William T. Coyle

Water Supply in the APEC Region: Scarcity or Abundance?

Roughly 70 percent of the earth's surface is covered by water, but less than 1 percent of the earth's water is fresh, and access to fresh water is critical to the food system. In the Asia-Pacific Economic Cooperation (APEC) region, the urban population is projected to grow from 1.1 billion to 2.0 billion by 2025, with most of the increase in China and developing economies of Southeast Asia. Such population growth in its cities will put huge stress on the region's capacity to provide basic services, including water supply. Unless water control facilities are expanded and/or efficiencies in water use are achieved, there is potential for water shortages in Korea, Chinese Taipei, Japan, China, Mexico, and the U.S.

Throughout history, increased water demand in water-deficit areas has been met by expanding available water supplies. Dam construction, groundwater pumping, and interbasin canals have provided the water to meet growing urban and agricultural needs. However, future opportunities for large-scale expansion of supplies in many parts of the region will be more limited. As a result, meeting future water demands will require some reallocation of existing supplies, better management of water resources, more efficient use of water for irrigation, greater recycling of water, and other measures that will increase efficient use.

Agriculture is the largest user, but a greater share of water withdrawals in the APEC region is allocated to industrial uses than in the rest of the world—25 percent compared with 14 percent. This is due to the region's rapid pace of economic growth and urbanization. Production agriculture in the APEC region accounts for 64 percent of water use. Nevertheless, it is still lower than the average 79 percent for the rest of the world. The share varies across the region, tending to be lower in the U.S., New Zealand, Japan, and Canada. Canadian agriculture uses only 7 percent, due to the dominance of rain-fed agriculture. Withdrawals are higher in Asia, where irrigated rice production is a large water user.

The role of water as an input in agriculture, industry, and the household, as well as its role as aquatic habitat and transportation medium, makes allocation decisions difficult. Applying market principles that price water use relative to its supply depends on unique local values and circumstances, but will become more common in areas where competition for water is most intense.

Water supply comes from net inflows of water from rivers and underground sources minus outflows; changes in stocks such as reservoirs or aquifers; runoff (precipitation minus evaporation); and desalination. Few major river systems cross into the APEC region. Six of the economies are islands: Australia, New Zealand, the Philippines, Indonesia, Chinese Taipei (Taiwan), and Japan. The Mekong is the largest river system in the APEC region that is shared by several economies (China, Vietnam, Thailand, Laos, and Cambodia).

The single most important source of water in the region is runoff from precipitation, which varies from 700 millimeters per year in Mexico to 3,000 millimeters per year in tropical Papua-New Guinea and Malaysia. Aquifers—underground reservoirs that are fed by infiltrating water from the surface—are also important. For example, the aquifer beneath the Huang-Huai-Hai plain in eastern China supplies drinking water for nearly 160 million people. Some of the largest cities in the APEC region, including Jakarta, Lima, and Mexico City, depend on aquifers for much of their water supply. Aquifers also supply a significant share of water for the irrigated areas in the U.S. and China. The Ogallala aquifer (which is under parts of eight states in the central U.S.) still suffers from water depletion, but use of more efficient irrigation methods has slowed this trend.

A minor water source is desalination—conversion of salt water to fresh water. Desalination capacity in the APEC region represents about one-quarter of the global total, with the U.S., Japan, and Korea leaders in the region. However, this potentially meets the water needs of just a few million people.

This article is based on the *Pacific Food System Outlook, 2001-02*, a report released at the 13th APEC Ministerial Meeting in Shanghai, China, October 17-18, 2001. USDA's Economic Research Service is a sponsor of this annual report, which focuses on the outlook for the Pacific food system.

Driven by income growth, a dietary shift away from rice in Asia has been rapid in recent years, except during the 1997-99 financial crisis. As incomes rise and consumers diversify their diets, they consume less rice and more meat and other products. On a per-calorie basis, wheat requires less water than rice to produce, raising meat animals requires much more. Thus, the impact of westernizing diets in East and Southeast Asia has had a mixed impact on water consumption, to the extent that foods are produced locally. The water intensity of diets in East and Southeast Asia will likely increase, despite lower rice production. On the other hand, the diet in North America is likely to become less water-intensive, as meat consumption levels off and consumers substitute chicken, a relatively efficient water user, for beef.

