Review

Management of source and drinking-water quality in Pakistan

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تدابير معالجة مصادر مياه الشرب ونوعيتها في باكستان

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الخلاصـة: إن نوعية مياه الشرب في كلٍّ من المناطق الحضرية والريفية في باكستان، لا تُعَامَل بالجدِّيَّة المناسبة. وتقدِّم نتائج الاستقصاءات المختلفة التي أُجريت، الدليل على أن هناك تلوثاً بالبراز في معظم إمدادات مياه الشرب. وفي بعض الأماكن تتدهور نوعية المياه الجوفية بسبب التلوُّث الطبيعي الذي يحدث في باطن الأرض، أو بفعل الأنشطة الإنسانية المنشأ. وقد أدَّت نوعية مياه الشرب المتدنِّية بفعل التلوُّث الجرثومي، بشكل متكرِّر، إلى ارتفاع نسبة وقوع الأمراض المنقولة بالماء، بينما أدَّت التلوُّثات التي تحدث في جوف الأرض، إلى إصابة مستهلكيها بعلل أخرى. وتقدِّم هذه الورقة استعراضاً تفصيلياً لنوعية مياه الشرب في البلاد والتأثيرات الصحية المترتبة عليها، كما تحدِّد العوامل المختلفة التي تُسهم في تدهور نوعية المياه، ومن ثَمَّ تعرض أهم الإجراءات التي يجب اتخاذها لضمان توفير إمدادات مياه صالحة للشرب لمستخدمي هذه المياه.

ABSTRACT Drinking-water quality in both urban and rural areas of Pakistan is not being managed properly. Results of various investigations provide evidence that most of the drinking-water supplies are faecally contaminated. At places groundwater quality is deteriorating due to the naturally occurring subsoil contaminants or to anthropogenic activities. The poor bacteriological quality of drinking-water has frequently resulted in high incidence of waterborne diseases while subsoil contaminants have caused other ailments to consumers. This paper presents a detailed review of drinking-water quality in the country and the consequent health impacts. It identifies various factors contributing to poor water quality and proposes key actions required to ensure safe drinking-water supplies to consumers.

Gestion de la source et de la qualité de l'eau de boisson au Pakistan

RÉSUMÉ La qualité de l'eau de boisson dans les zones urbaines et rurales au Pakistan n'est pas gérée correctement. Les résultats de diverses études fournissent des preuves d'une contamination fécale de la plupart des approvisionnements en eau de boisson. Dans certains endroits, la qualité de l'eau souterraine se détériore à cause des contaminants présents à l'état naturel dans le sous-sol ou d'activités anthropogènes. La mauvaise qualité bactériologique de l'eau de boisson entraîne fréquemment une forte incidence de maladies à transmission hydrique, les contaminants souterrains causant d'autres troubles aux consommateurs. Cet article présente une analyse détaillée de la qualité de l'eau de boisson dans le pays et des répercussions sur la santé. Il identifie différents facteurs qui contribuent à la mauvaise qualité de l'eau et propose des mesures essentielles pour garantir aux consommateurs un approvisionnement sûr en eau de boisson.

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Introduction

Pakistan's population has a current water supply coverage of 79% [*1*]. This inadequate supply of water also poses health risks to the consumers because of its poor quality. Faecally-contaminated water is a major contributor to waterborne diseases. With rapid urbanization, the chemical aspects of water quality have also become a cause of increasing concern as toxic chemicals in industrial effluents pose a high risk to human health. Unfortunately, little attention is being paid to drinking-water quality issues and quantity remains the priority focus of water supply agencies. There is a lack of drinking-water quality monitoring and surveillance programmes in the country. Weak institutional arrangements, lack of well equipped laboratories and the absence of a legal framework for drinking-water quality issues have aggravated the situation. Above all public awareness of the issue of water quality is dismally low. This paper presents an overview of the prevailing situation regarding source and drinking-water quality and its impact on human health, and delineates management strategies to ensure safe drinking-water supplies to consumers.

