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14. Rural Communities

Convening Lead Authors

David Hales, Second Nature, Inc.
William Hohenstein, U.S. Department of Agriculture

Lead Authors

Marcie D. Bidwell, Mountain Studies Institute
Craig Landry, East Carolina University
David McGranahan, U.S. Department of Agriculture
Joseph Molnar, Auburn University
Lois Wright Morton, Iowa State University
Marcela Vasquez, University of Arizona

Contributing Authors

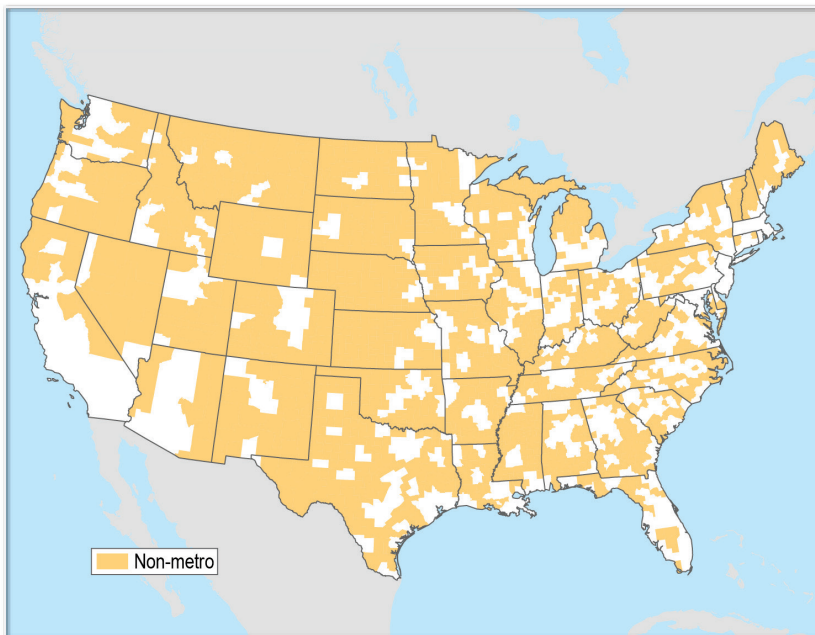
Jenna Jadin, U.S. Department of Agriculture

Key Messages

- 1. Rural Communities are highly dependent upon natural resources for their livelihoods and social structures. Climate change related impacts are currently affecting rural communities. These impacts will progressively increase over this century and will shift the locations where rural economic activities (like agriculture, forestry, and recreation) can thrive.**
- 2. Rural communities face particular geographic and demographic obstacles in responding to and preparing for climate change risks. In particular, physical isolation, limited economic diversity, and higher poverty rates, combined with an aging population, increases the vulnerability of rural communities. Systems of fundamental importance to rural populations are already stressed by remoteness and limited access.**
- 3. Responding to additional challenges from climate change impacts will require significant adaptation within rural transportation and infrastructure systems, as well as health and emergency response systems. Governments in rural communities have limited institutional capacity to respond to, plan for, and anticipate climate change impacts.**

Over 95% of U.S. land area is classified as rural, but is home to just 19.3% of the population (USDA 2012; U.S. Census Bureau 2010a, 2010b; HRSA 2012). Rural America's importance to the country's economic and social well-being is disproportionate to its population, however, since rural areas provide natural resources that much of the rest of the U.S. depends on for food, energy, water, forests, recreation, national character, and quality of life (ERS 2003). Rural economic foundations and community cohesion are intricately linked to these natural systems, which are inherently vulnerable to climate change. Urban areas that depend on goods and services from rural areas will also be affected by climate change-driven impacts across the countryside.

Rural Counties



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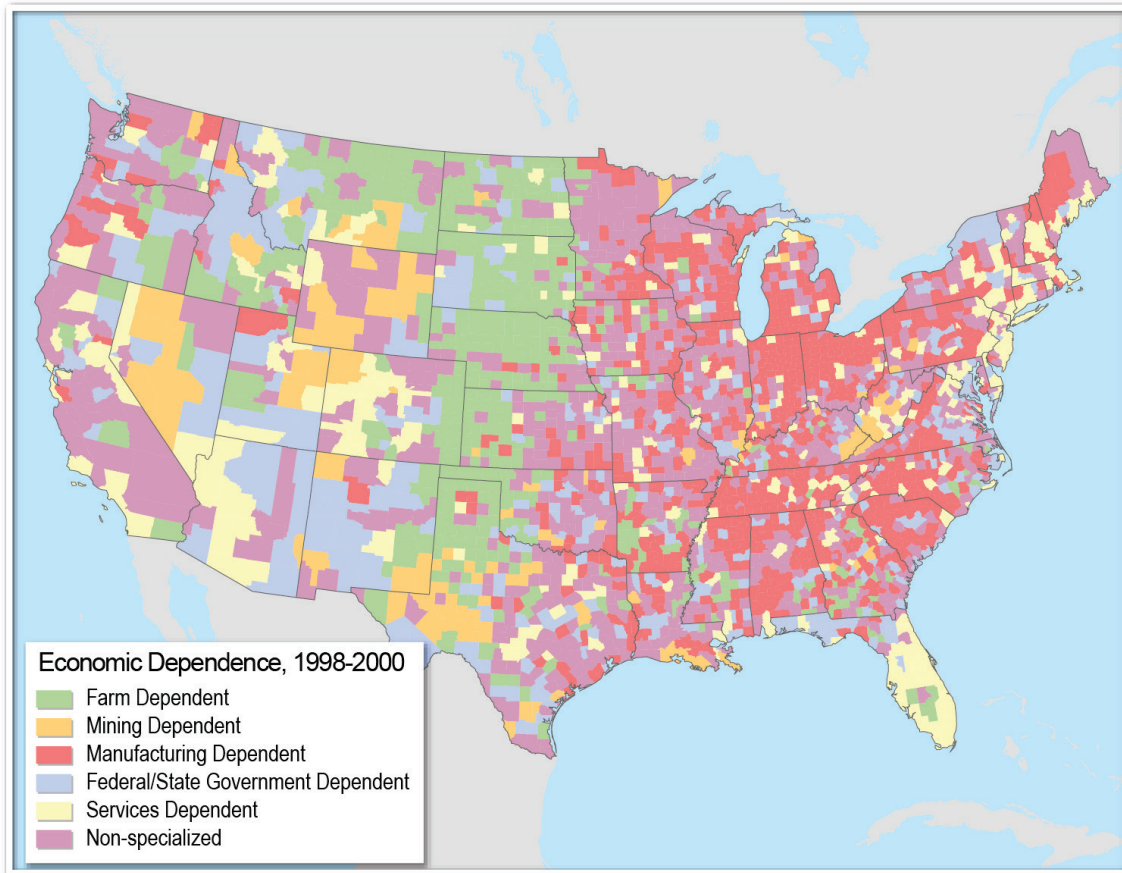
2 **Figure 14.1:** Rural Counties

