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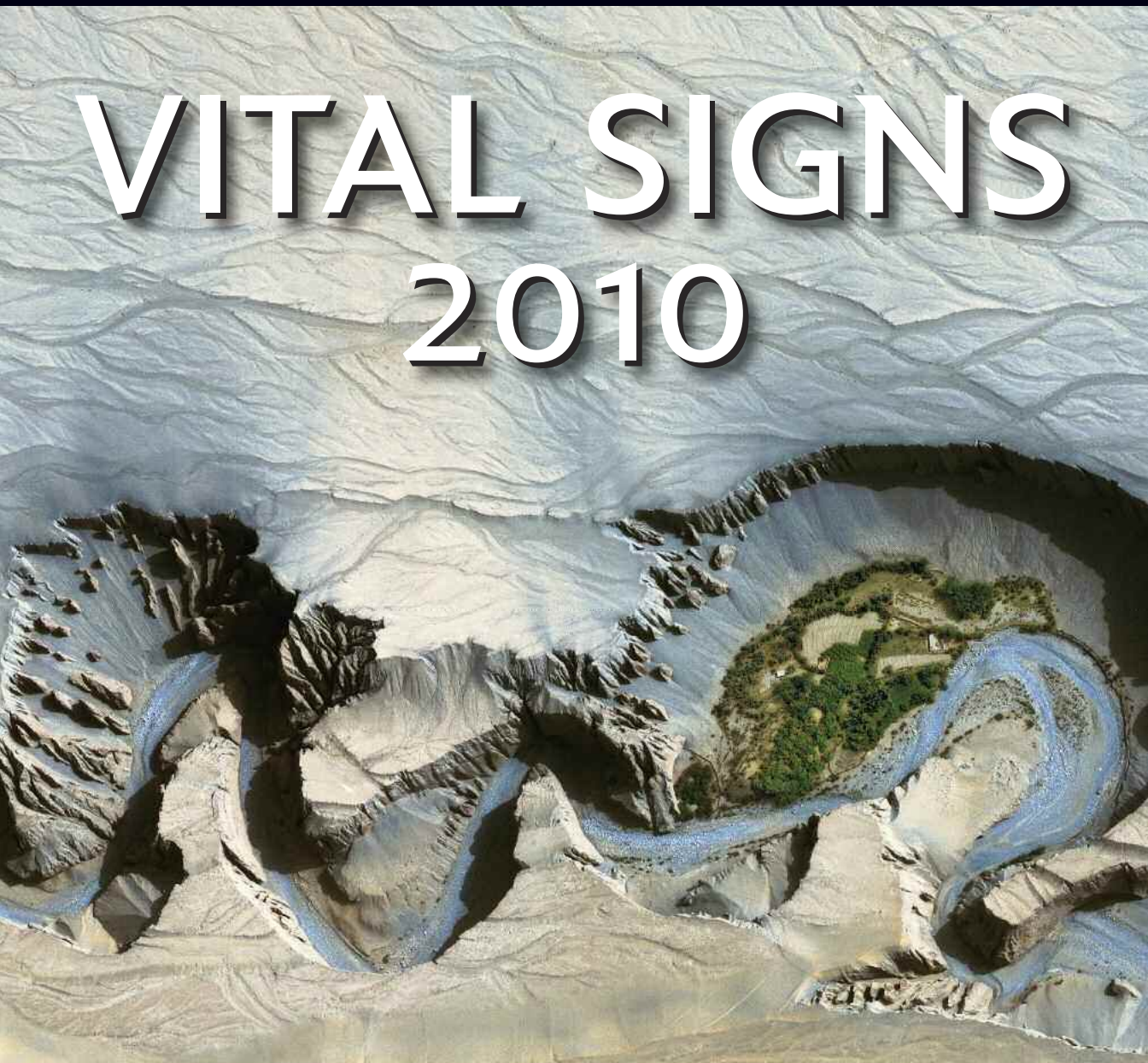
VITAL SIGNS 2010



The Trends That Are Shaping Our Future

VITAL SIGNS

2010

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TECHNICAL NOTE

Units of measure throughout this book are metric unless common usage dictates otherwise. Historical data series in *Vital Signs* are updated in each edition, incorporating any revisions by originating organizations. Unless noted otherwise, references to regions or groupings of countries follow definitions of the Statistics Division of the U.N. Department of Economic and Social Affairs. Data expressed in U.S. dollars have for the most part been deflated (see endnotes for specific details for each trend).

Acknowledgments

As we close out the last decade, it is hard to believe that just 10 years ago the world was faced with the fears of Y2K and mass mayhem in computerland. So many things have changed since then—some for the worse, some for the better—though now it seems that there is a true crisis worthy of alarm. Climate change promises to remain at the center of threats to the world for the long run.

Many of the trends included in this seventeenth edition of *Vital Signs* show that the world is nearing the brink of Earth's ecosystems, and most of the problems will only worsen with a changing climate. From water scarcity to coral reef loss to threats to agricultural systems, society is faced with untold disasters. Fortunately, there are also trends that can be part of the solution and that offer optimism, including renewable energy and organic agriculture. The question is which path the world chooses from here and how long it takes to change course.

The potential to address today's problems is within humanity's grasp; what is needed now is the political and economic will. We hope the trends covered in this book help push leaders in the right direction.

Tracking the most important sustainability trends of the day is an enormous task, and Worldwatch is fortunate to have many dedicated supporters and staff who make it all possible. At the top of this list is our funders, without whom we would not be able to pursue our work on creating a more just and sustainable society. A group of foundations, governments, and international agencies made much of our work possible over the last year, including the American Clean Skies Foundation, the Heinrich Böll Foundation, the Casten Family Foundation, the Compton Foundation, Inc., the Del Mar Global Trust, Sam Gary and Associates, Inc., the Bill & Melinda Gates Foundation, the Richard and Rhoda Goldman Fund, the Good Energies Foundation, the Steven C. Leuthold Family Foundation, MAP Royalty, Inc. Sustainable Energy Education Fellowship Program, the Marianists of the USA Sharing Fund, the Netherlands Environment Ministry, the Renewable Energy and Energy Efficiency Partnership, the Shared Earth Foundation, The Shenandoah Foundation, the Flora L. Thornton Foundation, the United Nations Foundation, the United Nations Population Fund, the United Nations Environment Programme, the Wallace Genetic Foundation, Inc., the Wallace Global Fund, the Johanette Wallerstein Institute, the Winslow Foundation, and the World Wildlife Fund–Europe.

We are also grateful for the Friends of Worldwatch who fund nearly one third of our operating budget. Without their support and trust our work would not be possible. In addition to providing financial support, our generous Board of Directors helps guide our mission and donates considerable time to our issues.

Worldwatch relies on its cadre of dedicated researchers who follow trends year round. Special thanks is given to staff researchers who contributed directly to this volume, including Erik Assadourian, Amanda Chiu, Robert Engelman,

Gary Gardner, Yingling Liu, John Mulrow, Danielle Nierenberg, Michael Renner, Janet Sawin, and Molly Theobald. We are honored to have a strong coalition of outside experts who work directly with us on *Vital Signs*, including Hilary French, Petra Löw from Munich Re, Elizabeth Leahy Madsen, and James Russell. There were also a number of hardworking interns who deserve recognition, including Sarah London, Elena Marszalek, and Margarita Yatsevich.

This year we launched our exciting, newly revamped online companion *Vital Signs Online*. This new subscription service would not have been possible without the leadership of Chris Flavin or the support of Darcey Rakestraw, Julia Tier, Corey Perkins, and Patricia Shyne. Thank you all.

As with all of our work here at Worldwatch, we would be lost without our supporting staff who make sure our work is funded, distributed, read, and contributing to a sustainable society. My gratitude extends to these people working on communications, development, marketing, and administration.

Finally, a special word of acknowledgment for two people who made this book possible. Linda Starke, our gracious editor, worked throughout the year to improve and polish all of the trends. Art Director Lyle Rosbotham once again has transformed a collection of short pieces into an elegant and captivating book format.

Whether you are a new *Vital Signs* reader or a dedicated follower, I hope that you will come to rely on this volume and our online trends for the information and knowledge needed to make sustainable choices. Please check out vitalsigns.worldwatch.org to stay up to date on all our trends throughout the year.

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Preface

The last two years have been a period of great global unrest, due in part to the sharp recession that has reached all corners of the world. Countries planned and passed economic stimulus packages to lessen the pain, and many global leaders included a "green" component. Hopes built around the political process of a new climate change treaty, but by the end of the year the disappointing Copenhagen summit was over without any binding commitments and with the way forward hazy at best.

Amid this backdrop of economic and ecological instability, the scientific evidence continued to mount that climate change is already occurring and that it is happening much faster than once predicted. Add to this the world's environmental, social, and economic trends covered in this seventeenth edition of *Vital Signs*, and the outlook shows cause for concern.

The atmospheric concentration of carbon dioxide, the primary source of global warming, continued its upward trend, reaching 385 parts per million in 2008. Carbon dioxide emissions that year were up 2 percent. Sea level rise is accelerating, and the loss of Arctic sea ice was so great that some ships could be rerouted through the Northeast Passage.

Water scarcity already affects more than 1 billion people, and the situation is expected to worsen. More than 1 billion people still live in extreme poverty. In the world's oceans, the latest assessment of the health of coral reefs indicates that some 20 percent have been effectively lost, and many more are at risk of collapse because of climate change and other human impacts.

Even some of the technologies once cast as part of the solution to environmental problems have turned out to be causing problems of their own. Driven in part by government mandates, world biofuels production was up 36 percent in 2008, even though first-generation biofuels can increase greenhouse gas (GHG) emissions by encouraging deforestation and other land use changes. Biofuels have also contributed to rising food prices, as some 5 percent of the global grain crop was used for biofuel production. A second generation of biofuels that may address many of these problems is under development, but its commercial production is still far away.

Putting additional strains on the world's land and water resources, meat production continues to soar. It has doubled since the mid-1970s, and experts project that production will double again by 2050 to reach 465 million tons. The feed used for these animals—largely corn and soybeans—depends heavily on artificial fertilizers, which are a significant source of carbon dioxide. Livestock production also releases large amounts of methane and nitrous oxide, two potent GHGs.

Amid these dismal developments, global population trends provide little solace. Annual population growth, which seemed to be slowing, now appears to have leveled off at 79 million per year, pushing out projections as to when—and whether—it will end.

But there are some silver linings to Earth's

vital signs. For one, the promise of a low-carbon economy is within closer reach than ever. As the energy trends in this volume document—tracking final numbers from 2008 and projecting forward—large strides have been made toward this new future even without a final international climate agreement. New wind power exceeded its 10-year average, making up 42 percent of new capacity additions in the United States and 36 percent in Europe. The wind now generates more than 1.5 percent of the world's electricity, and recent turmoil in the financial markets has done little to slow the pace of growth.

Solar power witnessed its strongest year of growth ever, with cumulative photovoltaic power installed worldwide nearing 15,000 megawatts in 2008. Solar thermal heating also bounded forward, with large gains in China. And China announced increases in vehicle fuel economy. In addition, the production of hybrid vehicles, which offer great efficiency gains, continued to rise worldwide.

Agricultural and social trends also showed a few encouraging signs. Organic agriculture, which can offer GHG reductions and increased climate resilience, has increased by 118 percent since 2000. Aquaculture production also grew rapidly, and it may be an important part of increasing the quality of life and diets among the world's poor.

Health assistance from industrial to developing countries increased significantly over the past 10 years, helping to combat HIV/AIDS and tuberculosis. Reductions in the number of people living without access to adequate sanitation continued, although the rate is slower than expected.

Although some of these positive trends may moderate in the near term, one of the great ironies is that as the Copenhagen talks foundered, the global economy appeared finally to be headed in a less carbon-intensive direction. A recent Worldwatch report shows that the world could be halfway to being all-renewable within two decades by relying on major improvements in energy efficiency and a rapid scale-up in renewable energy. The know-how and capacity are available—what is needed are the determination and the method.

Whether this trend continues—along with crucial changes in the modern culture of consumption, as explored in *State of the World 2010*—and how it plays out in both industrial and rapidly growing developing countries remains to be seen. It now seems likely that the important competition between the United States and China will be over who will lead the world in building and selling the low-carbon technologies that have recently become a $100-billion-plus market rather than over which country will be able to take on the least ambitious climate obligations.

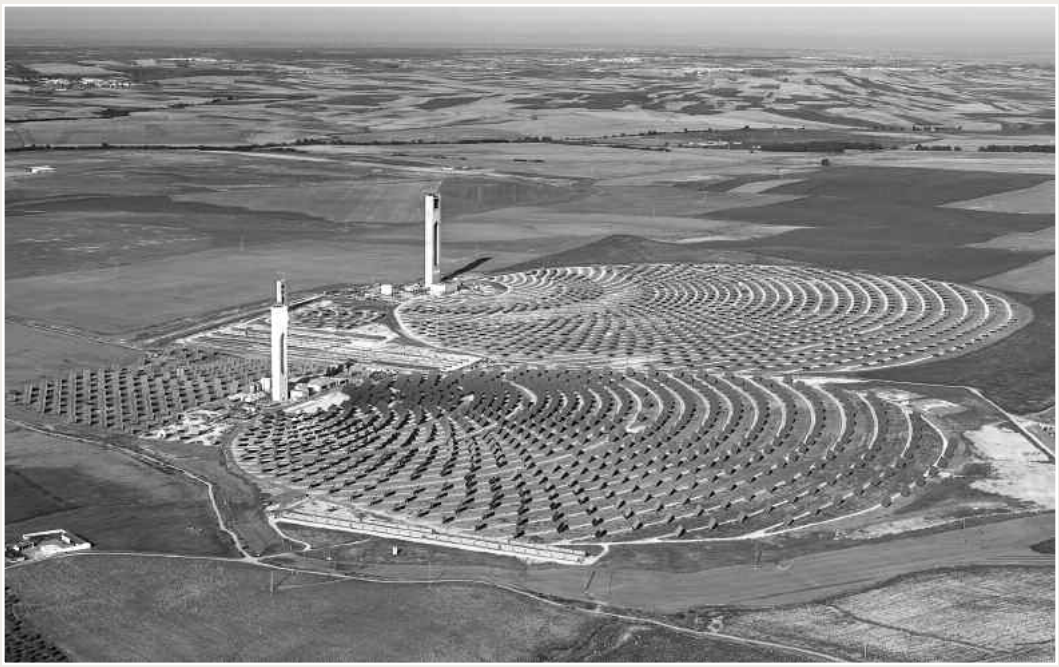
Despite the breakdown in Copenhagen, the United Nations climate process will go on. The challenge now is to prevent it from turning into a rhetorical talk shop. That can best be accomplished if it focuses on practical and critical goals that need to be accomplished: providing financial support for the world's poorest countries to mitigate and adapt to climate change, accelerating international cooperation on technology, and mounting an international effort to protect the world's remaining forests. The danger for developing countries is not only that they will suffer the greatest damage from climate change but that they will be left behind while big economies such as China and the United States build the low-carbon economies of the future.

Vital Signs 2010 examines the world at this crossroads, providing in-depth coverage of the trends that are shaping the future by showing where the world has come from and where it is headed. We hope you come to rely on the insights and analysis provided in this volume. Please also check out our electronic companion series, *Vital Signs Online*, which provides analysis, data, and references in one convenient place that is updated as trends are released throughout the year.

Christopher Flavin
President

Alice McKeown
Project Director

Energy and Transportation Trends



Abengoa Solar

PS10 and PS20, two solar tower power systems, together generate 31 megawatts outside of Seville, Spain

For data and analysis on energy and transportation trends, go to vitalsigns.worldwatch.org.

Wind Power Increase in 2008 Exceeds 10-year Average Growth Rate

Janet L. Sawin

Global wind capacity increased an estimated 27,051 megawatts in 2008, ending the year at 120,798 megawatts.[1] (See Figures 1 and 2.) With cumulative installations up almost 29 percent, the growth rate exceeded the annual average of the past decade.[2] Wind power accounted for 42 percent of new capacity additions in the United States (second only to natural gas for the fourth year running) and for 36 percent of new installations in Europe.[3] The wind now generates more than 1.5 percent of the world's electricity, up from 0.1 percent in 1997.[4] Around the world, 80 countries are now using wind power on a commercial basis.[5]

Figure 1. World Wind Energy Generating Capacity, 1980–2008

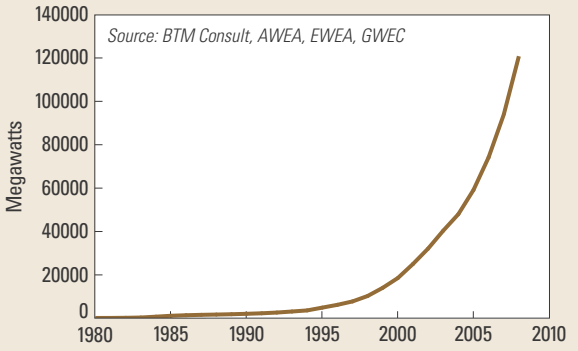
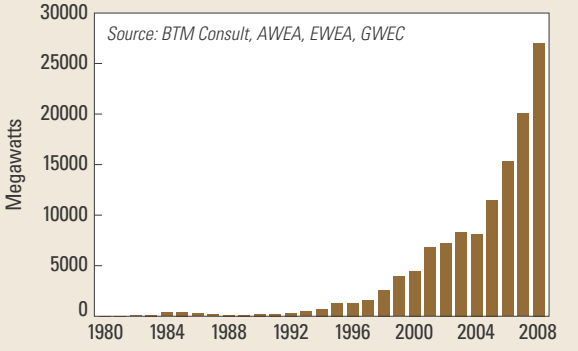


Figure 2. Annual Addition to World Wind Energy Generating Capacity, 1980–2008



The United States again led in new installations, surpassing Germany to rank first in cumulative capacity and electricity generation from the wind.[6] (See Figure 3.) U.S. capacity increased by 50 percent—8,358 megawatts—to 25,170 megawatts at year's end.[7] Additions would have been even greater if not for delayed extension of the federal Production Tax Credit, which caused developers to postpone an estimated 4,000 megawatts of further additions to 2009.[8] Texas is the leading state in the country for wind, with more than double the capacity of runner-up Iowa and more wind capacity than all but five countries.[9]

Asia accounted for almost one third of global wind capacity additions.[10] China ranked second after the United States, with approximately 6,300 megawatts installed during 2008, doubling the nation's cumulative wind capacity for the fourth year in a row.[11] In April 2008, the Chinese government increased its 2010 wind target from 5,000 to 10,000 megawatts—yet this revised goal was quickly surpassed, and more than 12,200 megawatts were in place by the end of the year.[12] Because market growth is racing ahead of the national plan, China continues to face problems aligning grid planning with wind energy development.[13] The Chinese Renewable Energy Industry Association projects that wind capacity will reach 50,000 megawatts by 2015.[14]

India ranked third in wind capacity additions in 2008, with 1,800 megawatts of new wind added, and is now fifth worldwide for cumula-

Click here to see notes for this section.

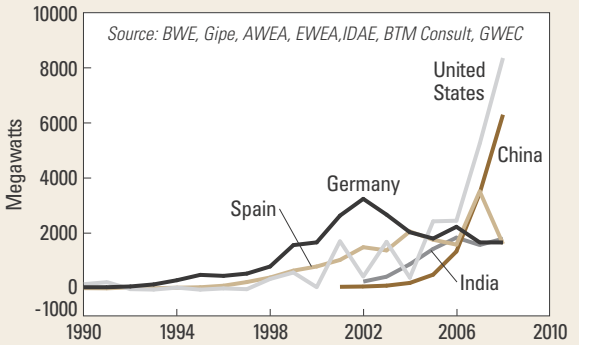
tive capacity—after the United States, Germany, Spain, and China—with a total of 9,645 megawatts.[15] The southern state of Tamil Nadu accounts for 44 percent of the nation's wind capacity, but other states are starting to catch up as they adopt new policy measures that support development of wind power.[16]

Europe added 8,877 megawatts to end the year with 65,946 megawatts of wind capacity—55 percent of the global total.[17] For the first time, wind power represented Europe's leading source of new electric capacity, well ahead of natural gas at 6,939 megawatts and coal at 763 megawatts.[18] By the end of 2008, wind power accounted for 8 percent of European Union (EU) power capacity, enough to generate about 4.2 percent of the region's electricity in a normal wind year.[19]

Germany continues to lead the region, but new installations were down slightly from 2007 (by an estimated 2 megawatts (less than 1 percent) from 2007) and nearly 50 percent off their 2002 record installations; 1,665 megawatts were added in 2008, bringing the total to 23,903.[20] Wind power now meets at least 40 percent of electricity demand in three German states and 7.5 percent of national net electricity demand.[21] Despite the slowdown, the German Wind Energy Institute projects that wind power could meet 31 percent of the nation's electricity demand by 2030.[22] Many of Germany's best onshore wind sites now have turbines on them, and the next wave of expansion in the country will likely be in its North Sea territorial waters.[23]

Spain placed fourth worldwide for new installations in 2008, adding 1,609 megawatts.[24] With a total of approximately 16,740 megawatts, Spain now ranks third after the United States and Germany for cumulative wind power capacity.[25] Wind power provided more than 11 percent of Spain's electricity last year and, according to Spanish utility Endesa, drove down electricity prices during 2008.[26] A recent study found that the wind industry contributes more to Spain's gross domestic product than any other industry.[27] Spain, Germany, and Denmark—long the primary markets in Europe—

Figure 3. Annual Wind Energy Capacity Additions, Selected Countries, 1990–2008



accounted for less than 40 percent of new installations in 2008, compared with 60 percent the previous year.[28] Other major European players in 2008 included Italy (1,010 megawatts added), France (950), the United Kingdom (836), and Portugal (712).[29]

Elsewhere, Australia added 482 megawatts, increasing its cumulative capacity by 58 percent.[30] Brazil was the only country in Latin America to add a significant amount of new wind capacity, with 94 megawatts installed in 2008.[31] Egypt, Morocco, and Tunisia added a combined total of 99 megawatts, and Iran installed 17 megawatts.[32] Turkey installed its largest wind farm to date, with more than 42 megawatts of capacity, and joined the growing list of nations with megawatt-class wind turbine manufacturers.[33]

Most of the world's wind capacity is operating onshore, but a growing share is spinning offshore; the vast majority of these installations are in Europe. Nine EU countries had operational offshore wind farms at the end of 2008, up from five at the beginning of the year.[34] An estimated 357 megawatts were added last year, for a total of 1,486 megawatts offshore in Europe.[35] More than 30,822 megawatts of offshore capacity are under construction or in the planning stages in Europe, with completion expected by 2015.[36]

The global market for wind turbine installations in 2008 was worth about $47.5 billion, an

increase of approximately 42 percent over 2007.[37] Globally, more than 400,000 people are employed in the wind industry.[38] But a significant number of jobs could be lost, particularly in the United States, due to project financing difficulties brought about by the global economic crisis.[39] By early 2009, financing for new projects and orders for turbines and components had slowed significantly.[40]

Although near-term expectations for the industry are gloomy, medium- and longer-term prospects are bright. Turbine prices are expected to fall as a result of the economic crisis, thanks to declining materials and construction costs.[41] And several large utilities and developers are continuing to move ahead, with at least three big offshore projects planned for northern Europe, for example.[42] Economic stimulus packages in the United States and elsewhere are targeting wind power and other renewables.[43] China's government reacted to the world financial crisis by identifying wind energy development as a key economic growth area.[44]

The Global Wind Energy Council projects that 332,000 megawatts of wind capacity will be installed by 2013.[45] BTM Consult, a Danish research firm, expects that global wind power installations could account for almost 6 percent of the world's electricity generation by 2017.[46]

Global Auto Industry in Crisis

Michael Renner

Production of passenger cars and light trucks declined from 70.9 million units in 2007 to 68.1 million in 2008, and the London-based IHS Global Insight Automotive Group expects output to drop dramatically to 59.8 million in 2009.[1] (See Figure 1.) Sales figures tell a similar story, falling from 69.5 million vehicles in 2007 to 66.3 million in 2008; the number is forecast to sag further to 59.2 million in 2009.[2] The share of worldwide production capacities actually used will likely fall from 83 percent in 2007 to 68 percent in 2009.[3] As of 2008, Global Insight estimated the global fleet at 619.5 million light-duty vehicles, rising to 637.8 million in 2009.[4]

Japan was the undisputed leader in light vehicle production in 2008, at 11 million. U.S. output dropped by 2 million to 8.5 million (and may fall as low as 6.3 million in 2009).[5] China edged into second place with 8.52 million (with 8.8 million projected in 2009).[6] In fourth place is Germany, with 5.8 million vehicles, down from 6 million.[7] (See Figure 2.) South Korea, Brazil, France, Spain, Mexico, Canada, India, and Russia account for the remainder of the top 12—which combined represented 81 percent of global light vehicle production in 2008.[8]

Toyota was the largest producer in 2008, manufacturing some 9.8 million light vehicles.[9] Next in line were General Motors (GM, at 8.6 million), Ford and Renault-Nissan (6.9 million each), and Volkswagen-Porsche (6.4 million).[10] Hyundai, Honda, Peugeot, Fiat, and Suzuki rounded out the top 10.[11]

Beset first by rollercoaster oil prices, then by a global financial crisis, the world's automobile industry is clearly in deep crisis. Automakers are closing plants, shedding jobs, reducing working hours for their employees, and trying to reduce their inventories through heavy discounts. At the same time, there is growing pressure on the industry to produce more-efficient and less polluting cars in the face of the gathering climate crisis.

