The Future of APEC Megacities: A Foresight Approach

Review of Studies by the APEC Center for Technology Foresight 1998-2000

Asia-Pacific Economic Co-operation

APEC Industrial Science and Technology Working Group

The APEC Center for Technology Foresight
National Science and Technology Development Agency
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Foreword

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

- Promoting the adoption of technology foresight across APEC member economies
- Providing a means for comparison of technology foresight exercises and implementation in APEC member economies and across the world, with a view to stimulating Best Practice in appropriate methodologies for Foresight in APEC economies
- Conducting technology foresight exercises on an APEC-wide basis, and between relevant member economies
- Improving the quality and effectiveness of technology-related planning and development and priority-setting for research, across APEC member economies; and
- Developing 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 future of science, technology, the economy 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 part of the program of the APEC Center, the issue of Sustainable Megacities in the APEC context was addressed. Urbanization was particularly pronounced in the Asia-Pacific region in the second half of the last century. By the year 2025, Asia alone is expected to become predominantly urban, and home to over half of the world's megacities.

Megacities have both positive and negative values. They generate higher than average proportions of their economy's output of goods and services, are centers of innovation in science, arts and lifestyles, contain many cultural assets of the economy and offer some of the better opportunities for people to lead full and satisfying lives. Yet they also offer potential shortages of water, environmental pollution, traffic congestion and a proliferation of slums, crime and social alienation.

The importance of the topic of 'Megacities' emerged from discussion at a Technology Foresight Symposium held in Chiang Mai, Thailand in 1997, attended by over 100 participants from 16 member economies. It was agreed that the issue of sustainability in Megacities would be increasingly important to the economy of the APEC region and the quality of life of its citizens in the 21st century, and that Foresight could assist policy-makers and planners to understand and resolve problems.

Over the period 1998 - 2000, the APEC Center conducted four Foresight studies relevant to sustainability in Megacities. The first two of these, namely Water Supply and Management in the APEC Region and Technology for Learning and Culture in the APEC Region to 2010, were broad in scope but had a number of elements relevant to Megacities; the second two, namely 'Sustainable Transport for APEC Megacities: Issues and Solutions and Healthy Futures for APEC Megacities' were directly relevant to Megacities.

This monograph sets out briefly the principles of Foresight and the methodologies used by the APEC Center in its studies, namely scenario planning and Delphi surveys. Scenario planning has proven to be a very effective methodology for multi-economy Foresight studies and was used in all four studies. The principal drivers of change which have been identified in the scenario workshops are discussed in some detail to provide a background to their outcomes. While involving a wider range of experts the Delphi approach has proven to be too resource-intensive for the APEC Center at the present stage of its development and was only used in the two initial studies.

The four studies are discussed in terms of the Foresight approach used, highlighting the key issues identified in the scenario workshops and in the Delphi studies, the policy implications and the role of technology in contributing to the

future implementation of new policy approaches. Finally the lessons learned from the studies are drawn out to provide guidance for future multi-economy Foresight projects.

The studies have provided a wealth of new thinking on the issue of 'The Future of APEC Megacities' and alerted a wide range of experts and policymakers to the benefits of taking a structured, long-term approach. The challenge is now to address the policy issues identified in the studies on an APEC-wide basis.

The APEC Center wishes to acknowledge the generous financial support from the APEC Central Fund and from the Royal Thai Government through the National Science and Technology Development Agency. The success achieved by the APEC Center in its short life could not have possible without the generous support of Governments and agencies in many APEC economies, the enthusiastic participation by a large number of consultants and experts who gave freely of their time and the dedicated support of the APEC center staff.

Finally, as Co-Director of the APEC Center for Technology Foresight since its inception, I would like to express my appreciation and gratitude to the author of this Monograph, Prof Greg Tegart. Prof Greg Tegart served as the first Director of the Center (1998-9) and continues to support the Center's activities in the role of Executive Director. The multi-economy research work undertaken by the Center, and described in this book, was initiated and led by Prof Tegart, and could not have proved so fruitful without his great expertise and dedication to the projects.

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SECTION I GENERAL

Introduction

1.1 The APEC Center for Technology Foresight

The APEC Center for Technology Foresight was established in Thailand in February 1998 with the aim of serving and involving all APEC member economies, in diffusing technology Foresight expertise across the region. This is achieved through training and public seminars, information exchange via a web site, consulting to member economies, and most importantly, by conducting Foresight research at multi-economy level.

Topics are selected for multi-economy study on the basis of 4 key criteria:

- The topic must be of concern to most member economies, with at least 4 participating in the study, and with potential to share the results to many more;
- The topic must transcend national boundaries, so that it can go beyond what might be achieved by a national or bi-lateral study.
- The topic must be of general public benefit and not one that is likely to be addressed by the private sector;
- The topic should have important technological, but not necessarily 'high-tech' components.

The importance of the topic of 'Megacities' emerged from discussion at a Technology Foresight Symposium held in Chiang Mai, Thailand in 1997, attended by over 100 participants from 16 member economies. It was agreed that the issue of sustainability in Megacities would be increasingly important to the economy of the APEC region and the quality of life of its citizens in the 21st century, and that Foresight could assist policy-makers and planners to understand and resolve problems.

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1.2 Foresight - Philosophy and Principles

Various definitions of Foresight have been proposed, but the one adopted by the APEC Center is "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 the emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic, environmental and social benefits."

There are a number of implications in this definition:

1. The attempts to look into the future must be systematic to come under the heading of 'Foresight';
2. These attempts must be concerned with the longer-term, typically 10 years and possibly 25 - 30 years;
3. Foresight is a process rather than a set of techniques and involves consultation and interaction between the research producers, research users, policymakers and the community.
4. One focus is on the prompt identification of emerging generic technologies i.e. technologies whose exploitation will yield benefits for several sectors of the economy or society. Such technologies are still at a pre-competitive state and can be targeted for selective funding to ensure rapid development;
5. Another focus is on strategic research i.e.. basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised current or future practical problems; and
6. Attention must be given to the likely social benefits (and disbenefits) of new technologies and not just their impact on industry and the economy. The social dimension of Foresight has been increasingly emphasised in recent studies throughout the world.

It is important to stress that Foresight is not the same as technology forecasting which assumes that there is an unique future. It is then the task of the forecaster to predict, as accurately as possible, what this will be. By contrast, Foresight is concerned not so much to predict the details and timing of specific developments as to outline the range of possible futures which emerge from alternative sets of assumptions about emerging trends and opportunities. Exactly which one is arrived at depends upon the choices made in the present. Foresight offers the chance to shape the future through wise decision making. We can distinguish between them as:

Forecasting	Foresight
Focuses on certainties and disguises uncertainties	Focuses on and legitimises recognition of uncertainties
Conceals risk	Clarifies risk
Results in single point projection	Results in adaptive understanding
More quantitative than qualitative	More qualitative than quantitative

The essential elements of Foresight are shown in Figure 1.1. In conducting a Foresight study it is necessary to maintain a balanced perspective between the 'science-push' and 'demand-pull' factors that influence future developments.

- Science-push factors include the creation of new technological or commercial opportunities by scientific research, and the strength and resources to exploit them.
- Developments in technology and production can create a use for existing and novel science through the mechanism of demand-pull. Demand factor include the priorities and needs of the broader community.

There can be problems in communication between proponents of science-push and demand-pull, particularly their different time perspectives. The time horizon of those making the demands may be too short for an effective dialogue. Looking ahead together, through Foresight, can bridge this gap in many cases.

There are many different techniques and methodologies for Foresight eg. extrapolation, Delphi surveys, consultation, scenario writing, patent analysis, critical technologies.[1,2] From much experience, including that presented at the recent International Conference on Technology Foresight in Tokyo in March this year[3], it is clear that the economic, instrumental and cultural contexts of different countries influence the choice of methodology used. In some cases combinations of methodologies can be extremely useful eg. the APEC Center has used scenarios plus Delphi Surveys in two of its studies on Water Supply and Management and on Technology for Learning and Culture. Scenario writing is discussed in Chapter 3 and the Delphi Survey is discussed in Chapter 4. The challenge for the APEC Center has been to develop techniques suitable for use in the APEC context where there are 21 economies involved with a wide range of economic, social and technological development.

Because of the interactive nature of Foresight the outputs of the process can often be as important (or even more important) as the products. We can list the process benefits as the six Cs:

- Communication - bringing together disparate groups of people and providing a structure within which they can interact and communicate;
- Concentration - providing opportunity to focus on an issue;
- Co-ordination - enabling different groups to form productive R & D partnerships;
- Consensus - so a clear picture of alternative future directions and research priorities can be formed;
- Commitment - generating a sense of commitment to the results among those who will be responsible for implementing changes in light of the foresight exercise;
- Comprehension - to encourage those involved to understand the changes happening in their business, or professions, at a global level, and to exert some control over these events.

The success or otherwise of a Foresight exercise can be gauged by assessing it against these six criteria.

Finally, experience has shown that Foresight can be carried out at several levels, ranging from bodies responsible for the co-ordination of overall national policy through industrial associations down to individual companies or research organizations. Thus, some Foresight exercises need to be more macro level, or 'holistic' in scope whilst others need to be focused at a more micro-level. Furthermore, the Foresight activities at different levels should be fully integrated, the results from higher and/or lower levels of Foresight being fed into the process, and the results in turn feeding into subsequent Foresight efforts at higher or lower levels.

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Megacities

2.1 Urbanisation

Over half of the world's population is already urbanised and this trend looks set to continue in the opening years of the new century, with at least 60% of the world's population expected to live in cities by 2030. Of course not all of these people will live in Megacities; in fact, more than half of all current urban dwellers live in cities of under half a million. But it is also true that Megacities are becoming larger, more numerous and sheltering an increasing proportion of the world's urban dwellers. (Table 2.1)

Table 2.1: The World's biggest cities (APEC members highlighted)

- City, Economy by World Rank in 1999	Population Size in 1999 - Millions	% increase expected between 1995-2015	- City, Economy by predicted World Rank in 2015	Predicted population Size in 2015 (Millions)
1 Tokyo, Japan	26.3	2.6	1 Tokyo, Japan	26.4
2 Mexico City, Mexico	17.9	15.8	2 Bombay, India	26.1
3 Bombay, India	17.5	72.7	3 Lagos, Nigeria	23.2
4 Sao Paulo, Brazil	17.5	23.4	4 Dhaka, Bangladesh	21.2
5 New York, U.S.A	16.5	6.7	5 Sao Paulo, Brazil	20.4
6 Los Angeles, U.S.A	13.0	13.5	6 Mexico City, Mexico	19.2
7 Shanghai, China	12.9	11.2	7 Karachi, Pakistan	19.2
8 Lagos, Nigeria	12.8	125.3	8 New York, U.S.A	17.4
9 Calcutta, India	12.7	44.7	9 Jakarta, Indonesia	17.3
10 Buenos Aires, Argentina	12.4	18.6	10 Calcutta, India	17.3
11 Dhaka, Bangladesh	11.7	124.3	11 Delhi, India	16.8
12 Karachi, Pakistan	11.4	97.4	12 Metro Manila, Philippines	14.8
13 Delhi, India	11.3	69.0	13 Shanghai, China	14.6
14 Osaka, Japan	11.0	-0.3	14 Los Angeles, U.S.A	14.1
15 Beijing, China	10.8	35.2	15 Buenos Aires, Argentina	14.1
16 Jakarta, Indonesia	10.6	88.4	16 Cairo, Egypt	13.8
17 Metro Manila, Philippines	10.6	59.4	17 Istanbul, Turkey	12.5
18 Rio de Janeiro, Brazil	10.5	16.9	18 Beijing, China	12.3
19 Cairo, Egypt	10.3	44.3	19 Rio de Janeiro, Brazil	11.9
20 Seoul, South Korea	9.9	-3.2	20 Osaka, Japan	11.0

Source: U.N. Dept of Economic and Social Affairs Population Division *World Urbanization Prospects (The 1999 Revision)* City size estimated on basis of urban agglomeration, not administrative boundaries

Megacities are often defined on the basis of population size - over 5 million or over 10 million for example, but there is no universally agreed definition. Any definition needs to be set in a historical context - thus in the 1950s only New York exceeded 10 million but in 2000 there are approximately 20 cities world wide exceeding 10 million and by 2020 there will be many Megacities of over 20 million. It is not clear if there is an optimal size for a city but it is clear that the sheer scale of Megacities creates an added level of complexity in both the genesis and resolution of problems.

2.2 Megacities and APEC

Asia-Pacific Economic Cooperation (APEC) was established in 1989 in response to the growing interdependence among Asia-Pacific economies. APEC is the primary regional vehicle for promoting open trade and practical economic cooperation, aiming to advance prosperity and improve quality of life in the Asia-Pacific region. APEC's 21 member economies are: Australia; Brunei; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; South Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; the Philippines; Russia; Singapore; Chinese Taipei; Thailand; the USA and Vietnam. Despite the financial instability of 1997-98, the Asia-Pacific remains one of the fastest growing regions in the world. By 2000, APEC member economies accounted for 55% of total world income and 46% of global trade. Development that is sustainable both economically and environmentally is a key APEC concern, and sustainable cities were identified at the Manila Ministerial Meeting in 1996 as one of its three top priorities.

The APEC region, which comprises both advanced and less developed economies, is expected to become predominately urban by the year 2020, with at least 15 cities exceeding 10 million residents (some estimates put the figure much higher). Many of these cities will be in the form of Extended Metropolitan Regions (EMR), as the expansion of large cities overtakes the surrounding countryside and incorporates nearby urban areas. In some Megacities, the EMR has already been given formal administrative status, such as JABOTABEK (the Jakarta Metropolitan region encompassing Jakarta, Bogor, Tangerang and Bekasi) in Indonesia.

By 1999, half of the world's 40 biggest cities were located in 12 different APEC member economies.

The global trend for greater urban population increases in less developed economies is also indicated within APEC, and can be seen more clearly from data about slightly smaller cities. The variation in growth rates of APEC cities is enormous, ranging from over 2% per annum in many of China's cities for example, to zero or even negative in some advanced economies.

Quality of life for APEC's urban residents also varies enormously, both between cities, but also, most importantly, within cities. No Megacity is without environmental problems: even New York for example, in one of APEC's most prosperous member economies, regularly records levels of ambient sulphur dioxide above the WHO standard. But not surprisingly, the worst levels of air pollution are found in the less developed economies. Beijing, China, for example regularly records sulphur dioxide levels 5 times the WHO maximum guideline during the winter. Within cities, data disaggregated by district and/or socio-economic status indicate great variations in health of residents, with the poor experiencing the brunt of environmental hazards. For example, in Manila a three-fold difference in infant mortality between poor and non-poor areas was found in 1996; tuberculosis rates were 9 times higher in poor areas, diarrhoea rates twice as high and typhoid rates 4 times as high.

Table 2.2: APEC's biggest cities

	APEC Megacities	APEC Economy	World Rank in 1999	Size in 1999 (in Millions)	% growth expected between 1995-2015
1.	**Tokyo**	Japan	1	26.3	2.6
2.	**Mexico City**	Mexico	2	17.9	15.8
3.	**New York**	USA	5	16.5	6.7
4.	**Los Angeles**	USA	6	13.0	13.5
5.	**Shanghai**	China	7	12.9	11.2
6.	**Osaka**	Japan	14	11.0	-0.3
7.	**Beijing**	China	15	10.8	35.2
8.	**Jakarta**	Indonesia	16	10.6	88.4
9.	**Metro Manila**	Philippines	17	10.5	59.2
10.	**Seoul**	S. Korea	20	9.9	-3.2
11.	**Moscow**	Russia	22	9.3	1.0
12.	**Tianjin**	China	24	9.1	19.4
13.	**Lima**	Peru	26	7.3	40.8
14.	**Bangkok**	Thailand	28	7.1	54.5
15.	**Chicago**	USA	29	6.9	7.9
16.	**Hong Kong**	Hong Kong	30	6.8	23.5
17.	**Santiago**	Chile	36	5.4	31.5
18.	**St Petersburg**	Russia	38	5.1	0.3
19.	**Chongqing**	China	39	5.0	119.7
20.	**Wuhan**	China	40	5.0	65.1

Source: UN Dept of Economic and Social Affairs Population Division *World Urbanization Prospects (The 1999 Revision)* City size estimated on basis of urban agglomeration, not administrative boundaries.

