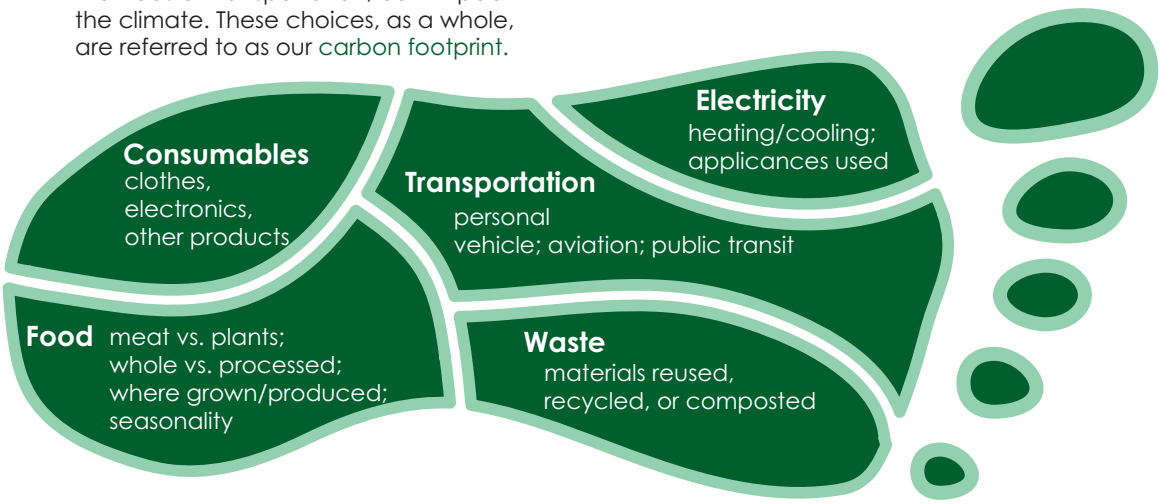
been found to lead to the development of holes in the planet's stratospheric ozone layer. The new chemicals, known as hydrofluorocarbons (HFCs), do not deplete the ozone later. However, they did turn out to be very active greenhouse gases. These chemicals are being phased out of use worldwide, as are the older products that they replaced. Other manufactured chemicals that contribute to global warming include per-fluorocarbons (PFCs), used in aluminum processing and other industrial processes, and sulfur hexafluoride (SF_6), used in distribution of electricity.[59]

Deforestation

Human interactions with the land have a significant effect on climate change. **Deforestation** refers to the permanent destruction of a forest to make the land usable for other purposes. Deforestation contributes to change primarily by removing trees – a key carbon sink – from the carbon cycle. Cutting down trees means they are not available for photosynthesis, which removes significant amounts of CO_2 from the atmosphere. Also, as trees decompose, they release carbon dioxide into the atmosphere. Forested land may be cleared to make room for farming or ranching, or to harvest the wood. A common crop grown on deforested areas is palm oil; this oil is found in many everyday products from baked goods to soap and shampoo.

What Makes Up a Carbon Footprint?

Our daily activities, from our diets to our methods of transportation, can impact the climate. These choices, as a whole, are referred to as our carbon footprint.



Our Carbon Footprint

A **carbon footprint** is a tool used to assess how our lifestyle generates greenhouse gas emissions. When you participate in an activity or use an item that produces greenhouse gases, you leave behind a carbon "footprint." This is the total amount of greenhouse gases the activity produces, expressed in tons of carbon. The footprint tool can be used to establish a baseline for an individual's actions to help measure progress toward a reduced impact on climate. Footprints can also be calculated for organizations like schools or businesses, cities, or countries.

Contributions of Different Nations

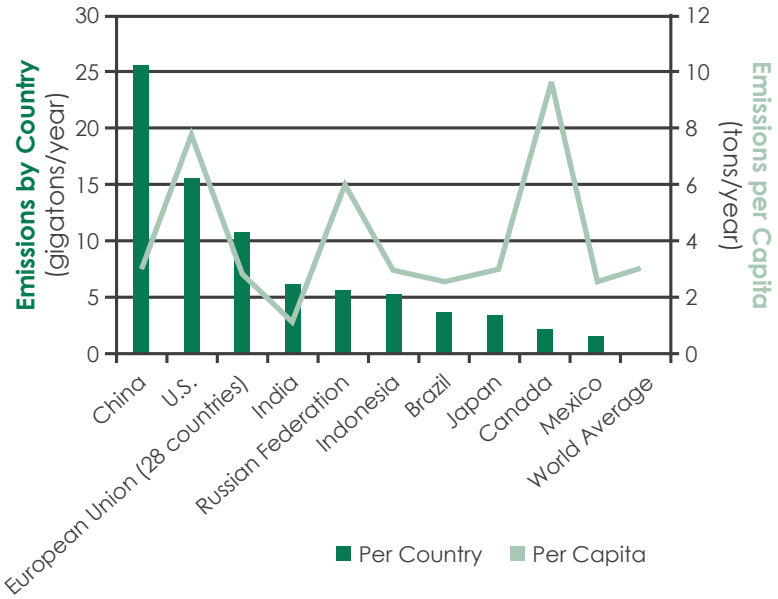
Different countries have contributed to climate change in very different ways. Ten countries produce 70% of annual greenhouse gas emissions. These top ten countries represent 60% of global population and 74% of global economic activity. In contrast, the 100 countries with the lowest emissions produce only 3%. A country's total emissions are generally influenced by the standard of living of its residents, the total number of people living in the country, and the types of fuels used. For example, China's per capita carbon footprint is equivalent to the world average: about 7 tons per year. But China's large population and heavy use of coal make the country's total CO_2 emissions the highest in the world. The United States also has large total carbon footprint due to high per capita emissions rather than an especially large population. The average U.S. per capita footprint is nearly 20 tons of CO_2 per year.

In years past, the top emitters were all industrialized countries. Today, several of the top ten emitters have developing industrial economies; these countries include India, Brazil, Indonesia, and Mexico. Per capita emissions in these developing countries are still well below those in industrialized countries.[60]

Another way to think about different countries' impacts is by looking at their cumulative emissions – the total greenhouse gas emissions produced by a country over a period of time. The United States and twenty-eight European Union countries have emitted the most greenhouse gases since 1850. The U.S. has produced 27% of all greenhouse gas emissions; the European Union has produced 25%, partly because of its early use of coal. The top ten countries together have produced 83% of all greenhouse gas emissions over time.[62]

All these factors influence decisions about how much and how rapidly different countries should reduce their greenhouse gas emissions.

Global Greenhouse Gas Emissions by Country[61]



Climate Change in the Future

Predicting the future is always uncertain. Predicting changes to our climate is no different. Scientists have developed predictive models that allow us to predict future climate change. These models look at different scenarios, which define expectations like the amount of greenhouse gases that will be emitted. One scenario may assume that major fossil fuel users convert to cleaner energy choices very soon; another scenario may assume a "business as usual" approach, in which habits and behaviors do not change. The models predict impacts of different amounts of warming on natural and human systems.

Changes in the Natural World

Climate change can have far-reaching effects on many aspects of the natural world. The degree of change depends greatly on the amount of greenhouse gases in the atmosphere. The descriptions below look at a range of possibilities. The lower impacts assume early, significant reductions in greenhouse gases; the more severe impacts assume no reductions in greenhouse gas emissions.[63]

- ***Global Surface Temperature:*** Temperatures could increase from a low range of 0.3 to 1.7°C to a high range of 1.4 to 4.8°C. However,

temperature change will not be consistent in all places. Landmasses will warm faster than oceans, and higher latitudes – those places further from the equator – will warm faster than lower latitudes. Scientists believe we should stay below 1.5°C total warming.

- ***Precipitation:*** Even with significant greenhouse gas reductions from today's levels, rainfall is likely to increase or decrease by up to 20%, depending on the region. Without these reductions, precipitation is likely to decline by up to 30% in some areas and increase by up to 50% in others. These changes can lead to an increased potential for droughts, flooding, or extreme storms.

- ***Ocean Chemistry:*** *Since the Industrial Revolution, the oceans have experienced increased* ***acidification****. This trend can be reversed with early greenhouse gas reductions, but the ocean may become 50 to 100% more acidic without reductions. Acidification can affect phytoplankton and shellfish, whose exterior protective layers are weakened by more acidic waters.*

ocean acidification:
The gradual process in which oceans become more acidic because of the absorption of increased levels of CO_2.

- ***Arctic Sea Ice:*** *Scientists expect some melting of Arctic sea ice, even with greenhouse gas reductions. Without reductions, the Arctic could be nearly ice-free in the summer season.*

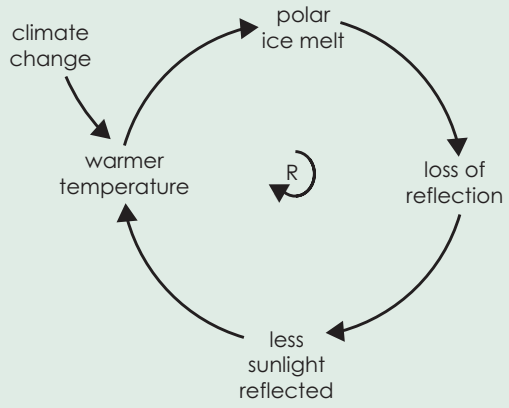
- ***Sea Level Rise:*** Sea level is expected to rise, primarily because of an increased volume of sea water from melting glaciers and polar sea ice. Sea level is predicted to rise by 0.25 to 0.82 meters (0.8 to 2.7 feet). The higher levels in particular can impact coastal cities and island nations.

Feedback in the Climate System

Climate feedback complicates our ability to predict how the climate system will change. An example of climate feedback is the link between polar ice and warming. When solar radiation hits reflective surfaces like polar ice, much of the sun's energy reflects back into space. This phenomenon is referred to as the **albedo effect**. But when surface temperatures rise, the planet's polar ice starts to melt. The melting lessens the amount of reflective surface – light-colored ice – on the planet. As Earth's reflective surfaces decrease, less heat reflects back into the atmosphere. More of the sun's energy is absorbed by the planet, causing the temperature to rise even further. In this example, an effect of climate change – melting polar ice – actually leads to further warming and in turn further melting. This feedback loop is shown in figure here.

This kind of situation is known as **positive feedback**, meaning the result further increases the change. In **negative feedback**, the result decreases change. An example of negative feedback is increased photosynthesis resulting from warmer temperatures; increased photosynthesis causes plants to absorb more CO_2 from the atmosphere. Removing CO_2 from the atmosphere reduces warming.

Polar Ice Feedback Loop



Changes within Human Communities

While humans have proven to be a **resilient** species, we are not immune to the impacts of climate change. Climate change may bring about many changes in the way we live.

- ***Health Challenges:*** Changing temperature and rainfall can bring mosquitoes, ticks, and other disease-carrying organisms into different regions. Heat-related illnesses like heat stroke can also increase.
- ***Food and Water Availability:*** Hazardous weather events such as drought or flooding have the potential to decrease the availability of food and fresh water. Rising temperatures and potential for drought and flooding can also affect food and water availability. In addition, as temperatures rise, farmers will need to use more water to produce crops in already dry regions. This may disproportionately affect countries located in Sub-Saharan Africa, where water availability and agricultural output are already a concern.
- ***Migration:*** In 1990, the IPCC predicted that the greatest impact of climate change would be on human migration. Many people may be displaced from their homes due to coastal erosion, flooding, and agricultural disruption. It is estimated that by 2050, millions of people may be forced to move from their homes or even their home regions because of climate change.[64]

Think About It!

The Earth Charter outlines principles for bringing about a sustainable and peaceful world. What do the following principles bring up for you regarding climate change?

EC6. Prevent harm as the best method of environmental protection and, when knowledge is limited, apply a precautionary approach.

EC7. Adopt patterns of production, consumption, and reproduction that safeguard Earth's regenerative capacities, human rights, and community well-being.

EC10. Ensure that economic activities and institutions at all levels promote human development in an equitable and sustainable manner.

Mitigation and Adaption

Mitigation

Now is the time to **mitigate** – meaning reduce or prevent – new greenhouse gas emissions. Mitigation means to make less severe or to lessen the impact of something. Scientists advise us to reduce greenhouse gas emissions over the next few decades and eventually stabilize the amount of these gases in the atmosphere. These steps will allow us to mitigate the effects of climate change. Thinking back to the sink idea, we can think about different greenhouse gas flows – both anthropogenic and natural into and out of the atmosphere. Looking at the atmosphere in this way can help us devise strategies to minimize greenhouse gases in the atmosphere. We can minimize these gases either by reducing inputs or by increasing outputs.

We have already looked at shifting from fossil fuels to renewable energy; a related strategy is conserving energy. By using more efficient appliances, carpooling, or using public transportation, we will use less energy and emit fewer greenhouse gases. Reducing other sources of greenhouse gas emissions can also help. Some possibilities include eating chicken or meatless choices instead of beef, avoiding unnecessary consumer purchases, and minimizing air travel.

Another way to remove CO_2 from the atmosphere is through **regenerative farming** practices. Traditional farming involves plowing the soil, which turns the soil over to expose it to sunlight and oxygen. Soil contains humus, which is a rich, black form of carbon. When the soil is disturbed, the sun and oxygen break down the humus, releasing the carbon as CO_2. Regenerative farming keeps carbon in the soil by eliminating plowing or tilling. It also helps draw carbon from the atmosphere deep into the soil as plants release excess carbon from photosynthesis through their roots. The world's farmlands have lost as much as 50-70% of their original carbon to the atmosphere. Regenerative farming may be able to reverse that process.[65]

Greenhouse gas emissions can also be removed from the atmosphere through **carbon capture and sequestration** (CCS). CCS is an air pollution control strategy that captures carbon dioxide from large industrial or power plant smokestacks and transports the CO_2 to underground rock formations for storage.

Adaptations

Climate **adaptations** are changes people make to prepare for or adjust to changing climate. Examples include building infrastructure systems like water storage in areas with declining rainfall or setting up sea walls to protect coastal cities from rising sea levels. Thinking differently about the difference between things we really need versus things we want but do not really need is another example of an adaptation.

Learning from Nature: Resiliency

A resilient system can continue to function under changing conditions. Nature is very good at resiliency: ecosystems flourish in spite of earthquakes, floods, droughts, and seasonal changes in weather. Resilient ecosystems typically have the following qualities: [66]

- ***Diversity:*** Species can fill more than one role, and individuals within a species have varied capabilities. In this way, if an ecosystem is under pressure, different individuals or species can fill in for others. For example, in the Great Barrier Reef in Australia, several species of large and small corals exist. The diversity of coral is one factor that makes this reef resilient.

- ***System Health:*** Stronger, healthier systems can withstand change better than ones that are already weakened. For example, in coral reefs, there is a balance between corals, fish, and algae. When the water temperature gets too warm, algae populations grow. If the fish population is healthy, it can feed on the algae and keep their numbers in check. But if the area has been overfished, the algae will surge and the corals will decline.

- ***Impacts:*** Ecosystems will be especially challenged by severe or multiple threats. Hurricanes can damage coral reefs to the point that they take a long time to rebuild. If it is a bad hurricane season, the reef could experience one severe threat after another. Climate change can bring multiple threats: water temperature can rise, storms can become more intense, and seawater can become more acidic. This combination of threats is part of the danger of climate change.

- ***Protection and Management:*** People can protect and manage ecosystems; at coral reefs, they can establish fishing limits or manage climate change.

Humans and our societies can build these qualities into our communities to build resiliency. Diversity of people, ideas, habits, technologies, and relationships helps us be open to new ideas, communicate widely, and adjust to change. A strong social system includes good jobs, good schools, healthy people, time for fun, and connections with nature and other people. It is not always possible to manage impacts, which is why resiliency is important. But we can try to avoid bringing trouble on ourselves by working for peace, understanding, and wellbeing. Protection and management can include social systems like health care, clean air and water, and social services.

Groups like 100 Resilient Cities work to help communities build in these measures. As part of this group, the City of Boulder, Colorado, has released its Resiliency Strategy, which outlines its plans to build these qualities into its city systems. They focus on engaging as many citizens as possible, creating a citizen science program to observe and respond to change, and managing thriving urban ecosystems, among other goals.[67]

Climate Change and Sustainability

Our worldviews determine the way we see, understand, and take action in the world. Worldviews consist of knowledge, values, intentions, and behaviors. These elements combine to give each of us a unique worldview. We can consider all these elements from a sustainability perspective to create a sustainability worldview – our personal way of being in the world that affirms life, focuses on a positive future, and carries out solutions. A group of big ideas can help us deepen our understanding of sustainability and develop a sustainability worldview. These big ideas and examples of their links with climate change are described below.

Nature Connection

The big idea of nature connection reminds us that our entire economy and society operate within nature. We cannot use more materials or energy than nature can provide, nor can we generate more waste than nature can transform or absorb. We can observe nature's patterns and learn from them.

Renewable Energy

One of nature's basic principles is using the sun's energy to power virtually all of life on Earth. Plants use photosynthesis to convert the sun's energy into usable energy. Animals obtain this energy by directly eating plants or by eating other animals that eat plants. Geological processes are also solar-powered: wind blows because the sun heats Earth's surface unevenly. Rain falls because of evaporation, powered by the sun.

These geological forces – as well as sunlight itself – can be harnessed to produce energy in the form of electricity. These renewable forms of energy do require energy and materials to build systems to capture energy and convert it to electricity. Beyond building those systems, solar, wind, and hydroelectric power create no greenhouse gases, no other air or water pollution, and are free. Each type of renewable energy has its own particular pros and cons, but they all provide carbon-free energy.

These types of energy are often less costly than fossil fuel-powered electricity, and building these systems can create new jobs. And by combining different renewables into a regional power system, electricity can be provided around the clock and throughout the seasons.[68] Renewable energy is growing: in 2013, renewable power accounted for 22% of all world power generation. And in 2014, 58% of new electricity generation came from renewable energy.[69] Worldwide, 164 countries have adopted specific renewable energy goals.

Interconnectedness

Interconnectedness is a foundation of sustainability: it reflects the ways in which different elements work together as a whole. Recognizing interconnections can help us understand how our choices may have wider impacts than we had imagined.

The Carbon Cycle

Carbon serves many purposes in natural systems, including building the bodies or structures of living things, storing energy in complex hydrocarbon molecules, and contributing to the greenhouse effect. Carbon molecules move from one function to another in an interconnected cycle. Humans are part of this cycle because we are part of nature. Our social and economic systems, as modern and technological as they are, are also part of nature. When we choose to use hydrocarbons to power our economy and society, we need to recognize that our actions are interconnected with the basic workings of the natural world.

Universal Responsibility

This big idea encourages us take personal responsibility for our actions and contribute to creating a safe and just world for all, forever.

Consideration of Future Generations

The effects of climate change are just beginning to be felt. But many greenhouse gases stay in the atmosphere for decades. The choices we make today will have significant impacts on the quality of life of future generations and other species.

Respect for Limits

Earth has a finite capacity to supply clean air, fresh water, food, waste recycling, and biodiversity. Respecting these limits means balancing our own wants and needs with those of other people and species, now and in the future.

Food Choices and Climate Change

Balancing our wants and needs with those of others can sometimes come down to a simple lunch choice. Americans eat close to 50 billion hamburgers a year. That works out to about three burgers a week. Just one quarter-pound burger results in 6.5 pounds of greenhouse gases. But most of those emissions are nitrous oxide and methane, which create far more warming than CO_2. A quarter-pound hamburger also takes 450 gallons of water to produce – and cleaning and delivering water requires energy, often provided by fossil fuels. In some countries, forests are clear-cut to make room for cattle ranching; this deforestation also contributes to climate change by removing trees as carbon sinks.[70]

There are better options. Chicken or turkey products release only about one-third the greenhouse gas emissions of beef production. Plant-based foods, including beans, grains, nuts, and vegetables, result in even lower greenhouse gas emissions. And even burgers are getting better: increasingly, cows are pastured on open grassland rather than being raised in crowded feedlots. Improved feeding practices can reduce greenhouse gas emissions, and grassland can act as a carbon sink.[71]

Local to Global

This idea reflects the links between our local actions and global impacts. The idea also reflects the understanding that all humans share values, goals, and rights, regardless of race, religion, or nationality.

Global Warming

The name says it all. Our local actions add up to significant global impacts. Fortunately, the global community is coming together to create change. In December 2015, virtually every country in the world came together to create the Paris Agreement. Under this agreement, countries pledged for the first time to take actions to limit total warming to well below 2°C and to continue to push for a 1.5°C warming limit. The United Nations' climate change leader, Christiana Figueres, said of the agreement, "Successive generations will, I am sure, mark the 12 December 2015 as a date when cooperation, vision, responsibility, a shared humanity and a care for our world took centre stage."[72]

Peace and Collaboration

Along with food, water, and shelter, people need peace and security. Living together peacefully and working together constructively is at the heart of this big idea.

As part of the Paris Agreement, developed countries would raise $100 billion per year in both government and business funding until 2025. This funding will be used to pay for mitigation and adaptation measures around the world. One

of the most challenging parts of international climate change negotiations has been finding a way to distribute costs fairly and support the needs of developing nations and high-impact regions. The funding mechanism represents important progress in collaboration toward addressing climate change.

Equity and Justice

The big idea of equity and justice points to equal access to opportunities and resources for all people. At the same time, the impacts of unsustainable behavior should be distributed justly.

Climate Equity

In general, the countries most vulnerable to climate change – and those least prepared to adapt – are the countries with the lowest incomes.[73] Low-income populations often rely solely on local resources, such as water and food, which could experience greater impacts from climate change. In another aspect of climate equity, many of the countries likely to be impacted most by climate change have contributed the least to warming. These countries include many island nations and countries with little industrialization, including many African and South American countries. To advance climate equity, countries that have benefited most from the practices that have led to warming would help those that are most affected.

Just Transition

The Just Transition movement seeks to support fossil fuel workers and their communities during the shift from fossil fuels to renewable energy. More jobs are expected to be created than lost in this shift. However, fossil fuel industry workers may need retraining and support for local job creation.[74]

Health and Resiliency

A fundamental concern of sustainability is the health and well-being of people and the environment. Resiliency reflects the ability of an individual or community to continue to function under changing conditions.

Distributed Electricity Generation

One way to build a resilient community is to diversify, or spread out, important functions. Today, most industrialized countries produce electricity at large generating stations; this power is then sent to a city or region through a system of electric power lines. While many large-scale solar, wind, and hydroelectric power plants are being built, renewable energy systems can also be built on homes and local businesses. These local generating systems are often linked to the electric grid, so the homeowner or business can buy additional electricity if needed. If they generate more electricity than they need, they can sell it to the power company.

Local generating stations diversify power generation, making communities more resilient. Because electricity is generated in many places instead of a few, the system is more reliable overall. If the system breaks down or needs maintenance, fewer people would be affected. Also, power plants need to be designed to meet the highest, or peak, demand for power. This peak usually occurs on hot, sunny afternoons, when many buildings run air conditioning. Rooftop solar systems produce their maximum power at this same peak time. This extra power at peak times means that fewer – or smaller – centralized power plants are needed.[75]

Youth Leadership: Vedika Khanna and the Cool School Challenge[76]

While a junior at the American School of Dubai, Vedika Khanna read a newspaper article about Dubai's large carbon footprint. That one article transformed her life. It inspired Vedika to change things, starting with her high school. She and other students formed a club called the Global Awareness Inner Awakening (GAIA). The group decided to participate in the Cool School Challenge in order to reduce their school's carbon footprint.

The Cool School Challenge is the brainchild of individuals and organizations in the state of Washington, halfway across the globe from Dubai. The purpose of the Challenge is to motivate students to lower their emissions of carbon dioxide and other greenhouse gases. Participating schools determine where they can reduce energy use and greenhouse gas emissions. Students, teachers, and administrators then work to set specific goals and implement strategies to reach those goals.

At the American School of Dubai, the first step toward a reduced carbon footprint was to audit the school to see how the building and people's behaviors linked to carbon emissions. GAIA members found that the use of electricity in classrooms and plastic water bottles were two major contributors to the school's carbon footprint. To save electricity, they spoke to teachers and students about turning off printers, computers, and projectors when not in use. GAIA members also made sure that lights were turned off in empty classrooms, especially overnight. To raise awareness among students about how many plastic water bottles they used each week, GAIA members collected and displayed the bottles for one week in a big net on the basketball court. They estimated that students used 90,000 bottles each year! Their solution was to encourage students to use refillable stainless steel water bottles.

Thanks to the work of Vedika and the other GAIA club members, the American School of Dubai reduced its greenhouse gas emissions by almost 72,000 pounds in a single year. They also helped to cut the use of disposable water bottles in half. "I think the most important thing I learned from GAIA and the Cool School Challenge was that I can be a catalyst for change," said Vedika.

Pathways to Progress: Climage Change

Governments and Climate Change Policy

Governments can influence behavior through laws, taxes, and benefits. Policymakers have the opportunity to levy taxes on pollution, remove fossil fuel subsidies, add renewable fuel subsidies, and implement international agreements as ways to address climate change. In addition to the groundbreaking Paris Agreement discussed above, here are other actions governments can take.

- ***Support renewable energy:*** Many governments worldwide are adopting renewable energy goals and providing funding to make them happen. Morocco has built one of the world's largest solar power plants.[77] The State of California has adopted a requirement for 50% of the state's electricity to be generated from renewable sources by 2030. The state offers a total of $2.4 billion to implement solar energy.[78] Some cities and universities – such as the University of California system – have committed to "carbon neutrality." This practice ensures that a facility reduces or offsets all of its carbon emissions.[79]
- ***Reduce fossil fuel subsidies:*** To make it less economically advantageous to pollute, governments could reduce or eliminate the $500 billion per year that they spend globally to support the fossil fuel industry. Eliminating fossil-fuel subsidies would reduce global carbon emissions by 6% by 2020.
- ***Reduce methane emissions:*** The U.S. and Canada agreed to reduce methane emissions from the oil and gas industry, pushing for a reduction of 40 to 45% by 2025.

- ***Promote sustainable forestry:*** Governments in Indonesia and Malaysia have adopted some protections of forests and other sensitive carbon sinks called peatlands. These measures support harvesting trees in such a way that forests continue to thrive.

Business Commitments

Businesses have actively partnered with the Paris Agreement process, forming a group called We Mean Business. These organizations see opportunities within the challenges of climate change, recognize the need to do business differently, and advocate a new low-carbon economy. Almost 600 companies and investors have committed to take actions like committing to emission reduction goals, using 100% renewable energy, or ceasing use of products linked to deforestation.[82]

Innovation

Technical and social innovation is bringing about many new solutions: electric vehicles, car- or ride-sharing practices, and selling tree planting services to offset greenhouse gas emissions from air travel. Innovations also bring down the price of new technologies like solar energy: the price of rooftop solar systems fell by more than half from 2007 to 2014.[83]

Career Profile

Low Carbon Business Developer

People working in low carbon business development operate under the belief that using low carbon technologies will stimulate the economy, slow climate change, and have a positive impact on human society, now and for future generations. People who work in business development are responsible for cutting-edge concepts to market businesses or develop new products. They love networking, are savvy in business operations, and use science to weigh the environmental costs and benefits of a certain development approach.

Richie Ahuja

Richie Ahuja is the Regional Director in Asia for the Environmental Defense Fund's Climate and Air Program. He works with civil society, businesses, leaders, and governments to creatively address climate change in rapidly developing economies in Asia. Richie began working on environmental issues in high school and went on to earn a Master's degree in Business Administration. Now he combines his interest in the environment with his skills in business to help climate-friendly businesses develop in Asia. According to Richie, "Asia is densely populated, with high levels of poverty, and is one of the fastest growing economic regions globally. This means that as the region grows it can either develop in ways that contribute to and increase the climate change problem, or it can follow a smart climate-friendly development path that is different, innovative, and in the process [become] a part of the solution to the climate change problem."

