WATER SUPPLY AND MANAGEMENT

VOLUME 2: THE SUPPORTING MATERIAL

APEC Center for Technology Foresight

73/1 Rama VI Road, Rajadhevee, Bangkok 10400, Thailand
Tel: 662 8150 to 94 ext. 703, 705, 706
Fax: 662 644 8020
http://www.nstda.or.th

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FOREWORD

The APEC Center for Technology Foresight was launched in Bangkok on 3 February 1998. The objectives of the Center are:

- Promote the adoption of technology foresight across APEC member economies.
- Provide a means for comparison of technology foresight exercises and implementation in APEC member economies and across the world, with a view to stimulation of Best Practice in appropriate methodologies for Foresight in APEC economies.
- Conduct technology foresight exercises on an APEC-wide basis, and between relevant member economies.
- Improve the quality and effectiveness of technology-related planning and development and priority-setting for research, across APEC member economies.
- Develop a technology foresight research and application capability available to APEC member economies and International agencies.

The Center has adopted the following definition of Foresight:

> *'Foresight involves systematic attempts to look into the longer-term future of science, technology, the economy, the environment and society, with a view to identifying emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic, social and environmental benefit'*

As its initial project, the Center chose the topic of 'Water Supply and Management' with a time horizon of 2010. The aim was to involve as many APEC economies and their Experts as possible to produce an outcome relevant to all APEC economies. The approach was to have an Issues Paper prepared by a consultant and then draw together a group of Experts to analyse the issues and develop scenarios. Based on these scenarios, a set of inputs for a Delphi Survey was constructed and distributed widely to Experts in the APEC economies. The results of the Delphi Survey were combined with the scenarios to produce a report for policymakers, which is published as Volume 1.

As contribution to stimulating debate in APEC member economies, Volume 2 reproduces the Issues Paper and sets down outcomes of the Experts' Meeting held at Hua Hin on 12-14 May 1998. These outcomes include the issues identified by the Experts, the uncertainties identified for future water supply and management and three scenarios based on groupings of these uncertainties. Using these scenarios the Experts identified a preliminary list of topic statements for the Delphi Survey, which were refined and expanded and then distributed. The analysis of the Delphi studies is reported in Volume 2.

The Experts' Meeting drew together 10 experts from 9 economies and we are particularly grateful to them for giving their time and experience and to their economies which supported their attendance. We are also very grateful to Professor Ron Johnston for preparing the Issues Paper, for carrying out the demanding role of facilitator and for preparing the policy makers' report. Dr Taeyoung Shin on whom fell the burden of the Delphi Survey ably assisted him.

To our knowledge, this is the first multi-economy Foresight project and the process has provided to be an intensive learning exercise both for the Experts and for the Center staff. We are indebted to Monthida Sitathani, Tamsin Jewell, Mayuree Vathanakuljarus, and Nalinrat Sirikantraporn for their dedicated support.

Greg Tegart Chatri Sripaipan

Director Co-Director

1. BACKGROUND TO THE STUDY

The topic of water supply was one of the three highly rated projects identified in a wide survey of opinions for possible topics for the APEC Center for Technology Foresight prior to the APEC Symposium at Chiang Mai, Thailand, on 10-13 June 1997. The background paper for the opinion survey stated:

"***Water Supply***

Beyond 2000 there will be great need of supplies of water for domestic, agricultural and industrial uses while excessive water supplies cause seasonal flooding and global warming may start to increase the sea level causing flooding of low lands. Clean water will become every-increasingly more scarce. Technologies include water management, remote sensing, irrigation with environmental concerns, and recycling and conservation technologies. Other technologies to purify water such as membrane filtering are needed."

The topic was then discussed at a Group Discussion Session at the Symposium and a number of further issues were identified. To quote from the record of the discussion:

"*On water supply, the Group discussed differing view points when viewed from differing perspective such as: industrial vs human usage, application of best practice vs developing new technology, agriculture (where mis-use pattern may be in particular importance) vs urbanization (over treatment of water notably when only 5% treated water is used for drinking). The group also discussed the following issues and topics; conservation, management protocol, valuation of water (as with crude oil), effect of climate change on water supply/distribution, membrane technologies, desalination technologies, potential for APEC-wide standards, flood management/control, regulatory issues as incentive to encourage proper management, and monitoring pollution*."

At their initial meeting on 2 February 1998, the International Advisory Board of the APEC Center identified this topic for early study and broadened it to 'Water Supply and Management' to reflect the issues raised above. This was endorsed by the Steering Committee. Further issues were identified in the Workshop held in Bangkok on 4-6 February 1998 when the topic was used in the session on Delphi techniques.

2. INTRODUCTION

The water resources upon which human life depends are under increasing stress. Almost no country will be spared the threat. Over the next 30 years, more than 60% of the world's population will face water related problems; that is, somewhere between four and seven billion people. (UN Secretary General Kofi Annan, First World Water Forum, Marrakesh, Morocco, March 1997)

Every eight seconds a child dies of a water-related disease. Every year more than five million human beings die from illnesses linked to unsafe drinking water, unclear domestic environments and improper excreta disposal. At any given time perhaps one-half of all peoples in the developing world are suffering from one or more of the six main diseases associated with poor water supply and sanitation… Nearly a quarter of humanity still remains today without proper access to water and sanitation. (World Health Organisation, fact Sheet No 112, November 1996)

Of more than 200 international river basins, 148 are shared by two countries, 30 by three countries and 22 by four or more… apart from island countries, almost all countries are involved in the problems of international riverbasins to some extent… Over a third of these major international riverbasins are not covered by any international Agreement… Pollution, impoundment and diversion of water by upstream nations is likely to be a growing source of international tension and insecurity. (Union of International Associations, April 1998)

Current patterns of water use in developing countries, countries with economies in transition and industrialised countries alike are often not sustainable. There is mounting evidence that the world faces a worsening series of local and regional water quantity and quality problems, largely as a result of poor resource management, including ill-adapted allocative mechanisms, wasteful use of the resource, unregulated effluent disposal and weak institutional frameworks. There is also a close interaction with declining biodiversity, desertification and pollution of the marine environment. (UN Economic and Social Council, Geneva, June 1997)

These four quotes show the extent of the challenge to effective water supply and management across the APEC region. Every member economy has a somewhat different set of problems, and a different infrastructure and capability to address them. But no economy is immune.

In the USA, the Ogallala Aquifer, which supplies about 30% of all groundwater irrigation, has dropped more than 30 metres in some areas, and the diversion of river water is leading to the destruction of the Florida Everglades.

In China, excessive withdrawals are causing intrusions of seawater into deltas and coastal aquifers, and groundwater is dropping as much as one metre per year.

In countries across South-East Asia, from Australia, to Papua New Guinea, Indonesia and Malaysia, the effects of the latest El Nino cycle have been major droughts and for the last two, prolonged fires which have produced levels of haze sufficient to threaten human life and safe travel.

Regions facing the greatest threat of freshwater scarcity include northern China, northern Mexico, western United States and Chile.
Because of dams and diversions for irrigation and industry, such great rivers as the Huang He, the Colorado and the Murray-Darling run almost dry before reaching the sea.

This is just an illustrative catalogue of the challenges facing, and the importance of achieving, effective water management and supply, sufficient to justify this project by the APEC Center for Technology Foresight in Bangkok. For it is evident that the many uncertainties surrounding the future of water management and supply are a considerable impediment to effective action.

As a starting point for the study, Professor Ron Johnston, Executive Director of the Australian Centre, for Innovation and Industrial Competitiveness at the University of Sydney prepared an Issues Paper. The purpose of this Issues Paper was to identify the major issues facing water management and supply, at a level comprehensible to the informed non-expert. The Issues Paper is reproduced in Section 3 and it should be noted that no attempt was made to produce a comprehensive description of challenges for, and capabilities of, water supply and management at the level of individual APEC economies. Rather, the situation in individual APEC economies was used as illustration and example to develop a more APEC-generic analysis and strategy over the next 10-20 years.

In Section 4, the processes of the Experts' Meeting at Hua Hin on 12-14 May, 1998 are described in detail, notably the identification of issues, the development of scenarios and the preliminary identification of issues for the Delphi Survey.

Section 5 details the process of the Delphi Survey and discusses the analysis of the results. Throughout Sections 4 and 5, the lessons from the overall study and the implications for future multi-country foresight studies are discussed in some detail at appropriate points.

3. KEY ISSUES AND POLICY OPTIONS IN WATER SUPPLY AND MANAGEMENT

3.1 WATER CHALLENGES - A LOOK TO THE FUTURE

Several major driving forces will shape water use in 2025:

- Population will influence how much water will be needed for a wide range of needs, including food production, industrial development and domestic use. The mid-range projection from the United Nations is that world population will grow from 5.7 billion in 1995 to about 8.3 billion in 2025, amounting to an increase of 2.6 billion people. Much of the population increase will be in the rapidly growing urban areas of developing countries, many of which are already experiencing serious water stress.

- Most of the new population will be found in the developing world, and the countries therein will move from being 37 per cent urban in 1995 to 56 per cent urban in 2025. At the same time, there will be more industrial development. These trends will take both people and water supplies from agriculture, creating an urgent need for more urban sanitation. Peri-urban agriculture is also increasing. By 1995, the world had 321 cities with a population over 1 million, including 15 mega-cities with populations in the 10 million-20 million range. The number of mega-cities is forecast to double over the next 20 years. In spite of that, there will still be more rural poor in 2025. If regions with high rates of urbanisation are to maintain current levels of water and sanitation supply, this could mean investments of over 1 per cent of gross domestic product (GDP) by 2025.

- The magnitude of the impact of a given population will vary depending on the amount and patterns of consumption of natural resources and of pollution. A United Nations Industrial Development Organisation (UNIDO) study showed that current trends will lead to more than a doubling of 1995 industrial water use by 2025, with an over fourfold rise in industrial pollution loading, unless changes are made. If more water-efficient technologies are used, this will cut wastage, and thus reduce the amount of water that needs to be taken from various sources to produce a given amount of food or industrial output. In the agricultural and industrial sectors, there are already many examples of technology changes that have reduced both the amount of water used and the amount of pollution released without reducing the output of products. At the domestic level, there are many examples of water-efficient fixtures, and there are attempts to educate more people in the safe use of hazardous materials so as to reduce the amount dumped into waterways or drains leading to waterways.

- A large part of the increase in world food demand will come from the arid and semi-arid developing world, where there are high population growth rates. Many of these countries will find it difficult to keep increases in food production in line with demand increases, and water will be a limiting factor. Countries may have to choose between

using their scarce water resources to maintain food self-sufficiency, and using the water to produce high-value products that can be exported to pay for food imports.

There is another potential factor that could affect water availability. According to the Intergovernmental Panel on Climate Change, the release of gases such as carbon dioxide (CO2) is increasing the ability of the atmosphere to trap heat. The Panel warns that this may bring about temperature increases, precipitation changes and sea-level rise, with varying impacts on the availability of freshwater around the world. Computer models of possible future climate patterns are not yet precise enough to forecast changes at the local or small basin level. Current indications are that if climate change is gradual, the impacts may be only minor by 2025, with some countries having positive impacts, and most being negatively affected. Climate change impacts are predicted to become increasingly strong during the decades following 2025.

As the risk of water stress increases, there will be a need for increased demand management in order to maximise the socio-economic benefits derived from the competing users of water. Water management must also be more prudent than in the past so as to avert the further degrading of agricultural areas through such impacts as salinisation, water erosion and waterlogging. Failure to protect the food growing capability of the world would have severe implications. To avert such problems countries, particularly water-scarce countries, need to look at projections in such sectors as population, urbanisation, and economic and agricultural development, and establish water strategies and policies.

As water becomes scarcer in relation to demand, and competition among various users increases, water ceases to be available as a free good and becomes in some cases a tradeable commodity. There is a shift taking place in the role of Governments - a shift from their role of providing water at very low cost to one of regulating water markets. As competition for available water grows among users, such as municipalities, industries, hydroelectric generators and irrigators, the price of water rises. While this allows the market place to choose the highest-valued use for water in economic terms, it will almost certainly entail water price increases and this means that some users will be able to outbid others for the available water. This has the potential to impose hardships on some users, and there will be a need to ensure that everyone has a basic amount of water available at reasonable cost.

A number of estimates have been made to how much water would be needed to produce enough food to give everyone in the world a healthy diet. The estimates ranged between a 50 per cent and a 100 per cent increase in water for food production over 30 years. The bulk of the increase in food production will need to come from irrigated land. Some of the estimates found that by 2025, it would require virtually all the economically accessible water in the world to meet the needs of agriculture, industry and households, and maintain adequate lake levels and flows in rivers. If more water is needed, more expensive projects such as high-cost dams and diversions to bring water from sources far away from the area will be required.

As water becomes more scarce, municipalities and industries will be able to outbid most farmers, and this will push up the cost of water. If cost of water is passed on to the consumer, then food prices will go up. If farmers have to absorb the increased cost, poorer farmers growing relatively low-value products could be forced out of business. While in the long run the use of pricing as a tool for allocating water resources is effective, the implementation of pricing policies needs to take into account the possible economic and social impacts on the peri-urban and rural poor.

As food production is closely linked to the quality of land, the proper management of irrigation is essential in order to prevent land degradation through, for example, salinisation and waterlogging. The installation of adequate drainage, while protecting this natural capital, is likely to raise the cost of irrigation.

The regions most vulnerable to domestic water shortages include those that currently have poor access to water, are characterised by rapid population growth, uncontrolled urbanisation and financial problems, and lack a skilled workforce. Even if the world maintained the pace of the 1990s in water supply development, it would not be enough to ensure that everyone had access to safe drinking water by 2025. Sanitation development is even more difficult to achieve. If everyone is to have sanitation facilities by 2025, this means providing services for more than 5 billion people in 30 years.

3.1.1 Making Water Available to Increase Food Production

In many regions, water scarcity is resulting in severe constraints on the expansion of agricultural production, thus raising pressure for water policy interventions and for more efficient water-use practices. Because globally little new land of adequate quality remains to be put into production, and since the environmental cost of converting land use is high, the largest part of future food requirements will have to be satisfied through higher productivity on existing agricultural land.

Application of water through various forms of irrigation, and the use of genetically improved crops and the considered application of pest management and plant nutrition systems, are the main factors for the agricultural productivity increases required to feed the world. Countries can improve the efficiency of water use for irrigation with such techniques as lining of canals and the use of more efficient ways of applying water to plants. However, attention must be drawn to the fact that water use in the entire river basin can be highly efficient even though the individual irrigation schemes within the basin are inefficient, in which case seeking a higher irrigation efficiency in one scheme is bound to result in further water scarcity in the downstream schemes. Under such situations, water savings have to be sought in the use of a less water demanding mix of crops and in shifts of the cropping period into a less evaporation-intensive season.

Besides new cropping patterns and conventional first-generation irrigation, many other 'drought-proofing' techniques exist. They include high-efficiency irrigation, water harvesting, inland valley swamp development, low-lift pump schemes, peri-urban irrigation with treated urban wastewater and conjunctive use of surface water and groundwater. Irrespective of what method is chosen, it would imply a consumption of water now passing through the landscape, meaning that water would not be available downstream for other uses.

If treated wastewater was used for irrigation, this would means that the amount of freshwater that could be used for other purposes would increase. In those water-scarce countries that, because of the domestic water shortage, will become heavy importers of basic foodstuffs, wastewater may well represent in the future the predominant long-term water supply for irrigated agriculture. Water harvesting, which means small-scale projects to capture run-off, can also improve soil moisture and food production.

Desalinisation of seawater is an option for such relatively low-volume, high-value users as industries and homeowners with at least a moderate income. However, even with technological advances, wheat production with desalinated water is economically prohibitive.

3.1.2 Increased Access to Drinking Water Supply and Sanitation

There are a number of relatively simple and inexpensive techniques for supplying drinking water and sanitation. If they are to succeed, they must be chosen in consultation with the users, and they must use technologies that can be installed and maintained at the community level. They must thus be user-friendly, affordable and appropriate.

When it comes to making decisions on water supply and sanitation systems, it is vital to involve all users. For example, women already play a crucial role in providing water and in decisions on hygiene in families. They should be closely involved in decision-making as well as in implementation of the water and sanitation supply programmes.

If not controlled, untreated sewage from cities, industrial discharges and non-point pollution from agricultural activities and urban run-off will continue to damage rivers, aquifers and coastal zones, with devastating effects on our freshwater resources and oceans. Even though pollution prevention sometimes has a higher initial cost than discharging untreated water, experience shows that in the long run it is cheaper than clean-ups. Wastewater, especially that which is not heavily polluted, can often be used for other purposes, such as industrial cooling and sometimes for irrigation. To encourage pollution prevention, it is important to apply the Polluter Pays Principle.

3.1.3 Water as a Resource having an Economic Value

Water has economic value, and should be considered an economic as well as a social good. Like any valuable commodity, water use has a cost in terms either of its development or of its forgone opportunities. The cost of using or misusing water does not disappear, but is paid either by the user or by the community at large or through depletion of the existing natural capital. As water demands increase, it becomes more important to see that water is put to high-valued economic uses. It is important to see that there is full cost accounting and full cost recovery for the provision of water, and that users pay for the water used for economic purposes.

The introduction of water markets and pricing mechanisms can encourage the private sector to play an increasingly important role in providing the necessary financial resources and management skill needed for the successful development and utilisation of the resources. Governments need to establish laws and regulations for the fair and efficient operation of water markets. Wherever subsidies or income transfers are deemed necessary for social or other national considerations, the objectives of such subsidies or transfers should be well defined and the incidence of the subsidy should not fall on the public or private utilities providing the service.

It is essential that economic planning incorporate the idea of water as natural capital whose services can be depleted, as in the using up of groundwater or polluting of water sources. Those services can only be restored at high cost. In the long run, a failure to include the state of water resources in economic analysis, particularly in macroeconomic analysis, leads to unnecessary, wasteful and costly investments in water supply developments, to misallocation of water resources among competing uses and, in some cases, to the actual collapse of schemes.

3.1.4 Building Human and Institutional Capacity to solve Water Problems

Capacity building is an essential step in preparing sustainable water strategies. It includes education, awareness-raising and the creation of a legal framework, institutions and an environment that enables people to take well-informed decisions for the long-term benefit of their society.

Many Governments will need to assign a high priority to their capacity-building efforts towards institution-building, legislation and human resources development. National efforts in this regard need to be supported by International, regional and national external support agencies, and by the non-governmental community, including the private sector.

3.1.5 Access to Reliable Data

Effective water resources assessment and management are not possible without adequate information, including hydrologic information, water-use and -quality data, demographic data (separated by gender where relevant), forestry and land management, and capacity to assess the data. There is a need for national and internationally agreed upon and harmonised information systems that provide data needed for decision making, as well as common ways of analysing the information.

Ideally, the river basin or watershed should constitute the geographical unit for data collection and analysis. Even though some countries have hydrologic data available, usually on the river basin level, almost no country has socio-economic data sorted at a comparable level.

The experience with the current assessment demonstrates that the capability to provide accurate water-quantity and -quality data is sorely lacking in the majority of countries. It is very difficult to obtain reliable, systematic information on water resources management and irrigation in most developing countries. There is also poor data on land degradation related to water use. Even developed countries have been reducing their environmental monitoring systems as part of general budget cuts in recent years.

3.2 KEY ISSUES

The Water Resources Section of ESCAP has identified 13 emerging issues in water resources in the Asia-Pacific region:

- Water resources assessment.
- Integration of water resources development into national policy, plans and programs for economic and social development.
- Integrated water resources development and management.
- Protection of water resources, water quality and aquatic ecosystems.
- River basin development and management.
- Water for sustainable urban development.
- Water for sustainable rural development.
- Promotion of infrastructure development and investment for drinking water supply and sanitation.
- Water pricing and promotion of private investment in the water sector.
- Water demand management, water saving and economic use of water.
- Promotion of women's role in water supply and sanitation.

- Mitigation of water related natural disasters, particularly flood loss reduction.
- Improvement in land use planning and practices for disaster reduction and watershed management.

These provide the basis for 12 key issues identified in Water Supply and Management in the APEC region for the purposes of the APEC Technology Foresight Expert's Workshop.

Issue 1. Water Quantity

The supply of freshwater in a region is limited by the dynamics of the hydrological cycle. The renewable supply of water is determined by the surface run-off from local precipitation, the inflow from other regions, and the groundwater recharge that replenishes aquifers. As water can, in principle, be re-used many times, the availability of water for human use depends as much on how it is used and how water resources are managed, as on any absolute limits. Apart from human use, water is also needed to sustain the natural ecosystems found in wetlands, rivers and the coastal waters into which they flow.

Based on the data that about 42,700 cubic kilometres of water that falls on the Earth flows through river systems, it is estimated that about 9,000 cubic kilometres per year are readily accessible for human use, plus a further 3,500 cubic kilometres that is captured and stored by dams and reservoirs.

However freshwater resources are very unevenly distributed, and subject to substantial cyclic variation. Thus, within the APEC region, the countries in tropical regions are normally subject to very high rainfall, and availability is largely determined by capture. However, the most recent El Nino cycle has demonstrated that even these countries can be subject to severe limitations of rainfall. At the other extreme, countries such as the USA (western region), China (northwest) and Australia (all except southeast), have normally very low rainfall, and hence have to concentrate on the effective use of the limited available resource.

What are the prospects for increasing the total water available for human and environmental use by improved capture, storage and usage?

Issue 2. Water Demand

Despite recent improvements in the efficiency of water use in many developed countries, the demand for water has continued to rise as the world's population and economic activity has increased. From 1940 to 1990, withdrawals of freshwater have increased by more than a factor of four, more than double the rate of population growth. Current total human usage is about half of the total available water identified above. With a 50% increase of the total world population forecast for the next 25 years, this alone unchanged would approach the limit of water availability.
One important consequence of the growing demand is the increasing reliance on essentially non-renewable water resources in the form of groundwater.

The uneven distribution of water resources has already led to this stage of scarcity in a number of regions. There is an accepted benchmark of 1000 cubic metres per capita per year to avoid chronic water scarcity on a scale sufficient to impede economic development and harm human health. Twenty countries have already fallen below this level, mostly in Africa and Western Asia. However it is worth noting that Israel supports its population, its

growing industrial base and extensive irrigation with less than 500 cubic metres per person per year.

Irrigated agriculture takes about 70% of water withdrawals, rising to 90% in the dry tropics. In total, agriculture consumes 87% of total water. Industry is also a growing user of water. Traditional manufacturing industries such as textiles, food production and chemicals, as well as power production and mining, consume large quantities of water, but largely in localised operations. The newer industries, such as electronics, much of the production of which has been established in developing and emerging economies, are also critically dependent on a reliable water supply.

What are the prospects for limiting the growth in the demand on water resources through demand management of general water consumption, and significantly increased efficiencies in agricultural and industrial use?

Issue 3. Water Quality

Contamination by pollutants has seriously degraded water quality in many rivers, lakes and groundwater sources, effectively reducing the supply of freshwater for human use. While the increase in population alone has increased the challenges to water management, particularly in the area of sanitation, the greatest threats are from a wide variety of industrial, municipal and agricultural sources. While there has been significant progress in developed nations over the past 30 years in controlling water pollution, it has continued to rise in most developing nations and in transition economies.

One important factor is the rapidly growing and industrialising cities of the developing world, where pollution control is still in its infancy and domestic sewage and industrial effluence have left many urban rivers and groundwater sources heavily contaminated. This widening penumbra of pollution around the 'mega-cities' exacerbates the problem of extending minimal freshwater and sanitation services to the residents, many of whom live in considerable poverty.

The nature of pollution problems vary by region, but include bacterial pollution, largely through inadequate sanitation (it is estimated that 90% of wastewater is discharged without treatment in the developing countries), algal blooms fertilised by the phosphorus and nitrogen contained in human and animal wastes, detergents and fertilisers, chemicals, heavy metals, salinity caused by widespread and inefficient irrigation and high sediment loads resulting from upstream erosion resulting from deforestation.

What range of measures, technologies, and management regimes are in prospect to improve water quality?

Issue 4. Current Water Technologies

A range of technologies is currently available for water supply and management. They include:

- detection and access - largely drilling supply bores into groundwater;
- capture and storage - dams etc; loss reduction, quality management of stored water;
- distribution infrastructure - pipeline construction and maintenance, leakage detection and control;
- wastewater treatment - biological, chemical, recycling;

- irrigation - supply, application, monitoring;
- sanitation - variety of filtration and purification techniques and processes, centralised and decentralised.

What are the potential and likely incremental and radical innovations in these technologies?

Issue 5. Water and Economic Development

Water is an essential input or infrastructure resource to much agriculture, energy production, industrial manufacture, mining, water transport, and water recreation industries. The increasing pressures of International competition, and the emergence of newly industrialising economies, are producing ever-increasing demands for the supply and management of this commodity. The availability of this commodity is a very real limit-to-growth upon economies.

This is leading to conflict over usage priorities for human direct consumption and sanitation needs, agricultural (particularly irrigation) and industrial demands, and the environmental requirements of a healthy functioning of water-reliant ecosystems. It is now recognised that this is not important only for ethical or 'visual amenity' reasons, but also because ecosystems health underpins the production of food, the reduction of flood risk, and 'natural' filtration of contaminants.

In addition, inappropriate or inefficient use and management of water is having directly deleterious effects upon these systems of production. Thus excessive or inappropriate irrigation is a primary cause of salination, leading to enormous degradation of land resources. Polluted run-off can have a very damaging effect on marine resources, including fishing, both directly and through producing the conditions for algal blooms and 'red tide'. Contaminants can render water unusable for manufacturing use, as in for example the food industry, and in extreme circumstances, even for cooling purposes.

What advances are in prospect to substantially improve the efficiency, effectiveness, and output quality and recycling of water in economic usage?

Issue 6. Water and Economic Policy

Water is often wasted because it is under-priced. There is a need for a widespread understanding of water as an economic as well as a social good. The cost of using or miss-using water is paid either by the user, by the community at large, or, commonly, by a depletion of the existing 'natural capital'. As water demand continues to increase, it becomes every more important to see that it is directed to high-valued economic or social uses.

Thus, a removal of the direct and indirect subsidies, especially for agricultural use, currently operating in many countries, would provide an incentive for more effective use, for conservation, and for the investment in and diffusion of more effective technologies and systems. Allocation of water rights not on a historical basis, but a more transparent market or administrative system based on full cost accounting and benefit analyses, can substantially reduce distortions and inefficiencies.

This points the way for Governments at national, provincial and municipal levels to shift progressively away from being a provider of water services to being the creator and

regulator of an environment that allows communities, the private sector, and non-governmental organisations to engage in the supply of water and sanitation services. The introduction of water pricing and market mechanisms can encourage the private sector to apply financial and management resources towards more effective water supply and management service delivery.

What are the most appropriate economic mechanisms to encourage more effective and efficient water supply and management?

Issue 7. Water and Environment

As indicated in the section on water quality, there is an increasing need, demand, and drive to develop policies and mechanisms to improve both the availability and quality of water supply through control of pollution, and the harmful effects of water mis-use and -management on land resources.

The importance of maintaining an adequate supply of water to maintain the health of rivers has already been mentioned. In addition, there is a growing concern about the negative consequences and economic balance of dam construction and river impedance as a mechanism to increase water supply. Strong opposition, largely on environmental and, to some extent, wilderness protection grounds, have emerged in a number of, particularly industrialised, countries.

Wastewater disposal is another major environmental issue, with different considerations being applied to urban, rural, industrial and mining outputs. The problem is at its greatest, and most visible, in the environment, where the consequences of inadequate treatment and disposal systems have become increasingly obvious. However, some more far-reaching and ultimately more damaging consequences may be associated with a long history of inattention to rural waste disposal.

Substantial progress has been made in recent years in dramatically improving best practice in waste disposal levels in both manufacturing industry and mining, particularly through the concept of 'total containment'. These have been achieved by a mix of regulation and market competition. However there is enormous scope for the diffusion and further development of these waste-reducing practices.