This lower quality of life has economic penalties. Thus as the Asian Development Bank states:

'Urban environmental conditions in the Asia-Pacific region are threatened by uncontrolled population growth, industrialisation and increasing vehicle densities. The economic impacts of pollution in Asian urban areas, in terms of productivity and health costs, have been estimated to range from 1 to 5 per cent of their GDP.'(1)

2.3 Sustainability of Megacities

Megacities have both positive and negative values. They generate higher-than-average proportions of their economy's output of goods and services: are centers

of innovation in science, the arts and lifestyles; contain many of the cultural assets of the economy and offer some of the better opportunities for people to lead full and satisfying lives. Yet they also offer potential shortages of water, environmental pollution, traffic congestion and a proliferation of slums, crime and social alienation. Increasing concern has been expressed as to whether such cities are sustainable in the longer term. The concepts of "sustainable societies" and "sustainable development" had their origin in the mid-1970's, when concern over the environment and an expanding world population began to grow in many industrialised nations.

The originators of the term "sustainable development" had a particular definition of the word sustainable in mind: *capable of being continued*. Thus, sustainable development is development (activity) that is capable of being continued. An oft-cited definition of sustainable development is the following, adopted in 1987 by the United Nations World Commission (WCED 1987): "A sustainable condition for this planet is one in which there is stability for both social and physical systems, achieved through meeting the needs of the present without compromising the ability of future generations of meet their own needs." The Brundtland Commission's definition was not only about sustainability in the various senses of the term but also about equity: equity among present inhabitants of the planet and equity among generations.

Sustainability needs to be considered in terms of its geographic scope. Activity may be globally unsustainable; for example, it may result in climate change or depletion of the stratospheric ozone layer. Activity may be regionally unsustainable, perhaps on account of the production and spread of tropospheric ozone or acidifying gases that kill vegetation and cause famine in one region but not in other parts of the world. Activity may be locally unsustainable (particularly in individual cities), perhaps because it results in hazardous ambient levels of carbon monoxide or because the noise it produced makes habitation impossible.

It has been suggested that a city can be conceived of as an ecosystem (Figure 2.1). The attainment of a sustainable city can be defined as reducing both the resource inputs to the city (principally land, water, energy and building materials), and its waste outputs (solid, liquid and gaseous, including sewage, toxins, air pollutants and greenhouse gases), while simultaneously improving human liveability in the city (income, employment, education, housing, leisure activities, accessibility, community and health). The sustainable city concept implies sustainable city subsystems such as transportation, water and waste disposal.

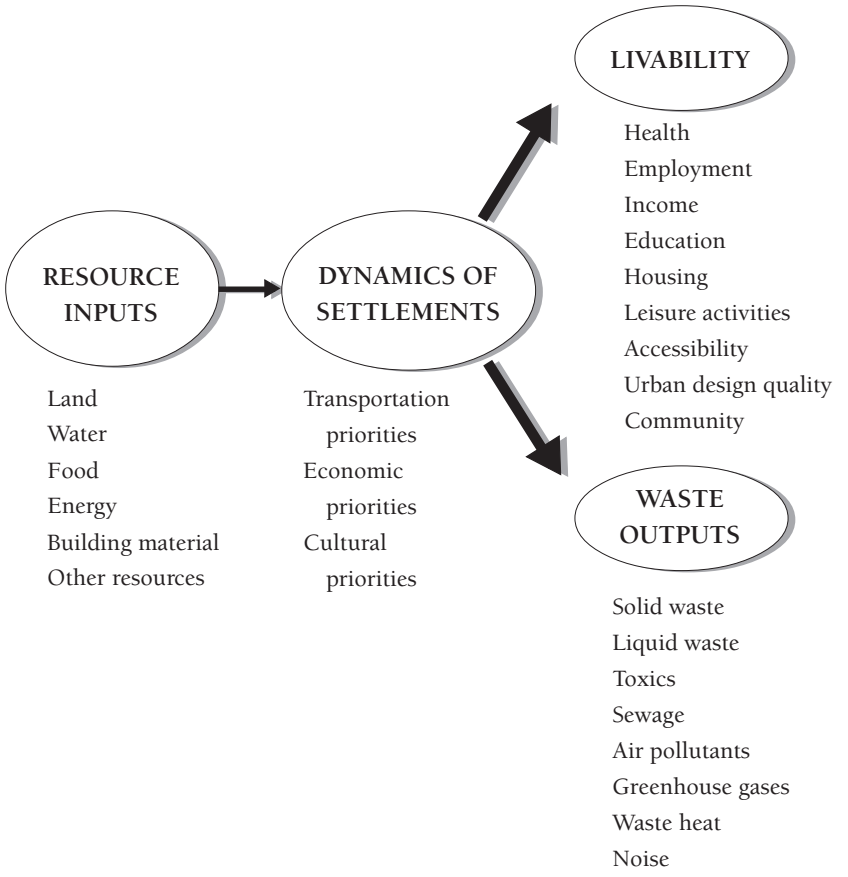

Fig. 2.1 Extended Metabolism Model of Human Settlements, from Kenworthy and Newman: Sustainability and Cities (1999).

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2. Newman, P. and Kenworthy, G. 1999 "*Sustainability and Cities: Overcoming Automobile Dependence*", Island Press, Washington, D.C.

The Scenario Approach to Foresight

3.1 What is Scenario Development

Scenario development is a way of envisaging what the future might hold for a particular economy, industrial sector, organisation or, in this case a Megacity. It is an attempt to identify the major drivers that are likely to shape the future and to gauge the impact that these will have on a particular entity and its relationships with society, stakeholders or customers (or in this case inhabitants).

Rather than using straight line projections from past trends, scenario development attempts to develop stories about possible and plausible futures. Despite its use of stories, scenario development follows a systematic sequence of steps. A focus for the work is first established, followed by examination of the 'key drivers' - social, economic, political and environmental. Key drivers can be defined as 'major' sources of change that impact on the future. We discuss a number of these in Section 3.2.

The next step is the 'scenario logic' or pattern of interactions that explain how the key drivers could contribute to determine future directions. The key drivers are divided into 'predetermined elements' (i.e. what is inevitable, like demographic factors) and critical uncertainties (i.e. what is unpredictable or a matter of choice

such as public opinion). The critical uncertainties are prioritised as to importance and uncertainty.

This analysis is then used to create scenarios - stories of future worlds that convey a range of possible outcomes. Such scenarios are internally consistent stories which present distinctly different possible futures - the actual outcome may be a blend of elements from more than one scenario. Stories are the chosen vehicle for dissecting complex environments because they can express multiple levels of meaning and show how events might unfold in a particular way.

Scenarios explore the possible future shape of the strategic environment, the future context that could play a large role in determining the success of decisions made today. They are effective because they:

- allow 'thought experiments'- thinking through the implications of different strategies in different future environments;
- allow learning and rehearsal of the responses that would be required in plausible future worlds (e.g. developing strategies that might influence particular outcomes);
- challenge existing strategy and policy thinking;
- describe the conditions that decision-makers may have to face - they do not describe the actions that policy-makers intend to take, or conditions that they would necessarily like to see;
- deliberately present distinctly different possible futures - portraying the future worlds as strongly different from one another allows greater learning than would a less distinct blend.

Scenarios sensitise decision-makers to unwelcome or subtle changes in the environment and improve the quality of decision making by questioning assumptions, developing fresh insights, getting the measure of problems, developing shared understanding, rehearsing responses and developing robust strategies if circumstances change. Scenario planning is based on the idea that it is better to 'get the future imprecisely right' than it is to 'get the future precisely wrong' by depending on a unique forecast based on extrapolation from past trends.

The technique was pioneered by Royal Dutch Shell and has been used worldwide by governments, companies and research institutes in their strategic planning. These studies have generally been in limited contexts and relatively few multi-economy scenario development exercises have been reported. The APEC Center has been able to draw on the expertise of Professor Ron Johnston, Executive Director, Australian Centre for Innovation and Industrial Competitiveness, University of Sydney, Australia, in conducting the workshops for the four studies.

3.2 Drivers of Change

Each of the four APEC Center studies identified a number of drivers of change and a number of uncertainties and these are set out in Section II. Examination of these shows a number of common elements and it seems important for future studies on Megacities to provide some background on the most important of these.

3.2.1 Population Dynamics[1,2]

The major world environmental problem is the pressure on the environment caused by continued population growth, mainly in developing countries, coupled with rapid urbanisation. World population projects are based on assumptions about the future number of births and deaths. Using what they deemed the most likely fertility and mortality trends, the United Nations projected that by 2010 the world population will increase by more than 30 per cent over its 1992 figure of 7.1 billion and may well reach 8.4 billion by the year 2025. One important aspect of these trends is the changing balance between the populations of developed and developing nations. Whereas at present about two-thirds of the population live in developing countries (4.2 billion), this is projected to rise 24 per cent to 5.2 billion by 2010 and 71 per cent to 7.2 billion by 2025. The population of developed countries is projected to increase only slightly from 1.2 billion in 1992 to 1.3 billion in 2010 and less than 1.4 billion in 2020 (Figure 3.1). More than 90 per cent of world population growth is occurring in the developing countries.

Of particular significance is the Asia-Pacific region which has 59 per cent of the world's people. Despite Asia's moderate growth rates, its numbers are still increasing rapidly because of the large population base. Thus, Indonesia is expected to have a significant increase of some 50 per cent to around 280 million in 2025, while Vietnam and the Philippines will attain over 100 million. China which is the world's most populous nation with around 1.2 billion is expected to increase to 1.6 billion by 2025. However, India is catching up with a faster growth rate of 2 per cent and there will be as many Indians as Chinese by the end of the 21st Century if present growth rates continue.

APECs developing economies which have yet to experience their demographic transition - from high fertility, high mortality to low mortality, low fertility - are mostly expected to do so during the early part of this century. During this transition, populations will surge as the decline in fertility lags behind that of mortality. Within cities, in addition to this natural increase, cities will be swelled with increasing numbers of rural to urban migrants. As an extreme example, it is estimated that the size of China's urban population will triple by the end of the century, when 90% of the Chinese population is expected to be urban. This urban population explosion - in the poorer economies - has massive implications for the sustainability of Megacities. (Table 3.1).

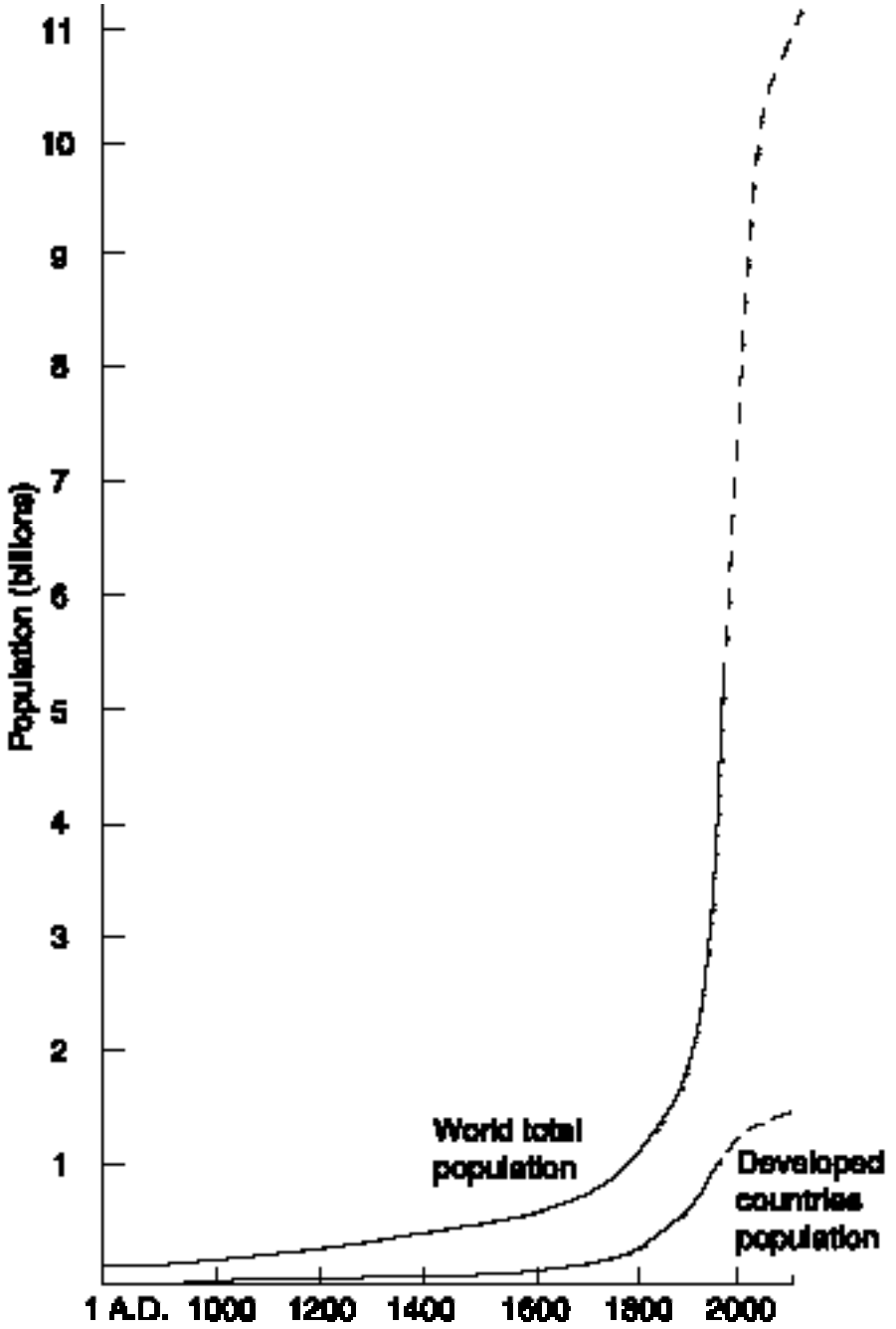


Fig. 3.1 World population to present and predicted increase.

Table 3.1 Urbanization and rates of urban growth in APEC member economies

APEC economy	% of population which is / will be urban		Average annual growth rate 1995-2000		APEC economy	% of population which is / will be urban		Average annual growth rate 1995-2000	
	1999	2030	Urban	Rural		1999	2030	Urban	Rural
Australia	84.7	88.5	1.0	1.0	Brunei	71.7	82.6	3.0	0.1
Canada	77.0	83.6	1.1	0.6	China	31.6	50.3	2.5	0.2
Chile	85.4	90.7	1.7	-0.4	Hong Kong	100.0	100.0	2.1	0.0
Indonesia	39.9	63.5	4.2	-0.3	Japan	78.6	84.8	0.4	-0.4
S. Korea	81.2	90.5	1.7	-2.8	Malaysia	56.7	72.7	3.3	0.4
Mexico	74.2	81.9	1.9	0.9	N. Zealand	85.7	89.8	1.1	0.3
PNG	17.1	33.0	3.8	1.9	Peru	72.4	81.9	2.3	0.4
Philippines	57.8	73.8	3.7	0.0	Russian Fed	77.3	85.2	0.3	-1.7
Singapore	100.0	100.0	1.4	0.0	Thailand	21.2	39.1	2.5	0.5
USA	77.0	84.5	1.1	-0.1	Vietnam	19.6	33.7	1.8	1.5

Source: UN Dept of Economic and Social Affairs Population Division. Urban and Rural Areas 1999 Factsheet (Data for Chinese Taipei not provided)

The working-age population seeking employment in many Megacities in less developed economies may double by 2025. Up to the present, rural to urban migration in APEC economies has been largely related to 'pull' factors, with migrants generally succeeding in improving their standard of living by moving to the city. But with the anticipated levels of population growth, remedial action will be essential to prevent widespread destitution and serious social problems. Alternatives to uncontrolled growth, such as the establishment of other industrial centers in rural areas based on local skills and resources should be seriously considered. For example, over the past two decades, the SPARK program in China has been very effective in establishing rural agri-food and industrial enterprises, but this has also created local environmental problems.

