

Drinking Water Quality in Cambodia

Country Report

Prepared by the Ministry of Rural Development Department of Rural Water Supply

Introduction

The quality of drinking water is important to human health and to provide a safe drinking water supply is one of the main objectives of Cambodian National Policy. Therefore, to gain a better understanding of levels of drinking water quality, the Royal Government of Cambodia initiated a survey in 2000 to identify potential human health threats from low quality drinking water throughout a significant portion of Cambodia. With the WPRO's financial and technical support and UNICEF, the government agencies, responsible for water resources and water supply management in the country collectively assessed the water quality in drinking water supply.

Country Profile

Cambodia is located in Southeast Asia between latitudes 10° and 15° N. and longitudes 102° and 108° E. The country covers an area of 181,035 km². Cambodia is bordered by Vietnam in the east and southeast, the Lao PDR in the north and by Thailand in the north and northwest. To the southwest the country has a seacoast on the Gulf of Thailand.

The central plain comprises 75% of the land area and lies between 10 to 30 meters above sea level. The Central Plain is drained by the Mekong river, the Tonle Sap River and by the Bassac and a number of smaller tributaries. The main feature of the Central Plain is the Tonle Sap Lake, the Great Lake. The Lake has an average surface area of 8,155 km² and an average storage volume estimated at 15.9 billion m³. It constitutes the largest single storage and source of inland fresh water. The central plain is surrounded by a sandstone mountain range in the north where it forms the border with Thailand, by granite mountains in the southwest and south and a basaltic plateau in the northeast of the country.

The temperature across the country ranges from a mean daily minimum of 19° C in January to a mean daily maximum of 35° C in April. The mean annual relative humidity values range from 75% to 80%.

Cambodia belongs to the Asian tropical monsoon zone with two main seasons in the year, a dry and a rainy season. The dry season starts from the end of November and ends in April, while the rainy season lasts from May to November. In the rainy season winds with moisture from the Gulf of Thailand provide rain irregularly as far as 200 km inland. During this season riverside areas in the central plain are inundated.

Cambodia is divided administratively into 20 provinces and 4 municipalities. Agriculture, fisheries and timber dominate the economy. According to the 1998 census, Cambodia had a total population of 11.4 million, of which more than 81% live in rural areas.

Brief History

The roots of Khmer culture lie in the flooded plains of the Mekong basin and between the first and eighth centuries the independent village-based societies were united under more centralized authority to form tributary polities. From the ninth to thirteenth centuries the Empire of Angkor ruled over the whole region. However, Khmer state power waned from the fifteenth century and in the nineteenth century it fell to the neighboring powers and subsequently came under European colonial rule. Prince Sihanouk was put on the throne by the French colonial rulers in 1941. King Sihanouk led the nation to independence in 1953. Unfortunately the young and newly independent nation was forced into a regional war by the major powers and suffered the turmoil of a prolonged civil war. The Cambodian people strived and gained peace back with the help of international communities in October 1991, through the Paris Accords. Under the supervision of the UN, Cambodian people and the Royal Government have established the Kingdom of Cambodia and the Royal Government of Cambodia in 1993. Cambodia is a constitutional monarchy. The constitution vests exclusive legislative power in the National Assembly and government is through sectoral ministries and provincial administrations.

Water Resources

In Cambodia, both surface water and groundwater are used for drinking water. The Mekong River and the Tonle Sap Lake are the predominant sources of surface water, with the Mekong serving the east and the Great Lake serving the more westerly populations. The river system provides abundant and good quality drinking water. Applying the WHO standards, these resources require only basic treatment including disinfection. Provincial towns generally have access to surface water from the river systems in unlimited quantities.

Like other tropical countries, surface waters in Cambodia are affected by the seasonal conditions. During the flood season the Mekong's flood-flow enters into the flood plain on both sides of the main channels through many side channels and over the banks.

The Great Lake (Tonle Sap) represents a vast natural storage; it covers an area, which increases from 2,500 km² in the dry season to 13,000 km² by the end of the rainy season. Recharge of suspended matter follows accordingly and circulation of chemical discharges from industry and of pesticides and fertilizers from agriculture is also a rainy season occurrence.

In most areas groundwater is also available in large quantities throughout the year. Groundwater is generally suitable for public supply after disinfection and without any other treatment. Fine sediment can be a problem in some places, and the use of groundwater can be environmentally sensitive. Many areas exist where groundwater is relied upon because of the shortage of surface water in the dry season.

