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DEVELOPING SOCIOECONOMIC SCENARIOS:

For Use in Vulnerability and Adaptation Assessments

A UNDP-GEF PROJECT

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DEFINITIONS

Adaptive Capacity	the degree to which adjustment are possible in practices, processes, or structures of systems to projected or actual changes of climate, particularly in anticipation of change
Coping Capacity	the ability to adjust to climate events in the short term
Indicator	a statistic of direct normative interest that facilitates concise, comprehensive, and balanced judgments about the condition of major aspects of a society
Proxy	something used in place of another. Proxies fulfill three criteria: (1) summarize or otherwise simplify relevant information; (2) make visible or perceptible phenomena of interest; and (3) quantify, measure, and communicate relevant information.
Resilience	a tendency to maintain integrity when subject to disturbance
Sector	an aspect of overall vulnerability that may be analyzed separately with regard to the sector’s impact on human welfare
Sensitivity	the degree to which a system will respond to a change in climatic conditions
Scenario	a coherent, internally consistent, and plausible description of a possible future state of the world
Storyline	a qualitative, holistic picture of the general structures of values of society in the future
Vulnerability	the extent to which climate change may damage or harm a system, depending not only on a system’s sensitivity but also on its ability to adapt to new climatic conditions
Vulnerability Assessment	an analysis of the difference between the impacts of climate change and adaptations to those impacts

PURPOSE OF THE HANDBOOK

More than 120 non-Annex I Parties have been preparing their initial communications for submission to the United Nations Framework Convention for Climate Change. The majority of these National Communications contain assessments of vulnerability and adaptation, but are lacking a key component: socioeconomic scenarios. Developing socioeconomic scenarios of the future is important because vulnerability to climate change may increase or decrease substantially, depending on socioeconomic changes. For example, population may grow, human activities that pollute may increase, and habitats may be fragmented. Together, these changes may increase the vulnerability of some aspects of human welfare. If the economy grows and technologies can be developed, vulnerability may be reduced in some sectors but possibly increased in others. These interactive changes can be explored (although not predicted) through the development of different socioeconomic scenarios of the future.

Yet construction of socioeconomic scenarios is, reportedly, one of the greatest challenges for the national teams. Even once the scenarios are constructed, their uncertainties often make it difficult for analysts to interpret the results with sufficient confidence to make policy decisions. Therefore, a need has been identified for a practical manual on how to develop socioeconomic scenarios for use in vulnerability and adaptation assessments.

This purpose of this manual is to assist countries in developing socioeconomic scenarios for analyses of vulnerability and adaptation as part of their National Communications under the Framework Convention for Climate Change. This manual is organized to provide guidance in a systematic, unifying framework at differing levels of spatial scale organized by sectors when relevant:

- global and regional
- national
- local.

For any study of impacts, vulnerability, or adaptation, it is critically important that socioeconomic scenarios are developed consistently with climate scenarios, since the drivers are highly interdependent. Because both climate and socioeconomic scenarios are needed for impact studies, the credibility of any analysis will greatly depend on the internal consistency of the different scenarios. If vulnerability and adaptation assessment is the main goal of a study, the local and sector-specific scales are likely to be the most important. However, they still need to be nested in a larger global or regional framework. For example, farmers make decisions based on the market prices of a produce in a global economy. Matters of national security such as energy, food, and water have to be seen in a global context. This handbook provides a systematic framework for preparing socioeconomic scenarios for both impact (i.e., vulnerability) and adaptation assessments across differing spatial scales.

At each level, the manual demonstrates a systematic process for describing and (where possible) quantifying alternatives for the future. Global and regional projections provide some general constraints within which to develop country- and sector-specific projections. More generalized data are most useful in long-term (e.g., century) projections. Sector-specific data are most useful for shorter term projections and planning.

ELEMENTS OF SCENARIOS FOR VULNERABILITY AND ADAPTATION ANALYSIS

Several different kinds of scenarios must be developed in order to perform a vulnerability and adaptation analysis. Climate change scenarios and many impact scenarios are based in the knowledge of how the physical world changes: the chemistry in the atmosphere, temperature, precipitation, and so on in the case of climate, and how plants, animals and ecosystems react to climate changes in the case of impacts scenarios. A third kind of scenario, the socioeconomic scenario, is the topic of this handbook. We cannot know what the climate-changed future will be like for human societies unless we know something about future populations and how they will live. Indeed, we cannot fully understand how vulnerable we may be to climate change without knowing something about future socioeconomic conditions.

Most existing socioeconomic scenarios are limited to demographic and economic characteristics, such as projections of total population, GDP, and energy production and consumption. Land use and rates of technological change are also sometimes included. Careful selection of the characteristics to include in a socioeconomic scenario is obviously important if the results are to be meaningful input to a vulnerability analysis. This handbook offers guidance on selecting what to include as well as on sources of existing socioeconomic scenarios that can be adapted for use in a specified vulnerability analysis.

What is a scenario?

A scenario is not a prediction. It is "a coherent, internally consistent and plausible description of a possible future state of the world" (Carter et al., 1994). The Third Assessment Report of the Intergovernmental Panel on Climate Change's (IPCC's) Special Report on Emissions Scenarios (SRES) (Nakicenovic et al., 2000, p. 594) further defines a scenario as

> a plausible description of how the future may develop, based on a coherent and internally consistent set of assumptions ("scenario logic") about key relationships and driving forces (e.g., rate of technology changes, prices). Note that scenarios are neither predictions nor forecasts.

Thus, a scenario comprises a set of interrelated variables to form a whole picture of what the world – or, in this case, what the country or urban area or other region – might be like at some future date. A scenario is not a forecast, which describes a future that is *highly likely*. Instead, a scenario describes a *possible* future. A number of scenarios might constitute alternative futures. Moreover, a scenario is distinguished from a projection, which is often a simple extrapolation of historical trends in one or more variables.

The whole picture: Storylines of the future

In the past, analysts developed scenarios by selecting key drivers of socioeconomic change and projecting current trends of these drivers into the future. Little if any consideration was given to whether the projected factors made sense together as a picture of the future. Furthermore, previous scenarios, while representing significant advances at the time of their development, accounted for only a narrow range of potential socioeconomic pathways toward the future.

Recognizing this problem, the SRES researchers developed "storylines" — coherent pictures of the future within which certain trends make sense. These storylines were widely reviewed in an open process (Nakicenovic et al., 2000). The scenario families diverge qualitatively and quantitatively. The two "A" families, for example, posit high economic growth, while the two "B" families explore the consequences of lower economic growth. "A1" and "B1" families are oriented toward global convergence, while "A2" and "B2" families focus more on regional structures. Environmental policies and outcomes are different in each family. The SRES storylines are discussed in more detail below.

Proxy values: Building blocks for scenarios

Vulnerability and adaptive capacity are in many respects intangible and cannot be measured directly, so we use proxy values as indicators of vulnerability and adaptive capacity. For example, we cannot directly measure social welfare; often, GDP per capita is used as a proxy. GDP per capita is an incomplete and flawed proxy for welfare; it neglects the value of unpaid work, people's satisfaction with their occupations, and many other aspects of welfare. A measure of economic productivity, however, is an accepted approximation that can be observed and measured. Desirable proxies fulfill three criteria: (1) summarize or otherwise simplify relevant information; (2) make visible or perceptible phenomena of interest; and (3) quantify, measure, and communicate relevant information.

Developing scenarios of the future relevant to climate change vulnerability and adaptive capacity involves choosing relevant proxies, collecting or locating appropriate data, and estimating future values for those proxies. (See box for the steps involved in developing proxy indicators.) In this guidance, we proceed from a regional analysis to the country level, and finally to the local level, with emphasis on key sectors. At each level, the first task is to characterize current conditions. Next comes the identification of and data for proxies for dimensions of current and future vulnerability. Alternative storylines for the future should include these dimensions. Projecting values for the chosen proxies into alternative futures is the last step in scenario development, followed by their use in vulnerability and adaptation assessment.

SCENARIO DEVELOPMENT

The goal of scenario development is to explore alternative futures both qualitatively and quantitatively so that you can assess the implications of current decisions and long-range policy for vulnerability and adaptation to climate change. Scenarios can assist you in looking at the international context of planning for climate change as well as decision-making aimed at reducing vulnerability and increasing adaptive capacity.

Thus, a useful product from your scenario development process might have the following characteristics:

- Represent the important factors in society and economy
- Account for the effects of climate variability and change on society and economy
- Be consistent across global, regional, and national scales and among sectors
- Support exploration of at least two different, coherent directions for the future (i.e., different storylines)
- Sufficient input from stakeholders to ensure usefulness of the scenarios.

Setting boundaries, involving stakeholders, and using multiple approaches

To develop scenarios that meet these criteria, an important requirement is to set the boundaries of the area to be analyzed and identify the area's connections with activities outside it. For example, the area to be analyzed may be a country, an urban area, an important agricultural area, or a watershed. Connections with activities outside an area might include trade, migration, upstream water withdrawals (and other water management), or agricultural runoff (and other agricultural practices).

A second important requirement is to involve stakeholders in the decisions to be made in the selection of factors (driving forces) and indicators, storylines, and projections. Stakeholders are likely to include various government ministries and bureaus and representatives of important economic, environmental, and cultural sectors. A first-level consideration is to gain input, review, and buy-in from officials who could use the scenarios in developing climate change policies (see box). At the next level, informed persons from state and local governments, business and labor communities, and civil society representatives could be brought together in meetings or workshops to help develop or review the scenarios. A stakeholder involvement process such as this can enhance the realism of the scenarios and facilitate the implementation of resulting policies by major affected groups.

Identifying Proxies

Proxies are used to represent concepts and values that cannot be measured directly, such as human welfare. There are four steps involved:

1. Identify categories of interest for the analysis, such as settlements, food security, human health, water, and economic activity.
2. Within each category, explore various ways that human well-being could be measured within that category. For example, settlement sensitivity could include markets, infrastructure, sea level rise, water quality, etc. The number of measures used should be large enough to capture the essential elements, yet small enough to not overwhelm the analysis with data.
3. Choose proxies, explicitly stating what they are proxies for. As an example, Table 4 lists "GDP (market) per capita" and "Gini Index" as proxies for "distribution of access to markets, technology, and other resources useful for adaptation." These choices should always be considered provisional until they have been tested through use.
4. Define the functional relationship of changes in the proxies to changes in the "proxy for." In the previous example, the functional relationship of "GDP (market) per capita" is defined as "adaptive capacity increases as GDP per capita increases." This step, also, should be subject to revision in use. For example, a proxy value may be positive up to a certain point and negative thereafter.

These boundary-setting and connection-identifying activities also imply that scenarios need to include factors and data at the global, regional, country, and sectoral levels. Climate change itself and economic globalization entail global and regional trends that will constrain any vulnerability or adaptation analysis. Similarly, national trends and policies will have a large effect on future social and economic conditions. Neglecting these large-scale processes would greatly skew any local-level analysis.

The guidance for global, regional, and country-level analyses takes a "top-down" approach, which is often contrasted to a "bottom-up" approach followed in the sectoral guidance. These are terms that are used in socioeconomic analysis and modeling. They indicate differences in viewpoint and purpose:

- Top-down means that the analysis focuses on a highly aggregated view of the whole object of study. Differences (e.g., in income) are often averaged out or otherwise not accounted for, and trend curves are generally smooth, so that short-term changes cannot be seen. "GDP per capita" is such an aggregate statistic — very good for country-to-country comparisons and to determine whether wealth is increasing or decreasing over the long term, but severely limited for assessing income inequality or the effects of a drought or flood.

- A bottom-up analysis, in contrast, is highly disaggregated, focusing on the local level, specific circumstances, and short-term effects. Data and analyses often emphasize differences among people, and the standard deviation, range, and volatility of events over time. Some measure of the frequency and severity of floods in a given location would help to assess the vulnerability of a particular society to withstand or recover from the floods likely to be experienced, but it provides little help in the comparative or trend analysis required for a global assessment.

Stakeholder Consultation: Request for Input

Those who develop national communications, along with socioeconomic scenarios and vulnerability and adaptation analyses, need to involve various stakeholders in these processes. Minimally, these stakeholders will include persons in ministries such as planning and natural resources. To make this guidance more useful, we would like to specify this process in as much detail as possible and request your input on the following questions:

Who should be included in the list of stakeholders who MUST be included in the process of developing scenarios for national communications, and vulnerability and adaptation analyses?

In addition, who could have meaningful input and could help facilitate the implementation of any resulting policies?

WHEN and HOW should various stakeholders be included in the process?

Would it be useful to have stakeholders comment upon or make recommendations about tradeoffs between economic development and environmental protection?

Socioeconomic scenarios need to be both top-down and bottom-up. First, they need to set the global, regional, and country context within which vulnerability (and adaptation options) can be assessed. No locale can act independently of larger socioeconomic conditions and policies. Second, the scenarios need to be specific about how local climate impacts and socioeconomic factors interact within the larger context as people produce food, manage water, build settlements, and so on. Consistency between top-down and bottom-up analyses is highly desirable to developing useful scenarios.

Good scenarios will recognize that factors ranging from the global to the local are integrated. The focus of good scenarios will go beyond merely identifying factors and collecting data to consider *how the factors interact in a given place and time to produce human well-being*.

Global and regional analysis

This guidance begins at the global-regional level to help you establish general directions for and limits to scenarios so they will (1) account for global factors that have been analyzed and, in the case of the SRES scenarios (Nakicenovic et al., 2000), approved by the IPCC, and (2) be internally consistent as the scenarios "tier down" to national and subnational levels. The rationale for using the SRES scenarios is that a large number of climate scenarios are being generated at global and regional scales from them; using these climate and emissions scenarios together will ensure that your national communications and other analyses are consistent with other analyses being developed.

Using existing scenarios

Socioeconomic scenarios for use in climate change analyses exist at global and regional (multi-national) levels; these can be adapted for use in more localized vulnerability analyses. Tol et al. (1998) give information and references for five socioeconomic scenarios generated by the World Bank, IPCC, and integrated assessment modeling groups.

Many projections of climate change make use of the IPCC's IS92 scenarios (Pepper et al., 1992). This handbook focuses on the new SRES scenarios (Nakicenovic et al., 2000). The authors of the SRES report define and elaborate the socioeconomic scenarios now used by the IPCC to project various emissions pathways. An argument for using the SRES scenarios is that their outputs will be used as inputs into global climate models that will create estimates of change in global climate to be used in impacts assessment (Hulme et al., 1995). If you use the SRES scenarios, your socioeconomic scenarios will be consistent with the climate change scenarios.

