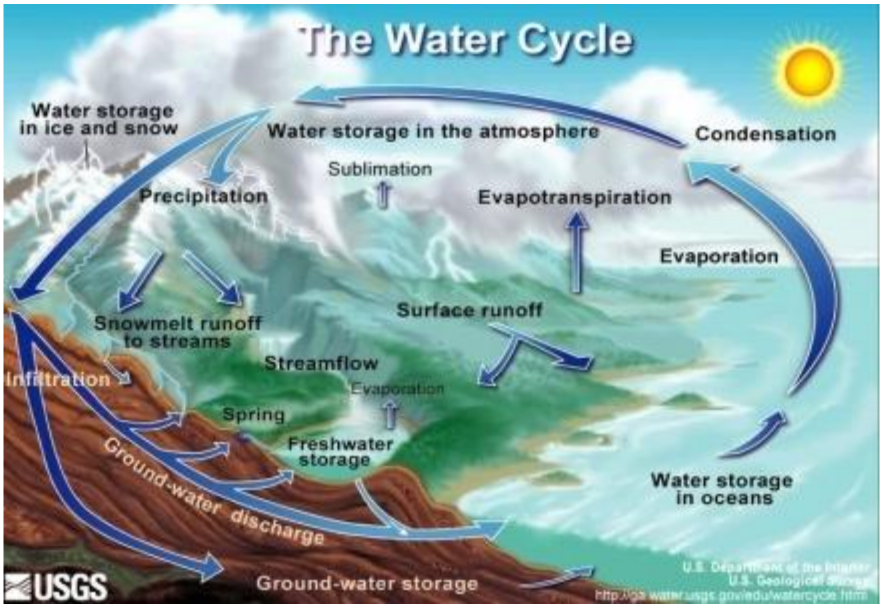
Water resources



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Introduction

Water resources are used in various ways including direct consumption, agricultural irrigation, fisheries, hydropower, industrial production, recreation, navigation, environmental protection, the disposal and treatment of sewage, and industrial effluents. Water has sources and supplies, economic, social, and political characteristics which make it a unique and challenging natural resource to manage.

Sources and Supplies

Water resources refer to the supply of groundwater and surface water in a given area. Water resources may also reference the current or potential value of the resource to the community and the environment. The maximum rate that water is potentially available for human use and management is often considered the best measure of the total water resources of a given region. Approximately 30 percent of the world's fresh water is in liquid form and therefore potentially accessible for human use and management at any given time. The rest is either locked up in polar or glacial ice or water vapor. Of the 30 percent of fresh water in liquid form, almost all is held in groundwaters.

Historically, attempts to develop global assessments of available water resources have resulted in limited applicability. The usefulness of resulting aggregated quantities, based upon streamflow and population calculations, which lead to measurements in terms of relative abundance and shortages of water regionally, have often been unreliable. The extreme difficulty in preparing a global assessment stems from the general lack of sufficient and reliable information on water availability, quality, and water use in many areas of the world. Efforts to balance supply and demand, and plans for a sustainable future are severely hampered by this lack of reliable information. Studies of water resources leading to meaningful assessments have been found to be realistic only if conducted on a regional or local basis. Only then has proper accounting of seasonal and inter-annual variability of streamflow as well as interactions between groundwater and surface water been appropriately accounted for. Likewise, only then have the potentials for reusing the water as it proceeds downstream and the balance of in-steam and withdrawal uses been appropriately managed. Reductions in scale also allow assessments of water quality in determining suitability for use, and perhaps most importantly the realistic evaluation of social, economic, and political factors that help determine per-capita water use.