Through his work, Richie has been involved in a wide variety of approaches to mitigating climate change. In the course of one educational project, Richie helped produce a Hindi movie called Aarohan (meaning "new beginning" in Hindi). The film is designed to engage and educate rural Indian leaders about the effects of climate change. It has been shown in more than 400 villages in India. When reflecting on his career, Richie states, "This is a great field to get into. It's very fulfilling. There's nothing better than getting up in the morning to work with smart people interested in finding solutions to some of the world's most pressing problems."

Researchers have put together an innovative tool to help bring about a major shift to renewable energy. The Solutions Project researchers figured out how to balance solar, wind, geothermal, and hydroelectric power to provide electricity 24 hours per day, 365 days per year. They worked out a solution for each state in the U.S. and 133 countries worldwide. In most cases, these solutions offer cost savings and new jobs as well as greenhouse gas reductions.[84]

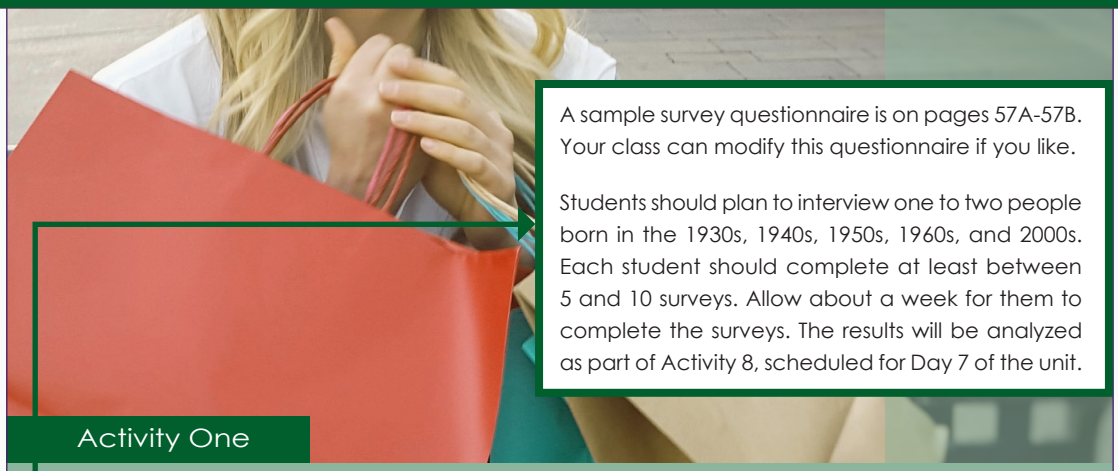
What You Can Do

You can probably think of many ways that our daily lives impact climate change. There are just as many ways to reduce or offset our impact. Here are a few ideas. What others can you think of?

- ***Conserve forests:*** Eat meat raised in a sustainable manner rather than beef grazed on former tropical rainforests. Avoid products made with palm oil: read the labels.
- ***Keep your cool:*** Reduce home energy costs through measures such as fans, thicker curtains, improving insulation, and weatherizing your doors and windows. Or simply lower your thermostat a couple of degrees in winter or raise it a bit in summer. You'll barely notice the difference.
- ***Eat lower on the food chain:*** Skip the burger in favor of chicken or plant-based food. Raising beef creates about twice the greenhouse gas emissions as does raising chicken. Switch to a black bean burger and cut the greenhouse gas emissions by more than 90%.[85]
- ***Cut standby energy use:*** Turn off or unplug appliances and electronic devices when you are not using them; this standby power can use 5 to 10% of home energy use.
- ***Ditch the car:*** When you are not going far, think of low-carbon ways to get there.
- ***Recruit others:*** Reducing energy costs at home and at school saves money. Educate family, friends, and teachers about this win-win solution.
- ***Keep it green:*** Remember that plants act as carbon sinks, so get out there and plant some trees! Trees also provide a shady place for humans and animals to hang out.
- ***Reduce, Reuse, Recycle:*** Reduce the resources used to make new things by buying only what you need and reusing and keeping items longer; when it's time to discard something, recycle it.
- ***Offset:*** If you have to travel far, think of ways that you can offset your carbon emissions, perhaps by helping to protect forest lands or reducing your daily carbon emissions.

Activities

Wants versus Needs: Pushing the Boundaries
Activity Section



A sample survey questionnaire is on pages 57A-57B. Your class can modify this questionnaire if you like.

Students should plan to interview one to two people born in the 1930s, 1940s, 1950s, 1960s, and 2000s. Each student should complete at least between 5 and 10 surveys. Allow about a week for them to complete the surveys. The results will be analyzed as part of Activity 8, scheduled for Day 7 of the unit.

Activity One

Consumption Then and Now, Part 1

Activity

1. **Review the survey questionnaire.** Familiarize yourself with the questions.
2. **Prepare a survey introduction.** As a class, create a brief explanation to introduce the survey to respondents, explain its purpose, let them know how long it will take, and describe the ways in which survey responses will be used.

Field Book

- **Nature Journal:** Make a quick list of all the items you use on a daily basis that use raw materials from nature, like wood, paper, or metal. Make some quick sketches of the places in nature where these items come from.
- Write a response to the **Think About It** boxes on pages 5 and 6.

Survey Steps

1. **Conduct surveys.** Over your survey period, conduct your surveys and collect responses. Because you are asking people to remember back to their childhoods and adolescence – which may have been decades ago – be prepared for them to give you estimates and even some guesses. Just ask them to give you the best answer they can. Be sure to bring in all of your completed questionnaires on the assigned day.

Explain to students that they can ask family members, neighbors, or other acquaintances to answer the questions.

Make copies of the blank survey forms for students or give them electronic copies if you have the technology available. Since they will have several days to complete the surveys, you can bring in blank copies in a day or so. If you modify the existing questionnaire or create a new one, you will also need to develop a new Tally Sheet; see the attached sheet for an example based on the attached sample questionnaire.

Summary

Learners survey people during the early- to mid-1900s, as well as people born in the 2000s, to identify changes in consumption patterns over time.

Time Required

- One 50-minute class period, plus time outside class to conduct surveys and a second day to analyze results in Activity 8.

Key Concepts

- Consumerism
- Conducting a survey

Objectives

- To identify similarities and differences between the everyday consumption habits of students and their families or other contacts over the past several decades

Inquiry/Critical Thinking Questions

- How have consumption patterns changed over the past several decades?

Materials

- Copies of the attached Survey Questionnaire for each student to conduct your agreed-upon number of surveys (see below).

Extensions

- **Expand your survey to include people living in – or having moved from – different countries.** If your class has students, family members, and/or friends who spent some of their adolescent or teen years in other countries, you could assign some portion of students to survey people from these other areas. You could continue to look at historical consumption patterns compared to current ones, or you could focus on current patterns in different countries.

Name: _____

Activity One Sample Questionnaire

Please answer the following questions about your life and the place where you lived longest between ages 8 and 12.

Section 1

Background Information

1.1 Respondent's name: _____

1.2 Respondent's birth year: _____

Section 2

Community Information

2.1 Number of people living in your town, city or village: _____

2.2 How many national chain stores did you or your family shop at? _____

2.3 How many locally owned stores did you or your family shop at? _____

2.4 What percentage of families in your community raised animals or grew fruit/vegetables for food?

_____

2.5 What percentage of families in your community owned a television? _____

2.6 What percentage of your friends had a grandparent living with them? _____

Section 3

Home Information

3.1 Number of people living in your home: _____

3.2 Size of house: _____

3.3 Number of major electric appliances: _____
(washing machine, dryer, refridgerator, dishwasher, air conditioner)

3.4 Number of small electronic appliances: _____
(blender, toasher, food processor, mixer, vacuum cleaner, garbage disposal, fan, trash compactor, etc.)

3.5 Number of telephones in your home: _____

3.6 Number of cars: _____

Section 4

Basic Needs Information

4.1 Thinking of goods you owned to meet basic needs, including food, water, clothing, shelter, and waste disposal, how many of the following items did you own:

4.1a Pairs of shoes: _____

4.1b Coats or jackets: _____

4.1c Skirts, dresses, or pairs of pants: _____

4.1d What percentage of your clothes were sewn by a family member? _____

Name: _____

Activity One Sample Questionnaire *continued*

Section 4

Basic Needs Information *continued*

4.2 What percentage of your clothes were handed down to or from another family member? _____

4.3 What percentage of your clothes were made from natural materials like cotton or wool?

4.4 How many times per week did you eat or drink the following foods:

4.4a Beef, chicken, pork, or other meat: _____ 4.4b Milk or cheese: _____

4.4c Fresh vegetables or fruits: _____ 4.4d Sweets: _____

4.4e Snack foods (crackers, chips, snack bars, etc.): _____

4.4f Other packaged or processed foods: _____

4.5 What percentage of your household's food waste was fed to animals or composted? _____

4.6 What percentage of your household's food waste was thrown in the trash? _____

Section 5

Satisfying Wants

5.1 How many times per week did you eat in a restaurant: _____

5.2 How many weeks per year did you travel on vacation? _____

5.3 How many toys and games did you own? _____

5.4 How many entertainment devices were in your household? _____
(record player, tape recorder, radio, television, etc.)

5.6 How many hours of free time did you have per week? _____

5.7 How many hours per week did you spend doing chores? _____

5.8 What percentage of your household items were made of plastic? _____

Summary

In this unit, learners will explore the following essential questions:

- How can I make more sustainable consumer choices
- Where do the things that I use go at the end of their useful life?
- Who made the things that I use? What is life like for those people?
- How does my consumption of goods affect overall global sustainability?

At the end of the unit, learners will be asked to respond to these questions.

Students will set up a Field Book that they will use throughout the unit to record their work, write reflections, and document daily observations of nature.

Time Required

- 15-20 minutes

Objectives

- To create a record of their work
- To document any changes in their sustainability worldview
- To provide evidence for self-assessments and formal assessment

Materials

- For each student: 1" binder, or 8-1/2" x 11" composition book, or 3 brads, or a spiral-bound notebook. If students use spiral binders, they will need to tape or glue work papers into the notebook.
- Lined paper, as needed
- Blank paper for the cover
- Colored pencils
- Tape or glue

Activity Two

Set Up Field Book

Activity

1. **Create Your Field Book.**

   a. ***Create a Cover page.***[86]
   Include:
   i. The module's title, "Wants versus Needs: Pushing the Boundaries"
   ii. Your name
   iii. Name of class
   iv. School term and year
   v. Illustration, collage, or other artwork representing the module's topics

   Tape your cover to your Field Book.

   b. ***Make a Table of Contents Page.*** This page will be completed over the course of the unit. Include the pages described below and leave room for additional note pages and classwork to be added.

   c. ***Make a Questions Page.*** Note any questions you have about the upcoming unit. Add questions to this page as you go through the unit.

   d. ***Make a Learning Links Page.*** This is a two-page spread; when the binder is open, both pages can be seen, as shown below. Write the essential questions near the middle of the page. For Unit 1, "Introduction to Consumerism," these questions are:

      i. How can I make more sustainable consumer choices?

      ii. Where do the things that I use go at the end of their useful life?

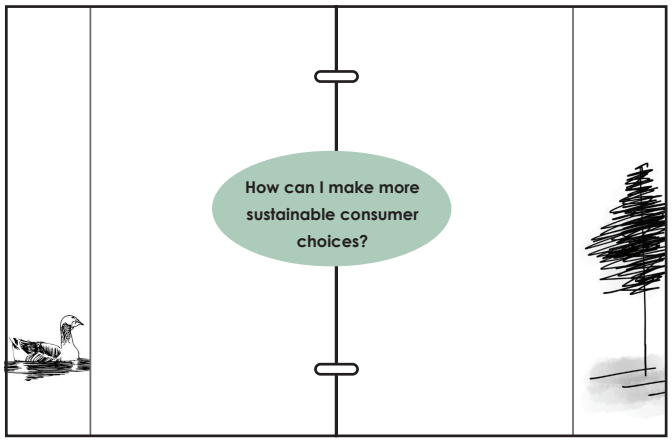
      iii. Who made the things that I use? What is life like for those people?

Students will record their work, add in work papers, write reflections, and create a nature journal in their Field Book. The Field Book is meant to be a record of academic work and reflections, analysis, and creativity. The Field Book should document their explorations, curiosity, and evolving understanding of the opportunities humanity has to learn from the natural world.

Daily activities have a Field Book section at the end. These sections include prompts for nature journaling, references to Think About It boxes in the day's reading assignment, and some other reflection questions or activities. You may also choose to ask students to write about some of the Discussion Questions listed under daily activities instead of discussing them in class.

Please encourage the use of color to highlight key insights and connections, drawings and sketches, charts and graphics, and even snippets of song lyrics that relate to the subject, as well as note-taking and assignment completion.

When you have handouts, students can add them to a notebook or tape or glue them to pages in a spiral-bound notebook or composition book.



iv. How does my consumption of goods affect overall global sustainability?

As you work through the unit, create a mind map using text, drawings, and graphs. This page lets you document your developing answers to the primary question as you go through the unit. Include preliminary conclusions and evidence to support them. Draw arrows and lines to link elements.

e. ***Add work papers as needed.*** Generally, right-hand pages will be for notes, information, tables, and other analytical work. Left-hand pages will be for drawings, reflections, Field Book notes described in activities, or other reflections or artwork.

f. On all your pages, leave wide margins – about 1-1/2 inches each – at the top, bottom, and outside edges. These margins will be used in a later activity.

2. **Add your work papers from class activities to your Field Book.** Throughout this unit, as you complete work on handouts given in class, add the pages to your Field Book. Add titles and page numbers to your work papers, and add these pages to your Table of Contents.

3. **Create a Reflection Page.** Write a paragraph about the following topics:

   a. What do you know about consumerism?

   b. What do you know about sustainable consumerism?

   c. What do you know about where the products and services you use come from?

   Add the page to your Table of Contents.

Summary

Throughout the duration of the module, students will adopt a daily practice of noticing and recording an example of wild nature in their everyday lives.

Time Required

- 5-10 minutes per day

Key Concepts

- Nature is everywhere
- I am part of nature

Objectives

- To create a sense of belonging in and awareness of the student's local place
- To build a habit of recognizing nature's continual presence in everyday life
- To bring an appreciation of natural beauty to students

Inquiry/Critical Thinking Questions

- Do I live in wild nature?

Materials

- Colored pencils

Activity Three

Activity

1. **Observe wild nature.** Each day, look for an example of wild nature in your daily life. You might notice a bird on a nearby tree, hear rain falling on the roof, or spot a weed pushing up through cracks in the sidewalk. The only requirement is that the observation not reflect a manufactured object or anything made with a manufactured object.

One option is to choose something to observe every day over the four weeks of the unit. You could notice the phases of the moon, the time and location of the sunset, the presence of birds or insects, patterns of wind or clouds, or something else that catches your interest.

Here is a mindfulness-based process you can use for observing wild organisms and building a sense of nature connection:

> Step outside with the intention of experiencing yourself as part of nature. Try to let your thoughts run in the background of your mind without focusing on them. As you step outside, use your entire field of vision to take in your surroundings. Notice everything, living and non-living alike. Tune in to all of your senses. Notice sights, smells, sounds, temperature, wind, and sun. Allow some living organism to draw your attention. Keep your focus on it for at least 10 seconds, longer if you

60

FacingTheFuture.org

One way to use this activity is to ask students to respond to the prompts in the Field Book sections of each activity. These prompts are intended to help learners see connections between themselves and nature in ways that relate to the content.

You can also choose to have students use this activity for finding a daily nature connection, making their own informal observations or – if they choose – using the mindfulness-based observation process below. Daily nature observation helps build a sense of nature connection and often reduces stress. The instructions below guide students in this method of nature journaling.

You can have students spend the first five minutes of class writing or drawing in their nature journal. Or they can complete the journal at home. Have colored pencils available, or have students have a set at home or at school.

can. Just silently observe. Notice the organism in its ecosystem, linked with other creatures. Notice yourself similarly surrounded by your ecosystem, linked with others – including, in some way, this organism. As your attention shifts away, see if you feel gratitude for this other living creature.

You are also welcome to observe in your own way or to use the prompts offered in the Field Book sections of the activities.

2. **Record your observation.** In your Field Book, write a few sentences each day describing your observation of wild nature. You can describe what you saw as a scientist would, including details of shape, color, movement, location, and other aspects of nature that were present. You can also write a personal journal about your feelings or reactions to your observation. Another possibility would be to write a short poem, haiku, or flash fiction story about what you observed, focusing on the natural elements.

   Sketch pictures to accompany your daily entries, using colored pencils, colored pens, or crayons. This activity isn't a drawing contest; it's just a way to document what you saw. Artistry is welcome if you are inspired, but not required. You can include in your sketch your subject's surroundings and interconnections or fill in details like a snowflake or bird feather. On some days you may just want to fill in the margins with the colors of the day.[87]

   Record your observations and sketches in the margins of your daily work pages. Use the top, side, and bottom margins and fill them in with images, color, and text. Weaving your observations in with your analytical work helps create a visual message that nature itself is woven throughout human society. It also can make your work pages look artistic and beautiful. You can draw a straight line on the three outside edges of your pages

to create a margin or use your creativity to design artistic borders. You can also write longer observation notes or add sketches at the bottom of pages or on entire sheets of your reflection pages, if you like.

Field Book

1. **Nature Journal:** Record your observations or responses to the prompts in your nature journal. For today, you can take in an overview of your natural surroundings – even if you live in a city. What natural elements do you see around you?

Summary

Learners analyze print advertisements to identify how the ads build the desire to consume.

Time Required

- One 50-minute class period

Reading Prior to Activity

- Pages 4-5
- Activity Background Information, page 62

Key Concepts

- Persuasion methods
- Consumerism

Objectives

- To identify advertising messages
- To evaluate advertised products from a sustainability perspective

Inquiry/Critical Thinking Questions

- How do advertisements use pathos – or emotions, logos – or logic, and ethos – or trust – to encourage people to purchase their product?
- How does constant exposure to advertisements contribute to consumerism?

Materials

- As homework before the day of the activity, students collect one or two print advertisements that promote products. These advertisements should be brought to class the day of the activity. If students do not have access to print ads, please bring some in to share with the class.
- Make a copy for each student of the Advertising Evaluation Sheet on pages 63A-63B of the Teacher Edition.

Activity Four

Background

Advertisements are designed to create desires in their audiences and persuade the audiences to purchase the advertised products to satisfy those desires. In general, advertising uses the classic methods of persuasion, which include pathos – or emotions, logos – or logic, and ethos – or trust and credibility. Here are some specific ways that advertising uses these methods; some advertising techniques use more than one method:[88]

Emotion: The audience's feelings of love, joy, confidence, kindness, pity, anger, fear, guilt, or envy are stimulated and used to build desire for the product.

Association: Buying the product makes the consumer believe they will become like the models in the ad, with a desirable look, feeling, emotion, or status.

Bandwagon: The consumer may be accepted or approved of once they buy the product; sometimes patriotism is evoked to encourage a sense of belonging.

Individualist: Opposite to the Bandwagon technique, some ads suggest that the buyer will be a rugged individualist if they use the advertised product.

Simple Solution: Simply buying the product will lead to a desired outcome presented in the ad.

Promotions: Coupons, discounts, sweepstakes, or games with prizes entice buyers. These techniques may be designed to get people to try a product, to increase the perceived value of the product by offering something for free along with the product, or to encourage customers to buy something immediately rather than wait.

Trusted Authority: Ads may encourage the buyer to trust the product by having a celebrity or famous organization endorse the product. Another tactic is having a model portray a scientist, doctor, or other expert. Claims may be factual or may use vague words like "best," "helps," "fights," or "natural."

Repetition: Repeating the product name improves product recognition and helps consumers remember it.

Characters and Storylines: Stories draw people in, using characters that engage the audience through humor, sympathy, inspiration, or other qualities.

Discussion Questions

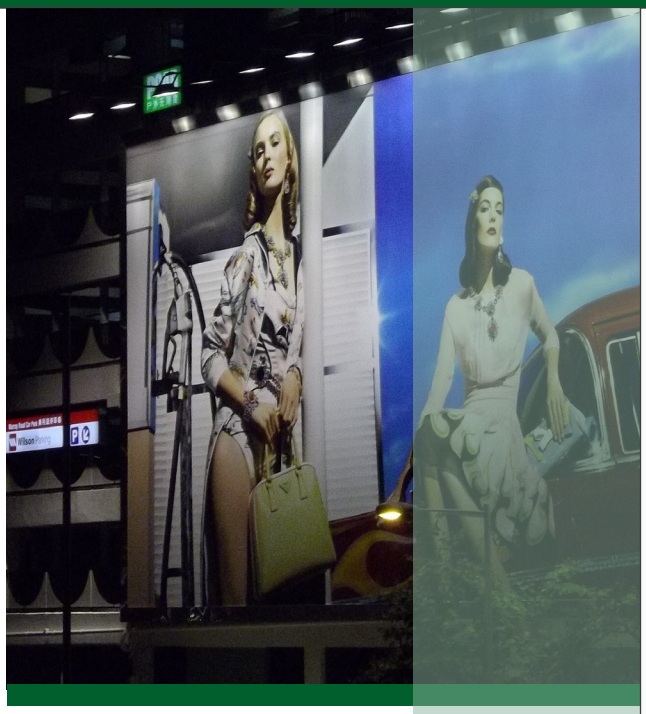
- How much do you think advertising influences your specific buying decisions?
- What advertisements have influenced you? Why?
- What other factors influence your buying decisions?
- Can you think of examples of product placement: brands shown in movies or television shows? How do you think these product placements affect your opinion – and likelihood of buying – these products?
- How much do you think people's overall exposure to advertisements contributes to consumerism?
- How do advertisements show – or mask – the environmental, social, and economic impacts of the products they feature?

Activity

1. **Working with your partner or in your small group, answer the questions on the Advertisement Evaluation Sheet** for your advertisements.
2. **As a class, discuss your findings.**
3. **Add your Advertisement Evaluation Sheet to your Field Book.**

Field Book

1. **Nature Journal:** Throughout the day, notice elements of the natural world that you enjoy or that make you feel happy. Notice what catches your attention: bright colors, beautiful sounds, or fragrant smells. Feel free to note brief descriptions. Also note words or phrases that describe your responses or feelings. You can form your writing into curves or shapes, with phrases mingling with one another. Add color or sketches as you like.
2. Write responses to the **Think About It** boxes on pages 7 and 10.



Review the background information and reading material with the class. You may want to go over a sample advertisement to show examples of some advertising techniques described in the Background Information section. Break the class into small groups or pairs to work on the activity.

Extensions

- Have students attach their ads to sheets of poster board. Have them use markers to circle key elements of the ad and label these elements with the persuasion technique they represent, as described above in the Background Information. Hang the posters around the classroom and give students time to look over one another's work.
- Ask students to track product placements in movies and television shows they see. Collect this information over time and create graphs of charting frequency of exposure, which brands are seen, and/or which movies or television shows feature these product placements.
- Have students create new ads based on the ads they evaluated, showing any hidden messages and/or sustainability problems with the product.

Name: _____

Advertisement Evaluation Sheet

What product is the advertisement promoting? _____

Who is the intended audience for this ad? _____

Which of the persuasion techniques described in the Activity Background section are used in this ad? Briefly describe each technique and explain how it is demonstrated.

What emotions does the ad target? (Please see the list in the Activity Background section.)

What messages do you take from the facial expressions, body language, hair, makeup, and clothing of the people in the image? What messages do you take from the setting: location, buildings, objects, time period, etc.?

What are underlying messages in the ad about the relationships between people shown in the ad, their status, and what is considered good and desirable? What do these messages tell you about the brand?

Name: _____

Advertisement Evaluation Sheet *continued*

What desires or needs does the ad highlight or create? Are these desires or needs real or constructed? What features of the product will satisfy these desires or needs? Can these features actually produce the proposed benefit(s)?

What descriptive or persuasive words are used to create desire for the product?

Does this ad make you want to buy the product? Why or why not?

What information or outcomes about making, using, and disposing of the product are left out of the ad?

How do you think this add does or does not support sustainability principles?

Summary

Learners will explore connections between nature and the materials economy.

Time Required

- One 50-minute class period

Reading Prior to Activity

- Pages 8-12 (through the Causal Loop Diagram)

Key Concepts

- Materials Economy
- Interconnectedness
- Renewable Resources
- Biodegradable Waste Products

Objectives

- To identify inter-connections between consumer products and nature
- To recognize that all materials used by humans come from nature and return to nature when we are finished with them

Inquiry/Critical Thinking Questions

- How is the materials economy linked to nature?

Materials

- Colored pencils (optional)

Activity Five

Nature and the Materials Economy

Activity

1. **Draw a Materials Economy graphic.** Turn your Field Book to the landscape position. Draw five large arrows pointing from left to right in the middle of the page. Label the arrows with the five stages of the materials economy: Extraction, Production, Distribution, Consumption, and Disposal.

Extraction → **Production** → **Distribution** → **Consumption** → **Disposal**

2. **Working with your group and your assigned category, choose a product to analyze.**
3. **Identify sources for your product within the natural world** at each of the five stages of its lifecycle in the material economy. Using a mind map format, write these sources in bubbles above the arrows, and link the bubbles with lines to the appropriate arrow(s). Some bubbles may link with more than one arrow. Highlight using color or heavy lines any items that are renewable within the lifetime of the product.

Consider:

- Air
- Water
- Energy
- Materials
- Transportation
- Packaging

64

FacingTheFuture.org

Divide the class into groups. Assign each group one of the following categories or choose other consumer product categories:

- Clothing
- Electronics
- Wood or paper products
- Metal products
- Plastic products
- Food products
- Energy
- Transportation

4. **Identify materials your product releases to nature at each of the five stages.** Write these sources in bubbles below the arrows and link the bubbles with lines to the appropriate arrow(s). Consider the same categories as above. Highlight using color or heavy lines any items that are biodegradable or can be absorbed by natural processes within the lifetime of the product.

5. **Share your findings with the class.** Each group can present their product, its inputs from nature, its releases to nature, and a summary of renewable and nonrenewable connections with nature.

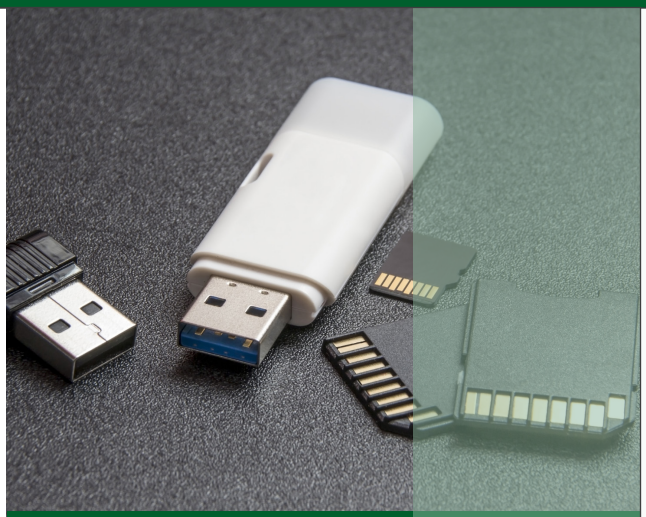
Field Book

1. **Nature Journal:** Notice how nature provides for the basic needs – food, water, clean air, shelter, and disposal of waste products – for wildlife. Even if you live in a city, you can probably spot birds, insects, small mammals, and "volunteer" plants. How are the basic needs of these creatures met by nature? Where do they sleep? What do they eat? How does nature process their waste products? Sketch any examples you see of these basic needs being met or write descriptions.

2. Write a response to the **Think About It** box on page 11.

3. Make notes about your ideas on consumerism on your **Learning Links** pages.

4. Note any questions you have on your **Questions** page.



Discussion Questions

- Did you find any inputs or outputs that could not ultimately be linked to nature?
- How many of the product's inputs or outputs were renewable or biodegradable within the product's lifetime? What does your answer suggest about how sustainable or unsustainable your products are?
- Before this activity, how aware were you about the connections between consumer products and nature? What do you think about these connections now?

Summary

Learners will estimate their personal ecological footprint and compare it to the average footprint for their country or a similar country, the global average, and other countries. Learners will also explore aspects in which their footprints are lower than average and where they might make reductions.

