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BERKSHIRE ENCYCLOPEDIA OF SUSTAINABILITY

The Americas and Oceania: Assessing Sustainability

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VOLUME 8

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THE AMERICAS AND OCEANIA: ASSESSING SUSTAINABILITY

Editors Sara G. Beavis, *The Australian National University*; Michael L. Dougherty, *Illinois State University*; Tirso Gonzales, *University of British Columbia Okanagan*

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Queen Elizabeth Islands
Ellesmere Island
Parry Islands
Greenland
Greenland Sea
Beaufort Sea
Baffin Bay
Victoria Island
Baffin Island
Norwegian Sea
Iceland
Faroe Islands
Hudson Bay
Labrador Sea
Gulf of Alaska
Canada
Island of Newfoundland
Norway
U. K.
North Sea
Denmark
Ireland
Neth.
Belgium
Lux.
France
Switz.
And.
Portugal
Spain
San Mar
Azores
North Pacific Ocean
North Atlantic Ocean
United States
Morocco
Canary Islands
Western Sahara
(Occupied by Morocco)
Algeria
Mauritania
Mali
Senegal
Gambia
Guinea-Bissau
Guinea
Burkina Faso
Ghana
Benin
Sierra Leone
Liberia
Cote d'Ivoire
Togo
Equatorial Guinea
Sao Tome & Principe
Cape Verde
Gulf of Mexico
Mexico
Bahamas
Cuba
Haiti
Dom. Rep.
Puerto Rico
St Kitts & Nevis
Antigua & Barbuda
St Lucia
Barbados
Dominica
Jamaica
Belize
Honduras
Guatemala
El Salvador
Caribbean Sea
St Vincent & the Grenadines
Grenada
Nicaragua
Panama
Costa Rica
Trinidad & Tobago
Venezuela
Guyana
French Guiana
Suriname
Colombia
Ecuador
Brazil
Peru
Bolivia
Chile
Paraguay
Uruguay
Argentina
South Pacific Ocean
South Atlantic Ocean
Falkland Islands
South Georgia
Tierra Del Fuego

The darkened areas on this map indicate regions covered in this volume.

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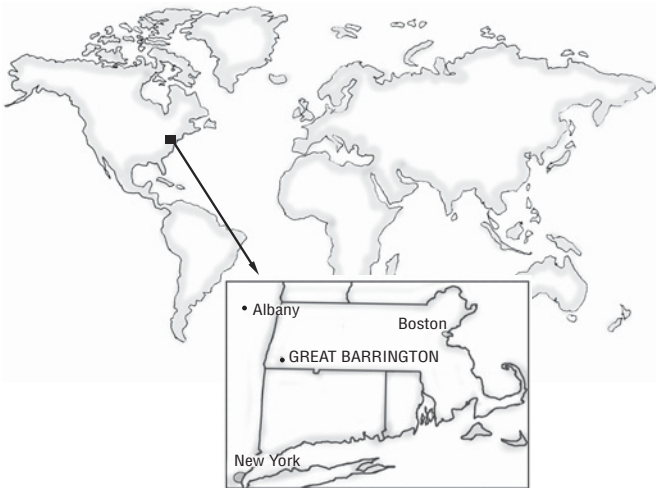

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Introduction to Volume 8

This volume, titled *The Americas and Oceania: Assessing Sustainability*, is the second of three regional volumes of the *Encyclopedia of Sustainability*. (Volume 7 focuses on China, India, and East and Southeast Asia; Volume 9 deals with Africa and Eurasia.) The regional volumes have a particular focus on the assessment of sustainability in each of these regions, which allows the reader to understand the variability of sustainability at a regional scale. This volume has a range of important articles—from the general to the specific in both topical and geographic terms. This volume also represents a very interdisciplinary take on sustainability with entries written by natural scientists, social scientists, philosophers, and humanists.

From the Earth Summit to Rio+20

The United Nations promoted the concept of sustainable development beginning in the 1980s as a way to address the dual crises of environmental degradation and persistent poverty in the developing world. In 1983 the United Nations convened the World Commission on Environment and Development, commonly referred to as the Brundtland Commission. Its 1987 report, *Our Common Future*, laid out a series of global challenges including uneven growth, food insecurity, species decline, and energy and resource depletion, and put forward a model of sustainable development as the solution. The Brundtland report's definition of sustainable development, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," remains the standard definition today.

The 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil (commonly known as the Earth Summit), built upon the work of the Brundtland Commission, further establishing concrete mechanisms to achieve sustainable development. Additionally, the conference produced the nonbinding Rio Declaration on Environment and Development, which put forth the twenty-seven principles, known as the Rio Principles, intended to guide future sustainable development. The Earth Summit succeeded in changing the discussion around environmental issues from government regulation to market provision of sustainable growth. The Rio Declaration, in large part, has made sustainability the dominant environmental discourse of recent decades. Yet, the outcomes of the Earth Summit and the sustainable development model in general for biodiversity conservation and environmental protection have been mixed. In this volume, Sandy Irvine's article, "Rio Earth Summit," does an excellent job of documenting and discussing this mixed record.

In 2012 we are celebrating the twentieth anniversary of the Earth Summit and the Rio Principles. It is, therefore, no coincidence that these final volumes of the *Berkshire Encyclopedia of Sustainability* are being published at this precise historical moment—to commemorate the Earth Summit and celebrate Rio+20, the United Nations Conference on Sustainable Development that took place in Rio de Janeiro, Brazil, in June of 2012. This conference—like its namesake the 1992 Earth Summit—brought together representatives of governments around the world (including heads of state) along with international institutions, organizations, researchers, and members of civil society to develop strategies for advancing poverty reduction and sustainability.

