Chapter 9

NIGER

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Niger is a landlocked country in West Africa located between 11°37′ and 23°23′ north latitude and between 00°10′ and 16°00′ east longitude, with an area of 1,267,000 square kilometers. Niger shares borders with Algeria and Libya in the north, Chad in the east, Nigeria and Benin in the south, and Burkina Faso and Mali in the west. Three-fourths of Niger is covered by the Sahara Desert. The southern part of the country is in the Sahelian climate zone, with Sudan savannah vegetation. The rainy season lasts for only three months, with total rainfall ranging from 150 to 600 millimeters per year in the Sudan savannah; maximum temperatures are high (45°C in the shade in April–May). The vegetation cover is sparse, and nomadic agriculture is dominant.

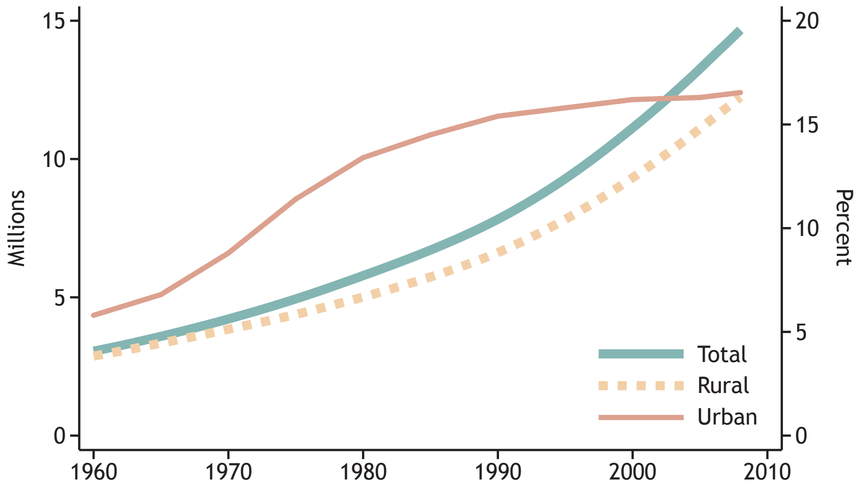
Review of the Current Situation

Population

Figure 9.1 shows trends in the size of the total population and the rural population (left axis), along with the share of the urban population (right axis). The population of Niger grew from 3.1 million in 1960 to 14.7 million in 2008. Based on the 2010 population census, the growth rate of the population was 3.3 percent between 1975 and 2010; a full 83 percent live in rural areas. The high fertility rate (7.1 children per woman) contributes significantly to the country's rapid population growth. In the 1960s and 1970s, the urban population grew much faster than the rural population (Table 9.1). Since the 1970s, the growth rate in the urban areas has declined, possibly due to sensitization campaigns as well as economic conditions. The capital city houses the bulk of the urban population (39.3 percent).

Figure 9.2 shows the (estimated) geographic distribution of the population. The population of Niger is concentrated in the southern part of the country, largely due to the pattern of increasing aridity from south to north.

FIGURE 9.1 Population trends in Niger: Total population, rural population, and percent urban, 1960–2008



Source: World Development Indicators (World Bank 2009).

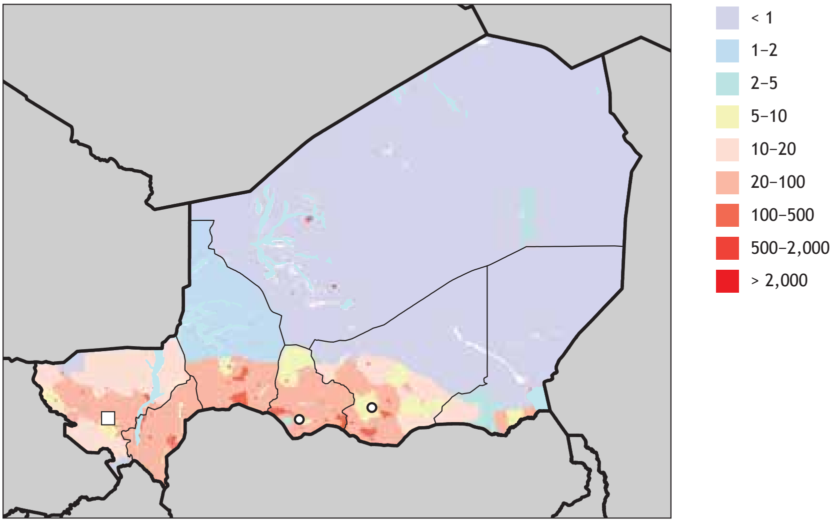
TABLE 9.1 Population growth rates in Niger, 1960–2008 (percent)

Decade	Total growth rate	Rural growth rate	Urban growth rate
1960–69	3.2	2.9	7.3
1970–79	3.2	2.6	7.5
1980–89	3.0	2.7	4.4
1990–99	3.5	3.4	4.0
2000–2008	3.5	3.4	3.7

Source: Authors' calculations based on World Development Indicators (World Bank 2009).

In addition to the capital city—Niamey, in the Tillabéri Region—the Dosso, Tahoua, Maradi, Zinder, and Diffa Regions are also highly populated. The unequal population distribution imposes considerable pressure on the arable land in the southwestern part of the country. In areas such as Madarounfa, Guidan-Roumdji, Matameye, Mirriah, and Magaria, the density is 100 inhabitants per square kilometer compared to the national average of 8 inhabitants per square kilometer.

FIGURE 9.2 Population distribution in Niger, 2000 (persons per square kilometer)



Source: CIESIN et al. (2004).

Income

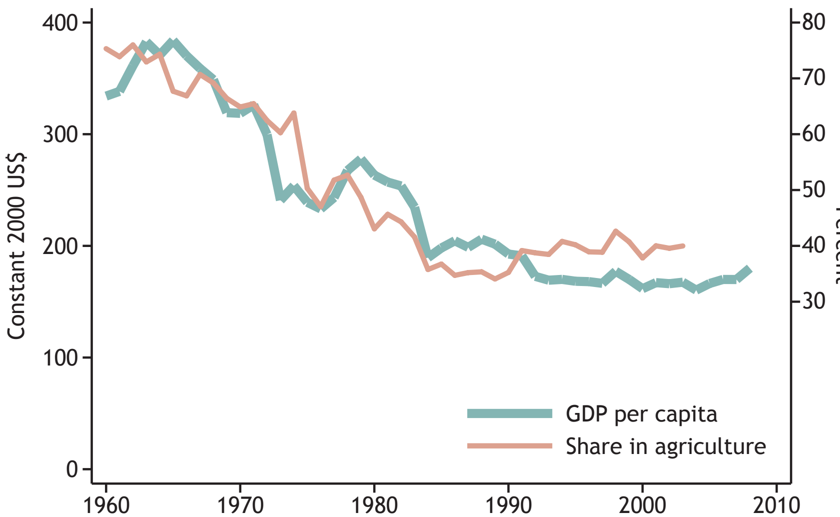
The share of income earned in agriculture shows the importance of agriculture as a sector for the economy. Figure 9.3 shows trends in gross domestic product (GDP) per capita, as well as the proportion of GDP from agriculture.

In Niger the rural sector accounted for 41 percent of GDP in 2007 and 49 percent in 2009, and it contributes significantly to export earnings. However, because the majority of the population lives in rural areas, the creation of wealth per capita in the rural zone is significantly lower than in the urban areas.