Water Resource Management: Institutional Frameworks

In many APEC economies, leaders and administrators have recognized that water is the most important resource and, in some economies, a scarce resource. Yet in their efforts to make the resource accessible to all, they have priced it as though it were in abundance. Rather than promoting efficiency and establishing priorities for water use, water policy typically encourages exploitation and exacerbates shortages.

Empirical work suggests that there are environmental payoffs when prices for water use are tied to the volume used, or when prices are applied in incremental tiers. Cost-conscious farmers are then less liable to overuse water, reducing the risk of water erosion, salination, and waterlogging. Underpricing water has led to exploitation of aquifers and overapplication of irrigation water in a number of APEC economies, including Australia, Canada, China, Mexico, and the U.S. As a result, some of the aquifers and water systems in question could soon pass the point of no return, and in other areas, problems with salination have become extreme. For example, 10 percent of the irrigated land in Mexico is damaged by salinity, as is more than 20 percent in China and the U.S.

Assuming significant improvements in irrigation efficiency, water demand in the APEC region could be met by a 10-percent increase in supply by 2025, according to projections by the International Water Management Institute (IWMI) in Sri Lanka. Without those efficiency gains, the increase in supply needed would be closer to 40 percent. The more efficient scenario in the IWMI study assumes sharp increases in irrigation efficiency by the U.S. and China as well as other heavy irrigators like Mexico, Thailand, Indonesia, and the Philippines.

A key factor in raising irrigation efficiency is the development of market institutions (such as a system of water rights, tradable water entitlements, and prices reflecting the marginal cost of supplying water). These market institutions create greater incentives for adoption of efficient storage, delivery, and application systems. In some economies, water resources are being privatized and turned over to local irrigation associations and to other entities that tend to be more efficient in managing water resources.

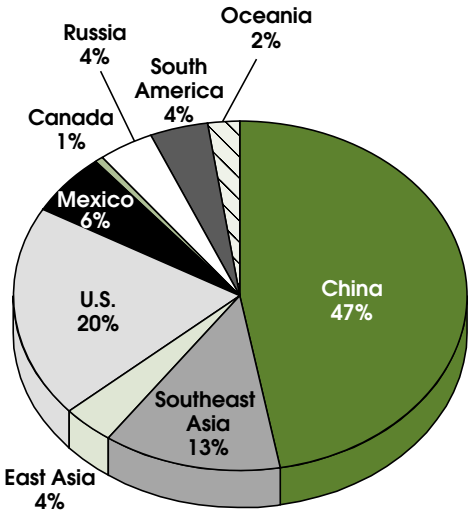
Around the Pacific Rim, the development of water markets has been slow, with a few exceptions. ***Chile*** enacted legislation 20 years ago to create a market system in which water rights could be traded freely under a regulatory framework, a unique system for a developing economy.

Who Belongs to APEC?

APEC is an informal grouping of market-oriented Asia-Pacific economies sharing goals of managing the growing interdependence in the Pacific region and sustaining its economic growth. Started in 1989, APEC provides a forum for ministerial-level discussions and cooperation on a range of economic issues, including trade promotion and liberalization, investment and technology transfer, human resource development, energy, telecommunications, transportation, and others.