What are the technologies, practices and procedures that can be developed and applied to most effectively improve the environmental quality of water supply and use?

Issue 8. Water and Human Health

Water represents an enormous potential threat to human health. It was only about 150 years ago that the crucial role of the provision of clean water and effective sanitation was recognised as the basis for effective public health. Since then there have been great advances, and the industrialised countries have largely enjoyed a century of freedom from the threat of water-borne diseases.

However that situation is changing, with population growth, and the decline of public investment in infrastructure. It was never the case in the economically less-developed countries. WHO estimates (see Section 3 for more detail) that more than five billion people die each year from diseases caused by unsafe drinking water and a lack of sanitation, and water for hygiene. An estimated one-half of the population of developing countries suffers from water-associated diseases caused either directly by infection through the consumption

of contaminated water, or indirectly, by water dependent disease carrying organisms. Improved water and sanitation can reduce morbidity and mortality rates of some of the most serious of these diseases by 20-80%.

Global progress has been poor since 1990. Approximately one billion people lack safe water and more than two billion do not have adequate sanitation. Rapid population growth and lagging investment have left more people without access to basic sanitation today than in 1990. It is estimated that to achieve the objective of 'universal coverage' by the year 2000 would require an investment of US$50 billion per year, five times the current level.

What are the prospects for, and the most appropriate mechanisms to achieve dramatic improvements in water-dependent aspects of human health?

Issue 9. Water Resource Assessment

A critical element in more effective water supply and management is more effective policy and planning, based on accurate information on the state (quantity and quality, stocks and flows, usage patterns, hydrological and demographic data, information on forestry and land management, etc) of water resources.

The capability to provide accurate water quantity and quality data, and to interpret it, is lacking in many countries. Few, if any developing countries have a significant capability in water quality monitoring. Which would provide important health-related information. Data on water resource management, irrigation, land degradation, and environmental quality are generally sparse and poor.

Moreover, there is evidence that this capability is in decline. In many industrialised nations, the pressures of competitiveness policies, privatisation, and shrinking public sector budgets, have seen a cutback in what are perceived 'public good' activities such as hydrological measurement, observing networks, and consequently in expert staffing. In the developing countries, the pressures of economic development have reduced such long-term approaches to the lowest priority.

What range of measures and techniques might be developed and put in place to maintain and improve water resource assessment?

Issue 10. Integrated Water Resource Management

A crucial component of an effective approach to addressing the challenges identified above, and to improve water supply and management is through an approach based on integrated water resource management. Such an approach rests on integrating, and effectively coordination, policies, programs and practices addressing the issues identified above.

Such an approach will need to include issues such as the efficiency of water use, long-term resource protection, the economic effects of deterioration in water quality, national, or where appropriate, river basin-based management of groundwater and wastewater, and data collection and model development.

In addition, it needs to be recognised that it is no longer adequate to treat water problems as, essentially, a local issue. Even when comprehensive water management plans have been devised, many developing countries lack the financial, managerial and political capacity to implement them. In developed countries, it is not uncommon that interest-based opposition

to ending subsidies or implementing a regime, which includes wider considerations, undermines the political will for change.

What are, and will be, the essential elements in the development and implementation of integrated water resource management?

Issue 11. Geopolitics and International Law of Water

About 300 major river basins, and many groundwater aquifers cross national boundaries. The potential for conflict, as scarcity, and the economic value of water grows, is considerable. While regional and International legal mechanisms can reduce water-related tensions these mechanisms have never received much support. Indeed existing International water law may be unable to handle the strain of future problems.

Under conditions of conflict water resources may become economic or military goals in the same way that oil has been in the past. Water resource systems could be military targets; in addition water resources can in fact be used as military means given the ability to control the flow of water to another nation.

Riparian countries will need to develop mechanisms for cooperation over the development and management of trans-boundary water sources. It would seem appropriate to develop processes for negotiation and non-violent resolution of these differences.

What are possible scenarios for water based conflict and how might they best be avoided or resolved?

Issue 12. New Technologies

There is a considerable range of new technologies either presently under development, or that could emerge over the next ten years, which could make a substantial contribution to the many challenges to effective water supply and management. While a comprehensive list could be impossible to generate, prominent candidates might include:

- greater use and re-use of wastewater for appropriate domestic, rural and industrial applications;
- more efficient delivery and application of irrigation water;
- lower water requirement crops;
- reduced evaporation;
- non-water based sanitation disposal;
- desalination;
- technologies of demand management;
- new plant nutrition systems;
- new cropping patterns;
- water harvesting;
- inland valley swamp development;
- low-lift pump schemes;
- per-urban irrigation with treated urban wastewater;

- bio-solid management and disposal;
- application of smart technologies and intelligent systems to urban and domestic water use;
- closed cycle industrial water usage systems.

What is the potential for the development, refinement and enhancement of new and improved technologies to address the major issues of water supply and management?

3.3 SOME POLICY OPTIONS

A useful approach to distinguish the different needs and policy options of different countries is offered by an analysis according to the following four broad categories:

3.3.1 High-income Countries with Low Water Stress

The main problem of these countries is water pollution rather than supply, although some large countries contain water-poor regions. They have the financial resources to deal with regional water supply problems, often using water diversions.

Pollution reduction and control are the major water-related challenge facing most countries in this category. Many of them also need to look at the issue of water pricing, because the fact that water might be plentiful does not mean that it should be free. Development and distribution costs need to be covered by either public or private utilities. Some countries in this group, with favourable land and climate conditions, may have a significant potential for increased food production from irrigation and rain-fed agriculture, and could play a significant role in providing food to world markets.

3.3.2 High-income Countries with High Water Stress

This category includes a number of countries that have fairly large amounts of water, but are facing stress conditions as a result of continuing overuse and pollution of their water resources which will be causing problems, such as groundwater depletion, in the near future. Other countries, however, have already used most of their accessible water resources. They have little if any scope for increasing the amount of water supplied to human uses through conventional means without inflicting damage on aquatic ecosystems, or seriously depleting groundwater aquifers.

For those countries with low per capita water availability, the allocation of water to the highest-value uses is a necessity. Demand management and water allocation policies designed to maximise the socio-economic value of water are of paramount importance, as is pollution control. Water markets with tradeable water rights and permits are already beginning to play an important role in the allocation of water, and will need to continue to play an increasingly important role. With increased allocation efficiency, it is likely that irrigated agriculture will decrease in importance, and it appears that more countries in this category will become increasingly dependent on the world market for agricultural products.

3.3.3 Low-income Countries with Low Water Stress

There are several different types of countries within this grouping - low-income countries that have low water stress because of abundant water resources (primarily tropically humid countries) and large countries that have a tropical region. Most of these countries or their humid regions suffer from too much water in the form of floods that occur during a short

rainy or monsoon season, causing damage to buildings, structures and agriculture. Since these countries are poor, they often suffer from inadequate drinking water supply and sanitation.

Overall, this grouping of countries suffers from inadequate access to its water resources owing to insufficient financial resources, technical expertise and institutional support. Because of these constraints, there is a lack of adequate water supply, sanitation and wastewater treatment. In cases where there is high population growth or economic development, there is likely to be and increase in water demand. If that demand is not well managed, it could drive the country into a high vulnerability situation.

Countries in this group that are well endowed with land and water resources may have the opportunity to increase agricultural production and exports into the world market from either irrigated or rain-fed agriculture. For those countries with relative water scarcity, and high levels of evaporation, agricultural production is probably best-directed into high-value, low-water-intensive products. Some poor countries lack adequate access to what little water they have, and development assistance could help them in using that water wisely.

Both water-rich and water-poor countries with low incomes generally suffer from a lack of sanitation and wastewater treatment. Water pollution from human or animal wastes is often already a problem, and steps are now needed to improve pollution control and treatment so as to protect human and ecosystem health. The acceptance of highly polluting industries with little or no control on their discharges may be tempting on the basis of short-term economic growth considerations. However, the overall long-term costs to redress environmental damages resulting from such decisions have often been shown to be more expensive than the creating of low-polluting industries in the first place.

3.3.4 Low-income Countries with High Water Stress

This category is made up of low-income countries that are using their water resources heavily now, often for farm irrigation. They also suffer from a lack of pollution controls. A number of countries in the arid or semi-arid regions of Africa and Asia fall within this category. These countries are the most constrained with respect to future development because they have neither the extra water nor the financial resources to shift development away from intensive irrigation and into other sectors that would create employment and generate the income with which to buy food from water-rich countries.

Given the high ratio of water use to availability, population growth and future economic development will require shifts in the utilisation of water towards the production of high-value products.

Countries in this category are urged to give the highest priority to the formulation of economic and regulatory measures designed to increase irrigation efficiency and optimise water

allocation among various uses. In particular they need to pay attention to the generation of foreign exchange that might be needed for food imports. These countries should increase wastewater treatment and reuse, and should control pollution from agricultural chemicals through land management and integrated pest management measures.

4. THE EXPERTS' MEETING AT HUA HIN, THAILAND, 12-14 MAY 1998

4.1 INTRODUCTION

Arising from a request to ISTWG Contact Points for nominations, ten Experts from nine economies (See Appendix 1) gathered at Hua Hin, Thailand on 12-14 May 1998. The Experts first reported on the issues in water supply and management in their economies, then debated the issues outlined in Section 3 and produced their own set of issues which, to a large extent, mirrored those of Section 3 (See 4.2).

They then constructed scenarios based on these issues and, in the process, raised a number of new ones. Based around the discussions, they identified a preliminary set of issues to be explored in the Delphi Survey. The development, conduct and analysis of the Delphi Survey will be described in Section 5.

4.2 IDENTIFICATION OF ISSUES

As a result of their discussions, the Experts identified 15 issues, which reinforced the selection of issues in Section 3 and added several new ones arising from their own experience. These issues were:

1 Quantity
2 Demand
3 Quality
4 Technologies
5 Economic Development
6 Market Forces - separation of supply and regulation
7 Environment
8 Human Health
9 Resource Assessment
10 Integrated Resource Management across full water cycle
11 Geo-politics
12 Structural Safety
13 Infrastructure
14 Enforcement - Water police
15 Energy Costs

4.3 SCENARIO DEVELOPMENT

Scenarios are not about predicting the future; rather they are about perceiving the future in the present (Schwartz, P, The Art of the Long View)

4.3.1 Introduction

That Foresight is not an exercise in forecasting cannot be over-emphasised. Rather, it is a mechanism for visioning possible futures, and for managing in the face of the unavoidable

uncertainty. The scenario technique is a powerful tool in Foresight exercises and was used at Hua Hin.

What are scenarios?

- scenarios are coherent pictures of alternative futures;
- scenarios are not predictions or forecasts of the future, nor are they science fiction stories;
- scenarios are stories about the future comprising a number of plots which bind together the elements of the scenario;
- plots within a scenario are based on the key variables and critical uncertainties in the participants' external environment; and
- in good scenarios, plot lines intercept.

Scenarios address:

- issues trends and events in the current environment that are of concern to decision-makers;
- elements in the environment that are determinable and somewhat predictable - pre-determined events or variables; and
- elements in the environment that are more uncertain, trend breakers that affect a system in unpredictable ways, but with understandable dynamics - turning points in the business, political or social environment, identifiable in the present, though often as early, weak signals of change.

Tests of a good scenario:

- it is plausible to a critical mass of experts and/or decision makers;
- it is internally consistent;
- it is relevant to the topic or issue of interest;
- it is recognisable from signals of the present - weak signals of change;
- it is challenging, containing some elements of surprise or novelty in directions where the participants' vision needs to be stretched;
- it is linked to participants' mental maps; and
- it should not be novel in every respect.

The box below provides a general description of the characteristics and use of scenario analysis, written by one of the pioneers of the technique with the Royal Dutch/Shell group of companies.

Using Scenarios to Navigate the Future

By: Peter Schwartz

Today's organisations face tremendous structural change and uncertainty: globalisation, multiculturalism, internal diversity, technological revolution, and decisions with huge consequences and risks. Anticipating the future in this volatile environment calls for more than systematic analysis; it also demands creativity insight and intuition. Scenarios - stories about possible futures - combine these elements into a foundation for robust strategies. The test of a good scenario is not whether it portrays the future accurately but whether it enables an organisation to learn and adapt.

A scenario is a tool for ordering one's perceptions about alternative future environments in which today's decisions might be played out. In practice, scenarios resemble a set of stories, written or spoken, built

carefully around constructed plots. Stories are an old way or organising knowledge; when used as planning tools, they defy denial by encouraging - in fact, requiring - the willing suspension of disbelief. Stories can express multiple perspectives on complex events; scenarios give meaning to these events.

Scenarios are powerful planning tools precisely because the future is unpredictable. Unlike traditional forecasting or market research, scenarios present alternative images instead of extrapolating current trends from the present. Scenarios also embrace qualitative perspectives and the potential for sharp discontinuities that econometric models exclude. Consequently, creating scenarios requires decision-makers to quester their broadest assumptions about the way the world works so they can foresee decisions that might be missed or denied. Within the organisation scenarios provide a common vocabulary and an effective basis for communicating complex - sometimes paradoxical - conditions and options.

Despite its story-like qualities, scenario planning follows systematic and recognisable phases. The process is highly interactive, intense, and imaginative. It begins by isolating the decision to be made, rigorously challenging the mental maps that shape one's perceptions and hunting and gathering information, often from unorthodox sources. The next steps are more analytical: identifying the driving forces (social, economic, political, and technological); the pre-determined elements (ie, what is inevitable, like many demographic factors that are already in the pipeline); and the critical uncertainties (ie, what is unpredictable or a matter of choice such as public opinion). These factors are then prioritised according to importance and uncertainty.

These exercises culminate in two or three carefully constructed scenario 'plots'. If the scenarios are to function as learning tools, the lessons they teach must be based on issues critical to the success of the focal decision. Moreover, only a few scenarios can be fully developed and remembered; each should represent a plausible alternative future, not a best case, worst case and 'most likely' continuum. Once the scenarios have been fleshed out and woven into a narrative, the team identifies their implications and the leading indicators to be monitored on an ongoing basis.

Good scenarios are plausible and surprising; they have the power to break old stereotypes; and their creators assume ownership and put them to work. Using scenarios is rehearsing the future; by recognising the warning signs and the drama that is unfolding one can avoid surprises, adapt and act effectively. Decisions which have been pre-tested against a range of what fate may offer are more likely to stand the test of time, produce robust and resilient strategies, and create distinct competitive advantage. Ultimately, the end result of scenario planning is not a more accurate picture of tomorrow but better decisions about the future

There are two particular challenges in scenario development, namely:

- to free the participants from their preconceptions and to cast their focus far enough beyond their present concerns;
- to focus on the **external** environment rather than on factors within their organisations and their futures.

Scenarios have been extensively used in Australia, the UK and The Netherlands. The Center has been able to draw on the expertise from Australia through Professor Ron Johnston.

4.3.2 Inputs to the Scenario Process

The Issues Paper, the discussion of their own experiences and the discussion leading to the identification of the 15 issues of Section 4.2 provided the Experts with an appreciation of the key predictable variables in future water supply and management. However a key in put to scenario development is the identification of possible discontinuities, or step changes, which could have a major impact on the topic. One approach is to cast forward to say 2010 and imagine what might be the 'if only I had known that' factors.

At Hua Hin, a fast brainstorming session produced the following unpredictable variables in future water supply and management:

1 Most severe El Nino in recorded history occurs with catastrophic effects on food and water supply.

2 APEC regulations for water quality and trade are introduced and enforced.

3 Water prices soar to unprecedented levels.

4 Three global water companies control APEC water.

5 Dramatic expansion of water capture uses improved technologies.

6 Water wars occur over supply and contamination disputes.

7 International treaty on groundwater use is concluded.

8 Epidemic of water-borne diseases occurs throughout Asia.

9 Advances in desalination technology allow cost-effective production of freshwater.

10 Low water reliant crops - 'dry rice' are developed on an economic basis.

11 Desertification advancing across Asia drastically reduces arable land and reduces water supplies.

12 A new economic miracle leads to tripled incomes in APEC and renewed prosperity.

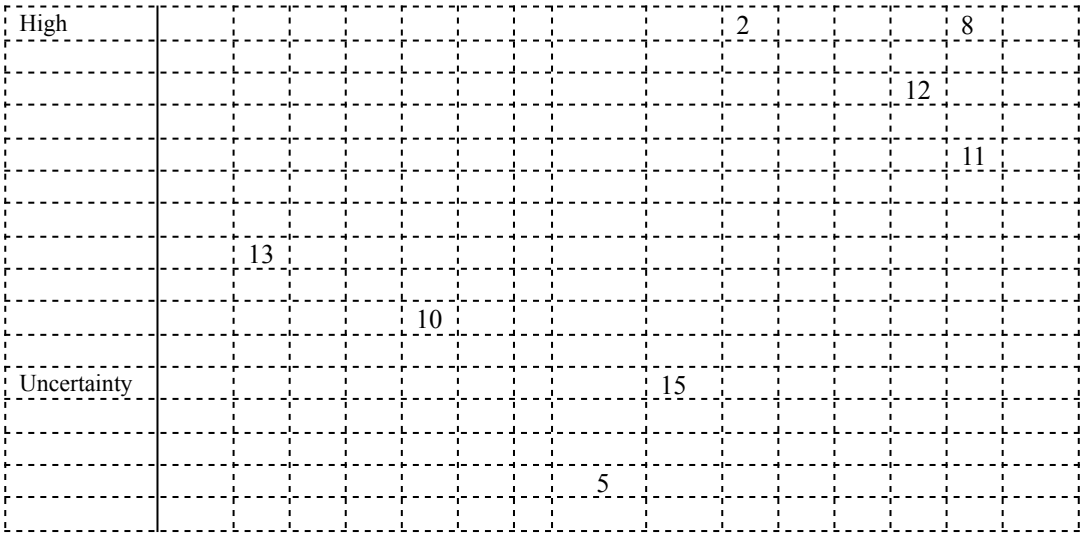
13 An insidious computer virus (not Y2K) paralyses computer systems in APEC economies.

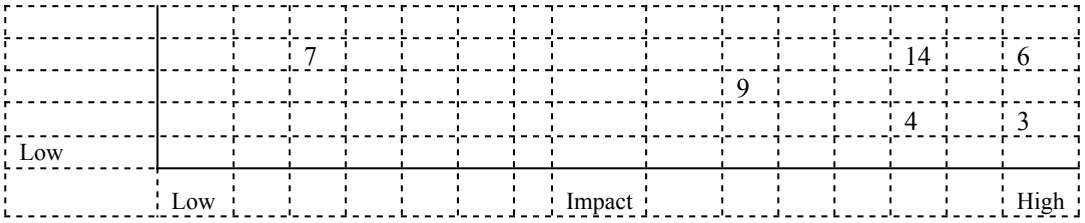
14 Integrated water management is fully established throughout APEC.

15 NSTDA/ITRI proclaimed APEC S&T Center as a focus for development of new technologies, including water treatment.

These variables clearly have different degrees of importance, and hence impact, and also different degrees of uncertainty. It is important to note that in scenario analysis, it is the degree of uncertainty, rather than the degree of likelihood, that is critical. Highly certain factors should be included in the predictable list. It is the small set of high impact, high uncertainty factors around which the alternative scenarios can be formulated.
The result of the Experts' consideration of the 15 variables is shown in Figure 4.1:

Figure 4.1 Uncertainty/Impact of Unpredictable Variables





In creating scenarios, the Experts were divided into three groups with each group assigned a set of key unpredictable variables drawn from the earlier list. Each group explored these variables from the viewpoint of a group in the year 2010 looking back at the events, which led to their present situation. The outputs of the group discussions were converted into three scenarios by Professor Ron Johnston and then further debated the following day. These three scenarios are given in Section 4.4.

4.4 THREE SCENARIOS FOR WATER SUPPLY AND MANAGEMENT IN 2010

APEC WATER TM

or

DANGER! WATER AHEAD

Key Unpredictable Variables:

- **Water prices soar**
- **Three global water companies dominate APEC water (Skywater, Fujiwater and Colorado Samsung)**
- **Water wars**
- **Water-borne disease epidemic**

The Headlines

- 'Bottled water Mafia boss jailed'
- 'US company accused of water extortion'
- 'Disease toll reaches 50 million'

The Scenario

Any perceptive current affairs watcher could have picked up the signs by 1998. The Gulf States 'water war' scenarios were a prominent feature in the news magazines. The El Nino of 97-98 provided dramatic evidence of the vulnerability of so many APEC economies (as they were quaintly called then) and regions, too inadequate water supply. There were the Colorado River legal wars in North America.

And there was that murky business of the prolonged tension between Chile and Argentina over territorial recognition in Antarctica, even though the Madrid Protocol clearly prohibited such claims, along with exploitation. (No good pointing out that towing icebergs was economically unfeasible - when did that ever stop a politician desperate to win an election).

Sure enough, by 2000, when all thoughts were supposed to be on the Sydney Olympics, the new millennium, and the bugs that came with it, the 'Cold Water War', as some smart journalist dubbed it, was centre stage. And as each month passed, it threatened to get distinctly warmer, as land, sea and air 'manoeuvres' were practiced near contentious zones, and charges were made of deliberate contamination of groundwaters.

At the same time, public suspicion, and in some cases hysteria, was directed towards contaminated water sources. Exclusion zones were declared within 300 metres of known polluted waterways, and residents forcibly removed from their homes. Bottled water sales soared, for those who could afford it. The market for irrigated food collapsed.

The irony did not escape some commentators, who noted that certain countries were apparently preparing to go to war for a resource that nobody wanted right now.

Naturally the world bodies were roused into endless debate, but the new alignments of geo-political forces prevented any concerted action. It was a landmark event that APEC,

given its lack of leadership during the 'Asian economic crisis', and the growing power of the EU and Americas trade blocks, called a leaders summit in Hua Hin in 2001.

The lead-up meeting of technology Experts produced much disagreement. The only consensus was that water supply and a plethora of historical, economic, social, technological, cultural and sovereignty complexities dogged management.

It was then that the venerable Chinese business leader, Madam Chiu, uttered that simplistic phrase which was to capture the hearts and minds of the assembled leaders: "Energy = Water". For the uninformed, her analysis was that water problems were so intractable that they had to be dramatically reconfigured to allow significant progress. Given the rising scarcity and price of water, and the cost of treating it, a supply of relatively cheaper energy was to be the new breakthrough.

Many were sceptical. Many still are. But within months Madam Chiu had put together the Asian Golden Company consortium. Within a couple of years they had brought together a range of energy sources and set up contracts with many of the leading energy research teams around the globe. Alone this would never have worked. But the pressure it placed on the other major water companies led to a fierce race for market share. In the process, water prices tumbled and quality was dramatically improved in response to customer demands. The epidemics disappeared.

The timing was fortunate as the continuing boom in the US stock market provided ready capital for such a major new industry. By 2009 mergers and takeovers had occurred leaving only three major companies dominating the APEC water industry. Prices inevitably soared. In 2010, Mme Chiu junior celebrated the 10th anniversary of the company by reformulating it as APECEW.

APEC WATER INTEGRATION

or

WATER RULES

Key Unpredictable Variables:

- **APEC regulations for water quality and trade**
- **Integrated water management fully established**
- **Computer virus disables IT-dependent systems**
- **NSTDA/ITRI established joint APEC S&T Centre**

By 2000, most Asian economies had recovered from the economic crisis without recourse to political upheaval, demonstrating the maturity of their democratic institutions. A sound economic and social environment was established.

Under these circumstances water emerged, obviously, as one of the major constraints to economic development. The mismatches between supply and demand between economies became steadily more apparent, leading to pressure not only for more efficient use but also the emergence of a market in which water could be traded internationally. The evidence costs in improving the quality of water led to the recognition that quality should correspond to usage requirements. Rice doesn't need Singha water.

The decline in the APEC economies had produced a new consensus among its leaders that there was a need to established APEC-wide standards in key inputs to economic competitiveness. Water offered a low cost and low risk opportunity to demonstrate commitment to these principles. At a meeting in Hua Hin, 2001, the APEC Regulatory Principle was established:

1) Users clean after use
2) Different standards for different users
3) Price related to usage and quality

This was supplemented by a commitment to the adoption of integrated water management policies, with the objective of maximising use of available resources and the adoption of the most cost effective means of meeting demand. An APEC Water Regulation Authority was established, headquartered in Taipei, to oversee the progress of individual member economies in achieving the APEC targets in 2008.

To encourage this process, an APEC Water Research Centre was established to assist economies to comply with the regulations (in 2003). Important new practical technologies developed included:

- instant electronic access to models and databases on the total water cycle
- satellite monitoring of water misuse and abuse
- dramatically improved systems for water storage and transport

The steady progress towards achieving these objectives was interrupted by that dastardly virus Lysistrata that cut International communications for a week. However the advanced programming of the water databases survived this attack and provided a useful spin-off technology for APEC.
By 2010, the APEC economies enjoyed substantial advantage in economic performance and quality of life over other regions of the world as a result of their far-sighted investment in harmonious water supply and management regimes and policies.

APEC TURNS ON THE TAP

Key Unpredictable Variables:

- **Most severe El Nino in history**
- **Advances in desalination technology**
- **Low water reliant crops – 'dry rice'**
- **Desertification advancing across Asia**

The Scenario

El Nino struck again in 2000 with devastating impact. There were widespread droughts and crop failures across Asia and the Americas and a dramatic downturn in both manufacturing and agricultural sectors as water shortages forced closures. Unemployment soared to 18% (official figures). In contrast, South America suffered record floods, property destruction and loss of life. Greenpeace reported a 15% increase in desertification in north Asia in just one year.

The extent of these crises so soon after the previous El Nino cycle and the Asian economic crisis provided the conditions for a commitment for significant political cooperation at the highest level. An emergency APEC Leaders Meeting, held in 2002 in Hua Hin, produced a record time the now celebrated Hua Hin agreement, with its two principles:

1) Coordinated water research management within and between economies.
2) A major investment in water R&D, focussing on four priority areas.

Foresight techniques were used to identify four priority areas: desalination, low-water use plants, sustainable groundwater use and flood control.

In hindsight, a particularly wise decision was the focus on biological systems of desalination. Close study of a range of natural zoological and botanical systems produced a low-energy breakthrough for the team led by Professor Leakey.

However, it was understood that these were long-term measures and that more immediate responses by member economies were also needed. This enlightened approach allowed the use of emergency short-term measures to address the immediate crisis, recognising that harmful effects could be remediated through the longer-term investment in new sustainable technologies.

Key elements of these short-term programs included more effectively controlled irrigation, domestic water saving through redesigned plumbing, mandatory use of recycled water in industry, and tighter controls on distribution.

2004 was a landmark year with the first major breakthrough from the APEC Groundwater R&D Center, bilateral and multi-lateral watershed agreements, and the commissioning of pilot desalination plants developed by Honda. The first field testing of low-water-use plants and scale-up of the desalination plants to industrial capacity followed this, in 2005. By 2006, groundwater use has increased by 50% over the past three years, reaching the agreed Hua Hin limit.

Fortunately on time and to budget, a series of full-scale desalination plants came into operation in 2007, reducing the reliance on groundwater. This was further reduced by the wide scale

planting of the new, commercially available salt-resistant and low water use plants (SRALWUPs).

The Desal Inc consortium was established in 2008, formed to manufacture and market the new technologies. In addressing the major problem on saline by-products application of new membrane technologies allowed the extraction of trace elements of valuable previous metals because of the sheer volume of water being treated.

Today in 2010, Desal's technology is a recognised world leader. The new generation of biological technologies have seen the APEC region take command of the new high-growth biogenetic industries and enabled a new era of agricultural production.
We are delighted to be able to announce that the Nobel Prize for biology for 2010 has been awarded to the greatly deserving Professor Leakey.