The crisis is more pronounced (and has lasted longer) in North America than in Western Europe and Japan. Sales in China and India, on the other hand, will likely continue to rise.[12] At

Figure 1. World Automobile Production, 1950–2009

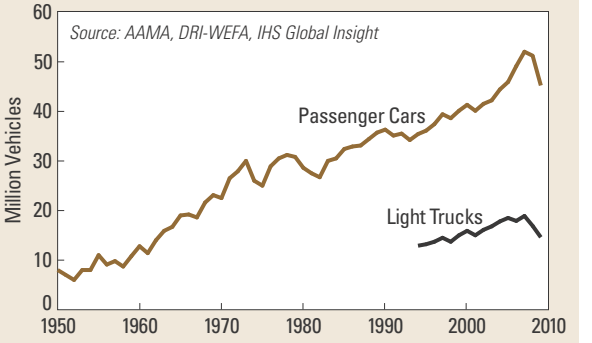
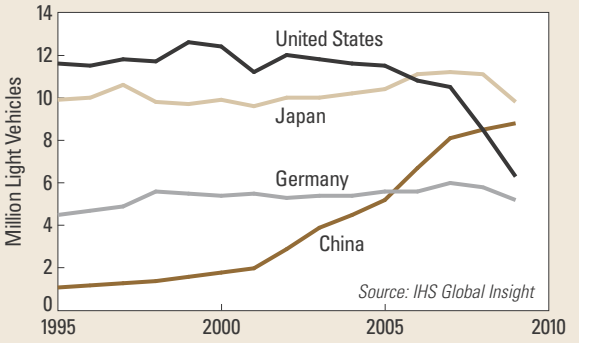


Figure 2. Light Vehicle Production, Leading Countries, 1995–2009



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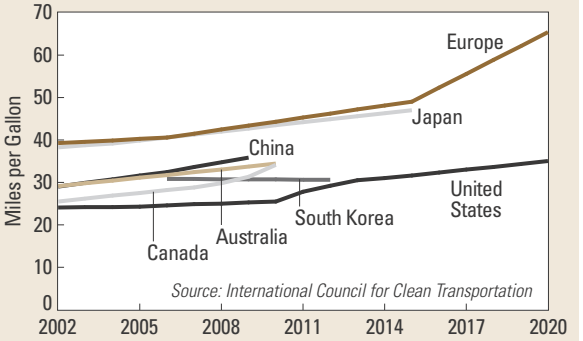
13.2 million vehicles, U.S. sales in 2008 were down 3 million from 2007—the biggest drop since 1974—and will likely decline to 10–11 million in 2009.[13]

Having lost $30.9 billion in 2008, General Motors announced in February 2009 that it will cut 47,000 jobs (19 percent of its worldwide workforce).[14] And in April, GM said it was planning to reduce its U.S. workforce to as few as 38,000, down from a peak of 395,000 in 1970.[15] GM and Chrysler are offering buyout and early retirement to almost all of their 90,600 hourly workers, trying to replace them with new hires who would be paid half as much as current workers.[16] The number of employees in automobile and light truck manufacturing in the United States has already fallen from 251,000 in 1995 to 163,000 in 2008.[17] More than 500,000 workers at parts and components suppliers, along with more than 1 million people employed by car dealerships, are also deeply affected by the crisis.[18]

Following a request to the government to help finance $25 billion worth of loan guarantees in September 2008, GM and Chrysler have to date requested an additional $39 billion in government loans.[19] After a number of hedge funds rejected an Obama administration plan for reducing Chrysler's debt, the company filed for bankruptcy protection at the end of April 2009. The restructured company will be owned by its union retiree health fund and by Italy's Fiat, with small stakes held by the U.S. and Canadian governments.[20] Ford's 2008 loss of $14.6 billion was its worst year ever, surpassing a loss of $12.7 billion in 2006. But Ford has not asked for government support.[21]

Figure 3. Fuel Efficiency of New Light Vehicle Sales, Selected Countries, 2002–20



Car production in Japan was cut more than in half from 951,000 vehicles in March 2008 to 468,000 in March 2009.[22] Car sales in Japan in February 2009 dropped 24 percent below the February 2008 figure.[23] Toyota suffered a $4.4 billion operating loss in the 2008—its first ever—and a stunning $7.7 billion loss in the first quarter of 2009; the company laid off 6,000 temporary workers.[24] Nissan said in February 2009 that it will shed 20,000 jobs, or 8.5 percent of its global workforce.[25]

In the biggest decline since 1993, passenger car sales in Europe fell 8 percent in 2008.[26] A report for the European Parliament expects vehicle production in the European Union to decline 20 percent between the start of 2008 and the end of 2009.[27] France's Peugeot-Citroën (PSA) is seeking to reduce its workforce by at least 11,000 employees during 2009.[28] In Germany, some 150,000 auto workers were put on mandatory shortened work hours.[29] Some 8,000–10,000 part-time workers were already let go in 2008.[30] In Sweden, GM subsidiary Saab filed for bankruptcy and faces closure. In an audacious bid to make itself into an auto powerhouse, heavily-indebted Fiat is proposing to take over Saab and GM's other troubled European subsidiaries—Opel in Germany and Vauxhall in the United Kingdom.[31]

Improving the fuel efficiency of automobiles is an important way to limit their greenhouse gas emissions, but the industry's achievements in this field are mixed at best. New cars produced in Japan and Europe go farthest on a gallon of gas, achieving an average of more than 40 miles per gallon (mpg), and Japan is planning to reach 47 mpg by 2015.[32] (See Figure 3.) Elsewhere in Asia, China raised the fuel economy of new cars produced in its factories from 29 mpg in 2002 to 36 mpg in 2009.[33]

The European Union is aiming to raise effi-

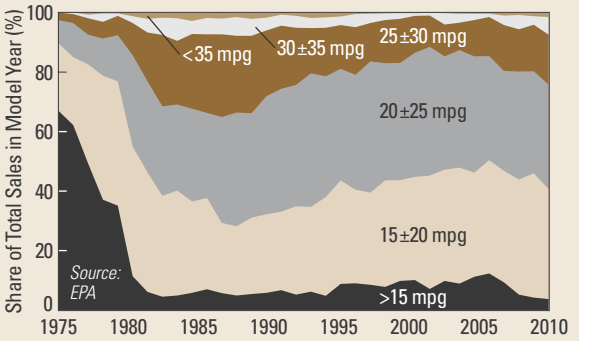
ciency levels to almost 49 mpg by 2015 and to 65 mpg by 2020 through new carbon emission standards.[34] Automakers must have 65 percent of their fleets in compliance by January 2012, rising to 100 percent by 2015.[35] However, these targets have been delayed and watered down since they were first proposed in 1995. The industry has also failed to meet its own voluntary goal.[36]

The United States is a global fuel economy laggard. Only 1.5 percent of light-duty vehicles sold in the United States in 2008 had reasonably high fuel efficiency by international comparison—achieving at least 35 mpg.[37] (See Figure 4.) Legislation passed in December 2007 mandates that the fleet average for new cars reach 35 mpg by 2020, with intermediate milestones still to be determined.[38] That would still be below China's current norms. But the Obama administration announced in May 2009 that it will push fuel economy standards to 39 mpg for cars by 2016, and 35.5 mpg for cars and light trucks combined.[39]

Hybrid vehicles are also widely seen as part of the solution. In 2008, slightly more than half a million gasoline-electric hybrids were produced worldwide.[40] PricewaterhouseCoopers projects that by 2015 some 2.7 million such cars might be produced, along with 250,000 diesel hybrids and 145,000 electric vehicles.[41] Their share of total car production might thus grow from 0.7 percent today to 3.7 percent.[42]

In the United States, average monthly hybrid sales in 2008 came to 26,148, down from 28,925 in 2007.[43] Hybrids account for a still small 2.4 percent share of all new vehicle sales.[44] In Germany, the government is aiming to put 1 million electric and plug-in hybrid electric vehicles on the roads by 2020 and at least 5 million by 2030.[45]

Figure 4. U.S. Light Vehicle Sales, by Fuel Economy Segment, 1975–2008



Making its debut in December 2008 in China, BYD Auto's F3DM is the first mass-produced plug-in hybrid. It is also to be introduced in Europe in 2010 and in the United States in 2011.[46] Toyota will introduce a plug-in hybrid vehicle in late 2009, followed by VW and GM in 2010.[47]

The current crisis presents a unique opportunity to "green" the auto industry—if government aid is leveraged to speed up a transition from business as usual. The European Commission, for instance, has proposed a €5 billion ($6.4 billion) "green cars initiative" to be funded by the Commission, member states, the European Investment Bank (EIB), and private industry.[48] The EIB is to provide €2 billion annually during 2009–10. It remains to be seen whether green will be more than a label in coming years. EIB loans to the industry over the past decade, ostensibly for greener vehicles, largely supported conventional purposes.[49]

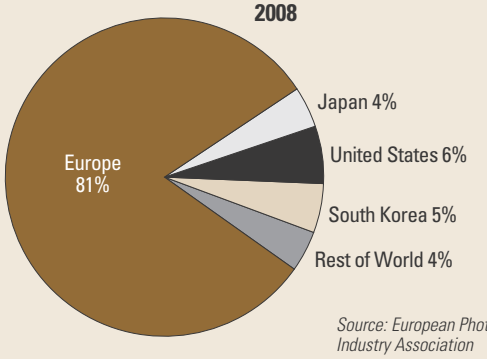
Solar Power Experiences Strongest Year of Growth Yet

Yingling Liu

The year 2008 saw the most phenomenal growth in the solar power market yet, with dramatic increases in installations of solar photovoltaics (PVs), which generate electricity directly from sunlight, and solar thermal plants, which use the sun's heat to produce power. Newly added PV power installations amounted to 5,600 megawatts (MW), more than double the 2,400 MW installed in 2007.[1] Cumulative PV power installed worldwide jumped from 9,000 MW in 2007 to almost 15,000 MW in 2008.[2]

Europe remains the leading market for PVs, accounting for over 80 percent of world demand in 2008.[3] (See Figure 1.) Spain overtook Germany to become the number one solar PV market worldwide, with its market increasing in one year from 560 MW to an estimated 2,600 MW in 2008.[4] This 364-percent growth accounted for almost half of all new installations in 2008.[5] Germany followed in second place, with new installations of about 1,500 MW.[6] The United States came in a distant third, adding approximately 348 MW, followed closely by Italy, South Korea, and Japan.[7]

Figure 1. Share of Global PV Market by Country or Region, 2008



Source: European Photovoltaic Industry Association

Europe leads in the cumulative PV installed capacity too, with more than 9,000 MW in operation, representing over 65 percent of the global total at the end of 2008.[8] Japan and the United States are following far behind, accounting respectively for 15 percent and 8 percent of the global total.[9]

The phenomenal growth in the top two national PV markets—Spain and Germany—suggests that government support programs are pivotal in the development of the solar market.[10] A feed-in tariff policy in Spain requires utilities to buy electricity generated from solar power projects at premium guaranteed long-term prices that are set by the government, an incentive introduced to encourage the adoption of renewable energy. The lucrative solar electricity rates in Spain fanned unexpected enthusiasm from the industry. In September 2008 the government reduced the payments under the feed-in tariff by a great margin and put a cap on annual PV installation from 2009 through 2010, aiming at a target of 3,000 MW by the end of 2010.[11] The anticipated decline in the solar electricity rates galvanized the private sector to rush to install new solar PV capacity before these changes came into force.[12] This policy change is expected to slow the PV market in Spain significantly over the next few years.

Germany, which was the number one solar market for years, also has a feed-in tariff program for renewable energy. It aims to reduce the premium solar electricity rates gradually and predictably until solar energy achieves price parity with conventional power.[13] As the result of amendments to the German law in mid-2008, payments for PVs declined considerably starting in January 2009, reflecting a reduction in installed cost.[14] The stability and consistency of Germany's feed-in tariff has proved beneficial for

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continuous market development, and the country is expected to regain the top PV market position in 2009.[15]

Driven by strong global market demand, both crystalline silicon-based and thin-film cell production saw dramatic growth in 2008.[16] Global PV cell production reached approximately 6,940 MW, compared with 3,715 MW in 2007, an increase of 87 percent.[17] (See Figure 2.) The Chinese PV industry is leading in silicon-based cell production, primarily to meet soaring demand from Spain and Germany.[18] Combined Chinese and Taiwanese production accounted for 39 percent of the global cell output in 2008, up from only 7 percent in 2004.[19] Europe's share of global silicon-based cell production stayed roughly flat at 28 percent, down 1 percent from that in 2007.[20] Japanese PV producers, once the world's top players, fell further behind their competitors, dropping from their 2001 peak of 46 percent to only 18 percent of the global market in 2008.[21] (See Figure 3.) The German company Q-Cells was the number one producer of solar cells in 2008, First Solar of the United States ranked second, and Suntech of China came in third.[22]

The strong market demand also fanned the development of thin films, a technology that produce solar cells with much less polysilicon material although generally with less efficiency than crystalline silicon cells.[23] Thin-film production grew 121 percent in one year, from 432 MW in 2007 to 954 MW in 2008.[24] Its global market share also rose, from 7 percent in 2006 to 13.7 percent in 2008.[25] The United States is leading in thin-film production. Industry leaders include First Solar (with plants in the United States, Germany, and Malaysia) and United Solar.[26] First Solar recently completed the largest thin-film solar power plant to date in North America, a 10-MW facility in Nevada.[27] Developers in Germany commissioned three new large-scale thin-film PV installations in 2008 with a combined capacity of some 50 MW.[28] Also in 2008, Masdar PV announced a multibillion-dollar investment in thin-film PV facilities in Germany and Abu Dhabi—one of the largest investments ever made in solar power.[29]

Figure 2. Annual Global Production of Photovoltaic Cells, 1980–2008

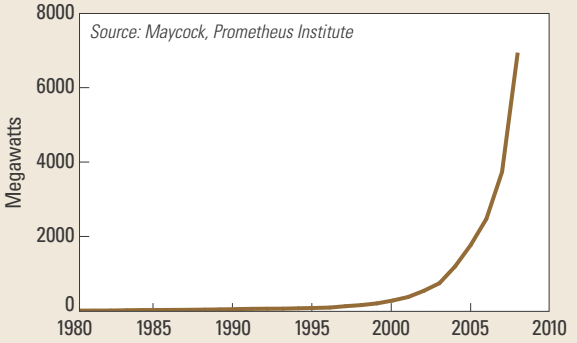
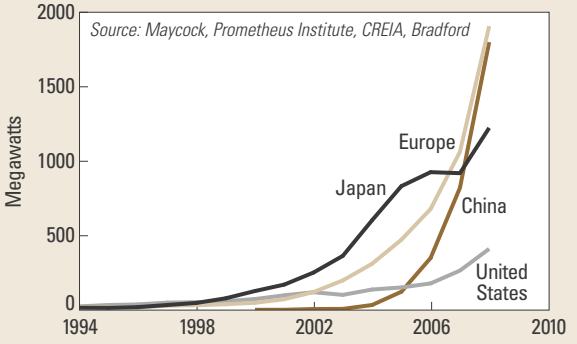


Figure 3. Photovoltaic Production by Country or Region, 1994–2008



Meanwhile, concentrating solar power (CSP)—a technology that uses mirrors to reflect and concentrate sunlight to heat water to drive a steam turbine for electricity generation—is expanding in many regions around the world that are blessed with abundant solar resources.[30] CSP has seen considerable development in the United States, with more than 350 MW of CSP built in California between the mid-1980s and the early 1990s.[31] The country also hosts one of the worldís largest CSP plants, the 64-MW Nevada Solar One CSP plant.[32] The Mediterranean region has started to see increasing new

CSP capacity as well, making Europe, North Africa, and Middle East a potential global hub for CSP generation.[33]

Two new CSP plants came on-line in 2008—the 50-MW Andasol-1 plant in Spain and a 5-MW plant in California.[34] The Andasol-1 plant has more than seven hours of full-load thermal storage capacity, allowing it to provide electricity to the grid when it is most needed and the price is highest.[35] Projects with more than 6,000 MW of capacity are now in the pipeline in the United States, mostly planned for California, Arizona, and Florida.[36] Over 3,000 MW of CSP projects have been announced in Europe, North Africa, and the Middle East; out of these, 2,500 MW are to be built in Spain. Israel and the United Arab Emirates opened tenders for 350 MW projects in the Middle East during 2008, and projects are now planned for Algeria, Morocco, and Egypt.[37]

The global economic crisis started to affect the global solar markets and industry in the latter half of 2008. Its influence will permeate all industry links and markets in 2009 and beyond. Some big industry players are leaving the industry or scaling down. Shell, for example, is leaving the industry all together, BP closed several plants, and Suntech scaled back its production.[38] The solar PV market is expected to contract by 17 percent in 2009.[39]

Solar Thermal Heating Up Sharply

Amanda Chiu

Solar thermal heating worldwide expanded by 19 gigawatts of thermal equivalent (GW_{th}) with the highest annual growth rate since 1995 to reach 147 GW_{th} (210 million square meters (m^2)) of capacity in 2007.[1] (See Figures 1 and 2 on solar water heating—a subset of solar thermal heating applications.) Water heating for domestic uses accounts for 126 GW_{th} (180 million m^2), or 86 percent of all installations, while space heating, swimming pool heating, and industrial processes account for the remaining 21 GW_{th} (30 million m^2).[2] Preliminary estimates for global solar thermal heating suggest additions of between 18 and 19 GW_{th} in 2008, mostly in China.[3]

The most mature of solar technologies, solar thermal heating harnesses the sun's energy for domestic water heating, space heating, swimming pool heating, and drying and other industrial processes. Solar thermal systems can also meet cooling needs by fueling a compressor driven by heat rather than by traditional mechanical energy. It is one of the most widely used renewable heating technologies and the only one to produce energy at levels comparable to renewable power, second only to wind in terms of energy produced annually.[4] Solar thermal heating produced enough energy globally in 2007 to meet the equivalent heating needs of 15 percent of U.S. households.[5]

China, by far the largest market, has two thirds (79.9 GW_{th}, 114.1 million m^2) of global capacity and, despite a one-third decrease in new installations to 16 GW_{th} (22.9 million m^2) in 2007 compared with 2006, accounted for 80 percent of newly installed systems in 2007.[6] (See Figure 3.) Solar water heating in single-family homes accounts for nearly half of all uses and 97 percent of new installations.[7] The remaining applications are split between multi-family homes and hotels, where the other 3 percent of new installations took place.[8]

Figure 1. World Solar Water Heating Capacity, Cumulative Installations, 1995–2007

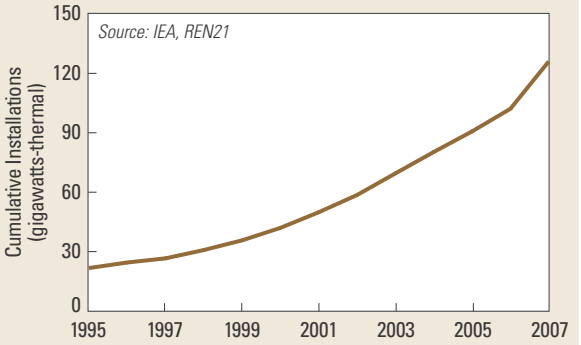
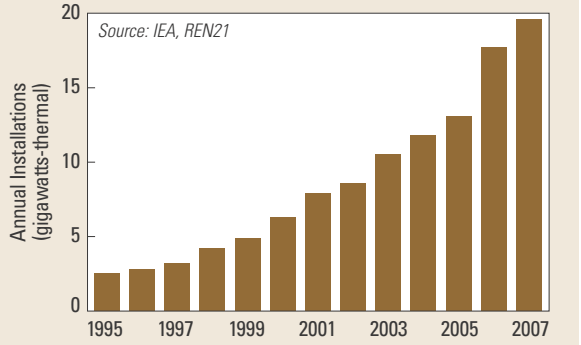


Figure 2. World Solar Water Heating Capacity, Annual Installations, 1995–2007



The contributing factors to Chinese dominance include a lack of natural gas access in most homes, low cost, and government support of research and development.[9] In the coastal city of Rizhao, where about 99 percent of all households use solar water heating, the initial capital costs

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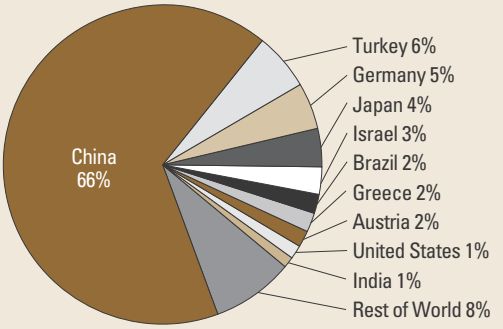
Figure 3. Share of World Solar Water Heating Capacity by Country, 2007



Source: IEA, REN21

for solar water heaters are on a par with conventional electric systems, while lifecycle costs demonstrate annual savings of 3–6 percent of the average 2006 household income.[10] Although national policies have so far not been the driving force behind solar thermal heating in China, spring 2009 saw the launch of the first national rebate program, which targets rural areas.[11]

The market in Turkey, second behind China, peaked in 2004 and reached an annual installation plateau of 490 MW_{th} (700,000 m^2) in 2006 and 2007.[12] The slowdown can be traced to increased access to new gas pipelines (which has affected cost competitiveness in some regions), a high value-added tax, and little government support.[13]

Germany remains the market leader in Europe, with 660 MW_{th} (940,000 m^2) of new installations, despite a substantial 37-percent decrease between 2006 and 2007.[14] This decline has been attributed to reductions in subsidies, a maturing heating market, the economic slowdown, an increase in the value-added tax, and a mild winter.[15] In 2008, the state of Baden Württemberg enacted Germany's first renewable energy heating law, which required new buildings to meet 20 percent of their space and water heating needs with renewables and gave existing buildings two years to transition to 10 percent renewables.[16] A similar law went into effect at the national level in 2009, requiring new residential buildings to use renewable resources for 14 percent of their space and heating needs by 2020, with a two-year transition period and a lower 10 percent target for existing buildings.[17]

The European market experienced its first slowdown in five years in 2007, with 10 percent fewer new installations than in 2006.[18] Germany had the largest decline in annual installations, but Denmark (down 21 percent compared with 2006), Sweden (11 percent), and Austria (4 percent) experienced similar dips, whereas markets in Hungary and Italy soared—with growth rates of 700 percent and 200 percent, respectively.[19] Early estimates for 2008 show a market recovery in Europe, with accelerated growth in the Mediterranean region and a strong rebound in Germany of more than double 2007 annual installations following readjustments in investment subsidies.[20]

Europe maintains the most comprehensive portfolio, with significant levels of applications in hot water and space heating for residential buildings and hotels, district heating, space cooling, and industrial processes. Just under half of new installations in 2007 were used for water heating in single-family homes.[21] In late 2008, the European Union passed a renewable energy directive that includes heating and cooling for the first time, and markets are expected to respond positively.[22]

In Israel, the fifth largest market, new installations (49.7 MW_{th}, 71,000 m^2) plummeted by two thirds in 2007 compared with 2006.[23] Despite this, Israel has a long history of promoting solar thermal heating, dating back to 1980 when it became the first country to implement a solar thermal heating law.[24] Solar thermal heating is now a mainstream technology and meets 4 percent of the country's total energy demand.[25] Similar laws have since been enacted in Portugal, Ireland, Italy, and Spain.[26]

In the United States, new installations (100 MW_{th}, 150,000 m^2) increased by 28 percent to reach a cumulative total of 1.7 GW_{th}.[27] Solar water heating received a supporting hand in late 2008 with the extension of the federal invest-

ment tax credit to 2016 and with the removal of a tax credit cap in early 2009.[28] Hawaii leads the U.S. market, with 37 percent of new installations nationally in 2008, and has enacted a law requiring solar water heating systems in new single-family homes starting in 2010.[29] The largest solar water heating program in the country was approved in California in 2007, and 11 other states include renewable heating and cooling in state renewable electricity targets.[30]

Cyprus has the highest solar thermal heating use per capita in the world (0.67 kW_{th} per capita), followed by Israel (0.52 kW_{th} per capita) and Austria (0.25 kW_{th} per capita).[31] Mediterranean countries like Cyprus and Greece (0.23 kW_{th} per capita) benefit from mild climates, where cheaper, less weatherized systems are economical options.[32] Germany ranks eighth with 71 W_{th} per capita, China steps in at ninth (61 W_{th} per capita), and the United States lags far behind at thirty-first (6 W_{th} per capita).[33]

Integration of solar thermal heating systems into architectural designs is becoming more prevalent and provides additional benefits, including shading and thermal insulation.[34] The best commercially available solar thermal heating systems demonstrate efficiencies of nearly 70 percent.[35]

Worldwide, 200,000 jobs support the production, installation, and maintenance needs of solar thermal heating systems.[36] In the European Union, more than 30,000 people are employed directly or indirectly in the industry, and the German industry alone is responsible for half of these jobs.[37]

Heating accounts for more than two thirds of total energy use in buildings, which emit 30–40 percent of global greenhouse gases.[38] In 2005, nearly 55 percent of energy use in buildings went toward space heating and another 16–17 percent to water heating.[39] Renewable heating resources like solar thermal energy displace conventional heating fuels, primarily natural gas and electricity.

The International Energy Agency estimates that residential solar water heating could displace 60–70 percent of the natural gas and electricity that would otherwise be used in these buildings.[40] In the United States, water heating accounts for 20 percent of total household energy use.[41] By using solar water heating, residential and commercial customers could reduce their heating fuel use by one third and displace the equivalent of 1 percent of the country's total energy use or one third of its natural gas–powered electricity.[42] These improvements would reduce greenhouse gas emissions by 50–75 million tons per year in the United States alone.[43]

In Europe, half of total energy demand is from heating and cooling in buildings and industrial processes. Through efficiency improvements and new technologies, the solar thermal heating industry estimates that Europe could reduce energy demand for heating and cooling by 40 percent and meet half of the remaining low and medium temperature demand with solar heating by 2050.[44] Solar thermal heating technologies also have the potential to provide the industrial sector with up to 125 GW_{th} of thermal fuel, enough for 4 percent of its heating needs.[45]

Solar thermal heating markets were inconsistently affected by the economic downturn in 2007, with major markets stumbling while emerging markets surged forward. In displacing fossil fuels, solar thermal heating provides stability in an era of volatile energy prices and supply while also reducing greenhouse gas emissions.

Fossil Fuel Production Up Despite Recession

James Russell

World production of fossil fuels—oil, coal, and natural gas—increased 2.9 percent in 2008 to reach 27.4 million tons of oil equivalent (Mtoe) per day.[1] (See Figure 1.) In the first half of the year, producers strained to meet global demand, but when the recession took hold later in the year the market was swamped by excess supply.

Figure 1. Fossil Fuel Production, 1981–2008

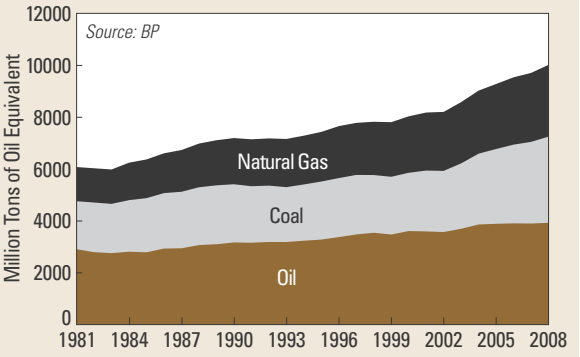
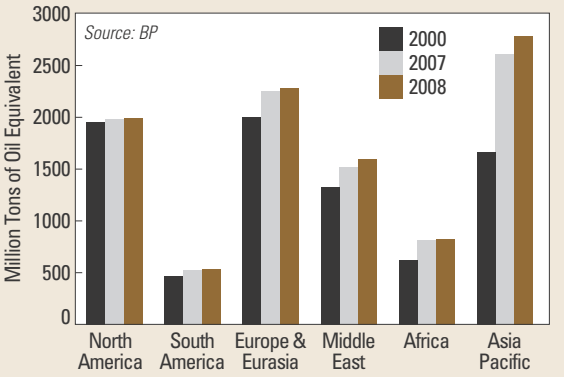


Figure 2. Fossil Fuel Production by Region, 2000, 2007, and 2008



Energy prices reflected this shift: oil peaked at $144 per barrel in July, then fell to $34 per barrel in December.[2] Continuing a decade-long trend, most of the growth was in the Asia-Pacific region, where production grew 6.3 percent.[3] (See Figure 2.)

Although the global economic crisis has caused a temporary slump in demand, the longterm trend is clear: fossil fuel consumption in developing countries has surpassed that in industrialized countries. With four times the population and a vast demand for economic development to raise standards of living, developing countries will see energy use rise further.[4]

For six years running, coal has led the growth in fossil fuel production. In 2000, it provided just 28 percent of the world's fossil fuel energy production, compared with 45 percent for oil. But by 2008, coal production reached 9.1 Mtoe per day, representing a third of fossil energy production and a 0.7 percent increase over 2007.[5] The growth in China's coal consumption since 2000 dwarfs that of all other countries combined. India, second in growth, added less than an eighth as much coal consumption as China during that period.[6] (See Figure 3.)

Globally, the largest share of coal production is for electricity generation.[7] Larger capacities and better materials have led to higher efficiencies at coal-fired power plants, particularly in China. China aims to reduce the energy intensity of its economy by 20 percent during the 2006–10 planning period, in part by improving power-plant efficiency by 4 percent.[8] Industry data suggest that this goal was already surpassed in 2007.[9] In the United States, the construction of new coal-fired power plants has been discouraged by expectations of greenhouse gas regulations, as well as factors such as materials costs

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and public opposition.[10]

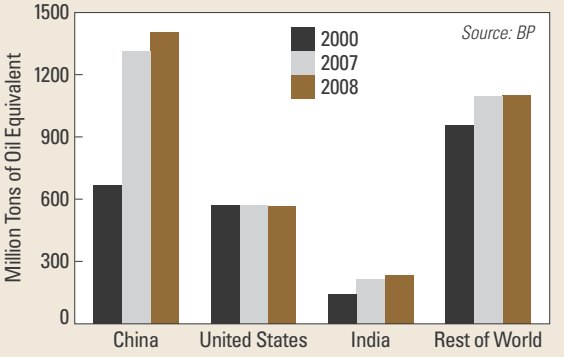
Despite marginal improvements in utilization efficiency, coal continues to be the most polluting fossil fuel. U.S. coal-fired plants with generators installed after 2000 emit the air pollutants nitrogen oxides and sulfur dioxide at 9 and 90 times the rate of new gas-fired plants, respectively.[11] These coal plants emit carbon at more than twice the rate of new gas plants.[12] Carbon capture and storage (CCS) has yet to be demonstrated at a commercial scale for coal power, although the U.S. Department of Energy is spending nearly $14 million to determine if it should invest more than $1 billion to complete a CCS demonstration project called FutureGen.[13]

Oil production reached 10.7 Mtoe per day in 2008, representing 39 percent of fossil energy production and slightly above the level in 2006, the next-highest production year.[14] Oil's slowing momentum coincides with the high oil prices that have been in place since 2004, which hit an all-time high (measured in inflation-adjusted dollars) in July 2008.[15] World oil production outside the Persian Gulf region has been roughly flat since 2005, with increases in countries such as Brazil and Angola offset by declines in the United States, the North Sea, and Mexico.[16]

The ratio of proved oil reserves to annual production has held steady at roughly 40:1 for more than 20 years, but the remaining reserves are increasingly concentrated in more politically and technically challenging terrain.[17] Most of these reserves are in countries where state-owned companies control the resource (such as Russia and Saudi Arabia) or where political instability increases the investment risk (such as Nigeria and Venezuela).[18] Even the Arctic, now seen as a potentially large store of oil resources, has a history of conflicting national claims to ownership that portends a contentious future for production.[19]

The less politically risky deposits present formidable technical challenges. The deep ocean, oil shales, and oil sands are all potentially major sources of future oil production, but these are often expensive to access and their development may significantly increase the environmental

Figure 3. Coal Consumption by Region, 2000, 2007, and 2008

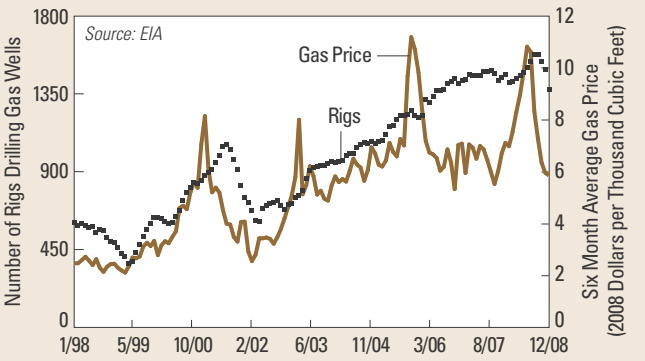


costs of fossil fuel use.[20] For example, well-to-wheels greenhouse gas emissions from oil sands in Alberta, Canada, are estimated to be 5–15 percent higher than emissions from conventional oil reservoirs.[21] Nonetheless, high oil prices pushed production from the Canadian oil sands to 1.2 million barrels per day (Mbpd) in 2008, up from 1.0 Mbpd in 2005.[22]

As oil prices neared their peak in mid-2008, consumption by industrialized countries fell by about 1 percent from one year before.[23] Economic turmoil dragged demand still lower later in the year, and the average industrial-country consumption for 2008 was 47.5 Mbpd, 3.5 percent below the 2007 level, with even sharper declines in the first half of 2009.[24] In contrast, developing-world demand increased by 1.4 Mbpd to 38.7 Mbpd, driven by rising transportation energy needs and government fuel subsidies that softened the pain of higher prices.[25] This growth offset much of the industrial-country decline, and global oil consumption ended only 0.3–0.6 percent lower than in 2007.[26]

Natural gas production has maintained a 27–28 percent share of fossil energy production since 2000.[27] Total gas production grew 3.8 percent in 2008 to reach 7.6 Mtoe per day.[28] High gas prices have spurred exploration and development, especially in the United States, which provided 19 percent of global gas production in 2008.[29] At the height of the 2008 market, nearly

Figure 4. U.S. Natural Gas Price and Drilling Activity, 1998–2008



1,600 rigs were drilling gas wells in the country.[30] (See Figure 4.) Although drilling activity plummeted as the gas price declined, the industry's success in commercializing production from "unconventional" sources such as coal deposits, tight sands, and especially shale rock, has sharply increased reserve estimates and led to a major upward revision in the forecast for future U.S. gas production.[31]

Countries that are seeking to reduce greenhouse gas emissions have increased their share of natural gas in electricity production, due primarily to the high energy-to-carbon ratio of gas relative to coal. The European Union's (EU) cap-and-trade system, which effectively puts a price on carbon emissions, caused the traditionally low cost of coal generation to exceed that of gas for much of 2008.[32] This trend has continued into 2009, even though the per-ton price of carbon dioxide has declined.[33] In the United States, sharp declines in the price of natural gas in 2009 allowed gas-fired power generation to rise slightly while coal-fired generation plummeted 13 percent in response to lower electricity demand, pushing carbon emissions down sharply.[34]

The shift toward gas-fired generation under the EU cap-and-trade system demonstrates how policies that force the externalities of fossil fuel use to be reflected in market prices can reshape energy markets. The slip in industrial-country demand as oil prices reached record levels in 2008 also indicated that conservation and improved efficiency are real options for reducing fossil fuel dependence—a fact highlighted by the recent U.S. move to increase vehicle efficiency by roughly one third over the next seven years.[35]

James Russell is an environmental engineer and a researcher at the Asia Pacific Energy Research Centre.