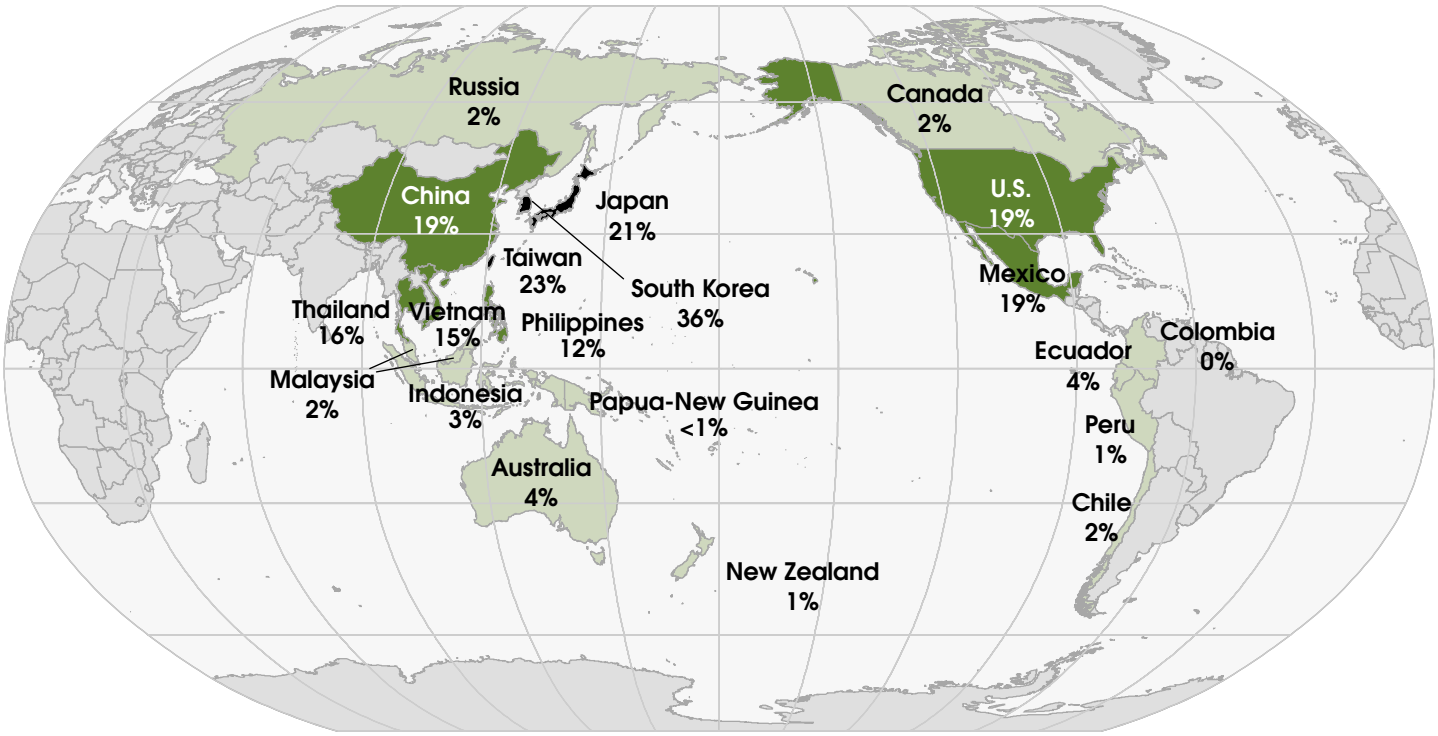
Members:
Australia, Brunei, Canada, Chile, China, Hong Kong/China, Indonesia, Japan, South Korea, Malaysia, Mexico, New Zealand, Peru, Philippines, Russia, Singapore, Taiwan (Chinese Taipei), Thailand, U.S., Vietnam, and Papua-New Guinea.

China and the U.S. Have the Largest Shares of Irrigated Land in APEC Region



Total does not equal 100 percent, due to rounding.
Source: Food and Agriculture Organization of the United Nations.
Economic Research Service, USDA

Annual Water Use in Six APEC Countries is 19 Percent or More of Available Supplies



Source: Food and Agriculture Organization of the United Nations.
Economic Research Service, USDA

According to the World Resources Institute (WRI), price reforms in Chile have reduced the use of irrigated water by as much as 26 percent and saved $400 million in new water infrastructure.

In ***Mexico***, water resources are in the public domain. Legislation allows transmission of water-use rights, which can be transferred independently of land. Irrigated areas are generally grouped into rural development districts (i.e. *Distritos de Desarrollo Rural)*, which are geographic areas surrounding water infrastructure. The beneficiaries are responsible for operating, maintaining, and collecting fees for the irrigation system.

Canada and ***New Zealand*** have the highest per capita water supplies in the region, and have little incentive to develop water markets. Both countries have legal systems that define and protect water rights as well as a variety of fee systems. Most Canadians pay water rates that do not promote conservation; only 4 percent of users were charged a progressively higher price with greater volumes. Water metering in New Zealand occurs only in the Auckland Region, where it began in the early 1990s.

