Wide Open Spaces:

Climate Change Impacts in Rural Areas of the United States

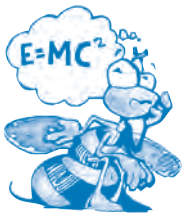
PHOTO BY: BABS MCDONALD

What Kinds of Scientists Did This Research?

economist: This scientist studies economics. Economics is a social science that addresses the production, distribution, and use of goods and services.

policy analyst: This scientist compares different policies to determine which **policy** will best help achieve an identified set of goals.

Thinking About Science



When scientists begin their research, they read as much as possible of what has already been written on the topic. This process is important because it allows the scientists to make sure they are up-to-date on all the newest research. In some cases, the topic the scientists are interested in has so much information that reading, understanding, and tying all the information together becomes a research project in itself. In this study, scientists read and compiled information and research on climate and rural areas. The scientists wanted to examine how climate change may affect rural areas and the people that live there.

Thinking About the Environment

Every living thing has basic things it needs to survive. Animals need air, water, food, and shelter. Plants need air, water, nutrients, and light. To do well and prosper, however, living things need a good habitat in which to live. A good habitat means that there is food and water available and that the climate is suitable for the living thing. As the climate changes, some living things may move to different habitats if they can. In this study, the scientists examined a particular group of living things and what might happen if their environment changes. The scientists looked at how rural areas in the United States and people living in rural areas may be affected by climate change.

Meet the Scientist

Pankaj Lal,
Environment and Forest Resource Economist:

My favorite science experience is using the principles of **economics** to solve environmental problems. These problems include **deforestation,** other natural resource **depletion**, climate change, and pollution control. I believe that the economy and environment can go together. I love working on policy options that can be used to solve environmental problems.

Meet the Scientist

Janaki Alavalapati,
Resource Economist and Policy Analyst:

My favorite science experience was a survey we did to explore factors influencing the **degradation** of Nyungwe Forest, Rwanda. One individual's response was, "I make more money by working in a tea estate; why would I go into Nyungwe Forest to do something that gives less money and has more risk?" The response is very insightful; it suggests that alternate income opportunities will help conserve tropical forests.

Introduction

The United States is made up of both rural and urban areas. Rural areas are areas with fewer people and more land (fig. 1). Urban areas are areas with a high population density (figs.2a and 2b). For this research, the scientists identified 2,050 counties in the United States that were rural and 1,090 counties that were urban (fig. 3). Rural areas make up about 17 percent of the population in the United States but cover 80 percent of the land area.

Figure 1. Rural area in Georgia. Photo by Babs McDonald.

Figure 2a. Urban area in Helsinki, Finland. Photo by Babs McDonald.

FIGURE 2B. URBAN AREA IN WASHINGTON, D.C.
PHOTO BY BABS MCDONALD.

