Water for all Cebuanos

Water Resources Management Action Plan for Central Cebu (2005—2030)

Main report

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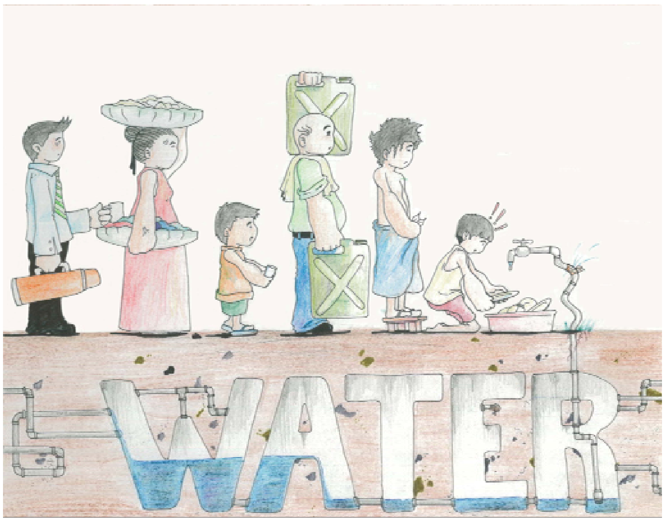
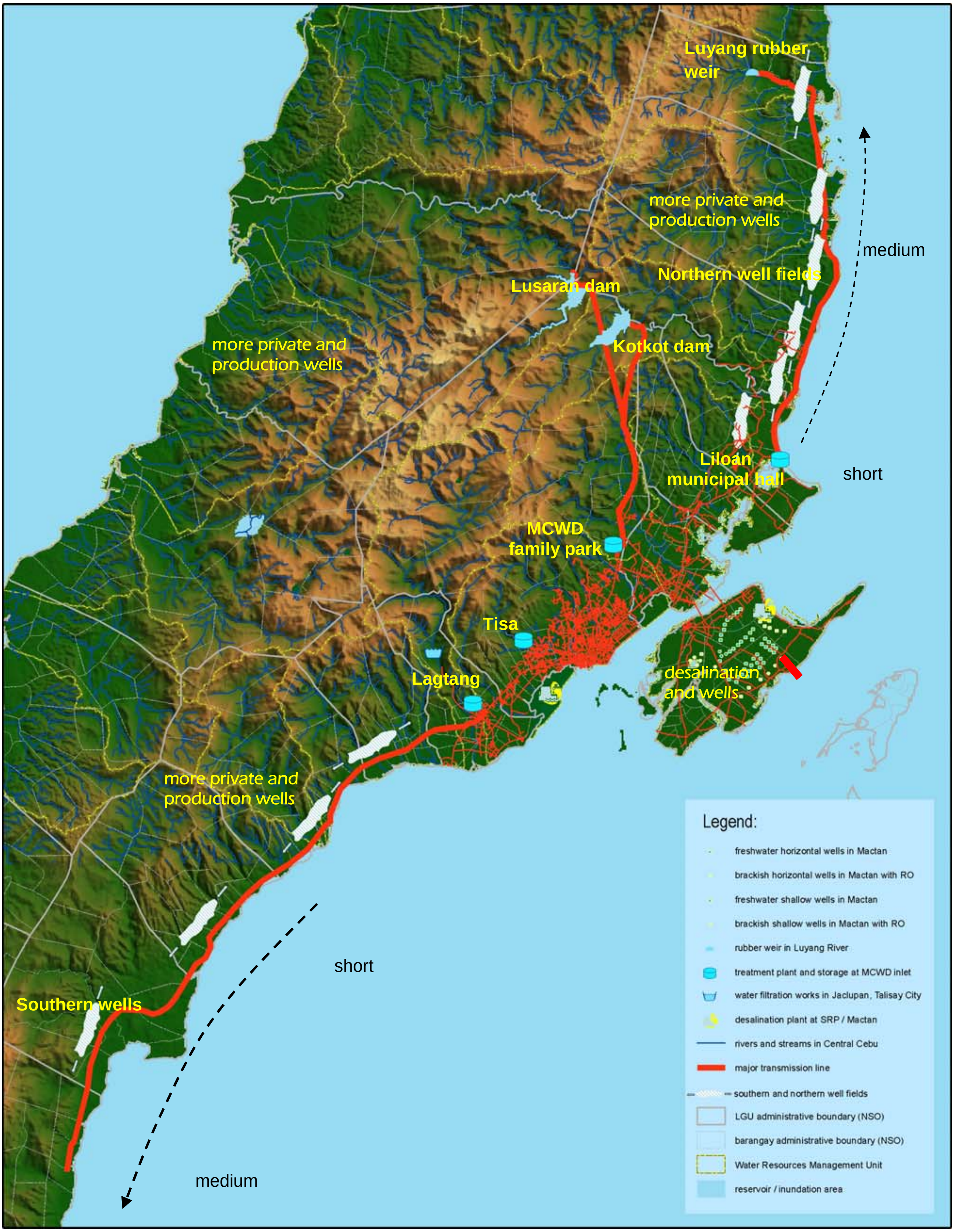


List of abbreviations

ADB	Asian Development Bank
AGR	Annual Growth Rate
AIP	Annual Investment Plan
AMSL	Above Mean Sea Level
AveGR	Average Growth Rate
CCPL	Central Cebu Protected Landscape
BOD	Biochemical Oxygen Demand
B/C	Benefit / Cost Ratio
CCCI	Cebu Chamber of Commerce and Industry
CCNP	Central Cebu National Park
CCPL	Central Cebu Protected Landscape
CUSW	Cebu Uniting for Sustainable Water
DAO	Department Administrative Order
DENR	Department of Environment and Natural Resources
DOH	Department of Health
DOT	Department of Tourism
EC	Electro-conductivity value
ECC	Environmental Compliance Certificate
EO	Executive order
EU	European Union
FAO	Food and Agriculture Organization of the UN
GI	Gross income
GIS	Geographical Information System
HDPE	High Density Pipe Ethylene
HLURB	Housing and Land Use Regulatory Board
HYMOS	Hydrological Modeling Software
ICC	Investment Coordinating Council
IDB	Inter-American Development Bank
IEC	Information, Education and Communication
IFI	International Financial Institution
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
KLRWFR	Kotkot-Lusaran Watershed Forest Reserve
LDC	Local Development Council
LGC	Local Government Code
LGU	Local Governmental Unit
LWUA	Local Water Utilities Administration
MAO	Municipal Agricultural Offices
MCWD	Metro Cebu Water District
MIS	Management Information System
MOA	Memorandum of Agreement
MOC	Memorandum of Cooperation
MSME	Micro, Small and Medium Sized Enterprises
MWFR	Mananga Watershed Forest Reserve
NEDA	National Economic Development Agency
NGO	Non government organization
NIPAS	National Integrated Protected Area System
OAS	Organization of American States
O&M	Operation and maintenance
PAMB	Protected Area Management Board
PBSP	Philippine Business for Social Progress
PCEEM	Phil. Canada Environment & Ecological Management
PD	Presidential Decree
PFPP	Philippine Family Planning Program
PWD	Pinamungajan Water District
PWS	Public Water Supply
RA	Republic Act
R&D	Research and Development
RDC	Regional Development Council
RIBASIM	River Basin Simulation Model
SNP	Sudlon National Park
TCWD	Toledo City Water District
TS	Technical Secretariat
UN	United Nations
UNEP	United Nation Environmental Program
USC-WRC	University of San Carlos, Water Resources Center
WB	World Bank
WRM	Water Resource Management
WRMB	Water Resources Management Board
WRMU	Water Resources Management Unit
WRP	Water REMIND Project
mcm/yr	million cubic meter per year
MPN / ml	Most Probable Number per milliliter
MT	Metric tonne
NO_3 / l	Nitrate per liter
PhP	Philippine pesos

Water Resources Management Strategy for Central Cebu



EXECUTIVE SUMMARY

Why a WRM Action Plan for Central Cebu?

The growing population of Central Cebu is challenging the public authorities to provide the people with safe and healthy living conditions, and water is an essential part of this. People have the right to a good, accessible and affordable water supply. The water quality of surface water as well as groundwater is worsening and watersheds are degrading. Moreover, the growing population and related socio-economic activities put pressure on the environmental conditions in the region.

The cities and municipalities, supported by national and provincial agencies and authorities, have the prime responsibility in addressing such issues. However, many of the solutions are beyond the jurisdiction of the cities and municipalities and would require cooperation between them. Such is the case for the cities of Cebu, Mandaue and Lapulapu who will have to rely on their neighbors for the supply of the water. This would entail a comprehensive and planned approach. Until now, the management of the water supply has been based on a short term perspective and mainly depended on unsolicited proposals. These proposals tend to be more costly due to non-utilization of the benefits of the economy of scale, and are also not very transparent since the information flow is steered by the proponent.

The Action Plan described in this report will spell out how to manage and develop the water resources in Central Cebu in the next 25 years (until 2030). The focus of this Action Plan will not only be to meet the demand for a safe water supply but also to lay the foundation in addressing the related issues of water quality and watershed protection. A very important element of the Action Plan is to re-structure the involvement of all key players and make them pro-active in implementing the solutions. This includes the establishment of a strategic and coordinating Water Resources Development Board for Metro Cebu that will act as a discussion and negotiation platform and will involve all stakeholders.

Present water supply situation

In principle there is an abundant supply of water in Central Cebu. Rainfall is high (on average, about 1740 mm) with only slight regional variations (1650 along the eastern coastal plain). The evaporation is about 1100 mm/yr which leaves sufficient water available for natural runoff, groundwater infiltration and consumption. The temporal variation of rainfall has to be taken into account, both intra-annual (with 4 dry months from January till April) and inter-annual. The river basins are small and steep. The largest east flowing rivers are the Mananga, Kotkot and Danao rivers while the largest west flowing river is the Combado which includes the Lusaran watershed. The Mananga, Kotkot and Lusaran rivers are all located within the Central Cebu Protected Landscape Area.

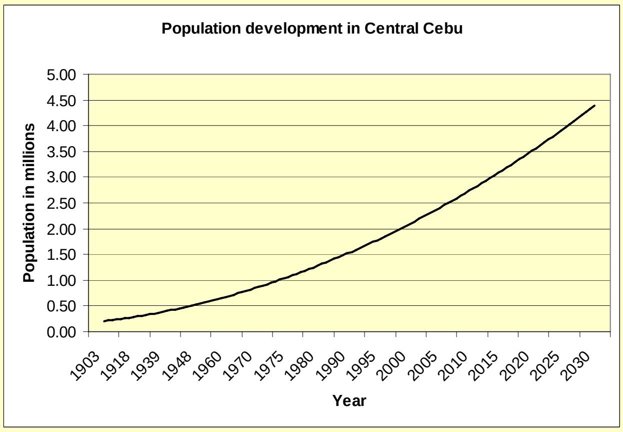
The nearly 100 watersheds in Central Cebu are combined into 21 hydrologically defined Water Resources Management Units (WRMUs) which are the basic units for determining the water balance (supply and demand) of the region. The main current source for domestic and industrial water supply is groundwater. The Carcar limestone aquifer along the coast, in particular, is an important groundwater system and the main source of water supply of Metro Cebu. High abstraction rates from this aquifer are possibly due to high recharge of this limestone area. This in turn may result in salt intrusion through upconing or from the sea, making the effected groundwater wells unfit for use. Another threat is groundwater pollution by domestic sewage. In particular the increase in nitrate concentration is alarming and, in combination with bacterial pollution (coliforms), has already forced MCWD to close some production wells.

Water supply in Central Cebu is taken cared of by public and private systems. Water districts, such as MCWD, provide for the majority of the water requirements for the urban population. Rural waterworks and sanitation associations provide for the rest, mostly managed by private groups. MCWD is by far the largest water district in the area, servicing (parts of) the cities of Cebu, Mandaue, Talisay and Lapulapu along with the municipalities of Compostela, Consolacion, Cordova and Liloan.

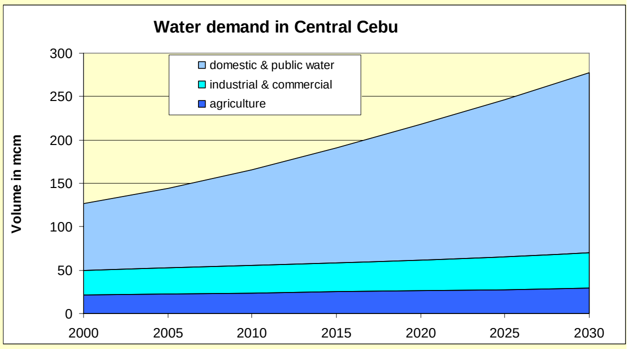
In addition to groundwater three other sources are used. The most important other source is the Jaclupan surface water infiltration facility in WRMU Mananga (8.2 mcm/yr) while Buhisan reservoir (1.8 mcm/yr) and desalination (2.2 mcm/yr) are the two remaining supplemental resources.

Developments - a growing demand

The population growth in Central Cebu is spectacularly high. In the 40 year period between 1960 and 2000 the population tripled to 2.1 million. This was based on an average growth rate of 2.8% as a result of a high birth rate and in-migration. The high growth rate is expected to decrease by 2.33% in 2005-2030, but this will still result in another two-fold increase of the population to 4.3 million by 2030. Cebu City will be the most populated area (1.35 million), followed by Mandaue City (0.62 million) and Lapulapu City (0.52 million).



The increased population, in combination with an upgrading of the service level and an increase of the service area of MCWD, will result in an increase of the domestic water demand (household consumption, tourism and public water use) from 94 mcm/yr at present (2005) to 210 mcm/yr by 2030 in Central Cebu. The industrial and commercial demand is mainly concentrated in Metro Cebu (particularly Cebu City, Mandaue City and Mactan). The demand in 2005 for Metro Cebu was 27 mcm/yr while for the entire Central Cebu area this was only slightly higher at 30 mcm/yr. The industrial and commercial demand for Central Cebu is expected to grow from 30 to 41 mcm/yr by 2030. Agriculture is also a major consumer (22 mcm/yr in 2005 and 29 mcm/yr in 2030 for Central Cebu).



Meeting the demand

The ultimate objective of the Action Plan is to ensure the continuous availability of water of good quality to all existing and future uses and users in Central Cebu at an affordable cost and in an environmentally friendly and sustainable way. The best way to achieve this is to start with optimizing the use of the present groundwater sources for local use. Only when sustainable yields are extracted, will this local problem solving approach assure environmental soundness and a high reliability of the supply. After the local demand is satisfied, the remaining groundwater can be 'exported' to neighboring areas where shortages exist, particularly Metro Cebu. As local demand increases in time, this might mean that less water will be available for export. At a certain point this will no longer be possible, either physically or economically. When this occurs, Metro Cebu will have to rely on far-flung areas for its supply or other sources such as the development of surface water reservoirs and desalination.

The development of the demand over time in relation to the sustainable yields of the aquifers is presented in the adjacent table for each WRMU. The last column of the table shows whether sufficient groundwater is available to supply the local demand. This is the case for all non-MCWD WRMUs. In the case of MCWD areas, several WRMUs suffer shortages which have to rely on external sources, either from groundwater of neighboring WRMUs or by developing surface water and/or desalination projects. The shaded area in the table show that in the present situation this is already the case for the WRMU Cebu City while Butuanon and Mactan will start having shortages by 2020.

The options considered to develop surface water included:

- Mananga High Dam (various levels: 43, 73 and 83 m high)
- Malubog Dam rehabilitation
- Lusaran Dam (47 and 63 m high)

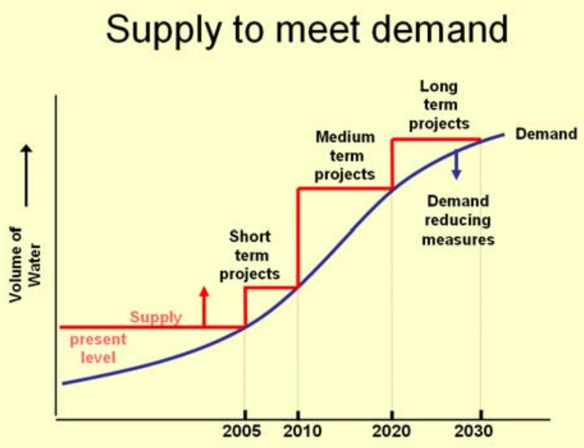
	Gross water demand, excluding uplands and agriculture (mcm)				Max. potential coastal aquifer	Local problem solving
Time horizon	2005	2010	2020	2030		
MCWD area						
BUTUANON	22.1	26.6	38.4	51.3	26.9	no
CANSAGA	4.5	5.4	7.8	10.7	12.4	yes
CEBU CITY	68.3	79.9	107.8	137.3	42.6	no
COMPOSTELA	2.2	2.6	3.9	5.7	15.9	yes
KOTKOT	0.4	0.4	0.6	0.8	4.0	yes
LILOAN	2.5	2.9	4.2	6.1	9.7	yes
MACTAN	22.4	26.3	36.4	48.7	27.1	no
MANANGA	2.2	2.5	3.5	4.8	4.4	no
MINGLANILLA-TALISAY	3.4	3.8	4.9	6.5	9.5	yes
subtotal MCWD area	127.9	150.5	207.4	272.1	152.5	no
non-MCWD area						
ASTURIAS	0.4	0.4	0.5	0.7	9.4	yes
BALAMBAN	1.9	2.2	2.8	3.6	13.1	yes
CABIANGON	1.0	1.1	1.6	2.1	16.5	yes
CARMEN	0.8	0.9	1.2	1.6	8.0	yes
COMBADO-LUSARAN	0.5	0.5	0.6	0.8	12.9	yes
DANAO	1.3	1.5	2.0	2.6	6.0	yes
GUINABASAN	0.3	0.3	0.4	0.5	7.4	yes
LUYANG	0.3	0.3	0.4	0.5	5.4	yes
MANGOTO	0.8	1.0	1.3	1.6	8.4	yes
PANGDAN	0.3	0.4	0.5	0.6	2.1	yes
SAPANG-DAKU	0.9	1.0	1.3	1.6	8.8	yes
TOLEDO	1.4	1.6	1.9	2.4	8.5	yes
subtotal non-MCWD area	9.9	11.3	14.5	18.6	106.5	yes
total Central Cebu coastal area	**137.8**	**161.8**	**221.9**	**290.7**	**259.0**	**no**

- Kotkot weir (6, 19 and 25 m high)
- Luyang Dam (43m and 28m high) or weir
- Buhisan reservoir dredging
- Bohol-Cebu water transfer

Six alternative strategies were developed consisting of various levels of groundwater use, surface water options and reliability levels. Ultimately a preferred strategy was selected that made maximum use of the groundwater in combination with the Southern Wells project (including intake from the Napo/Carcar river), the Luyang-Carmen weir development, the Lusaran 63m High Dam, the Kotkot 25 m dam and additional desalination in Mactan. This strategy scored best with respect to all criteria on (i) technical efficiency, (ii) cost efficiency, (iii) health and socio-environmental aspects, and (iv) institutional and organizational aspects. This strategy is called 'Water for all Cebuanos'.

The Action Plan

Since demand will grow over time then supply should follow that demand, which becomes costly. However, supply should neither be too fast as this will lead to overcapacity, nor too slow because then shortages will occur. Three phases are distinguished: short term (until 2010), mid-term (2010-2020) and long-term (2020-2030). Both supply increase as demand reduction measures are considered.



The solutions to meet the demand will strongly depend on the location. A distinction is made among the West Coastal Zone, the Upland Area, East Coastal Zone - outside MCWD, the MCWD service area actually served by MCWD, the MCWD service area that is not served by MCWD and the Mactan area.

West Coast

The groundwater potential in the western coastal zone is high (85 mcm/yr) and well exceeds the demand (13.4 mcm/yr in 2030). Private wells and production wells can take care that the demand is met.

Central Cebu Uplands

Although water demand in the Central Cebu Uplands is only a fraction (about 3%) of the total demand, supplying the demand is difficult since reliable water resources are scarce. Construction of spring boxes Level II is by far the best way to provide safe drinking water. Reliability of spring boxes, however, is rated low. In dry years, spring discharges may reduce considerably or even become zero for extended periods. Therefore, this measure should be combined with other measures such as rainwater impoundments. Since these impoundments also have a high risk to run dry, spring boxes are still needed to be able to bring potable water to the Uplands by trucks. This will require a system which makes use of an existing transport capacity that could be made on a 'need-only' basis.

East Coast, non MCWD service area

The non-MCWD area along the East Coast is comparable with the West Coast: the safe yields of the aquifers (21.4 mcm/yr) are much higher than the demand (5.2 mcm/yr). The increasing demand can be met by private or production wells with the preference of using private wells in rural areas and production wells in areas with industrial and population concentrations.

East Coast, MCWD service area (without Mactan)

The MCWD service area covers Cebu City, Talisay City, Mandaue City, Lapulapu City and the municipalities of Consolacion, Liloan and (partly) Compostela. The demand in the MCWD service area will exceed the safe yields of the WRMUs involved. At present both WRMU Cebu City and WRMU Mactan import water from other WRMUs (particularly from Butuanon, Cansaga, Kotkot, Liloan, Mananga and Minglanilla-Talisay). In addition, Cebu City also draws water from Buhisan and Jaclupan while Mactan has started to use desalinated water. The demand for MCWD water (excl. Mactan) is nearly increasing fourfold from 2005 to 2030 resulting in an additional demand of 118 mcm/yr in 2030. This additional demand will be met as follows (all figures compared to 2005):

Short term (2010). Additional water demand 18.8 mcm/yr:

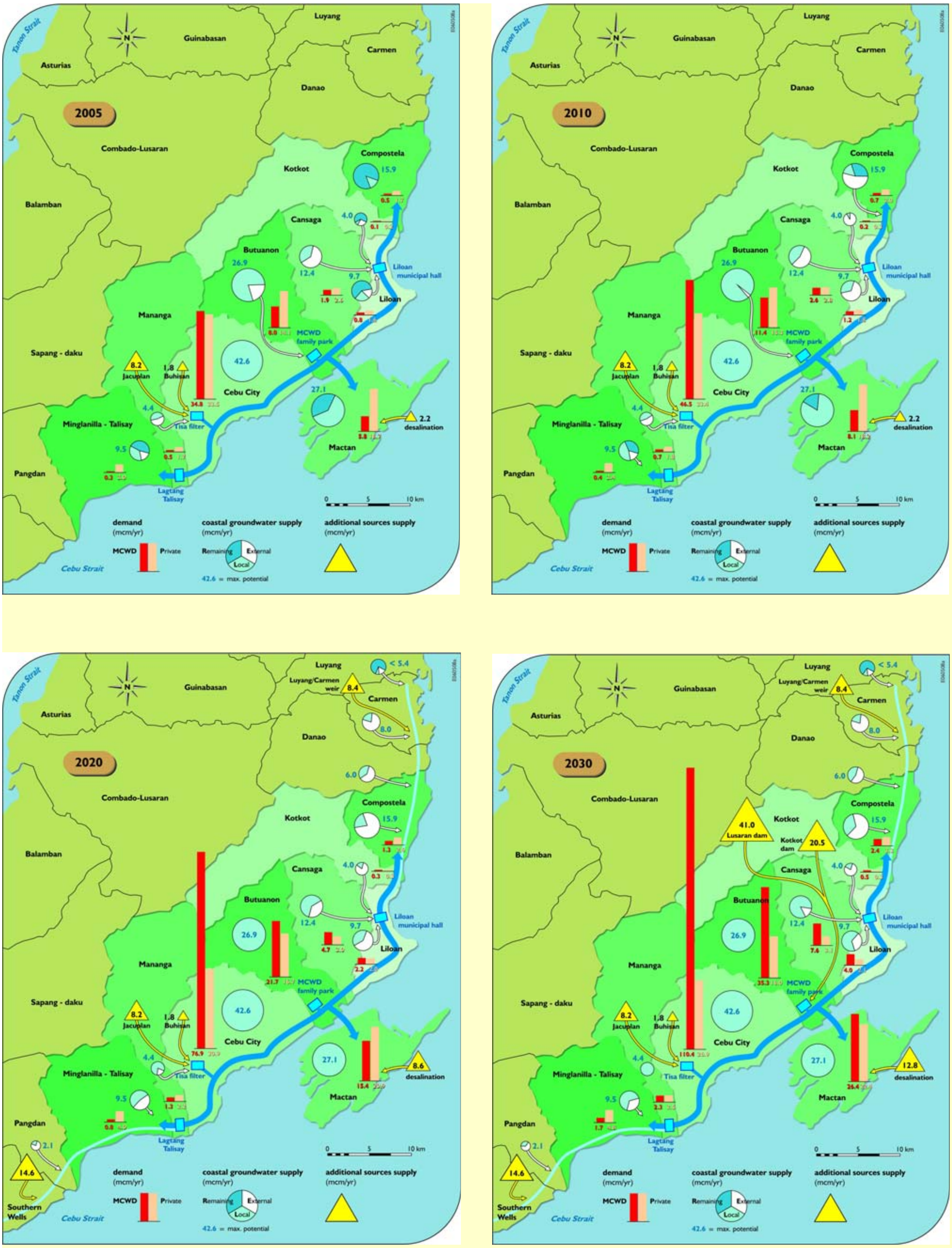
- using groundwater from other WRMUs in the MCWD area by means of production wells: 16.9 mcm/yr from the North (Compostela, Kotkot and Liloan)
- raising local groundwater abstraction for local use: 0.4 mcm/yr
- reducing export of groundwater to Mactan: 1.5 mcm/yr

Medium term (2020). Additional water demand 65.6 mcm/yr:

- raising local groundwater abstraction for local use: 2.0 mcm/yr
- reducing export of groundwater to Mactan: 2.6 mcm/yr
- using groundwater from other WRMUs in the MCWD area by means of production wells: 20.2 mcm/yr from the North (Compostela, Kotkot and Liloan) and 4.5 mcm/yr from the South (Minglanilla-Talisay)
- 'importing' groundwater from WRMUs outside the MCWD area: 11.6 mcm/yr from the North (Luyang, Carmen, Danao) and 1.6 mcm/yr from the South (Pangdan)
- 'importing' groundwater from outside Central Cebu: 14.6 mcm/yr from the Southern Wells
- developing surface water project, Luyang-Carmen weir (low yield option): 8.4 mcm/yr

Long term (2030). Additional water demand 117.9 mcm/yr:

- raising groundwater abstraction for local use: 7.3 mcm/yr
- using groundwater from other WRMUs in the MCWD area



Water demand and supply for the Metro Cebu WRMUs (2005—2030) by means of production wells: 16.5 mcm/yr from the North (Compostela, Kotkot and Liloan) and 3.0 mcm/yr from the South (Minglanilla-Talisay)

- 'importing' groundwater from WRMUs outside the MCWD area: 10.6 mcm/yr from the North (Luyang, Carmen, Danao) and 1.6 mcm/yr form the South (Pangdan)
- 'importing' groundwater from outside Central Cebu: 14.6 mcm/yr from the Southern Wells
- developing surface water projects in the North: Luyang-Carmen weir (8.4 mcm/yr), Lusaran 63 m dam (41.0 mcm/yr) and Kotkot 25 m dam (20.5 mcm/yr).
- reducing export of groundwater to Mactan: 2.9 mcm/yr
- exporting surface water from reservoirs to Mactan: -8.4 mcm/yr

For the non-MCWD serviced portion of the MCWD service area, a 'stand still' policy regarding new groundwater abstractions will be applied. Ultimately the demand will remain about the same as the growth in demand will be compensated by a shift from own supply to MCWD supply. Where needed, a limited number of either selected production wells or new production wells near the demand will be allowed. If hydrogeological surveys indicate that such local solutions are not possible, then consideration must be made to connect these specific, well defined, demand locations to the MCWD distribution net.

Mactan Island

The growth in demand in Mactan island can be partially supplied by an increase in the abstraction of groundwater. Horizontal wells and shallow wells are preferably used to prevent salt intrusion. The solutions are as follows (all figures compared 2005):

Short term (2010). Additional water demand 3.8 mcm/yr (plus 1.5 mcm/yr less supply from Cebu):

- 5.3 mcm/yr to be supplied by horizontal and shallow wells in Mactan

Medium term (2020). Additional water demand 13.9 mcm/yr (plus 2.6 mcm/yr less supply from Cebu):

- 10.1 mcm/yr by increasing horizontal and shallow wells in Mactan (bringing the capacity up to a safe yield)
- new desalination plants with a capacity of 6.4 mcm/yr

Long term (2030). Additional water demand 26.3 mcm/yr (plus 2.9 mcm/yr less supply from Cebu):

- 10.1 mcm/yr by increasing horizontal and shallow wells in Mactan (as in 2020)
- increase supply from Cebu island of 8.4 mcm/yr (requiring additional pipeline connections between the two islands)
- extension capacity of desalination plants up to 10.6 mcm/yr (bringing a total of 12.8 mcm/yr)

Other strategy components

The focus of the Action Plan is providing safe and affordable water for all Cebuanos. This approach is clearly supply driven. At the same time, all efforts should be made to reduce the demand and to protect the resources. Moreover, implementing this plan requires good governance and the necessary research and development to support the developments.

Water demand reduction

Rainfall harvesting. To be applied in rural as well as urban areas. This is already in the city ordinances although not very popular nor well implemented in Cebu. The total investment costs are also high. Further implementation of this measure requires a well organized and convincing information campaign that clearly demonstrates the benefits involved.

Reduction of losses in MCWD distribution system. This is an on-going measure. The 8-year program aims to reduce the losses each year by 1%. The benefits in terms of losses are clear but the costs are high. Moreover, fewer losses means also less additional supply to the aquifer which possibly will effect local / private groundwater withdrawals. A further technical and economical analysis is recommended on these aspects.

Adequate and differentiated pricing. MCWD already has a differentiated pricing system in place which provides the needed incentives to reduce the demand. Further optimization of the system and the elimination of certain constraints (e.g. the one-time connection fee) should be considered and a detailed study is recommended on the subject.

Promoting water saving equipment. Various options to stimulate industries and domestic users should be considered, such as providing subsidies, tax reductions (industry) or issuing regulations.

Awareness campaigns. Since domestic and public use are by far the greatest water users in Central Cebu, a reduction of the demand in this category will have a major impact. Two specific awareness campaigns are recommended: (i) a general awareness campaign for the whole Central Cebu, and (ii) a specific awareness campaign for selected high-consuming neighborhoods in the MCWD area.

Protecting the resources

The sustainable development of the water resources requires the protection of the resource from pollution and over-exploitation. Safe yields are introduced to avoid over-exploitation of the groundwater. Specific measures are needed to protect the surface system from further deterioration. Not only are these needed from an environmental point of view, but from a supply point of view, the resource need to be protected so that it actually could be used for socio-economic purposes.

Watershed management - land use practices. The watersheds in Central Cebu are very prone to degradation due to a combination of steep slopes, deforestation and shifting cultivating farming methods. Improved watershed management is needed to control and prevent erosion, including: (i) maintenance and enhancement of soil cover, (ii) maintenance and enhancement of infiltration capacity to reduce surface water runoff, and (iii) reducing flow velocities, to prevent flows from becoming erosive.