Climate change has had significant effects on the development of the country. Since 1967 there have been several food crises (one every three years on average) due mainly to unfavorable climatic conditions, resulting in a drastic reduction in living standards. The situation worsened when the CFA franc was devaluated in January 1994. The country entered a turbulent political era in the 1990s, with two military coups (in January 1996 and April 1999). This situation culminated in major donors suspending aid to the country, with severe consequences for the national economy and the living standards of the people.

Figure 9.3 clearly shows that since the 1960s the contribution of the agricultural sector to GDP has been declining, from more than 70 percent to about 40 percent in the 1980s and then leveling out onward. Increasing

FIGURE 9.3 Per capita GDP in Niger (constant 2000 US$) and share of GDP from agriculture (percent), 1960–2008



Source: World Development Indicators (World Bank 2009).
Note: GDP = gross domestic product; US$ = US dollars.

urbanization along with the development of the service industry has resulted in this decline in the contribution of the agricultural sector to GDP.

Vulnerability to Climate Change

Table 9.2 provides some data on Niger's performance on several indicators of a population's vulnerability and resiliency to economic shocks beyond the factor of income level: level of education, literacy, and concentration of labor in poorer or less dynamic sectors. These social indicators show Niger among the most vulnerable countries in the region. Its primary school enrolment is about 50 percent, while its enrolment in secondary school is below 15 percent. The dropout rate after primary school is drastic. In addition, the adult literacy rate is very low (29 percent). Niger has a Muslim majority, and many families prefer Islamic education, sending their children to Koranic schools rather than the formal schools. The popularity of Koranic schools may help to account for the low enrolment in primary schools. The drastic fall in secondary school education could be due to poverty, early marriages for girls, and the need for family labor on farms.

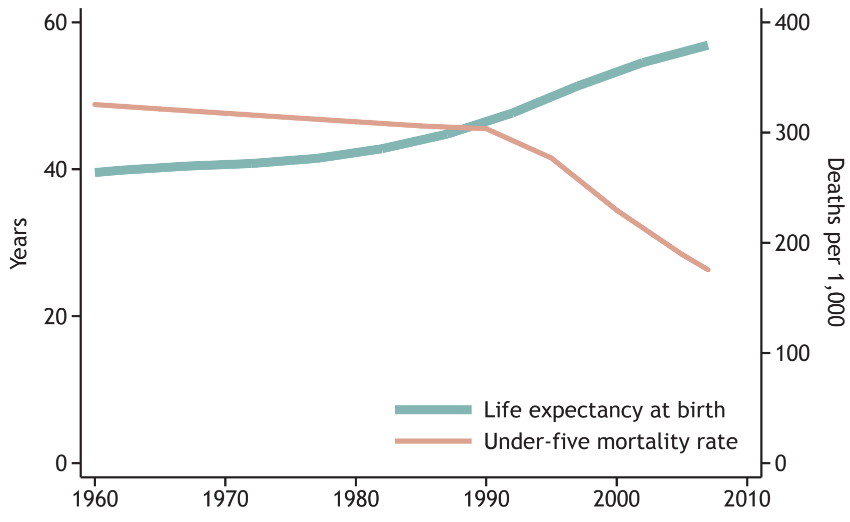
TABLE 9.2 Education and labor statistics for Niger, 2000s

Indicator	Year	Percent
Primary school enrollment (percent gross, three-year average)	2007	53.3
Secondary school enrollment (percent gross, three-year average)	2007	10.6
Adult literacy rate	2005	28.7
Percent employed in agriculture	2008	80.0
Under-five malnutrition (weight for age)	2006	39.9

Source: Authors' calculations based on World Development Indicators (World Bank 2009).

Figure 9.4 shows two noneconomic correlates of poverty: life expectancy and under-five mortality. Life expectancy in Niger stagnated at about 40 years during the 1960s–1980s but gradually increased to 50 in the 1990s and to about 55 years after 2000. The increase in life expectancy after the mid-1980s slightly preceded the decrease in infant mortality, which fell from over 300 deaths per 1,000 to below 200 in 2008. The improvement in life expectancy and the decline in under-five mortality could be accounted for by the gradual improvement in heath conditions, including vaccinations, as well as by the increase in the world price of uranium, a resource abundant in Niger, in the 1990s.

FIGURE 9.4 Well-being indicators in Niger, 1960–2008



Source: World Development Indicators (World Bank 2009).

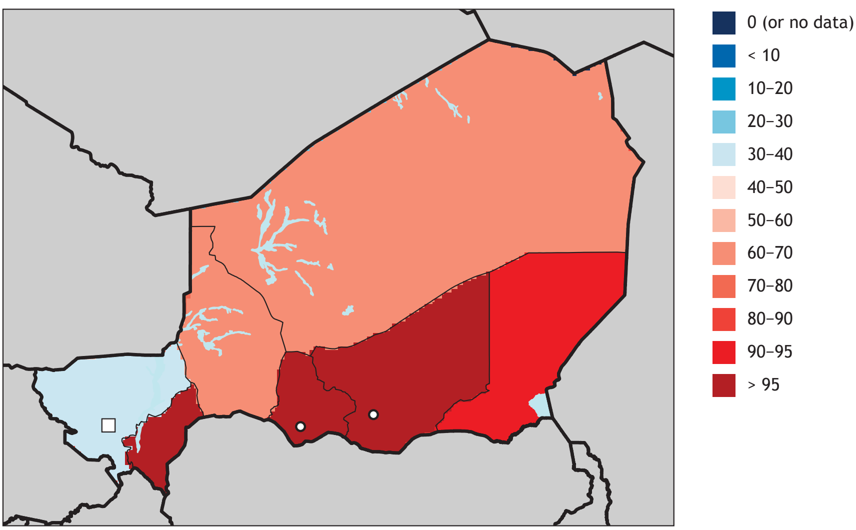
Figure 9.5 shows the proportion of the population living on less than US$2 (US dollars) per day. In general, the incidence of poverty in Niger is higher in the densely populated areas. More than 95 percent of the population lives on less than US$2 (800 CFA francs) per day in the regions of Dosso, Maradi, and Zinder; the number is 80–90 percent in Diffa. Agadez and Tahoua have 60–70 percent of their populations living on less than US$2 per day. The Tillabéri Region, which hosts the capital city Niamey, has the lowest poverty rate, at 20–30 percent. This may reflect the relatively greater and more diversified employment opportunities in and around the capital city.

Review of Land Use and Agriculture

Land Use Overview

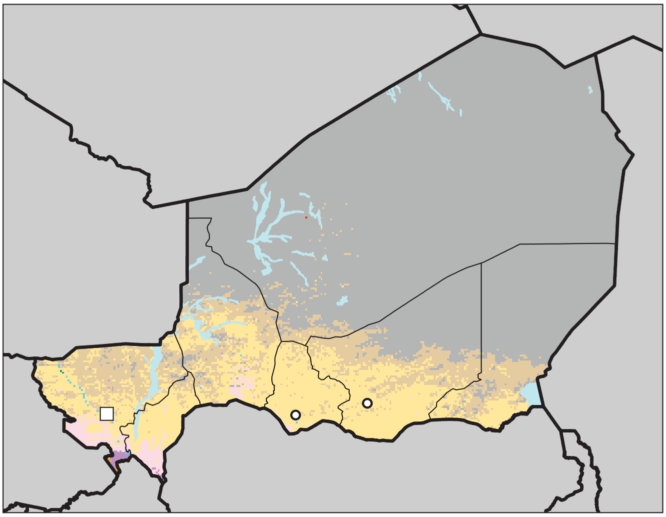
Figure 9.6 shows land cover and land use in Niger as of 2000. Three-fourths of the area of Niger is covered by the Sahara Desert, and the Sudan savanna covers the southern quarter of the country. The vegetation cover is sparse, and nomadic agriculture is dominant. Most grasses are annuals because of drought stress in the

FIGURE 9.5 Poverty in Niger, 1960–2008 (percentage of population living on less than US$2 per day)



Source: Wood et al. (2010).
Note: Based on 2005 US$ (US dollars) and on purchasing power parity value.