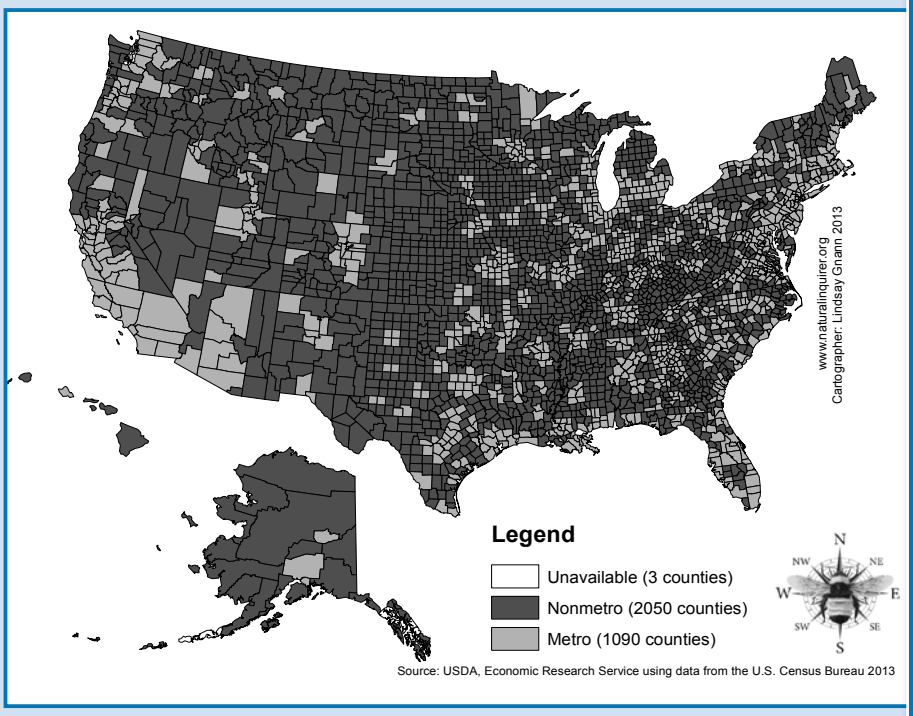


FIGURE 3. THE RURAL COUNTIES ARE IN DARK GRAY AND CALLED NONMETRO. METRO INDICATES A MORE URBAN AREA. FIND WHERE YOU LIVE ON THE MAP. ARE YOU IN AN URBAN AREA OR A RURAL AREA?

What is the Pareto (pə **rā** tō) Principle?

Have you ever heard of the 80-20 rule? This rule is also called the Pareto Principle. The Pareto Principle was coined in 1941 by Joseph Juran. He named the principle after an Italian named Vilfredo Pareto. In 1906, Pareto observed that 80 percent of Italy's land was owned by 20 percent of the population. Pareto also observed that 20 percent of the pea pods in his garden contained 80 percent of the peas. The rule has come to describe the observation that 80 percent of an effect comes from 20 percent of the cause.

In this study, a little less than 20 percent of the United States population was identified as living on 80 percent of the country's land area. Think about your classroom. About 80 percent of the time, do the same 20 percent of students raise their hand? Be on the lookout for examples of the Pareto Principle!

Meet the Scientist

Evan Mercer,
Forest Economist:

One of my favorite science experiences was finding ways to help poor farmers in isolated mountain villages in the Philippines improve their farms. The villages were groups of 15-20 small grass shacks (one for each family). The shacks were all close together. We were interviewing the families to find out all about their farms and livestock. One question we asked was how many chickens each family owned, and each family gave a specific number. Since the chickens weren't kept in pens, they were running wildly all over the village. So I asked one villager, "How do you know which chickens are yours if everybody's chickens run all over the village?" The villager responded, "The chickens know."

Rural counties tend to be poorer than urban counties. Rural counties also have higher unemployment, lower educational **attainment**, fewer highly skilled jobs, and greater dependency on government funds. Because of the **socioeconomic** challenges rural areas face, these areas may be vulnerable to climate change in some ways while not as vulnerable in other ways. When something is vulnerable, it is open to attack or damage. For example, rural areas are expected to experience more negative impacts from the change in agriculture due to climate change than urban areas experience. However, rural areas may not experience as many extreme heat events as urban areas. The scientists in this study were interested in studying how climate change may impact rural areas in the United States.

Reflection Section

- What were the scientists interested in learning from this research?
- Do you live in an urban or rural area? How do you know?

Methods

The scientists collected journal articles, government reports, and other publications about climate change. The scientists read all of the information and organized it into three areas. The three areas were human health, **indigenous** communities, and economic impacts. Much of the literature did not specifically address social and economic effects of climate change, so the scientists made **inferences** about these effects.

The inferences were based on general climate models (GCMs). GCMs are computer models that allow people to create long-term weather forecasts and predict future changes in climate. These models use mathematical equations to **simulate** the interactions of things like water, atmosphere, land surfaces, and ice. These equations are then run through computers and interpreted by scientists.

Reflection Section

- Think of a time when you have made a model. (For example, you may have made a model of a cell, the solar system, a mathematical model, or a model of a historical event.) How did creating this model help you better understand what you were learning?

- The scientists in this research used evidence and reasoning to draw inferences about how climate change may affect rural areas and the people living there. An inference is a conclusion reached based on evidence and reasoning. Think of a time when you used evidence and reasoning to infer a particular conclusion. Write two sentences describing when and why you used inference. Do you think this is a good way to draw conclusions? Why or why not?

Photo by Babs McDonald.

What Is the Heat Island Effect?