In the more advanced economies, a converse problem is occurring. With low fertility rates, populations are hardly growing at all, or are even in decline, but improvements in health care and social welfare have prolonged life expectancy to the extent that the share of the elderly in the population is rising quite dramatically. This will create immense pressure on public finances generally, especially health and social care, as well as having major implications for many aspects of city life. Based on current legal working ages, the dependency ratio between those employed

and those unable to work will increase from 52% to 65% in the U.S., and from 44% to 86% in Japan over the period 1998-2050. Economies which are undergoing the demographic transition very rapidly, such as China, may experience problems of 'aging population' quite soon; by 2025, the average age in China will be 40 (in 1995 it was 27). Fertility tends to fall fastest in urban areas, where more and more women are not having children at all.

Ageing-related social, political and economic issues will be a focus internationally and some of the areas that will be experiencing the greatest impacts will be health, housing, financial services and manufacturers of consumer products. The effects of an ageing population, particularly in developed economies, will be felt in the workplace, as ageing 'baby boomers' and Generations X and Y will remain in the workforce beyond traditional retirement age. The ageing population is wealthier and healthier than any previous generation. They are better educated and are critical consumers. Ageing 'boomers' hold a strong conviction that 'ageing well' is their right. They desire 'retirements' where they are busy, contributing their skills and experience, contributing to their communities and ensuring that the world is a fit place for their grandchildren. The fastest growing Internet user group in U.S.A. is people aged over 50 years.

3.2.2 The Global Knowledge Economy[3,4]

It is not a new idea that knowledge plays an important role in the economy, nor is it a new fact. All economies, however simple, are based on knowledge about how to farm, to mine and to build, and this use of knowledge has been increasing since the Industrial Revolution. But the degree of incorporation of knowledge and information into economic activity is now so great that it is inducing profound structural and qualitative changes in the operation of the economy and transforming the basis of competitive advantage. The growing intensity of the world economy and our increasing ability to distribute that knowledge have increased its value to all participants in the economic system.

The Global Knowledge Economy is emerging from two driving forces: the rise in knowledge intensity of economic activities and the increasing globalisation of economic affairs. The rise in knowledge intensity is being driven by the combined forces of the IT revolution and the increasing pace of technological change. Globalisation is being driven by national and international deregulation and by the information technology (IT) related communications revolution. However, it is important to note that the term Global Knowledge Economy' refers to the overall economic structure that is emerging, not to any one, or combination of these phenomena. The Global Knowledge Economy manifests itself in significant change in many aspects of society (Fig. 3.2) and this impacts profoundly on the future of Megacities.

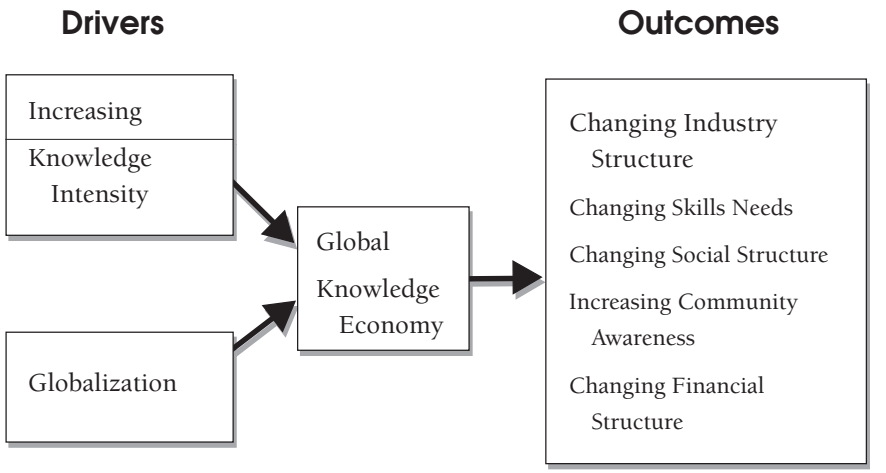


Fig. 3.2 The Structure of the Global Knowledge Economy.

Increasing knowledge intensity

The last twenty years have seen an explosion in the application of computing and communications technologies in all areas of business and community life. This explosion has been driven by sharp falls in the cost of computing and communications per unit of performance, and by the rapid development of applications relevant to the needs of users. Digitalisation, open systems standards, and the development software and supporting technologies for the application of new computing and communications systems - including scanning and imaging technologies, memory and storage technologies, display systems and copying technologies - are now helping users realise the potential of the IT revolution.

It is in the Internet that these technologies come together, and it is the Internet phenomenon that exemplifies the IT revolution. Over the first decade of its development the Internet remained a specialist research network. By 1989 there were 159,000 Internet hosts worldwide. Now, just 11 years later, there are more than 43 million. (Fig. 3.3)

In economic terms, the central feature of the IT revolution is the ability to manipulate, store and transmit large quantities of information at very low cost. An equally important feature of these technologies is their pervasiveness. While most earlier episodes of technical change have centred on particular products or industrial sectors, information technology is generic. It impacts on every element of the economy, on both goods and services; and on every element of the business chain, from research and development to production, marketing and distribution.

Because the marginal cost of manipulating, storing and transmitting information is virtually zero, the application of knowledge to all aspects of the economy is being greatly facilitated, and the knowledge intensity of economic activities greatly increased.

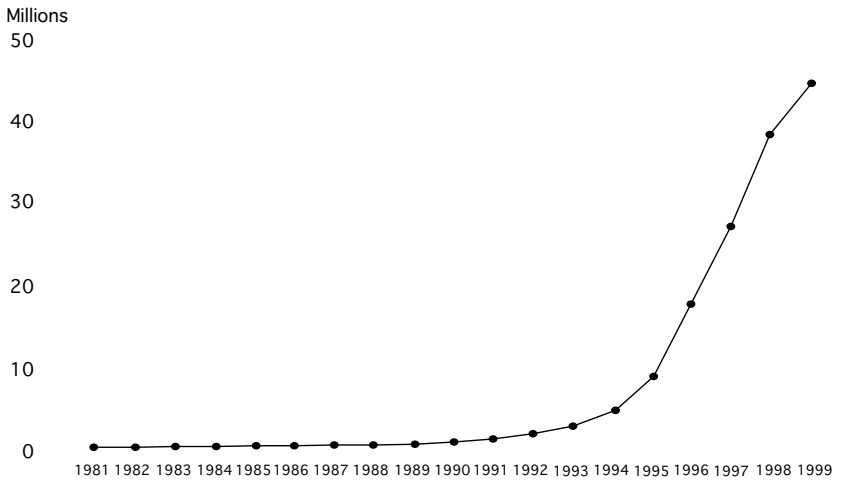


Fig. 3.3 Estimated Numbers of Internet Hosts, 1981-1999.

This increasing knowledge intensity involves both the increasing knowledge intensity of individual goods and services, and the growing importance of those goods and services in the economy.

Trade data is one area in which these changes can be observed. In both goods and services trade it is the relatively knowledge intensive exports that are growing most rapidly. World exports of high technology products grew by 15 per cent per annum between 1985 and 1995, compared to less than 10 per cent for all other goods. The knowledge intensity of world manufactured exports remained largely unchanged between 1970 and 1977, but since 1977 it has increased steadily and persistently - from an index value of 0.71 in 1977 to 1.04 in 1995 (Fig. 3.4). United States exports of data base and other information services (26.7%), engineering, architectural, construction and mining services (16.7% pa), and computer and data processing services (12.6% pa) have all exhibited much higher growth than have exports of other services, manufactures or commodities exports.

National economies are showing the benefits of these trends. In the United States the index of knowledge composition for wages is well above that for employment, and the gap between the two has increased since the early 1980s. This implies both higher wages per unit of employment in the more knowledge intensive industries over the period since 1972, and a more rapid growth in wages in knowledge intensive industries.

Note: Index of knowledge composition for countries exports is defined by weighting industry's share of total manufacturing by the average OECD R&D production ratio for industry for the period 1987-89, and dividing by the average R&D weight.

Fig. 3.4 Knowledge intensity of manufactured exports, 1970-95.

Globalisation

The other main driver of the emerging knowledge economy is the rapid globalisation of economic activities. While there have been other periods of relative openness in the world economy, the pace and extent of the current phase of globalisation is without precedent.

The global communications revolution has been accompanied by a widespread movement to economic deregulation, including:

- the reduction of tariff and non-tariff barriers on trade in both goods and services;
- the floating of currencies and deregulation of financial markets more generally;
- the reduction of barriers of foreign direct investment and other international capital flows, and of barriers to technology transfers; and
- the deregulation of product markets in many countries, particularly in terms of the reduction in the power of national monopolies in areas such as telecommunications, air transport and the finance and insurance industries.

Together these changes have led to rapid globalisation.

The recent phase of globalisation is characterised by rapid increases in the flows of foreign direct investment (FDI), capital transfers other than direct investment, trade flows of goods and services, and technology transfers. But two things stand out. First, FDI and other capital flows have grown more rapidly in recent years than have trade flows - suggesting that the current phase of globalisation is about capital movement rather than trade. Second, these flows of FDI other capital, trade, and technology are becoming are becoming increasingly inter-related.

Implications for Megacities

The key features of the current transition to the Global Knowledge Economy in terms of Megacities are:

a. The growth of global telecommunications and fast transport networks;
b. The convergence of previously-separate information and communication technologies, including the Internet.
c. Their further linking with transport and land use.
d. The shift to information and knowledge as a resource base for new industries.
e. The strengthening of the role of Megacities as economic entities, network nodes, and centers for generating, exchanging and processing information.
f. The growth of informational services, particularly finance and business services, and e-commerce.
g. The competition among Megacities for these new key elements of the urban economy.

The Megacities which will survive the best will be those which learn to create globally competitive, knowledge-intensive industrial and service activities and base their work on the local capacity for learning innovation and change. Table 3.2 contrasts the elements of a mass production economy with those of a knowledge economy; these elements are reflected in Megacities of such economies.

Table 3.2 Elements of Mass Production and Learning Economies

	Mass Production	Learning
Basis of competitiveness	- Comparative advantage based on natural resources - Physical labour	- Sustainable advantage based on knowledge creation - Continuous improvement
Production system	- Mass production - Physical labour as source of value - Separation of innovation and production	- Knowledge-based production - Continuous creation - Knowledge as source of value - Synthesis of innovation and production
Human infrastructure	- Low-skill, low-cost labour - Maximising worker efficiency and productivity - Fixed education and training - Skilled elite	- Knowledge workers - Continuous improvement of human resources - Continuous education and training
Physical / communication infrastructure	- Domestically oriented	- Globally oriented - Electronic data exchange
Industrial Governance system	- Adversarial relationships - Command and control regulatory framework	- Mutually dependent relationships - Network organisation - Flexible regulatory framework

Source: adapted from Richard Florida *Learning Regions* Futures Vol 27, No.5

The commonly held notion that a knowledge economy is a services economy is dangerously misleading. As information and knowledge add value to basic products, manufacturing and services are becoming increasingly integrated into complex chains of creation, production and distribution. At the core of the economy are goods-producing industries, linked into value chains which see inputs coming from knowledge-based business services and goods-related construction and energy industries, and outputs going to goods-related distribution service industries. Megacities are likely to remain major centers of manufacturing but with a different character to the past.

3.2.3 Climate Change[5,6]

Clearly the increasing world population places increasing demands on supply of non-renewable resources, such as coal, gas and minerals, on water supplies and land usage for food supplies, on forests for timber supplies for fuel and housing and on the atmosphere and oceans as dumping grounds for waste products. In

particular, research over the past two decades has reinforced the view that one of the most challenging issues for human society is that of human-induced climate change due to the so-called 'enhanced greenhouse effect' associated with changes in the composition of the atmosphere.

A simplified explanation of the greenhouse effect is as follows (Fig. 3.5). Shortwave solar radiation can pass relatively unimpeded through the clear atmosphere around the Earth. However, long wave terrestrial radiation emitted by the warm surface of the Earth is partially absorbed and then re-emitted by a number of trace gases in the cooler atmosphere above. Since, on average, the outgoing long-wave radiation balances the incoming solar radiation, both the atmosphere and the surface are warmer than they would be without the greenhouse gases.

The greenhouse effect is an entirely real and natural process for keeping the Earth warmer (about 33 degrees C) than would otherwise be the case if the natural greenhouse gases such as water vapour, carbon dioxide and methane were not present. The concern is that the relatively stable balance of these in the atmosphere is being changed as the result of the influences of humankind.

Direct measurements of the composition of the Earth's atmosphere have only been made since 1957 but it is possible to go back much further in time by analysing air bubbles trapped in the Antarctic cap. The data show that for a thousand years prior to the Industrial Revolution, abundances of greenhouse gases such as carbon dioxide and methane were relatively constant. However, as the world's

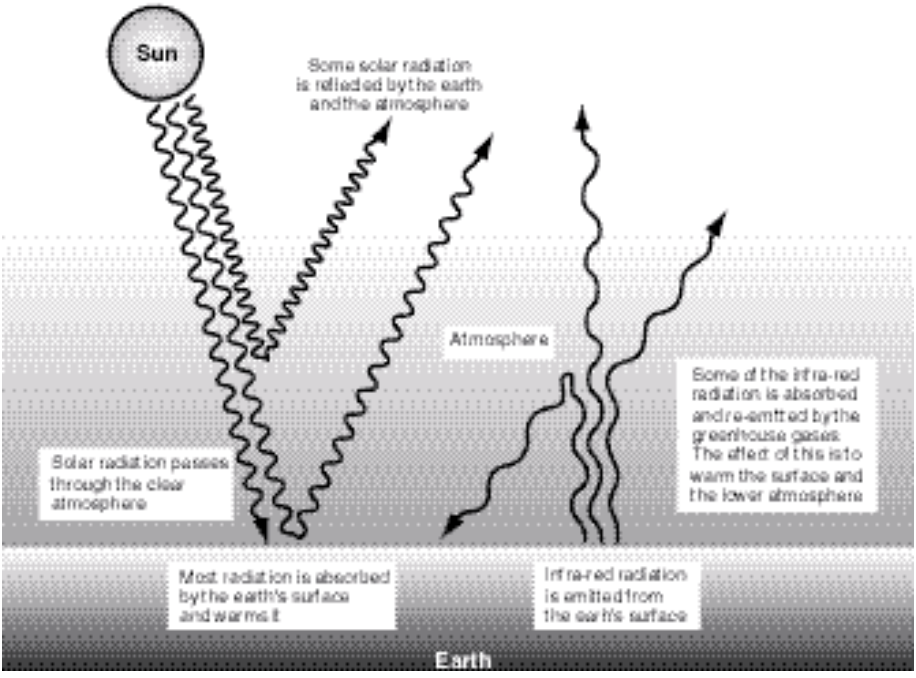
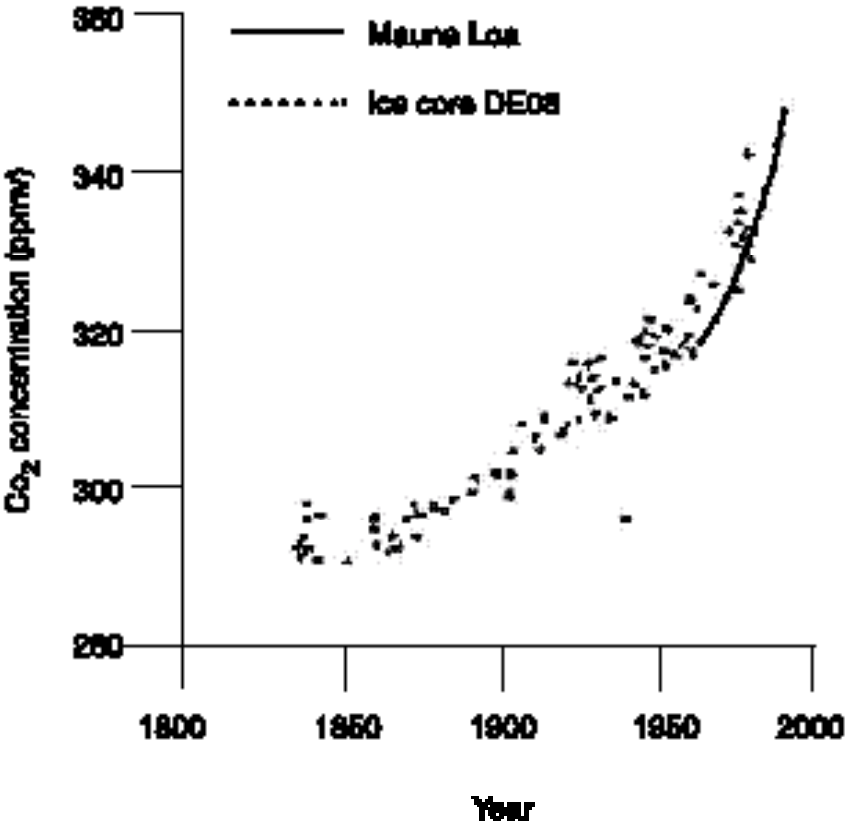


Fig. 3.5 A scheme of the greenhouse effect.

population increased, as the world become more industrialised and as agriculture developed, the abundances of these gases increased markedly (Fig. 3.6 and 3.7). By increasing the concentrations of these naturally occurring greenhouse gases and by adding new greenhouse gases such as nitrous oxides and chlorofluorocarbons, humankind appears capable of raising the global average annual-mean surface-air temperature through an enhanced greenhouse effect. In fact, the latest report of the Intergovernmental Panel on Climate Change (IPCC) asserts that 'man-made gases have contributed substantially to the observed warming over the past 50 years'.

