Arsenic in Cambodia
Table of Contents

1. **Country Background** .................................................................

2. **Arsenic Situation and Mitigation Activities** .................................

   2.1 Discovery of Arsenic in Cambodia ...........................................

   2.2 Areas Affected .................................................................

   2.3 Population Affected ...........................................................

   2.4 Incidence of Arsenicosis ....................................................... 

   2.5 Government’s Response .........................................................

      ➢ Arsenic Inter-ministerial Sub Committee ..................................

      ➢ Water Quality Standard ......................................................

      ➢ Testing and marking of wells ..............................................

      ➢ Database Management ......................................................

      ➢ Information, Education and Communication (IEC) .................

      ➢ Baseline Survey and Clinical Examination of Arsenicosis among exposed population in Kien Svay district, Kandal province ......................

      ➢ Detection, Confirmation and Management of Arsenicosis in Preak Russie village, Koah Thom district, Kandal province ......................

      ➢ Training and development of technical guidelines on the detection and management – supported by WHO

      ➢ Provision of Alternative Water Sources .................................

      ➢ Strategic Action Plan ...........................................................

      ➢ National Policy Program ......................................................

      ➢ Capacity Building to Staff ....................................................
List of Tables
Table 1 : Population with suspected arsenicosis symptoms ..................... 8
Table 2 : Priority parameters in small water supplies facility .................. 10
Table 3 : Families/population using tube wells in the At Risk Areas .......... 14

List of Figures
Figure 1 : Arsenic risk map in Cambodia ................................................. 7
Figure 2 : Arsenicosis symptoms identified in Kandal Province in 2006 ...... 8
Figure 3 : Status of arsenic contamination in the At Risk Areas ............... 13
Figure 4 : Result of testing in At Risk Areas ........................................... 13
Figure 5 : Arsenic contamination by public and private wells ................... 14
Figure 6 : Distribution of arsenic level in At Risk Areas .......................... 15
Figure 7 : Result of arsenic testing in school and health centre .................. 16
Figure 8 : Map of arsenic distribution in the At Risk Areas ....................... 17
Figure 9 : Arsenic versus well age ......................................................... 18
Figure 10 : Well depth versus frequency of arsenic contamination .......... 19
Figure 11 : Result of KAP survey .......................................................... 22
Figure 12 : Status of families using arsenic safe water ............................. 29

List of Abbreviations
AISC  : Arsenic Inter-ministerial Sub Committee
CNMC  : Cambodia National Mekong Commission
CSI  : Cooperative Services International
CWP  : Ceramic Water Purifiers
DRHC  : Department of Rural Health Care
DRWS  : Department of Rural Water Supply
GPS  : Global Positioning System
IDE  : International Development Enterprise
IEC  : Information Education and Communication
ITC  : Institute of Technology Cambodia
JMP  : Joint Monitoring Programme
MAFF  : Ministry of Agriculture, Forestry and Fisheries
MEF  : Ministry of Economics and Finance
MIME  : Ministry of Industry, Mines and Energy
MoE  : Ministry of Environment
MoH  : Ministry of Health
MOI  : Ministry of Interior
MOP  : Ministry of Planning
MOWRAM  : Ministry of Water Resources and Meteorology
MPWT  : Ministry of Public Works and Transport
MRD  : Ministry of Rural Development
NDWQS  : National Drinking Water Quality Standard
PDRD  : Provincial Department of Rural Development
PFDF  : Partners For Development
PoE  : Provincial Office of Education
PPWSA  : Phnom Penh Water Authority
RDI  : Resource Development International
SDP  : Strategic Development Plan
SEILA  : A Khmer language word approximating to “foundation stone”
Purpose of this document

This document aims to present an overall picture of arsenic situation in Cambodia and various efforts that have been undertaken to address this issue. Detail information about arsenic in Cambodia can be found in different documents, which are available in arsenic center as well as arsenic website http://www.arseniccenter.com/, listed in table.

<table>
<thead>
<tr>
<th>No</th>
<th>Type of Document</th>
<th>Year</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>A nation-wide rapid assessment of Drinking Water Quality conducted jointly by the Ministry of Rural Development (MRD) and the Ministry of Industry, Mines and Energy (MIME).</td>
<td>2001</td>
</tr>
<tr>
<td>2</td>
<td>National Drinking Water Quality Standard</td>
<td>2003</td>
</tr>
<tr>
<td>3</td>
<td>Baseline Survey and Clinical Examination of Arsenicosis among Exposed Population in Kien Svay District, Kandal Province.</td>
<td>2003</td>
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<td>4</td>
<td><strong>Situation Analysis:</strong> Arsenic Contamination of Groundwater in Cambodia</td>
<td>2004-2006</td>
</tr>
<tr>
<td>5</td>
<td>IEC document and material (school song, video, T-shirt, School lesson plan, poster, leaflet and booklet )</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Arsenic Database</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>KAP Survey Report</td>
<td>2006</td>
</tr>
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<td>8</td>
<td>Detection, Confirmation and Management of Arsenicosis in Cambodia</td>
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<td>9</td>
<td>Strategic Action Plan</td>
<td>2006</td>
</tr>
<tr>
<td>10</td>
<td>Informed Choice Manual for promotion of arsenic safe water</td>
<td>2007</td>
</tr>
</tbody>
</table>
Cambodia lies in continental Southeast Asia, between the latitudes 10.5 and 14.5 North. Geographically the country is mainly flat in the central area and is bordered by Thailand and Laos to the West and North by Vietnam on the East and South, and the Gulf of Thailand on the Southwest. It covers an area of 181,035 Km\(^2\) with a total population of 13.6 million of which 8% live in the Phnom Penh city, 10 % in other urban areas, and the remaining 82% in rural areas. Administratively the country divided into 20 provinces and 4 municipalities.