Biofuel Production Up Despite Economic Downturn

Alice McKeown

Global biofuel production topped 81 billion liters in 2008, an increase of more than 36 percent over the previous year.[1] This includes more than 66 billion liters of fuel ethanol and nearly 15 billion liters of biodiesel.[2] (See Figure 1.) However, growth in biofuel output is projected to slow significantly in 2009 to below 10 percent.[3] Combined biofuel production has increased more than 350 percent since the start of the decade, and biofuels now make up some 1.67 percent of the total world liquid fuel supply, up 0.4 percentage points since 2007.[4]

The United States and Brazil dominate the global ethanol industry, producing the fuel primarily from corn and sugarcane respectively. In 2008, the United States produced nearly 35 billion liters, more than 53 percent of the global total.[5] (See Figure 2.) The U.S. ethanol market experienced a significant downturn in 2008 and had nearly 5.8 billion liters of refinery capacity idled by the middle of 2009, though there is still considerable potential for growth.[6] In late 2009 there were 202 refineries with a total capacity of 49.7 billion liters and more than 5.4 billion liters of new capacity in development.[7]

Brazil produced 37 percent of the world's ethanol in 2008, at 24.2 billion liters.[8] By late 2009 there were 159 ethanol distilleries and 248 additional mills that produce both sugar and ethanol.[9] Ethanol production capacity is also expected to increase in Brazil due to continued national and foreign investments.[10] About 90 percent of ethanol production is concentrated in the south central part of the country, with the remainder in the northeast.[11]

Other areas with notable ethanol production included the European Union (2.8 billion liters), China (1.9 billion liters), and Canada (950 million liters).[12]

For biodiesel, Europe produced more than half of the global supply in 2008.[13] Germany continued to hold the lead with 2.8 billion liters, although France was close behind and may gain ground in 2009.[14] (See Figure 3.) U.S. production of biodiesel reached 2.7 billion liters.[15]

Although biofuel production is often cited for its climate benefits, studies suggest that with today's feedstocks and technologies, the benefits

Figure 1. Ethanol and Biodiesel Production, 1975–2008

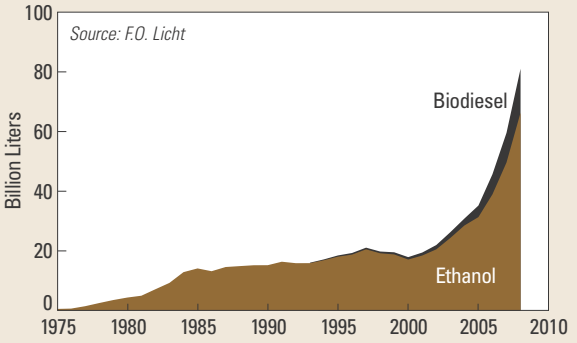


Figure 2. Fuel Ethanol Production, Brazil, United States, and Rest of World, 1990–2008

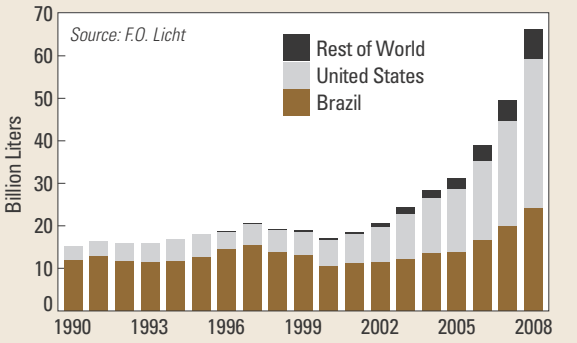


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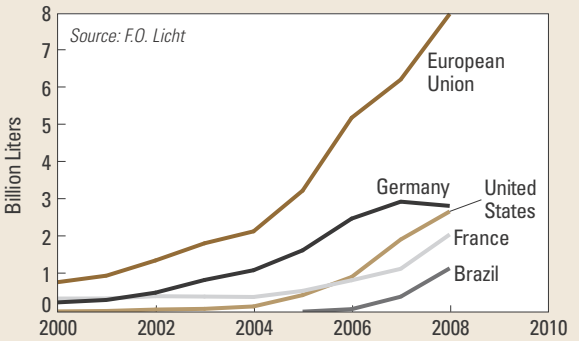
Figure 3. Biodiesel Production, Selected Countries, 2000–08



of producing biofuels on a large scale may not outweigh the costs. First-generation corn ethanol provides only a 12–18 percent net reduction in direct greenhouse gas emissions on average compared with gasoline, while sugarcane ethanol provides a 56–70 percent reduction.[16] For soy-based biodiesel, the reduction is 41 percent compared with diesel.[17] Advanced biofuels on the horizon, such as cellulosic ethanol, show the potential to achieve an 86–94 percent reduction, although the exact impacts will not be known until they can be commercially produced.[18]

If indirect effects—specifically, land use changes—are counted, the greenhouse gas footprint of biofuels rises significantly.[19] Clearing carbon-rich ecosystems like forests, savannas, and grasslands for biofuel feedstocks incurs a "carbon debt" as greenhouse gases are released. Carbon debts are paid off over time if the biofuels release less total greenhouse gas than the fossil fuels they are replacing. Studies show that clearing tropical forests for palm oil biodiesel causes a carbon debt payoff period of 75–93 years; grasslands used for corn ethanol have a payoff in 93 years; and with wooded lands for sugarcane ethanol, the figure is 17 years.[20] Greater production of cellulosic ethanol will also increase indirect emissions.[21] Including these indirect effects means that biofuels can actually increase greenhouse gas emissions rather than reduce them.[22]

Another potential trouble with biofuels is water use. In the United States, corn ethanol consumes between 10 and 324 liters of water for every liter of ethanol produced, depending on the climate, while cellulosic ethanol is expected to use between 1.9 and 9.8 liters.[23] Although water use rates have been declining as ethanol production becomes more efficient, irrigation demands are expected to increase worldwide to accommodate further biofuel expansion.[24] Biofuels have also been linked to water pollution from agricultural runoff and to "dead zones" in the Gulf of Mexico.[25]

Expanded biofuel production and consumption also raise economic and social concerns. Rapid growth in the sector in the past five years has contributed to a sharp increase in the prices of food and feed grain.[26] The International Institute for Applied Systems Analysis looked at a series of stimulated biofuel scenarios and concluded that increasing biofuel production will lead to more hunger across the world.[27] Africa and Asia are expected to be hit the hardest, making up two thirds and three quarters, respectively, of the additional number of people experiencing food insecurity due to biofuel increases in 2020 and 2030.[28]

Increased biofuel use is also contributing to the global conversion of land to agriculture for growing feedstocks.[29] The grain used in biofuels accounted for more than 5 percent of the global total in 2008, a 10-percent increase over the year before.[30] The United States, which grew 37 percent of the world's corn last year, now devotes nearly 33 percent of this crop to fuel production, up from 6 percent in 2000.[31] (See Figure 4.) By some estimates, pressure to expand biofuel production could increase the expansion of cultivated land by 20–40 percent by 2020, accelerating deforestation, biodiversity loss, and other problems.[32]

One of the primary drivers behind expanded biofuel production is a patchwork of national and regional production and consumption targets, mandates, and subsidies. The European Union (EU) will require 10 percent of the

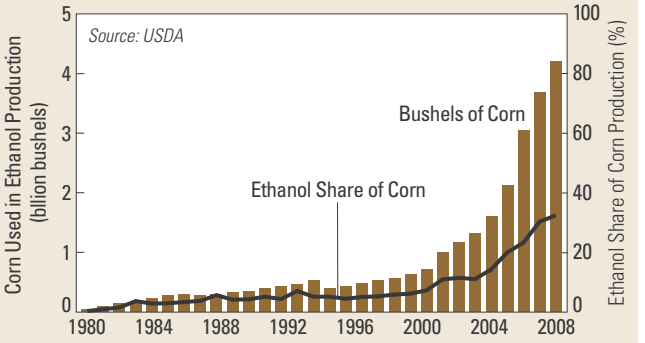
region's transportation fuels to come from renewable sources like biofuels by 2020.[33] The United States mandates the blending of 136 billion liters of biofuels annually into conventional motor fuels by 2022 under its revised Renewable Fuel Standard.[34] Other countries with mandates include Thailand, India, China, Australia, and Colombia.[35]

Meeting these biofuel targets and mandates could increase the share of biofuels in world transport fuel to around 7 percent by 2020.[36] But these mandates are expected to increase the problems of biofuel use, including significant rising demand for grains until advanced feedstocks are readily available.[37]

In recognition of these concerns, governments are promoting advanced or second-generation biofuels that rely on non-food feedstocks and offer lower greenhouse gas emissions and less pressure on food supplies than first-generation biofuels like corn ethanol. The most widely cited of these is cellulosic ethanol; in 2008, some 18 billion liters of cellulosic ethanol capacity were operational, with substantial increases under construction.[38] Despite extensive research and development efforts, however, advanced biofuels are not expected to be commercially and widely available for at least five years.[39]

Other issues likely to receive attention in the near term include a decision by the U.S. Environmental Protection Agency on the best way to calculate greenhouse gas emissions of biofuels as required by the national biofuel mandate. The European Union's renewable fuels directive will take effect in December 2010, and a further study on indirect land use effects is expected by then too.[40] Palm oil biodiesel may get a boost—despite ongoing controversy and its connection with deforestation and land clearing in tropical areas—if a new review concludes that its emissions reductions are greater than previously thought, making it eligible for EU incentives.[41] Overall, the biofuel market is expected to reach $247 billion by 2020—up from a projected $76 billion in 2010.[42]

Figure 4. U.S. Corn Used in Ethanol Production, 1980–2009



Environment and Climate Trends

Scott Carter

The aftermath of Hurricane Katrina: six miles from the shore in Mississippi

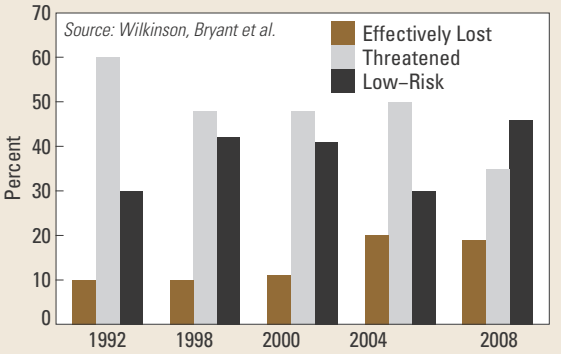
For data and analysis on environment and climate trends, go to vitalsigns.worldwatch.org.

One Fifth of Coral Reefs Lost, Rest Threatened by Climate Change and Human Activities

Alice McKeown

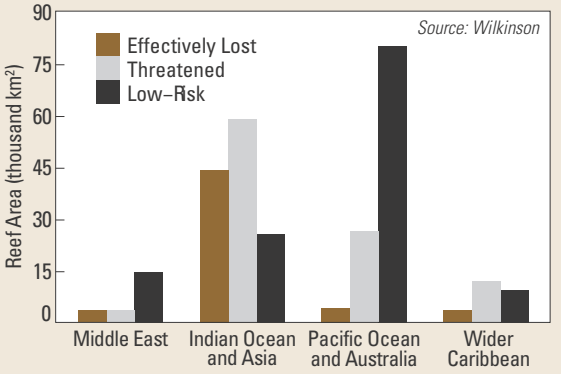
About one fifth of the world's coral reefs have already been lost or severely damaged, while another 35 percent could be lost within 10–40 years, according to the latest review by the Global Coral Reef Monitoring Network.[1] The review contained mixed news: the number of coral reefs considered at low risk stood at 46 percent, up from 30 percent only four years ago, but the number of effectively lost reefs remained constant during the same period—although this figure was double the 10 percent lost or severely damaged in the first global estimate in 1992.[2] (See Figure 1.) Notably, the recent threatened reef estimates do not take into account risks from climate change; when these are included, all coral reefs are at danger and widespread mortality is predicted.[3]

Figure 1. Global Status of Coral Reefs, 1992–2008



Note: Decline of 1 percent in reefs effectively lost in 2008 is due to strong recovery of reefs severely damaged in the 1998 bleaching event.

Figure 2. Coral Reef Area Threatened, 2008



Coral reefs in Asia and the Indian Ocean are most at risk, with 54 percent either lost or critically threatened and another 25 percent moderately threatened.[4] (See Figure 2.) This marks a worsening trend since 1998.[5] Southeast Asia, which contains the highest biodiversity of all coral reefs as well some of the world's highest population densities, has already lost 40 percent of its reefs (36,680 square kilometers).[6] (See Table 1.)

The wider Caribbean region also has a significant portion of at-risk coral reefs, including 38 percent either lost or critically threatened and 24 percent moderately threatened.[7] A survey completed in 2008 found that reefs in the area were in poor or fair condition and that threats like tropical storms, tourism, and coastal development have grown consistently over the last 10–25 years.[8]

The Middle East region is marked by contrasts: it contains one of the areas with the lowest-risk reefs, in the Red Sea, as well as the area with the largest percentage of lost reefs, the Persian Gulf, Arabian Sea, and Gulf of Oman.[9]

Coral reefs in the Pacific Ocean are by far in the best shape, with only 11 percent lost or critically threatened, 16 percent moderately threatened, and 72 percent considered at low risk.[10] This trend has been consistent over the last

Click here to see notes for this section.

Table 1. Top Coral Reef Regions, by Percent Lost

Geographic Area	Total Coral Reefs	Lost	Low Risk
	(sq. km.)	(percent)	(percent)
The Gulfs	3,800	70	3
Southeast Asia	91,700	40	15
South Asia	19,210	25	30
U.S. Caribbean	3,040	21	29
East & North Asia	5,400	20	40
World total	**284,803**	**19**	**46**

Source: Clive Wilkinson, ed., Status of Coral Reefs of the World: 2008 *(Townsville, Australia: Global Coral Reef Monitoring Network, 2008).*

decade and correlates with the overall trend of the most remote coral reefs being least at risk.[11]

There are roughly 284,000 square kilometers of coral reefs in the world, covering less than 0.1 percent of the world's oceans—equal to about 0.6 percent of the world's agricultural lands.[12]

Even though they are relatively rare, coral reefs support more than a quarter of all known fish species, making them a vital part of marine ecosystems.[13] They are hotspots of biodiversity comparable to tropical rainforests, and they contain more species per unit area than in any other ecosystem in the world.[14]

Coral reefs directly supply about 2–5 percent of the global fisheries harvaest and are an important protein and income source, especially in developing countries.[15] They provide resources and food for about 500 million people across the globe, including 30 million people who are almost completely dependent on reefs and associated coral resources.[16]

These resource contributions can be measured in monetary equivalents, with coral reefs estimated to provide $30 billion worth of goods and services each year, including $5.7 billion in fisheries production, $9 billion in coastal protection, and $9.6 billion in tourism and recreation.[17] In general, socioeconomic benefits and services offer higher value than potential revenues from fishing.[18] Degradation of reefs is projected to decrease these benefits by as much as 75 percent in some regions.[19] One study estimated that sea temperature rises and species losses due to climate change will cause $109.9 million in losses in the Caribbean alone, about 14 percent of the gross domestic product of the region.[20]

Many of the ongoing threats to coral reefs can be linked to human activities, including overfishing and destructive fishing practices such as using explosives and cyanide poison.[21] Some estimates show that coral reef fishery landings are already 64 percent higher than is sustainable.[22] Another threat is coastal development, which leads to lower water quality, increased sedimentation, and more pollution, among other problems.[23] These threats are expected to worsen: at least 39 percent of the world lives within 100 kilometers of an ocean, and projections indicate that population density will continue to grow in these coastal areas.[24]

Although these and other factors like storm damage are well documented, climate change is arguably the most important factor for the future of coral reefs because of their low adaptive capacity.[25] Climate change threats are also notable because they can combine with other risk factors and increase chances of reef collapse or destruction.[26]

Coral reefs are particularly susceptible to warming sea surface temperatures caused by climate change, which over the last few decades has contributed to the increased frequency and intensity of coral bleaching events.[27] So-named because a loss of symbiotic algae makes the affected reefs appear whiter, bleaching events can reduce coral growth and reproductive capacity, change reef fish species composition, and make the reefs vulnerable to disease and mortality.[28] In 1998—the second warmest year on record—the largest documented bleaching event killed 16 percent of the world's corals, while 2005—the warmest year on record—was marked by a massive bleaching event in the Caribbean, with reef-affected rates as high as 50 percent.[29] Climate models predict widespread annual or biannual bleaching events worldwide by 2030 to 2050.[30]

Another worrying climate change factor for coral reefs is increasing ocean acidity due to higher atmospheric carbon dioxide concentrations, which can decrease coral calcification and growth and lead to weaker structures and slowed reproduction, among other negative effects.[31] Ocean acidity has already increased by 30 percent, and a recent study shows that calcification has been reduced by more than 14 percent in the Great Barrier Reef since 1990, a rate unknown for at least 400 years.[32] Some climate models show that continued increasing carbon dioxide concentrations will reduce some coral calcification rates by 20–60 percent.[33]

These growing threats and others have led many coral reef experts to focus on reef resilience—the ability of coral reefs to adapt to and survive both human and climate-induced changes. Some have argued that resilience indicators should be integrated into coral reef monitoring programs.[34] Other resilience-based approaches argue for expanding locally managed marine protected areas and no-take areas and looking toward geographical and regional networks to help counteract the potential for large-scale disturbances.[35] One recent study argues that reefs that are likely to be the most resilient—as measured by scientific modeling—should be given protection priority for no-take area status.[36] One last resilience approach involves increasing herbivore fish and invertebrates on coral reefs through improved management and catch limits.[37]

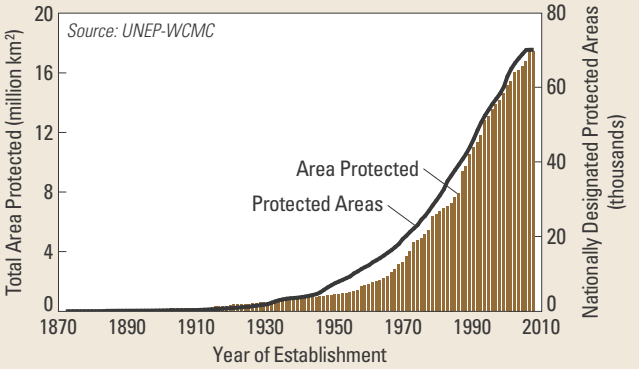
In fact, most approaches to coral reef protection rely on some degree of improved management. For example, socioeconomic modeling looks at how local peoples perceive threats to coral reefs as a way to help inform local management approaches.[38] And a revision to the monumental *Reefs at Risk* survey coordinated by the World Resources Institute is under way—relying on improved modeling and data and looking specifically at climate change threats—to offer a new look at coral reef threats that can be used in management decisions.[39]

Growth in Protected Areas Slows

Margarita Yatsevich

The areas of the world that are officially protected—national parks and the like—grew by some 26 percent between 1997 and 2007, roughly one third as fast as during the preceding 10 years, when the rate topped 75 percent.[1] (See Figure 1.) In total, land-based and sea-based protected areas occupy 21.8 million square kilometers, or 4.27 percent of Earth's surface.[2] Globally, 12.4 percent of terrestrial land and territorial waters (that is, water up to 12 nautical miles from shore) are devoted to protection.[3]

Figure 1. Nationally Designated Protected Areas Worldwide, 1872–2007



Protected areas are managed for a broad range of purposes: some are managed mainly for recreation or use of natural resources, while others have a clear conservation goal and allow only scientific pursuits.[4] The International Union for Conservation of Nature (IUCN) defines a protected area as "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."[5] IUCN divides protected areas into seven classifications, based on their management objectives, each with a different level of protection so that different needs are addressed accordingly. (See Table 1.) Between 1872 and 2007, governments around the world designated nearly 114,000 terrestrial and marine sites.[6]

Countries vary greatly in the number, size, and share of protected areas they establish. Table 2 shows the top five countries in each of these categories.[7]

Since 2000, small island developing states (SIDS) have registered the biggest increase in countries' share in protected areas.[8] In total, however, the world's industrial regions have designated the highest percentage of their lands for conservation (18 percent), followed by SIDS (17.8 percent) and then other developing regions (13 percent).[9] (See Figure 2.)

More than 30 percent of the world's protected areas are found in mountains.[10] They are a valuable source of high-quality fresh water and are often critical to water supply. [11] Mountain ecosystems have an extremely high level of biodiversity and an outstanding level of endemism (when a species is found only in a particular region or location and nowhere else in the world) due to the isolation of mountains from one another and the lowlands.[12] Mountain peoples are critical to planning efforts for protected areas because of their experience in sustainable coexistence with nature.

Marine environments are much less protected than their terrestrial counterparts: only 0.7 percent (about 2 million square kilometers) of the world's oceans are included in protected areas.[13] Over the last century, the annual rate of increase in protection of marine environments has been approximately 3–5 percent.[14] At this rate, the Convention on Biological Diversity's

Click here to see notes for this section.

Table 1. IUCN Protected Area Management Categories: Number and Area of Sites in 2007 and Examples

IUCN Category	Number of Sites	Area (sq. km.)	Examples
Category Ia: Strict nature reserve	5,410	1,085,194	French Guiana: Réserve Biologique Domaniale de Lucifer Dékou-Dékou Forest Biological Reserve (1,103 sq. km.)
Category Ib: Wilderness area	1,317	640,681	Bulgaria: Djendema Strict Nature Reserve (42 sq. km.)
Category II: National park	4,013	4,618,146	Australia: Discovery Bay Marine National Park (28 sq. km.)
Category III: Natural monument	20,028	612,731	Philippines: Bessang Pass Natural Monument (5 sq. km.)
Category IV: Habitat/species management area	29,318	3,048,334	United States: Chesapeake Bay National Estuarine Research Reserve, in Maryland and Virginia (42 sq. km.)
Category V: Protected landscape/	13,838	2,701,741	New Zealand: Aorangi Forest Park Conservation Park seascape (194 sq. km.)
Category VI: Managed resource protected area	3,707	4,459,822	Brazil: Amazonas National Forest (15,731 sq. km.)
No category applied	36,137	4,599,047	New Zealand: Lewis Pass National Reserve (183 sq. km.)
Total	**113,768**	**21,765,696**	

Note: The total number does not include 194 sites in an additional category added at the end of 2008, and total area does not include the additional 6406.89 square kilometers in that category.

Source: World Database on Protected Areas, *2008.*

Table 2. Top Five Countries with Protected Areas, by Number, Area, and Coverage of Protection

Rank	Highest Number of Protected Areas		Largest Amount of Area Protected		Highest Share of Terrestrial Land and Territorial Waters Protected	
	Country	Number	Country	Area (sq. km.)	Country	Percent Protected
1	Germany	14,388	United States	3,234,962	Svalbard and Jan Mayen Islands	74
2	Russia	11,181	Brazil	2,536,290	Venezuela	66
3	Estonia	9,617	Russia	1,628,653	Germany	54
4	United States	6,848	China	1,454,145	Hong Kong	50
5	Finland	6,046	Australia	1,449,822	Zambia	41

Source: World Database on Protected Areas, *2008.*

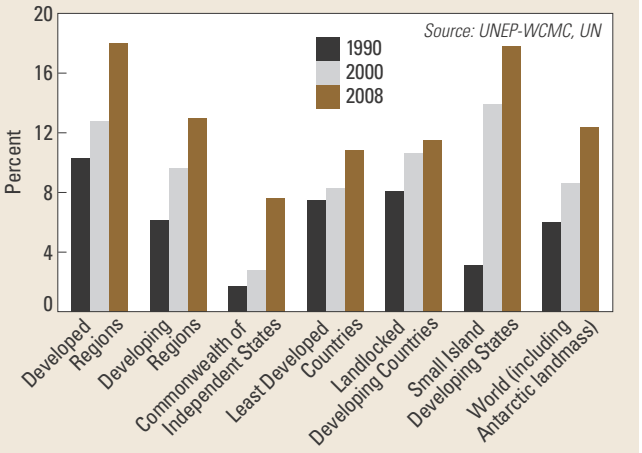
target for 2012—that 10 percent of all marine and coastal ecoregions should be conserved—will not be met until 2069.[15]

There is some good news, however: In 2006, the United States designated a marine area of the northwestern Hawaiian Islands (362,000 square kilometers—about the size of California) as the PapahÇnaumokuÇkea Marine National Monument, the second largest marine protected area in the world.[16] And in January 2009, in one of his final acts in office, President Bush designated three Marine National Monuments in the Pacific Ocean, covering 314,273 square kilometers.[17] But only the deep waters of these monuments are

protected. If uncontrolled fishing of the surface waters continues, many deepwater organisms will starve.

Yet simply creating protected areas is not enough to conserve biodiversity. Adequate funding and intelligent management are also necessary to make them a safe refuge for species. According to a 2006 study by WWF International, successful protection of biodiversity requires strong law enforcement, control of access, resource management, monitoring and evaluation, maintenance of equipment, budget management, and annual work plans.[18]

Figure 2. Protected Areas' Share of Total Land Area, 1990–2008



International initiatives sometimes spur the creation of protected areas. Signatories to the Convention on Biological Diversity, the international treaty that aims to protect the planet's plant and animal species, have agreed that protecting at least 10 percent of each of the world's 825 terrestrial ecoregions is an effective way to conserve biodiversity.[19] Similarly, conservation is a part of the Millennium Development Goals, the set of social, economic, and environmental targets that governments worldwide are striving to achieve by 2015. Goal seven, which focuses on reversing the loss of environmental resources, lists the growth in protected area coverage as an indicator of progress.[20]

An empirical study on the relationship between biodiversity conservation and poverty reduction found that marine protected areas can alleviate poverty. It found that they accomplished this in several ways: fishing improved as a spillover from no-fishing zones; more jobs were created, especially in tourism; local governance improved; and people gained health benefits from their increased protein intake from fish and from their higher incomes.[21]

Other studies have found that the stricter IUCN categories generally have higher scores in management effectiveness.[22] In addition to national reserves, some protected areas have international designation, such as natural World Heritage sites, UNESCO Man and The Biosphere reserves, and Ramsar wetlands (established under the Ramsar Convention on Wetlands). Studies have found, however, that these are not necessarily more effective than national reserves in preserving biodiversity.[23]

Innovative public-private partnerships are helping protect ecosystems while providing recreation and employment opportunities. A 2008 Goldman Environmental Prize winner, Ignace Schops of Belgium, led the establishment of that nation's first and only national park by raising more than $90 million from public and private sources.[24] The Hoge Kempen National Park opened in early 2006 and covers 60 square kilometers.[25] Since its opening, 400,000 people have visited the park, bringing in $48 million a year.[26] The park has also created 400 new jobs for the local community, increasing the income of the region.[27] IUCN plans to use Schops's model for creating and funding a national park as an example for its other member countries around the world.[28]

In response to climate change and the other pressures that humans put on the environment, international organizations and governments are uniting to restore and conserve nature through protected areas. One major example of this cooperation is the World Parks Congress, an international event held every 10 years to take stock of the world's protected areas and their progress. The next World Parks Congress will be held in 2013.[29]

Devastating Natural Disasters Continue Steady Rise

Petra Löw

In 2008, some 750 natural disasters occurred worldwide, down from 960 in 2007, a drop of 22 percent.[1] But the decline is less heartening than it appears: first, 2007 had been a record year, and, second, while the number of smaller disasters fell in 2008, major catastrophes continued their longstanding upward trend.[2] Some 82 percent of these—672 events—were weather-related disasters.[3]

Natural disasters can be divided into six damage categories based on their financial and human impact—from a natural event with very little economic impact to a great natural disaster.[4] (See Table 1.) A decline in disasters from 2007 to 2008 is noticeable in Categories 1 and 2 (minor events). In Categories 3 and 4, the number was roughly the same in both years. But in Category 5 an upward trend is discernible: there were 40 "devastating disasters" in 2008—the highest number ever recorded in this category.[5] (See Figure 1.) These included Hurricane Gustav; the monsoon floods in India, Bangladesh, and Nepal; and Typhoon Fengshen in the Philippines. Only one event in this category—the earthquake in June in Japan, with an overall economic losses of $520 million —was not weather-related.[6]

Catastrophes are also divided into geophysical, hydrological, meteorological, and climatological events. Analysis of each event type back to 1980 shows a distinct difference between weather-related events and geophysical ones. The number of hydrological events (floods, flash floods, mass movements) in particular has risen significantly worldwide over the years, but so have the number of meteorological events (tropical and extra tropical storms) and the incidence of extreme temperatures (heat wave, drought,

Table 1. Disaster Categories

		Overall Losses			
Category	Loss profile	1980s	1990s	2000–09	Fatalities
1. Small-scale loss event	Small-scale property damage	—	—	—	1–9
2. Moderate loss event	Moderate property and structural damage	—	—	—	> 10
3. Severe disaster	Severe property, infrastructure, and structural damage	More than $25 million	More than $40 million	More than $50 million	> 20
4. Major disaster	Major property, infrastructure, and structural damage	More than $85 million	More than $160 million	More than $200 million	> 100
5. Devastating disaster	Devastating losses within the affected region	More than $275 million	More than $400 million	More than $500 million	> 500
6. Great natural disaster	Region's ability to help itself clearly overtaxed, interregional/ international assistance necessary, thousands of fatalities and/or hundreds of thousands homeless, substantial economic losses (UN definition). Insured losses reach exceptional orders of magnitude.				