Groundwater use remains more popular in rural areas and some in smaller urban centers. More than 81% of the population is rural, and close to 60% of this group use groundwater. In contrast, only 15% of Phnom Penh consumes well water. Hand dug wells (or open wells) are widely used throughout the country, but the trend towards drilled wells with hand pumps will continue as the rural development efforts succeed.

Water Supply Status

Construction of water supply and sanitation facilities has been ongoing in Cambodia since the late 1970s. In the period between 1979 and 1994 activities mainly focused on the provision of emergency water supply facilities in areas where security conditions were favorable. In the early 1990s, as security improved and political stability was restored, the water supply sector's focus began to shift from emergency relief to long-term development. During the course of the past 20 years significant results have been achieved in a number of areas, including the water supply sector. According to the 1999 Socio-Economic Survey, 54.3% of the total population has access to safe water supply services as illustrated below.

Source %	Cambodia %	Phnom Penh %	Other urban%	Rural %
Piped in dwelling	5.1	45.4	7.2	0.7
Public Tap	1.3	2.9	1.6	1.1
Tube/piped well of borehole	19.0	8.0	24.8	19.4
Protected dug well	22.1	6.4	18.1	24.2
Rainwater	0.7	-	2.0	0.6
Tanker, truck or otherwise bought	6.1	31.5	12.8	2.6
Subtotal for protected sources	54.3	94.2	66.5	48.6
Unprotected dug well	15.5	0.4	9.7	17.8
Pond, river or stream	28.3	5.0	22.3	31.5
Other	1.9	0.4	1.5	2.0
Subtotal for unprotected sources	45.7	5.8	33.5	51.4
Total	100	100	100	100
Number of households in (000)	2,093	174	214	1,705

Of the total urban population of 1.79 million (1998 census), nearly a million live in the capital city of Phnom Penh while 0.8 million are distributed over the remaining 23 urban centers (20 provincial towns and 3 municipalities). The availability of water supplied by piped line in the provincial/municipal towns is as low as 15%, with service restricted to the central core areas of the town.

Water Supply Agencies and Their Role

The provision of drinking water falls within the responsibility of key ministries and public entities. The Ministry of Industry, Mines and Energy (MIME), The Ministry of Rural Development (MRD) and the Phnom Penh Water Supply Authority (PPWSA) are the three main agencies but others are also involved. A complete listing is provided in the table overleaf.

International Organizations and NGOs collaborate with and support these national agencies. Cambodia is a member of international and UN agencies including the WHO. The responsibilities of the government institutions are mostly separate from one another, but there are also some areas in which they collaborate and cooperate.

Agency	Role and Responsibility
PPWSA	<p>The PPWSA serving the capital city of Phnom Penh is the largest provider in Cambodia. It operates as an autonomous public enterprise. PPWSA has three water treatment plants and in the near future a new treatment plant and an expanded treatment plant will be added to treat about 235,000m³ per day.</p> <p>PPWSA has implemented several water quality monitoring activities including the routine quality control in the treatment processes, general water quality analysis and distribution network quality control.</p>
MIME	<p>The Department of Potable Water Supply (DPWS) under the MIME is responsible for the development of urban water supply systems outside Phnom Penh. The DPWS is in charge of the promotion of piped water supply systems, with monitoring of water quality and water tariffs, and with technical assistance to the public and private drinking water suppliers. To effectively monitor water quality, the DPWS needs national standards for safe drinking water as well as a central laboratory and some regional lab capacity.</p> <p>The Technology and Standards Office of the Department of Industrial Technology (DIT) under the MIME analyzes bottled water quality for manufacture certification.</p> <p>A National Water supply Policy has been enacted in year 2000.</p>
MRD	<p>The Department of Rural Water Supply (DRWS) under the MRD is responsible for community water supply in rural areas. The DRWS collaborates with International Organizations/NGOs and with private sector initiatives to guide development of the rural water supply sub-sector. The MRD has issued the National Policy Framework for Rural Water Supply and Sanitation in 2002, which outlines the needs and approaches for community responsibility and self-help and private sector participation and the role of IO/NGOs.</p> <p>Beneficiary communities have been educated on the safe use and maintenance of their new facilities. Water Use and Hygiene Education is usually provided. In the rural water supply sector, water quality testing and laboratory capacity is generally very inadequate. Only a few parameters such as pH, Iron and Salinity are normally measured on-site using portable equipment.</p>
MOWRAM Ministry of Water Resources and Meteorology	<p>The MOWRAM is responsible for the overall management of the nation's water resources. Groundwater and Surface water policies focusing on irrigation in particular are included. The main activities are in the lower Mekong basin under the supervision of the Department of Hydrology and River Works in the lower Mekong basin.</p> <p>MOWRAM has completed a draft National Water Policy with support from the ADB and involving other water sector ministries. A National Water Sector Profile was also completed and has been discussed among the water sector players, including development of national drinking water quality standards.</p>
MOH Ministry of Health	<p>The Department of Food and Drugs under the MOH bears the responsibility for researching water borne diseases. The National Center for Health Promotion (NCHP) is engaged primarily in health communication and education activities.</p>
MOE Ministry of Environment	<p>The MOE is responsible for the conservation of national bio-diversity and environmental aspects of water pollution where it relates to the protection of human health.</p>