Time Required

- One 50-minute class period

Reading Prior to Activity

- Pages 13-15 (up to Local to Global section)

Key Concepts

- Ecological Footprint
- Consumerism
- Consumption
- Systems

Objectives

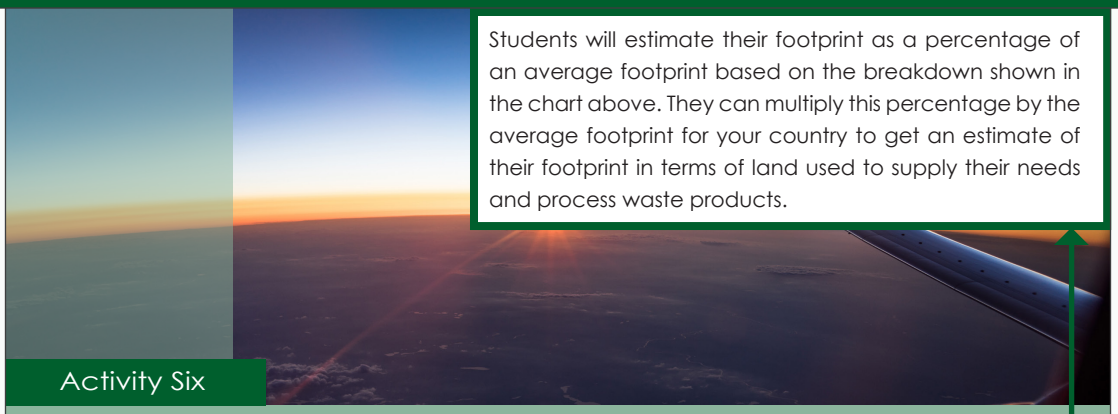
- To measure individual ecological footprints
- To compare individual ecological footprints to national and global averages
- To identify ways to reduce individual ecological footprints

Inquiry/Critical Thinking Questions

- How does my personal footprint compare to the average footprint in my country and the world's average?
- What can I do to reduce my ecological footprint?
- Is Earth capable of sustaining continuing growth in consumption?

Handouts

- Ecological Footprint Estimator Handout, page 67A-67B



Students will estimate their footprint as a percentage of an average footprint based on the breakdown shown in the chart above. They can multiply this percentage by the average footprint for your country to get an estimate of their footprint in terms of land used to supply their needs and process waste products.

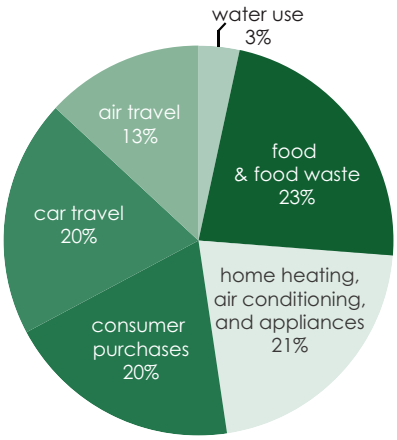
Activity Six

Calculating Your Ecological Footprint

Background

Ecological footprints are made up of many activities, including burning fossil fuels; using paper and wood products; and consuming food, water, and other materials. The chart below shows a typical breakdown of the activities that contribute to ecological footprints in industrialized countries.

Typical Ecological Footprint Breakdown



Activity

1. **Estimate your ecological footprint** using the handout provided by your teacher.
2. **Answer the questions on the handout.**
3. **In your Field Book, write a few paragraphs in response to the following questions:**

   a. Experts estimate that it would take 1.6 Earths to supply humans' resource use and process our waste products.[89] According to this estimate, reducing our footprint by one-third would bring our resource use and waste generation close to the rate at which nature can replenish resources and process waste products. What steps would you – or our society – need to take to reduce our footprints by one-third?

   b. The estimate of 1.6 Earths does not take into account the needs of other species. What steps could you – or our society – take to reduce our footprints enough to meet the needs of non-human species? Noted biologist E.O. Wilson advocates for setting aside half of the planet for other species.[90] How much do you think we would need to reduce our footprints to accomplish this state?

66

FacingTheFuture.org

If Internet access is not available, your students can use Step 1 to estimate how their personal footprint compares to the average. If your class has Internet access at home or at school, students can calculate their footprints online at:

http://ecologicalfootprint.com or http://www.footprintnetwork.org/resources/footprint-calculator/

To answer the questions on the handout, students can refer to the chart provided on the handout.

c. What assumptions do we make about the natural world in order to have a consumer lifestyle?

4. **Add your Personal Ecological Footprint Estimator to your Field Book.**

Field Book

1. **Nature Journal:** Throughout the day, notice the elements of nature that contribute to the ***web of life*** – the interconnection of living and nonliving systems that support all of life on the planet. You may notice living plants or animals, and you may notice geological or physical processes like rainfall or clean air. Document these elements of nature and any interconnections you notice; sketch them, make lists, note descriptions, or reference them in another way of your choosing.

2. Write responses to the **Think About It** boxes on pages 15 (two boxes).

Preparation

- Make a copy for each student of the Ecological Footprint Estimator handout on pages 68A-68B. This handout will be used in Steps 1 and 2 below.
- Look up your country's ecological footprint per capita at:

  http://www.footprintnetwork.org/content/documents/ecological_footprint_nations/index.html

  or use data on page 14 to find data on the country most similar to yours. This information will be used in Step 1 below.
- Optional: You or your students can also look up your country's ecological deficit/reserve – a comparison of a country's ability to produce renewable resources and absorb its waste products through natural systems with that country's ecological footprint. Please see:

  http://www.footprintnetwork.org/content/documents/ecological_footprint_nations/index.html

Discussion Questions

- Have students share and discuss their answers to the questions on the Ecological Footprint Estimator handout, as well as their overall results if they are comfortable sharing this information.
- What assumptions do we make about the natural world to allow us to have a consumer lifestyle?

Extensions

- Follow the lead of the City of Vancouver, Canada, and track ecological footprints over time. Vancouver has selected three neighborhoods where residents calculate their ecological footprints based on data they collect over two weeks. The residents will work to reduce their footprints by 15% over a year; they will recalculate their footprints to measure their success. While your class may not have a full year to make changes, they could do a similar before-and-after project over a shorter time frame. For more information, please see:

  http://www.footprintnetwork.org/2017/02/20/vancouver-kicks-off-neighborhood-footprint-campaign/

- For ideas of ways to reduce footprints, see:

  http://www.overshootday.org

Name: _____

Ecological Footprint Estimator[90a]

Use the table below to estimate differences between your ecological footprint and the average.

1. Identify any items in Column B that describe your lifestyle.
2. For items in Column B that describe your lifestyle, copy the points shown in Column C into Column D.
3. Subtotal the points in Column D for each category in Column A.
4. Total the subtotals on the Total line.
5. Subtract your total from 100. This figure shows your footprint as a percentage of an average footprint.

Column A	Column B	Column C	Column D
Category	**If you...**	**...you can subtract this many points from 100:**	**Your Reduction Points** *(copy from Column C as appropriate)*
Food	Eat a vegetarian diet	-12	
	Eat meat no more than twice a week	-9	
	Eat meat no more than once a day	-6	
		Food Subtotal	
Home	Live in a small house	-3	
	Use high-efficiency light bulbs	-3	
	Use a fan or open windows in the summer *(no air conditioning)*	-3	
	Avoid generating more trash than would fill a small single *(room trash can a week)*	-4	
		Home Subtotal	
Consumer Choices	Limit the electronic devices in your home to fewer than 10 *(televisions, computers, game systems, etc.)*	-4	
	Recycle all possible paper, plastic, and metal trash	-3	
	Use most of your clothing for more than one year	-3	
		Consumer Choices Subtotal	
Transportation and Travel	Carpool most of the time	-3	
	Use public transit most of the time	-4	
	Walk or ride a bike most of the time	-6	
	Drive a small, fuel-efficient car *(over 13 kilometers per liter or 30 miles per gallon)*	-10	
	Usually spend less than one-half hour in the car per day	-4	
	Take no more than 2 flights per year	-6	
	Take zero flights per year	-12	
		Transportation and Travel Subtotal	
		Total	
Comparison of Your Footprint to an Average Footprint as a percentage *(100 - Total from row above)*			**%**

Name: _____

Ecological Footprint Estimator *continued*

1. In which categories (Water Use, Food and Food Waste, etc.) are your habits similar to the average for your country – in other words, you have no reduction points?

2. In which categories do your habits create a smaller footprint than the average for your country – in other words, you have a high number of reduction points?

3. Are there categories or elements in which you deliberately try to reduce your ecological footprint? If so, which ones?

4. In which category(ies) could you make reductions? By what percentage could you reduce your footprint?

5. Compare your estimated footprint from the table with the global average and with average footprints from the graph on page 14. How does your footprint compare? What different behaviors and choices do you think cause the different footprint sizes?

Summary

Learners explore the geographic origins of their own clothing and compare their purchases with the likely purchasing power of workers in other countries. Learners also explore the Sustainability Big Idea of Equity as it applies to garment workers.

Time Required

- Two 50-minute class periods

Reading Prior to Activity

- Pages 15-19

Key Concepts

- Consumerism
- Equity
- Local to Global

Objectives

- To analyze the interdependence of the global economy
- To explore the origins and consequences of consumer purchases
- To learn the different standards of living that apply in different parts of the world
- To create a map showing data (optional)

Inquiry/Critical Thinking Questions

- How do my purchases connect me with people in other parts of the world?
- How do the lives of producers of goods – like garment workers – compare with the lives of consumers of goods?

Activity Seven

Closet Connections

Set-Up

1. **Make a table in your Field Book** titled "Closet Connections." Make five columns: "Garment Description," "Approximate Cost," "Country Garment Was Manufactured In," "Minimum Wage for Country Garment Was Manufactured In," and "Hours of Work Needed to Buy Garment." Make fifteen rows for data.
2. **Fill in the first three columns of the table with information for fifteen articles of clothing that you own.** Look for labels saying, "Made in (country)." Write in your best estimate of the cost of each garment when it was new.

Students may also look at clothing owned by family members if needed.

Activity

Day 1

1. **Fill in the "Minimum Wage" column.** The table below, "Minimum Wage Hourly Pay Rates by Country," shows hourly wages for the countries that manufacture the most clothing globally. For each garment, look up the minimum wage in the table for the country in which the garment was manufactured. Write the minimum wage in your table for each garment. If the country you are looking for is not shown, choose a nearby country that is similar.
2. **Fill in the "Hours of Work" column.** Assuming that garment workers are paid the minimum wage in most countries, calculate how many hours a worker would need to work to earn the purchase price of the garment. Write your answers in your table.
3. **Identify the countries where garment workers could purchase your garments.** Use reasoning to identify the countries where you believe garment workers earn enough to purchase garments they made. Mark these rows by coloring them in with a colored pencil or making another identifying mark. Also identify the countries where you believe workers could not afford to purchase these garments. Mark these rows by coloring them with a different color or identifying them with a different mark.

Materials

- Calculators or pencils and scratch paper
- Colored pencils (optional)
- Blank map of the world with country names labeled (optional)

Preparation

- Before the classroom activity, students will need to complete the Set-Up activities

(Optional) As a class, mark a map with two colors, identifying those countries in which garment workers are or are not likely to be able to purchase clothing like that owned by your class.

Minimum Wage Hourly Pay Rates by Country[91]

Use the estimates for costs of goods and services shownin the following table.

Country	Hourly Minimum Wage (U.S. Dolars)
Austria	7.40
Bangladesh	0.09
Belgium	10.31
Bulgaria	1.42
Cambodia	0.68
Canada	8.21
China	2.09
Czech Republic	2.39
Denmark	18.00
Dominican Republic	0.41
Egypt	0.30
El Salvador	0.50
France	11.03
Germany	9.99
Guatemala	1.59
Honduras	1.01
Hong Kong	4.19
India	0.31
Indonesia	0.47
Italy	None
Jordan	1.29
Lithuania	2.41
Malaysia	0.99
Mexico	0.58
Morocco	1.61
Myanmar	0.39

Country	Hourly Minimum Wage (U.S. Dolars)
Netherlands	10.11
Nicaragua	0.56
Pakistan	0.70
Panama	1.22
Peru	1.13
Philippines	1.28
Poland	3.06
Portugal	4.03
Republic of Macedonia	1.09
Romania	2.09
Singapore	5.81
Slovakia	2.63
South Korea (Republic of Korea)	5.72
Spain	4.98
Sri Lanka	0.38
Sweden	None
Switzerland	24.09
Thailand	1.09
Tunisia	0.51
Turkey	3.11
United Kingdom	11.00
United States	7.25
Vietnam	0.64

Discussion Questions

- How did you decide which workers could afford to buy clothing? What evidence or reasoning did you use?
- Which countries' garment workers were likely to be able to buy the clothing they made?
- Which countries' garment workers were not likely to be able to buy the clothing they made?
- How has your understanding of the global economy changed since completing this activity?
- How does the Sustainability Big Idea of Equity apply to this situation? How would you suggest making garment manufacturing more equitable – and therefore, more sustainable?

Extensions

- Have students organize the list of countries by continent and/or by developed or developing countries. Students can create a bar graph, grouping countries by these categories, to compare wages in different regions and economic conditions. Groups of students can examine different groupings and compare results.

You may want to divide the class into groups – with one group representing each continent – to perform the calculations more quickly.

Activity

Day 2

1. **Estimate average wages earned by people who make the clothing worn by students in your class.** Based on your work on Day 1 of this activity, create a list of the countries where clothing worn by students in the class was manufactured. Group the countries by continent. Using the data in the Minimum Wage Hourly Pay Rates by Country table on page 69, calculate the average hourly wage for a garment worker on each continent. Create a simple T-chart in your field book to record the averages for each continent.

2. **Create a table in your Field Book with seven columns and nine rows.** Use a full two-page spread if you need to. Title the table "Garment Workers' Purchasing Power Around the World." Use the example below to set up the top row of your table, dividing most of the row in half as shown. In the left column, write the following headings: One Kilogram of Rice, One Can of Soda, Monthly Bus Pass, Basic Pair of Jeans, Doctor Visit, One Month of Cell Phone Service, Television (32" screen), and Two-Hour Flight.

Good or Service	Work Hours Needed for Garment Workers to Purchase the Good or Service on Each Continent					
	Africa	Asia	Europe	North America	Oceania	South America
One Kilogram of Rice						
(list remaining goods and services)						

3. **Estimate the number of hours that garment workers would need to work to pay for various goods and services.** To calculate the number of hours, use the following equation:

work hours needed = (cost of good or service) / (garment worker average hourly wage for the continent)

Use the estimates for costs of goods and services shown in the following table.

70

FacingTheFuture.org

Item	Estimated Cost (U.S. dollars)[92]						
	Africa	Asia	Europe	North America	Oceania	South America	Developed Nations
One Kilogram of Rice	$1.64	$1.53	$2.15	$1.91	$1.32	$1.33	$1.47
One Can of Soda	$0.13	$0.12	$0.20	$0.25	$0.58	$0.24	$0.17
Monthly Bus Pass	$24.00	$34.00	$33.00	$17.00	$34.00	$25.00	$83.00

Item	All Countries
Basic Pair of Jeans	$20.00
Doctor Visit	$20.00
One Month of Cell Phone Service (Including Fee to use the Phone)	$29.00
Television (32" screen)	$425.00
Two-Hour flight (Round Trip)	$200.00

4. **Evaluate your results.** Compare results for different continents, goods, and services. Share results with the class.

Field Book

Day 2

1. **Nature Journal:** Notice the ways in which plants and animals protect themselves from the elements – the basic function of clothing. How do other living things stay warm, cool down, stay dry, retain moisture, and avoid sunburn? What natural protections do humans have? Write down or sketch what you observe.
2. Write a response to the **Think About It** box on page 16.
3. Update your **Questions** and **Learning Links** pages.

Discussion Questions

- On which continents do workers have to work the most hours to pay for basic and more discretionary goods and services? On which continents do workers have to work the fewest hours to buy the same goods and services? Why do you think these differences exist?
- Considering that garment workers would also have to pay for housing, additional food, clothing, and other goods and services, what do you think their daily life is like? How does their level of material resources compare to yours?
- Consider the Sustainability Big Idea of Equity. How does this Big Idea apply in this activity? How might different worldviews see the idea of equity? How could equity create a more sustainable world? Do you think a more equitable world would be more sustainable? Why or why not?
- Can you think of ways to increase equity between the producers of goods – like garment workers – and consumers of goods? Do you think equity between these groups should be increased? Why or why not?

Additional Resources

PBS Nova World in the Balance coverage of Material World, a photo-graphic book that documents the material goods owned by families around the world:
http://www.pbs.org/wgbh/nova/worldbalance/material.html

List of developing countries:
http://www.ssr.org/DevelopingCountries

Landfill Harmonic, "The World Sends Us Garbage, We Send Back Music" video. Children living in poverty in Paraguay create musical instruments from garbage and form an orchestra:
https://www.youtube.com/watch?v=CsfOvJEdurk

Summary

Learners analyze the data from the survey they conducted as part of Activity 1.

Time Required

- One 50-minute class period, plus time to set up the surveys as part of Activity 1 and time outside of class to conduct surveys

Key Concepts

- Consumerism
- Conducting a survey

Objectives

- To identify similarities and differences between the everyday consumption habits of students and their families or other contacts over the past several decades
- To increase awareness of consumerism today

Inquiry/Critical Thinking Questions

- How have consumption patterns changed over the past several decades?
- How does survey design affect the outcome?

Handouts

- Sample Survey Questionnaire or your class questionnaire
- Survey Tally Sheet 1 and Survey Tally Sheet 2

Materials

- Scissors

Preparation

- Make five copies of Survey Tally Sheet 1: one each for people born in the 1930s, 1940s, 1950s, 1960s, and 2000s
- Make five copies of Survey Tally Sheet 2

Activity Eight

Consumption Then and Now, Part 2

Activity

1. **Compile results from your surveys into subtotals and averages by decade.** Sort the completed questionnaires into stacks according to the decade during which the respondent was born. For example, all questionnaires for respondents born in the 1960s would be placed in one stack, and all questionnaires for respondents born in the 1950s would be placed in another stack. You will work in a small group, with each group focusing on all of the questionnaires completed by respondents born in a specific decade.

   To evaluate the survey results, you will average the responses for your group of questionnaires. Add up all the responses to each question, writing the subtotals on the Survey Tally Sheet 1 provided by your teacher. Then calculate the average response by dividing the subtotal by the number of responses for your decade. Record the results on the tally sheet. Be sure to mark the birth decade of respondents on each section; this information will be used in the next step.

2. **Re-sort results by questionnaire section.** Your group will now create a table with all of the responses to your assigned section of the questionnaire. Please use Survey Tally Sheet 2, provided by your teacher, to record your results.
3. **Graph results.** Create bar graphs comparing the results by decade for each question in your assigned section. Use blank paper.

Field Book

1. **Nature Journal:** Look back at your Nature Journal from Day 1 of this activity and review your list of items you use that are made of natural materials. Over the next day, notice trees, plants, animals, or minerals that could be used to make goods for humans. How does it feel to look at these entities as resources compared to looking at them as living things? Make notes and/or sketches of your thoughts.
2. Write responses to the **Think About It** boxes on pages 17 and 19.

Divide students into small groups so that each group can work on survey data from respondents born during one decade. Give each group all of the responses for a given decade, as explained in the following instructions. Give each group a copy of Survey Tally Sheet 1: Results by Decade; please see page 73B.

After your survey period, have students bring their completed questionnaires to class to tally results and identify trends. Students will subtotal and average survey results by the decade during which respondents were born, then graph the results.

Collect all of the groups' copies of Survey Tally Sheet 1. Assign each student group to now focus on the responses from all decades for a particular section of the survey: Section 2, 3, 4 or 5. Divide Section 4 in half and give one half to each of two groups.

Make sure that groups marked the birth decade of respondents on each section. Cut apart the individual tally sheets with scissors, separating the Section 2 segments, Section 3 segments, Section 4 segments (divided into halves), and Section 5 segments into separate stacks. Give all of the Section 2 portions to one group, the Section 3 portions to another group, and so on.

Ask students to add a vertical axis title, range, and units to their graphs in Survey Tally Sheet 2.

Discussion Questions

- According to your survey results, in what ways did consumption increase over the past several decades?
- According to your survey results, in what ways did consumption decrease over the past several decades?
- According to your survey results, in what ways did consumption remain the same over the past several decades?
- Think about the results of your ecological footprint work in Activity 6. How would the ecological footprints of previous decades compare to footprints of today?
- What other patterns or trends can you identify from your survey results?
- Do you think this survey represents the trends in society overall? Why or why not?
- How accurate do you think the survey was? Why?

Survey Tally Sheet 1: Results by Decade

Respondents' Decade of Birth: _____ Number of Respondents in this Decade: _____

	Question	Results Subtotal	Results Average
Section 2: Community Information for Decade _____			
2.1	Average number of people living in your town, city, or village		
2.2	Average number of national chain stores you or your family shopped at		
2.3	Average number of locally owned stores you or your family shopped at		
2.4	Average percentage of families in your community that raised animals or grew fruit or vegetables for food		
2.5	Average percentage of families in your community that owned a television		
2.6	Average percentage of your friends with a grandparent living with them?		

- cut here in Step 2 -

Respondents' Decade of Birth: _____ Number of Respondents in this Decade: _____

	Question	Results Subtotal	Results Average
Section 3: Home Information for Decade _____			
3.1	Average number of people living in a home		
3.2	Average size of house: *(square feet or square meters)*		
3.3	Average number of major electric appliances *(for example, a washing machine, dryer, refrigerator, dishwasher, or air conditioner)*		
3.4	Average number of small electric appliances *(for example, a blender, toaster, food processor, mixer, vacuum cleaner, or garbage disposal)*		
3.5	Average number of telephones		
3.6	Average number of cars		

Respondents' Decade of Birth: _____ Number of Respondents in this Decade: _____

	Question	Results Subtotal	Results Average
	Section 4: Basic Needs Information for Decade _____		
	Clothing		
4.1	Average number of:		
	4.1a Pairs of shoes		
	4.2a Skirts, dresses, or pairs of pants		
	4.3a Coats or jackets		
	4.4a Average percentage of clothes sewn by a family member		
4.2	Average percentage of clothes handed down to or from a family member		
4.3	Average percentage of clothes made from natural materials like cotton or wool		

- cut here in Step 2 -

Respondents' Decade of Birth: _____ Number of Respondents in this Decade: _____

	Question	Results Subtotal	Results Average
	Decade _____		
	Food		
4.4	Average times per week consuming:		
	4.4a Beef, chicken, pork, or other meat		
	4.4b Milk		
	4.4c Fresh vegetables or fruits		
	4.4d Sweets		
	4.4e Snack foods (crackers, chips, snack bars, etc.)		
	4.4f Other processed or packaged foods		
4.5	Average percentage of household food waste fed to animals or composted		
4.6	Average percentage of household food waste thrown in trash		

- cut here in Step 2 -

Respondents' Decade of Birth: _____ Number of Respondents in this Decade: _____

	Question	Results Subtotal	Results Average
	Section 5: Satisfying Wants for Decade _____		
5.1	Average times per week that respondents ate in a restaurant		
5.2	Average number of weeks per year respondents traveled on vacation		
5.3	Average number of toys and games owned		
5.4	Average number of entertainment devices in households		
5.5	How many hours of free time did you have per week?		
5.6	How many hours per week did you spend doing chores?		

Survey Tally Sheet 2: Results by Survey Question

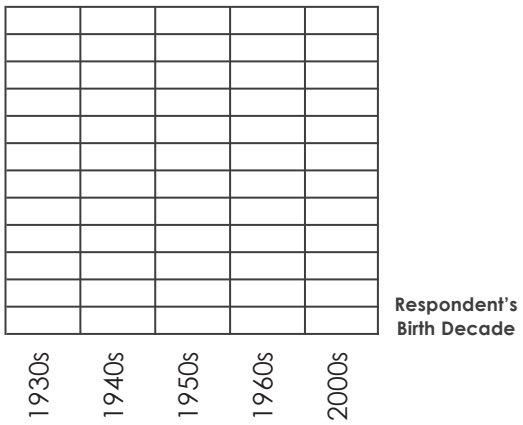
Survey Question Number: _____

Survey Question: _____

_____

Table A
Survey Question Results by Birth Decade

Respondent Birth Decade	Average Result (from Survey Tally Sheet A: Results by Decade)
1930s	
1940s	
1950s	
1960s	
2000s	



cut here

Survey Tally Sheet 2: Results by Survey Question

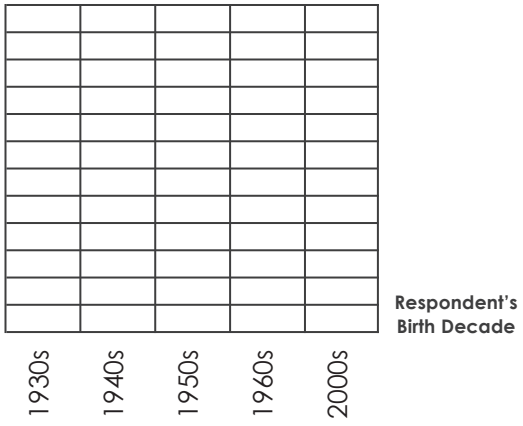
Survey Question Number: _____

Survey Question: _____

_____

Table A
Survey Question Results by Birth Decade

Respondent Birth Decade	Average Result (from Survey Tally Sheet A: Results by Decade)
1930s	
1940s	
1950s	
1960s	
2000s	



Activity Nine

Nature, The Materials Economy, and Feedback

Background

Causal loops are sometimes called feedback loops. In a cause-and-effect cycle, a change in one component provides ***feedback*** – or information – to other components of the cycle. These other components change in response to the feedback, affecting the system as a whole.

There are two types of feedback: ***reinforcing*** and ***balancing***. When reinforcing feedback occurs, an increase in one component causes an increase in other components, so the whole system increases. The changes in each component lead to the same overall result in the system's behavior. In other words, the change in one component is reinforced by changes in another component. This kind of feedback is described on page 10 and is shown in the Take-Make-Waste Causal Loop Diagram on page 11. The Sustainable Materials Economy Causal Loop Diagram on page 12 also shows a reinforcing loop. Reinforcing feedback is sometimes called ***positive feedback***.

In systems with balancing feedback, change in one component cancels out change in another component. The result is a system that stays within a range of behavior: it stays in balance. An example of a system with balancing feedback is a thermostat on a space heater. The thermostat is set at a certain temperature. If the room gets colder, the heater turns on and warms up the room. When the room reaches the desired temperature, the heater turns off.

Feedback is an important element of systems: feedback is the information that tells different components that something has changed. This flow of information creates the interconnections between system components that allow them to work together to accomplish some purpose. Without the information that feedback provides, the components would not influence one another.

In natural systems, information flows through senses, movement, and actions of animals; growth and health of plants; physical forces; and other methods. For instance, when the population of deer increases in an area, more predators like wolves will come into the area. The predators may see or smell the deer, which acts as information – or feedback – to the deer-wolf system. As the deer population declines through predation, the wolves will spread out to other

Summary

Learners will explore ways in which the systems concept of feedback can improve sustainability. For practice with a real-world example, students will add feedback to the five-stage materials economy process for their chosen product from Activity 5, Nature and the Materials Economy. Students will assess the improvement in sustainability that their feedback mechanism(s) would produce.

Time Required

- One 50-minute class period

Reading Prior to Activity

- Review pages 8-13
- Pages 18-19, 24-26
- Activity Background Section, page 73

Key Concepts

- Reinforcing and Balancing Feedback
- Materials Economy
- Interconnectedness
- Sustainable Products
- Externalities
- Wants vs. Needs

Objectives

- To use feedback in a real-world situation
- To assess how feedback improves sustainability

Inquiry/Critical Thinking Questions

- How can feedback affect business and consumer decisions?
- How can products be made more sustainable?