Cambodia is dominated by the two great lakes of the Tonle Sap Lake and the Mekong River. The Tonle Sap covers an area of about 2,600 km\(^2\) in the dry season, and over 13,000 km\(^2\) in the rainy season. The Mekong River flows southward through the country from the border of Laos, and westward through Phnom Penh to join the Tonle Sap River. The Mekong and Bassac River flow southward from Phnom Penh to the border of Vietnam, passing the Mekong Delta on its way to the South China Sea.

The Tonlé Sap Lake provides a huge source of fresh water. During the late wet season the Mekong River backs up northwards into the lake increasing the volume of the lake tenfold at the height of the flooding. As the flooding abates, the flow reverses and the level of the lake drops leaving the surrounding area as marshland unsuitable for agriculture, and resulting in a gradual silting up of the lake.

The climate is monsoonal with distinct wet and dry seasons of relatively equal length. The southwest monsoon brings the rainy season from mid-May to mid-September, and the northeast monsoon flow of drier, cooler air lasts from early November to March. The total annual rainfall average is between 1000 and 1500 mm, but the amount varies considerably from year to year. It is heaviest in the mountains along the coast in the southwest, which receive from 2500 to more than 5000 mm.

The country economy depends mainly on agriculture, fisheries and timber. Some 36% of the population is living below the poverty line and the country has some of the lowest human development indicators in South East Asia. Please also refer to annex III on more statistics of Cambodia.
2.1 Discovery of Arsenic in Cambodia

Naturally occurring arsenic was first confirmed in drinking water in Cambodia during the Cambodia Drinking Water Quality Assessment, conducted jointly by the Ministry of Rural Development (MRD) and the Ministry of Industry, Mines and Energy (MIME) between 1999 and 2000. This assessment screened approximately 94 urban and rural drinking water sources in 13 provinces for chemically hazardous elements and found elevated arsenic levels in approximately 11 per cent of the groundwater samples from 5 of the 13 studied, exceeding the WHO guideline value of 10 ppb.

2.2 Arsenic Affected Areas

Arsenic-risk map was developed using the 1:500,000 geological map of Cambodia in digital form to define an area most At Risk. Geological Units were assigned to three levels of risk category (high, medium and low risk) based on the characteristics of the unit. The highest risk category was designated as being “At-Risk”, which included Holocene floodplains of the major rivers and minor rivers.

Geological mapping and available data from screening program indicated that the condition occurs mainly in sediments near the major rivers, Mekong, Bassac, and Tonle Sap River. Arsenic Risk Map shows areas most at risk in Figure 2. A total of 1607 villages in 318 communes in 49 districts with 6 provinces (Kandal, Prey Veng, Kampong Cham, Kampong Chhnang, Kampong Thom and Kratie), and peri-urban Phnom Penh, are estimated to be the most at risk.

2.3 Population Affected

Cambodia seems face a two-fold public health crisis:

1. a high reliance on untreated surface water with its associated risks of bacterial contamination, diarrhoeal diseases and infant mortality, and
2. significant contamination of shallow ground-waters with arsenic, and the associated risks of arsenicosis and cancer.

Population census data indicate that 2.25 million people live within the arsenic affected area. However, only a portion of this population use tube-wells as a source of drinking and cooking water and only a portion of these wells are contaminated.

A large proportion of the population in the areas At Risk are currently using bacterially contaminated surface water as their primary source of drinking water.
2.4 Incidence of Arsenicosis

Clinical survey was conducted in 2003 in Kien Svay district where arsenic concentration was found very high in every tube well water. However, the result of the survey showed no evidence arsenicosis symptoms.

In 2006, through a KAP (Knowledge, Attitude and Practice) survey conducted by MRD, a number of people with suspected arsenicosis were coincidentally identified in Kandal Province. Subsequently – PDRD from Prey Veng Province also reported findings of similar cases during testing activities. The cases in Kandal were immediately followed up by MOH with support from WHO.