Interaction of the Water Supply Agencies

The key water-sector institutions have conducted seminars and meetings on the various aspects of the provision of the drinking water. MRD and MIME provincial staff were, jointly trained in basic drinking water quality testing and monitoring in May 2000, with technical and financial support of the WHO. The Water and Sanitation Coordinating Working Group monthly meeting serves as a forum for all water and sanitation related issues among the government agencies and IO/NGOs in the sector.

There is also inter-ministerial cooperation in National Policy development and long-term strategy formulation.

Major pollution sources and pollutants

In terms of water quality, water pollution is not yet a significant problem. Consumers complain about taste, smell and color. Hard water is frequently cited for its damage to hair and calcium is widely believed to cause the formation of kidney stones. People are concerned about the turbidity of the river water and chlorine smell. Toxic algae in Phnom Penh's raw water and sedimentation tanks were reported in 2000. Toxic algae growths were also detected, especially in the late dry season from April to May in the Tonle Sap. These algae can produce toxins and release them into drinking water supply.

Pathogens are commonly found in surface water, however, and arsenic has recently been detected in 5 provinces in concentrations that exceed WHO standards. In August 2000, MRD and MIME completed a nationwide survey on the chemical quality of urban and rural drinking water sources with technical and financial support from the WHO. Drinking water sources representative for thirteen provinces were sampled and analyzed for more than 80 chemicals and pesticide compounds by a certified laboratory in Australia.

The survey reported that the chemical quality of most urban and rural drinking water sources was generally good. No pesticides were detected in any of the samples. Although not the subject of the survey, bacteriological quality was emphasized as the priority for the safe drinking water. Nitrites and nitrates were detected at elevated levels in several locations. Contaminants such as barium, chromium, fluoride, lead, manganese, molybdenum, and selenium were also found but appeared to be exceptions to the general trend. On the other hand, iron and other aesthetic concerns like hardness proved a significant issue for many rural consumers of groundwater.

The most significant finding of the survey was the naturally occurring arsenic in groundwater from certain areas in Cambodia. The element was detected at levels above the WHO guideline value of $10\mu\text{g l}^{-1}$ in five of thirteen surveyed provinces. Some 9% of the randomly selected groundwater sources were affected with arsenic. The MRD hosted an inter-ministerial meeting to share the survey results, and the arsenic finding in particular. The meeting called for inter-ministerial efforts towards developing national drinking water standards and a national monitoring capacity. The findings were submitted to the Council of Ministers recommending a national arsenic response to be led by the MRD. Meanwhile the MRD has begun further field surveys with NGO partners to delineate the extent of the arsenic occurrence in three provinces, with WHO and UNICEF support.

Water Quality Standards and Water Quality Test/ Analysis Formats

Due to the lack of a National Standard for drinking water quality, different standards for some chemicals in drinking water, are used by individual laboratories in Cambodia as shown below:

Parameters	PPWSA	MIME
1. Color	x	x
2. Conductivity	x	x
3. Odor	x	
4. pH values	x	x
5. Suspended solids	x	
6. Turbidity	x	x
7. Total dissolved solids	x	x
8. Carbon dioxide	x	
9. Calcium hardness	x	x
10. Magnesium hardness	x	x
11. Total hardness	x	x
12. Aluminum	x	
13. Chloride		x
14. Chlorine	x	x
15. Copper	x	
16. Fluoride	x	
17. Iron	x	x
18. Manganese	x	
19. Nitrate	x	
20. Nitrite	x	
21. N-Ammonia	x	
22. Phosphorous	x	
23. Potassium	x	
24. Sulfide	x	
25. Sulfate	x	
26. Zinc	x	
27. Cyanide	x	
28. Chromium	x	
29. Coliform	x	x
30. E.Coli	x	x
31. Bacteria aerobes		

The water quality standard of the Pollution Control Department (PCD) of the Ministry of Environment shows higher values for the parameters. This is because its purpose is to control the pollution of the natural water sources.