Urban sewage systems and treatment. The lack of proper sewage systems in urban areas threaten the quality of the groundwater, the prime source for drinking and industrial water supply. The introduction of a full sewage and treatment system is very costly but ultimately can not be avoided. A three level implementation is viewed as:

- the inclusion of sewage facilities in building requirements, taking care that all new developments can easily be connected in future;
- the establishment of a comprehensive septic management system for Metro Cebu, which includes hauling of sewage with hauler trucks and treatment at a central location; and
- the construction of full sewage and treatment systems at a central location with a controlled discharge of the effluent to the sea, industry (as grey water) or the aquifer.

Sanitary programs in uplands. This measure includes the provision of pour-flush toilet facilities for individual households and connected to one communal septic tank. This measure should be combined with an awareness program to show the relationship between health and the environment.

Well head protection. Besides the general activities to prevent groundwater pollution, specific measures are needed to protect the areas around the well heads. The main instrument is land use planning, ensuring that contaminating activities are not taking place in the water winning areas.

Improved solid waste management. This measure aims at the enforcement of waste separation at the household level and encouraging the community to re-use and recycle. The main components are: (i) mobilization and capacity building of the barangay leaders, (ii) community information and education, and (iii) promotion of income generating projects by using waste materials. The measure addresses only part of the issue; other measures are needed to solve the problem.

Implement strict effluent permitting. The Clean Water Act of 2004 provides sufficient facilities to control effluents. What is lacking is the capacity to implement the system. The proposed measure consists of the creation and operation of a multi-sectoral governing boards for water quality monitoring and surveillance. Strategies will be formulated and multi-sectoral groups are established to enforce the implementation.

Preventing sand and gravel mining in river beds. Also this measure addresses the implementation of existing regulations. A review by the concerned agencies, together with various stakeholders will be carried out to identify and remove possible bottlenecks for this enforcement.

Water governance

Effective water governance is a pre-requisite for the implementation of all measures in the strategy 'Water for all Cebuanos'. For most issues adequate laws, regulations and plans are already available. What is lacking is the political will at the LGU level (province, cities and municipalities and barangays) to enforce the laws and regulations and to cooperate and coordinate. The following activities are proposed:

Institutional setting for the implementation of IWRM. This measure aims at the establishment of a powerful, efficient and accountable Water Resources Management Board together with a strong Technical Secretariat to support IWRM in the area and the implementation of the Action Plan.

Control of water withdrawal. This activity aims to increase our insights on the volumes of extracted groundwater by private wells. It includes: (i) improvement of existing well information, (ii) identification of non-registered wells, and (iii) improvement of quality and quantity data on water abstraction. NWRB should play a major role in this.

Spatial planning - implementation and enforcement. Improvement of spatial planning will greatly contribute to a better tuning between supply and demand. This can be done by bringing future demand closer to existing water resources and by moving pollution sources away from groundwater resources.

Family planning and migration control. This measure seeks to slow down the increase in water demand by reducing the rate of population growth. As population growth is the main driver of the increased demand this can be a very effective measure. The measure is somewhat at the edge of a water plan but certainly deserves attention.

Priority allocation rules during dry periods. This measure aims to reduce the impacts of extended dry seasons. During such periods these impacts can be mitigated by allocating water to specific uses and users and by that reducing the social and economic impacts.

Research and Development

The activities in this category aim to support the implementation and further development of the Action Plan. Two activities are identified, both strongly related to the Technical Secretariat as mentioned above.

Improved data collection, analysis and presentation. This involves increasing our knowledge on the natural resources system (surface water, groundwater, quantity and quality) as well as our knowledge on the socio-economic system that determines the demand for water.

Improved decision support tools. The Water REMIND project has put in place a number of management tools. The present Action Plan is based on those tools. These tools need to be continuously updated and extended to support the next phases of the Action Plan.

How to implement the Action Plan

The implementation of the Action Plan will be accomplished by the various parties involved. An implementation plan is developed that specifies for each activity **what** has to be done, **who** will be responsible for that, **how** it will be done and **when**. The implementation framework includes monitoring and evaluation mechanisms on progress and effectivity of the implementation. A strong independent Technical Secretariat is needed to support the LGUs and take care of the monitoring and updating of the Action Plan.

Planning is a rolling exercise. The presented Action Plan should be seen as a first phase with a strong focus on the urgent needs for drinking and industrial water supply. Subsequent updating of the Action Plan should address the other issues involved. The following is the suggested 3 phase approach:

- **Action Plan 2006** (Phase I): focus on drinking and industrial water supply
- **Action Plan 2008** (Phase II): extension to include sanitation aspects, in particular in urban areas to protect surface water and groundwater quality
- **Action Plan 2010** (Phase III): extension with watershed management and spatial planning aspects.

Required investments and related recurrent costs

The implementation of the various components of the Action Plan will be scheduled in such a way that supply will follow demand. This will be straightforward for the West, Upland and East non-MCWD as the Action Plan includes for these areas relative small scale projects (groundwater pumping stations and spring boxes) that can easily follow the demand. For the MCWD area this will be less easy since some larger scale projects are involved. In particular, the surface water projects require much lead-time and will result in sudden large capacity increases.

The table below gives an overview of the required investment and recurrent cost as well as the life cycle and breakeven costs. Of particular importance is the breakeven costs which tells us the price level per unit of water (m^3) that should be charged to cover the investment and O&M costs involved. For MCWD, West, East and Uplands this breakeven costs are resp. 24, 23, 39 and 47 PhP/m^3. It is noted that the breakeven costs of MCWD is influenced by the fact that major projects such as Lusaran and Kotkot Dams are brought in late in the considered 2005-2030 period. Hence the dams mainly contribute to the costs, while the benefits are only limited to the period beyond the year 2030. If one considers a 45-yr period (up to 2045) these benefits will result in substantial lower breakeven costs.

Financing the Action Plan

To finance the Action Plan four financing sources are considered: public, private, public-private partnerships and local finance of small projects. Donor financing is not included specifically in this list. The mean reason is that donor loans tend to be made to and paid back by governments. As a result, the public finance source could well include funds not just from the government budget but from IFI loans made to the government of the Philippines. Based on the characteristics of the investments the following financing sources are considered for the various Action Plan projects:

- **Public Financing** (about 60%): Lusaran dam, Southern well fields and northern well fields
- **Private Financing** (about 20%): Kotkot weir, all desalination plants
- **Public-Private Partnership** (about 10%): Mactan horizontal & shallow wells, local production wells (MCWD,

Category	**Units**	**MCWD**	**West**	**East**	**Uplands**
25-yr Investment cost	PhP millions	15,387	849	639	737
25-yr Recurrent cost		11,968	458	331	1,460
25-yr Total cost		27,355	1,307	970	2,197
25-yr Water supply	mcm	1,829	81	33	55
25 yr Life cycle cost	PhP	15	16	29	40
25 yr Breakeven Cost		23	23	39	46
Economic evaluation					
Unit Price of Water	PhP/m^3	24	23	39	47
Net Present Value @ 12%	PhP millions	216	4	3	8
Benefit: Cost Ratio	PhP1 of benefit per PhP1 of cost	1.03	1.01	1.01	1.02
Internal Rate of Return	Percent	13	12	13	13

West and East)
- **Local Finance** (about 10%): Local private wells (MCWD, West, East) and uplands spring boxes / impoundments

The numbers between brackets indicate the approximate percentages of the total investment costs involved. The suggested projects are logical choices but other distributions are possible and may even be needed as a maximization of the private sector involvement which will depend on a reform of the Local Water Utility Administration (LWUA).

Communication and public awareness

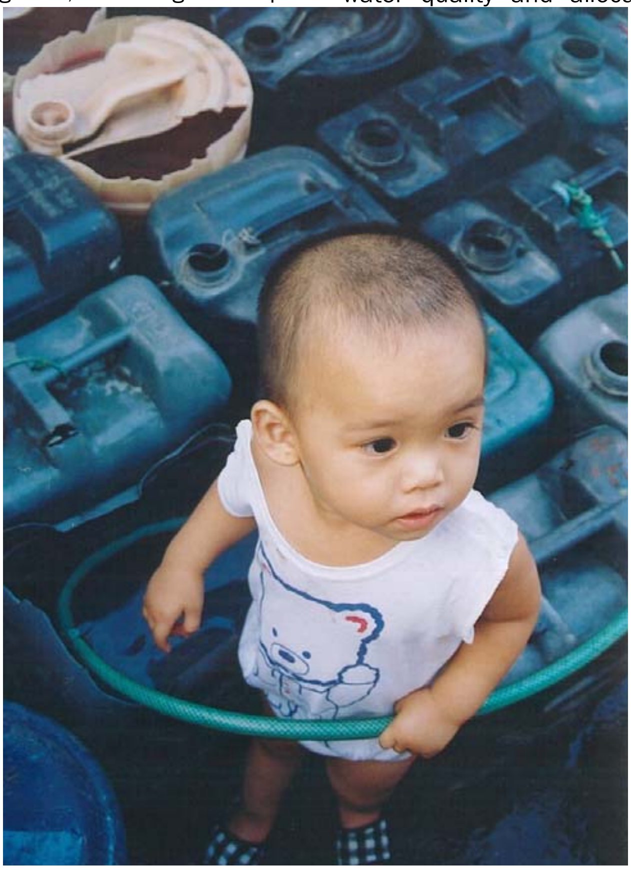
Communication and public awareness are essential conditions for a successful implementation of the Action Plan. The Action Plan depends on regional as well as local cooperation with a mutual understanding of the problems to be solved. Good communication will also help the public understand the reasons for certain measures and can facilitate the acceptance of these measures, in particular the measures for enhancing cost recovery. These measures will on the short term have substantial socio-economic impacts for individual households and companies without resulting in concrete benefits immediately. Public Awareness of the public but also of the business sector can result in substantial savings if water is used more efficiently and pollution is prevented. Cooperation with NGOs, in particular using their communication channels and jointly launching awareness campaigns, is recommended.

1. INTRODUCTION

1.1 Why a Water Resources Management Action Plan for Central Cebu

Problems with the present water resources situation and the way water resources are being managed in Central Cebu take many forms and affect many people. For some, it is simply not enough water available, but for many the issue is more on the quality of the water as a consequence of competition between incompatible uses or social, economic or institutional barriers which limit access to resources that may be abundant in an absolute sense.

A growing demand for safe, accessible and affordable water due to urbanization, population growth, increasing consumption levels, expanding industrial and commercial use and other factors all contribute to the emerging scarcities which are the challenges that any policy for managing water resources must address.



Only by efficient management and development of its water resources and water regeneration capacity, could Cebu be envisioned to sustain its steadily growing need for water. Without a strong commitment to improve the water resources and environmental management the damage would become irreversible, resulting in huge negative impacts on the quality of life of the people and the economy in the future.

For too long, the management of the water supply in Cebu has been more on a short term, if not ad hoc basis: the current practice of only reacting to unsolicited proposals or only considering projects as they are presented, rather than making them part of a bigger well-planned Water Resources Management development. As a consequence, these stand-alone projects are not very transparent and difficult to evaluate since the information flow is steered by the proponent. These are most likely more costly due to lack of combinations and considerations of economy of scale and therefore do not ensure a sustainable and responsible management of the resource.

Local Government Units (LGUs) and water districts, as mandated by law, have been mainly oriented towards today's water utilization with very little consideration towards protection and conservation of the water resources in the area. Consequently, this development is causing the local over-extraction and pollution of groundwater in most places. There is a lack of strategic vision and program to guide the development and management of the water resources.

Clearly, there are many different interests that may lead to conflicts. These are the basis for an Integrated Water Resources Management (IWRM) approach. Water Resources Management and Development plans should incorporate IWRM as a mandatory component of an investment strategy. This requires more long-term approaches, better scientific and technical input taking into account possible changes in the water resources availability and variability brought about by developments that go beyond the control of the WRM managers. Comprehensive water resources planning should also consider environmental needs, specifically carrying out water balance, water quality and allocation studies. In the case of groundwater, extractions should be limited to sustainable yields. Water resources development and management should therefore be founded upon a firm environmental sustainable base.

The international community recognizes the importance of safe water supply as a necessary building block in the development of healthier and more productive communities in the alleviation of poverty. The United Nations Millennium Declaration resolved to halve the number of people who are unable to reach or to afford safe drinking water by the year 2015. The main indicator for progress towards this goal is the proportion of the population (urban and rural) with sustainable access to an improved water source that meets the public health standards at a cost within an acceptable percentage of household income.

Similarly, one of the goals of the 10-point agenda by the present Philippine administration is that there should be clean water for all barangays. The administration is committed to the formulation and the implementation of effective measures to resolve water shortages by exploring the feasibility of the transfer of water rights and water allocation to address the scarcity problem in a rational and fair manner and prevent substantial losses to the economy.

This strategic Action Plan will spell out how to manage and develop the water resources in Central Cebu in the next 25 years to meet the local requirements as well as the national and international goals. The issues and solutions are related to policy, institutional, technical, financial, socio-cultural and economic environments.

The biggest challenge of this Action Plan is to enhance and re-structure the involvement of all key players and make them pro-active in implementing those solutions to the problems which have full ownership by all stakeholders. Only by joint collaboration, as well as adhering to the directions and recommended actions of an overall guiding and continuously updated strategic plan, could responsible and sustainable solutions that best address the needs of all Cebuanos be implemented.

1.2 Problem analysis

1.2.1 General perception

The water supply problems in Central Cebu have been under discussion for decades and were triggered by observed seawater intrusion. Recent observations of polluted coastal aquifers and surface water systems were considered even more threatening for the present and future sources. Moreover, the degradation and incoherent land use in the watersheds aggravated these problems.

At the same time it is generally believed that very little has been done so far to relieve the problems, while the demand for water considerably increases. The major water supply related problems in Central Cebu are best described as:

- Increasing lack of water and serious underdevelopment of new sources due to financial, political and capacity constraints
- Deteriorating water resources due to the degradation of watersheds and increased surface and groundwater pollution, also leading to less affordable water since costly water treatment will have to be considered
- Institutional constraints caused by fragmented and inefficient short term management and planning as well as the many different and often non-cooperating organizations involved

1.2.2 Scarcity versus expected water shortage

According to a FAO article[1] scarcity is a situation where there is insufficient water to satisfy normal requirements. However, this common-sense definition is of little use to policy-makers and planners. The degrees of scarcity can be categorized as absolute, life-threatening, seasonal or temporary. People with high levels of consumption may experience temporary scarcity more keenly than other people accustomed to using much less water.

Water shortage is most often used to describe an absolute shortage where levels of available water do not meet certain defined minimum requirements (i.e. it relates to immediate suffering and making water a serious constraint). The actual quantity that determines a minimum consumption per capita may differ from place to place. Water scarcity is a more relative concept describing the relationship between demand for water and its availability. The demands may also vary considerably between regions depending on the sectoral usage of water. A region with a high industrial demand will therefore experience times of scarcity more than a region with similar climatic conditions without such demands. Water stress is the symptomatic consequence of scarcity which manifests itself as an increasing conflict over sectoral usage, a decline in service levels, crop failure, food insecurity and many more. Water security is a situation of reliable and secure access to water over time. It does not equate to constant quantity of supply as much as predictability, which enables measures to be taken in times of scarcity to avoid stress.

There are a number of problems related to determining water shortage and water scarcity. In general, average figures are used which mask annual, seasonal and local variability within regions.

Water scarcity provides a measure of the sensitivity of a given situation. In situations when the average availability of water per capita is low, slight variations can render whole communities unable to cope. Water scarcity is a relative concept – it is partly a 'social construct' that it is determined both by the availability of water and by consumption patterns. Because of the large number of factors which influence both availability and consumption, determining water scarcity will vary widely from region to region. Adopting typically required water demands per capita to indicate water scarcity should therefore be done with great caution. While a threshold might be useful for purposes of comparison, it should be used carefully because it may understate situations of potentially serious water stress.

Because the concept of water scarcity is a social construct or, to put in other terms, a matter of political and economic perception, it is more useful to describe water scarcity as a particular mix of availability and demand at which water stress occurs, rather than a per capita figure. This means that its determination is more qualitative than quantitative, as the point at which water scarcity occurs may vary widely from one situation to another.

The causes of water scarcity are varied. Some are natural and others are a result of human activity. The current debate cites the causes as largely deterministic in that scarcity is a result of identifiable cause and effect. However, if water scarcity is the point at which water stress occurs (the point at which health effects occur, conflicts may arise, harvests fail and the like), then there are also less definable sociological and political causes. Many of the causes are interrelated and are not easily distinguished.

Table 1-1 Causes of water scarcity

Causes of water scarcity may be very diverse:	
Too little water	• Climatic change and variability • Population growth • Land use / sectoral activities • Changing consumption patters
Too polluted water	• Water quality • Watershed degradation
Inadequate institutional setting	• Poverty • Economic policy • Institutional capacity • Water resources management • Political realities

[1] Winpenny, J.T., 2000. Managing water scarcity for water security; Prepared for FAO.

The following starting points were adopted for this action plan:

- It is considered acceptable that water consumption varies from place to place (e.g. uplands vs. high-end residential sub-divisions). The plan will only guarantee that the consumption will be assured in the next 25 years.
- Future water requirements should be upgraded for lowest consuming portion of the population (adopting the millennium development goals).
- Future water requirements can be expressed as 'shortage'. Whereas for the present perception of lack of water, the term 'scarcity' would be more appropriate. The search for future water supply is based upon present consumption levels.

1.2.3 Too little water

The Dublin Principles on IWRM recognize every human being has the right to claim an essential minimum amount of freshwater: the amount necessary to sustain life and meet basic sanitation needs. For human survival, the absolute minimum daily water requirement is only about 5 liters/day, whereas for sanitation (bathing, cooking and other needs) the daily requirement is about 50 liters per person per day.

Water supply in the Philippines can be categorized into three levels: Level I (rural areas) refers to a point source like a protected well or spring without a distribution system, Level II (rural and urban fringes) refers to a source, a local storage, a distribution system and communal faucets while Level III (urban areas) refers to a source, a storage, a piped distribution system and household taps.

Various studies showed that different level users consume considerably different volumes of water per day, per capita use in liters. This is indicated below in *Table 1-2*. Unsuppressed demand (consumption under no limitations such as availability and costs) in Metro Cebu was estimated by MCWD at 190–200 liters/capita/day. With this upper limit, it would mean that residents in Central Cebu already faced some sort of lack of water.

Table 1-2 Per capita use (liters) in Central Cebu

SERVICE LEVEL	SERVICE AREA		
	MCWD	Non-MCWD	
	Urban/City	Town (Poblacion)	Town (Rural)
Level I (Unmetered)	10-15		
Level II (Communal)	30-40	15-25	
Level III (Individual)	150-175	120-130	100-120

[1] Boderie, P., 2005.Water Quality Technical Report

Scarcity in Central Cebu is observed in various ways: e.g. upland residents depended on importation of water by trucks after a dry spell, while Mactan residents utilized brackish wells to meet their water requirements in the absence of adequate freshwater supply. Industrial activities, especially high water consuming ones, are hampered or will not be initiated (worse case scenario) due to lack of water, related intermittent water services or too low pressure on the taps.

The demand for water depends on a multitude of different factors such as the present population, the expected population growth as well as economic growth affecting both industrial and commercial needs. In addition, improvement of the standard of living and service level will lead to increased water usage as well.

The dynamics of change in demand is directly related to other policy fields. Agricultural, infrastructure development, energy policies, industrial and tourism development all have an impact on the way water is consumed. Therefore water demand and supply management need to be considered in the light of a wider development context for the region.

1.2.4 Too polluted water

Water sources are quickly being depleted due to environmental degradation and inappropriate sanitation. In many areas, saltwater and pollutants have seeped into groundwater sources resulting in poor water quality. Some of the MCWD production wells were shut down due to nitrate pollution[1] in the Metro Cebu aquifers. In this case regular monitoring prevented the occurrence of public health impacts. These will ultimately lead to an increased need for costly water treatment in the future.

Insufficient distribution of water due to low pressure generally causes polluted groundwater to enter the drinking water system causing all sorts of waterborne diseases. Recently (2005), drinking water contaminated by human and animal waste caused a gastroenteritis outbreak in Moalboal (89 km southwest of Cebu City) killing four people. In less than a month, 22 residents of the neighboring town of Alcantara were admitted for treatment due to illness caused by drinking contaminated water from a non-treated spring source.

With the absence of adequate sanitation, demonstrated by utilization of open septic tank systems and lack of sewerage systems and treatment plants, further deterioration of the aquifers and surface water systems may be expected.

Inadequate provisions for wastewater management, lack of appropriate water quality and waste management together with increased population growth and sector development will all lead to an even more polluted water situation in the near future.

1.2.5 Inadequate institutional setting

Water problems, particularly scarcity and pollution, reflect failings in the institutional systems that had been developed to use and manage the resource potentials. The complicated relationship of 'who has access to the resources', 'who makes decisions about how they are to be used' and

'who benefits from the use' affecting the legal rights and social entitlements which relate to the resources need to be addressed. The various problems related to the institutional setting are described below:

Water resources development

The presence of many illegal well activities in the area was further stimulated by the lack of expansion of the coverage of the water district. The existing distribution system is old and inefficient, affecting the full utilization of water throughout the distribution network. In addition, leakage of up to 30% further reduces the available freshwater supply considerably.

The problem of widespread scarcity is not due to local water shortage per se (roughly only 10% of all precipitation in Central Cebu is used for water supply purposes) but is due to 'supply and demand mismatches' caused by inadequate infrastructure to capture and store abundant run-off during the rainy season for consumption throughout the year.

Funding and pricing of water

Water projects are not the only problems confronting LGUs and therefore must compete for LGU scarce resources. Financing for large scale water systems is very limited due to strict limitations on LGU borrowing. Future investments are also hampered by: limited possibilities for equity build-up; LWUA regulations imposed on water districts or associations; difficult utilization of financial flows coming from financial markets, multilateral financing institutions, government and development grants.

From an analysis of the municipal plans it appears that water funding allocation in the Annual Investment Programs (AIP) of LGUs is among the lowest, ranging from less than 1% to 15% of the total budget.

Throughout Central Cebu the price of water varies enormously: from an average 12 PhP/m^3 for private wells and 21 PhP/m^3 for households with MCWD connection to some 100 PhP/m^3 for vended water in the uplands. 'High quality' bottled water is even several orders of magnitude more expensive. At the same time, proposed rate increases by water providers are often viewed with suspicion and are difficult to implement (due to LWUA regulations or public resistance).

Cooperation, coordination and the present institutional system

A multitude of players are involved for the operational and strategic water management, often with confusing mandates and without efficient cooperation mechanisms. There is a lack of professional consultancy firms apparently due to too little work load or development potential. As a result NGOs have stepped in supposedly having and providing the required expertise.

Political interference and planning usually only holds true during the term of the elected officials. It is generally believed that investments for larger water schemes were not made because the implementation will not be delivering votes. The realization of a large-scale water infrastructure project as well can take many years (from pre-Feasibility Study / Feasibility Study, Financial Arrangements / Investment Coordinating Council, obtaining an Environmental Compliance Certificate, bidding and construction to operation) and requires substantial technical know-how and long-term planning.

Planning and capacity building

Capacity building is not regarded as an important investment cost. There is a predominant preference for short-term projects or heavily subsidized projects that yield short-term returns. That is why there is an urgent need for an Action Plan on water that would spell out the best strategies of interventions for the short, medium and long term rather than implementing an *ad hoc* 'politics of the day' decision-making.

1.3 Scope and policy objectives

Water Resources Management aims to support socio-economic developments. As such it includes all water related activities and phenomena. It addresses the various water uses (drinking water, irrigation, industry) and the problems associated with that use. The term IWRM emphasizes the required comprehensive approach needed to develop and manage the water, taking into account the interaction among three different dimensions: the natural resources system; the socio-economic system; and, the administrative and institutional system.

Table 1-3 WRMU percentage area per LGU

WRMU	Total (km^2)	LGU name	% covered
Asturias	31.80	Asturias	100.00%
Balamban	122.37	Balamban	57.80%
	122.37	Toledo City	42.20%
Butuanon	72.50	Cebu City	73.70%
	72.50	Consolacion	0.20%
	72.50	Mandaue City	26.10%
Cabiangon	73.90	Naga	12.30%
	73.90	Pinamungajan	68.50%
	73.90	San Fernando	0.40%
	73.90	Toledo City	18.70%
Cansaga	54.90	Cebu City	3.60%
	54.90	Consolacion	60.20%
	54.90	Liloan	30.20%
	54.90	Mandaue City	6.00%
Carmen	35.24	Carmen	51.00%
	35.24	Danao City	49.00%
Cebu City	100.71	Cebu City	82.20%
	100.71	Mandaue City	7.90%
	100.71	Talisay City	9.90%
Combado-Lusaran	226.70	Asturias	9.80%
	226.70	Balamban	64.10%
	226.70	Cebu City	15.10%
	226.70	Compostela	0.50%
	226.70	Danao City	10.50%
Compostela	39.69	Compostela	57.20%
	39.69	Danao City	42.80%
Danao	74.73	Carmen	1.80%
	74.73	Danao City	98.20%
Guinabasan	133.40	Asturias	58.30%
	133.40	Danao City	20.50%
	133.40	Tuburan	21.20%
Kotkot	80.52	Cebu City	45.40%
	80.52	Compostela	29.00%
	80.52	Consolacion	4.00%
	80.52	Danao City	6.00%
	80.52	Liloan	15.60%
Liloan	21.32	Compostela	0.00%
	21.32	Consolacion	19.70%
	21.32	Liloan	80.30%
Luyang	54.00	Carmen	88.40%
	54.00	Catmon	0.10%
	54.00	Danao City	11.50%
Mactan	58.67	Lapu-lapu City,Cordova	100.00%
Mananga	87.12	Cebu City	72.40%
	87.12	Minglanilla	0.40%
	87.12	Talisay City	27.20%
Mangoto	57.23	Aloguinsan	0.00%
	57.23	Pinamungajan	99.80%
	57.23	San Fernando	0.20%
Minglanilla-Talisay	76.12	Minglanilla	57.20%
	76.12	Naga	30.30%
	76.12	Talisay City	12.20%
	76.12	Toledo City	0.30%
Pangdan	47.67	Naga	99.70%
	47.67	Toledo City	0.30%
Sapang-daku	156.91	Balamban	8.50%
	156.91	Cebu City	9.70%
	156.91	Minglanilla	4.40%
	156.91	Naga	2.30%
	156.91	Pinamungajan	0.10%
	156.91	Talisay City	0.30%
	156.91	Toledo City	74.70%
Toledo	31.51	Pinamungajan	1.50%
	31.51	Toledo City	98.50%

The key issue therefore is the institutional context within which management decisions are reached. This means that IWRM is more than just matching demand with supply.

The IWRM approach relates to sustainability and public interest. The first deals with the maintenance of environmental quality, financial and economic sustainability (including cost recovery), participatory or democratic control mechanisms and the institutional framework through which decisions are reached and implemented. The second one deals with equity (ensuring the basic rights of all people to have access to affordable water resources), poverty alleviation (realizing the development potentials of water resources), gender, food security, health, employment, security (protection against floods, droughts and hazards) and merit values (culture and landscape).

Solving all issues will require an enormous effort from the local decision-makers. The financial and institutional constraints would entail a phased approach wherein the most urgent issues are addressed first and the other issues are gradually included in the next rounds.

The specific policy objective to be addressed by the Action Plan can be formulated as follows:

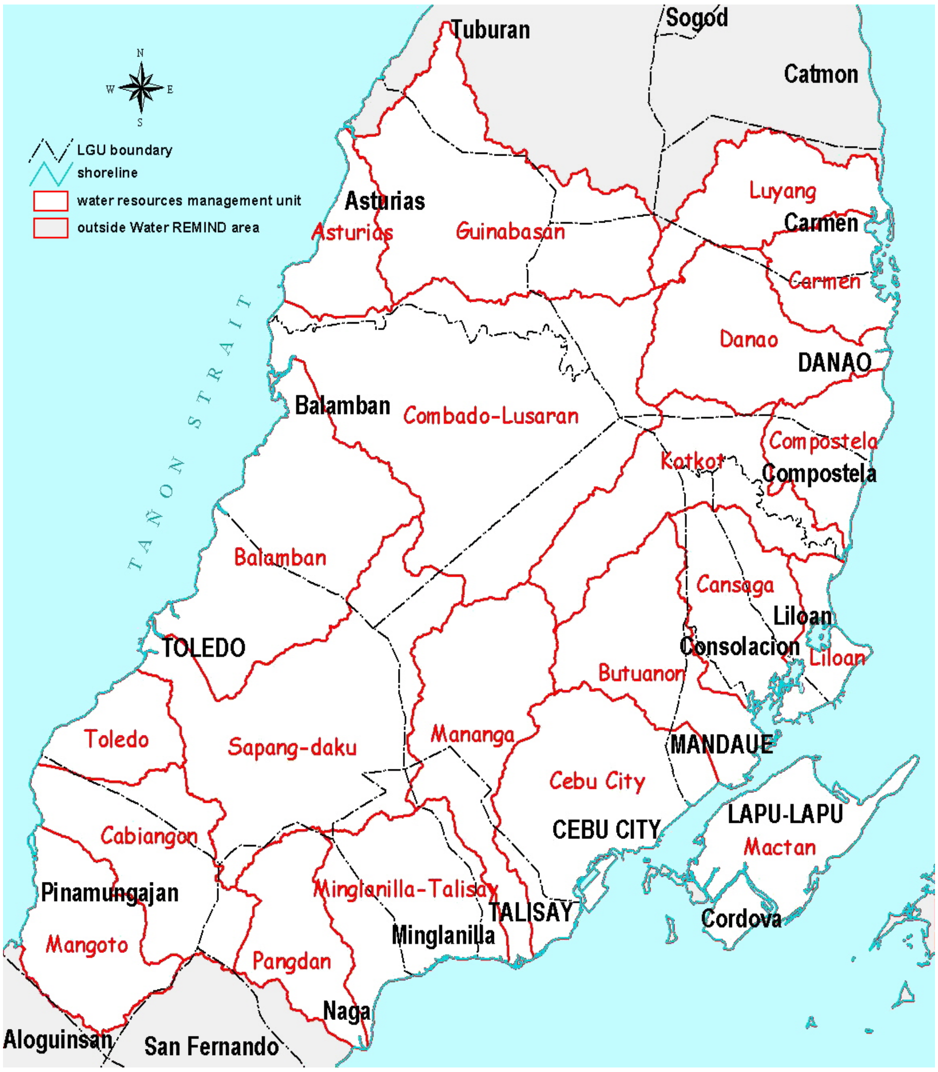
To ensure the continuous availability of water of good quality to all existing and future uses and users in Central Cebu at an affordable cost and in an environmentally friendly and sustainable way.

This focus on water supply and demand means that in the first strategic action planning phase, less attention will be given to issues such as sanitation, watershed management, livelihood development, and the like. These subjects will still be considered but only as far as they are needed in relation to the objective given above. In the next phase of the WRM planning these other issues will be addressed more explicitly.