Water quality

In Pakistan, drinking-water supplies are generally obtained from surface water sources (such as rivers, canals or lakes) or the underground aquifers. The quality of surface water is deteriorating as a result of the disposal of untreated municipal and industrial wastewaters and saline drainage effluent from agricultural areas [*2*]. The river waters have very high suspended solids, particularly during high flow conditions. Many rivers have stretches which do not support aquatic life. The range of water quality characteristics in some of the major rivers in Pakistan as reported by Aziz is presented in Table 1 [*2*]. Table 2 summarizes the range of water quality characteristics of some important lakes in Pakistan, which are used as raw water sources for drinking supplies [*3*]. It is evident that these waters are faecally contaminated and require elaborate treatment for human consumption. Only a few major urban cities in Pakistan use surface water sources; these include Karachi, Hyderabad, Islamabad and Rawalpindi. In rural areas, where the groundwater is saline, irrigation canal water after treatment is supplied for domestic use. Unfortunately the surface water quality has not been monitored on a routine basis as a raw water source for domestic supplies and no reliable data are available in this respect. Furthermore, no detailed investigations on biological characteristics of waters including algae and parasitic stages have ever been undertaken.

There is a reliance on groundwater as opposed to surface water sources for drinking-water supplies in most areas of Pakistan [*2*]. Around 70% of drinking-water supplies come from aquifers [*4*]. This reliance at present is growing. However, groundwaters in Pakistan are being contaminated by raw sewage irrigation and land disposal of industrial effluents, and through the use of deep soakage pits and heavy application of fertilizers and pesticides. The intrusion of saline water into the fresh water zone as a result of over-pumping has also caused the deterioration of groundwater quality. The quality of groundwater ranges from fresh near the major rivers to highly saline farther away. The general distribution of fresh and saline groundwater in the country is well known and mapped. Cholistan area, Makran coastal zone, Thar, Nara and Kohistan are reported to contain highly brackish groundwater [*2*].

Table 1 **Water quality of some rivers of Pakistan [*2*]**

Parameter	Indus at Kotri	Chenab at Rakh branch canal	River Ravi at Balloki	Haro at Khanpur	Soan at Chira
pH	7.1–7.5	7.0–8.0	7.4–8.35	7.7–8.2	7.5–8.0
Electrical conductivity (µµmhos/cm)	257–487	125–286	280–430	–	–
Total dissolved solids (mg/L)	154–315	149–213	98–250	156–204	116–256
Suspended solids (mg/L)	10–2000	137–340	156–605	16–4320	11–6130
Dissolved oxygen (mg/L)	1.5–6.9	6.8–7.9	6.3–8.2	–	–
Biochemical oxygen demand (mg/L)	1.5–5.0	1.4–2.5	2.3–3.9	–	–
Chemical oxygen demand (mg/L)	7.0–19.0	11.0–30.5	16–80	–	–
Faecal coliform (/100 mL)	150–400	1050–5000	1200–15000	–	–
Calcium (mg/L)	12–46	35–53	29–59	28–44	24–36
Magnesium (mg/L)	3–29	13.5–40	8–22	12–23	7–28
Chlorides (mg/L)	6–100	30–50	20–30	7–13	7–25
Sulfates (mg/L)	6–140	28.6–46	27.6–39.3	16–77	5–34
Nitrates (mg/L)	4.2–10.5	2.0–3.6	0.53–6.0	–	–

Values shown are the range of measurements.

Geological settings have also affected the groundwater quality from place to place. The salt range between Kasur and Mianwali has been found to have groundwaters with high fluoride content, ranging from 5 to 29 mg/L in waters obtained from shallow wells and hand pumps [*5,6*]. Other areas with high fluoride content include Kharan,

Table 2 **Water quality of some major lakes in Pakistan [*3*]**

Parameter	Lake			
	Kalari	Haleji	Keenjhar	Rawal
pH	8.0–8.2	7.8–9.1	8.0–9.0	7.2–8.4
Turbidity (nephelometric turbidity units)	20–29	8–46	20–100	–
Electrical conductivity (mµmhos/cm)	150–400	–	–	100–400
Alkalinity (mg/L as $CaCO_3$)	82–96	113–148	88–116	98–164
Total dissolved solids (mg/L)	142–370	196–340	140–300	–
Chlorides (mg/L)	46–54	44–78	26–80	9–21
Total coliform (/100 mL)	3400–4600	750–1800	900–1800	2000–3000
Faecal coliform (/100 mL)	1400–1700	120–200	96–225	50–1800

Values shown are the range of measurements.