The original Earth Summit was vaguer than Rio+20 in the way it conceived sustainable development. Where the original Earth Summit was focused on conceptually linking environmental stewardship and economic growth more generally, Rio+20 specifically focused on honing and reaching consensus around strategies of the so-called green economy to stem the tide of climate change. The United Nations identified seven critical axes that

made up the focus of the Rio+20 meetings: jobs, energy, cities, food, water, oceans, and disasters. The model of the green economy—economic revitalization through transforming our energy, waste management, and transportation infrastructures—is a set of ideas that captures the spirit of the original Rio Principles but with much more coherence and specificity. Further, where the original conference was focused on environmental issues more broadly, Rio+20 focused more specifically on the urgent issue of global climate change. Because the emphasis of these meetings was more specific, and because climate change is such an urgent and salient issue today, there was hope that Rio+20 would produce concrete and binding resolutions that would bring us closer to the elusive goal of sustainable development. Unfortunately, though, this does not appear to have happened. Although it is too soon to judge the long-term outcome of Rio+20, many commentators seem to be of the opinion that the meeting had low expectations for any real change in global climate change governance, and that even these low expectations were not met; the consensus on the meeting's legacy appears to be that the major changes in environmental behavior that the world desperately needs must be made first by individuals and groups, rather than waiting for governments to act.

Rio de Janeiro (Rio), Brazil's second-largest and best-known city, was a fitting site for this meeting, as it was for the original Earth Summit in 1992. Rio is located in an ecologically important stretch of Atlantic rain forest, a global biodiversity hotspot. In addition, Rio is a massive, industrial city with sprawling slums (*favelas*) ringing the urban core. Being both a biodiversity hotspot and a source of a great deal of contamination and ecosystem degradation made Rio an ideal site, both symbolically and practically, for this conference. Rio represents the contradictions of development and is a place where sustainability must be worked out and put in place. Further, under Brazilian President Luiz Inácio Lula da Silva (in office from 2003–2010), cash transfer programs and social policies helping the poor succeeded in dramatically reducing inequality during a period of high economic growth (Seidman 2010). Achieving economic growth and economic justice simultaneously has been a rare outcome throughout modern world history. Therefore, Brazil serves as a symbol of growth with justice and was thus further appropriate as a site for Rio+20. In this volume, Colin Crawford's article, "Rio de Janeiro," captures many of these complex issues in great detail.

Toward *Developing Sustainability*

The Rio+20 United Nations Conference on Sustainable Development, like its predecessors, made it clear that the emphasis in the term *sustainable development* is on the noun, *development,* and that *sustainability* is relegated to adjective status. This focus has changed little since the original Rio Principles stated, "Human beings are at the center of concerns for sustainable development." Terminology used throughout the original Rio Declaration—"production, exploitation, technology, and free trade"—underscored the intent of the doctrine to address environmental ills as spillovers of advocating economic growth. The Earth Summit took the position that both poverty and wealth were leading causes of environmental degradation, and therefore framed economic growth itself as a solution to environmental ills as well as a cause. As the Rio Principles suggest, sustainable development is a model in which environmental stewardship and economic growth are understood not simply as complementary but as codependent. One cannot exist without the other.

Because sustainable development treats economic growth and environmental stewardship as correlated, it has wide appeal across the political and geographic spectrums. Further, since *sustainable* is used widely to apply to a broad range of institutions, the meaning has become so diluted as to be virtually meaningless. The win-win framing of sustainable development, as well as its definitional ambiguity, has imbued sustainability with a near-universal appeal. As the sociologists Craig Humphrey, Tammy Lewis, and Frederick Buttel (2002, 224) point out, no politician has ever come out in favor of "unsustainable development."

Regarding the definitional problem, economist Herman Daly (1996, 2003) has pointed out that it is unclear what exactly is being sustained in discussions about sustainability. Is it the economic growth that we are sustaining or is it the Earth's stocks of biophysical resources? Daly calls the former of these interpretations *the utility definition,* and the latter *the throughput definition*. The utility definition suggests that the happiness of future generations is to be non-declining. This is the common definition bequeathed by Brundtland, Rio, and subsequent conferences. Daly's favored definition, the throughput definition, takes nature as its focal point rather than human society. The throughout definition holds that resource inputs into economic production be returned to nature's resource stocks in the same proportions in which they are extracted.

Following the throughput definition, then, is human society practicing sustainability? Regrettably, we haven't been converting proportional amounts of outputs into inputs (throughput) since the late 1970s. In 1961, human society was consuming approximately half of what the Earth could provide in terms of energy and material resources, but we crossed the sustainability threshold in the late 1970s. By 2010, human civilization was consuming approximately one and a half times what the Earth could sustainably supply. We are drawing down nature's stocks 50 percent faster than they can be replenished, and this pattern is intensifying every year (Ewing et al. 2010).

In light of our wildly unsustainable current rate of resource consumption, we must move beyond the Brundtland utility definition. We must shift the focus away from the phrase *sustainable development*—where *sustainable* merely modifies the noun *development*—to a focus on *developing sustainability,* where *sustainability* itself becomes the operative noun. Many hoped that Rio+20 would have taken such a revised conceptual framework seriously, although (admittedly) this would have been difficult to accomplish at a conference designed for broad appeal and intended to achieve consensus among the world's diverse heads of state. As Sandy Irvine highlights in the article titled "Rio Earth Summit" in this volume, neither the original Earth Summit nor Rio+20 were focused on reducing consumption as a centerpiece of the agenda.