The greenhouse gases now in the Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide and the chlorofluorocarbons. Water vapour is the most important greenhouse gas, responsible for about 75% of the natural

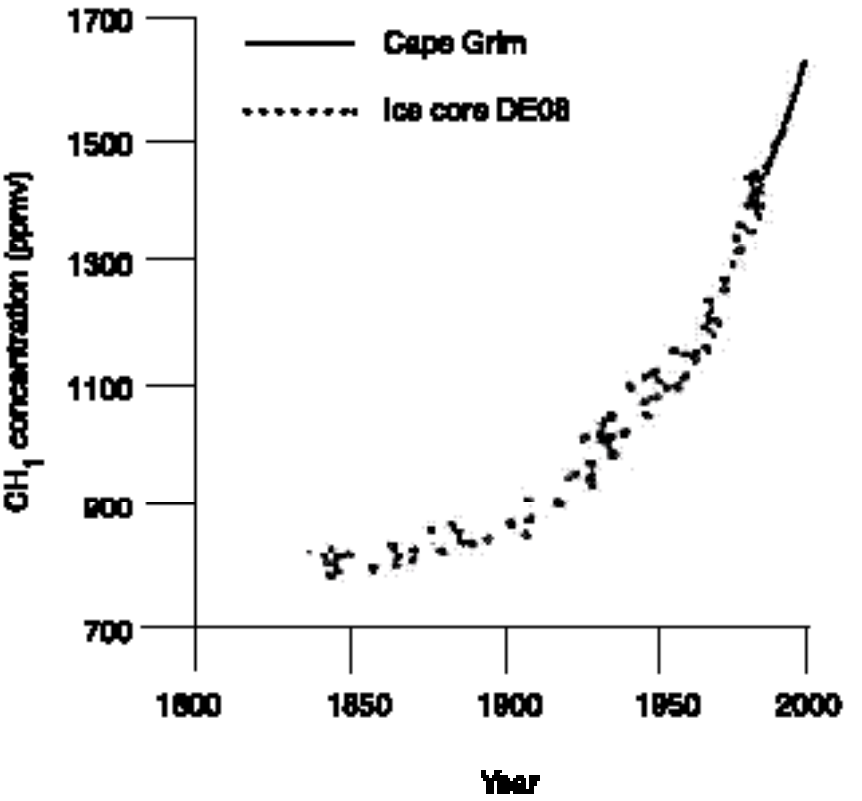


Atmospheric concentration of carbon dioxide as measured in air trapped in the Antarctic ice core DE08 and compared with modera atmospheric measurements made at Mauna Loa in Hawaii.

Source: National Greenhouse Advisory Committee, AUSTRALIA (1992).

Fig. 3.6 Atmospheric concentrations of carbon dioxide.

greenhouse effect. Unlike most of the other greenhouse gases, the amount of water vapour directly put into the atmosphere as a result of human activities is negligible compared with the atmospheric water vapour present naturally. For this reason, there are no opportunities for directly controlling the amount of water vapour in the atmosphere. Carbon dioxide is mostly released into the atmosphere as a result of burning fossil fuels such as oil, coal and gas and also as a result of burning plant material resulting from deforestation. It is the most important contributor to the enhanced greenhouse effect. Large amounts of carbon dioxide are removed from the atmosphere by plants and by the oceans. Methane is released into the atmosphere from a number of sources: gas drilling, venting and transmission; coal mining; landfills and annual wastes; natural marshes and swamps; rice paddies; the burning



Atmospheric concentration of methane as measured in air trapped in the Antarctic ice core DE08 and compared with modem atmospheric measurements made at Cape Grim in Tasmania.

Source: National Greenhouse Advisory Committee, AUSTRALIA (1992).

Fig. 3.7 Atmospheric concentrations of methane.

of vegetation and through digestive processes of ruminants and termites. Between 40 and 70% of the methane released globally is due to human activity. Nitrous oxide is released into the atmosphere from exhaust emissions of vehicles and from nitrogen fertilisers and nitrogen-fixing plants used in agriculture. Chloro-fluorocarbons (CFCs) are part of a larger family of compounds known as halocarbons and those containing chlorine and bromine are of primary concern. They are completely the result of human invention and were not present in the atmosphere until the 1930s. They are released from aerosol sprays, foamed plastics, refrigerant fluids, etc. Although their concentrations are small, they are potent greenhouse gases and contribute to enhancement.

Changes to the composition of the atmosphere are global in scale and it is impossible to build a physical scale-model of the atmosphere. The best tools for investigating aspects of climate and greenhouse gases are Global Climate Models which are computer programs based on mathematical equations derived from physical laws. A variety of these have been developed with different assumptions being made about the roles of the atmosphere and of the oceans. They are capable of reproducing a range of aspects of the variability of present day climate but have limitations in their resolution which is on the scale of several hundred kilometres.

Assuming that a reasonable representation of present day climate can be given by global climate models, it is then possible to simulate the climate under conditions of increased greenhouse gases and to examine possible changes in climate resulting from such increases. To estimate the size of these emissions, it is necessary to construct scenarios of population growth and of economic activity. A 'Business as Usual' scenario i.e. continual growth with little or no control suggests that carbon dioxide concentrations in the atmosphere will be about 550 parts per million (ppm) by 2050 and about 820 ppm by 2100 (i.e. roughly 3 times the present figure).

While there are variations between the models, the results generally estimate future warming rates of 0.3 degrees C per decade (range 0.2 to 0.5 degrees C/decade) over the next century for a 'Business as Usual' scenario. This means an increase of roughly 1.0 to 2.5 degrees C by 2050 in the average global surface-air temperature (the latest IPCC report estimates a range of 1.5 to 6.0 degrees C by 2100). Such an increase would not be uniform with surface-air temperatures increasing more over land than over the oceans and the poles becoming warmer than the equatorial regions. It is important to stress that this rate of change of temperature would be faster than anything experienced over the last 5000 years, at least. This has implications for health problems in Megacities due to pollution and heat stress.

Such an increase in global surface-air temperature has implications in terms of changes in rainfall patterns and in sea level. Thus the models for the enhanced greenhouse effect predict that precipitation will increase on average at high latitudes, in the monsoon region of Asia and in the winter in mid-latitudes. Further, over some mid-latitude continental areas, values of soil moisture will be

lower on average in summer. This has implications for food and water supplies to Megacities.

In the case of sea level, there will be a rise resulting from two causes. The first is that a warmer atmosphere will result in warmer oceans and a component of sea level rise will result from thermal expansion of the oceans. A second component will be due to extra water added to the oceans from the melting of mountain glaciers and snow from mid-latitudes. Some of the potential rise in sea level will be offset because more snow is likely to accumulate over Antarctica and the Arctic. The best estimate (under the 'Business as Usual' scenario) is for global average sea level to increase by 30 cm from the 1990 level by 2050 (the latest IPCC report estimates a range of 14 to 80cm by 2100). This has implications for inundation and damage to Megacities on the coast.

3.2.4 Availability of Water[1, 7, 8]

The Discussion Paper for the study on Water Supply and Management (see Chapter 5) covered a wide range of issues related to water but did not elaborate on water and its role in food production. The issue of availability of water is a major driver for change in considering the future of Megacities.

Only a small fraction of global water resources is consumable by humankind: approximately 97% is considered saline; 2.25% is trapped in glaciers and mountain ice caps; 0.72% is stored in freshwater aquifers; and only 0.03% is found in streams and freshwater lakes. Most of the freshwater (69%) is used for agricultural production, another 23% for industries and the remaining 8% for domestic purposes.

Global evaporation and precipitation are in balance, confirming that water is a finite resource. This is evident from Table 3.3.

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 fresh water 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

Table 3.3 Global Water Balance

	Area (Million km^2)	Evaporation (mm)	Run-off (mm)	Precipitation (mm)
Land	134.8	480	320	800
Ocean	361.3	1400	130	1270

that even these countries can be subject to severe limitations of rainfall. At the other extreme, countries such as the U.S.A. (western region), China (northwest), Chinese Taipei, Hong Kong and Australia (all except southeast), have normally very low rainfall, and hence have to concentrate on the effective use of the limited available resource. Climate change due to the enhanced greenhouse effect (see Chapter 3.2.3) may further accentuate these variations.

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 twenty-five 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. In a number of countries, excessive extraction of groundwater has led to subsidence.

The uneven distribution of water resources has already led to 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; none of these have Megacities in them but increased urbanisation and population growth is a potential threat to water availability per capita in some APEC Megacities.

In a recent study, it was estimated that nearly 1.4 billion people live in regions that will experience severe water scarcity within the first quarter of the next century. This amounts to a quarter of the world's population or a third of the population of developing countries.

Slightly more than one billion people live in regions that will face absolute water scarcity by 2025. Even at high levels of irrigation efficiency, by 2025 these regions will not have sufficient water resources to maintain 1990 levels of per capita food production from irrigated agriculture and still meet reasonable water needs for domestic, industrial and environmental purposes. People in these regions will therefore have to reduce water use in agriculture and transfer it to other sectors, meaning that less food will be produced locally and more will be imported.

An additional 350 million people face severe economic water scarcity. They live in regions where the potential water resources are sufficient to meet reasonable water needs by 2025 only if massive water development projects are embarked on at enormous cost and with the possibility of causing severe environmental damage.

Currently, global food supplies are made up of 77.5% agricultural, 16% livestock, 6.6% fisheries products. Population growth is expected to increase the

demand for cereal by 1.27%. At present, irrigated agriculture produces 40% of all food, and consumes 69% of all freshwater resources.

During the next 25 years, urban population is expected to increase significantly. In 1990, 43% of the global population were in urban areas; this is expected to increase to 61% in 2025. The food consumption pattern of the urban population with higher income will shift from predominately cereal to animal products. This will increase the demand for domestic water supplies, and reduce water available for irrigated agriculture.

Over the next 40 years, as much additional food will need to be produced as humankind has produced since agriculture began. This can be achieved by increasing one or more of the following:

- area under agriculture;
- productivity per unit area; and
- productivity per unit of water.

The area available for productive agriculture is decreasing in many countries due to urbanisation and increase of infrastructure such as roads and railways. Further, in many cases, water available for agriculture will decrease as water is reallocated for industrial and urban sectors where its value is generally much greater.

Thus an important means of achieving increased productivity will be to get more from the amount of water that is beneficially depleted by agriculture. This can be achieved in a number of ways:

- Changing crop varieties by the gene revolution (see Chapter 3.2.4). Plant breeding plays an important role in developing varieties that yield more mass per unit transpiration. Keeping transpiration constant, more mass can be obtained, resulting in increased water productivity. Alternatively, for the same mass of production, transpiration can be reduced, yielding water that can be made available for other uses.
- Crop substitution. People can switch to a crop that consumes less water, or one with a higher economic or physical productivity per unit of water consumed by transpiration.
- Deficit, supplemental or precision irrigation. With sufficient water control, it is possible to achieve more productivity per unit of water by irrigation strategies such as;
    - reducing evaporation from water applied to irrigated fields through special irrigation technologies like drip irrigation, through agronomic practices such as mulching, or by changing the planting date to match with periods of less evaporative demand; and

- reducing evaporation by controlling evaporation from fallow land, decreasing areas of free water surface, and controlling weeds.

3.2.5 Production of Food and the Role of Technology[9,10]

The previous section raised a number of factors which impact on future food supplies and thus the sustainability of Megacities, as:

- Increasing population will lead to increased demand for food and reduced per capita availability of arable land and irrigated water.
- Improved purchasing power and increased urbanisation will result in a higher consumption of animal products, leading to increased per capita grain requirements.
- Marine fish production is tending to become stagnant and coastal aquaculture is facing environmental problems.
- The potential adverse impacts of climate change noted in Chapter 3.2.3.

The so-called 'Green Revolution' has so far helped to keep the rate of growth in food production above population growth rate but new technologies are needed to maintain this situation. Three major revolutions in science and technology are underway that will influence agriculture and industry in a fundamental manner in this century.

- The gene revolution - this provides a molecular understanding of the genetic basis of living organisms and the ability to use this understanding to develop new processes and products for agriculture, industry, the environment, and human and animal health.
- The ecotechnology revolution - this promotes the blending of the best in traditional knowledge and technology with frontier technologies such as biotechnology, space and information technologies, renewable energy and new materials.
- The information and communication revolution - this allows a very rapid growth in the systematic assimilation and dissemination of relevant and timely information, as well as a dramatically improved ability to access knowledge and communicate through low-cost electronic networks (see Chapter 3.2.2).

In principle, these three types of advances, when coupled with improvements in management and governance, greatly increase the power of a scientific approach to genetic improvement, management of natural resources and ecosystems, and local and regional development strategies.

The gene revolution

The past 10 years have seen dramatic advances in our understanding of how biological organisms function at the molecular level, as well as in our ability to analyse, understand and manipulate DNA molecules - the biological material from which all genes are made. The process has been accelerated by the Human Genome Project, which has poured substantial resources into the development of new technologies for working with human genes. These technologies, directly applicable to all organisms, have given rise to the scientific discipline of genomics, which has contributed to powerful new approaches in agriculture and medicine and helped to promote the biotechnology industry.

The key technological developments in this area are:

- genomics - the molecular characterisation of species;
- bioinformatics - data banks and data processing for genomic analysis;
- transformation - introduction of individual genes conferring potentially useful traits on plants, trees, livestock and fish species;
- molecular breeding - identification and evaluation of useful traits by use of marker assisted selection which greatly speeds up traditional breeding processes;
- diagnostics - identification of pathogens by molecular characterisation; and
- vaccine technology - use of modern immunology to develop recombinant DNA vaccines for improved control of lethal diseases of animals and fish.

Biotechnology will play an increasingly important role in strengthening food, water and health security systems. The need for more effective and transparent mechanisms to assess the benefits and risks associated withe transgenic plants and animals is highlighted by recent widespread public concern over genetically modified (GM) food. There are also concerns about the potential adverse impact of genetically modified organisms (GMOs) on human health, biodiversity and the environment. Some of these concerns are genuine. In order to take advantage of recombinant DNA technologies without associated harm to human or ecological health, it is important that every country has in place suitable institutional structures and regulations for biosafety, bioethics and biosurveillance.

The ecotechnology revolution

There is much to learn from the past in terms of the ecological and social sustainability of technologies. At the same time, new developments have opened up new opportunities for developing technologies which can lead to higher productivity without adverse impact on the natural resources base. Blending traditional and frontier technologies leads to the birth of ecotechnologies with

combined strengths in economics, ecology, social and gender equity, employment generation and energy conservation. For example, in the area of water harvesting and sustainable use, there are many lessons to be learnt from the Australian experience.