FIGURE 9.6 Land cover and land use in Niger, 2000



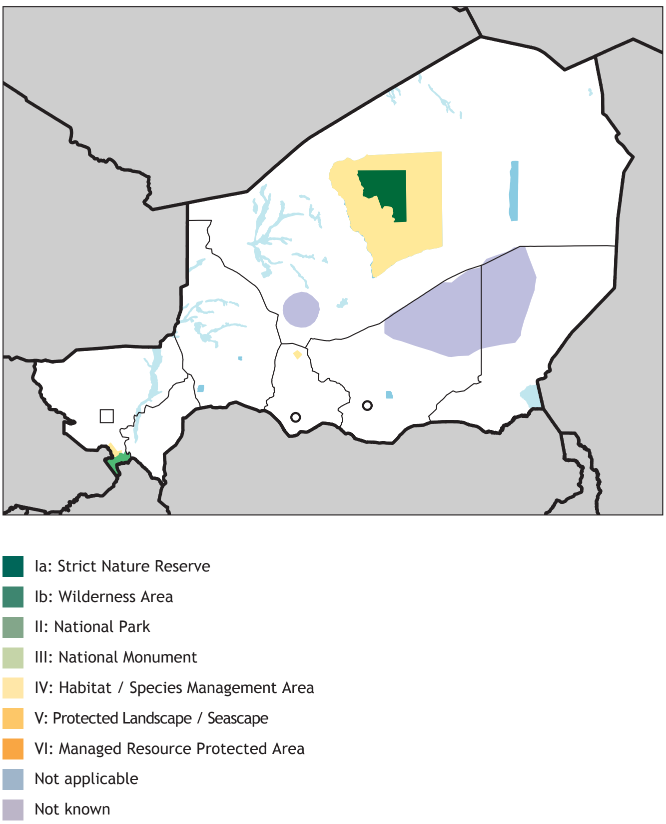
- Tree cover, broadleaved, evergreen
- Tree cover, broadleaved, deciduous, closed
- Tree cover, broadleaved, deciduous, open
- Tree cover, broadleaved, needle-leaved, evergreen
- Tree cover, broadleaved, needle-leaved, deciduous
- Tree cover, broadleaved, mixed leaf type
- Tree cover, broadleaved, regularly flooded, fresh water
- Tree cover, broadleaved, regularly flooded, saline water
- Mosaic of tree cover/other natural vegetation
- Tree cover, burnt
- Shrub cover, closed-open, evergreen
- Shrub cover, closed-open, deciduous
- Herbacious cover, closed-open
- Sparse herbacious or sparse shrub cover
- Regularly flooded shrub or herbacious cover
- Cultivated and managed areas
- Mosaic of cropland/tree cover/other natural vegetation
- Mosaic of cropland/shrub/grass cover
- Bare areas
- Water bodies
- Snow and ice
- Artificial surfaces and associated areas
- No data

Source: GLC2000 (Global Land Cover 2000) (Bartholome and Belward 2005).

long dry period. Commonly occurring annuals include *Andropogon pseudapricus, Hyparrhenia,* and *Loudetia* spp. A number of perennials grow vigorously: *Andropogon gayanus, Anthrophora nigritane, Aristida stipoides, Pennisetum setosum,* and *Hyparrhenia* spp. More to the north, trees with thorns (such as *Acacia* spp.) become more common and the grasses become shorter, less tussocky, and more feathery. In the southern part of the country, millet, requiring a minimum growing period of 75 days, can be grown (ILRI 1993).

Figure 9.7 shows the locations of protected areas, including parks and reserves. These locations provide important protection for fragile environmental areas, which may also be important for the tourism industry as the country tries to diversify its economic base.

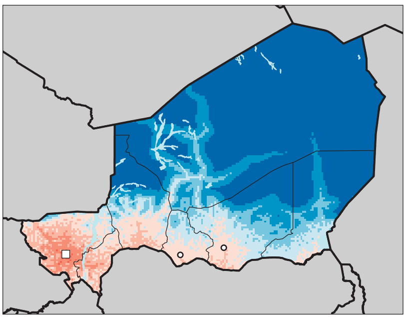
FIGURE 9.7 Protected areas in Niger, 2009



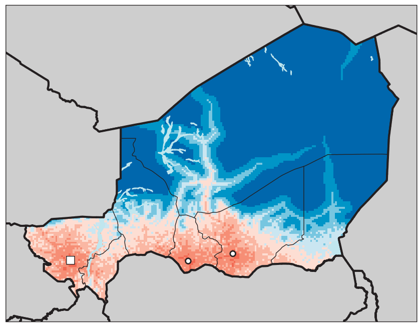
Sources: Protected areas are from the World Database on Protected Areas (UNEP and IUCN 2009). Water bodies are from the World Wildlife Fund's Global Lakes and Wetlands Database (Lehner and Döll 2004).

Figure 9.8 shows the travel time to urban areas as potential markets for agricultural products as well as sources of agricultural inputs and consumer goods for farm households. The road network is good in the Tillabéri Region, particularly around the capital city Niamey. The southern parts of the regions bordering Nigeria have road networks, particularly around the regional

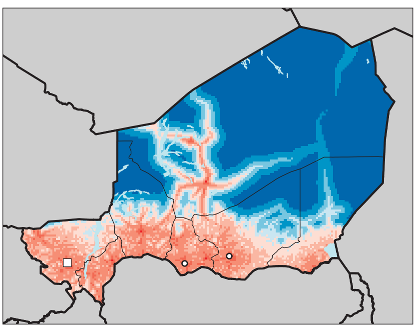
FIGURE 9.8 Travel time to urban areas of various sizes in Niger, circa 2000



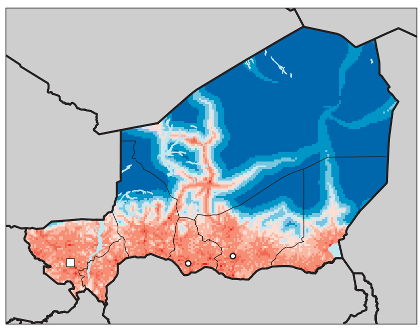
To cities of 500,000 or more people



To cities of 100,000 or more people



To towns and cities of 25,000 or more people



To towns and cities of 10,000 or more people

- Urban location
- < 1 hour
- 1–3 hours
- 3–5 hours
- 5–8 hours
- 8–11 hours
- 11–16 hours
- 16–26 hours
- > 26 hours

Source: Authors' calculations.

capitals. In general, the travel time to these cities ranges from one to three hours. Most of the Agadez Region—which is mainly desert—is not connected by roads. The regional capital of Agadez is connected to the regional capitals of Tillabéri, Tahoua, and Zinder; the road leading to Algeria is not paved.