The heat island effect refers to the fact that concrete and asphalt in cities absorb and hold heat. The tall buildings in cities prevent heat from **dissipating**. Air flow is also reduced. All of these elements combine to create an area of greater heat (FIG. 5). According to the U.S. Environmental Protection Agency, areas that experience the heat island effect can have a mean annual temperature 1.8–5.4 °F higher than surrounding rural areas. For additional information, visit http://www.epa.gov/hiri/.

Findings

The scientists made a variety of inferences and determinations based on the climate change literature they read. Below you will read about some of the inferences they made about rural areas in each of the following areas: impacts on human health, impacts on indigenous populations, and economic impacts.

Impacts on Human Health

The scientists looked at direct and indirect impacts when they studied human health impacts in rural areas. The scientists found that direct impacts resulted from increased exposure to temperature and extreme weather. The scientists found that rural areas may be less vulnerable to extreme heat events than cities due to the heat island effect. Additionally, rural areas typically have more vegetation. The increased vegetation provides more shade and cooling from evaporation (FIGS. 4A AND 4B).

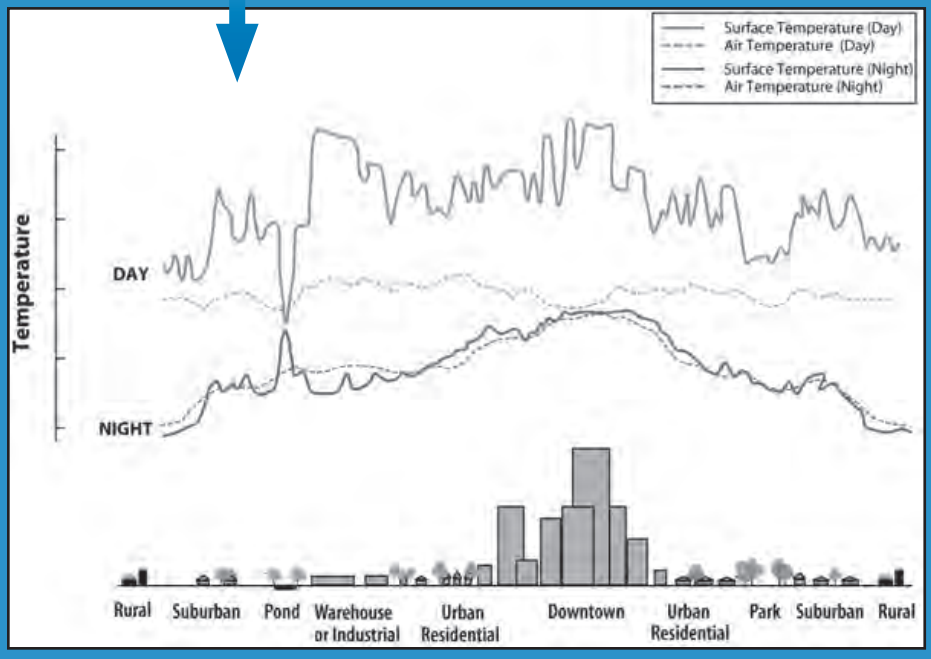


FIGURE 5. LOOK AT THE GRAPH. NOTICE THE DIFFERENCE BETWEEN THE DAYTIME AND NIGHTTIME SURFACE TEMPERATURE IN URBAN VERSUS RURAL AREAS. WHAT ELSE DO YOU NOTICE IN THIS GRAPH? GRAPH COURTESY OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

Figure 4a.
Rural area with vegetation in Alaska.
Photo by Babs McDonald.

Figure 4b.
Rural area with vegetation in North Carolina.
Photo by Babs McDonald.

The scientists also found that indirect impacts from disease and infection could potentially have a negative impact on rural communities. Heavy downpours, for example, could lead to an increase in **sediment** runoff into waterways. This increase in sediment in the waterways could lead to an increase in waterborne diseases.

Impacts on Indigenous Communities

Many indigenous communities are located in rural areas. The scientists found that communities such as Native American communities and Native Alaskan communities may experience negative impacts from climate change. For example, it is estimated that climate change may increase flooding and erosion by 86 percent in Native Alaskan communities (FIG. 6).