1.4 Approach and analysis condition

In general, water has to be considered at the river basin level but most of the LGUs in Central Cebu are interested mainly in their own administrative units. This makes a combined approach necessary as indicated in *Figure 1-1*. Even

Figure 1-1 Cities, municipalities and WRMU's in Action Plan area



the World Bank states that managing the resources at basin level is a *'fata morgana'* (a theoretical construct with no practical applications). According to them, expectations are too high and need to be re-addressed. The basin approach will only suffice when dealing with large basins.

The Action Plan is area specific for Central Cebu which is composed of 6 cities and 10 municipalities, namely: the cities of Cebu, Danao, Lapulapu, Mandaue, Talisay, and Toledo; and the municipalities of Asturias, Balamban, Carmen, Compostela, Consolacion, Cordova, Liloan, Minglanilla, Naga, and Pinamungajan.

These administrative units are covered by 21 Water Resources Management Units (WRMUs). The WRMUs describe practical aggregations of hydrological basins of small streams. In the case of Central Cebu, the WRMUs overlap 454 barangays.

The time horizon addressed in the Action Plan is 25 years, starting from the base year 2005 and addressing the situations in 2010, 2020 and 2030. The year 2005 is also used as the financial base year, i.e. all prices and costs in this Action Plan are expressed in 2005 Pesos.

To avoid confusion it is important to define the terminology that will be used in this Action Plan:

Base case: situation at start year of the analysis (2005)

Reference case (short term: 2010, medium term: 2020 or long term: 2030): situation in that year if no new actions are taken while autonomous developments will continue to take place (such as population growth which will increase the demand)

Policy (objective): identification of the needs, the prioritizing of issues and the setting of targets for sectors or regions

Strategy: comprehensive and logical combination of individual measures or decisions that provides a solution to the WRM problem

Measure: individual action or decision; sometimes also called 'interventions' or 'actions'; one ready for implementation usually referred to as projects.

Scenario: a development exogenous to the water system under consideration, i.e. developments that cannot be controlled by the decision makers involving the WRM system such as climate change and population growth.

1.5 Outline of this document

In order to properly place into context the recommended water supply and demand strategy for the short, medium and long term it is necessary to introduce a number of aspects.

In *Chapter 1* the need for a Water Resources Management Action Plan. A comprehensive problem analysis and scope of the plan are presented, together with a brief description of the approach and analysis conditions.

In *Chapter 2* the Water Resources System in Central Cebu. The Natural Resources System, the Socio-Economic System and the Administrative and Institutional Systems are described.

In *Chapter 3,* the developments in the Water Demand and Water Use, as well as the forecasting of water demand, are determining factors for supply planning. In addition to a sector analysis, the related pricing of water is also explained.

In *Chapter 4*, a Water Balance Analysis is presented to describe the different flows of water in Central Cebu and to study whether the demand can be met. A description is also given of the analysis approach and the selection procedure.

In *Chapter 5,* the selected strategy, referred to as 'Water for all Cebuanos' is described. It includes an overview of all different measures that will be considered as part of this strategy.

In the *last Chapter* the various implementation aspects are covered, including the financial and economic consequences of the selected strategy, the risks involved and the different communication and public awareness aspects involved.

In separate *Annexes,* a more detailed description is given of the separate measures, alternative strategies, the financial and economic details of the selected strategy as well as the recommended institutional development.

Policy / objective: where do we want to go

Strategy: how do we want to get there

Measure: what are we going to do

Scenario: external development, affecting our strategy

2. WATER RESOURCES SYSTEM IN CENTRAL CEBU

2.1 General

Cebu lies between Luzon in the north and Mindanao in the south. It is surrounded to the east by Negros, southwest by Bohol and northeast by Leyte. With an area of 4,870 km² Cebu is 210 km long and 23 km wide, measuring 35 km in its broadest section near the centre. The Water REMIND project covers only Central Cebu which has an approximate area of 1635 km².

2.2 Natural resource system

2.2.1 Geology, geomorphology and soils

Cebu island is underlain by a core of Mesozoic basement rocks. Deposited on top of these rocks are sequences of younger volcanic and sedimentary formations. Capping this sequence of rocks is the Plio-Pleistocene Carcar limestone, formed along the periphery of the island. The most recent geological formation in the project area is unconsolidated silts, sands and gravels deposited in the alluvial plains and riverbeds and on top of the Carcar limestone. Geomorphologically speaking, Cebu can be divided in 2 major units: the central mountainous part of the island having a rugged topography with steep slopes and deeply incised valleys and the relatively flat coastal zones around the island. Population is concentrated in these coastal zones. Most of the soils in the Central Highlands are well drained clay loam soils, with a dark brown top soil, ranging in depth between 20 and 30 cm only. In the coastal zone alluvial soils prevail. These clay or loamy soils are generally well drained and sparsely vegetated.

2.2.2 Hydrometeorology

Within the Water REMIND project area a large number of rivers and watersheds can be distinguished. The largest east flowing rivers are the Mananga, Kotkot and Danao Rivers with basin areas of over 70 km². The largest west flowing river is Combado, which covers 219 km², inclusive of Lusaran watershed and the Sapang-daku (156 km²), which drains at Toledo and the Bago river (129 km²) in the north. The watersheds of the Mananga, Kotkot and Lusaran rivers are located within the Central Cebu Protected Landscape Area.

The nearly 100 watersheds in Central Cebu have been plotted into 21 Water Resources Management Units (WRMUs), the basic units for water supply and demand assessment in the Water REMIND project. *Figure 1-1* shows the boundaries of these WRMUs.

The general monsoon circulation pattern determines the variation of the temperature and humidity in the area. Average monthly temperature is highest in April-May (about 29° C) and lowest in January. The variation of the humidity is the opposite of the temperature variation: it is lowest in April-May when the temperature is highest and is very high from June to December. Monthly average wind data from Mactan airport indicate wind speeds of 2 to 3 m/s throughout the year.

Figure 2-1 illustrates the distribution of the rainfall over the years based on records taken from the Mananga watershed which distinguishes a wet period, from June to November, and a relatively dry period, from December till May. The average annual rainfall for 1981-2004 is about 1742 mm and varies between 932 and 2528 mm. In the early nineties the rainfall was below normal for three consecutive years.

Rainfall rates in the eastern coastal plain were lower: 1654 mm/y. Water balance calculations for the Mananga catchment resulted in an annual evaporation ranging between 1275 and 1075 mm. An average value of 1100 mm/year had been adopted.

The steep slopes and intense rainfall of Cebu resulted in very 'flashy' discharge regimes. Reliable flow-records for the past 25 years, derived from a discharge model with a daily time step, are available for 5 rivers: the Mananga, Combado-Lusaran, Danao, Kotkot and the Luyang River. Discharge characteristics of the rivers in Central Cebu are largely explained by the relative area of limestone within the catchments: the larger the limestone cover, the greater the capacity to store rainfall in aquifers, resulting in higher baseflows. See *Figure 2-2*.

Data on limestone cover within all catchments in Central Cebu, combined with area-rainfall records, allowed selection of a suitable Sacramento model parameter set. Long-term discharge records for all catchments in the area were generated by applying the Sacramento rainfall-runoff model.

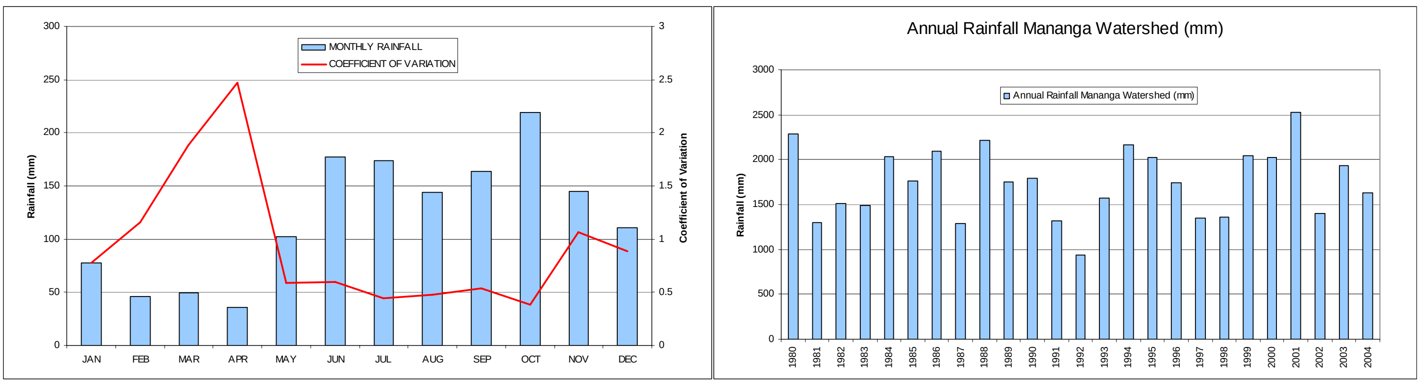


Figure 2-1 Average and variation of monthly rainfall and average annual rainfall (period 1980-2004) in Mananga watershed

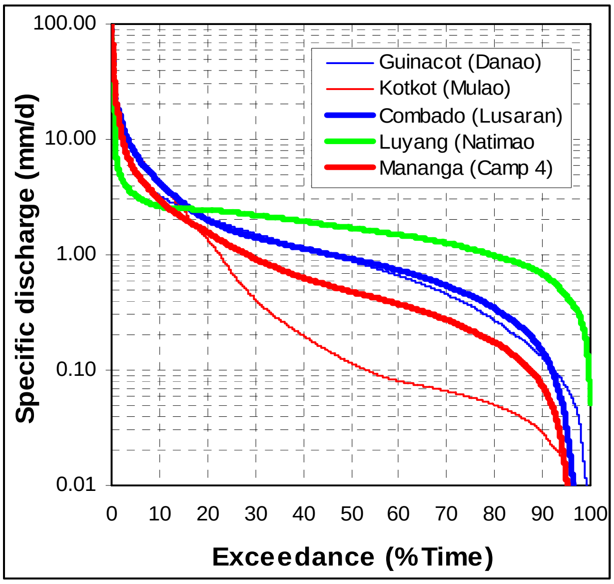


Figure 2-2 A 25 year data of flow duration curve For the five representative rivers (and their monitoring stations) studied in Water REMIND[1]

2.2.3 Hydrogeology

Groundwater is found in the porous and permeable parts of the geological formations. These are called aquifers. Within the Water REMIND project area the following main aquifers can be distinguished:

- the Carcar limestone aquifer composed of unconsolidated coralline limestone which is the most important groundwater system on the west and east coast and is the main source of water for the water supply of Metro Cebu and other towns.
- the alluvial sandy to gravelly sediments in river valleys providing groundwater from shallow wells, as well as offering possibilities for infiltration schemes such as at Jaclupan on the Mananga River.
- the alluvial sandy sediments near the coast providing groundwater from shallow private wells for domestic use;
- the Cebu limestone aquifers found at higher altitudes capping less permeable rocks and providing water mainly through springs.
- the sandstone aquifers of the Malubog formation in the Kotkot valley with a small but not yet fully exploited groundwater potential.

The other groundwater sources were small local systems within the volcanic or conglomerate rocks, situated in the uplands and providing water mainly through springs or wells with hand pumps.

The groundwater balance calculations of Water REMIND for the Talamban-Mandaue area indicated that high extraction rates, which were not a result of a rise in salinity, were only possible when a high recharge coefficient of 0.46 in the limestone area was assumed and when the river bed infiltration along the rivers crossing the area was at least 10% of its total discharge. Calculations for the San Vicente well field indicated high, or even higher recharge coefficients, as those calculated for the Talamban area. An almost complete absence of a surface drainage pattern and the presence of sinkholes supported this finding.

Groundwater had been used by MCWD for the public water supply of Metro Cebu since 1959. Prior to this public water supply came from the Buhisan Reservoir and Hagubiau spring, while groundwater abstraction existed only from a limited number of private wells. Since 1959 the total groundwater abstraction on the coast, from Minglanilla to Compostela, had increased annually to some 121 million m^3/year in 2004. Of this quantity about 41 million m^3/year was abstracted by MCWD and about 80 million m^3/year was abstracted by private wells. All groundwater abstraction in the coastal area came from the Carcar limestone or from the alluvial sediments[2].

Another major source of groundwater for Cebu City is the Jaclupan infiltration facility. In the areas to the north and south of Metro Cebu, groundwater was abstracted from private wells only. The total volume was estimated at 3 million m^3/year. On the west coast groundwater was used for public water supply in Balamban, Toledo and Pinamungajan. Groundwater was also abstracted from private wells using hand pumps or other means. The abstracted volume was estimated to be around 7 million m^3/year. The use of groundwater in the central part of the island was mainly restricted to shallow wells in the alluvial sediments of the river valleys and small diameter deep wells equipped with hand pumps. The abstracted volumes were small and probably around 1 million m^3/year.

In the built-up area of Cebu City further development of the groundwater resource is not recommended because of the existing high abstraction rate, the danger of sea water intrusion and waste water contamination. Further north and south of Cebu City more possibilities exist to develop additional groundwater sources in unexploited areas. The Compostela wells were drilled in 1984 which would have provided a total yield of about 15,000 m^3/day. These wells have not been used due to conditions set by the local government of Compostela. In the south two well fields were identified at Linao and Tungkop, Minglanilla which were expected to yield 7,200 m^3/day. Plans also existed to tap aquifers as far as Carcar to supply water to Cebu City. The available volume was estimated at 25,000 m^3/day.

On the west coast, potential developments remain in the currently underexploited limestone aquifer. The alluvial sediments along the rivers in the uplands is related to the existence of sufficiently thick deposits offering good groundwater storage. However, the available storage is sufficient for local water supply only. The development of untapped aquifers in the uplands is probably possible only from the sandstone of the Malubog formation in Barangay Paril.

2.2.4 Quality of the water system

From the limited data available it can be concluded that groundwater quality is generally quite good. Next to total hardness and total dissolved solids, only the chlorine and nitrate concentrations of the groundwater sometimes do not fall within the standards for drinking water set by the Department of Health.

The salinity of the groundwater, as an indicator of seawater

[1] Hooijer, A., 2005. Hydrology: 6th Technical Mission Report
[2] Linden, W. vd, 2005. Geohydrology: 4th Technical Mission Report

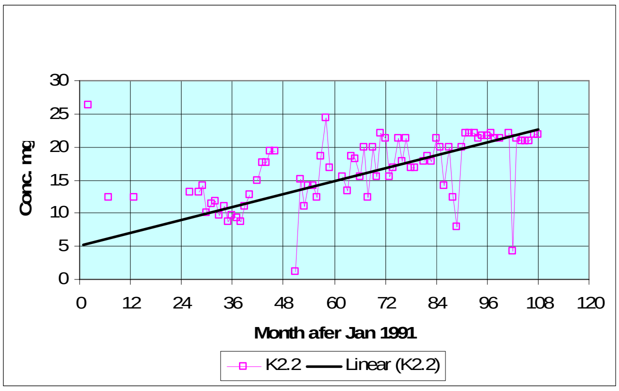
intrusion, has been monitored in Cebu City's coastal aquifer. Since 1975, USC-WRC had been measuring chloride concentrations in circa 180 wells on a yearly basis while MCWD gathered data of its production and monitoring wells on a monthly basis. According to these observations, the 50 ppm chloride concentration isoline (considered to represent the salt-freshwater interface) had moved 1 to 3 km inland in Metro Cebu. Over-pumping of groundwater from the coastal aquifer was thought to be the cause of the problem. Time series analysis of chloride levels in production wells showed that upward trends tend to level off at values somewhere between 300 and 600 mg/l. This was caused by the fact that MCWD reduces the production volume of wells that already have high chloride concentrations or where concentrations tend to increase rapidly.

When data on wells are grouped into three classes on the basis of maximum Cl concentration observed (< 75 mg/l, 75 < Cl < 300 mg/l, and Cl > 300 mg/l), no trends in Cl concentrations over the years were observed for the two classes with the higher chloride concentrations. Only wells that had very low chloride concentrations (< 100 mg/l during the last 30 years) showed a slight increase in chloride concentrations. Most likely this increase was caused by domestic wastewater seeping into the aquifer, and not by seawater further intruding in the freshwater aquifer.

MCWD data on nitrate concentrations in the production wells in the coastal area of eastern Central Cebu (1990-2000) showed average concentrations varying between 5 to 35 mg NO_3/l, which was well above the maximum allowable drinking water standard of DOH.

A large number of production wells showed a steady increase in nitrate concentrations since 1991. A typical trend for this period is depicted in *Figure 2-3* for one of the MCWD production wells. The alarming overall rising trend shown in

Figure 2-3 Nitrate concentration (mg NO_3/l) for one of the MCWD production wells in the period 1991—1999



the figure is typical for many MCWD production wells for this period. Increasing nitrate levels were caused by domestic wastewater seeping into the aquifer. This also resulted in bacterial pollution (coliforms) in deep and open wells. The pollution was generally only moderate (1-100 MPN/100ml). Springs have occasionally coliform values over 100 MPN/100ml.

Data on surface water quality showed that rivers traversing the urban centers of Cebu City and Mandaue City had poor water quality. Average annual biochemical oxygen demand (BOD) values were very high, ranging from 13 to 81 mg/l. The rivers crossing the comparatively less densely populated municipalities of Metro Cebu were somewhat less polluted, whereas in the upstream parts of the Guadalupe and Cansaga watersheds, water quality was rated as 'satisfactory'. As for the Kotkot and Mananga Rivers, water quality was rated as 'good'.

2.2.5 Vegetation cover and land use

About 10% of the total Water REMIND project area is classified as built-up environment. The largest percentage of built-up areas are found in Cebu City (55%), Mactan (44%) and Butuanon (32%). In most of the WRMUs, however, less than 5% of the area is built up. Agriculture is practiced on one third of the area while forests cover more than half the project area (53%).

Because slopes are steep, farmers in Central Cebu cannot use draft animals for tilling operations. As a result, the tilled area is relatively small and consists of scattered small parcels. Although the farmers depended on corn as a staple crop, mango production, vegetable and flower growing were prevalent in steep areas. The central part of the study area is composed of the Central Cebu Protected Landscape (CCPL), consisting of the Kotkot-Lusaran Watershed Forest Reserve (KLRWFR) and the Mananga Watershed Forest Reserve (MWFR). Aside from the CCPL, the Central Cebu National Park (CCNP) and the Sudlon National Park (SNP) are also protected areas.

Due to a combination of steep slopes, deforestation and shifting cultivation practices, soil erosion rates are high. Erosion plot studies suggested erosion rates between 10 t/ha/y for well covered agricultural fields, and 408 t/ha/y for bare tilled soils. Sediment deposits in the Buhisan reservoir indicated an erosion rate well over 100 t/ha/y. A long-term average soil loss/sediment yield figure of 50 t/ha/y, though high by international standards, was assumed for the upland area. From a water resources management point of view such high sediment yields are important: storage reservoirs will lose part of their storage capacity as a result of sediment deposition. Between 7 and 12% of the storage volume of the three reservoirs under study in Central Cebu will be lost through sedimentation in the next 25 years.

In Cebu, many reforestation projects had been implemented since 1911. These projects often took the form of replacing naturally regrowing shrub/forest by monocultures of commercial timber on very steep slopes. These do not contribute to the main benefits expected: increased river flows, decreased erosion and decreased landslides. In fact it may reduce river discharge (due to increased water loss through evapotranspiration) and enhance erosion. Reforestation should therefore only be contemplated in areas of limited slope, especially when the aim is to create a forest with good ground cover. In other circumstances, the best form of reforestation is to simply let natural regrowth mature, i.e. to leave the forest alone. Augmentation by selective planting of valuable species may be considered.

Next to reforestation, a number of pilot projects to improve agricultural management had been carried out. Contour plowing, strip cropping, maintenance of a good vegetation cover and establishment of vegetation on riparian zones (along streams) were measures that had been locally implemented.

Soil conservation, especially reforestation, is often regarded as a significant contribution to water conservation. However, there are doubts on the overall positive effect of reforestation on streamflows. Nowadays, it is generally accepted that forest clearing leads to increased annual water yields while seriously impaired infiltration opportunities due to gradual soil degradation or increase in compacted areas (roads, settlements) will lead to disturbed flow regimes (i.e. enhanced peakflows in the wet season and reductions in dry season flows). On the other hand, plantation forestry or forest regeneration on grassland or cropland will greatly reduce annual water yields (typically with 400 to 700 mm) due to the higher water use. Effects on streamflow are proportional to the fraction of the catchment treated, with a tree cover change of less than 20% of the catchment area, not producing a measurable effect.

2.3 Socio-economic system

2.3.1 Population

Prior to World War II, Cebu's population was among the slowest growing in the country. It was only during the 70s that the provincial population accelerated and its growth began to rival the annual growth rate (AGR) of the country. Cebu is now the modern-day economic phenomenon of the South, a factor that contributed to its steady population growth as well as being among the most highly populated provinces in the Philippines today.

The most logical explanation to the rapid increase of population was the expansion of Cebu and the emergence of Metropolitan Cebu (Metro Cebu). The metropolis is composed of four adjacent cities (Cebu, Mandaue, Talisay and Lapulapu) and six municipalities (Minglanilla, Naga, Cordova, Consolacion, Liloan, and Compostela). Metro Cebu, with Cebu City as the economic center, is the second largest metropolis in the Philippines after Metro Manila.

Central Cebu's population tripled in 40 years (1960-2000) with a rapid population change occurring in the 90s brought about by Cebu's economic progress, particularly on the eastern side of Metro Cebu. Based on the forty-year history, the population of Central Cebu grew from 661,861 in 1960 to 2,121,785 in 2000.

The average growth rate (AveGR) of Central Cebu, based on the intercensal growth rates from 1960-2000 and taking into account the median rate of the AGRs that occurred in between censuses, was computed at 2.8%. This figure was lower than NSO's 1995-2000 AGR of 3.4% for Central Cebu and 3% for the island of Cebu, but higher compared to 2.4% for the whole country[1].

As population growth was considerably faster on the eastern side of Central Cebu, Mandaue City, with the highest AveGR (5%) in Central Cebu, became a magnet for migrants lured by employment opportunities. Due to rapid commercial and residential growth, the eastern side of Central Cebu (Consolacion, Lapulapu, Talisay, Liloan, Cordova, Minglanilla, and Naga) had AveGRs of not less than 3%. On the other hand, Cebu City experienced a slower population growth with an AveGR of 2.2% as residential areas were shifting to adjacent cities and municipalities.

Population growth in Central Cebu, particularly in major cities close to Cebu City, was attributed to high birth rates, increasing number of informal settlers due to economic opportunities, and development of housing projects to accommodate the growing trend of in-migration.

Population trends for the cities of Cebu, Mandaue, and Lapulapu followed a similar pattern with population increasing at the interior upland portions and declining at the coastal downtown areas to give way to commercial establishments. In the case of Lapulapu City, the population had spilled over to Cordova and to smaller islets. As land for residential purposes in major cities including that of Talisay became scarce (and expensive), population movement continued to drift toward nearby municipalities such as Consolacion, Liloan, Cordova, Minglanilla, Naga, and Compostela. These municipalities were currently undergoing dramatic population growth as they became recipients of the populace that could no longer be accommodated in the major cities.

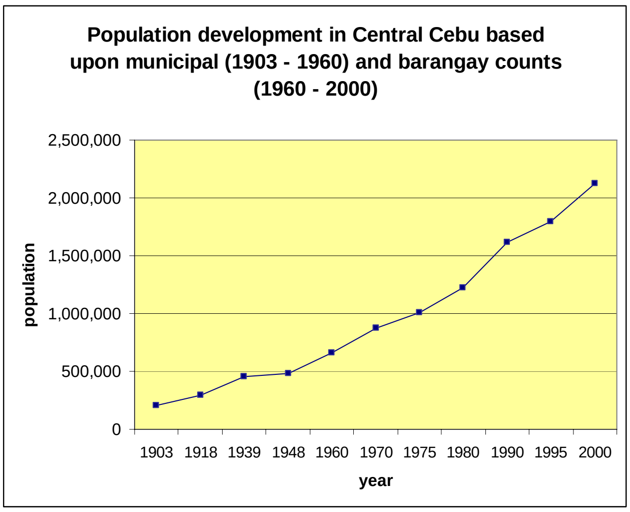


Figure 2-4 Population Growth The earliest census record on Cebu by the National Statistics Office (NSO) was in 1903. It was from 1960 onwards that censuses occurred at regular intervals; in 1960, 1970, 1975, 1980, 1995, and 2000.

[1] Arco, Edwin. Population Trends in Central Cebu, 2004.

Population growth rates on the western side of Central Cebu were relatively lower compared to their eastern counterparts. After the closure of the Atlas Mining Corporation in Toledo City, growth rates plunged from 1990-1995 but picked up again 1995-2000 after the establishment of the ship building industry in Balamban. Asturias, with an AveGR of 1.6%, had the slowest growing area as it experienced a decline in the agriculture sector.

Within the Central Cebu Protected Landscape (CCPL), a protected area that covers three critical watersheds and two national parks, population also tripled from 1960 to 2000. The presence of the Trans-Central Highway had been a factor for the accelerated population growth, particularly in barangays belonging to Cebu City. This was a clear indication that population was fast moving into the interior upland areas.

By the year 2000, the eastern portion of Central Cebu had a population density of not less than 1,000 persons/km^2 with Mandaue City as the most congested at 8,993 persons/km^2. More than 60% of the population of Mandaue, Cordova, Talisay, Lapulapu, Cebu, Minglanilla, Consolacion, and Liloan were residing on coastal and midsection barangays. Cordova was considered the densest of among all the municipalities in Central Cebu with 4,022 persons/km^2 having the smallest land area with a high AveGR (3.6%) as it continued to absorb in-migration from Lapulapu City, mainland Cebu, and other parts of Central Visayas[1].

[1] Arco, Edwin. Population Trends in Central Cebu, 2004.

On the western portion, the territorial units of Toledo City, Pinamungajan, Balamban, and Asturias had comfortable levels of population density with less than 700 persons/km^2 due to larger land areas and lesser AveGRs. Asturias was the least congested with 155 persons/km^2 as it had the lowest AveGR and a larger land area.

2.3.2 Economic sectors

2.3.2.1 Macro-economic conditions

The Cebu City Strategic Master Plan Study estimated the 2000 Cebu City GDP at 43.7 billion pesos with an annual growth rate of 8.4% in 1994-1997 sliding down to 2.4% in 1997-1999 during the Asian economic crisis. In Central Visayas, GDP rose to 80.5 billion pesos in 2004 contributing to an increased share of the national GDP. According to the data released by the National Economic Development Authority (NEDA), Central Visayas contributed 7.1% share to the national GDP, an increase of 7.02% in 2002-2003. GDP data are reflected only at regional and national levels while disaggregated data for the province of Cebu are not readily available.

2.3.2.2 Agriculture

NEDA also reported that the agricultural sector in Central Visayas had the least growth among the economic sectors with forestry posting a 'negative' growth of 60.3% in 2003. The same trend was observed in Central Cebu, and according to a study conducted by WRP in 2005, the total cultivated land decreased by 34.3% in the last seven years (1998-2004). In comparison to 1997, the land area used for agriculture had dwindled by 10.7% in 2004.

In total, only about 341.53 km^2 (34,153 ha) of the 1,669.62 km^2 (166,692 ha) in Central Cebu were used for agriculture. This represented 20.5% of the total land area in Central Cebu indicating that a minimal portion was actually cultivated for agricultural crops.

More and more productive men left traditional agriculture for other main sources of income. The presence of a shipbuilding industry in the municipality of Balamban was a classic example of this trend. In another case, productive age groups from Talisay City, Liloan, and Minglanilla took more lucrative or monthly-paying jobs in the cities of Cebu, Mandaue, and Lapulapu rather than indulging in agricultural activities.

The Cebu City Comprehensive Land Use Plan (1998-2003) indicated that the main source of livelihood in the city was derived from salaries in the services, manufacturing, trade, industrial, and commercial sectors. The Municipality of Cordova and the Lapulapu City were the only places in Central Cebu where agricultural production was not reported since livelihood was derived from manufacturing, services, tourism, fishery and commercial sectors.

The Regional Physical Framework Plan (RPFP) of Central Visayas (2001-2030) sees the decline of productive lands by 3.9% in the next 30 years. This will be due to the reversion of some lands presently under the productive uses to protective and urban uses. In Metro Cebu and in the municipalities straddling it, rapid urbanization has led to the increased demand for urban land. Moreover, upland areas

have not been spared by encroachment of settlements and economic activities. It was, thus, envisioned by the RPFP that, considering the limited natural resources of the province of Cebu, food and water source shall include most of the uplands, forest areas, and prime agricultural lands. Further, all economic activities to be undertaken in these areas shall be managed so as not to contribute to the degradation of natural resources and depletion of the fertility of the land.

2.3.2.3 Industry

According to the 2005 year-end report of the Cebu Chamber of Commerce and Industry (CCCI), political turmoil, peace and order problems, and natural catastrophes failed to dampen the economy in Central Visayas. In the same report, tourism, export, and services are the major growth drivers in the region for 2005. The Department of Trade and Industry (DTI) also reported that the major industrial activities of Cebu included industrial parts assembly, food processing, furniture, stone craft, fashion accessories, gifts, toys, housewares, electronics or electrical equipment, and coal and dolomite mining.

Although the Philippines was less affected by the Asian financial crisis of 1998 than its neighbors, Cebu had weathered the serious consequences brought about by national conditions and economic retrogression. The presence of other growth centers in outlying areas; the continually aggregating economic activities within Cebu City through additional investment inputs; increasing and improving exports; establishment of more industries in Mandaue City; and, implementation of government infrastructure projects all have contributed to opportunities for employment and income. According to CCCI, inflation rate in Central Visayas stood at 6.5% from January to October 2005, which was 1.3% lower than that of the Philippines in the same period.

Local incentives for investors play a major role in Cebu's industrial policy. For example, in January 2001, Mandaue City offered new businesses, as well as existing enterprises planning to expand their investments in the city, certain privileges such as exemption from tax payments and exemption from the payment of all licenses and permit fees (subject to the provisions of Mandaue City's Ordinance 2001/2004).

2.3.2.4 Fisheries and aquaculture

In Central Cebu, fisheries and aquaculture did not have a big impact on fresh water resources since the fishing industry was mainly concentrated on marine resources. There were no major inland fishing activities in this part of the province due to the absence of lakes and highly diverse rivers. Aquaculture activities such as *bangus* (milkfish) raising and shrimp production were mostly utilizing brackish water along coastlines. Freshwater fish production on a commercial scale is something that Central Cebu does not enjoy.

2.3.2.5 Tourism

Tourism in the Philippines developed rapidly in the 70s. According to the Department of Tourism (DOT), the Philippine tourism industry generated nearly US $2 million in revenues in 2005, with a 30.7% growth from the industry's income in 2004.

The biggest bulk of international tourists in the Philippines went to Region 7 comprising 16% of all destinations in the country in 2004. In Central Visayas, the tourism industry started with a big bang in 2005 after the tsunami, with visitors reaching almost 2.7 million. The region experienced a 15% growth of tourist arrivals between 2003 and 2004 with Cebu taking the largest share at 77%. During the first three quarters of 2004, tourist arrivals in the province increased by 17% from 2003. The Cebu Visitors and Convention Bureau (CVCB) projected 2 million pesos in revenues that would be generated by Cebu alone at the end of 2006[1].