Makran Coast, Mastung Valley, Umar Kot and Tharparkar (AA Khan, unpublished data, 1999). Sampling of groundwater in Jhelum, Gujrat and Sargodha districts by the United Nations Children's Fund has shown concentrations of arsenic in some samples above the World Health Organization (WHO) guideline value of 10 µ/L (B.A. Chandio, A. Majeed, R. Aftab, unpublished report, 1995). A recent survey conducted by the Pakistan Council of Research for Water Resources (PCRWR) has also indicated arsenic concentrations in some groundwater samples obtained from Bahawalpur, Multan, Lahore and Shekhupura are above the WHO guideline value (M.A. Kahlown, unpublished data, 2002). Heavy use of fertilizers has raised nitrate levels in groundwater at various places including Islamabad, Gujar Khan, Faisalabad and many areas in southern Punjab [*6*]. Groundwaters in Karachi, Faisalabad and Raiwind have been found to contain pesticide residues [*7*]. In the city of Kasur, disposal of tannery effluent on the land has caused high total dissolved solids, chromium and sulfide content in groundwater [*6*].

Groundwater quality data for some cities in Pakistan as reported through various investigations are presented in Table 3 [*6,8,* M.A. Kahlown, unpublished data, 2002]. It is evident that a vast concentration range of various quality parameters occurs in groundwaters at different places and WHO guidelines are often exceeded. More recently, detailed investigation on sub-soil water has been undertaken in 14 main districts of the Punjab province [*9*]. In this study, 280 samples of water were collected from existing wells, tube wells, hand pumps and motor pumps. Depth of water for the samples taken varied from 10 to 150 metres. Bacteriological quality of sub-soil water was found to be very poor as 180 samples were contaminated with coliform bacteria. Table 4 presents details of the limits exceeded for various parameters detected in different samples.

Invariably groundwaters are supplied for human consumption without any treatment at all or after disinfection only. From the reported results it is evident that the contamination of groundwater sources, if not controlled, may cause substantial damage or irreversible deterioration of the groundwater quality in future.

Drinking-water quality is largely influenced by the source water quality, the extent and efficacy of the treatment rendered and the integrity of the distribution system. In many areas where the groundwater is saline and a surface water source is not available, people have no choice but to use such waters for drinking purposes. Poor microbial quality of drinking-water is the most pressing issue. No urban water supply meets WHO drinking-water quality guidelines [*10*]. The major reasons for this are the intermittent supply through leaking pipes and cross-connections with nearby sewer lines. In rural areas, where surface waters are supplied after slow sand filtration, arrangements for chlorination at many installations do not exist. In addition pre-treatment facilities such as roughing filters have not been provided. This inadequacy often results in shorter filter runs and poor quality of treated water. Hand pumps and wells in rural areas are invariably not protected from contamination resulting from surface drainage and flooding. In rural areas there is no system in place to assess the quality of water. The institutions responsible for water quality monitoring maintain that there is not much point in monitoring the quality of water where alternative sources of supply do not exist. Estimates suggest that 90% of the country's population is exposed to unsafe drinking-water [*11*].

Table 3 **Groundwater quality data of some cities of Pakistan** [*6,8*]

City	pH	Total dissolved solids (mg/L)	Hardness ($CaCO_3$ mg/L)	Chlorides (mg/L)	Iron (mg/L)	Arsenic (μμg/L)	Total coliform (/100 mL)	Faecal coliform (/100 mL)
Lahore	7.6–7.8	260–290	192–196	14–95	0.2–0.5	0–50	2–7	0–0
Faisalabad	8.2–8.4	220–600	74–186	21–52	0.1–0.4	0–10	6–20	0–1
Peshawar	7.5–7.8	300–342	90–120	18–50	0.5–0.6	0–10	14–20	0–0
Multan	7.5–8.1	400–1160	170–370	40–220	0.1	0–>50	–	–
Jhelum	7.4–8.3	500–540	160–182	5–14	1.0–1.2	–	7–16	1–2
Rahim Yar Khan	7.3–7.5	300–500	150–170	12–20	0.2–0.9	–	11–12	1–2
Mardan	7.2–7.4	230–320	140–170	26–30	0.2–0.4	0–10	7–11	0–0
Kohat	7.4–7.7	500–560	280–330	46–64	0.1–0.2	–	–	–
Rawalpindi	7.0–8.3	209–1042	150–540	5–163	0.03–0.07	0–10	0–>240	–
Quetta	7.6–8.6	400–950	170–480	24–121	0.2–0.4	0–10	–	–
Dera Ghazi Khan	7.7–8.0	230–240	140–152	17–20	0.2–0.9	–	7–9	0–2
Dera Ismail Khan	7.4–7.5	230–300	143–160	14–30	1–8.7	–	10–40	1–2
Khushab	7.4–7.6	300–500	138–160	8–11	0.2–0.6	–	4–8	0–1
Hyderabad	7.1–8.2	167–1140	105–600	–	0.03–0.2	0–10	–	–
Karachi	7.3–7.6	211–467	–	–	–	0–10	150–2400	15–460
Islamabad	7.0–8.3	190–589	130–400	3–25	0.03–1.53	0–10	0–>240	–

Values shown are the range of measurements.