3 **Caption:** Although about 80% of the U.S. population lives in urban areas, most of the
 4 country is still classified as rural. (Source: USDA Economic Research Service, Atlas of
 5 Rural and Small-Town America, 2012; based on data from 2000).

6 Warming trends, climate volatility, extreme weather events, and environmental change are
 7 already affecting the economies and cultures of rural areas. Many rural communities face
 8 considerable risk to their infrastructure, livelihoods, and quality of life from observed and
 9 projected climate shifts. These changes will progressively increase volatility in food commodity
 10 markets, shift the ranges of plant and animal species, and, depending on the region, increase
 11 water scarcity, exacerbate flooding and coastal erosion, and increase the intensity and frequency
 12 of wildfires across the rural landscape.

13 Climate changes will severely challenge many rural communities, shifting locations where
 14 particular economic activities are capable of thriving. Changes in the timing of seasons,
 15 temperatures, and precipitation will alter where commodities, value-added crops, and
 16 recreational activities are best suited. Because many rural communities are less diverse than
 17 urban areas in their economic activities, changes in the viability of one traditional economic
 18 sector will place additional stresses on community stability.

Economic Dependence Varies by Region



1

2 **Figure 14.2:** Economic Dependence Varies by Region

3 **Caption:** Much of the rural U.S. depends on agriculture, mining, and manufacturing.
 4 Climate changes will affect each region and each economic sector in complex and
 5 interrelated ways. (Source: USDA Economic Research Service, Atlas of Rural and Small-
 6 Town America, 2012).

7 Climate change impacts will not be uniform or consistent across rural areas, and some
 8 communities may benefit from climate change. In the short term, the U.S. agricultural system is
 9 expected to be fairly resilient to climate change due to the system's flexibility to engage in
 10 adaptive behaviors, such as expansion of irrigated acreage, regional shifts in acreage for specific
 11 crops, crop rotations, changes to management decisions (such as choice and timing of inputs and
 12 cultivation practices), and altered trade patterns compensating for yield changes caused by
 13 changing climate patterns (Walthall et al. 2012). Recreation, tourism, and leisure activities in
 14 some regions will benefit from shifts in temperature and precipitation.

1 Negative impacts from projected climate changes, however, will ripple throughout rural
2 America. In lakes and riparian areas, for example, warming is projected to increase the growth of
3 algae and invasive species, particularly in areas already facing water quality impairments
4 (Hansson et al. 2012). Mountain species and cold water fish, such as salmon, are expected to see
5 a decrease in their range size due to warming, while some warm water fish, such as bass, could
6 expand their ranges (Janetos et al. 2008). Alaska, with its reliance on commercial and
7 subsistence fishing catch, is particularly vulnerable. Warmer weather and higher water
8 temperatures will reduce salmon harvests, creating hardships for the rural communities that
9 depend upon these catches (NTAA 2009). Communities in Guam and American Samoa, which
10 depend on fish for 25% to 69% of their protein, are expected to be particularly hard hit, as
11 climate change alters the composition of coral reef ecosystems (Lal et al. 2011).

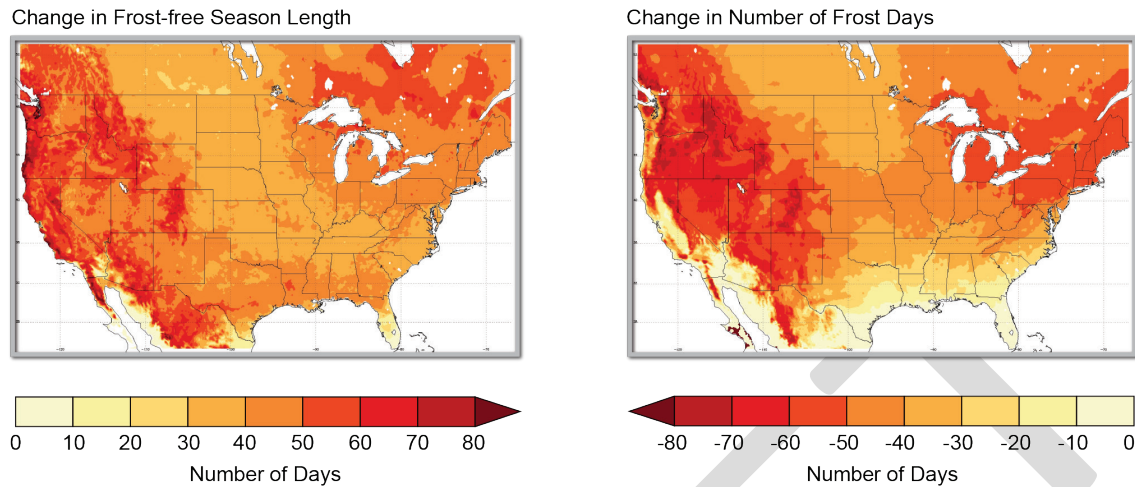
12 Across the U.S., rural areas provide ecosystem services – like carbon absorption in forests, water
13 filtration in wetlands, and wildlife habitat in prairies – whose value tends to be overlooked.
14 Preserving these ecosystem services sustains the quality of life in rural communities and also
15 benefits those who come to rural communities for second homes, tourism, and other amenities,
16 while providing urban residents with vital resources – like food, energy and fresh water – that
17 meet essential needs. This layered connection between rural areas and populous urban centers
18 suggests that maintaining the health of rural areas is a national, and not simply a local, concern.