There is a need to conserve traditional wisdom and practices, which are often tending to become extinct. The decision of the World Intellectual Property Organisation to explore property needs, rights and expectations of holders of traditional knowledge, innovations and culture is hence an important step in widening the concept of intellectual property. The Food and Agriculture Organisation has been a pioneer in the recognition of the contribution of farm families in genetic resource conservation and enhancement by promoting the concept of farmer's rights.

The information technology revolution

New communication and computing technologies have significant implications for food production.

- As noted in Chapter 3.2.2, access to the Internet will soon be universal, providing unrestricted low-cost access to information, as well as highly interactive distance learning. This will not only facilitate interactions among agricultural researchers, but also greatly improve their ability to communicate effectively with farmers, the potential users of research knowledge.
- Computing makes it possible to process large-capacity data-bases, such as those for libraries, remote sensing, GIS and gene banks, and to construct simulation models. These have potential applications in ecosystem modelling and preparation of contingency plans to suit different weather probabilities and market variables.
- The software industry is continuously providing new tools that increase research productivity and create new opportunities for understanding complex agro-ecosystems.
- Remote sensing and other space satellite outputs are providing detailed geographic information useful for management of land and natural resources. Emerging farming technologies will be based on precision farming methods leading to plant-scale rather than field-scale husbandry. Farming will be knowledge intensive, using information from remote sensing, geographical information systems (GIS), global positioning systems (GPS), and information and computer technologies. Farmers in industrialised countries are already using satellite imagery and GPS for early detection of diseases and pests, and to target the application of pesticides, fertiliser and water to those parts of their fields that need them urgently. GIS is an effective tool for solving complex planning,

management and priority setting problems. Similarly, remote-sensing technology can be mobilised in programs designed to ensure drinking water security.

3.2.6 Availability of Energy[1, 11]

Since the Industrial Revolution, the availability of energy has been a major driver of change, particularly for cities. The growth of Megacities would not have been possible without the availability of electricity and gas for power, heating and lighting and of liquid fuels for transport of goods and people.

As the population increases and the aspirations of that population increases, the demand for energy rises inexorably. Some developments such as communications, increased environmental awareness and the Internet are perhaps slowing that growth but population growth, increased living standards, global markets and travel keep driving it. World energy demand grows at such a rate that it doubles every 33 years but in Asia the rate is much faster. The major growth in demand is in the developing economies of APEC in Asia and some Latin American countries and it is clear that fossil fuels, namely coal and gas, will continue to be the major energy source for power production against the background of the recognition of the need to limit emission of greenhouse gases.

A study of the Asia-Pacific region shows how important coal is to the economic development in the region. Only 4 per cent of the world's oil reserves and 6 per cent of the world's natural gas reserves are found in the region. While the region contains 3 per cent of the world's reserves of anthracite and bituminous coal, these are concentrated in China (83 per cent of regional total) and Australia (16 per cent of regional total). About 52 per cent of the coal consumed in the Asia-Pacific region is imported with Australia as the major coal supplier and a stable source of supply for the future. However continued use of coal will depend on improved combustion technologies and the development of new technologies for carbon dioxide capture and sequestration. Proven reserves are sufficient for hundreds of years.

Natural gas is less potent as a producer of greenhouse gases on combustion and is a more flexible power source, particularly for smaller units using gas turbines and for supplying peak load demands for electricity. Increasingly, natural gas is seen as the supplemental energy source to coal. Proven reserves are sufficient for several hundred years but, in time, natural gas may be seen as a valuable source of petrochemicals rather than simply as an energy source.

Other sources for electricity production (with negligible greenhouse gas emissions) are hydropower and nuclear power. While some large scale hydropower schemes are still being built e.g. the Three Gorges project in China, the potential sources are limited in most economies. Nuclear power is a proven technology which provides a large part of the electricity in the world. Several APEC

economies in Asia generate a significant component of their electricity with this technology e.g. Korea 36 per cent, Chinese Taipei 32 per cent, Japan 31 per cent (planned for 40 per cent in 2010). China, although small at present (several per cent) is planning a major expansion by 2020.

Renewable energy sources such as solar energy using photovoltaic cells for electricity production, or solar thermal systems for heating are being actively pursued in many APEC economies. Other promising options are wind energy (significant in Europe and U.S.A.) and biomass conversion (although lack of arable land may prevent its expansion). At present these only provide a small proportion of electricity generation but cost reductions due to increased production and improved technology may increase this in the future e.g. Germany is planning to produce 10 per cent of its electricity from renewables by 2035. Given the rate of energy growth in the Megacities of developing APEC economies, renewables are unlikely to contribute much, except in rural areas.

Liquid fuels for transport are a different story. Proven reserves are limited to less than a hundred years and most are located in politically volatile areas of the world, in particular the Middle East. The pattern of demand is however similar to that for power production.

Thus, over the past 10 years, the average annual world growth in consumption of petroleum was 1.3 per cent compared to 4.4 per cent for the Asia-Pacific region. Within that region, there were significant variations e.g. Korea 9.7 per cent, Thailand 7.5 per cent, China 6.8 per cent and Indonesia 5 per cent reflecting the rapid growth in vehicles in this period, particularly in the Megacities of these economies. By contrast Japan only grew at 1.2 per cent. reflecting the changing demography and perceived saturation of demand for vehicles. The long term growth of transport and its impact on the future of Megacities depends critically on the continued availability and cost of supplies. Recent events indicate how shifts in these can drastically alter this pattern.

3.3 Uncertainties or 'Wildcards'

There is no certainty in planning. There are of course, certain developments that could occur, that are not included in the scenarios. Some of these represent transformational changes. If they come about they will have enormous impacts on all scenarios.

These changes or 'discontinuities' are sometimes called 'wildcards'. They include developments such as breakthroughs in transport or energy technologies, global wars or epidemics, or a wildly changed political or social environment,

Breakthroughs in transport or fuel technologies could have a revolutionary impact on sustainable transport. Likewise a modern 'Black Plague' like that which wiped out half the population of Europe in the 13th century would drastically alter the future of Megacities, as would other major global calamities.

In creating scenarios a decision has to be made on whether to base scenarios on these more speculative wildcards. To do so makes the scenarios less plausible and means that people may not engage as effectively in the process of envisioning the future. Also, to incorporate some of the more dramatic wildcards into the scenarios may distract from the understanding to be gained regarding the impact over time of the principal drivers, which form the heart of the scenario logic. People may spend more time debating whether such things as world plague, flying cars or extraterrestials are possible, rather than examining how other key drivers could impact on the future. If scenarios are based on drivers that are regarded as implausible, then the tendency is for people to reject the whole scenario.

Nonetheless, certain wildcards could have a huge impact on the future of Megacities. For that reason, they need to be monitored and periodic consideration given to whether or not the scenarios developed in the studies require modification in light of underlying developments affecting the wildcards.

Some examples of wildcards that emerged in the APEC Center studies are:

Epidemics
- World-wide plague/influenza
- Ebola-type fever/something more virulent than AIDS

War
- Nuclear/biological/electronic
- Middle East War cutting off oil supplies

Refugees/migration shock
- Displaced millions from Asia, Africa, India, South America

Natural disasters
- Catastrophic earthquake(s), tidal waves, cyclones
- Large meteorite strike

Systems failures
- Computer virus
- Solar flares

Political
- Regional Governments take over from Nation States
- The emergence of a World government in response to inability of independent government to manage their nations

X-Files
- UFOs arrive
- Search for Extra-Terrestrial Intelligence succeeds

People's Values Change
- Most people stop working for money
- Reaction against Western materialism

3.4 References

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The Delphi Approach to Foresight

The Delphi Survey technique allows groups of experts to be consulted on a range of possible future developments in 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 e.g., average realisation time, importance. 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, Direcror, 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 assisted with analysis of the results of the studies on Water Supply and Management and Technology for Learning and Culture.

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 in 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 APEC studies represent the first attempts at a truly multi-national Delphi Survey.

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.

Thus, in formulating Delphi questionnaires, the APEC Center used the concept of innovation stages as:

- Elucidation - the earliest stage. Scientists have discovered the principles or ideas in and 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 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 half of the member economies.

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 development approach specifically addressed the issue of change (see Chapter 3), the APEC Center decided that the topics arising from the scenarios would cover most of the concerns about incorporating change in the period of the Delphi Surveys and thus the instructions to the respondents were maintained in the same form as the Japanese and Korean surveys.

SECTION II - SPECIFIC STUDIES

Water Supply and Management

5.1 The Foresight Approach Used in the Water Supply and Management Study[1]

This was the first study carried out by the APEC Center and it was decided to gain experience in multi-economy Foresight by using the scenario development technique to involve a limited number of experts and then use the Delphi technique to involve a larger number of people.

5.2 Scenario Development

The steps were:-

a. Preparation of a Discussion Paper in early 1998 by a consultant from the Australian Centre for Innovation and Industrial Competitiveness at the University of Sydney in Australia. This Paper covered three main areas:
   - Water challenges for the future e.g. availability of water for food production, increased access to drinking water supply and sanitation, water as an economic resource, building infrastructure, access to data.
   - Key issues - twelve issues were identified.

- Policy options - some policy options for countries facing different problems of income distribution and different degrees of water stress were set out.

b. The Discussion Paper was distributed to a number of experts in the APEC region and an Experts Meeting with 10 participants from 9 economies was held in Hua Hin in Thailand in May, 1998 to critique the Paper, to present economy experiences and to develop scenarios. The Meeting identified key drivers and, speculated on possible, even improbable, events which could alter the future. Based on these inputs, the Experts created three scenarios for 2010. These are given in detail in Vol. 2 of the APEC Center report (1) but a brief summary is as follows:

In '**Danger! Water Ahead**' a pessimistic future was characterised by a water- borne disease epidemic, a consequent dramatic increase in the price of water, and the outbreak of conflict between nation states over to access to water. Governments and international bodies were paralysed, and world trade was substantially diminished, leading to a much higher recognition of the central role of water in economic and political, as well as human survival, matters.

In '**Water Rules**' APEC member economies agreed on mutual binding regulations for water quality and trade, and established integrated water management as accepted practice. As a consequence, by 2010 the APEC economies enjoyed a substantial advantage in economic performance and water quality. Important new underpinning technologies were electronic access to models and databases on the total water cycle, satellite monitoring of water use, and improved transport and storage systems.

In '**APEC Turns on the Tap**' devastating impact of a prolonged 'El Nino' event catalysed the introduction across APEC member economies of a series of appropriate emergency short-term measures including highly controlled irrigation, domestic water saving through redesigned plumbing, mandatory use of recycled water by industry and setting of market prices for water. However, the major advances resulted from an APEC investment in longer term R & D which established the basis for economically competitive desalination plants, linked to the genetic design of salt-resistant, low water use crops.

c. The Meeting debated the key issues set out in the Discussion Paper and in the light of the scenarios, expanded these to a list of 14 key issues which are set out in Table 5.1.

Table 5.1 Key Issues in Water Supply and Management Identified at the Experts Meeting (in no priority order)

1. Water supply
2. Water demand
3. Water quality
4. Current and new water technologies
5. Water in economic development
6. Application of market forces to the supply and management of water
7. Water and the environment
8. Water and human health
9. Water resource assessment
10. Integrated water resource management
11. Geopolitics and international laws for water
12. Infrastructure and structural safety
13. Water use and management enforcement
14. Energy costs

5.3 The Delphi Survey

The steps were:

a. Preliminary identification of 28 topics by the Experts at Hua Hin followed by discussion and interaction among other water experts and experts in Delphi surveys in Japan and Korea produced a list of 58 topics covering: Water as a Resource, Technologies, Policy Issues. The details of these are set out in Vol. 2 of the APEC Center report.[1]

b. Preparation of a questionnaire for Round 1 of the Delphi survey. This sought opinions on: degree of expertise of the respondent in each area, degree of importance, year of realisation in APEC region, year of realisation in your economy. 605 nominated experts were contacted with a response rate of 18.8%.

c. The data were analysed and the results were sent to the respondents of Round 1 to review their responses in the light of these results. 59% of these responded in Round 2. Full details are given in Vol. 2 of the APEC Center Report.[1]

Table 5.2 Key Delphi Results.

Topic	High Importance %	Mean Year of Realisation APEC Region	High Need for Cooperation %
Scientific methods for flood forecasting, warning and management to protect important areas at high risk in practical use.	88.2	2005	38.6
Technology to detect/locate leaks of over 10% from the distribution system developed.	87.9	2005	43.6
90% of people have easy access to safe water for domestic use.	87.5	2008	40.0
'User pay' and 'Polluters Pay' policies are enforced.	85.7	2004	33.3
Pricing system that encourages water users to recognise water as a finite and valuable resource in operation.	82.9	2007	26.4
Water pricing systems used to control demand.	82.9	2007	23.1
Nationally coordinated approach to water supply and management implemented.	79.4	2005	30.9
Systems for monitoring water source contamination in widespread use.	79.4	2007	37.0
70% of water used in industry recycled for further use.	75.8	2009	33.3
Accurate rain and precipitation water-balance forecast, aiming at effective utilisation of rainfall in widespread use.	74.3	2007	48.3
Integrated water resource management plan linked with other natural and human features implemented for every major river basin.	74.3	2009	30.9
Nationally determined priorities of water usage/sharing among the sectors (domestic, industrial and agricultural) enforced.	73.5	2006	22.6
Irrigation systems exceed 75% efficiency.	72.7	2008	30.9
International standards for dam safety are enforced.	72.2	2005	48.1
50% of natural run-off is captured and stored for use.	68.8	2010	25.0
Rainfall prediction accurate enough to allow effective flood control using dams in widesprread use.	67.6	2006	42.1
Water information (quality, quantity, usage) readily available to the public	67.6	2006	29.1

Table 5.2 lists the seventeen topics, in descending order, from the 64 surveyed, that more than two-thirds of respondents (in the second round) considered to have a high degree of importance - presumably the most important changes needed or possible in APEC water supply and management systems. They constitute an interesting, and rather mixed, set of issues.

Eight of them fall into the category of policy, regulation or management issues (e.g. user pays, pricing systems, nationally coordinated approaches). It would appear that the most significant changes are needed at this level. Five topics describe a level of performance of the water system (e.g. 70% of water used in industry is recycled, irrigation systems exceed 75% efficiency). Obviously achieving this level of performance would require advances in both technology and management practice. Just four topics are substantial advances in science and technology (e.g. scientific methods for flood forecasting, technology to detect and locate leaks.).

The mean year of expected realisation within the APEC region for each of these topics is bunched tightly in a six-year time span between 2005 and 2010. The policy, regulation and management issues and the science and technology events average realisation in 2006, whereas the system performance events are not achieved, on average, until 2008. Perhaps this last category is seen as requiring the uniting of a greater range of forces. It is important to note that none of these important issues were seen as not being achievable within a reasonably immediate time frame of ten years; they are all seen as practically achievable.

The level of cooperation required within APEC to achieve these outcomes was much lower than the rating of importance. Among these 17 'high importance' events, the average proportion of respondents who rated cooperation within APEC as being of high importance to their realisation was only 34.3% - just over a third. The level of cooperation was lowest for policy and regulation issues - 30.6%, which are viewed as more a national matter, than system performance issues - 33.2% and science and technology issues - 43.2%. The traditional role of cooperation in achieving scientific and technological targets is evident. The highest level of cooperation was necessary in achieving accurate rain and precipitation forecasts, and in international standards for dam safety.

Relatively few topics were seen as of little importance. Only two had a rating of high importance by less than 10% of respondents in the second round - techniques to transport icebergs cost-effectively, and water containers for large-scale long distance transport across oceans in practical use.

5. 4 Conclusion

This, and many other reports, point to the need for a new paradigm in water supply and management. The approaches developed largely in the nineteenth century in Europe and the U.S., and significantly refined during the twentieth century, do not appear adequate to address the huge challenges that have been identified for

overall availability of water (see Chapter 3.2.4) and particularly for the growing Megacities of Asia. While there is substantial room, and need for, continuing incremental improvements, they alone will not be sufficient. Rather, approaches based on the recognition of water as a precious and valuable resource, which needs to be used economically and socially to maximum advantage, and hence requiring the adoption and acceptance of demand, and integrated water resource management.