The results of some studies [*12*] carried out on water quality from hand pumps and open wells are shown in Table 5 and clearly indicate that the water is bacteriologically contaminated and unacceptable for human consumption. Similar results were earlier reported by the Public Health Engineering Department in 1991, when a survey concluded that 99% of water samples obtained from hand pumps and wells in 114 villages of Punjab were unfit for human consumption due to faecal contamination [*13*]. A similar situation is expected to prevail in other provinces. A detailed survey of drinking-water supplies has been undertaken by the Pakistan Council of Research in Water Resources in 21 major cities of Pakistan (MA Kahlown, unpublished data, 2002). The results revealed that the quality of drinking-water exceeded WHO guidelines with respect to various parameters; these are shown in Table 6.

Health impacts

Due to contamination of drinking-water, people repeatedly suffer from waterborne diseases. Almost 30% of all reported diseases and 40% of all deaths in the country are attributed to faecal contamination of drinking waters [*14*].

Table 4 **Analysis of 280 Punjab groundwater samples [*9*]**

Parameter	WHO guidelines	Maximum	Minimum	Mean	No. exceeding WHO guidelines
pH	–	8.86	6.51	7.6	–
Turbidity (nephelometric turbidity units)	5	100	0	2.6	25
Total dissolved solids (mg/L)	1000	4530	140	817	59
Hardness (as $CaCO_3$) (mg/L)	–	1900	42	282	–
Chlorides (mg/L)	250	1740	10	148	45
Sulfates (mg/L)	250	1500	19	202	60
Total iron (mg/L)	0.3	1.15	0.01	0.07	9
Nitrates (mg/L)	50	30.12	0.01	4.8	0
Fluorides (mg/L)	1.5	11.60	0.02	0.7	28
Total coliform bacteria (/100 mL)	0	–[a]	–[a]	–[a]	180

[a]*Not reported.*
WHO = World Health Organization.

Cases of cholera, typhoid, hepatitis and dysentery are consistently reported in urban and rural areas. However, such cases are hard to quantify because of under-reporting of disease and the fact that no regular records are maintained in health clinics and hospitals regarding illness due to poor water quality. In Punjab, diarrhoea ranks second amongst 15 priority infectious diseases in children under 5 years of age, clearly indicating the faecal contamination of drinking-water supplies [*15*]. In Islam-

Table 5 **Water quality from hand pumps and open wells in Punjab [*12*]**

Cluster No.	Ground-water level (m)	Public hand pumps Coliform (/100 mL)	Public hand pumps *E. coli* (/100 mL)	Private hand pumps Coliform (/100 mL)	Private hand pumps *E. coli* (/100 mL)	Open wells Coliform (/100 mL)	Open wells *E. coli* (/100 mL)
1	20	–	–	9–800	0–0	600–5000	80–2000
2	10	10–240	1–10	14–72	0–0	200–4100	82–1500
3	3	81–690	9–10	125–1400	4–300	570–2000	40–4000
4	3	2–180	9–10	48–125	6–10	290–600	30–80
5	5	31–109	0–20	21–100	6–10	54–150	3–6
6	10	13–51	6–20	9–225	0–10	29–300	1–20
7	10	0–14	0–3	0–12000	0–150	23100–31200	30–8000
8	7	10–700	0–10	0–70	0–0	2000–2100	20–100
9	5	0–4000	0–200	0–9000	0–2000	450	200
10	7	0–200	0–10	0–4000	0–166	400	1700

Values shown are the range of measurements.