Approximately 139 families with a total of 311 people in 9 villages of 7 communes, 4 districts in Kandal and Prey Veng identified suspected arsenicosis symptom. Of these people 135 are women and 56 are children. The common symptoms identified with most of the patients are Leukomelanosis (rain-drop pigmentation on skin) and Nodular Keratosis. This case shows the potential indicator for an increase disease burden in future if not addressed early. Detail information of patients and symptom is shown in the table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Province</th>
<th>District</th>
<th>Commune</th>
<th>Village</th>
<th>Family</th>
<th>Total Pop.</th>
<th>Female</th>
<th>Children</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>KD</td>
<td>Koah Thom</td>
<td>K.Kong</td>
<td>Preak Rusey</td>
<td>116</td>
<td>262</td>
<td>113</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trabek Pok</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chr. Takeo</td>
<td>Preak Takin</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chh.Khmao</td>
<td>Chh.Khmao</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preak Chrey</td>
<td>Preak Chrey</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lvea Em</td>
<td>Phum Thom</td>
<td>P. Taprang</td>
<td>2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>PV</td>
<td>Pearaing</td>
<td>Preak Tarsenicor</td>
<td>Preak Tarsenicor</td>
<td>4</td>
<td>13</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preak Kroch</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Peam Chor</td>
<td>P. Sambour</td>
<td>3</td>
<td>7</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>139</td>
<td>311</td>
<td>135</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Arsenicosis symptoms identified in Kandal Province in 2006

Arsenical Nodular Keratosis: a picture from Kandal province- this woman and her family have similarly affected and her symptom has recently lead to cancer, reported by PDRD As team.

Arsenical Nodular Keratosis: a picture from Kandal province- a man with his son has serious problem with cancer; his son was operated with support from RDI.

Arsenical Leukomelanosis- picture from Kandal province.
2.5 Government’s Response

Following the discovery of arsenic, the Government responded to the issue in a number of ways including:

- Establishment of Arsenic Inter-ministerial Sub Committee (AISC) chaired by MRD. Arsenic secretariat was formed under MRD and involved two departments, DRWS and DRHC, to implement the overall Arsenic mitigation activities.
- Development of Interim National Drinking Water Standards which set a maximum permissible limit of 50ppb Arsenic in drinking water.
- Evaluation of ceramic water filter as methodology for household water treatment
- Coordination and management of a national testing, marking of well (green when the water is Arsenic safe and red when the water contains Arsenic above the national standard of 50ppb in the at-risk areas, and IEC (information, Education and Communication) activities in the arsenic at-risk areas.
- Management of arsenic database.
- Promotion of alternative arsenic free water supply using technology options such as rainwater harvesting, shallow wells, community piped water system and household treatment to treat surface water through subsidy scheme.
- KAP (Knowledge, Attitude and Practice) survey to assess the extent of awareness and practice relating to arsenic.
- Development of a 5 year arsenic mitigation strategic action plans
- Capacity building: both national and provincial teams including establishment of arsenic centre at MRD.
- Collaboration with other partners to respond to the problem.

➢ Arsenic Inter-ministerial Sub Committee

AISC was established in 2002 to coordinate activities of the government across the various ministries in the area of water and health which are concerned with arsenic contamination. It is also tasked to develop document policy/guideline related to arsenic. The AISC consists of representatives from 5 ministries which have responsibilities for water: MRD, MOWRAM, MoH and MIME and MoE. This committee is chaired by Ministry of Rural Development with a sub-secretariat team (staff of DRWS and DRHC) under the umbrella of AISC to deal with technical matters.

Role and responsibilities of the AISC

- Act as arsenic central data repository and information distributor- data collection, analysis of drinking water in rural areas and mapping arsenic affected areas;
- Coordinate arsenic assessment/well sampling programs,
- Operational research on arsenic in drinking water;
- Develop strategic plans and action plans for mitigation of arsenic in drinking water;
- Develop arsenic information, education and communication material;
- Undertake and coordinate education and information campaigns in the arsenic affected communities.
The operational activities of the AISC

All activities are undertaken by the secretariat that is based in the Ministry of Rural development. The activities of the secretariat include:

- Well Testing, painting and community education activities (IEC)
- Database management
- Training
- Mitigation activities

Operational Structure of AISC

Water Quality Standard

The NDWQS applies arsenic standard as the minimum requirement for all sources of drinking water in both urban and rural areas, public or private water supply regardless of its source including groundwater, surface water and rainwater, which is intended for human consumption. Seven parameters are identified and set up for small water supplies and Arsenic in one of the parameter set up among those. Detail is shown in Table 2.

Table 2: Priority parameters in small water supplies facility

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>Turbidity</td>
<td>5 NTU</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.05 mg/L</td>
</tr>
<tr>
<td>Iron</td>
<td>0.3 mg/L</td>
</tr>
<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>800 mg/L</td>
</tr>
<tr>
<td>Thermotolerant Coliforms or E. coli</td>
<td>0 per 100 mL</td>
</tr>
</tbody>
</table>
Testing and Marking of Wells

With support from UNICEF in 2002, 100 field test kits (Hach-5 reagent) were imported and distributed to government and NGOs to test drinking water sources, especially tube wells. However, there was no central plan to undertake a systematic testing program across the country at that time. The pattern of testing had reflected only the locations where participating NGOs and partners were operating.