Source: Munich Re.

Click here to see notes for this section.

wildfire).[7] (See Figure 2.)

Worldwide, the annual average number of hydrological events has tripled since the 1980s, whereas meteorological and climatological events have nearly doubled.[8] The analysis of natural disasters based on Munich Re's long-term data evaluation—a systematic recording of natural perils that began in 1974—and the disaster classification have helped over the years to discern the different trends of weather-related and geophysical disasters.

Economic and insured losses continued the global trend of increase. In 2008, economic losses totaled $200 billion, of which $45 billion was insured.[9] Adjusted for inflation, 2008 was the third most expensive year on record.[10] These figures were only exceeded by the extremely strong hurricane season of 2005 and the disastrous earthquake in Kobe, Japan, in 1995.[11] The drivers of the losses in 2008 were the earthquake in China (losses of $85 billion) and Hurricane Ike ($38 billion).[12] About 57 percent of economic losses from natural catastrophes and 99 percent of insured losses resulted from weather-related disasters.[13]

For weather-related disasters, 2008 was the fifth most expensive one on record.[14] (See Figure 3.) They caused losses in the amount of $113 billion for national economies and $41 billion for the insurance industry.[15] This is an increase of more than 60 and 70 percent, respectively, over the figures in 2007.[16]

Despite fewer events in 2008, fatalities were significantly higher. At least 163,000 people were killed as a result of natural catastrophes, mainly due to Tropical Cyclone Nargis in Myanmar (85,000 confirmed dead plus 54,000 missing) and the earthquake in China (70,000 confirmed dead plus 18,000).[17] Weather-related disasters accounted for 57 percent of the year's fatalities (92,500), largely from storms (53 percent) but also from floods (3 percent) and climatological events like extreme temperatures and wildfires (1 percent).[18] In terms of weather-related disasters, this was the third highest annual death toll since 1980.[19] (See Table 2.)

Three of the four "great natural disasters" in

Figure 1. Number of Devastating Natural Disasters (Category 5), 1980–2008

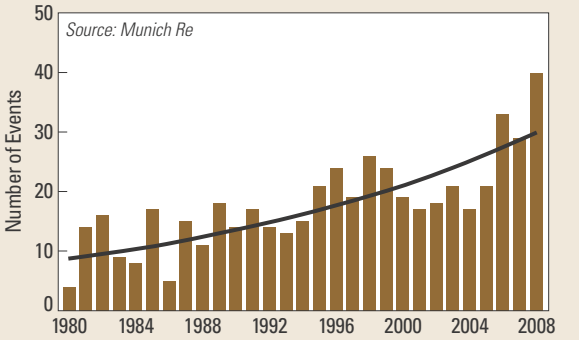


Figure 2. Relative Trends for Natural Disasters, by Type, 1980–2008

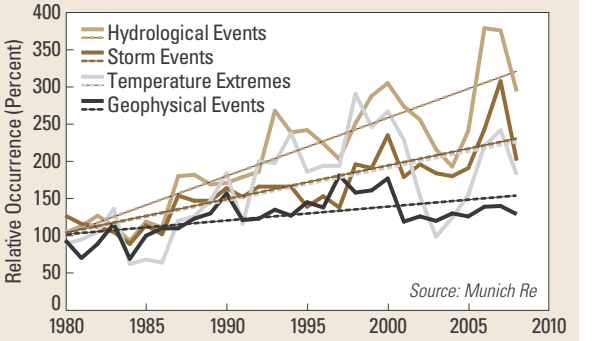


Figure 3. Economic and Insured Losses from Weather-Related Disasters, 1980–2008

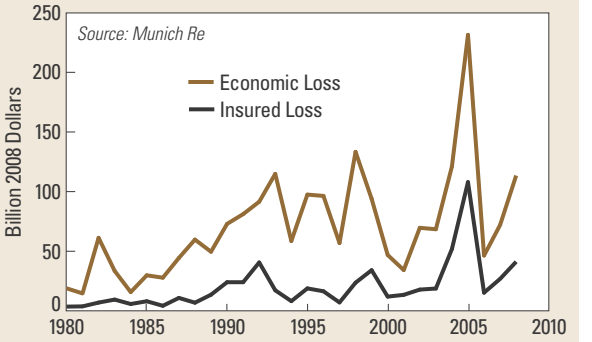


Table 2. Fatalities Caused by Weather-related Disasters, Selected Years

Year	Fatalities per year	Weather-related Disasters, Main Events
1984	256,000	Drought in Africa, tropical cyclone in the Philippines
1991	155,000	Tropical cyclones in Bangladesh, Philippines
2008	92,500	Cylone Nargis,* Hurricane Ike, tornadoes in the United States
2003	81,000	Heat wave in Europe
1999	50,000	Typhoons, flash floods in Venezuela

** Does not include people still missing.*

Source: Munich Re.

2008 happened in Asia, and they were all weather-related.[20] Asia had 34 percent of all events worldwide, 98 percent of all fatalities, and 59 percent of all economic losses.[21] More than 80 percent of the Asian natural catastrophes were weather-related disasters.[22] Snow and ice brought parts of China to a standstill for several weeks in January and caused economic losses exceeding $20 billion.[23] In May, Tropical Cyclone Nargis hit Myanmar. That same month an earthquake in Sichuan (China) was the deadliest natural disaster in China since the Tangshan earthquake in July 1976. And some 72,000 persons are still missing due to these two disastrous events—54,000 from Cyclone Nargis and 18,000 from the earthquake in China—so the total number of fatalities could rise to 235,000.[24] Particularly heavy rain in the monsoon regions of South and Southeast Asia killed or displaced thousands of people in India, Pakistan, and Viet Nam.[25]

The 2008 hurricane season in the United States and the Caribbean, with 16 tropical storms (including 8 hurricanes), was well above the 1950–2007 long-term average of 10.3 tropical storms and 6.2 Atlantic hurricanes.[26] There were 5 major hurricanes (Categories 3–5 on the Saffir-Simpson scale) in 2008, again well above the long-term average of 2.7 storms per season.[27] For the first time on record, 6 consecutive tropical storms—Dolly, Edouard, Fay, Gustav, Hanna, and Ike—made landfall in the United States.[28] Cuba was hit for the first time in one season by three Category 3 hurricanes.[29]

More than 900 people lost their lives in these storms.[30] Economic losses exceeded $50 billion, with insured losses totaling some $20 billion.[31] This made 2008 one of the most expensive hurricane years ever, mainly for the insurance industry.[32] Ike was the year's most destructive hurricane, hitting the Caribbean and the United States. The enormous size of the affected area and the impact of the strong storm surge on coastal areas explained the high economic losses of $38 billion and insured losses of $15 billion in the Caribbean and the United States.[33]

The United States also registered 1,700 tornadoes in 2008—one of the most tornado-intense years since reliable records began in 1953.[34] Persistent rain over the upper Midwest caused the worst flooding on the Mississippi River since the Great Floods of 1993.[35] There were also severe wildfires in southern California in November, collectively making the U.S. economy the one most severely affected by weather-related disasters. Overall economic losses totaled $68 billion in 2008.[36] Only 2005—with a figure of $177 billion, adjusted for inflation—produced such high losses.[37]

Some 7 percent of all natural disasters occurred in South America, and 75 percent of them were weather-related, mostly flood events.[38] In southern Brazil, more than 1.5 million people were affected by heavy rains, and 80,000 became homeless.[39] In Peru, Bolivia, and Ecuador, flooding in February and March damaged or destroyed more than 60,000 houses.[40] Honduras, Nicaragua, and Guatemala were hit by floods and landslides in October, when thousands of houses were destroyed.[41] Nevertheless, there were periods of dry conditions in South America. Prolonged drought (January-September) across parts of Argentina, Paraguay, and Uruguay significantly affected agriculture.[42] Some areas experienced their worst droughts in over five decades. Extreme temperatures and dry conditions caused an economic loss in

Argentina of about $700 million.[43]

In 2008, Europe accounted for 13 percent of all natural disasters, of which 89 percent were weather-related.[44] The loss figures were mainly the result of three events—Winter Storm Emma, Depression Hilal in Germany, and severe storms and floods in Southern and Central France—which caused economic losses exceeding $3 billion.[45]

The number of weather-related disasters in Africa was in line with the long-term average, with 9 percent of all events worldwide happening there.[46] More than 300,000 people were affected by heavy rain and floods in the West African monsoon.[47] Two tropical cyclones—Ivan and Jokwe—generated economic losses of $80 million, while bush fires in South Africa destroyed more than 300 square kilometers of forest, with economic losses totaling $430 million.[48]

Australia and the Oceania region registered 44 fatalities in 50 natural disasters, nearly all of which were weather-related.[49] The economic cost associated with these events was estimated at $2.4 billion, more than half of which ($1.6 billion) was insured.[50] In March, South Australia experienced a record heat wave, which brought scorching temperatures across the state. Adelaide, the state capital, experienced its longest-running heat wave on record: 15 consecutive days of maximum temperatures above 35 degrees Celsius.[51]

The long-term analysis of Categories 5 and 6—devastating and great natural disasters—worldwide confirms a rising loss trend over the years, especially for weather-related events. To a large extent this is due to socioeconomic developments, such as increasing concentrations of valuable property and infrastructure, rising population, and the settlement and industrialization of exposed areas. Climate change and the increase in major weather-related natural disasters that is expected as a result need to be considered as essential drivers of economic losses in the future.[52]

Petra Löw is a Geographer and a NatCat Analyst at the Munich Reinsurance Company.

Water Scarcity Looms

Gary Gardner

Water scarcity grows in urgency in many regions as population growth, climate change, pollution, lack of investment, and management failures restrict the amount of water available relative to demand. The Stockholm International Water Institute calculated in 2008 that 1.4 billion people live in "closed basins"—regions where existing water cannot meet the agricultural, industrial, municipal, and environmental needs of all.[1] Their estimate is consistent with a 2007 Food and Agriculture Organization (FAO) calculation that 1.2 billion people live in countries and regions that are water-scarce.[2] And the situation is projected to worsen rapidly: FAO estimates that the number of water-scarce will rise to 1.8 billion by 2025, particularly as population growth pushes many countries and regions into the scarcity column.[3]

"Water scarcity" has several meanings. Physical water scarcity exists wherever available water is insufficient to meet demand: parts of the southwestern United States, northern Mexico, North Africa, the Middle East, Central Asia, northern China, and southeastern Australia are characterized by physical water scarcity.[4] Economic water scarcity occurs when water is available but inaccessible because of a lack of investment in water provision or poor management and regulation of water resources. Much of the water scarcity of sub-Saharan Africa falls into this category. [5]

Signs of scarcity are plentiful. Several major rivers, including the Indus, Rio Grande, Colorado, Murray-Darling, and Yellow, no longer reach the sea year-round as a growing share of their waters are claimed for various uses.[6] Water tables are falling as groundwater is overpumped in South Asia, northern China, the Middle East, North Africa, and the southwestern United States, often propping up food production unsustainably.[7] The World Bank estimates that some 15 percent of India's food, for example, is produced using water from nonrenewable aquifers.[8] Another sign of scarcity is that desalination, a limited and expensive water supply solution, is on the rise.

Water scarcity has many causes. Population growth is a major driver at the regional and global levels, but other factors play a large role locally. Pollution reduces the amount of usable water available to farmers, industry, and cities. The World Bank and the government of China have estimated, for instance, that 54 percent of the water in seven main rivers in China is unusable because of pollution.[9] In addition, urbanization tends to increase domestic and industrial demand for water, as does rising incomes—two trends prominent in rapidly developing countries such as China, India, and Brazil.[10]

In some cases, water scarcity leads to greater dependence on foreign sources of water. A country's "water footprint"—the volume of water used to produce the goods and services, including imports, that people consume—can be used to demonstrate this.[11] The ratio between the water footprint of a country's imports and its total water footprint yields its water import dependence. The higher the ratio, the more a country depends on outside water resources. In the Netherlands, for example, imported goods and services account for 82 percent of the country's total water footprint.[12] (See Table 1.)

A looming new threat to water supplies is climate change, which is causing rainfall patterns to shift, ice stocks to melt, and soil moisture content and runoff to change.[13] According to the Intergovernmental Panel on Climate Change, the area of our planet classified as "very dry" has more than doubled since the 1970s, and the volume of glaciers in many

Click here to see notes for this section.

Table 1. Water Import Dependence, Selected Countries, 1997–2001

Country	Water Import Dependence
	(percent)
Netherlands	82
Jordan	73
United Kingdom	70
Japan	64
South Korea	62
Germany	53
Italy	51
France	37
Spain	36
Mexico	30
South Africa	22
Canada	20
Egypt	19
United States	19
Australia	18
Russia	16
Indonesia	10
Brazil	8
Thailand	8
China	7
Argentina	6
Pakistan	5
Bangladesh	3
India	2

Note: Water import dependence is the ratio of a country's external water footprint to its total water footprint.

Source: Chapagain and Hoekstra, Water International*, March 2008.*

regions and snow pack in northern hemisphere mountains—two important freshwater sources—has decreased significantly.[14]

Climate change is expected to have a net negative impact on water scarcity globally this century. By the 2050s, the area subject to greater water stress due to climate change will be twice as large as the area experiencing decreased water stress.[15] Less rainfall is expected in already arid areas, including the Mediterranean Basin, western United States, southern Africa, and northeastern Brazil, where various models all indicate that runoff will decrease by 10–30 percent in the coming decades.[16] And loss of snowpack will remove a natural, off-season water reservoir in many regions: by the 2020s, for example, 41 percent of the water supply to the populous southern California region is likely to be vulnerable to warming as some of the Sierra Nevada and Colorado River basin snowpacks disappear.[17]

Policymakers look to a variety of solutions to address water scarcity. Desalination is increasingly feasible for small-scale water supply, as technological advances reduce costs. This involves removing most salt from salt water, typically by passing it through a series of membranes. Global desalination capacity doubled between 1995 and 2006, and according to some business forecasts it could double again by 2016.[18] But production is tiny: global capacity in 2005 was some 55.4 million cubic meters, barely 0.003 percent of the world's municipal and industrial water consumption, largely because desalination remains an energy-intensive and expensive option.[19] Not surprisingly, 47 percent of global capacity in 2006 was in the Middle East, where the need is great and energy is cheap.[20] In addition, the technology is plagued by environmental concerns, especially disposal of salt concentrates.

Another limited solution to scarcity involves accounting for "virtual water"—the water used to produce a crop or product—when designing trade policy. Nations conserve their own water if they import products having a large virtual water component, such as foodstuffs, rather than producing them domestically. Imports to Jordan, for instance, including wheat and rice from the United States, have a virtual water content of some 5–7 billion cubic meters per year compared with domestic water use of some 1 billion cubic meters per year.[21] Jordan's import policy yields enormous water savings for the country, although it also increases its food dependency. The bulk of North and South America, Australia, Asia, and Central Africa are net exporters of virtual water.[22] Most of Europe, Japan, North and South Africa, the Middle East, Mexico, and Indonesia, in contrast, are net importers of virtual water.[23]

Other solutions focus on structural shifts in

water use, including growing crops that are less water-intensive, changing dietary patterns to reduce meat consumption, and shifting to renewable sources of energy. Diets heavy in livestock products, for example, are water-intensive because of the huge quantities of water required for livestock production.[24] (See Table 2.) Similarly, fossil fuel production requires many times more water than renewable energy sources do.[25] (See Table 3.)

Additional Resources

An excellent audio interview on water scarcity with Tom Chartres, Director General of the International Water Management Institute, is available at odeo.com/episodes/23521894-IWMI-s-Chartres-Sees-Need-to-Review-Global-Irrigation-Policies, based on "IWMI's Chartres Sees Need to Review Global Irrigation Policies," *Business*, 23 October 2008.

Table 2. Water Required to Produce Selected Foods

Product	Embedded Water Content
	(cubic meters per ton)
Beef	13,500
Pork	4,600
Poultry	4,100
Soybean	2,750
Eggs	2,700
Rice	1,400
Wheat	1,160
Milk	790

Source: World Water Council.

Table 3. Water Consumption by Energy Type in the United States

Energy Type	Water Consumed
	(cubic meters per megawatt-hour)
Solar	0.0001
Wind	0.0001
Gas	1
Coal	2
Nuclear	2.5
Oil	4
Hydropower	68
Biofuel (first generation)	178

Source: Morrison et al.

Climate Change Proceeds Down Worrisome Path

John Mulrow

Global temperature dropped slightly in 2008, but two other climate indicators—emissions of carbon dioxide (CO_2) and its concentration in Earth's atmosphere—continued their worrisome upward trends. The concentration of carbon dioxide increased to 385 parts per million (ppm), extending the past decade's trend of rising 1.9 ppm per year on average.[1] (See Figure 1.) Meanwhile, some 31,794 million tons of CO_2 from fossil fuels were emitted—up 2 percent from the previous year despite high oil prices and the economic downturn of 2008, which reduced fossil fuel demand significantly.[2] (See Figure 2.) The International Energy Agency predicts that in 2009 emissions will drop by 3 percent, the largest decline in 40 years, owing mostly to the recession but also to national climate action policies.[3]

Worldwide, per capita CO_2 emissions averaged 4.71 tons in 2008, with great variation among countries.[4] It has long been true that developing countries have much lower per capita emission rates than industrial countries. To give one dramatic example, the average Haitian caused 0.1 tons of CO_2 emissions in 2008 while the average American was responsible for 18 tons.[5] Emissions are rising rapidly in the developing world, however, even if per capita emissions remain lower there. China's CO_2 emissions have risen almost 6 percent a year since 1971, a trend that is expected to continue.[6]

Though CO_2 concentrations and emissions continued their steady rise, global mean temperature actually dropped slightly, to 14.44 degrees Celsius.[7] (See Figure 3.) This is the lowest recorded temperature since the beginning of the twenty-first century, causing some advocacy groups to claim a "halt" to global warming.[8] But the dip is actually a result of interannual climate variability rather than a shift in the long-term warming trend.[9] The Pacific was much colder than normal in 2008 owing to the climate phenomenon known as La Niña, which caused equatorial surface water temperature to fall due to changes in air pressure and circulation.[10] Experts warn that the warm counterpart phenomenon El Niño is

Figure 1. Atmospheric Concentration of Carbon Dioxide, 1960–2008

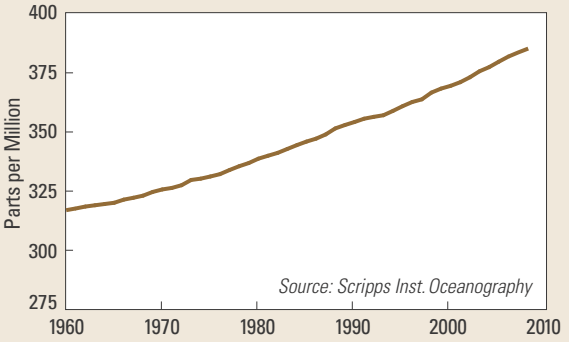


Figure 2. World Carbon Dioxide Emissions from Fossil Fuel Burning, 1950–2008

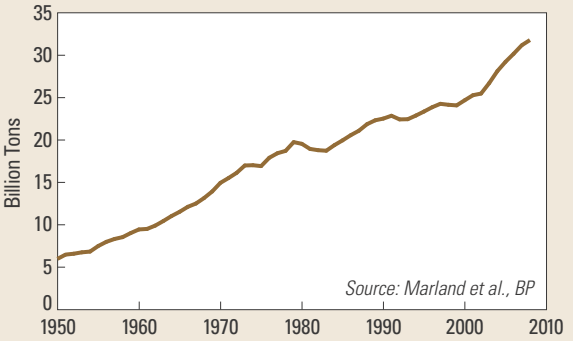


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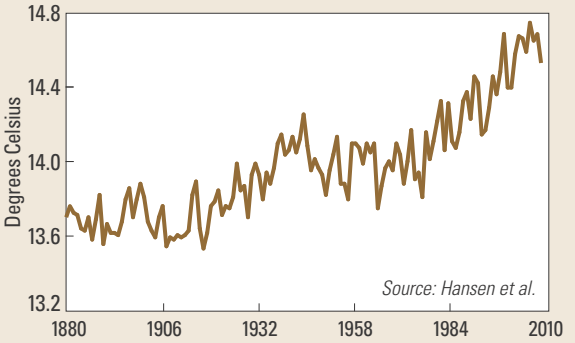
Figure 3. Global Average Land-Ocean Temperature at Earth's Surface, 1880–2008



likely to return next year, bringing back higher temperatures.[11]

Even if emissions slow, their tendency to raise temperatures lasts long into the future. CO_2 concentrations are expected to rise for decades after emissions peak, and temperatures could continue going up for centuries, depending on when emissions stabilize.[12] A 2008 study calculated that even if greenhouse gas concentrations in the atmosphere stabilize at 2005 levels, it would be impossible to avoid a total warming of 1.4–4.3 degrees Celsius above pre-industrial levels by the end of this century.[13]

Other consequences of CO_2 emissions are of continuing concern as well. Over the course of the twentieth century, mean sea level rose on average 1.7 millimeters (mm) per year; since 2003 this has accelerated, rising 2.5 mm a year.[14] Sea levels are rising due to the additions of water from melting land-based ice and glaciers as well as thermal expansion of the ocean. These processes are much slower than the increase of atmospheric temperatures, meaning that sea level rise could continue for millennia beyond peak emissions.[15] Experts predict that sea level could rise 0.5–1.4 meters above 1990 levels in this century, affecting more than 100 million people living within a meter of current sea levels as well as inland communities faced with migrations from coastal areas.[16] Sea level rise poses the greatest threat to small island states with little interior space for migration. The Alliance of Small Island States has even proposed lowering the maximum global warming goal from 2 degrees Celsius to 1.5 degrees, as their countries could be the first to be highly affected by climate change.[17]

Inhabitants of water basins fed by mountain glaciers also face a variety of risks from warmer mountain temperatures. The World Glacier Monitoring Service (WGMS) reports that yearly glacier ice loss has accelerated in the past few decades.[18] In the Himalayas, where 112,000 square kilometers of snow and ice feed several major Asian river systems, the temperature has risen six times faster than the global average over the last century.[19] Such changes disrupt the flow of fresh water to surrounding areas throughout the year, forcing 1.3 billion people in the region to deal with irregular water availability.[20] The effects of higher mountain temperatures and glacial melt in the Himalayas include increases in pest and disease populations, losses in local biodiversity, and more forest fires—at least 3,500 occurred in the spring of 2009 alone.[21] Though Himalayan glacier melt is more severe than in most mountain regions, the cumulative average mass of all worldwide glaciers monitored by the WGMS has been declining ever since monitoring began.[22] (See Figure 4.)

Melting of the Arctic ice cap was so extensive in the summer of 2009 that a non-Russian shipping company rerouted some of its ships through the Northeast Passage on their way from South Korea to Siberia.[23] In mid-September 2009, Arctic sea ice reached its annual minimum at 5.36 million square kilometers, the third lowest on record (after 2007 and 2008) and 1.68 million square kilometers below the 1979–2000 average.[24] Another first occurred in the Arctic when scientists discovered methane (CH_4), a potent greenhouse gas, bubbling up from the seabed off the coast of the Svalbard Islands between Norway and the North Pole.[25] Experts have long predicted that such a release of CH_4 might occur as a result of ocean warming and sea level rise, and this is the first record

of this phenomenon in modern times.[26]

Climate anomalies in 2008–09 also created unfavorable conditions for agriculture in many parts of the world. Drought conditions in Australia have now lasted for over a decade, and parts of China, Portugal, Mexico, and high-latitude South American countries all experienced their worst droughts in 50 years or more.[27] Heavy rainfall and flooding affected not only crops but vast amounts of urban residential and commercial areas in India, Southeast Asia, and Southeast Africa.[28] A 2008 analysis by the International Institute for Applied Systems Analysis predicted both positive and negative impacts of climate change on food security in the coming century.[29] Unfortunately, most of the negative effects are concentrated in poor areas of the world, especially sub-Saharan Africa. The potential for cereal production will take an especially large hit in this region, while North America, Northern Europe, Russia, and East Asia may see greater cereal production potential.[30]

There is now widespread acknowledgment that the countries least responsible for global climate change will be the ones most severely threatened by it.[31] An extensive ranking of climate change vulnerability released in 2009 revealed that the vast majority of extreme or high vulnerability countries have per capita CO_2 emissions far below the global average, whereas countries with low and medium vulnerability are generally high emitters.[32] Virtually all the industrial counties that signed the United Nations Framework Convention on Climate Change face either low or medium vulnerability.[33] (See Figure 5.) Nearly 80 percent of the 28 extremely vulnerable countries are located in Africa, with most of the others in Southeast Asia.[34]

Current climate trends are lining up with what the Intergovernmental Panel on Climate Change called "the worst-case scenario" in its Fourth Assessment Report.[35] The dire observations have increased global interest in the U.N. Climate Change Conference scheduled for December 2009 in Copenhagen. The summit aims to replace or renew the Kyoto Protocol with a set of global policies and actions for stabilizing the climate. The run-up to Copenhagen has brought a heightened sense of urgency to discussions around climate change mitigation and adaptation, and the forecasts of the costs and benefits of taking action are becoming more positive. A report prepared by The Climate Group predicts that the benefits will be far greater under a global climate agreement than if individual nations take action separately.[36] For example, a Copenhagen agreement could increase global

Figure 4. Change in Average Glacier Mass for Monitored Glaciers, 1945–2007

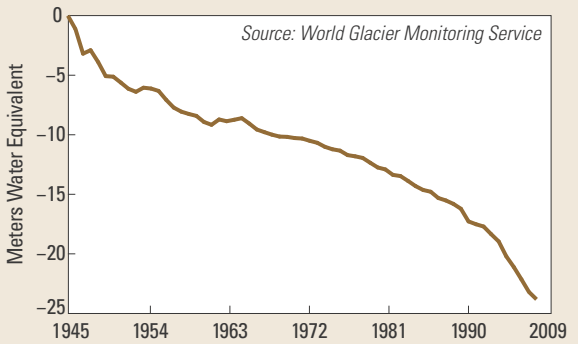
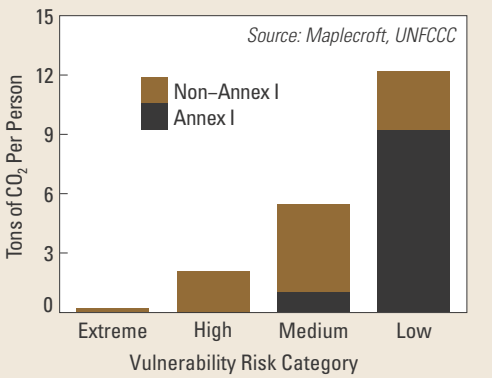


Figure 5. Average Per Capita CO_2 Emissions, Annex I and Non-Annex I Countries, by Climate Change Vulnerability



gross domestic products 0.8 percent by 2020 relative to a "no-action scenario" and, with developing countries on board, could create up to 10 million jobs worldwide by 2020.[37] Realizing the social, economic, and environmental benefits of climate change mitigation is essential for sealing a global climate deal.

Food and Agriculture Trends

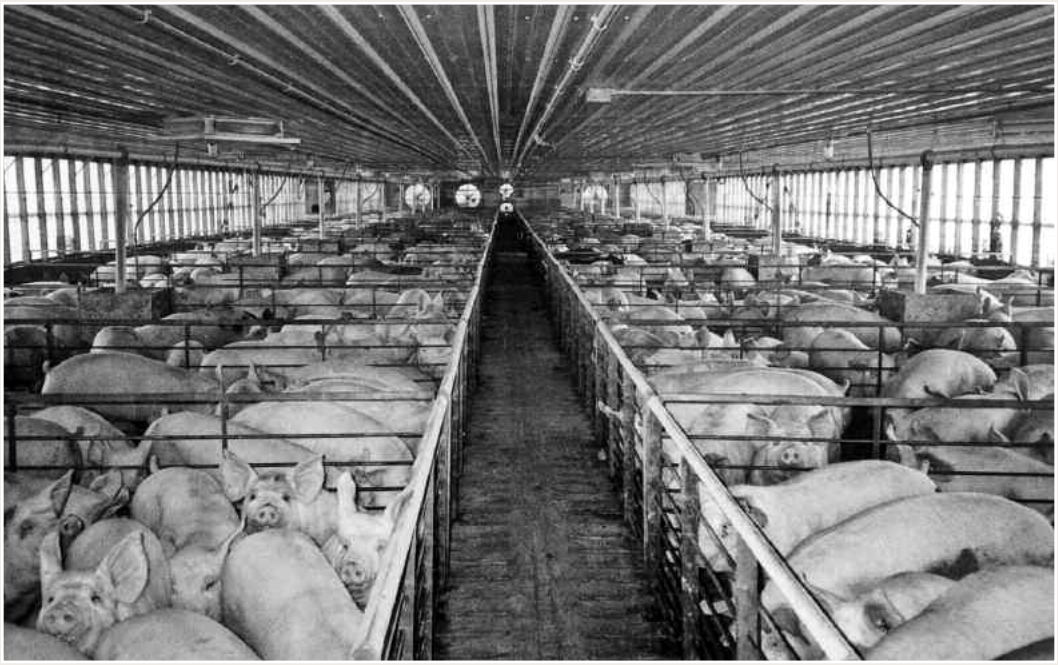


Photo courtesy Farm Sanctuary

Pigs in a factory farm

For data and analysis on food and agriculture trends, go to vitalsigns.worldwatch.org.