Table 6 **Statistical analysis of drinking-water quality in urban centres**

City	No. of samples collected	Samples exceeding World Health Organization guideline values (%)															
		Colour	Odour	Taste	Turbidity	Arsenic	Chlorides	Hardness	Fluorides	Iron	Magnesium	Nitrates	Potassium	Sodium	Sulfate	TDS	MA
Islamabad	27	–	–	–	4	–	–	–	–	4	–	–	–	–	–	–	74
Bahawalpur	25	16	–	4	16	60	4	12	4	60	–	–	4	8	12	16	96
Faisalabad	14	–	–	29	–	–	36	21	–	–	–	–	36	43	36	43	79
Gujranwala	14	–	–	14	7	–	–	–	7	–	–	–	7	7	–	7	29
Gujrat	9	–	–	–	33	30	–	–	–	–	–	–	11	11	11	11	100
Kasur	10	–	21	10	–	31	–	–	30	–	–	–	20	30	20	30	40
Lahore	16	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	12
Multan	16	–	–	–	6	75	–	–	–	31	–	–	–	–	–	–	87
Rawalpindi	15	13		–	20	–	–	7	–	7	–	–	–	–	–	7	87
Shekhupura	11		–	–	–	45	–	9	–	–	–	–	–	27	9	18	55
Sialkot	10	10	10	–	–	–	10	–	–	–	–	–	–	10	10	10	40
Hyderabad	16	25	25	25	69	6	6	6	–	56	6		6	6	6	6	75
Karachi	28	–	–	–	11	–	4	4	7	21	4	4	–	7	–	4	61
Sukkur	12	8	–	–	58	–	–	–	–	75	–	–	–	25	–	25	84
Khuzdar	8	–	–	–	12	–	–	–	–	–	–	–	–	–	–	–	100

Table 6 **Statistical analysis of drinking-water quality in urban centres** *(concluded)*

City	No. of samples collected	Samples exceeding World Health Organization guideline values (%)															
		Col-our	Od-our	Taste	Turbi-dity	Arse-nic	Chlo-rides	Hard-ness	Fluo-rides	Iron	Magne-sium	Nitra-tes	Potas-sium	Sod-ium	Sulf-ate	TDS	MA
Loralai	11	9	–	–	18	–	–	9	55	36	–	–	–	–	–	10	100
Quetta	38	5	–	3	16	–	3	13	42	8	3	–	–	5	8	13	50
Ziarat	8	12	–	–	25	–	–	12	12	–	–	–	–	–	–	–	100
Mangora	10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
Mardan	12	–	–	–	8	–	–	8	–	–	–	–	–	–	–	–	84
Pesha-war	13	–	–	–	8	–	–	8	–	–	–	–	–	–	–	8	69

TDS = total dissolved solids; MA = microbiological agents.

abad and Rawalpindi, the 1993 epidemic of hepatitis, resulting in 4000 cases, was linked to pollution of the raw water source and inadequate water treatment [*16*]. Some cases of methaemoglobinaemia in southern Punjab have been reported [*17*]. Dental fluorosis is quite evident in Kasur, Pattoki and Raiwind [*18*]. In Manga Mandi, near Lahore, limb deformities in more than 100 patients have been attributed to high fluoride groundwater, although this link is not confirmed [*18*]. In Kasur, contamination of groundwater with tannery effluent has caused diseases such as skin irritation, nausea and abdominal disorders (UNIDO, unpublished data, 1999).

Management strategies

To ensure the safety of drinking-water supplies, a management strategy should be based on multibarriers of protection from source to the point of use [*19*]. These barriers include: source protection, water treatment, distribution system integrity, monitoring/surveillance and public information. Effective programmes for drinking-water quality management would require adequate legislation, institutional strengthening and coordination, provision of analytical laboratories and data-handling facilities. All these issues are discussed in this section to formulate an effective management strategy.

Legal

In the first instance there is lack of adequate legislation covering drinking-water supplies in Pakistan. Legislation should make provisions for the establishment of drinking-water quality standards/guidelines as well as regulations for the development of drinking-water sources and the production, maintenance and distribution of safe drinking-water. The water supply agencies should be authorized to initiate legal action to protect their water sources and distribution system from sources of pollution. There is also a need to establish a groundwater regulatory framework to avoid intrusion of saline water into the fresh groundwater zone. A legal ban also needs to be placed on the disposal of wastewaters on land. All these issues could be addressed by introducing new relevant clauses in the 1997 Environmental Protection Act [*20*].

Governance

Presently, no agency is involved in routine monitoring of drinking-water quality. To ensure safe water supply, the concerned agencies need to design and initiate water-quality monitoring programmes. In urban centres, sampling could be done twice a year for chemical analysis before and after the monsoon. Bacteriological analysis could be done on the basis of the population as proposed in the WHO guidelines [*10*]. In urban areas monitoring of shallow groundwater should be given priority as it is extensively used for private supplies.