A coordinated testing program was undertaken in Kratie province by one NGO, Partners For Development (PFD), and almost all tube-wells in the “At-Risk” zone in this province were tested. Similarly intensive and systematic testing was also undertaken in the Kien Svay District of Kandal by one other NGO, Cooperative Services International (CSI), which was later renamed as Resource Development International (RDI).

Testing was also undertaken by PDRDs through the SEILA program (mainly in Pursat and Kampong Chhnang provinces, and was largely at the discretion of the PDRDs). In many cases the community was not informed of the outcome of the testing. IEC material was not available, and IEC activities were limited mainly to avoid ill-informed rumour and wholesale abandonment of tube-wells, regardless of the results of any test.

In 2003, very little testing was directly supported and coordinated. Testing was postponed to allow for the development of IEC material and the analysis of the existing data. National testing programme was established, and it was designed to test all wells in the “At-Risk Areas” and to mark well red or green based on the Arsenic content (marking green when Arsenic level is equal or less than 50 ppb and red when Arsenic level is greater than 50 ppb). Families using the wells are informed about the testing result and of the danger of consuming arsenic. The information was provided at the time of testing.

In 2004, a trial testing program in the At-Risk Villages was initiated. Testing teams from high Risk provinces were trained in the use of GPS, test kits, well numbering procedures etc. The trial testing program was undertaken by the trained teams, but there were no IEC activities carried out because the IEC teams had not been trained. A quality assessment was informally undertaken to identify the gaps and to improve the quality of the testing program See appendix 1.

Starting from 2005, the national testing programme was reviewed and a comprehensive testing procedure was designed to test all wells in the areas “At-Risk” including wells in schools and health centres, and to inform families of the testing results and of the consequence of consuming arsenic.

A standard form of data sheet (testing form) was revised to include a unique well number for each well and a standard well code to aid with identification. Other information also includes a qualitative assessment of location, use (community or private), owner detail, type of well, year of construction, depth in meter, number of users, type of test kit used, arsenic level and others physical water quality such arsenic smell, taste, odour and iron.

National and provincial teams from areas At Risk was provided with re-fresher training on the overall testing procedure, the use of testing equipment, information collection and IEC material. Data of well testing (testing sheet) was collected and sent to national database to enter into the national arsenic data base and to use to update the arsenic maps by province.
The testing program has generally been carried out by the trained PDRD staff, but starting from late 2006 it has involved commune and community members through community based testing and education, as well as students from the Institute of Technology Cambodia (ITC). By December 2008, blanket testing of tube wells were completed in the At Risk Areas of 1607 villages. In additional, a random testing of 10 wells per village was initiated and completed three provinces of Kratie, KChhnang and Kandal.

**Testing equipment used**

- **Test Kit**: different types of field test kit (Hach 5-reagents, Hach 2-reagents, and Quick used. These test kits are likely to have similar method (the tip of the test strip is impregnated with mercury bromide and the visual colour comparison with the standard colour scale given), but they have different reagents used, different reaction time and different colour comparison scale.
  - Hach 5 reagents: 0 10 30 50 70 300 500 ppb
  - Hach 2 reagents: 0 10 25, 50, 100, 250, 500
  - Quick: 0 5 10 20 30 40 50 60 80 100 200 250 300 400 500
- **GPS**: used to record well location- it was recorded manually by testing teams into testing sheet.
- **Testing sheet**: printed with serial number and distributed to province by the national database person and collected back after testing completed.
- **IEC material**: leaflet used to give message about As to family at the time of testing completed.

** A standard testing sheet is attached in appendix 2.**
Results of Testing and Marking Well

The data presented here is based on the latest update of the national database.

Available data shows that 3,726 villages across the country were visited by the testing teams to screen the arsenic contamination in tube wells used by rural families. A blanket testing was carried in the areas At Risk (1607 villages) and the outcome shows approximately 600 (37%) villages out of the total are the most affected- almost of all tube wells tested had proven to have high arsenic level (above national standard) while 200 (12.5%) villages in this areas reported that no tube wells were used and people rely mainly on water from open well and surface water. Details about the status of arsenic contamination in the areas At Risk are presented in figure 4.

![Status of testing in At Risk Area](image)

**Figure 3: status of arsenic contamination in the At Risk Areas**

A total of 37,280 tube wells had been tested across the country. Of these 24,792 tube wells tested in the areas At Risk. 8,672 (35%) wells have arsenic level greater than national standards (50 ppb); 10,419 (42%) of all tube wells in these areas have arsenic level within acceptable limits while 5,701 (23%) tube wells have no arsenic. Figure 5 shows information on arsenic contamination in this areas.