The Value of This Volume

Nowhere are questions of sustainability more acute and salient than in Latin America and Oceania—the two regions with the greatest stocks of biological capacity remaining in the world. Australia and South America, together with Canada, comprise the densest concentrations of biological capacity. Yet Australia—like the United States, Canada, and Scandinavia—has one of the largest per capita ecological footprints in the world. This means that Australia, with very high levels of biocapacity and a deep ecological footprint, is a crucial nexus for reversing global patterns of unsustainable consumption. Oceania overall, despite its tremendous biocapacity, has a per capita ecological footprint of more than double the global average, a majority of which is contributed by Australia (Ewing et al. 2010).

In Latin America, biocapacity is high relative to its levels of consumption. As a region, residents of Latin America are below the global average per capita ecological footprint, although this varies greatly by nation. Haiti has the smallest per capita footprint in the region, and Paraguay has the largest. To a large extent, the considerable biocapacity of Brazil, Argentina, Uruguay, Paraguay, and Bolivia compensate for high levels of consumption in the region, maintaining Latin America as "by far the largest regional ecological remainder in the world" (Ewing et al. 2010, 64).

Despite Latin America's high concentrations of biomass, the region faces severe environmental issues. The glaciers in Chilean and Argentine Patagonia are thinning at a dramatic rate. Glacial melt from Patagonia alone, over the past half century, has contributed approximately 10 percent to the total increase in the sea level from mountain glacier melt (Glasser, Harrison, Jansson, Anderson, and Cowley 2011).

The Amazon rain forest is giving way to monocultures of soy beans and natural gas fields at an exponential pace, diminishing biodiversity and emitting a great deal of carbon. As infrastructure in the Amazon improves, more and more of the rainforest is being cleared for soy production. Brazilian soy production exploded in the 1990s and has been increasing exponentially since. In 2006, Brazilian exports outpaced US exports for the first time in history with a record 26.1 million metric tons as compared to US exports of only 24.8 million metric tons (USDA 2006).

Further, the so-called political turn to the left in Latin America in the first decade of the twenty-first century has not meant greater environmental protections for this vulnerable region. Extractive industries—mining and petroleum—continue to expand in the region under weak regulatory institutions. Matthew D. Himley's article, "Mining (The Andes)," in this volume discusses this in detail as does Erkan Topal and Diarmid (Dinty) Mather's entry, "Mining (Australia)." For these and many other reasons, assessing sustainability in the Americas is crucial at this particular historical moment.

The economies of Oceania range from advanced industrial world leaders like Australia, to traditional smallholder agricultural economies on many small islands. Agriculture is a small part of the overall economy of the region but accounts for the majority of foreign exchange earnings. Agriculture is more important on smaller islands such as Vanuatu and Fiji. Across Oceania, the largest economic sector is service, owing to the large tourism industry.

Glacial melt from Patagonia links sustainability concerns in Latin America with Oceania in visceral ways that highlight the global dimensions of the climate crisis. Smaller islands in the Pacific Ocean are losing surface

area at an alarming rate as a result of sea level rise, yielding the world's first climate-change refugees and serving as symbols of the urgency of addressing greenhouse gas emissions. Between 1979 and 2008 the average global rate of coastline erosion has increased by 300 percent. Because of their unique position as the world's first climate change refugees, the governments and civil society in many parts of Oceania are on the cutting edge of climate change activism. As of 2009, for example, Fiji derived 66 percent of its energy from renewable sources (Bohane 2009).

Not only are many islands in Oceania losing surface area, but the encroachment of the sea salinizes agricultural land, making farming more difficult, forcing residents to change their traditional diets, and creating new dependencies on foreign food aid. Further, neighboring areas must absorb these refugees, creating fiscal stress for local governments and generating social conflict. In this volume, C. Michael Hall's "Small Island States" explores this phenomenon of sea level rise in Oceania as part of a larger discussion of small island ecosystems and the particular sustainability challenges these small island nations face. In many parts of Oceania, non-Western cosmologies are still strong but are increasingly threatened by displacement and social change wrought by climate change. James D. Sellmann and Robert Andreas have an article in this volume titled "Pacific Island Environmental Philosophy," which provides a well-informed and elegant discussion of this issue, among many other topics.

In addition to their connection via sea level rise, both Latin America and Oceania are home to a variety of indigenous peoples and minority ethnic groups that bear disproportionate amounts of the global environmental burden. More frequent and more intense droughts (as well as the increased frequency of tropical cyclones and their associated devastating effects) impact subsistence farmers disproportionately, and indigenous and remote rural settlements are increasingly being asked to absorb waste-treatment facilities, extractive projects, and hydroelectric dams that transform the landscape and take a toll on traditional social relations.

About This Volume

These regional volumes of the *Berkshire Encyclopedia of Sustainability* series are additionally important because they serve to highlight the fact that human civilization's unsustainable rates of growth do not impact all regions and all countries evenly. In fact, one of the great tragedies of advanced global capitalism is that those countries with the smallest ecological footprints often face the costs of unsustainability most acutely. Parts of Latin America and Oceania, in particular, face new challenges wrought by overconsumption in the wealthy countries of Europe, North America, and parts of Asia.

These regional volumes also are important because of their emphasis on assessment. As discussed above, there is no definitional consensus for sustainability. The meaning of the term varies widely depending on the intentions of the speaker. For this reason, sustainability is difficult to assess and even harder to measure. These volumes lead us incrementally toward those elusive goals of a consensual definition of sustainability and a standard for assessment.