19 ***Rural Economies***

20 **Rural communities are highly dependent upon natural resources for their livelihoods and**
21 **social structures. Climate change related impacts are currently affecting rural**
22 **communities. These impacts will progressively increase over this century and will shift the**
23 **locations where rural economic activities (like agriculture, forestry, and recreation) can**
24 **thrive.**

25 Rural America has already experienced some of the impacts of climate change related weather
26 effects, including crop and livestock loss from severe drought and flooding (Peterson et al.,
27 2012), infrastructure damage to levees and roads from extreme storms (DOT 2010), shifting
28 planting and harvesting times in farming communities (Kunkel 2009), and large-scale losses
29 from fires and other weather-related disasters (Westerling et al. 2006). These impacts have
30 profound effects, and are amplified by the essential economic link that many of these
31 communities have to their natural resource base.

Growing Season Lengthens



1

2 **Figure 14.3:** Growing Season Lengthens

3 **Caption:** The left map shows that if emissions continue to increase (A2 scenario), the
 4 U.S. growing season (or frost-free season) will lengthen by as much as 20 to 40 days by
 5 the end of the century (2070-2099 as compared to 1971-2000). The right map shows a
 6 reduction in the number of frost days (days with minimum temperatures below freezing)
 7 by 20 to 60 days in much of the U.S. in the same time period. Reductions in the number
 8 of frost days can result in early bud-bursts or blooms, consequently damaging some
 9 perennial crops grown in the U.S. (See also Ch. 6: Agriculture). (Figure source: NOAA
 10 NCDC / CICS-NC. Data from CMIP3.)

11 Rural communities are often characterized by their natural resources and associated economic
 12 activity. Dominant economic drivers include agriculture, forestry, mining, energy, outdoor
 13 recreation, and tourism. In addition, many rural areas with pleasant climates and appealing
 14 landscapes are increasingly reliant on second-home owners and retirees for their tax base and
 15 community activities.

16 Nationally, fewer than 7% of rural workers are directly employed in agriculture, but the nation's
 17 two million farms occupy more than 40% of U.S. land mass – and many rural communities rely
 18 extensively on farming and ranching (Brown and Schafft 2011; Ch. 6 Agriculture; Ch. 13 Land
 19 Use and Land Cover Change). Ongoing climate changes will continue to shift cropping patterns
 20 and timing of planting and harvesting. Changes in rainfall, temperature, and extreme weather
 21 events will increase the risk of poor yields and reduced crop profitability. It is projected that
 22 increased intensity of extreme weather events (like more intense rainfall events and more
 23 frequent heat waves) will accelerate soil erosion rates, increasing deposition of nitrogen and
 24 phosphorous into water bodies, and diminished water quality (Delgado et al. 2011).

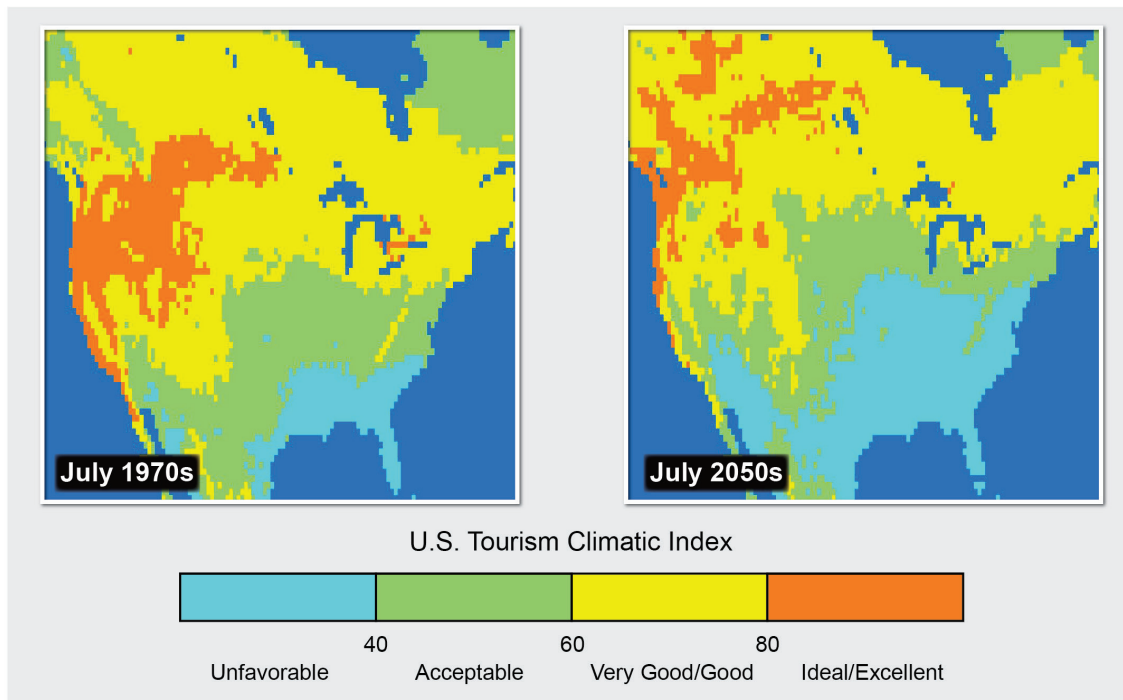
1 Many areas will face increasing competition for water among household, industrial, agricultural
2 and urban users (Iverson et al. 2008; Ch. 3 Water Resources). While irrigated cropland is an
3 important and growing component of the farm economy (NRC 2010), water withdrawals
4 necessary for generation of electricity in thermal power plants are already roughly equal to
5 irrigation withdrawals (Hutson 2004). As climate change increases water scarcity in some
6 regions, demand for water for both energy production and agriculture will increase (CCSP 2008;
7 Wilbanks et al. 2008). Mining also requires large quantities of water, and water scarcity resulting
8 from drought associated with climate change may affect operations. Changes in seasonality and
9 intensity of precipitation will increase costs of runoff containment.