![Result of testing in At Risk Areas](image)

**Figure 4: Result of testing in At Risk Areas**
Majority of tube wells (89%) tested in the At Risk Areas was found to be private wells. Figure shows the status of arsenic contamination within private and public wells.

![Graph showing contamination in private vs public wells]

**Figure 5: Arsenic contamination by public and private wells**

Making an assumption that private well is only used by the owner and his family while community well is used by a group of 25 families, according to the national standard for water and sanitation user group (WSUG). This assumption is used to estimate proportion of population in At Risk Area relying on water from wells and the number of people exposed to arsenic level above national standard. Table 3 shows number families/population exposed to arsenic.

**Table 3: Families/population using tube wells in the At Risk Areas**

<table>
<thead>
<tr>
<th></th>
<th>No Wells</th>
<th>Families Using Wells</th>
<th>Population Using wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Public wells</td>
<td>2,723</td>
<td>68,075</td>
<td>340,375</td>
</tr>
<tr>
<td>Total Private wells</td>
<td>21,978</td>
<td>21,978</td>
<td>109,890</td>
</tr>
<tr>
<td><strong>Total Families/population using wells</strong></td>
<td><strong>90,053</strong></td>
<td><strong>450,265</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Detail with arsenic level**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Public wells - Arsenic &gt;50</td>
<td>811</td>
<td>20,275</td>
<td>101,375</td>
</tr>
<tr>
<td>Private wells - Arsenic &gt;50</td>
<td>6,895</td>
<td>6,895</td>
<td>34,475</td>
</tr>
<tr>
<td><strong>Families/population using wells</strong></td>
<td><strong>27,170</strong></td>
<td><strong>135,850</strong></td>
<td></td>
</tr>
<tr>
<td>Public wells - Arsenic = 0-50</td>
<td>1,912</td>
<td>47,800</td>
<td>239,000</td>
</tr>
<tr>
<td>Private wells - Arsenic = 0-50</td>
<td>15,083</td>
<td>15,083</td>
<td>75,415</td>
</tr>
<tr>
<td><strong>Families/population using wells</strong></td>
<td><strong>62,883</strong></td>
<td><strong>314,415</strong></td>
<td></td>
</tr>
</tbody>
</table>
Exposed population

Estimation of the exposed population here is made by calculating the proportion of wells that is contaminated by arsenic above 50 ppb with the proportion of population in the affected areas using those tube-wells. The data used to estimate this number of population is the latest available data from national testing program, June 2008.

KAP survey indicated that only 24% (wet season) to 27% (dry season) of the population in the areas At Risk relied on tube-wells for drinking water. The National arsenic database indicates that about 35% of the tube-wells in the areas are contaminated with arsenic above the current National Standard (50ppb). Assuming that all the wells contaminated by arsenic above the national standard are used as the main sources for drinking and cooking, these data indicate that the population exposed to arsenic at the present time is about 135,850.

Arsenic distribution level by province

The data shows that Kandal, home to approximately 1 million people and also the most densely populated urban and peri-urban area in the country, is the most severely affected province. 35% of wells tested had proven to have arsenic greater than national standard of 50 ppb (parts per billion); 48% in Kampong Cham, 19% in Prey Veng, 13% in Kratie, 9% in PP, 6% in Kampong Chhnang, and 3% in Kampong Thom.

![Arsenic level by province](image)

**Figure 6: Distribution of arsenic level in At Risk Areas**

At provincial level, a provincial map showing arsenic distribution level has been produced; a provincial profile with detail information about arsenic mitigation activities in each respective province was developed. The profile consists of specific background information about arsenic, activities for an intervention, achievement, data management, distribution level of arsenic and contact person for arsenic related information. The available profile with arsenic map has been disseminated to line departments, districts, communes, NGOs and private driller throughout the areas At Risk during arsenic public meeting in early 2008.
Arsenic level in school and health centre

A total of 1056 school wells and 201 health centre wells tested. Out these 6 provinces, 112 and 14 (6.5 and 7%) wells in Kandal, Prey Veng and Kampong Cham have proven to have high level of arsenic respectively. Following the testing, 1,356 school teachers and 45,064 school children in 93 schools in the three provinces had informed about the danger of arsenic through school education activities. Medical staff from 13 Health centre that using wells with high level of arsenic were also informed about the danger of arsenic.

**Figure 7: Result of arsenic testing in school and health centre**

Dug wells and arsenic concentration

Experience in Bangladesh has shown that arsenic contamination is generally associated with tube-wells. The same observation is true in Cambodia, only 10% of 1420 open wells tested are contaminated, and generally at lower concentrations (maximum recorded arsenic value in open well range form 20-30 µg/L)

The mechanisms that produce water with low arsenic concentration and other dissolved minerals in dug wells are not fully understood. The following mechanisms may occur:
- The oxidation of well water due to exposure to open air can cause precipitation of dissolved arsenic and iron within the well reservoir.
- Dug wells are generally shallow and may only contain water from relatively shallow, oxygenated surface waters low in arsenic.