Both the scenario analysis and the Delphi survey identify political action, effective policies and regulation, and appropriate management as the key to effective response to the challenges to water supply and management in the twenty-first century. Thus, 85% of Delphi respondents regarded as of medium-to-high importance that water would be an important issue in national elections by 2006.

A substantial range of S & T issues were raised as playing an important role in addressing the future of water supply and management. The technologies which were identified at the Experts Meeting as being most significant were:

- Information technology
- Membrane filtration
- Lining materials for storage, distribution and irrigation
- Groundwater recharge techniques
- Trenchless technologies
- Ultrasonics for leak detection
- Water barges, to supply sites near rivers (being developed in China)
- Mini-management systems e.g. to recycle water in one apartment block

In some contrast, the most important technological needs that were identified by the Delphi survey were:

- Flood forecasting
- Leak detection
- Rain and precipitation forecast
- GPS (Global Positioning System) and GIS (Geographic Information System) to assist water resource management
- Effective animal waste treatment
- Water- use reducing technologies
- Remote water quality monitoring stations
- Technology to determine the structural strength and surface conditions of pipelines in situ

This could suggest there would be considerable value in an APEC-based process that provides an actively managed database of research and technology development relevant to the very wide range of issues emerging to challenge water supply and management. Moreover, a series of fora between experts in various aspects of water systems could assess the most appropriate technological approaches to addressing some of the needs identified in thus study.

5.5 References

1. APEC Center 1998 *"Water Supply and Management in the APEC Region"*, Vol. 1 Summary Report, Vol. 2 The Supporting Material, APEC Center for Technology Foresight, Bangkok.

Technology for Learning and Culture

6.1 The Foresight Approach Used in the Technology for Learning and Culture Study[1]

In the second study carried out by the APEC Center, it was decided to try again the combination of scenario development and Delphi techniques to gain further experience in multi-economy Foresight studies. The Water Supply and Management Study had revealed a number of challenges that were addressed in this second study. These included:

- Familiarisation of the participants with the process and anticipated outcomes of Foresight;
- Establishment of the necessary legitimacy and credibility for the project and its findings;
- The commitment of national experts to a project whose genesis lies outside their own systems, structures, and communities;
- The use of English as the only language of the project;
- Determination of an 'APEC perspective'; and
- Transformation of generic findings into country-specific outcomes.

6.2 Scenario Development

The steps were:

a. Preparation of an Issues Paper in early 1999 by a Vice-President of the National Research Council of Canada supported by a further Discussion Paper prepared by an independent Canadian consultant. These Papers covered six main areas:

- Democratisation of access through flexible, universal service infrastructures linked with a commitment to equity in access;
- The need for continuing study of the impact of the information highway on economic activity, trade the workplace, the community and society at large;
- Ensuring cultural enrichment for all citizens through strong commitment to diversity of cultural and linguistic content;
- Encouraging the private sector to develop information networks and offer new information services, thereby encouraging international cooperation in developing a global information infrastructure;
- The need to improve, and exchange experience of, new developments in learning, training and skill upgrading, both in the school and higher education systems and through adult learning distance programs;
- The need to improve the understanding of social change, through initiatives that demonstrate the possibility of improving and increasing the flexibility of working conditions, opportunities for leisure-time education, urban life-styles, and the greater participation of disadvantaged in society.

b. The Issues and Discussion Papers were distributed to a number of experts and an Experts' Meeting with 37 participants from 12 economies was held in Canada in May, 1999 to critique the Papers, to present economy experiences and to develop scenarios. The Meeting identified key drivers and speculated on possible, even improbable, events which could alter the future.

Based on these inputs, the Experts created four scenarios for 2010. These are given in detail in Vol. 2 of the APEC Center report[1] but a brief summary is as follows:

Water, Water Everywhere described a situation in which a major environmental disruption had occurred as a result of a significant increase in global warming impacts, leading to substantial rises in sea-level. Under these circumstances, engineers, health workers, and teachers have the skills that are most in demand. Teachers, in particular, are seen as crucial carriers of heritage and culture, and providers of education for the new future. Their position as an elite is reinforced by the need for the community to preserve and re-capture cultural heritage. This increases the importance of the network of teachers for archiving since a functioning

material culture has been essentially destroyed. Schooling is now largely home-based, drawing from a centralised APEC education bank, accessed through wireless Internet. Common concepts and learning artefacts are shared.

Learning through Adversity dealt with a world in which global economic depression and collapse of trade and finance regulating organizations had occurred. Under these circumstances, there is a great emphasis on sustainable subsistence living and production. Children walk each day to the Community Center and look over the weekly schedule of learning activities. Knowledge transfer is largely experimental plus that taken from the books in the archives. Internet sources are difficult and expensive to access. Culture is valued in a new way. Family life seems to move at a slower pace, commercial competition has become greatly reduced, and the extended family provides a comforting social support system.

Helpless and Hopeless describes a world in which there has been a major loss of technological capacity, resulting from a huge electro-magnetic pulse from outer-space that has destroyed much computer capacity. While economies and stockmarkets collapsed, pedagogy survived. Good teachers were still good teachers, albeit having to make do with less available resources to support their work. The learning theories still prevailed. A more reflective learning environment re-emerged. There was a revamp of the curriculum so that basic literacy and the 3Rs became important again. Teaching was revived as an important profession. Community-based instruction became a trend. Libraries and museums became centers of knowledge. The scenario at tertiary institutions was less positive with the research community being very badly hit.

The Pholkes Next Door described a world that had been transformed through a dramatic increase in technological capacity resulting from an entirely new electronic chip. Under these conditions, schools that had been changing from knowledge transfer stations to higher learning centers in 2003, now took on the role of socialisation and knowledge integration centers. With the youngest children already possessing good computer skills, the most amazing potential was being seen from the best students who now spent almost no time in drudgery learning. Good pedagogy of 2001 had been transferred to the 'infinite bandwidth' net and true multi-sensory stimulation, already developing in the VR games centers of 1999, had become a learning tool.

In developed societies, all historical and cultural artefacts had been placed within electronic reach of all. Special research programs, mindful of eco-disasters, had begun to ensure that cultural heritage of the less developed world was protected at least by e-storage as those countries were encouraged by the new technology to develop to late 20th century first world economic standards.

c. The Meeting debated the points raised in the Discussion Papers and in the light of the scenarios, identified a list of 11 key issues which are set out in Table 6.1.

d. With the experience of the four scenarios, five 'actions' were identified as crucial for the future development of technology for learning and culture:

- Investment in new concept computers
- Development of wireless/satellite technology
- Capture and preservation of information
- Common international protocol and standards for learning and culture
- Investment in teachers upgrading/retraining

One interesting outcome of the scenario-based process appears to have been a recognition among participants of potential drawbacks and vulnerabilities associated with the drive to a much higher level of technology dependence in learning and cultural formation and transmission.

Table 6.1 Key Issues in Technology for Learning and Culture Identified at the Experts Meeting (in no priority order)

1. Economic aspects of learning and culture - human capital development and deployment, cost benefit assessment of new technologies and methods, human resource development, globalised competitive education industry.
2. Learning - changing theories of learning, drive towards life-long and/or continuous learning, importance of un-learning, learning models, colloboration/sharing in learning development.
3. Technology - infra-/(or info) structure, capacity, standards, bandwidth availability, means of delivery and access.
4. Access - controlled (by government or private sector) versus free availability with little of no restrictions, information rich versus information poor.
5. Culture - values, sovereignty (as opposed to domination/imperialism), ethical issues.
6. Language - of the medium and technology - mono-lingual (English) of multi-lingual, content dominance.
7. Institutions - patterns of organisation, corporisation, management.
8. Diversity - age, demography, gender.
9. Social and cultural impacts/changes.
10. IT for education - training, equipment, networking.
11. Accreditation - including consumer protection, quality control.

6.3 The Delphi Survey

a. Preliminary identification of 57 topics by the Experts at Vancouver followed by discussion and interaction among other education and communication technology experts produced a list of 51 topics covering: Technologies, Management, Contents and Learning Resources, Government Policies, Human Resource Development/

Training, and Culture. The details of these are set out in Vol. 2 of the APEC Center report.[1]

b. Preparation of a questionnaire for Round 1 of the Delphi survey. This sought opinions on: the importance of the topic, year of realisation across APEC and in their own economy, and probability of realisation. 480 nominated experts were contacted with a response rate of 28 per cent.

c. The data were analysed and the results were sent to the respondents of Round 1 to review their responses in the light of these results. per cent of these responded in Round 2. Full details are given in Vol. 2 of the APEC Center report.[1]

Table 6.2 presents the key results for the 25 per cent of topic statements, (in order of descending importance) that were rated as of the highest importance. Based on the responses, almost two-thirds, or more, of respondents identified these topics as of high importance.

Of these thirteen topics, four were in the category of technology. The predominant theme is the widespread availability, cheapness, and easy use of information and communication technologies. The ease of use is facilitated by user-friendly interfaces and knowledge management systems. The only other specific technology rated highly was global wireless networks supporting global communications at a thousand times current speeds.

Four of the highly important topics dealt with contents and learning resources. These largely addressed access to and skills, (on the part of both student and teacher) for a computer-aided learning environment. In particular IT literacy is integrated throughout curricula. An additional resource that was rated important was a network of digital libraries and museums.

Another three of the highly important topics were concerned with government policies, though closely related to the themes in the previous two categories: ready access to the Internet in schools, and availability of this ITC resource to the wider community. The distinct topic addressed international laws to regulate and protect electronic transactions and exchange.

Under training, freely available websites to support reskilling were also rated as highly important. One highly important topic was concerned with management issue: best practices in information technology-based learning and teaching on a continuing basis by national and international bodies.

More than half of the topics were rated by less than half of respondents as highly important. Those rated as least important were the emergence of robots capable of acting as opponents to humans in sports and other activities (5.3% high importance), Chinese characters on 50% of www pages (5.6%) and widely available subsidised programs for promoting computer literacy in elderly retirees (15.5%).

Table 6.2 Key Delphi Results.

Topic	Degree of Importance	Median Year of Realization across the APEC Economies	Industrialized Median Year of i) APEC ii) Own Economy Realization	Industrializing Median Year of i) APEC ii) Own Economy Realization
Information Technology literacy is integrated throughout the curricula of schools.	9.561	2005	2005/2002	2005/2005
Cheap computers for education and interactive learning are in widespread use.	9.474	2005	2005/2002	2005/2005
Use of the Internet by primary and secondary school students is widespread.	9.211	2006	2005/2001	2006/2007
All teachers in schools are trained in Information Technology-enabled teaching and learning.	9.140	2007	2008/2003	2007/2009
90% of the students in all grades have access to computer-aided learning environments.	9.138	2008	2008/2003	2008/2010
Information and communications technologies are accessible by 90% of the population.	8.964	2009	2010/2004	2009/2010
Best practices in Information Technology-based learning and teaching are identified on a continuing basis by national and international bodies.	8.889	2005	2007/2004	2005/2006
Computer Input / Output devices which have user friendly interface are in widespread use.	8.836	2005	2005/2004	2005/2006
Global wireless networks to allow global communications at a thousand times current speeds are in widespread use.	8.796	2008	2009/2005	2008/2009
Websites designed to assist people to reskill themselves are freely available.	8.649	2007	2009/2004	2005/2006
International cyber-laws to cover digital signature, electronic evidence, electronic transaction and documents are developed.	8.508	2007	2007/2004	2007/2007
Community access to school Information and Communication Technologies learning resources is freely available.	8.414	2008	2009/2004	2008/2008
A network of digital libraries and museums is in place.	8.397	2007	2009/2005	2007/2009

Note: 1) Index for the degree of importance was obtained by I=10* (% of H)+5*(% of M)+1*(% of L)+0*(5 of UN)

2) Industrialized economies are responses from Australia, Canada, Chinese Taipei, Hong Kong, Japan, Korea and Singapore.

3) Industrializing economies are response from Indonesia, Malaysia, Philippines and Thailand. (There are no responses in the second round from China, USA and Vietnam).

As Table 6.2 shows, the mean year of expected realisation of topics across the APEC economies were tightly bunched in just four-year time period between 2005 and 2008. The most distant mean year for any topic was 2013. The spread of responses was also quite uniform, with upper and lower quartile estimates, in the great majority of responses, being four years from the mean. This concentration of expected year of realisation allows little useful analysis of time differences between the various topics.

Perhaps of greater interest is the breakdown of the estimates of the years of realisation across the APEC economies versus 'within your own economy'. Responses are insufficient to permit meaningful analysis at the country level. However when responses were grouped into industrialised and industrialising member economies (based on simple GDP per head of population), some interesting findings emerged.

First, and perhaps surprisingly, the responses from the industrialising countries indicated an earlier date of realisation across APEC than those from the industrialised nations. Across the 13 high importance topics, the mean year of realisation for the former was 2005.3, compared with 2007.5 for the latter. However, across all 13 topics, realisation in the industrialised countries was seen as occurring earlier than across APEC, by an average of 3.4 years. In contrast, realisation in the industrialising countries was seen as occurring after realisation, by a mean of 2.1 years.

There were 60 second round responses from 11 APEC member economies (a 45% response rate). Second round responses essentially confirmed the first round outcome, with a marked exception. Thus Topic 19 (Best practices in Information Technology based learning and teaching are identified on a continuing basis by national and international bodies) rose dramatically from an 'Importance Rating' of 14^{th} to 7^{th}. Apparently in the second round, respondents saw the role of national and international bodies in diffusing learning as more important.

6.4 Conclusion

Technology is systematically transforming the basis of education and culture, while at the same time, rendering them even more crucial to the economic and social futures of Megacities. The capabilities of information and communication technology, in an era marked by globalisation and the emergence of the knowledge economy, and the reach and access of the Internet, require a fundamental re-examination of the roles and effectiveness of existing institutions and systems to support learning and culture.

While there is great pressure towards internationalisation, learning and culture remain at the heart of the economic and social fabric of each nation and the Megacities within it. Therefore, each nation must arrive at solutions which are appropriate to its own historical and cultural antecedents, and to its preferred future. At the same time, there is much to be gained by learning from and cooperating with other countries in developing the most appropriate responses to these challenges.

The Foresight approach taken in the study, using both scenario planning and a Delphi survey, identified a range of important issues that need to be taken into account.

Perhaps the principal one of these was the vulnerabilities inherent in converting learning and culture systems so that they become entirely dependent on electronic communication. Appropriate risk management strategies are needed to preclude, or at least protect against, catastrophic failure and/or loss of traditional knowledge and skills.

This also led to an emphasis on:

- the need for systematic capture and preservation of codified knowledge;
- increased understanding and valuing of tacit knowledge and those individuals and institutions that are important repositories;
- the development of international protocols and standards to protect and facilitate learning and transmission of culture;
- increased recognition of the central role of learning, and of the professions that are directly responsible for, or involved in facilitating, learning;
- the need for learning to be redefined in common culture as an essential life-long process;
- the need for substantial investment in continuous retraining of all those involved in assisting learning, whether formally as 'teachers' or informally through their community roles and expertise.

A number of technological issues were raised during the study as playing an important role in addressing the future of technology for learning and culture in the APEC region. The technologies that were identified at the Experts' Meeting were:

- Wireless community using satellite technology
- Data storage for digital libraries and museums
- Virus-immune software
- Language translation and teaching systems
- New concept, more user-friendly computers.

They were reinforced by the needs identified in the Delphi survey as:

- Cheaper computers for education and interactive learning
- Computer input/output devices with user-friendly interface
- Global wireless networks operating at 1000 x current speeds.

Given the massive R & D efforts in the ICT industry there is no doubt that these needs will be met in the next decade.

An area which was mentioned but not explored in the study is cognitive science which is exploding with new findings about the plasticity of the brain and how learning takes place at different ages. Computer firms are trying to capitalise on this research but there is yet no evidence for increased learning based on cognitive

science. Nevertheless this is an area that needs to be closely followed by experts in APEC economies.