4.5 PRELIMINARY IDENTIFICATION OF ISSUES FOR DELPHI SURVEY

Based on the intensive discussions on critical issues and scenario creation, the Experts, under the guidance of Dr Taeyoung Shin, identified a starting list of 28 statements as the basis for a Delphi Survey.

1 Electronic access to models and databases will be developed on the total water cycle (precipitation, run off, infiltration, superficial and groundwater)

2 Satellite monitoring of water use and abuse will be in widespread use.

3 Water containers for large-scale long-distance transport across oceans and along rivers will be in practical use.

4 Infrastructure, like container terminals to handle bulk water transport, will be developed

5 Practical use of multiple water quality supply system to households will be implemented.

6 Technologies, which reduce water, use by 50% and emit 50% less pollutants into effluent water in sugar industry will be in practical use.

7 Technologies, which reduce water, use by 50% and emit 50% less pollutants into effluent water in pulp and paper industry will be in practical use.

8 Food plants such as rice and sugar cane, which use less than 50% of current water requirements, will be developed.

9 Different quality standards for different usage of water will be developed.

10 Systems for monitoring water source contamination will be in practical use.

11 Dissemination of water information (quantity, quality, usage) to the public will be implemented.

12 Mechanisms to establish regulations for trading, extraction and discharge of water in APEC economies would be developed.

13 Groundwater will be detected and assessed at depths of 200m.

14 Leakage of over 10% in water supply will be accurately detected.

15 Accurate inventories of water usage will be available for all industries, public and private buildings in urban areas.

16 Desalination of water by biological means will produce high quality water.

17 Advances in membrane technology will allow continuous desalination at a competitive price.

18 New technology for groundwater exploitation such as remote sensing technology and geophysics will be developed.

19 Trenchless technologies will have a major influence on servicing urban areas.

20 50% of water pumping systems will be powered by renewable energy such as solar wind and tidal power.

21 Desalination will be in practical use for 50% of households, high-technology industry, urban water supply, a cost of less than 0.5 US$ per cu. m. (These four questions of the same topic will be different times for realization).

22 70% of water used in industry will be recycled for further use in industry.

23 50% of water used by groups of households will be recycled locally.

24 Water saving devices will be installed in all new houses as a demand management.

25 Water will be an important political issue in national elections in APEC economies.

26 The majority of APEC economies will implement a National Water Policy with a nationally coordinated approach to water supply and management.

27 There will be significant increase in the assessment of potential groundwater resources.

28 There will be significant increase in sustainable exploitation of groundwater.

5. THE DELPHI SURVEY

5.1 INTRODUCTION

The Delphi Survey technique allows groups of experts to be consulted on a range of possible future developments in the their respective fields. The questions include such issues as the expected time of realisation of the development, and demand and supply variables connected with the development such as ranking of importance and other factors including technical, institutional, cultural and funding constraints, or the need for international collaboration etc.

Typically the steps in a Delphi Survey are:

- the establishment of working groups to explore issues, areas and nominate a set of 'Topic Statements';
- a Round 1 Survey is prepared and circulated to selected experts;
- replies are analysed and a Round 2 survey is conducted; this includes information from Round 1 eg, average realisation time, importance etc. This gives respondents the opportunity to re-evaluate their response to the first round and for convergence to occur (although outliers often have a better view than the majority!)
- sometimes a Round 3 is needed for additional clarification but generally two rounds are sufficient and the information is then analysed in terms of average values and dispersion.

The Delphi technique has four main characteristics: anonymity (no physical contact between respondents); iteration (several rounds); controlled feedback (the results of the previous round are provided to respondents) and a statistical presentation of the group response (average and spread)

Delphi Surveys have a number of advantages. They allow for both narrow and wide-ranging views of long-term trends in technology. They are particularly suited to long time frames (over 10 years) and allow the gathering of views from a very large number of people. Further they allow respondents to change their minds on topics without being personally identified and they give those respondents with firm views an ability to stick by them.

Japan in particular has considerable experience in the Delphi technique having conducted six surveys since 1971. More recently, Germany, France and Korea have carried out extensive Delphi Surveys. The APEC Center has been able to draw in the expertise from Japan through Mr Terutaka Kuwahara, Director, Technology Forecast Research Team, National Institute of Science and Technology Policy (NISTEP), Science and Technology Agency, Japan and from Korea through Dr Taeyoung Shin, Head S&T Indicators and Analyses, Science and Technology Policy Institute, Korea. In particular, Dr. Shin designed the format of the Delphi Questionnaires, computed the statistical results, and wrote an analysis report which is the substance of this chapter.

While a comparative Delphi study using the same statements was carried out between Germany and Japan in 1991 yielding a remarkable similarity in general expectations, illustrating the global nature of technology transfer on many of the statements, there were differences in expectations between the two countries. Thus in Germany there was a generally higher confidence in the resources of Germany in basic research without the need for international collaboration. The present exercise represents the first attempt at a truly multi-national Delphi Survey.

The Delphi Survey was conducted over the period May-December 1998 with identification of issues in May-July, Delphi rounds in July-November and analysis in November-December.

5.2 IDENTIFICATION OF TOPICS AND FORMULATION OF QUESTIONNAIRE

As noted in Section 4.5, a preliminary identification of topics was carried out at Hua Hin. Over the period May-July, these topics were refined and others added in an interactive process between staff of the APEC Center, the Experts, a group of Thai water experts and Professor Ron Johnston, Mr Terutaka Kuwahara and Dr Taeyong Shin. The topics covered technology, resources and policy issues.

It rapidly became clear that the formulation of a questionnaire for a multi-economy Delphi Survey in the APEC context posed a range of new problems compared with those encountered in a single country study. Thus the APEC group encompasses an extremely diverse group of countries in terms of population, language, economic development, geographic size, climate conditions, S&T capability, GDP/capita etc.

Noteworthy differences were:

1) The interpretation of statements in English by participants who only had English as a second language. Although interpretation can be a problem even in national studies, it is a major issue in multi-national studies and much time and effort was required to frame statements that were unambiguous.
2) Following from (1), it was clearly essential to have concise statements which were technically correct and which only addressed one issue. Multi-issue questions became very confusing even to native English speakers.
3) National surveys focus on the issue of technology development within the country based on exploitation of national research capabilities and do not address technology diffusion from

other countries. In the case of the APEC economies, the smaller economies depend essentially on technology diffusion and its adaptation to local circumstances rather than indigenous development.

For the technology and resource questions, the survey used the concept of innovation stages as:

- **Elucidation**: the earliest stage – scientists have discovered the principles or ideas in an APEC member economy and are exploring it further. Elucidation will probably occur in just one (or a few) member economies, with transfer to other member economies at a later innovation stage.
- **Development**: scientists have reached a specific technological goal eg completion of the first prototype in the laboratory. Development will probably occur in just one (or a few) member economies, with transfer to other member economies at a later innovation stage.
- **Practical use**: the technology or idea has been proved possible and economically viable, and has been used a few times outside laboratory or prototype conditions. Practical use *in the APEC region* refers to more than one APEC member economy.
- **Widespread use**: after the technology was introduced for practical use, it has been adopted in many different places. Widespread use *in the APEC region* refers to at least 10 of the 18 member economies.

These innovation stages were not applicable to the policy questions, and instead it was explained that 'year of realisation in the APEC region' should be taken to mean 'year of realisation in a majority of APEC members'.

1) Even within one economy, the respondents to Delphi Surveys are not familiar with areas outside their immediate discipline or topic of research and find difficulty in answering questions relating to 'time to realisation' of different technologies. This problem is exacerbated in a multi-economy study, particularly in the APEC context.

   The time horizon of the study was set at about 12 years, i.e. 2010 and to assist respondents it was decided that the Delphi questionnaire should provide time slots of five years each covering a total of 15 years and beyond. Further, the respondents were asked to consider 'time of realisation' both in the APEC region and in their own economy.

2) The conventional approach in the Japanese and Korean surveys is to instruct the respondents to assume that there will be no sudden changes in the country in the time horizon of the survey. While this is a sweeping assumption in one country, it is clearly more so in the APEC region given the mix of political systems and economic levels - the recent and continuing economic crises in a number of Asian countries are a clear example of such sudden changes in a short time period.

Since the scenarios specifically addressed the issue of change (see Section 4.3.2), it was agreed that the topics arising from the scenarios would cover most of the concerns above incorporating change in the period of 2010 and thus the instructions to the respondents were maintained in the same form as the Japanese and Korean surveys.

After considerable discussion and interaction between the group noted above, 58 topics covering technology, resources and policy issues were formulated. The questionnaire for Round 1 follows.

1st round Questionnaire for the Research Study on

- **Water Supply and Management in the APEC Economies ·**

Introduction

This survey is a core part of the APEC Technology Foresight Center study on "Water Supply and Management". The topics in the survey are based on a discussion paper outlining key issues concerning water for the APEC region. Scenarios were then created by APEC water experts at a meeting in Thailand on 12-14 May 1998, as a means of identifying topics for this survey. Topics were further refined by subsequent inputs from the same experts and from others. In this respect, we gratefully acknowledge NISTEP in Japan for granting permission to use some of the topics from the Sixth Japanese Delphi. The Issues Paper is published on the APEC Technology Foresight web site along with other details of this project such as the consultants and experts involved, the background and rationale for the study and its schedule. The web site can be found at: **http://apectf.nstda.or.th**. The research study information is listed under "Our Activities".

Asia-**P**acific-**E**conomic-**C**ooperation has 18 full member economies, which are: Australia, Brunei Darussalam, Canada, Chile, China, Hong Kong China, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, the Philippines, Singapore, Chinese Taipei, Thailand and the USA. Your answers will make a major contribution to the identification of those topics that you, as part of the APEC scientific and technological community, consider likely to shape the future of water supply and management in these APEC economies. This research study aims to provide a valuable opportunity to think seriously about significant technological and policy trends in the field of water, and their contribution to quality of life and wealth creation over the next 20 years.

This survey has 2 rounds. Firstly, you are asked to give your views on a number of topics. Then, in a second round, you will be given a summary report of the responses of the first round. You will then be asked to review your responses and complete a second survey. The second survey will be sent to you a few weeks after the first. This approach, known as Delphi survey methodology, has been used in many APEC economies, for example, in South Korea, Japan, Australia and Thailand, and in Europe.

In this survey, some topics refer to futures that we can expect by extrapolating current trends. Other topics refer to preferred futures, and others refer to possible futures for which there may be only weak signals at the moment. You do not have to answer every topic. You should use your judgement to decide whether to respond to a topic, according to your interest and expertise. We also invite you to suggest new topics in the blank space at the end of the questionnaire.

We would be very grateful for your cooperation in completing and returning the form by the due date.

Confidentiality

Your answers will remain confidential to the APEC Center and its consultants. No information will be released which allows your responses to be identified.

Due Date

Please return the completed questionnaire by: Monday 24th August 1998.

For *postal returns*, an addressed envelope has been provided. We regret that we were unable to provide a stamp since postal rates vary around the APEC region. We would be most grateful for your support in this respect.

Faxed returns should be sent to: 66-2-644-8020, and clearly marked for the attention of the APEC Center.

Email returns should be addressed to: apectf@nstda.or.th.

Help Available

If you have any problems completing this questionnaire, please contact: Dr Chatri Sripaipan, on 66-2-644-8009 (direct phone), or email: **chatri@nstda.or.th**.

We would like to thank you for your kind cooperation.

Professor Greg Tegart	Dr Chatri Sripaipan
Director	Co-Director

Guidelines for Questionnaire.

- This questionnaire is the first round of an APEC-wide survey, concerning issues and technologies in the area of "Water Supply and Management." The questionnaire contains 58 topics which could, and perhaps should, occur within the next 20 years.
- Each topic includes survey parameters, such as degree of expertise, degree of importance and year of realization. These parameters are explained below.
- You will also be asked to make open comments on these topics, and to suggest new topics.
- Your answers will be compiled anonymously. You will be sent a summary of all the answers we receive. You will then be asked to reconsider your answers and fill in the questionnaire again.

A. Definition of terminology:

(1) Many of the topics in the first two sections (water as a resource / technologies) refer to "Innovation Stages". These are:

- ***Elucidation:*** the earliest stage – scientists have discovered the principles or ideas in an APEC member economy and are exploring it further. Elucidation will probably occur in just one (or a few) member economies, with transfer to other member economies at a later innovation stage.

- ***Development***: scientists have reached a specific technological goal , e.g., completion of the first prototype in the lab. Development will probably occur in just one (or a few) member economies, with transfer to other member economies at a later innovation stage.
- ***Practical use***: the technology or idea has been proved possible and economically viable, and has been used a few times outside laboratory or prototype conditions. Practical use ***in the APEC region*** refers to more than one APEC member economy.
- ***Widespread use:*** after the technology or policy was introduced for practical use, it has been adopted in many different places. Widespread use ***in the APEC region*** refers to at least 10 of the 18 member economies.

These innovation stages are not used in the third section - policy topics.

(2) Degree of Expertise: Please check one of the following.

- ***High***: you have considerable specialist knowledge about the topic, through current research or current work.
- ***Medium:*** you engaged in research or work related to the topic in the past; or you have some specialist knowledge about the topic through research or work in adjoining areas.
- ***Low***: you have read technical books or literature about the topic or you have listened to discussions by experts on the topic.
- ***None***: you have no special knowledge of this area

(3) Degree of importance: Please check one of the following.

- ***High***: extremely important
- ***Medium:*** important
- ***Low***: somewhat important
- ***Unnecessary***: not important

(4) Year of realization: Please try to estimate the period in which you think this topic will be realized.

- **In the case of the policy topics #33-55**, 'year of realization in the APEC region' should be taken to mean '**year of realization in a majority of APEC member economies**', where the topic does not specify.
- Topics #56-#58 refer to measures adopted by APEC itself; therefore, the category 'year of realization in your country' is not applicable.
- Please note that (as explained above under 'innovation stages'), there may also be other topics where the category of 'year of realization in your country' is not applicable. This will arise when a technology is elucidated and/or developed in a more advanced part of APEC and you judge that it will be adopted in your country at a later innovation stage (after its use has become 'practical' and/or 'widespread).

B. Survey instructions

(1) Please read the guidelines above carefully and then respond to the topics.

(2) Please assume that there will be no sudden changes in the APEC region, such as wars, major (natural and/or human-made) disaster, and so on.

(3) Please make comments about the topics on the sheet provided. For example, you could describe the major actions that need to be taken to achieve the goal, or you could describe the major constraints on achieving the goal. If you think a topic is unnecessary or undesirable, you could explain why. All your comments are welcome.

(4) Have we missed anything important? Please make suggestions and recommendations for additional topics, if any, which should be included in this questionnaire on the final sheet.

Thank you for reading these instructions carefully.

Please answer the following questions, and then proceed to the topics.

Age: 20- 29_____ 30-39 _____ 40-49 _____ 50-59 _____ 60-69_____ 70+ _____

Family Name _____ Given Name: _____

Institution to which you are affiliated:_____

Address: _____

_____

Tel: _____Fax: _____E-Mail: _____

APEC member economy: _____

Number of years experience in your specialist area: _____

Key words for the area of your specialization:

(1) _____ (2) _____(3)_____

For each of the four questions, please check one box.

Topic #	Topics	1. Degree of Expertise					2. Degree of Importance						3. Year of Realisation In APEC Region					4. Year of Realisation In Your Economy
		High	Medium	Low	None	High	Medium	Low	Unnecessary	1999-2003	2004-2008	2009-2013	Beyond 2013	Never	1999-2003	2004-2008	2009-2013	Beyond 2013	Never	

	Water as a Resource																		
1	Scientific methods of accurate long-range weather forecasting, up to 3 months in advance, are developed.																		
2	Accurate rain and precipitation water-balance forecast, aiming at effective utilization of rainfall, is in widespread use.																		
3	Rainfall prediction accurate enough to allow effective flood control using dams is in widespread use.																		
4	Scientific methods for flood forecasting, warning and management to protect important areas at high risk, are in practical use.																		
5	Technology to induce artificial rain is in practical use.																		
6	Global Positioning System (GPS) and Geographic Information System (GIS) to assist water resource management and development are in practical use.																		
7	Satellite monitoring of water/catchment use and abuse is in widespread use.																		
8	Remote techniques and automated control systems to regulate domestic and industrial water supply are in widespread use.																		
9	Remote techniques and automated control systems to regulate water supply for agricultural irrigation are in widespread use.																		
10	50% of natural run-off is captured and stored for use.																		
11	Recharging of acquifers is widely used to enable sustainable exploitation of groundwater.																		
12	Natural ecosystems for localized water storage are in practical use.																		
13	Effective treatment of wastes from animal farms is in widespread use, preventing pollution of water sources.																		
14	Automatic remote water quality monitoring stations are installed at most catchment basins susceptible to pollution.																		
15	Cost effective techniques to de-silt heavily silted lakes and impounded reservoirs are in practical use to restore regulatory capacities.																		
16	Techniques to transport icebergs cost-effectively are elucidated.																		

For each of the four questions, please check one box.

Topic #	Topics	1. Degree of Expertise		2. Degree of Importance		3. Year of Realisation In APEC Region		4. Year of Realisation In Your Economy	

		High	Medium	Low	None	High	Medium	Low	Unnecessary	1999-2003	2004-2008	2009-2013	Beyond 2013	Never	1999-2003	2004-2008	2009-2013	Beyond 2013	Never
	Technologies																		
17	Water containers for large-scale long distance transport across oceans are in practical use.																		
18	Water containers for large-scale long distance transport along rivers are in practical use.																		
19	Dedicated infrastructure, such as container terminals, to handle bulk water transport is in widespread use.																		
20	Biological methods to desalinate water, producing water suitable for agricultural irrigation in terms of both cost and quality, are in practical use.																		
21	Due to advances in membrane technology, large-scale continuous desalination at a cost of less than US$ 0.5 per cubic meter is in practical use.																		
22	More than 50% of drinking water in coastal cities is obtained by desalination.																		
23	Technologies for ground water exploitation, such as remote sensing technology, are in widespread use.																		
24	A technology breakthrough leads to the development of a solar cell system cheap enough to provide energy for use by rural pumping systems.																		
25	Over 50% of households in urban areas have multiple water quality supply systems.																		
26	In the industrial sector, technologies which reduce the volume of water used by 50%, from 1995 levels, are in practical use.																		
27	Genetically-altered food plants, such as rice and sugar cane, which use less than 50% of current water requirements, are in widespread use.																		
28	Technology to detect and locate leaks of over 10% from the water distribution system is developed.																		
29	Trenchless technologies are in practical use in suitable urban areas.																		
30	70% of water used in industry is recycled for further use.																		
31	50% of water used by households or groups of households is recycled locally, for further domestic use, owing to the development of cheap and simple package treatment plants.																		
32	Prefabricated water treatment plants have been developed as a cost-effective means to treat industrial waste water.																		

For each of the four questions, please check one box.

Topic #	Topics	1. Degree of Expertise				2. Degree of Importance				3. Year of Realisation In APEC Region								
		High	Medium	Low	None	High	Medium	Low	Unnecessary	1999-2003	2004-2008	2009-2013	Beyond 2013	Never	1999-2003	2004-2008	2009-2013	Beyond 2013
33	Technology to determine the structural strength and surface conditions of pipelines, in situ, for planning pipe replacement programs are in widespread use.																	
34	New materials are developed to produce highly durable and easily maintained pipes at significantly lower cost.																	
	Policy Issues																	
35	A mechanism for negotiating and concluding agreements for international water transfer is accepted.																	
36	At least 5 international water treaties, covering issues such as extraction, disposal of waste into water and artificial rain-making, are negotiated and ratified.																	
37	Water is an important political issue in national elections.																	
38	A nationally coordinated approach to water supply and management is implemented.																	
39	Nationally determined priorities of water usage and sharing among the sectors (domestic, industrial and agricultural) are enforced.																	
40	A policy that 50% of water used in the domestic and industrial sectors must be recycled for further use is adopted.																	
41	The policies “Users Pay” and “Polluters Pay” are enforced.																	
42	International standards for dam safety are enforced successfully.																	
43	50% of water supplies and management are in private ownership.																	
44	Different quality standards for different uses of water are widely used.																	
45	Systems for monitoring water source contamination are in widespread use.																	
46	Water information (quality, quantity, usage) is readily available to the public.																	
47	Accurate inventories of urban water usage covering all industries, public and private buildings, are available to water managers.																	

For each of the four questions, please check one box.

Topic #	Topics	1. Degree of Expertise				2. Degree of Importance									3. Year of Realisation In APEC Region					4. Year of Realisation In Your Economy
		High	Medium	Low	None	High	Medium	Low	Unnecessary	1999-2003	2004-2008	2009-2013	Beyond 2013	Never	1999-2003	2004-2008	2009-2013	Beyond 2013	Never	
48	Water saving devices, such as dual-flush toilets and automatic-turn-off taps, are installed in all new buildings.																			
49	Irrigation systems exceed 75% efficiency.																			
50	90% of people have easy access to safe water for their domestic use.																			
51	The price of a barrel of water is listed alongside the price of a barrel of oil, in financial papers like the Wall Street Journal and Financial Times.																			
52	An integrated water resource management plan, which links in with other natural and human features, is drawn up and implemented for every major river basin.																			
53	A pricing system that encourages water users to recognize that water is a finite and valuable resource is operated.																			
54	Water pricing systems are used to control demand.																			
55	Major cities have installed integrated systems to manage normal water sources and storm water for water supply.																			
56	APEC-wide performance standards of water supply systems are defined for reference by water regulators.																			
57	Internet-based sharing of water information and technological developments is promoted by APEC.																			
58	An APEC fund is established to assist in strengthening and improving substandard water-related structures.																			

Please write down your comments on any topic:

For example, you could describe the major actions that need to be taken to realize the topic, or you could describe the major constraints on achieving the topic. If you think a topic is unnecessary or undesirable, you could explain why. All your comments are welcome. Please feel free to add extra sheets if you want to.

Topic #	**Comments**

Suggestions for additional topics
Please feel free to add extra sheets if you want to.

This is the end. Thank you for completing this survey.

5.3 CONDUCT OF, AND OUTCOMES FROM, THE FIRST ROUND

The sample of Delphi experts was obtained through the APEC Experts that attended the workshop, through the APEC Industrial Science and Technology Working Group, and through other contacts of the Center and its Consultants. For some economies, co-nomination was also attempted to increase the sample size, and this yielded a few extra names. In the end, the total of potential respondents was 605.

It was very difficult for the Center to exert any control over the expert samples. Neither the original nominees, nor those actually responding can be viewed as representative of all water

experts in each economy, in view of the sample size and the way in which their names were obtained. However, it is to be expected that the degree of representativeness will vary between economies and probably reach a good level where the Center succeeds in cooperating with a key water agency in an economy and obtaining a decent response rate from there, for example, as was the case for Chinese Taipei, Hong Kong, China and Malaysia. Much of the success here can be attributed to the interest and involvement of the Experts from those economies that attended the scenario-building workshop and went on to contribute actively to the Delphi process. However, other Experts appeared equally enthusiastic at the Hua Hin workshop and yet were less successful in promoting the cooperation of others from their economy in the Delphi, suggesting that it is sensible not to rely on one individual or, even, one institution. Building credible links with key agencies in each economy is therefore likely to be an essential task in any multi-country study, in order to secure the cooperation of relevant Experts and institutions. This would have the added advantage of increasing the changes that the research output will be respected and implemented. Further, although it had been hoped that the questionnaire could be sent electronically, in practice, two-thirds of them did not have access to email and so post was mostly used. This could also have contributed to the poor rate of return from some economies.

Table 5.1 shows the responses for the first round.

Table 5.1 Distribution of Responses to the First Round of the Delphi Questionnaire

Economy	Number of Experts contacted	Number of Experts responding	Economy	Number of Experts contacted	Number of Experts responding
Australia *	36	3	Malaysia *	37	15
Brunei Darussalam	0	0	Mexico *	27	2
Canada *	28	4	New Zealand	0	0
Chile*	27	2	Papua New Guinea	8	1
China	5	2	Philippines	48	6
Hong Kong, China*	38	22	Singapore	7	1
Indonesia	7	1	Chinese Taipei *	35	19
Japan	18	8	Thailand *	84	28
Korea *	53	4	USA	147	1
			Total:	605	114 (18.8%)

* represented by an Expert at the Hua Hin meeting.

The lack of response from some countries can be attributed to the absence of an expert at the Hua Hin meeting and hence no further interest. The support of the contact points in the ISTWG is critical at the initial stages and also in the identification of experts. It is clear that the topic chosen did not fit with many of the national Departments and Agencies represented at ISTWG and hence was not followed-up. For example, in the case of the USA, there was no expert at Huan Hin and hence no one with responsibility to follow-up on the experts subsequently identified through the Department of Commerce and the National Academy of Engineering.

The questionnaire did not contain a benchmarking question but this information emerges from the responses to the final parameter about 'realisation in your economy' since the responses range from 'now' to 'never'. Thus the issue of technology adoption and diffusion was also highlighted in the Delphi responses. Neither are explicitly parameters on 'contribution to quality of life' and 'contribution to wealth creation' included, but again, some indirect information is provided by the Experts' rating of each topic's importance. In any case, wealth creation was not considered particularly relevant since water was viewed as an issue of such basic human need and value. The number of parameters was deliberately kept to a minimum, in view of the complexity of considering both an own-economy and an APEC-wide view. The accompanying notes and explanations were nevertheless rather complicated and it was clear

from a few of the respondents comments, that some of them had not really understood what they were being asked to do. Since many respondents were non-native English speakers, a pilot study might have been helpful to assist the Center to produce clearer instructions, but since other studies have found similar confusion on the part of a few respondents even when using their own language, there may be only a little scope for improvement. Given the complexity of Delphi Surveys, a fairly low response rate was not unexpected; indeed the leader of German national Foresight efforts comments that: *'as a rule of thumb, detailed and time-consuming questionnaire surveys with a response rate of some 15-20% are considered successful'*. However, many other national Foresight studies have managed first round response rates of over 30%. The first round response rate in this study was 19%, indicating that a multi-country study must attempt to compile a larger initial sample of Experts for a Delphi Survey than a survey of smaller scope.

Owing to time constraints, it was decided not to contact first round 'outliers' for an explanation of their response. In many cases, no comment has been volunteered, perhaps because they are unaware that they hold an unusual view, although the second questionnaire tried to encourage self-evaluated outliers to explain their position. It is possible that moves towards consensus detected between rounds are more attributable to a common tendency towards conformity, rather than being based on a genuine consideration of new evidence or a different point of view. However, this possible weakness is shared by many, if not most, other Delphi Surveys as used in Foresight research.

The questionnaire invited respondents to make comments on the statements and these offered considerable insights into the reactions of respondents, many of whom had never been involved before in a Delphi Study. These comments were conveyed back to the respondents in the second round. In addition, many respondents made suggestions for additional topics. These are reproduced in the document that follows.

The responses of the first round indicated that, if we use 60% as a cut-off, then are 13 statements judged to be of high importance. Of these, four cover Resources namely 2, 3, 4 and 13; one covers Technologies namely 28, while eight cover Policy namely 38, 39, 41, 45, 50, 52, 53 and 54. The mean year of expected realisation within the APEC region is bunched tightly in a six-year time span between 2005 and 2010.

Comments from the 1st and 2nd round Delphi questionnaires are combined in Appendix IV. There were 58 suggested additional topics from the respondents of 1st round questionnaire. However, some are already presented in the questionnaire, some are just comments, and some are not really suitable. After consultation with experts, some wordings in the 1st round questionnaire were altered for clearer meaning and six more questions were added (topics 59 to 64). The list of topics for the 2nd round questionnaire is shown below.