10 Climate change impacts on forestry have important implications for timber and forest amenity-
11 based rural communities. Shifting forest range and composition, as well as increased attacks
12 from pests and diseases, will have negative effects on biodiversity and will increase wildfire
13 risks (Lal et al. 2011; Negron et al. 2009; Ch. 7 Forestry). Shifts in the distribution and
14 abundance of many economically important tree species would affect the pulp and wood
15 industry. As ranges shift and the species composition of forests change, dependent species will
16 also change, causing additional economic and socio-cultural impacts.

17 Tourism contributes significantly to rural economies. Changes in the length and timing of
18 seasons, temperature, precipitation, and severe weather events can have a direct impact on
19 tourism and recreation activities by influencing visitation patterns and tourism-related economic
20 activity.

21 Climate change impacts on tourism and recreation will vary significantly according to region.
22 For instance, some of Florida's top tourist attractions, including the Everglades and Florida
23 Keys, are threatened by sea level rise (Stanton and Ackerman 2007), with estimated loss of
24 revenue that could total \$9 billion by 2025 and \$40 billion by the 2050s. The effects of climate
25 change on the tourism industry will not be exclusively negative. In Maine, coastal tourism could
26 increase due to warmer summer months, with more people visiting the state's beaches (Burkett
27 and Davidson 2012). Employing a Tourism Climatic Index that accounts for temperature,
28 precipitation, sunshine, and wind, one study finds that conditions conducive for outdoor
29 recreation will be shifting northward with climate change, though it is unclear whether absolute
30 conditions or relative weather conditions will be more important in influencing future tourist
31 behaviors (Amelung et al. 2007).

Climate-Change Impacts on Summertime Tourism



1

2 **Figure 14.4:** Climate-Change Impacts on Summertime Tourism

3 **Caption:** Tourism is often climate-dependent as well as seasonally-dependent. Increasing
 4 heat and humidity projected for summers in the Midwest, Southeast, and parts of the
 5 Southwest region by mid-century (compared to the period 1961-1990) is likely to create
 6 unfavorable conditions for summertime outdoor recreation and tourism activity. The
 7 figures illustrate projected changes in climatic attractiveness (based on maximum daily
 8 temperature and minimum daily relative humidity, mean daily temperature and mean
 9 daily relative humidity, precipitation, sunshine, and wind speed) in July for much of
 10 North America. In the coming century, the distribution of these conditions is projected to
 11 shift from acceptable to unfavorable across most of the Southeast and southern Midwest
 12 region, and from very good or good to acceptable conditions in the northern portions of
 13 the Midwest. (Figure source: Nicholls et al. 2005).

14 Climate change will also influence the distribution and composition of plants and animals across
 15 the U.S. Hunting, fishing, bird watching, and other wildlife-related activities will be affected as
 16 habitats shift and relationships among species change (Allen et al. 2009; Carter et al. 2012).
 17 Cold-weather recreation and tourism will be adversely affected by climate change. Snow
 18 accumulation in the western U.S. has decreased, and is expected to continue to decrease, as a
 19 result of observed and projected warming. Reduced snow accumulation also reduces the amount
 20 of spring snowmelt, decreasing warm-season runoff in mid- to high-latitude regions.

21 Similar changes to snowpack are expected in the Northeast U.S. (Bales et al. 2012). Adverse
 22 impacts on winter sports are projected to be more pronounced in the Northeast and Southwest

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1 regions of the U.S. (Lal et al. 2011). Coastal areas will be adversely affected by sea level rise and
2 increased severity of storms (Hoyos et al. 2006; Kleinosky et al. 2006; Wu et al.
3 2002). Changing environmental conditions, such as wetland loss and beach erosion in coastal
4 areas (Galgano and Douglas 2000) and increased risk of natural hazards such as wildfire, flash
5 flooding, storm surge, river flooding, drought, and extremely high temperatures can alter the
6 character and attraction of rural areas as tourist destinations.

7 The implications of climate change on communities that are dependent on resource extraction
8 (coal, oil, natural gas, and mining) have not been well studied. Attributes of economic
9 development in these communities, such as cyclical growth, transient workforce, rapid
10 development, pressure on infrastructure, and lack of economic diversification suggest that these
11 communities could face challenges in adapting to climate change (Austin 2006; Brown and
12 Schafft 2011; Krannich 2012; Stedman et al. 2011).