For rural areas, bacteriological quality could be monitored on a needs basis. However, sanitary inspection of their schemes, e.g. wells, hand pumps, stand posts, etc., should be done according to the frequency proposed in the WHO guidelines. To support water source option consideration in water scheme planning and to assess the impact of fertilizer and pesticide use, there is a need to initiate survey and mapping of rural groundwater quality. This could be done by the public health engineering departments, local government and rural development departments, or their successors in the devolution plan.

Presently, no surveillance of drinking-water quality is undertaken by any agency. For effective management purposes, there is a need for a comprehensive surveillance programme. The responsibility of surveillance could be entrusted to the provincial environmental protection agencies (EPAs). EPAs should also check the illegal practice of disposal of industrial effluent on land. Strict compliance with the National Environmental Quality Standards is also needed under the 1997 Act to protect water bodies from pollution [*21*].

Institutional

For effective water quality management, there is a need to strengthen the capacity of the administration at the district and *tehsil* (sub-district) levels. Technical assistance will be needed at the *tehsil* level for collection of samples for transport to district laboratories, use of field test kits and initiation of sanitary inspections. District level administration would require strengthening to start water quality monitoring projects and upgrade water supply systems. Analytical laboratories present at the district level would have to be upgraded in terms of staff and equipment to undertake water quality testing. Technical assistance would also be needed for installing roughing filters and chlorination equipment at treatment plants. Water supply providers (public health engineering departments, water and sanitation agencies, development authorities, municipal committees, local government, rural development authorities, cantonment boards, etc) in urban areas would require funding to shift from an intermittent system to a system of continuous supply and for effective maintenance of the distribution network.

Presently various institutions involved in collecting water quality data do not collaborate and share data with each other. This practice needs to be changed by enhancing the data generation capacity and sharing trends of related institutions. For easy access to the water quality data required to formulate strategies and monitoring programmes, it is recommended that a national database on water quality be established at the Pakistan Environmental Protection Agency (PEPA) in Islamabad. Data relating to drinking-water quality should be retained at the district level so that water quality problems can be dealt with and also forwarded to the PEPA database.

There is need to develop and provide for special treatment facilities for waters with high fluoride, nitrate or arsenic content. Research institutions could therefore be funded to undertake research to devise low-cost water treatment technologies.

General

There is need to launch public awareness campaigns to educate people about the importance of safe drinking-water supplies. Nongovernmental organizations can play a pivotal role in this aspect. Building awareness should also be carried out at the primary education level. Rural communities should be advised to adopt suitable measures for protecting stored water from possible contamination inside the house and about simple techniques for disinfection of the drinking water.

Conclusions

It is clear that both urban and rural drinking-water supplies in Pakistan are largely contaminated and pose serious health risks to the consumers. To ensure safe water supplies for drinking, there is need to formulate an effective management strategy. The key actions for such a strategy should comprise of the following strategies.

- Establish drinking-water quality standards.
- Establish a groundwater regulatory framework.
- Ban land disposal of wastewaters.
- Strictly enforce national environmental quality standards.
- Initiate mapping of the rural groundwater quality.
- Define the type of monitoring for urban and rural drinking-water quality.
- Set up district-level drinking-water quality monitoring projects.
- Assign surveillance responsibilities to EPAs.
- Conduct sanitary inspection of rural water sources.
- Strengthen district and *tehsil* administration for drinking-water quality monitoring.
- Upgrade analytical laboratories in terms of staff and equipment.
- Establish a national database on water quality at PEPA.
- Assist research institutions to develop appropriate water treatment technologies.
- Raise public awareness at all levels about the issues of drinking-water quality.

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Second meeting for the WHO technical committee for the preparation of the guidance document on desalination for safe water supply

The World Health Organization (WHO) organized the above-mentioned meeting in Kuwait from 12 to 14 November 2005. The objectives of the meeting were: to review content and completeness of draft background and analysis documents that have been prepared by each technical group; to share information between groups to ensure that each document contains the essential information and interrelates with the other group documents; to prepare revised and expanded drafts of each group's documents; to recommend specific points and principles to be included in the WHO guidance; to work on editorial and format requirements; and to agree on the plan of work and schedule to complete any remaining needs for the draft guidance after the meeting.

Experts from Australia, Canada, Cyprus, Denmark, Egypt, Germany, Japan, Kuwait, United Arab Emirates, UK, and USA, UNEP/ROWA, ROPME, as well as WHO concerned staff and members of the Steering Committee of the Initiative on Desalination Guidelines from Spain and the Cayman Islands attended the meeting.