In this volume we have included a wide range of country-specific articles as well as many more general topical articles that span the focal regions. There are a rich series of pieces herein dealing with the environmental history of key countries and subregions within the geographic compass of this volume. We have also included a number of articles on key geologic and hydrogeologic resources within the scope of this volume. For North America, we have provided articles on the Chesapeake Bay—the world's largest estuary—the Mississippi and Missouri Rivers, the Appalachian Mountains, and the Great Lakes, among others. Regarding Latin America, we have articles on the Andes Mountains, the Southern Cone (the southern tip of the continent), and the Amazon River, among others. Regarding Oceania, articles such as that on the Murray-Darling Basin and those on the environmental histories of Australia, New Zealand, and Oceania in general, highlight key focuses of regional sustainability. This volume also offers a series of excellent articles on urban sustainability in major urban centers within the target region—from New York City and Detroit, to Guatemala City and Bogotá, to Vancouver, Sydney, and Auckland. Finally, the volume also offers a variety of more general articles on sustainability issues as wide-ranging as fair trade, rural development, gender equality, and parks and protected areas.

We have sought to strike a balance between the geographically specific and topically broad in this volume, yet no single volume encompassing such a wide swath of world geography can be entirely comprehensive. There are inevitable omissions in our coverage here, but the geographic range, the cross-cutting focuses on urban and rural issues, the transdisciplinarity, and the combination of specific and general topics provides a useful reference guide for understanding and assessing sustainability in the Americas and Oceania.

It is urgent that human civilization achieve sustainability—in throughput terms rather than utility terms—in the immediate future. Already we have begun to witness irreversible environmental degradation as a product of global climate change, and nowhere are these changes more visible and urgent than in the ecological toll on Latin America and the human toll in Oceania. Since the original Earth Summit in 1992, the considerable amount of debate, research, and advocacy undertaken has failed to resolve the tensions in human society between the drive for economic growth and material satisfaction and the need to shepherd our biophysical world. The Rio+20 conference was a landmark meeting and an opportunity to reach a binding consensus on the steps toward sustainability. This volume, and indeed the entire ten-volume *Berkshire Encyclopedia of Sustainability* series, serves as a comprehensive inventory of themes, issues, and phenomena related to understanding, assessing, and achieving these goals. Thank you for using this reference.

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A

Agriculture, Tropical (the Americas)

Diversity is the key word to describe agriculture in tropical America. The ever-changing climate, the varied natural and human geography, increased urbanization, and new consumption patterns give rise to different types of agriculture, which often coexist in the same territories. There are about 15 million farms and over 100,000 small- to medium-sized agriculture-related enterprises. Strong agricultural growth is closely related to export markets.

Altitude, soils, rainfall, temperature, winds, natural vegetation, and human factors such as population density, proximity of cities, infrastructure, income, and market demands determine the presence and the practice of extremely different types of agriculture in what is often referred to as the Americas tropical belt, an area between 23.5° N (the Tropic of Cancer) and 23.5° S (the Tropic of Capricorn). This area encompasses the lower half of Mexico, the Caribbean, Central America, and the top half of South America, ending at the bottom of Bolivia and Brazil. The region possesses important resources, particularly abundant freshwater and good soils, which offer comparative and competitive advantages for the future; however, some resources are also threatened and need to be better protected in order to assure long-term sustainability. A significant regional tendency is the shift, particularly in those countries where income is higher, toward a more diversified diet (more animal protein and more fruits and vegetables). This tendency has important implications for the way food production and markets will be organized and carried out in the future.

The relative importance of agriculture in tropical America, when compared to other economic activities in terms of the gross domestic product, has decreased since the 1980s. Despite this fact and according to the Inter-American Institute for Cooperation in Agriculture (IICA), if forward and backward linkages (input manufacturing, product transformation, value added, packaging, and transport) are considered, the weight of agriculture in the total economy of some countries could reach up to 30 percent (IICA 2007). There is no consensus on how to classify agriculture in tropical America; however, for practical purposes a relatively straightforward classification, with subcategories and specific characteristics, is offered below.

Market-Oriented High-Input Agriculture

High-input agriculture—involving large inputs of water, fertilizers, and pesticides—is common practice in crops and animals intended for high-end markets, including vegetables for export (asparagus, snap beans, paprika, mini-vegetables), fruits (avocado, mango, melon, pineapple, and others), nuts (macadamia), ornamentals, aquaculture (fish and crustaceans produced in fresh or brackish water), nutraceuticals (plants that provide components with health benefits), and forest products (teakwood and others). Additionally, production of coca leaves, intended for drug manufacturing or legal indigenous traditional consumption (by chewing) in the South American Andes, occupy approximately 0.1 percent of arable land.

The areas used for high-input agriculture may be large or small, but they show common characteristics: resource use (water, fertilizers, or agrochemicals) and labor are high-intensity, and production and post-harvest technologies are imported or are developed and adapted locally by companies. The main objective is to satisfy national or international markets. Risks are high (pests, diseases, transport losses, market price fluctuations), but also incomes are high

when everything goes well. Finally, due to the intensity of resource use, the pollution of natural resources such as soil and water can be significant and may require constant monitoring and remediation practices.

There are several activities and fields of interest for high-input agriculture practitioners: value added, food safety, quality control, nutritive value, optimization of resource use, certification, market information, and well-managed value chains.

Traditional Commercial Agriculture

Before the substantial agricultural diversification undertaken by most tropical countries in the last decades of the twentieth century, a few commodities were the mainstays and key sources of income and employment for the rural sector, especially the growing of bananas, cacao, coffee, cotton, sugarcane, and beef production. These are still important but have lost ground to other economic activities and to the highly diverse products of market-oriented high-input agriculture.

Traditional commercial agriculture is, in general, undertaken in large areas of land and involves significant numbers of individuals and families. The term *traditional commercial* is more appropriate than *plantation* agriculture because beef production and crops such as coffee or cotton can also be found in medium-scale holdings, not just large plantations, throughout the American tropics.