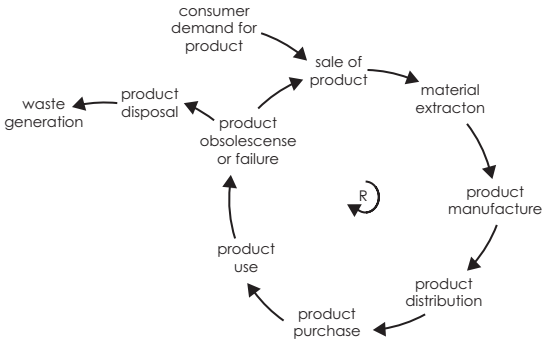
areas, again using their senses for information. After the deer have eaten many plants, space opens up for new seeds – possibly for species other than those that were eaten – to sprout. The seeds used the warmth of the sunshine, made available because other plants no longer created shade, as a signal to sprout. This signal is a form of feedback. Natural systems use a wide variety of biological and physical signals.

Human systems can also use biological and physical signals. We use our senses in the same ways animals do. In the materials economy, we can use any or all of our senses to become aware of consumer goods and decide whether we want those goods or not. Humans also use language and media as information: we read newspapers, listen to music, watch commercials, talk with our friends, and see advertisements.

All of these activities act as information that can prompt us to buy new things, driving the consumer feedback loop as shown in the diagram below.

Other forms of information can affect different parts of the materials economy: sales orders, availability of raw materials, laws and regulations, discounted or increased prices, or trucker strikes or storms affecting transportation. Ultimately, we – like animals – receive information through our senses. But often it comes to us through uniquely human communication channels.

Feedback, or information, is important for sustainability because many of the impacts of unsustainable choices are not visible to consumers or businesses. We rarely see environmentally damaging mining or logging sites. Once our trash is thrown away, we no longer feel any sense of responsibility for it because we do not see landfills. We may use products that have environmental or social externalities. Creating feedback – linking materials and behaviors with their impacts – helps consumers and businesses make more sustainable decisions. Our choices can away shift from reinforcing loops with continuing resource use and pollution. Instead, we can move toward balancing loops, where our consumer and business choices are in balance with the natural cycles that support all of life.



74

FacingTheFuture.org

Activity

1. **Review your Materials Economy diagram from Activity 5,** focusing on the items that were highlighted as being nonrenewable materials or non-biodegradable waste.

2. **With your group, identify types of feedback – or information – that could be added** to the five stages of the materials economy for your product. Look for ways to bring information directly to consumers and businesses about unsustainable aspects of the product; direct information could include education, media, or other communication tools. Also, look for ways to bring information through nonverbal methods described in the Background section: pricing, laws, availability of materials and/or waste disposal, and so on. Remember that the goal of the feedback measures is to encourage more sustainable behavior by businesses and consumers throughout the lifecycle of the product.

3. **Share your results.** Report your feedback measures back to the class.

Field Book

1. **Nature Journal:** What forms of feedback can you notice in the natural world around you? How do plants and animals respond to changes in food, weather, available shelter, population changes, or other shifts in the systems in which they live? How do physical systems like the water cycle and air circulation use feedback to adapt to changes? Describe what you observe in words or pictures. Also note some ideas of how you adapt to changes in the natural systems in which you live, systems that affect food, temperature, or the need for shelter.

2. Write a response to the **Think About It** box on page 20.

Discussion Questions

- What feedback tools do you think would be most effective in encouraging more sustainable choices? Why?

- What parts of the materials economy can be most strongly affected by feedback? Provide reasoning and evidence to support your answers.

Review the following material with the class:

- the causal loop diagram information on pages 10-11
- the information in the "Learning from Nature: Cycles and Flows" call-out box on page 12
- the description of sustainable products on pages 12-13

Ask students to rejoin their groups from Activity 5, Nature and the Materials Economy.

Activity Ten

Sustainable Decision-Making, Part 1

Summary

Learners practice the skill of making sustainable decisions, using a guided process applied to a real-world issue.

Time Required

- One 50-minute class period plus optional time before activity to collect information. Please see the Preparation section below

Reading Prior to Activity

- Review pages 1-21
- Read pages 20-26

Key Concepts

- Decision-Making
- Critical Thinking
- Universal Responsibility
- Sustainability Big Ideas
- Wicked Problems

Objectives

- To practice using a structured decision-making process
- To use critical thinking and Sustainability Big Ideas in decision-making

Inquiry/Critical Thinking Questions

- How can a guided process help develop solutions to wicked problems and other sustainability issues?
- How can critical thinking support good decision-making?
- How can the Big Ideas of Sustainability help solve wicked problems?
- How is consumerism a wicked problem?

Preparation

You may choose to assign or select a topic ahead of time and give the class time to collect information called for in the Decision-Making Flow Chart on page 23.

Activity

1. **Follow the steps in the Decision-Making Flow Chart** on page 23 to address a consumerism issue and to make sustainable decisions related to the issue. Use the guide to organize and guide your information collection, analysis, and development of conclusions. Document your work in your Field Book, using the flow chart as a model for organizing your notes; use a similar flow chart format, an outline, or other format of your choosing. Also use the critical thinking guidelines listed on page 22.
2. **Share your results with the class.**

Field Book

1. **Nature Journal:** Take a look at yourself – as part of nature – when you make decisions throughout the day. Notice how each choice feels in your body when you choose what to eat, what to say, or what to do. Notice your gut, your heart, your hands, your throat, or any other areas that come to your attention. Do you feel sensations of tightness, warmth, tingling, or ease? See if your body registers choices differently the more your decisions support your well-being or the well-being of others. Write about your experiences.
2. Write responses to the two **Think About It** boxes on page 21.
3. Update your **Learning Links** pages. What connections are you making?
4. Update your **Questions** page. What material is not clear? What would you like to know more about?

Assign, or have the class select, a consumerism-related issue of interest to them. One possibility is to find ways to address the influences of consumerism on students' choices. Elements could include:

- helping students to notice advertising, peer judgments, wants vs. needs, and other influences when making purchasing decisions
- considering the impact of buying decisions on the natural world and workers throughout the five stages of the materials economy
- making consumer decisions based on sustainability principles
- influencing others to consider consumer decisions based on sustainability principles
- redefining wants and needs into choices that benefit all of life, not just the consumer.

Divide the class into working groups. They may address the same issue or different issues.

Discussion Questions

- How did the process work?
- What sustainability elements were included in your decision?
- What critical thinking elements did you use?
- How can you use these decision-making tools in making future decisions?

Activity Eleven

Consumerism Reflections, Self-Assessment, and Commitments

Activity

Complete the following items in your Field Book. Use the following definition of sustainability: a safe and just world for all species, forever.[93]

1. **Create a table with three columns and five rows.** Write the following headings across the top: Worldview Element, Consumerism Worldview, and Sustainability Worldview. In the left-hand column, write the following headings for each row: Knowledge, Capabilities and Intentions, Values, and Behavior. Fill in the remaining boxes, describing, comparing, and contrasting the knowledge, capabilities and intentions, values, and behavior that make up a consumerism worldview with those that make up a sustainability worldview.

2. **Write a brief response to each of the unit's essential questions:**

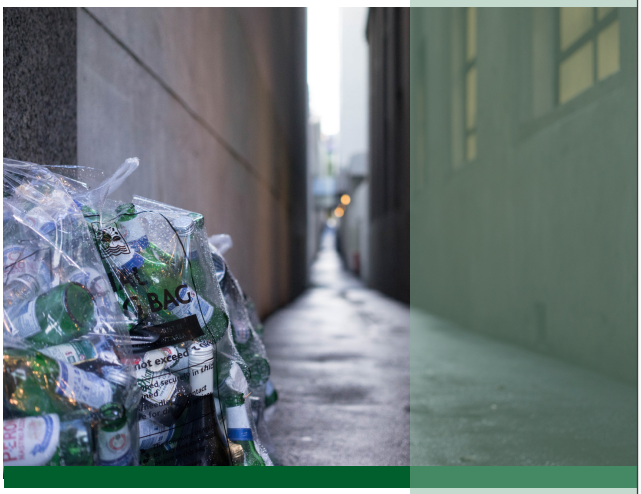
   a. How can I make more sustainable consumer choices?

   b. Where do the things that I use go at the end of their useful life?

   c. Who made the things that I use? What is life like for those people?

   d. How does my consumption of goods affect overall global sustainability?

3. **Write about your views on consumerism and consumer desires,** considering all that you have learned about ecological footprints, overshoot, the effects of the materials economy, the influence of advertising, separating wants from needs, sustainable decision-making, and other ideas from this unit. How would you now define your beliefs and expectations about your consumer desires and choices? How would you now define what is desirable? What factors would



You may want to have students prepare for or complete some of these items outside of class.

Summary

Learners compare consumerism and sustainability worldviews, reflect on their learning, and examine next steps they would like to take.

Time Required

- One 50-minute class period

Reading Prior to Activity

- Review pages 1-26

Key Concepts

- Consumerism
- Materials Economy
- Ecological Footprint
- Overshoot
- Big Ideas of Sustainability
- Sustainable Decision-Making

Objectives

- To reflect on learning, build the ability to transfer learning outside of class, and identify changes in worldview

Inquiry/Critical Thinking Questions

- How can I make more sustainable consumer choices?
- Where do the things that I use go at the end of their useful life?
- Who made the things that I use? What is life like for those people?
- How does my consumption of goods affect overall global sustainability?

Materials

- Colored pencils, optional

you like to influence you, and from what factors would you like to be free of influence? What kind of influence – either respectfully spoken or just by your way of being – would you like to offer to others?

4. **Write a one- or two-sentence creed** – a belief statement – defining your way of evaluating your wants and needs from a sustainability perspective.

5. **Look back at the Questions page in your Field Book.** Are there unanswered questions? How can you get them answered? What else would you like to know about sharing the planet with nature in the future?

6. **What parts of the Consumerism unit represented your best work?** What would you like to do differently?

7. **Review the section on What You Can Do** in the text on pages 49-50. Are there any suggestions that inspire you? What, if any, actions would you like to take to support biodiversity? Write down concrete action steps, goals, and timing for any commitments you would like to make.

8. **In the margins of your pages, sketch images** that reflect your vision of a world in which consumer choices are sustainable and in balance with the needs of all people and other species.

78

FacingTheFuture.org

Because students will complete the questionnaire again at the end of the unit to see what they have learned, do not go over the answers at this time.

Activity Twelve

Climate Questionnaire

Activity

1. **Complete the Climate Questionnaire provided by your teacher.**
2. **Add your completed questionnaire to your Field Book.**

Field Book

1. **Create a new Learning Links page** in your Field Book with the essential questions for this unit:
   a. What are the natural and anthropogenic processes that influence climate change?
   b. What can I do to reduce my contribution to climate change?
   c. Are the impacts of climate change experienced equitably by all humans on the planet?
   d. Whose responsibility is it to address the impacts of climate change?
2. **Create a new Questions page** in your Field Book.

MODULE FOUR 79

Additional Resources

National Oceanic and Atmospheric Administration (NOAA) document, Climate Literacy. Please see:

http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf

Summary

Learners will check their expanded knowledge about climate change. Students will compare the results of the questionnaire with the questionnaire they completed at the beginning of the unit to check their learning. This activity addresses the National Oceanic and Atmospheric Administration's (NOAA) Climate Literacy principle of understanding the essential principles of Earth's climate system.[93a]

Time Required

- 20 minutes

Key Concepts

- Climate Change Basics

Objectives

- To identify preconceptions about climate change
- To identify strengths and gaps in students' existing knowledge about climate change

Inquiry/Critical Thinking Questions

- What is climate change?
- What do I need to know about climate change?

Handouts

- Climate Questionnaire, page 79A

Preparation

- Make a copy of the Climate Questionnaire, page 79A, for each student

Discussion Questions

- How knowledgeable do you think you are about climate change?
- What questions do you have about climate change?

Name: _____

Climate Change Questionnaire[93b]

Is Earth's climate warming? Yes No

Do the majority of climate scientists believe that evidence shows the climate is warming? Yes No

What natural processes could cause Earth to warm? _____

What human actions could cause Earth to warm? Circle the main human contributor to climate change in your list.

Which is causing more warming of Earth's climate: natural processes or human actions?

What is the greenhouse effect? _____

List any greenhouse gases that you know of. Circle the most significant one on your list.

How are fossil fuels related to climate change? _____

How far back in history do scientists need to look to find atmospheric CO_2 levels as high as they are today?

What are the main effects of global warming on ecosystems? _____

How will global warming affect different countries? Will all countries be affected equally?

Which countries contribute most to global warming? _____

Is the hole in the ozone layer related to climate change? If so, how? _____

What can people do to reduce climate change? _____

On a scale of 1 to 10, with "10" being well informed and "1" being you have very little information, how informed are you about climate change? _____

Climate Change Questionnaire

Solutions

Is Earth's climate warming? Yes No

Do the majority of climate scientists believe that evidence shows the climate is warming? Yes No

What natural processes could cause Earth to warm? Changes in the sun's intensity or solar flare activity, volcanic eruptions, changes to Earth's orbit around the sun, changes to the tilt and direction of Earth's axis. (See page 33)

What human actions could cause Earth to warm? Circle the main human contributor to global warming.
Burning fossil fuels, farming, deforestation, eating meat and some agricultural practices. (See page 37)

Which is causing more warming of Earth's climate: natural processes or human actions?
Human actions. (See page 37-41)

What is the greenhouse effect? (See page 29)

List any greenhouse gases that you know of. Circle the most significant one.
Carbon dioxide (CO_2) methane (CH_4), nitrous oxide (N_2O), and water vapor. (See pages 38-40)

How are fossil fuels related to climate change? When fossil fuels are burned, they emit carbon dioxide. Carbon dioxide is the most significant greenhouse gas and causes global warming. (See page 38)

How far back in history do scientists need to look to find atmospheric CO_2 levels as high as they are today? Ice core data is available for the past 800,000 years. Scientists drilled into ice sheets in Antarctica and analyzed tiny air bubbles trapped in the ice. Over that time period, CO_2 levels were never as high as they are today.[93c]

What are the main effects of global warming? Changes in rainfall, leading to droughts, flooding, or extreme storms; ocean acidification affecting phytoplankton, which are the base of the marine food chain and a major source of photosynthesis; melting of glaciers and polar ice caps; rising sea levels. These factors can affect habitat and ecosystems for wildlife. For humans, farming and coastal cities can be affected, and infrastructure like roads, bridges, and power plants can be damaged. Island nations may be inundated with rising ocean levels. Water may become scarce in some areas. (See pages 43-45)

How will global warming affect different countries? Will all countries be affected equally? Coastal cities and island nations may be strongly affected. Some countries may experience food or water shortages, especially in sub-Saharan Africa. Diseases may spread to new areas. Many people may be displaced as they need to move in search of food or water. (See page 45)

Which countries contribute most to global warming? Top emitters of greenhouse gases are industrialized countries like the United States and China. Other high emitters are countries building industrial economies such as India and Brazil.

Is the hole in the ozone layer related to climate change? If so, how? The two atmospheric issues are not directly related. The hole in the stratospheric ozone layer has been caused mainly by emissions of chemicals called chlorofluorohydrocarbons (CFCs), which were manufactured to be used as refrigerants and solvents. Greenhouse gases like carbon dioxide, methane, and water vapor do not contribute to the ozone hole. Nations around the world have worked together to stop production of CFCs, and the ozone hole has stopped growing. New chemicals called hydrochlorofluorohydrocarbons (HCFCs) were developed to replace CFCS. Unfortunately, CFCs are greenhouse gases and will stay in the atmosphere for about 100 years before breaking down. HCFCs are also greenhouse gases, but they break down more quickly. In this way, the ozone hole is indirectly related to global warming.

What can people do to reduce climate change? Individuals can reduce their fossil fuel consumption, eat less meat and other animal products, and avoiding buying unnecessary consumer goods. On the positive side, these reductions can be a good excuse for riding bikes, spending time with friends and family, spending time outdoors, making music, and building a sustainable, safe, and just world for all.[93d]

On a scale of 1 to 10, with "10" being well informed and "1" being you have very little information, how informed are you about climate change? _____

Summary

Students learn to differentiate between short-term weather and long-term climate. This activity addresses the National Oceanic and Atmospheric Administration's (NOAA) climate literacy principle of understanding the essential principles of Earth's climate system.[93e]

Time Required

- One 50-minute class period

Reading Prior to Activity

- Pages 27-29 (up to Understanding Climate)

Key Concepts

- Weather
- Climate

Objectives

- To know that "weather" means short-term atmospheric conditions and "climate" means long-term atmospheric conditions

Inquiry/Critical Thinking Questions

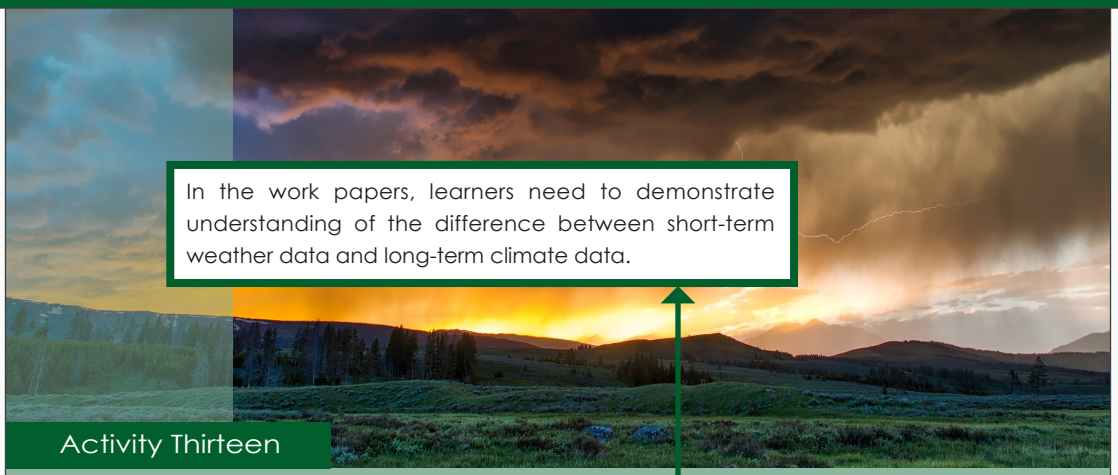
- What is the difference between climate and weather?
- How does understanding the difference between climate and weather help us understand climate change?

Handouts

- Weather and Climate Work Paper, pages 81A-81D

Preparation

- Make a copy of the Weather and Climate Work Paper, pages 80A-80D, for each student



In the work papers, learners need to demonstrate understanding of the difference between short-term weather data and long-term climate data.

Activity Thirteen

Weather or Climate?

Review the definitions of weather and climate from page 29. Ask students to give examples of each.

Activity

1. **Complete the Weather and Climate Work Paper** provided by your teacher.
2. **Add your Weather and Climate Work Paper to your Field Book.**

Field Book

1. **Nature Journal:** Notice today's weather. How does it affect you – do you want to go outside? Does the weather make you want to stay indoors? How does it affect your mood? What aspects of the weather do you sense with your five senses?
2. Write a response to the **Think About It** box on page 29.
3. **Create a new Learning Links page** in your Field Book with the essential questions for this unit:
   a. What are the natural and anthropogenic processes that influence climate change?
   b. What can I do to reduce my contribution to climate change?
   c. Are the impacts of climate change experienced equitably by all humans on the planet?
   d. Whose responsibility is it to address the impacts of climate change?
4. **Create a new Questions page** in your Field Book.

80

FacingTheFuture.org

Discussion Questions

- Have students explain the difference between weather and climate in their own words.
- For understanding climate change, why is it important to understand the difference between weather and climate?
- What do short-term changes in weather – a snowy day, a cold winter, an unusually dry spring – tell us about long-term climate trends?
- How can there be extreme winter storms – or even a colder winter than usual – if the climate is warming? (Because of complex interactions between the atmosphere, the water cycle, ocean currents, land masses, and other physical factors, warming is not necessarily equal or constant across the planet. Over the long run, however, science tells us that the average global temperature has increased.)
- What length of time do scientists consider to represent climate rather than weather? (Usually about 30 years.)[93f]
- Are students aware of any unusual weather or changes in climate in your local area?

Name: _____

Weather and Climate Work Paper

1. Explain the similarities and differences between the two graphs below in terms of weather and climate.

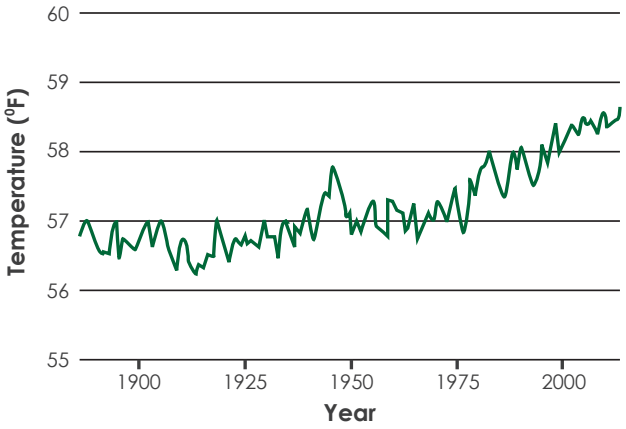
_____

_____

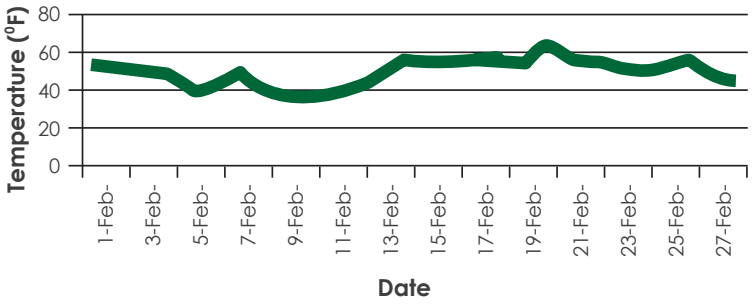
_____

_____

Average Global Temperature by Year [93g]



Maximum Daily Temperatures in London - February, 2017 [93h]



2. Explain the differences in the reports below in terms of weather and climate.

_____

_____

_____

_____

Report 1

"There has been a substantial increase in most measures of Atlantic hurricane activity since the early 1980s, the period during which high quality satellite data are available. These include measures of intensity, frequency, and duration as well as the number of strongest (Category 4 and 5) storms. The recent increases in activity are linked, in part, to higher sea surface temperatures in the region that Atlantic hurricanes form in and move through." [93i]

Report 2

"Heavy rainfall has disrupted normal life in Mumbai in the last 48 hours with the weatherman predicting rainfall at regular intervals in the next 24 hours.

From Wednesday 8 am to 8 am this morning, the city recorded 84.7 mm rainfall, western suburbs recorded 95.89 mm, while eastern suburbs registered 76.27 mm rainfall, according to civic body weather stations.

"Heavy to very heavy rainfall at regular intervals are likely to occur at one or two places in the city today," a senior official at Met Department, Mumbai regional office, said.

The official informed that other parts of the state have also recorded adequate rainfall."[93j]

Name: _____

Weather and Climate Work Paper *continued*

3. Explain the two maps below in terms of weather and climate.

_____

_____

_____

_____

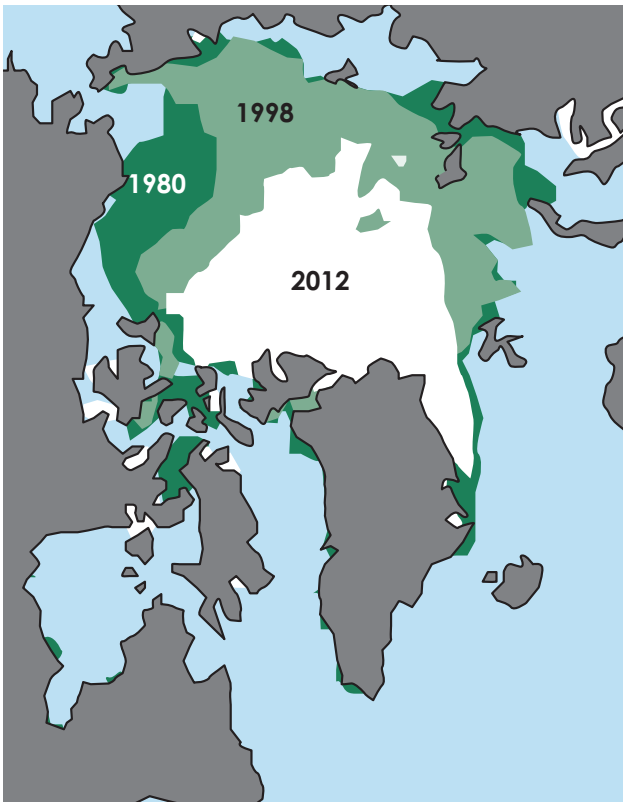
Map 1

The graph shows annual variations in the amount of sea ice in September in the Arctic from 1980 – 2000 as measured by satellites. The areas colored in greens were all covered in ice in 1980. In 1998, only the medium green and white areas were covered in ice. By 2012, only the white area of the map was covered in ice.[93k]

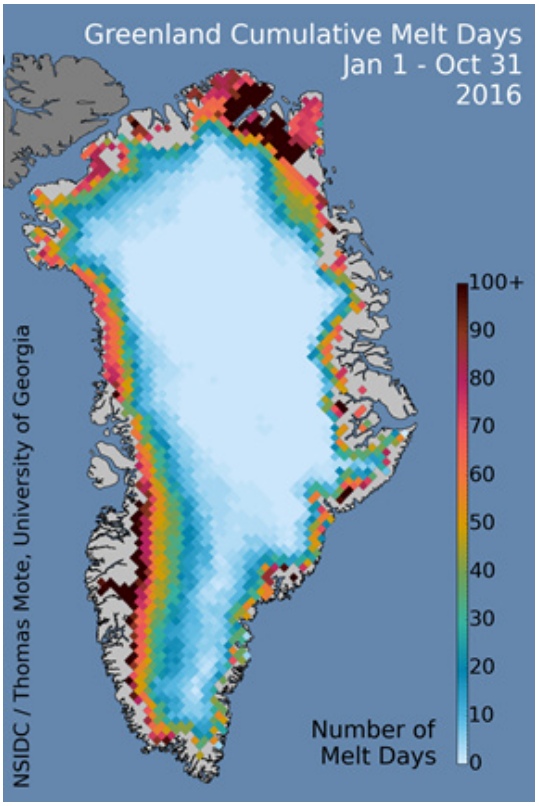
Map 2

The map below shows how many days the thick ice on different areas of Greenland has melted during 2016. In the dark red areas, the ice has been melting for more than 100 days. In the lightest blue areas, there have been zero days on which ice has melted.[93l]

Artic Sea Ice from 1980 - 2000



Greenland Cumulative Melt Days Jan 1 - Oct 31, 2016



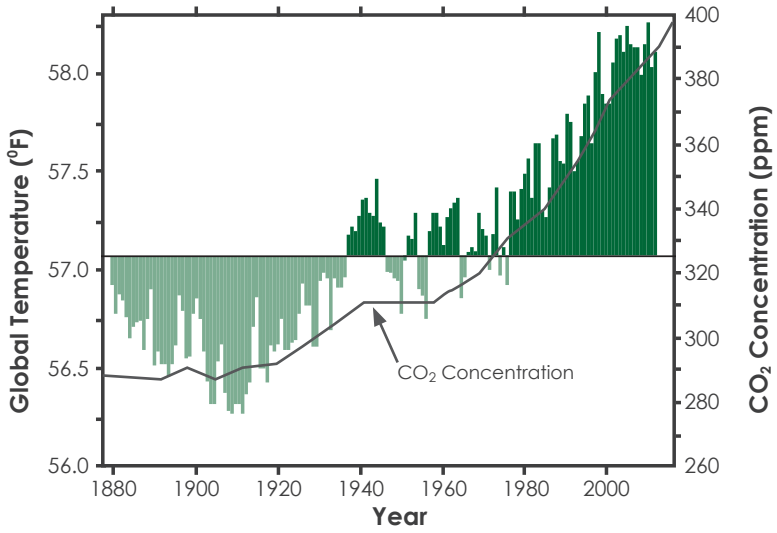
Name: _____

Weather and Climate Work Paper *continued*

4. The chart below compares the average global temperature over the 20th century – 57.1°F – with each year's average global temperature from 1880 to 2012. Light green bars represent years that were cooler than 57.1°F. The length of the bar shows how much cooler the average temperature that year was compared to the 20th century average temperature. Dark green bars represent years that were warmer than 57.1°F.[93m] The average temperature for each year can be read on the vertical axis.