In ***Australia***, national and state governments have introduced a more market-oriented system of water allocation. The catalyst for reform was a 1994 agreement by the Council of Australian Governments. This reform included commitments to:

- consumption-based pricing and full cost recovery for water delivery services,
- clearly specified water property rights separated from the land,
- formal determination of water allocations to the environment, and
- introduction of water trade to maximize economic returns from water use.

While some water trading is taking place in ***California*** and ***Colorado***, water costs in the U.S. still do not reflect their full economic cost; infrastructure development for delivering off-farm surface water is generally publicly subsidized.

Privatization of ***Malaysia's*** water supply is expected to increase, along with pressure to improve efficiency. Water tariffs will undoubtedly rise, as current rates do not cover costs of production.

In ***Peru***, the agriculture sector rarely pays for water, despite the fact that 42 percent of all cropland is irrigated. As a result, water costs are estimated to make up less than 1 percent of total agricultural production costs, contributing to poor irrigation practices and low water-use efficiency.

Japanese irrigation development and water management are stipulated in the country's Agricultural Land Improvement Law. While controlled locally, both the central and local governments heavily subsidize construction of these systems because of the perceived broader societal benefits associated with paddy rice cultivation.

Increasing Water Supplies

Measures to augment area water supplies in various economies to meet projected demand are proceeding in some parts of the region. The demand for water resources by ***Chile's*** hydroelectric sector in the next 40 years is expected to increase six times, prompting a need to build some 100 new hydroelectric plants. The demand for industrial and mining uses of water will likely more than double.

These large increases in demand for water will be met by a combination of public and private resources. ***Chile*** has announced plans to invest US$320 million in the coming years, with financial support from the World Bank and cost recovery from beneficiaries. Public funding generally focuses on smaller projects. In 2001, for the first time, a water project will be offered for investment by the private sector, following the policy of concessions to private entities already in use for highways and ports.

In the central region of ***Chinese Taipei***, the government has approved construction of the Hushan Reservoir, having a total budget of US$700 million and scheduled for completion in 2008. This reservoir will satisfy the water needs of the industrial sector in that region until 2021.

The ***Philippines*** expects to increase irrigated area from 1.55 million to 1.64 million hectares by 2004. In ***Malaysia***, interbasin and interstate transfers of water like the Pahang-Selangor Raw Water Transfer scheme will become more common in the future. For some time, there has been discussion regarding the export of Canadian water to the western U.S.

China faces massive economic challenges, with more than 20 percent of the world's population, limited land area, and rapid economic growth. Its annual water supply ranks fifth—behind Brazil, Russia, Canada, and Indonesia—but per capita supplies are among the lowest in the region and world. In the APEC region, only Korea has a lower per capita water level.

China, which is plagued with flooding in the south and drought in the north, hopes to optimize the allocation of its water resources by developing water control facilities, like The Three Gorges (Yangtze River) and Xiaolangdi (Yellow River) Dams. China is also planning to undertake the largest water diversion project in its history—channeling water from the Yangtze River to the north. The dams are multipurpose projects for flood control, industrial and municipal water supply, and hydroelectric power.

Taking Steps to Increase Efficiency

Different countries use a variety of approaches to increase efficiency of water use.

In 2000, ***China*** undertook some major water-saving measures, including more intensive management of water use, water rationing, and charges for excess consumption. Some cities installed newly developed water-saving taps, both in homes and in public places.

New Zealand has concentrated on raising water quality over the past 20 years and has achieved considerable success by treating wastewater at specific pollution points. Over the next 20 years, attention will shift to methods of reducing nonpoint pollution. Governmental and private efforts in the water industry will focus on continuing to improve water quality and reducing per capita consumption, rather than on expanding the amount of water available.