In a study conducted by WRP in 2005, the tourism industry was also reported to be among the sectors that will boost the Cebu economy. With a variety of attractions (historical, religious, man-made, and cultural), Metro Cebu had evolved into one of the region's economic hubs, attracting both local and foreign investments.

2.3.3 Social aspects of water management

In a World Bank 1999 report, the incidence of Philippine poverty was said to be declining slowly and unevenly, and that severe regional disparities remained. In the same report, the urban poor became a rising share of the total poor population in the Philippines, although about two-thirds of the poor still live in rural areas.

In a sample survey conducted by WRP in 2004, 73% of the families in CCPL were below the poverty threshold indicating that poverty was significantly higher in rural areas. With an even higher poverty rate in the upland rural areas in Central Cebu, watershed management was observed to be greatly compromised. According to DENR-VII, the presence of poor people in the watershed area made restoration and management of protected and forest areas more complicated. Subsistence farming was generally considered responsible for deforestation and, along with cash cropping, subsequent ecological degradation in the uplands. Rural ecosystems faced additional pressures from suburban expansion, migration, commercial development, road building, and resource mining for urban construction.

In a study on behavioral patterns related to water use, land use, and watershed management practices conducted by WRP, water management in Cebu was faced with challenging scenarios. The rural poor, particularly those in upland areas, have limited access to water for domestic and agricultural use, with many farming families in upland areas relying on less developed water sources. While these families have become the subject of community-based management programs, they were also faced with insecurity of land tenure, tenancy, poor livelihood condition, and limited access to alternative farming technologies.

Problems on health and sanitation were found to be persistent. In a 2000 socio-economic profiling and environmental study of the four protected areas in Central Cebu by DENR-VII, almost 70% of water samples from boxed springs showed *E-coli* contamination[2]. According to the Cebu City Health Department, the lack of sanitation facilities in the upland rural areas resulted in water-borne diseases which were among the leading causes of morbidity in 2002.

While poverty is a major social factor affecting watershed / water resources management, institutional issues also play a considerable part. Majority of the water systems in Central Cebu are managed by the private sectors that are faced with

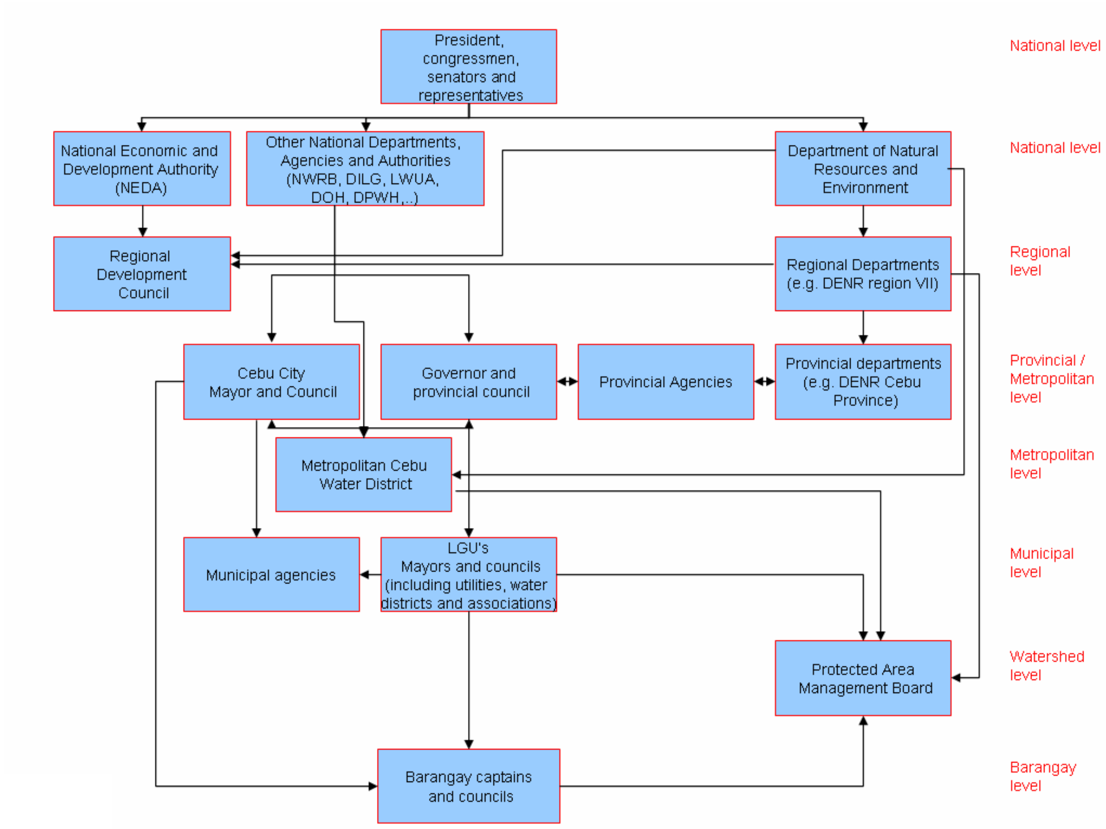


Figure 2-5 Water related key players in the Philippines

[1] NIPAS (R.A. 7586 & DAO 25-92 Chapter VI)
[2] DENR. Water Resources Profile, Vol.2. 2000

management problems as well as technical limitations on effective water resources management. The Cebu provincial government, on the other hand, iterates that the water system management should be an LGU concern and part of their income generating programs.

2.4 Administrative and institutional system

2.4.1 Introduction

The Philippine government has two levels: national and local. The national government has three branches: executive, legislative and judicial, while the local government unit has three tiers: provincial, city or municipal, and barangay. With the advent of the Local Government Code (LGC) of 1991, and consistent with local autonomy and decentralization, provisions for the delivery of basic services and facilities were devolved from the national government to the provinces, cities / municipalities and the barangays in accordance with the established national policies, guidelines, and standards. These basic services and facilities included, among others, general hygiene and sanitation, water supply system development, water and soil resource utilization, and irrigation systems.

2.4.2 Key players

Figure 2-5 sketches the water-related key players in the Philippines, identifying them according to the level they belong to.

At the national level, the National Water Resources Board (NWRB), through Executive Order Number 123, serves as the government coordinating and regulating agency for all water resources management development activities. The objective of NWRB is to achieve a scientific and orderly development of all water resources of the Philippines consistent with the principles of optimum utilization, conservation, and protection to meet the present and future needs. It is tasked with the formulation and development of policies on water utilization and appropriation, the control and supervision of water utilities and franchises, and the regulation and rationalization of water rates.

DENR and DOH provide administrative and technical supervision of its regional, provincial, and municipal offices. The former formulates policies for the enforcement of environmental protection and pollution control regulations, primarily responsible for the preservation of watershed areas and ensures water quality with respect to rivers, streams, and other sources of water. The latter is responsible for drinking water quality regulation and supervision of general sanitation activities.

For planning and policy formulation, NEDA provides inputs to the Local Development Councils (LDC), such as the Regional Development Councils, in crafting their respective short, medium, and long-term development plans. For every LGU, the LDC assists the corresponding *sanggunian* (legislative council) in setting the direction of economic and social development, and coordinating development efforts within its territorial jurisdiction.

LGUs are also resource regulators based on the LGC. Sector priorities including water are programmed by LGUs with the assistance of their respective LDCs and incorporated into their respective Annual Investment Plans (AIP). In Metro Cebu, the Metro Cebu Water District (MCWD) takes charge in exploring and undertaking development activities for the preservation and sustainability of Metro Cebu's water re-

Table 2-1 Key functions of water-related national agencies

AGENCY	FUNCTIONS
NWRB	The oversight body for efficient water use and sourcing. Issues the water permits and regulates non-water district water providers[3].
NEDA	Highest socio-economic planning and policy-making agency of the government. Ensures that programs are consistent with the national government's Medium and Long-Term Development Plans.
DENR	Responsible for the management, development, and proper use of the country's environment and natural resources, including those in reservation areas and lands of the public domain, as well as the licensing and regulation of all natural resources utilization.
DILG	Promotes peace and order, ensures public safety, and further strengthens local government capability aimed towards the effective delivery of basic services to the citizenry.
LUWA	Provides financial, technical, institutional development and regulatory services to local water utilities nationwide.
DOH	Principal health agency in the Philippines responsible for ensuring access to basic public health services to all Filipinos through the provision of quality health care and regulation of providers of health goods and services.
DPWH	Undertakes planning of infrastructure, such as roads and bridges, flood control, water resources projects and other public works, and the design and construction, and maintenance of national roads and bridges, and flood control systems.
Other Agencies coordinated by NWRB in terms of water resources management: Bureau of Fisheries & Aquatic Resources (BFAR), Bureau of Research & Labs. (BRL), Bureau of Soil & Water Mgt. (BSWM), Dept. of Agriculture (DA), Dept. of National Defense (DND), Dept. of Energy (DOE), Dept. of Science & Technology (DOST), Dept. of Transportation & Communication (DOTC), Dept. of Trade & Industries (DTI), Environmental Health Sciences (EHS), Laguna Lake Dev. Authority (LLDA), Natl. Mapping & Resource Information Authority (NAMRIA), Natl. Electrification Authority (NEA), Natl. Irrigation Administration (NIA), National Power Corp. (NPC), Office of Civil Defense (OCD), Philippine Air Force (PAF), Philippine Atmospheric Geophysical & Astronomical Services Administration (PAGASA), Philippine Council for Agriculture Forestry Natural Resources & Resource Research (PCAFNRRD), Philippine Ports Authority (PPA), and Philippine Tourism Authority (PTA) .	

[3] Indon, Reginald. Water & Sanitation Services for all, 2003

sources by providing proper water services in a timely, innovative safe and cost-effective manner conforming to internationally accepted standards. In the areas outside MCWDs jurisdiction, water services are provided by LGUs or private organizations such as water associations and cooperatives. Like MCWD, these private water utilities are sanctioned by the *sanggunian* and permitted by NWRB.

Crucial to the sustainability of Central Cebu's water supply is the viability of its critical watersheds which are protected areas under the management of the Protected Area Management Board (PAMB). Since the five protected areas in Central Cebu had been consolidated into the Central Cebu Protected Landscape (CCPL), the duties and functions of PAMB, among others, is deciding on matters related to planning, resource protection and general administration of the area in accordance with the General Management Planning Strategy. Based on the NIPAS Act of 1991, CCPL is under the control and administration of DENR. The CCPL PAMB serves as a vehicle for representative management on site.

NWRB is expected to effect the inter-sectoral or inter-departmental coordination of water resources plans and programs within the context of national plans and policies for social and economic development. To implement these policies, water resources management functions were distributed among numerous government agencies (see *Table 2-1*).

2.4.3 Water supply in Cebu

Water in Central Cebu is supplied both by public and private systems, either managed or sanctioned by LGUs. Water districts, such as MCWD, provide for the majority of the water requirements for the total urban population while rural waterworks and sanitation associations provide for the rest and which are mostly managed by private groups. Small water projects (such as hand pumps and spring developments) at the barangay / sitio level are either funded by LGUs or the consumers themselves.

To describe the existing public as well as the private water supply situation in Central Cebu, a simple diagram outlining the various actors and their perceived involvement is shown in *Figure 2-6*. Once the LGUs decide to organize their water supply activities through districts or associations, LUWA can extend technical and financial support. Developments in Cebu are clearly towards further private sector participation due to the financial status of the governmental institutions.

The visions of the Philippine National Development Plan for the 21st century (Plan 21) are to create a modern and humane society, to raise the quality of life of all Filipinos and to bequeath an ecologically healthy homeland to future generations. Its biggest challenge is to develop and implement sustainable policies, programs and projects and provide a harmonious and coordinated approach to water resources

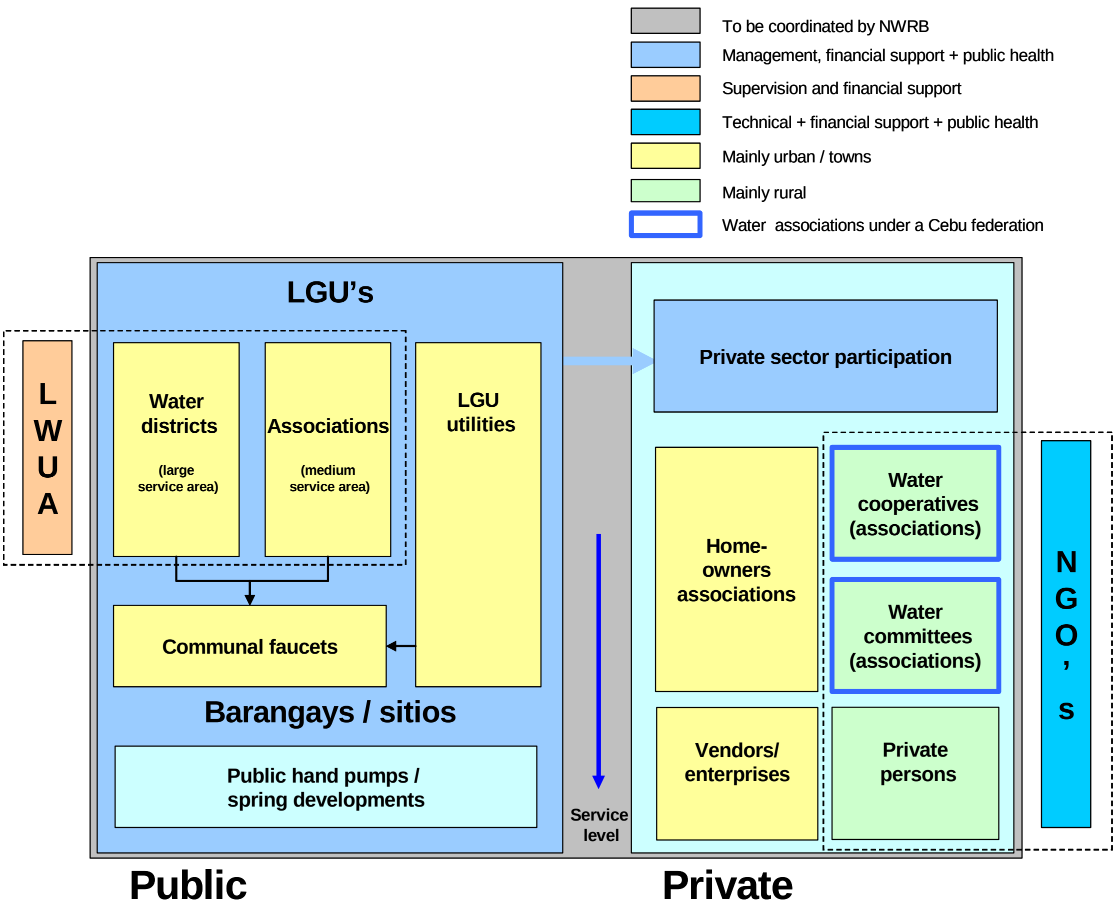


Figure 2-6 Water supply organization in Central Cebu

development while creating an environment conducive to private and public sectors' participation so as to increase investment. Plan 21 encourages participation in all aspects of water resources management, its use as well as its development. It calls for the promotion of market-based incentives for water conservation, a creation of a one-stop shopping for water resources development, and a provision of incentive programs for private sector investment in all water resources development initiatives.

2.4.4 Governance and legal system

There are sufficient and excellent policies, laws, rules and regulations in the Philippines that could provide the enabling environment for IWRM. These can empower all stakeholders to play their respective roles in the development and management of water resources. The forums and mechanisms, including information and capability building, have been created to establish the 'rules of the game' for stakeholder participation in water governance.

These include the aspect on ownership and rights over natural resources as embodied in the 1987 Philippine Constitution, the Water Code (PD 1067), and the Provincial Water Utilities Act (PD 198). Also signified in the Philippine Constitution is the concern on environmental protection and sustainable development, as stipulated in various Presidential Decrees (PDs 1151, 1152, 705, and 1586), the NIPAS Act (National Integrated Protected Areas System or R.A. 7586) and the Clean Water Act (R.A. 9275). Moreover, national policy documents on sustainable development include the Philippine Strategy for Sustainable Development, Philippine Agenda 21, Ecosystems Agenda, and Philippine Strategy for Improved Watershed Resources Management. Another significant feature is the mandate of various government agencies, the LGUs, and water districts. However, these agencies often have overlapping and/or ambivalent provisions.

All together there are 60 water management bodies in the entire Central Cebu area consisting of 20 water cooperatives, 18 rural water supply associations (RWSA), 15 barangay local government units (BLGUs), 3 water districts and 2 farmers' organizations.

About 33 management bodies are registered either with the Cooperative Development Authority (CDA), Local Water Utilites Administration (LWUA), Rural Development Corporation (RWDC) or Department of Labor and Employment (DOLE); 3 with pending registration; and the rest (22 bodies) are not registered and are not intending to register because these are managed by the barangay local government units.

Only a few of these management bodies are members of water federations. There are only 14 of them who are members: 7 are with the Cebu Federation of Water Associations (CEFEWA), 4 with the Central Visayas Federation of Water and Sanitation Service Cooperatives (CEVIFEWASSCO) and 3 with the Philippine Association of Water Districts (PAWAD). Moreover, MCWD has 298 communal water associations (CWAs) created from their installed communal water connections but these have not been federated.

Table 2-2 Type of Water Service within Central Cebu

City or Municipality	Type of Water Service
Asturias	Community water associations / communal water systems / Municipal waterworks system
Balamban	Community water associations / communal water systems / Water cooperatives
Carmen	Community water associations / Municipal waterworks cooperative
Cebu City	Metro Cebu Water District / "Barrio Waterworks System" project / Community water associations / private water vendors
Compostela	Metro Cebu Water District / Community water associations
Consolacion	Metro Cebu Water District / Community water associations / communal water systems
Cordova	Metro Cebu Water District / Private water vendors
Danao City	Danao City Waterworks System / Community water associations / communal water systems
Lapulapu City	Metro Cebu Water District / Private water providers
Liloan	Metro Cebu Water District / Community water associations / communal water systems
Mandaue City	Metro Cebu Water District / Communal water associations / private water vendors
Minglanilla	Municipal waterworks system / Private water providers / Communal water associations / water cooperatives
Naga	Naga Waterworks and Sewerage System / Community water associations / communal water systems
Pinamungahan	Community water associations / communal water systems / Private water providers
Talisay City	Metro Cebu Water District / Communal water systems / community water associations
Toledo City	Toledo City Water District / Community water associations / communal water systems

The limitation that besets Philippine Water Governance is the absence of an integrated national policy on water as well as the absence of an 'APEX' body to coordinate various government agencies in the implementation of water and water-related policies, laws, rules, and regulations. Ideally, the aim of such body would be to provide structures for co-ordination among various organizations in water resources management. In the Philippines, water policy and management is centered on NWRB, but in many instances and due to the absence of a regional presence of NWRB, responsibility for water is shared among a number of agencies and LGUs who do not operate easily together.

The apex body could provide a useful coordinating function at either the national or subsidiary levels of implementation. This could lead to creating more effective channels for communication and shared decision-making among government agencies, organizations, interest groups, and communities as well as encouraging people to think 'outside the box' of traditional sectoral definitions. This would eventually instill 'water awareness' among decision-makers responsible for economic policy in water-related sectors.

In the Philippine context and particularly for Central Cebu, the existing policies, laws, rules, and regulations provide an environment for cross-sectoral integration through IWRM.

This has already gained world-wide support as proven by experiences in many places. It addresses the interconnection of water, development, and sustainability. However, to truly manage and develop water in ways that advance sustainable development, an IWRM approach has to be viewed as a process of change in political, social, economic, and administrative systems. Access to this change can take place through the establishment of a coordinative institutional body that spearheads the implementation of IWRM working along certain enabling factors (see Annex D).

2.4.5 Planning and investment

2.4.5.1 Water supply

The Cebu Integrated Area Development Master Plan (CIADMP) for 2000-2010 has described the urgency of addressing the water issue in Cebu. But water sector plans and programs proposed by the CIADMP were of least priority for most LGUs in Central Cebu, as these are generally relied on the Metro Cebu Water District (MCWD) or water associations, and/or requiring larger technical and financial investments.

Water system development and maintenance was among the lowest expenditures of LGUs although it was seen as one of their sector priorities. Water spending accounted for less than 5% of LGU expenses as other basic services including agriculture, health, social welfare, and other infrastructures were given higher priorities.

The main reasons for limited water spending by the LGUs were: (1) reliance on MCWD / water district operations, (2) financial constraints, (3) dependency on special projects or external assistance, (4) privatization schemes of water systems, (5) proliferation of private wells, and (6) dependency on the private sector for new water sources and alternative technologies. Since the water sector was of low priority, its funding allocation in the AIP of LGUs ranged from less than 1% to 15%.

2.4.5.2 Sanitation

Clean water is an integral part of the strategy for reducing poverty and achieving the Millennium Development Goals in the Philippines. Laws that have direct relation to sanitation regulation in the Philippines include the Sanitation Code of 1975 (PD 856), the Ecological Solid Waste Management Act of 2000 (R.A. 9003), and most recently the Clean Water Act of 2004 (R.A. 9275). The last two laws mentioned were specifically formulated to widen and improve the Philippine Sanitation Code. R.A. 9003 and R.A. 9275 were also interlinked since poor solid waste management will eventually affect the quality of water.

The Central Visayas RPFP for 2001-2010 considers the significance of arresting water pollution threatened areas primarily caused by indiscriminate dumping of wastes into the rivers, streams, and seas by both industries and households.

The biggest challenge facing the local government includes the effective operation of the Solid Waste Management Board and the development and implementation of a comprehensive waste quality management program to guarantee effective water utilization and conservation.

3. DEVELOPMENTS IN WATER DEMAND AND WATER USE

3.1 Water demand forecasting

Forecasting water demand is a determining factor for supply oriented planning and operating of water systems. Ideally, water supply related projects must be developed to cover the calculated demand.

In determining water demand, local conditions must be determined separately due to the varying requirements among individual users and sectors (consisting of domestic, agricultural, tourism, aquaculture, mining, industrial and commercial demand). In addition, public water demand (street cleaning, fire fighting, watering of public areas), leakage of the distribution system and other unaccounted for factors (like illegal tapping) have to be considered as well.

Because of the numerous uncertainties concerning the future development of influencing factors and the significant lack of knowledge regarding current conditions in Central Cebu, a highly reliable assessment of water demand is difficult to obtain. What complicates a reliable assessment even more is that some factors influence consumption with short notice (meteorological factors, new infrastructure and economic developments), while others influence consumption over a long period of time (climatic factors, population development), so that these influences are able to either intensify each other or balance each other out.

Extrapolations from historic developments in population growth are no guarantee for future developments. For this, at least a full demographic model will be required which will include environmental factors such as habitable space and conditions, livelihood opportunities, public health, migration, and the like.

Demand forecasting for the next 25 years deals with many certainties which do not give a high level of confidence to decision-makers on how to organize Water Resources Management and Development. Previous studies of water demand projection included among others PIDS 1 & 2 (1998), JICA Water Master Plan (1998), Expertelligence Dev. Corp. (1997), JICA Cebu Integrated Area Development Plan (1994), Brown and Root, and ElectroWatt Eng. Services (1991) and CEST (2004). All these studies followed different approaches and have resulted in different outcomes.

The results represented what was possible within its limitations (data availability, time) the current knowledge and the mentality regarding the present demand. Estimates had been carried out on a barangay level which made use of the updated Provincial Physical Framework Plan / Comprehensive Provincial Land Use Plan (1993-2002) to map out the present land uses (built-up, agriculture, forest and mining). Regarding future predictions some choices were made with the key institutions (MCWD and LGUs) that would best reflect the policy directions and targets in the MCWD coverage area, see *Table 3-1.*

3.2 Domestic water demand

According to the Philippine Legislators' Committee on Population and Development (PLCPD), the population of the Philippines will increase by twofold in 29 years from 2004. The country's population had already doubled in the past 50 years and will do so again in less time.

In a study conducted by the Water REMIND Project, in which the median rate of minimum and maximum annual growth rates from 1960-2000 was utilized with a saturation concept based upon the available habitable space within a barangay, the population of Central Cebu is projected to accelerate in the next thirty years, from 2.1 million in 2000 to 4.3 million in 2030, *see Figure 3-1.*

Cebu City will be the most populated area, followed by the cities of Mandaue and Lapulapu. Likewise, population inside CCPL will more than double in 30 years time. By extrapolation, the population of CCPL will increase from 106,756 in 2000 to 250,000 in 2030. This extrapolation is similar to the overall trend in Central Cebu.

The 2000 NSO census data and projected future population per LGU is depicted in *Table 3-2.* This also gives an average short term growth (2005 – 2010) as well as the average growth for the entire planning period. It can be concluded that the growth in the dense areas will decline (saturated

Table 3-1 Policy directions and targets for future water demand forecasting

	short term	medium term	long term
Private well development	business as usual	stand still or less due to stricter regulation / NWRB presence	stand still or less due to stricter regulation / NWRB presence
Set-up of new water districts within MCWD coverage area	not to be considered	none	none
MCWD coverage	some 50% service in coverage area	some 70% service in coverage area	some 80% service in coverage area
Servicel level changes	Although a status quo was expected the MDG was applied by assuming that the consumption	Although a status quo was expected the MDG was applied by assuming that the consumption	Although a status quo was expected the MDG was applied by assuming that the consumption
MCWD expansion coverage area	none	none	none

growth), while in the less dense areas the growth rates will be fairly constant or even slightly increase (following standard geometric growth development).

It was assumed that for every individual connection an average household with a member size of 5.0 was applicable, while in communal water service connections, an average of 35 household-users with an average household size of 5.0 was adopted. The average daily demand per person of all service levels was computed from a random sampling of monthly water bills from households of different living standards, with known number of household members and water usage, and their locations. *Table 3-3* shows the breakdown of water consumption per person per day per service level.

Figure 3-1 Population increase in Central Cebu in the planning period (2005-2030)

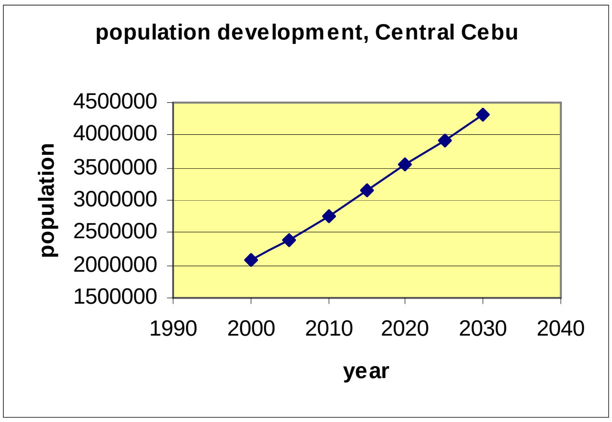


Table 3-2 Projected population and corresponding average growth rates (%) per LGU

	2000 (NSO data)	2005	2010	2015	2020	2025	2030	Average growth	Average growth
ALOGUINSAN	5,112	5,631	6,213	6,867	7,602	8,429	9,360	2.03	1.97
ASTURIAS	38,961	42,436	46,258	50,462	55,083	60,159	65,729	1.75	1.72
BALAMBAN	59,922	65,774	72,293	79,558	87,657	96,682	106,727	1.94	1.89
CARMEN	37,351	41,652	46,414	51,676	57,489	63,910	71,007	2.13	2.16
CATMON	2,195	2,417	2,667	2,950	3,271	3,634	4,046	2.06	1.97
CEBU CITY	718,821	812,498	910,942	1,013,374	1,120,909	1,234,437	1,350,229	2.03	2.29
COMPOSTELA	31,446	36,229	41,772	48,164	55,458	63,622	72,456	2.77	2.85
CONSOLACION	62,298	68,483	74,524	81,098	87,821	94,911	102,532	1.61	1.69
CORDOBA	32,883	37,071	41,219	45,359	49,521	53,792	58,301	1.81	2.12
DANAO CITY	98,781	112,735	128,714	146,855	167,092	189,170	212,620	2.54	2.65
LAPU-LAPU CITY	191,378	234,551	285,672	343,508	402,902	458,657	516,239	3.16	3.94
LILOAN	64,970	74,533	85,241	97,170	109,626	121,867	134,441	2.36	2.68
MANDAUE CITY	259,728	320,940	393,525	472,400	543,330	588,368	617,782	2.62	4.08
MINGLANILLA	77,268	85,593	93,957	102,599	111,691	121,310	131,410	1.71	1.86
NAGA	73,555	81,883	91,502	102,523	114,907	128,414	142,631	2.22	2.22
PINAMUNGAHAN	51,715	58,156	65,461	73,742	83,108	93,660	105,466	2.38	2.37
SAN FERNANDO	1,468	1,572	1,683	1,802	1,930	2,066	2,212	1.37	1.37
TALISAY	148,110	175,836	206,798	240,606	276,350	313,185	349,685	2.75	3.24
TOLEDO CITY	141,174	157,402	175,546	195,844	218,492	243,569	270,953	2.17	2.18
TUBURAN	7,333	7,665	8,015	8,383	8,771	9,178	9,608	0.90	0.89
Total	2,104,469	2,423,057	2,778,419	3,164,942	3,563,008	3,949,022	4,333,436	2.33	2.74

Source: NSO DATOS 2000

The combination of population growth, per capita consumption, water supply service level coverage as well as the targeted increase in growth, will determine the total domestic water demand per LGU, see *Tables 3-4* and *Table 3-5.*

In the assessment of domestic water demand for the short, medium and long term it was assumed that service Level I will be upgraded to Level II as a result of the implementation of the MDG.

*Table 3-3 Potable water consumption and observed ranges in metered water systems with water tariff. Level I consumption was estimated using information from selected rural communities (*Service level 2004, liter per capita per day)

SERVICE LEVEL	SERVICE AREA		
	MCWD	Non-MCWD	
	Urban/City	Town (Poblacion)	Town (Rural)
Level I (Unmetered)	13		
Level II (Communal)	33	30	19
Level III (Individual)	172	125	111

3.4 Industrial and commercial water demand

Industrial and commercial demands were assessed mainly from a constant percentage (3% for Metro Cebu and Balamban, and 1% for the rest of the area) of the yearly increasing built-up areas based on the Provincial Physical Framework Plan. Recently the region's industrial and commercial sector did not perform as well as in the nineties and therefore the average growth of the sector dropped to some 3.4%. At the same time the expansion of the sector did not show a similar increase in water consumption even if different activities were initiated. For this reason, as well as foreseen growth limitations due to lack of land, the long term growth numbers had been moderated to maintain a reasonable demand density per barangay (the growth rates of 0.6% and 3.2% for industrial respective commercial activities as provided by a previous water demand study for MCWD had been maintained.

From the MCWD records it appeared that only about 13% of the total volume of water it supplied was delivered for industrial and commercial purposes. Many industries still operated their own private wells and little information was available on the total water usage. Available permit-related data from NWRB only revealed maximum abstraction volumes adding up to unrealistically high values. A survey conducted by Water REMIND on actual abstraction rates was unsuccessful since only a few responded to the questionnaires circulated.