Agriculture Overview

Agropastoralism is the major farming system in Niger. Livestock production is a major component, based mainly on open grazing. During the dry season, herds are moved southward across the borders to Benin, Nigeria, and Burkina Faso. The major livestock-producing regions are Agadez, Diffa, Tahoua, and Tillabéri. Recurring droughts severely affect livestock production: the drought of 1969 led to an estimated loss of 30 percent of the cattle in Agadez and at least 13 percent in the rest of the country, and the catastrophic drought of 1974 killed almost all of the livestock in the country. As recently as 2009, the livestock sector was hit by a drought leading to the loss of thousands of cattle.

Tables 9.3–9.5 show key agricultural commodities in terms of area harvested, the value of the harvest, and the provision of food for human consumption (ranked by weight). A wide range of crops is grown in the semiarid areas of Niger: finger millet, pearl millet, bulrush millet, sorghum, cowpeas, pigeon peas, groundnuts, green grams, *phaesolus* beans, and chickpeas. Millet is the

TABLE 9.3 Harvest area of leading agricultural commodities in Niger, 2006–08 (thousands of hectares)

Rank	Crop	Percent of total	Harvest area
	Total	100.0	14,761
1	Millet	43.4	6,410
2	Cowpeas	32.1	4,743
3	Sorghum	19.4	2,859
4	Groundnuts	3.1	460
5	Sesame seed	0.5	73
6	Other pulses	0.2	33
7	Mangoes, mangosteens, guavas	0.1	22
8	Rice	0.1	20
9	Beans	0.1	18
10	Cabbages and other brassicas	0.1	13

Source: FAOSTAT (FAO 2010).
Note: All values are based on the three-year average for 2006–08.

TABLE 9.4 Value of production of leading agricultural commodities in Niger, 2005–07 (millions of US$)

Rank	Crop	Percent of total	Value of production
	Total	100.0	885.1
1	Millet	44.9	397.7
2	Sorghum	13.2	117.2
3	Cowpeas	10.6	94.2
4	Onions, dry	6.6	58.2
5	Groundnuts	5.1	45.2
6	Tomatoes	3.1	27.3
7	Sugarcane	2.7	23.5
8	Cassava	1.9	17.1
9	Chilies and peppers	1.9	16.7
10	Rice	1.7	14.6

Source: FAOSTAT (FAO 2010).

Note: All values are based on the three-year average for 2005–07. US$ = US dollars.

TABLE 9.5 Consumption of leading food commodities in Niger, 2003–05 (thousands of metric tons)

Rank	Crop	Percent of total	Food consumption
	Total	100.0	4,132
1	Millet	39.8	1,646
2	Sorghum	11.9	493
3	Other vegetables	6.5	268
4	Rice	6.3	261
5	Other pulses	6.1	251
6	Onions	5.5	228
7	Cassava	3.1	127
8	Tomatoes	2.5	104
9	Sugar	2.3	94
10	Groundnuts	1.7	71

Source: FAOSTAT (FAO 2010).

Note: All values are based on the three-year average for 2003–05.

most important crop, occupying nearly half of the total cropped area of the country and being the main staple food item. The other important crops are cowpeas, sorghum, and groundnuts.

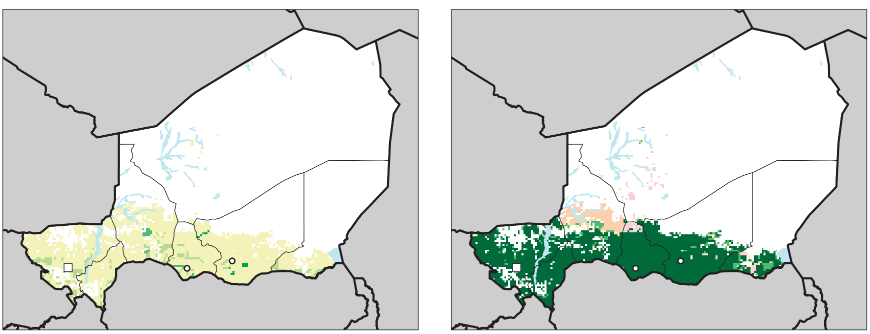
The next three figures show the estimated yields and growing areas of key crops. Millet (Figure 9.9), cowpeas (Figure 9.10), and sorghum (Figure 9.11) are grown in the southern part of the country, where it rains about three months of the year. Millet is more widely grown than the other crops. The yields of all the crops are very low, an average of 0.5 metric tons per hectare.

Economic and Demographic Scenarios

Population

Figure 9.12 shows population projections for Niger made by the United Nations (UN) population office through 2050 (UNPOP 2009). The population of Niger is projected to grow to about 24 million by 2020; after that point, estimates for the low, medium, and high variants differ. In 2050 the difference between the low and high variants is greater than 10 million people,

FIGURE 9.9 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed millet in Niger, 2000

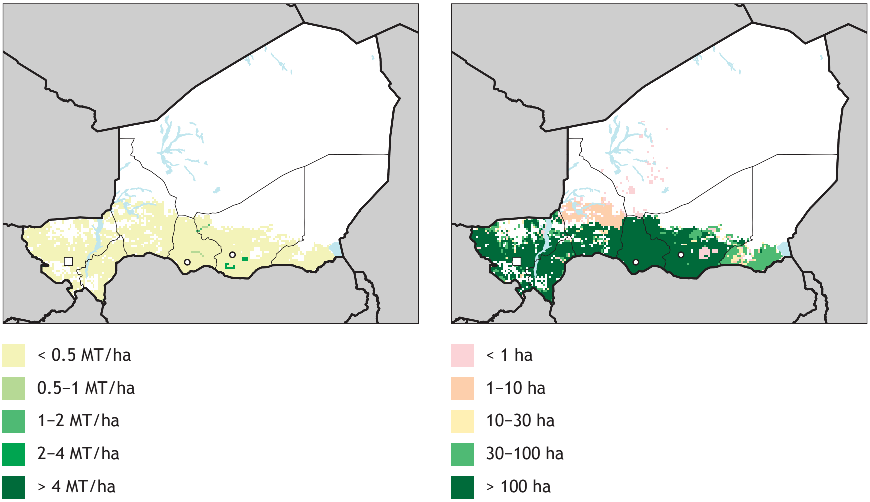


< 0.5 MT/ha
0.5–1 MT/ha
1–2 MT/ha
2–4 MT/ha
> 4 MT/ha

< 1 ha
1–10 ha
10–30 ha
30–100 ha
> 100 ha

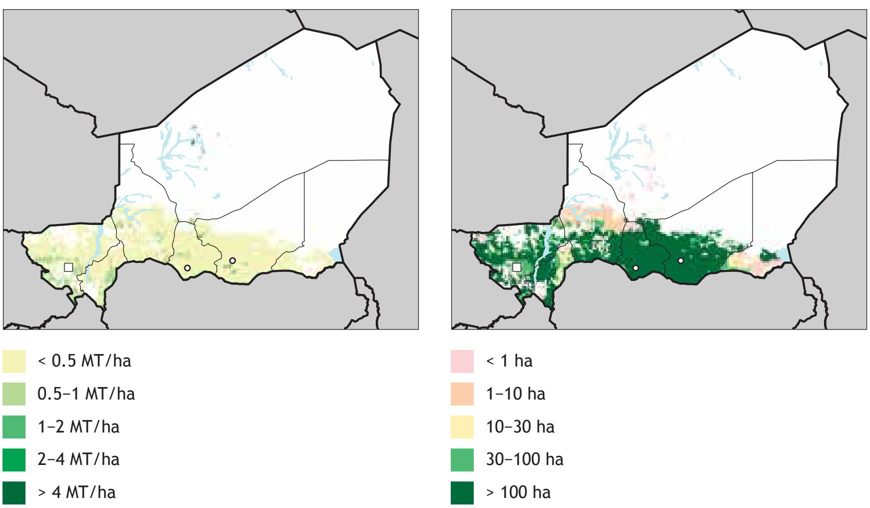
Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 9.10 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed cowpeas in Niger, 2000