The SRES features alternative "storylines" about the future. The storylines are qualitative, holistic pictures of the general structures and values of global society. They describe conditions that might be produced by human choices about economic and social policy, reproduction, occupations, and energy/technology use. The paces of population growth and economic development are set within and partially explained by the alternative tendencies of policies to support forms of global governance or localized self-sufficiency. There are four storylines (Nakicenovic et al., 2000):

- The A1 storyline and scenario family describe a future world of very rapid economic growth, global population that peaks midcentury and declines thereafter, and rapid introduction of new and more efficient technologies. Major underlying themes are economic and cultural convergence and capacity building, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system: fossil intensive (A1F1), nonfossil energy sources (A1T), and a balance across all sources.
- The A2 storyline and scenario family describe a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines.
- The B1 storyline and scenario family describe a convergent world with the same global population that peaks in midcentury and declines thereafter as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, reductions

in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

- The B2 storyline and scenario family describe a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

Note, however, that the SRES scenarios were developed for the specific purpose of projecting future emissions of greenhouse gases. This means that they are not ready-made answers to the problem of developing socioeconomic scenarios for vulnerability and adaptation analyses. They are a good starting point for considering such important factors as population growth and composition, economic conditions, and technological change. They do not explicitly represent other social institutions, such as farming, labor organizations, or the ways in which a government provides for the welfare of its citizens.

Adapting storylines and projections from SRES scenarios
This section will help you choose the appropriate storylines, data, and projections for your socioeconomic scenarios. A country or a region such as an urban area or watershed exhibits its own variety of linked environmental-social conditions, providing the challenge of representing these in the context of a global socioeconomic scenario. A region may have fragile ecosystems; major pollution problems, particularly air and water; and growing population and economy. International differences may further complicate the situation. Future developments in society hinge on the types of choices that are made, so that many paths to the future are possible.

In other words, a region has its own set of storylines, which can be derived from the SRES storylines and adapted to regional circumstances. A scenario developer should ask, What does an "A1" kind of world mean for this specific region, and how would the A1 characteristics be manifested here?

> Vulnerabilities will be very different if a country seeks rapid industrialisation, takes food imports for granted, seeks self-reliance in food production, or chooses a path of agricultural export-led growth. Vulnerabilities will also be different if a country chooses to protect and support its farmers, or let them face the whims of the market and the weather on their own strength (Tol, 1998, p. 2-14).

Your country's likely approach to these policy matters must be considered in developing a storyline that will determine many of the socioeconomic characteristics. Then appropriate values for the SRES variables can be determined by proportional calculations, i.e., applying the SRES percentage increases in population and GDP from the appropriate scenarios to the existing data for the region under study.

Using the SRES data and projections, you can review data on population and GDP projections, at a minimum. Appendix 2 provides population data, disaggregated by region and storyline. (Appendix 4 provides additional demographic information; historical data are available from UNDP 1999 and World Bank 1998.) For example, if your country is in the ALM region (Africa and Latin America – see Appendix 1 for a list of countries in the SRES regions), you would consider the data drawn from the Appendix tables and illustrated in Tables 1 and 2. Table 1 gives a wide range of possible population growth trajectories. For 2050 the range is from a 40% increase to over twice the current population. Note that these pathways to the future are not simply linear extrapolations of current population trends; in the A1 and B1 scenarios, for example, population grows and then declines.

Using the data in the appendices consists of collecting the appropriate baseline data for the region your country belongs to, for your country, or for a smaller scale entity and substituting those, and the appropriate Δ from the table or appendices in the following equation:
baseline data*(1+Δ/100) where Δ stands for the percentage change from the 1990 regional data

This will result in calculating country-specific projected information as exemplified in Figures 1 and 2.

Table 1. Percentage increases and decreases in ALM population from baseline year 1990 in SRES. Calculated by MiniCAM, an integrated assessment model, one of six models used in the SRES calculations. See Nakicenovic et al., 2000.

	2000	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
A1 Scenario	24	51	81	104	124	141	148	150	147	135	123
A2 Scenario	26	58	94	133	172	212	248	281	309	329	349
B1 Scenario	24	51	81	104	124	141	148	150	147	135	123
B2 Scenario	25	55	88	120	151	180	202	219	232	236	239

All of these are *possible* paths; your task is to choose two or more *likely* paths, given your current understanding. Since, of course, yours is only one country among many in this region, you will use country-specific projections if you have them. Comparisons among different data sources will provide a sound basis for thinking through the factors that may affect population growth and determining two or more alternative pathways, based on the storylines you have developed.

For GDP projections, you could use the SRES data or adjust them based on your country-specific storylines. In using your own region- or country-specific projections, you can identify which SRES storylines most closely match the assumptions behind your projections. That will make it easier to associate and develop a consistent storyline for your area. The SRES projections for Region ALM are given in Table 2 and Appendix 2; they are calculated from the website http://sres.ciesin.org/OpenProcess/.

Table 2. Percentage increases and decreases in GNP/GDP (mex) for ALM region from baseline year 1990 in SRES in projections by MiniCAM

	2000	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
A1 Scenario	47	147	289	710	1331	2142	3426	4852	6410	8068	9915
A2 Scenario	47	126	226	421	673	989	1452	1978	2578	3284	4073
B1 Scenario	47	147	289	657	1147	1773	2636	3510	4405	5242	6152
B2 Scenario	47	136	257	521	868	1310	1926	2589	3300	4052	4884

For example, examining the storylines and the projections, you might decide that the two most likely storylines to elaborate for your country are the A2, which emphasizes self-reliance and preservation of local identities, and B1, which emphasizes global solutions to economic, social, and environmental stability: a heterogeneous world versus a convergent world. For your country, some of the differences in the storylines imply that your country would,

- in the “self-reliant” scenario (A2), work to feed its own people, emphasize regional trade and political alliances, and try to preserve its national character and culture.
- in the “global solutions” scenario (B1), perhaps emphasize producing goods for the international market, seek efficiency and prosperity through global trade, and rapidly complete technological transformations.

The populations and GDP projections are significantly different. In the self-reliant scenario (A2), the ALM regional projections rise steadily and rapidly over the twenty-first century to more than triple by 2100. In the global solutions scenario (B1), population rises much more slowly to a 150% increase by 2070 (about 2% annually) and declines thereafter to a net 123% increase by 2100.

The GDP projections also differ, but both project rising wealth. The self-reliant scenario exhibits slower growth than the global solutions scenario but projects a more than forty-fold increase by 2100, compared to the over sixty-fold increase by 2100 in the global solutions scenario.[1]

Country-level data will help you adjust these projected rates, depending on your comparison of your country with the whole ALM region. The projections you determine will be the start of your socioeconomic scenario, giving you general boundaries within which to complete a more detailed socioeconomic scenario.

Adding Country-Specific Factors to the Socioeconomic Scenario

This section discusses national-level factors and storylines that will delineate two or more directions for the future. The examples used here are based on the SRES global storylines, but you can choose to develop more and/or different pictures of your country’s socioeconomic development. Appendix 3 provides data you could use from the SRES projections on energy use, land use, emissions of sulfur oxides, and nuclear energy. The primary concern is to keep your country’s future development choices consistent with potential global developments and your country’s own current policy directions. Your storylines of the future will help you decide the most influential elements of that future and construct ways to represent — and, if possible, to quantify — those elements.

Lorenzoni et al. (2000) provide an example of “downscaling” the SRES storylines for a subnational area. They use the SRES storylines in climate change impact assessment for East Anglia in the United Kingdom. They emphasize the integration (co-evolution) of the socioeconomic and climate change drivers in their assessment work. They display the scenarios using an axis for governance on which the 1 and 2 scenarios represent globalization > localization, while the other axis represents the A to B difference from consumerism > community/ conservation. Table 3 lists the implications of the differences in scenarios.

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1. The percentages are large, but the base GDP on which the calculations are made is relatively small (e.g., a 40-fold increase in $100 of income would be $4000). Moreover, in general, GDP increases are expressed on an annual basis; the increases in the Tables and Appendices are relative to the 1990 baseline data. You may want to recalculate the, for example, 10-year increases back to annual increases by dividing by the appropriate number of years and obtain an averaged annual rate of increase relative to the baseline value. The actual year-by-year rates are, of course, based on a compound function for which we do not have the exact information.

Table 3. SRES scenarios downscaled to East Anglia (source: Lorenzoni et al., 2000)

World Markets (A1)	Provincial Enterprise (A2)	Global Sustainability (B1)	Local Stewardship (B2)
Responsibility for action at enterprise level under market forces. Fast-growing sectors: health care, leisure, financial. Declining sectors: manufacturing, agriculture. Annual country GDP growth: high (% see region; modify for country or location). Global carbon emissions: medium increase (cf. 1990 levels).	Responsibility for action at individual level. Fast-growing sectors: private health care, defense, maintenance services. Declining sectors: high-tech specialized services, finance. Annual GDP increases moderate. Global carbon emissions: high increase (cf. 1990 levels).	Responsibility for action at state level, dictated by international government. Fast-growing sectors: renewable energy, business services, clean technology. Declining sectors: fossil-fuel based and resource-intensive systems. High GDP growth. Global carbon emissions: low increase (cf. 1990 levels).	Responsibility for action at collective level, supportive governmental framework. Fast-growing sectors: small-scale manufacture and agriculture, local enterprises. Declining sectors: retailing, leisure and tourism. Low annual GDP increases. Global carbon emissions: medium low increase (cf. 1990 levels)
Weak international climate regime. Voluntary reduction of emissions. Emissions trading through markets	Very weak climate regime. Increased emissions. No controls. Voluntary action.	Strong international climate regime. Stringent reduction of emissions. Regulatory approach.	Strong/weak climate regime. Uneven emission controls. Fragmented regulatory approach.

Besides the variables adapted from SRES or other sources of socioeconomic scenarios, additional data for scenarios to be used in vulnerability analyses should be gathered from the literature (studies done about your particular country) and relevant databases (e.g., World Bank, 1998) to describe the social, economic, and institutional context in which climate variability and change will take place in your country. The important factors for the country's social future must be represented in its socioeconomic scenario.

The Relationship of Government, Social Values and Economic Development: Request for Input

The nature of government, government policies, and social values are particularly difficult to quantify in socioeconomic scenarios. How should these be represented in socioeconomic scenarios so that the scenarios will be both realistic and useful?

These factors include national indicators of well-being. You should add to population and GDP figures (for the present and projections into the future) any elements that capture more dimensions of overall development and the variations as well as the averages. It is possible to develop a specific and highly detailed set of indicators of national well-being. (See, for example, Douglas et al., 1998 for descriptions of human needs, particularly Box 3.1.) Or you can use the UNDP's Human Development Index (HDI; World Bank, 1998). The HDI uses three indicators:

- life expectancy at birth
- literacy rates
- purchasing-power-adjusted GDP per capita (in logarithmic form).

The first two indicators reflect the supporting infrastructure for an individual's life. Life expectancy is a good indicator of public health, resulting from clean water, sewerage, medical practice, and nutritional status. Literacy reflects the spread of education and access to information. The third indicator, purchasing power, reflects the individual's ability to acquire goods and services.

The HDI rankings are given to countries on the human deprivation continuum (0 to 1) for each indicator; the average of the three indicators, subtracted from 1, provides the overall HDI.

Table 4 demonstrates an approach midway between an elaborate set of country-specific indicators and the three that comprise the HDI. This approach is multidimensional, with indicators for economic capacity, human and civic resources, and environmental capacity. Within each category a selection of proxy variables has been made, the relationship between the proxy and the category has been specified, and the functional relationship has been defined.

Table 4. Country-Level Factors for Use in Socioeconomic Scenarios (Moss et al., 2001)

Category	Proxy variables	Proxy for:	Functional relationship
Economic capacity	**GDP(market)/capita** **Gini index**	**Distribution of access to markets, technology, and other resources useful for adaptation**	**Adaptive capacity ↑ as GDP/cap ↑** **at present Gini held constant**
Human and civic resources	**Dependency ratio** **Literacy**	**Social and economic resources available for adaptation after meeting other present needs** **Human capital and adaptability of labor force**	**Adaptive capacity ↓ as dependency ↑** **Adaptive capacity ↑ as literacy ↑**
Environmental capacity	**Population density** **SO_2/area** **% land unmanaged**	**Population pressure and stresses on ecosystems** **Air quality and other stresses on ecosystems** **Landscape fragmentation and ease of ecosystem migration**	**Adaptive capacity ↓ as density ↑** **Adaptive capacity ↓ as SO_2 ↑** **Adaptive capacity [of the environment]↑ as % unmanaged land ↑**

For the chosen proxies, data are available from various sources. The data in Table 5 are drawn from SRES data and from the MiniCAM model's postprocessor, Sustain (Pitcher, 1997). These same data are graphed in Figures 1 and 2. The Sustain postprocessor provides information at a more disaggregated regional level, e.g., Africa instead of Africa/Latin America in SRES. It also provide projections on changing demographics. Here, the example countries are Pakistan and Senegal, which start with very different initial conditions.

Table 5. Projections of National Data for Pakistan and Senegal

	Income/Cap (constant US$ for 1987)	**Age Dependency (15<working age>65)**	**Population density (/km^2)**	**Literacy (%)**	**Gini Coefficient (equity)**	**Unmanaged land (%)**	**SO_2 emissions (kg/km2)**
Pakistan							
1990	**$350**	**0.85**	**146**	**35%**	**31.15**	**66%**	**198**
A2 Scenario							
2000	$529	0.73	173	40%		65%	201
2020	$1,118	0.63	235	47%		59%	221
2050	$2,512	0.52	320	51%		51%	379
B1 Scenario							
2000	$535	0.71	170	40%		65%	169
2020	$1,611	0.55	222	49%		61%	146
2050	$6,752	0.37	258	55%		60%	112
Senegal							
1990	**$680**	**0.94**	**38**	**38%**	**54.10**	**58%**	**30**
A2 Scenario							
2000	$717	0.89	49	39%		57%	30
2020	$1,115	0.83	78	45%		53%	33

2050	$3,428	0.52	125	54%		47%	57
B1 Scenario							
2000	$723	0.87	48	39%		57%	25
2020	$1,349	0.77	75	47%		53%	22
2050	$8,770	0.40	104	58%		50%	17

The appendix lists changes in those variables that are the foundation for the SRES scenarios. Changes are expressed as percentage changes relative to 1990 baseline information. After collecting relevant information for a country (e.g., from FAO, 1999, World Bank, 1998, WRI, 2000, expert opinion, country studies, and other sources), we developed projections by applying the change factors directly through the following equation: baseline data*(1+Δ/100) where Δ stands for the percentage change from the 1990 regional data.

The A2 and B1 scenarios result in, by 2050, people in these countries having quite different levels of income. However, the differences in per capita income are more scenario-dependent than country-dependent. Another way these scenarios differ markedly is in the expected level of technological and industrial development (represented by the proxy of SO_2 emissions). In the global convergence (B1) scenario, sulfur emissions decline, while they increase in the self-reliant (A2) scenario. Literacy rates are expected to increase to a few percentage points over 50% by 2050 in both countries, while population is expected to increase steadily, especially in Senegal's B1 scenario.