Table 3-4 MCWD coverage and water supply service levels within Central Cebu

LGU	MCWD			NON-MCWD*		
	MCWD coverage in % of households	Level II %	Level III %	Level I %	Level II %	Level III %
ALOGUINSAN		0	0	63	3	34
ASTURIAS		0	0	52 - 93	2 - 28	4 - 20
BALAMBAN		0	0	50 - 100	0 - 12	0 -38
CARMEN		0	0	52 - 94	2 - 28	4 - 20
CATMON		0	0	94	2	4
CEBU CITY	54	9	91	4 - 67	11 - 12	21 - 84
COMPOSTELA	32	4	96	65 - 67	1 - 14	21 - 31
CONSOLACION	27	11	89	57 - 91	0 - 7	9 - 36
CORDOBA	17	45	55	60	22	18
DANAO CITY		0	0	29 - 67	8 - 12	21 - 63
LAPU-LAPU CITY	30	12	88	0	0	100
LILOAN	41	9	91	53 - 75	13 - 26	12 - 20
MANDAUE CITY	43	13	87	21	32	47
MINGLANILLA		0	0	82 - 100	0 - 9	0 - 9
NAGA		0	0	72 - 100	0 - 17	0 - 11
PINAMUNGAHAN		0	0	18 - 63	0 - 3	34 - 82
SAN FERNANDO		0	0	63	3	34
TALISAY	35	1	99	72 - 100	0	0 - 27
TOLEDO CITY		0	0	8 - 52	17 - 18	31 - 74
TUBURAN		0	0	94	2	4

*Service levels within an LGU are different for rural and urban barangays

Table 3-5 Domestic water demand for all LGUs in Central Cebu

LGU	Domestic water demand (mcm / yr)			
	2005	2010	2020	2030
ALOGUINSAN	0.10	0.12	0.15	0.19
ASTURIAS	0.40	0.44	0.54	0.66
BALAMBAN	0.93	1.03	1.26	1.55
CARMEN	0.37	0.42	0.53	0.67
CATMON	0.02	0.02	0.03	0.03
CEBU CITY	37.28	44.13	60.00	78.24
COMPOSTELA	0.84	1.05	1.65	2.57
CONSOLACION	1.96	2.24	2.93	3.85
CORDOBA	0.75	0.86	1.14	1.52
DANAO CITY	2.40	2.81	3.81	5.01
LAPU-LAPU CITY	7.85	10.18	16.38	23.84
LILOAN	1.96	2.46	3.87	5.87
MANDAUE CITY	11.94	15.63	25.17	33.17
MINGLANILLA	1.14	1.26	1.50	1.78
NAGA	0.80	0.88	1.09	1.32
PINAMUNGAHAN	1.42	1.64	2.20	2.94
SAN FERNANDO	0.03	0.03	0.04	0.05
TALISAY	4.77	6.02	9.40	13.69
TOLEDO CITY	4.09	4.60	5.84	7.37
TUBURAN	0.06	0.07	0.07	0.08

Table 3-6 Total water demand by industries and commercial establishments for all LGUs in Central Cebu

LGU	Industrial and commercial water demand (mcm / yr)			
	2005	2010	2020	2030
ALOGUINSAN	0.00	0.00	0.00	0.00
ASTURIAS	0.21	0.24	0.32	0.43
BALAMBAN	0.74	0.81	1.00	1.23
CARMEN	0.25	0.28	0.35	0.45
CATMON	0.02	0.02	0.03	0.04
CEBU CITY	8.48	9.05	10.37	12.02
COMPOSTELA	0.26	0.29	0.36	0.46
CONSOLACION	0.18	0.20	0.25	0.32
CORDOBA	0.33	0.36	0.44	0.55
DANAO CITY	0.37	0.42	0.53	0.68
LAPU-LAPU CITY	7.07	7.39	8.15	9.10
LILOAN	0.69	0.76	0.93	1.16
MANDAUE CITY	7.77	8.02	8.63	9.38
MINGLANILLA	0.19	0.21	0.27	0.34
NAGA	0.13	0.14	0.19	0.25
PINAMUNGAHAN	0.24	0.27	0.36	0.48
SAN FERNANDO	0.00	0.00	0.00	0.00
TALISAY	2.28	2.43	2.80	3.25
TOLEDO CITY	0.27	0.31	0.41	0.55
TUBURAN	0.08	0.09	0.12	0.16

In Table 3-6 the total estimated water demand by industries and commercial activities is presented. The total net annual demand in Metro Cebu (especially Cebu City, Mandaue and Mactan) was 27 mcm for 2005. For the entire Central Cebu area this is only slightly higher than 30 mcm. Little or no industrial and commercial activities were found beyond Balamban and, to a lesser extent, Toledo City. The percentage of industries and commercial establishments served by MCWD increased from 22% of the total demand to circa 67%, in line with MCWDs targeted increase in service coverage.

3.5 Tourism

Tourism peaks in Cebu occur during the months of January (due to the Sinulog festival), July-August (when beaches are favorite destinations / vacation months in other countries), and October (when the temperature is cooler / start of the winter season in other countries). The Regional DOT Office reported that hotels and resorts were nearly 100% full during peak seasons. In lean months, room occupancy dropped to 50% to 70% in economy class / tourist inn hotels / resorts, and 60% to 80% in standard class / first class De Luxe / Class A hotels / resorts. Cebu City hosted the most number of hotels while Lapulapu City hosted most of the resorts. In total, DOT accredited hotels and resorts in Cebu could accommodate up to 18,000 guests/day who normally stay for 2-3 days.

The assessment is based upon a few simple assumptions. All the latest arrivals (some 765,000) had been spread over the available accommodation in the coastal barangays of Mactan, Cebu City and Compostela. It was assumed that the average length of stay was 3 days. The assessment assumed that the average growth during 1993—2000 of 5.7%, as observed by NEDA, would be steady during the planning period. The per capita water consumption by tourists was assumed to be 400 l/d. Total water demand by the tourism industry increased from 1—3 mcm/yr.

3.6 Agriculture and aquaculture

Based on the records available at the Municipal Agriculture Offices (MAO), 16 major crops were cultivated in Central Cebu with corn occupying the largest land area representing 40% of all the cultivated lands. It was followed by coconut (28%), mango (12%), and rice (11%). Crops that were exported by Cebu included mango, banana, sugarcane, and coconut. The other crops were solely for local consumption. Cebu is still dependent on agricultural imports from other parts of the Philippines. All of the 16 major crops produced nearly 895 thousand MT in 2004 with mango having the highest production at 78.7% of total yield. It was followed by corn (9.3%), rice (3.3%), sugarcane (3.1%), and coconut (2.4%)[1].

Factors that contributed to the downward trend of agriculture in Central Cebu include land conversions from agricultural to residential, commercial, or industrial purposes; increased population growth; upland out-migration; and negative farming outlook. More and more people within the pro-

[1] Arco, Edwin. Agriculture and Tourism Trends in Central Cebu,2005.

ductive age group were seeking monthly-paying jobs and other lucrative employment such as small-scale enterprises. Utilizing data from LGU yields, Central Cebu will see a decline of crop production by 2030 due to a decrease of cultivated lands. By that time, water demand for agriculture will reduce thereby creating a scenario of an increased water demand for industrial, commercial, and residential purposes. Watershed management will also be severely affected as population growth will impact on land and water resources. On the other hand further intensification of agriculture production would require more water.

The agricultural water demand considered in this study was based upon the total crop water requirements under non-stressed conditions (no limitations assumed to the growth: farmers supply sufficient water to the crops to prevent water shortages).

The term crop water requirement is defined as the water needed for evapotranspiration, from planting to harvest for a given crop in a specific climate regime, when adequate soil water is maintained by rainfall and/or irrigation so that it does not limit plant growth and crop yield. Based upon the available municipal crop information and known available municipal area per crop, a simple method was applied to calculate the agricultural water demand.

As irrigation practices are quite unknown, it was assumed that all municipalities applied a similar practice in meeting the crop water demands (utilizing surface water). Moreover, no information existed on where and how the crops were grown (coastal versus uphill, slopes, soil geology, fertilization, intensity, density, etc.).

The municipal crop yields per hectare, together with the available area per crop were used to obtain an estimate of the total water consumption per crop per annum. The procedure is outlined in *Figure 3-2*.

First the harvested biomass was used as an indicator for the entire annual biomass production. It was also assumed that the entire biomass included crop plants as well as weeds. In the case of perennial crops, only the biomass increased. During the period of time of harvest mass production had to be considered.

Using a harvest index, the harvested biomass was converted to the total plant biomass (or total annual increase in biomass). The factor was small (1.2 - 2.0) in the case of crops such as carrots and sugar cane but higher in the case of corn, banana or papaya (5–12). The fresh weight had to be converted to dry weight since most literature data on water consumption were expressed in water consumption per kg of dry plant matter (i.e. dried at 105°C). Average values between 0.25 and 0.32 were assumed in the formula (0.25 for fleshy herbs, 0.28 for dry herbs and 0.32 for woody plants). Approximately 60 – 95% of the normal biomass consisted of water. However, the water content of seeds was significantly lower (0.5 – 20%).

In the final step, the water consumption in the production of plant matter was estimated using a transpiration index. This index expressed the volume of water needed to produce one kilogram of dry weight plant matter. According to literature, this value could vary between 250 m^3 and 1,000 m^3. However, in most cases it ranges between 300 m^3 and 600 m^3 of water. With the transpiration index the water consumption of the whole production system was considered (i.e. yield + biomass increase + shrubs / weeds). As this approach was rather straight-forward and did not result in uncertain subtractions of large values (in case the potential evapotranspiration and effective rainfall would have been considered) it was applied as a best estimate in the water demand approach. In addition to this conversion an irrigation efficiency correction was applied.

In *Table 3-7,* the agricultural water demand is presented. It is assumed that the demand is already reflected in the calculated water balances as a total consumption in the basin due to evapotranspiration. Due to the incompleteness of data, no additional aquaculture demand was considered.

3.7 Others

3.7.1 Public water use

Public water demand (street cleaning, fire fighting and watering of public areas) was considered as a spatial constant but slightly increasing (1% / yr) demand in a percentage (10%) of the built-up area in urban barangays (5 m^3/ha/d). The estimated outcome of public water use were highest in the dense urban areas such as Cebu City (5 mcm/yr as of 2005).

3.7.2 Non-revenue water

The problem of non-revenue water is usually attributed to leakages, illegal connections, defective meters and administrative losses due to incorrect reading and billing procedures. Comparing earlier estimates on the system recovery rates, indicating the total volume of water that still will be lost as a result of inadequate recovery, showed that over the past years there was some progress. According to MCWD it now moves slowly to 72%, see *Figure 3-3*.

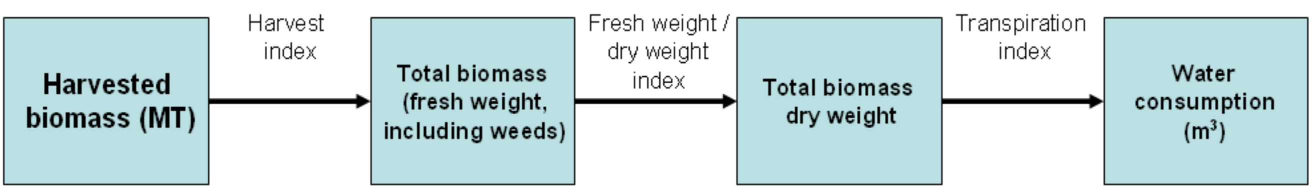


Figure 3-2 Method of computation of agricultural water demand

Table 3-7 Agricultural water demand for all LGUs in Central Cebu

LGU	Agricultural water demand (mcm / yr)			
	2005	2010	2020	2030
ASTURIAS	3.30	3.47	3.83	4.23
BALAMBAN	2.97	3.12	3.45	3.81
CARMEN	0.94	0.99	1.09	1.20
CEBU CITY	0.24	0.25	0.28	0.31
COMPOSTELA	2.36	2.48	2.74	3.03
CONSOLACION	0.41	0.43	0.47	0.52
CORDOvA	0.00	0.00	0.00	0.00
DANAO CITY	2.55	2.68	2.96	3.27
LAPU-LAPU CITY	0.00	0.00	0.00	0.00
LILOAN	0.32	0.33	0.37	0.41
MANDAUE CITY	0.40	0.42	0.46	0.51
MINGLANILLA	0.55	0.57	0.63	0.70
NAGA	1.54	1.62	1.79	1.98
PINAMUNGAHAN	3.06	3.22	3.55	3.92
TALISAY	1.25	1.31	1.45	1.60
TOLEDO CITY	2.78	2.92	3.22	3.56

The projections for the entire planning period, therefore, made use of conservative estimates from constant system losses of 28%. This unaccounted percentage was assumed to be largely related to leakage.

It should be realized that the loss implies that for the year 2030 the volume loss will amount to almost 42 mcm, i.e. slightly more than the total abstraction volume of the bigger reservoirs considered (Mananga, Lusaran).

Upgrading the water supply services to provide better services in the near future could be a substantial task, especially if consumers are accustomed to supplies of a few hours every so often at very low pressures. The fittings of the consumers will not withstand higher pressures without leaking. Similarly, the distribution network will probably leak at a higher rate. Therefore the task of upgrading poor systems is huge and expensive. Despite the recent success in achieving increased system recovery processes, it is expected that, when new sources come in, these may come to a stand-still.

3.8 Performance and summary

The water demand assessment was done in a way that the current knowledge on water demand, taken from various studies and based on the metered consumption records of MCWD and current thinking, was reasonably represented in terms of short term population growth, total estimated current water demand in Metro Cebu, total industrial water demand in Metro Cebu and Mactan. The present study distinguishes itself from other studies by the higher level of detail of the calculations, capturing more specific developments and expressed on a barangay, municipal or a WRMU level. It should be noted however that any prediction on future water demand strongly depends on the population and economic development in the region and more detailed demographic and economic studies will have to be initiated to update the current estimates.

The increase in water demand per barangay expressed as the total required consumption per hectare is presented in *Figure 3-4*. The highest consumption increase (more than 50 m^3/ha/d) were found in the areas of Cebu City, Mandaue City and the Mactan area, while minimal increases (less than 1 m^3/ha/d) were found in the upland areas.

The total water demand in Metro Cebu, therefore, is projected to increase from 146 mcm in 2005 to 280 mcm in 2030 based on the estimated current water demand.

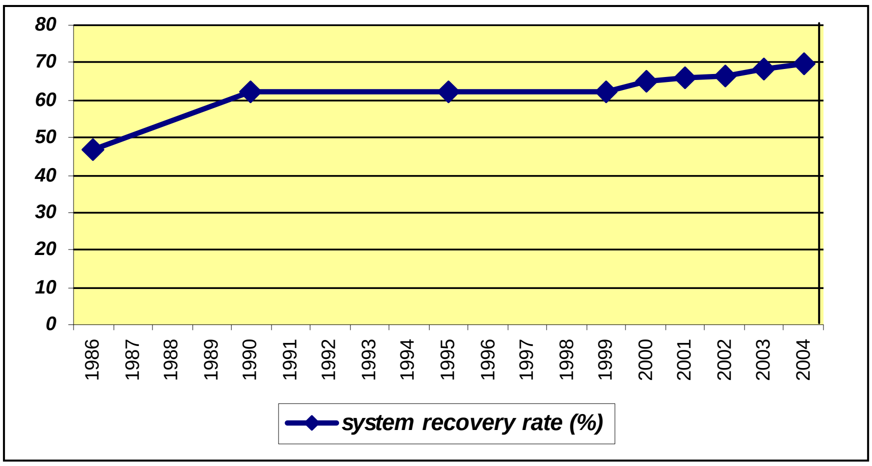


Figure 3-3 Historic system recovery rate in the MCWD distribution network

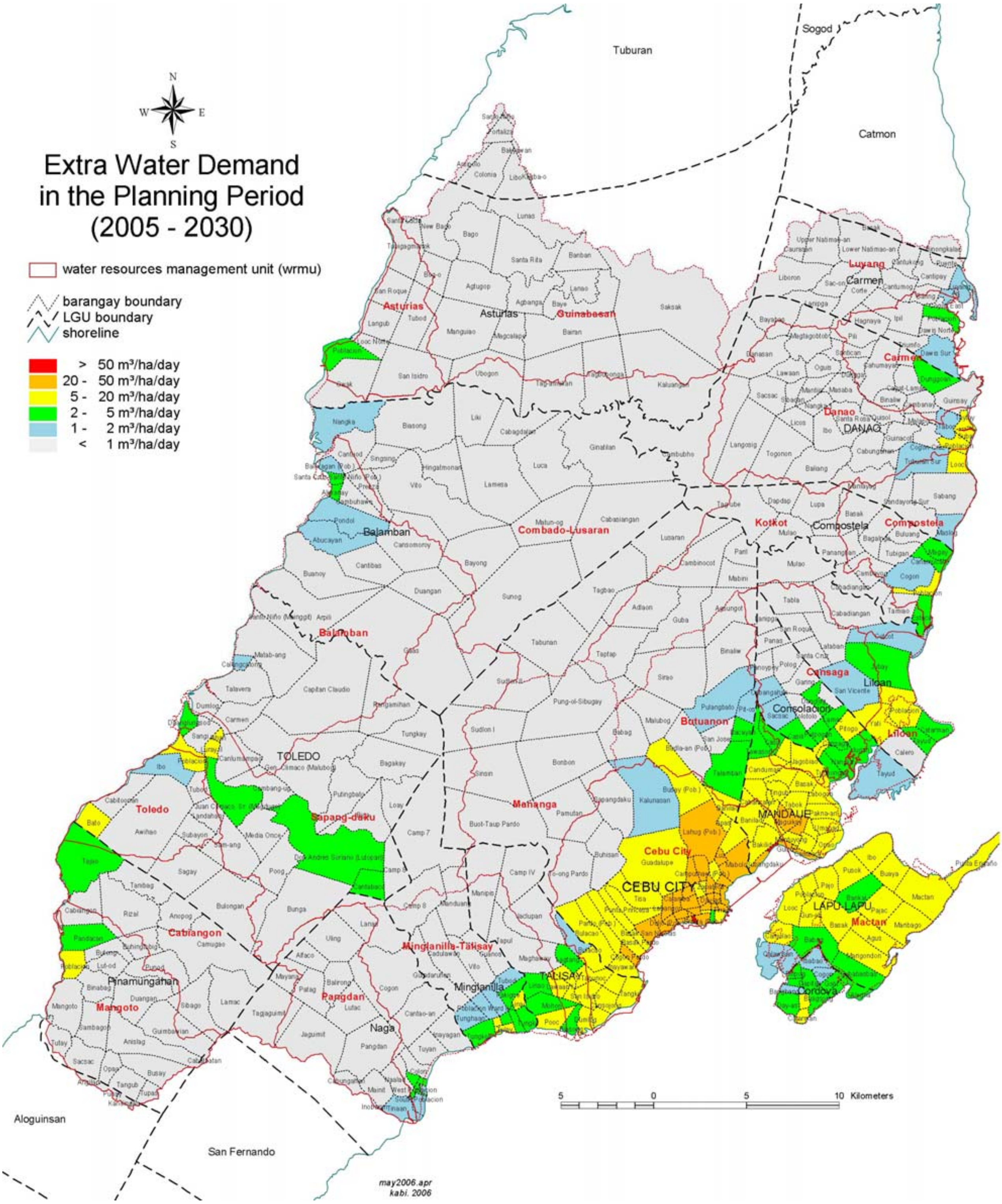


Figure 3-4 Spatial increase in water demand (2005—2030) in Central Cebu (m³/ha/d)

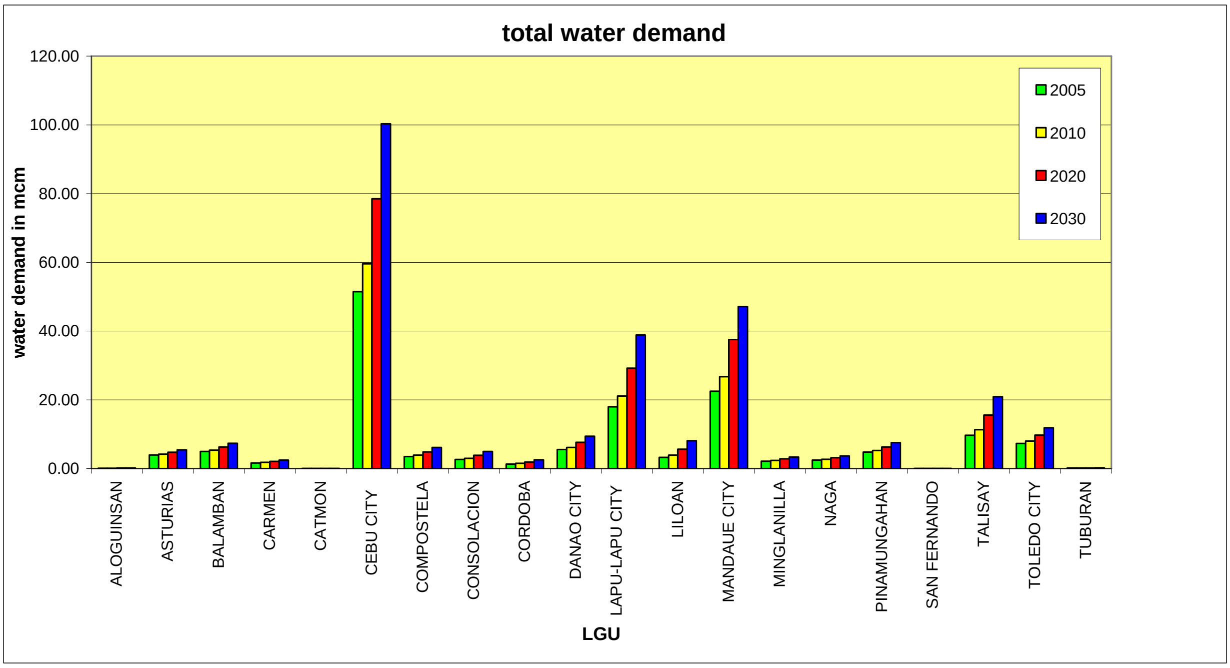


Figure 3-5 Total water demand increase for LGUs in Central Cebu for 2005, 2010, 2020 and 2030

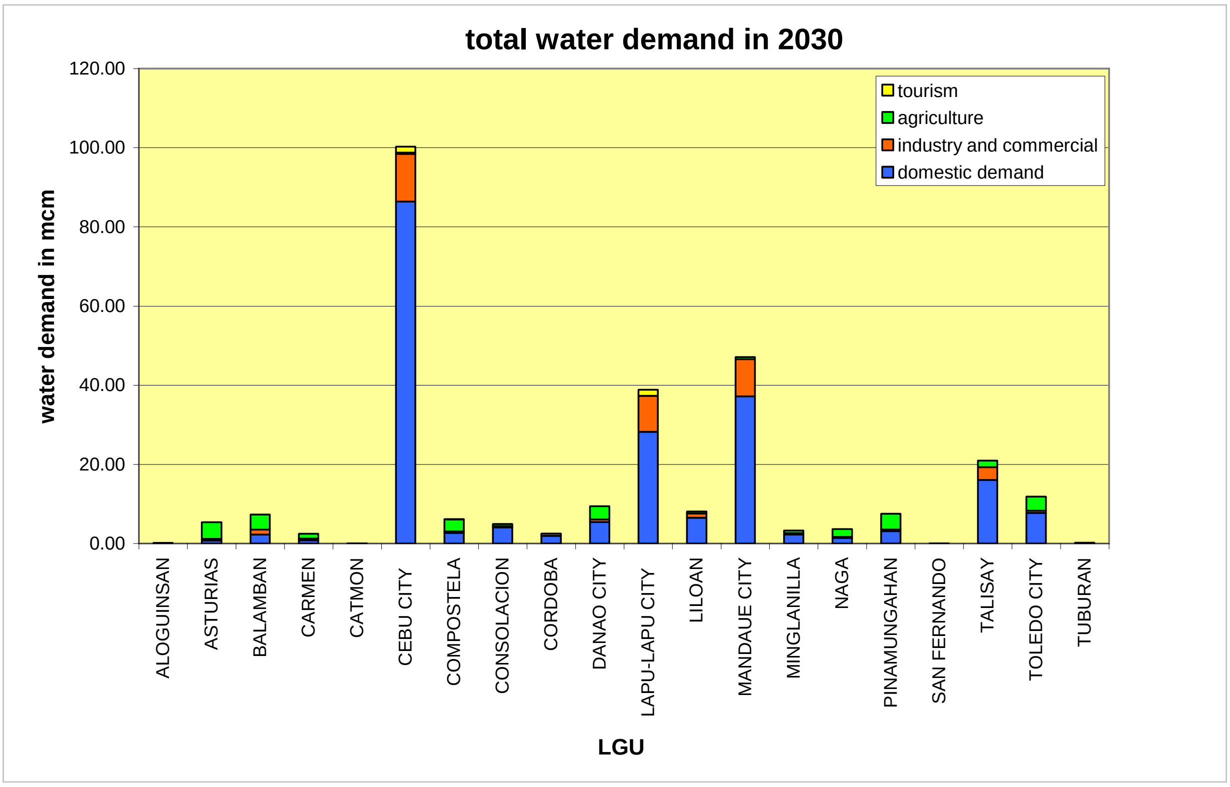


Figure 3-6 Water demand per WRMU for the various sectors in 2030

4. CAN WE MEET THE DEMAND?

4.1 Present water supply situation

To describe the present water supply situation in Central Cebu, different areas need to be distinguished. The first area is the eastern coast of Central Cebu, consisting of five cities (Danao, Mandaue, Cebu, Lapulapu and Talisay) and the seven municipalities (Carmen, Compostela, Liloan, Consolacion, Cordova, Minglanilla and Naga). These areas are mostly served by the Metro Cebu Water District (MCWD), except for Danao City and the Municipalities of Minglanilla, Naga and Carmen.

MCWD has almost 100,000 service connections (domestic, residential, commercial and industrial) with an average net rate of increase of some 600 new connections per month. There are about 300 communal water connections, while the rest are individual connections. Each communal connection has an MCWD-organized communal water association (CWA) with on average 35 active household-members. These units are located in informal settlements or highly congested areas of served barangays.

The second area is the western coast of Central Cebu covering the City of Toledo and the Municipalities of Asturias, Balamban and Pinamungajan. Most of the water supply in these areas are provided by Level II and Level III piped-water systems which are managed by barangays, water associations, water cooperatives and water districts. These are managed by a people's organization, either through a rural waterworks and sanitation association (RWSA) or through a water cooperative (WC).

MCWD network

The water supply in Metro Cebu is provided mainly through a water distribution network operated by MCWD. The large MCWD network extends from the City of Talisay in the south up to the town of Compostela in the north. Compostela itself has a small separate MCWD network which is fed by its own production wells. The large MCWD network spans the coastline with about 30 kilometers length of water mains, while the lateral distribution reaches 3 kilometers inland up to the 100m Above Mean Sea Level (AMSL).

The network is mainly fed by coastal groundwater wells. Currently, there are 104 operational production wells (excluding the Ayala wells), while 14 other wells in Compostela are not operational due to a legal dispute. There are two major extra sources: Jaclupan weir including an infiltration field (15 wells) and the Buhisan reservoir. In Mactan there is a commercial desalination plant which sells treated fresh water to MCWD for extra supply in addition to the 5 production wells on the island. The total water supply by MCWD is about 150,000 m³/day of potable water. MCWD has four main service water reservoirs totaling 20,000 m³ in capacity. All service reservoirs are situated at 65m AMSL except for one which is located at 60 m AMSL.

The sources and their average production for the distribution systems are listed in *Table 4-1 and Table 4-2* while *Figure 4-1* shows the MCWD service coverage area and the main sources of supply.

All pipelines of the MCWD distribution network are connected to each other. Theoretically it is a complete open system where water from the northern inlet can be distributed in the southern part of the distribution area and vice versa. In practice it will not occur on a large scale as water is pumped in from both sides and the small pipelines in the middle of the network limit the transport of (additional) water. Hence, water from groundwater wells will mainly be used locally. Mactan Island is connected to Cebu (Liloan connection) and the capacity of the pipeline between the two islands limits the volume of water that can be supplied to Mactan (around 8,500 m³/day). This imported water is abstracted from the San Vicente Well field. Cebu City is another area which has a high demand and which requires import of water from its neighboring WRMUs.

Non-MCWD networks

Private and public wells and springs basically provide the water supply for those areas in and outside Metro Cebu that are not served by MCWD. Also included are commercial establishments that provide for their own water needs. Information on current groundwater abstraction rates is very incomplete. The current non-MCWD water supply for domestic and industrial usage is therefore esti-

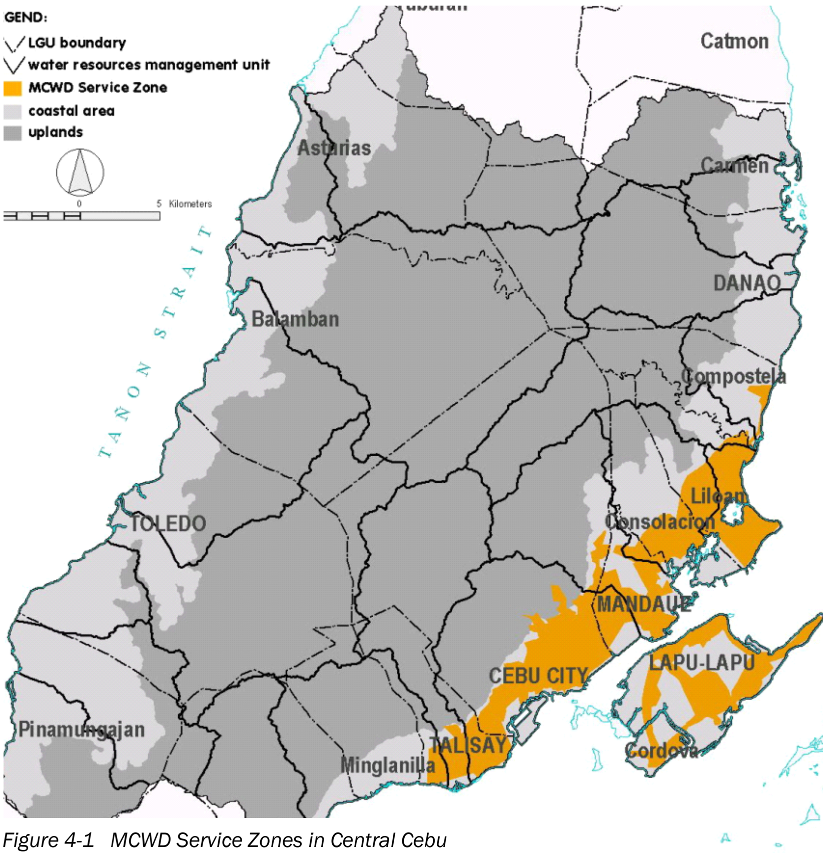


Figure 4-1 MCWD Service Zones in Central Cebu

Table 4-1 Supply from coastal aquifers in 2005 (in million m^3 per year)

WRMU	MCWD supply (mcm/yr)	Non-MCWD supply (mcm/yr)
ASTURIAS		0.4
BALAMBAN		2.3
BUTUANON	12.8	12.0
CABIANGON		1.3
CANSAGA	9.8	2.4
CARMEN		1.0
CEBU CITY	9.1	28.1
COMBADO-LUSARAN		2.1
COMPOSTELA	0.5	1.7
DANAO		1.9
GUINABASAN		1.0
KOTKOT	1.1	0.8
LILOAN	2.2	1.5
LUYANG		0.5
MACTAN	0.6	12.0
MANANGA	2.8	2.1
MANGOTO		1.1
MINGLANILLA-TALISAY	2.0	2.8
PANGDAN		0.6
SAPANG-DAKU		3.0
TOLEDO		1.4
TOTAL	**40.8**	**80.0**

Table 4-2 Supply from additional sources in 2005 (in million m^3 per year)

From other sources	MCWD supply (mcm/yr)	Non-MCWD supply (mcm/yr)
Buhisan – an old dam in WRMU Cebu City	1.8	
Jaclupan – surface water infiltration facility in WRMU Mananga	8.2	
Desalination – plants in WRMU Mactan Island operated by private companies	1.8	0.4
TOTAL	**11.8**	**0.4**

[1] Water REMIND technical report on Water Demand
[2] Linden, W. vd, 2005. Water REMIND technical report on Geohydrology

mated through projected water demand based upon population and known sector activities[1]. All water is gained locally to satisfy local demand.