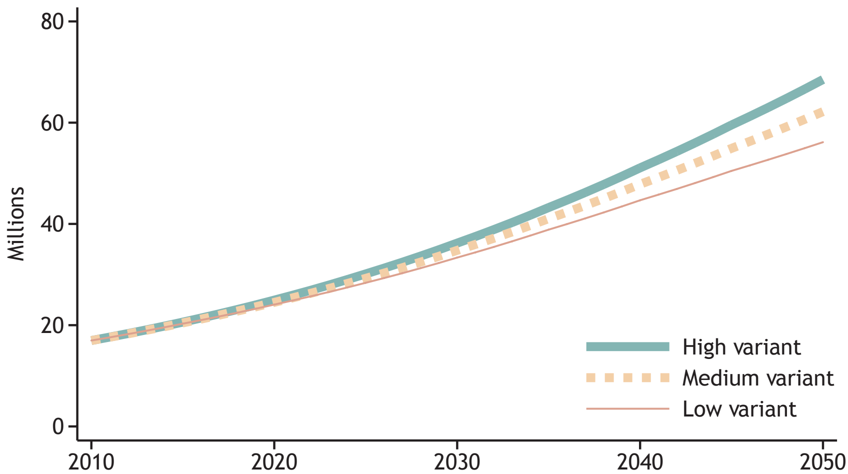
Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 9.11 Yield (metric tons per hectare) and harvest area density (hectares) for rainfed sorghum in Niger, 2000



Sources: SPAM (Spatial Production Allocation Model) (You and Wood 2006; You, Wood, and Wood-Sichra 2006, 2009).
Notes: ha = hectare; MT = metric tons.

FIGURE 9.12 Population projections for Niger, 2010–50



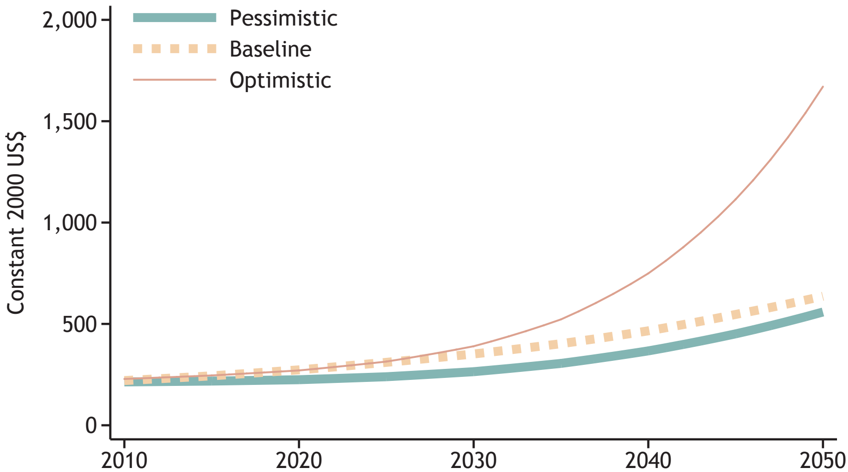
Source: UNPOP (2009).

and the high variant estimates the population at 68.5 million. That is almost triple the population of 2010. That number of people in Niger would create very high densities in the cultivable areas and put significant pressure on arable land as well as on utilities. One possible policy option is the reclamation of the desert to make it more habitable, enabling an environment for growing crops and rearing livestock. This would be an uphill task based on the limited resources of the country.

Income

Figure 9.13 presents three overall scenarios for Niger's GDP per capita derived by combining three GDP scenarios with the three population scenarios of Figure 9.12 (based on UN population data). The optimistic scenario combines high GDP with low population scenarios for all countries, the baseline scenario combines the medium GDP projection with the medium population scenario, and the pessimistic scenario combines the low GDP scenario with the high population scenario. The agricultural modeling in the next section uses these scenarios.

FIGURE 9.13 Gross domestic product (GDP) per capita in Niger, future scenarios, 2010–50



Sources: Computed from GDP data from the World Bank Economic Adaptation to Climate Change project (World Bank 2010), from the Millennium Ecosystem Assessment (2005) reports, and from population data from the United Nations (UNPOP 2009).
Note: US$ = US dollars.

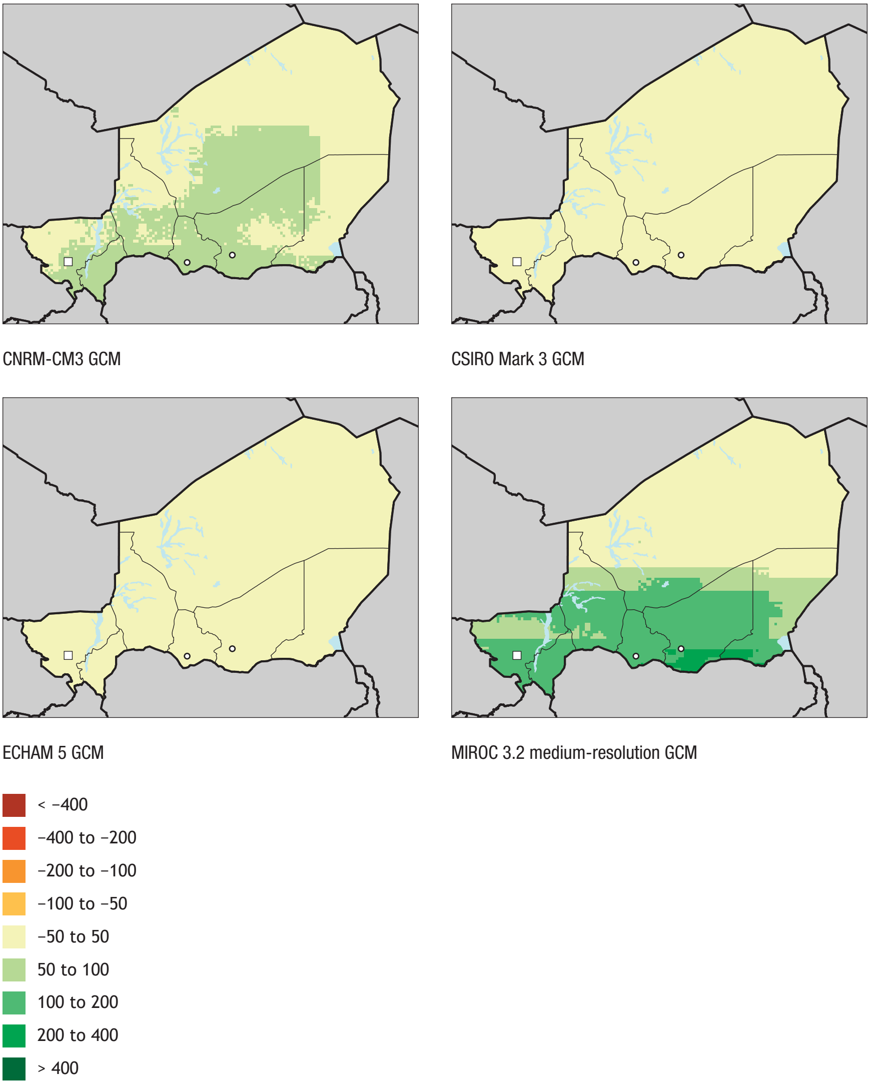
The baseline and pessimistic scenarios follow a similar trend, showing only about US$600–650 per capita GDP by 2050. The optimistic scenario follows the baseline until the late 2020s. After 2030, low population and high GDP—the optimistic scenario—are predicted to result in a significant increase in per capita GDP, to US$750 in 2040 and to more than US$1,670 by 2050.