Production technology in traditional commercial agriculture can be the responsibility of national research programs or, as is often the case, is conducted by private companies or producers' associations that contribute an agreed tax on production or export volumes to support their own research and development. Technological inputs can be very intensive, as in the case of bananas, or it can be more environmentally friendly, as it is for shaded coffee and cacao, which are planted with other species in succession systems. Beef production, while critically important as a source of income and nutrition, has been controversial and often associated with deforestation, essentially the clearing of forested land in order to respond to market demands for beef.

Similarly to market-oriented high-input agriculture, traditional commercial agriculture attempts to better position itself in world markets by such initiatives as brand recognition, certificates of origin, food safety, environmental safeguards, and value added.

Agro-Silvo-Pastoral Systems

Although agro-silvo-pastoral (ASP) systems have existed since the early times of agriculture, they are a relatively newly recognized agricultural category—for example, in Central American countries—that includes crops, animals, and trees in various time and space combinations. They have shown significant advantages in terms of optimizing resource use and in terms of better protecting the natural resource base. Common arrangements include trees and pastures that allow cattle to grow and develop while tree growth is enhanced by the addition of manure. Also, the combination of crops in the early stage of tree development brings mutual benefits (nitrogen fixation, water use, pest and disease tolerance) to the various species. Some ASP, particularly those based in coffee and cacao associated with shade trees, tends to be permanent, often lasting thirty to fifty years.

Other advantages of ASP include the diversification of income and the time and spatial distribution of labor throughout the year; in essence ASP tends to be less risky than single crop or single animal production systems. Additionally, ASP may be part of national efforts to enhance environmental services and initiatives to promote agritourism.

Family Agriculture

In terms of the number of people involved, family agriculture is the predominant type of exploitation found in tropical America. It continues to be so, despite the increasing importance of other economic activities and the intensity and impact of world trade. Family agriculture is not easily defined; however, it is easily recognized. Of the different categories and definitions available, a number of common elements are shared by family agriculture: all or most of the labor required in the farm is provided by the family; the farms are often located in marginal lands (on slopes, with poor soils, having inadequate infrastructure and services); the use of outside inputs is limited or nonexistent; significant amounts of the goods produced are consumed by family members; poverty and vulnerability runs high, particularly in those cases where access to markets is severely limited; and family agriculture tends to be highly diversified in terms of the number of species grown or maintained and the prevalence of a variety of domestic animals.

Family agriculture falls generally into three categories: subsistence, transitional, and consolidated. At the subsistence level, it often involves the poorest of the poor, families with insecure land tenure for whom agriculture may be only a part-time activity and a partial source of income and nutrition. Additional income, if available, is found off farm as hired labor or in nonfarm work. People involved in subsistence farming are highly vulnerable and often require assistance from government-supported programs. This type of agriculture includes the well-known practice of slash and burn, whereby a piece of forested land is burned to make room for crops, also taking advantage of

higher soil fertility present after burning trees and shrubs; once the land loses its initial fertility, it is left fallow for several years before it can be used again. Slash and burn, as a production system, is not capable of providing sustenance to large populations, not productively sustainable over time, and often results in serious negative impacts to the environment.

Family agriculture at the transitional level constitutes an intermediate category where families are relatively better off in terms of availability of services and infrastructure, are able to grow most of what is consumed by family members, and may be able to sell part of the produce in local markets, securing some income to fulfill other family needs. In this category, land titles are often available, which provides security and, if needed, limited access to credit. As in the case of subsistence agriculture the level of diversification is high regarding the number of crops, trees, and animal species present in the farm. For example, in the South American Andes, potato, quinoa, cereals such as barley, maize, and wheat, and some pulses such as broad beans, lupins, and peas, are very important for food security, and any harvest surplus may provide extra income. Also, raising livestock such as llamas and alpacas and dairy production are helping to build assets for small rural businesses and provide a major source of income for farming households.

Families in the consolidated category of family agriculture normally have better or secured access to markets; may need to hire one or a few outside workers at peak times in order to fulfill planting, harvesting, or processing needs; and enjoy better infrastructure and services. These farms, while still diversified, tend to specialize in one or two products with market demand—such as grains, fruits, vegetables, beef, or coffee—that are the leading sources of family income. The use of outside inputs and improved technologies and cultivars is much more common. Income security is significantly higher in this condition, and families are less vulnerable.

Going Forward

According to the World Development Report (World Bank 2007), Latin America and the Caribbean is now an urbanized region, where agriculture accounts for a small share of national growth, even though several subsectors have sustained spectacular growth, for example soybeans in Brazil, rice in Peru, and vegetables in Guatemala. The report described key structural features of the region, in particular, the supermarket revolution (higher incomes and rapid urbanization have increased the demand for higher-value products); the stubbornly high rural poverty and inequality; and the overall weak governance of public organizations. The agenda set forth by the World Development Report for urbanized countries supports and promotes the inclusion of smallholders in the new food markets, enhancing productivity in subsistence agriculture, and following a territorial approach to promote the rural nonfarm economy and enhance skills to give access to jobs and investment opportunities.

In a 2010 paper, Bernard Hubert, senior scientist at the National Institute for Agricultural Research, and his colleagues predicted stable economic growth rates (3.5–4.5 percent per year on average) for Latin America and the Caribbean through the early twenty-first century. The region will therefore experience a significant increase in daily per capita calorie consumption and decline in child malnutrition by 2050. Meat exports will increase, whereas average grain yield growth will be slightly up (1.25 percent per year), and total cereal areas will grow by 9 percent. In 2050, however, about one hectare of land will be needed to feed one person (compared to 0.7 and 0.5 in 2000 and 1965, respectively). Hence, sustainable intensification of agro-ecosystems leading to higher productivity will be required to meet the increasing demands for food, feed, fiber, and fuel, particularly in Mesoamerica and the South American Andes, where climate change will negatively affect food output and quality due to a higher occurrence of extreme events such as droughts and floods. Diversification with high-value crops should also enhance farmers' income, generating new jobs both in rural and urban areas, improving the long-term sustainability and profitability of agro-ecosystems. Agro-biotechnology is expected to contribute sustainably to the agriculture of this region by conserving agro-biodiversity, reducing pesticide use, and improving competitiveness by lowering farming and processing costs. Innovations in agriculture should provide solutions

to farmers and the agricultural industry and respond to social requirements of end users. Enabling policies, secure land rights, output markets, sharing new knowledge and technology with farmers, and public–private partnerships will be among the various factors needing attention in order to succeed in the short and long terms.