From *Table 4-1* it can be seen that for the current situation (2005) the non-MCWD well abstraction almost doubles the MCWD one.

Desalination as additional source of water is hardly utilized yet. At present only 1.5% of the supply is supplied by desalination plants. Due to the large coastline of the project area and significant improvements in cost-efficiency of the desalination technology over the past years, this source has a high potential for future supply. Surface water is also hardly utilized. The potential of this source has been assessed based upon a water balance analysis.

4.2 Water balances for the present (2005) and long term (2030) situation

In order to increase insight in the available water resources and flow of water within Central Cebu several balances were composed based upon extensive geohydrological data analysis of all existing and newly collected data within the Water REMIND project[2]:

- Overall water balances for Central Cebu
- Water balances for the distribution network
- Water balances for upland rivers
- Water balances for coastal areas

In the determination of the water balances, first the Central Cebu study area must be represented in a schematization that faithfully reproduces the dominant flow processes in the area from the natural water resources system and the supply system. It is important to find an optimum level of detail for such a schematization taking into account the scarce knowledge that is available in terms of e.g. water fluxes, geology and location of demand groups.

Hydrological regions (watersheds) form the basis for the derivation of the water balances and all subsequent activities leading to the development of the strategy. A total of 21 water resources management units are distinguished (see *Figure 1-1*). Some units correspond to the watershed of one or two large rivers, while others include the catchments of many small streams.

4.2.1 Conceptualization of the water resources system

A distinction has been made in surface water and groundwater in the upland area and in the coastal area. The borderline between the two areas is the 100 m elevation contour line. This line was chosen taking into account factors such as:

- the urbanization rate (distinguishing between coastal urbanized and upland rural areas)
- the slope (sharply increasing at higher elevations)
- the geological layers (marking the limestone area)
- the hydrological behavior of the coastal and upland areas

Upland area

River flow generated in the uplands runs off to the coastal area and partly infiltrates into the coastal aquifer or flows to the sea. With the application of the Hydrological Modeling Software (HYMOS) and Geographical information system

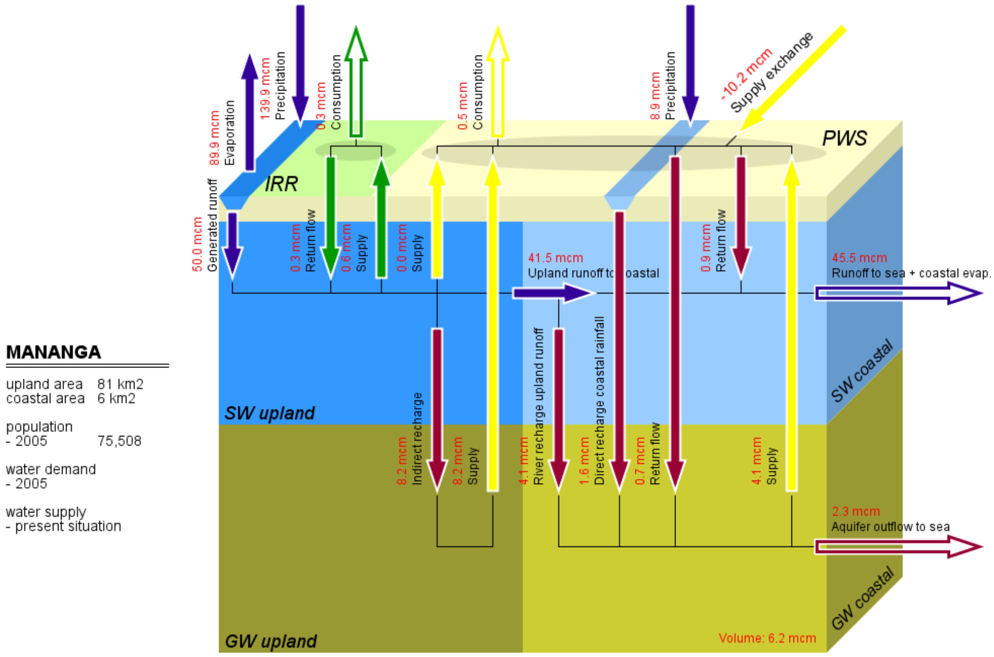


Figure 4-2 Main conceptualization of the water flows of Central Cebu

(GIS) daily rainfall series are derived for coastal and upland areas within each of the WRMUs. At least one river runoff series is generated for the upland area by making use of the Sacramento rainfall-runoff model concept. For some watersheds more than one series were generated, which allowed for a detailed analysis of the flow in the catchment as affected by infrastructural works (reservoir or intake). On the other hand if no infrastructure is present or will be present (measure) small rivers in one WRMU are lumped together and represented by one series. The series cover the period 1980-2005, while for the water balances the average annual value for this time period is applied.

In the upland area water is abstracted for irrigation supply, but since this is only minor a conservative approach is followed, i.e. all water is assumingly abstracted from the river affecting the water availability downstream or the replenishment of coastal aquifer which is important for water supply.

For the WRMU Mananga there is a significant river recharge in the upland area relevant for water supply, which is the Jaclupan aquifer and infiltration scheme. In other units the exchange with groundwater or springs is negligible and local recharge to groundwater will contribute to the base flow of the river. Evaporation is then simply the difference between rainfall and runoff with additional evaporation from surface water areas of reservoirs.

In the WRMU Cebu City river runoff is regulated by the Buhisan surface water reservoir and water is transported directly to the supply system in the coastal area. In the future this can be the case in more WRMUs if surface water reservoir measures are implemented. In the WRMU Sapang-daku the Malubog reservoir is present but it is not yet used for water supply.

As shown in *Figure 4-2* the modeling of the upland population water supply is left out from the water balances analysis. The water demand is too low (see Chapter 3) and hardly anything is known about present small scale abstraction rates of local wells and springs. Measures to improve the water supply in the uplands are discussed separately (see Chapter 5).

Coastal area

Main water demand is in the coastal zone where a large fraction of the population resides and all industry is located. High densities are found especially in Cebu City, Mandaue City and Lapulapu City. Water for present supply is mainly abstracted from the coastal aquifers and completed by additional abstraction from the Buhisan surface water reservoir and the Jaclupan groundwater reservoir in the uplands. In Mactan Island two small desalination plants are present: one operated by Mactan Rock and another one by the Shangri-La Resort Hotel. Exchange of water between WRMUs occur due to the MCWD network. Figures are already discussed in Chapter 3.

In the coastal zone the groundwater reservoir is directly fed by recharge from local rainfall in the coastal area. The estimated direct recharge percentage, ranging from 15% to 38% of the precipitation, is estimated per WRMU and based on geology, infiltration capacity and effects of built up area, among others. The weighted average for Cebu is 27%. The remainder of the water coming from local rainfall evaporates or flushes to sea unused.

Secondly, replenishment occurs indirectly by recharge of the upland river runoff that reaches the coastal area where the slope is minor and the water table is a few meters below the river bottom. The percentages are likely to vary between 10% and 30% depending on various factors such as geology, river bottom width and slope.

The third source for recharge to the aquifer is the return flow from the public water supply system. A major sewerage pipeline system is still absent in Central Cebu and most residents have at best septic tanks. Due to the absence of a sewerage scheme, water will not leave the WRMU and the often open septic tanks contribute to gradual infiltration of waste water to the local aquifer. After infiltration it can be re-used for water supply again. Thus, septic tanks are also significant sources for pollution of the groundwater.

The assumption is made that 25% of the water supplied evaporates or is consumed. This is defined as a loss in the water balance. The remaining fraction (75%) will partly flow to the sea through drains, overland run-off and pipelines or will infiltrate to the local aquifer again. For domestic wastewater half of the water used will re-supply the aquifer. This is 37.5% of the total water supplied. Since the medium to large scale industries are more concentrated and make use of pipelines, the infiltration to the aquifer will be less (only some 18.75% of the water will be re-supplied).

A future sewerage system can prevent the increase of pollution of the aquifer. This can divert all additional future water consumed to a waste water treatment plant before it flushes out into the sea. As a result the recharge potential of the aquifer remains as is rather than increasing with the growth in supply.

The identified modeled WRMU groundwater reservoirs represent the large limestone aquifer that stretches along the coastline (see *Figure 4-3* for the limestone and alluvial geological layers). From groundwater level data it is observed that lateral water fluxes between the identified units exist. Also the narrow coastline in combination with the large upland area of some watersheds make it reasonable to expect that an outflow towards the sea throughout neighboring WRMU exists. The lateral flow therefore ranges between 0 and 6 million m^3 per year.

Due to the hydraulic gradient of the water table and the transmissivity of the geological layer, water is continuously flowing towards the sea. Sufficient outflow limits the salt water intrusion. In the water balances the outflow is also the closing parameter. Important condition is that for an average hydrological year situation the water balances must be in an equilibrium which means representing a situation without mining of reservoir storage and with sufficient outflow.

4.2.2 Water balances supply network

MCWD network

In *Table 4-3* the water balances of the MCWD supply network are given. The surplus production from installed pump capacity, i.e. exceeding the internal water demand of WRMUs is exported to neighboring WRMUs that have the highest water demand, Mactan and Cebu City. Mactan for example gets additional water from the San Vicente well field located in the WRMUs Cansaga, Kotkot and Liloan. Of all WRMUs, Cebu City requires the largest import of water.

In the future, the water fluxes will change when the export of water to other WRMUs will be reduced by satisfying the local demand growth first.

Private abstractions

As stated earlier little is known about the private abstractions. In addition to a desalination plant, water is abstracted from thousands of non-registered wells. In the water balance analysis, total abstractions of the coastal aquifers are assessed using the total local water demand (see *Table 4-4*). For this it is implicitly assumed that the water demand is locally satisfied and that no water transport from one WRMU to another takes place. Therefore the total groundwater abstraction rate is assumed equal to the water demand in the same area, except for Mactan where one private desalination plant is operational (0.4 million m^3/yr).

Future supply

The water balances have also been calculated for the future situation to represent the situation when no actions will be taken ('trended development'). The abstraction rates still apply as practiced in 2005 (see *Table 4-5*). It can be concluded that the shortage in supply based on the water balances will be almost equal to the present production volume. Only 47% of the water demand can be satisfied in 2030 given the present supply sources. Hence, particularly for the MCWD coverage area substantial new sources have to be identified within and/or outside the area.

4.2.3 Water balances upland river

The water balance analysis has pointed out that hardly any surface water is used as present water supply source. Only in the Mananga and Kinalumsan watershed, water is abstracted from the river system and temporarily stored for MCWD supply.

In the Kinalumsan watershed the small Buhisan reservoir is already operational. On average it produces 1.8 million m^3 per year for the MCWD network in the Cebu City area (1.5% of the total Central Cebu supply).

In the Sapang-daku watershed water is stored in the Malubog reservoir which was previously used for mining activities. The reservoir is not yet used for water supply. However, plans exist to re-open the mine and tunnel surplus of water from the reservoir to the MCWD network.

In order to maximize the benefits from the surface water sources, water could be collected from the Lusaran, Kotkot or Mananga watersheds. Water can be stored in new reservoirs or abstracted directly through installing intakes or weirs. In Luyang and Kotkot an abstraction volume of approximately 20 million m^3 per year would be possible, while Mananga and Lusaran each could produce even 30 to 40 million m^3 per year.

These contributions are very significant compared to the Buhisan Reservoir, which is currently providing only 1.8 million m^3 per year and the Jaclupan aquifer infiltration scheme which is supplying 8.2 million m^3 per year.

4.2.4 Water balances coastal aquifer

The volume of water that can be abstracted from the aquifer should not exceed the maximum abstraction potential which represents the volume that can safely be abstracted from the coastal aquifer without irreversible effects such as salt water intrusion. The maximum abstraction volume depends on the recharge volume as well as the outflow towards the sea from the coastal aquifer. The availability of water in practice depends on many factors such as the specific yield and the volume of the live storage. Within an average hydrological year groundwater mining may exist in practice, but this is not applied in the water balances for sustainability reasons and safe approach.

With the use of the current situation and knowledge on the future requirements, a minimum percentage of 40% of the natural inflow has been reserved as outflow to prevent intrusion of seawater. This minimum requirement is supported by water balance assessments and the present knowledge of salinity intrusion in the WRMUs. Cebu City and Butuanon have a percentage less than 10% and are already experiencing salinity intrusion problems. In Cansaga and Mananga the percentages range between 30 and 40%. It is expected that the abstraction without implementing measures to enhance the recharge in this area will most likely introduce irreversible effects of salinity intrusion. In other WRMUs the percentage is much higher than 40%. Hence no problems regarding salinity intrusion are foreseen. Outside the MCWD area the percentages are even close to 100%.

The groundwater abstraction outside the MCWD area is relatively small (10 million m^3 in 2005) compared to its potential capacity (106.5 million m^3 per year). Although the water demand will increase in the future (to 19 million m^3 in 2030), it is still relatively small. Increased groundwater abstraction seems to be the best approach.

In the WRMUs that include the MCWD network the coastal aquifer is much more vulnerable. At present 75% of the total maximum potential capacity within the MCWD area is already utilized for water supply (MCWD wells provide 41 million m^3/yr while the private wells provide 85 million m^3/yr). The aquifer is under pressure by waste water pollution. The present occurrence of salinity intrusion limits the abstraction in some WRMUs. For Cebu City a large fraction of water that replenishes the aquifer originates from the return flow of polluted waste water making the future abstraction even more unsustainable.

Table 4-8 shows the projected water demand per WRMU in the coastal area for 2005 up to 2030 as well as the maximum potential groundwater supply. The water demand in 2005 in the WRMU Cebu City already exceeds the local groundwater potential. Since the coastal aquifer is already fully utilized (with a pump capacity of 42.6 million m^3 per year), this is compensated by additional supply from Buhisan, Jaclupan and the neighboring coastal aquifers.

The table indicates that the further utilization of the local groundwater resources in the MCWD area can only meet the demand up to 2010. For the medium and long term, additional sources are necessary for the Butuanon, Cebu City, Mactan and Mananga WRMUs.

Table 4-3 Water balances (2005) MCWD supply network (in million m³ per year)

WRMU	BUTUANON	CANSAGA	CEBU-CITY	COMPOSTELA	KOTKOT	LILOAN	MACTAN	MANANGA	MINGL.-TALISAY	Total MCWD
IN										
MCWD w ells abstraction	12.8	9.8	9.1	0.5	1.1	2.2	0.6	2.8	2.0	40.8
additional sources (Buhisan, Jacuplan, desalination)	0.0	0.0	1.8	0.0	0.0	0.0	1.8	8.2	0.0	11.9
supply from MCWD w ells and addtl sources from other WRMU	0.0	0.0	23.9	0.0	0.0	0.0	3.3	0.0	0.0	27.3
shortage in MCWD supply (closing parameter)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
total w ater availability for local netw ork	12.8	9.8	34.8	0.5	1.1	2.2	5.8	11.0	2.0	80.0
OUT										
w ater demand MCWD	8.0	1.9	34.8	0.5	0.1	0.9	5.8	0.5	0.3	52.7
supply from local MCWD w ells and addtl sources to other WRMU	4.9	7.9	0.0	0.0	1.0	1.4	0.0	10.5	1.7	27.3
total w ater extraction from netw ork	12.8	9.8	34.8	0.5	1.1	2.2	5.8	11.0	2.0	80.0

Table 4-4 Water balances (2005) non-MCWD served in coastal area in Central Cebu (in million m³ per year)

	Total or weighted average for Central Cebu	Total or weighted average for MCWD area	Total or weighted average for East, non MCWD area	Total or weighted average for West
IN				
private wells abstraction (2005)	85	74.8	2.7	7.2
additional sources (2005)	0	0.4	0.0	0.0
supply from private wells and additional sources from other WRMU	0	0.0	0.0	0.0
shortage in private supply (closing parameter)	0	0.0	0.0	0.0
total water availability for local network	85	75.1	2.7	7.2
OUT				
water demand private	85	75.1	2.7	7.2
supply from local private wells and additional sources to other WRMU	0	0.0	0.0	0.0
total water extraction from network	85	75.1	2.7	7.2

Table 4-5 Water balances total private and MCWD public water supply network – autonomous development for 2030 (in million m^3 per year)

	Total or weighted average for Central Cebu	Total or weighted average for MCWD area	Total or weighted average for East, non MCWD area	Total or weighted average for West
IN				
wells abstraction (2005)	126	115.6	2.7	7.2
additional sources (buh, jac, desal) (2005)	12	12.2	0.0	0.0
supply from wells and additional sources from other WRMU	27	27.3	0.0	0.0
shortage in supply (closing parameter)	153	144.2	2.5	6.2
total water availability for local network	318	299.3	5.2	13.4
OUT				
water demand	291	272.1	5.2	13.4
supply from local wells and additional sources to other WRMU	27	27.3	0.0	0.0
total water extraction from network	318	299.3	5.2	13.4

Table 4-6 Maximum potential abstraction of surface water in main river systems (in million m³ per year)

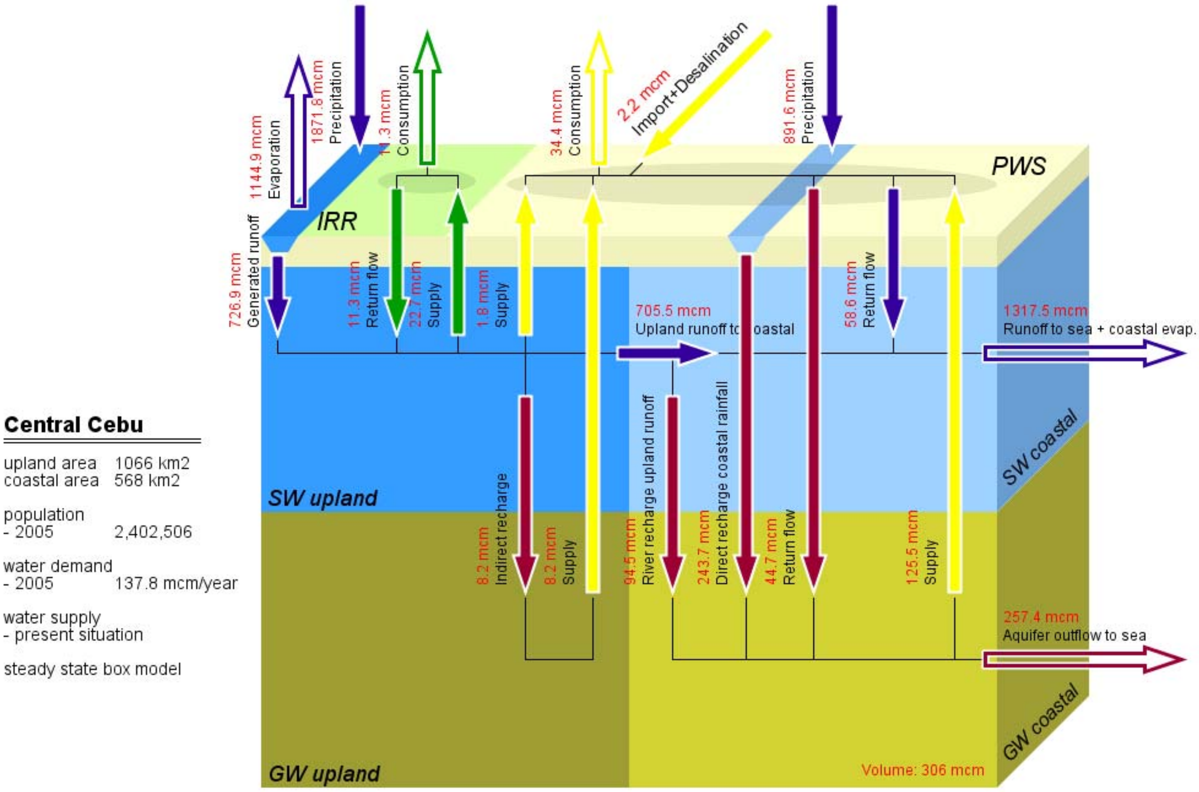
WRMU	Name	Yearly river runoff at (proposed) damsite (mcm/yr)
CEBU-CITY	Buhisan dam	5
COMBADO-LUSARAN	Lusaran dam	52
KOTKOT	Kotkot dam/weir	24
LUYANG	Luyang-Carmen dam/weir	29
MANANGA	Mananga dam	52
SAPANG-DAKU	Malubog dam	55

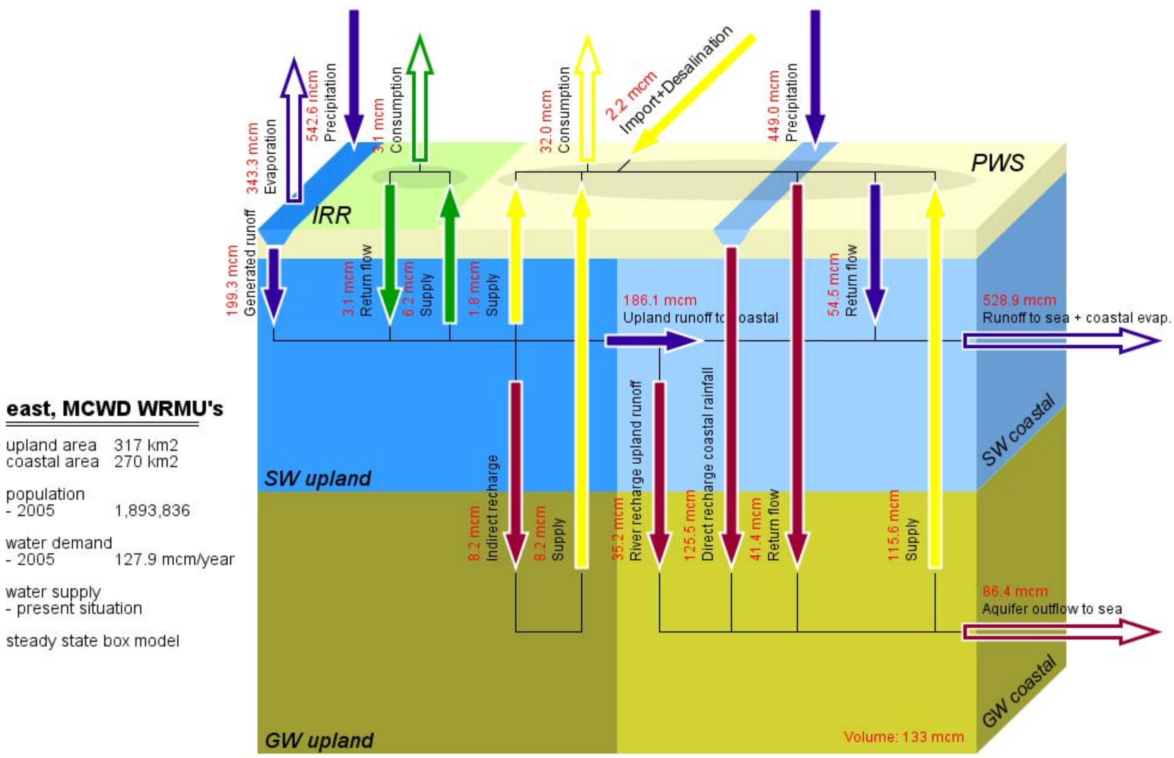
Table 4-7 Water balances coastal aquifer in MCWD area (2005) (in million m³ per year)

WRMU	BUTUANON	CANSAGA	CEBU-CITY	COMPOSTELA	KOTKOT	LILOAN	MACTAN	MANANGA	MINGL.-TALISAY	Total MCWD
IN										
Indirect recharge upland runoff	8.0	1.3	9.8	1.6	4.4	0	0	4.2	6.0	35.2
Direct recharge coastal rainfall	7.7	19.7	16.4	22.2	5.5	10.3	34	1.6	8.1	125.5
Returnflow PWS	6.8	1.6	22.9	0.7	0.1	0.8	6.6	0.7	1.1	41.4
Receiving lateral outflow from other WRMU	6	1	0	1.5	0	4.5	0	0	0	13
Storage change (-)	0	0	0	0	0	0	0	0	0	0
total in	28.5	23.6	49.1	26	10	15.6	40.7	6.5	15.2	215
OUT										
Abstraction PWS from coastal wells	26.9	12.4	42.6	2.2	1.3	3.9	16.9	4.4	5.0	115.6
Lateral outflow to other WRMU	1	4	6	0	2	0	0	0	0	13
Outflow to sea (closing parameter)	0.6	7.2	0.5	23.8	6.7	11.7	23.7	2.0	10.2	86.4
Storage change (+)	0	0	0	0	0	0	0	0	0	0
total out	28.5	23.6	49.1	26	10	15.6	40.7	6.5	15.2	215
outflow to sea as % of natural recharge from rainfall & lateral flow	3%	33%	2%	94%	67%	79%	70%	35%	72%	50%

Schematic representation of the water balances in:

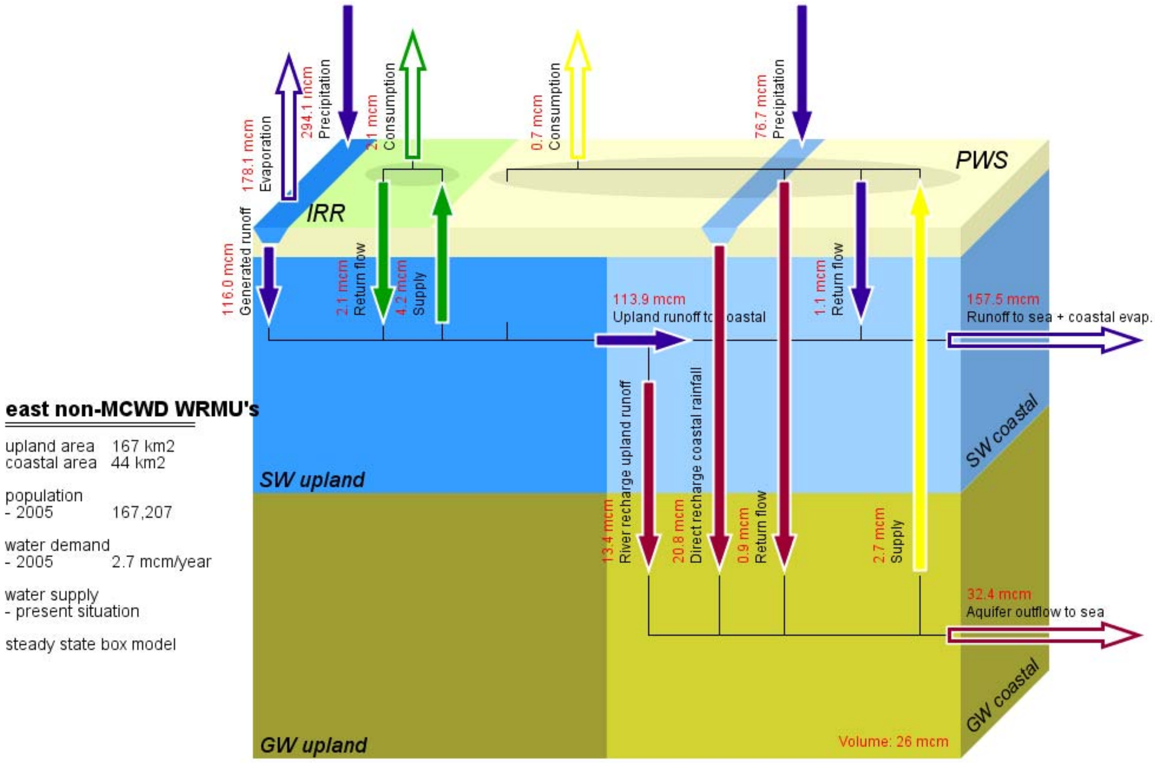
- all WRMUs of Central Cebu, and
- all WRMUs that include the MCWD network





Schematic representation of the water balances in:

- all WRMUs situated on the East Coast that do not include the MCWD network, and
- all WRMUs situated on the West Coast



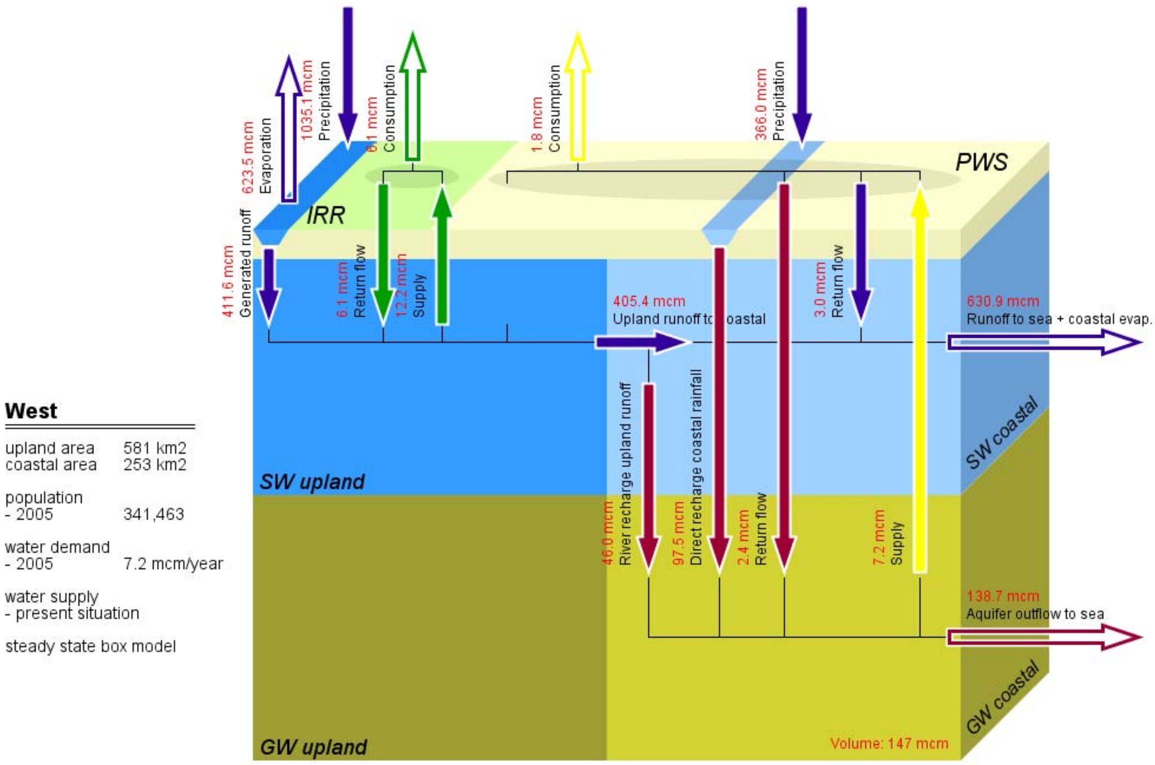


Table 4-8 Projected water demand vs. maximum potential abstraction of local coastal aquifer – constraints and extra potential (in million m^3 per year)