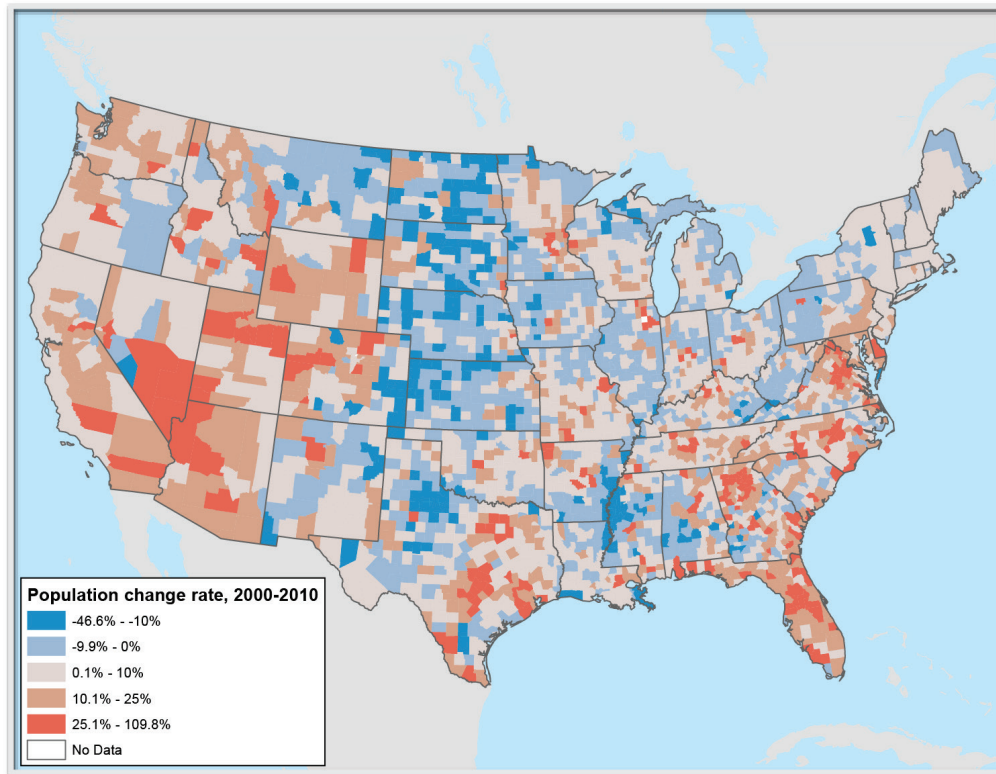
13 ***Responding to Risks***

14 **Rural communities face particular geographic and demographic obstacles in responding to**
15 **and preparing for climate change risks. In particular, physical isolation, limited economic**
16 **diversity, and higher poverty rates, combined with an aging population increases the**
17 **vulnerability of rural communities. Systems of fundamental importance to rural**
18 **populations are already stressed by remoteness and limited access.**

19 Relatively rapid changes in demographics, economic activity, and climate are particularly
20 challenging in rural communities, where local, agrarian values often run generations deep.
21 Changing rural demographics, influenced by new immigration patterns, fluctuating economic
22 conditions, and evolving community values add to these challenges – especially with regard to
23 climate changes.

24 Modern rural populations are generally older, less affluent, and less educated than their urban
25 counterparts. Rural areas are characterized by higher unemployment, more dependence on
26 government transfer payments, less diversified economies, and fewer social and economic
27 resources needed for resilience in the face of major changes (Isserman et al. 2009; Lal et al.
28 2011). In particular, the combination of an aging population and poverty increases the
29 vulnerability of rural communities to climate fluctuations.

Many Rural Areas are Losing Population



1

2 **Figure 14.5:** Many Rural Areas are Losing Population

3 **Caption:** Census data show significant population declines in many rural areas, notably
 4 in the Great Plains. Many rural communities' existing vulnerabilities to climate change,
 5 including physical isolation, reduced services like health care, and an aging population,
 6 are projected to increase as population decreases. (Data from U.S. Census Bureau 2010a;
 7 Figure Source: USDA Economic Research Service, Atlas of Rural and Small-Town
 8 America 2012).

9 There has been a trend away from manufacturing, resource extraction, and farming to amenity-
 10 based economic activity in many rural areas of the United States (English et al. 2000; Green
 11 2001; Kim et al. 2005). Expanding amenity-based economic activities in rural areas include
 12 recreation and leisure, e-commuting residents, tourism, and second home and retirement home
 13 development. This shift has stressed traditional cultural values (Green et al. 1996) and put
 14 pressure on infrastructure (Reeder and Brown 2005) and natural amenities (Cohen 1978) that
 15 draw people to rural areas. Changes in climate and weather are likely to increase these stresses.
 16 Rural components of transportation systems are particularly vulnerable to risks from flooding
 17 and sea level rise (Gill et al. 2009). Since rural areas often have fewer transportation options and

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1 fewer infrastructure redundancies, any disruptions in road, rail, or air transport will deeply affect
2 rural communities.

3 Rural communities rely on various transportation modes, both for export and import of critical
4 goods (Ch. 5: Transportation). Climate changes will result in increased erosion and maintenance
5 costs for local road and rail systems, as well as changes in streamflows and predictability that
6 will result in increased maintenance costs for waterways. More frequent disruption of shipping is
7 projected, with serious economic consequences. For example, in 2010, about 40 million tons of
8 cereal grains were shipped by water to Louisiana, while less than 4 million tons traveled by rail
9 (DOT 2010). While rail can help ameliorate small-scale or off-peak capacity limitations on the
10 Mississippi River, it seems unlikely that the rail system can fully replace the river system in the
11 event of a prolonged harvest-time disruption. Events that affect both rail and barge traffic would
12 be particularly damaging to rural communities that depend upon these systems to get
13 commodities to market.