Biophysical Scenarios

Climate Scenarios

Figure 9.14 shows projected precipitation changes in Niger in the four downscaled general circulation models (GCMs) we use in this chapter in the A1B scenario. The CSIRO Mark 3 and ECHAM 5 GCMs both show little or no change in rainfall throughout the country. The CNRM-CM3 and MIROC 3.2 medium-resolution GCMs both show an increase in rainfall

FIGURE 9.14 Changes in mean precipitation in Niger, 2000–2050, A1B scenario (millimeters)



Source: Authors' calculations based on Jones, Thornton, and Heinke (2009).

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

for the southern part of the country.[1] MIROC 3.2 predicts higher rainfall at 100–200 millimeters than does the CNRM-CM3 scenario, which shows 50–100 millimeters; however, the CNRM-CM3 GCM predicts increased rainfall in a greater part of the desert area of the country.

Figure 9.15 shows the predicted change in the average daily maximum temperature for the warmest month of the year in the A1B scenario according to various GCMs. The CNRM-CM3 and ECHAM 5 GCMs show a uniform 2.0°–2.5°C increase in temperature in the country. The CSIRO Mark 3 GCM shows the least increase in temperature, with most of the country experiencing an increase of only 1.0°–1.5°C, whereas the MIROC 3.2 medium-resolution GCM shows an increase ranging from 1.0°–1.5°C in the southernmost part of the country to 3.0°–3.5°C in the northernmost part of the country.

Crop Physiological Response to Climate Change

The effect of climate change on sorghum in Niger is mapped in Figure 9.16. Crop yields for 2050 with climate change are compared to the projected 2050 yields with an unchanged (2000) climate. All the scenarios predict a yield loss of 5–25 percent, as well as varying losses in baseline area in the southern part of the country. However, the loss in the baseline area is relatively less in CSIRO Mark 3 than in the other models.

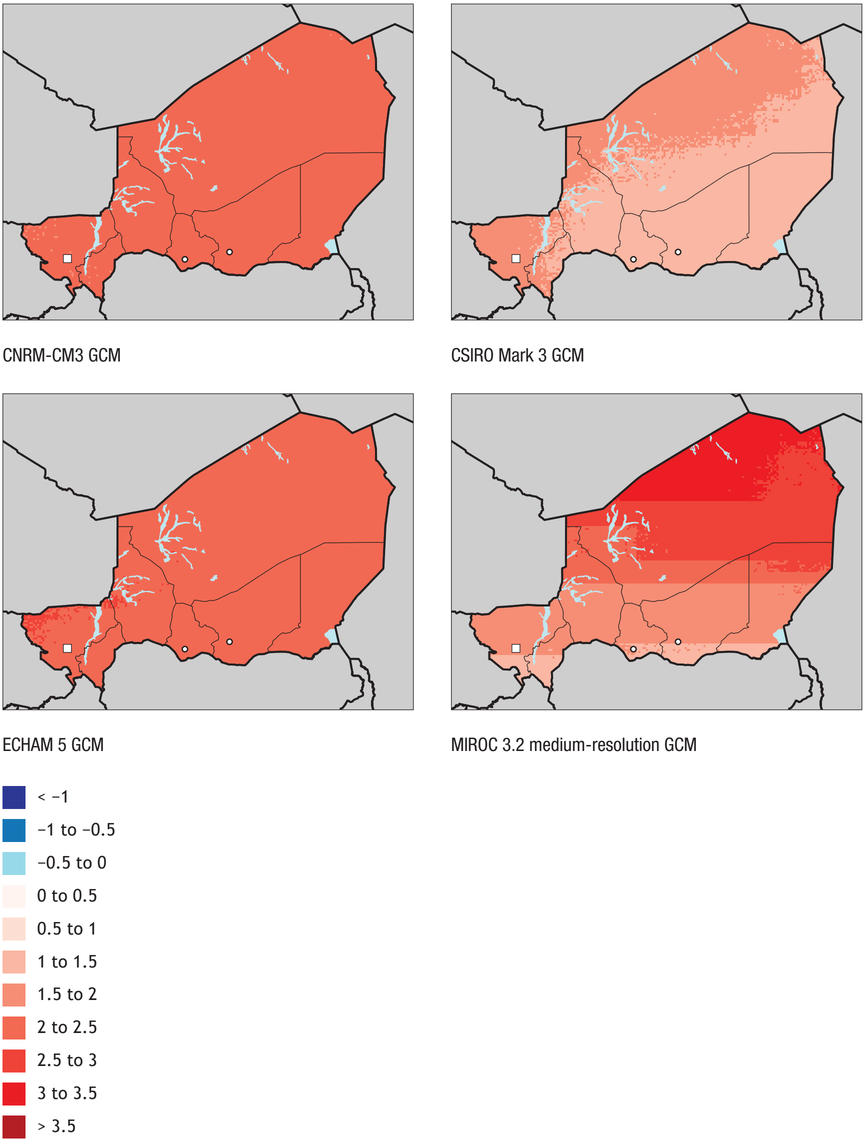
Agricultural Vulnerability Scenarios (Crop-Specific)

The next two figures show simulation results from the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) associated with key agricultural crops in Niger. The figure for each featured crop has five graphs: production, yield, area, net exports, and world price.