FIGURE 6. ALASKA HAS BEAUTIFUL LANDSCAPES. NOTICE THE ARCTIC GROUND SQUIRREL IN THE PHOTO. NATIVE ALASKANS AND OTHERS LIVING IN ALASKA MAY SEE THIS LANDSCAPE CHANGE AS A RESULT OF A CHANGING CLIMATE. PHOTO BY TIM RAINS, NATIONAL PARK SERVICE.

Native American communities and other indigenous communities are not as flexible in terms of moving to different areas. In the case of Native Americans, some of these people live on land that is specially protected for them (FIG. 7). Therefore, if the climate changes and creates problems in the area that they live, they may not be as likely to change location as some other people. Additionally, access to traditional food sources and ways of collecting and sharing food may be impacted.

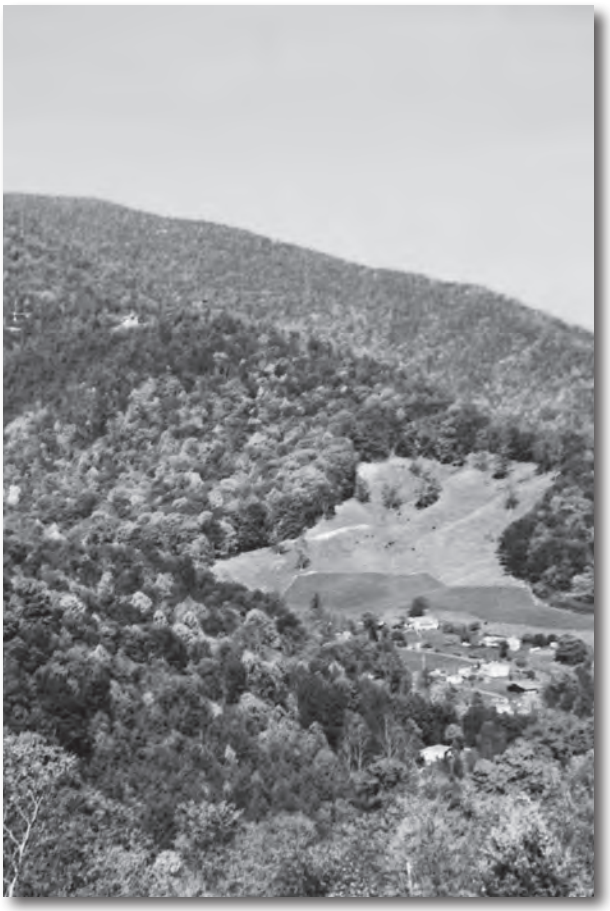


FIGURE 7. QUALLA BOUNDARY OF THE CHEROKEE INDIAN RESERVATION.
PHOTO COURTESY OF RICHARD WEISSER AND HTTP://WWW.SMOKYPHOTOS.COM.

Economic Impacts

The scientists examined six different areas in the category of economic impacts. The scientists examined **agriculture**, recreation and tourism, **forestry**, water, **fisheries**, and energy. Below are examples from the two areas of agriculture and forestry.

Agriculture takes place largely in rural areas because of the amount of land required for agricultural activities. The impact of climate change on agricultural activities, therefore, directly affects rural areas. Some crop plants, for example, may not