Irrigated Area Expands Slowly

Gary Gardner

The global area equipped for irrigation expanded by 0.3 percent to 280 million hectares between 2004 and 2005, the last year for which global data are available.[1] (See Figure 1.) The advance is one of the slowest in the past decade and is consistent with the generally sluggish pace of irrigation growth since the late 1970s.[2] (See Figure 2.) The slowdown occurs in the context of a world of steadily growing demand for food and limited opportunities for farmland expansion.

Figure 1. World Area Equipped for Irrigation, 1961–2005

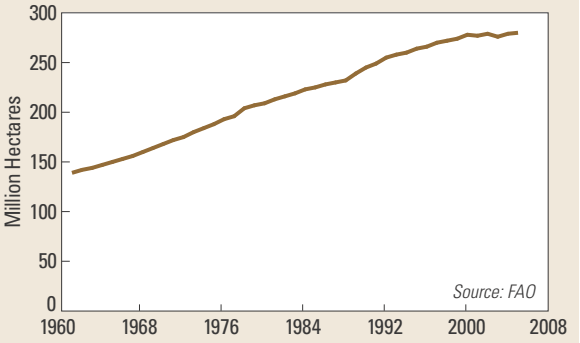
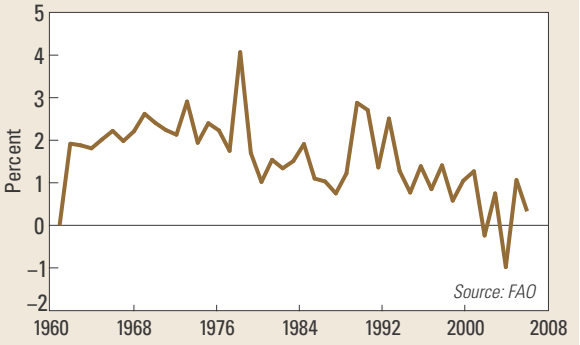


Figure 2. Annual Growth in World Area Equipped for Irrigation, 1961–2005



Irrigated area accounts for about 20 percent of cultivated land, but it provides roughly 40 percent of the world's food.[3] Irrigation allows farmers to apply water when crops need it and in the quantities required, leading to yields two to four times greater than in rainfed farming.[4] Along with fertilizer and improved crop varieties, the expansion of irrigation is responsible for the dramatic increase in global agricultural output since the 1960s.[5]

Yet irrigation growth has slowed perceptibly in the past few decades as investment in surface irrigation infrastructure (dams, canals, and the like) has declined. This has happened for a variety of reasons: the choicest irrigation areas have been developed and remaining options are expensive; the generally declining price of food over the past 40 years has lowered irrigation's return on investment; and the social and environmental liabilities of some projects (residents displaced by dam building, for example, and river flows diminished to a point harmful to fish or other wildlife) have made projects politically unfeasible.[6]

Irrigation is overwhelmingly concentrated in Asia, which accounted for 70 percent of global capacity in 2005.[7] (See Table 1.) All other major regions claim only single-digit shares of irrigated area worldwide. The diverse physical and cultural characteristics of different regions has led to a variety of irrigation systems. In dry areas such as the Middle East, northern China, the Indo-Gangetic Plain, and Mexico, irrigation systems are often large, government-run operations. Paddy rice irrigation, as in Southeast Asia, East and South India, and Sri Lanka, is also managed publicly. The highland areas of the Andes in South America, the Atlas mountains in

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Table 1. Area Equipped for Irrigation, by Region, 2005

Area	Share of Global Total	
	(million hectares)	(percent)
Africa	13.5	4.8
Asia	195.5	69.7
Central America and Caribbean	8.1	2.9
Europe	26.6	9.5
North America	23.2	8.3
South America	10.5	3.8
Oceania	2.9	1.1
World	280.3	100.0

Source: FAO.

northern Africa, and sub-Saharan Africa often use small, community-run systems.[8]

In contrast to the slowdown in surface-water irrigation, groundwater-based irrigation is expanding rapidly in some regions, especially in South Asia. Since the 1970s, inexpensive pumps and tubewells have opened irrigation to millions of farmers, and private wells have proliferated. In India, the number of wells has grown from fewer than 100,000 in 1960 to more than 25 million by 2008, and groundwater is now the primary source of irrigation water.[9]

Pumps and wells are attractive to poor farmers because they generate higher incomes (due to greater output) and improve diets, thanks to bountiful kitchen gardens.[10] But the shift from government-managed surface water to individually controlled well water moves irrigation from public to private hands, introducing a "tragedy of the commons" dilemma: farmers have a strong incentive to pump, but as many of them tap this option, aquifers are drained faster than they are recharged by rainfall. The World Bank estimates that 15 percent of India's aquifers are in critical condition and that this number will grow to 60 percent over the next quarter-century.[11] It also estimates that some 15 percent of India's food is produced using water from nonrenewable aquifers, an inherently unsustainable situation.[12]

Even as aquifers are being overexploited in South Asia, northern China, the Middle East, North Africa, and the southwestern United States, the potential for expanded groundwater exploitation is substantial in Africa and in places like Sri Lanka and Viet Nam.[13] Properly managed, groundwater irrigation could be a source of prosperity and agricultural bounty for poor farmers in places like sub-Saharan Africa.[14]

As a significant re-plumbing of natural flows of water, irrigation has clear environmental impacts, especially if poorly managed. An estimated 10 percent of irrigated area globally suffers from waterlogging (saturation) or salinization (salt deposits).[15] In addition, water is sometimes diverted from rivers in quantities that leave insufficient flows for fish and other species and for the natural functioning of the river ecosystem. On the other hand, irrigation can provide habitat for some species, as when rice paddies become home for migratory birds.[16] And highly productive irrigated land lessens the need to expand rainfed agriculture into forested or other natural areas.

A new wildcard in the outlook for irrigation is climate change, which is shifting water availability in some regions.[17] According to the Intergovernmental Panel on Climate Change, by 2050 the area subject to greater water stress due to climate change will be twice as large as the area experiencing decreased water stress.[18] Less rainfall is expected in already arid areas, including the Mediterranean Basin, western United States, southern Africa, and northeastern Brazil, which may put pressure on these regions to expand irrigation capacity, if indeed any water is available for that.[19] And glaciers and snowpack—natural reservoirs that release water steadily throughout the warm season—may be greatly diminished, leading to greater flooding during periods of precipitation and greater scarcity during dry seasons.

Irrigated area is projected to grow over the coming decades at 0.6 percent per year, roughly a continuation of the slow growth of recent years.[20] The share of agricultural output

supplied by irrigation could rise from the current 40 percent to some 45 percent by mid-century.[21] But the future of irrigation is as much a question of intelligent management as it is of water availability. In India, for example, where groundwater pumping competes with surface irrigation schemes for water in some places, investments might need to shift from extending the surface irrigation system to recharging depleted aquifers.[22]

Organic Agriculture More than Doubled Since 2000

Alice McKeown

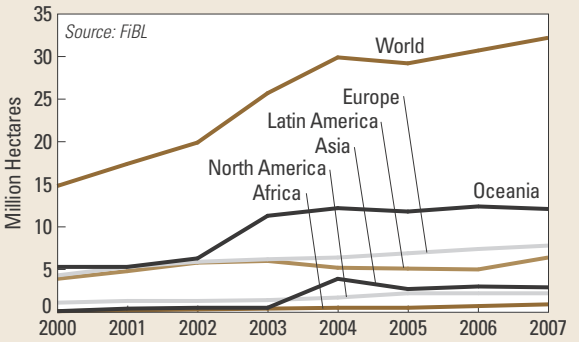
Farmers worldwide managed 32.2 million hectares of agricultural land organically in 2007, nearly 5 percent more than in the previous year and a 118-percent increase since 2000.[1] (See Figure 1.) Organic farming is now reported in 141 countries; about two thirds of this land area is in industrial countries, and nearly half of the producers are in Africa.[2] Still, more than three times as much land is devoted to genetically modified crops, and less than 1 percent of the world's agricultural land is now managed organically.[3]

Although there is no standard definition of organic agriculture, the International Federation of Organic Agriculture Movements describes it as a system that "relies on ecological processes rather than the use of inputs."[4] Organic agriculture typically avoids the use of chemicals and prohibits genetically modified organisms.[5]

Oceania, with some 12.1 million hectares, has more than one third of the land being farmed organically, most of which is in Australia.[6] (See Figure 2.) A large portion of this is pastureland, which supports significant beef production in Australia as well as meat, dairy/milk, and wool production in New Zealand.[7] Important organic crops include grains in Australia, kiwis and apples in New Zealand, and high-value export crops such as vanilla and cocoa in Pacific Island countries.[8]

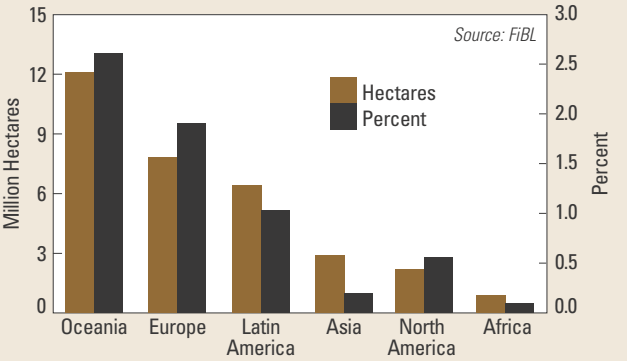
Italy, Spain, and Germany account for nearly 40 percent of the 7.8 million hectares of organic cropland in Europe.[9] Spain, Poland, and the United Kingdom saw the largest growth since 2006, but countries in Eastern and Southeastern Europe also showed significant increases.[10] Consumer demand has been increasing faster than land conversion, leading to a greater reliance on imports even though several countries have national organic action plans and other supportive policies.[11]

Figure 1. Organic Agricultural Area by Continent, 2000–07



Latin America now has 6.4 million hectares of organic land, with Argentina, Brazil, and Uruguay as the leaders.[12] Most of this is used to grow crops destined for the European Union, the United States, and Japan; at least 85 percent of organic food grown in Mexico is exported, for

Figure 2. Organic Agricultural Area by Continent, Total and as Share of World Agricultural Area, 2007



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example.[13] Two of the most important organic crops in the region are cocoa and coffee, which provide an important income source to small farmers.[14]

In Asia, China has more than half of the region's 2.8 million hectares of organically managed land.[15] India follows closely with more than 1 million hectares and far outpaces China in the number of producers: nearly 200,000 compared with China's 1,600.[16] Recent news reports indicate that the rate of adopting organic farming practices in India may be on the rise.[17]

Canada has 556,273 hectares of organic land, while the United States has 1.6 million hectares.[18] (Updated estimates for the United States are due out in the second half of 2009.) Like Europe, the demand for organic products in the United States continues to outpace regional production, leading to an ever-increasing reliance on foreign suppliers.[19] In Canada, a national system that tracks imported products may show the best areas of opportunity for increased domestic organic production.[20]

Africa has 870,329 hectares of organically managed agricultural land, with Uganda topping the list at nearly 300,000 hectares (2.33 percent of its total agricultural land).[21] Although the region is home to nearly half of the world's organic producers, the farms tend to be much smaller than in other regions.[22] The largest documented organic crop in Africa is coffee, followed by olives.[23]

Consumer demand led to $46 billion of global sales of organic food and drink products in 2007, with an average annual growth of $5 billion over the last decade.[24] The European Union (EU) accounts for 54 percent of this revenue, and organic products make up 4–6 percent of food sales in some countries.[25] The United States accounts for 43 percent of the global revenue stream, with organic now commanding 3.5 percent of total food and beverage sales, up 1 percent since 2005.[26] Because the European market is more mature and has higher product penetration, the annual growth rate in the United States is larger, rising 16 percent in 2008 from the previous year to reach some $23 billion, compared with an average growth of some 10 percent in Europe.[27] Although at a much smaller scale, the Asian market is also experiencing double-digit growth rates of 15–20 percent per year, fueled partly by concerns over food safety.[28]

Many organic product labels are now owned by large companies such as Kraft, General Mills, Heinz, and Kellogg as supply and market chains continue to consolidate.[29] Some large companies have also started to produce organic versions of their own popular brand name products, a development that was due in part to a 2006 decision by Wal-Mart to offer more organic products at its stores.[30] A more recent trend is private labels, with large retailers selling organic products under a store brand.[31] U.S. store brand sales account for 30 percent of all organic product sales in 2008, in part because large retailers provide about a third of total organic food and beverage sales.[32]

There are several consequences of market consolidation, including a shift from small-scale to large-scale production.[33] Market analysts have highlighted a growing trend in the number of highly processed organic foods, in the share of organic food going through conventional mass market food supply chains, in global sourcing rather than local, and in the amount of organic products that are traded internationally.[34]

Scientists and policy analysts are increasingly pointing to the climate change benefits of transitioning to organic agriculture. Agriculture accounts for some 30 percent of total global greenhouse gas emissions annually when the effects of encroachment on forestlands are included.[35] These emissions are expected to continue rising over the next few decades as agricultural production is expanded, chemical inputs are increased, and changing diets lead to greater meat, dairy, and egg consumption.[36] Organic agriculture can help reverse this trend by reducing greenhouse-gas-intensive inputs, improving energy efficiency, and significantly increasing carbon sequestration in soils.[37] Organic agriculture may also be more resilient to changing climate conditions than conven-

tional agriculture is because it increases soil fertility, helps crops survive drought, and promotes greater biodiversity.[38]

Moving away from intensive agriculture may also lead to higher crop yields.[39] One study has estimated that converting all current farmland to organic production could produce enough food per capita to satisfy a growing population without increasing total agricultural land.[40] A shift to the sustainable practices of organic agriculture also has ecosystem benefits, such as reduced flooding and increases in bird and wildlife habitat.[41]

Organic agriculture also offers social advantages over conventional production, including more jobs, reliable incomes for farmers and communities, and reliance on traditional skills and knowledge that do not depend on modern inputs.[42] Studies of organic production in Africa have shown that it can increase food security for those most in need and create lasting food security solutions over the long term.[43]

Farmers, international food producers and processors, and decisionmakers are likely to pay increasing attention to the nexus of national regulations, certification systems, and efforts to "harmonize" standards across borders. Several countries have equivalency agreements in place—whereby they agree to recognize each others' organic certifications—and more are under way, such as between the United States and Canada.[44] In October 2008, three international organizations launched new harmonization tools to help small-scale farmers market their organic products internationally.[45] The EU's updated organic regulations took effect in January 2009, including new rules to simplify imports of organic products.[46] Some groups are calling for the widespread incorporation of social justice principles that protect workers and farmers.[47]

Most experts on organic production highlight an urgent need for additional research, especially on improving organic crop yields and climate change mitigation.[48] In the meantime, growth in organic food demand is expected to continue, although it may be dampened by the global recession.[49] Consumer purchases of non-food organic products such as personal care products, nutritional supplements, and clothing, are also expected to increase—sales of these items were up 39 percent in the United States in 2008.[50]

Grain Production Continues Growth After Mixed Decade

Alice McKeown

For the second year in a row, world grain production rose in 2008, with farmers producing some 2.287 billion tons.[1] (See Figure 1.) The record harvest was up more than 7 percent over the previous year and caps a decade in which only half the years registered gains.[2] Per capita production also recovered, reaching 339 kilograms per person.[3] The total amount of land dedicated to grain harvests worldwide has remained relatively stable over the past 15 years at around 700 million hectares—though it was below the average experienced from 1975 to 1986—but yields have increased 146 percent over the last 46 years.[4]

Three of the top four global agricultural crops by quantity are grains: maize, rice, and wheat (sugarcane is the fourth).[5] Other cereals and grains include millet, sorghum, oats, barley, quinoa, and rye. Together these crops make up nearly half of global daily calorie consumption and are considered critical for global food security.[6] Some 35 percent of all grains in 2008 were used to feed industrial livestock, while 47 percent were consumed by humans.[7]

Farmers in Asia led grain production in 2008, growing 42 percent of the world total (969 million tons), of which some 43 percent was rice (milled equivalent).[8] (See Table 1.) The Americas were the next largest growing region, with maize as the prominent crop, followed by Europe, which grew a significant amount of wheat.[9]

Oceania showed the largest percentage increases in grain production over the previous year.[10] However, total harvest there remains well behind record harvests in the past.[11] And looking back to 1990, Africa's production grew more than Oceania's, at 67 percent compared with 46 percent.[12]

Over the past 50 years, farmers in the least developed countries have grown a slowly increasing share of global grains, ending at just over 6 percent in 2008—although their population is 12 percent of the global total.[13] Ongoing structural and production capacity problems, such as lack of market access and underinvestment in human capital, infrastructure, and research, are expected to continue in developing countries as a whole, leading to lower growth

Figure 1. World Grain Production, 1961–2008

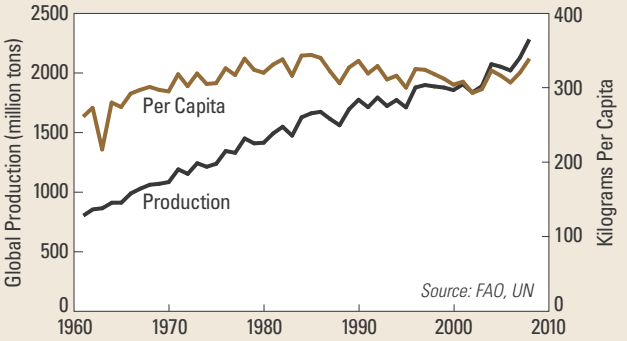


Table 1. Grain Production by Region, 1990–2008

Region	1990	2000	2007	2008	Growth over 1990
		(million tons)			(percent)
Asia	713.5	814.6	948.9	969.1	36
Africa	89.2	105.8	132.7	149.0	67
Americas	460.7	521.4	632.2	634.3	38
Europe	492.3	383.8	395.0	500.5	2
Oceania	23.6	35.0	22.9	34.4	46
World	1,779.4	1,860.6	2,131.8	2,287.2	29

Source: FAO.

Click here to see notes for this section.

rates than in industrial countries as well as to growing domestic demand for grain and other crop imports.[14]

Global production of rice rose significantly in 2008 due to a bumper crop of 460.3 million tons.[15] (See Figure 2.) Some 90 percent was grown by farmers in Asian countries, including China (133.3 million tons) and India (98.9 million tons).[16] World rice stocks rebounded to a seven-year high, although further near-term increases are not likely to reach the records set in the late 1990s.[17]

Wheat production also benefited from a record harvest year in 2008, rising 12 percent to reach 684.6 million tons.[18] Farmers in Asia (especially in China and India), together with those in Europe, grew three fourths of the global total.[19] Developing countries continue to drive demand for wheat imports, especially in South and East Asia and Africa.[20] However, changes in diets resulting from higher incomes mean that per capita demand in countries like China will stay stable or decline as consumers shift demand to processed foods.[21]

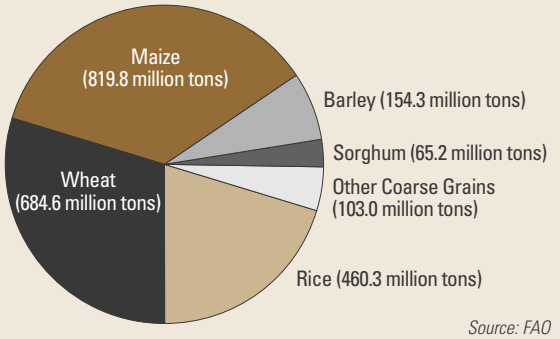
Farmers grew a record 1,142 million tons of coarse grains in 2008, up 5 percent over the previous year, including 820 million tons of maize, 154 million tons of barley, and 65 million tons of sorghum.[22] The United States dominates maize production, growing 37 percent of the global total, with China next at 20 percent.[23] Demand for coarse grains is expected to slow due to the global recession because of reduced demand for livestock; 58 percent of the coarse grain crop in 2008 was used for feed.[24]

Traditional indigenous grains, which often provide higher nutritional value than the more commonly grown grains, are referred to as "orphan" crops. One example, millet—which is an important staple in rural diets in Asia and Africa—reached 34 million tons in 2007, about 2 percent of the total grain harvest.[25] Investments in expanding production of this and other orphan crops like quinoa may be an important way to improve the food security of many of the world's poor.[26]

World grain stocks have recovered somewhat since the lows of recent years and are at the highest level since 2001.[27] (See Figure 3.) A related measure considered important for food security, the stock-to-use ratio—the level of global reserves expressed as a percentage of annual consumption—is now around 23 percent, above the level estimated to ensure global food security but still below the five-year average and previous higher years.[28] However, recent studies have disputed a simple correlation of stocks to security , pointing to biofuels production, energy prices, volatile commodity prices, and rising demand as other factors that affect global food prices and food security.[29]

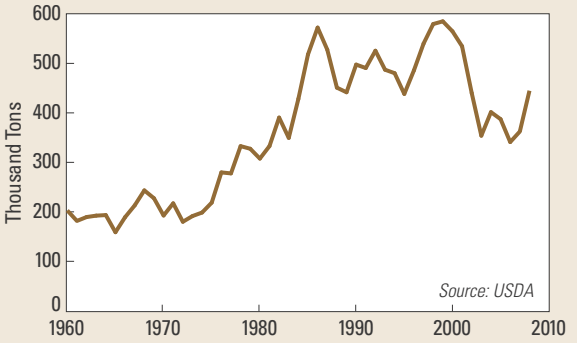
Grain production destined for biofuels continues to grow, topping more than 5 percent in

Figure 2. Global Grain Production Composition, 2008



Source: FAO

Figure 3. World Grain Stocks, 1960–2008



2008, at 120 million tons.[30] This marks a nearly 10 percent increase over the previous year, but a slower rate than the 25 percent experienced the year before.[31] Various national biofuels mandates are expected to drive rising demand for grains for biofuels until second-generation feedstocks are readily available.[32] In addition to diverting crop usage, demand for biofuels also influences farmers' planting choices and could take land away from other crops.[33]

Grain prices have fallen more than 50 percent from their peak levels in 2008, but they are still well above the 2007 levels and the long-term average.[34] This situation is expected to continue during the medium term.[35] Although high crop prices are often assumed to increase profitability, a recent report by the U.N. Food and Agriculture Organization concludes that higher prices only benefit producers and farmers who are connected to international markets, leaving most small farmers in developing nations out of the picture.[36]

Heavy reliance on a limited number of grains for food, feed, and industry jeopardizes the global food system.[37] Today only 150 crops are cultivated, a sharp drop from the 10,000 used over time, and three grains—maize, rice, and wheat—combined with potatoes provide more than 50 percent of humans' energy needs.[38] With the Green Revolution that began in the 1950s, high-yielding grains quickly spread around the world, displacing local varieties; within 40 years they accounted for half of all land planted in wheat and rice.[39] This loss of agricultural biodiversity—an estimated 75 percent decline since 1900—can limit the ability to adapt to climate change, lower nutritional security, and create monoculture crops that are more susceptible to pests and diseases.[40]

Even as grain production expands, large production gains and improvements in the future are unlikely because of resource constraints such as the spread of irrigation, the availability of water supplies, and soil quality.[41] Some observers see the looming threat of climate change as a cause of concern. Rising temperatures, shifting rainfall, and altered growing ranges may affect the quality and quantity of land and water available for grain crops. Temperature increases can also lead to yield reductions or crop failures.[42] Genetic modification of grains may alter growing and consumption patterns, too; corn already accounts for 31 percent of all genetically modified (GM) crop production, and research continues into GM rice.[43] Some food security experts are focused on reducing post-harvest losses in developing countries, which have reached up to 20 percent in parts of Africa.[44] With the growing number of hungry people worldwide expected to top 1 billion by the end of 2009, the success of future grain crops becomes even more important.[45]

Meat Production Continues to Rise

Danielle Nierenberg

The world's appetite for meat continues to grow—in 2008, meat production topped an estimated 280 million tons and production is expected to exceed 285 million tons by the end of 2009.[1] (See Figure 1.) Meat production has doubled since the mid-1970s and over the last 50 years has increased fivefold. Experts project that by 2050 nearly twice as much meat will be produced as today, at more than 465 million tons.[2] More than half of all meat and dairy products are produced in developing nations.[3] (See Figure 2.)

Meat consumption is also growing worldwide. Currently 42 kilograms of meat are consumed per person worldwide. Consumption varies greatly, however, between countries.[4] In the developing world, people eat about 32 kilograms of meat a year—a 17 percent increase over the last 10 years.[5] But consumers in the industrial world eat more than 81 kilograms each in a year.[6]

Rising meat consumption is the result of several factors, including increased population growth, the movement of people to cities, and growing incomes.[7] The income elasticity of demand for meat products is high; in other words, increases in income are positively correlated with meat consumption.[8]

Consumers worldwide eat more pork than any other meat, followed by poultry, beef, sheep, and other animals like buffalo and duck.[9] (See Figure 3.) Pig meat production in 2008 increased nearly 2 percent, to 101 million tons, and is forecast to continue to rise another 2 percent in 2009 to 106 million tons.[10] China raises nearly 70 percent of the world's 1 billion pigs and consumes more than half of the world's pork.[11] The country is still recovering, however, from its massive culling of pigs in 2007 as a result of Porcine Reproductive and Respiratory Disease.[12]

Figure 1. World Meat Production, 1961–2008

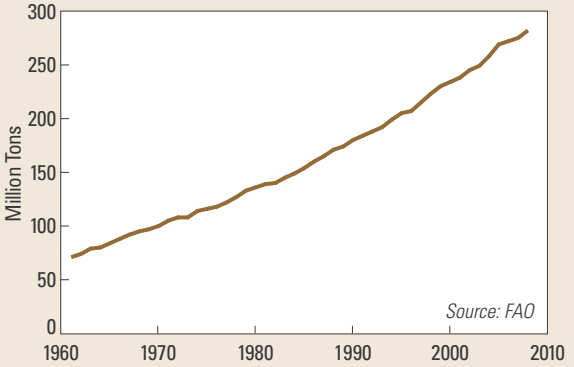
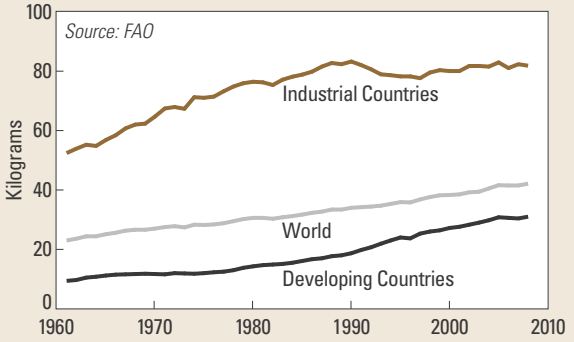


Figure 2. Meat Production Per Person, World, Industrial, and Developing Countries, 1961–2008



Poultry output reached 93 million tons in 2008, up from 90 million tons over the preceding year.[13] The United States is the biggest poultry producer, but other major producers, including Argentina, Brazil, China, the Philippines, and Thailand, are all expecting increases in production.[14] Global egg production has also

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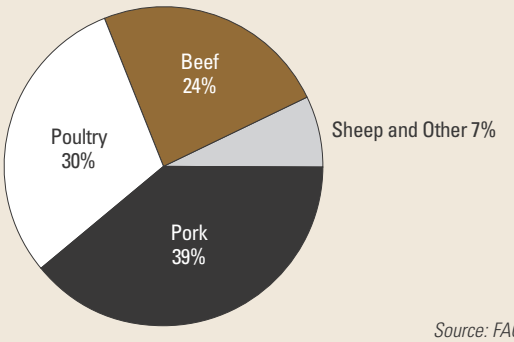
Figure 3. World Meat Production by Source, 2008



Source: FAO

been on the rise, reaching nearly 59 million tons in 2007, the last year with data.[15] This was a growth of more than 2 percent over the previous year and of nearly 23 percent over 10 years.[16]

Beef output is expected to remain steady for 2008 at about 65 million tons.[17] The United States is still the world's largest beef producer, accounting for over 12 million tons in 2007, the most recent year with data. But more than half of beef production now takes place in the developing world. In Asia, China's production is expected to shrink due to low profits and competition from the pig and poultry sectors.[18]

Livestock are an important source of food, income, and livelihoods for millions of people, particularly in sub-Saharan Africa. Nearly 105 million people depend on livestock to support part or all of their daily needs, and some 50 million people depend on grazing livestock as their only source of income.[19] They act as living banks, or walking credit cards, allowing farmers to use them as investment or as quick cash in times of need. Livestock are also an important and obvious source of nutrition, providing eggs, milk, meat, blood, and other protein.