The production and productivity of both millet (Figure 9.17) and sorghum (Figure 9.18) are seen to increase in all the scenarios. However, the area under cultivation will increase significantly only in the case of sorghum. For both crops, productivity will increase by at least 100 percent, accounting for the increase in production. The increase in productivity will be related to improvement in management rather than improved varieties; the indicated

1 The A1B scenario is a greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources. CSIRO Mark 3 is a climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation. ECHAM 5 is a fifth-generation climate model developed at the Max Planck Institute for Meteorology in Hamburg. CNRM-CM3 is National Meteorological Research Center–Climate Model 3. MIROC is the Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

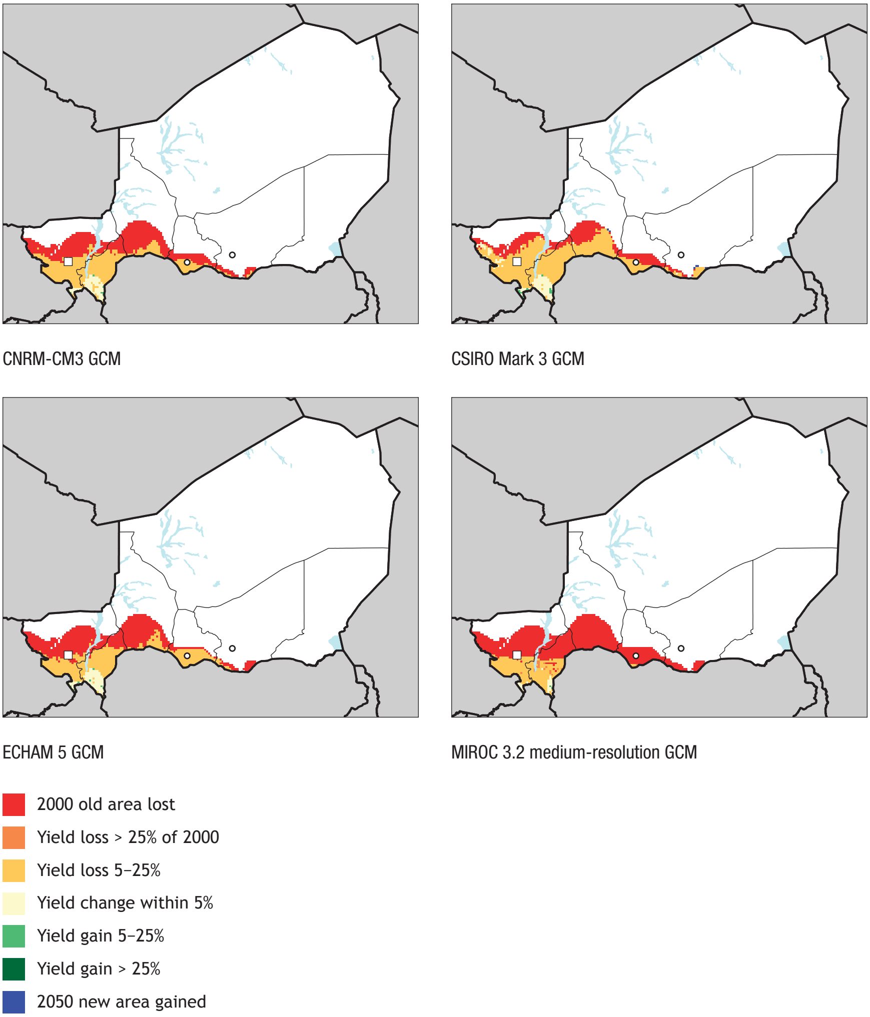
FIGURE 9.15 Changes in normal daily maximum temperature in Niger for the warmest month, 2000–2050, A1B scenario (ºC)



Source: Authors' calculations based on Jones, Thornton, and Heinke (2009).

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

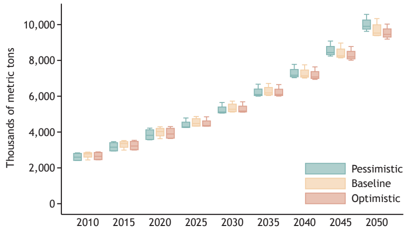
FIGURE 9.16 Yield change under climate change: Rainfed sorghum in Niger, 2000–2050, AIB scenario



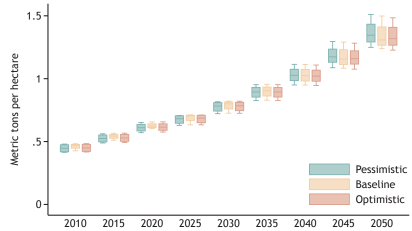
Source: Authors' estimates.

Notes: A1B = greenhouse gas emissions scenario that assumes fast economic growth, a population that peaks midcentury, and the development of new and efficient technologies, along with a balanced use of energy sources; CNRM-CM3 = National Meteorological Research Center–Climate Model 3; CSIRO = climate model developed at the Australia Commonwealth Scientific and Industrial Research Organisation; ECHAM 5 = fifth-generation climate model developed at the Max Planck Institute for Meteorology (Hamburg); GCM = general circulation model; MIROC = Model for Interdisciplinary Research on Climate, developed at the University of Tokyo Center for Climate System Research.

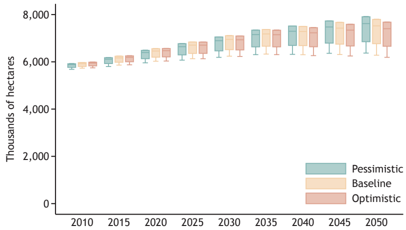
FIGURE 9.17 Impact of changes in GDP and population on millet in Niger, 2010–50



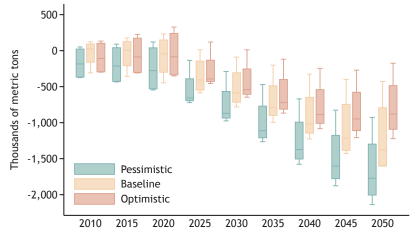
Production



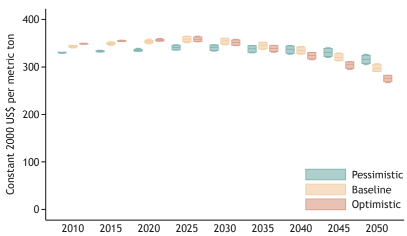
Yield



Area



Net exports

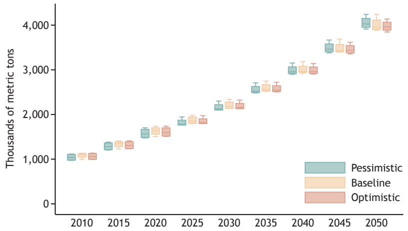


Prices

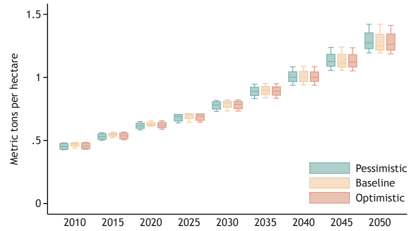
Source: Based on analysis conducted for Nelson et al. (2010).

Notes: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios. GDP = gross domestic product; US$ = US dollars.

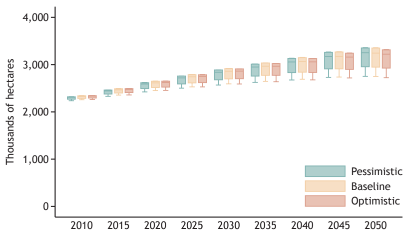
FIGURE 9.18 Impact of changes in GDP and population on sorghum in Niger, 2010–50



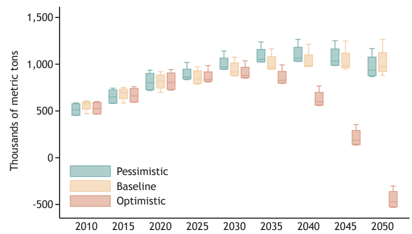
Production



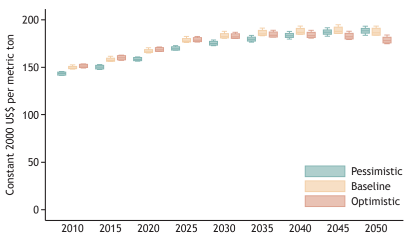
Yield



Area



Net exports



Prices

Source: Based on analysis conducted for Nelson et al. (2010).