   Scientists use this kind of comparison of annual temperatures with longer-term averages to identify long-term trends. This graph is similar to the one shown on page 36. What information about climate and weather can you learn from this graph?[93n]

Global Temperature and Carbon Dioxide



Source: Globalchange.gov[49]

Name: _____

Weather and Climate Work Paper *continued*

5. The map below shows how much warmer or cooler different regions of the planet were in January 2017 compared to the whole planet's average temperature in the mid-1900s. The bar below shows the temperature range represented by each color. For example, the dark red regions were 9.5°C warmer than the mid-century average. The medium blue regions were 4.0°C cooler than the mid-century average. What conclusions can you draw from this map about weather and climate?

_____

_____

_____

_____

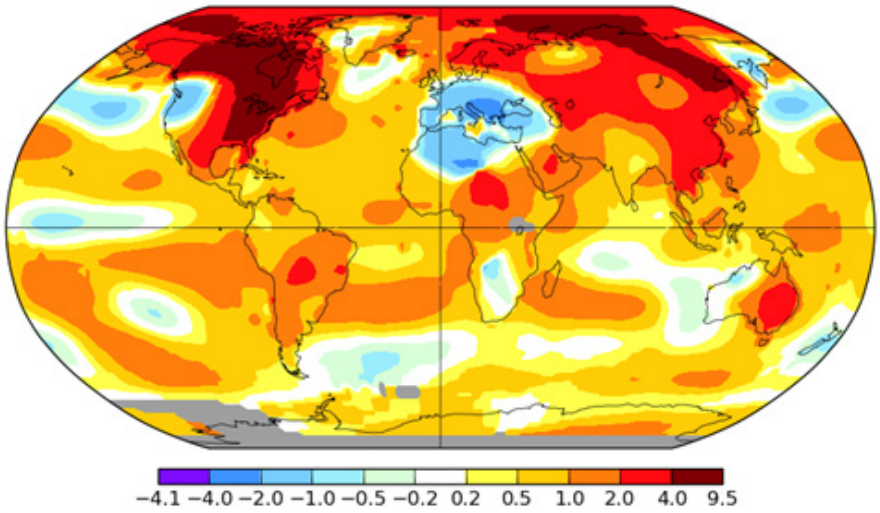
_____

_____

_____

_____

Difference Between Local Temperature and Global mid-20th Century Average, °F



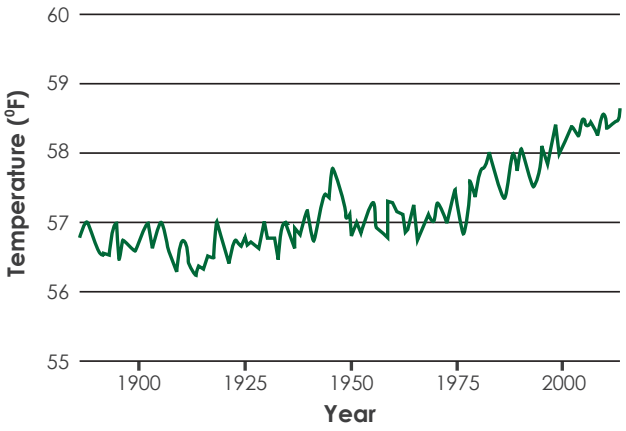
Weather and Climate Work Paper

Solutions

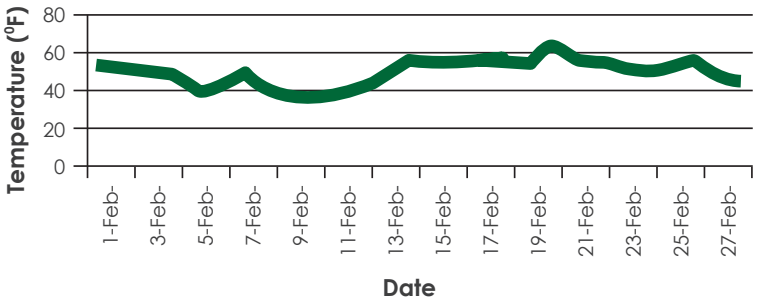
In each of the following questions, learners need to demonstrate understanding of the difference between short-term weather data and long-term climate data.

1. **Explain the similarities and differences between the two graphs below in terms of weather and climate.**
   The Average Global Temperature by Year chart shows a long-term climate trend over about 120 years. It shows temperature increasing from about 57oF to about 58.5oF. The Maximum Daily Temperatures in London chart shows temperature variations over one month. This chart data represents weather information and does not by itself give us information about climate.

Average Global Temperature by Year[93g]



Maximum Daily Temperatures in London - February, 2017[93h]



2. **Explain the differences in these two reports in terms of weather and climate.**
   Report one tells us about hurricane trends over more than 30 years, so the report presents climate information. Report 2 is a weather report and a weather prediction. This report could be combined with other data over time to provide climate information, but does not represent climate information on its own.

   Report 1
   "There has been a substantial increase in most measures of Atlantic hurricane activity since the early 1980s, the period during which high quality satellite data are available. These include measures of intensity, frequency, and duration as well as the number of strongest (Category 4 and 5) storms. The recent increases in activity are linked, in part, to higher sea surface temperatures in the region that Atlantic hurricanes form in and move through."[93i]

   Report 2
   "Heavy rainfall has disrupted normal life in Mumbai in the last 48 hours with the weatherman predicting rainfall at regular intervals in the next 24 hours.

   From Wednesday 8 am to 8 am this morning, the city recorded 84.7 mm rainfall, western suburbs recorded 95.89 mm, while eastern suburbs registered 76.27 mm rainfall, according to civic body weather stations.

   "Heavy to very heavy rainfall at regular intervals are likely to occur at one or two places in the city today," a senior official at Met Department, Mumbai regional office, said.

   The official informed that other parts of the state have also recorded adequate rainfall."[93j]

Weather and Climate Work Paper

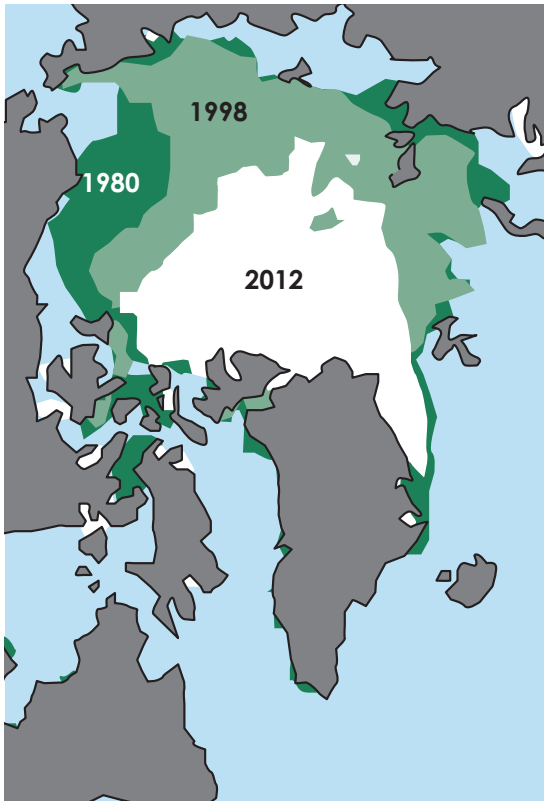
Solutions

3. **Explain the two maps below in terms of weather and climate.**
   Map 1 shows the long-term melting trend, representing over 30 years of data. This map represents climate information. Map 2 shows melting over several months, representing weather data.

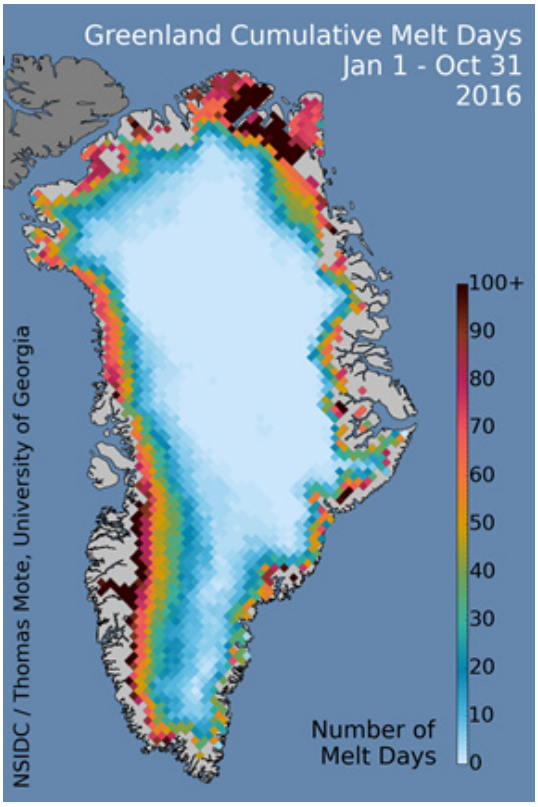
   Map 1
   The graph shows annual variations in the amount of sea ice in September in the Arctic from 1979 – 2000 as measured by satellites. The areas colored in red, pink, and white were all covered in ice in 1980. In 1998, only the pink and white areas were covered in ice. By 2012, only the white area of the map was covered in ice.[93k]

   Map 2
   The map below shows how many days the thick ice on different areas of Greenland has melted during 2016. In the dark red areas, the ice has been melting for more than 100 days. In the lightest blue areas, there have been zero days on which ice has melted.[93l]

Artic Sea Ice from 1980 - 2000



Greenland Cumulative Melt Days Jan 1 - Oct 31, 2016



Weather and Climate Work Paper

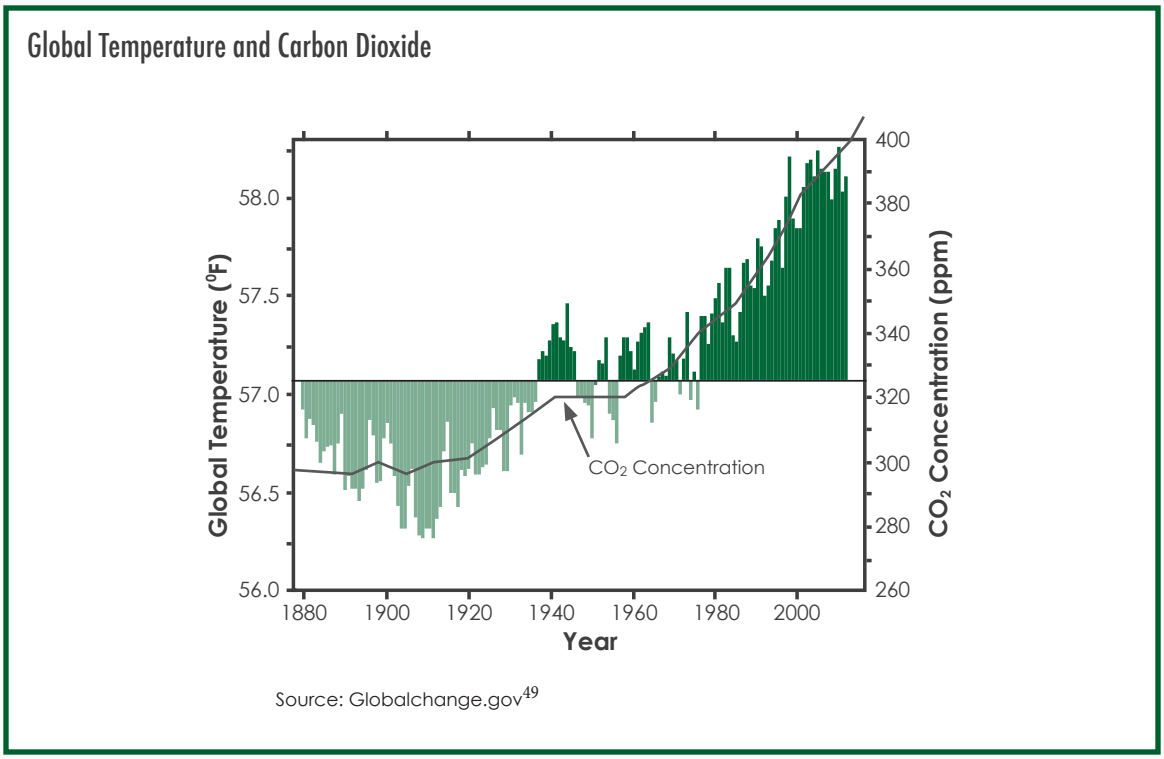
Solutions

4. **The chart below compares the average global temperature over the 20th century – 57.1°F – with each year's average global temperature from 1880 to 2012. Light green bars represent years that were cooler than 57.1°F. The length of the bar shows how much cooler the average temperature that year was compared to the 20th century average temperature. Dark green bars represent years that were warmer than 57.1°F.[93m] The average temperature for each year can be read on the vertical axis.**

   Scientists use this kind of comparison of annual temperatures with longer-term averages to identify long-term trends. This graph is similar to the one shown on page 36. What information about climate and weather can you learn from this graph?[93n]

   Climate
   In general, years before the mid-1900s were cooler than the average temperature for the century. Beginning in the 1970s, the climate became consistently warmer than the century average. We can also see that carbon dioxide concentrations correlate with global average temperature. We cannot tell from this graph alone whether there is a causative relationship.

   Weather
   In any given year, average temperatures varied. Changes in average temperature from year to year were usually relatively small.



Source: Globalchange.gov[49]

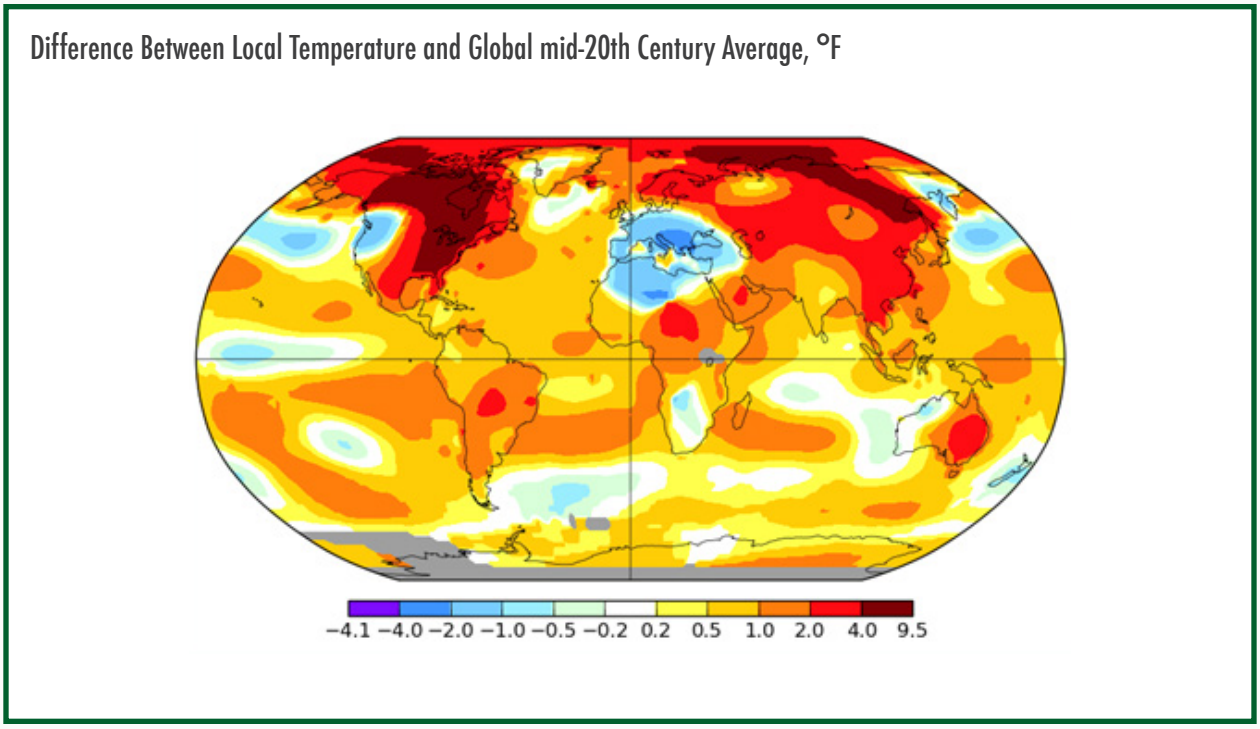
Weather and Climate Work Paper

Solutions

5. **The map below shows how much warmer or cooler different regions of the planet were in January 2017 compared to the whole planet's average temperature in the mid-1900s. The bar below shows the temperature range represented by each color. For example, the dark red regions were 9.5°C warmer than the mid-century average. The medium blue regions were 4.0°C cooler than the mid-century average. What conclusions can you draw from this map about weather and climate?**

Climate
The dark and bright red regions of North America, Asia, South America, Africa, and Australia warmed the most compared to the mid-century average global temperature. Southern Europe, northern Africa, and the part of western North America cooled the least.

Weather
Because the map only compares January temperatures with the mid-century global average, no conclusions about short-term weather can be made.



Read students this story about the game they are about to play:

Global temperatures are rising. One of the best ways to slow the rate of rising temperatures is to replace fossil fuel-powered electric generation with renewable energy: solar, wind, hydroelectric, and geothermal. In this game, you will be builders of a new, renewable electricity system. Your job is to build a grid for each type of renewable energy and connect the four grids. Linking the grids will make the power from each renewable energy type available to all the residents in your community. But you need to get the systems built and connected before temperatures increase by 1.5°C: the maximum temperature increase most scientists now believe to be safe.

Break learners into groups of four. If you have a remaining group of two or three, please see Game Play, section 5.a.ii.1.h below. Let students know that – much like addressing climate change – this game is collaborative rather than competitive: everyone wins or everyone loses.

Activity Fourteen

"Beat the Heat" Climate Awareness Game[94]

Game Description

In this cooperative game – with a possible twist – four players work together to create a renewable electricity system before the climate gets too hot. On their turn, a player draws two playing cards; the cards guide the player to power up their grid and/or release greenhouse gases to the atmosphere. Each player builds one of the system's four grids by placing Renewable Energy Grid Tokens on the game board. Greenhouse Gas Tokens are also placed on the game board, as directed by playing cards, blocking possible spaces to build Renewable Energy Grids. The group wins if all four grids are connected at the Tower of Power before the greenhouse gases add 1.5°C of heat. But if greenhouse gases create too much heat before the grids join up, the game ends. And if a player draws the Tipping Point card, the game is over!

Individual players can also try to win the game for themselves alone by making a Power Grab, blocking the group's ability to complete the grids. In a Power Grab, an individual player can win by collecting enough money to buy up the other players' grids; see below.

The four types of renewable energy in this game are solar, wind, hydroelectric, and geothermal. The four greenhouse gases (GHGs) are carbon dioxide (CO_2), nitrous oxide (N_2O), water vapor (H_2O), and methane (CH_4).

Objective

To join all four renewable power systems in the Tower of Power before the greenhouse gases add 1.5°C of heat.

Materials

a. Playing Cards
   i. Power Up Cards
   ii. The Heat is On Greenhouse Gas (GHG) Cards
   iii. Real-World Impacts Renewable Energy Grid or Greenhouse Gas Cards
   iv. Money Cards
   v. Tipping Point Cards
b. Climate Saver Cards

MODULE FOUR 81

Summary

Learners will play a cooperative game in which they use the concepts of the greenhouse effect and climate change. This activity addresses the National Oceanic and Atmospheric Administration's (NOAA) Climate Literacy principle of understanding the essential principles of Earth's climate system.[94a]

Time Required

- One 50-minute class period

Reading Prior to Activity

- Read game rules, pages 81-84
- Review pages 29-32, 36-41

Key Concepts

- Greenhouse Effect
- Greenhouse Gases
- Adaptation
- Mitigation

Objectives

- To identify the human activities that contribute to climate change
- To identify the human actions that can reduce greenhouse gas emissions
- To identify the human actions that can help the planet remove greenhouse gas emissions from the atmosphere

Materials

- Two types of tokens:
  - 48 Renewable Energy Grid tokens. These tokens can be nickels, other low-value coins, or other items.
  - 80 Greenhouse Gas Tokens. These markers can be pennies, other low-value coins, or other items.

Preparation

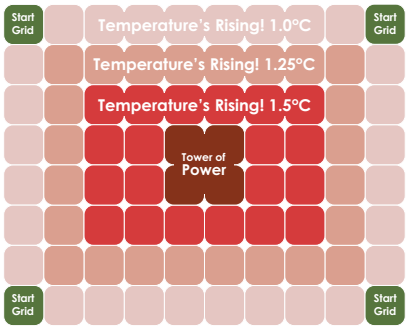
- Make one copy of the "Beat the Heat" Game Board Handout for each group of four students; see page 84A.
- Make one copy of the "Beat the Heat" Playing Cards Handout for each group of four students; see pages 84B-84D.
- Cut the "Beat the Heat" Playing Cards apart along the solid lines. Students can cut the cards apart if you have scissors in your classroom and time available. Keep the Climate Saver cards separate from the other playing cards.

Inquiry/Critical Thinking Questions

- What human actions contribute to climate change?
- How do different greenhouse gases affect the climate?
- What can societies do to reduce greenhouse gas emissions?
- How can societies help the planet's systems remove greenhouse gases from the atmosphere?

If students need strategy tips, here are a few suggestions :

- They should avoid letting the 1.0°C Temperature's Rising! Band get filled up with Greenhouse Gas Tokens.
- They should avoid blocking the spaces next to the Start Grid squares, so players can build their grid from these squares
- They will be most successful if they work together.



c. Game Board

d. Tokens

i. Renewable Energy Grid Tokens: nickels or other small tokens.

ii. Greenhouse Gas Tokens: pennies or other tokens. These tokens must have different markings on the two sides, like coins have heads and tails.

Set-up

a. Each player is given 12 Renewable Energy Grid Tokens.

b. Greenhouse Gas Tokens are placed together within reach of all the players.

c. All playing cards except the Climate Saver cards are shuffled thoroughly and placed face down in a stack within reach of all the players.

d. The Climate Saver cards are placed face down in a stack near the stack of playing cards.

Game Play

a. Draw 2 playing cards.

i. All playing cards must be played when they are drawn, except for:

1. Money Cards, which can be used or saved until another turn.

2. Tipping Point Cards, which must be held until the end of the game.

ii. Use the playing cards as follows:

1. Build your Grid: Use a Power Up Card to start or expand your grid, or use a Real-World Impacts Renewable Energy Grid Card to expand your grid.

a. To build your grid, place a Renewable Energy Grid Token face down on an empty space on the playing board.

b. The first Renewable Energy Grid Token in any grid must be placed on a Start Grid square.

c. All later Renewable Energy Grid Tokens must be placed next to, above, or below another Renewable Energy Grid token. Tokens diagonal to one another are not linked.

d. Any type of Power Up Card can be used to build the card holder's grid.

e. Keep all of your Power Up Cards, even if your grid is complete. See "Strengthen Your Grid" and "Sell a Power Up Card" below.

f. Each player can only build their own grid. In two-player games, each player can build their two grids. In three-player games, each player can build their own grid and contribute to the fourth grid.

g. If a Real-World Impacts Renewable Energy Grid Card instructs a player to remove Renewable Energy Grid Tokens, the tokens may be removed from any location on the playing board.

h. In two- or three-player games, Real-World Impacts Renewable Energy Grid Cards and Power Up Cards can be used to build your own grid or the additional one or two grids.

82

FacingTheFuture.org

i. Complete your grid by reaching the Tower of Power.

2. Release Greenhouse Gases: If you drew a The Heat is On Card or a Real-World Impacts Greenhouse Gas Card, place greenhouse gases in the atmosphere by adding a Greenhouse Gas Token to the playing board.

a. Add Greenhouse Gas Tokens to the 1.0°C Temperature's Rising Band until that band is filled, then to the 1.25°C Temperature's Rising Band, and finally to the 1.5°C Temperature's Rising Band.

b. Greenhouse Gas Tokens are to be removed – when instructed by Real-World Impacts Greenhouse Gas Cards – in reverse order. For example, tokens should be removed first from the 1.5°C Temperature's Rising Band. When that band contains no more Greenhouse Gas Tokens, tokens should be removed from the 1.25°C Temperature's Rising Band. Tokens should be removed from the 1.0°C Temperature's Rising Band last.

c. Greenhouse Gas Tokens cannot be placed on Start Grid squares.

iii. Once the two cards are played, The Heat is On Greenhouse Gas Cards, Real-World Impacts Cards, and used Money Cards are placed in a discard stack. These cards can be shuffled and reused once the whole stack has been used, if needed.

b. After you take the actions described on your two playing cards, you have the option to take one of the following additional actions.

i. Trade a Power Up Card:

1. Trade one of your Power Up Cards for one Power Up Card held by another player.

a. Each player must agree to the trade.

2. Trade one of your Power Up Cards for one Renewable Energy Grid Token.

3. Building a grid with a traded Power Up Card or Renewable Energy Grid Token is a separate action.

ii. Sell a Power Up Card:

1. Sell a Power Up Card to another player for one Money Card.

2. Convert a Power Up Card into a Money Card. The Power Up Card is turned upside down and kept with the player's Money Cards. Converting a Power Up Card into a Money Card means that card can no longer be used to strengthen the grid.

iii. Buy a Token: Use one Money Card to add a Renewable Energy Grid token to your grid or remove a Greenhouse Gas token from the game board.

iv. Strengthen Your Grid: If you have one of each type of Power Up Cards – solar, wind, hydroelectric, and geothermal – or four Power Up Cards of one type, you can strengthen your grid. Strengthening your grid costs two Money Cards.

1. Strengthened grid tokens are not removed when Real-World Impacts Cards would otherwise require you to remove Renewable Energy Grid tokens.

2. To show that your grid is strengthened, turn four Renewable Energy Grid tokens face up.

3. Once your grid is strengthened, return the four Power Up Cards to the discard stack.

4. Each player can only strengthen their own grid.

v. Save the Climate: Buy a Climate Saver Card.

Discussion Questions

- Which groups won? Which groups lost?
- What strategies contributed to winning or losing?
- What did the game show students about greenhouse gas sources, mitigation measures, and adaptations?

1. At least three players must contribute one or more Money Cards to buy a Climate Saver Card.
2. A Climate Saver Card costs four Money Cards. The Money Cards are placed in the Discard stack.
3. A Climate Saver Card allows players to remove five Greenhouse Gas tokens from the playing board. Greenhouse Gas tokens are removed from the 1.5°C Temperature's Rising Band first, then from the 1.25°C Temperature's Rising Band, and from the 1.0°C Temperature's Rising Band last.
4. Each Climate Saver Card can be used only once.
5. The player who initiates the Climate Saver Card purchase uses their optional action.

vi. Make a Power Grab: End the game with a Power Grab. To make a Power Grab, you must have:

1. One more Money Card than all other players' Money Cards combined, *plus*
2. One Money Card for each of the three Renewable Energy Grids that do not belong to you.

c. End of Game: The game ends when one of the following events takes place:

i. All four Renewable Energy Grids connect at the Tower of Power – everybody wins!

ii. The climate heats up to 1.5°C: all spaces on 1.5°C Temperature's Band are filled with Greenhouse Gas Tokens. Everybody loses – the planet included.