Industrial animal feeding operations, or factory farms, are now meeting much of the demand for the world's meat, egg, and dairy products.[20] Worldwide, more than 64 billion animals are raised and slaughtered for food each year.[21] Factory farms account for nearly two thirds of poultry meat production, 50 percent of egg production, and 42 percent of pork production.[22] These facilities rely on commercial breeds of livestock that have been bred to gain weight quickly on high-protein, energy-intensive feeds.[23] Factory farms first developed in the United States and Europe and have now spread across the developing world, including into Mexico, India, Thailand, and Viet Nam.[24]

These facilities tend to be very crowded and dirty, creating the perfect conditions for the spread of diseases from animal to animal and eventually to people. Some scientists believe that H1NI, also known as swine flu, originated on a pig factory farm in the Mexican state of Vera Cruz in mid-2009.[25] The virus has killed more than 3,400 people and infected thousands.[26]

Avian influenza, or bird flu, may have developed on poultry farms in Asia because of high stocking densities of birds.[27] Tens of thousands of birds can be confined in one shed, making an ideal environment for the spread of disease from bird to bird and even to people. In 2003, avian influenza jumped the species and spread to humans and to date has killed 262 people.[28]

Nipah virus is another disease that is believed to have emerged on factory farms, this time in Malaysia. It first spread from pigs to humans in 1999 and killed nearly 100 people.[29] And BSE, or mad cow disease, was likely the result of feeding cattle the ground-up bits of other cattle.[30]

Factory farms also contribute to antibiotic resistance, making it harder to treat disease among animals and humans alike.[31] Producers often feed animals sub-therapeutic levels of antibiotics to increase weight gain and prevent diseases endemic on factory farms. Livestock in the United States consume at least 70 percent of all antimicrobial drugs.[32]

Worldwide, an estimated 40 percent of the global corn crop and up to 80 percent of the global soybean crop is used to feed animals rather than people.[33] These crops depend heavily on artificial fertilizers and, according to the U.N. Food and Agriculture Organization (FAO), producing and using fertilizer for feed crops

contributes some 40 million tons of carbon dioxide emissions annually.[34]

Research from the University of Manitoba has shown that it takes about 3 kilograms of grain to produce just 1 kilogram of meat.[35] Poultry raised on a grain diet only use 20 percent of the protein present in those grains, meaning that 80 percent is wasted; for pork, 90 percent of the protein is lost.[36] The U.N. Environment Programme notes that "stabilizing the current meat production per capita by reducing meat consumption in the industrialized world and restraining it worldwide to 2000 levels of 37.4/kg/capital in 2050 would free an estimated 400 million tons of cereal per year for human consumption."[37] That is enough food to meet the annual calorie needs for some 1 billion people.[38]

It takes vast amounts of water to raise, slaughter, and process livestock. A report from the World Wildlife Fund found that meat, milk, leather, and other products from livestock account for 23 percent of global water use in agriculture, the equivalent of roughly 1,150 liters of water per person per day.[39] It can take five times as much water to supply 10 grams of protein from beef than from rice—and 20 times as much water to supply 500 calories.[40] Another source of concern is that manure from factory farms can also leak into groundwater or contaminate rivers and streams.[41]

Livestock production contributes significantly to climate change as well. FAO estimates that livestock are responsible for 18 percent of greenhouse gas (GHG) emissions, as measured in carbon dioxide equivalent, which is higher than the share of GHG emissions from cars, trucks, ships, and airplanes.[42] Livestock produce nearly 40 percent of methane and 65 percent of nitrous oxide, which are also GHGs.[43]

But not all meat is created equal. Raising livestock—and raising fewer of them—in more natural environments can help mitigate many environmental problems. Well-managed grazing land and rotational pasture systems can act as carbon sinks, sequestering carbon in soils rather than releasing it into the atmosphere.[44]

Fish Production Reaches a Record

Molly Theobald

Total global fish production, including both wild catch and aquaculture, rose to about 157 million tons in 2007, the most recent year with data, up from 153 million tons in 2006.[1] (See Figure 1.) Reaching a record high as the industry continues to grow, nearly half of the fish produced for human consumption came from aquaculture.[2] (See Table 1.)

Aquaculture production has consistently grown by nearly 9 percent annually worldwide since 1970, making it the most rapidly growing animal food sector.[3] The Asia-Pacific region produces the overwhelming majority of the world's aquaculture output: 89 percent in terms of quantity and 77 percent in terms of value.[4] This is in large part due to China's long tradition of fish farming and its massive appetite for seafood; this one country accounts for 67 percent of the global production and nearly 50 percent of the market for farmed fish.[5] (See Figure 2.)

In 2007, some 80 percent of the world fish stocks for which information is available were considered fully exploited or overexploited.[6] And management of existing fish stocks is a challenging and increasingly important prospect for most countries, particularly those lacking other food resources.[7]

In Oma, Japan, for example, increased demand for bluefin tuna coupled with a sharp decline in the population of this prized sashimi ingredient has caused prices to skyrocket.[8] A large bluefin tuna can go for as much as $10,000 in Tokyo's Tsukiji Fish Market.[9] The result is that fishers are even more eager to catch the species; trawlers from as far away as Taiwan and China are using large nets and long lines of baited hooks to collect a large catch, while many smaller boats return after days of fishing with nothing.[10]

Even as public concerns about farmed fish and fish stock exploitation grow, the trade of aquaculture products continues to increase in

Figure 1. World Seafood Harvest, 1950–2007

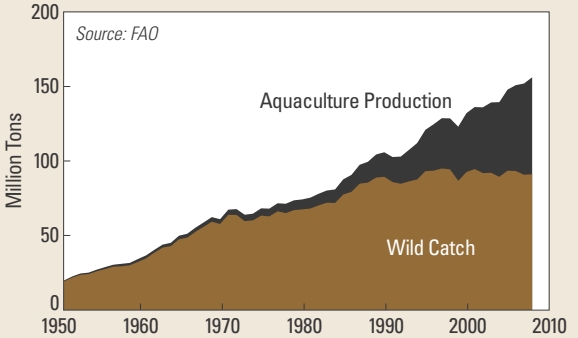


Table 1. Wild Catch and Aquaculture Production, 1997–2007

Year	Wild Catch	Aquaculture Production
	(million tons)	(million tons)
1997	94.5	34.3
1998	86.8	36.4
1999	92.7	39.6
2000	94.7	41.7
2001	92.0	44.2
2002	92.2	47.3
2003	89.5	50.2
2004	93.6	54.5
2005	93.4	57.7
2006	90.9	61.3
2007	91.2	65.2

Note: The Food and Agriculture Organization released numbers in 2009 that significantly revised previous estimates for the years 1997 through 2006 due to new reports from China.

Source: FAO.

Click here to see notes for this section.

both sectors, with exports for species like catfish and tilapia growing at more than 50 percent a year.[11] (See Figure 3.) In response to the demand for affordable white-meat fillets and to the depletion of popular edible species, such as red snapper, monkfish, and tuna, previously unknown species such as hoki or whiptail are growing in use and popularity.[12] Hoki is a growing wild catch export from New Zealand, and concerns are mounting regarding its overexploitation.[13]

For the first time in decades, global fish prices went up in 2007 and early 2008, following the recent upward trend for most food prices.[14] World exports of fish and fishery products reached $85.9 billion in 2006, and, adjusted for inflation, were up by 32 percent in the period 2000–06.[15] Exports of fish specifically for human consumption have increased by 57 percent since 1996.[16]

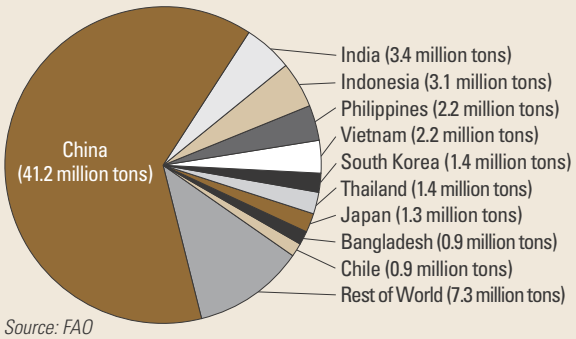
Despite slowing down in early 2008 because of the financial crisis, global per capita fish consumption increased at a steady rate from an average of 9.9 kilograms in the 1960s to 16.4 kilograms in 2005, according to the Food and Agriculture Organization.[17] This increase has not been evenly distributed by region and is overwhelmingly affected by China's significant apparent per capita consumption increase (for which revised numbers will soon be released).[18] But it is estimated that fish provides at least 50 percent of total animal protein intake for some coastal developing countries, including Bangladesh, Cambodia, Equatorial Guinea, French Guiana, the Gambia, Ghana, Indonesia, and Sierra Leone.[19]

The growing market for carnivorous farmed fish has increased demand for some wild species that are turned into fish food and fish oil used in production; demand for these smaller, less valuable, species has more than doubled in the past decade.[20] These fish-derived feed products require more energy to produce than plant-based ones.[21] For example, as much as 90 percent of all energy inputs for farmed salmon go into providing the feed.[22]

In 2008, Chile, the second largest producer of farmed salmon, found its stocks devastated by unchecked disease due to having too many fish in crowded underwater holding pens offshore.[23] As a result of the disease and stricter trade regulations on the use of antibiotics, a 30 percent drop in Chile's salmon exports is expected this year.[24] Many large companies were forced to lay off thousands of workers and relocate, spreading the salmon disease along the coast and further threatening the country's fourth largest export industry.[25]

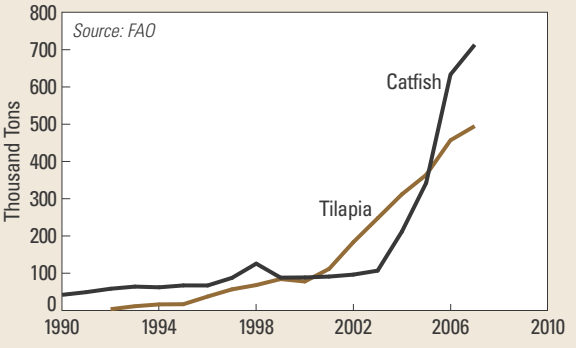
These problems have led some researchers and fish farmers to consider alternative practices that would minimize environmental harm while allowing increased aquaculture production.[26] However, new methods of salmon aquaculture tested in Canada as a way to minimize pollution

Figure 2. Top Aquaculture-Producing Countries, 2007



Source: FAO

Figure 3. World Trade of Catfish and Tilapia, 1990–2007



led to increased demand in energy large enough to raise concerns about electricity use and carbon emissions, indicating that some alternative practices may not be as beneficial as expected.[27]

Recent climate change studies show that rising water temperatures are leading to changes in fisheries, including biogeographical range shifts, reduced fitness, and population extinctions.[28] Small fish that are captured in high volume and processed into fish meal and fish oil to feed larger fish are highly sensitive to changing ocean conditions.[29] Climate change will also continue to drive more species toward the poles.[30] In the North Sea, nearly two thirds of fish species shifted significantly in mean latitude or depth or both over the past 25 years.[31]

While fisheries and fish farms can play a significant role in improving the quality of life of people living in developing nations, steps must also be taken to preserve the world's increasingly overexploited fish stocks.[32] For example, integrated fish farming creates a self-sustaining ecosystem that filters waste and provides food through a combination of fish, shellfish, and aquatic plants.[33] In Bangladesh, increasing demand for fish due to rapid population growth allowed small-scale fish farmers, with support and training from international organizations, to grow in productivity and profit, improving the local economy.[34] Families with few resources were able to improve nutrition by integrating fish production into their rice paddies.[35] Integrated fish farming has an added benefit in that it can treat human waste, and it has been used outside cities for that purpose in addition to raising fish for human consumption. [36]

Global Economy and Resources Trends

Jascha Hoste

A chemical plant by night, Veenda, Netherlands

For data and analysis on global economy and resources trends, go to vitalsigns.worldwatch.org.

World Metals Production Surges

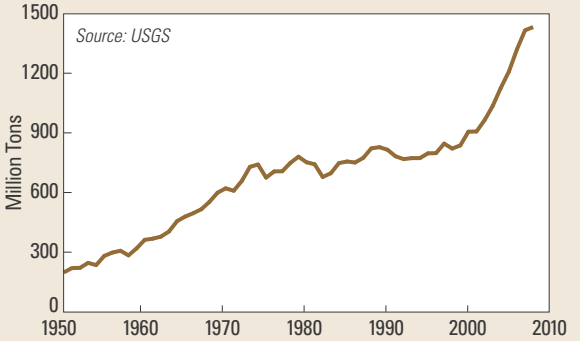
Michael Renner

In 2008, more than 1.4 billion tons of metals were produced globally—double the quantity of the late 1970s and more than seven times as much as in 1950.[1] (See Figure 1.) Since the midpoint of the twentieth century, a cumulative 40 billion tons of metals have been produced.[2] This figure includes aluminum, arsenic, cadmium, chromium, copper, gold, lead, mercury, nickel, and steel.

Following steady growth from the postwar boom years until 1974, world metals production leveled off during the next 20 years. The late 1990s, however, witnessed the beginning of a new expansion—one far more rapid than the previous one.[3] This second expansion was largely driven by the dramatic growth of the Chinese economy.[4] Consumption growth rates have also been high in India and South Korea, but much smaller in overall quantities than in China.[5]

Average per capita metals use rose from 77 kilograms in 1950 to 165 kilograms in 1975 and 213 kilograms in 2008.[6] But these global averages conceal the fact that metals consumption is still heavily concentrated in a small number of countries. For instance, U.S. per capita consumption in 2008 (380 kilograms) was roughly nine times that in China and 15 times that in India.[7]

Figure 1. World Metals Production, 1950–2008



Among the broad range of metals that are mined for commercial use, a few stand out. Steel—produced from iron ore—is by far the most important in terms of weight, accounting for 95 percent of the total.[8] Aluminum—derived from bauxite—is a distant second, followed by considerably smaller quantities of copper and zinc.[9]

Still, weight alone does not tell the full story. A range of metals—such as arsenic, cadmium, chromium, mercury, nickel, and gold—have serious environmental impacts but are mined in comparatively small quantities. Across the array of materials extracted, mining has serious environmental consequences. It involves large quantities of waste, toxics, and removal of natural vegetation.

In 2005, the production of 10 key metals commodities led to more than 3 billion tons of waste materials (excluding so-called overburden removal—the dirt, rock, and other material removed to reach ores).[10] This was four times the weight of the actual metals extracted. Principally as a result of declining ore quality, the flow of processing wastes is increasing faster than that of the metals themselves.[11]

As noted, iron ore is used in steel production, with chromium and nickel being added to produce stainless steel. China, Brazil, and Australia are the leading iron ore producers.[12] Global steel production has risen steeply, from 189 million tons in 1950 to more than 1.3 billion tons in 2008.[13] But the recent global economic crisis translated into sharply reduced volumes and lower prices in late 2008, a development that carried over into 2009. China, with

Click here to see notes for this section.

its economic stimulus program an apparent success, is currently the only growing market in the steel sector.[14]

China's steel production skyrocketed from 66 million tons in 1990 to 500 million tons in 2008, which was 38 percent of the world's total.[15] It was followed at a considerable distance in 2008 by Japan (119 million tons), the United States (91 million), Russia (69 million), India (55 million), and South Korea (53 million).[16] (See Figure 2.)

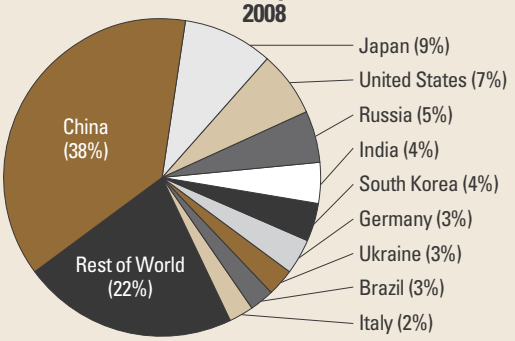
A decade ago, North America and Europe dominated steel use, using 44 percent of the world's total. Today China is the largest user with 36 percent, and other Asian countries account for another 22 percent.[17]

Steelmaking is a highly energy-intensive process that releases large amounts of greenhouse gases. On average, producing 1 ton of primary steel results in emissions of about 1.7 tons of carbon dioxide (CO_2).[18] Technological advances over the past two to three decades have led to improved energy efficiency, greater use of byproduct gases and materials, and substantial reductions in CO_2 emissions per ton produced.[19] Still, these per-unit gains have to some degree been offset by surging production. Altogether, steelmaking accounts for 5–6 percent of CO_2 emissions due to human activities and 27 percent of emissions from manufacturing.[20]

Energy intensity and carbon emissions vary greatly from country to country. Steel mills in Italy, Germany, South Korea, and Japan are among the most energy-efficient worldwide.[21] Russia and especially Ukraine are still relying strongly on outdated open-hearth furnaces.[22] Steelmaking in India carries a heavy environmental burden due to the prevalence of the low-quality coal as an energy source.[23] China contends with old and inefficient facilities, but the country is making major strides in modernizing its industry.[24]

A growing amount of steel is now produced from recycled scrap material—the result of changing economics and environmental considerations. The International Energy Agency notes that "the amount of steel that is stored in capital stock is more than 10 times annual steel production."[25] This "secondary" production accounts for about 35 percent of total steel output worldwide.[26] Recycling saves 40–75 percent of the energy needed to produce virgin steel.[27]

Figure 2. Steel Production, Top 10 Producers and World, 2008



Source: World Steel Association

In Spain and Turkey, secondary steel production accounted for 88 and 87 percent of their total output, respectively, in 2008.[28] Other countries with prominent shares of recycling-based production include Italy (77 percent), the United States (64), South Korea (52), Russia/Ukraine (48), and Germany (45).[29] The share of recycled steel in Brazil, China, and India, on the other hand, is still considerably lower.[30]

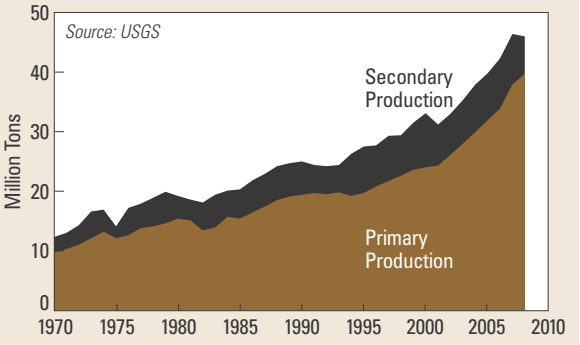
Aluminum is made from bauxite, a metal that is primarily mined in Australia, China, Brazil, and India.[31] This lightweight yet strong material is mainly used in the automotive industry, the aerospace industry, buildings and construction, and packaging.

World primary aluminum production has grown from about 2 million tons in 1950 to 39.7 million tons in 2008.[32] As with steel, dramatic changes have occurred in the lineup of major producers. From a share of slightly more than 40 percent in 1960, the United States is now down to less than 7 percent.[33] China surged to take a commanding 34 percent share in 2008. Russia, the second largest producer, accounts for 11 percent, and Canada has 8 percent.[34]

Accounting for roughly 3 percent of global

electricity use, the aluminum industry is among the most energy-intensive sectors of the world economy.[35] Typically, the smelting process releases 1.6 tons of CO_2 per ton of aluminum and another ton of CO_2 equivalent from perfluorocarbon emissions.[36] The industry has become steadily more energy-efficient, however. Worldwide average energy use in smelting has come down from more than 50,000 kilowatt hours (kWh) per ton in 1900 to 25,000 kWh in 1950 and 16,000 kWh in 2000.[37]

Figure 3. World Aluminum Production, 1970–2008



Producing aluminum from recycled scrap uses only 5–10 percent as much energy as making it from scratch.[38] And by reducing the need to mine bauxite, scrap recycling helps to avoid toxic mining wastes.

World secondary production of aluminum grew steadily from 2.6 million tons in 1970 to about 9 million tons in 2000, or about 38 percent.[39] Since then, however, trends have reversed, even as primary production continued to increase rapidly. In 2008, scrap-based production of 6.3 million tons was equivalent to just 16 percent of total production.[40] (See Figure 3.)

Japan's experience is unique in that it has almost completely abandoned domestic primary production of aluminum, switching instead to secondary production and imports.[41] In the United States, secondary production from old (post-consumer) scrap accounts for 30 percent of supply, with new scrap (from production processes) at least doubling that share.[42] In the European Union, secondary aluminum production has tripled since 1980, accounting for about 40 percent of total output.[43] The Chinese government intends to increase use of secondary aluminum from today's 17 percent of the total to 25 percent by 2010.[44]

The author thanks Grecia R. Matos, Minerals and Materials Specialist at the U.S. Geological Survey, for her generous help in providing metals production data and her comments on a draft version of this piece.

World Labor Force Growing at Divergent Rates

Elizabeth Leahy Madsen

The world's potential labor force, measured as men and women from the ages of 15 to 64, stands at 4.46 billion people in 2009, up 18 percent over the last decade.[1] The potential labor force has nearly tripled since 1950, when it was 1.5 billion, and people of working age now account for 65 percent of the world's total population—the highest ratio since 1950.[2] (See Figure 1.) Although the pace is slowing, this ongoing growth has both positive and negative implications: there are more potential workers to drive economic expansion, but the number of available jobs may not keep pace. Given the current recession, the International Labor Organization (ILO) projects the ranks of the unemployed in the world will grow to well over 200 million people in 2009, a global unemployment rate of roughly 7 percent.[3]

While the overall picture is one of slowing but steady growth in the potential labor force, and hence a growing need to maintain employment rates worldwide, trends are heading in quite disparate directions in different regions and countries. In developing countries, where women have an average of nearly three children each, the labor force has grown much more rapidly since 1950 (260 percent) than it has in industrial countries (where it grew nearly 60 percent), where fertility rates on average are already lower than the "replacement level" needed to sustain a population at a steady level.[4] This is reflected in the disparities between the proportional size of regional labor forces and economies. (See Figure 2.)

Of course, everyone between the ages of 15 to 64 does not hold a job or produce income, for reasons such as schooling, child or elder care, unemployment, social custom, early retirement, and poor health or disability. The ILO calculates the difference between the size of the potential labor force and the economically active population.[5] For the world as a whole, there were 3.1 billion economically active

Figure 1. World Labor Force, Total and as Share of World Population, 1950–2010

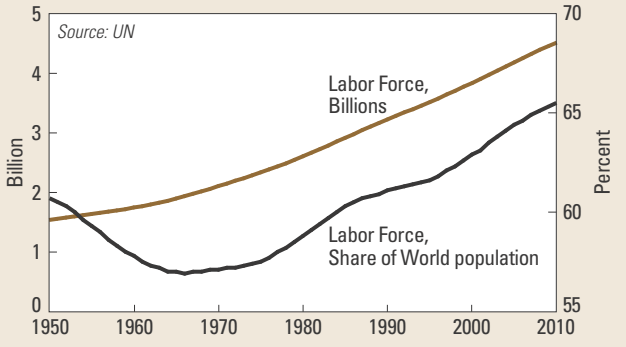
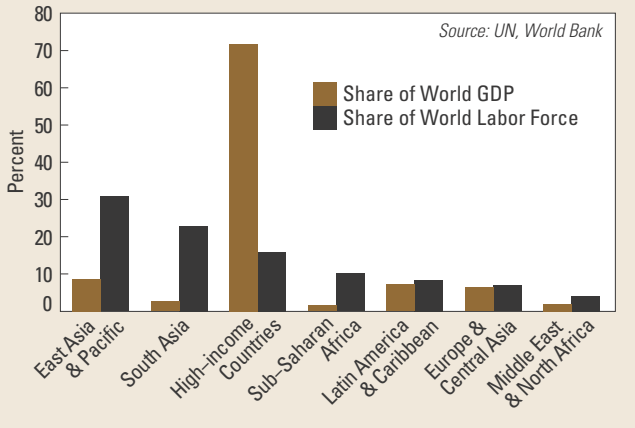


Figure 2. Shares of World Labor Force and GDP, by Region, 2008



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people aged 15 to 64 in 2009, or about 69 percent of the potential labor force.[6] Fewer women than men are active in the labor force; this "gender gap" is largest in the Middle East and North Africa and smallest in East Asia and the Pacific.[7] The proportion of the world's working-age population that is economically active is remarkably consistent, having declined by just one percentage point over the past 30 years.[8]

These figures also vary by country; in China, about 81 percent of the potential labor force is economically active, while the figure for France matches the world average of 69 percent.[9] High participation rates, however, do not necessarily lead to prosperity; in some countries where the ratio of active workers in the potential labor force exceeds 80 percent, as in China, the labor market is saturated with unskilled, low-paying jobs.[10]

Countries with a high share of their population in the potential labor force have gone through a pronounced demographic shift: fertility rates have declined fairly recently, the proportion of older adults remains low, and women are more likely to enter the workforce because of smaller family sizes. During this period of demographic change, countries can experience significant economic benefits if their growing labor forces are healthy and educated and if government policies promote savings, investment, and open economies. Research has shown that the growth in the share of the population in the potential workforce accounted for 25–40 percent of the economic boom experienced by the rapidly growing East Asian countries between 1965 and 1990.[11] Human capital and government policies are particularly important to the achievement of this "demographic dividend" because countries with a higher share of educated workers have higher productivity and economic growth rates.[12]

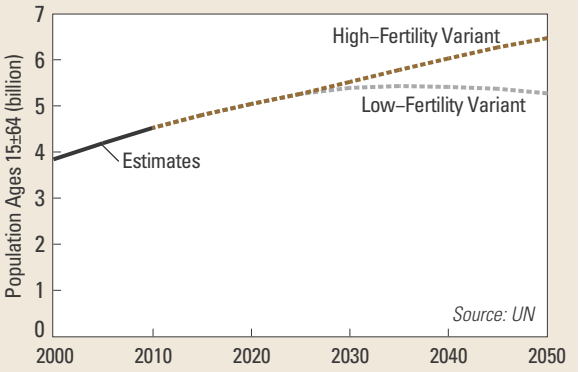
The world's potential labor force is projected to continue growing, though at a slower pace, through 2050.[13] (See Figure 3.) If the total fertility rate across the world falls slightly, the size of the potential labor force is expected to reach 6.47 billion people by 2050, an increase of 45 percent relative to 2009.[14] Even if fertility rates were to fall much lower, the power of demographic momentum would still drive the labor force to 5.27 billion, an 18 percent increase.[15]

Labor force differences due to regionally varying fertility rates are likely to become more pronounced, as by 2050 industrial countries will see a decline in the size of their potential labor force for the first time.[16] Meanwhile, the labor force in developing countries is projected to grow by 25–50 percent or more.[17] This growth will be concentrated in the areas with the highest fertility rates—sub-Saharan Africa, the Middle East, and South Asia.[18] Many of these countries are already struggling to provide sufficient education and jobs to their populations.

Declines in the size of the labor force as the effects of below-replacement fertility take hold are projected for most of Europe (although not in northern Europe, due to its higher fertility rates) and the more industrialized countries in Eastern Asia.[19] Three of the world's largest economies—Germany, Japan, and Russia—are already experiencing declining workforces; in Japan, the labor force could be cut nearly in half by 2050 if fertility rates continue to decline.[20]

Perhaps surprisingly, the labor force will get smaller in some areas of the developing world as well. China's labor force will continue growing until the 2030s but thereafter will decline; by

Figure 3. Projected World Labor Force, 2000–50



2050 it could be just below today's levels or even as much as one fifth smaller.[21] Sri Lanka and Thailand are also likely to see a decline in their potential labor force by mid-century.[22] In these and other similar cases, the drops can be attributed to rapid declines in fertility that have already occurred.

Labor forces in regions such as the Caribbean, South America, and Southeast Asia, while unlikely to experience an absolute decline, are projected to grow by 40 percent or less over the next four decades.[23] In the United States, where fertility rates are currently at replacement level, the labor force is projected to hold steady or perhaps grow slightly.[24]

Historically, high rates of labor force growth in developing countries with poor employment prospects have motivated people to migrate in search of work. International migrants account for 10 percent of the total population of industrial countries, which have seen an increase in the number of migrants arriving to look for work.[25] These countries are targeted in particular by highly skilled workers from developing countries; more than one quarter of all university graduates in 17 African countries are living abroad.[26]

Migration has a mitigating effect on population aging in industrial countries. Without it, the working-age population of these regions would shrink by more than 170 million people by 2050, compared with a projected decline of 63 million with continuing migration. In areas of the developing world where growth of the labor force is projected to slow or stop, pressures to migrate may ease if national economies are able to provide sufficient jobs.

Although many policymakers have expressed alarm about health care and pension system costs from an aging workforce in industrial countries, there is significant variation in the age at which people stop working. Many people are working past age 65; in Japan and South Korea, men work on average to age 70.[27] Policies that promote an extension of working years for healthy and productive older adults may help offset the economic consequences of demographic change.[28] Already, more than one fifth of people age 65 or older are economically active, especially in developing countries.[29] More than half of men over the age of 65 in Africa are still in the labor force.[30]

The demographics of global and regional labor forces, which can be relatively confidently predicted for the near term, will have important implications for the world economy. Many developing countries will face the challenge of expanding their labor markets to provide jobs for a growing workforce. Meanwhile, industrial countries will face important policy decisions about productivity in an aging workforce and about their openness to migration.