14 Health and emergency response systems also face additional demands from substantial direct and
15 indirect health risks associated with global climate changes. Indirect risks, particularly those
16 posed by emerging and re-emerging infectious diseases, are more difficult to assess, but pose
17 looming threats to economically challenged communities where health services are limited.
18 Direct threats (such as extreme heat and storm events, coastal and riparian flooding) tend to be
19 more associated with specific local vulnerabilities, and the risk somewhat easier to assess
20 (Setlow et al. 1996)

21 The socioeconomic and demographic characteristics of rural areas interact with climate change
22 to create health concerns that differ from those of urban and suburban communities. Older
23 populations with lower income and educational levels in rural areas spend a larger proportion of
24 their income on health care than their urban counterparts. Moreover, health care access declines
25 as geographic isolation increases. Overall, rural residents already have higher rates of age-
26 adjusted mortality, disability, and chronic disease than do urban populations (Jones et al. 2009).
27 These trends are likely to be exacerbated by climate change (Ch. 9: Human Health).

28 Governments in rural areas are generally ill-prepared to respond quickly and effectively to large-
29 scale events, although individuals and voluntary associations often show significant resilience.
30 Health risks are exacerbated by limitations in the health service systems characteristic of rural
31 areas, including the distance between rural residents and health care providers and the reduced
32 availability of medical specialists.

33 The effects of climate change on mental health merit special consideration. Rural residents are
34 already at a heightened risk from mental health issues because of the lack of access to mental
35 health providers. The adverse impact of severe weather disasters on mental health is well
36 established (Salcioglu et al. 2007), and there is emerging evidence that climate change in the
37 form of increasing heat waves and droughts has harmful effects on mental health. Droughts often
38 result in people relocating to seek other employment, causing a loss of home and social
39 networks. Studies have shown that spring droughts in rural areas cause a decrease in life
40 satisfaction (Hart et al. 2011). Primary care physicians who form the backbone of rural health

1 care often have insufficient training in mental health issues, as well as heavy caseloads and a
2 lack of specialized training or backup (Jones et al. 2009).

3 The frequency and distribution of infectious diseases is also projected to increase with rising
4 temperatures and associated seasonal shifts. Increased rates of mutation and increased resistance
5 to drugs and other treatments are already evident in the behavior of infectious disease-causing
6 bacteria and viruses (Alanis 2005). In addition, changes in temperature, surface water, humidity,
7 and precipitation affect the distribution and abundance of disease-carriers and intermediate hosts,
8 and result in larger distributions for many parasites and diseases. Rural residents who spend
9 significant time outdoors have an increased risk to being exposed to these disease-carriers, like
10 ticks and mosquitoes (Ch. 9: Human Health).

11 *Adaptation*

12 **Responding to additional challenges from climate change impacts will require significant**
13 **adaptation within rural transportation and infrastructure systems, as well as health and**
14 **emergency response systems. Governments in rural communities have limited institutional**
15 **capacity to respond to, plan for, and anticipate climate change impacts.**

16 Climate variability and increases in temperature, extreme events (storms, flooding, heat waves,
17 droughts), and sea level rise are expected to have widespread impact on the provision of services
18 from local, regional, and state governments. Emergency management, energy use and
19 distribution systems, transportation and infrastructure planning, and public health will all be
20 affected.

21 Rural governments often depend heavily on volunteers to meet community challenges like fire
22 protection or flood response. In addition, rural communities have limited locally available
23 financial resources to help deal with the effects of climate change. Small community size tends
24 to make services expensive or available only by traveling some distance.

25 Local governance structures tend to de-emphasize planning capacity, compared to urban areas.
26 While 73% of metropolitan counties have land-use planners, only 29% of rural counties not
27 adjacent to a metropolitan county had one or more planners. Moreover, rural communities are
28 not equipped to deal with major infrastructure expenses (Kraybill and Lobao 2001).

29 Communities across the U.S. are experiencing infrastructure losses, water scarcity, unpredictable
30 water availability, and increased frequency and intensity of wildfires. However, these observed
31 changes are often not explicitly associated with climate change by local authorities, and
32 responses rarely take climate disruption into account. Even in communities where there is
33 increasing awareness of climate change and interest in comprehensive adaptation planning, lack
34 of funding, human resources, and access to information, training, and expertise provide
35 significant barriers for many rural communities.

36 To respond adequately to future climate changes, rural communities will need help assessing
37 their risks and vulnerabilities, prioritizing and coordinating projects, funding and allocating
38 financial and human resources, and deploying information-sharing and decision support tools.

1 Impacts due to climate change will interact across communities and regions, making solutions
2 dependent upon meaningful participation of numerous stakeholders from federal, state and local
3 governments, science and academia, the private sector, non-profits, and the general public.

4 Effective adaptation measures are closely tied to specific local conditions and needs and take into
5 account existing social networks (Berkes 2007; Nelson 2011; Ostrom 2009). The economic and
6 social diversity of rural communities affects the ability of both individuals and communities to
7 adapt to climate changes, and underscores the need to assess climate change impacts on a local
8 basis. The quality and availability of natural resources, legacies of past use, and changing
9 industrial needs affect the economic, environmental, and social conditions of rural places and are
10 critical factors to be assessed (Adger and Nelson 2010; Bark and Jacobs 2009; Brown and
11 Schafft 2011; Flora 2001; Oliver-Smith 2006; Peacock and Girard 1997; Peguero 2006; Stedman
12 et al. 2011; Vásquez-León 2009). Successful adaptation to climate change requires balancing
13 immediate needs with long-term development goals, as well as development of local-level
14 capacities to deal with climate change (Furman et al. 2011; Nelson 2011; O'Brien 2009).

15 Potential national climate change mitigation responses, especially those that require extensive
16 use of land – permanent reforestation, constructing large solar or wind arrays, hydroelectric
17 generation, and biofuel cropping – are also likely to significantly affect rural communities. As
18 with the development of rural resource-intensive economic activities, where national or multi-
19 national companies tend to wield ownership and control, local residents and communities are
20 unlikely to be the primary investors or beneficiaries of this kind of new economic activity.