	Gross water demand, excluding uplands and agriculture				Maximum potential coastal aquifer	Is local problem solving possible?
Time horizon	2005	2010	2020	2030		
MCWD area						
BUTUANON	22.1	26.6	38.4	51.3	26.9	no
CANSAGA	4.5	5.4	7.8	10.7	12.4	yes
CEBU CITY	68.3	79.9	107.8	137.3	42.6	no
COMPOSTELA	2.2	2.6	3.9	5.7	15.9	yes
KOTKOT	0.4	0.4	0.6	0.8	4.0	yes
LILOAN	2.5	2.9	4.2	6.1	9.7	yes
MACTAN	22.4	26.3	36.4	48.7	27.1	no
MANANGA	2.2	2.5	3.5	4.8	4.4	no
MINGLANILLA-TALISAY	3.4	3.8	4.9	6.5	9.5	yes
subtotal MCWD area	127.9	150.5	207.4	272.1	152.5	no
non-MCWD area						
ASTURIAS	0.4	0.4	0.5	0.7	9.4	yes
BALAMBAN	1.9	2.2	2.8	3.6	13.1	yes
CABIANGON	1.0	1.1	1.6	2.1	16.5	yes
CARMEN	0.8	0.9	1.2	1.6	8.0	yes
COMBADO-LUSARAN	0.5	0.5	0.6	0.8	12.9	yes
DANAO	1.3	1.5	2.0	2.6	6.0	yes
GUINABASAN	0.3	0.3	0.4	0.5	7.4	yes
LUYANG	0.3	0.3	0.4	0.5	5.4	yes
MANGOTO	0.8	1.0	1.3	1.6	8.4	yes
PANGDAN	0.3	0.4	0.5	0.6	2.1	yes
SAPANG-DAKU	0.9	1.0	1.3	1.6	8.8	yes
TOLEDO	1.4	1.6	1.9	2.4	8.5	yes
subtotal non-MCWD area	9.9	11.3	14.5	18.6	106.5	yes
total central cebu coastal area	**137.8**	**161.8**	**221.9**	**290.7**	**259.0**	**no**

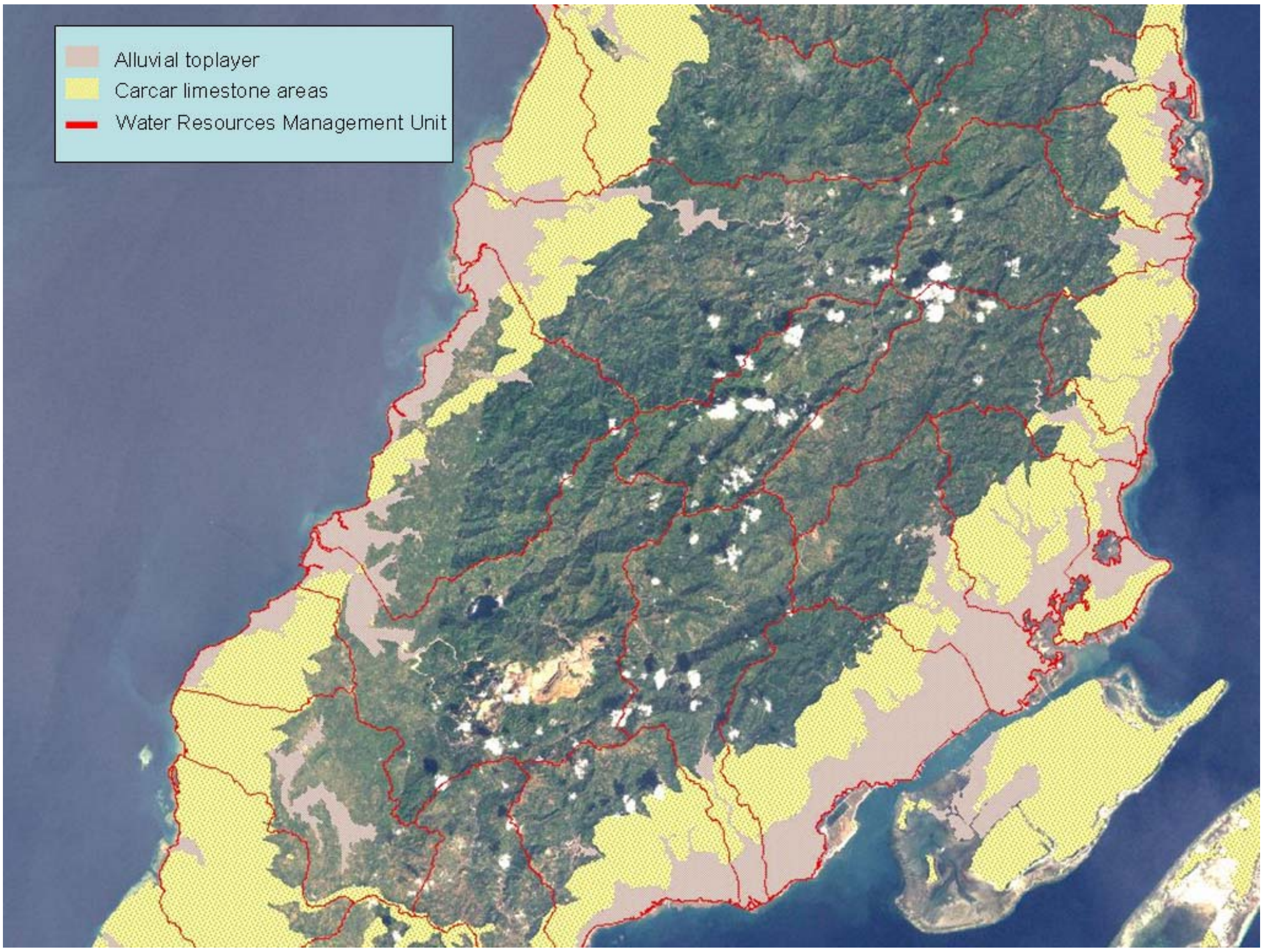


Figure 4-3 Carcar limestone and alluvial top layer of the coastal areas

4.3 Analysis approach

To develop the most effective and cost-efficient strategy a step-wise approach was followed (see *Figure 4-4*), leading to the best selection of Water Resources Management measures to be implemented in the planning period in Central Cebu. In this respect it should be realized that the action plan gives strategic directions for the project implementation but does not yet include the complete feasibility studies. The latter, revealing more detailed and updated technical and financial data, may lead to new adjustments of the final strategy in a later stage.

As the first step the policy objectives, targets and criteria were identified. The present situation of the Water Resources System had been described and future bottlenecks were identified if no actions would be taken. Secondly, potential measures were selected, as building blocks in the elimination of the bottlenecks. All these measures have been described in detail to allow for a selection based upon a number of criteria. Thirdly, promising measures were combined into strategies that could address the (future) problems in the water resources system. These strategies reflected different starting points. With the use of a multi-criteria analysis the strategies are weighted and ranked. Finally, a preferred strategy was chosen: the ‘Water for all Cebuanos’ strategy.

An operational framework was used to assist in the strategy development and to structure the analysis of the performance of the water resources system under different conditions. The operational framework consisted of different tools forming the ‘decision support system’.

4.3.1 Policy objectives and targets

On the first step of the Water Resources Management Action Planning only the water supply and demand related objectives have been addressed. To make these objectives tangible targets have been set related to the consumption and consumption growth per person (only growth is expected in the service Level III consumption), service level upgrading from Level I to Level II (following the millennium development goals), the service coverage area of MCWD (increased coverage in the same franchise area) and expansion of this coverage (no expansion to be expected), the starting points for the strategy development (minimizing on costs, local problem solving prevails and high reliability of supply).

4.3.2 Selection and ranking of measures

In relation to the policy objective and analysis conditions, a full inventory was made of all potential measures which could address the water supply and demand related problems and issues. An overview of these measures was documented in Annex A.

Given the current focus of the project on the supply of water, the set of possible solutions were clustered into 5 categories: 'develop more resources', 'water demand reduction', 'protecting the resources', 'water governance' and 'research and development'. These categories, including subcategorization, are enumerated in *Table 4-9*.

Each of these measures are described by the following information:

- Short description of the measure
- Background, introduction to the measure and justification of the measure
- Cost-estimate based on previous studies
- Advantages and disadvantages of using this measure
- Analysis of measure by the Water REMIND Project
- Institutions and organizations involved
- Implementation and timing
- Source of information

Hence, the multi-criteria analysis tool is used which allows ranking on various criteria (effectiveness, efficiency, implementability and sustainability).

Table 4-9 Grouping of water resources related measures

Proposed direct / indirect water supply related solutions	
Develop more resources and improve distribution	Surface water
	Groundwater
	Miscellaneous
Water demand reduction	Reducing losses
	Awareness and training
Protecting the resource	Watershed management
	Water Quality Improvement
Water governance	Organizational improvements
	Regulation and control
Research and Development	Training and data / knowledge / tool development

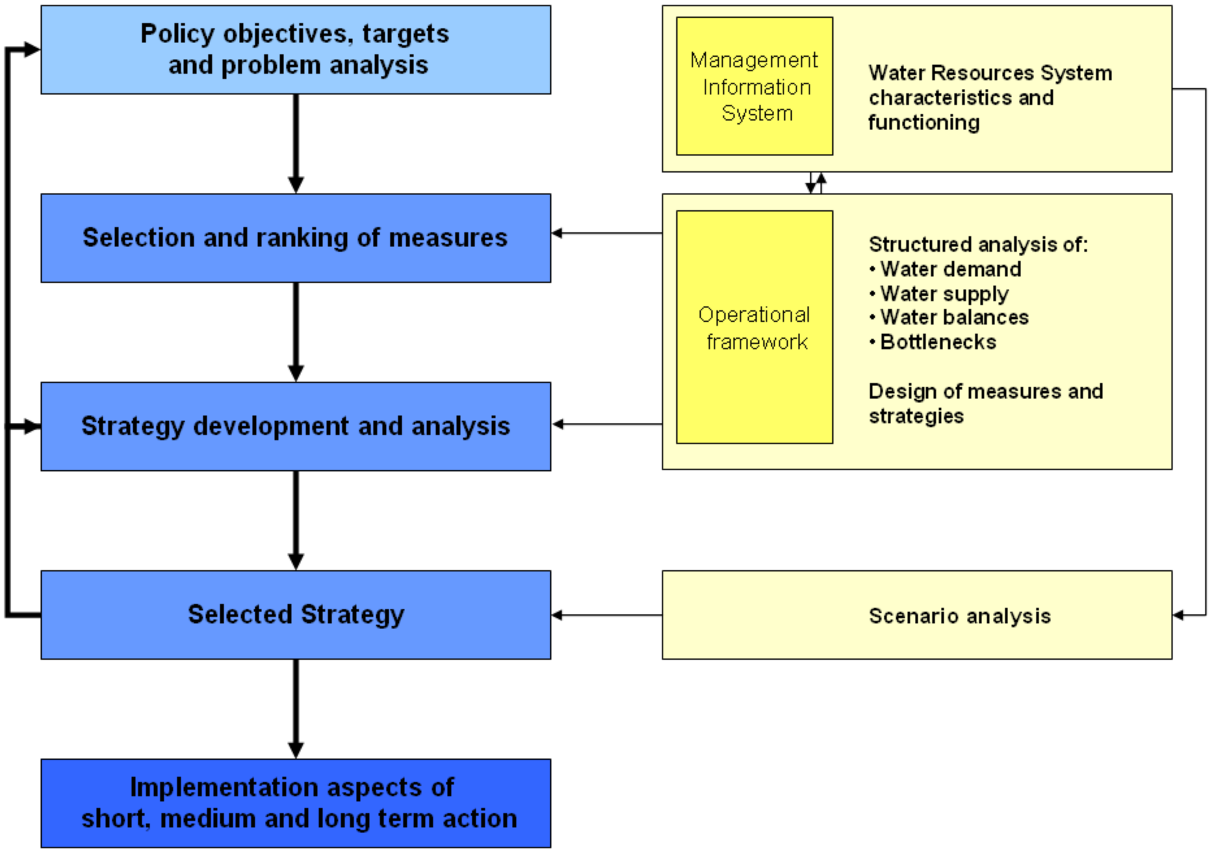


Figure 4-4 Stepwise approach leading to the action plan

The RIBASIM computer model was also used to design the surface water reservoirs and test their reliability in volume and time of supply. Other measures that were tested are: allocation priorities, capacities of main transmission pipelines, operational rules, etcetera. With the RIBASIM computer model the reliability of the water supply provoked by the strategy was also tested.

4.3.3 Strategy development and analysis

A strategy is a logical combination of measures which aims at reaching the policy objective. As such, the Water REMIND project is basically a search for the best supported strategy. Using this information different strategies were designed. The design of a strategy is more or less an iterative process. Measures are considered and scaled once they meet the overall strategy requirements or until supply meets demand.

Likewise the pragmatic assessment or evaluation criteria have to be defined to be able to prioritize on the appropriate measures / strategies to reach the objectives and targets. These criteria are related to the following aspects:

- Technical effectiveness
- Cost-efficiency (financial and economic aspects)
- Social and environmental impacts
- Institutional and organizational aspects

Reflecting the specific interests of various stakeholders and sectors (captured in several stakeholders workshops and expressed in weight coefficients) combined with using a simple multi-criteria analysis evaluation, the best strategy had been identified.

4.3.4 Selection - scorecard analysis

During this selection process a mixture of acceptable (with regard to the strategy) and doable (implementation time) measures were identified.

Frequent interactions with partners, stakeholders, and future implementers were needed to guide the activities. The ultimate strategy represented the common interest of all stakeholders and designed to fit their needs, see *Table 4-10* (e.g. extra emphasis on industrial interests in industrialized regions and extra emphasis on local solution solving in the uphill area).

Finally in a simple score-card analysis (dealing with target related criteria such as costs, number of people served, reaching acceptable consumption levels, etc.), it was expressed how the strategy could meet the targets.

4.3.5 Scenario analysis

To predict the future and its uncertainties, assumptions are made and scenarios (what-if conditions) are developed. In this case scenarios represent uncertain conditions which are beyond the control of water resources interventions, e.g. population growth, tourism development, hydrology. These uncertainties have been analyzed in a quantitative way. Results are described in Section 5.9.

4.4 Brief discussion on results of strategy development

4.4.1 Building blocks

In *Table 4-11* a short list of the measures is presented which were used as building blocks during the development of alternative strategies. The measures were scored qualitatively according to socio-economic (SE), political (P), financial (F), institutional (I) and environmental (E) impacts. If the impact category scored 'low' then the measure was considered implementable. On the other hand a 'high' score was reason to be cautious about implementing the measure. Notice that a measure was scored individually. When strategies were developed and as a consequence measures were combined, the economy of scale came in and the partly redesigned measures could come out more favorable than when they were considered as stand-alone. For example the combination of the Lusaran High Dam and the Kotkot Dam became even more attractive compared to the alternative Mananga High Dam. Other measures such as the Bohol pipeline and the tunneling of water from the Malubog reservoir were not attractive even after being redesigned (reducing the abstraction volumes to improve their reliability). In this case the high risks involved with the installation of the Bohol—Mactan pipeline and the pollution levels in the reservoir, as well as the socio-economic impacts disqualified them. These considerations and qualifications are addressed in Annex A.

All measures were from the category 'development of new sources', since the primary objective of the strategy was to realize full water supply. In addition measures were added from the other categories. This will be discussed in detail in Chapter 5.

Table 4-10 Most relevant measures and strategy criteria as derived from the various stakeholders workshops

Water supply related criteria	Description
low cost of water for end-user	measures and strategy should deliver water at competitive / lowest costs
maximum reliability of supply	measures and strategy should guarantee constant supply of sufficient water (with no interruptions or low pressure)
prioritizing the local problem solving	measures and strategy should address the local water needs first. Export of water to other areas can only be considered once the local demand is met
maximum environmental protection	measures and strategy should be environmentally sound with minimal impacts on the environment (water / air quality, biodiversity, valuable habitats, nature and so forth)
guaranteed high quality water	measures and strategy should deliver constant high quality water (meeting public health, industrial standards, agricultural requirements and the like) and as such should be very critical regarding source and treatment aspects

Table 4-11 Building blocks for development of alternative strategies

Area	Potential infrastructural measures to develop more sources	Brief description of potential measure				
West	Groundwater wells West	Meeting local demand by development of local wells: drilling new wells, installing pump capacity and laying pipelines in order to provide water to local community water supply systems. Maximum capacity to be installed in order to meet 2030 demand is 6.2 million m^3 per year. All new connections are at least of level 2 type.				
		SE: low	*P: low*	*F: medium*	*I: low*	*E: low*
Uplands	Spring boxes + small impoundments + trucking infrastructure for drought periods	Meeting local demand by the development of spring boxes and rainwater impoundments: construction of spring boxes and small storage reservoir structure to collect surface water runoff, pipeline systems and communal taps. As the reliability of this combined system may still not be 100%, in extreme dry periods hauling of water by trucks is the only remaining solution. Maximum capacity of new spring boxes and rainwater impoundments in order to meet 2030 demand is 6.2 million m^3 per year. All new connections are at least of level 2 type.				
		SE: low	*P: low*	*F: med*	*I: low*	*E: low*
East-non MCWD area	Groundwater wells East	Meeting local demand by development of local wells: drilling new wells, installing pump capacity and lying pipelines in order to provide water to local community water supply systems. The maximum installed capacity to be installed in order to meet 2030 demand is 2.5 million m^3 per year. All connections are at least of level 2 type.				
		SE: low	*P: low*	*F: medium*	*I: low*	*E: low*
East-MCWD area	Groundwater wells MCWD area	Meeting local demand by development of local wells: drilling new private or production wells, installing pump capacity and lying pipelines in order to provide water to local private water supply systems or the MCWD network. Maximum installed capacity to be installed for optimizing local supply is 17.4 million m^3 per year in 2030. All new connections are at least of level 2 type.				
	private wells	*SE: low*	*P: low*	*F: medium*	*I: low*	*E: low*
	production wells	*SE: very low*	*P: low-high*	*F: medium*	*I: low-high*	*E: med*
	Luyang-Carmen weir	Meeting the high demand areas by development of a surface water intake in the Luyang river: construction of an inflatable rubber weir or concrete dam, spillway and diversion structures, lying pipelines and construction of raw water treatment plant in order to provide water to the MCWD network. This measure is in combination with the development of the Northern well fields. The maximum abstraction under high reliability conditions possible is 8.4 million m^3 per year under 97% reliability operational scheme. Establishment of the weir will reduce the potential abstraction of the aquifer downstream.				
		SE: medium	*P: med-high*	*F: high*	*I: medium*	*E: med-high*
	Northern well fields: Liloan, Compostella, Kotkot, Danao, Carmen, Luyang	Meeting the high demand areas by development of wells: drilling new production wells, installing pump capacity and lying pipelines to the Liloan network inlet in order to provide water to the MCWD network. The maximum potential abstraction within the MCWD area for this purpose is 16.4 m^3 per year and outside the MCWD area (without correction impact weir) 14.7 million m^3 per year (in 2030).				
		SE: med-high	*P: high*	*F: low*	*I: high*	*E: med-high*
	Lusaran Dam	Meeting the high demand areas by a large surface water reservoir development: construction of a dam in the Lusaran watershed, spillway and diversion structures, construction of a bulk water conveyance tunnel, lying pipelines to the MCWD family park inlet, impoundment of a large, mainly forested area and construction of a raw water treatment plant, in order to provide water to the MCWD network. A 47 m dam can provide 44 million m^3 per year under 90% reliability operational scheme; otherwise a 63 dam high can supply 41 million m^3 per year under 97% reliability operational scheme.				
		SE: very high	*P: very high*	*F: low*	*I: very high*	*E: high*
	Kokot Dam	Meeting the high demand areas by a medium surface water reservoir development: construction of a dam in the Kotkot watershed, spillway and diversion structures, construction of a bulk water conveyance tunnel, lying pipelines to the MCWD family park inlet, impoundment of a large, mainly forested area and construction of a raw water treatment plant, in order to provide water to the MCWD network. A 19 m dam can provide 22 million m^3 per year with under 90% reliability operational scheme;; otherwise a 25 dam high can supply 21 million m^3 per year with under 97% reliability operational scheme.				
		SE: very high	*P: very high*	*F: low*	*I: very high*	*E: high*

Impact category	SE (Socio-economic)	P (Political)	F (Financial)	I (Institutional)	E (Environmental)
Magnitude of impact	low	medium	high	low-med (low to medium)	high-med (high to medium)

Table 4-11 Building blocks for development of alternative strategies (continued)

Area	Potential infrastructural measures to develop more sources	Brief description of potential measure	SE	P	F	I	E
East-MCWD area	Malubog Dam	Meeting the high demand areas by rehabilitation of the existing surface water reservoir in the Sapangdaku catchment: rehabilitation of the Malubog dam and reservoir, construction of a bulk water conveyance tunnel and pipelines to the network inlet Tisa and a raw water treatment plant, in order to provide water to the MCWD network. The reservoir can supply 18.3 million m^3 per year under 97% reliability operational scheme (remaining water is reserved for mining activities in the area). Water quality in the Sapangdaku river is a problem. The problem is attributed to runoff of contaminated water from the exposed quarry area upstream of the Biga Confluence. River runoff has to be diverted.	*SE: low*	*P: medium*	*F: high*	*I: medium*	*E: very high*
East-MCWD area	Mananga Dam	Meeting the high demand areas by a medium or large surface water reservoir development: construction of a dam in the Mananga watershed, spillway and diversion structures, construction of a bulk water conveyance tunnel, lying pipelines to the network inlet Tisa, impoundment of a large, mainly forested area and construction of a raw water treatment plant, in order to provide water to the MCWD network. A 73 m high dam can provide 45 million m^3 per year under 90% reliability operational scheme; otherwise a 83 high dam can supply additional 41 million m^3 per year under 97% reliability operational scheme. Establishment of the dam will affect the potential abstraction of the Jacuplan aquifer downstream, but the effect is included in this scheme. The option of a medium high dam 43 m high is also considered, which makes an additional abstraction of 29 million m^3 per year possible when Jacuplan is still full operational.					
East-MCWD area	73 and 83 m high dam		*SE: high*	*P: high*	*F: low*	*I: very high*	*E: medium*
East-MCWD area	43 m high dam		*SE: medium*	*P: high*	*F: low*	*I: very high*	*E: medium*
East-MCWD area	Southern well fields: Napo/Carcar river, Pangdan, Minglanilla + pipeline	Meeting the high demand areas by development of production wells: drilling new production wells, installing pump capacity and lying pipelines to the Lagtang Talisay network inlet in order to provide water to the MCWD network. The maximum potential abstraction is 4.5 mcm (in 2030) in Pangdan and Minglanilla-Talisay and 14.6 mcm/yr outside Central Cebu.	*SE: med-high*	*P: high*	*F: low*	*I: high*	*E: med-high*
East-MCWD area	Desalination by MCWD for industry	Meeting local demand by development of desalination plants with industrial standard: construction of an intake, treatment facilities, reverse osmoses or distillation units, pump capacity, storage reservoirs and lying pipelines in order to provide water to the MCWD clients on Mactan Island. The abstraction rate is highly reliable and very flexible. The rate depend on the number of units installed, but on average the abstraction for a small unit 1 m million m^3 per year, while a large unit supplies 5.5 million m^3 per year.	*SE: low-med*	*P: low*	*F: high*	*I: low*	*E: high-med*
Mactan-MCWD	Horizontal fresh water wells	Meeting local demand by development of local horizontal directional drilled wells: drilling of new wells, installing pump capacity and lying pipelines in order to provide water to the MCWD network. Maximum potential abstraction is 1.1 million m^3 per year.	*SE: low*	*P: low*	*F: low-med*	*I: low*	*E: med*
Mactan-MCWD	Shallow fresh water wells	Meeting local demand by development of a cluster of local shallow wells with low abstraction rates: drilling wells, installing pump capacity and lying pipelines in order to provide water to the MCWD network. Maximum potential abstraction (for MCWD and non-MCWD together) is 8.2 million m^3 per year.	*SE: low*	*P: low*	*F: medium*	*I: low*	*E: low*
Mactan-MCWD	Shallow brackish water wells + treatment	Same is valid as for the shallow fresh water wells, but treatment is included to remove the salts from the water. Maximum potential abstraction (for MCWD and non-MCWD together) is 0.8 million m^3 per year.	*SE: low*	*P: low*	*F: medium*	*I: low*	*E: low*
Mactan-MCWD	Desalination by MCWD for industry	Meeting local demand by development of desalination plants with industrial standard: construction of an intake, treatment facilities, reverse osmoses or distillation units, pump capacity, storage reservoirs and lying pipelines in order to provide water to the MCWD clients on Mactan Island. The abstraction rate is highly reliable and very flexible. The production depends on the number of units installed, but on average the abstraction for a small unit is 1 m million m^3 per year, while a large unit supplies 5.5 million m^3 per year.	*SE: low-med*	*P: low*	*F: high*	*I: low*	*E: high-med*
Mactan-MCWD	Desalination by MCWD for domestic use	Meeting local demand by development of desalination plants with potable standard: construction of an intake, treatment facilities, reverse osmoses or distillation units, pump capacity, storage reservoirs and lying pipelines in order to provide water to the Mactan MCWD network. The abstraction rate is highly reliable and very flexible. The production depends on the number of units installed, but on average the abstraction for a small unit is 1 m million m^3 per year, while a large unit supplies 5.5 million m^3 per year.	*SE: low-med*	*P: low*	*F: high*	*I: low*	*E: high-med*

Table 4-11 Building blocks for development of alternative strategies (continued)

Area	Potential infrastructural measures to develop more sources	Brief description of potential measure				
Mactan-non MCWD	Desalination by industry	Meeting local private demand by development of desalination plants with industrial standard: construction of an intake, treatment facilities, reverse osmoses or distillation units, pump capacity, storage reservoirs and lying pipelines in order to provide water to private industrial supply systems. The production depends on the number of units installed, but on average the abstraction for a small unit is 1 m million m^3 per year, while a large unit supplies 5.5 million m^3 per year.				
		SE: low-med	*P: low*	*F: high*	*I: low*	*E: high-med*
	Shallow fresh water wells	Meeting local demand by development of a cluster of local shallow wells with low abstraction rates: drilling wells, installing pump capacity and lying pipelines in order to provide water to local community water supply systems. Maximum potential abstraction (for MCWD and non-MCWD together) is 8.2 million m^3 per year.				
		SE: low	*P: low*	*F: medium*	*I: low*	*E: low*

4.4.2 Alternative strategies for high demand WRMUs

The "Water for all Cebuanos" strategy is based on optimizing the available local groundwater resources and gradually moving to areas further away from the Metro Cebu coastal zone in search for additional groundwater and/or surface water sources to satisfy the needs of the high demand WRMUs.

By increasing local abstractions for local supply and extra abstractions in the Kotkot, Compostela and Liloan WRMUs in the north for extra supply in Cebu City, the total water supply upto 2010 can be guaranteed. After 2010 additional new sources have to be identified, particularly for the WRMUs Butuanon, Cebu City and Mactan. In the period 2020-2030, a small deficit occurs in Mananga as well.

In accordance with the strategy for Central Cebu, the shortages in the high demand areas can be solved up to 2020 with extra groundwater abstractions. Hereafter surface water need to be utilized. It appeared that a number of surface water measures are more favorable than new groundwater production fields since these produce larger volumes of water and lower prices of water. This fits with the target of minimizing the cost for the end-users.

A number of detailed alternative solutions to the 'Water for all Cebuanos strategy' were developed that all addressed the water shortage in the four high demand WRMUs for the medium to long term. The proposed strategy for 2010 remains the same, i.e. groundwater use only. As for the other WRMUs demand could also be met locally. Unfortunately, surface water measures could not be constructed and be operational before 2010.

During the screening of potential measures, surface water reservoirs were designed for a 90% and 97% reliability in volume, which meant that for the same abstraction target for a 100% volume supply a higher dam must be built to increase the reliability. More live storage should be preserved to overcome severe dry periods. In case of a 97% reliability in volume, the annual production of a reservoir should be 97% of its targeted supply (defined as 'high' reliability). In the 90% reliability option still 90% of the required volume was produced but this made the reservoir less reliable in time and as a consequence the effects will be more noticeable during dry periods. All the reservoirs were tested for their reliability using data from 25 historical hydrological years[1]. For both reliability options two alternative strategies have been developed. These alternatives all made use of the same solution for the short term, namely maximum use of groundwater. As a last alternative the most likely developmental projects (i.e. the ones currently under discussion) had been included.

Alternative strategy 0: maximum use of groundwater

Strategy priority was given to optimize the use of the groundwater resources in the coastal zone. Groundwater was perceived as a reliable source, which was easy to implement. In line with this approach, Alternative 0 describes the maximum utilization of groundwater resources in the coastal zone, for the benefits of the high demand areas. Groundwater from outside the MCWD area (Luyang, Carmen, Danao and Pangdan) and even outside Central Cebu (Southern Wells project) will be transported through a pipeline system to the WRMUs with high demand. From an economical point of view (economy of scale), connecting the Luyang-Carmen weir to this new pipeline will be highly recommendable. In 2020-2030 all groundwater along the east coast will be fully tapped and that was why additional surface water reservoir abstraction and desalination were introduced as new measures. The Lusaran 63 m High Dam and the Kotkot 25m dam, both having a reliability of 97% in volume, were selected from a cost-efficiency point of view. The surface water reservoirs supply a sufficient volume of water to contribute also to the supply network of Mactan Island.

Table 4-12 Water deficit after implementing first measure: raising abstraction from local aquifer for local supply

	Deficit in million m^3/yr		
	2010	2020	2030
Butuanon	0	11.5	24.4
Cebu City	16.9	49.5	83.0
Mactan	0	6.4	19.0
Mananga	0	0	0.4
total	16.9	67.4	126.8

[1] Water REMIND technical report on RIBASIM

Table 4-13 Alternative strategies for high demand Butuanon, Cebu City, Mactan and Mananga (supply and demand in million m³/year)

Time horizon	Short term (2010)	Medium term (2020)						Long term (2030)					
Alternative strategies	Basic	0	1	2	3	4	5	0	1	2	3	4	5
Total demand	**162**	**222**						**291**					
Total abstraction local coastal aquifer	120	136						150					
Total import from other coastal aquifers	12	6						2					
Total abstraction present Jaclupan, Buhisan, desalination	12	12						12					
Total abstraction new sources needed	**17**	**67**						**127**					
Extra wells within MCWD area	17	25	17		20			19	19		19		10
Extra wells outside MCWD area, within Central Cebu		13						12					
Extra wells outside Central Cebu		15						15					15
Desalination		6	6		6	6	6	11	19	14	26	16	21
Kotkot weir				22		21		21		22		21	
Lusaran dam			44		41	41		41	44	44	41	41	
Luyang-Carmen weir		8		17			18	8		18		8	18
Malubog dam							18						18
Mananga dam + Jacuplan				29			24		45	29	41	41	45
Total target supply	**162**	**222**						**291**					

Alternative solution 1: mix surface water and groundwater, 90% reliability

Instead of abstracting groundwater from the three northern WRMUs or from the Southern wells outside Central Cebu (included in Alternative 0) Alternative 1 recommends the abstraction from two large surface water reservoirs. In the year 2020, about 49.5 million m³ of extra supply will be needed for Cebu City. This could be provided by the new Lusaran reservoir with a dam height of 47m in combination with some wells in the MCWD area.