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Growth in World Economic Output Slows

Gary Gardner

The world's total output of goods and services, known as the gross world product (GWP), rose by 5.4 percent in 2008, to $69 trillion.[1] (See Figure 1.) The rate of growth, a deceleration from the heated 7.5 percent annual average of the previous five years, was dampened by the global recession that emerged during the year.[2] (See Figure 2.) The data are calculated based on the purchasing power parity exchange rate, which converts national output to a common currency that reflects equivalent purchasing power across countries.[3]

Growth was highly uneven around the world, with the greatest advances in developing economies and the least in the largely mature industrialized economies.[4] (See Table 1.) The highest rates of growth were recorded for developing Asian nations, which includes the rapidly expanding economies of India and China. At 7.6 percent, the growth in this region was more than 12 times the average rate in industrial countries.[5] It is projected to slow only slightly, to 6.2 percent, in 2009, in part because of adoption of very large stimulus packages, particularly in South Korea and China.[6]

The world's least developed economies—a

Figure 1. Gross World Product, 1980–2008

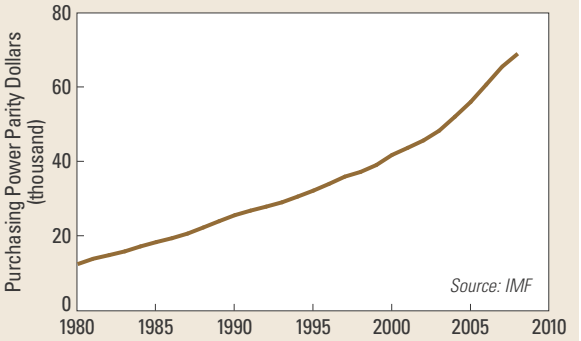


Figure 2. Gross World Product Annual Growth Rate, 1981–2008

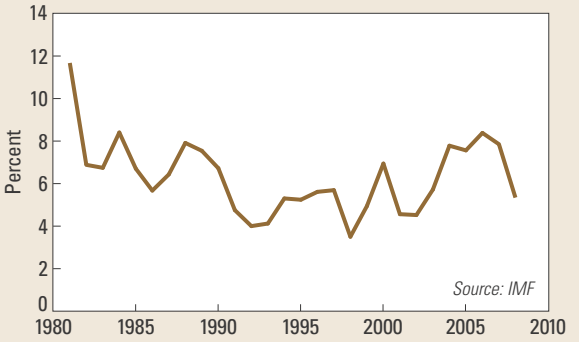


Table 1. Gross Domestic Product Growth Rate, Selected Economies, 2008

Economy	Growth rate
	(percent)
Industrial Economies	0.6
United States	0.4
Euro area	0.7
Japan	–0.7
United Kingdom	0.7
Canada	0.4
Other industrial countries	1.6
Emerging and Developing Countries	6.0
Africa	5.2
Central and Eastern Europe	3.0
Commonwealth of Independent States	5.5
Developing Asia	7.6
Middle East	5.4
Western Hemisphere	4.2

Source: International Monetary Fund.

Click here to see notes for this section.

United Nations designation for 50 countries characterized by low income, by low levels of nutrition, health, and literacy, and by economic vulnerability—also showed strong growth in 2008.[7] Sub-Saharan Africa, for example, saw a growth rate of 5.5 percent in 2008.[8] But the road ahead for the poorest nations is projected to be rocky: the International Monetary Fund (IMF) expects sub-Saharan Africa to grow by only 1.3 percent in 2009.[9] The least developed economies often lack diversity of economic activity, and they are strongly dependent on exports of commodities, whose prices can be volatile. Both factors make these countries vulnerable to economic disruption in a global economic downturn.[10]

Sluggish growth in the gross domestic product (GDP) in much of the world was precipitated by a burst in the housing bubble in the United States in 2008, which brought prices down to more realistic levels. House prices declined globally by an average 7 percent in 2008.[11] IMF data for 50 countries show that housing prices fell in 2008 in 40 nations and rose in only 10.[12] Countries that saw an increase in housing values, like China and India, also tended to be countries that were relatively mildly affected by the recession.[13]

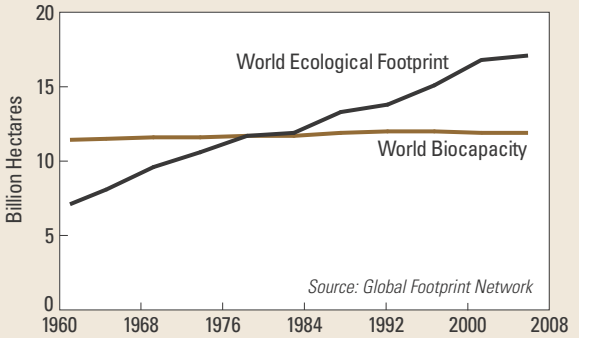
While GWP is a good measure of output of goods and services worldwide, it falls short as a yardstick of societal advance in several ways.[14] First, many of the items tracked arguably do not represent progress. Ambulances rushing to a traffic accident, crews cleaning up oil spills, home burglary systems, and duplicate health care procedures merely redress harm done by other economic activity; they do not advance society in meaningful ways.[15] Yet all are counted as a boost to GWP. An effort to quantify this economic waste in the late 1990s estimated that it accounted for between a quarter and a fifth of U.S. GDP.[16]

At the same time, GWP does not include many services that actually do contribute to a better quality of life and to societal well-being, such as stay-at-home parents who tend to children and volunteers who build more-resilient communities through work in soup kitchens, tutoring programs, and the like. But because these are not market-based services and carry no price tag, they are not rolled into the GWP tally. In addition, GWP does not account for the depletion of natural capital—the resources and ecosystem services that underpin all economies. Building on a wetland, for example, is counted as economic advance, even if the wetlands' water purification and flood control functions are lost in the process.

In response to these deficiencies, nongovernmental organizations and a handful of governments have developed alternative measures of societal advance. A commonly cited one is the Ecological Footprint indicator, which expresses human demand for ecological goods (such as forest wood) and services (such as carbon absorption) in hectares, then compares the total to the biocapacity of the planet.[17] (See Figure 3.) Human ecological demand began to exceed biocapacity in the mid-1980s; by 2006, the last year for which calculations were available, demand was 44 percent greater than biocapacity.[18] (This overshoot is temporarily possible by overpumping aquifers, cutting forests faster than they regenerate, and making similar drawdowns of ecological capital.)

Other alternative measures include the Genuine Progress Indicator, the Happy Planet Index, the Well-Being Index, the Human Development

Figure 3. World Ecological Footprint and Biocapacity, 1961–2006



Index, and the Sustainable Society Index developed in 2006 by the Netherlands-based Sustainable Society Foundation.[19] All move beyond economic accounting in their measurements and show in different ways that global economic advance is not sustainable. None has emerged yet as the preferred complement to GDP.

Nevertheless, alternative measures of societal advance are receiving increasing attention from officials. The Organisation for Economic Cooperation and Development, which represents 30 industrial countries, held a series of forums called "Measuring the Progress of Societies" to develop economic, social, and environmental indicators of societal well-being.[20] In addition, the European Union (EU) announced that it will complement GDP reporting with an environmental index beginning in 2010.[21] This will cover greenhouse gas emissions, loss of natural landscapes, air pollution, water use, and waste generation, among other indicators. The EU also expects to develop a European Sustainable Development Scoreboard that will track environmental trends and highlight best practices.

Meanwhile, French President Nicolas Sarkozy established a commission led by Nobel laureates in economics Joseph Stiglitz and Amartya Sen and by French economist Jean-Paul Fitoussi to examine alternatives to GWP.[22] The commission called for tracking the distribution of income, consumption, and wealth, for developing non-market indicators of well-being, and for monitoring physical indicators of environmental pressures.[23]

Beyond questions of measurement, economic growth itself is increasingly criticized as being unsustainable on a finite planet. A group of academics led by former World Bank senior economist Herman Daly has argued for decades that human numbers and spreading prosperity have generated materials-intensive economic activity at levels so great that it threatens key natural systems.[24] The latest research consistent with this perspective is a 2009 study on "planetary boundaries," which showed that three indicators—atmospheric concentrations of carbon dioxide, species loss, and disruptions to the global nitrogen and phosphorus cycles—have reached unsustainable levels and that six other indicators of planetary health are also at risk of crossing critical thresholds.[25]

The growth critique has spawned a "de-growth" movement in Europe, complete with an international conference on the topic in Paris in 2008.[26] "De-growth" refers not to economic stagnation but to an end to growth in virgin materials use (initially in wealthy economies, to allow for continued and needed growth in developing economies). De-growth economies would be characterized by high levels of conservation, recycling, and the use of services in place of goods, which would allow for growth in economic output but with minimal growth in virgin materials use. An important boost to the de-growth concept came in 2009 with publication of *Prosperity without Growth*, a report of the U.K.'s Sustainable Development Commission, an independent body established to advise the U.K. government on sustainability issues.[27]

The focus on limits to growth suggests that physical measures of economic output—the amount of metals, biomass, minerals, and fossil fuels used in the global economy each year—offer an increasingly relevant yardstick of economic activity. Global materials use increased by 50 percent in the past 30 years—despite a 30-percent increase in efficiency of materials use.[28] Projections from the Sustainable Europe Research Institute show that unless economies become highly dematerialized—relying on services in place of some goods and using technologies to achieve radical increases in materials efficiency—materials use will nearly double again by 2030.[29] Because environmental degradation correlates roughly with materials use, this projection suggests that a planet already reeling from a variety of environmental injuries faces major ecological disruptions over the next two decades.

Ad Spending Slumps in 2008, Projected to Decline Significantly in 2009

Erik Assadourian

Advertising expenditures worldwide fell 2 percent in 2008 to $643 billion, about 1 percent of the gross world product (all figures in 2008 dollars).[1] (See Figure 1.) Of this total, 42 percent was spent in the United States, the lowest percentage since measurements started in 1950.[2] Yet a much greater amount is still spent per person on advertising in the United States than in the rest of the world. In 2008, some $891 was spent per American—nine times as much as the $96 spent per person worldwide.[3] (See Figure 2.)

Advertising expenditures on major media—on television, newspapers, magazines, the Internet, radio, outdoor ads such as billboards, and movies (listed order from largest to smallest spending)—reached $494 billion in 2008.[4] This figure was 1 percent below the number in 2007 and is projected to decline another 11 percent in 2009.[5] This significant contraction has been driven primarily by the stagnant global consumer economy and the resulting declines in consumer spending, which in turn has tightened marketing budgets.[6]

Declines in ad spending have been felt more in some media than others. Spending in newspapers worldwide fell 7 percent from 2007 to 2008—a decline of $7 billion—and is projected to fall another 18 percent in 2009.[7] Magazines witnessed a similar drop, with ad revenue falling 6 percent in 2008 and projected to fall another 21 percent in 2009.[8] This decline in advertising and the loss of readers to digital media have led many magazines and newspapers to shut down or file for bankruptcy protection, including the major U.S. media corporation Tribune Company, which filed for bankruptcy in December 2008.[9]

Ad spending on television stayed relatively flat in 2008, declining less than 1 percent, but it is expected to drop 8 percent in 2009.[10] Of ads in major media types, only the Internet continues to grow, jumping 21 percent in 2008 to reach $49.5 billion and projected to increase another 8 percent in 2009.[11]

Some regions have also experienced more contraction in ad spending than others. North America and Western Europe saw moderate

Figure 1. Advertising Expenditures, World and United States, 1950–2008

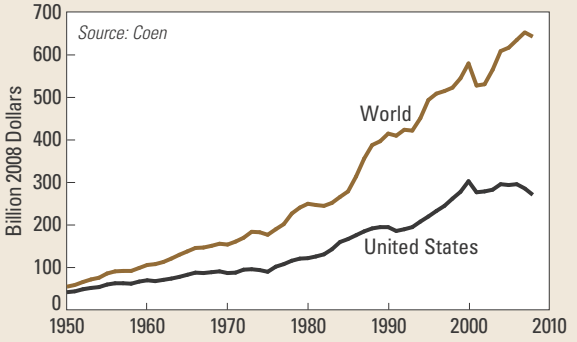
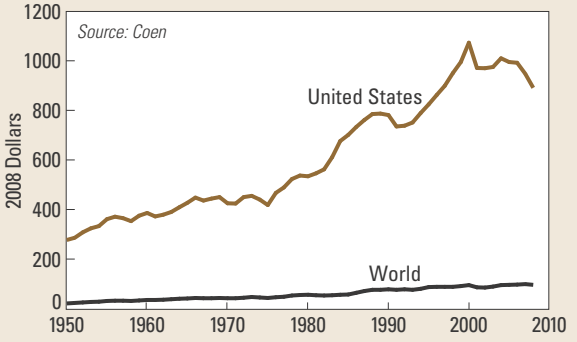


Figure 2. Advertising Expenditures, Per Person, World and United States, 1950–2008



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reductions in 2008 (6 and 4 percent respectively), but they face projected shrinkages of 14 and 12 percent in 2009.[12] Despite the declines, North America and Western Europe still account for 61 percent of total advertising on major media.[13] (See Figure 3.) Spending in Asia stayed stable in 2008 but is projected to decrease 4 percent in 2009.[14] Latin America seems to be faring best during the global economic downturn, having increased spending 12 percent in 2008 and expected to stay stable in 2009.[15]

Advertising is dominated by several industries, particularly the retail and automotive industries. In 2008, car companies spent $15.6 billion and retail companies spent $17.2 billion in the United States.[16] Among retailers, Walmart increased ad spending by 16 percent to $1.7 billion, leveraging its image as a discount store to appeal to consumers concerned with the recession.[17] (These expenditures were small compared with Walmart's revenues, however, which hit $401 billion in 2008, up 5 percent over 2007.)[18]

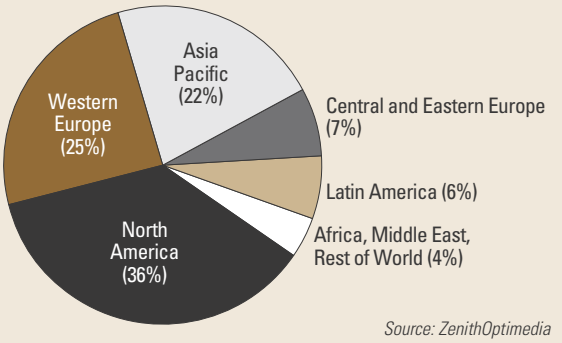
As technologies and consumers' behaviors evolve, innovative new marketing tools are displacing traditional forms of advertising. One form, product placement—intentionally placing, referencing, or using products in media such as a television program so that they are positively associated with characters—has grown in recent years, especially as digital video recorders allow viewers to skip commercials on television. In 2004, companies spent $3.9 billion strategically placing their products in influential media in the United States, three times the amount spent 15 years earlier.[19]

Another new tool is "word of mouth" marketing, which harnesses social networks rather than relying on increasingly segmented media outlets. People who volunteer to act as unpaid "brand agents" market products to unsuspecting friends or acquaintances, using their personal relationships to penetrate people's typical resistance to advertising. While some observers may think that few people would be interested in participating in such a tactic, in fact many people volunteer in order to get early access to new products and feel like they are trendsetters.[20] One word of mouth marketing firm, BzzAgent, has a network of 600,000 "BzzAgents" helping to market products as diverse as coffee drinks, books, alcoholic beverages, and baby bottles.[21] In 2008, U.S. businesses spent $1.5 billion on this kind of marketing, a number projected to reach $1.9 billion by 2010.[22]

Underlying marketing efforts are a comprehensive suite of "market research" tools. Today, these go far beyond focus groups and surveys to harness sophisticated psychological and social science techniques. For example, marketers recruit anthropologists to better understand their audiences and customers' behaviors, as Disney did in 2009 when it studied the consumer habits of teenage boys in order to better target this group, a demographic segment that Disney has had less success attracting.[23]

Advertising and other forms of marketing do not just stimulate desire for specific products; as marketing analyst Victor Lebow noted over 50 years ago, they can "contribute to the general pressure by which wants are stimulated and maintained."[24] The World Health Organization has found that product placement of cigarettes in movies has a causal, "dose-response" relationship in promoting smoking behaviors in teens.[25] The more that teenagers are exposed to cigarette smoking in the movies, the more likely they are to start smoking.[26]

Figure 3. Global Major Media Ad Spending By Region, 2008



Source: ZenithOptimedia

Similar findings by a congressionally commissioned panel of scientists show that food and beverage marketing influences children's preferences and purchase requests, and "is a likely contributor to less healthful diets, and may contribute to negative diet-related health outcomes and risks among children and youth."[27]

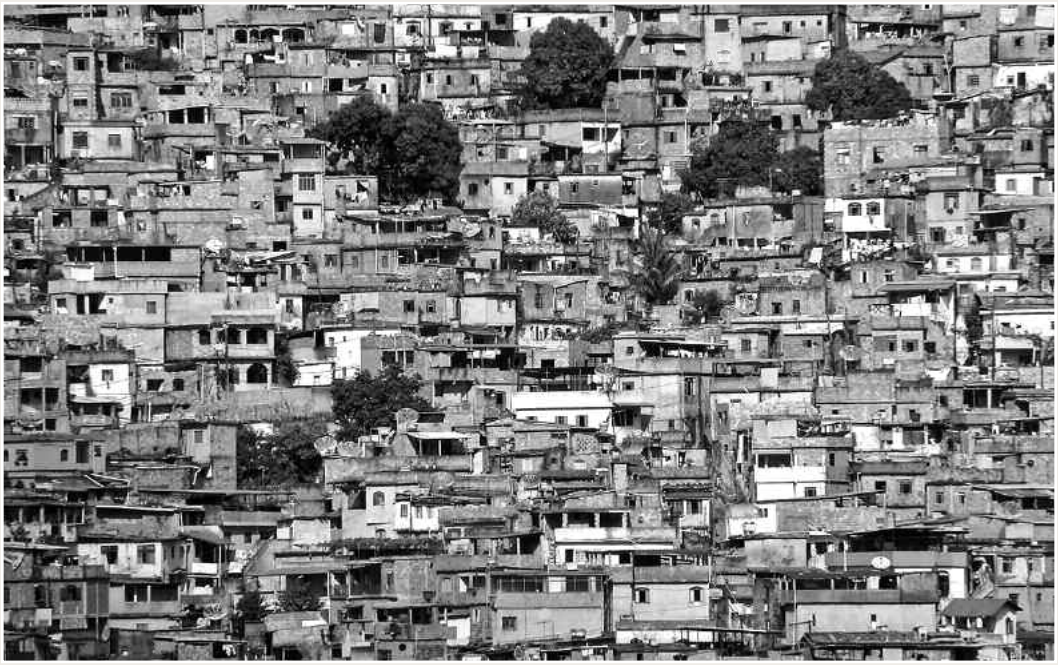
In response to these and other findings, some governments and citizen groups are working to lessen the impacts of advertising through bans and educational efforts. In 2006, the city council of São Paulo voted 45 to 1 to ban all outdoor advertising.[28] In July 2009, the government of Spain voted to ban commercials on its public television stations starting in 2010.[29]

Many governments and organizations have created media literacy educational programs to help create awareness of advertising and media influences on behavior. In Canada, Ontario's Ministry of Education, for example, has made media literacy mandatory as one of its four key components of education, along with reading, writing, and oral communication.[30]

In the United States, the citizen group Commercial Alert has been working to get Channel One News out of public schools.[31] This 12-minute daily "news" program includes 2 minutes of commercials, product placements, and company sponsorships of specific news segments.[32] Channel One is shown to nearly 6 million students—almost a quarter of American teens—who are essentially a captive audience to marketers since this program is part of the school curriculum.[33]

At the other end of the spectrum, marketing is starting to be harnessed to promote social causes, like eating less factory-farmed meat, stopping smoking, or consuming less "stuff" in general.[34] These efforts, however, represent just a fraction of total marketing spending.[35]

Population and Society Trends



Auro Queiroz

Slums in Belo Horizonte, Brazil

For data and analysis on population and society trends, go to vitalsigns.worldwatch.org.

Despite Significant Increase Since 1990, Access to Sanitation Still Inadequate

Amanda Chiu

The share of people in the world with access to improved sanitation rose to 62 percent in 2006, according to the most recent data from the Joint Monitoring Programme for Water Supply and Sanitation.[1] (See Table 1.) This is an increase from 54 percent in 1990.[2] Some 1.2 billion people have gained access to improved sanitation since 1990, yet more than twice that number—2.5 billion people worldwide—still lack such access, and 1.2 billion people still have no choice but to defecate outdoors in the open.[3]

Global efforts to improve this situation are falling short of the Millennium Development Goal (MDG) to "halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation," which would require bringing sanitation access up to 77 percent by 2015.[4] If current trends continue, by then 67 percent of people in the world will have such access.[5]

Improved sanitation is the highest level on the sanitation ladder. It is defined by the World Health Organization (WHO) and UNICEF as "facilities that ensure hygienic separation of human excreta from human contact."[6] This includes not only traditional western toilets and extensive sewage systems but also facilities like flush or pour-flush toilets or latrines connected to a piped-sewer system, septic tank, or pit latrine as well as ventilated improved pit latrines, pit latrines with a slab to stand on, and composting toilets.[7] On the bottom of this ladder is open defecation, defined as "defecation in fields, forests, bushes, bodies of water or other open spaces, or disposal of human faeces with solid waste."[8]

Universal access has been nearly achieved in industrial countries, while developing countries

Table 1. Access to Improved Sanitation, by Region

	Population (million)		Urban (percent)		Rural (percent)		Total (percent)	
Region	1990	2006	1990	2006	1990	2006	1990	2006
Sub-Saharan Africa	519	788	40	42	20	24	26	31
Southern Asia	1,193	1,613	53	57	10	23	21	33
Oceania	6	9	80	80	44	43	52	52
Eastern Asia	1,220	1,403	61	74	43	59	48	65
Southeastern Asia	441	565	74	78	40	58	50	67
Northern Africa	118	155	82	90	44	59	62	76
Latin America & Caribbean	444	565	81	86	35	52	68	79
Western Asia	138	200	93	94	56	64	79	84
Commonwealth of Independent States	281	278	95	94	81	81	90	89
Industrial regions	934	1,016	100	100	96	96	99	99
Developing regions	4,079	5,299	66	71	28	39	41	53
World	5,294	6,592	78	79	36	45	54	62

Source: WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, Progress on Drinking Water and Sanitation: Special Focus on Sanitation *(New York: 2008).*

Click here to see notes for this section.

have increased access for an additional 1.1 billion people since 1990. By 2006, a little over half of the people in developing countries had access to improved sanitation.[9] Efforts in western Asia, eastern Asia, southeastern Asia, northern Africa, and Latin America and the Caribbean have kept these regions on track to meet regional MDG targets; this is not the case, however, in sub-Saharan Africa, southern Asia, and the Commonwealth of Independent States.[10]

Sub-Saharan Africa has the lowest regional coverage, at 31 percent of the population.[11] Although this is an increase from 26 percent in 1990, more than half a billion Africans—544 million of the region's 788 million people—still lack access to improved sanitation.[12] The lowest levels of improved access globally are found in Eritrea, where only 5 percent of the population had access to improved sanitation and 85 percent defecate in the open in 2006, followed by Niger (7 percent with improved sanitation), Chad (9 percent), and Ghana (10 percent).[13] (See Figure 1.)

Despite low regional coverage, some countries in sub-Saharan Africa have made significant progress since 1990. Benin ranks among the top 12 countries in the world making the most rapid improvements in coverage, expanding access from 12 percent in 1990 to 30 percent in 2006.[14] The number of people with improved access more than quadrupled even though Benin's population grew by two thirds.[15] In Malawi, a 40 percent increase in the number of people with access accompanied a 44 percent increase in population between 1990 and 2006.[16] The largest number of people in the region to gain access are in Nigeria.[17] And despite low sanitation coverage in Ethiopia (11 percent with improved sanitation), astounding regional progress has been documented.[18] In most African countries, however, access to sanitation is falling behind population growth.[19]

In the most populous region in the world—southern Asia—one in three people has access to improved sanitation, slightly higher than in sub-Saharan Africa, but the number of people still lacking this access—just over 1 billion—is far greater.[20] The number of people defecating in the open has decreased from two out of three to one out of two, but this is still the highest portion globally.[21] In southeastern Asia, access increased by 158 million people from 1990 to 2006, yet 187 million people are still without access to improved sanitation.[22]

In Asia, access in Viet Nam increased the most dramatically, with coverage more than doubling (from 29 percent in 1990 to 65 percent in 2006) and the practice of open defecation more than halving (from 30 percent in 1990 to 12 percent in 2006).[23] (See Figure 2.) Access in

Figure 1. Access to Sanitation in Sub-Saharan Africa, Selected Countries, 1990 and 2006

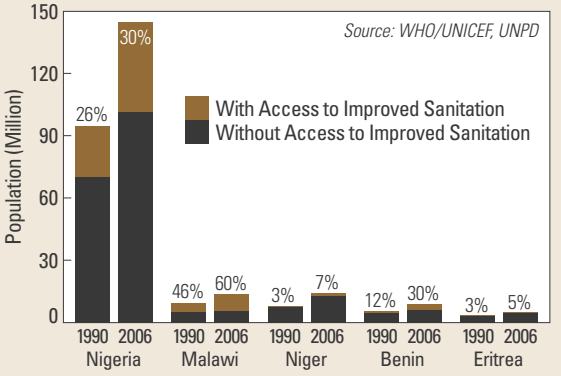
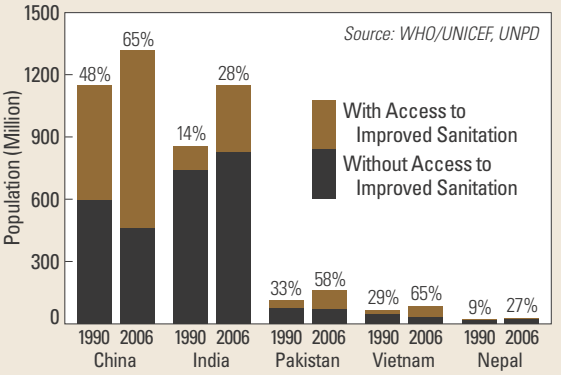


Figure 2. Access to Sanitation in Asia, Selected Countries, 1990 and 2006



Pakistan has nearly doubled, but one in three people still defecate in the open. The highest numbers of people to gain access are in China and India, although in China one third of the population still has no access.[24] In India, 28 percent of the population has access, up from 14 percent in 1990; more than half the population still has to defecate in the open, although this has been reduced from 73 percent in 1990.[25] Government commitment in this country has been raising the sanitation profile.[26] Access in Nepal has increased threefold since 1990, although only slightly more than one quarter of the population has access and half the people still defecate in the open.[27]

Wide disparities in access continue to exist between urban and rural areas. Globally, this gap shrank from 42 to 34 percentage points in 2006, with urban areas having 79 percent coverage and rural areas, 45 percent.[28] The largest urban-rural disparities are found in Oceania (80 percent urban coverage, 43 percent rural), Latin America and the Caribbean (86 percent versus 52 percent), and southern Asia (57 percent versus 23 percent).[29]

Income disparities also play a role in sanitation access. A survey of 38 developing countries found that the poorest 20 percent of the population in 2005 and 2006 was three times less likely than the richest 20 percent to have access to improved sanitation.[30]

Access to improved sanitation is an indicator of development progress, and long-term sustainability depends on local geological, cultural, social, and financial factors. In addition to locally appropriate physical infrastructure (the hardware), efforts to improve sustainable access must incorporate software—the social knowledge and marketing necessary to change sanitation and hygiene behavior and to institutionalize safer practices.[31]

In developing countries, social issues like pride and shame are driving the demand for improvements and raising the sanitation profile.[32] One of the most recent and successful approaches to sustainable sanitation access, Community Led Total Sanitation, uses these social factors to trigger awareness of and demand for improved sanitation.[33] While efforts like these are making good progress, political will is needed to achieve universal sanitation. Some countries have openly undertaken this challenge.[34]

The importance of removing excreta—human or animal—from human contact lies in the pathogenic bacteria found in fecal matter and urine. Water or food contaminated by these bacteria is a major transmitter of diarrheal and other diseases—an entirely preventable avenue of transmission. According to the WHO, improved water, sanitation, and hygiene could reduce the societal costs of illness and premature mortality by 10 percent.[35]

Diarrheal diseases like cholera, typhoid, and dysentery are one of the three leading causes of death for children under the age of five, killing 1.7 million of them a year.[36] Sanitation is a critical deterrent of diarrheal and other diseases, providing a direct barrier between infectious pathogens in fecal matter and the human environment. Hygiene serves as a secondary barrier, preventing disease transmission through human-to-human contact or contaminated food or water.[37] Studies have found that sanitation and hygiene interventions can both lower diarrheal morbidity by one third.[38]

In addition to reducing morbidity and mortality, particularly child mortality, from diarrheal diseases, improved sanitation also combats malnutrition, as half of all cases in children are associated with diarrheal diseases.[39] Better access also provides greater human dignity and privacy to the entire community, particularly women and girls.[40]

While sanitation and water improvements do not directly induce financial growth, they do provide substantial economic benefits. One study estimated the return in developing regions on a $1 investment to be between $5 and $46, with the biggest payback in the form of time saved from, for example, avoiding illness related to poor water, sanitation, or hygiene.[41] The economic cost of inaction for sanitation for four southeastern Asian countries alone totals an estimated $9.7 billion (in 2008

dollars) annually.[42]

At the global scale, the annual economic benefits of meeting the water and sanitation MDG by 2015 amount to $103.3 billion (in 2008 dollars).[43] Almost two thirds of this is attributed to quality-of-life improvements and to the value of time saved by having toilets or latrines more accessible or nearby and by public facilities having shorter lines.[44] While these seem like simple considerations, women and girls in many parts of the developing world must wait until nightfall to relieve themselves for various reasons; in doing so, however, they put themselves at a higher risk of being harassed or attacked by animals or men.[45] Higher rates of school attendance, prevented deaths, and savings in health sector costs from avoided illnesses also contribute major economic benefits.[46]

The United Nations has tried to reinvigorate efforts on improved water and sanitation access under the auspices of the International Decade for Action from 2005 to 2015 and the 2008 International Year of Sanitation. These efforts to mobilize U.N. agencies, nongovernmental organizations, the private sector, and academia seek to make the Millennium Development Goal for sanitation by 2015 achievable.[47] Accomplishing this will take a determined and concerted effort throughout the remaining years.