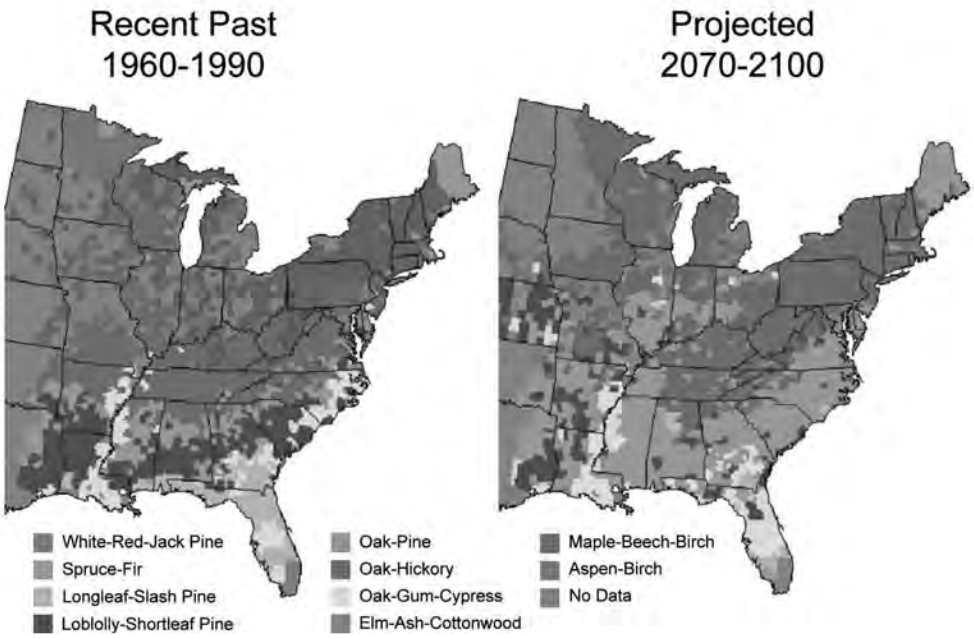
be able to grow in areas that they traditionally grew in due to increases in the average temperature. The change in crop location may benefit where crops are able to grow and may benefit some rural areas while it may **devastate** other rural areas. Additionally, a warming climate may cause crops to develop and bloom too early which may expose these plants to late season frosts. Another example can be found in the dairy industry. The dairy industry can be affected by climate change because dairy cows' productivity decreases when the temperature goes above 77 ºF.

Another area of possible economic impact for rural areas is forestry. Depending on how the temperature changes due to climate change, scientists have made projections about what types of trees will grow in different areas (FIG. 8). If forests in the South and Northeast shift to oak and hickory trees instead of **softwoods** like pine trees, then the wood and **pulp** industry may experience large losses. These losses would impact rural communities because many people in these rural areas make their living from working in the wood and pulp industry.

Number Crunch

Dairy cows' productivity decreases when temperatures go above 77 °F. What is that temperature in °C? The equation you should use is °C = (°F-32) x 5/9.

FIGURE 8. LOOK AT EACH OF THE STATES. COMPARE THE RECENT PAST TO THE PROJECTED FUTURE. WHAT DO YOU NOTICE ABOUT HOW THE TREE SPECIES WILL CHANGE?



MAP COURTESY OF PANKAJ LAL.

Reflection Section

- Look at figure 8. According to this map, how would the areas of loblolly-shortleaf pine change if the climate changes as the scientists have projected? How do you think these changes would affect these areas?
- Reread the sidebar on the heat island effect. Name one way you think cities could help reduce this effect. Why do you think your idea will help?

Discussion

The potential impacts of climate change on rural areas include increased risks to human health, changes to agriculture and forestry, and increased demand on water resources. Other potential impacts include those from increased stress on fisheries, changes to tourism and recreation, negative effects on indigenous communities, and other **adverse** impacts related to extreme weather events.

The scientists recommend doing additional research that focuses on rural areas' ability to adapt to climate change. Researchers need to look at the costs of adapting to climate change. They also should explore what problems may arise when rural communities adapt to this change, and the consequences of climate change for rural communities. This type of research would allow rural communities to prepare for a changing climate and may help reduce negative impacts from climate change.

The scientists also recommend examining alternative energy sources as a way to help rural areas. Solar energy and wind energy, for example, may help reduce the negative impacts of climate change on rural areas. The scientists warn, however, that the focus on alternative energy should take into account the predictions for climate change.

The scientists recommend that some policies should be developed to help rural areas adapt to a changing climate. With these policies in place, rural areas will be better prepared for the potential impacts of climate change and may be able to more quickly adapt and respond to changes.

Reflection Section

- In your own words, summarize the scientists' key findings. After you have summarized the key findings, explain two things that could be done to help reduce the possible negative impacts of climate change on rural areas.
- Think about a time when you had to adapt to a change. For example, maybe you changed schools or moved to a different town. How did planning help you adapt to this change? Why do you think the scientists recommend planning for the impacts of climate change on rural areas?

Extreme Weather Events in the News

In October and November 2012, Hurricane Sandy moved up the Eastern United States coastline. In November 2013, Typhoon Haiyan moved across the Philippines in the Western Pacific Ocean and into Vietnam. Some people wondered if these two extreme weather events, which caused damage to human communities and to the environment, were related to climate change. On the Internet or in your school's media center, conduct research on these and other recent extreme weather events. Share your findings with your classmates. Hold a class discussion about extreme weather events and climate change. Do you think they are related? Why or why not?