21 Decisions regarding adaptation responses for both urban and rural populations can occur at
22 various scales (federal, state, local, private sector, individual) but need to take interdependencies
23 into account. Some decisions may not be under the control of local governments or rural
24 residents. Given that timing is a critical aspect of adaptation, engaging rural residents early in
25 decision processes about investments in public infrastructure, protection of shorelines, changes
26 in insurance provision, or new management initiatives can influence individual behavior and
27 choice in ways that enhance adaptation.

28 **Box: Local Responses to Climate Change in the San Juan Mountains**

29 The San Juan Mountains region straddles the southern edge of the Southern Rocky Mountains
30 and the northeastern tip of the arid Southwest. The high mountain headwaters of the Rio Grande,
31 San Juan, and major tributaries of the Upper Colorado River are critical water towers for six
32 states: Texas, Nevada, California, Arizona, and New Mexico. The diversity of the landforms,
33 high plateaus, steep mountains, deep canyons, and foothills leads to a complex and diverse mix
34 of coniferous and deciduous forested landscapes (Romme et al. 2009). Counties in the area range
35 from 700 to 51,000 people, with population changes between 2000 and 2010 ranging from a 25%
36 decline to an 86% increase. Public lands account for 69% of the land base (U.S. Forest Service
37 2008). Over half of the local economies are dependent upon natural resources to support tourism,
38 minerals and natural gas extraction, and second home development.

39 Average annual temperatures in the San Juan Mountains have risen 1.1°F in only three decades
40 (Rangwala and Miller 2010), a rate of warming greater than any other region of the U.S. except
41 Alaska (Ray et al. 2008). The timing of snowmelt has shifted two weeks earlier, and this earlier

1 seasonal release of water resources is of particular concern to all western states (Clow 2010).
2 Current challenges for the region include changes in forests due to pests and diseases, intensive
3 recreation use, fire management for natural and prescribed fires, and increasing development in
4 the wildland-urban interface. Communities are vulnerable to changes from a warmer and drier
5 climate that would affect frequency and intensity of wildfires, shift vegetation and range of forest
6 types, and increase pressures on water supplies.

7 In response, the San Juan Climate Initiative drew together stakeholders, including natural
8 resource managers, community planners, elected officials, industry, resource users, citizens, non-
9 profit organizations, and scientists. By combining resources and capabilities, stakeholders have
10 been able to accomplish much more together than if they had worked independently. For
11 example, local governments developed a plan to reduce greenhouse gas emissions and identify
12 strategies for adaptation, signing the U.S. Mayor’s Climate Protection Agreement in 2009.
13 Climate modelers at University of Colorado and National Center for Atmospheric Research
14 analyzed regional trends in temperature, precipitation, snowpack, and streamflow. Researchers at
15 Mountain Studies Institute, University of Colorado, and Fort Lewis College are partnering with
16 San Juan National Forest to monitor alpine plant communities and changes in climate across the
17 region, and to document carbon resources. San Juan National Forest is developing strategies for
18 adapting to climate changes in the region related to drought, wildfire, and other potential effects.
19 La Plata County is leading an effort to plan for sustainable transportation and food networks that
20 will be less dependent upon carbon-based fuels, while the Mountain Studies Institute is leading
21 citizen science programs to monitor changes to sensitive species like the American pika.

22 -- end box --

Traceable Accounts

Chapter 14: Rural Communities

Key Message Process: The key messages were initially developed at a meeting of the authors in Charleston, South Carolina, in February, 2012. This initial discussion was supported by a series of conference calls from March through June, 2012. These ensuing discussions were held after a thorough review of the technical inputs and associated literature, including the Rural Communities Workshop Report prepared for the NCA (Hauser and Jadin 2012) and additional technical inputs on a variety of topics.

Key message #1/3	Rural Communities are highly dependent upon natural resources for their livelihoods and social structures. Climate change related impacts are currently affecting rural communities. These impacts will progressively increase over this century and will shift the locations where rural economic activities (like agriculture, forestry, and recreation) can thrive.
Description of evidence base	<p>The key message and supporting text summarizes extensive evidence documented in the rural communities' workshop report (Hauser and Jadin 2012), and 31 technical input reports on a wide range of topics were also received and reviewed as part of the Federal Register Notice solicitation for public input.</p> <p>Evidence that the impacts of climate change are increasing is compelling and widespread. This evidence is based on historical records and observations and on GCMs, including those driven by B1 (substantial emissions reduction) and A2 (continued increases in global emissions) Scenarios. This evidence is clearly summarized and persuasively referenced in the "Our Changing Climate" chapter of this Assessment and in the Scenarios developed for the NCA by Kunkel et al. Work done by Brown et al. (Brown and Schafft 2011) has demonstrated the dependency of rural communities on their natural resources, with a number of studies showing that climate change results in crop and livestock loss (Peterson et al. 2012), infrastructure damage to levees and roads (DOT 2010), shifts in agriculture practices (Kunkel 2009), and losses due to disasters (Westerling et al. 2006). A number of publications project these impacts to increase, with effects to the natural environment (Delgado et al. 2011; Lal et al. 2011; Negron et al. 2009) and increased competition for water between agriculture and energy (CCSP 2008; Wilbanks et al. 2008). Studies have projected tourism locations in the Everglades and Florida Keys are threatened (Stanton and Ackerman 2007) while Maine's tourism could increase (Burkett and Davidson 2012), which coincides with a projected northern shift of outdoor recreation (Amelung et al. 2007). Additionally, beach erosion and wetland loss (Galgano and Douglas 2000), plant and animal habitats, and inter-species relationships will change, affecting hunting, fishing, and bird watching (Karl et al. 2009), and many areas are affected by early snowpack melt (Bales et al. 2012; Lal et al. 2011), while all effect outdoor recreation and tourism in the U.S.</p>
New information and remaining uncertainties	Key remaining uncertainties relate to precise magnitude, timing, and location at regional and local scales.
Assessment of confidence based on evidence	<p>Given the evidence and uncertainties, there is very high confidence that rural communities are highly dependent on natural resources that are expected to be affected by climate change, especially the many communities that rely on farming, forestry or tourism for their livelihoods.</p> <p>Given the evidence and uncertainties, there is high confidence that climate change</p>