Population Growth Steady in Recent Years

Robert Engelman

The world's population surpassed 6.8 billion in early 2009, with no significant slowing in the pace of growth in recent years.[1] (See Figure 1.) Estimates by the United Nations Population Division indicate that humanity has been consistently gaining more than 79 million people—a population almost the size of Germany's—each year since 1999.[2] During the 1990s, annual additions fell from nearly 90 million people to less than 80 million, feeding optimism that world population might peak not long after the middle of this century.[3] But the recent stability of annual population increments adds to the uncertainty and when—and how—world population growth will end.[4] (See Figure 2.)

Figure 1. World Population, 1950–2009

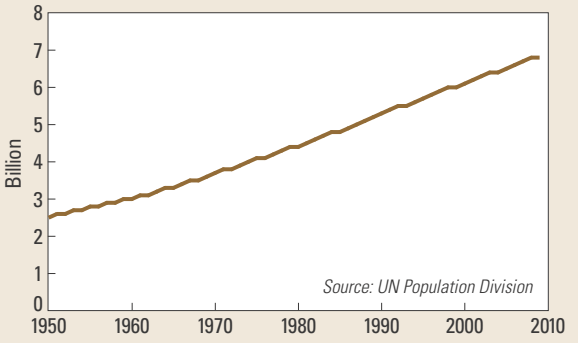
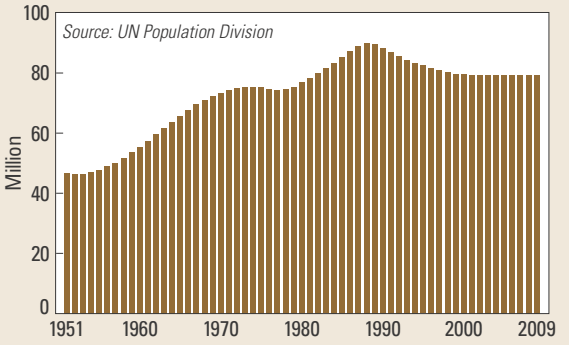


Figure 2. Annual Addition to World Population, 1951–2009



U.N. demographers currently offer eight variant projections for the future, with the median and most cited one placing world population slightly above 9.1 billion in 2050.[5] Non-demographers often misinterpret this number, however, as an expert prediction or forecast of what population will be. Rather, all projections are conditional assessments based on current numbers, age structure, and trends and reasonable assumptions about the future.[6] Thus the projections the United Nations offers produce a range of 2050 world population from slightly less than 8 billion to slightly more than 11 billion.[7] The Washington-based Population Reference Bureau (PRB) recently released its own projections, suggesting a population at mid-century of slightly more than 9.4 billion.[8]

The recent leveling out of annual population growth increments, which no demographer had predicted, helps illustrate that there is no way to be sure that population is "likely" or "expected" to peak at roughly 9 billion people at mid-century, or indeed at any particular time in the future.

Regionally, more than 95 percent of world population growth is occurring in developing countries, especially in Africa and Asia, regions that account for more than three quarters of the world's current population.[9] Despite perceptions that population growth has stopped or reversed in most of the wealthier countries, however, growth continues in the industrial world as a whole and is likely to keep going, though at modest levels, for some time. Although the pop-

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ulations of Japan, Germany, Russia, and some other East European countries are already declining, U.N. demographers in their median projection do not indicate a population peak among industrial countries as a group until 2036.[10] In the same projection, by mid-century Africa will be adding 21 million people a year to world population and Asia, 5 million.[11]

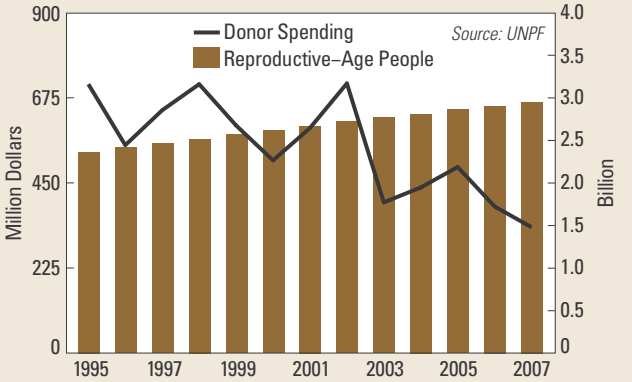
Today's population growth is occurring midst two important population-related trends, to which current growth rates may be related. First, global assistance for family planning services—provision of contraceptives with counseling on how to use them safely and effectively—in poor countries is falling significantly.[12] Though it was once the main recipient in the foreign assistance category known as population and reproductive health (a category that includes maternal and child health as well as prevention of HIV and other sexually transmitted infections), aid for voluntary family planning has shrunk in recent years to a minor component. Global spending on contraceptive supplies and services totaled just $338 million in 2007, considerably less than half what it was in 1995—despite a 20-percent increase in the number of women and men of reproductive age in developing countries.[13]

Ironically, donor spending on the larger category of population and reproductive health has been growing steadily in recent years, a reflection of major boosts among the largest health donors in spending to address the HIV/AIDS pandemic.[14] In percentage terms, partly because of the growth of HIV-related spending, the provision of contraceptive services and goods fell from 55 percent of donor spending on population and reproductive health in 1995 to just 5 percent in 2007.[15] (See Figure 3.)

Second, in many countries the fertility rate—the number of children that average women in a particular country have in their lifetimes—is fairly stable at levels significantly above what would be needed to end population growth.[16] Both U.N. data and those of ICF Macro, a company that does demographic and health surveys for the U.S. government, show that in many countries fertility is not falling significantly—and certainly not rapidly enough to arrive at "replacement" level (between 2.1 and 3 children, depending mostly on levels of infant and child mortality) by or close to mid-century.[17] In some cases—in Indonesia, Ghana, and Kenya, for example—fertility appears to have stalled above replacement levels despite having fallen significantly in previous decades.[18] This all but guarantees decades of continued population growth in these countries.

In the world's wealthier countries, fertility decline has largely stopped, albeit at low levels, often well below replacement fertility.[19] In some cases—the United States and Spain, for example—the number of children per woman is actually increasing slightly, or at least it was when data were collected and analyzed just before the global economic slowdown began.[20] The net result of these trends, in combination with improvements in life expectancy for people living with HIV, is a human population that is growing somewhat more rapidly than demographers had expected—and that shows no clear sign of realizing any time soon the assumptions on fertility that would yield a 2050 population of 9.1 billion.[21]

Figure 3. Donor Family-Planning Expenditures and Reproductive-Age Population in Developing Countries, 1995–2007



Due to current demographic momentum stemming from the youthfulness of the world's population and large cohorts of young women entering their childbearing years, only unexpected and near-catastrophic increases in mortality rates or declines in fertility could reverse population growth before 2025 or 2030. Indeed, it is almost certain that the 7 billion mark will be reached in 2012, according to the United Nations.[22] PRB's new *World Population Data Sheet* projects the world will hit that number even sooner, in the second half of 2011.[23]

After that, the rate of population growth becomes much more uncertain. Demographers tend to assume that all populations, even those with very low incomes, will at some point in this century have fertility rates equal to or below replacement values.[24] Yet trends in many low-income countries raise questions about this assumption. Demographic and Health Surveys conducted for the U.S. Agency for International Development, for example, measured total fertility in Indonesia at 2.8 children per woman in 1997, at 2.6 in 2002, and at 2.6 again in 2007.[25] In Chad, surveyed fertility was 6.4 in 1996 and 6.3 in 2004.[26]

Since the vast majority of the world's current and projected future population growth takes place in poorer countries, stable fertility rates above replacement level raise an obvious question: What is likely to change in coming years that will produce much more rapid fertility decline in such countries? And without more rapid fertility decline, how likely are demographers' median population projections? Even among environmentalists there is little appreciation of how much demographers' projections of some 9 billion people in 2050 rely on an assumed fertility decline over the next 40 years that may not unfold.

By the same token, these projections rely on an assumption that life expectancy will continue to rise worldwide.[27] This has indeed been a robust demographic trend not just for decades but for centuries. But suppose life expectancy were to stop rising? Climate change, for example, is predicted to have the greatest effect in tropical countries with low incomes and exposure to sea level rise.[28] Bangladesh, among the most populous countries in this category, nearly quadrupled its population from 1950 to 2009, growing from an estimated 44 million to 162 million.[29] The country is projected in the U.N. median scenario to gain an additional 80 million people by 2050—but that assumes that neither climate change nor other types of environmental or health degradation prevent assumed improvements in life expectancy in the country.[30]

For perspective on the importance of assumptions that death rates will continue falling (that is, that people will live longer), U.N. demographers offer a population projection that assumes such rates remain stable—neither falling nor rising—from today's levels. With the same fertility assumptions as in the medium projection, world population would reach only 8.4 billion in 2050, fully 700 million fewer people than in the commonly cited medium projection.[31] That's twice the size of the combined populations of the United States and Canada today.[32] If death rates actually rise, under the median-variant fertility assumptions the 2050 population would be lower still. This results in a lower world population, but not by means any caring person would approve. If environmental and health conditions and food security deteriorate significantly in a warming and environmentally degrading world, it could become especially hard to predict when and at what level human population will stop growing—and whether lower birth rates or higher death rates play the larger role in reaching that point.

Income Poverty Still Falling, But More Slowly

Hilary French

The World Bank projects that the number of people living in extreme poverty (on less than $1.25 a day) will fall slightly in 2009, declining from 1,203 million in 2008 to 1,184 million (see Table 1).[1] The share of the world's population living in extreme poverty is also expected to decline by a small amount, from 21.3 percent in 2008 to 20.7 percent in 2009.[2]

But the economic crisis is slowing recent progress in reducing the number of people around the world living in extreme poverty. The projected 0.6 percentage point reduction in the poverty rate for 2009 is a significant reduction from the 1.3 percentage point average annual decline experienced during the previous three years.[3] All told, the World Bank projects that the global recession will cause anywhere from 55 million to 90 million more people to remain in poverty in 2009 than would otherwise have been the case.[4]

By the end of 2010, the World Bank currently estimates that 89 million more people will be living in extreme poverty due to the recession than had earlier been expected.[5] Important human development gains are also threatened. For example, the Bank projects that the economic downturn could cause 30,000 to 50,000 additional infant deaths in Sub-Saharan Africa alone in 2009.[6]

Despite the negative effect of the economic crisis, the world as a whole is nonetheless currently on track to reduce by half the share of the world's population living in extreme poverty from 1990 levels by 2015, as called for in the Millennium Development Goals (MDGs) established in 2000.[7] In 1990, some 42 percent of the world's population lived in extreme poverty; by 2005 this share had fallen to 25 percent.[8] (See Figure 1.) In absolute terms, the number of people living in extreme poverty fell from 1.8 billion people in 1990 to 1.4 billion people in 2005 even though global population rose by 1.2

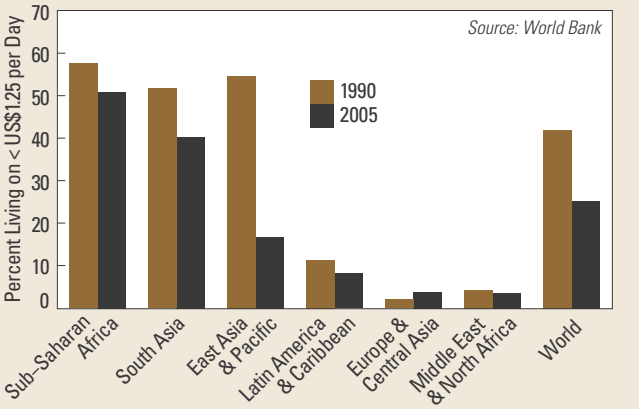
Table 1: Poverty Outlook, 2008 and 2009

Region	2008	2009	Change in Number, 2009
	(million living in extreme poverty)*		
East Asia and the Pacific	222.5	203.0	–19.50
Europe and Central Asia	15.1	15.5	0.40
Latin America and the Caribbean	37.6	40.3	2.70
Middle East and North Africa	8.6	8.3	–0.30
South Asia	536.3	530.6	–5.70
Sub-Saharan Africa	382.7	385.9	3.20
Total	1,202.8	1,183.6	–19.20

** Extreme poverty is defined as living on less than $1.25 a day in 2005 PPP.*

Source: World Bank.

Figure 1. Share of Population Living in Extreme Poverty, by Region, 1990 and 2005



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billion during the same period.[9] Still, 2.6 billion people—40 percent of humanity—were living on less than $2 per day in 2005, a higher threshold than that for extreme poverty but still an unacceptable level of poverty by any reasonable measure.[10] (Comprehensive poverty data based on household surveys and not just computer models are not yet available beyond 2005.)

The World Bank projects that the share of the world's people living in extreme poverty will decline to 15.1 percent by 2015—exceeding the MDG target by nearly 6 percentage points.[11] But that means an estimated 925 million people will still be extremely poor that year, in part due to population growth.[12] And a slower than currently anticipated economic recovery could shift the world off this course.[13]

The overall global income poverty picture obscures significant variations at the regional and national levels. The World Bank currently projects that more than half of all developing countries will see a rise in the number of people living in extreme poverty in 2009 and that this will be the case for two thirds of the low-income countries and three fourths of those in sub-Saharan Africa.[14] Altogether, 3.2 million people are projected to be added to the ranks of Africa's extremely poor population in 2009.[15]

Much of the progress in reducing poverty in recent years has taken place in East Asia. Poverty reduction has occurred at a particularly remarkable pace in China, where the share of the country's people living in extreme poverty fell from 84 to 16 percent between 1981 and 2005.[16] In absolute terms, 627 million fewer people in China were living in poverty in 2005 than in 1981, even though the country's population grew by more than 450 million over this period.[17]

Latin America and the Caribbean and South Asia are making slower progress than East Asia.[18] And as noted, the situation is bleakest in sub-Saharan Africa, where the share of the population living in extreme poverty declined only modestly between 1990 and 2005, from 57.6 to 50.9 percent, and where the absolute number of poor people climbed from 295 million to 388 million as population growth continued to swell the ranks of the poor.[19] Current projections indicate that the share of sub-Saharan Africa's population that is living in extreme poverty will be reduced to 36.6 percent by 2015, but that will still leave 353 million people mired in extreme poverty.[20]

Although welcome, reductions in income poverty do not always translate into improvements in broader measures of human development, such as those that track hunger, health, and literacy. For example, the number of chronically hungry people is expected to top 1 billion in 2009, up from 850 million in 2007.[21] And more than three quarters of the countries with available data on child mortality are not on track to meet the MDG target of reducing child mortality rates by two thirds by 2015.[22]

Reductions in income poverty also do not necessarily lead to reductions in "ecological poverty," defined by the late Indian environmental leader Anil Agarwal as the lack of a healthy natural resource base.[23] Agarwal argued that high levels of ecological poverty are a key cause of economic poverty in rural areas and that "conversely, healthy lands and ecosystems, when used sustainably, can provide all the economic wealth that is needed for healthy and dignified lives."[24]

Climate change looms as still another impending major threat for the world's poor. Scientists project that it will cause diminished agricultural productivity and water shortages as well as increased flooding and storm damage in some of the world's poorest countries.[25] By one estimate, agricultural productivity losses associated with climate change could increase the number of people suffering from malnutrition by 600 million by 2080.[26] And flooding due to rising sea levels could cause as many as 330 million people to be displaced from their homes.[27]

The double poverty threats posed by the ongoing economic and ecological crises cry out for an urgent political response. At the September 2009 G-20 Summit meeting in Pittsburgh, world leaders reaffirmed their commitment to the MDGs, including their earlier promises of increased development assistance and debt

relief.[28] They also reiterated their commitment to jointly address climate change.[29] It remains to be seen whether these noble promises will translate into concrete actions in coming months.

Hilary French is a longtime Worldwatch Institute researcher and served most recently as Senior Advisor for Programs. She is currently on leave from Worldwatch, working as a Program Officer at the United Nations Environment Programme.

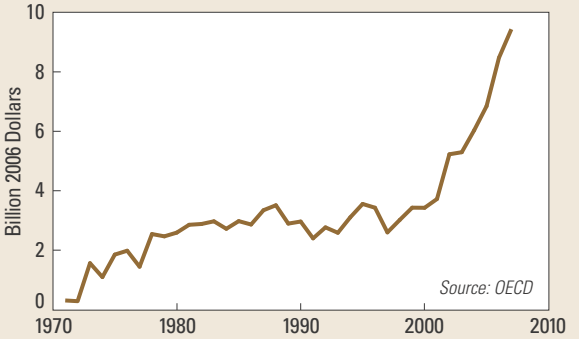
Health Assistance to Developing Countries Soars

Elena Marszalek and Sarah London

After years of stagnation, health assistance from industrial to developing countries has risen sharply over the past decade, setting a record in 2007 of nearly $10 billion.[1] Official development assistance (ODA) for health from key members of the Organisation for Economic Co-operation and Development (OECD) in 2000 was nearly three times as high as the average of roughly $3 billion in the late 1970s, when adjusted for inflation.[2] (See Figure 1.) The share of health-related ODA in relation to other ODA sectors has also risen, from slightly more than 5 percent in 1980 to nearly 8 percent in 2007.[3]

OECD's Development Assistance Committee (DAC) includes 23 countries (effectively, all advanced industrial economies) and the European Commission. Just a handful of these countries contribute the bulk of funding for health-related ODA. In 2005 and 2006, the three countries with the largest average bilateral ODA commitments for health were the United States ($3.9 billion, in 2006 dollars), the United Kingdom ($1.4 billion), and the Netherlands ($503 million).[4]

Figure 1. OECD Health Aid to Developing Countries, 1971–2007



Multilateral and private donors are also playing a large role. Since its establishment in 2002, for example, the multilateral Global Fund to Fight AIDS, Tuberculosis and Malaria has mobilized and allocated $15.6 billion to prevent and treat these three conditions in over 140 countries.[5] Its expenditures currently account for 47 percent of all multilateral health ODA in the world's least developed countries.[6] The private Bill and Melinda Gates Foundation has allocated more than $11.7 billion to global health since its inception in 1994.[7]

Among major developing country regions, sub-Saharan Africa has been the largest recipient of ODA for health since 1999, receiving almost half of the total in 2005 and 2006.[8] Asia is the second largest regional recipient, with 30 percent of health ODA in those years.[9] In terms of countries, the three largest recipients annually for 2002 to 2004 were India ($382 million), Nigeria ($359 million), and China ($265 million).[10] And when looked at on a per capita basis, health ODA is quite variable: Zambia, for example receives $20 per person a year, while Chad receives just $1.59.[11]

Health ODA falls into three categories: general (including health policy and medical education), basic (including primary health care and infrastructure), and population and reproductive health. The last category includes spending for family planning, maternal and child health, prevention of sexually transmitted diseases, and HIV/AIDS prevention and treatment.

Although overall spending on health ODA is increasing, its focus is relatively narrow. Dramatic increases in HIV/AIDS spending in recent years have boosted the population and reproductive health category and, in turn, the whole health sector within foreign assistance. (See Figure 2.) HIV/AIDS funding accounted for 25 per-

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cent of total health ODA from 2000 to 2004, which increased to 35 percent from 2005 to 2006 as governments—along with the United Nations, multilateral development banks, and some private foundations—mobilized to improve both prevention and treatment of HIV/AIDS in developing countries.[12]

Unfortunately, there is little evidence that the recent surge in health assistance has helped efforts to reach some of the United Nations Millennium Development Goals (MDGs) for health by 2015.[13] Maternal mortality has shown little improvement recently, for example, with rates of maternal deaths per 100,000 births decreasing by less than 1 percent from 1990 to 2005.[14] Far from the 5.5 percent decrease needed in order to achieve the MDG on maternal mortality, half a million women die from pregnancy or childbirth-related causes each year.[15]

For tuberculosis, however, increased spending seems to have helped. (See Figure 3.) The number of deaths worldwide decreased by 8.5 percent from 2001 to 2007, from 1.86 million to 1.7 million.[16] While tuberculosis control programs have proved effective in treating patients and preventing deaths, efforts to reduce global incidence and transmission rates of the disease nonetheless have had little success.[17]

The exception may be the MDG target for HIV/AIDS, malaria, and other infectious diseases, as the global number of people newly infected with HIV and AIDS mortalities are both in decline. And according to the World Health Organization, 27 countries reported a 50 percent reduction of malaria cases between 1990 and 2006.[18]

Significant progress has been made in treating HIV/AIDS. UNAIDS, the U.N. agency that tracks this disease, reports that the number of people receiving antiretroviral treatment (ART) has quadrupled from 2004 to 2007.[19] Those treated, however, represented only 31 percent of the estimated global need for ART: only 3 million of the 9.7 million in need of treatment have received therapy.[20] There has also been an increase in the number of pregnant women receiving ART to prevent mother-to-child transmission, from 9 percent in 2004 to 33 percent in 2007.[21] But the incidence of HIV continues to outstrip access to treatment. For every two people receiving antiretrovirals, another five become infected with the virus.[22]

Under President George W. Bush, the U.S. government dramatically increased funding to combat HIV/AIDS with the President's Emergency Plan for AIDS Relief (PEPFAR). From 2003 to 2008, PEPFAR allocated $18.8 billion toward HIV/AIDS as well as malaria and tuberculosis in developing countries.[23] And in 2008 Congress more than doubled funding to $48 billion over five years, earmarking $39 billion

Figure 2. OECD Health Aid to Developing Countries, by Sector, 1995–2007

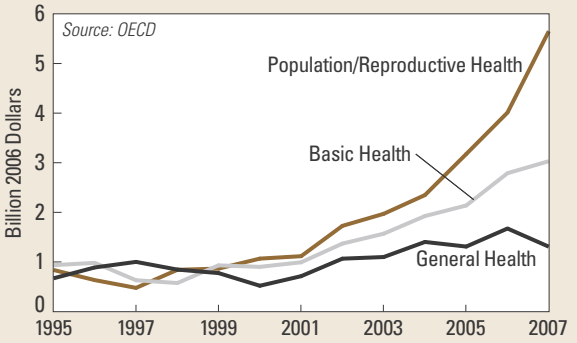
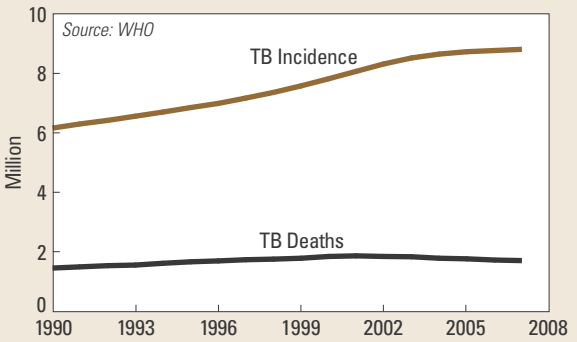


Figure 3. Tuberculosis Incidence versus Deaths, 1990–2007



exclusively for AIDS.[24]

An estimated 1.2 million deaths were prevented as a result of the first four years of PEPFAR.[25] Some critics have charged that such high levels of HIV/AIDS funding weakened health services in some recipient countries, as local providers abandon primary health care sectors for more highly paid work on HIV/AIDS.[26] In Rwanda, for example, two thirds of all U.S. foreign aid is allocated to HIV/AIDS, even though less than 3 percent of the population is HIV-positive.[27] Since taking office in 2009, President Barack Obama has reauthorized PEPFAR funding and expanded its scope beyond HIV/AIDS, tuberculosis, and malaria.[28]

U.S. spending on HIV/AIDS in 15 of the worst-affected countries increased from $3.2 billion in 2007 to $4.3 billion in 2008, indicating that this category of U.S. health assistance continued growing after 2007.[29] Data are insufficient, however, to indicate how or to what extent the current global economic slowdown may be affecting this foreign development assistance category. Past economic downturns have been marked by reductions in such assistance, though they have resumed their growth when economic growth has returned.[30]

Despite the recent increase in foreign health assistance, many analysts fear that the global economic crisis will dampen funding from donor countries while directly undermining health in developing countries.[31] World Bank researchers estimate that 40 percent of developing countries are "highly exposed to poverty effects" of the current financial crisis, and decreasing ODA for health could seriously impede progress toward the Millennium Development Goals.[32]

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The Vital Signs Series

Some topics are included each year in *Vital Signs*; others are covered only in certain years. The following is a list of topics covered in *Vital Signs* thus far, with the year or years they appeared indicated in parentheses. The reference to 2006 indicates *Vital Signs 2006–2007*; 2007 refers to *Vital Signs 2007–2008*.

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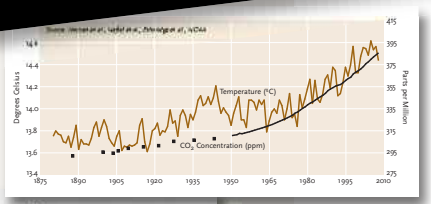

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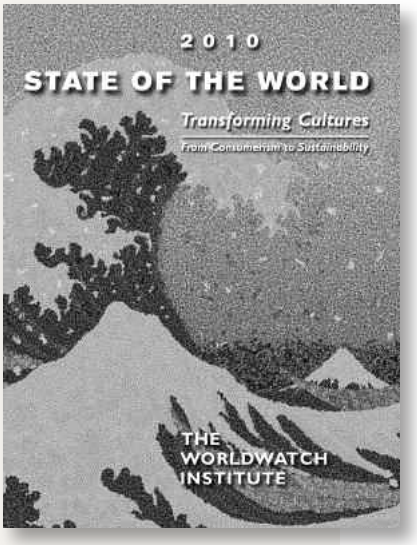

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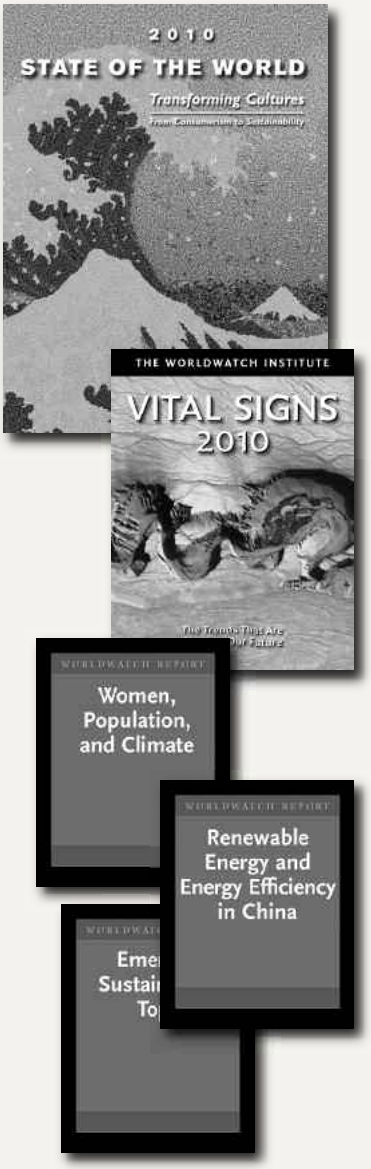

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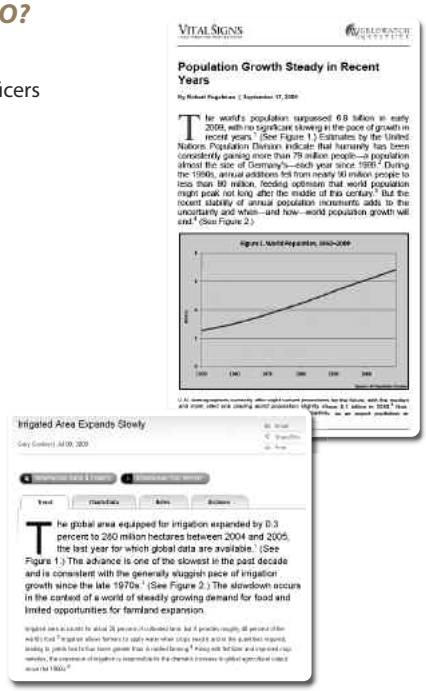

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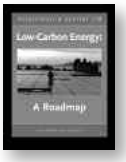

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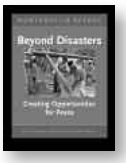

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- Carbon dioxide emissions from fossil fuels were up 2 percent, despite high oil prices and the economic recession.
- The most devastating types of natural disasters continued to rise steadily, especially for weather-related events.
- Meat consumption in the developing world has increased 17 percent over the last 10 years, although people in the industrial world still eat more than twice as much meat per person.
- Grain yields have increased 146 percent over the last 46 years, even though the land dedicated to grain has remained relatively stable for the past 15 years.
- Aquaculture continued to expand, with exports for species like catfish and tilapia growing at more than 50 percent a year.
- The world's population is now more than 6.8 billion, and there is no sign that its growth will slow.
- The potential labor force has nearly tripled since 1950.
- Twice as many tons of metals were produced in 2008 than in the late 1970s.
- Global advertising expenditures fell 2 percent to $643 billion, about 1 percent of the gross world product.
- Biofuels production was up 36 percent, though growth is expected to moderate.
- More than twice as many solar photovoltaic megawatts were installed in 2008 than in 2007.
- The wind now generates more than 1.5 percent of the world's electricity.

ON THE COVER: Taklamakan Desert
Flanked to the north and south by two parts of the ancient Silk Road, the Taklamakan Desert in northwestern China is one of the largest sandy deserts in the world. The area has become a major oil and gas supplier even as local oasis communities battle advancing sands. Desertification in China and Asia is expected to worsen due to human activities like farming and to a changing climate that includes more frequent and prolonged droughts.

Satellite image by GeoEye, captured October 6, 2009.

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