6.5 References

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Sustainable Transport for APEC Megacities

7.1 The Foresight Approach Used in the Sustainable Transport Study[1]

The APEC Center decided to use the technique of scenario development coupled with intensive consultations. These techniques have recently been used to tackle transport futures in Queensland[2] and Sydney.[3] The steps were:

a. Preparation of a Discussion Paper in early 1999 by a consultant from the Centre for Strategic Economic Studies at the Victoria University of Technology in Melbourne, Australia and its circulation to a number of experts in the APEC region;

b. An Experts' Meeting in Melbourne with 16 participants from 10 economies in July 1999 to critique the Paper and develop scenarios. The Meeting identified the future of transport in Megacities and speculated on possible, even improbable events (uncertainties) which could alter the future course of events by major political changes, wars, natural disasters, scientific and technical breakthrough etc.

Based on these inputs, the Experts created three scenarios for 2020 as:

"**Green Light Ahead**" - Increasing concerns about environmental problems provoke significant political actions which trigger a technological response. Thus breakthroughs occur in the use of hydrogen as a fuel in vehicles using fuel cells, the establishment of driverless people movers using intelligent road systems, and in tele-commuting.

"**Take the Train**" - Instability in world markets lead to a recession and loss of purchasing power, while concerns over greenhouse gas emissions prompt actions to curb private vehicles. This suggests a social change against private transport and a shift to public transport based on bus and train networks.

"**Back to Basics**" - World-wide problems with computer systems lead to massive disruptions to vehicle production. Coupled with an oil crisis provoked by instability in several oil-producing countries, private transport becomes a difficult option and people move back to simpler modes of transport and change their travel patterns.

c. The identification of key issues and policy implications. This part of the process started during the Experts' Meeting and was continued in consultations with transport authorities in Bangkok and with the Experts in relation to their own economies. An extensive literature search was carried out by the consultant as part of this process.

The key issues are set out in Table 7.1. Not surprisingly they have many points in common with those of other studies of sustainable transport.[2-7] They are discussed in some detail in the APEC Center Report.[1]

Table 7.1 Key Issues in Sustainable Transport Identified at the Experts Meeting (in no priority order)

1. Impact of post-industrial economy change in characteristics of employment and leisure;
2. Impact of e-commerce and other 'non-transport' technologies;
3. Impact of environment and energy supply considerations in terms of meeting greenhouse gas targets;
4. Balance between public and private transport;
5. Degree of continued reliance on automobile;
6. Management of traffic demand;
7. Transparency and awareness of full cost of options;
8. Development of intelligent transport systems;
9. Funding (including subsidies) to transport);
10. Interaction between land use and transport planning;
11. Heterogeneity in terms of different solutions for different economies;
12. Transport infrastructure provision;

Table 7.1 Key Issues in Sustainable Transport Identified at the Experts Meeting (in no priority order)(Cont'd)

13. Institutional reform;
14. Changes in professional practice of transport planning;
15. New transport technologies; and
16. Human and community dimensions of equity, social and environmental costs, and safety concerns.

7.2 The Concept of Sustainable Transport

We can group the key issues of Table 7.1 into three broad headings of economically efficient transportation, environmentally sustainable transportation and socially sustainable transportation which are the elements of the concept of sustainable transport proposed by the World Bank.[8]

The World Bank defines these concepts in the following way:

"*Economic and financial sustainability* requires that resources be used efficiently and that assets be maintained properly. *Environmental and ecological sustainability* requires that the external effects of transport be taken into account fully when public or private decisions are made that determine future development. *Social sustainability* requires that the benefits of improved transport reach all sections of the community".[7]

7.2.1 Economically Efficient Transportation

To be economically and financially sustainable, transport must be cost effective and continuously responsive to changing demands. In many cities around the world, securely protected transport monopolies have failed to satisfy demands for expanded service or improved quality of service and have neglected the needs of growing low-income peripheral areas around the major metropolitan centres. Costs are often way too high. Road systems are often poorly maintained and not designed to service many of the needs of users. Many of the costs associated with road use are not directly borne by users, and traffic congestion has become a major problem.

In the United States, studies have shown that somewhere between 49% and 61% of the total social costs of motor vehicle use are paid for entirely by motor vehicle users.[6] Examples of costs not taken into account when travel decisions are made by individuals are road construction and maintenance, environmental impacts, congestion travel time costs inflicted on others, and aspects of the costs of accidents.

Congestion costs are an externality to the extent that drivers during congested periods impose costs on all other drivers sharing the road but do not account for these costs in their decisions to drive. Congestion costs not only reduce the economic efficiency of urban centres, but more importantly, they also add

considerably to environmental costs because stop-go driving wastes fuel and generates more pollution per kilometre than free-flowing driving.

Congestion or peak pricing is widely applied in mass transport, urban rail and bus, and air transport. Congestion pricing can also be applied to capture the added costs of road use during peak periods. Singapore was the pioneer for road congestion pricing in 1975, and it was followed by cities in Norway and northern Italy. Regular or non-peak road pricing is used more widely than congestion pricing and provides a means of incorporating some of the costs of road usage that are external to the individual user into travel decisions. It can, however, lead to distortions in road use if applied only on a narrow basis by diverting traffic onto non-tolled roadways.

Traffic incidents, associated with accidents, vehicle breakdowns, traffic signal failures and roadworks, play an important role in traffic congestion, Perhaps around half of the traffic congestion in Australia is incident-based, and U.S. studies indicate a one-minute blockage of a road link may lead to a 6 - 10 minute episode of congestion. Incidents also contribute to the propagation of accidents.

7.2.2 Environmentally Sustainable Transportation

Externalities associated with the environmental impacts of transportation are an important issue of the future. Air pollution, global warming, leaking tanks and oil spills are the major problems. In many of the industrialised countries, emission controls on new vehicles and inspection and maintenance requirements on the vehicle fleet have reduced air pollution impacts of road transportation. However, the benefits associated with such policies are likely to be overwhelmed in the next two decades by further growth in vehicular traffic in many urban areas in the industrialised world. Moreover, in many of the developing countries even elementary anti-pollution policies are lacking.

Road traffic is the primary source of some categories of air pollution; lead and carbon monoxide, nitrogen oxides and hydrocarbons. It is also an important source of particular matter. These emissions are damaging to health. Lead is particularly harmful to the development of younger children. Carbon monoxide hinders the transfer of blood into tissue, ultimately stopping the heart. Nitrogen oxides react with other pollutants in the atmosphere to produce a form of ozone that provokes asthma and other respiratory problems. The release from car exhausts of volatile organic compounds derived from hydrocarbons increase the risks of cancer, while particulates aggravate bronchial diseases.

Local conditions with respect to air quality have improved in many industrial countries over recent years. The catalytic converters installed in newer cars remove most of the carbon monoxide previously emitted into the atmosphere, and the introduction of lead-free petrol has had significant benefits. However, further technological improvements will be required to avert a resurgence of difficulties

next century. Projections indicate that the increased volume of traffic will lead to major environmental problems in megacities of the developed economies in the absence of new initiatives. Of significant concern are rising levels of fine particulate emissions, especially related to the use of diesel fuels. These air pollution problems affect not only the major metropolitan centres but also broad regional areas downwind from the polluted cities. Transport also damages the global environment. Pollution from motor vehicles produces about one-fifth of the incremental carbon dioxide in the atmosphere arising from human activity (which contributes to the depletion of the ozone layer), and half of the nitrogen oxide (which can contribute to acidification of rain and snow).

7.2.3 Socially Sustainable Transportation

Road traffic gives rise to several external social costs. Two of these primarily relate to economic factors: costs to transport infrastructure (principally damage to roads), and congestion costs. A third, environmental harms, has been discussed above. The fourth, injury and death caused by accidents, is perhaps the largest. Hence safety is a key issue for both future vehicle design and in the development of innovations in transport infrastructure.

Transportation is of vital importance to the poor because it provides the means of accessing employment, education and health services. Reducing the costs of access to these services through improved transportation is of particular importance to the urban poor in terms of affordability and accessibility. Road or public transport systems that fall into disrepair because of funding bottlenecks or general inefficiency have socially damaging consequences.

7.2.4 Sustainability as the Basis of Transport Policy

Economic, environmental and social sustainability are often mutually reinforcing. Road or public transport systems that fall into disrepair reduce economic efficiency and hinder access for the poor. Measures to improve asset maintenance, the technical efficiency of supply, and safety can produce substantial economic, environmental and social benefits.

Because, in developing countries, the poor are most affected by inner city concentrations of exhaust emissions from automobiles, while the rich benefit from vehicle use, there are social benefits from addressing environmental goals. However, the simultaneous achievement of these three goals is not always easy, and difficult tradeoffs may be required. A sustainable transportation strategy is one that both identifies and implements the win-win policy instruments and explicitly confronts the tradeoffs in order to achieve deliberately chosen outcomes.[7]

7.3 Policy Actions to Achieve Sustainable Transport in Megacities

New policies are needed to achieve reduced emissions of carbon dioxide from transport, to overcome problems with air pollution, to increase safety and to ensure wider access to transport services. There is no simple solution to these problems. The APEC Center study has identified that policy actions are required on six broad fronts:

1. The integration of urban planning with transport planning;
2. Giving priority to transit in the development of transport infrastructure;
3. The introduction of reforms to transit services;
4. Strengthening transport management policies;
5. Encouraging the development of sustainable new technologies over the whole range of transport service provision; and
6. Utilising buses as a means of shaping transport demand, encouraging the adoption of sustainable technologies, and providing a means of indirectly funding new transport infrastructure.

These are discussed in some detail in the APEC Center Report.[1]

The APEC Experts ranked a similar but slight different set of policy actions with the results as follows (the numbers refer to the set above):

No. 1: 4% No. 2 plus No. 3: 35% No. 4: 9% No. 5: 11% No. 6: 4%.

This suggests that new technologies for vehicles and traffic management, together with fiscal measures, were seen as the means for achieving desirable outcomes once the major policy steps of improved land use planning and reprioritisation to public transport were taken.

Technological opportunities likely to play the biggest role in supporting these major policy steps were identified as:

1. Development of electric and hybrid vehicles;
2. Intelligent vehicle/highway systems;
3. New types of transit vehicles;
4. Alternative urban freight distribution systems; and
5. Transport logistics.

7.4 Conclusion

Sustainable transport means finding ways of meeting transportation needs that are environmentally sound, socially equitable and economically viable. The key symptoms of unsustainable transport, present in some measure in most of the

Megacities of APEC, are traffic congestion poor traffic safety, the lack of accessibility of transport for many groups, significant air pollution and growing contributions to global warming through greenhouse gas emissions.

The APEC Center study using the scenario planning technique involving a group of APEC Experts identified key drivers and uncertainties and developed three scenarios to stimulate strategic thinking. From these, key issues have been drawn out and policy options needed have been identified. The integration of urban planning and transport planning, the development of transit infrastructure and new traffic management approaches are seen as essential policies that need to be pursued to achieve sustainable transport. The examples set by Hong Kong, China and Singapore in these areas show what can be achieved if the political will is present.

7.5 References

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Healthy Futures For APEC Megacities

8.1 The Foresight Approach Used in the Healthy Futures for Megacities Study[1]

In this fourth study, given the breadth of the topic and the diversity of the professionals involved, the APEC Center decided to use the scenario development technique to carry out the study. The steps were:

a. A focus for the study was developed through a short Discussion Paper prepared in late 1999 by colleagues from the Kenan Institute of Private Enterprise, Kenan Flager Business School, University of North Carolina at Chapel Hill, U.S.A. and the National Centers for Disease Control and Prevention, Atlanta, U.S.A.. This paper discussed the concept of health of a city in the broadest sense. The issues identified in the Discussion Paper were under three general headings:

1. Natural environment, e.g. geography and climate;
2. Manmade environment, e.g. air, water sanitation, noise; and
3. Quality of life, e.g. overcrowding, traffic congestion, crime.

b. The Discussion Paper was then distributed to a small group of experts,

including an expert from the WHO Healthy Cities Program, and a Core Group from the two groups involved in the Discussion Paper, the WHO Expert on Healthy Cities and the APEC Center met in Bangkok in February 2000 to critique the Paper and to develop scenarios. The Core Group identified key drivers in the development of Megacities and speculated on possible, even improbable, events which could occur to change the pattern of development. These are listed in Table 8.1.

Based on these inputs, three scenarios were created for the year 2020 and named by their creators as 'Econologic City', 'Monopolis' and 'Fat City'. These are given in detail in the APEC report[1] but a brief summary is as follows.

Econologic City is one of the top 5 cities in the world, in terms of wealth and standard of living. Major environmental redesign has provided cabling for electronic connectivity, and open and safe meeting spaces to facilitate social connectivity. Energy sources are 'alternative', water is recycled and transport is low-polluting. Econologic City is highly IT committed and internet connected, with an electronic

Table 8.1 Key Drivers and Uncertainties in the Development of Megacities, identified at the Core Experts Meeting

Key Drivers	Uncertainties
Expected significant influences on the developments of Megacities	*Possibilities but unpredictable influences; new developments in these areas could have a major impact (positive or negative) on the health of the Megacity, if they occurred.*
1. Demographic	Genetic or medical revolution transforms the implications of ageing / reproductive technologies / epidemics / bioterrorism
2. Digital Economy / Global Knowledge Economy	Ownership and regulation of the Internet / backlash against modern information and communications technologies.
3. Economic Performance	Natural disasters / disasters following from technology, e.g. major antibiotic resistance / plagues.
4. Education and Capacity Building (information skills)	Reaction against cultural dominance of 'western world' / mono-culture
5. Technology based health delivery	Personalised health management / backlash against technology / 'smart health care'.
6. Governance / Polity Capital	International and national regulation / public-private-NGO partnerships / 'aid with positive strings'.
7. Environmental	Climate change / food contamination
8. Social Values	'Virtual communities' / social alienation.
9. Inter-Group	Rise of nationalism / immigration controls / tribalism
10. Transnational	War / education / labour mobility.

communication system that underpins community involvement and responsive government, as well as a strong health care system. Migration to Econologic City is strictly limited but would-be residents find ways around the system to get hold of that precious "EC-card.

Monopolis, the intelligent tropical Megacity places great emphasis on survival and self-sufficiency. With substantial independence from national government, Monopolis has been radically redesigned, with more efficient resource allocation, mixed use land planning, innovative transport modes, and a target of 4 square meters of open space for every resident. Monopolis is a city of advanced and accessible technology, significantly internet-linked throughout the city, to the region and internationally. Regulations are stringent, with slums demolished and private cars banned.

Finally, **Fat City** 2020 is bulging at the seams, a vibrant cauldron of intercultural and intellectual interaction. It is not really a Megacity at all, but rather a concentrated network of self-governing communities. The corrupt and convoluted bureaucracy has been superseded by rational and open administration, a positive development reinforced by significant local democracy and participation. With low unemployment, concern for the elderly and disadvantaged and substantial decision-making at community level, Fat City is a Megacity on a human scale.

It is important to emphasise that the scenarios constructed were alternative visions of future Megacities, not best or worst case scenarios. While they contained some surprising elements, nevertheless, all aspects of the scenarios were intended to be plausible.

c. Following the Core Experts Meeting the Discussion Paper was revised and the scenarios were refined to reflect some issues more clearly, including some of the policy debates already occurring around them. All of this material was then used as background for an Experts Meeting with 46 participants from 10 member economies, held in Bangkok in May 2000. These experts provided further inputs of issues based on their experience, together with material relevant to their national Megacities. The scenarios were then reviewed and analysed, in order to draw together a comprehensive set of issues and policy actions relevant to healthy futures for APEC Megacities over the next two decades. Technologies relevant to the issues were explored in general discussion.

8.2 The Concept of a Healthy City

According to the World Health Organisation (WHO) Healthy Cities Program, a healthy city is 'one that is continually creating and improving those physical and social environments and expanding those community resources which enable people to mutually support each other in performing all the functions of life and in developing to their maximum potential'. This definition reflects a similar definition of health in a living organism (Figure 8.1).