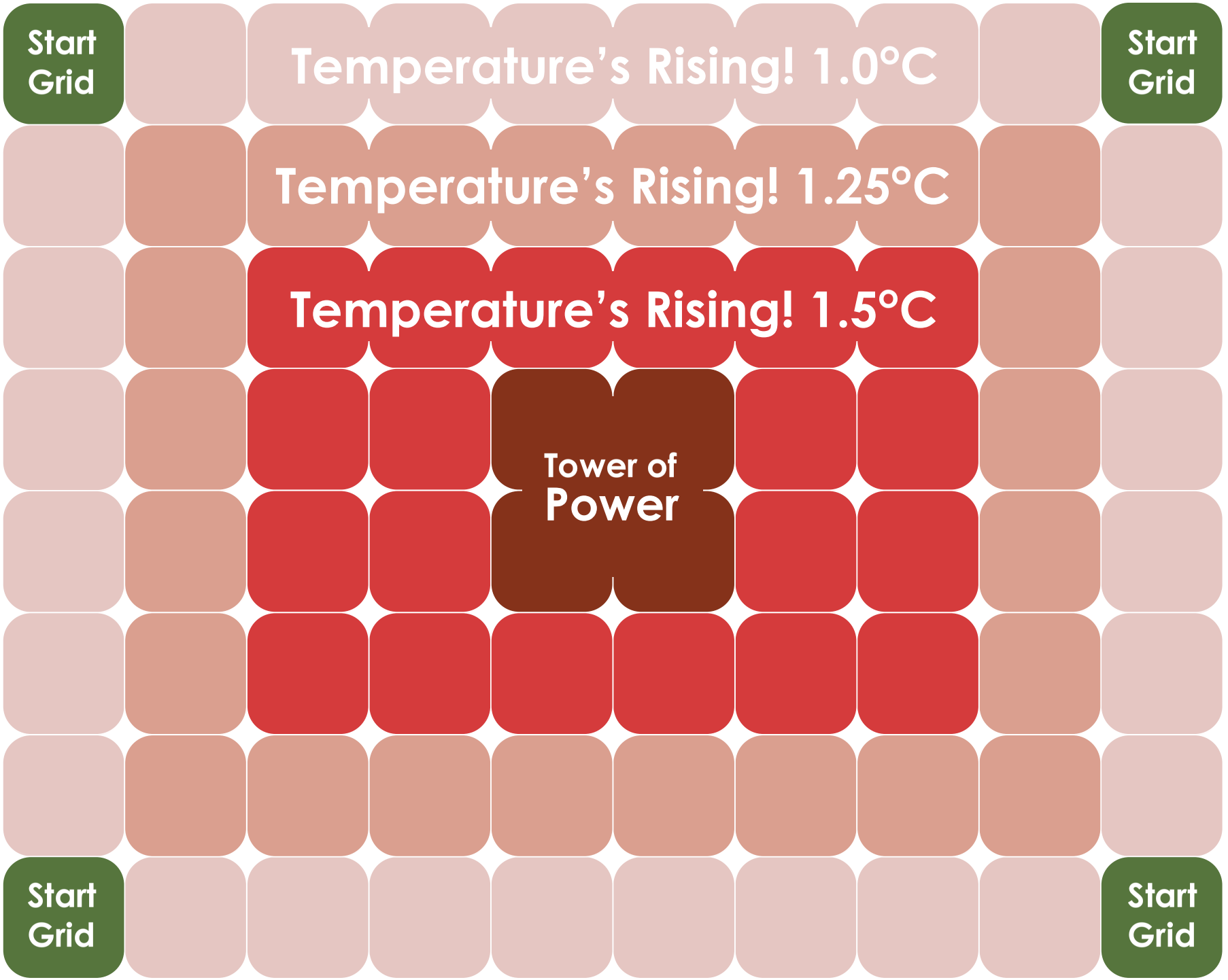
iii. Climate systems reach a tipping point and runaway warming occurs. The Tipping Point is reached if three players each hold at least one Tipping Point Card or one player holds three Tipping Point Cards.

iv. One player makes a Power Grab and wins. Other players lose. The planet? It's up to the Power Grabber to decide whether they run the Renewable Energy System or shut it down.

Field Book

Nature Journal: Spend a few minutes outside being still. Pay attention to the temperature of the air and the sunshine. Picture in your mind the molecules in the atmosphere – the greenhouse gases – that provide the greenhouse effect. These molecules keep warmth from the sun within our atmosphere and prevent that warmth from reflecting back out to space. This warmth makes life on Earth possible. Spend a few moments experiencing yourself as part of this life-giving planetary system. Then make some notes or sketches to reflect your experience.

84 FacingTheFuture.org


Start Grid
Temperature's Rising! 1.0°C
Start Grid
Temperature's Rising! 1.25°C
Temperature's Rising! 1.5°C
Tower of Power
Start Grid
Start Grid

The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase
The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase
The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase
The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase
The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase	The Heat is On! CO_2 Emissions Increase
$	$	$	$	$	$

Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Tipping Point!	The Heat is On! CO_2 Emissions Increase
Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Tipping Point!	The Heat is On! CO_2 Emissions Increase
Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Tipping Point!	The Heat is On! CO_2 Emissions Increase
Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Tipping Point!	The Heat is On! CO_2 Emissions Increase
Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Power Up! Build Solar Power Grid	Tipping Point!	The Heat is On! CO_2 Emissions Increase
$	$	$	$	$	$

Real World Impacts N_2O Emissions Increase, Add 3 Greenhouse Gas Tokens	Real World Impacts N_2O Emissions Increase, Add 3 Greenhouse Gas Tokens	Real World Impacts Methane Emissions Increase, Add 2 Greenhouse Gas Tokens	Real World Impacts Methane Emissions Increase, Add 2 Greenhouse Gas Tokens	Real World Impacts Water Vapor Emissions Increase, Add 1 Greenhouse Gas Token	Real World Impacts Water Vapor Emissions Increase, Add 1 Greenhouse Gas Token
Real World Impacts Island Nation is Flooded by Sea Rise, Remove 3 Grid Tokens	Real World Impacts Superstorm Wipes out Part of City, Remove 1 Grid Token	Real World Impacts International GHG Treaty Fails, Remove 1 Grid Token	Real World Impacts Deforestation Increases, Remove 3 Grid Tokens	Real World Impacts Animal and Plant Species Having a Hard Time Adapting to Rising Temperatures, Remove 2 Grid Tokens	Real World Impacts Heat Waves Overload Grid,Remove 2 Grid Tokens
Real World Impacts Community Adopts Meatless Monday, Remove 3 Greenhouse Gas Tokens	Real World Impacts Teens Start Band Instead of Shopping, Remove 2 Greenhouse Gas Tokens	Real World Impacts Citizens Ride Bikes to Work or School, Remove 2 Greenhouse Gas Tokens	Real World Impacts Community Plants Urban Forest, Remove 1 Greenhouse Gas Token	Real World Impacts Local Stores Ban Rainforest Products, Remove 2 Greenhouse Gas Tokens	Real World Impacts Families Take Summer Staycations, Remove 2 Greenhouse Gas Tokens
Real World Impacts Neighborhoods Install Edible Gardens, Build 2 Grid Squares	Real World Impacts Local Drivers Convert to Electric Cars, Build 2 Grid Squares	Real World Impacts Philanthropist Donates their Fortune to Research, Build 3 Grid Squares and Remove 1 Greenhouse Gas Token	Real World Impacts Research Funds Increase, Build 1 Grid Square	Real World Impacts School Build Gardens for School Lunches, Build 1 Grid Square	Real World Impacts Community Adopts Carbon Neutral Policy, Build 3 Grid Squares
$	$	$	$	$	$
Climate Saver Card Breakthrough in Inexpensive Renewable Energy	Climate Saver Card Citizens Worldwide cut GHG Emissions by Half	Climate Saver Card Rainforest Deforestation Ends	Climate Saver Card World Governments Work Together to Reduce GHGs	Climate Saver Card Businesses Worldwide cut GHG Emissions by Half	Climate Saver Card Farming Practices Support Soil Microbes

Activity Fifteen

Climate Change Science and the Scientific Method

Background

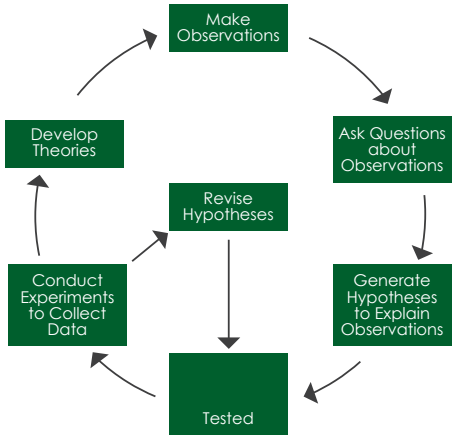
The Scientific Method

Scientists use a specific process to answer questions about the world around us. This process seeks to answer a specific, well-defined question by designing an experiment to measure some phenomenon that will logically answer the question. This process helps scientists make sure that their questions are valid, their investigations are well-designed, and their conclusions are logical.

Peer Review, Challenges, and Certainty

Scientific inquiry is an ongoing process, continually seeking the most accurate descriptions of the natural world. Once a scientist has completed an experiment they feel is significant, they will seek input from other experts in their field. This ***peer review*** gives other scientists the opportunity to examine the logic behind the hypothesis, the rigor of the experiment's design, the accuracy of the data, and the strength of the conclusions. It is important that scientists who offer peer review are experts in the field of science in which the experiment was conducted. For example, a chemist might be an excellent scientist but would not be qualified to review an experiment on gravity in deep space.

The Cycle of Scientific Inquiry[95]



Peer review often results in challenges, debates, and even disputes. These challenges are expected and actually strengthen scientific conclusions by revealing any gaps or inconsistencies. Before experimental results and conclusions are widely accepted, other scientists will repeat the experiment or design similar experiments. When the results are shown to be ***repeatable*** by several other studies, the scientific community will be more likely to accept the results as true.

Summary

Learners review the scientific method and critical thinking process. The learners use the text and additional background information to apply these processes to address questions and challenges often raised about climate change science. Students write responses to these common questions on Day 1, and write an essay on their views of climate change science on Day 2. This activity addresses the second National Oceanic and Atmospheric Administration (NOAA) climate literacy principle: knowing how to assess scientifically credible information about climate.[94b]

Time Required

- Two 50-minute class periods

Reading Prior to Activity

- Review Page 22, Critical Thinking Guidelines
- Pages 35-41
- Activity Background, pages 85-89

Key Concepts

- Scientific Method
- Peer Review
- Critical Thinking
- International Panel on Climate Change

Objectives

- To identify how scientists study climate change
- To identify how scientists view certainty and uncertainty about their research results
- To identify credible science
- To identify ways in which society can use scientific research to make decisions

Inquiry/ Critical Thinking Questions

- How certain are scientists that climate change is happening?
- What choices should individuals and society make based on the current scientific understanding of climate change?

Because of ongoing reviews, challenges, and new information from other research, it often takes a long time for the scientific community to reach ***consensus*** – agreement – on results. As scientific understanding develops over time, certainty increases.

Science and Climate Change

The main global scientific organization that evaluates climate science is the Intergovernmental Panel on Climate Change (IPCC). The IPCC was put together in 1988 to provide governments with regular reports on climate change science; 195 countries – almost all the countries in the world – are now members of the Panel. The Panel publishes reports on current science periodically.[96]

The IPCC reports are written by hundreds of scientists who are considered leaders in their fields. Thousands of additional scientific experts review published, peer-reviewed reports as well as reports from governments, industry, research institutions, scientific conferences, and other organizations.[97] The authors compile results into three major documents that look at physical science; impacts, adaptation, and vulnerability; and mitigation. Hundreds of expert reviewers and governments offer multiple reviews of the reports to make sure they are accurate and complete.[98]

The most recent report was published in 2013; it represented 9,200 scientific studies reviewed by over 1,000 experts.[99] In addition to reporting overall scientific findings, the report authors evaluate the certainty of scientific findings. Some are simply rated from very low to very high. In other cases, the authors were able to assign numerical probabilities. Some findings are so well-accepted that they are presented as facts.[100] The report made the following overall conclusions:[101]

- **Human Influence:**
  - "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems." (page 2)
  - "It is *extremely likely* (95-100% probability) that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in GHG concentrations and other anthropogenic forcings together… Anthropogenic forcings have *likely* (66-100% probability) made a substantial contribution to surface temperature increases since the mid-20th century over every continental region except Antarctica." (page 5)
- **Certainty of Warming:** "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen." (page 2)
- **Emissions and Concentrations of Greenhouse Gases:** "Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been

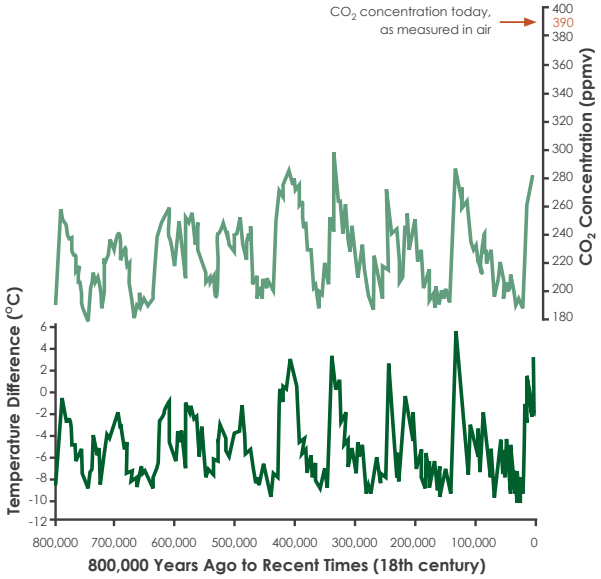
86 FacingTheFuture.org

detected throughout the climate system and are *extremely likely* (95-100%) to have been the dominant cause of the observed warming since the mid-20th century." (page 4)

- **Changes to Natural and Human Systems:** "In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate." (page 6)
- **Impact of Continued Greenhouse Gas Emissions:** "Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions, which, together with adaptation, can limit climate change risks." (page 8)
- **Projected Increase in Warming:** "Surface temperature is projected to rise over the 21st century... It is *very likely* (90-100%) that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise." (page 10)
- **Risks of Climate Change:** "Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development." (page 13)
- **Long-term Effects of Greenhouse Gases:** "Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases." (page 16)
- **Benefits of Reducing Emissions:** "Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond… and reduce the costs and challenges of mitigation in the longer term." (page 17)
- **Urgency of Mitigation:** "Without additional mitigation efforts beyond those in place today, … warming by the end of the 21st century will lead to high to very high risk of severe, wide- spread and irreversible impacts globally (*high confidence*)." (page 17)
- **Effectiveness of Adaptation:** "Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness." (page 19)
- **Ways to Limit Warming:** "There are multiple mitigation pathways that are *likely* (66–100%) to limit warming to below 2°C relative to pre-industrial levels. These pathways would require substantial emission reductions over the next few decades and near-zero emissions of CO_2 and other long-lived greenhouse gases by the end of the century." (page 20)

MODULE FOUR

The figure below shows two graphs: the top graph shows the concentration of CO_2 in the atmosphere over the last 800,000 years. The lower graph shows how much Earth's average temperature has varied from the average temperature over the same time period.[102] The figure clearly shows that temperature and CO_2 are linked. The graphs show that temperatures increase first, likely through shifts in Earth's orbit. As temperatures begin to rise, CO_2 also begins to rise. Scientists believe that this increase in CO_2 then causes further warming. The graph shows that the amount of CO_2 in Earth's atmosphere and the planet's average temperature have stayed within a consistent range over the past 800,000 years. However, as the red arrow shows, CO_2 concentration levels measured in the atmosphere today are much higher than the levels that have been seen in known history.



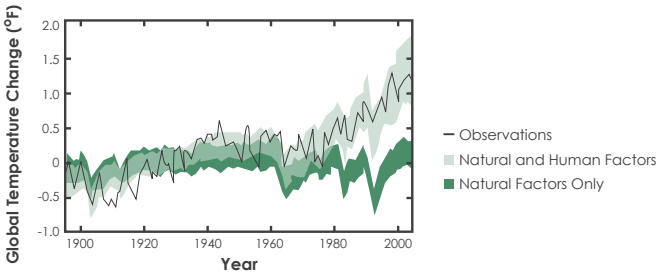
88

FacingTheFuture.org

Natural and Human Drivers of Climate Change

While both human actions and natural factors contribute to climate change, science now tells us that the increase in warming we see is due to human factors. The figure below shows the warming influence of natural factors alone, along with warming due to both human and natural factors. These ranges of possible warming are compared with actual temperature measurements.[103]

Separating Human and Natural Influence on Climate



Scientific Consensus

Beyond the strong position of the IPCC report, here is other evidence that climate scientists agree that global warming is caused by humans:

1. A recent published study showed that 90-100% – likely 97% – of climate scientists support the view that humans are causing climate change.[104]
2. Eighteen American scientific societies have endorsed the following statement: "Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver." These scientific organizations include the American Association for the Advancement of Science, the American Chemical Society, and the Geological Society of America.[105]
3. The national science academies representing the world's major highly industrialized countries released a statement supporting the understanding that humans are causing climate change. This group included Brazil, Canada, China, France, Germany, India, Italy, Japan, Russia, the United Kingdom, and the United States.[106] These countries are the largest emitters of greenhouse gases.
4. The National Academies of Science from 80 countries have published statements supporting the conclusion that humans are causing climate change.[107]

Discussion Questions

- What opinions do students have about whether Earth's climate is changing, whether humans are causing any change that is happening, and how we know?
- What evidence can they present to support their views?
- What are a citizen's responsibilities in evaluating climate science?
- What are a citizen's responsibilities in disputing incorrect information?

Extensions

- Facing the Future. Climate Change: Connections and Solutions, Grades 9-12. Unit Lesson 3, "Effects of Climate Change on Living Things." Please see: **https://www.facingthefuture.org/collections/high-school-curriculum/products/climate-change-connections-and-solutions-grades-9-12?variant=13632716355**
- Facing the Future. Climate Change: Connections and Solutions, Grades 9-12. Unit Lesson 6, "Changes All Around." Please see: **https://www.facingthefuture.org/collections/high-school-curriculum/products/climate-change-connections-and-solutions-grades-9-12?variant=13632716355**

Have students work in small discussion groups to address the questions below. You can decide how many questions each group should address.

Activity

Day 1

1. **Working in small groups, address the questions listed below.** These questions are common concerns or objections raised to challenge climate change science. As a group, come up with responses based on the material above, the material in the text, your knowledge of climate change, and other credible sources. Write your responses in your Field Book.

   a. CO_2 is not a significant contributor to global warming.

   b. Scientists do not agree on whether climate change is occurring.

   c. The data is not accurate, or we don't have enough data to decide if warming is occurring.

   d. The climate is always changing. Current changes are nothing unusual.

   e. Natural causes can explain the warming we are seeing.

   f. Renewable energy cannot meet the energy needs of the modern world.

   g. We had an unusually cold winter. How can the planet be warming?

   h. Only scientists can form opinions on whether climate change is occurring.

2. **As a class, discuss your responses to the climate change questions above.**

90

Field Book

Day 1

1. **Nature Journal:** Like yesterday, spend a few minutes outside. Think again about the greenhouse gas system that keeps the planet at a temperature that supports life. Notice now the many other living things that are part of this system along with you: trees, shrubs, birds, insects, other people, food that you eat. Even cars and other machines are part of the system. Spend a few minutes letting yourself feel those interconnections. Write or sketch about your experience.

Activity

Day 2

1. **Based on the material in the Background section, the text, your own knowledge of climate change, and other credible sources, write an essay** addressing the following questions: "Is Earth's climate changing, are humans causing any change that may be happening, and how do we know?" Provide evidence to support your views.

Field Book

Day 2

1. **Nature Journal:** What other living organisms live in your area? How does the weather affect them? What do you notice about how living creatures benefit from the weather in your area? How do they protect themselves from the weather?
2. Write a response to the **Think About It** box on page 29.
3. Update your **Learning Links** page with any new connections or insights.
4. Update your **Questions** page with new questions.

FacingTheFuture.org

Additional Resources

- U.S. Environmental Protection Agency, "Causes of Climate Change," **https://www.epa.gov/climate-change-science/causes-climate-change**
- "IPCC Synthesis Report Summary for Policymakers," **https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf**

If your class has Internet access at home or at school, students can calculate their footprints online. One calculator designed for use in the United States can be found online at: **https://www3.epa.gov/carbon-footprint-calculator/**

For a more detailed calculator that can be used for other countries, please see: **http://www.carbonfootprint.com/calculator.aspx**

If Internet access is not available, your students can use Step 1 to estimate how their personal footprint compares to the average one. Students can use the chart provided in the handout to estimate reductions in carbon footprints.

Activity Sixteen

Students will estimate their footprint as a percentage of an average footprint, based on the breakdown shown in the chart above. They can multiply this percentage by the average footprint for your country to get an estimate of their footprint in terms of land used to supply their needs and process waste products.

Calculating Your Carbon Footprint

Activity

1. **Estimate your carbon footprint** using the handout provided by your teacher.
2. **Answer the questions following the carbon footprint estimator.**
3. **Add your Carbon Footprint Estimator to your Field Book.**

Field Book

1. Write responses to the **Think About It** box on page 30.

Discussion Questions

- Have students share and discuss their answers to the questions on the Carbon Footprint Estimator handout, as well as their overall results if they are comfortable sharing this information.
- What choices contribute most to your carbon footprint?
- What choices can you make to minimize your carbon footprint?
- How do you feel about the need to make an average of 2.5% reductions per year through 2055? Should everyone have to make the same reductions? Why or why not? If not, how should reductions be assigned to different people or groups?

Extensions

- Take part in the "Cool School Challenge" to reduce greenhouse gases at your school. Please see: **http://www.nwf.org/Eco-Schools-USA/About-Eco-Schools-USA/Take-Action/Cool-School-Challenge.aspx.**
- Make class commitments to make reductions. Follow up later in the school year to see how students are progressing toward their reduction goals.

Preparation

- Make a copy for each student of the "Carbon Footprint Estimator Handout" on page 91A-91B. This handout will be used in Steps 1 and 2 below.
- Look up your country's carbon footprint per capita at: **https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=751**

  or use data on page 42 for the country most similar to yours. In the U.S., the average individual carbon footprint is 16 metric tons (35,000 pounds) per year.[107b] This information will be used in Step 1.

Summary

Learners will estimate their personal carbon footprint and compare it to the average footprint for their country or a similar country, the global average, and other countries. Learners will also explore where their footprints are already lower than average and where they might make reductions. This activity addresses the fourth National Oceanic and Atmospheric Administration climate literacy principle: the ability to make informed and responsible decisions with regard to actions taken that may affect climate.[107a]

Time Required

- One 50-minute class period

Reading Prior to Activity

- Pages 37-42

Key Concepts

- Carbon Footprint
- Greenhouse Gas Emission Sources

Objectives

- To measure individual carbon footprints
- To examine the choices that contribute to larger carbon footprints

Inquiry/ Critical Thinking Questions

- What activities contribute to my carbon footprint?
- How does my carbon footprint compare to the average in my country and the world?
- What can I do to reduce my carbon footprint?

Handouts

- Carbon Footprint Estimator Handout, pages 91A-91B

Name: _____

Carbon Footprint Estimator[107c]

Use the table below to estimate differences between your carbon footprint and the average.

1. Identify any changes in Column B that you could adopt or have adopted.
2. For changes in Column B that you could adopt or have adopted, copy the points shown in Column C into Column D.
3. Subtotal the points in Column D for each category in Column A.
4. Total the subtotals on the Total line.
5. Calculate your percent reduction compared to the national average footprint of your country; see instructions given in the chart.

Column A	Column B	Column C	Column D
Category	**CO_2 Reduction Action**	**Carbon Dioxide Reductions in Kilograms (pounds)**	**Your Reduction in Kilograms (pounds)**
Food	Eat meatless meals instead of meat one day per week	320 (700)	
	Eat local, seasonal produce	200 (500)	
		Food Subtotal	
Home	Cut trash by 1/2 to 1/3	1,100 (2,400)	
	Recycle all possible waste	550 (1,200)	
	Reduce heating temperature by 2°C (4°F)	600 (1,400)	
	Replace gas or electric water heating with a solar system	1,100 (2,500)	
	Replace 5 traditional lightbulbs with compact fluorescent or LED bulbs	50 (100)	
	Seal air leaks around doors, windows, fireplaces, basements, and attics	350 (800)	
	Seal and insulate heating ducts	350 (800)	
	Replace an old heater or furnace with a new, energy-efficient model	300 (700)	
	Insulate walls and attic	550 (1,200)	
	Replace single-paned windows with double-paned ones	700 (1,350)	
	Shift your home electricity to renewable power	3,100 (1,400)	
	Dry laundry on a rack or clothesline	200 (500)	
		Home Subtotal	

Carbon Footprint Estimator *continued*

Column A	Column B	Column C	Column D
Category	**CO_2 Reduction Action**	**Carbon Dioxide Reductions in Kilograms (pounds)**	**Your Reduction in Kilograms (pounds)**
Transportation and Travel	Reduce driving by 20%	1,100 (2,500)	
	Use fuel-efficient driving practices: reduce idling, drive at 55 miles/hour, and avoid quick accelerations	500 (1,100)	
	Eliminate a 2-hour round trip flight	200 (500)	
	Maintain your car and keep tires properly inflated	700 (1,500)	
	Replace an older, inefficient car with a more fuel-efficient one	1,100 (2,500)	
	Transportation and Travel Subtotal		
	Total Reductions You Can Make		
	Average Footprint per Capita for Your Country		
	Percentage Reduction You Can Make *(Average Footprint per Capita for Your Country – Total Reductions You Can Make) *100/(Average Footprint per Capita for Your Country)*		**%**

6. In which categories (Food, Home, or Transportation and Travel) can you make the biggest reduction?

7. Are there categories or elements in which you already try to reduce your carbon footprint? If so, which ones?

8. Compare your estimated footprint from the table with the global average of 7 tons of carbon dioxide per year and with average footprints from the graph on page 42 or as provided by your teacher. How does your footprint compare? What different behaviors and choices do you think are the cause of the different footprint sizes?

9. Scientists recommend eliminating CO_2 emissions by 2055 to prevent the average global temperature from increasing more than 1.5°C – the level requested by over 100 countries.[107d] Achieving this level of carbon reductions will require an average of 2.5% reductions per year. What steps could you take over the next one, five, and ten years to meet this level of reductions?

a. One year (2.5% reduction)

b. Five years (12.5% reduction)

c. Ten years (25% reduction)

Summary

Learners will identify, evaluate, and select actions to take to reduce their carbon footprints. They will use a sustainable decision-making model to make their decisions. This activity addresses the fourth National Oceanic and Atmospheric Administration climate literacy principle: the ability to make informed and responsible decisions with regard to actions taken that may affect climate.[107e]

Time Required

- One 50-minute class period

Reading Prior to Activity

- Review pages 22-23
- Review 48-55
- Review Earth Charter Principles, page 45

Key Concepts

- Big Ideas of Sustainability
- Decision-Making
- Critical Thinking

Objectives

- To practice using tools to make decisions in the face of uncertainty
- To practice using tools to support sustainable decision-making

Inquiry/Critical Thinking Questions

- How can I make decisions when I am not sure of their outcome?
- How do I balance the needs of people today with the needs of future generations and other species?
- What sustainability tools can I use to help make good decisions?

Extensions

- Explore renewable energy possibilities for your area. If you have Internet access, go to the "Solutions Project" website at **http://thesolutionsproject.org**. If you are located in the United States, click on the "United States of America" tab and find your state on the map. If you are located outside the United States, click on the "International" tab to find a world map. Click on your region on the map shown and download the recommended renewable energy transition plan for your region. Evaluate action based on this information using the same decision-making process described above. Work with your class to present this information to your school leadership and/or city council.
- Extend climate change action to other groups within – or outside – your school. Experts tell us that community influence is a powerful motivator for changing our behavior. When we see people around us taking steps to reduce our climate impact, we are more likely to do the same. Your students can encourage or challenge school groups they are members of – like sports teams, drama or debate clubs, or service groups – to estimate and reduce their carbon footprints. Students can compare results, share successes and failures, and encourage each other in person and on social media. Creating a new normal is an important part of addressing climate change, and students can help one another lead the way.