In sum, while tropical agriculture in the Americas faces important challenges, the region is well positioned not only to feed its future population but also to contribute surplus food production to the rest of the world. The astonishing diversity of environments and ecosystems found in Mesoamerica and South America, as well as the abundance of freshwater and relatively good soils point to a bright future, provided good stewardship of natural resources becomes the norm, and sufficient resources for infrastructure, services, and research and development are consistently invested now and in the future.

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See also Amazonia; Brazil; Caribbean; Columbia River; Ecotourism (the Americas); Fair Trade; Forest Management; Labor; Multilateral Environmental Agreements (MEAs); North American Free Trade Agreement (NAFTA)

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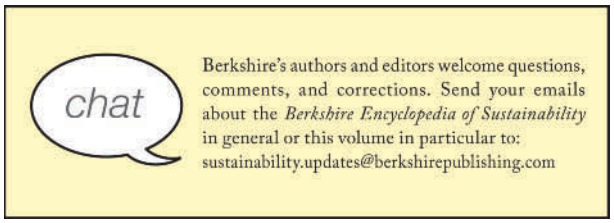

Amazon River

The Amazon River, the world's largest, is part of a basin that, by some standards, hosts the planet's highest levels of biodiversity. Its climate has fluctuated between wet and dry periods since the last ice age. The more recent effects of colonization have been largely negative for its ecosystems, although large areas of the basin remain intact. The future effects of climate change and human interference remain unclear.

The Amazon River basin is the largest river system in the world, draining approximately 7 million square kilometers (40 percent of the South American landmass) and accounting for almost a third of the world's freshwater. Although the Nile is marginally longer, the Amazon is the world's largest river in terms of water volume. The main stem of the river, flowing from the Andes eastward into the Atlantic, is nourished by a complex network of headwaters in the eastern Andes and very large tributary rivers to both the north and south. The Amazon's largest tributary, the 2,400-kilometer-long Rio Negro (Black River), which joins the Amazon at the city of Manaus, is itself the world's second largest river by volume (Pollard 2010, 22). The Amazon flows through eight countries (Venezuela, Colombia, Ecuador, Peru, Bolivia, Brazil, Suriname, and Guyana), but approximately 60 percent of its basin falls within Brazil, whose modern history has been the most important determinant of recent environmental trends. At its mouth, the Amazon is so wide that it surrounds the world's largest freshwater island (Marajó Island), which, at 48,000 square kilometers, is roughly the size of Switzerland.

Geology and Prehistory

In geological terms the Amazon River is young, having assumed its current form around 4 million years ago, when tectonic plate shifts in the Earth uplifted the Andes Mountains to the point where they blocked off the Amazon's original westward drainage into the Pacific Ocean, creating an enormous lake in the heart of the South American landmass. Around 2 million years ago a new channel developed, draining eastward into the Atlantic Ocean, and the Amazon River basin assumed something like its present form. The climatic fluctuations of the Quaternary Period (2 million year ago to the present), and especially of the last million years, subsequently altered Amazonian geography. During the ice ages, when temperatures and sea levels were lower, the Amazon's estuary lay 320 kilometers farther out into the Atlantic from its present position and flowed into the ocean through a network of high and narrow drainage channels. The Amazon River during the ice ages, then, was quite unlike the modern Amazon. Its current large delta, broad main channel, and meandering flow are also temporary and will undoubtedly change again during the next ice age.

Pollen cores from lake sediments, marine cores from the Amazon delta, ice cores from the Andes, and carbon isotope data from soil analyses all suggest the climate of the Amazon basin has been unstable, fluctuating between wet and dry periods since the last ice age ended around 13,000 years ago (Mayle and Beerling 2004). The Amazon's high levels of biodiversity (biological diversity as indicated by numbers of species of animals and plants), by some standards the most elevated on the planet, may have been even higher during the early Holocene Epoch (around 8,000 years ago), when mean temperatures were some 5° C lower, the Andean snowline was about 0.6 kilometers lower, and there were cold-adapted tree species at lower elevations in the western Amazon. At that time, what is now steamy jungle would have been more similar to a temperate forest (Behling 1997).

This climatic instability led scientists concerned with the origins of Amazonian biodiversity to formulate the Pleistocene refuge theory, which dominated models of Pleistocene Amazonian environmental history until the 1990s. This theory asserted that the Amazon was dry, even arid, during the portion of the Pleistocene Epoch spanning from 100,000 years ago to about 10,000 years ago, and that patches of forests were separated by the more dominant savannas, so that there existed multiple "islands," or species reservoirs, wherein allopatric (isolated) speciation occurred. When the forests expanded during wetter periods, species spread over a wider area, only to be isolated again as the forests retracted. Repetition of this process was believed to be the reason for the high biodiversity. More recently, however, the scientific consensus has been that the Pleistocene refuge theory is mistaken and that Amazonian biodiversity is better explained by a combination of high levels of natural disturbance, the presence of river barriers, and the stability of forest ecosystems over time (Brew 2005).