Averaged equity with regard to income and expenditure data (see Deininger and Squire, 1996, 1998) for the world equals 35.6, for all Asian countries 35.7, and for African countries 44.3. For Pakistan, the reported Gini coefficient is 31.15; for Senegal, 54.10. In the B1 scenario one may expect these equity coefficients to move faster to the world average, compared to the A2 scenario. For Pakistan this move would be to a somewhat higher inequity, while for Senegal the move would be to more equity.

None of the individual projections can fully represent how adaptive capacity to climate variability or change can be expected to change. That projection requires an integration of, at a minimum, the elements listed and discussed above. Having been carefully considered by the researchers involved in the SRES scenarios, the interactions and mutual dependencies of these pathways are at least partly taken into account in their assessment modeling.

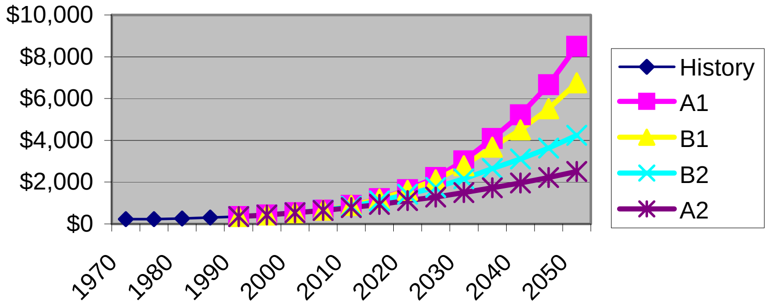


Figure 1. Pakistan's historical and projected income per capita

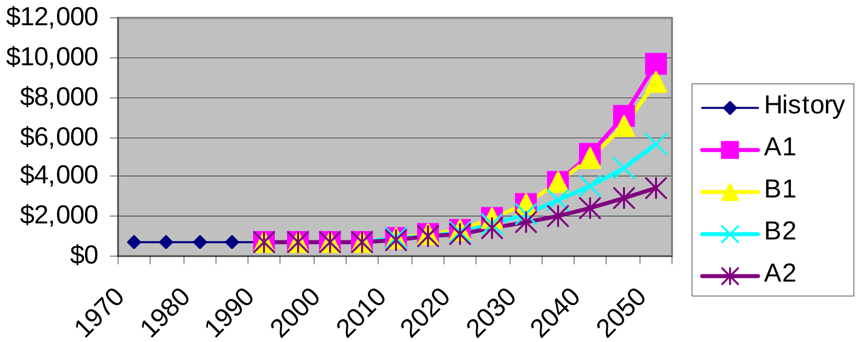


Figure 2. Senegal's historical and projected income per capita

The discussions above should give you a picture of the methodology that you can adapt to develop projections, again using the storylines you have selected to provide a basis for your determination of rates of change. For example, access to health care may increase more under the global solutions scenario than under the self-reliant scenario, since presumably your country would be able to obtain medical services and products on the global market more easily than developing them in-country. Conversely, a self-reliant scenario would indicate that your country would have more development of national programs to address climatic and other extreme events.

Each choice you make of projected values must have an underlying rationale. Remember that a straight-line extrapolation will rarely be defensible. For example, a literacy rate cannot improve indefinitely, and increasing calories over the amount to ensure adequate nutrition actually decreases well-being. Also remember that the projections must be realistic; projected reductions in income inequality must be based on the potential of the national society to achieve them, a difficult goal for any country to attain. Finally, many of the proxies that can be identified may reinforce one another; increased GDP may have implications for educational advancement and technological change – another reason to be very selective in choosing proxies to use.

These additional characteristics, along with the adapted SRES projections, will provide a more detailed picture of your country's socioeconomic future. Within these constraints, you can extend your analysis into important sectors in your country.

Adding Sector-Specific Factors to the Socioeconomic Scenario

Building on the concepts and approaches developed in the previous sections, you will find below some approaches for developing sector-specific scenarios. In this case, we provide discussion and examples for two such sectors, agriculture and water. The sector-specific analysis is intended to help you to think through and construct future socioeconomic scenarios at subnational sectoral levels consistent with each top-down scenario. At these levels the interdependence of the various elements is important to consider. For example, the relationships among crop production, water availability, and settlements need to be carefully considered.

Since time and resources are likely to limit the scope of your analysis, you should select those sectors that are crucial for your country's future economic and social development. For one country, fisheries may be in the crucial category, while for another country fisheries will be unimportant. The discussions below for agriculture and water illustrate the process and the type of issues, data, and indicators that are useful in constructing socioeconomic scenarios. In all cases, we recommend you use common sense and reason in applying these concepts to your country situation. The process of thinking through each scenario and inferring the key implications for vulnerability at the sectoral level is preferable to focusing exclusively on specific indicators. Application of these concepts requires your judgment and skill to adapt and refine the process as appropriate to the available data and circumstances of the country or region.

Table 6, building on the indicators shown in Table 4, lists a variety of sectors beyond the two covered in this guidance, demonstrating some of the key issues and indicators that other researchers have found to be important and which may be important to a specific country's application. The indicators presented here are only suggestive, and each practitioner must decide which indicators and factors to use (including those not listed) that are appropriate to a specific country's situation. These data may be available from case studies (e.g., Kasperson et al., 1995, Riebsame et al., 1991, Smith et al., 1996) and from literature and databases at the country, state, and local levels from a variety of sources.

Table 6. Sector-Level Factors for Use in Socioeconomic Scenarios (Moss et al., 2001)

Category	Proxy variables	Proxy for:	Functional relationship
Settlement/ infrastructure sensitivity	Population or property at flood risk from sea level rise	Potential extent of disruption from sea level rise	Sensitivity ↑ as population at risk ↑
	Population no access clean water/sanitation	Access of population to basic services to buffer against climate variability and change	Sensitivity ↑ as population with no access ↑
Food sensitivity	Cereals production/area	Degree of modernization in the agriculture sector; access of farmers to inputs to buffer against climate variability and change	Sensitivity ↓ as production ↑
	Animal protein consumption/capita	Access of a population to markets and other mechanisms (e.g., consumption shift) for compensating for shortfalls in production	Sensitivity ↓ as consumption ↑
Ecosystem sensitivity	% Land managed	Degree of human intrusion into the natural landscape and land fragmentation	Sensitivity ↑ as % land managed ↑

	Fertilizer use	Nitrogen/phosphorus loading of ecosystems and stresses from pollution	60-100 kg/ha is optimal. X<60 kg/ha, sensitivity ↑ due to nutrient deficits and potential cultivation of adjacent ecosystems. X>100 kg/ha (capped at 500 kg/ha), sensitivity ↑ due to increasing runoff
Human health sensitivity	Completed fertility Life expectancy	Composite of conditions that affect human health including nutrition, exposure to disease risks, and access to health services	Sensitivity ↓ as fertility ↓ Sensitivity ↓ as life expectancy ↑
Water resource sensitivity	Renewable supply and inflow Water use	Supply of water from internal renewable resources and inflow from rivers Withdrawals to meet current or projected needs	Sensitivity calculated using ratio of available water used: Sensitivity ↑ as % water used increases

Of course, it is impossible to include all *relevant* data from all sectors – or even all relevant proxies. Choices of what proxy variables to include must reflect their importance to the future of the region. Ultimately, there is a tradeoff between the number and complexity of variables used and the difficulty and complexity of conducting the analysis.

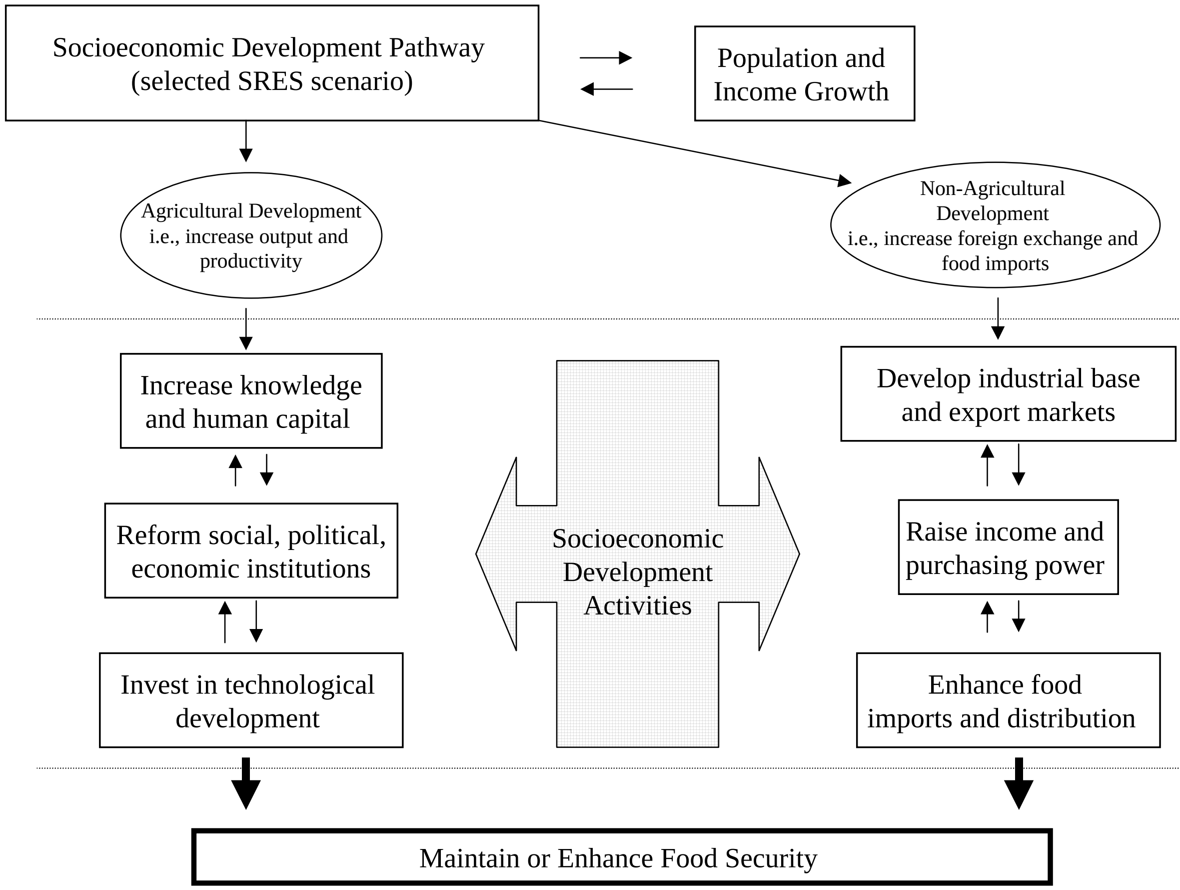
Agriculture/Food Security Sector

Agriculture and food security are inherently linked to socioeconomic changes. As populations grow, so does the quantity of food and fiber required to meet society's needs. In addition, as communities develop and increase their income and wealth and as technology improves, their capacity to shift labor from agriculture to other sectors increases along with changes in consumption patterns, including preferences for types of food. These changes lead to specialization, trade, and diversification of developing economies.

Socioeconomic conditions can greatly affect and determine the vulnerability and adaptive capacity of human settlements to climate changes. This explains how vulnerability can be vastly different between regions with otherwise comparable agricultural systems that experience similar climates. Economic development and wealth, for example, can enhance adaptive capacity by enabling a more resilient and robust recovery after an adverse event, increase the capability of insuring against potential losses, and create a safety net for food imports. In addition, reform and development of social institutions and relationships also contribute to adaptive capacity by creating social bonds and obligations between families, communities, and countries. These relationships foster aid and reciprocal sharing when adverse events arise.

As socioeconomic conditions change, the methods for maintaining and enhancing a society's food security typically change. The balance of food produced within the country and imported may in some cases shift. Countries may choose to specialize in certain crops and to develop nonfarm industries to improve export earnings, while others may seek self-reliance and crop diversity. Such changes may either increase or decrease vulnerability and adaptive capacity. For example, population and income growth can and has put significant pressure on agricultural systems to continually expand yields and production. In response, some technological improvements have yielded hybrids that under carefully controlled conditions can convert sunlight, nutrients, and water into edible products with high efficiency. In an ideal world (one without variability), these crops could result in tremendous productivity increases to feed a growing population. However, the sensitivity of many of these hybrids to climate variability has not decreased, and thus they may not be able to tolerate increases in the frequency and magnitude

Figure 3: Socioeconomic Scenarios and Food Security



of extreme events. If your country encourages monocropping, more food production could be at risk than if a variety of crops are grown, but the potential for trade may be larger.

The framework in Figure 3 shows the relationship between socioeconomic scenarios, development pathways, and food security. The framework highlights that there are multiple strategies for achieving food security, both agricultural and nonagricultural. It also illustrates that there may be important socioeconomic activities that are common to both pathways. For example, increasing knowledge and human capital is likely to be necessary for taking either pathway. Also, increasing nonagricultural development will provide some of the necessary financial resources for improving agricultural development. The reality is that both pathways are critically linked and, depending on particular scenario characteristics (i.e., consistency with the selected SRES storyline), one pathway may receive more emphasis than the other in achieving food security.

Here, using as examples the A2 and B1 SRES storylines and data available for Senegal, we develop some quantitative and qualitative approaches to developing aspects of a socioeconomic scenario relevant to characterizing the vulnerability of food and agricultural systems. Questions relevant to the development of a storyline for the food and agriculture sector that is consistent with the broader SRES storylines, include:

- What development and investment choices will the country make in order to meet its projected food security needs?

- What mix of agricultural production and food imports is desired, and how does this mix enhance or detract from adaptation capacity, vulnerability, and food security of the country?
- Will development emphasize globalization and increased reliance on imported food? If so, what type of industrialization is desired and are the resources available to undertake that pathway?
- What measures can be taken to increase crop yields and agricultural output? Can acceptable technologies be identified and applied?
- Will more free trade and reduced subsidies make the agricultural system more or less vulnerable to climate?

For example, under the A2 scenario, economic growth and regional identity and self-sufficiency are more highly emphasized. Population growth is high, while technology and economic development are somewhat fragmented and relatively slower. For a country with a relatively large and nationally important agricultural sector, emphasis under this scenario might be given to efforts to further increase agricultural output, and continued reliance on agricultural labor and extensive production methods (i.e., using more land and labor rather than nonlabor inputs such as irrigation and chemicals). In contrast, scenario B1 suggests a globally centered pathway with lower population growth and higher economic growth. This pathway would emphasize greater nonagricultural development, enhancing the capability for economic trade and greater food imports. Smaller population growth rates might encourage intensification of agricultural systems, using some of the income growth to finance investments in agricultural technology and human capital, which will free more of the population to move into nonagricultural lifestyles and jobs.