Shallow protected well is likely an option for arsenic mitigation in most areas, though these wells are more susceptible to bacterial contamination. This means that there is unlikely to be a "one size fits all" solution to the arsenic problem. Open well or new well still needs to be tested and decisions about having these options is depended on individuals.

**Database Management**

Arsenic database was designed to allow only partial entry in both English and Khmer for information about wells, arsenic level, water sample physical details and other water quality parameters. However, it had limited administrative data and it did not have a relational structure.
The system was reviewed and included date, well depth, static water level, location, well code, arsenic level, well owner, number of families using well for cooking and drinking and other water aesthetic information. Moreover, the updated version made greater use of a relational structure plus other features.

Relevant information from the database can be exported and displayed spatially within a GIS (ArcMap). The latest data is updated in the map arsenic data when the database is updated. The map is capable of displaying the following data at the village, commune, district and provincial level. The GIS also contains ancillary data coverage such arsenic geology, hydrology, major roads, and Land sat images and can incorporate data from other groundwater surveys.

All detailed information of water point tested from the areas At-Risk has been collected and entered into database system. The database has been used to estimate the proportion of contaminated wells, to update map of the distribution arsenic contamination and to provide a list of potentially contaminated wells in each province. Figure 9 show arsenic distribution Map.
The families using wells in areas At Risk have been informed of the results of testing, and the danger of arsenic related to their health. Those who use tube well with high arsenic contamination (>50ppb) were advised to stop using the water from the wells for drinking or cooking but to use it for other purposes such as washing and gardening. In addition, IEC materials (poster and leaflet) are distributed to families and other public facilities during education campaigns.

The school communication materials for grade 1 to 6 were reviewed and printed in early 2007 for use at primary schools. Posters and leaflets are used particularly with children in grade 6 because they are old enough to get the same message as community members. Students, teachers and parents of the schools in at risk areas that have proved to have contaminated wells have been reached through the school arsenic education program.

PDRD and PoE (Provincial Office of Education) staff from two key provinces, Kandal and Prey Veng, were trained to be the master trainers who subsequently trained teachers from the affected schools. A total of 1,356 school teachers and 45,064 school children from 93 schools in Kandal, Prey Veng and Kampong Cham had been reached through these arsenic education activities. Parents Approximately 1000 of the children’s parent) were also reached during school education through distribution of an information brochure and a questionnaire to be filled.

National and local government agencies have been advocated through public meeting. A national level meeting with related Government agencies ie MOI, MOH, MOP, MO Information, MOEYS and development partner agencies was organized and subsequent provincial level meetings attended by a total of 1121 provincial, district and commune level authorities have been conducted in the 6 high provinces.

New intervention for communication was piloted in 2007 through community based testing and education approach. Commune council and village chief were involved in the intervention including selection of village volunteers, ToT training, monitoring activities carried out by the trained village volunteer, collecting information and reporting to PDRD.

A KAP survey conducted by MRD in mid-2006 showed that only 12 percent of the population are aware of arsenic issues and 10 percent used Arsenic safe water.

![Result of KAP Survey 2006](image-url)
Assessment of the knowledge of parents in 14 pilot schools

In February 2007 MRD in collaboration with MoEYS conducted a pilot education initiative for 14 schools in Koah Thom district in Kandal province. A total of 2500 questionnaires were sent through children to their parents with a leaflet and were collected back one week later.

1500 completed questionnaires were returned and analyzed and the results showed that:

- 90% of respondents know that arsenic exposure takes place through using water from red painted wells for drinking and cooking;
- 90% of respondents know that arsenic free water could be obtained from green wells, rainwater, river, pond and shallow well;
- 80% understand that water from wells painted green is safe for drinking and cooking while water from wells painted red is not safe;
- 90% know that arsenic is harmful to human.
- However, around 60% still believe that arsenic in water can be reduced through boiling and filtering and also that arsenicosis is contagious.

Baseline Survey and Clinical Examination of Arsenicosis among exposed population in Kien Svay district, Kandal province - MOH/WHO/UNICEF

A first cross-sectional survey was carried out in Kien Svay district in 2003 to determine the prevalence of arsenicosis among the exposed population because this district had proven to have highest Arsenic level in tube well during the initial screening program. The survey was carried out in 12 selected villages with a total of 1470 households (7817 people). Twenty one medical staff was trained on health effects of arsenic, diagnosis and management of arsenicosis patients and interview technique. The household members interviewed were examined for the arsenical skin lesions i.e., melanosis, leucomelanosis and keratoses. Water samples from tube wells and biological samples were collected for laboratory testing.