Note: GDP = gross dom Source: Based on analysis conducted for Nelson et al. (2010).

Notes: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios. GDP = gross domestic product; US$ = US dollars. estic product.

yields of both crops in 2050 will remain below the genetic potential of varieties currently available.

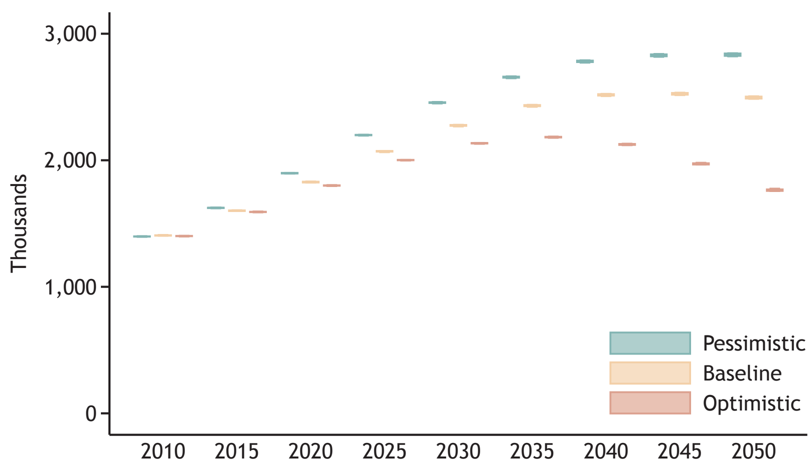
Millet production in Niger is still insufficient to meet demand. All scenarios project a growing deficit of millet after 2020, with the greatest deficit in the pessimistic scenario and the smallest in the optimistic scenario. The increase in imports will be driven by a decline in the world price of millet coupled with an increase in population. Sorghum exports are projected to rise in all scenarios through 2030, then level off in the pessimistic and baseline scenarios while declining in the optimistic scenario. The fall in net exports will coincide with stagnation in the world price of sorghum but also with the increased welfare of the population in the optimistic scenario, which will enable households to purchase foods.

Human Vulnerability Scenarios

In addition to agricultural scenarios, IMPACT also shows the number of malnourished children under the age of five, as well as the number of available kilocalories per capita.

Figure 9.19 shows the impact of future GDP and population scenarios on under-five malnutrition rates. The box-and-whisker plots in the figure

FIGURE 9.19 Number of malnourished children under five years of age in Niger in multiple income and climate scenarios, 2010–50



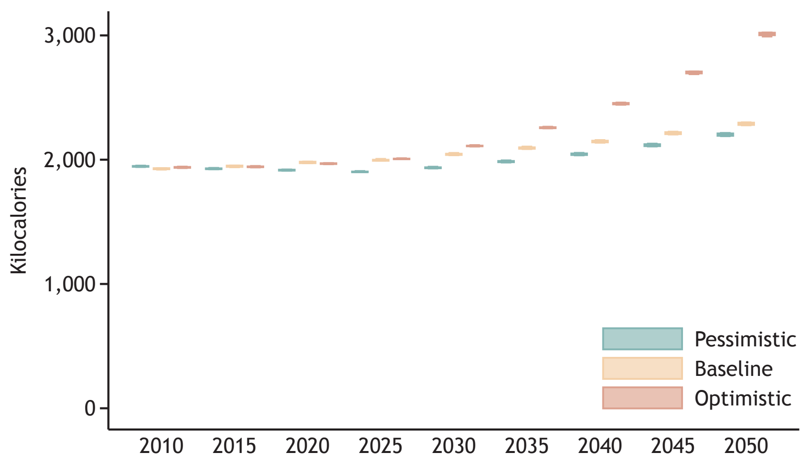
Source: Based on analysis conducted for Nelson et al. (2010).

Note: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios.

indicate the range of climate scenario effects. The number of malnourished children under age five is shown to be increasing in all scenarios through 2035. After 2025 the differences between the scenarios become increasingly pronounced: the number of malnourished children under age five appears lowest in the optimistic scenario and highest in the pessimistic scenario. The optimistic scenario shows a decline after 2035, while in the baseline scenario the number will further increase, stabilizing at 2.3 million by 2040. The pessimistic scenario shows a continuing but relatively small increase after 2040. Although the absolute numbers of malnourished children are projected to rise during many of the years to come, the percentage of malnourished children is likely to decline steadily and dramatically due to the rapid population increase.

Figure 9.20 shows the available kilocalories per capita. As might be expected, there appears to be an inverse relationship between the availability of kilocalories and the number of malnourished children under age five. The increase in available kilocalories after 2025 in the optimistic scenario coincides with the decline in the number of malnourished children under age five.

FIGURE 9.20 Kilocalories per capita in Niger in multiple income and climate scenarios, 2010–50



Source: Based on analysis conducted for Nelson et al. (2010).

Note: The box and whiskers plot for each socioeconomic scenario shows the range of effects from the four future climate scenarios.

Conclusions and Policy Recommendations

According to the modeled scenarios, the effects of climate change in Niger may be manifested in accelerated degradation of natural resources (farmland, pastures, rivers, and forests), militating against the country's ability to meet the food needs of its growing population. From our crop modeling analysis we found that all climate models show areas that currently grow sorghum but will be unable to do so in the future unless new heat-tolerant (and possibly drought-tolerant) varieties are developed.

IMPACT predicts increased agricultural production for the next 40 years, which it appears will be sufficient in most cases to provide many of the food needs of the nation in most scenarios.

Population growth means higher population density, which will put more pressure on the natural resource base. The models show neutral or increasing precipitation in Niger in the future. An increase in precipitation far beyond the prevailing amounts will require significant adjustments in farming as well as associated livelihoods. Decisionmakers need to design and implement policies to ensure sustainable development in the country against the background of changing climatic conditions. These policies should be designed to do the following:

- Support adequate monitoring of climate and provide information on climate change impacts.
- Provide a framework for responding to adverse climate change, for example, an increase in precipitation in a hitherto dry country. Policies for adequate housing, roads, and other infrastructure, particularly those related to agriculture, should be seriously considered.
- Provide adequate support to the agricultural research and extension system to develop appropriate crop varieties that will be adaptable to future climate conditions and to help farmers learn about them and any new agricultural techniques and technologies for cultivation and livestock husbandry.
- Support the high council for food security created in 2010 to ensure that it is effective in coordinating improved food production in the face of climate change.
- Provide adequate support for institutions responsible for managing rural areas and develop the most degraded lands.
- Promote agricultural diversification, particularly crop livestock production systems that will provide flexibility in adapting to changing climates,

especially if the increased precipitation will favoring crop production more than livestock production.

- Establish water points and fodder stocks all over the country to guard against drought effects. This would require significant resources but would certainly improve livestock production.
- Develop capacity at all levels to follow up on environment management policies.

Although climate change will present some challenges to agriculture in Niger, the models used in this chapter suggest that rising temperatures will be the main challenge, because precipitation is predicted to stay the same or increase. Adopting these policy recommendations or similar ones that are designed to provide a supportive environment for farmers, including helping farmers gain access to new technologies designed for a hotter climate, will allow the positive future of some of the scenarios discussed above to be realized.

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