1. Scientific methods of accurate long-range weather forecasting, up to 3 months in advance, are developed.
2. Accurate rain and precipitation water-balance forecast, aiming at effective utilization of rainfall, is in widespread use.
3. Rainfall prediction accurate enough to allow effective flood control using dams is in widespread use.
4. Scientific methods for flood forecasting, warning and management to protect important areas at high risk, are in practical use.
5. Technology to induce artificial rain successfully is in practical use.
6. Global Positioning System (GPS) and Geographic Information System (GIS) to assist water resource management and development are in practical use.
7. Satellite monitoring of water/catchment use and abuse is in widespread use.
8. Remote techniques and automated control systems to regulate domestic and industrial water supply are in widespread use.
9. Remote techniques and automated control systems to regulate water supply for agricultural irrigation are in widespread use.

10. 50% of natural run-off is captured and stored for use.
11. Recharging of acquifers is widely used to enable sustainable exploitation of groundwater.
12. Natural ecosystems for localized water storage are in practical use.
13. Effective treatment of wastes from animal farms is in widespread use, preventing pollution of water sources.
14. Automatic remote water quality monitoring stations are installed at most catchment basins susceptible to pollution.
15. Cost effective techniques to de-silt heavily silted lakes and impounded reservoirs are in practical use to restore regulatory capacities.
16. Techniques to transport icebergs cost-effectively are elucidated.
17. Water containers for large-scale long distance transport across oceans are in practical use.
18. Water containers for large-scale long distance transport along rivers are in practical use.
19. Dedicated infrastructure, such as container terminals, to handle bulk water transport is in widespread use.
20. Biological methods to desalinate water, producing water suitable for agricultural irrigation in terms of both cost and quality, are in practical use.
21. Due to advances in membrane technology, large-scale continuous desalination at a cost of less than US$ 0.5 per cubic meter is in practical use.
22. More than 50% of drinking water in coastal cities is obtained by desalination.
23. Technologies for ground water exploitation, such as remote sensing technology, are in widespread use.
24. A technology breakthrough leads to the development of a solar cell system cheap enough to provide energy for use by rural pumping systems.
25. Over 50% of households in urban areas have multiple water quality supply systems.
26. In the industrial sector, technologies which reduce the volume of water used by 50%, from 1995 levels, are in practical use.
27. Genetically-altered food plants, such as rice and sugar cane, which use less than 50% of current water requirements, are in widespread use.
28. Technology to detect and locate leaks of over 10% from the water distribution system is developed.
29. Trenchless technologies are in practical use in suitable urban areas.
30. 70% of water used in industry is recycled for further use.
31. 50% of water used by households or groups of households is recycled locally, for further domestic use, owing to the development of cheap and simple package treatment plants.
32. Prefabricated water treatment plants have been developed as a cost-effective means to treat industrial waste water.
33. Technology to determine the structural strength and surface conditions of pipelines, in situ, for planning pipe replacement programs are in widespread use.
34. New materials are developed to produce highly durable and easily maintained pipes at significantly lower cost.
35. A mechanism for negotiating and concluding agreements for international water transfer is accepted.
36. At least 5 international water treaties, covering issues such as extraction, disposal of waste into water and artificial rain-making, are negotiated and ratified.
37. Water is an important political issue in national elections.
38. A nationally coordinated approach to water supply and management is implemented.
39. Nationally determined priorities of water usage and sharing among the sectors (domestic, industrial and agricultural) are enforced.
40. A policy that 50% of water used in the domestic and industrial sectors must be recycled for further use is adopted.
41. The policies “Users Pay” and “Polluters Pay” are enforced.
42. International standards for dam safety are enforced successfully.
43. 50% of water supplies and management are in private ownership.
44. Different quality standards for different uses of water are widely used.
45. Systems for monitoring water source contamination are in widespread use.
46. Water information (quality, quantity, usage) is readily available to the public.
47. Accurate inventories of urban water usage covering all industries, public and private buildings, are available to water managers.
48. Water saving devices, such as dual-flush toilets and automatic-turn-off taps, are installed in all new buildings.
49. Irrigation systems exceed 75% efficiency.
50. 90% of people have easy access to safe water for their domestic use.

51. The price of a barrel of water is listed alongside the price of a barrel of oil, in financial papers like the Wall Street Journal and Financial Times.
52. An integrated water resource management plan, which links in with other natural and human features, is drawn up and implemented for every major river basin.
53. A pricing system that encourages water users to recognize that water is a finite and valuable resource is operated.
54. Water pricing systems are used to control demand.
55. Major cities have installed integrated systems to manage normal water sources and storm water for water supply.
56. APEC-wide performance standards of water supply systems are defined for reference by water regulators.
57. Internet-based sharing of water information and technological developments is promoted by APEC.
58. An APEC fund is established to assist in strengthening and improving substandard water-related structures.
59. Better alternatives to chlorine are used in all new water treatment developments.
60. Organizations are making practical use of a range of models for public, private, and user participation in the management of water supply and waste water disposal, taking into account the cultural differences in the APEC region.
61. Impact of major climate change on water supply can be predicted.
62. Membrane technology for evaporation prevention from water reservoirs has been developed.
63. The concepts of 'sustainable water supply' and 'sustainable development with sufficient water supply' have been understood and implemented widely.
64. Integrated water management of urban areas combining urban water storage, urban flood control, and restoration of urban hydrological cycle is in practical use.

5.4 CONDUCT OF, AND OUTCOMES FROM, THE SECOND ROUND

The respondents to the first round were sent the outputs and asked to review their responses in the light of these results. In addition, some changes were made to the form of the survey. Thus the responses to 'time of realisation in your own economy' were split into economies to assist respondents. Clearly, given the small number of respondents in some economies, the figure may not be representative of those economies; however in others with strong responses, the result is a good indicator. Further, another six topics (three on technology and three on policy issues) were added as a result of the inputs by respondents to the first round. Also, the respondents were asked to assess the needs for APEC-wide cooperation to achieve the estimated times of realisation. These changes had the result of making the questionnaire considerably more bulky and may have contributed to lowering the expected response rate.

A figure of 80% first round respondents returning the second round questionnaire is normal. In our case, we achieved 59%. Table 5.2 shows the responses for the second round:

Table 5.2 Distribution of responses to the second round of the Delphi questionnaire

Economy	Number of Experts contacted	Number of Experts responding	Economy	Number of Experts contacted	Number of Experts responding
Australia	3	3	Malaysia	15	8
Brunei Darussalam	0	0	Mexico	2	2
Canada	4	4	New Zealand	0	0
Chile	2	2	Papua New Guinea	1	0
China	2	2	Philippines	6	2
Hong Kong, China	22	15	Singapore	1	1
Indonesia	1	0	Chinese Taipei	19	7
Japan	8	4	Thailand	38	17
Korea	4	3	USA	1	0
			Total:	114	67 (58.8%)

The results for the first and second rounds are given in Appendix II. These show that in all cases except one (3), support for those of the first round increased substantially towards a consensus. In two cases, 28 and 56, a significant increase occurred. In addition, a number of others increased to above 60% namely 6, 10, 26, 30, 42, 46, 49, 56 while a new one (63) introduced in Round 2 achieved over 60 per cent. Thus the emphasis on technologies increased in the second round while policy issues continued to be strongly supported. The time frame continued to be in the near future between 2005 and 2010 indicating a considerable degree of optimism about the rate of change in political terms.

5.5 DETAILED ANALYSIS OF OVERALL RESULTS OF DELPHI SURVEY

Against the background of his experience with the Korean national Delphi Survey, Dr Taeyoung Shin has carried out a detailed analysis of the overall results.

5.5.1 Degree of Expertise

Experts were asked to evaluate their own expertise for each topic they answered. Some studies show that the degree of expertise is not highly correlated to the accuracy of the forecasting results. Nonetheless, the degree of expertise of the panel is always controversial in Delphi Studies. Therefore, by the self-evaluation of expertise, survey results with high degree of expertise can be provided separately.

The degree of expertise of the panel in the APEC Delphi Survey is quite high, relative to other studies[1*] . The average degree of expertise for 64 topics was 16.3%; 14.7% in *water* as a resource; 13.0% in *technologies,* and 19.5% in *policy issues*. Thus, more experts with higher expertise in the policy area participated, relative to scientists and technologists in water supply and management. This implies that the APEC Delphi would place a greater emphasis on the policy issues. This will be further discussed in the next Section.

5.5.2 Assessment of Topics: Importance and Needs for APEC-wide Cooperation

Two parameters were included to assess the topics. The degree of importance was evaluated in terms of technological progress and management of foreseeable future problems in water supply and management. On the other hand, the APEC Delphi Survey expected active participation of the member economies, and therefore some issues could be addressed, sharing common interests of APEC member economies in the field of water supply and management. Thus, the parameter '*Needs for APEC-wide Cooperation'* was included.

From the Survey results, the measurement of both the degree of importance and needs for APEC-wide cooperation was made, and the index for the measurement was obtained by weighting the results as:

$$I = 3xH + 2xM + 1xL + 0xU$$

where I denotes index for degree of importance or needs for APEC-wide cooperation; H high, M medium, L low, and U unnecessary. Thus, the value of index will be between 0 and 3, ie $0 \leq I \leq 3$.

Using this index, the top 20 topics are listed in Table 5.3. As shown in the Table, most of the important issues are from the policy area, rather than technological ones. Thus, 12 topics are from *policy issues,* six topics from *water as a resource* and two topics from *technologies*. This may imply that the important issues in water supply and management are most likely policy problems, rather than technological ones.

In view of those top 20 topics, important events over the next 14 years can be summarised into (1) pricing water resources (Topic 41, 53 and 54), (2) efficient re/use of water resources (Topic 28, 30, 2, 46, 13 and 49), and (3) integrated management of water supply (Topic 38, 39 and 52). On the other hand, securing water resource is also regarded as an important issue (topic 63 and 10), and others (Topic 4 and 3) are related to flood control.

An index for needs for APEC-wide cooperation can be obtained similarly, and the top 20 topics are listed in Table 5.4. As in the case of degree of importance, policy issues also are more emphasised. APEC-wide cooperation would be necessary for the issues about (1) standardisation (Topic 58, 56 and 42), (2) monitoring (Topic 57, 7, 6 and 45) (3) weather forecasting (1, 61 3 and 4) and (4) international collaboration (36, 35 and 60), etc.

Table 5.3 Top 20 Topics in Degree of Importance

Value of Index		Topic	Year of Realisation
2.882	4.	Scientific methods for flood forecasting, aiming and management to protect important areas at high risk, are in practical use.	2005

[1] For example, the average degree of expertise in the Korean Delphi is not greater than 10%

2.879	28.	Technology to detect and locate leaks of over 10% from the water distribution system is developed.	2005
2.875	50.	90% of people have easy access to safe water for their domestic use.	2008
2.857	41.	The policies 'User Pay' and 'Polluters Pay' are enforced.	2004
2.800	53.	A pricing system that encourages water users to recognise that water is a finite and valuable resource is operated.	2007
2.771	54.	Water pricing systems are used to control demand.	2007
2.758	30.	70% of water used in industry is recycled for further use.	2009
2.735	38.	A nationally coordinated approach to water supply and management is implemented.	2005
2.735	45.	Systems for monitoring water source contamination are in widespread use.	2007
2.708	39.	Nationally determined priorities of water usage and sharing among the sectors (domestic, industrial and agricultural) are enforced.	2008
2.686	2.	Accurate rain and precipitation water-balance forecast, aiming at effective utilisation of rainfall, is in widespread use.	2007
2.676	46.	Water information (quality, quantity, and usage) is readily available to the public.	2006
2.667	42.	International standards for dam safety are enforced successfully.	2005
2.657	52.	An integrated water resource management plan, which links in with other natural and human features, is drawn up and implemented for every major river basin.	2009
2.618	3.	Rainfall prediction accurate enough to allow effective flood control using dams is in widespread use.	2006
2.618	13.	Effective treatment of wastes from animal farms is in widespread use, preventing pollution of water sources.	2008
2.606	49.	Irrigation systems exceed 75% efficiency.	2008
2.597	6.	Global positioning system (GPS) and geographic information system (GIS) to assist water resource management and development are in practical use.	2005
2.581	63.	The concepts of 'sustainable water supply' and 'sustainable development with sufficient water supply' have been understood and implemented widely.	2011
2.579	10.	50% of natural run-off is captured and stored for use.	2010

Table 5.4 Top 20 Topics in Needs of APEC-Wide Cooperation

Value of Index		Topic	Year of Realisation
2.585	58.	An APEC fund is established to assist in strengthening and improving substandard water-related structures.	-
2.467	1.	Scientific methods of accurate long-range weather forecasting, up to 3 months in advance, are developed.	2008
2.455	57.	Internet-based sharing of water information and technological developments is promoted by APEC.	-
2.400	61.	Impact of major climate change on water supply can be predicted.	2011
2.388	56.	APEC-wide performance standards of water supply systems are defined for reference by water regulators.	-
2.382	2.	Accurate rain and precipitation water-balance forecast, aiming at effective utilisation of rainfall, is in widespread use.	2007
2.358	36.	At least 5 International water treaties, covering issues such as extraction, disposal of waste into water and artificial rainmaking, are negotiated and ratified.	2009
2.352	42.	International standards for dam safety are enforced successfully.	2005
2.339	63.	The concepts of 'sustainable water supply' and 'sustainable development with sufficient water supply' have been understood and implemented widely.	2011
2.298	45.	Systems for monitoring water source contamination are in widespread use.	2006
2.298	35.	A mechanism for negotiating and concluding agreements for international water transfer is accepted.	2008
2.263	4.	Scientific methods for flood forecasting, aiming and management to protect important areas at high risk, are in practical use.	2005
2.254	28.	Technology to detect and locate leaks of over 10% from the water distribution system is developed.	2005
2.206	7.	Satellite monitoring of water/catchment use and abuse is in widespread use.	2007
2.159	6.	Global positioning system (GPS) and geographic information system (GIS) to assist water resource management and development are in practical use.	2005
2.148	45.	Systems for monitoring water source contamination are in widespread use.	2007
2.145	60.	Organisation are making practical use of a range of models for public, private and user participation in the management of water supply and waste water disposal, taking into account the cultural differences in the APEC region.	2010
2.135	26.	In the industrial sector, technologies, which reduce the volume of water used by 50%, from 1995 levels, are in practical use.	2010
2.132	30.	70% of water used in industry is recycled for further use.	2009
2.132	34.	New materials are developed to produce highly durable and easily maintained pipes at significantly lower cost.	2008

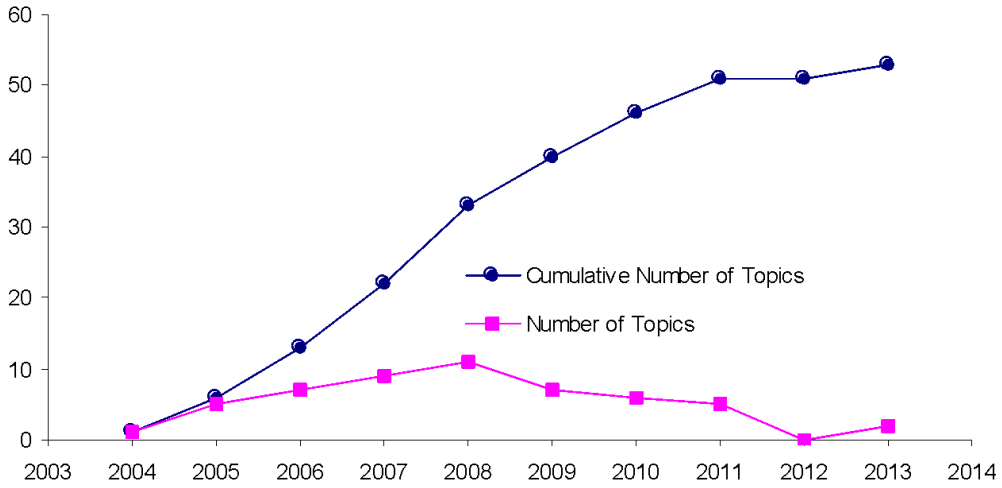
5.5.3 Forecast Time of Future Events in APEC Region

The year of realisation of each topic was estimated. To do this, the inter-quartile range was obtained and the median year represents the year of realisation[2**].

[2] * The inter-quartile range includes lower- and upper-quartiles and median. The lower-quartile represents the year corresponding to the response at the 25th percentile of all responses in chronological order; the median at the 50th percentile; and the upper-quartile at the 75th percentile.

More precisely speaking, a half of the responses expect that the event will occur before the median year and the other half after the median year. Or it can be said that the half of responses expect that the event will occur between lower-quartile and upper-quartile years. The inter-quartile range of each topic is reported in Appendix III for the APEC region.

Figure 5.1 Distribution of Topics over Forecast Time



Using the inter-quartile range, 53 topics out of 64 topics are expected to be realised before the year 2014, and the year of realisation of the remaining 11 topics are indeterminate; that is, they could be realised beyond 2013, or would be never realised[3***]. In some cases where the estimate did not fall inside the inter-quartile range, comments and opinions were made, as noted in Section 5.3. For those 53 topics, which are expected to be realised before 2014, 11 topics are expected to be realised in the year 2009. (See Figure 5.1). The years of realisation show a bell-shaped distribution around 2008[4****]. A breakdown in terms of water as a resource, technologies and policy issues is given in Table 5.5.

Table 5.5 Distribution of Topics by Forecast Time

Year of Realisation	Water as a Resource	Technologies	Policy Issues	Total
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	1	1
2005	2	1	2	5

3 ** It might be said that, for those 11 topics, the forecasting time horizon was given relatively too short, or that selection of topics should have longer-term views. On the other hand, it seems that such a short time horizon could have an effect in the estimation of the forecast time, leading to more optimistic views.

4 *** Other Delphi studies such as Korean Delphi, Japanese Delphi and German Delphi shows that the accuracy of forecast is well correlated to the time distance of the forecast year from the time when the forecast is made. That is, the nearer is the forecast year, the more accurate is the forecast time.

2006	2	2	3	7
2007	2	1	6	9
2008	6	2	3	11
2009	2	2	3	7
2010	1	3	2	6
2011	0	2	3	5
2012	0	0	0	0
2013	0	2	0	2
Beyond 2013, or Never	1	6	4	11
Total	16	21	27	64

On the other hand, the dispersion of the opinions in estimating forecast time could be represented by the distance between the upper- and lower-quartiles. The greater the distance, the greater is the dispersion of opinions. As shown in Table 5.6, most topics (50 topics) show the distance less than seven years. Distances of others are greater than six years or indeterminate, showing a split of opinions. On the whole, the survey results show a good convergence in forecast time.

Table 5.6 Distance between Upper Quartile and Lower Quartile

	1-2 years	3-4 years	5-6 years	7-8 years	Intermediate	Total
Water as a Resource	0	7	3	3	3	16
Technologies	0	8	3	0	10	21
Policy Issues	1	13	5	2	6	27
Total	1	28	11	5	18	64

5.5.4 Chronology of Future Events in APEC Region

Based on the year of realisation, it is possible to construct a chronology of future developments in water supply and management in the APEC region. Topic 41 about the pricing system is the earliest one that is expected to be realised, with a median year of 2004. Five topics are expected to be realised in 2005; seven topics in 2006; nine topics in 2007; and 11 topics in 2008, etc. The last 11 topics are expected to be realised beyond 2013, or would be never realised. In the following, 'B2013' represents that the topic is expected to be realised beyond 2013 or never realised.

2004	41.	The policies 'User Pay' and 'Polluters Pay' are enforced.
2005	28.	Technology to detect and locate leaks of over 10% from the water distribution system is developed.
2005	38	A nationally coordinated approach to water supply and management is implemented.
2005	4	Scientific methods for flood forecasting, aiming and management to protect important areas at high risk, are in practical use.
2005	42.	International standards for dam safety are enforced successfully.
2005	6	Global positioning system (GPS) and geographic information system (GIS) to assist water resource management and development are in practical use.
2006	3	Rainfall prediction accurate enough to allow effective flood control using dams is in widespread use.

2006	32.	Prefabricated water treatment plans have been developed as a cost-effective means to treat industrial wastewater.
2006	37.	Water is an important political issue in national elections.
2006	39.	Nationally determined priorities of water usage and sharing among the sectors (domestic, industrial and agricultural) are enforced.
2006	46.	Water information (quality, quantity, and usage) is readily available to the public.
2006	64.	Integrated water management of urban areas combining urban water storage, urban flood control, and restoration of urban hydrological cycle is in practical use.
2006	8.	Remote techniques and automated control systems to regulate domestic and industrial water supply are in widespread use.
2007	2.	Accurate rain and precipitation water-balance forecast, aiming at effective utilisation of rainfall, is in widespread use.
2007	29.	Trenchless technologies are in practical use in suitable urban areas.
2007	44.	Different quality standards for different uses of water are widely used.
2007	45.	Systems for monitoring water source contamination are in widespread use.
2007	47.	Accurate inventories of urban water usage covering all industries, public and private buildings are available to water managers.
2007	48.	Water saving devices, such as dual-flush toilets and automatic-turn-off taps, are installed in all new buildings.
2007	53.	A pricing system that encourages water users to recognise that water is a finite and valuable resource is operated.
2007	54.	Water pricing systems are used to control demand.
2007	7.	Satellite monitoring of water/catchment use and abuse is in widespread use.
2008	1.	Scientific methods of accurate long-range weather forecasting, up to three months in advance, are developed.
2008	12.	Natural ecosystems for localised water storage are in practical use.
2008	13.	Effective treatment of wastes from animal farms is in widespread use, preventing pollution of water sources.
2008	14.	Automatic remote water quality monitoring stations are installed at most catchment basins susceptible to pollution.
2008	33.	Technology to determine the structural strength and surface conditions of pipelines, in situ, for planning pipe replacement programs are in widespread use.
2008	34.	New materials are developed to produce highly durable and easily maintained pipes at significantly lower cost.
2008	35.	A mechanism for negotiating and concluding agreements for international water transfer is accepted.
2008	49.	Irrigation systems exceed 75% efficiency.
2008	5.	Technology to induce artificial rain is in practical use.
2008	50.	90% of people have easy access to safe water for their domestic use.
2008	9.	Remote techniques and automated control systems to regulate water supply for agricultural irrigation are in widespread use.
2009	11.	Recharging of acquifers is widely used to enable sustainable exploitation of groundwater.
2009	15.	Cost effective techniques to de-silt heavily silted lakes and impounded reservoirs are in practical use to restore regulatory capacities.
2009	23.	Technologies for groundwater exploitation, such as remote sensing technology, are in widespread use.

2009	30.	70% of water used in industry is recycled for further use.
2009	36.	At least five international water treaties, covering issues such as extraction, disposal of waste into water and artificial rainmaking, are negotiated and ratified.
2009	40.	A policy that 50% of water used in the domestic and industrial sectors must be recycled for further use is adopted.
2009	52.	An integrated water resource management plan, which links in with other natural and human features, is drawn up and implemented for every major river basin.
2010	10.	50% of natural run-off is captured and stored for use.
2010	24.	A technology breakthrough leads to the development of a solar cell system cheap enough to provide energy for use by rural pumping systems.
2010	26.	In the industrial sector, technologies that reduce the volume of water used by 50%, from 1995 levels, are in practical use.
2010	55.	Major cities have installed integrated systems to manage normal water sources and stormwater for water supply.
2010	60.	Organisation are making practical use of a range of models for public, private and user participation in the management of water supply and waste water disposal, taking into account the cultural differences in the APEC region.
2010	61.	Impact of major climate change on water supply can be predicted.
2011	31.	50% of water used by households or groups of households is recycled locally, for further domestic use, owing to the development of cheap and simple package treatment plants.
2011	43.	50% of water supplies and management are in private ownership.
2011	59.	Better alternatives to chlorine are used in all new water treatment development.
2011	62.	Membrane technology for evaporation prevention from water reservoirs has been developed.
2011	63.	The concepts of ‘sustainable water supply’ and ‘sustainable development with sufficient water supply’ have been understood and implemented widely.
2013	25.	Over 50% of households in urban areas have multiple water quality supply systems.
2013	27.	Genetically altered food plants, such as rice and sugar cane, which use less than 50% of current water requirement, are in widespread use.
B2013	16.	Techniques to transport icebergs cost-effectively are elucidated.
B2013	17.	Water containers for large-scale long distance transport across oceans are in practical use.
B2013	18.	Water containers for large-scale long distance transport along rivers are in practical use.
B2013	19.	Dedicated infrastructure, such as container terminals, to handle bulk water transport is in widespread use.
B2013	20.	Biological methods to desalinate water, producing water suitable for agricultural irrigation in terms of both cost and quality, are in practical use.
B2013	21.	Due to advances in membrane technology, large-scale continuous desalination at a cost of less than US$0.5 per cubic meter is in practical use.
B2013	22.	More than 50% of drinking water in coastal cities is obtained by desalination.
B2013	51.	The price of a barrel of water is listed alongside the price of a barrel of oil, in financial papers like the Wall Street Journal and Financial Times.
B2013	56.	APEC-wide performance standards of water supply systems are defined for reference by water regulators.
B2013	57.	Internet-based sharing of water information and technological developments is promoted by APEC.

B2013 58. An APEC fund is established to assist in strengthening and improving substandard water-related structures.

5.5.5 Forecast Time of Future Events in Member Economies

As noted in Section 5.4, the question of 'Time of Realisation in Own Economy' was added in the Second Round.

Since the rates of responses were widely varying across economies, it was difficult to get statistically significant results from the survey. However, the estimated time of the topics in different economies, are quite close to each other as shown in Table 5.7. The mean years in most economies fall between 2004 and 2008 and the standard deviations are not varying widely.

Table 5.7 Distribution of Forecast Time by Economies

	Number of Topics by 2013	Mean Year of Realisation	Standard Deviation
Australia	55	2004	3.6
Canada	26	2005	3.8
China	55	2007	2.9
Chile	45	2007	3.4
China, Hong Kong	43	2005	3.7
Indonesia	0	--	--
Japan	48	2008	2.1
Korea	48	2007	2.7
Malaysia	50	2006	2.8
Mexico	52	2007	3.0
Philippines	55	2006	3.5
Singapore	31	2006	4.1
Thailand	52	2007	2.7
Chinese Taipei	46	2005	3.4
United States	0	--	--

An interesting result in this exercise is that estimating the forecast time simultaneously in both the APEC region and member economies seems to have a strong effect on convergence. That is, convergence seems to have been achieved quickly and effectively when the experts made estimates for own economies with feedback of information about the regional and/or other economies, relative to when they do a closed forecast, ie forecasting only for domestic events without feedback of other information. It implies that experts might have a systematic way to make a comparison with the situations of other economies. Thus, when they make a forecast, additional factors are taken into consideration. When provided with such information, a dramatic convergence of opinions was achieved in the second round, as shown in Table 5.8.

Table 5.8 Dispersion of Expert Opinions about Forecast Time for Own Economies

	Number of Topics Considered		Average Distance between Upper- and Lower-Quartile	
	First Round	Second Round	First Round	Second Round
Australia	35	50	4.4	0.7
Canada	34	20	2.4	1.0

China	34	50	6.0	2.2
Chile	39	42	4.4	0.0
China, Hong Kong	28	35	5.9	2.6
Indonesia	23	0	2.0	--
Japan	18	43	7.1	0.5
Korea	36	43	5.9	2.4
Malaysia	35	43	6.1	3.4
Mexico	36	47	2.3	3.3
Philippines	49	48	5.1	3.2
Papua New Guinea	40	15	2.0	0.0
Singapore	52	31	2.8	0.0
Thailand	37	37	7.2	3.5
Chinese Taipei	35	34	6.1	3.1
United States	35	0	2.0	--

Note: Only topics that have the values of upper- and lower-quartile are considered.

6. CONCLUDING REMARKS

A 1996 OECD review of Technology Foresight concluded that there is no one correct, nor perfect, method of carrying out foresight research, and that any study should be designed to meet the circumstances of the organisation, the topic and the research environment[5+]. Since there is no precedent for a multi-economy Foresight study, this study of water supply and management in the APEC region provides a unique opportunity to assess the effectiveness or otherwise of such exercises. The following remarks drawn from the paper by Jewell and Sripaipan[6++] are pertinent.