Putting Water Scarcity in Perspective

Analyses of global and regional water resources are hampered by inadequate data and methodological issues. Measuring stocks and flows of water is difficult. For example, data for water use seldom include direct agricultural use of rainwater—an essential water source for farming in many economies of the APEC region, even in heavily irrigated areas. Globally, about 60 percent of food is produced using rainwater, 40 percent using irrigation. The rain-fed crop area in the region varies from 37 percent in Japan to 98 percent in Canada. The APEC region accounts for 40 percent of global irrigated acreage.

An economy's aggregate data tend to mask many concerns about water resources. The common use of national and annual data disguises significant regional and inter-annual variations. The most reliable data and information are at the basin level, since that is the level at which water scarcity or abundance can truly be measured and efforts to save water can be evaluated. It may also be the level at which water resources are best managed. It may even be that water is scarce within a particular city or locality in a basin. Also, water can be scarce for certain groups within a relatively water-rich area, even if it is in abundance for others within the same area.

Using the ratio of water withdrawal (a measure of demand) to annual water resources (a measure of supply) as a relative measure of scarcity, the APEC region uses 9 percent of its annual water resources, compared with 6 percent in the rest of the world, according to the International Water Management Institute in Sri Lanka. In six of the APEC economies, water use is nearly 20 percent or more of available supplies: Korea (36 percent), Chinese Taipei (23 percent), Japan (21 percent), China (19 percent), Mexico (19 percent), and the U.S. (19 percent).

In ***Mexico***, leakage in the water distribution system (e.g., evaporation) accounts for a loss of 30 to 50 percent, mostly from agricultural activities. Some 1.2 million hectares is cultivated with modern, efficient technology, but it is only a small proportion of the total.

Another way of using water more efficiently is to apply it to the production of higher value commodities. In Java, ***Indonesia***, brackish water ponds for shrimp are being developed in formerly irrigated coastal lands or in new locations in the outer islands. Aquaculture in Java is still modest in its use of water, about 2 percent of total agricultural withdrawals.

In the coastal areas of ***Chinese Taipei***, freshwater and brackish-water fishponds use large amounts of groundwater, about 10 times the amount used by paddy fields, to regulate salinity, oxygen, and temperature. Nevertheless, aquacultural farming has proved to be more profitable than crops. The government has begun to impose restrictions on expansion of aquaculture, however, since land settling is a growing problem in some coastal areas because of falling water tables.

Conservation of water, reducing pollution, and recycling increase water basin efficiency and thus overall water availability. The ***U.S.*** has increased the efficiency of water use in the economy's principal irrigated areas: the Central Valley of California, the Snake River Valley in Idaho, the High Plains from Texas to Nebraska, the Mississippi Delta in Arkansas and adjoining states, and south central Florida.

Although irrigated agriculture remains the dominant user of fresh water in the U.S., it's share of freshwater consumption has declined since 1970. While irrigated cropland area has expanded by about 30 percent since 1969, field water application rates per acre have declined about 15 percent. Increased use of sprinkler systems and other more efficient means of irrigation have resulted in only a 12 percent increase in total irrigation water applications.

The 1972 U.S. Clean Water Act defines quality standards for drinking water, for recreational uses, and for support of aquatic life. Since passage of the legislation, surface water quality has improved, largely through reductions in toxic and organic chemical loadings from point sources. Discharges of toxic pollutants have been reduced by an estimated billion pounds per year. Rivers affected by sewage treatment plants show a consistent reduction in ammonia between 1970 and 1992.

Opportunities & Challenges

Making more efficient use of water requires complex and multifaceted strategies that must take the communal nature of water into account. This includes the interdependence of users within a water basin, as well as the competing roles of water as an input in agriculture, industry, and households; as a habitat and medium for aquatic life; and as a medium for transportation, including waste disposal.

Where water is scarce, creation of market mechanisms will assure more efficient and sustainable use of water resources in the region. The alternative is to raise the supply of water with costly investments in water infrastructure, dams, and diversion channels, which are becoming increasingly unaffordable, from both economic and environmental perspectives. AO

William T. Coyle (202) 694-5216
Brad Gilmour (Agriculture and Agrifood Canada).
wcoyle@ers.usda.gov

This article is based on contributions by economists from 17 Pacific Rim economies. Views expressed are those of the authors and do not necessarily reflect those of USDA's Economic Research Service or Agriculture and Agri-Food Canada.