General Criteria for Developing Indicators

The following criteria provide useful guidelines for selecting and developing indicators

- **Appropriateness and relevance**
  Does the indicator describe a meaningful characteristic of the sensitivity, vulnerability, or adaptive capacity of the system?
- **Transparency**
  The formula and data for calculating the indicator should not be unduly complex or difficult to interpret.
- **Feasibility**
  Indicators are based on data. These data must be available to the practitioner or suitable substitutes need to be identified.
- **Relationship to SRES**
  For the purposes of this guidance, either the underlying data or the indicator itself needs to be linked to key variables or attributes of the overall socioeconomic scenario (i.e., the SRES storyline). This criterion enables the indicator and sector storyline to be consistent with the overall scenario assumptions.

Agricultural Indicators

Agriculture provides two principal benefits to a country: food and trade income. Countries with insufficient production require imports and food aid to meet the food demands of their population.

Given a socioeconomic scenario such as the SRES A2 or B1, what types of changes might be anticipated for the food and agricultural sector? How might food security be affected? Can we identify a relatively small and focused set of indicators that provide insight to these questions, and which satisfy the general criteria given in the accompanying text box?

Based on these criteria, study goals, a brief survey of data availability, and the SRES data and storylines, we identified a short list of indicators for the food and agricultural sector. These indicators may not be the most appropriate in every case, but they are sufficiently general and may be sufficient in most cases.

Food Security. A country's food demand is driven fundamentally by its population and, to a lesser degree, its income and wealth. People require a basic level of food consumption — subsistence levels — that are met through direct production from agriculture or market purchases using available income and wealth. Primary food requirements (expressed in terms of kilocalories) are, for many countries, satisfied to a large extent by cereal grains. Once subsistence levels are reached, income and wealth can contribute further to a higher level of consumption and a more diverse diet.

To examine food security, an indicator of basic food demand can be constructed that measures the total amount of, for example, cereal needed to satisfy the basic nutritional needs of a country. Using population estimates from the selected socioeconomic scenarios, the total food demand can be estimated. This measure assumes that present levels of consumption must at least be maintained and that total food needs rise linearly with population. Basic food demands can be satisfied through a combination of in-country production and food imports (which can include both purchased food imports and food aid).

Based on available country-level data from WRI (2000) and the population estimates given for the A2 scenario, Table 7 illustrates an assessment of food security needs for Senegal. The assessment begins by using the population and income change estimates for each socioeconomic scenario (e.g., A2). Given current production and import levels, an estimate of total food demand is calculated and is assumed to grow at the same percentage rate as population. (Note that, as GDP increases, some further increase in food demand might be expected; however, the income effect is not likely to be linear and would level off at some point.) As shown, the A2 scenario for Senegal shows population growing by nearly 350% over the century. Assuming that food need grows proportionately, demand rises from 1,486,000 metric tons (i.e., 847,000 mt produced + 639,000 mt imported) in the mid 1990s to over 6,600,000 mt by 2100. The process of constructing Table 7 is given in the Text Box below Table 7.

An aspect of the A2 storyline is increasing self-reliance along with economic growth. This scenario, therefore, suggests that countries may strive for more country-centered development and less global and regional trade emphasis. Under this scenario, it may be reasonable for the imported share of food consumption to fall. In the example shown in Table 7, we illustrate an example where import share falls in Senegal from 43% to 25%. The target of 25% in this case is simply a judgment made by you based on consistency with the scenario storyline and given expectations about the resource conditions of the country. In the case shown in Table 7, in order for the import share to fall it is necessary that internal agricultural production rise by MORE than the increase in population.

The implications of this scenario are very important, and suggest that agricultural capacity will be expanded, either by increasing crop yields as shown, or by expanding the arable land base. Under this scenario the implied annual rate of crop yield increase to raise yields by nearly 5 fold within 100 years, is about 1.6%, which is within the rate of increase estimated for agriculture over the last 50 years. For example, technological advances in biotechnology, irrigation, and better management may be reasonably anticipated. However, each analyst must assess carefully the extent of this capacity for his or her own country.

Table 7. Estimated Basic Food Demand for Senegal: SRES A2 Scenario

Senegal	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Percentage change in population from 1990 (from Table 1)	26	58	94	133	172	212	248	281	309	329	349
Estimated percentage change in GDP from 1990 (from Table 2)	47	126	226	421	673	989	1452	1978	2578	3284	4073
Estimated percentage change in total food consumption from 1990	26	58	94	133	172	212	248	281	309	329	349
Estimated total cereal needs (thousands of metric tons)	1872	2348	2883	3462	4042	4636	5171	5662	6078	6375	6672
Estimated import and food aid share (%)[a]	43	43	43	42	41	40	38	36	33	30	25
Estimated in-country production (thousands of metric tons)	1067	1338	1643	2008	2385	2782	3206	3624	4072	4463	5004
Average cereal crop yields (kg/ha)[b]	906	1136	1395	1705	2025	2362	2722	3076	3457	3789	4248
Estimated percentage increase in crop yields from 1995	26	58	94	137	182	229	279	328	381	427	491

Notes:

Net cereal imports and food aid as a percentage of total cereal consumption, 1995-1997 (WRI, 2000): Senegal: 43%.

a. Estimated import and food aid share is based on taking current share and using judgment to estimate the target share for 2100 under the given SRES scenario. In this case, the A2 scenario suggests greater self-reliance. Therefore, a goal might be to reduce food imports from 43% to 25% by 2100. Capacity to reduce imports is a function of income; therefore, estimated food import shares is scaled by the percentage change in projected income. For example, 2% of the overall increase in income occurs between 2000 and 2010; therefore, we estimate that 2% of the total 33% change in import share (i.e., -0.6%) occurs in this decade. Caution must be used here to ensure overall consistency — falling import shares must be matched by increasing in-country agricultural production, which implies an increase in the intensity of agricultural production or in the cultivated land area.

b. Cereal crop yields are estimated based on required in-country production and assume that planted area is constant. Cereal crop planted area is estimated from data in WRI (2000) in which total cereal production in 1996-1998 is 847,000 metric tons, and average cereal crop yields are given as 719 kg/ha. Therefore, estimated planted area in Senegal in 1996-1998 is 1.18 million hectares. Production levels, however, are also subject to increases by increasing the land base.

Table 8 illustrates a parallel assessment for the B1 scenario, in which population peaks and then declines, material intensity diminishes, and there is a greater emphasis on trade and global cooperation. In this case, the limited growth in population results in a more modest increase in total food demand compared with the A2 scenario. There is also a less intensive need to limit food imports as a share of the total. As a result, this scenario places less pressure on the need to rapidly and intensively develop agricultural production, and allows a greater share of resources to flow into nonagricultural development, thus furthering the overall growth in income by 2100. Under this scenario, crop yields need to increase less than 170% in about 80 years, less than 1% annually.

Steps for Developing the Socioeconomic Scenarios for Agriculture (Tables 7 and 8)

Step 1: Use SRES scenarios to develop estimates of population and GDP percentage changes from base year (e.g., 1990).

Step 2: Estimate percentage changes in total food consumption from base year. This is likely to follow population changes, but may be adjusted up or down to reflect anticipated improvements or decreases in overall diet and nutrition. Tables 7 and 8 show no adjustment.

Step 3: Estimate total cereal needs in thousands of metric tons. WRI (2000) reports, by country, the "average production of cereals" and the "net cereal imports and food aid as a percent of total cereal consumption." Together, these two measures can be used to estimate total cereal needs, assuming that if there are imports that all the country's production is also consumed internally. For example, the estimates for Senegal are 847,000 metric tons produced, and 43% of consumption met with imports in 1995. Therefore, the share met by internal production is 57%, which, divided into total production, yields 1,486,000 metric tons of cereal needed in 1995. This number is then adjusted by population growth to reflect demand in 2000 and is estimated at 1,872,000, as shown in Table 8 (here we assume the full amount of growth between 1990 and 2000 even though production and import estimates are for 1995-1998 – in all cases, use the most accurate information available).

Step 4: Estimate import and food aid shares. Tables 7 and 8 show food imports beginning at 43% for Senegal as reported in WRI (2000) for 1995. One way to proceed (as in Tables 7 and 8) is to choose a target import share for 2100 that is consistent with the relevant SRES storyline. These targets were set at 25% and 35% in Tables 7 and 8, respectively. These particular estimates were estimated subjectively by the authors, and are intended to illustrate consistency with the SRES scenarios – not necessarily accuracy or consistency with Senegal's own situation. Having both endpoints (i.e., estimates for 2000 and 2100), the intervening years can be estimated by proportional scaling with the estimated changes in income (based on the assumption that changes in either agricultural production or imports is enabled by GDP growth). For example, the following equation is used to interpolate import shares:

$I_{2010} = I_{2000} - (I_{2000} - I_{2100}) * [(GDP_{2010} - GDP_{2000})/(GDP_{2100} - GDP_{2000})]$

where:

I_{2000}, I_{2010}, and I_{2100} = estimated import/food aid share in 2000, 2010, and 2100, respectively

GDP_{2000}, GDP_{2010}, and GDP_{2100} = estimated GDP percentage changes from 1990 for 2000, 2010, and 2100, respectively.

Step 5. Estimate in-country production. This estimate is calculated by subtracting from 1 the import share calculated in Step 4. This gives the share of total cereal needs that is met by in-country production. This number is then multiplied by estimated total cereal needs to give the estimated level of agricultural production implied by the scenario.

Step 6. Estimate crop yields and percentage changes. Cereal crop yields are estimated based on required in-country production and assume that planted area is constant. Cereal crop planted area is estimated from data in WRI (2000) in which total cereal production in Senegal in 1996-1998 is 847,000 metric tons, and average cereal crop yields are given as 719 kg/ha. Therefore, estimated planted area in Senegal in 1996-1998 is 1.18 million hectares. Using this land base and dividing into the estimated production level gives the required crop yield. The percentage change in crop yields is then estimated using 719 kg/ha in 1995 as the base. An estimate of annualized yield changes is also helpful. The example shown in Table 7 in which yields rise by 491% by 2100 implies an annual rate of change of 1.6%. Note that production levels are also subject to change by changes the planted area.

Table 8. Estimated Basic Food Demand for Senegal: SRES B1 Scenario

Senegal	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Percentage change in population from 1990 (from Table 1)	24	51	81	104	124	141	148	150	147	135	123
Estimated percentage change in GDP from 1990 (from Table 2)	47	147	289	657	1147	1773	2636	3510	4405	5242	6152
Estimated percentage change in total food consumption from 1990	24	51	81	104	124	141	148	150	147	135	123
Estimated total cereal needs (thousands of metric tons)	1843	2244	2690	3031	3329	3581	3685	3715	3670	3492	3314
Estimated import and food aid share (%)[a]	43	43	43	43	42	41	40	39	38	37	35
Estimated in-country production (thousands of metric tons)	1051	1279	1533	1728	1931	2113	2211	2266	2275	2200	2154
Average cereal crop yields (kg/ha)[b]	892	1086	1301	1467	1639	1794	1877	1924	1931	1868	1829
Estimated percentage increase in crop yields from 1995	24	51	81	104	128	150	161	168	169	160	154

Notes:

Net cereal imports and food aid as a percentage of total cereal consumption, 1995-1997 (WRI, 2000): Senegal: 43%.

a. Estimated import and food aid share is based on taking current share and using subjective judgment to estimate the target share for 2100 under the given SRES scenario. In this case, the B1 scenario suggests global cooperation. Therefore, a goal might be to reduce food imports from 43% to only 35% by 2100.

b. Cereal crop yields are estimated based on required in-country production and assume that planted area is constant. Cereal crop planted area is estimated from data in WRI (2000) in which total cereal production in 1996-1998 is in Senegal in 1996-1998 is 1.18 million hectares. Production levels, however, are also subject to increases by increasing the land base.

Water Resources Sector

Fundamental to many important socioeconomic and ecological systems, water is a vital resource. For many countries it is considered a security issue every bit as important as food. Water shares many characteristics with other commodities. For example, water can often be stored to equalize periods of natural abundance with periods of natural drought; in some cases it can be traded with other users, and where demand is high enough, it can even be "manufactured" — desalination technologies can produce high quality water from low-grade sources such as seawater. However, water is in many ways unique and difficult to replace. Quality drinking water, for example, is absolutely necessary and there are no substitutes, and one cannot irrigate fields with anything other than freshwater.

A natural part of the hydrologic system, water is integrally linked to climate and landscape. Furthermore, availability and quality are affected by upstream users and natural conditions. Laws, regulations, treaties, and institutions can exert some influence over water conditions, but the resulting influences of upstream socioeconomic conditions frequently dominate; for example, under drought conditions downstream users often suffer losses in both volume and quality regardless of their own requirements, and in some cases calling into question the enforceability of certain regulations and agreements. This section identifies some of the key indicators related to water resources, describes how socioeconomic trends and scenarios may alter water resource conditions — both positively and negatively — and, where appropriate, identifies linkages of these indicators to scenarios of economic development and adaptation capacity.

Throughout much of the world, agriculture, in the form of irrigation, is the principal use of water. However, countries differ markedly (see, e.g., Table 9). Globally, irrigation use approaches 71%, followed by industry at 20%, and domestic use at 9% (WRI, 2000). Agriculture, therefore, is critically linked to water resources and their use and development in many countries. In these countries, it will be important to recognize these linkages and develop consistent scenarios of socioeconomic change and development. For example, some water-scarce countries may choose to focus economic development on industry and commerce, diverting water away from agriculture and perhaps away from a self-reliant food security system. A consistent storyline would then be that less water for irrigation and agricultural production implies a rise in food imports. Shifting food reliance toward trade and exchange indirectly increases imports of water in the form of food. This development path presumably rewards both importers and exporters, allowing water-intensive food production to shift away from relatively water-scarce regions to those that are relatively water-rich.

Table 9. Example of country differences in water use (WRI, 2000)

	Agriculture (%)	**Domestic (%)**	**Industry (%)**
Finland	1	17	82
United Kingdom	2	65	8
Estonia	5	56	39
Lithuania	3	81	16
Kuwait	60	37	2
Switzerland	0	42	58
Senegal	92	5	3
Pakistan	97	2	2
Afghanistan	99	1	0
Sudan	94	5	1
Guyana	98	1	0
Madagascar	99	1	0

Based on available country-level data from WRI (2000) and the population and income estimates given for the A2 scenario, Table 10 presents an assessment of key water sector indicators for Senegal. The text box describes the steps for developing socioeconomic scenarios for water resources. A key indicator to focus attention on is the level of development, which is the ratio of current water withdrawal to mean annual internal renewable water resources. An initial estimate for 1990 is given in WRI (2000) as the percentage of water resources withdrawn annually. This indicator can show where water scarcity and competing demands are greatest. Countries where development is high relative to endogenous water availability are potentially vulnerable to both natural variability and climate change and to the actions of upstream countries that may affect the levels and distribution of streamflow and/or water quality. Should climate change result in streamflow reductions (perhaps just seasonal changes, for example, during the summer growing season), curtailment of both off-stream and instream water uses is more likely in a watershed with a high level of development than in one with a low level of development.