Despite formidable constraints, some attempts to describe global water use have lead to amenable conclusions. For example, estimates indicate that since 1900, global water withdrawal has increased about nine-fold and per capita withdrawal has quadrupled. Globally, the largest use of water is for irrigation (70 percent), while industry uses 20 percent, and the remaining 10 percent is utilized for direct human consumption. As a result, humans now withdraw about 35 percent of the world’s reliable runoff. At least another 20 percent of this runoff is left in streams to transport goods by boats, dilute pollution, and sustain fisheries and wildlife. Obviously, these percentages may vary greatly from one region to another depending on natural precipitation and the degree of development and human population in the region. There may be further variance due to the fact that the distribution of water resources over the landmass of Earth is uneven and unrelated to population demographics or economic development. It is due to these complexities and constraints that humans have attempted to increase available water resources by increasing precipitation in various anthropogenic manners including cloud seeding. Humans have also attempted to decrease evapotranspiration by altering vegetation management scenarios, and sometimes through genetic manipulation. The benefits of alterations are usually minimal and most often temporary, and unfortunately often have serious environmental, social, economic, and legal ramifications.

Physical characteristics

Water is made available by the natural hydraulic cycle of the atmospheric-oceanic-terrestrial system. In most forms, water is a renewable resource since its continued flows are not affected by withdrawals or use. However, not all natural waters are renewable and renewable waters can become non-renewable by human actions such as contamination, watershed modification, or extraction in excess of inflow rate. Water is a vital resource for human and other animal and plant health. Water bodies provide habitats for aquatic life and riparian systems provide moisture for vegetation and terrestrial biota, transporting nutrients between one ecosystem and another (Gleick, 2002). As well, large water systems provide regional and climatic weather services. Large-scale withdrawals or transfers of water can change ecological conditions and thus the in situ benefits of a water body.

Water use has grown rapidly in modern times. The first 80 years of the 20th century saw a 200 percent increase in the world's average per capita water use, which accounted for a remarkable 566 percent increase in withdrawals from the world's freshwater resources (ITT, 2003). In addition, a significant portion of water resources have become unusable due to industrial and agriculture pollution. Diversions or transfers of water from watersheds to other regions have led to many ecological and human health disasters. For example, the diversion of water from the Amu Darya and Syr Darya rivers in Central Asia has caused the destruction of the Aral Sea ecosystem, the extinction of the Sea's endemic fish populations, the dramatic shrinking of the Sea itself, and widespread local health problems associated with the exposure to atmospheric salts (Gleick, 2002). Similar withdrawals of water from North American and European rivers have lead to a decline in ecosystem integrity. Worldwide, more than 20 percent of all freshwater fish species are now threatened or endangered because of dams and water withdrawals. Also, groundwateraquifers are threatened by exhaustion and saltwater intrusions from overuse worldwide in places as far apart as India, China, and the United States. These inefficient and detrimental uses of water have led to concerns that its physical value is not reflected in its cost, an economic question.

Economic characteristics

In recognition of the above problems, the international development community clearly expressed the need for applying economic tools and principals to water. The International Conference on Water and Environment, held in Dublin, Ireland in January 1992, concluded, among other things, that "water has an economic value in all its competing uses and should be recognized as an economic good" (ICWE, 1992).

Water is used in economic activities and hence must be allocated among competing uses. The commercial needs for water resources complicate matters, since water is a difficult to measure and identify. Water flows, evaporates, seeps and is transpired. This evasive nature entails that exclusive property rights are difficult to establish or enforce. As such it is difficult to subject water to market forces in a market economy. Furthermore water has a long-term value to the sustainability of life and economic activity, over periods that dwarf those considered in conventional cost-benefit analysis. The value of useable water to future generations is hard to quantify and define and requires considerations of quantity, quality, timing, and accessibility. As well, the value of water to particular uses depends crucially on its location, quality, and timing. Its location determines its accessibility and costs. Its quality affects whether it can be used, and what treatment cost it will require. The time when it is available governs its reliability and its relative value for power, irrigation, environmental or potable uses (FAO, 1995). Moreover, many development economists agree that the widespread provision of water is a prerequisite for the transformation of poorer economies into modern economies. For instance, new industries can be constrained by lack of useable water. Currently, developed countries' industry uses more than 40 percent of total worldwide water withdrawals versus 10 percent in developing countries (ITT, 2003). Lack of control on pollution and consumption of water could lead to greater scarcity as developing countries pursue industrial growth.