The internal drinking water quality standards in Cambodia are mainly adopted from international standards or guideline values. This is partly donor driven with no reference to the actual situation in the country. Since Cambodia was under French colonial rule for nearly 100 years, French standards are still in popular use. During the UNTAC, when multinational experts started their missions in Cambodia, water quality was defined according to their recommendations.

The WB/UNDP technical team adopted WHO guideline values and referenced EU guideline values for drinking water for the Phnom Penh water supply. Health sector education in Cambodia is based mostly on the French system, and thus the National Laboratory (MOH) favors French standards for drinking water quality. However, during 1998 and 1999, the laboratory made changes in the numbers of parameters and the values of these standards by adopting values from WHO, Germany, Malaysia and Thailand.

The water quality standards differ according to their applications. PPWSA standard values are presented under two headings: the highest desirable level and the maximum permissible level. This was done because the values reflected existing international standards, but allowances were still needed to guide authorities faced with an inefficient treatment plant. Most of the PPWSA values are similar to the WHO Guideline values. The National Laboratory relies more upon microbiological parameters because bacteriological quality is much more the domain of the health sector than chemical constituents. The higher values of some chemical parameters found in the water quality standards of the Ministry of Environment are typical for use in monitoring untreated surface water and groundwater. These are not yet strictly aimed at drinking water quality monitoring.

National capacities in monitoring water quality and safety

The procedures for water quality monitoring also differ from one department to another. Among the laboratories engaged in water quality monitoring in Cambodia, the PPWSA and MOWRAM laboratories are the most efficient and experienced.

PPWSA monitors water quality in three levels (Routine tests at treatment plants every day; weekly tests of selected samples from the distribution system; and a general test of 32 parameters monthly). MOWRAM conducts monthly sampling of water from eleven stations along the Mekong and Tonle Sap rivers. DPWS of MIME intend monthly tests for provincial water supply works, but practically only quarterly tests have been done due to logistical constraints. The National Laboratory of MRD carries out occasional quality control of locally marketed bottled drinking water and ice. The MRD usually apply initial analysis for all newly constructed rural water supply facilities, mostly drilled wells with hand pumps.

Legislation, standards, regulations, and implementation guidelines

It is the mandate of the MRD to improve access to safe water supply and sanitation services in rural areas. In collaboration with other key line ministries, the MRD issued the "Water and Sanitation guidelines" in 1995 and the "Policy Framework for Rural Water Supply and Sanitation Sector" in 2001.

Contributions from other ministries include a "draft on water resources management" that is now in the final stages of preparation under the overall guidance of MOWRAM, while legislation for an appropriate water sector regulatory framework and water tariff reform" is being drafted by MIME.

A sub-decree on water pollution control was issued in April 1999 to support the authority of the Ministry of Environment on water pollution control. The MOE is committed to developing a national action plan for prevention of pollution of water sources. It consists of the establishment of national standards for pollution sources, including wastewater discharges to public areas or sewers. Collection and evaluation of data and the analysis of the results are part of the development of the national action plan, which is expected to be completed within three years.

MAJOR LIMITATIONS AND CONSTRAINTS

Water Quality and Health

The use of unsafe water and improper disposal of human wastes, in combination with low hygiene awareness, can result in sickness that prevents people from working and being productive, thus contributing to increased levels of poverty. The impact that lack of access to safe water supply services can have on health is indicated by high infant mortality rate of 89.4 per 1,000 live births. In Cambodia most infectious water related diseases are transmitted primarily through human and animal excreta. The majority of the rural population uses such water for drinking or for preparing food. The human pathogens transmitted orally by drinking water that present a serious risk of disease among the Cambodian population have been identified by Pasteur Institute Phnom Penh and other national hospital and private laboratories as *Salmonella enterica*, *Salmonella typhi*, *Salmonella paratyphi A*, other *Salmonella*, *Shigella flexneri*, other *shigella*, *Escherichia coli*, *vibrio cholerae*, *Campylobacter jejuni and coli*. Results from epidemiological studies on human feces show nearly 30.7% among 2170 samples containing one or more parasites. *Schistosomiasis Mekong* is found in the Mekong River where people that are living along this river are infected, primarily through contact with water during bathing or washing.