On the other hand, as shown in Table 10 for Senegal, a country with a relatively low level of development has a significant potential to increase development (depending on downstream commitments) and thus raise the overall level of water use. Here, based on the movement toward self-reliance indicated by the A2 scenario, and the subsequent need for both increased agricultural production and economic development, we estimate a target of 40% for the level of development by 2100. The capacity to develop water resources is strongly tied to income growth. As a result, the level of development for the intervening decades is interpolated between 6% and 40% using the rate and timing of estimated income growth.

Annual average withdrawals will depend on the level of development. As development proceeds, capacity to withdraw and use water rises. Therefore, the table indicates that withdrawals rise from their initial level of 1.5 km^3 as the level of development permits, to 10.6 km^3 of withdrawals in 2100. During this period, withdrawals on a per capita basis at first fall and then rise, reflecting the lag between growth in population and level of development (which is tied to income).

Estimates of sector water use should be examined so that they are consistent with the patterns and storylines of the socioeconomic scenarios and the implications for sectors such as agriculture, domestic use, which depends on population growth, and industrial use. Again, your judgment is needed to estimate a target share for each sector in 2100. These target shares must be consistent with the scenario storylines and should add up to about 100 across all uses. In this case, we assume that the increasing level of development will permit increases in absolute levels of water to all three sectors, and that with increasing water use efficiency in agriculture, a greater share of total water is available to support the needs of the growing population and industrial base.

Table 10. Estimated Water Resource Situation for Senegal: SRES A2 Scenario

Senegal	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Population (% change from 1990; from Table 1)	26	58	94	133	172	212	248	281	309	329	349
Estimated change in GNP/GDP (% change from 1990, from Table 2)	47	126	226	421	673	989	1452	1978	2578	3284	4073
Level of development of internal renewable water resources (share of annual internal renewable water resources)	6	7	8	10	12	15	19	23	28	34	40
Annual withdrawals (km^3)	1.5	1.8	2.1	2.6	3.2	4.0	5.0	6.1	7.4	9.0	10.6
Per capita annual withdrawals (m^3)	125.6	120.2	115.3	136.7	125.3	159.9	174.0	195.2	197.8	242.9	249.0
Sector water use share (percent)											
agriculture	92	91.76	91.46	90.88	90.13	89.19	87.81	86.24	84.45	82.35	80
industry	3	3.14	3.31	3.65	4.09	4.64	5.45	6.36	7.40	8.63	10
domestic	5	5.10	5.22	5.46	5.77	6.16	6.74	7.39	8.14	9.02	10

Notes:

Average annual internal renewable water resources (WRI, 2000): Total 26.4 km^3; per capita 2,784 m^3.

The level of development is a key indicator that estimates the share of available internal renewable resources that are withdrawn for use. In this case, similar to the import share for food, you must use judgment to estimate how the level of development may evolve over time. In this example, we assumed that Senegal had sufficient potential to increase the level of development from 6% to 40%. The pace and timing of development are tied to the rate and timing of income growth.

Per capita annual withdrawals are estimated as the ratio of estimated annual withdrawals, which is adjusted upward as the level of development increases, and the population that is assumed to follow the given SRES scenario.

Sector water share. Initial shares are those given in WRI (2000). Shares in 2100 are estimated based on expert judgment and consistency with the SRES scenario and agriculture sector storyline. Intervening years are interpolated based on the rate and timing of income growth that may enable improvements in agricultural water use efficiency.

Steps for Developing the Socioeconomic Scenarios for Water (Tables 10 and 11)

Step 1: Use SRES scenarios to develop estimates of population and GDP percentage changes from base year (e.g., 1990).

Step 2: Estimate the level of development.. Tables 10 and 11 show the level of development beginning at 6% for Senegal as reported in WRI (2000) for 1990. One way to proceed (as in Tables 10 and 11) is to choose a target level of development for 2100 that is consistent with the relevant SRES storyline. These targets were set at 40% and 15% in Tables 10 and 11, respectively. These particular estimates were estimated subjectively by the authors, and are intended to illustrate consistency with the SRES scenarios – not necessarily accuracy or consistency with Senegal's own situation. Having both endpoints (i.e., estimates for 2000 and 2100), the intervening years can be estimated by proportional scaling with the estimated changes in income (based on the assumption that changes in the level of development are enabled by GDP growth). For example, the following equation is used to interpolate the level of development:

$$L_{2010} = L_{2000} + (L_{2100} – L_{2000}) * [(GDP_{2010} – GDP_{2000})/(GDP_{2100} – GDP_{2000})]$$

where:

L_{2000} , L_{2010}, and L_{2100} = estimated import/food aid share in 2000, 2010, and 2100, respectively
GDP_{2000} , GDP_{2010} , and GDP_{2100} = estimated GDP percentage changes from 1990 for 2000, 2010, and 2100, respectively.

Step 3. Estimate annual withdrawal. WRI (2000) provides an estimate of "average annual internal renewable water resources," which for Senegal is given as 26.4 km^3, and an estimate of "total annual withdrawals," which for Senegal in 1990 is estimated at 1.5 km^3 . The ratio of withdrawals to available resources is the level of development, in this case equal initially to 6%. Therefore, to estimate annual withdrawals to 2100, multiply the level of development times the amount of internal renewable resources (e.g., 26.4 km^3 in Senegal).

Step 4. Estimate per capita annual withdrawals. Per capita withdrawal estimates need to reflect growth in both the level of development and in population, and the conversion from km^3 to m^3. This estimate is made by multiplying the estimate of annual withdrawals times 1 billion (i.e., the number of m^3 in a km^3). This number is then divided by population, which grows each decade according to the SRES scenario estimates. For example, per capita water withdrawals in Senegal in 2010 are estimated by multiplying estimated withdrawals in 2010 of 1.8 km^3 by 10^9 and dividing by estimated population in 2010, which is 9,481,000 in 1990 times 1.58 to reflect the 58% growth between 2010 and 1990.

Step 5. Estimate sector water use shares. Similar to estimating the level of development above and the import share of food in the agriculture section, these estimates are based on an initial value given, for example, in WRI (2000), and a target value that is determined by your judgment consistent with the SRES scenario and the country's overall development objectives. Once initial and target values are set for each sector (note that the sum across sectors should be 100%), then the intervening years can be estimated in a similar fashion using the above formula to scale these changes by changes in GDP, which is assumed to enable the changes, for example, allowing industry shares to rise with increases in economic development.

Table 11 illustrates the socioeconomic indicators and baselines for the B1 scenario. In this case, the environmental goals of the B1 scenario, coupled with the diminished rate of population growth and focus on global cooperation, limit the level of development necessary to meet the country's water requirements. More modest increases in agricultural production leave more water available for industry development and more instream uses; therefore, the share of water uses can shift. Economic growth enables increases in water use efficiency in all the sectors, and thus domestic water use, for example, need not increase as much as the overall population increases.[2]

Table 11. Estimated Water Resource Situation for Senegal: SRES B1 Scenario

Senegal	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Population (% change from 1990; from Table 1)	24	51	81	104	124	141	148	150	147	135	123
Estimated change in GNP/GDP (% change from 1990, from Table 2)	47	147	289	657	1147	1773	2636	3510	4405	5242	6152
Level of development of internal renewable water resources (share of annual internal renewable water resources)	6	6	6	7	8	9	10	11	12	13	15
Annual withdrawals (km^3)	1.5	1.6	1.6	1.8	2.1	2.4	2.6	2.9	3.2	3.4	4.0
Per capita annual withdrawals (m^3)	127.6	111.8	134.6	93.1	99.8	119.0	110.6	122.3	150.7	180.9	189.2
Sector water use share (percent)											
agriculture	92	91.72	91.32	90.30	88.94	87.20	84.80	82.37	79.88	77.55	75
industry	3	3.25	3.60	4.50	5.70	7.24	9.36	11.51	13.71	15.77	18
domestic	5	5.03	5.08	5.20	5.36	5.57	5.85	6.14	6.43	6.70	7

Notes:

Average annual internal renewable water resources (WRI, 2000): Total 26.4 km^3; per capita 2,784 m^3.

The level of development is a key indicator that estimates the share of available internal renewable resources that are withdrawn for use. In this case, similar to the import share for food, you must use judgment to estimate how the level of development may evolve over time. In this example, we assumed that Senegal desired to increase the level of development from 6% to 15%, and thus ensure the viability of many of its aquatic ecosystems consistent with the B1 storyline. The pace and timing of development are tied to the rate and timing of income growth.

Per capita annual withdrawals are estimated as the ratio of estimated annual withdrawals, which is adjusted upward as the level of development increases, and the population that is assumed to follow the given SRES scenario.

Sector water share. Initial shares are those given in WRI (2000). Shares in 2100 are estimated based on expert judgment and consistency with the SRES scenario and agriculture sector storyline. Intervening years are interpolated based on the rate and timing of income growth that may enable improvements in agricultural water use efficiency.

2. Downing (1992) estimates that Senegal has the resource capacity to feed itself in 2050 if climate change, that is, drought intensity, does not occur. Expected climate change will increase the number of rural people that would not be supported by rain-fed food production, however.

Finally, when considering water resources and estimating conditions and vulnerabilities for future populations there are several additional indicators that could provide insights:

- vulnerability of human settlements to flood risk
- impacts of development and population growth on water quality
- vulnerability of aquatic and aquatic dependent ecosystems.

Flood Risk. Significant flood events can cause severe damage and dislocation. Human settlements must frequently weigh the tradeoffs between proximity to water resources and the flood risks tied to that proximity. Increasing economic development in flood prone areas raises the vulnerability of both property and people. In developing socioeconomic scenarios, it may be important to consider population trends and growth rates in vulnerable areas. To develop a useful indicator of flood risk, the vulnerable area needs to be identified. For many regions where settlements are at risk, a flood plain has been already defined, typically addressing some frequency of flood events, such as a 100 year or 500 year floodplain.[3] Consistent with the population estimates for the SRES scenarios, it is possible that the flood risk rises more steeply under the A2 scenario with its higher population growth estimates. However, flood risk could also rise under the B1 estimates, depending on where economic development is likely to occur. If development occurs largely within flood plains, damages could rise.

Water Quality. Dissolved oxygen (DO) is vitally important to the health and maintenance of aquatic ecosystems. It can also indicate areas where pollution levels may be high as a result of, for example, insufficient wastewater treatment. Furthermore, DO is reduced not only by higher temperatures that naturally limit the oxygen carrying capacity of water but also by introducing biochemical oxygen demanding (BOD) materials to water resources, which occurs both naturally and as a result of human activities. Depending on data availability, this measure is highly region and river specific, so it may be necessary to find another measure for water quality. If DO data for key river systems are available for the country of interest, it will be necessary to identify a quality standard. For example, in the United States, the standard is 5mg/L, below which oxygen levels are limited and can adversely affect aquatic ecosystems. Though this critical level may be periodically reached in some parts of the river system, what matters most is the frequency and persistence of violation. Given that the level of water resource development may be considerably lower under the B1 scenario compared with the A2 scenario, water quality is likely to be higher.

Ecosystems at Risk. Water resources are vital not only to human settlements but also to wildlife and ecosystems. Ecosystems require both sufficient quantity and quality to maintain their health and viability. Development of water resources for human uses often requires diversions that reduce streamflows, which can be particularly stressful for ecosystems during low flow seasons. Population growth and industrial development not only increase competition that further reduces streamflows but also generate waste and pollution that must be assimilated back into the riverine system. The combination of these stresses degrades habitat and leads to species loss and reduced biodiversity. An indicator such as the number of species at risk identifies watersheds containing aquatic and wetland animals and plants that may be critically vulnerable to hydrologic and water quality changes. The number of at-risk, water-dependent species within a watershed characterizes a degree of relative stress that a watershed may be currently experiencing from a variety of sources, including habitat loss and encroachment, pollution, predation, and disease. Similarly, a

3. Such floodplain definitions are based on an assumed "stationary" or unchanging distribution of flood events. Climate change, however, could affect the frequency and magnitude of flood events, which over the long run may result in redefinition of the vulnerable regions.

lower level of water resource development permits more water to remain and be available for use by ecosystems. Therefore, although the level of development may rise under both A2 and B1 SRES scenarios, the increase could be much less under B1.

SUMMARY

Reviewing the sector-specific examples given for the A2 and B1 SRES scenarios reveals the differences in the implications of alternative socioeconomic assumptions. As stated at the beginning of this guidance, building socioeconomic scenarios is about creating alternative visions for the future, visions that can be informed and differentiated by critically assessing key features of the socioeconomic system and drawing out the implications. Population and income growth, economic development, social institutions, preferences about the environment, and globalization can significantly influence the type of future that evolves.

This guidance serves as a beginning for analysts who, it is hoped, will take from these examples a structure and process for initiating their own analysis of the implications of different development paths for vulnerability to climate change. It will prove successful if analysts can build onto and adapt these ideas to fit and blend well with their specific country situations, and develop suitable storylines of their own that are both internally and externally consistent with the broader set of scenarios developed to assess climate change vulnerability and adaptation.

REFERENCES

Carter, T.R., M.L. Parry, H. Harasawa, and S. Nishioka. 1994. *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations*. Intergovernmental Panel on Climate Change, Geneva.

Douglas, M., D. Gasper, S. Ney, and M. Thompson. 1998. Human needs and wants. In *Human Choice and Climate Change, Volume 1: The Societal Framework*, S. Rayner and E.L. Malone (eds). Battelle Press, Columbus, OH.

Deininger, K. and L. Squire. 1996. A new data set measuring income equality. The World Bank Review 10 (3):565-91

Deininger, K. and L. Squire. 1998. New ways of looking at old issues: inequality and growth. Journal of Development Economics 57:259-287

Downing, T.E. 1992. *Climate Change and Vulnerable Places: Global Food Security and Country Studies in Zimbabwe, Kenya, Senegal and Chile*. Research Report 1, Environmental Change Unit, University of Oxford, UK.

FAO. 1999. Food and Agriculture Organization of the United Nations Statistical Databases (FAOSTAT). Online at: http//apps.fao.org.

Hulme, M., T. Jiang, and T. Wigley. 1995. SCENGEN: A Climate Change SCENario GENerator. Software User Manual, Version 1.0. Climatic Research Unit, University of East Anglia, Norwich, UK, and WWF International, Gland, Switzerland.

Kasperson, J.X., R.E. Kasperson, and B.L. Turner II (eds). 1995. Regions at Risk: International Comparisons of Threatened Environments. UNU Press, Tokyo.