Key findings:

The study had shown that arsenic concentration is relatively high:

- approximately 60% of the tube wells tested contain arsenic > 50 ppb and 29% contain arsenic > 500 ppb.
- A total of 58% and 30% of the population were exposed to arsenic > 50 ppb and > 500 ppb respectively.
- Approximately 580 people per 1000 in the study area are drinking arsenic contaminated water > 50 ppb and are at potential risk of developing arsenic related health hazards.

No clinical evidence of arsenicosis was found during the survey. There were a number of factors observed:

- duration of exposure (relatively short according the mean age of the tube well recorded only 4.49 years),
- drinking water sources (use rainwater for drinking purpose especially during the wet season, surface water sources, dug well, ....).
  - More than 80% of HH have rainwater harvesting system,
  - 39.59% of the study population reported to use rainwater for drinking purpose during the wet season.
Detection, Confirmation and Management of Arsenicosis in Preak Russie village, Koah Thom district, Kandal province – MOH/WHO

Clinical investigation and biological sample collection of suspected arsenicosis cases were done at Prek Reussie, Koah Thom district of Kandal province, where a number of suspected cases were identified during the KAP survey activities. Detailed history with dermatological examination of each case was studied to ascertain presence of arsenical skin lesion (e.g. pigmentation and keratosis). Hair and nail samples were collected from each participants and also water sample from tube wells used by those participants; age group was also studied.

Key findings:

- 97 subjects belonging to 40 families were examined and the results showed that most of these people had evidences of chronic arsenic exposure.
- Out of these, 70 cases were diagnosed to be suffering from arsenicosis (clinically and laboratory confirmed according to WHO criteria) arsenic all these cases had evidences of pigmentation and/or keratosis characteristic of arsenicosis and history of exposure of arsenic contaminated water and/or elevated level of arsenic in hair and/or nail.

Highest number of cases belonged to age group of 31 to 45 years; both the sexes are more or less affected equally.
- 66 cases (65.04%) were found pigmentary lesion (melanosis or leuco-melanosis);
- 64 cases (65.98%) were found keratotic lesion (diffuse or nodular);
- 60 cases were observed an evidence of both pigmentation and keratosis;
- 6 and 4 cases only pigmentation and only keratosis was found respectively.

Arsenic level in nail or hair of 93 participants showed value above normal limit suggesting that nearly all the participants had chronic exposure to arsenic. (The minimum and maximum arsenic values detected in the nails were 1.06 and 69.48 and in hair were 0.92 and 25.6 ppm respectively.) It was seen that:
- 77% of individuals had arsenic value in nail varying from 1.06 to 30 ppm.
- 82% of cases had hair arsenic value ranging between 0.92 and 10.9 ppm.
- Arsenic values in the nail and hair were correlated with arsenic exposure data through water taken by 57 participants.
- Out of 97 subjects examined one cases was found to be suffering from suspected skin cancer. He had ulcerated tumor like lesion in the sole of one foot having evidence of keratosis.

Training and development of technical guidelines on the detection and management – supported by WHO

Two days training on arsenicosis cases detection and management was organized with a total of 79 medical doctors. They are directors of provincial health department, directors of provincial rural development, directors of referral hospitals, technical bureau chief, offices of health promotion unit (clinical bureau), and officials in charge of continuing education in the province.

Technical guidelines on the detection and management of arsenicosis cases in Cambodia in accordance to WHO protocol have been prepared.
Provision of alternative water supply

Arsenic free water sources and water treatment systems have been introduced to families in arsenic affected areas during the testing and IEC activities. The support to promote to use these alternative arsenic free water sources were initiated in 2004 through cooperation with NGOs (GRET, RDI and IDE), and through direct support to MRD.

Activities include:
- Provision of rainwater tanks in schools;
- Production and marketing of ceramic water purifiers (CWP);
- Adoption of public/private partnerships in providing treated community piped water;
- Promotion of community informed choice, which include protected shallow wells, ceramic water filters and rainwater harvesting system.

Key Results:

Promotion of Rain Water Harvesting
- Rain water tanks with 25 m³ capacity to 20 primary schools.
- Earth tanks with 4000 litter capacity to 500 families.

Promotion of Ceramic Water
- A CWP factory established in Prey Veng, owned and operated by the Cambodian Red Cross (CRC), the factory has managed to produce 7,000 CWPs during the first semester of 2005;
- Approximately 7000 filters were distributed through subsidy scheme and 6000 CWPs distributed through a market-based system (unsubsidized);
- IEC materials on CWP use and benefits for arsenic and clean water produced and disseminated.

Promotion of community piped water supply: the project cooperation was done through an NGO (GRET-Kosan) that has technical expertise to support the commune councils. The system is operated by private companies through a public-private partnership.
- Two community piped water supply systems were established in two communes in Koah Thom district in Kandal. More than 1000 households with approximately 5500 people are served by the two systems;
- The technical manual on small scale piped water system was developed and disseminated through a seminar, and the designs have been integrated into the Government templates.