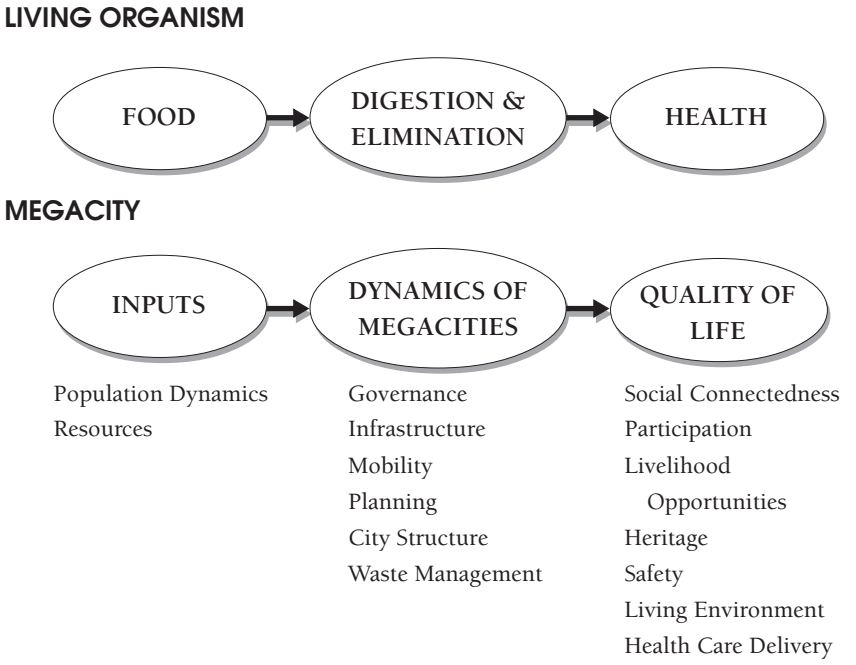

Fig. 8.1 The Megacity as a Living Organism: A Conceptual Approach to the Key Issues Identified in the Study.

According to Herbert Girardet, an author and consultant with the United Nations Habitat II project, "A city is a living thing. It has a complex metabolism, a voracious appetite and very poor eyesight. Improvements in transportation and communication mean that its feeding ground is now global and the consequences of its consumption distant and forgettable." If this is true, then can the largely unrestrained growth that results in the creation of a Megacity occur without significant hazards developing for both the residents of the Megacity and others who are indirectly impacted by its existence?

A healthy living organism must be able to grow and develop in an environment that permits effective responses to both challenges and threats and offers the opportunity to continuously improve its condition. The same is true of cities. Cities must be able to grow, develop, meet challenges and assure a decent quality of life for all its inhabitants.

If a significant portion of a city is poor, excluded, or disadvantaged, the city cannot be healthy. Health will not exist while large segments of the population are uneducated, lack opportunity, or remain unemployed. A healthy city does no exist when children are undernourished, abandoned (at any age), grow up in a physically polluted environment or do not receive moral and ethical guidance.

Something that does not continue to grow, develop, reproduce or sustain itself, and successfully respond to new challenges is not "healthy" even if it is not

invaded by disease or even if the community is not racked by poverty. "Growth", however, does not necessarily imply either population increases or geographic expansion, but rather refers to the ability of individuals and society to be creative (taking initiatives that appear desirable) and to adapt and change in response to external pressures. Change is inevitable, and therefore successful adaptation change is essential in any system that hopes to survive. Continued responses to environmental changes, population growth, increasing mobility through transportation improvements, and the search for wider economic and educational opportunities have continued to push the growth of cities to the level of Megacities.

Many Megacities have mega-problems, for they often do not grow in a balanced fashion. Responses to the imbalances require considerable vision, energy, and effort to achieve effective policies and feasible interventions.

8.3 Key Issues in Healthy Futures for APEC Megacities

The preparation of the Discussion Paper, and the scenario-planning process used in the Experts Meetings, led to the identification of fifteen key issues which are discussed in detail in the APEC Report.[1] Many of these are interlinked but a conceptual approach to grouping them is given in Figure 8.1. This is based on the concept of the city as a living organism. (cf Figure 2.1)

8.3.1 Issues Related to Inputs

As noted above, cities have a voracious appetite and Megacities even more so. They exist and grow because of the inputs they receive from vast distances outside the cities. Improvements in communication and transportation mean that they draw on global resources, both economic and physical as well as human. Here we group the issues of :

- Population dynamics - changing size and age distribution in cities; and
- Resources - ensuring adequate supplies of energy, water, food and building materials.

8.3.2 Issues Related to Dynamics of Megacities.

The inputs to Megacities must be adapted and used to ensure that cities are able to grow, develop, meet challenges and ensure a decent quality of life for all the inhabitants. Using the analogy of a living organism, the dynamics of Megacities can be likened to the digestion and utilisation of inputs to provide sustenance for thinking, breathing and movement.

Here we group the issues of :

- Governance - running an efficient and equitable city;
- Infrastructure - building roads, sewers, communications and services;
- Mobility - transporting people by public and private means;
- Planning - looking to future development;
- City Structure - eliminating inequalities by adequate design; and
- Waste Management - efficient disposal of wastes and elimination of pollution.

8.3.3 Issues Related to Quality of Life

The study has reinforced the view that people cannot have a healthy life in an unhealthy city and that the rationale for ensuring a healthy and sustainable city is to maximise the quality of life for its inhabitants which in turn leads to a successful economy.

Here we group the issues of:

- Social Connectedness - getting people together;
- Participation of individuals and communities - ensuring a voice in running the city;
- Livelihood Opportunities - ensuring training for employment in the knowledge economy;
- Heritage - preserving the past;
- Safety - ensuring people and property are safe;
- Living Environment - providing adequate housing and recreation facilities; and
- Health Care Delivery and Health Provision - ensuring adequate health care facilities for all.

8.4 Policy Outcomes

This study has dramatically reinforced APEC Minister's views as expressed at the Manila Ministerial Meeting in 1996 that the topic of Sustainable Megacities required urgent attention to ensure future wealth creation and social stability of APEC economies. Through consultation with experts across the APEC region, this study identified a set of key issues critical to the health of Megacities, and policies that need to be developed to address these. It was emphasised throughout this study that none of these issues is resolvable in isolation, integrated policy making and implementation is essential. Yet this remains hampered by the fragmentation of public responsibility, both horizontally (different agencies dealing with the same concern) and vertically (different levels of government). The lack of involvement of stakeholders in the policy formulation and decision-making processes is an equally important problem which impedes the development of healthy Megacities.

The experts identified the following key policy areas as critical to the future of Megacities:

- Managed growth, of both population size and Megacity area to ensure sustainability;
- Integration of land use and transport planning;
- Effective participation of all stakeholders in decision-making, via both 'top-down' and 'bottom-up' processes;
- Equity for all city residents, including especially disadvantaged groups such as recent migrants, workers in the informal economy and ethnic minorities;
- Good governance at all levels;
- Implications of the development of knowledge-based city for employment;
- Multi modal and sustainable transport systems;
- Integrated information and communication technologies especially their application in health, education and skills training, governance, public participation and commerce;
- New approaches to funding and operating 'megaprojects' for infrastructure and services, including assessment of the effectiveness of public-private partnerships;
- Reduction of pollution by cleaner production systems, improved waste management and a shift from private to public transport; and
- Better understanding of population dynamics and migration to urban areas.

While individual Megacities can tackle these within their own economic systems, there is already a wealth of experience that can be drawn on through regional collaboration to :

- Share their experience of the fifteen key issues;
- Facilitate the development of standards data bases in technical areas;
- Set up benchmarking criteria for healthy cities;
- Support multi-economy and multi-disciplinary R & D programs in areas such as public health, transport systems, water supply and management, technology for learning and culture, environmental protection and cleaner pollution; and
- Develop efficient and effective frameworks for public-private partnerships for infrastructure development.

8.5 Conclusion

The major challenges to the sustainability of APEC's Megacities can appear overwhelming. The Foresight approach was helpful for defining and assessing these challenges, providing a mechanism for grasping the complexity of the problems and for reconciling the many different perspectives and areas of expertise required

to solve them. The Foresight process also enabled excellent networking across cultures and levels of development. The study outlined the core elements of Megacities that need to be addressed in order to move towards healthier futures, and identified critical areas for research and the development of policy.

The study firmly concluded that, with more and more of the world's population going to live in Megacities, the goal of healthy Megacities is both realistic and essential. Megacities that function well will make a highly significant contribution to the economic wellbeing of the whole economy but there is no room for complacency. Generating healthier Megacities depends crucially on political vision and will to understand the threats to future Megacities, and to implement major changes. Equally crucial is the much wider participation of Megacity residents from all sections of the community in decision making. It is vital to recognise the symbiotic relationship between the health of the Megacity and of its residents. You cannot have healthy people in an unhealthy Megacity, and you cannot have a healthy economy without healthy people. For the millions of people living in APEC's multiplying Megacities, actions to create healthy Megacities are the critical link between the first APEC goal of increasing prosperity, and the second - improving quality of life.

8.6 References

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The Lessons Learned from the Studies[1,2]

9.1 Issues Arising

When these studies commenced in 1998, they were essentially the first multi-economy Foresight studies to be attempted. Since then, the Institute for Prospective Technological Studies in Seville has carried out a multi-economy project on Futures for Europe. This covered a range of social, technical and policy issues. From the outset the APEC Center studies have been strongly supported by APEC member economies with, on average, more than half the economies participating. The interest and support has grown over the past two and a half years and there is clearly a continuing need for such APEC-wide studies. The thrust of the studies has moved strongly to the role of technology in achieving society's needs for the future rather than technology for technology's sake.

The first study on Water Supply and Management revealed many of the challenges associated with the conduct of an effective multi-economy Foresight Study. The apparently simple issue of engaging a range of national experts and stakeholders in a project whose genesis lies entirely outside their own structures and systems, and of conducting a challenging exercise in a single language, namely English, presents many practical problems.

In the Experts' Meeting dealing with scenario development, problems of definitions, methodology and interpretation were resolved by discussion and, as a result, three excellent scenarios were produced which brought out a number of critical issues which led to development of policies. However in the Delphi Study, the comments and opinions that were offered by the respondents indicated many problems of definition and interpretation. While the number of parameters was deliberately kept to a minimum, the accompanying notes and explanations were rather complicated, particularly for non-native English speakers. A pilot study may have been useful to the Center to assist with the production of clearer instructions but since similar national studies have found similar confusion with respondents using their own language, the room for improvement is limited. Given the complexity of Delphi Surveys, a fairly low response rate was not unexpected. However the rate of 18.8 per cent in the first round was well below national response rates of around 30 per cent.

The sample of Delphi experts was obtained through the APEC Experts that attended the workshop, through the APEC Industrial Science and Technology Working Group (ISTWG), and the 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 respresentative 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 APEC 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 the 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 chances 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.

Commitment (generating a sense of commitment to the results among those who will be responsible for implementing changes in the light of the Foresight Study) is a key concern of the Center and this will depend very much on the nature of the study. Authority, legitimacy and credibility are fundamental to success in Foresight and it is clear that a 'third party' international body like the APEC Center for Technology Foresight cannot hope to achieve them in a multi-country study at the same level and in the same way as a Foresight exercise conducted at a national level.

On one hand, the Center is not part of the water community which implements water policies. It became clear that the post-Foresight activities are as important as the study itself in ensuring the degree of support needed to implement the policy outcomes. In the water study, three major meetings were held with officials and consultants in Hong Kong, China, Malaysia and Bangkok and support was expressed for the findings of the study in their respective economy contexts.

On the other hand, to get the recommendations to the 'APEC power structure', the Center and its project has to be brought to the attention of many levels of APEC bureaucracy. Thus, the water study was reported to the APEC Industrial Science and Technology Working Group so that the ISTWG contact points could report to their bureaucracies. Ideally with their strong support, the policy outcomes could be passed to the next meeting of APEC Ministers in the S & T and industry area to ensure APEC-wide implementation. However, it became apparent that the topic did not fit with many of the national Departments and Agencies represented at ISTWG and hence was not followed up with action.

Another substantial issue is that of an 'APEC perspective', given the great diversity in the economies, cultures, geography and history. Clearly a 'one size fits all' approach is quite inadequate. The water study sought to address this issue through an exploration of what are the common, as well as the different features, and to emphasise the extent to which many water supply and management issues have a multi-country dimension. One consequence, and in sharp contrast to the Foresight exercises conducted by the leading industrialised nations, was an emphasis on when particular technologies, or management practices would be adopted within various APEC member economies, as opposed to when they would first be produced.

The second Study in Technology for Learning and Culture reinforced the challenges of multi-economy Foresight studies. Thus the Experts' Meeting, aimed at scenario development, was very successful with excellent interaction among participants and a strong commitment to outcomes. The computer literacy of the overall group was high and it was possible to rapidly diffuse results among the four working groups and to come to a consensus. However the groups became engrossed with some of the wildcards raised in the scenario development and the scenarios lost some of their richness as a result. As noted in Chapter 3.3, this can arise in normal scenario development but can be more of a problem in multi-economy studies in distracting from the major policy issues.

The Experts' Meeting produced a draft set of Delphi questions and these were subsequently refined by interaction with experts and stakeholders. However, as in the Water Supply and Management Delphi, there was considerable difficulty in ensuring that the Delphi statements were unambiguous, clear and understandable by respondents whose first language is not English. The feedback from respondents highlighted a number of difficulties which may have contributed to the low response rate of 28 per cent in the first round. This was higher than Water Supply and Management but still lower than most national Delphi studies which have averaged over 30 per cent.

Although the Delphi studies involved a wider range of people than the Experts' Meetings and produced an extremely interesting set of responses which reinforced and extended the discussion of the key issues, the demands on the limited resources of the APEC Center to ensure an adequate response rate were considerable. It is clear that a multi-economy Delphi which yields the numbers of respondents comparable to a national one such as the Japanese or Korean Delphi requires far greater resources than the APEC Center can muster at its present state of development.

In view of the resource demands of Delphi Surveys, the APEC Center decided not to use them in the next two studies but to use scenario development linked to literature surveys and consultations with a wider group of experts.

Thus the third study on Sustainable Transport for APEC Megacities used the services of a consultant over several months to prepare an Issues Paper, to play a leading part in the Experts' Meeting, to prepare a critical literature review and to participate in consultations with APEC experts, notably in Bangkok. Again the Experts' Meeting was very successful with excellent interaction among participants. However, the Experts were keen to spend more time in sharing experiences and developing policies than producing scenarios and thus the scenarios were not as fully developed as in the Water Study. Nevertheless the policy outcomes were stronger. Clearly each group of Experts has its own characteristics!

The consultations in Bangkok as part of the post-Foresight process were very productive and provided an excellent opportunity to influence the future of sustainable transport in an Asian Megacity. The results of the study, together with those of the Healthy Cities study, were also presented to a wider audience at the 17th Congress of the Eastern Regional Organisation for Planning and Housing in Onyang, Korea in October 2000.[3]

Finally, the fourth study on Healthy Futures for Megacities used a different approach. Because of the breadth of the topic and the diversity of professionals involved, the APEC Center used a core Group of Experts from institutions involved in both governance and health studies, with an expert from the WHO Healthy Cities program. Together with a facilitator and APEC Center staff, this Group were able to produce scenarios and draw out issues which were presented to a large group of diverse Experts from the APEC region. This preliminary study by the Core Group

provided a focus for the larger group; this would not have been possible in the time available, given the scope of the study. Despite the diversity of the Experts present, both in discipline and in non-native English speakers, the Meeting produced significant outcomes in terms of policy proposals. There was a strong commitment by the participants to follow through and at least one Megacity group has set up a working party as a result of the study.

While it is difficult enough to assess policy outcomes of national Foresight studies because of the lags involved and the political forces involved, it is even more difficult in multi-economy Foresight studies to assess their impact. Nevertheless it is clear from the feedback from participants and from the post-Foresight activities that the APEC Center studies are making a substantial contribution to better strategic management in a number of areas linking technology and society in the APEC region. Based on the lessons learned from these studies, the APEC Center should continue to meet its objectives of promoting and developing the application of Foresight in APEC member economies.

9.2 References

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2. Tegart, G. 2000 *"Multi-Economy Foresight"*, presented to International Conference on Technology Foresight, NISTEP, Tokyo.
3. Tegart, G. 2000 *"Technology Foresight for Urban Sustainability - Regional Collaboration"*, presented to the 17th EAROPH World Planning Congress, Onyang, Korea.