In Cambodia the failure to provide adequate protection and effective treatment of water exposes the community to the risk of intestinal and other infectious diseases such as diarrhea, dysentery, typhoid fever, cholera, parasites and gastro-enteritis.

The problems associated with chemical constituents of drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure. However, the Ministry of Health is unable to collect the information on health risks due to toxic chemicals in drinking water.

Issues

People see an important link between water and health, although there is generally very little information available at the community level regarding these issues. Infectious water related diseases are still endemic throughout Cambodia and the bacteriological contamination of drinking water is one of the most important health-related concerns. No pesticides were detected in any of the samples tested in a WHO assisted survey in 2000. It is concluded that pesticides do not currently present a significant health threat in Cambodia's drinking water.

However, it is important to note that the improper use or disposal of pesticides can result in occupational health problems and/or environment threats.

The major rivers in Cambodia appear to have very good chemical water quality. With proper treatment to remove suspended matter and neutralize harmful bacteria, this surface water can provide high quality drinking water. The chemical quality of Cambodia's groundwater presents greater challenges than that of its surface waters. Groundwater from certain areas may contain chemicals that could pose concerns for human health. Most of these chemicals are naturally occurring, although a few may result from human activity such as high nitrate levels. The most important finding of the WHO assisted Water Quality Assessment Survey in 2000 from a human health perspective is that in certain areas groundwater contains elevated levels of arsenic. Further testing will be needed to more accurately determine the extent of the arsenic problem in Cambodia. A few other chemicals including barium, chromium, fluoride, lead, manganese, molybdenum, nitrate, nitrite, and selenium were detected in the study areas. Nitrate and nitrite have been detected at levels exceeding their respective WHO Guideline Value in several locations. Consumers are more concerned with taste, odor and appearance of water than with other qualities. Therefore acceptability of groundwater is critical to the long-term success of water supply wells in rural areas. Several widespread misconceptions regarding the connection between water quality and health exist. The most frequently encountered misconception about water and health is the belief that calcium or hardness in drinking water causes kidney stones. Improved education of authorities in the water sector and of community members on this issue is warranted.

Recommendations

- A central national laboratory could be established, which should be independent from the key ministries, although these ministries should rely on this laboratory for 'Quality Assured' analyses.
- A national standard for all drinking water including tap water, bottled water, well water, etc. should be established as soon as possible so that monitoring of drinking water quality could be developed and improved. Such efforts require high-level commitments from several key agencies and input from technical experts and the support of external agencies.
- National and regional laboratory-supported monitoring networks should be set up to support the application of the national standards. Monitoring should be independent from the service providers and proactive with communities involved.
- Geological information, including available drilling logs from water supply programs, should be developed as an overall response to the arsenic issue.
- The concerned departments should take follow-up actions where water supplies exceed recommended health-based limits for chemicals.
- A greater emphasis on water quality should be placed in the RGC's policies and practices regarding water supply development.

Establishment of the National Standard for drinking Water Quality

The immediate task for water supply sector in Cambodia is to establish a National Standard for drinking water quality. Since each department uses various standards, depending on their own purposes, there is no standard and where there is, it is mostly introduced by the donor or funding agencies regardless of national requirements. The National Standard should be realistic and related to the actual requirements of the people's health.

Development of a National Water Quality Surveillance and Monitoring System

At present, various departments are monitoring water quality depending on their requirements not reflecting the consumers' health requirements. Even the water supply service providers are carrying out the monitoring for their operational purposes. Therefore, RGC should mandate one government agency to conduct monitoring and surveillance on behalf of the consumers as per the National Standard. This agency should not be a service provider but preferably a public health authority (or independent agency) with a mandate to protect the people's health and enforcing the National Standard.

Follow-up Nationwide Study on the Groundwater Quality for major health hazards

As found in the preliminary survey of the chemicals in groundwater, some hazardous chemicals have been detected in groundwater in Cambodia. Immediate action is required to conduct nationwide surveys for hazardous chemical constituents such as arsenic and fluoride. Such action requires cooperative efforts of all stakeholders, particularly of key players in the water supply sector with technical and financial support of IO/NGOs and external support agencies. In such action, the RGC requests the WHO to play a key role in facilitation and cooperation with regional and international partners.