Promotion of technology informed choice: the technologies include traditional rainwater jars, rainwater tanks (ferro cement tank, giant Jar, concrete ring tank), shallow wells. Community informed choice aimed to promote community ownership through decision making in selection of technology and cost sharing for the technology selected.
- Shallow wells were constructed for 17 community water points with approximately 100 families in 2 villages in Kratie and Kampong Chhnang.
- Renovation of wells to 20 community groups with approximately 50 families and 2 schools in KD, Kampong Chhnang and Kratie.
- Traditional rainwater jars with 600 litter capacity were distributed to 302 families.
**Families using alternative arsenic free water**

In 2007 with Unicef support, 9% (0.75% families living in high risk areas) of families using tube well with high arsenic content (>50ppb) has been supported to use alternative arsenic free water (rainwater, water from shallow well, and surface water with ceramic water purifier).

**Progress toward the five years’ targets**

The baseline from KAP survey in 2006 revealed 10% families using alternative As free water together.

![Result of KAP Survey 2006](image)

**Figure 13: Status of families using arsenic safe water**

The incidence of arsenicosis in 2006 has attracted the attention of a diverse group of stakeholders to participate in the arsenic mitigation activities. More NGOs and local private investors have actively participated in the promotion of alternative arsenic free water in many parts of the high risk areas particularly in Kandal province. A number of families have also shown initiative to obtain alternative water supply from available source in their villages. **However, there is no systematic data collection to monitor and report on the progress in the areas.**

- **Strategic Action Plan**

Strategic Action Plan was developed to help ensuring coordinated response amongst the many Government Ministries, agencies, International Organisations and NGO’s. It will enable each of the organisations involved to identify their roles and responsibilities, and encourage investment and additional input from new organisations and donors. The nature of the document contains different components include **vision, goal, objective, strategies and detail activities.**
In order to achieve the Sector Vision (Ensure every person in rural communities has sustained access to safe water supply and sanitation services and lives in a hygienic environment by 2025), this Strategic Action Plan describes a structured set of goals and specific objectives to be reached in relation to the arsenic contamination of groundwater. This plan also describes the specific strategies to be employed to reach these goals.

GOAL # 1: Every person exposed to arsenic through the consumption of water from arsenic contaminated wells shall have sustained access to alternative safe water source so that the occurrence of arsenicosis and arsenic related diseases in Cambodia are minimised.

Objective 1: to ensure at least a 75% reduction in the number of people consuming arsenic contaminated water in the high risk areas of Cambodia by the year of 2011

Strategies
- Well screening and marking program to mark arsenic safe and contaminated wells.
- Information, Education and Communication Programs.
- Advocacy with all levels of government to increase awareness of the arsenic contamination issue and promote the development of alternative water sources.
- Regulation of the construction of new wells in the “At Risk” areas.
- Development of an institutional environment that enables the provision of alternative safe water in arsenic affected areas.
- Provision of alternative safe water.

Objective 2: to understand the scale and extent of the arsenic contamination problem, exposure of the population, incidence of arsenicosis in the population, and effectiveness of the arsenic mitigation programs so that the Royal Government of Cambodia (RGC) can plan and effectively respond to the situation.

Strategies
- Collate, manage and interpret data collected by arsenic screening, IEC and public health programs.
- Undertake specific investigations of groundwater contamination, consumption, IEC, incidence of arsenicosis, and treatment.
- Manage and disseminate knowledge.

GOAL # 2: Every person affected by arsenicosis can be swiftly diagnosed, receive treatment for the signs and symptoms of the disease, access and use an alternative safe water source and not be discriminated against or excluded from their community.

Objective 3: to ensure that within 5 years, there will be a case detection, management and surveillance system that ensures that all people with arsenic related health problems living in high risk areas, receive treatment

Strategies
- Development of a targeted and self-referral case detection system in the arsenic affected areas.
- Development of a case confirmation and referral system in arsenic affected areas.
- Development of a case surveillance system.

With support from Unicef, Ministry of Rural Development is currently working to achieve goal # 1.

- National Level Policies and Programmes
  - Development and dissemination of a situation analysis document on arsenic contamination of drinking water.
  - Development and dissemination of arsenic guidelines and strategic action plan.
- Development and dissemination of educational materials which include poster, leaflet, T-shirt and advance media (poppet and karaoke song) for community, and lesson plan for school.
- Development and management of National Arsenic Database.
- Studies research on performance of HH treatment options (CWP, SODIS and Bio-sand filter) used in Cambodia including arsenic removal filter in order to recommend for application.

#### Capacity Building to Staff

- Regular coordination meeting of Arsenic Inter-Ministerial Sub-Committee to provide updated information on activities and progress by key players;
- Regular meeting between Secretariat technical staff and PDRDs from 7 provinces to update information, problem solving and sharing experiences to each other in term of arsenic testing and Education;
- National workshop and advocacy meeting conducted through national and provincial level.
- Regular monitoring and capacity building to national and provincial staff.
- International learning exchange in others arsenic affected countries.