6.1 OVERALL METHODOLOGY

In terms of the classification of Foresight studies, as suggested by Martin and Irvine[7+++] the key features and distinguishing characteristics of the study can be described as:

a) **Organisation Characteristics**. The APEC Center for Technology Foresight, though hosted by NSTDA of Thailand, is an *international body* under the Industrial Science and Technology Working Group of APEC.

b) **Degree of Specificity**. The study focussing on a limited number of research fields of Water Supply and Management is at *macro-level*.

c) **Aims, Objectives and Functions of Foresight**. The main objective of the study is to develop a strategic and coherent view about water supply and management in APEC

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5 OECD STI Review No. 17, *'Special Issue on Government Technology Foresight Exercises'* (1996), OECD (Paris).

6 + Jewell, T. and Sripaipan, C. *'Multi-Country Foresight : Issues and Challenges'* presented in Third International Conference held by IATAFI (New Delhi), November 1998.

7 ++ Martin, B.R. and Irvine, J. *'Research Foresight : Priority Setting in Science'* (1989) Ch 2. Printer Publishers (London).

region. The functions of the study therefore provide *anticipatory intelligence* through the scenario building exercise and consensus generation by Delphi Survey. Its results should be direction setting. *Advocacy* is more limited because it did not involve many important stakeholders. *Communication and education* are planned through dissemination activities. The task of *determining priorities* is left to individual economies due to their diversity of problems and different levels of development.

d) **Orientation and Structural Characteristics of Research.** The orientation of the study is *strategic or applied* whereas its structural characteristics is *complex* involving a large number of disciplines from meteorology to membrane materials to genetic engineering.

e) **The Balance between Various 'Intrinsic Tensions' in Foresight** may be stated as follows. The Center has no stake in water supply and management and is therefore a neutral *third party*. *Demand-pull* factors were considered in the Issues Paper and in the scenarios and are rather prominent in the topic statements of the Delphi questionnaire. Since we have not involved most of the stakeholders, the study has to be classified as a *top down* approach.

f) **Time Horizon**. The time horizon is set at about 12 years or in the year 1020 in the scenario building exercise. However, the Delphi questionnaire provides time slots of five years each covering a total of 15 years and beyond. The time horizon is therefore *long term.*

g) **Methodological Approach**. Scenario building was deployed to generate more visionary topics for a subsequent Delphi Survey. The survey is conducted *formally* and the results are *quantitative* predictions of year of realisation, as well as more *qualitative* information emerging from the comments offered, and more significantly, from the scenario-building exercise.

6.2 SCOPE OF STUDY

As the Issues Paper clearly shows, the study included both technological and policy issues from the outset. While this may be a feature of choosing a topic of such immense socio-political importance, it also reflects the fact that the study encompassed a divergent group of economies, at widely different levels of economic and technological development. Thus, the issue of how and why new technologies become adopted and diffused was at least as relevant as when and how genuinely new technologies might emerge in the APEC region. It was also made clear in the Issues Paper that the study sought to develop an APEC-wide perspective, rather than collect a series of national pictures.

6.3 SCENARIO-BUILDING WORKSHOP

The scenario workshop involved Experts from various sub-disciplines and institutional settings (academia, public service and private organisations), all of whom were sufficiently senior to contribute to policy as well as technical matters. In terms of the range of people who could be considered to be 'stakeholders' in the field of water, this was obviously a very narrow group but this was appropriate for the clearly defined purpose of the exercise. Most of the Experts were completely new to foresight and to scenario building, and moreover, most were using English as a second language. The presence of small-group facilitators was therefore important to overcoming their initial confusion about the task and increasing their commitment. The scenario exercise succeeded in encouraging these Experts to look beyond their every-day concerns about water, and into the longer-term future, a leap of imagination that was greatly assisted by such a structured approach. The scenario material contributed to developing the findings of Volume 1. It also proved successful as a mechanism for developing Delphi topics.

6.4 THE DELPHI SURVEY

Some of the problems of a Delphi Survey across a number of economies have been highlighted in Sections 5.3 and 5.4. Neither the original Experts, nor those actually responding can be viewed as representative of all water experts in each economy, in view of the sample size and the way in which their names were obtained. Moreover, the degree of representativeness varied between economies and probably reached a good level where the Center succeeded in cooperating with a key water agency in an economy and obtaining a decent response rate from there, for example, as was the case for Chinese Taipei, Hong Kong, and Malaysia. Building credible links with key agencies in each APEC economy is therefore likely to be an essential task in future studies, in order to secure the cooperation of relevant experts and institutions. This would have the added advantage of increasing the chances that the research output will be respected and implemented. Given the distance between experts and the Center, both geographical and professional, multi-country Delphi surveys clearly take longer than national ones, since the follow-up is more complex, yet more necessary. Despite these shortcomings the detailed analysis of the available data shows that the Delphi technique is certainly an effective method to draw out issues across a number of diverse economies and the APEC Center for Technology Foresight will continue to use the technique in its next study.

6.5 POST FORESIGHT

The findings of the study will be presented to the APEC Industrial Science and Technology Working Group and to groups of experts and decision-makers in a number of APEC economies. Both the scenario analysis and the Delphi Survey identify political action, effective responses and regulation, and appropriate management as the key to effective response to the challenges of water supply and management in the twenty-first century. Changes must occur on the national, regional and, desirably, APEC level, but as the Delphi Survey shows, there is a strong body of opinion that such changes can occur. The outcomes of the study can only be judged in the longer term.

APPENDIX I: Participants of the experts' Meeting

PARTICIPANTS OF THE EXPERT' S MEETING AT HUAHIN, THAILAND, 12-14 MAY 1998

Australia	
Dr Alan Wade	Principal Water Quality Advisor, ACTEW Corporation, Canberra.
Canada	Professor and NSERC Industrial Research Chair,
Dr Robert Gillham	University of Waterloo, Waterloo.
Chile	
Mr Alejandro Lopez	Executive Director, National Institute of Hydraulics, Santiago.
Chinese Taipei	Deputy General Director, Energy and Resources Laboratory,
Dr Cy C Chen	Industrial Technology Research Institute
Hong Kong	
Mr Ku Chi-Chung, Damien	Chief Engineer, Water Supplies Department, Government of Hong Kong
Korea	Principal Hydrogeologist, Korea Institute of Geology,
Dr Ig-Hwan Sung	Mining and Materials
Malaysia	Senior Assistant Director, Planning and Evaluation Division,
Ir Azuhan Mohamed	Department of Irrigation and Drainage, Kuala Lumpur.
Mexico	
Dr Oscar Monroy	Universidad Autonomia Matropolitana, Mexico City.
Thailand	
Mr Pramote Maiklad	Director-General, Royal Irrigation Department

Dr Jesda Kaewkulaya	Vice-President, Kasetsart University, Bangkok.

Guest of Honor

Dr Yongyuth Yuthavong	Director, National Science and Technology Development Agency, Bangkok.

Facilitators

Prof Ron Johnston	Executive Director, Australian Centre for Innovation and Industrial Competitiveness, University of Sydney, Sydney.
Dr Taeyoung Shin	Head, S&T Indicators and Analyses, Science and Technology Policy Institute, Seoul.

Observer

Mr Kwanchai Lamubol	Assistant Deputy Director, National Electronics and Computer Technology Center, Bangkok, representative of Thai Foresight Unit.

APEC TF Staff

Prof Greg Tegart	Director
Dr Chatri Sripaipan	Co-director
Monthida Sitathani	Senior International Coordinator
Tamsin Jewell	International Coordinator
Mayuree Watanakuljaras	International Coordinator
Nalinrat Sirikantraporn	International Coordinator

APPENDIX II: Summary of Survey Results

Appendix II: Summary of Survey Results

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
1	Scientific methods of accurate long-range weather forecasting, up to 3 months in advance, are developed.	1	93	45.2	14.0	7.5	32.3	10.8	37.6	49.5	1.1	2004	2008	201
		2	46	40.0	20.0	14.3	25.7	5.7	42.9	51.4	0.0	2004	2008	200
		E	5					0.0	20.0	80.0	0.0	2006	2008	200
2	Accurate rain and precipitation water-balance forecast, aiming at effective utilization of rainfall, is in widespread use.	1	93	36.6	29.0	11.8	21.5	4.3	25.8	67.7	0.0	2003	2006	201
		2	46	42.9	28.6	17.1	11.4	5.7	20.0	74.3	0.0	2004	2007	200
		E	6					0.0	0.0	100.0	0.0	2004	2004	200
3	Rainfall prediction accurate enough to allow effective flood control using dams is in widespread use.	1	95	40.0	30.5	15.8	12.6	3.2	22.1	70.5	0.0	2002	2006	201

		2	45	47.1	26.5	14.7	11.8	5.9	26.5	67.6	0.0	2002	2006	200
		E	5					0.0	0.0	100.0	0.0	2006	2007	200
4	Scientific methods for flood forecasting, aiming and management to protect important areas at high risk, are in practical use.	1	96	34.4	31.3	21.9	11.5	1.0	16.7	80.2	0.0	2002	2005	200
		2	45	20.6	35.3	32.4	11.8	0.0	11.8	88.2	0.0	2002	2005	200
		E	11					0.0	0.0	100.0	0.0	2002	2005	200
5	Technology to induce artificial rain is in practical use.	1	88	52.3	12.5	2.3	33.0	30.7	51.1	9.1	8.0	2003	2008	
		2	40	33.3	18.2	6.1	42.4	15.2	57.6	27.3	0.0	2003	2008	201
		E	2					0.0	50.0	50.0	0.0	2003	2003	200

To pic #	Topic	Ro un d #	# of Re sp on ses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization i APEC Region		
				Low	Medi um	High	None	Low	Medi um	High	Unne cess ary	QL	QM	QU
6	Global positioning system (GPS) and geographic information system (GIS) to assist water resource management and development are in practical use.	1	94	46.8	29.8	13.8	9.6	6.4	43.6	47.9	1.1	2001	2005	200
		2	42	24.2	45.5	15.2	15.2	3.0	33.6	63.6	0.0	2001	2005	200
		E	5					0.0	0.0	100.0	0.0	2001	2001	200
7	Satellite monitoring of water/catchment use and abuse is in widespread use.	1	93	47.3	19.4	6.5	26.9	11.8	47.3	35.5	4.3	2004	2007	201
		2	43	33.3	36.4	3.0	27.3	6.1	51.5	42.4	0.0	2005	2007	200
		E	1					0.0	0.0	100.0	0.0	--	--	
8	Remote techniques and automated control systems to regulate domestic and industrial water supply are in widespread use.	1	94	41.1	37.8	8.9	12.2	12.2	51.1	34.4	0.0	2003	2006	201
		2	41	27.3	45.5	15.2	12.1	12.5	46.9	37.5	3.1	2003	2006	200
		E	5					20.0	40.0	40.0	0.0	2006	2006	200
9	Remote techniques and automated control systems to regulate water supply for agricultural irrigation are in widespread use.	1	94	46.8	29.8	6.4	17.0	20.2	46.8	28.7	3.2	2004	2008	201
		2	42	36.4	39.4	9.1	15.2	6.3	56.3	31.3	6.3	2004	2008	201

		E	3					0.0	33.3	66.7	0.0	2006	2008	201
10	50% of natural run-off is captured and stored for use	1	91	28.6	42.9	17.6	11.0	20.9	24.2	50.5	3.3	2005	2010	
		2	42	21.2	51.5	18.2	9.1	6.3	25.0	68.8	0.0	2005	2010	
		E	6					0.0	16.7	83.3	0.0	2006	2009	201

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
11	Recharging of acquifers is widely used to enable sustainable exploitation of groundwater	1	90	44.4	21.1	14.4	20.0	22.2	33.3	41.1	2.2	2005	2009	
		2	42	29.4	23.5	17.6	29.4	21.2	33.3	45.5	0.0	2005	2009	
		E	6					16.7	33.3	50.0	0.0	2006	2009	201
12	Natural ecosystems for localized water storage are in practical use	1	89	43.8	29.2	11.2	15.7	22.5	40.4	36.0	0.0	2005	2009	201
		2	42	30.3	33.3	15.2	21.2	12.1	48.5	39.4	0.0	2004	2008	201
		E	5					20.0	20.0	60.0	0.0	2004	2005	200
13	Effective treatment of waters from animal farms is in widespread use, preventing pollution of water sources.	1	94	37.2	33.0	16.0	12.8	3.2	33.0	61.7	0.0	2004	2008	201
		2	44	29.4	26.5	29.4	14.7	2.9	32.4	64.7	0.0	2004	2008	200
		E	10					0.0	20.0	80.0	0.0	2004	2004	200
14	Automatic remote water quality monitoring stations are installed at most catchment basins susceptible to pollution.	1	95	45.3	23.2	18.9	12.6	12.6	45.3	41.1	0.0	2005	2008	201
		2	43	30.3	45.5	12.1	12.1	6.1	42.4	51.5	0.0	2005	2008	201
		E	4					0.0	50.0	50.0	0.0	2007	2008	200
15	Cost effective techniques to de-silt heavily silted lakes and impounded reservoirs are in practical use to restore regulatory capacities.	1	91	35.2	31.9	9.9	23.1	17.6	46.2	35.2	1.1	2005	2009	201
		2	42	41.2	38.2	8.8	11.8	12.5	65.6	21.9	0.0	2005	2009	201
		E	3					0.0	66.7	33.3	0.0	2002	2005	200

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
16	Techniques to transport icebergs cost-effectively are elucidated.	1	82	28.0	4.9	3.7	63.4	45.1	13.4	1.2	39.0	2013	--	
		2	38	26.7	6.7	6.7	60.0	34.5	17.2	6.9	41.4	-	--	
		E	2					0.0	100.0	0.0	0.0	2013	--	
17	Water containers for large-scale long distance transport across oceans are in practical use.	1	88	43.2	5.7	1.1	50.0	54.5	13.6	2.3	28.4	2010	--	
		2	40	28.1	21.9	3.1	46.9	40.6	15.6	9.4	34.4	2013	--	
		E	1					0.0	0.0	0.0	100	1999	1999	199
18	Water containers for large-scale long distance transport along rivers are in practical use.	1	82	37.8	8.5	2.4	51.2	50.0	17.1	6.1	25.6	2008	--	
		2	39	25.8	19.4	3.2	51.6	36.7	23.3	10.0	30.0	-	--	
		E	1					0.0	0.0	0.0	100	1999	1999	199
19	Dedicated infrastructure, such as container terminals, to handle bulk water transport is in widespread use.	1	83	34.9	10.8	1.2	53.0	53.0	20.5	4.8	20.5	2009	--	
		2	38	36.4	9.1	0.0	54.5	24.2	27.3	12.1	36.4	--	--	
		E	0					--	--	--	--	--	--	
20	Biological methods to desalinate water, producing water suitable for agricultural irrigation in terms of both cost and quality, are in practical use.	1	87	33.3	12.6	5.7	48.3	35.6	39.1	12.6	12.6	2010	--	
		2	42	17.6	11.8	11.8	58.8	25.0	46.9	18.8	9.4	-	--	
		E	4					25.0	25.0	50.0	0.0	2012	--	

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)	Degree of Importance (%)	Year of Realization in APEC Region

				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
21	Due to advances in membrane technology, large-scale continuous desalination at a cost of less than US$0.5 per cubic meters is in practical use.	1	90	36.7	16.7	12.2	34.4	27.8	28.9	34.4	7.8	2006	2011	
		2	41	23.5	29.4	11.8	35.3	21.2	33.3	36.4	9.1	2011	--	
		E	4					0.0	25.0	75.0	0.0	2005	2011	201
22	More than 50% of drinking water in coastal cities is obtained by desalination.	1	91	38.5	20.9	8.8	31.9	34.1	26.4	23.1	16.5	2010	--	
		2	39	30.3	12.1	18.2	39.4	25.0	37.5	25.0	12.5	-	--	
		E	8					16.7	33.3	50.0	0.0	2010	--	
23	Technologies for ground water exploitation, such as remote sensing technology, are in widespread use.	1	91	39.6	25.3	7.7	27.5	26.4	51.6	17.6	4.4	2005	2009	201
		2	44	36.4	24.2	12.1	27.3	18.2	60.6	21.2	0.0	2009	2009	201
		E	4					0.0	25.0	75.0	0.0	2004	2009	201
24	A technology breakthrough leads to the development of a solar cell system cheap enough to provide energy for use by rural pumping systems.	1	88	47.7	18.2	2.3	31.8	20.5	45.5	29.5	3.4	2006	2010	
		2	43	24.2	18.2	6.1	51.5	18.8	50.0	25.0	6.3	2008	2010	
		E	2					0.0	50.0	50.0	0.0	1999	1999	199
25	Over 50% of households in urban areas have multiple water quality supply systems.	1	86	36.0	27.9	23.3	12.8	29.1	30.2	37.2	3.5	2008	2012	
		2	41	32.4	11.8	2.9	52.9	18.2	54.5	24.2	3.0	2013	2013	
		E	9					0.0	11.1	77.8	11.1	2012	2012	201

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
26	In the industrial sector, technologies which reduce the volume of water used by 50%, from 1995 levels, are in practical use.	1	89	44.9	25.8	13.5	15.7	10.1	39.3	49.4	0.0	2007	2010	201

		2	43	35.3	32.4	17.6	14.7	0.0	39.4	60.6	0.0	2007	2010	201
		E	6					0.0	16.7	83.3	0.0	2008	2010	201
27	Genetically-altered food plants, such as rice and sugar cane, which use less than 50% of current water requirement, are in widespread use.	1	86	37.2	16.3	2.3	44.2	22.1	48.8	17.4	10.5	2008	2013	
		2	41	32.4	11.8	2.9	52.9	18.2	54.5	24.2	3.0	2013	2013	
		E	1					0.0	0.0	100.0	0.0	2013	2013	201
28	Technology to detect and locate leaks of over 10% from the water distribution system is developed.	1	91	27.5	39.6	25.3	7.7	5.5	28.6	64.8	1.1	2003	2006	201
		2	42	20.6	50.0	20.6	8.8	0.0	12.1	87.9	0.0	2003	2005	200
		E	7					0.0	0.0	100	0.0	2003	2005	200
29	Trenchless technologies are in practical use in suitable urban areas.	1	85	45.9	28.2	9.4	16.5	30.6	37.6	28.2	2.4	2003	2007	201
		2	39	21.2	42.4	15.2	21.2	15.6	50.0	31.3	3.1	2003	2007	200
		E	5					0.0	40.0	60.0	0.0	2003	2004	200
30	70% of water used in industry is recycled for further use.	1	94	44.7	28.7	17.0	9.6	10.6	36.2	53.2	0.0	2005	2009	201
		2	43	20.6	38.2	29.4	11.8	0.0	24.2	75.8	0.0	2005	2009	200
		E	10					0.0	10.0	90.0	0.0	2005	2009	200

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
31	50% of water used by households or groups of households is recycled locally, for further domestic use, owing to the development of cheap and simple package treatment plants.	1	96	51.0	26.0	10.4	12.5	21.9	41.7	35.4	1.0	2007	2011	
		2	43	50.0	14.7	23.5	11.8	9.1	54.5	36.4	0.0	2007	2011	
		E	8					12.5	25.0	62.5	0.0	2007	2011	201
32	Prefabricated water treatment plants have been developed as a cost-effective means to treat industrial waste water.	1	89	43.8	23.6	16.9	15.7	16.9	46.1	36.0	1.1	2004	2008	201

		2	41	35.3	26.5	26.5	11.8	2.9	48.6	45.7	2.9	2004	2006	200
		E	9					0.0	33.3	66.7	0.0	2004	2004	200
33	Technology to determine the structural strength and surface conditions of pipelines, in situ, for planning pipe replacement programs are in widespread use.	1	90	37.8	30.0	10.0	22.2	17.8	47.8	31.1	3.3	2005	2008	201
		2	42	24.2	30.3	18.2	27.3	6.3	53.1	40.6	0.0	2005	2008	200
		E	6					0.0	16.7	83.3	0.0	2005	2007	200
34	New materials are developed to produce highly durable and easily maintained pipes at significantly lower cost.	1	87	42.5	24.1	9.2	24.1	12.6	48.3	37.9	1.1	2004	2008	201
		2	42	24.2	33.3	15.2	27.3	3.1	59.4	37.5	0.0	2004	2008	200
		E	5					0.0	20.0	80.0	0.0	2005	2007	200
35	A mechanism for negotiating and concluding agreements for international water transfer is accepted.	1	88	42.0	26.1	6.8	22.7	20.5	35.2	44.3	0.0	2004	2008	201
		2	43	36.4	36.4	6.1	21.2	23.5	26.5	44.1	5.9	2006	2008	200
		E	2					0.0	0.0	100	0.0	2009	2011	201

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
36	At least 5 international water treaties, covering issues such as extraction, disposal of waste into water and artificial rain-making, are negotiated and ratified.	1	82	37.8	20.7	2.4	37.8	32.9	37.8	23.2	6.1	2006	2009	
		2	42	30.3	27.3	6.1	36.4	21.9	37.5	37.5	3.1	2009	2009	
		E	2					0.0	50.0	50.0	0.0	2003	2007	201
37	Water is an important political issue in national elections.	1	88	36.4	33.0	15.9	12.5	18.2	37.5	35.2	8.0	2002	2006	201
		2	45	32.4	29.4	26.5	11.8	14.7	41.2	44.1	0.0	2002	2006	200
		E	9					11.1	22.2	66.7	0.0	2002	2002	200
38	A nationally coordinated approach to water supply and management is implemented.	1	89	27.0	37.1	27.0	7.9	3.4	25.8	69.7	0.0	2002	2006	201

		2	45	29.4	35.3	29.4	5.9	5.9	14.7	79.4	0.0	2002	2005	200
		E	10					0.0	10.0	90.0	0.0	2002	2002	200
39	Nationally determined priorities of water usage and sharing among the sectors (domestic, industrial and agricultural) are enforced.	1	91	23.1	39.6	25.3	11.0	5.5	22.0	68.1	3.3	2002	2006	201
		2	45	26.5	44.1	17.6	11.8	2.9	23.5	73.5	0.0	2002	2006	200
		E	6					0.0	0.0	100.0	0.0	2002	2002	200
40	A policy that 50% of water used in the domestic and industrial sectors must be recycled for further use is adopted.	1	90	34.4	43.3	10.0	10.0	15.6	41.1	41.1	1.1	2006	2009	201
		2	44	23.5	47.1	11.8	17.6	6.1	48.5	45.5	0.0	2006	2009	200
		E	4					0.0	0.0	100.0	0.0	2006	2006	200

To pic #	Topic	Ro un d #	# of Re sp on ses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization i APEC Region		
				Low	Medi um	High	None	Low	Medi um	High	Unne cess ary	QL	QM	QU
41	The policy “Users Pay” and “Polluters Pay” are enforced.	1	92	17.4	53.3	21.7	4.3	3.3	19.6	76.1	0.0	2003	2007	201
		2	44	20.6	44.1	26.5	8.8	0.0	14.3	85.7	0.0	2003	2004	200
		E	9					0.0	11.1	88.9	0.0	2003	2003	200
42	International standards for dam safety are enforced successfully.	1	90	32.2	37.8	15.6	11.1	4.4	36.7	56.7	1.1	2004	2006	201
		2	44	32.4	47.1	14.7	5.9	5.6	22.2	72.2	0.0	2004	2005	200
		E	5					0.0	20.0	80.0	0.0	2004	2004	200
43	50% of water supplies and management are in private ownership.	1	91	40.7	30.8	13.2	12.1	29.7	36.3	22.0	11.0	2006	2011	
		2	44	35.3	41.1	11.8	11.8	24.2	51.5	21.2	3.0	2007	2011	
		E	4					25.0	25.0	50.0	0.0	2006	2007	201
44	Different quality standards for different uses of water are widely used.	1	94	28.7	42.6	21.3	5.3	13.8	41.5	42.6	1.1	2004	2007	201
		2	44	20.6	44.1	23.5	11.8	9.1	39.4	51.5	0.0	2004	2007	200

		E	8					0.0	0.0	100	0.0	2004	2005	200
45	Systems for monitoring water source contamination are in widespread use.	1	95	28.4	38.9	20.0	9.5	9.5	26.3	63.2	0.0	2003	2007	201
		2	45	23.5	47.1	20.6	8.8	5.9	14.7	79.4	0.0	2003	2007	200
		E	7					0.0	0.0	100	0.0	2003	2003	200

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
46	Water information (quality, quantity, and usage) is readily available to the public.	1	96	27.1	35.4	31.3	3.1	8.3	36.5	54.2	0.0	2003	2006	201
		2	44	18.2	57.6	21.2	3.0	0.0	32.4	67.6	0.0	2003	2006	200
		E	7					0.0	0.0	100.0	0.0	2003	2003	200
47	Accurate inventories of urban water usage covering all industries, public and private buildings, are available to water man agers.	1	89	23.6	44.9	18.0	10.1	9.0	44.9	43.8	1.1	2004	2007	201
		2	43	23.5	50.0	14.7	11.8	2.9	44.1	52.9	0.0	2004	2007	200
		E	5					0.0	0.0	100.0	0.0	2007	2007	200
48	Water saving devices, such as dual-flush toilets and automatic-turn-off taps, are installed in all new buildings.	1	93	35.5	43.0	12.9	6.5	12.9	45.2	40.9	0.0	2004	2007	201
		2	44	30.3	42.4	18.2	9.1	5.7	37.1	57.1	0.0	2004	2007	200
		E	6					0.0	0.0	100	0.0	2004	2004	200
49	Irrigation systems exceed 75% efficiency.	1	91	36.3	25.3	15.4	20.9	11.0	34.1	52.7	1.1	2006	2008	201
		2	43	26.5	41.2	11.8	20.6	6.1	18.2	72.7	3.0	2006	2008	201
		E	4					0.0	0.0	100.0	0.0	2006	2006	200
50	90% of people have easy access to safe water for their domestic use.	1	95	28.4	29.5	34.7	4.2	0.0	17.9	81.1	0.0	2004	2008	201
		2	43	14.7	35.3	41.2	8.8	0.0	12.5	87.5	0.0	2004	2008	200
		E	14					0.0	7.1	85.7	0.0	2004	2005	200

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
51	The price of a barrel of water is listed alongside the price of a barrel of oil, in financial papers like the Wall Street Journal and Financial Times.	1	82	34.1	29.3	3.7	29.3	28.0	31.7	20.7	18.3	2009	--	
		2	42	41.2	17.6	8.8	32.4	39.4	30.3	15.2	15.2	--	--	
		E	3					0.0	66.7	33.3	0.0	2012	--	
52	An integrated water resource management plan, which links in with other natural and human features, is drawn up and implemented for every major river basin	1	95	27.4	33.7	24.2	11.6	4.2	30.5	63.2	1.1	2005	2009	
		2	45	20.6	47.1	23.5	8.8	28.6	20.0	74.3	2.9	2005	2009	201
		E	8					0.0	0.0	100.0	0.0	2005	2007	200
53	A pricing system that encourages water users to recognize that water is a finite and valuable resource is operated.	1	98	19.4	43.9	28.6	5.1	2.0	34.7	62.2	0.0	2004	2007	201
		2	43	17.6	41.2	38.2	2.9	2.9	14.3	82.9	0.0	2004	2007	200
		E	13					0.0	15.4	84.6	0.0	2004	2004	200
54	Water pricing systems are used to control demand.	1	95	18.9	47.4	26.3	4.2	4.2	28.4	65.3	0.0	2004	2007	201
		2	43	14.7	50.0	29.4	5.9	0.0	14.3	82.9	2.9	2004	2007	200
		E	10					0.0	10.0	80.0	10.0	2004	2004	200
55	Major cities have installed integrated systems to manage normal water sources and storm water for water supply.	1	88	39.8	34.1	12.5	11.4	14.8	47.7	36.4	0.0	2006	2010	201
		2	42	33.3	30.3	27.3	9.1	9.1	39.3	48.5	3.0	2006	2010	201
		E	9					0.0	22.2	66.7	11.1	2006	2008	201

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)	Degree of Importance (%)	Year of Realization in APEC Region

				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
56	APEC-wide performance standards of water supply systems are defined for reference by water regulators.	1	89	37.1	24.7	11.2	23.6	10.1	57.3	28.1	2.2	--	--	
		2	38	34.3	28.1	15.6	21.9	6.5	64.5	29.0	0.0	--	--	
		E	5					0.0	40.0	60.0	0.0	2011	2013	
57	Internet-based sharing of water information and technological developments is promoted by APEC.	1	91	37.8	36.7	6.7	18.9	12.6	51.7	39.1	0.0	--	--	
		2	40	31.2	28.1	18.8	21.9	3.2	58.1	38.7	0.0	--	--	
		E	6					0.0	16.7	83.3	0.0	2012	2013	
58	An APEC fund is established to assist in strengthening and improving substandard water-related structures.	1	88	36.0	33.7	5.6	22.5	13.5	43.8	40.4	0.0	--	--	
		2	38	31.3	28.1	12.5	28.1	0.0	54.8	45.2	0.0	--	--	
		E	4					0.0	50.0	50.0	0.0	--	--	
59	Better alternatives to chlorine are used in all new water treatment development.	1												
		2	61	35.5	27.4	22.6	14.5	4.9	50.8	42.6	1.6	2006	2011	201
		E	14					7.1	14.3	78.6	0.0	2006	2006	201
60	Organizations are making practical use of a range of models for public, private and user participation in the management of water supply and waste water disposal, taking into account the cultural differences in the APEC region.	1												
		2	56	30.5	47.5	10.2	11.9	10.5	45.6	42.1	1.8	2006	2010	201
		E	6					0.0	16.7	83.3	0.0	2006	2006	201

Topic #	Topic	Round #	# of Responses	Degree of Expertise (%)				Degree of Importance (%)				Year of Realization in APEC Region		
				Low	Medium	High	None	Low	Medium	High	Unnecessary	QL	QM	QU
61	Impact of major climate change on water supply can be predicted.	1												

		2	62	42.9	23.8	11.1	22.2	8.2	41.0	49.2	1.6	2006	2011	201
		E	7					0.0	0.0	100.0	0.0	2006	2011	201
62	Membrane technology for evaporation prevention from water reservoirs has been developed.	1												
		2	54	32.8	19.0	6.9	41.4	24.1	48.1	16.7	11.1	2011	2011	
		E	4					0.0	50.0	50.0	0.0	2006	2009	201
63	The concepts of 'sustainable water supply' and 'sustainable development with sufficient water supply' have been understood and implemented widely.	1												
		2	62	25.8	48.4	19.4	6.5	6.5	29.0	64.5	0.0	2006	2011	201
		E	12					0.0	16.7	83.3	0.0	2001	2009	201
64	Integrated water management of urban areas combining urban water storage, urban flood control, and restoration of urban hydrological cycle is in practical use.	1												
		2	63	25.4	46.0	20.6	7.9	9.5	39.7	50.8	0.0	2006	2006	201
		E	13					0.0	30.8	69.2	0.0	2006	2006	201

Note: 1. (--) denotes that quartile are indeterminate, and topic #59-64 were newly added to the second round of the survey.
2. E in the column of 'round #' denotes the results of panelists with high expertise in the second round.
3. In some cases, the sum of the columns of the survey parameter does not make 100.0%, since some panelists did not check the answers.