Activity Seventeen

Sustainable Skill Building - Sustainable Decision-Making, Part 2

Activity

1. **Identify possible actions to reduce your carbon footprint.** Based on the "Climate Change" and the "Big Ideas of Sustainability" sections on pages 48-52, the "Pathways to Progress" section on pages 53-55, the "What You Can Do" section on page 55, and the results of your carbon footprint analysis, list two to four actions you are interested in taking to reduce your carbon footprint.
2. **Evaluate and decide on actions to take.** Use the "Sustainable Decision-Making" flowchart on page 23 to decide what actions you would like to take to reduce your carbon footprint. Document your analysis in your Field Book, using a format like the "Sustainable Decision-Making" flowchart, an outline, or other structured format.
3. **Share your results** with the class.

Field Book

1. **Nature Journal:** Notice how the sun, which powers virtually all of life on the planet, affects you. How do you feel in the sunlight? In shade? In darkness? Is today sunny or cloudy? How does the weather affect your mood?
2. Write a response to the **Think About It** box on page 32.

92

FacingTheFuture.org

Discussion Questions

- What actions did students decide to take to reduce their carbon footprints?
- What factors led to their decisions?
- How did Big Ideas of Sustainability and Earth Charter values factor into their decisions?
- How does the precautionary principle, as described in Earth Charter Principle 6 on page 45, come into play in taking action on climate change?

Activity Eighteen

Climate Change and Systems Thinking

Activity

1. **Complete the "Climate Change and Systems Thinking" work paper** provided by your teacher. Add the completed handout to your Field Book.

Field Book

1. **Nature Journal:** What fresh produce have you eaten today? Is it in season? Think about the sun recently shining on the plant that grew the food and about that energy from the sun entering your body. Sketch or write about the process, the transfer of the sun's energy through the plant to you, and your thoughts and feelings.
2. Write a response to the **Think About It** box on page 33.
3. Update your **Learning Links** page. Try to wrap up and connect any ideas you have noted during the unit.
4. Review your **Questions** page. Do you have unanswered questions? How can you get them answered?
5. Review your **Field Book** work over the unit. You will draw on this work in tomorrow's activity.

Summary

Learners will use systems thinking tools to understand climate change and consider solutions to reduce rising greenhouse gas emissions. This activity addresses the National Oceanic and Atmospheric Administration's (NOAA) Climate Literacy principles of understanding the essential principles of Earth's climate system and being able to make informed and responsible decisions with regard to actions that may affect climate.[107f]

Time Required

- One 50-minute class period

Reading Prior to Activity

- Review pages 29-32, 38-39, 45-46

Key Concepts

- Systems Thinking
- Stock and Flow Diagram
- Feedback Loop

Objectives

- To apply systems thinking tools to real-world climate change issues
- To practice using systems thinking to understand and respond to real-world issues

Inquiry/Critical Thinking Questions

- What elements of the climate and climate change can be described as systems?
- What systems thinking tools will help us understand and respond to climate change?

Discussion Questions

- How can systems thinking help us understand the climate, climate change, and possible solutions to increasing warming?
- What other examples of systems can you think of that relate to the climate and society's response to climate change?

Preparation

- Make a copy of the "Climate Change and Systems Thinking" work paper for each student

Handouts

- "Climate Change and Systems Thinking" work paper, pages 93A-93B

Name: _____

Climate Change and Systems Thinking Work Paper

1. **Human-Caused Greenhouse Gas Emissions Stock and Flow Diagram:** Using the diagram on page 32 as a guide, draw a stock and flow diagram representing human-caused additions of greenhouse gases to the atmosphere. Use pencil, and leave room on the right side of the diagram to add flows leaving the atmosphere.

2. **Greenhouse Gas Mitigation Stock and Flow Diagram:** Add to your diagram from above. Include mitigation measures – human-caused flows of greenhouse gases out of the atmosphere. See pages 45-46 for suggestions.

   What flows could be increased or decreased to reduce the amount of greenhouse gases in the atmosphere?

   _____

   _____

Name: _____

Climate Change and Systems Thinking Work Paper
continued

How do people know if the stock of greenhouse gases in the atmosphere were filling up? How would we know if it was getting too full?

_____

_____

What do you think of mitigation as a climate strategy compared to reducing greenhouse gas emissions?

_____

_____

3. **Feedback Loop in Human Systems:** In nature, feedback loops provide systems with information that allows them to adapt to changing conditions. Systems that lack feedback have difficulty recognizing changing conditions, and so have a harder time adapting. In human systems, feedback often comes in the form of news, reports, scientific data, or other numerical or verbal information. Using the feedback loops and discussions on pages 39 and 44 as guides, draw a feedback loop that could provide people with information on changing climate conditions to help drive action.

Is this loop a balancing or reinforcing feedback loop? How do you know?

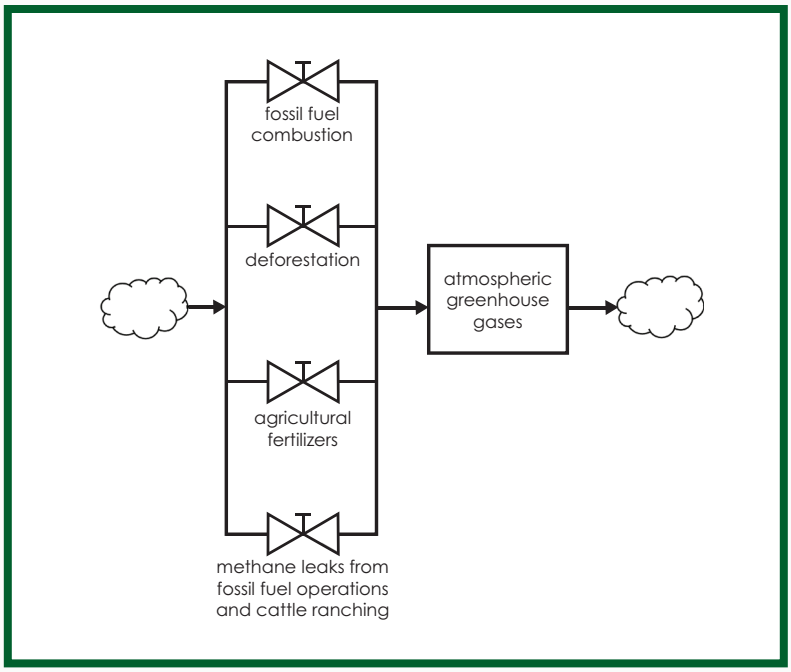
_____

_____

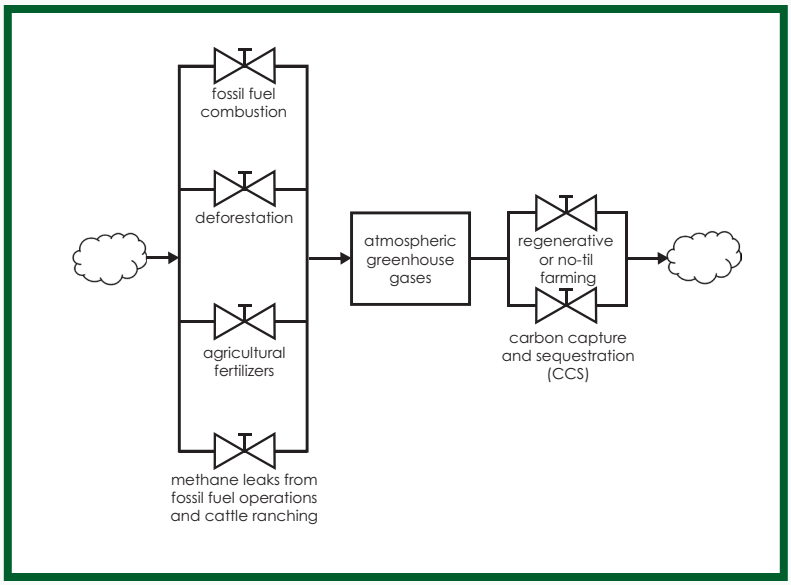
Climate Change and Systems Thinking Work Paper

Solutions

1. **Human-Caused Greenhouse Gas Emissions Stock and Flow Diagram:** Using the diagram on page 32 as a guide, draw a stock and flow diagram representing human-caused additions of greenhouse gases to the atmosphere. Use pencil, and leave room on the right side of the diagram to add flows leaving the atmosphere. Draw the diagram in your Field Book.



2. **Greenhouse Gas Mitigation Stock and Flow Diagram:** Add to your diagram from above. Include mitigation measures – human-caused flows of greenhouse gases out of the atmosphere. See pages 45-46 for suggestions.



Climate Change and Systems Thinking Work Paper

Solutions

What flows could be increased or decreased to reduce the amount of greenhouse gases in the atmosphere?

Fossil fuel combustion, deforestation, agricultural fertilizers, and methane leak flows could be reduced to limit the amount of greenhouse gases in the atmosphere. Regenerative farming or carbon capture and sequestration flows could be increased to draw greenhouse gases out of the atmosphere.

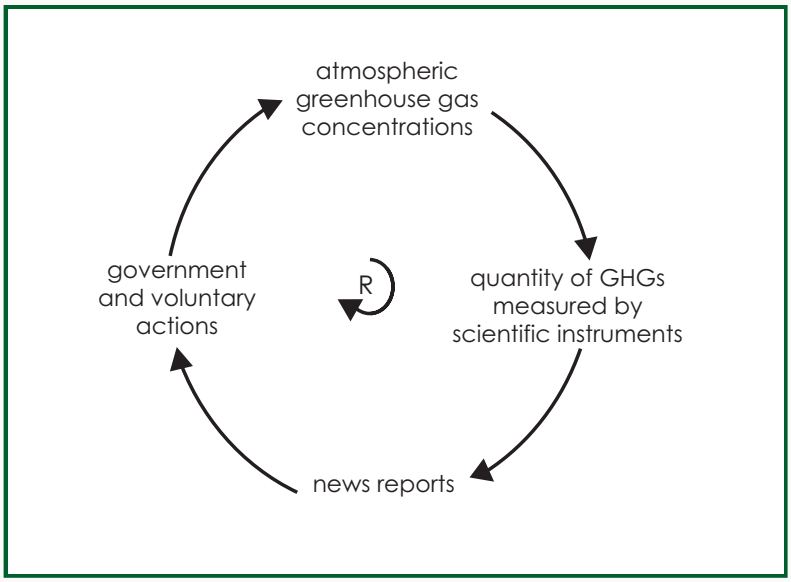
How do people know if the stock of greenhouse gases in the atmosphere were filling up?
How would we know if it was getting too full?

Scientific measurements are one way for us to track the concentration of greenhouse gas emissions. If we understand climate science, we can deduce that there greenhouse gas concentrations would increase based on our observations of changes in climate. Because the climate is complicated and changes based on many interactions, observing effects would not give us certainty that greenhouse gas concentrations were increasing.

What do you think of mitigation as a climate strategy compared to reducing greenhouse gas emissions?

The precautionary principle advises us to "prevent harm as the best method of environmental protection, and when knowledge is limited, apply a precautionary approach."[107g] Since we aren't sure how effectively, quickly, or economically we can remove greenhouse gases from the atmosphere, the precautionary approach suggests avoiding emissions as the best approach.

3. **Feedback Loop in Human Systems:** In nature, feedback loops provide systems with information that allows them to adapt to changing conditions. Systems that lack feedback have difficulty recognizing changing conditions, and so have a harder time adapting. In human systems, feedback often comes in the form of news, reports, scientific data, or other numerical or verbal information. Using the feedback loops and discussions on pages 39 and 44 as guides, draw a feedback loop that could provide people with information on changing climate conditions to help drive action. Draw the diagram in your Field Book.



Is this loop a balancing or reinforcing feedback loop? How do you know?

It is a reinforcing loop. If greenhouse gas concentrations increase, the quantity of greenhouse gases measured by scientific instruments will increase. This measurement will increase news reports of the increase. Then government and voluntary actions will increase. Actions will decrease the emissions of greenhouse gases or increase mitigation measures, decreasing atmospheric greenhouse gas concentrations. This cycle will continue to reinforce change at least until a safe level of greenhouse gas concentration is reached.

Summary

Learners explore ways to communicate constructively and effectively about climate change. Learners demonstrate their understanding by creating an infographic. This activity addresses the third National Oceanic and Atmospheric Administration climate literacy principle: communicating about climate and climate change in a meaningful way.[107h]

Time Required

- Two 50-minute class periods

Reading Prior to Activity

- Review pages 27-55

Key Concepts

- Communication
- Big Ideas of Sustainability
- Preparedness
- Web of Life
- Creating the World We Want

Objectives

- To examine different climate change messages that can reach diverse audiences

Inquiry/Critical Thinking Questions

- How can I communicate about climate change in a way that others can hear?
- How can I inspire others to take action on climate change?

Activity Nineteen

Effective Climage Change Communication

Background

Climate change conversations can bring up disagreements, worry, and avoidance. Here are some tips for effective climate communication:

- **Be clear and concise on the facts.** Review your responses to questions from Activity 15.
- **Focus on the benefits of creating the world we want, rather than doing without.** Cleaner air, abundant energy, healthier food, more physical activity, and more connection with our communities and nature are all desirable outcomes of climate-friendly choices.[108]
- **Look for common ground.** While you may not agree with someone on the science, you may both believe that minimizing risks or reducing energy costs are important. Many climate change actions have other benefits. Riding a bike or walking is good for health. Riding public transit reduces traffic. Using renewable energy can save money and reduces other forms of pollution, which harm health.
- **Encourage others to prepare for risk.** Society uses many practices to prepare for risk: fire, health, and life insurance; military forces; physical exams; and dental floss. We spend money and time on these practices, hoping they will avoid larger problems and expenses in the future. Climate change conversations can be approached the same way – even if people aren't certain about the science. In order to avoid future losses, what should we do today?[109]
- **Encourage others to do the right thing.** Planet Earth is home to millions of species of living things. All work together to form a web of life. Not only is a healthy web of interconnections between rain forest, seals, bacteria, daisies, rice fields, and more vital for all of life – including humans – it also matters that we care for other living beings, today and into the future.
- **Remind people that personal action matters.** While it may seem like one person cannot make a difference, small changes add up. Also, people tend to act like the people they

Materials

- Blank paper or poster board
- Colored pencils
- Markers
- Colored paper
- Drawing tools, including compasses, triangles, and rulers
- Tape or glue
- Scissors
- Digital technology and graphics software

know. As more people adopt climate-friendly behavior, their actions can have a snowball effect. The more that people see others taking steps to address climate change, the more people will take action themselves.

- **Avoid using guilt.** Most people are not motivated by guilt.
- **Acknowledge the challenges.** If people feel that climate change is too big, too frightening, or too depressing to talk about, respect their feelings. Show by example that taking action brings positive feelings of care, strength, courage, and responsibility.
- **Try methods of persuasion that advertisers use.** See the Activity 4 Background section on page 62 for more information.

Activity

Day 1

In this activity, you will create a climate change infographic. You can choose the topic of your infographic from the following list or develop a topic of your own:

- Climate Change Facts (option: Facts and Fiction)
- The Greenhouse Effect (or Greenhouse Gases and Sources)
- Climate Change Preparedness
- Creating the World We Want – A Carbon-Free Future
- Staying Cool Protects Life and Prevents Harm
- What the Experts Say about Global Warming
- Team Up to Cut Carbon

1. **Create an infographic.** Working with your group, use the following steps to design and make your infographic.[110]

   Come up with a visual metaphor to use to present your content. Use this metaphor as the foundation for your design.

   a. To come up with ideas, try the following prompts:

      i. Global warming is like a …

      ii. Greenhouse gases mostly come from…

      iii. We can prepare for risk by…

      iv. Climate change mostly affects…

      v. Our hope for the future is …

      vi. Working together helps us…

   b. **Select your content.** Become familiar with the information presented in the text, activities, and other credible sources. Add any additional information you and your group know about climate change issues. Decide which information is most important to present. Notice any links, overlaps, or trends in the information that could make your infographic more powerful. Include sustainability ideas if and as they fit with your message. Try to select information that will be clear, accurate, informative, and useful.

   c. **Design your infographic.** Use different types of fonts, colors, size and shape to help the viewer understand your message. Sketch out a rough draft before you start your final version.

   d. **Make your infographic.**

Students can work alone, in pairs, or in small groups to design their infographics.

Discussion Questions

- What choices did you make in deciding how to communicate about climate change?
- How did you try to frame your message in a way that would help people be open to your message, understand your material, and make changes?

Extension

- After the class has viewed one another's work, post the infographics in the school library, cafeteria, hallways, or other school location.

Field Book

Day 1

1. **Nature Journal:** What living organisms might be affected by changing climate? Think about possible changes like more or harder rain, less rain, hotter temperatures, more severe storms, or rising sea levels. How might these organisms adapt to change? Where else might they go to find a habitat like they have now?

2. Write a response to the **Think About It** box on page 35.

3. **Write about your emotions surrounding climate change.** People often feel sad, angry, or worried. These are normal feelings. Try to take some time to acknowledge them. Then try to use the energy of anger or worry and the empathy that is part of sadness to motivate yourself to work for change. Spend time with friends, family, and nature to stay connected with the important parts of your life.

4. Update your **Learning Links** page with new ideas, connections, or conclusions.

5. Update your **Questions** page with new topics you are curious about.

Activity

Day 2

1. **Complete your infographic.**

2. **Post infographics around the classroom.** Hold an art walk to give students time to view all the infographics.

Field Book

Day 2

1. **Nature Journal:** Notice other people – also part of nature – going about their day in your area. How might changes in climate affect them? Again, consider possible changes like more or harder rain, less rain, hotter temperatures, more severe storms, or rising sea levels. How might these people adapt to change?

   After you answer these questions, spend some time outside. Notice the sun, atmosphere, and weather that support life. As you did in an earlier exercise, notice yourself as part of this living system. Spend some time experiencing this wide-ranging interconnectedness. Write about your observations and experiences.

2. Write a response to the **Think About It** box on page 45.

96

FacingTheFuture.org

Activity Twenty

Climate Questionnaire Revisited

Activity

1. **Complete the Climate Questionnaire** provided by your teacher.
2. **Compare answers on this questionnaire to the answers on the one you completed at the beginning of the unit.** Note which questions you answered differently. Which do you think are more correct?
3. **Add your completed questionnaire to your Field Book.**

MODULE FOUR 97

Go over correct answers with students after they have had a chance to compare their two questionnaires.

Discussion Questions

- Review answers and discuss questions
- On which questions did your answers change?
- On which questions did your answers stay the same?

Summary

Learners will check their expanded knowledge about climate change. Students will compare the results of the questionnaire with the questionnaire they completed at the beginning of the unit to check their learning. This activity addresses the National Oceanic and Atmospheric Administration's (NOAA) Climate Literacy principle of understanding the essential principles of Earth's climate system.[110a]

Time Required

- 20 minutes

Key Concepts

- Climate Change Basics

Objectives

- To identify learning about climate change
- To identify strengths and gaps in students' existing knowledge about climate change

Inquiry/Critical Thinking Questions

- What is climate change?
- What do I need to know about climate change?

Handouts

- Climate Questionnaire, pages 79A-79B

Preparation

- Make a copy of the Climate Questionnaire, pages 79A-79B, for each student

Summary

Students examine next steps they would like to take and reflect on their learning.

Time Required

- 20 minutes

Reading Prior to Activity

- Review pages 41-71

Key Concepts

- Climate Change
- Big Ideas of Sustainability
- Earth Charter Principles

Objectives

- To reflect on learning and changes in worldview
- To transfer learning outside of class

Inquiry/Critical Thinking Questions

- What are the natural and anthropogenic processes that influence climate change?
- What can I do to reduce my contribution to climate change?
- Are the impacts of climate change experienced equitably by all humans on the planet?
- Whose responsibility is it to address the impacts of climate change?

Materials

Colored pencils, optional

Activity Twenty-One

Climate Change Reflections, Self-Assessment, and Commitments

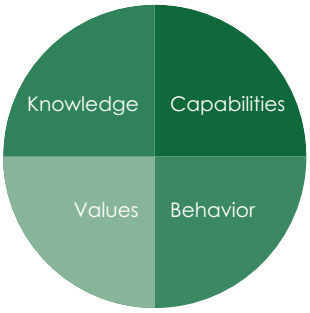
Activity

In your Field Book, respond to the following questions and prompts.

1. **Write one paragraph in response to each of the unit's essential questions:**
   a. What are the natural and anthropogenic processes that influence climate change?
   b. What can I do to reduce my contribution to climate change?
   c. Are the impacts of climate change experienced equitably by all humans on the planet?
   d. Whose responsibility is it to address the impacts of climate change?

2. **Consider your commitments.** What can you do to carry through with the carbon footprint reductions you identified in this unit? With whom can you share your climate change knowledge? Write down concrete action steps, goals, and timing for any commitments you would like to make. What might make it difficult for you to take these steps? How can you overcome these obstacles?
3. **Describe your sustainability worldview.** A sustainability worldview is based on knowledge, capabilities, values, and behavior. Think about how your worldview has changed through what you have

learned about climate change. Make a circle and divide it into quarters. Write one of the elements of a sustainability worldview in each quarter. Note any changes that have taken place in these areas; use arrows to show interconnections between the four quarters. Use colors.



4. **Look back at the Questions page in your Field Book.** Are there unanswered questions? How can you get them answered? What else would you like to know about climate change in the future?
5. **How have the daily nature connection activities affected you?**
6. **Assess your work.** What parts of the Climate Change unit represented your best work? What would you like to do differently?

MODULE FOUR 99

References

i Next Generation Science Standards. (n.d.) **Improving Science Education Through Three-Dimensional Learning.** Retrieved from http://www.nextgenscience.org

ii National Council for the Social Studies. (n.d.) N**ational Curriculum Standards for Social Studies: Chapter 2 – The Themes for Social Studies.** Retrieved from http://www.socialstudies.org/standards/strands.

iii Common Core State Standards Initiative. (2017). **English Language Arts Standards.** Retrieved from http://www.corestandards.org/ELA-Literacy/.

1 Lebow, V. (1955). Price Competition in 1955. **Journal of Retailing**, XXXI (1).

2 The World Bank. (2016). BRetrieved from http://data.worldbank.org/indicator/NE.CON.PETC.ZS?page=6.

3 Lucintel. (2012). **Global Beauty Care Products Industry 2012-2017: Trend, Profit, and Forecast Analysis**. Retrieved from http://www.lucintel.com/reports/personal_care/global_beauty_care_products_industry_2012_2017_trend_profit_and_forecast_analysis_september_2012.aspx.

4 Statistica. (2016). **Revenue of the cruise industry worldwide from 2008 to 2015 (in billion U.S.dollars)**. Retrieved from http://www.statista.com/statistics/204572/revenue-of-the-cruise-line-industry-worldwide-since-2008/.

5 GfK. (2016). **US, Europe Account for 63% of Global Pet Retail Sales - GfK POS Data**. Retrieved from http://www.gfk.com/en-us/insights/press-release/us-europe-account-for-63-of-global-pet-retail-sales-gfk-pos-data/.

6 Assadourian, E. (2010) The Rise and Fall of Consumer Cultures. **2010 State of the World: Transforming Cultures from Consumerism to Sustainability**. Ed. E. Assadourian and Worldwatch Institute. New York City:W. W. Norton & Company.

7 Meikle, J. (1979). **Twentieth-Century Limited**. Philadelphia, Pennsylvania: Temple University Press. Quoted in Lasch, C. (n.d.) The Culture of Consumerism. **Smithsonian Center for Education and Museum Studies**. Retrieved from http://www.smithsonianeducation.org/idealabs/ap/essays/consume2.htm.

8 Vitelli, R. (2013). Television, Commercials, and Your Child. **Psychology Today**. Retrieved from https://www.psychologytoday.com/blog/media-spotlight/201307/television-commercials-and-your-child.

9 **Statistica**. (n.d.). Media advertising spending in the United States from 2011 to 2018 (in billion U.S. dollars). Retrieved from http://www.statista.com/statistics/272314/advertising-spending-in-the-us/.

10 Earth Charter Initiative. (2012). **The Earth Charter**. Retrieved from http://earthcharter.org/discover/the-earth-charter/.

11 U.S. Department of Commerce. (2016). **Personal Consumption Expenditures by Major Type of Product and by Major Function.** Retrieved from http://www.bea.gov/iTable/iTable.cfm?reqid=12&step=1&acrdn=1#reqid=12&step=3&isuri=1&1204=1960&1203=2014&1206=a&1205=1000&1210=x&1211=0.

U.S. Census Bureau. (n.d.). **Census of Population and Housing, 1960 - 2010**. Retrieved from https://www.census.gov/prod/www/decennial.html.

12 Bureau of Labor Statistics. (2014). **American Time Use Survey**. Retrieved from http://www.bls.gov/tus/tables/a1_2014.pdf.

Gemmell, D. (2016) Gray Wolf Reintroduction – Yellowstone National Park. **Ecology Eduction Consulting, Inc.** Retrieved from http://www.ecologyedu.com/ecology_education_resources/gray_wolf_reintroduction/introductionpage_1.html.

13 Lagorio, C. (2007). Resources: Marketing to Kids. **CBS**. Retrieved from http://www.cbsnews.com/news/resources-marketing-to-kids/.

14 Statistic Brain Research Institute. (2014). **Teenage Consumer Spending Statistics**. Retrieved from http://www.statisticbrain.com/teenage-consumer-spending-statistics/.

15 U.S. Environmental Protection Agency. (2015). **Advancing Sustainable Materials Management: 2013 Fact Sheet**. Retrieved from https://www.epa.gov/sites/production/files/2015-09/documents/2013_advncng_smm_fs.pdf.

16 U.S. Environmental Protection Agency. (n.d.). **Advancing Sustainable Materials Management: Facts and Figures**. Retrieved from http://www.epa.gov/smm/advancing-sustainable-materials-management-facts-and-figures.

17 WasteZero. (2016). P**ay-as-You-Throw**. Retrieved from http://wastezero.com/our-solutions/pay-as-you-throw/.

18 Simmons, A. (2016). The world's trash crisis, and why many Americans are oblivious. **Los Angeles Times**. Retrieved from http://www.latimes.com/world/global-development/la-fg-global-trash-20160422-20160421-snap-htmlstory.html.

19 World Wide Fund for Nature. (2014). **Infographic: Footprint by Country**. Retrieved from http://wwf.panda.org/_core/general.cfc?method=getOriginalImage&uImgID=%26%2AR%5C%2C%20%2EW%3E%0A.

20 Global Footprint Network. (2016). **World Footprint**. Retrieved from http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/.

References

21 Srivastava, M. and S. Shannon. (2013). Ninety Cents Buys Safety on $22 Jeans in Bangladesh. **Bloomberg**. Retrieved from http://www.bloomberg.com/news/articles/2013-06-05/ninety-cents-buys-safety-on-22-jeans-in-bangladesh.

22 Binkley, C. (2011). How Can Jeans Cost $300? **Wall Street Journal**. Retrieved from http://www.wsj.com/news/articles/SB10001424052702303365804576429730284498872.

23 Srivastava, M. and S. Shannon. (2013). Ninety Cents Buys Safety on $22 Jeans in Bangladesh. **Bloomberg**. Retrieved from http://www.bloomberg.com/news/articles/2013-06-05/ninety-cents-buys-safety-on-22-jeans-in-bangladesh.

24 World Bank. (2016). **Household final consumption expenditure per capita (constant 2005 US$)**. Retrieved from http://data.worldbank.org/indicator/NE.CON.PRVT.PC.KD. "International Energy Statistics: Population." Energy Information Agency. Retrieved February 12, 2016. From http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=93&pid=44&aid=33.

25 Maslow, A. (1943). A theory of human motivation. **Psychological Review**, 50, 370-396.
Maslow, A. (1970). **Motivation and Personality** (2nd ed.). New York: Harper and Row.

26 Sterling, P. (2016). Why We Consume: Neural Design and Sustainability. **Great Transition Initiative**. Retrieved from http://www.greattransition.org/publication/why-we-consume.

27 DeAngelis, T. (2004). Consumerism and its discontents. **American Psychological Association**. Retrieved from http://www.apa.org/monitor/jun04/discontents.aspx.