Early Human Colonization

The precise date of human colonization of the Amazon is unknown. The earliest reliable radiocarbon dates are from 11,500 years ago, but the earliest sites, coastal and riverine by definition, have been destroyed by changing sea levels and river courses. Most specialists accept early penetration by humans at around 15,000 years ago, or even earlier. Some genetic and linguistic evidence suggests a human presence as long as 20,000 years ago, but this is controversial. The archaeological record suggests that human impacts on Amazonian ecosystems were more intense and longer lasting than previously thought. By the late prehistoric period, there were few parts of the Amazon that had not been occupied at least sporadically, and sophisticated cultures had evolved in both floodplain and upland areas. These cultures supplemented agriculture by gathering, especially of palm products; they created large patches of fertile artificial soils throughout the basin and intensively exploited aquatic and marine ecosystems. Although population densities were lower than in Andean and Central America, total populations were probably comparable to either (Denevan 1992). Jewelry, metalwork, and other evidence from grave sites also suggest the existence of extensive trade networks linking the central Amazon to the Caribbean.

Consequently, there was considerable human impact on ecosystems even before the arrival of Europeans. Forest burning was probably sufficient to cause greater seasonality and local decrease in rainfall in the late prehistoric period, and at least one complex prehistoric culture, the Marajoara, may well have collapsed through overexploitation of its natural resource base. The arrival of Europeans and the colonial experience paradoxically reduced human impacts on the floodplain through the destruction or enslavement of its indigenous population. Much of the floodplain, which had been an intensively exploited landscape in the sixteenth century, was reclaimed by forest. Much less is known about environmental change in the upland areas during the colonial period, but it is likely that there was a similar advance in forest cover. The greater productivity brought on by metal tools was counterbalanced by the long-term decline of the indigenous population. It is one of the great ironies of Amazonian history that these young forests were construed by early European science as primeval and as uninhabited rather than as having undergone a process of depopulation.

Environmental Change in the Modern Period

Large-scale colonization has dominated the modern history of the Amazon. The first wave of settlement grew out of the rubber boom of the late nineteenth century; at this time, the new influx of people into both floodplain and upland areas raised the Amazon's population back up to late prehistoric levels. Far-reaching environmental impacts were brought about when the demands of rapidly growing urban centers drove settlers to cut back forests on a large scale for the first time through slash-and-burn

agriculture and ranching. Belém and Manaus, in Brazil, and Iquitos, in Peru, had populations of more than 100,000 in 1900—the first time there were cities of such size in the Amazon basin; Belém and Manaus would have populations of well over 1 million just a century later.

The composition of the region's population also changed: many of the indigenous groups that had previously withdrawn from the floodplain to the uplands, to avoid enslavement during the colonial period, were incorporated, often violently, into the rubber economy. As their numbers declined and the flow of outsiders increased, an even greater proportion of the Amazon's population was of European descent.

After 1912, the environmental impacts of the rubber boom subsided along with the rapid collapse of the demand for Amazonian rubber, which was replaced in world markets by plantation rubber from southeastern Asia (grown from stolen Amazonian seedlings). Colonization of the Amazon stopped and people began to leave the region, with many parts of the basin reverting to secondary forest. Not until the 1960s did national societies renew their penetration of the Amazon, this time with far more dramatic environmental consequences.

Beginning in the late 1960s the construction of a network of highways linked the Amazon to the national hinterlands of the states that shared the basin and funneled millions of migrants into the region. Road building was most extensive in Brazil, where it had the most far-reaching effects, but all Amazonian countries experienced a similar cycle of frontier development. The consequences were largely disastrous. Some 12 percent of the Amazon's forest cover was removed by the end of the twentieth century, replaced largely by low-productivity ranches and subsistence smallholdings. Many of these enterprises lasted less than a generation before the declining pasture quality forced their abandonment. The destruction was concentrated mostly in the uplands; the floodplain remained relatively unaffected by colonization.

In the early twenty-first century, partly owing to improved governance (with more effective satellite monitoring of land clearance in Brazil), and partly owing to gradually increasing productivity in the beef industry and in agriculture in general, deforestation rates declined from their peak in the 1980s. Consumer concern over deforestation and greater state presence in Brazil have encouraged commercial farming and ranching to intensify rather than expand, starting a transition to production systems that make fewer demands on the land. At least in Brazil, reclaiming degraded pasture may in the future allow agricultural expansion with minimal to no land clearance. The growth of extensive and robust protected areas and indigenous reserve networks in a number of Amazonian countries is another positive development.

Outlook

It is too soon to be confident about the future. There is already strong evidence of climate change in some parts of the Amazon basin linked to forest clearance, with declines in rainfall and greater seasonality. This change will likely be permanent. The long-term effect of global warming will be to increase drought stress and make many parts of the Amazon more flammable. Local and global climate change may feed into each other, to the detriment of forest cover and biodiversity. Some climate models suggest that "forest drying," combined with more intense fires, could shift significant areas of the Amazon to savanna-type vegetation during the course of the next century or two.

Equally important is the fact that improvements in Brazil could be offset by accelerated land clearances elsewhere. Improvements in security in Peru and Colombia could see those countries invest more in road building and further development of oil and gas reserves; this development could touch off a largely uncontrolled influx of migrants along the lines of the influx into the Brazilian Amazon from the 1960s to the 1980s. Eastern Bolivia is well suited for large-scale ranching and commercial agriculture, but has nothing approaching the governance levels or monitoring systems of much of the Brazilian Amazon. Increasing urbanization and demand for clean energy in all the Amazonian countries will inevitably expand the number and scale of hydroelectric projects in the Amazon, including their potential to affect riverine environments downstream and pose challenges for relations between the countries sharing the basin. On the other hand, the basin's enormous size and the resilience of its ecosystems may buffer human influences. It is a gamble whose outcome remains to be seen.