Appendix III: Forecast Time by Member Economies

Appendix III: Forecast Time by APEC Member Economies

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
1	Scientific methods of accurate long-range weather forecasting, up to 3 months in advance, are developed	Australia	1	3	2003	2006	2010
			2	1	2003	2003	2003
		Canada	1	2	2006	2009	2011
			2	1	2009	2009	2009
		China	1	0	2005	2006	2007
			2	3	2003	2004	2005
		Chile	1	2	2005	2006	2007
			2	1	2005	2005	2005
		China, Hong Kong	1	20	2002	2007	--
			2	12	2005	2007	2007
		Indonesia	1	1	2000	2001	2002
			2	0	--	--	--
		Japan	1	8	--	--	--
			2	2	2010	2011	2013
		Korea	1	4	2000	2004	2006
			2	3	2005	2006	2008
		Malaysia	1	8	2001	2004	2007
			2	7	2002	2004	2004
		Mexico	1	1	2000	2001	2002
			2	2	2001	2002	2002
		Philippines	1	5	2004	2007	--

			2	2	2004	2008	2011
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	22	2003	2007	2010
			2	15	2007	2008	2010
		Chinese Taipei	1	15	2004	2007	--
			2	6	2005	2009	2012
		United States	1	1	2000	2001	2002
			2	0	--	--	--
2	Accurate rain and precipitation water-balance forecast, aiming at effective utilization of rainfall, is in widespread use.	Australia	1	3	2001	2002	2010
			2	1	2001	2001	2001
		Canada	1	2	2001	2004	2006
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2002	2002	2003
		Chile	1	2	2001	2004	2006
			2	1	2001	2001	2001
		China, Hong Kong	1	18	2002	2006	2011
			2	12	2003	2006	2006
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2008	2011	--
			2	2	2007	2009	2011
		Korea	1	4	2000	2001	2003
			2	3	2005	2005	2007
		Malaysia	1	8	2002	2005	2008
			2	7	2003	2005	2006
		Mexico	1	1	2000	2001	2002
			2	2	2005	2008	2011
		Philippines	1	5	2004	2007	2010
			2	2	2003	2006	2008
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	23	2001	2004	2008
			2	15	2004	2004	2006
		Chinese Taipei	1	14	2002	2006	2010
			2	6	2005	2009	2010
		United States	1	1	2000	2001	2002
			2	0	--	--	--
Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
3	Rainfall prediction accurate enough to allow effective flood control using dams is in widespread use.	Australia	1	3	2000	2001	2002
			2	2	2000	2000	2001
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2006	2009	2011
			2	2	2001	2002	2002
		Chile	1	2	2005	2006	2007
			2	1	2005	2005	2005
		China, Hong Kong	1	17	2001	2003	2008
			2	13	2003	2003	2003
		Indonesia	1	1	--	--	--

			2	0	--	--	--
		Japan	1	8	2007	2009	2013
			2	1	2010	2010	2010
		Korea	1	4	2000	2001	2003
			2	3	2002	2003	2005
		Malaysia	1	9	2004	2006	2008
			2	7	2002	2004	2006
		Mexico	1	1	2000	2001	2002
			2	2	2001	2002	2002
		Philippines	1	5	2004	2007	2010
			2	2	2003	2006	2008
		Papua New Guinea	1	1	2000	2001	2002
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	23	2000	2002	2006
			2	14	2002	2003	2004
		Chinese Taipei	1	17	2001	2003	2007
			2	4	2003	2004	2006
		United States	1	1	2000	2001	2002
			2	0	--	--	--
4	Scientific methods for flood forecasting, aiming and management to protect important areas at high risk, are in practical use.	Australia	1	3	2001	2002	2005
			2	2	2001	2002	2002
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2000	2001	2002
			2	2	2001	2003	2004
		Chile	1	2	2005	2006	2007
			2	1	2005	2005	2005
		China, Hong Kong	1	18	2001	2003	2006
			2	13	2001	2003	2003
		Indonesia	1	1	2000	2001	2002
			2	0	--	--	--
		Japan	1	8	2003	2006	2010
			2	1	2008	2008	2008
		Korea	1	4	1999	2001	2003
			2	3	2002	2003	2004
		Malaysia	1	9	2000	2002	2005
			2	7	2002	2002	2003
		Mexico	1	1	2005	2006	2007
			2	2	2003	2006	2010
		Philippines	1	5	2002	2002	2012
			2	2	2003	2006	2009
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	23	2000	2002	2007
			2	15	2002	2002	2004
		Chinese Taipei	1	17	2000	2002	2003
			2	4	2002	2002	2003
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
5	Technology to induce artificial rain is in practical use.	Australia	1	3	2003	--	--
			2	2	2005	2007	2008
		Canada	1	1	--	--	--

			2	0	--	--	--
		China	1	2	2001	2004	2006
			2	2	2009	2011	2012
		Chile	1	2	2001	2009	--
			2	1	--	--	--
		China, Hong Kong	1	16	2009	--	--
			2	12	2012	--	--
		Indonesia	1	1	2000	2001	2002
			2	0	--	--	--
		Japan	1	7	2008	2012	--
			2	1	--	--	--
		Korea	1	4	2000	2004	2010
			2	3	2008	2010	2010
		Malaysia	1	8	2002	2009	--
			2	7	2002	2008	2010
		Mexico	1	1	--	--	--
			2	2	2003	2006	2010
		Philippines	1	5	2001	2002	2003
			2	2	2001	2002	2002
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	--	--	--
			2	1	--	--	--
		Thailand	1	20	2001	2003	2008
			2	15	2003	2003	2005
		Chinese Taipei	1	15	2001	2005	--
			2	4	2008	2012	--
		United States	1	1	2000	2001	2002
			2	0	--	--	--
6	Global positioning system (GPS) and geographic information system (GIS) to assist water resource management and development are in practical use.	Australia	1	3	2000	2001	2002
			2	2	2002	2003	2005
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2000	2001	2002
			2	2	2002	2004	2005
		Chile	1	2	2001	2004	2006
			2	1	2001	2001	2001
		China, Hong Kong	1	17	2003	2006	2008
			2	12	2006	2006	2006
		Indonesia	1	1	2000	2001	2002
			2	0	--	--	--
		Japan	1	8	2001	2003	2006
			2	1	2004	2004	2004
		Korea	1	4	1999	2004	2006
			2	3	2004	2004	2004
		Malaysia	1	9	2001	2004	2006
			2	7	2002	2003	2005
		Mexico	1	1	2010	2011	2012
			2	2	2004	2007	2009
		Philippines	1	6	2000	2002	2003
			2	2	2000	2000	2000
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	21	2001	2003	2006
			2	15	2002	2003	2005
		Chinese Taipei	1	15	2000	2002	2003
			2	4	2001	2003	2003
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU

7	Satellite monitoring of water/catch-ment use and abuse is in widespread use.	Australia	1	3	2000	2001	2002
			2	2	2000	2001	2001
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2008	2009	2011
		Chile	1	2	2006	2009	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	17	2006	2010	--
			2	13	2006	2010	2010
		Indonesia	1	1	2000	2001	2002
			2	0	--	--	--
		Japan	1	8	2002	2006	2008
			2	1	2006	2006	2006
		Korea	1	4	2003	2006	2008
			2	3	2007	2008	2008
		Malaysia	1	9	2001	2004	2007
			2	7	2004	2004	2005
		Mexico	1	1	--	--	--
			2	2	2004	2008	2011
		Philippines	1	6	2002	2005	2008
			2	2	2003	2005	2006
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	20	2002	2005	2008
			2	15	2005	2005	2007
		Chinese Taipei	1	15	2001	2003	2006
			2	4	2002	2003	2004
		United States	1	1	2000	2001	2002
			2	0	--	--	--
8	Remote techniques and automated control systems to regulate domestic and industrial water supply are in widespread use.	Australia	1	3	2001	2002	2010
			2	2	2002	2002	2002
		Canada	1	1	2000	2001	2002
			2	0	--	--	--
		China	1	2	2000	2001	2002
			2	2	2003	2006	2008
		Chile	1	2	2006	2009	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	17	2000	2002	2005
			2	12	2001	2002	2002
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2003	2006	2013
			2	1	2006	2006	2006
		Korea	1	4	2000	2001	2003
			2	3	2004	2005	2006
		Malaysia	1	9	2004	2006	2008
			2	7	2005	2006	2006
		Mexico	1	1	2000	2001	2002
			2	2	2003	2007	2010
		Philippines	1	5	2005	2006	2010
			2	1	2010	2010	2010
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	2	2001	2004	2006
			2	1	2004	2004	2004
		Thailand	1	21	2003	2007	2011

			2	15	2005	2006	2010
		Chinese Taipei	1	14	2001	2004	2007
			2	4	2005	2007	2008
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
9	Remote techniques and automated control systems to regulate water supply for agricultural irrigation are in widespread use.	Australia	1	3	2001	2002	--
			2	2	2002	2002	2002
		Canada	1	1	2000	2001	2002
			2	0	--	--	--
		China	1	2	2005	2006	2007
			2	2	2009	2010	2010
		Chile	1	2	2006	2009	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	18	2011	--	--
			2	12	2012	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2006	2011	2013
			2	2	2008	2010	2011
		Korea	1	4	1999	2004	2008
			2	3	2005	2006	2008
		Malaysia	1	9	2005	2007	2012
			2	7	2005	2007	2009
		Mexico	1	1	--	--	--
			2	2	2003	2007	2010
		Philippines	1	5	2002	2005	2008
			2	2	2003	2005	2006
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	2005	2006	2007
			2	1	2006	2006	2006
		Thailand	1	22	2005	2008	2011
			2	15	2008	2008	2008
		Chinese Taipei	1	15	2002	2005	2008
			2	5	2004	2008	--
		United States	1	1	2000	2001	2002
			2	0	--	--	--
10	50% of natural run-off is captured and stored for use	Australia	1	3	2001	2002	--
			2	2	2002	2002	2002
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2001	2004	2006
			2	2	2001	2004	2007
		Chile	1	2	2005	2006	2007
			2	1	2007	2007	2007
		China, Hong Kong	1	18	2001	2004	2012
			2	12	2004	2005	2011
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	--	--	--
			2	3	2007	2008	2011
		Korea	1	4	2004	2009	2011
			2	3	2009	2009	2012
		Malaysia	1	10	2002	2006	--
			2	6	2005	2007	2009

		Mexico	1	1	--	--	--
			2	2	2003	2007	2010
		Philippines	1	5	2002	2002	2005
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	19	2004	2007	2012
			2	15	2007	2010	2011
		Chinese Taipei	1	16	2010	--	--
			2	5	--	--	--
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
11	Recharging of acquifers is widely used to enable sustainable exploitation of groundwater	Australia	1	3	2003	2006	2010
			2	2	2004	2005	2005
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2009	2011	2012
		Chile	1	2	2005	2006	2007
			2	1	2007	2007	2007
		China, Hong Kong	1	16	--	--	--
			2	12	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2009	2012	--
			2	2	2005	2006	2008
		Korea	1	4	2004	2005	2010
			2	3	2008	2010	2010
		Malaysia	1	7	2008	--	--
			2	5	2008	2008	--
		Mexico	1	1	2005	2006	2007
			2	2	2001	2003	2005
		Philippines	1	6	2002	2004	2010
			2	2	2003	2005	2008
		Papua New Guinea	1	1	2000	2001	2002
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	19	2005	2007	2012
			2	14	2004	2007	2010
		Chinese Taipei	1	16	2005	2008	--
			2	5	2013	--	--
		United States	1	1	2000	2001	2002
			2	0	--	--	--
12	Natural ecosystems for localized water storage are in practical use	Australia	1	3	2001	2002	2005
			2	2	2002	2002	2002
		Canada	1	2	2001	2009	--
			2	0	--	--	--
		China	1	1	2010	2011	2012
			2	2	2003	2005	2006
		Chile	1	1	2010	2011	2012

			2	1	2010	2010	2010
		China, Hong Kong	1	20	2001	2004	2013
			2	12	2003	2004	2006
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2005	2007	2013
			2	1	2009	2009	2009
		Korea	1	4	2005	2009	2013
			2	3	2005	2005	2009
		Malaysia	1	7	2003	2011	--
			2	6	2004	2005	2010
		Mexico	1	1	--	--	--
			2	2	2003	2006	2010
		Philippines	1	5	2002	2005	2007
			2	2	2002	2004	2005
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	20	2002	2005	2010
			2	15	2003	2005	2008
		Chinese Taipei	1	15	2007	--	--
			2	4	2010	2012	--
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
13	Effective treatment of waters from animal farms is in widespread use, preventing pollution of water sources.	Australia	1	3	2001	2002	2005
			2	2	2000	2001	2001
		Canada	1	2	2001	2004	2006
			2	0	--	--	--
		China	1	2	2006	2011	--
			2	2	2003	2006	2008
		Chile	1	2	2010	2011	2012
			2	1	2012	2012	2012
		China, Hong Kong	1	20	2000	2001	2003
			2	13	2000	2001	2001
		Indonesia	1	1	2000	2001	2002
			2	0	--	--	--
		Japan	1	8	2004	2011	--
			2	1	2008	2008	2008
		Korea	1	4	2000	2001	2005
			2	3	2005	2005	2008
		Malaysia	1	9	2002	2007	2013
			2	7	2003	2007	2008
		Mexico	1	1	2000	2001	2002
			2	2	2000	2000	2001
		Philippines	1	6	2000	2004	2007
			2	2	2000	2001	2001
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	2	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	20	2001	2005	2010
			2	15	2005	2005	2007
		Chinese Taipei	1	16	2002	2005	2008
			2	5	2003	2003	2005
		United States	1	1	2000	2001	2002
			2	0	--	--	--
14	Automatic remote water quality monitoring stations are installed at	Australia	1	3	2001	2002	2005

	most catchment basins susceptible to pollution.						
			2	2	2001	2001	2001
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2000	2001	2002
			2	2	2005	2007	2009
		Chile	1	2	2006	2009	2011
			2	1	2009	2009	2009
		China, Hong Kong	1	18	2003	2006	2010
			2	13	2005	2006	2006
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2001	2006	2013
			2	1	2008	2008	2008
		Korea	1	4	2004	2005	2008
			2	3	2005	2005	2007
		Malaysia	1	9	2001	2006	2013
			2	6	2002	2004	2007
		Mexico	1	1	2010	2011	2012
			2	2	2003	2006	2009
		Philippines	1	6	2001	2006	2010
			2	2	2003	2006	2008
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	2	2001	2004	2006
			2	1	2004	2004	2004
		Thailand	1	21	2004	2008	2012
			2	15	2005	2008	2011
		Chinese Taipei	1	17	2002	2006	2010
			2	5	2005	2006	2008
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
15	Cost effective techniques to de-silt heavily silted lakes and impounded reservoirs are in practical use to restore regulatory capacities.	Australia	1	3	2001	2002	2010
			2	2	2003	2004	2004
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2001	2004	2006
			2	2	2003	2004	2004
		Chile	1	2	2006	2009	2011
			2	1	2011	2011	2011
		China, Hong Kong	1	21	2002	2006	2010
			2	13	2005	2005	2006
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2005	2007	2011
			2	1	2008	2008	2008
		Korea	1	4	2007	2010	2012
			2	3	2005	2009	2011
		Malaysia	1	9	2004	2008	2011
			2	6	2006	2009	2010
		Mexico	1	1	--	--	--
			2	2	2004	2008	2011
		Philippines	1	4	2000	2004	2008
			2	2	2004	2005	2007
		Papua New Guinea	1	1	--	--	--

			2	0	--	--	--
		Singapore	1	1	2005	2006	2007
			2	1	2006	2006	2006
		Thailand	1	17	2005	2008	--
			2	13	2008	2010	2010
		Chinese Taipei	1	17	2004	2006	2010
			2	5	2006	2006	2008
		United States	1	1	2000	2001	2002
			2	0	--	--	--
16	Techniques to transport icebergs cost-effectively are elucidated.	Australia	1	3	2008	2011	--
			2	2	2009	2009	2010
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	--	--	--
			2	2	2013	--	--
		Chile	1	2	--	--	--
			2	1	--	--	--
		China, Hong Kong	1	19	--	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	--	--	--
			2	1	--	--	--
		Korea	1	4	2013	--	--
			2	2	2013	--	--
		Malaysia	1	7	--	--	--
			2	5	--	--	--
		Mexico	1	0	--	--	--
			2	2	--	--	--
		Philippines	1	2	--	--	--
			2	0	--	--	--
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	--	--	--
			2	1	--	--	--
		Thailand	1	16	--	--	--
			2	12	--	--	--
		Chinese Taipei	1	14	2013	--	--
			2	5	--	--	--
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
17	Water containers for large-scale long distance transport across oceans are in practical use.	Australia	1	3	2013	--	--
			2	2	--	--	--
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2006	2011	--
			2	2	2013	--	--
		Chile	1	2	2011	--	--
			2	1	--	--	--
		China, Hong Kong	1	20	--	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	8	2012	--	--

			2	1	2012	2012	2012
		Korea	1	4	2009	--	--
			2	2	--	--	--
		Malaysia	1	8	--	--	--
			2	5	--	--	--
		Mexico	1	1	--	--	--
			2	2	--	--	--
		Philippines	1	3	2013	--	--
			2	2	--	--	--
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2005	2006	2007
			2	1	2006	2006	2006
		Thailand	1	17	--	--	--
			2	12	--	--	--
		Chinese Taipei	1	17	2007	--	--
			2	6	--	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
18	Water containers for large-scale long distance transport along rivers are in practical use.	Australia	1	3	--	--	--
			2	2	--	--	--
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2006	2011	--
			2	2	2013	--	--
		Chile	1	2	--	--	--
			2	1	--	--	--
		China, Hong Kong	1	19	--	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2008	--	--
			2	1	2012	2012	2012
		Korea	1	4	2013	--	--
			2	2	--	--	--
		Malaysia	1	7	--	--	--
			2	4	--	--	--
		Mexico	1	1	--	--	--
			2	2	--	--	--
		Philippines	1	3	--	--	--
			2	2	--	--	--
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	16	--	--	--
			2	12	--	--	--
		Chinese Taipei	1	14	2007	--	--
			2	6	2013	--	--
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
19	Dedicated infrastructure, such as container terminals, to handle bulk water transport is in widespread use.	Australia	1	3	2013	--	--
			2	2	--	--	--

		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2006	2011	--
			2	2	2006	2009	2011
		Chile	1	2	2011	--	--
			2	1	--	--	--
		China, Hong Kong	1	19	2003	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2013	--	--
			2	0	--	--	--
		Korea	1	4	2013	--	--
			2	2	--	--	--
		Malaysia	1	6	--	--	--
			2	4	--	--	--
		Mexico	1	1	--	--	--
			2	2	--	--	--
		Philippines	1	3	--	--	--
			2	2	--	--	--
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	17	--	--	--
			2	12	--	--	--
		Chinese Taipei	1	14	2009	--	--
			2	6	--	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
20	Biological methods to desalinate water, producing water suitable for agricultural irrigation in terms of both cost and quality, are in practical use.	Australia	1	3	2013	--	--
			2	2	--	--	--
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2001	2004	2006
			2	2	2009	2011	2012
		Chile	1	2	2006	2009	2011
			2	1	2010	2010	2010
		China, Hong Kong	1	19	--	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2013	--	--
			2	0	--	--	--
		Korea	1	4	2012	--	--
			2	3	--	--	--
		Malaysia	1	6	--	--	--
			2	5	2013	--	--
		Mexico	1	1	--	--	--
			2	2	2003	2006	2010
		Philippines	1	4	2009	2012	2013
			2	2	2013	--	--
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	18	2011	--	--
			2	12	--	--	--
		Chinese Taipei	1	16	2004	2011	--
			2	6	2011	--	--
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
21	Due to advances in membrane technology, large-scale continuous desalination at a cost of less than US$0.5 per cubic meters is in practical use.	Australia	1	3	2008	2011	--
			2	2	2010	2011	2013
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2006	2009	2011
			2	2	2006	2008	2011
		Chile	1	2	2006	2009	2011
			2	1	2009	2009	2009
		China, Hong Kong	1	19	--	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2008	--	--
			2	0	--	--	--
		Korea	1	4	2006	2011	2013
			2	3	2012	2013	2013
		Malaysia	1	6	--	--	--
			2	5	--	--	--
		Mexico	1	1	2000	2001	2002
			2	2	2003	2006	2010
		Philippines	1	4	2006	2007	2010
			2	2	2011	2012	2013
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	2	2001	2004	2006
			2	1	2004	2004	2004
		Thailand	1	19	2009	--	--
			2	12	2010	--	--
		Chinese Taipei	1	17	2004	2007	2013
			2	6	2013	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
22	More than 50% of drinking water in coastal cities is obtained by desalination.	Australia	1	3	2011	2012	--
			2	2	--	--	--
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	--	--	--
			2	2	2013	--	--
		Chile	1	2	2011	--	--
			2	1	--	--	--
		China, Hong Kong	1	19	--	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2008	--	--
			2	0	--	--	--
		Korea	1	4	2009	--	--
			2	3	--	--	--
		Malaysia	1	6	--	--	--
			2	6	--	--	--
		Mexico	1	1	2005	2006	2007
			2	2	2009	2011	2012
		Philippines	1	5	2004	2007	--

			2	1	--	--	--
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	2	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	19	2013	--	--
			2	12	--	--	--
		Chinese Taipei	1	17	2004	2011	--
			2	6	2010	2012	--
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
23	Technologies for ground water exploitation, such as remote sensing technology, are in widespread use.	Australia	1	3	2011	2012	--
			2	2	2011	2012	2012
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2004	2006
			2	2	2007	2007	2008
		Chile	1	2	2005	2006	2007
			2	1	2005	2005	2005
		China, Hong Kong	1	19	2008	--	--
			2	13	2013	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2005	2007	2009
			2	0	--	--	--
		Korea	1	4	2008	2011	2013
			2	3	2009	2010	2012
		Malaysia	1	7	2006	2010	--
			2	5	2008	2011	--
		Mexico	1	1	--	--	--
			2	2	2003	2007	2010
		Philippines	1	5	2004	2005	2008
			2	2	2010	2011	2013
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	21	2006	2010	--
			2	14	2009	2010	2013
		Chinese Taipei	1	14	2005	2011	--
			2	6	2012	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
24	A technology breakthrough leads to the development of a solar cell system cheap enough to provide energy for use by rural pumping systems.	Australia	1	3	2013	--	--
			2	2	2013	2013	2013
		Canada	1	1	2005	2006	2007
			2	0	--	--	--
		China	1	1	2005	2006	2007
			2	2	2009	2010	2010
		Chile	1	2	2011	--	--
			2	1	--	--	--
		China, Hong Kong	1	20	2011	--	--

			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2006	--	--
			2	0	--	--	--
		Korea	1	4	2008	--	--
			2	3	2011	--	--
		Malaysia	1	6	2009	2012	--
			2	6	2012	2013	2014
		Mexico	1	1	--	--	--
			2	2	--	--	--
		Philippines	1	5	2002	2006	2012
			2	2	2013	2013	--
		Papua New Guinea	1	1	2000	2001	2002
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	20	2004	2010	2013
			2	15	2010	2012	--
		Chinese Taipei	1	15	2007	2011	--
			2	5	--	--	--
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
25	Over 50% of households in urban areas have multiple water quality supply systems.	Australia	1	3	2005	2006	2007
			2	2	2006	2007	2007
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2010	2011	2012
			2	2	2003	2007	2010
		Chile	1	2	--	--	--
			2	1	--	--	--
		China, Hong Kong	1	21	2000	2002	2010
			2	13	1999	1999	2000
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2008	2011	2012
			2	0	--	--	--
		Korea	1	4	2008	--	--
			2	3	2013	2013	--
		Malaysia	1	6	2012	--	--
			2	5	--	--	--
		Mexico	1	1	2000	2001	2002
			2	2	2003	2006	2010
		Philippines	1	3	2006	2007	2010
			2	2	2011	2012	2013
		Papua New Guinea	1	1	2000	2001	2002
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	17	2004	2011	--
			2	14	2010	2012	--
		Chinese Taipei	1	17	2009	--	--
			2	6	2013	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
26	In the industrial sector, technologies which reduce the volume of water used by 50%, from 1995 levels, are in practical use.	Australia	1	3	2003	2005	2007