	<p>is currently affecting rural communities.</p> <p>There is very high confidence that impacts will increase, as evidenced by climate science chapter of this assessment given the evidence and uncertainties</p>
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1

CONFIDENCE LEVEL			
Very High	High	Medium	Low
Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus	Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts

2

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1 **Chapter 14: Rural Communities**

2 **Key Message Process:** See Key Message #1

Key message #2/3	Rural communities face particular geographic and demographic obstacles in responding to and preparing for climate change risks. In particular, physical isolation, limited economic diversity, and higher poverty rates, combined with an aging population increases the vulnerability of rural communities. Systems of fundamental importance to rural populations are already stressed by remoteness and limited access.
Description of evidence base	The key message and supporting text summarizes extensive evidence documented in the rural communities’ workshop report (Hauser and Jadin 2012) and 31 technical input reports on a wide range of topics that were also received and reviewed as part of the Federal Register Notice solicitation for public input. With studies showing that rural communities are already stressed (Cohen 1978; Green et al. 1996; Reeder and Brown 2005), a number of publications have explored the barriers of rural communities to preparing and responding to climate change (Isserman et al. 2009; Lal et al. 2011), with some studies providing in-depth looks at the obstacles that limited economic diversity (English et al. 2000; Green 2001; Kim et al. 2005) and an aging population (Jones et al. 2009) create.
New information and remaining uncertainties	Projecting the interactions of these variables on each other and applying this analysis to local or regional realities is complex at best, with uncertainties at every level of analysis.
Assessment of confidence based on evidence	Given the evidence and uncertainties, there is high confidence that the obstacle of physical isolation will hamper some communities’ ability to adapt or have an adequate response during extreme events. Given the evidence and uncertainties, there is high confidence that the obstacle of limited economic diversity will hinder rural communities’ ability to adapt. Given the evidence and uncertainties, there is high confidence that the obstacle of higher poverty rates will prevent some communities from adapting properly Given the evidence and uncertainties, there is high confidence that the obstacle of an aging population will hinder some rural communities and prevent them from having an adequate response. Given the evidence and uncertainties, there is high confidence that fundamental systems in rural communities are already stressed by remoteness and limited access

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CONFIDENCE LEVEL			
Very High	High	Medium	Low
Strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus	Suggestive evidence (a few sources, limited consistency, models incomplete, methods emerging, etc.), competing schools of thought	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.), disagreement or lack of opinions among experts

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1 **Chapter 14: Rural Communities**2 **Key Message Process:** See Key Message #1

Key message #3/3	Responding to additional challenges from climate change impacts will require significant adaptation within rural transportation and infrastructure systems, as well as health and emergency response systems. Governments in rural communities have limited institutional capacity to respond to, plan for, and anticipate climate change impacts.
Description of evidence base	<p>The key message and supporting text summarizes extensive evidence documented in the rural communities' workshop report (Hauser and Jadin 2012), and 31 technical input reports on a wide range of topics that were also received and reviewed as part of the Federal Register Notice solicitation for public input.</p> <p>Kraybill and Lobao (Kraybill and Lobao 2001) note that rural communities are not equipped to deal with major infrastructure expenses. Work has been performed illustrating the need to tie adaptation measures to specific local conditions and needs and take into account existing social networks (Berkes 2007; Nelson 2011; Ostrom 2009). Publications have shown that there are a number of critical factors to be assessed, including the quality and availability of natural resources, legacies of past use, and changing industrial needs that effect economic, environmental, and social conditions (Adger and Nelson 2010; Bark and Jacobs 2009; Brown and Schafft 2011; Flora 2001; Oliver-Smith 2006; Peacock and Girard 1997; Peguero 2006; Stedman et al. 2011; Vásquez-León 2009). Additionally, studies have expressed the requirement of accounting for both near- and long-term needs in order for climate change adaptation to be successful (Furman et al. 2011; O'Brien 2009) (Nelson et al. 2007).</p>
New information and remaining uncertainties	<p>It is difficult to fully capture the complex interactions of the entire socio-economic-ecological system within which the effects of climate change will interact, especially in regard to local and regional impacts. Impact assessments and adaptation strategies require improved understanding of capacity and resilience at every level, international to local. The policy context in which individuals and communities will react to climate effects is vague and uncertain. Identification of informational needs alone indicates that adaptation will be expensive.</p>
Assessment of confidence based on evidence	<p>Given the evidence and uncertainties, there is high confidence that rural communities have limited capacity to respond to impacts, because of their remoteness, age, lack of diversity, and all the other reasons listed previously.</p> <p>Given the evidence and uncertainties, there is high confidence that rural communities have limited capacity to plan for impacts because of all of the reasons cited earlier.</p> <p>Given the evidence and uncertainties, there is high confidence that rural communities will have limited capacity to anticipate impacts because of the lack of infrastructure and expertise available in rural communities.</p> <p>Given the evidence and uncertainties, there is high confidence that significant climate change adaptation is needed for transportation in rural communities, especially those in low lying coastal areas.</p> <p>Given the evidence and uncertainties, there is high confidence that significant climate change adaptation is needed for health care and emergency response in rural communities, so that rural communities can handle extreme weather events.</p>

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