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See also Agriculture, Tropical (the Americas); Amazonia; Andes Mountains; Bogotá, Colombia; Brazil; Caribbean; Colombia; Curitiba, Brazil; Forest Management; Labor; Lima, Peru; Mining (Andes); Rio de Janeiro, Brazil; Urbanization

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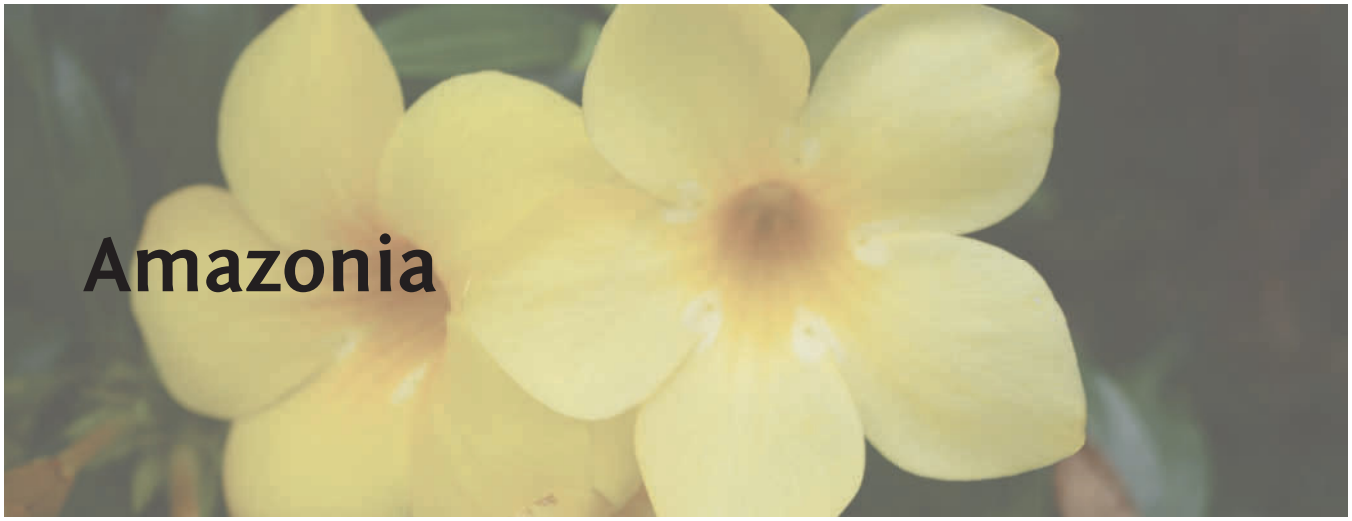

Amazonia

The tropical regions of South America were once thought to have been unfavorable for sustained human occupation on a large scale. That picture in the twenty-first century is rapidly changing. The archaeological recovery of ancient artifacts has revealed complex adaptations and management of Amazonian environments for at least twelve thousand years, while anthropogenic soils have proved to be far more widespread and of greater antiquity than previously thought.

As the largest tropical rain forest on the planet, Amazonia holds a unique place in both world environmental history and the imagination of South America. A vast region that extends through present-day Brazil and seven other South American nations (Colombia, Ecuador, French Guiana, Guyana, Peru, Surinam, and Venezuela), it symbolically stands for the dominance of nature over humans and as a source of still-unknown plants and animals. In fact Amazonia has been an intensively managed, human-made environment for many hundreds of years. The current perception of Amazonia as one of the last wildernesses reflects not the rain forest's pristine nature, but rather the colonial conquest's erasure of the native population through violence.

The Amazon River basin is considered, at a minimum, to comprise 96 million hectares; the Amazon River itself is the largest (by volume) in the world, nearly 160 kilometers wide at its mouth. The civilizations that arose there were functionally isolated from the rest of the world. Evidence for these past civilizations has emerged slowly, given the absence of stone building and the sheer scale of the Amazon as a context for research.

Any definition of Amazonia as an ecological, cultural, or political unit therefore proceeds more by a process of exclusion than by reference to broad uniformities in the Amazonian environment because such uniformities are illusory. The definition of Amazonia employed here reflects the conventions established in the US anthropologist Julian H. Steward's *Handbook of South American Indians* (1946–1963) and carried over into twenty-first-century anthropological usages. Amazonia comprises the whole of the Amazon River drainage system, including the right-bank tributaries of the Orinoco, to which the Amazon River has two connections: one permanent (via the Casiquiare Canal) and one seasonal (via the flooding of the upland savannas between the Rio Branco and the Essequibo River). This latter connection effectively unites the Atlantic coastal region of the Guianas with the Amazon River basin, giving rise to the designation "Guayana" or "Guianas" (in Steward's *Handbook*) for this area encircled by the Atlantic, Orinoco, and Amazon, which anthropologists consider a subregion of Amazonia. Steward (1946–1963, 3:885) also hypothesized that Guiana was a center of dispersal for the "tropical forest-complex" of agriculture of the manioc plant—a tuber whose pulp became a staple of the regional diet—although later anthropologists challenged this view.

Steward connected these conventions in the geographical criteria for the delimitation of regions to a wider classificatory scheme in the *Handbook*. In an attempt to give some analytical shape to the mass of ethnological, historical, and archaeological information that the *Handbook* brought together, anthropologists thought these contrasting geographical zones delineated cultural regions. As the Austrian-born US anthropologist Robert Lowie put it in his introductory essay to volume 3 of the *Handbook,* "The Tropical Forest complex is marked off from the higher Andean civilizations by lacking architectural and metallurgical refinements,