			2	1	2003	2003	2003
		Canada	1	1	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2009	--
			2	2	2008	2008	2008
		Chile	1	2	2011	--	--
			2	1	2011	2011	2011
		China, Hong Kong	1	19	2008	2013	--
			2	13	2008	2013	--
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2003	2006	--
			2	1	2006	2006	2006
		Korea	1	4	2004	2011	--
			2	3	2007	2010	2010
		Malaysia	1	7	2010	2013	--
			2	6	2006	2010	2012
		Mexico	1	1	2000	2001	2002
			2	2	2003	2004	2004
		Philippines	1	3	2008	2010	2012
			2	2	2007	2007	2008
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	2	2001	2006	2011
			2	1	2006	2006	2006
		Thailand	1	19	2005	2010	--
			2	14	2010	2010	--
		Chinese Taipei	1	17	2004	2008	2012
			2	6	2005	2008	2011
		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
27	Genetically-altered food plants, such as rice and sugar cane, which use less than 50% of current water requirement, are in widespread use.	Australia	1	3	2008	--	--
			2	2	2009	2011	2012
		Canada	1	0	--	--	--
			2	0	--	--	--
		China	1	2	2006	2011	--
			2	2	2008	2008	2008
		Chile	1	2	2011	--	--
			2	1	--	--	--
		China, Hong Kong	1	18	2011	--	--
			2	12	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2009	--	--
			2	0	--	--	--
		Korea	1	4	2013	--	--
			2	3	--	--	--
		Malaysia	1	7	2013	--	--
			2	5	--	--	--
		Mexico	1	1	--	--	--
			2	2	--	--	--
		Philippines	1	3	2006	2007	2010
			2	2	2008	2010	2012
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	1	--	--	--
			2	1	--	--	--
		Thailand	1	19	2006	2010	--
			2	14	2010	2010	--

		Chinese Taipei	1	16	2006	2011	--
			2	4	--	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
28	Technology to detect and locate leaks of over 10% from the water distribution system is developed.	Australia	1	3	2003	2005	2007
			2	2	2004	2004	2005
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2004	2006
			2	2	2001	2002	2002
		Chile	1	2	2001	2006	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	21	2000	2002	2003
			2	12	2000	2002	2002
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2003	2007	--
			2	1	2008	2008	2008
		Korea	1	4	2001	2004	2007
			2	3	2005	2005	2006
		Malaysia	1	6	2004	2007	2011
			2	6	2004	2006	2008
		Mexico	1	1	--	--	--
			2	2	2002	2005	2007
		Philippines	1	4	2000	2001	2002
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2000	2001	2002
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	1	2001	2001	2001
		Thailand	1	18	2002	2006	2010
			2	13	2004	2006	2008
		Chinese Taipei	1	17	2003	2006	2010
			2	6	2005	2006	2008
		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
29	Trenchless technologies are in practical use in suitable urban areas.	Australia	1	3	2000	2001	2002
			2	2	2000	2001	2001
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2001	2002	2002
		Chile	1	2	2006	2011	--
			2	1	2011	2011	2011
		China, Hong Kong	1	20	2000	2002	2003
			2	13	2000	2001	2002
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	6	2004	2007	--
			2	0	--	--	--
		Korea	1	3	2011	2012	--
			2	2	2011	2012	2012
		Malaysia	1	9	2001	2004	2008

			2	6	2003	2004	2006
		Mexico	1	1	2010	2011	2012
			2	1	2010	2010	2010
		Philippines	1	4	2000	2002	2003
			2	2	2004	2007	2011
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	17	2007	2011	--
			2	14	2010	2012	--
		Chinese Taipei	1	13	2003	2006	2012
			2	5	2003	2003	2006
		United States	1	1	--	--	--
			2	0	--	--	--
30	70% of water used in industry is recycled for further use.	Australia	1	3	2001	2002	2005
			2	2	2001	2002	2002
		Canada	1	1	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2004	2005	2005
		Chile	1	2	2010	2011	2012
			2	1	2012	2012	2012
		China, Hong Kong	1	20	2003	2007	--
			2	13	2005	2007	2012
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	6	1999	2001	2003
			2	0	--	--	--
		Korea	1	4	2004	2011	--
			2	3	2005	2005	2007
		Malaysia	1	9	2001	2004	2008
			2	7	2005	2006	2008
		Mexico	1	1	2000	2001	2002
			2	2	2008	2010	2011
		Philippines	1	5	2004	2006	2008
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	2	2001	2006	2011
			2	1	2006	2006	2006
		Thailand	1	21	2004	2008	2012
			2	15	2005	2008	2010
		Chinese Taipei	1	16	2004	2007	2010
			2	5	2004	2005	2010
		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
31	50% of water used by households or groups of households is recycled locally, for further domestic use, owing to the development of cheap and simple package treatment plants.	Australia	1	3	2005	2006	2007
			2	2	2006	2007	2007
		Canada	1	1	--	--	--
			2	0	--	--	--
		China	1	2	2001	2009	--
			2	2	2009	2010	2011
		Chile	1	2	--	--	--
			2	1	--	--	--

		China, Hong Kong	1	20	2012	2012	--
			2	13	2012	2012	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2006	2009	--
			2	1	2012	2012	2012
		Korea	1	4	2006	2011	--
			2	3	2009	2010	2012
		Malaysia	1	9	2006	2009	2013
			2	7	2009	2010	2010
		Mexico	1	1	2000	2001	2012
			2	2	2008	2009	2011
		Philippines	1	5	2004	2007	2010
			2	2	2006	2008	2009
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	2	2005	2006	2007
			2	1	2006	2006	2006
		Thailand	1	21	2004	2009	--
			2	15	2008	2010	--
		Chinese Taipei	1	17	2005	2007	--
			2	5	2008	2013	--
		United States	1	1	2005	2006	2007
			2	0	--	--	--
32	Prefabricated water treatment plants have been developed as a cost-effective means to treat industrial waste water.	Australia	1	3	2001	2002	2005
			2	2	2006	2006	2007
		Canada	1	1	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2009	--
			2	2	2002	2002	2003
		Chile	1	2	2006	2009	2011
			2	1	2011	2011	2011
		China, Hong Kong	1	20	2001	2006	2013
			2	13	2005	2006	2011
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2008	2010	--
			2	1	2008	2008	2008
		Korea	1	4	2005	2007	2013
			2	3	2010	2010	2012
		Malaysia	1	9	2006	2009	2012
			2	6	2006	2007	2009
		Mexico	1	1	2005	2006	2007
			2	2	2007	2007	2008
		Philippines	1	4	2001	2004	2006
			2	2	2002	2003	2004
		Papua New Guinea	1	1	2000	2001	2002
			2	0	--	--	--
		Singapore	1	2	2005	2006	2007
			2	1	2006	2006	2006
		Thailand	1	19	2004	2007	2013
			2	14	2004	2006	2010
		Chinese Taipei	1	14	2002	2006	2009
			2	5	2002	2003	2008
		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
33	Technology to determine the structural strength and surface conditions of pipelines, in situ, for	Australia	1	3	2001	2002	--

	planning pipe replacement programs are in widespread use.						
			2	2	2004	2008	2011
		Canada	1	2	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2002	2003	2003
		Chile	1	2	2001	2009	--
			2	1	2009	2009	2009
		China, Hong Kong	1	21	2003	2006	2008
			2	12	2005	2006	2006
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2003	2005	--
			2	1	2008	2008	2008
		Korea	1	4	2005	2007	2013
			2	3	2003	2005	2009
		Malaysia	1	7	2006	2009	2011
			2	6	2007	2010	2010
		Mexico	1	1	2000	2001	2002
			2	2	2007	2009	2011
		Philippines	1	5	2002	2004	2006
			2	2	2007	2009	2012
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2010	2011	2012
			2	1	2011	2011	2011
		Thailand	1	18	2004	2008	2011
			2	14	2008	2010	--
		Chinese Taipei	1	15	2003	2006	2010
			2	6	2005	2006	2008
		United States	1	1	--	--	--
			2	0	--	--	--
34	New materials are developed to produce highly durable and easily maintained pipes at significantly lower cost.	Australia	1	3	2003	2005	2007
			2	2	2004	2004	2005
		Canada	1	2	2001	2004	2006
			2	0	--	--	--
		China	1	2	2001	2009	--
			2	2	2003	2004	2004
		Chile	1	2	2006	2009	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	19	2004	2006	2009
			2	12	2005	2006	2006
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2008	2011	--
			2	1	2008	2008	2008
		Korea	1	3	2003	2006	--
			2	3	2007	2008	2009
		Malaysia	1	9	2004	2007	2010
			2	7	2005	2005	2008
		Mexico	1	1	--	--	--
			2	2	2007	2009	2011
		Philippines	1	5	2000	2002	2003
			2	2	2004	2004	2005
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2005	2006	2007
			2	1	2006	2006	2006
		Thailand	1	18	2003	2007	2011
			2	14	2007	2007	2009
		Chinese Taipei	1	14	2005	2008	2013
			2	6	2005	2007	2009

		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
35	A mechanism for negotiating and concluding agreements for international water transfer is accepted	Australia	1	3	2003	2011	--
			2	1	2011	2011	2011
		Canada	1	1	2000	2001	2002
			2	1	2001	2001	2001
		China	1	2	2001	2009	--
			2	2	2008	2008	2008
		Chile	1	1	2005	2006	2007
			2	1	2007	2007	2007
		China, Hong Kong	1	19	2000	2002	--
			2	13	2000	2002	2002
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2002	2006	--
			2	1	2008	2008	2008
		Korea	1	4	2004	2009	2011
			2	1	--	--	--
		Malaysia	1	9	2002	2007	2013
			2	6	2003	2006	2008
		Mexico	1	1	--	--	--
			2	2	2013	--	--
		Philippines	1	5	2002	2006	2012
			2	2	2006	2008	2009
		Papua New Guinea	1	1	2005	2006	2007
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	20	2002	2007	2011
			2	16	2006	2007	2010
		Chinese Taipei	1	15	2010	--	--
			2	7	--	--	--
		United States	1	1	2005	2006	2007
			2	0	--	--	--
36	*At least 5 international water treaties, covering issues such as extraction, disposal of waste into water and artificial rain-making, are negotiated and ratified.*	Australia	1	3	2003	2011	--
			2	1	2011	2011	2011
		Canada	1	1	--	--	--
			2	1	2011	2011	2011
		China	1	2	2001	2009	--
			2	2	2010	2012	2013
		Chile	1	1	2005	2006	2007
			2	1	2007	2007	2007
		China, Hong Kong	1	15	2013	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2006	2008	--
			2	1	2008	2008	2008
		Korea	1	3	2003	2006	--
			2	2	2010	2011	2013
		Malaysia	1	5	2005	2011	--

			2	6	2009	2012	2013
		Mexico	1	1	--	--	--
			2	2	2011	2011	2012
		Philippines	1	5	2004	2007	2012
			2	2	2007	2009	2012
		Papua New Guinea	1	1	2010	2011	2012
			2	0	--	--	--
		Singapore	1	1	2005	2006	2007
			2	0	--	--	--
		Thailand	1	19	2004	2007	2012
			2	15	2007	2008	2011
		Chinese Taipei	1	14	2010	--	--
			2	7	2011	--	--
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
37	Water is an important political issue in national elections.	Australia	1	3	2001	2002	2010
			2	1	2001	2001	2001
		Canada	1	1	2000	2001	2002
			2	2	2002	2005	2007
		China	1	2	--	--	--
			2	2	2007	2010	2012
		Chile	1	1	2000	2001	2002
			2	1	2002	2002	2002
		China, Hong Kong	1	17	2005	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2008	2011	--
			2	1	2006	2006	2006
		Korea	1	4	1999	2001	2003
			2	2	2005	2007	2009
		Malaysia	1	8	2001	2003	2006
			2	6	2001	2003	2003
		Mexico	1	1	2010	2011	2012
			2	2	2007	2008	2009
		Philippines	1	5	2000	2002	2003
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2005	2006	2007
			2	1	2010	2010	2010
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	21	2001	2004	2010
			2	16	2002	2004	2005
		Chinese Taipei	1	17	2000	2002	2005
			2	7	2000	2000	2001
		United States	1	1	2005	2006	2007
			2	0	--	--	--
38	A nationally coordinated approach to water supply and management is implemented.	Australia	1	3	2001	2002	--
			2	1	2001	2001	2001
		Canada	1	1	2005	2006	2007
			2	2	2003	2005	2006
		China	1	2	2001	2009	--
			2	2	2004	2004	2005
		Chile	1	2	2001	2006	2011

			2	1	2006	2006	2006
		China, Hong Kong	1	16	2000	2002	2006
			2	13	2000	2002	2003
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2003	2004	2007
			2	1	2006	2006	2006
		Korea	1	4	2000	2004	2006
			2	2	2004	2005	2005
		Malaysia	1	10	2000	2002	2003
			2	6	2000	2002	2003
		Mexico	1	1	2005	2006	2007
			2	2	2004	2004	2005
		Philippines	1	5	2000	2002	2003
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2005	2006	2007
			2	1	2007	2007	2007
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	20	2001	2003	2006
			2	16	2002	2003	2003
		Chinese Taipei	1	16	2000	2002	2005
			2	7	2000	2000	2003
		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
39	Nationally determined priorities of water usage and sharing among the sectors (domestic, industrial and agricultural) are enforced.	Australia	1	3	2003	--	--
			2	1	2003	2003	2003
		Canada	1	1	2005	2006	2007
			2	2	2010	2011	2013
		China	1	2	2001	2009	--
			2	2	2004	2006	2007
		Chile	1	1	2005	2006	2007
			2	1	2005	2005	2005
		China, Hong Kong	1	17	2001	2006	--
			2	13	2002	2005	2006
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2006	2010	--
			2	1	2006	2006	2006
		Korea	1	4	2004	2006	2008
			2	2	2006	2007	2009
		Malaysia	1	9	2000	2002	2005
			2	6	2001	2002	2003
		Mexico	1	1	2000	2001	2002
			2	2	2003	2003	2004
		Philippines	1	5	2000	2002	2003
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2005	2006	2007
			2	0	2000	2000	2000
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	22	2001	2004	2007
			2	16	2003	2004	2005
		Chinese Taipei	1	17	2000	2002	2003
			2	7	2000	2001	2002
		United States	1	1	2005	2006	2007

			2	0	--	--	--
40	A policy that 50% of water used in the domestic and industrial sectors must be recycled for further use is adopted.	Australia	1	3	2008	2010	2012
			2	1	2010	2010	2010
		Canada	1	0	--	--	--
			2	1	2012	2012	2012
		China	1	2	2001	2009	--
			2	2	2006	2006	2006
		Chile	1	2	2006	2011	--
			2	1	--	--	--
		China, Hong Kong	1	19	2010	--	--
			2	13	--	--	--
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2003	2007	--
			2	1	2006	2006	2006
		Korea	1	4	2005	2006	2010
			2	2	2006	2007	2009
		Malaysia	1	7	2005	2008	--
			2	7	2005	2008	2009
		Mexico	1	1	2005	2006	2007
			2	2	2007	2009	2010
		Philippines	1	5	2002	2006	2010
			2	2	2005	2008	2011
		Papua New Guinea	1	1	2010	2011	2012
			2	1	2005	2005	2005
		Singapore	1	2	2001	2004	2006
			2	0	--	--	--
		Thailand	1	20	2004	2007	2010
			2	16	2005	2007	2010
		Chinese Taipei	1	16	2004	2007	2009
			2	7	2005	2007	2008
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
41	The policies “User Pay” and “Polluters Pay” are enforced	Australia	1	2	2000	2001	2002
			2	1	2000	2000	2000
		Canada	1	1	2000	2001	2002
			2	1	2001	2001	2001
		China	1	2	2000	2001	2002
			2	2	2003	2004	2004
		Chile	1	2	2001	2006	2011
			2	1	2001	2001	2001
		China, Hong Kong	1	21	2000	2002	2003
			2	13	1999	2000	2002
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2000	2003	--
			2	1	2008	2008	2008
		Korea	1	4	1999	2004	2006
			2	2	2004	2005	2005
		Malaysia	1	9	2002	2005	2008
			2	6	2004	2005	2007
		Mexico	1	1	2000	2001	2002
			2	2	2003	2005	2006
		Philippines	1	5	2001	2003	2007

			2	2	2009	2011	2012
		Papua New Guinea	1	1	2000	2001	2002
			2	1	--	--	--
		Singapore	1	2	2001	2006	2011
			2	0	--	--	--
		Thailand	1	20	2001	2005	2009
			2	15	2005	2005	2008
		Chinese Taipei	1	16	2001	2003	2006
			2	7	2001	2002	2003
		United States	1	1	--	--	--
			2	0	--	--	--
42	International standards for dam safety are enforced successfully.	Australia	1	3	2001	2002	2005
			2	1	2001	2001	2001
		Canada	1	2	2000	2001	2002
			2	2	2001	2002	2004
		China	1	2	2001	2006	2011
			2	2	2002	2003	2003
		Chile	1	1	2010	2011	2012
			2	1	2010	2010	2010
		China, Hong Kong	1	20	2000	2002	2003
			2	13	1999	1999	2000
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2000	2002	2005
			2	1	2006	2006	2006
		Korea	1	4	2000	2002	2006
			2	2	2004	2005	2006
		Malaysia	1	8	2002	2005	2007
			2	7	2000	2002	2007
		Mexico	1	1	2005	2006	2007
			2	2	2001	2003	2004
		Philippines	1	4	2001	2004	2006
			2	2	2002	2003	2005
		Papua New Guinea	1	1	2005	2006	2007
			2	1	2007	2007	2007
		Singapore	1	1	2005	2006	2007
			2	0	--	--	--
		Thailand	1	19	2003	2006	2009
			2	15	2003	2005	2006
		Chinese Taipei	1	17	2001	2003	2006
			2	7	2001	2002	2004
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
43	50% of water supplies and management are in private ownership	Australia	1	3	2003	--	--
			2	1	2003	2003	2003
		Canada	1	1	--	--	--
			2	1	--	--	--
		China	1	2	2001	2009	2013
			2	2	2011	2012	2012
		Chile	1	2	2001	2006	2011
			2	1	2001	2001	2001
		China, Hong Kong	1	21	2004	2008	--
			2	13	2005	2008	2008
		Indonesia	1	1	2005	2006	2007
			2	0	--	--	--
		Japan	1	7	2013	--	--
			2	1	2010	2010	2010

		Korea	1	3	2008	2013	--
			2	2	--	--	--
		Malaysia	1	9	2002	2006	2007
			2	6	2006	2007	2008
		Mexico	1	1	2005	2006	2007
			2	2	2006	2006	2006
		Philippines	1	5	2001	2003	2007
			2	2	2004	2008	2011
		Papua New Guinea	1	1	--	--	--
			2	1	2005	2005	2005
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	21	2004	2010	--
			2	16	2010	2010	--
		Chinese Taipei	1	17	2010	--	--
			2	7	--	--	--
		United States	1	1	--	--	--
			2	0	--	--	--
44	Different quality standards for different uses of water are widely used.	Australia	1	3	2001	2002	2005
			2	1	2002	2002	2002
		Canada	1	1	2000	2001	2002
			2	1	2005	2005	2005
		China	1	2	2001	2006	2011
			2	2	2004	2004	2005
		Chile	1	2	2001	2004	2006
			2	1	2001	2001	2001
		China, Hong Kong	1	22	2000	2002	2005
			2	13	1999	2002	2002
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2008	2011	--
			2	2	2002	2004	2005
		Korea	1	4	1999	2001	2003
			2	2	2001	2003	2004
		Malaysia	1	8	2005	2007	2008
			2	6	2001	2006	2007
		Mexico	1	1	2005	2006	2007
			2	2	2006	2006	2007
		Philippines	1	5	2001	2003	2005
			2	2	2000	2001	2001
		Papua New Guinea	1	1	--	--	--
			2	1	2000	2000	2000
		Singapore	1	2	2001	2004	2006
			2	0	--	--	--
		Thailand	1	19	2003	2006	2011
			2	16	2005	2006	2010
		Chinese Taipei	1	18	2002	2006	2009
			2	7	2003	2003	2005
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
45	Systems for monitoring water source contamination are in widespread use.	Australia	1	3	2001	2002	2005
			2	1	2001	2001	2001
		Canada	1	2	2000	2001	2002
			2	2	2001	2001	2001
		China	1	2	2001	2006	2011
			2	2	2006	2007	2007
		Chile	1	2	2006	2009	2011

			2	1	2006	2006	2006
		China, Hong Kong	1	20	2000	2002	2005
			2	13	2000	2002	2003
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	8	2004	2009	2013
			2	1	2008	2008	2008
		Korea	1	3	1999	2005	2007
			2	2	2002	2003	2004
		Malaysia	1	8	2002	2005	2008
			2	6	2002	2003	2005
		Mexico	1	1	2005	2006	2007
			2	2	2006	2007	2007
		Philippines	1	5	2001	2003	2005
			2	2	2000	2001	2001
		Papua New Guinea	1	1	2005	2006	2007
			2	1	2004	2004	2004
		Singapore	1	2	2000	2001	2002
			2	0	--	--	--
		Thailand	1	21	2003	2006	2009
			2	16	2003	2006	2009
		Chinese Taipei	1	18	2002	2005	2008
			2	7	2004	2005	2006
		United States	1	1	2000	2001	2002
			2	0	--	--	--
46	Water information (quality, quantity, usage) is readily available to the public.	Australia	1	3	2003	2005	2007
			2	1	2005	2005	2005
		Canada	1	2	2000	2001	2002
			2	2	2002	2002	2003
		China	1	2	2001	2006	2011
			2	2	2006	2007	2007
		Chile	1	2	1999	2002	2006
			2	1	2002	2002	2002
		China, Hong Kong	1	21	2000	2002	2004
			2	11	2000	2000	2002
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2000	2005	2009
			2	1	2006	2006	2006
		Korea	1	4	1999	2004	2008
			2	2	2005	2006	2006
		Malaysia	1	8	2002	2005	2007
			2	7	2001	2002	2003
		Mexico	1	1	2005	2006	2007
			2	2	2007	2007	2007
		Philippines	1	5	2000	2002	2003
			2	2	2000	2000	2000
		Papua New Guinea	1	1	2005	2006	2007
			2	1	2005	2005	2005
		Singapore	1	2	2000	2001	2002
			2	0	--	--	--
		Thailand	1	21	2001	2003	2007
			2	16	2003	2003	2004
		Chinese Taipei	1	18	2001	2003	2006
			2	7	2001	2003	2005
		United States	1	1	2000	2001	2002
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
47	Accurate inventories of urban water usage covering	Australia	1	3	2003	2006	2010

	all industries, public and private buildings, are available to water man agers						
			2	1	2003	2003	2003
		Canada	1	1	2000	2001	2002
			2	0	--	--	--
		China	1	2	2001	2006	2011
			2	2	2004	2006	2007
		Chile	1	2	2001	2006	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	19	2001	2003	2007
			2	13	2001	2003	2003
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2003	2007	--
			2	1	2006	2006	2006
		Korea	1	3	1999	2001	--
			2	2	2001	2003	2004
		Malaysia	1	7	2005	2008	2011
			2	6	2005	2005	2007
		Mexico	1	1	2005	2006	2007
			2	2	2011	2012	2013
		Philippines	1	5	2000	2002	2003
			2	2	2001	2003	2004
		Papua New Guinea	1	1	2005	2006	2007
			2	1	2005	2005	2005
		Singapore	1	2	2000	2001	2002
			2	0	--	--	--
		Thailand	1	18	2003	2006	2011
			2	15	2004	2006	2010
		Chinese Taipei	1	18	2003	2006	2008
			2	7	2004	2005	2006
		United States	1	1	2005	2006	2007
			2	0	--	--	--
48	Water saving devices, such as dual-flush toilets and automatic-turn-off taps, are installed in all new buildings.	Australia	1	3	2001	2002	2005
			2	1	2001	2001	2001
		Canada	1	1	2000	2001	2002
			2	1	2001	2001	2001
		China	1	2	2001	2006	2011
			2	2	2006	2008	2009
		Chile	1	2	2006	2011	--
			2	1	--	--	--
		China, Hong Kong	1	21	2003	2005	2008
			2	13	2005	2005	2005
		Indonesia	1	1	2010	2011	2012
			2	0	--	--	--
		Japan	1	7	2003	2007	--
			2	1	2008	2008	2008
		Korea	1	4	2003	2005	2007
			2	2	2004	2004	2005
		Malaysia	1	8	2004	2006	2007
			2	7	2004	2005	2006
		Mexico	1	1	2000	2001	2002
			2	2	2003	2004	2005
		Philippines	1	4	2001	2004	2006
			2	2	2005	2005	2006
		Papua New Guinea	1	1	2000	2001	2002
			2	1	2000	2000	2000
		Singapore	1	2	2001	2004	2006
			2	0	--	--	--

		Thailand	1	20	2004	2007	2011
			2	16	2005	2007	2010
		Chinese Taipei	1	18	2001	2003	2006
			2	7	2003	2003	2004
		United States	1	1	2005	2006	2007
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
49	Irrigation systems exceed 75% efficiency.	Australia	1	3	2001	2002	2005
			2	1	2002	2002	2002
		Canada	1	0	--	--	--
			2	1	2005	2005	2005
		China	1	2	2006	2011	--
			2	2	2009	2009	2010
		Chile	1	2	2006	2009	2011
			2	1	2006	2006	2006
		China, Hong Kong	1	18	2009	--	--
			2	12	2010	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2008	2011	--
			2	1	2008	2008	2008
		Korea	1	3	2003	2005	2007
			2	2	2004	2005	2005
		Malaysia	1	9	2004	2011	--
			2	6	2008	2010	2011
		Mexico	1	1	2005	2006	2007
			2	2	2008	2009	2010
		Philippines	1	4	2004	2005	2007
			2	2	2006	2007	2007
		Papua New Guinea	1	1	--	--	--
			2	1	2007	2007	2007
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	23	2004	2008	2013
			2	16	2008	2010	2011
		Chinese Taipei	1	17	2003	2006	2009
			2	6	2003	2004	2006
		United States	1	1	2005	2006	2007
			2	0	--	--	--
50	90% of people have easy access to safe water for their domestic use.	Australia	1	3	2000	2001	2002
			2	1	2000	2000	2000
		Canada	1	1	2000	2001	2002
			2	1	2000	2000	2000
		China	1	2	2011	--	--
			2	2	2007	2010	2012
		Chile	1	2	1999	1999	2001
			2	1	2001	2001	2001
		China, Hong Kong	1	21	1999	2001	2002
			2	13	1999	1999	1999
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	1999	2002	2012
			2	1	2006	2006	2006
		Korea	1	4	1999	2006	2011
			2	2	2005	2008	2010
		Malaysia	1	9	2001	2003	2006
			2	6	2001	2002	2005

		Mexico	1	1	2000	2001	2002
			2	2	2003	2003	2004
		Philippines	1	5	2002	2004	2006
			2	2	2007	2009	2012
		Papua New Guinea	1	1	--	--	--
			2	1	2005	2005	2005
		Singapore	1	2	2000	2001	2002
			2	0	--	--	--
		Thailand	1	21	2006	--	--
			2	16	2006	--	--
		Chinese Taipei	1	18	2001	2004	2007
			2	7	2002	2003	2006
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
51	The price of a barrel of water is listed alongside the price of a barrel of oil, in financial papers like the Wall Street Journal and Financial Times.	Australia	1	3	2006	2007	2010
			2	1	2007	2007	2007
		Canada	1	1	--	--	--
			2	1	2010	2010	2010
		China	1	2	2001	2009	--
			2	2	--	--	--
		Chile	1	1	2010	2011	2012
			2	1	2012	2012	2012
		China, Hong Kong	1	17	2003	--	--
			2	13	--	--	--
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2013	--	--
			2	1	2010	2010	2010
		Korea	1	3	2008	2011	--
			2	2	--	--	--
		Malaysia	1	6	--	--	--
			2	5	--	--	--
		Mexico	1	1	--	--	--
			2	2	--	--	--
		Philippines	1	4	2004	2006	2010
			2	2	2011	2012	2013
		Papua New Guinea	1	1	--	--	--
			2	1	--	--	--
		Singapore	1	1	2010	2011	2012
			2	0	--	--	--
		Thailand	1	18	2006	--	--
			2	15	2013	--	--
		Chinese Taipei	1	17	2007	2012	--
			2	6	2011	2013	--
		United States	1	1	--	--	--
			2	0	--	--	--
52	An integrated water resource management plan, which links in with other natural and human features, is drawn up and implemented for every major river basin.	Australia	1	3	2003	2006	--