Glossary

adverse (ad **vərs**): Results in negative effects.

agriculture (**a** gri **kəl** chər): The science or practice of preparing the soil, producing crops, and raising livestock.

attainment (ə **tān** mənt): To have possession of.

deforestation (dē **for** ə **stā** shən): The action or process of clearing of forests. Deforestation happens when a forest is destroyed and the area previously occupied by the trees is used for other purposes.

depletion (de **plē** shən): The state of having most or all of something being used.

devastate (**de** və stāt): To ruin or destroy.

dissipate (**di** sə pāt): To break up and scatter or vanish.

economics (**e** kə **nä** miks): The study of the way that goods, services, and wealth are produced, distributed, and used.

fisheries (**fi** shə rēz): Places for catching fish or other sea animals.

forestry (**for** ə strē): The science and management of growing trees and timber.

indigenous (in **di** jə nəs): Produced, growing, living, or occurring naturally in a particular region or environment.

inference (**in** f(ə-) rən(t)s): Conclusion or opinion that is formed because of known facts or evidence.

policy (**pä** lə sē): Overall plan with rules that must be followed, generally made by a government.

pulp (**pəlp**): A material prepared by chemical or mechanical means from various materials (such as wood) for use in making paper products.

sediment (**se** də mənt): Material deposited by water, wind, or glaciers.

simulate (**sim** yə lāt): To create the appearance or effect of something for purposes of evaluation.

socioeconomic (**sō** sē ō **e** kə **nä** mik): Of, relating to, or involving a combination of social and economic factors.

softwood (**soft** wüd): Coniferous tree (such as fir or pine).

Accented syllables are in **bold**. Marks and definitions are from http://www.merriam-webster.com.

Web Resources

PBS Harriman Expedition Retraced- Alaska Native Communities
http://www.pbs.org/harriman/1899/native.html

U.S. Environmental Protection Agency (EPA) Heat Island Effect
http://www.epa.gov/hiri/

National Aeronautics and Space Agency (NASA) Climate Kids
http://climatekids.nasa.gov/

U.S. Environmental Protection Agency Climate Change Kids Site
http://www.kidsnewsroom.org/climatechange/

If you are a Project Learning Tree-trained educator, you may also use the following activities as an added resource: "Our Changing World" or "The Global Climate."

FACTivity

Time Needed

2-3 class periods

Materials

- "Wide Open Spaces" article
- Construction paper
- Poster board
- Markers

The question you will answer in this FACTivity is:
How do I effectively explain the possible effects of climate change to people that live in rural areas?

To create awareness and an educated public, officials often create informational brochures and hold public meetings to inform people about different topics. For this FACTivity, you can choose to either create an informational brochure or create a presentation to inform people in rural areas about the possible impacts of climate change.

The method you will use to answer this question is:

1) You will work in small groups. In your small groups, decide if you would like to create an informational brochure or create a presentation. You will create your presentation on poster board. You will create your brochure using construction paper.

2) Either product that you choose to work on must include the following components:

    a. A brief introduction to the topic of climate change.

b. A brief overview of rural areas.

c. A discussion of at least two out of the three areas of impact that are covered in the article.

d. A discussion about things that could be done to help reduce the negative effects of climate change. You should provide at least 2 examples.

e. A graph.

f. Two pictures.

g. A map.

3) After you have completed your product, your teacher may have you present it to the class or share it with another group in your class.

4) As a whole class, discuss why it is important to provide information to the general public about different topics. Also discuss what some of the challenges may be to providing this type of information.

A possible extension is to incorporate technology into this project, if you have access to computers and the Internet. If this is a possibility, then you may want to create a digital presentation, digital brochure, or create an informational Web page.

FACTivity Extension

If you live in a rural area, write a letter to community officials and tell them what you have learned and share your presentation or informational brochure with them. Use proper form in your letter, as well as proper sentence structure, spelling, and punctuation. If you live in an urban area, look around you and see if you think there are places where changes could be made to reduce the heat island effect. Write a letter to city officials to tell them about your ideas.