Lorenzoni, I., A. Jordan, M. Hulme, R.K. Turner, and T. O'Riordan. 2000. A co-evolutionary approach to climate change impact assessment: Part I, Integrating socio-economic and climate change scenarios. *Global Environmental Change* 10, 57-68.

Moss, R.H., A. Brenkert, and E.L. Malone. 2001. *Vulnerability Indicators*. Pacific Northwest National Laboratory, Washington, DC.

Nakicenovic, N. et al. 2000. *Special Report on Emissions Scenarios*. Cambridge University Press, Cambridge, UK.

Pepper, W.J., J. Leggett, R. Swart, J. Wasson, J. Edmonds, and I. Mintzer. 1992. *Emissions Scenarios for the IPCC: An Update — Assumptions, Methodology, and Results*. Intergovernmental Panel on Climate Change, Geneva.

Pitcher, H. 1997. Sustainability: an exploratory analysis using the MiniCAM integrated climate model. Pacific Northwest National Laboratory, Washington, DC.

Riebsame, W.E., S.A. Changnon Jr., and T.R. Karl. 1991. *Drought and Natural Resources Management in the United States: Impacts and Implications of the 1987-89 Drought*. Westview Press, Boulder, CO, USA.

Smith, J.B., G.V. Menzhulin, M. Campos, N. Bhatti, R. Benioff, and B. Jallow (eds). 1996. *Adapting to Climate Change: Assessments and Issues*. Springer, New York.

Tol, R.S.J. 1998. Socio-economic scenarios. In *UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Studies*, J.F. Feenstra, I. Burton, J.B. Smith, and R.S.J. Tol (eds). United Nations Environment Programme and Vrije Universiteit, Amsterdam and http://www.vu.nl/english/o_o/instituten/IVM/research/climatechange/Handbook.htm

UNDP [United Nations Development Program.] 1999. *Human Development Report* [CD-ROM]. HDRs 1990-1999. United Nations, Geneva.

World Bank. 1998. World Development Indicators 1998 [CD-ROM]. International Bank for Reconstruction and Development/The World Bank, Washington, DC.

WRI [World Resources Institute]. 2000. *World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life*. In collaboration with the United Nations Development Program, United Nations Environment Program, and the World Bank. WRI, Washington, D.C.

APPENDIX 1. COUNTRIES BELONGING IN SRES REGIONS

ALM Region (LAM = Latin America; SSAFR = Sub-Sahara Africa; MEA = N-Africa)			**REForm Region (countries undergoing economic reform: EEU = Eastern Europe; NIS-FSU = Nations in Transition and the Former Soviet Union)**			**ASIA Region (CPA = Centrally Planned Asia ; SAS = Southeast Asia; PAS = Pacific Asia)**	
ALM(LAM)	Antigua Barbados		REF(EEU)	Albania		ASIA(CPA)	Cambodia
ALM(LAM)	Argentina		REF(EEU)	Bosnia Herzegovina		ASIA(CPA)	China, Hong.Kong
ALM(LAM)	Bahamas		REF(EEU)	Bulgaria		ASIA(CPA)	Korea D P Rep
ALM(LAM)	Barbados		REF(EEU)	Croatia		ASIA(CPA)	Laos
ALM(LAM)	Belize		REF(EEU)	Czech Rep		ASIA(CPA)	Mongolia
ALM(LAM)	Bermuda		REF(EEU)	Czechoslovakia		ASIA(CPA)	Viet Nam
ALM(LAM)	Bolivia		REF(EEU)	Hungary		.	.
ALM(LAM)	Brazil		REF(EEU)	Macedonia		ASIA(SAS)	Afghanistan
ALM(LAM)	Chile		REF(EEU)	Poland		ASIA(SAS)	Bangladesh
ALM(LAM)	Colombia		REF(EEU)	Romania		ASIA(SAS)	Bhutan
ALM(LAM)	Costa Rica		REF(EEU)	Slovakia		ASIA(SAS)	India
ALM(LAM)	Cuba		REF(EEU)	Slovenia		ASIA(SAS)	Nepal
ALM(LAM)	Dominica		REF(EEU)	Yugoslav SFR		ASIA(SAS)	Pakistan
ALM(LAM)	Dominican Rep		REF(EEU)	Yugoslavia		ASIA(SAS)	Sri Lanka
ALM(LAM)	Ecuador		.	.		.	.
ALM(LAM)	El Salvador		REF(NIS-FSU)	Armenia		ASIA(PAS)	American Samoa
ALM(LAM)	Grenada		REF(NIS-FSU)	Azerbaijan		ASIA(PAS)	Brunei
ALM(LAM)	Guadeloupe		REF(NIS-FSU)	Belarus		ASIA(PAS)	Fiji Islands
ALM(LAM)	Guatemala		REF(NIS-FSU)	Estonia		ASIA(PAS)	Fr Polynesia
ALM(LAM)	Guyana		REF(NIS-FSU)	Georgia		ASIA(PAS)	Indonesia
ALM(LAM)	Haiti		REF(NIS-FSU)	Kazakhstan		ASIA(PAS)	Kiribati
ALM(LAM)	Honduras		REF(NIS-FSU)	Kyrgyz Republic		ASIA(PAS)	Korea Rep
ALM(LAM)	Jamaica		REF(NIS-FSU)	Latvia		ASIA(PAS)	Malaysia
ALM(LAM)	Martinique		REF(NIS-FSU)	Lithuania		ASIA(PAS)	Myanmar
ALM(LAM)	Mexico		REF(NIS-FSU)	Moldova Rep		ASIA(PAS)	New Caledonia
ALM(LAM)	Netherlands Antilles		REF(NIS-FSU)	Russian Federation		ASIA(PAS)	Papua N Guinea
ALM(LAM)	Nicaragua		REF(NIS-FSU)	Tajikistan		ASIA(PAS)	Philippines
ALM(LAM)	Panama		REF(NIS-FSU)	Turkmenistan		ASIA(PAS)	Singapore
ALM(LAM)	Paraguay		REF(NIS-FSU)	Ukraine		ASIA(PAS)	Solomon Is
ALM(LAM)	Peru		REF(NIS-FSU)	USSR		ASIA(PAS)	St Helena
ALM(LAM)	St Kitts Nev		REF(NIS-FSU)	Uzbekistan		ASIA(PAS)	Thailand
ALM(LAM)	St Lucia					ASIA(PAS)	Tonga
ALM(LAM)	St Pierre Mq					ASIA(PAS)	Vanuatu

ALM(LAM)	St Vincent						
ALM(LAM)	Suriname		**ALM Region (MEA = N-Africa)**				**OECD Region WEU = Western Europe; NAM = North America; PAO = Pacific OECD countries)**
ALM(LAM)	Trinidad Tob		ALM(MEA)	Algeria		Andorra	OECD(WEU)
ALM(LAM)	Uruguay		ALM(MEA)	Bahrain		Austria	OECD(WEU)
ALM(LAM)	Venezuela		ALM(MEA)	Egypt		Belgium	OECD(WEU)
			ALM(MEA)	Iran		Belgium-Luxemburg	OECD(WEU)
ALM(SSAFR)	Angola		ALM(MEA)	Iraq		Cyprus	OECD(WEU)
ALM(SSAFR)	Benin		ALM(MEA)	Israel		Denmark	OECD(WEU)
ALM(SSAFR)	Botswana		ALM(MEA)	Jordan		Faeroe Is	OECD(WEU)
ALM(SSAFR)	Burkina Faso		ALM(MEA)	Kuwait		Finland	OECD(WEU)
ALM(SSAFR)	Burundi		ALM(MEA)	Lebanon		France	OECD(WEU)
ALM(SSAFR)	Cameroon					Germany	OECD(WEU)
ALM(SSAFR)	Cape Verde		ALM(MEA)	Libya		Gibraltar	OECD(WEU)
ALM(SSAFR)	Central African Republic		ALM(MEA)	Morocco		Greece	OECD(WEU)
ALM(SSAFR)	Chad		ALM(MEA)	Oman		Greenland	OECD(WEU)
ALM(SSAFR)	Comoros		ALM(MEA)	Qatar		Iceland	OECD(WEU)
ALM(SSAFR)	Congo, Dem R		ALM(MEA)	Saudi Arabia		Ireland	OECD(WEU)
ALM(SSAFR)	Congo, Rep		ALM(MEA)	Sudan		Italy	OECD(WEU)
ALM(SSAFR)	Côte d’Ivoire		ALM(MEA)	Syria		Liechtenstein	OECD(WEU)
ALM(SSAFR)	Djibouti		ALM(MEA)	Tunisia		Luxembourg	OECD(WEU)
ALM(SSAFR)	Equatorial Guinea		ALM(MEA)	United Arab Emirates		Malta	OECD(WEU)
ALM(SSAFR)	Eritrea		ALM(MEA)	Yemen		Monaco	OECD(WEU)
ALM(SSAFR)	Ethiopia					Netherlands	OECD(WEU)
ALM(SSAFR)	Ethiopia PDR					Norway	OECD(WEU)
ALM(SSAFR)	Gabon					Portugal	OECD(WEU)
ALM(SSAFR)	Gambia					Spain	OECD(WEU)
ALM(SSAFR)	Ghana					Sweden	OECD(WEU)
ALM(SSAFR)	Guinea					Switzerland	OECD(WEU)
ALM(SSAFR)	Guinea Bissau					Turkey	OECD(WEU)
ALM(SSAFR)	Kenya					UK	OECD(WEU)
ALM(SSAFR)	Lesotho						
ALM(SSAFR)	Liberia					Canada	OECD(NAM)
ALM(SSAFR)	Madagascar					Guam	OECD(NAM)
ALM(SSAFR)	Malawi					Puerto Rico	OECD(NAM)
ALM(SSAFR)	Mali					US Virgin Is	OECD(NAM)
ALM(SSAFR)	Mauritania					USA	OECD(NAM)
ALM(SSAFR)	Mauritius					.	.
ALM(SSAFR)	Mozambique					Australia	OECD(PAO)
ALM(SSAFR)	Namibia					Japan	OECD(PAO)
ALM(SSAFR)	Niger					New Zealand	OECD(PAO)

ALM(SSAFR)	Nigeria						
ALM(SSAFR)	Niue						
ALM(SSAFR)	Palau						
ALM(SSAFR)	Réunion						
ALM(SSAFR)	Rwanda						
ALM(SSAFR)	Senegal						
ALM(SSAFR)	Seychelles						
ALM(SSAFR)	Sierra Leone						
ALM(SSAFR)	Somalia						
ALM(SSAFR)	South Africa						
ALM(SSAFR)	Swaziland						
ALM(SSAFR)	Tanzania						
ALM(SSAFR)	Togo						
ALM(SSAFR)	Uganda						
ALM(SSAFR)	Western Sahara						
ALM(SSAFR)	Zambia						
ALM(SSAFR)	Zimbabwe						

APPENDIX 2. GDP (OR GNP WHEN NOT AVAILABLE) AND POPULATION CHANGES

as percentage of 1990 values over time in all four SRES scenarios

Percentage increases/decreases from 1990 data in GNP/GDP (mex) in the SRES regions											
A1 scenario (MiniCAM)											
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	47%	147%	289%	710%	1331%	2142%	3426%	4852%	6410%	8068%	9915%
Asia	0%	121%	364%	735%	1607%	2785%	4278%	6071%	7921%	9835%	11757%	13850%
OECD	0%	25%	57%	93%	111%	174%	228%	288%	356%	431%	526%	628%
REForm	0%	0%	27%	90%	218%	363%	536%	809%	1136%	1518%	1881%	2290%
World	0%	32%	84%	155%	287%	466%	694%	995%	1322%	1674%	2050%	2463%
A2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	47%	126%	226%	421%	673%	989%	1452%	1978%	2578%	3284%	4073%
Asia	0%	121%	292%	521%	828%	1207%	1657%	2257%	2978%	3814%	4835%	5985%
OECD	0%	25%	50%	73%	81%	109%	135%	160%	192%	230%	282%	339%
REForm	0%	0%	9%	36%	63%	100%	145%	236%	345%	490%	654%	854%
World	0%	32%	71%	115%	168%	235%	317%	425%	553%	701%	885%	1091%
B1 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	47%	147%	289%	657%	1147%	1773%	2636%	3510%	4405%	5242%	6152%
Asia	0%	121%	357%	721%	1450%	2335%	3371%	4421%	5442%	6435%	7321%	8264%
OECD	0%	25%	53%	84%	96%	138%	173%	208%	246%	287%	335%	386%
REForm	0%	0%	27%	81%	172%	272%	381%	545%	736%	945%	1118%	1318%
World	0%	32%	81%	146%	252%	386%	547%	734%	923%	1116%	1300%	1498%
B2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	47%	136%	257%	521%	868%	1310%	1926%	2589%	3300%	4052%	4884%
Asia	0%	121%	335%	635%	1150%	1750%	2442%	3228%	4071%	4971%	5935%	6992%
OECD	0%	25%	50%	74%	80%	103%	122%	135%	150%	168%	190%	214%
REForm	0%	0%	18%	63%	109%	163%	209%	309%	418%	536%	654%	790%
World	0%	32%	75%	128%	200%	287%	392%	517%	653%	800%	958%	1132%

Percentage increases/decreases from 1990 data in the SRES regions and scenarios in Population											
A1 scenario (MiniCAM)											
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	24%	51%	81%	104%	124%	141%	148%	150%	147%	135%	123%
Asia	0%	15%	29%	41%	47%	50%	51%	45%	38%	28%	16%	4%
OECD	0%	8%	15%	20%	22%	27%	28%	29%	30%	31%	31%	32%
REForm	0%	0%	0%	1%	1%	0%	-1%	-4%	-8%	-12%	-16%	-20%
World	0%	15%	29%	43%	53%	60%	64%	62%	59%	53%	43%	34%
A2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	26%	58%	94%	133%	172%	212%	248%	281%	309%	329%	349%
Asia	0%	18%	36%	54%	72%	90%	106%	121%	135%	147%	155%	164%
OECD	0%	9%	16%	22%	25%	33%	37%	42%	49%	57%	67%	78%
REForm	0%	0%	2%	6%	10%	15%	21%	28%	36%	45%	55%	65%
World	0%	17%	35%	54%	74%	94%	113%	131%	147%	162%	174%	185%
B1 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	24%	51%	81%	104%	124%	141%	148%	150%	147%	135%	123%
Asia	0%	15%	29%	41%	47%	50%	51%	45%	38%	28%	16%	4%
OECD	0%	8%	15%	20%	22%	27%	28%	29%	30%	31%	31%	32%
REForm	0%	0%	0%	1%	1%	0%	-1%	-4%	-8%	-12%	-16%	-20%
World	0%	15%	29%	43%	53%	60%	64%	62%	59%	53%	43%	34%
B2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ALM	0%	25%	55%	88%	120%	151%	180%	202%	219%	232%	236%	239%
Asia	0%	16%	32%	47%	59%	69%	77%	80%	81%	81%	76%	72%
OECD	0%	8%	14%	18%	19%	22%	22%	20%	20%	19%	19%	19%
REForm	0%	0%	0%	1%	2%	2%	1%	0%	-1%	-2%	-3%	-4%
World	0%	16%	32%	48%	63%	75%	86%	93%	97%	99%	98%	96%