			2	1	2003	2003	2003
		Canada	1	2	2001	2004	2006
			2	2	2003	2006	2008
		China	1	2	2001	2009	--
			2	2	2007	2010	2012
		Chile	1	2	2006	2009	2009
			2	1	2009	2009	2009
		China, Hong Kong	1	19	2002	2012	--
			2	13	2006	2010	2012
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2003	2010	--
			2	2	2006	2006	2006
		Korea	1	4	2004	2006	2008
			2	2	2006	2007	2007
		Malaysia	1	10	2002	2006	2012
			2	6	2004	2007	2010
		Mexico	1	1	2010	2011	2012
			2	2	2012	2012	2012
		Philippines	1	5	2001	2003	2005
			2	2	2006	2009	2011
		Papua New Guinea	1	1	--	--	--
			2	1	--	--	--
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	21	2003	2006	2009
			2	16	2006	2008	2009
		Chinese Taipei	1	18	2003	2006	2009
			2	7	2003	2005	2008
		United States	1	1	--	--	--
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
53	A pricing system that encourages water users to recognize that water is a finite and valuable resource is operated.	Australia	1	3	2001	2002	2005
			2	1	2001	2001	2001
		Canada	1	1	2005	2006	2007
			21	1	2001	2001	2001
		China	1	2	2001	2004	2006
			2	2	2006	2006	2006
		Chile	1	2	2006	2009	2009
			2	1	2006	2006	2006
		China, Hong Kong	1	22	2000	2002	2003
			2	13	1999	1999	2002
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2003	2007	--
			2	1	2006	2006	2006
		Korea	1	4	2003	2006	2008
			2	2	2007	2007	2008
		Malaysia	1	10	2003	2007	2011
			2	6	2005	2007	2008
		Mexico	1	1	2010	2011	2012
			2	2	2011	2011	2012
		Philippines	1	5	2000	2002	2003
			2	2	2003	2005	2008
		Papua New Guinea	1	1	2000	2001	2002
			2	1	2010	2010	2010
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--

		Thailand	1	23	2003	2006	2010
			2	16	2003	2006	2010
		Chinese Taipei	1	18	2001	2004	2008
			2	6	2001	2002	2002
		United States	1	1	2010	2011	2012
			2	0	--	--	--
54	Water pricing systems are used to control demand.	Australia	1	3	2001	2002	2005
			2	1	2001	2001	2001
		Canada	1	1	2005	2006	2007
			2	1	2001	2001	2001
		China	1	2	2000	2001	2002
			2	2	2004	2005	2005
		Chile	1	2	2001	2006	2009
			2	1	2009	2009	2009
		China, Hong Kong	1	21	2000	2002	2003
			2	13	1999	2000	2001
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2003	2007	2012
			2	1	2008	2008	2008
		Korea	1	4	2003	2005	2007
			2	2	2002	2003	2004
		Malaysia	1	9	2004	2008	2011
			2	6	2004	2005	2007
		Mexico	1	1	2010	2011	2012
			2	2	2011	2011	2012
		Philippines	1	5	2001	2003	2007
			2	2	2003	2006	2008
		Papua New Guinea	1	1	2000	2001	2002
			2	1	2008	2008	2008
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	22	2004	2006	2009
			2	16	2005	2006	2008
		Chinese Taipei	1	18	2001	2004	2007
			2	6	2001	2002	2004
		United States	1	1	2010	2011	2012
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
55	Major cities have installed integrated systems to manage normal water sources and storm water for water supply.	Australia	1	3	2003	2005	2007
			2	1	2005	2005	2005
		Canada	1	2	2001	2009	--
			2	1	2001	2001	2001
		China	1	2	2001	2004	2006
			2	2	2009	2009	2010
		Chile	1	2	2006	2011	--
			2	1	--	--	--
		China, Hong Kong	1	18	2002	2005	2011
			2	13	2002	2005	2010
		Indonesia	1	1	--	--	--
			2	0	--	--	--
		Japan	1	7	2006	2010	--
			2	1	2008	2008	2008
		Korea	1	3	2006	2007	--
			2	2	2006	2008	2009

		Malaysia	1	8	2007	2010	2011
			2	7	2008	2008	2011
		Mexico	1	1	2010	2011	2012
			2	2	2010	2010	2010
		Philippines	1	5	2004	2007	2012
			2	2	2006	2008	2009
		Papua New Guinea	1	1	--	--	--
			2	0	--	--	--
		Singapore	1	1	2000	2001	2002
			2	0	--	--	--
		Thailand	1	19	2005	2008	--
			2	15	2008	2010	--
		Chinese Taipei	1	17	2004	2007	2012
			2	6	2004	2005	2007
		United States	1	1	2010	2011	2012
			2	0	--	--	--
59	Better Alternatives to chlorine are used in all new water treatment development.	Australia	1				
			2	1	2001	2001	2001
		Canada	1				
			2	2	2001	2001	2001
		China	1				
			2	3	2002	2003	2005
		Chile	1				
			2	1	--	--	--
		China, Hong Kong	1				
			2	14	2001	2006	2010
		Indonesia	1				
			2	0	--	--	--
		Japan	1				
			2	3	2009	2011	2013
		Korea	1				
			2	2	2007	2009	2010
		Malaysia	1				
			2	7	2004	2006	2013
		Mexico	1				
			2	2	2008	2010	2011
		Philippines	1				
			2	2	2002	2004	2005
		Papua New Guinea	1				
			2	1	2001	2001	2001
		Singapore	1				
			2	0	--	--	--
		Thailand	1				
			2	16	2006	2006	2011
		Chinese Taipei	1				
			2	7	2001	2006	2006
		United States	1				
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
60	Organization are making practical use of a range of models for public, private and user participation in the management of water supply and waste water disposal, taking into account the cultural	Australia	1				

	differences in the APEC region.						
			2	1	2001	2001	2001
		Canada	1				
			2	3	2004	2006	2006
		China	1				
			2	2	2002	2003	2004
		Chile	1				
			2	1	2006	2006	2006
		China, Hong Kong	1				
			2	13	2006	2006	2011
		Indonesia	1				
			2	0	--	--	--
		Japan	1				
			2	2	2012	2013	2013
		Korea	1				
			2	2	2007	2009	2010
		Malaysia	1				
			2	6	2006	2006	2006
		Mexico	1				
			2	2	2008	2010	2012
		Philippines	1				
			2	2	2002	2004	2005
		Papua New Guinea	1				
			2	1	2001	2001	2001
		Singapore	1				
			2	0	--	--	--
		Thailand	1				
			2	15	2006	2006	2011
		Chinese Taipei	1				
			2	6	2006	2006	2010
		United States	1				
			2	0	--	--	--
61	Impact of major climate change on water supply can be predicted.	Australia	1				
			2	1	2001	2001	2001
		Canada	1				
			2	3	2006	2006	2009
		China	1				
			2	2	--	--	--
		Chile	1				
			2	1	--	--	--
		China, Hong Kong	1				
			2	14	2006	2009	2011
		Indonesia	1				
			2	0	--	--	--
		Japan	1				
			2	3	2006	2011	2011
		Korea	1				
			2	2	2011	2011	2011
		Malaysia	1				
			2	7	2001	2001	2006
		Mexico	1				
			2	2	2012	2013	2013
		Philippines	1				
			2	2	2004	2008	2011
		Papua New Guinea	1				
			2	1	2006	2006	2006
		Singapore	1				
			2	0	--	--	--
		Thailand	1				
			2	17	2006	2011	2011
		Chinese Taipei	1				
			2	7	2004	2006	2011

		United States	1				
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
62	Membrane technology for evaporation prevention from water reservoirs has been developed.	Australia	1				
			2	1	--	--	--
		Canada	1				
			2	2	2008	2010	2012
		China	1				
			2	2	2008	2010	2012
		Chile	1				
			2	1	--	--	--
		China, Hong Kong	1				
			2	12	2010	2013	--
		Indonesia	1				
			2	0	--	--	--
		Japan	1				
			2	3	2009	2011	2011
		Korea	1				
			2	2	--	--	--
		Malaysia	1				
			2	5	2011	--	--
		Mexico	1				
			2	2	2012	2013	2013
		Philippines	1				
			2	1	--	--	--
		Papua New Guinea	1				
			2	1	2006	2006	2006
		Singapore	1				
			2	0	--	--	--
		Thailand	1				
			2	17	2006	2011	2011
		Chinese Taipei	1				
			2	5	2011	2011	--
		United States	1				
			2	0	--	--	--
63	The concepts of ‘sustainable water supply’ and ‘sustainable development with sufficient water supply’ have been understood and implemented widely.	Australia	1				
			2	1	2001	2001	2001
		Canada	1				
			2	3	2004	2006	2009
		China	1				
			2	3	2004	2006	2010
		Chile	1				
			2	1	2011	2011	2011
		China, Hong Kong	1				
			2	14	2001	2006	2011
		Indonesia	1				
			2	0	--	--	--
		Japan	1				
			2	3	2006	2006	2009

		Korea	1				
			2	2	2007	2009	2010
		Malaysia	1				
			2	6	2002	2006	2006
		Mexico	1				
			2	2	2005	2005	2006
		Philippines	1				
			2	2	2001	2001	2001
		Papua New Guinea	1				
			2	1	2006	2006	2006
		Singapore	1				
			2	0	--	--	--
		Thailand	1				
			2	17	2001	2006	2011
		Chinese Taipei	1				
			2	7	2001	2006	2006
		United States	1				
			2	0	--	--	--

Topic #	Topic	Economies	Round #	# of Res	QL	QM	QU
64	Integrated water management of urban areas combining urban water storage, urban flood control, and restoration of urban hydrological cycle is in practical use.	Australia	1				
			2	1	2001	2001	2001
		Canada	1				
			2	3	2004	2006	2006
		China	1				
			2	3	2004	2006	2010
		Chile	1				
			2	1	2011	2011	2011
		China, Hong Kong	1				
			2	14	2002	2006	2010
		Indonesia	1				
			2	0	--	--	--
		Japan	1				
			2	3	2004	2006	2006
		Korea	1				
			2	2	2007	2009	2010
		Malaysia	1				
			2	7	2004	2006	2009
		Mexico	1				
			2	2	2005	2005	2006
		Philippines	1				
			2	2	2001	2001	2001
		Papua New Guinea	1				
			2	1	2006	2006	2006
		Singapore	1				
			2	0	--	--	--
		Thailand	1				
			2	17	2006	2006	2006
		Chinese Taipei	1				
			2	7	2006	2006	2006
		United States	1				
			2	0	--	--	--
		Australia	1				
			2				
		Canada	1				
			2				
		China	1				

			2				
		Chile	1				
			2				
		China, Hong Kong	1				
			2				
		Indonesia	1				
			2				
		Japan	1				
			2				
		Korea	1				
			2				
		Malaysia	1				
			2				
		Mexico	1				
			2				
		Philippines	1				
			2				
		Papua New Guinea	1				
			2				
		Singapore	1				
			2				
		Thailand	1				
			2				
		Chinese Taipei	1				
			2				
		United States	1				
			2				

Appendix IV: Comments and Opinions of Panel Experts

Appendix IV: Expert's Opinions

Topic#	Expert's Opinions
1	1. How accurate is accurate? Weather change is a stochastic process, has always some degree of uncertainty 2. In practice in Hong Kong 3. There are many technology transfer (with pay) but very less benefit in return. I would love to see the honest in this kind of technology transfer business. 4. Constraints – it may be too expensive to install this technology 5. Both water availability and quality as key limited to economic growth and sustainable use. Environmental, health and social outcomes will be limited by population; water resource availability.
6. 2	7. There are many technology transfer (with pay) but very less benefit in return. I would love to see the honest in this kind of technology transfer business. 8. This topic has been realized 9. In the section of water as a resource, I really want to see the topic of catchment management in terms of enhancing raw water quality and reducing treatment cost. 10. Water resource should also be focused on protected and unprotected catchments 11. In the section of technologies should be divided into treatment technologies and management of distribution network.
12. 3	13. The term "flood control" is misleading. We cannot control the flood; the best we can do is only to mitigate the flood problems. Therefore, the term 'flood control' should never be used. 14. In Canada, water supplies, management, legal framework, available resources vary widely accoss the country. The replies better reflect conditions in Central Canada (Ontario and Quebec).
15. 4	16. Risky area determination 17. I expect this to be realised before 1999 18. Integrated models for water resources, such as Quality, Hydro-ecology, Management policy etc.
19. 5	20. This topic has been realized. 21. the impact taken by it is not clear

	22. Artificial rainfall enhancement has been carried out during dry seasons since 1980s. 23. For solving drought problem 24. In the long run, demand of water resources should be limited by the availability of Supply. 25. Water resources management as a whole should be considered instead of "water supply and management" only. 26. Hydrologic "Certainty" vs. "uncertainty" is the key point in water resources management and therefore it draw much more attention.
27. 6	28. GIS system on water resources, development and utilization information for all water engineer/? 29. useful technologies in APEC Region 30. for water budget 31. This survey should include the impact of environment for developing different water supply systems. 32. The cost comparison for different water supply systems.
33. 7	34. This topic has no connection with water supply and management. 35. useful technologies in APEC Region 36. Only if international laws are released 37. For inter-river 38. Desalination technologies other than membrane technology. 39. Use of solar energy other than solar cell
40. 8	41. useful technologies in APEC Region 42. water usage 43. Rainwater Catchment System are cost effective and widespread use . 44. Accurate leak detection of UST or above storage tank systems of gas station are in practical use.
45. 9	46. The regulation of water use should be legislated by the authorities (water) prior to imposing the techniques to control. It is not easy to control. 47. Development of visible alternatives to Chlorine services reserves must be provided for all new developments
48. 10	49. Country-wide, capturing 50% runoff is not necessary yet as mean runoff is 566 b.m3/yr. While water use is 15 b.m3/yr. 50. Wet season run-off should be captured and used for aquifer recharge and surface water storage. 51. Develop a range of models of public/private participation in the management of water supply and wastewater disposal that can be accepted by the cultural range in APEC. 52. Institutional Development targets that take into account cultural differences 53. Water supply autitority performance targets- staff, billings, cost recovery, etc. with annual competition for "Best" APEC performance
54. 11	55. No recharging of acquifers since surface runoff is abundant while groundwater usage is very low 56. Before we begin recharging- we must know what is happening- by monitoring- today we don' t. 57. An additional box to indicate whether the issue concerned has been in practice in the member economy.
58. 12	59. Does not quite understand it's meaning. 60. Difficult to answer because of the "such as…" expression. Answer highly depends on what other technologies come to mind. 61. In practice by Hong Kong Observatory 62. More topics on water quality and water treatment technology
63. 13	64. In this topic, we should add waster from other sources such as mining industries, paper industries, which cause incredible pollution inputs into water ways 65. In practice by Hong Kong Observatory 66. Already practised in Hong Kong 67. The main problem is how to deal with draught if it takes in the very wide area in the region. We have to prepare for it.
68. 14	69. Water Resources Management Union will be held.

	70. Integrated Basin Management is important with international countries like EU.
71. 15	72. Very big cost 73. Before asking such questions, secretary side have to supply basic information and data for answers. Because I have experienced to meet Delphi method, but forecasting by experts never realized. It seems that water quality issues will come out more seriously in Asian Region.
74. 16	75. Transport iceberg is too far and may cause other problems 76. Questionnaires on disease related issues relating to health which is of public interest.
77. 17	78. Hypothetical scenario due to economic viability of this approach. Should treatment be considered as an alternative? 79. This type of high energy consuming systems are very difficult to accept. 80. No 81. Too far 82. Impact of Climate Change on water supply and management.
83. 18	84. Rivers in Chile are not navigable 85. No 86. I think this questionnaire should be a kind of formulary structurated just to fill an exclusive area for the information. Better to solve, better to read.
87. 19	88. Submarine pipelines for water transport 89. No 90. Already practised in Hong Kong 91. Public awareness and public relations in respect of decisions to be made on water management and water development are going to be very important to achieving improvements in the next decade.
92. 20	*93. Biological methods (Such as Bacillus treatment) in the domestic and industrial sectors to produce water suitable for different water uses in terms of both cost and quality are in practical use.* 94. No *95. In Thailand, there is enough fresh water. The problem is how we can keep it clean, use it wisely and also store it in the appropriate place.* 96. Decolination Technology won' t be generalized but for very particular places. 97. Water management is implemented by water users group.
98. 21	*99. Biological methods (Such as Bacillus treatment) in the domestic and industrial sectors to produce water suitable for different water uses in terms of both cost and quality are in practical use.* 100. No *101. In Thailand, there is enough fresh water. The problem is how we can keep it clean, use it wisely and also store it in the appropriate place.* 102. Decolination Technology won' t be generalized but for very particular places. 103. Can' t see it getting that low. I' ve heard of $1.00-$5.00/m3 which depends on size mostly. 104. An APEC provide the financial and technical assistance for strenghening: and improving water users institutions in developing countries in the region 105. The program for sharing of experiences and transfer knowledge of privating irrigation institutions and training over management to water users organization in developing countries are promoted by APEC
106. 2 2	107. No *108. In Thailand, there is enough fresh water. The problem is how we can keep it clean, use it wisely and also store it in the appropriate place.* 109. Decolination Technology won' t be generalized but for very particular places. 110. Prefabricated plants are not limiting waste water treatment. It is more a cost policy for ? factories. 111. Regional compaign for Water conservation & utilization 112. Community participated water saving program. 113. Automatic Water quantity monitoring station for water Management (surface & Law) 114. Membrane technologies for infiltration prevention

	115.membrane technologies for evaporation prevention 116.water allocation criteria among different users. 117.Water quality prevention & saving measures in centive system.
118.23	119.Difficult to answer because of the "such as…" expression. Answer highly depends on what other technologies come to mind. 120. No 121. The most importance in water awareness (in term of water deficit) is that the implant in education. The young (new) generation will realize how / why water is a valuable thing that need to be used wisely and economically. The moral principal is also necessary; people should feel ashamed to take more and give less; also inconsidering the other people (in term of polluted the public water sources). In the worst case, water related law is needed to be enforced.
122. 24	123. No 124. Some important issues not adequately treated: Consider 125. water quality, 126. environmental protection, 127. Aquatic habitat preservation 128. Ecosystem enhancement, 129. Public health
130. 25	131. 100% of urban households are provided with a good quality and reliable potable water supply 132. Hong Kong has fresh water for potable water system and salt water for flushing purposes 133. separate salt water flushing system in use 134. No 135. Health risks due to poor infrastruction and education 136. Water Pollution problems have to be considered in a special topic.
137. 26	138. No 139. More than 50% 140. Policy makes / Decision makers - Need to be made aware of this importance of water as a resource. They need to be educated with sufficient knowledge to handle the water crisis. The area of public awareness of water management and good practice of it needs to be further enhanced in this region of South East Asia.
141. 27	142. No 143. This needs a lot of research work, ie. a lot of finance support. But it will bring a lot of benefit if it comes true. 144. Concerning the policies of water supply, it is important to understand (and to let the APEC governments to implement) the concepts of "sustainable water supply" and "sustainable development with sufficient water supply". The kinds of questions should be included in the next survey. Besides, the sustainability concepts must be promoted in the APEC.
145. 28	146. Further development of technology and equipment for wastage/ leakeage detection is a way to save water resources. 147. No 148. Water supply services 149. Though it seems this technology will take a long time to come but a very important one to develop. 150. Potential for funding from Governments and other donor agencies like ADB, Worldbank, etc. is suggested as another topic that can be looked at.
151. 29	152. No 153. Privatisation of water and waste water 154. Adequate charges to users for operation. Maintenance and capital expenses for water and waste water. 155. Use of pre-payment meters to users of water. Complete metering to users for water.
156. 30	157. Reuse of water will become more commonplace in short term 158. No 159. Enforcing strict legislation and system of fines to those breaking the law.

	160. Promoting water re-use and recycling in industrial and domestic sectors will be extremely important in the next century. This is because more people are aware of the importance of water quality preservation and saving of insufficient technology supports to industrial and domestic sectors of the APEC countries. Also, most countries or industrial sectors do not have enough money and sense to implement reuse and recycling. 161. 70% target is unrealistic 162. The importance of the National Water Master Plan for the APEC Economies
163. 31	164. Reuse of water will become more commonplace in short term 165. Although this topic is feasible in terms of technology, the implementation is depended upon many factors such as space availability, cost … 166. In the case of water used by households, because of large scale economies sewage collection systems and large sewage treatment plants are more economical than small plants, and are likely to remain so unless a complete new technology for waste water collection can be developed. Treatment of industrial waste water is rather different because of the specific characteristics of the waster of each type of industry. However, industry treats its waste water in order to be allowed to be discharged in domestic waste water collectors. 167. recycled use for irrigation? 168. No 169. I don't think 50% is a realistic target. But 30% is achievable. Big and western houses can >50%. 170. Promoting water re-use and recycling in industrial and domestic sectors will be extremely important in the next century. This is because more people are aware of the importance of water quality preservation and saving of insufficient technology supports to industrial and domestic sectors of the APEC countries. Also, most countries or industrial sectors do not have enough money and sense to implement reuse and recycling.
171. 32	172. Reuse of water will become more commonplace in short term
173. 33	174. Reuse of water will become more commonplace in short term
175. 35	176. negotiation is historically difficult 177. Need to differentiate where it involves economies with shared river basins.
178. 36	179. Need to differentiate where it involves economies with shared river basins.
180. 37	181. In Canada, water is mainly a provincial responsibility, although the Federal Government also holds a certain number of responsibilities (experts, navigation, Canadian north, oceans etc) 182. The politicians have got to learn to keep these noses out of what is provision of a basic human need.
183. 38	184. In Canada, water is mainly a provincial responsibility, although the Federal Government also holds a certain number of responsibilities (experts, navigation, Canadian north, oceans etc) 185. No 186. Some economies comprise federation of states having Federal and State political systems. Ownership of water normally rests with each state. Hence need to differentiate.
187. 39	188. In Canada, water is mainly a provincial responsibility, although the Federal Government also holds a certain number of responsibilities (experts, navigation, Canadian north, oceans etc) 189. I am not sure of the benefit of enforced priorities. Better a user coordination approach. 190. No 191. Some economies comprise federation of states having Federal and State political systems. Ownership of water normally rests with each state. Hence need to differentiate.

192. 40	193. In Canada, water is mainly a provincial responsibility, although the Federal Government also holds a certain number of responsibilities (experts, navigation, Canadian north, oceans etc) 194. Broker valuing of water may encourage more effective treatment and recycling 195. The conditions of water use in the domestic section are different from that of the industrial one. 50% of water reuse for domestic sector appears to be high. Thus, these two questions should be separated. A lower percentage of water reuse for domestic sector is expected. 196. No 197. The government should work towards such a policy and enforse it, very important.
198. 41	199. Broker valuing of water may encourage more effective treatment and recycling 200. This is the second most important topic 201. No 202. Water resource utilization must be economically worthiness and environmentally cleanliness. 203. Already practised in Hong Kong
204. 42	205. No
206. 43	207. I will say 100% government has to keep all resources, control of quality and scheme of fines. 208. Very dangerous, if it becomes so. Poor people shall suffer. 209. No 210. Privatization should be introduced only where the enabling environment cannot be otherwise created.
211.44	212. In practice by Hong Kong Observatory 213. No 214. Impossible
215. 45	216. Not yet
217. 46	218. No 219. We have to introduce the means to accurately measure and monitor- by outside agency.
220. 47	221. No
222. 48	223. Being suggested 224. Already practised in Hong Kong
225. 49	226. No 227. Due to the natural conditions of soil/land/type of crops such as rice, it is unrealistic to set the irrigation efficiency target as high as 75%
228. 50	229. No
230. 51	231. Realistic pricing of water is likely to emerge as the mechanism for water resource allocation and management: prices are likely to rise steeply as value of water is recognised despite current paradigm to control prices 232. As a basic requirement of human being, water is important but it will not become a too-expensive goods like oil. 233. No 234. Water is resource for human being – not only for sale
235. 52	236. Being done 237. Need to differentiate where river basins are shared between states within an economy, or between economies
238. 53	239. This is the most important topic. 240. More accurate and durable water meters are available at reasonable price. 241. In practice by Hong Kong Observatory 242. Water charges must be implemented according to user' s ability and willingness to pay. 243. No

	244. Regulation of water supply and usage by a pricing system is widely used in Hong Kong, and should be implemented by other nations because this provides effective incentive for saving water.
245. 54	246. All the users pay the cost without being subsidized by government, including cost of protection of resources 247. In practice by Hong Kong Observatory 248. No 249. This is the only way to go and the sooner politicians are educated to this fact of life the better. 250. Water demand management is important as its supply management. 251. Regulation of water supply and usage by a pricing system is widely used in Hong Kong, and should be implemented by other nations because this provides effective incentive for saving water.
55	252. No
253. 56	254. A unit standard to be adopted for all APEC Countries.
255. 58	256. To assist poor countries to provide a good quality and reliable potable water supply to their people. 257. Most countries need fund to do studies and develop systems for better water resource management Unless funds are made available concerted APEC approach will not subsidise.
258. General	259. I have limited access to the background information on the year of realisation in APEC Region. 260. I found all the topics very interesting. Although in many of them I have no expertise at all, I gave my opinion on the degree of importance and my estimate on the year of realisation, thinking in the benefit of the APEC economies. 261. In the absence of sufficient background of other countries in the APEC Region, it would be difficult to complete column 3 "year of realisation in APEC Region". 262. Policy issues – this based on a sincerity basis 263. Because of the very different situation of the individual APEC Countries/economies, the results under the category " year of realization in your economy " will be very divergent. 264. Some of the topics are very specialised, e.g. artificial rain, use of satellite, etc., and may not be familiar to a lot of the professionals or experts who are filling the questionnaire. In the second round of survey it might be beneficial to everyone if a brief introduction of the latest development of these subjects could be provided. 265. There seems to be a lack of topics on water treatment. I would suggest the following: a) Membrane technology is in widespread use for controlling water 266. qualities to suit various purposes b) Biological water treatment processes are in 267. Widespread use. 268. To help in early realisation of various technology advancements, research work and experience sharing are very important. Joint effort of APEC economies in these regards should be emphasised. 269. Many of the proven water-use-efficient systems adopted in different countries will never be applied in APEC because of political constraints. 270. It is essential that all technical improvements are assessed alongside the need for institutional development. 271. Resent : More Focus on Practical Pragmatic System for water short / poor Areas- too much emphasis on high tech. issues. 272. The distinction between APEC region and "economy" is not clear, at least for the USA. 273. My responses relate primarily to the western United States, e.g. California; therefore they may not apply over the whole USA. 274. The degree of expertise is generally high throughout the USA, but may not be applied in some regions. 275. The questionnaire is very weak on aspects of water management related to water quality, environmental protection and ecology.

	276. Techniques to aid decision and policy makers are little referenced, e.g. mathematical models, visualization, data bases, etc 277. Policy Issues - In PNG the successive Governments have failed to provide consistancy in policy relating to the water sector. This is a major obstacle for developing this sector which is already fragmented and neglected by the Government in PNG.

This is the end of the Water Supply and Management Volume 2.