28 Meadows, D.H., D. Meadows, and J. Randers. (1992). **Beyond the Limits**. Post Mills, VT: Chelsea Green. P. 216.

29 Beyer, B.K. (1995). **Critical Thinking**. Bloomington, IN: Phi Delta Kappa Educational Foundation.
Ennis, R.H. (2001). Goals for a critical thinking curriculum and its assessment. In A.L. Costa (Ed.), **Developing Minds: A Resource Book for Teaching Thinking** (pp. 44-46). Alexandria: VA: ASCD.
Paul, R. & Elder, L. (2014). **Critical Thinking Concepts and Tools**. Tomales, CA: Foundation for Critical Thinking.

30 Nolet, V. (2016). **Educating for Sustainability: Principles and Practices for Teachers**. New York, NY: Routledge.

31 Markkula Center for Applied Ethics. "A Framework for Ethical Decision Making." (August 1, 2015). Retrieved from https://www.scu.edu/ethics/ethics-resources/ethical-decision-making/a-framework-for-ethical-decision-making/.
Nolet, V. (2016). **Educating for Sustainability: Principles and Practices for Teachers**. New York, NY: Routledge.

32 Shuman, M. (2009). Invest Locally: Put Your Money Where Your Life Is. **Yes! Magazin**e. Retrieved from http://www.yesmagazine.org/issues/the-new-economy/invest-locally-put-your-money-where-your-life-is.

33 Business Alliance for Local Living Economies. (2014). **2014 Balle Impact Report**. Retrieved from https://bealocalist.org/about-us.

34 StatisticBrain. (2014). **Teen Consumer Spending Statistics**. Retrieved from http://www.statisticbrain.com/teenage-consumer-spending-statistics/.
cfm?reqid=12&step=1&acrdn=1#reqid=12&step=3&isuri=1&1204=1960&1203=2014&1206=a&1205=1000&1210=x&1211=0.

35 Brower Youth Awards. (n.d.) **Jessica Assaf**. Retrieved from http://www.broweryouthawards.org/winner/jessica-assaf/.

36 Namoliki, C. (2011). Effects on Climate Change on Nukulaelae, Tuvalu. **University of the South Pacific**. Retrieved from http://www.usp.ac.fj/fileadmin/files/faculties/fste/geography/Earthcaching/students/Collin/Collin_Full_Report.pdf.

37 Butler, J. and Montzka, S. (2015). The NOAA Annual Greenhouse Gas Index (AGGI). **National Oceanic and Atmospheric Administration**. Retrieved from http://s2.thingpic.com/images/wA/PwH23KPLuMW1xtDoxzVuTepo.jpeg.
Ma, Q. (1998). Greenhouse Gases: Refining the Role of Carbon Dioxide. **National Aeronautics and Space Administration**. Retrieved from http://www.giss.nasa.gov/research/briefs/ma_01/.

38 University of New Hampshire. (2008). **Pools, Fluxes, and a Word About Units**. Retrieved from http://globecarboncycle.unh.edu/CarbonPoolsFluxes.shtml.

39 Riebeek, H. (2005). Paleoclimatology: The Ice Core Record. **National Aeronautics and Space Administration Earth Observatory**. Retrieved from http://earthobservatory.nasa.gov/Features/Paleoclimatology_IceCores/.

40 (n.d.) Climate Change 2001: Working Group I, The Scientific Basis, 2.3.2.1 Palaeoclimate proxy indicators. **GRID-Arendal**. Retrieved from http://www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/wg1/068.htm.

41 (n.d.) About Mauna Loa Observatory. **National Oceanic and Atmospheric Administration Earth System Research Laboratory**. Retrieved from http://www.esrl.noaa.gov/gmd/obop/mlo/aboutus/aboutus.html.

42 International Panel on Climate Change. (2014). **Climate Change: The Physical Science Basis; t. Working Group Fact Sheet**. Retrieved from https://www.ipcc.ch/report/ar5/wg1/docs/WG1AR5_FactSheet.pdf.

References

43 (2014). Climate Change 2014 Synthesis Report Summary for Policymakers. **Intergovernmental Panel on Climate Change, p. 2.** Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

44 (2014). Climate Change 2014 Synthesis Report Summary for Policymakers. **Intergovernmental Panel on Climate Change**. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

45 (2014). Climate Change 2014 Synthesis Report Summary for Policymakers. **Intergovernmental Panel on Climate Change**. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

46 National Aeronautics and Space **Administration. (n.d.)** How is Today's Warming Different from the Past? Retrieved from http://earthobservatory.nasa.gov/Features/GlobalWarming/page3.php.

47 Climate Change 2014 Synthesis Report Summary for Policymakers. (2014). **Intergovernmental Panel on Climate Change**. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

48 National Aeronautics and Space Administration. (2008). **Target Atmospheric CO2: Where Should Humanity Aim?** Retrieved from http://www.giss.nasa.gov/research/briefs/hansen_13/.

49 U.S. Global Change. (2014). **Our Changing Climate**. Retrieved from http://nca2014.globalchange.gov/highlights/report-findings/our-changing-climate.

50 U.S. Environmental Protection Agency. (2016). **Earth's temperature is a balancing act**. Retrieved from https://www3.epa.gov/climatechange/science/causes.html.

51 (2014). Climate Change 2014 Synthesis Report Summary for Policymakers. **Intergovernmental Panel on Climate Change, p. 4**. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

52 U.S. Environmental Protection Agency. (2016). **U.S. Greenhouse Gas Inventory Report: 1990 - 2014**. Retrieved from https://www3.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

53 U.S. Energy Information Administration. (2013). **EIA projects world energy consumption will increase 56% by 2040**. Retrieved from http://www.eia.gov/todayinenergy/detail.cfm?id=12251#.

U.S. Energy Information Agency (April 2015). **Annual Energy Outlook 2015**. Retrieved from http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf.

54 U.S. Environmental Protection Agency. (2014). **Global Emissions by Gas**. Retrieved from https://www3.epa.gov/climatechange/ghgemissions/global.html.

55 International Energy Agency. (2012). **World Energy Outlook 2012 Executive Summary**. Retrieved from http://www.iea.org/publications/freepublications/publication/English.pdf.

56 Hansen, K. (2008). Water Vapor Confirmed as Major Player in Climate Change. **National Aeronautics and Space Administration**. http://www.nasa.gov/topics/earth/features/vapor_warming.html.

57 U.S. Environmental Protection Agency. (2016). **Overview of Greenhouse Gases: Nitrous Oxide Emissions**. Retrieved from https://www3.epa.gov/climatechange/ghgemissions/gases/n2o.html.

58 U.S. Environmental Protection Agency. (2016). **Overview of Greenhouse Gases**. Retrieved from https://www3.epa.gov/climatechange/ghgemissions/gases/ch4.html.

59 U.S. Environmental Protection Agency. (2016). **Overview of Greenhouse Gases**. Retrieved from https://www3.epa.gov/climatechange/ghgemissions/gases/fgases.html.

60 Ge, M, Friedrich, J., and Tamassa, T. (2014). 6 Graphs Explain the World's Top 10 Emitters. **World Resources Institute**. http://www.wri.org/blog/2014/11/6-graphs-explain-world's-top-10-emitters.

61 Ge, M, Friedrich, J., and Tamassa, T. (2014). 6 Graphs Explain the World's Top 10 Emitters. **World Resources Institute**. http://www.wri.org/blog/2014/11/6-graphs-explain-world's-top-10-emitters.

62 Ge, M, Friedrich, J., and Tamassa, T. (2014). 6 Graphs Explain the World's Top 10 Emitters. **World Resources Institute**. http://www.wri.org/blog/2014/11/6-graphs-explain-world's-top-10-emitters.

63 (2014). Climate Change 2014 Synthesis Report Summary for Policymakers. **Intergovernmental Panel on Climate Change**. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

64 Brown, Oli. (2008). Climate change and forced migration: Observations, projections and implications in Human Development Report 2007/2008: Fighting Climate Change; Human Solidarity in a divided world. **United Nations Development Programme**. Retrieved from http://hdr.undp.org/sites/default/files/reports/268/hdr_20072008_en_complete.pdf

References

65 Schwartz, J. (2014). Soil as Carbon Storehouse: New Weapon in Climate Fight? **Yale Environment 360**. Retrieved from http://e360.yale.edu/feature/soil_as_carbon_storehouse_new_weapon_in_climate_fight/2744/.

66 Great Barrier Reef Marine Park Authority. (2007). **Great Barrier Reef Outlook Report**. Retrieved from http://www.gbrmpa.gov.au/__data/assets/pdf_file/0016/3904/GBRMPA_OR_CH7.pdf.

67 00 Resilient Cities. (2016). **Latest Resilience News**. Retrieved from http://www.100resilientcitiesorg/#/-_Yz45MzE5NCdpPTEocz5j/.

68 The Solutions Project. (2016). **100% Renewable Energy Vision**. Retrieved from http://thesolutionsproject.org.

69 Renewable Energy Policy Network for the 21st Century. (2015). **Renewables 2015 Global Status Report**. Paris: REN21 Secretariat.

70 Rolfes, E. (2012). The Hidden Costs of Hamburgers. **PBS Newshour**. Retrieved from http://www.pbs.org/newshour/rundown/the-hidden-costs-of-hamburgers/.

71 Food and Agriculture Organization of the United Nations. (2016). **By the numbers: GHG emissions by livestock**. Retrieved from http://www.fao.org/news/story/en/item/197623/icode/.

72 United Nations Framework Convention on Climate Change. (2015). **Historic Paris Agreement on Climate Change -195 Nations Set Path to Keep Temperature Rise Well Below 2 Degrees Celsius.** Retrieved from http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/.

73 Notre Dame Global Adaptation Index. (2014). **Country Rankings**. Retrieved from http://index.gain.org/ranking/vulnerability.

74 Sierra Club. (2015). **Fair and Just Transition from Fossil Fuels to Clean Energy**. Retrieved from http://www.sierraclub.org/labor/fair-and-just-transition-fossil-fuels-clean-energy.

75 U.S. Department of Energy. (2007). **The Potential Benefits of Distributed Generation and Rate-Related Issues that May Impede Their Expansion**. Retrieved from https://www.ferc.gov/legal/fed-sta/exp-study.pdf.

76 National Wildlife Federation. (2016). **Cool School Challenge**. Retrieved from http://www.nwf.org/Eco-Schools-USA/Become-an-Eco-School/Cool-School-Challenge.aspx.

77 Waskow, D. and Dagnet, Y. (2016). **3 Key Tasks to Spur Climate Action**. Retrieved from http://www.wri.org/blog/2016/04/3-key-tasks-spur-climate-action-2016.

78 California Energy Commission. (2016). **Renewable Energy Programs**. Retrieved from http://www.energy.ca.gov/renewables/renewable_links.html.

79 University of California. (n.d.) **Carbon Neutrality Initiative**. Retrieved from http://www.ucop.edu/initiatives/carbon-neutrality-initiative.html.

80 The Economist. (2014). **Energy Subsidies: Scrap Them**. Retrieved from http://www.economist.com/news/leaders/21604170-there-are-moves-around-world-get-rid-energy-subsidies-heres-best-way-going.

81 CBC News. (2016). Canada, **U.S. agreement to cut methane emissions "hefty goal" for Alberta energy sector**. Retrieved from http://www.cbc.ca/news/canada/calgary/canada-us-methane-cut-deal-emissions-alberta-energy-reaction-1.3485741.

82 We Mean Business. (2016). **Take Action**. Retrieved from http://www.wemeanbusinesscoalition.org/take-action.

83 U.S. Department of Energy. (2015). **Photovoltaic System Pricing Trends. NREL/pr-6a20-64898**. Retrieved from https://emp.lbl.gov/sites/all/files/pv_system_pricing_trends_presentation_0.pdf.

84 The Solutions Project. (2016). **Resources**. Retrieved from http://thesolutionsproject.org/resources/.

85 Environmental Working Group. (2011). **Meat Eaters Guide**. Retrieved from http://static.ewg.org/reports/2011/meateaters/pdf/methodology_ewg_meat_eaters_guide_to_health_and_climate_2011.pdf.

86 Gil, C. (2016). **Interactive Notebooks: No Special Hardware Required.** Edutopia. Retrieved from https://www.edutopia.org/blog/interactive-notebooks-no-special-hardware-christina-lovdal-gil.

Interactive Notebooks Wiki. (n.d.) **Interactive Notebooks.** Retrieved from http://interactive-notebooks.wikispaces.com.

Marcarelli, Kellie. (2010). **Teaching Science with Interactive Notebooks.** Thousand Oaks: Corwin.

87 Leslie, Clare Walker and Charles E. Roth. (2000). **Keeping a Nature Journal.** North Adams, MA: Storey Publishing.

88 Media Literacy Project. (n.d.) **Deconstruction Gallery.** Retrieved from http://medialiteracyproject.org/deconstructions/.

Boykin, G. (n.d.) **Examples of Different Kinds of Persuasion in Marketing.** Chron. Retrieved from http://smallbusiness.chron.com/examples-different-kinds-persuasion-advertising-56550.html.

Xi, T. (n.d.) **What Are the Key Persuasive Techniques Used in Consumer Advertising?** Chron. Retrieved from http://smallbusiness.chron.com/key-persuasive-techniques-used-consumer-advertising-74567.html.

References

Wittbrodt, A. (n.d.) **Deconstruct Media Images.** Sophia. Retrieved from https://www.sophia.org/tutorials/deconstruct-media-messages?utm_campaign=share&utm_content=tutorial&utm_medium=facebook&utm_source=sophia.

89 Global Footprint Network. (2016). **World Footprint.** Retrieved from http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/.

90 Wilson, E. (2016). **Half-Earth: Our Planet's Fight for Life.** New York: W.W. Norton.

90a Institute for Sustainable Energy at Eastern Connecticut State University. (n.d.) **Personal Ecological Footprint.** Retrieved from www.sustainenergy.org.

91 Wikipedia. (2017). **List of minimum wages by country.** Retrieved from https://en.wikipedia.org/wiki/List_of_minimum_wages_by_country.

92 Numbeo. (2017). **Prices by Country of Coke/Pepsi** (.33 liter bottle)

NationMaster. (2014). **Countries Compared by Cost of living > Prices at markets > Rice > White, 1kg.** Retrieved from http://www.nationmaster.com/country-info/stats/Cost-of-living/Prices-at-markets/Rice/White,-1kg#.

Advisory Board. (2012). **A $9 doctor's visit? Report charts how U.S. cost of care compares.** Retrieved from https://www.advisory.com/Daily-Briefing/2012/03/06/costs-of-care.

Expatistan Cost of Living Index. (2015). **Cost of Living.** Retrieved from https://www.expatistan.com/price/doctor/kigali/USD.

International Living. (2013). **Healthcare in Mexico.** Retrieved from https://internationalliving.com/countries/mexico/health-care/.

93 Nolet, V. (2016). **Educating for Sustainability: Principles and Practices for Teachers.** New York: Taylor and Francis.

93a National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf.

93b Leiserowitz, A., Smith, N. & Marlon, J.R. (2011) **American Teens' Knowledge of Climate Change.** Yale Project on Climate Change Communication. Retrieved from http://environment.yale.edu/uploads/american-teens-knowledge-of-climate-change.pdf

93c Freedman, A. (2013). Climate Central. **The Last Time CO2 Was This High, Humans Didn't Exist.** Retrieved from http://www.climatecentral.org/news/the-last-time-co2-was-this-high-humans-didnt-exist-15938

93d Nolet, V. (2016). **Educating for Sustainability: Principles and Practices for Teachers.** New York, NY: Routledge.

93e National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf.

93f National Aeronautics and Space Administration. (2005). **NASA – What's the Difference Between Weather and Climate?** Retrieved from https://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html.

93g Bump, P. (2015). Washington Post. **Why this National Review global temperature graph is so misleading.** Retrieved from https://www.washingtonpost.com/news/the-fixwp/2015/12/14why-the-national-reviews-global-temperature-graph-is-so-misleading/?utm_term=.726714289b50.

93h WeatherOnline. (2017). **Heathrow Airport Maximum Temperature.** Retrieved from http://www.weatheronline.co.uk/weather/maps/city

93i U.S. Global Change Climate Research Program. (2014). **National Climate Assessment.** Retrieved from http://nca2014.globalchange.gov/report

93j NDTV. (2016). **Mumbai Battles Heavy Rain, More Predicted in 24 Hours.** Retrieved from http://www.ndtv.com/mumbai-news/mumbai-battles-heavy-rain-more-predicted-in-24-hours-1465006.

93k U.S. Global Change Climate Research Program. (2014). **National Climate Assessment.** Retrieved from http://nca2014.globalchange.gov/report/our-changing-climate/melting-ice

93l National Snow and Ice Data Center. (2016). **Greenland Ice Sheet Today.** Retrieved from http://nsidc.org/greenland-today/

93m National Oceanic and Atmospheric Administration. (n.d.) **Climate at a Glance: Time Series.** Retrieved from https://www.ncdc.noaa.gov/cag/time-series/global

93n U.S. Global Change. (2014). **Our Changing Climate.** Retrieved from http://nca2014.globalchange.gov/highlights/report-findings/our-changing-climate

94 Hungerford, E. (2010). **Forbidden Island.** Newton, MA: Gamewright.

94a National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf

References

94b National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf.

95 Garland, Jr., T.(2016). University of California, Riverside. **The Scientific Method as an Ongoing Process.** Retrieved from http://idea.ucr.edu/documents/flash/scientific_method/story_html5.html.

96 Intergovernmental Panel on Climate Change. (2013). **IPCC Factsheet: What is the IPCC?** Retrieved from http://ipcc.ch/news_and_events/docs/factsheets/FS_what_ipcc.pdf.

97 International Panel on Climate Change. (2013). **IPCC Factsheet: What literature does the IPCC assess?** Retrieved from https://www.ipcc.ch/news_and_events/docs/factsheets/FS_ipcc_assess.pdf.

98 Intergovernmental Panel on Climate Change. (2015). **IPCC Factsheet: How does the IPCC review process work?** Retrieved from https://www.ipcc.ch/news_and_events/docs/factsheets/FS_review_process.pdf.

99 International Panel on Climate Change. (2014). **Climate Change: The Physical Science Basis**; t. Working Group Fact Sheet. Retrieved from https://www.ipcc.ch/report/ar5/wg1/docs/WG1AR5_FactSheet.pdf.

100 Intergovernmental Panel on Climate Change. (2014). **Climate Change Synthesis Report: Summary for Policymakers.** Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

101 Intergovernmental Panel on Climate Change. (2014). **Climate Change Synthesis Report: Summary for Policymakers.** Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

102 The National Academies of Sciences, Engineering, and Medicine. (n.d.) **Climate Change at the National Academies.** Evidence, Impact, and Choices. Retrieved from https://nas-sites.org/americasclimatechoices/more-resources-on-climate-change/climate-change-lines-of-evidence-booklet/evidence-impacts-and-choices-figure-gallery/figure-14/.

103 U.S. Environmental Protection Agency. (2016). **Causes of Climate Change.** Retrieved from https://www.epa.gov/climate-change-science/causes-climate-change.

104 Cook, J., et al. (2015). IOP Science. **Consensus on consensus: a synthesis of consensus estimates on human-caused global warming.** Retrieved from http://iopscience.iop.org/article/10.1088/1748-9326/11/4/048002/pdf.

105 National Aeronautical and Space Administration. (2017). **Scientific Consensus: Earth's climate is warming.** Retrieved from https://climate.nasa.gov/scientific-consensus/.

106 Academia Brasiliera de Ciências Brazil, et al. (2005). **Joint science academies' statement: Global response to climate change.** Retrieved from http://www.nationalacademies.org/onpi/06072005.pdf.

107 Cook, J., et al. (2015). IOP Science. **Consensus on consensus: a synthesis of consensus estimates on human-caused global warming.** Retrieved from http://iopscience.iop.org/article/10.1088/1748-9326/11/4/048002/pdf.

107a National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf

107b United Nations. (2015). **Millenium Development Goals Indicators.** Retrieved from https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=751.

107c Gershon, D. (2006). **Low Carbon Diet.** Woodstock, NY: Empowerment Institute.

Carbon Footprint. (n.d.) **Welcome to the web's leading carbon footprint calculator.** Retrieved from http://calculator.carbonfootprint.com/calculator.aspx?lang=en-GB&tab=3.

Terrapass. (2017). **Eat your way to a smaller carbon footprint.** Retrieved from https://www.terrapass.com/eat-your-way-to-a-smaller-carbon-footprint.

U.S. Environmental Protection Agency. (2017). **Household Carbon Footprint Calculator.** Retrieved from https://www.epa.gov/ghgemissions/household-carbon-footprint-calculator

107d Hare, B., Schaeffer, M., Serdeczny, O., Friedrich-Schleussner. (2014). **Climate Analytics. Is it possible to return warming to below 1.5oC within this century?** Retrieved from http://climateanalytics.org/files/climate_analytics_briefing_is_it_possible_to_return_warming_to_below_1_5degc_within_this_century-.pdf.

107e National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf

107f National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf

107g Earth Charter Initiative. (2012). **The Earth Charter.** Retrieved from http://earthcharter.org/discover/the-earth-charter

References

[107h] National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf

[108] Stoknes, P. (2015). **What We Think About When We Try Not to Think About Global Warming.** White River Junction, Vermont: Chelsea Green Publishing.

[109] Stoknes, P. (2015). **What We Think About When We Try Not to Think About Global Warming.** White River Junction, Vermont: Chelsea Green Publishing.

[110] Zomick, B. (2013). **SkilledUp for Learners.** How It's Made: Learn to Create Your Own Infographic with Designer Mike Wirth. Retrieved from http://www.skilledup.com/articles/create-your-own-infographic-mike-wirth.

[110a] National Oceanic and Atmospheric Administration. (2009). **Climate Literacy: The Essential Principles of the Climate Sciences.** Retrieved from http://oceanservice.noaa.gov/education/literacy/climate_literacy.pdf.

Photo and Image Credits

Thank you to the generous and talented photographers and artists who contributed their photos and art.

p. 1 Different shirts on colorful hangers ©Adobe Stock Photo/Africa Studio
p. 2 Paying with credit card online ©Adobe Stock Photo/kkolosov
p. 3 Makeup tools ©Adobe Stock Photo/dexailo
p. 4 Supermarket aisle with empty green shopping cart©Adobe Stock Photo/Kwangmoo
p. 6 Texting messages ©Adobe Stock Photo/StockRocket
p. 7 Group of multi-ethnic teenagers outside ©Adobe Stock Photo/ryflip
p. 8 Household garbage heap make pollution of flora, Earth planet ©Adobe Stock Photo/FMUA
p. 9 Plant growing from shredded paper ©Adobe Stock Photo/pogonici
p. 10 Funny flower decoration set in old rubber boot with wood wall in ©Adobe Stock Photo/kamonrat
p. 11 A bulldozer and garbage truck on a landfill waste site ©Adobe Stock Photo/rob245
p. 13 Idea, light bulb ©iStock/violetkaipa
p. 14 Forest ©Adobe Stock Photo/SkyLine
p. 16 Kids sharing one pencil ©Adobe Stock Photo/implementarfilms
p. 17 Spoiled boy ©Adobe Stock Photo/bramgino
p. 18 Drain in sink ©Adobe Stock Photo/Win Nondakowit
p. 19 Customer at grocery store ©Adobe Stock Photo/wideonet
p. 20 Girl holding gift bags ©Adobe Stock Photo/lefata
p. 22 Trail in the forest ©Adobe Stock Photo/tarasylo
p. 24 Happy interracial family is enjoying a day in the park ©Adobe Stock Photo/_jure
p. 26 ©Jessica Assaf
p. 27 Lightening landscape ©Adobe Stock Photo/Paul Lampard
p. 28 Single penguin on a piece of ice ©Adobe Stock Photo/adimas
p. 30 Autobahnstau 2014 ©Adobe Stock Photo/Kara
p. 30 ©Wikipedia
p. 31 The carbon cycle ©Adobe Stock Photo/doethion
p. 33 Difference of natural resources ©iStock/Kittichai Songprakob
p. 34 ©NOAA
p. 35 Forest waterfall ©Adobe Stock Photo/dreamsofmemory
p. 36 Severe air pollution in Shanghai, China ©Adobe Stock Photo/wusuowei
p. 36 ©Globalchange.gov
p. 37 Commercial ship loading container in shipping port image use for ©Adobe Stock Photo/stockphoto mania
p. 40 Kuhstall ©Adobe Stock Photo/haitaucher39
p. 42 Traffic jams in the city ©Adobe Stock Photo/kichigin19
p. 43 ©Greg Brusseau
p. 46 Plane artistic ©Adobe Stock Photo/Eray
p. 48 Wind turbines silhouette on mountain at sunset ©Adobe Stock Photo/mimadeo
p. 49 Solar panel installation ©Adobe Stock Photo/Elenathewise
p. 50 Farm chicken in a barn, eating from an automatic feeder ©Adobe Stock Photo/zlikovec
p. 51 Solar panel on a red roof ©Adobe Stock Photo/diyanadimitrova
p. 53 Lemon tree nursary ©Adobe Stock Photo/riderfoot
p. 54 Highway interchange ©Adobe Stock Photo/iofoto
p. 54 ©Richie Ahuja
p. 55 ©Amber Parkin

Photo and Image Credits

p. 56 Fashion clothing in window ©Pixabay/Unsplash
p. 57 Happy woman shopping bags ©Pixabay/Hwellrich
p. 57 Basic bathroom rolls ©Pixabay/Meditations
p. 58 Female hand drawing plants in sketchbook ©Adobe Stock Photo/Africa Studio
p. 58 Youg brunette woman writing to notepad ©Adobe Stock Photo/dobok
p. 60 Fox next to fence ©Adobe Stock Photo/Lovell
p. 60 Girls hands with pen writing ©Adobe Stock Photo/Ivan Kruk
p. 61 Drop of water on twig ©Pixabay/Myriams-Fotos
p. 62 Subway station tunnel ©Pixabay/Unsplash
p. 63 Outdoor billboard ©Pixabay/StephenLondon
p. 64 Garzweiler openpit mine ©Pixabay/firstmillion
p. 65 Computer accessories ©Pixabay/Pexels
p. 66 Airplane wing at sunset ©Pixabay/Pexels
p. 67 Closeup of ants on wood ©Pixabay/Tworkowsky
P. 68 Manufacture clothes stitching ©Pixabay/Activedia
P. 70 Chinese seamstress in a textile factory ©Adobe Stock Photo/Kzenon
p. 72 Down jackets retail ©Pixabay/Pexels
p. 73 Forestry logging, deforestation ©Pixabay/Unsplash
p. 74 Wolf in woods ©Pixabay/Pexels
P. 75 Industrial factory work ©Pixabay/chaingam990
p. 76 Tree trunk forest floor ©Pixabay/Picography
p. 76 Countryside leisure ©Pixabay/Pexels
p. 77 Colorful magazines ©Pixabay/kconcha
p. 77 Urban garbage ©Pixabay/jeffjuit
p. 78 Cartons recycle ©Pixabay/MarieMLH
p. 79 Highway logistics ©Pixabay/andreas 160578
p. 79 Iceland cattle ©Pixabay/tpsdave
p. 80 Yellowstone sunset landscape ©Pixabay/tpsdave
p. 81 Electric car power ©Pixabay/Mike Bird
p. 85 Cold front hurricane ©Pixabay/WikiImages
p. 90 Ladybug bloom ©Pixabay/cocoparisienne
p. 91 Person standing red rock ©Pixabay/stokpic
p. 92 Group of smiling students in classroom ©Adobe Stock Photo/Syda Productions
p. 93 Cyclist in traffic on the city roadway ©Adobe Stock Photo/vitality_melnik
p. 94 San Francisco trolley ©Pixabay/tpsdave
p. 97 Glaciers mountains ©Pixabay/Unsplash
p. 98 Earth lights globe ©Pixabay/Unsplash
p. 98 Mulltonnen waste separation ©Pixabay/efes
p. 99 Leaf back light sun ©Pixabay/congerdesign