Percentage increases/decreases from 1990 data in the SRES regions in Rural Population calculated from FAO98 country information

	1990	1995	2000	2005	2010	2015	2020	2025	2030
ALM	0%	7%	15%	23%	30%	37%	44%	49%	52%
Asia	0%	4%	6%	8%	8%	8%	7%	5%	2%
OECD	0%	-2%	-4%	-8%	-12%	-16%	-20%	-25%	-30%
REForm	0%	-4%	-9%	-13%	-17%	-21%	-25%	-30%	-34%
World	0%	4%	7%	9%	10%	11%	11%	10%	8%

Percentage increases/decreases from 1990 data in the SRES regions in Urban Population calculated from FAO98 country information

	1990	1995	2000	2005	2010	2015	2020	2025	2030
ALM	0%	18%	37%	59%	82%	108%	134%	162%	190%
Asia	0%	19%	41%	63%	87%	112%	138%	164%	190%
OECD	0%	5%	9%	13%	17%	21%	24%	28%	29%
REForm	0%	4%	6%	9%	12%	15%	17%	19%	21%
World	0%	13%	27%	41%	57%	74%	90%	108%	124%

Percentage increases/decreases from 1990 data in the SRES regions in Total Population calculated from FAO98 country information

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
ALM	0%	13%	26%	40%	56%	72%	89%	105%	121%	136%	149%
Asia	0%	8%	16%	23%	30%	37%	43%	49%	54%	58%	62%
OECD	0%	3%	6%	8%	10%	12%	14%	15%	15%	15%	14%
REForm	0%	0%	0%	0%	0%	1%	1%	0%	0%	-1%	-1%
World	0%	8%	15%	23%	30%	38%	45%	52%	58%	64%	69%

Percentage increases/decreases from 1990 data in the World Population calculated from World Bank world population information

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
World	0%	7%	15%	22%	28%	35%	42%	48%	53%	58%	62%

Percentages of the total population that are rural, urban, agrarian or non-agrarian in 1990 in the SRES regions calculated for 1990				
	AGR	**NONAGR**	**RURAL**	**URBAN**
ALM	45%	55%	51%	49%
Asia	63%	36%	73%	27%
OECD	12%	88%	25%	75%
REForm	21%	79%	37%	63%
World	47%	53%	57%	43%

World Development Indicator data of land distribution in 1990				
	Cropland	**Grasslands**	**Forest**	**Other Lands**
ALM	5%	20%	49%	26%
Asia	14%	19%	43%	24%
OECD	13%	25%	29%	32%
REForm	12%	17%	42%	29%
World	11%	24%	32%	33%

APPENDIX 3. CHANGES IN LAND-USE, ENERGY USE, SO_X EMISSIONS, AND NUCLEAR ENERGY

as percentage of 1990 baseline values in all four SRES scenarios

Percentage increases/decreases from 1990 data in Land Use in the SRES regions												
A1 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Cropland												
ALM	0%	-7%	-10%	-12%	-13%	-16%	-20%	-28%	-37%	-47%	-54%	-61%
Asia	0%	2%	5%	7%	6%	4%	0%	-10%	-19%	-29%	-39%	-49%
OECD	0%	0%	0%	0%	-1%	-7%	-13%	-24%	-34%	-43%	-51%	-60%
REForm	0%	3%	7%	11%	13%	13%	9%	-3%	-19%	-35%	-44%	-52%
World	0%	0%	0%	1%	0%	-2%	-7%	-17%	-28%	-39%	-47%	-56%
Forest												
ALM	0%	-1%	-4%	-9%	-14%	-19%	-23%	-20%	-16%	-10%	-5%	-1%
Asia	0%	-2%	-5%	-10%	-16%	-20%	-23%	-20%	-16%	-9%	-4%	0%
OECD	0%	1%	0%	-2%	-5%	-13%	-17%	-10%	-1%	8%	11%	14%
REForm	0%	0%	-1%	-6%	-14%	-21%	-26%	-18%	-7%	5%	10%	14%
World	0%	1%	0%	-5%	-13%	-20%	-26%	-20%	-11%	1%	6%	11%
Grassland												
ALM	0%	5%	14%	26%	39%	49%	57%	51%	43%	31%	22%	12%
Asia	0%	3%	9%	18%	27%	34%	39%	38%	36%	31%	26%	20%
OECD	0%	3%	8%	16%	20%	31%	35%	31%	26%	19%	12%	5%
REForm	0%	3%	14%	33%	54%	71%	84%	73%	55%	33%	23%	14%
World	0%	4%	12%	23%	35%	45%	52%	47%	39%	28%	20%	12%
Other land												
ALM	0%	-3%	-8%	-13%	-15%	-16%	-16%	-16%	-15%	-15%	-12%	-10%
Asia	0%	-4%	-9%	-14%	-17%	-17%	-17%	-17%	-16%	-15%	-12%	-9%
OECD	0%	-3%	-8%	-13%	-14%	-15%	-15%	-15%	-14%	-13%	-11%	-9%
REForm	0%	-4%	-9%	-15%	-17%	-18%	-17%	-17%	-16%	-15%	-12%	-9%
World	0%	-4%	-8%	-13%	-15%	-16%	-16%	-16%	-15%	-14%	-12%	-9%
A2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Cropland												
ALM	0%	-5%	-6%	-1%	3%	5%	6%	3%	0%	-1%	-3%	-4%
Asia	0%	3%	8%	14%	18%	21%	22%	18%	16%	14%	12%	11%
OECD	0%	1%	4%	9%	10%	12%	12%	7%	5%	3%	2%	1%
REForm	0%	4%	11%	21%	29%	34%	36%	29%	24%	21%	22%	23%
World	0%	0%	4%	10%	14%	17%	18%	13%	10%	8%	7%	6%
Forest												
ALM	0%	-1%	-4%	-8%	-13%	-16%	-19%	-19%	-19%	-19%	-20%	-21%
Asia	0%	-2%	-5%	-10%	-15%	-19%	-22%	-23%	-23%	-23%	-24%	-25%
OECD	0%	0%	0%	-3%	-4%	-9%	-9%	-4%	-1%	0%	-2%	-5%
REForm	0%	0%	-1%	-6%	-12%	-16%	-19%	-13%	-10%	-8%	-12%	-16%
World	0%	0%	0%	-5%	-11%	-16%	-18%	-13%	-10%	-9%	-12%	-16%
Grassland												
ALM	0%	5%	13%	22%	31%	38%	44%	42%	41%	40%	42%	44%
Asia	0%	2%	7%	13%	19%	24%	28%	29%	30%	31%	32%	33%
OECD	0%	2%	7%	12%	15%	20%	23%	22%	22%	23%	24%	25%

REForm	0%	3%	12%	26%	38%	48%	54%	48%	45%	44%	50%	55%
World	0%	4%	10%	19%	26%	33%	37%	36%	35%	35%	37%	39%
Other land												
ALM	0%	-4%	-8%	-11%	-13%	-15%	-18%	-21%	-24%	-25%	-24%	-24%
Asia	0%	-5%	-9%	-14%	-16%	-18%	-20%	-24%	-27%	-28%	-27%	-26%
OECD	0%	-4%	-8%	-12%	-13%	-16%	-18%	-22%	-24%	-25%	-24%	-24%
REForm	0%	-5%	-10%	-14%	-16%	-19%	-21%	-25%	-28%	-29%	-28%	-27%
World	0%	-4%	-8%	-12%	-14%	-16%	-19%	-22%	-25%	-26%	-25%	-25%
B1 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Cropland												
ALM	0%	-7%	-12%	-15%	-20%	-27%	-34%	-42%	-51%	-59%	-65%	-71%
Asia	0%	2%	4%	4%	2%	-2%	-8%	-22%	-34%	-45%	-52%	-58%
OECD	0%	0%	0%	-2%	-5%	-15%	-25%	-36%	-45%	-52%	-61%	-69%
REForm	0%	3%	5%	7%	3%	-2%	-11%	-27%	-41%	-53%	-58%	-64%
World	0%	0%	-1%	-2%	-6%	-12%	-20%	-32%	-43%	-52%	-59%	-66%
Forest												
ALM	0%	-1%	-4%	-8%	-11%	-13%	-14%	-10%	-5%	0%	3%	6%
Asia	0%	-2%	-5%	-9%	-12%	-13%	-12%	-7%	0%	5%	9%	13%
OECD	0%	1%	0%	-2%	-4%	-6%	-5%	5%	12%	18%	21%	24%
REForm	0%	0%	0%	-5%	-11%	-13%	-13%	-1%	8%	15%	13%	11%
World	0%	0%	0%	-5%	-10%	-13%	-14%	-3%	6%	13%	14%	15%
Grassland												
ALM	0%	5%	13%	24%	34%	40%	43%	35%	25%	14%	9%	3%
Asia	0%	3%	9%	18%	26%	32%	36%	32%	27%	21%	16%	12%
OECD	0%	3%	8%	17%	20%	28%	30%	24%	17%	11%	6%	1%
REForm	0%	3%	14%	32%	48%	58%	62%	42%	24%	8%	8%	7%
World	0%	4%	11%	22%	32%	38%	41%	33%	23%	14%	9%	5%
Other land												
ALM	0%	-3%	-7%	-10%	-11%	-11%	-10%	-10%	-9%	-7%	-2%	1%
Asia	0%	-4%	-8%	-12%	-12%	-11%	-10%	-10%	-8%	-5%	0%	5%
OECD	0%	-3%	-7%	-10%	-10%	-10%	-9%	-9%	-7%	-4%	0%	4%
REForm	0%	-4%	-9%	-12%	-12%	-12%	-11%	-10%	-9%	-6%	0%	4%
World	0%	-4%	-7%	-11%	-11%	-11%	-10%	-10%	-8%	-6%	-1%	3%
B2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Cropland												
ALM	0%	-6%	-9%	-9%	-10%	-12%	-16%	-23%	-30%	-37%	-42%	-48%
Asia	0%	3%	6%	9%	10%	10%	7%	-2%	-10%	-17%	-22%	-28%
OECD	0%	0%	2%	3%	2%	-2%	-8%	-16%	-24%	-29%	-36%	-42%
REForm	0%	3%	8%	14%	16%	14%	10%	-2%	-13%	-23%	-28%	-33%
World	0%	0%	1%	3%	3%	1%	-2%	-12%	-20%	-27%	-32%	-38%
Forest												
ALM	0%	-1%	-4%	-8%	-12%	-15%	-17%	-14%	-11%	-8%	-7%	-5%
Asia	0%	-2%	-5%	-9%	-13%	-16%	-17%	-14%	-11%	-7%	-4%	-2%
OECD	0%	1%	0%	-2%	-4%	-8%	-7%	0%	6%	10%	10%	10%
REForm	0%	0%	-1%	-6%	-12%	-15%	-16%	-7%	0%	5%	3%	0%
World	0%	0%	0%	-5%	-11%	-15%	-16%	-8%	-1%	3%	2%	1%

Grassland												
ALM	0%	5%	13%	23%	33%	40%	45%	40%	35%	30%	28%	26%
Asia	0%	2%	8%	15%	23%	28%	33%	32%	31%	28%	27%	26%
OECD	0%	3%	8%	15%	18%	25%	28%	25%	22%	19%	18%	17%
REForm	0%	3%	13%	29%	44%	55%	62%	49%	40%	31%	33%	36%
World	0%	4%	11%	21%	30%	36%	41%	36%	32%	27%	26%	25%
Other land												
ALM	0%	-3%	-7%	-11%	-12%	-13%	-13%	-15%	-15%	-14%	-11%	-8%
Asia	0%	-4%	-9%	-13%	-13%	-14%	-14%	-16%	-16%	-15%	-11%	-7%
OECD	0%	-4%	-7%	-11%	-11%	-12%	-13%	-14%	-14%	-13%	-10%	-6%
REForm	0%	-5%	-9%	-13%	-14%	-15%	-15%	-17%	-17%	-16%	-12%	-8%
World	0%	-4%	-8%	-11%	-12%	-13%	-14%	-15%	-15%	-14%	-11%	-7%

Percentage increases/decreases from 1990 in Final Energy Use in the SRES regions												
A1 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
						GAS						
ALM	0%	41%	125%	250%	550%	841%	1141%	1500%	1808%	2075%	1325%	575%
Asia	0%	180%	540%	1100%	2220%	3200%	4080%	4680%	5060%	5220%	3200%	1180%
OECD	0%	36%	86%	150%	159%	180%	193%	221%	250%	283%	173%	60%
REForm	0%	-22%	-22%	8%	37%	51%	53%	64%	71%	73%	4%	-62%
World	0%	21%	71%	150%	241%	324%	396%	474%	538%	587%	350%	113%
Liquids												
ALM	0%	29%	70%	117%	152%	229%	341%	476%	605%	735%	882%	1035%
Asia	0%	35%	92%	157%	235%	335%	457%	564%	657%	742%	828%	921%
OECD	0%	1%	-2%	-15%	-29%	-58%	-61%	-58%	-55%	-51%	-40%	-29%
REForm	0%	-33%	-50%	-38%	-33%	-22%	-11%	5%	16%	27%	27%	33%
World	0%	4%	10%	19%	19%	33%	62%	96%	130%	162%	200%	239%
Solids												
ALM	0%	50%	100%	200%	350%	400%	450%	350%	300%	250%	250%	300%
Asia	0%	55%	125%	210%	265%	290%	280%	170%	100%	60%	55%	55%
OECD	0%	30%	20%	-10%	-10%	-30%	-50%	-60%	-70%	-70%	-60%	-50%
REForm	0%	-23%	-30%	-30%	-38%	-38%	-38%	-53%	-69%	-69%	-69%	-69%
World	0%	26%	57%	91%	117%	128%	120%	62%	20%	0%	2%	4%
Electricity												
ALM	0%	100%	266%	500%	1166%	2033%	3033%	4466%	5966%	7500%	9200%	10900%
Asia	0%	175%	525%	1075%	2150%	3425%	4900%	6250%	7525%	8700%	9450%	10200%
OECD	0%	27%	50%	63%	68%	81%	90%	131%	186%	245%	363%	481%
REForm	0%	33%	116%	250%	450%	633%	833%	1033%	1216%	1383%	1466%	1533%
World	0%	51%	134%	251%	468%	725%	1020%	1360%	1694%	2028%	2345%	2665%
Total Final Energy												
ALM	0%	40%	103%	188%	344%	562%	848%	1174%	1500%	1818%	1981%	2144%
Asia	0%	67%	170%	307%	495%	705%	940%	1090%	1237%	1385%	1427%	1472%
OECD	0%	16%	32%	50%	50%	57%	76%	93%	114%	139%	140%	142%
REForm	0%	-21%	-19%	1%	25%	50%	75%	100%	123%	144%	139%	135%
World	0%	18%	49%	94%	145%	212%	294%	367%	441%	516%	540%	564%
A2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Gas												