Theoretically, managing water as an economic good entails that water can be allocated across competing uses in a way that maximizes the net benefit from the amount of water in question. Practically, the increasing financial burden on users to pay for clean water has social and political implications. For example, more than three thousand million people worldwide have daily incomes of less than $US 2, which places a severe limitation on their capacity to pay the full economic costs of water services (FAO, 1995). There has been growing controversy over the privatization of water worldwide as the economic principals of valuation, privatization, and efficiency are being applied to water, a resource that many consider a basic human need and right.

Social characteristics

It is commonly accepted that access to water is a basic human right. The Dublin Conference in 1992 asserted that "it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price" (ICWE , 1992). Moreover, it is argued that water is a social good in that the widespread availability of clean and affordable water improves both individual and social well-being. Clean water reduces the prevalence of water-related diseases, a social benefit shared by all users of the same water source. The public health impacts of inadequate water supply and sanitation has serious social and economic consequences for all. Being a social good and private good are not mutually exclusive conditions. In fact, more water for one individual can mean less water for other individuals who share a water-supply system. Ensuring that the public receives an adequate supply of social goods requires some level of governmental action, since purely private markets often do not find it profitable to provide social goods (Gleick, 2002).

Classifying water as a basic human right introduces further social complications in terms of equitable distribution. Only a fraction of water consumption is actually used for preserving life. A large portion of urban water is used for convenience and comfort. For example in the arid western United States, the per capita water withdrawal by households frequently exceeds 400 liters per day, about half of which is used to irrigate lawns and gardens, the remainder being used for toilets, bathing, and washing cars (FAO, 1995). Clearly with 1.1 billion people still lacking access to safe drinking water, the allowance for such frivolous usage is inequitable. Moreover, the moral dimensions of water management intersect with the property rights issues that underlie the economic allocation of water. If local people "own" or have a right to water in its natural place, they must be persuaded to voluntarily accept removal of water from its natural place (Gleick, 2002). Tens of millions of people have been forced from their homes, without compensation or little warning to make way for economic water uses. The case of China's Three Gorges Dam exemplifies these moral issues. In addition, water has cultural and symbolic importance. It is used in religious rituals such as baptism and it acts as a source of national identities for many native peoples (Graz, 1998). As such, the value of water to people will differ across cultures and further complicates the characteristics of the resource.

Political characteristics

In addition, water is not evenly distributed throughout the world, and there are great variations in natural abundance. For example, mountain areas produce 80 percent of global water resources yet they have less than 10 percent of the global population (FAO, 1995). This uneven distribution entails the need for large-scale transfers and agreements. Previously, large-scale transfers of water occurred within national borders. Agreements were common among nations that shared a watershed, such as the U.S. and Mexico (Gleick, 2002). Recently, as domestic, industrial, and agricultural demands for fresh water have grown, proposals for bulk water transfers are being made at the international level. Entrepreneurs have created a wide range of markets for water, leading to various forms of international water trading and exchanges. Thus, fresh water has become an issue in international trade negotiations and disputes. The lack of legal precedence governing the trade of water has placed water at the forefront of international concern and tension.

As well, it is historically common for regions to experience vulnerability to water availability. Disputes over shared water resources can lead to violence and continue to raise local, national, and even international tensions (Gleick, 2002). Countries may be willing to go to war to defend their interests. There is a serious risk of water becoming a casus belli in some of the arid parts of the world (FAO, 1995). Rising conflict is expected as populations expand, economies grow, and the competition for limited water supplies intensifies. Competition for and conflicts over water are not new, although the mismatch between expected supplies and expected demand is historically unprecedented.

In addition, decisions about water concern many interested parties or stakeholders. The decision to use more water in agriculture, for instance, could have implications for power generation, for municipal use, for industrial off take, for in-stream uses such as fishing, navigation and recreation, and for the environment, including wetlands, deltas and game parks (FAO, 1995). Decisions over water could also entail major public health risks, such as the spread of malaria. As such, national political implications regarding water management are also a characteristic of choosing among competing water uses.

The above physical, economic, social and political characteristics of water make it a unique resource in which a degree of government involvement is inevitable. The discussion will now turn to the governance structures which have been implemented in order to manage and provide this complicated and vital resource.

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