ALM	0%	41%	108%	191%	325%	408%	433%	500%	583%	691%	658%	633%
Asia	0%	180%	420%	740%	880%	960%	1060%	1140%	1280%	1480%	1400%	1280%
OECD	0%	32%	70%	111%	109%	88%	63%	49%	45%	49%	27%	4%
REForm	0%	-22%	-33%	-33%	-33%	-37%	-46%	-46%	-42%	-35%	-44%	-48%
World	0%	19%	51%	92%	109%	111%	101%	104%	118%	140%	119%	100%
Liquids												
ALM	0%	29%	58%	94%	117%	182%	282%	388%	511%	652%	788%	923%
Asia	0%	42%	85%	128%	150%	200%	285%	371%	471%	585%	700%	814%
OECD	0%	0%	-2%	-6%	-13%	-26%	-20%	-20%	-15%	-5%	5%	15%
REForm	0%	-33%	-55%	-61%	-61%	-61%	-55%	-50%	-38%	-22%	-11%	-5%
World	0%	3%	8%	14%	12%	23%	51%	78%	112%	152%	192%	233%
Solids												
ALM	0%	50%	150%	250%	450%	650%	850%	900%	1000%	1050%	1100%	1150%
Asia	0%	65%	130%	200%	240%	290%	340%	340%	360%	395%	410%	430%
OECD	0%	20%	30%	30%	30%	40%	60%	50%	40%	50%	50%	60%
REForm	0%	-23%	-30%	-46%	-46%	-38%	-30%	-30%	-30%	-30%	-30%	-30%
World	0%	28%	62%	95%	122%	153%	191%	191%	202%	222%	233%	244%
Electricity												
ALM	0%	100%	233%	433%	833%	1400%	2066%	3033%	4166%	5433%	6900%	8366%
Asia	0%	175%	450%	825%	1125%	1575%	2100%	2900%	3875%	5000%	6375%	7750%
OECD	0%	27%	59%	95%	113%	168%	213%	236%	277%	336%	409%	481%
REForm	0%	33%	83%	133%	166%	233%	300%	433%	583%	750%	933%	1116%
World	0%	51%	122%	211%	311%	442%	602%	814%	1071%	1377%	1737%	2097%
Total Final Energy												
ALM	0%	40%	92%	151%	244%	366%	518%	700%	914%	1159%	1403%	1648%
Asia	0%	75%	157%	247%	307%	392%	500%	610%	752%	930%	1112%	1297%
OECD	0%	13%	23%	30%	28%	27%	33%	33%	42%	58%	76%	93%
REForm	0%	-21%	-30%	-30%	-26%	-23%	-14%	1%	21%	44%	67%	89%
World	0%	18%	39%	64%	82%	110%	148%	189%	243%	310%	379%	448%
B1 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Gas												
ALM	0%	16%	83%	175%	300%	391%	433%	450%	475%	483%	508%	533%
Asia	0%	160%	420%	820%	1080%	1240%	1300%	1260%	1160%	1080%	1060%	1040%
OECD	0%	16%	40%	72%	63%	45%	32%	24%	22%	26%	31%	37%
REForm	0%	-22%	-24%	-2%	-2%	-11%	-26%	-37%	-46%	-53%	-55%	-60%
World	0%	9%	36%	85%	103%	109%	101%	95%	90%	86%	88%	92%
Liquids												
ALM	0%	11%	35%	64%	94%	141%	205%	252%	294%	329%	347%	370%
Asia	0%	28%	64%	107%	142%	185%	235%	257%	278%	292%	292%	292%
OECD	0%	-12%	-23%	-33%	-40%	-52%	-51%	-51%	-50%	-47%	-45%	-43%
REForm	0%	-33%	-55%	-55%	-55%	-55%	-61%	-61%	-61%	-66%	-66%	-66%
World	0%	-7%	-9%	-6%	-6%	1%	17%	25%	33%	42%	45%	49%
Solids												
ALM	0%	50%	100%	150%	250%	300%	350%	250%	200%	150%	150%	150%
Asia	0%	35%	70%	110%	130%	130%	105%	45%	0%	-20%	-30%	-35%
OECD	0%	10%	0%	-30%	-30%	-30%	-40%	-50%	-60%	-70%	-70%	-70%
REForm	0%	-23%	-38%	-46%	-53%	-61%	-69%	-76%	-84%	-84%	-92%	-92%
World	0%	11%	22%	33%	46%	46%	35%	-4%	-28%	-44%	-46%	-51%

Electricity												
ALM	0%	66%	166%	300%	600%	1000%	1500%	2000%	2466%	2866%	3000%	3100%
Asia	0%	150%	375%	700%	1075%	1475%	1925%	2275%	2525%	2725%	2675%	2625%
OECD	0%	9%	13%	22%	27%	40%	59%	72%	90%	109%	113%	113%
REForm	0%	33%	83%	150%	183%	216%	250%	266%	283%	266%	250%	233%
World	0%	31%	80%	142%	222%	320%	428%	525%	605%	671%	677%	680%
Total Final Energy												
ALM	0%	22%	59%	111%	192%	281%	385%	466%	537%	603%	637%	666%
Asia	0%	47%	110%	187%	252%	312%	362%	372%	385%	400%	390%	382%
OECD	0%	-1%	-3%	-5%	-10%	-17%	-16%	-16%	-13%	-9%	-6%	-3%
REForm	0%	-21%	-28%	-17%	-16%	-17%	-19%	-25%	-28%	-32%	-35%	-39%
World	0%	4%	16%	34%	49%	66%	85%	94%	104%	115%	118%	121%
B2 scenario (MiniCAM)												
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
Gas												
ALM	0%	33%	100%	200%	375%	541%	675%	883%	1100%	1325%	1425%	1516%
Asia	0%	180%	460%	860%	1200%	1520%	1840%	2200%	2560%	2880%	2880%	2900%
OECD	0%	26%	65%	111%	111%	103%	93%	90%	91%	103%	101%	100%
REForm	0%	-22%	-28%	-20%	-20%	-24%	-33%	-35%	-31%	-26%	-26%	-28%
World	0%	15%	50%	104%	135%	159%	177%	209%	247%	290%	299%	307%
Liquids												
ALM	0%	23%	58%	100%	135%	205%	329%	452%	582%	711%	811%	917%
Asia	0%	35%	85%	150%	192%	257%	357%	457%	550%	635%	692%	750%
OECD	0%	-4%	-8%	-12%	-20%	-34%	-31%	-31%	-30%	-27%	-26%	-23%
REForm	0%	-33%	-55%	-55%	-61%	-61%	-61%	-61%	-61%	-55%	-55%	-50%
World	0%	0%	4%	15%	14%	28%	58%	88%	118%	147%	170%	193%
Solids												
ALM	0%	50%	150%	200%	350%	500%	650%	600%	600%	600%	600%	600%
Asia	0%	50%	110%	175%	220%	245%	260%	195%	160%	150%	150%	150%
OECD	0%	20%	20%	10%	10%	10%	10%	-20%	-30%	-40%	-40%	-40%
REForm	0%	-23%	-38%	-46%	-53%	-61%	-61%	-69%	-76%	-76%	-76%	-76%
World	0%	22%	48%	75%	100%	115%	128%	88%	66%	62%	62%	60%
Electricity												
ALM	0%	100%	200%	400%	800%	1333%	2000%	2866%	3766%	4666%	5533%	6400%
Asia	0%	175%	450%	825%	1275%	1825%	2450%	3175%	3900%	4625%	5275%	5925%
OECD	0%	18%	40%	63%	72%	100%	127%	136%	145%	154%	168%	186%
REForm	0%	33%	66%	133%	150%	183%	216%	233%	266%	316%	350%	383%
World	0%	45%	108%	191%	291%	417%	568%	734%	905%	1080%	1242%	1405%
Total Final Energy												
ALM	0%	33%	85%	155%	259%	396%	574%	770%	981%	1200%	1377%	1559%
Asia	0%	65%	147%	250%	340%	440%	550%	632%	730%	842%	927%	1012%
OECD	0%	8%	16%	23%	20%	14%	18%	17%	20%	25%	29%	33%
REForm	0%	-21%	-30%	-25%	-25%	-26%	-26%	-26%	-23%	-16%	-10%	-7%
World	0%	13%	33%	62%	83%	113%	151%	185%	225%	270%	305%	341%

Percentage increases/decreases from 1990 data in the SRES regions in SO_x emissions indicating industry development, but when decreasing, possibly clean air technology

A1 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	21%	39%	46%	45%	42%	38%	0%	-21%	-29%	-22%	-15%
Asia	0%	42%	114%	182%	167%	116%	28%	-19%	-46%	-53%	-46%	-40%
OECD	0%	-25%	-42%	-90%	-95%	-98%	-98%	-96%	-93%	-90%	-85%	-80%
REForm	0%	-35%	-40%	-40%	-37%	-44%	-62%	-80%	-90%	-91%	-89%	-87%
World	0%	-2%	11%	13%	9%	-6%	-33%	-54%	-66%	-68%	-63%	-58%

A2 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	21%	39%	46%	72%	106%	148%	167%	164%	140%	108%	76%
Asia	0%	42%	107%	159%	188%	215%	240%	236%	216%	183%	145%	108%
OECD	0%	-25%	-28%	-63%	-66%	-70%	-74%	-76%	-76%	-74%	-71%	-67%
REForm	0%	-35%	-38%	-41%	-30%	-20%	-9%	-5%	-3%	-4%	-12%	-20%
World	0%	-2%	14%	16%	28%	42%	55%	58%	53%	41%	26%	11%

B1 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	21%	23%	27%	26%	21%	14%	-14%	-36%	-50%	-54%	-58%
Asia	0%	42%	76%	108%	92%	57%	1%	-37%	-62%	-73%	-75%	-76%
OECD	0%	-25%	-46%	-70%	-74%	-78%	-81%	-83%	-85%	-85%	-84%	-83%
REForm	0%	-35%	-43%	-47%	-44%	-49%	-61%	-78%	-89%	-94%	-92%	-92%
World	0%	-2%	-2%	-2%	-7%	-19%	-38%	-57%	-69%	-75%	-76%	-76%

B2 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	21%	35%	45%	60%	83%	115%	100%	78%	50%	25%	0%
Asia	0%	42%	102%	157%	174%	172%	152%	95%	48%	9%	-9%	-29%
OECD	0%	-25%	-41%	-69%	-72%	-75%	-77%	-80%	-81%	-80%	-78%	-76%
REForm	0%	-35%	-40%	-43%	-38%	-35%	-34%	-48%	-60%	-70%	-75%	-81%
World	0%	-2%	8%	13%	20%	22%	21%	1%	-16%	-32%	-42%	-51%

Percentage increases/decreases from 1990 data in the SRES regions in Nuclear Energy, possibly standing for 'investment'

A1 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	200%	400%	700%	1100%	1600%	2100%	2700%	3200%	3800%	7200%	10500%
Asia	0%	300%	800%	1600%	2600%	3600%	4600%	5000%	5400%	5900%	9600%	13400%
OECD	0%	-20%	-35%	-40%	-45%	-55%	-60%	-55%	-50%	-40%	30%	95%
REForm	0%	33%	100%	233%	266%	300%	333%	333%	366%	400%	666%	933%
World	0%	4%	37%	87%	150%	212%	270%	316%	366%	420%	808%	1195%

A2 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	200%	400%	600%	1200%	1900%	2700%	3300%	4100%	5000%	6200%	7400%
Asia	0%	300%	700%	1200%	1800%	2600%	3700%	4200%	4900%	6000%	7400%	8800%
OECD	0%	-25%	-35%	-30%	-30%	-20%	-10%	-10%	-5%	10%	35%	60%
REForm	0%	33%	66%	100%	133%	166%	233%	266%	300%	366%	466%	533%
World	0%	4%	25%	62%	120%	195%	287%	337%	412%	516%	654%	791%

B1 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	200%	300%	400%	800%	1100%	1400%	1500%	1400%	1300%	1400%	1400%
Asia	0%	200%	600%	1000%	1700%	2200%	2500%	2300%	2000%	1600%	1600%	1600%
OECD	0%	-35%	-55%	-60%	-60%	-60%	-65%	-65%	-70%	-70%	-70%	-65%
REForm	0%	33%	66%	133%	133%	133%	100%	66%	33%	0%	0%	0%
World	0%	-8%	0%	20%	70%	104%	125%	112%	91%	58%	66%	70%

B2 scenario (MiniCAM)

	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ALM	0%	200%	400%	500%	900%	1600%	2300%	2900%	3600%	4300%	5500%	6800%
Asia	0%	300%	700%	1100%	1900%	2800%	3900%	4400%	5000%	5600%	7000%	8300%
OECD	0%	-25%	-40%	-45%	-45%	-45%	-40%	-40%	-40%	-35%	-20%	0%
REForm	0%	33%	66%	100%	100%	100%	133%	100%	100%	133%	166%	200%
World	0%	0%	16%	41%	91%	158%	241%	287%	337%	400%	525%	654%

APPENDIX 4. DEMOGRAPHIC PROJECTIONS

as percentage change from 1990 baseline data calculated from World Bank data (historic data for all countries are available from the World Bank, the World Resources Institute, and UNDP)

World Bank									
	1995-00	**2000-05**	**2005-10**	**2010-15**	**2015-20**	**2020-25**	**2025-30**	**2030-35**	**2035-40**
Birth rate	22%	21%	19%	19%	18%	17%	16%	16%	15%
Death rate	9%	9%	9%	9%	9%	9%	9%	9%	10%
Rate of natural increase	1%	1%	1%	1%	1%	1%	1%	1%	1%
Net migration rate	0%	0%	0%	0%	0%	0%	0%	0%	0%
Growth rate	1%	1%	1%	1%	1%	1%	1%	1%	1%
Total fertility rate	3%	3%	2%	2%	2%	2%	2%	2%	2%
Net reproduction rate	1%	1%	1%	1%	1%	1%	1%	1%	1%
Life expectancy at birth	67%	67%	68%	70%	70%	71%	72%	73%	73%
Life expectancy at age 15	57%	56%	57%	58%	58%	59%	59%	60%	61%
Infant mortality rate	53%	49%	43%	36%	34%	31%	28%	25%	23%