For this alternative Butuanon could be supplied by the Compostela aquifer. The demand in Butuanon is 11.5 million m³ while the local aquifer still has a potential of 12 million m³ in 2020. Before the reservoir of Lusaran will become productive, water from Compostela could be directed to Cebu City. The established infrastructure could then be used for Butuanon, while Cebu City could be served by the new reservoir.

Another high cost-effective large scale project is the Mananga high dam. Jacuplan in this case will still be operational, but will produce a smaller volume after the Mananga dam is constructed. In combination with the maximum use of the coastal aquifers within the MCWD area this will be sufficient to supply the demand for 2030.

For Mactan a separate measure is assumed to be implemented making the island independent from Cebu Island. In addition to the use of local groundwater, desalination plants (for both domestic and industrial users) will be built for extra supply.

Alternative solution 2: surface water, 90% reliability

In this alternative there will be no extra abstraction from groundwater in 2020 and 2030. Groundwater will only be abstracted for local use and preserved as back up or safety storage, e.g. to overcome extreme dry periods or will provide flexibility in supply during the construction of the reservoirs.

In 2030 one large size reservoir will be operational (most feasible Lusaran) together with the low yield Luyang-Carmen rubber dam, the medium size Mananga 43 m dam (in combination with Jaclupan) and the Kotkot 19 m dam. The combination of the last three measures will assure full supply in 2020.

Up to 2020, Mactan could be supplied by new local wells and the surface water reservoirs on Cebu Island. Upgrading of the existing pipeline connection between the two islands will be necessary. In 2030 a minimum of 13.8 million m³ desalination volume will be necessary in addition to the 5.2 million m³ water coming from the main island Cebu. The total supply needed in 2030 for Mactan will be 19 million m³.

Alternative solution 3: mix of surface water and groundwater, 97% reliability

Higher reliability will require a larger storage volume to minimize the effects of the dry season. The two largest surface water reservoirs will be implemented: Lusaran and Mananga. Jaclupan is still operational, but will produce a smaller volume after the Mananga dam will be constructed. The projects together will have a potential abstraction rate of 82 million m^3/yr, which would almost be enough for the WRMU Cebu City. Further supply will be found in full utilization of the groundwater resources in the MCWD area (19.5 mcm). Desalination in Cebu City (6.6 mcm) will be the last high reliable source to implement. Mactan will have its independent system and will be supplied separately by desalination plants in addition to new local wells.

Alternative solution 4: surface water, 97% reliability

For this alternative all new sources of supply will be related to surface water or desalination measures and groundwater will be preserved for safety storage purposes. All major river systems, except the Sapang-Daku river, will be used to provide water. To meet the requirements for the medium term, a large sized dam will be built in Lusaran together with a smaller dam in Kotkot. This will be succeeded by the construction of a second large scale dam in the Mananga river and a rubber weir in the Luyang river (low yield). Jaclupan should be kept operational. Small surplus of water could be transported by the present pipeline infrastructure to Mactan. Further supply for Mactan will be produced by desalination plants.

Alternative solution 5: Most likely projects

This alternative will be a combination of projects that will most likely be implemented. These projects have all been initiated by the private sector and/or have already been incorporated in developmental plans.

The following projects will be included:

- The Luyang-Carmen rubber dam for abstracting water from the Luyang river near Carmen town and transport water by pipeline to the Liloan inlet of the MCWD supply network. Estimated target abstraction is 50.000 m^3/d. According to the simulation, this maximum abstraction can be reached 66% of the time. The reliability in volume is 88% of the annual target setting.
- The Malubog dam. With the re-opening of the mines in the Sapang-daku WRMU, it was assumed that the existing Malubog reservoir will produce a volume of 50,000 m^3/d available for tunneling to the MCWD supply network. With such a supply volume the project will have a reliability of 97% in volume.
- Desalination. Especially in Mactan there are ongoing developments for construction of new desalination plants. The water from these plants could be sold to the private sector as well as to MCWD. Water could be treated up to industry or potable standards.
- Mananga & Jaclupan. In current land use planning and development plans the possibility of the construction of a dam in the Mananga watershed will be included. The infrastructure for abstraction of the Jacuplan aquifer is

already there and could be upgraded or combined with the Mananga dam infrastructure. The combination of the two will make this project more likely to occur than other dam projects.

- The Southern wells and the Compostela wells projects. Both projects are still under consideration by MCWD. The Southern wells will include the digging of new wells in the Carcar and Naga area and the abstraction of water from the Carcar River, while Compostela will reflect the rehabilitation of an existing well field that has never been used so far due to political reasons.

An overview of the selected measures is presented in *Table 4-13*. The table reflects the demand, supply and measures for the high demand WRMUs Butuanon, Cebu City, Mactan and Mananga.

4.4.3 Selecting the 'Water for all Cebuanos' Strategy

A comparison among the alternative strategies was made to identify the ultimate strategy that represents the common interest of all stakeholders. As shown in *Table 4-14,* the technical effectivity and cost-efficiency criteria are similarly scored 1/3 of the total weight. The weight coefficients are in agreement with the results from the stakeholder's consultation. After performing the multi-criteria analysis the preferred strategy was based on the maximum use of groundwater, because this strategy scored best in all scoring categories. This strategy is called 'Water for all Cebuanos'. A detailed description of the strategy is given in the Chapter 5.

Table 4-14 Selection of the ultimate strategy 'Water for all Cebuanos': overall scores range from 1 –5

				Strategy 'Water for all Cebuanos'					
Criteria	**Parameter**	**Scoring explanation**	**Weight**	**Alternative 0**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**
Technical effectivity	Local problem solving	Local solutions prevail and local needs are addressed first	10	high	medium	low	medium	low	low
	Overall adequacy of meeting the demand	Reliability (time and volume) / meeting the water quality	10	very high	medium	medium	high	high	medium
	Ease of implementation	Technical requirements	5	very high	medium	low	medium	low	very high
	Flexibility	Many options for future supply / no regret	10	high	low	low	high	high	medium
	Low risk vulnerability	Deterioration, seismic, terrorism	5	high	low	medium	low	medium	medium
Cost-efficiency	Internal rate of return	CBA parameter	20	high	medium	high	medium	medium	low
	Cost-affordability	Willingness and capability to pay	10	high	medium	medium	medium	medium	very low
	Development potential	Spin-off (irrigation, tourism, etc.)	5	low	medium	high	medium	high	low
	Limited financial risk potential	Foreign / private inputs, macro-economic sensitivity, energy costs, etc.	5	high	medium	medium	medium	medium	very high
Health and socio-environmental aspects	Environmental acceptability	Sustainability and max. conservation / no regret / public health	15	high	low	low	low	low	low
	Social acceptability	Public perception, livelihood protection, property loss	10	high	medium	low	medium	low	low
	Equity	Fair sharing of resources and equal pricing	5	high	medium	medium	medium	medium	low
Institutional and organizational aspects	Ease of implementation	Legal implementability / little conflict of interest / few organizations involved/ corruption / politics	15	high	medium	low	medium	low	high
Technical score			32%	4.4	2.6	2.4	3.4	3.1	3.0
Financial score			32%	3.8	3.1	3.6	3.1	3.1	2.1
Health and socio-environmental score			24%	4.0	2.5	2.2	2.5	2.2	2.0
Institutional and organizational score			12%	4.0	3.0	2.0	3.0	2.0	4.0
Overall score			**125**	**4.0**	2.8	2.7	3.0	2.8	2.6

5. WRM STRATEGY FOR CENTRAL CEBU

5.1 Introduction to the selected strategy

The solution presented in this chapter describes the proposed water resources management strategy for the Central Cebu area. It is based on the concept of Integrated Water Resources Management (IWRM) and takes into account the water resource management policies described in Chapter 4, together with the interests of all stakeholders identified. The strategy addresses the present as well as the expected water related problems in the area and aims at providing 'Water for all Cebuanos', not only for the short term (2010), but also for the medium term (2010-2020) and for the long term (2020-2030).

The future water demand is calculated based on the most likely socio-economic development scenario as described in Chapter 3. The challenge is to select and implement sufficient measures to make the supply meet the demands, as illustrated in *Figure 5-1.*

Meeting the demand is not simply implementing supply-oriented measures. It has to include measures that aim to reduce the demand and to protect the resource. In addition, institutional measures are also needed to enable the implementation of the strategy. Finally, research and development activities are required to provide the information background for the further development of the strategy, the monitoring of the implementation, and the impacts of the strategy on the socio-economic and environmental situation in Central Cebu.

The 'Water for all Cebuanos' strategy includes a combination of the most promising measures selected from the inventory of potential measures described in Annex A. These are categorized as follows and will be described in the indicated sections:

- development of additional water resources (Section 5.4)
- reduction of the water demand (Section 5.5)
- protecting the resource (Section 5.6)
- water governance (Section 5.7)
- research and development (Section 5.8)

Sections 5.2 and 5.3 describe the approach for strategy development as well as the current situation and what will happen if we don't take action. In Section 5.9, a scenario and sensitivity analysis will be carried out that describes the consequences if things turn out differently than expected. Finally in Section 5.10, the overall performance of the strategy is discussed.

5.2 Approach followed for strategy development

5.2.1 Starting points for the strategy

Starting points for strategy development are the minimum or maximum requirements that each measure or strategy should meet. Therefore, each solution should:

- result in affordable water for all Cebuanos with only gradual cost increases.
- have a minimum reliability of 90% for its targeted abstraction volume for the entire Central Cebu, i.e. 24 hrs full time delivery of at least 90% of the required volume.
- should be environmentally sound and sustainable with maximum protection for all users and uses in the area aimed at local problem solving.

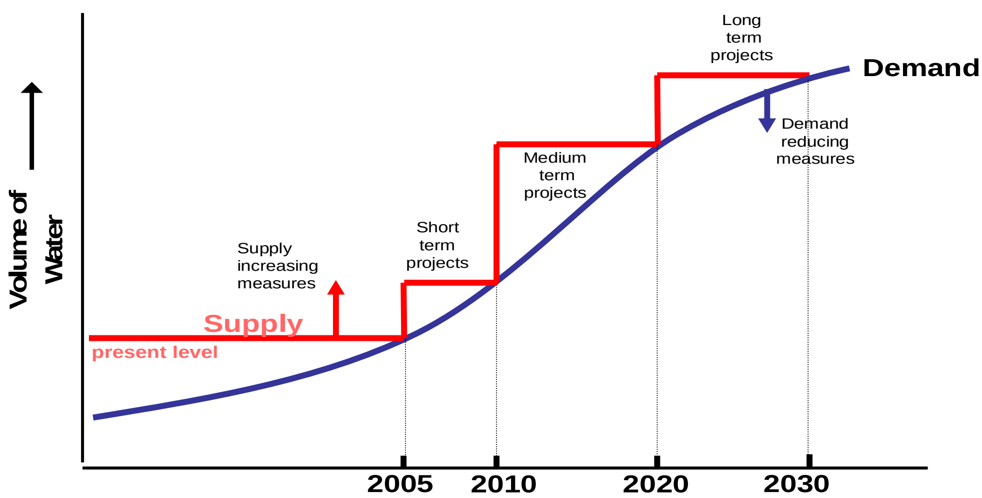


Figure 5-1 Meeting the demand - strategy 'Water for all Cebuanos'

5.2.2 WRM units and planning regions

The analysis of supply and demand is based on the WRMUs, as explained in Section 1.4. In total 21 WRMUs were distinguished for Central Cebu. As the scale and measures for the upland and the coastal areas are significantly different, the former will be treated separately.

The coastal areas of the WRMUs have been clustered according to their geographical location (West, East and Mactan) and whether or not the area is being serviced by MCWD. This led to the distinction of four planning regions, which further sub-divided the MCWD planning region into 4 sub-areas:

1. West coastal zone
2. Upland area
3. East coastal zone - outside MCWD service area
4. East coastal zone - MCWD service area
   - 4.1 Coastal area excl. Mactan, not yet served by MCWD
   - 4.2 Coastal area excl. Mactan, actually served by MCWD
   - 4.3 Mactan island, area not yet served by MCWD
   - 4.4 Mactan island, area served by MCWD

The MCWD service area comprises the WRMUs Compostela, Kotkot, Liloan, Cansaga, Butuanon, Cebu City, Mananga, Minglanilla-Talisay and Mactan. The MCWD distribution covers parts of the area. In the previous chapter, *Figure 4-2* showed the location of the WRMUs and the planning regions.

5.2.3 Basic approach

The main focus of the Action Plan is in providing sufficient and safe water for the population of Central Cebu. Hence the basic approach would be to develop new sources to meet the demand. Once that is taken cared of, the other elements such as environmental quality and governance will be dealt with.

Meeting the demand

Keeping the 'starting points' of the previous section, it was concluded that the strategy development should preferably start with optimizing the use of the present groundwater sources for local use. This would provide ample possibilities for local problem solving and, when only sustainable yields are extracted, environmental soundness and a high reliability of the supply will be assured.

By choice, the utilization of the present coastal aquifers has first priority for local supply for each time horizon. At all times, the abstraction should not exceed its 'safe yields' which is defined from a sustainability point of view. The defined WRMUs were used as basic units for the analyses. Their maximum potential abstractions were described in Section 4.2. The following approach was adopted as the basic solution:

- First, make maximum use of the local groundwater pump capacity which existed in 2005 (base year). It means that abstraction for external supply (across WRMU boundary) is reduced if capacity is necessary for a growing local use. For example, water should not be exported from Liloan to Mactan if the water is needed in Liloan itself to satisfy the local demand growth.
- The next step is to increase groundwater abstraction for local use. This can be necessary because of local demand growth and/or by compensation for reduced import groundwater flows (e.g. Mactan does not get extra water from Liloan in the future since Liloan needs its water locally). In practice this means digging new wells and installing new pump capacity and pipeline infrastructure. This can only be done if there is still enough groundwater in the area.
- In case not enough groundwater is available locally, it can be imported from neighboring WRMUs where groundwater is still available. This availability over time will decrease as a result of the growing demand in the WRMU itself.
- When this is no longer possible (either physically or economically) then the final step will be to choose extra, non-groundwater measures. Several options are available for this, such as the development of surface water reservoirs, desalination, and many more.

The last approach will only be needed for the medium and long term. At the same time new infrastructures for surface water abstraction or other sources like desalination plants can be made available. These make a wide selection of optional measures possible. Alternative solutions would be based on the following additional criteria:

- High reliability of supply: it is reasoned that reliability of the supply is more important for industry and commerce and tourism facilities than for households.
- Minimizing the investments cost: very important for the public sector since the government does not have enough budget to spend and additional funding will be necessary.
- Flexibility, gradual development and safe storage: to make the strategy flexible for different water demand or hydrological scenarios. It improves the reliability of the system and it secures the maximum success of achievement.
- Combination of measures that are most likely to be implemented anyway: due to ongoing developments or initiatives by the private/public sector some measures could have high preference.

The selection process of the 'best' alternative was described in Chapter 4. Several solutions of the different combination of measures have been developed to solve the water shortage and to meet pre-defined design criteria, such as minimum costs for end-users, maximum water resource use equity, maximum reliability of supply, optimized local problem solving, as well as high quality of water. The alternatives however emphasize special interests of different stakeholders (e.g. high reliability for industry versus minimum cost for house holds) that meet different policies or have different technical solutions. De facto, the alternatives show different 'paths' to solve the problems or tackle the bottlenecks in the water resources system. However, through a simple multi-criteria analysis, one alternative has been selected as the recommended solution to be implemented for overall Central Cebu. This solution is included in the 'Water for all Cebuanos' strategy.

Other strategy components

Other strategy components will have to be addressed too, such as: demand reduction, protecting the resources, water governance as well as research and development. Various demand reduction measures will also be analyzed and a recommendation for implementation will be asserted. However, given the uncertainty in the effectiveness of these measures it is recommended to plan the supply for the time being for the unreduced demand. If indeed the demand will develop slower than expected, then adjustments in the speed of implementation of supply measures can be made.
The other strategy components such as protecting the resources, water governance and research and development are logical consequences of the supply and demand management components of the strategy and will be determined once these first components have been developed.

5.3 Base case - the present situation and what will happen if we don't take action

5.3.1 Quantity of the supply

The base case will describe the performance of the water system for the various time horizons if no action is taken. Given the growing water demand this would mean that conditions will deteriorate further while the frequency and total volume of deficits will increase. The base case will be referred to as the 'do-nothing' or comparison case. The effects

Table 5-1 Additional required water supply in the project area (in million m³/year)

Service area		Demand category	Demand 2005	Additional demand		
			= Supply	2010	2020	2030
1. West		population and public	5.6	0.7	2.5	4.8
		industry and commerce	1.6	0.2	0.7	1.4
		Total West	**7.2**	**0.9**	**3.2**	**6.2**
2. Uplands		**Total Uplands (population)**	**5.0**	**0.7**	**2.4**	**4.5**
3. East outside MCWD service area		population and public	2.2	0.3	1.1	2.1
		industry and commerce	0.6	0.1	0.2	0.5
		Total East outside MCWD	**2.7**	**0.4**	**1.4**	**2.5**
4. MCWD service area	4.1 East excl. Mactan, not-MCWD served	population and public	37.9	2.0	3.9	4.5
		industry and commerce	20.0	-0.1	-1.3	-4.9
		tourism	0.6	0.2	0.6	1.0
	4.2 East excl. Mactan, MCWD served	population and public	41.5	15.2	56.2	103.4
		industry and commerce	5.5	1.5	6.1	14.0
	4.3 Mactan, not-MCWD served	population and public	8.7	1.5	4.4	7.1
		industry and commerce	7.3	-0.1	-0.8	-2.3
		tourism	0.6	0.2	0.6	0.9
	4.4 Mactan, MCWD served	population and public	3.7	1.8	7.4	15.5
		industry and commerce	2.1	0.6	2.3	5.2
		Total MCWD	**127.9**	**22.7**	**79.5**	**144.2**
Central Cebu		**Total project area**	**142.7**	**24.7**	**86.5**	**157.4**

of the strategy will be compared with the base case to determine the performance, in terms of effectiveness, of the proposed strategy.

The base case includes all present infrastructure: private wells, MCWD production wells and well fields, Jaclupan infiltration facilities, raw water treatment facilities and the Buhisan reservoirs and transmission mains. The results of the base case analysis are given in *Table 5.1*, spelling out the calculated additional demands for the entire Central Cebu project area, as well as for the separate 'service areas' and the various demand categories (population and public, industry and commerce and tourism). It is assumed that the 2005-supply is able to provide the present demand, either by public facilities (such as MCWD) or by private facilities (private groundwater wells, and others). This means that the additional demands as given in *Table 5.1* will be the shortages in the system if no additional measures will be taken. These are categorized as 'gross' demands which are to be supplied to the treatment stations and include the losses in the distribution system. The table shows that the total water shortage (the additional demand) in the project area will increase from 24.7 mcm/yr in 2010 to 86.5 mcm/yr in 2020 and 157.4 mcm/yr in 2030. Demand growth on the west coast and in the upland area is limited. About 80% of the total increase is related to increased domestic and public water demand in the east coast MCWD service area.

Demand from non-MCWD water users within the MCWD service area is expected to grow only very slightly because of the gradual increase of MCWD coverage in the area. *Figure 5.3* illustrates the table graphically, showing the dominance

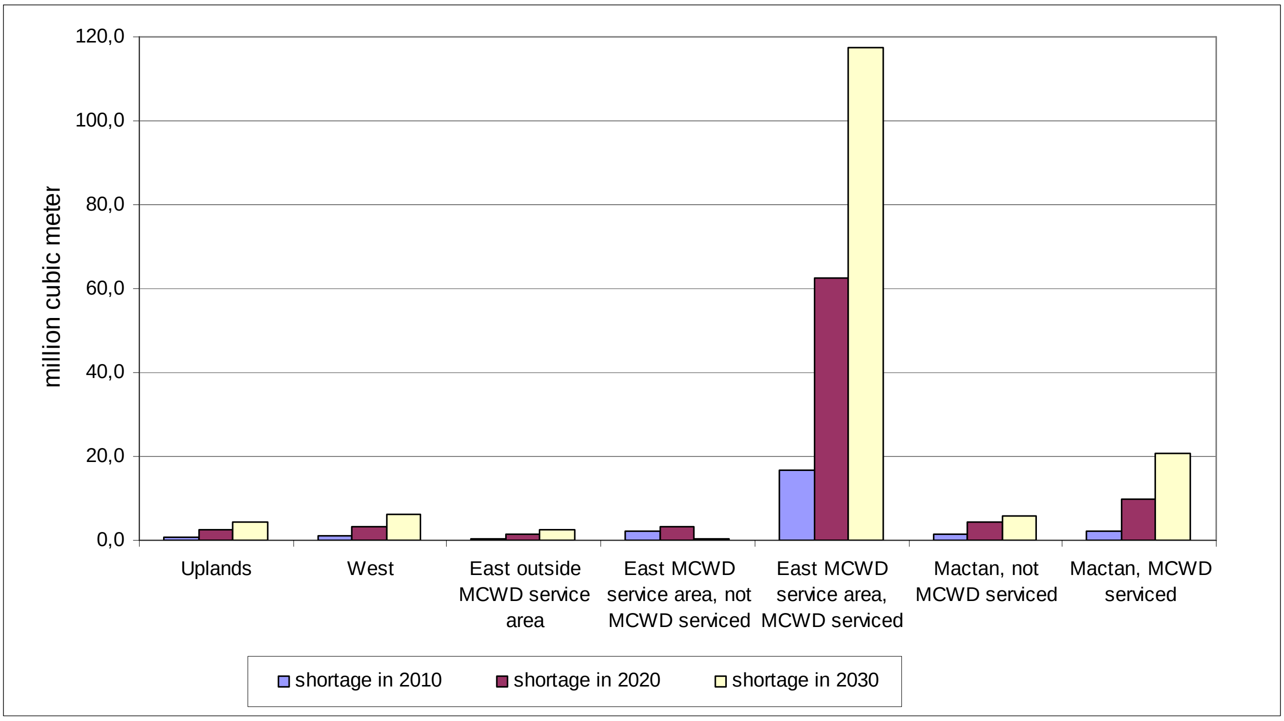


Figure 5-3 Future water shortages in the various service areas if no new measures are taken

of the water demand for MCWD, for the main island as well as for Mactan.

5.3.2 Quality of the supply

The environmental aspects related to the water system in Central Cebu are described in Sections 2.4 and 2.5. The environmental quality of the area is already under great pressure and the rapidly growing population and socio-economic activities will put additional pressure on the system. Without proper measures it is expected that the environmental quality in certain parts of Central Cebu will result in important health problems for the people and will form a constraint to the socio-economic development of the region.

The major threats for the drinking water supply are the pollution of groundwater and the deterioration of the watersheds which are the sources of the groundwater and surface water that the supply system relies on. The groundwater in particular is threatened in urban areas which lack sufficient sanitation and sewage treatment facilities. It is expected that production wells in these areas have to be taken out of production because of water quality reasons, unless proper measures are taken.

5.4 Development of additional water resources

The first part of the 'Water for all Cebuanos' strategy consists of the development of additional resources. The required developments will be described in this section for the 4 planning regions: West Coast; Upland; East Coast non-MCWD; and East Coast serviced by MCWD.

5.4.1 West coast

Groundwater potential in the western coastal zone is still high. In total more than 85 mcm/yr groundwater can be extracted from the coastal aquifer on a sustainable basis. When comparing this with the present groundwater use of 7.2 mcm/yr and the expected increase with 6.2 mcm/yr over the period 2005-2030, it will be clear that increasing groundwater extraction, either by private wells (measures 9.3, 9.4 and 9.5 of Annex A) or by production wells (measures 9.1 and 9.2) is a very viable option to meet the increasing demand. Private wells are defined here as wells that do not deliver water to distribution systems, but to individual users or clusters of users.

Table 5.2 shows the present and future demand and the groundwater potential for the coastal areas in the various WRMUs on the west coast. It shows that a shortage is not expected in any of the WRMUs. This is illustrated in *Figure 5.4*.

As stated, either private wells or production wells can be used to increase groundwater abstraction in the future. To improve control on the system it is recommended to use production wells in the urban areas as well as for the supply of water to industry and commerce. In the rural areas, private well development is the preferred option.

Table 5-2 Present groundwater potential and gross demands (in mcm/yr) for the coastal areas of the WRMUs on the Central Cebu west coast

WRMU	Total potential	Demand	Demand	Demand	Demand	Remaining
		2005	2010	2020	2030	2030
Asturias	9.4	0.4	0.4	0.5	0.7	8.7
Balamban	13.1	1.9	2.2	2.8	3.6	9.4
Cabiangon	16.5	1.0	1.1	1.6	2.1	14.4
Combado-Lusaran	12.9	0.5	0.5	0.6	0.8	12.1
Guinabasan	7.4	0.3	0.3	0.4	0.5	6.8
Mangoto	8.4	0.8	1.0	1.3	1.6	6.8
Sapang-daku	8.8	0.9	1.0	1.3	1.6	7.3
Toledo	8.5	1.4	1.6	1.9	2.4	6.2
Total	85.1	7.2	8.1	10.4	13.4	71.7

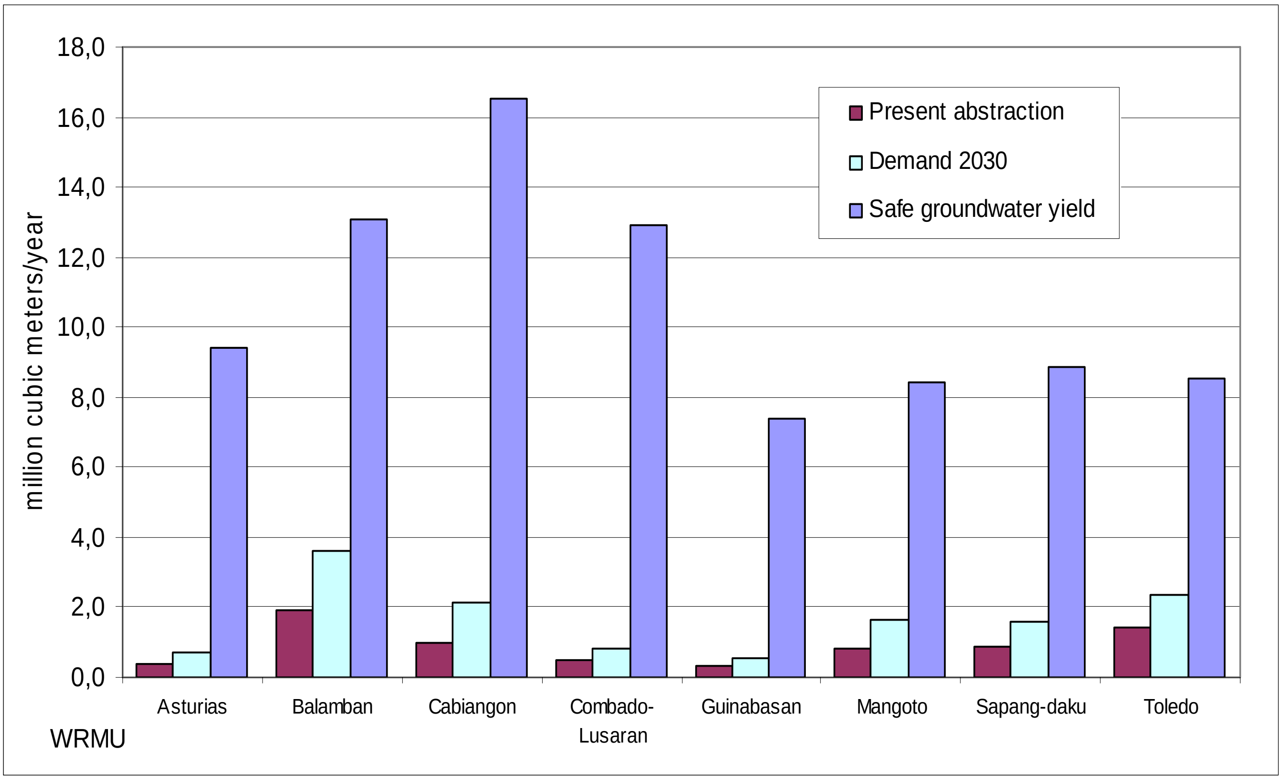


Figure 5.4 Safe yields, present abstractions and future gross water demand in the coastal areas of the west coast WRMUs

5.4.2 Central Cebu uplands

The water demand in the upland area is only a minor fraction of the total water demand in Central Cebu (about 3% in 2030). The water demand in the uplands will increase between 2005 and 2030 with 4.5 mcm/yr. (see *Table 5-3*).

Table 5-3 Present and future demands (in mcm/yr) for the Central Cebu uplands

Area	Supply	Demand			
	2005	2005	2010	2020	2030
Central Cebu uplands	5.0	5.0	5.7	7.4	9.5

Since large aquifers are not present in the uplands, this would mean that only a few new wells could be drilled. The supply will highly depend on springs as the case already is in the present situation. Construction of spring boxes, Levels 1, 2, or 3 (measure 8.1, 8.2 and 8.3 of Annex A) will be the best way to provide safe drinking water. Spring boxes Level 1 are relatively cheap, whereas costs involved in the construction and operation for spring boxes at Levels 2 and level 3 are quite high. Nevertheless, Level 2 is considered the minimum level that should be aimed for. This is also in line with the Millennium Development Goals of the United Nations which state that by 2015 the proportion of people without sustainable access to safe drinking water should be reduced by 50%. Level 2 spring boxes are considered to be 'safe drinking water' supply facilities (with the protection of the surrounding space) while this is not the case for spring boxes Level 1.

Reliability of spring boxes, however, is rated low. In dry years spring discharges may reduce considerably or even become zero for extended periods. Also, in certain areas springs may not be present. Therefore this measure has to be combined with other measures to guarantee water delivery in dry periods. First of all this implies the construction of rainwater impoundments (measure 8.4) to add storage (surface water and/or groundwater depending on local conditions). But also these have the risk to run dry during prolonged dry periods. The only remaining way to reach the rural population, scattered over the area, is by bringing potable water by truck (measure 8.5, see Annex A). An important element of this measure is that a system is developed which makes use of existing transport capacity, that can be made available on a 'need-only' basis.

It is assumed that 50% of the additional water demand in the uplands will be provided by spring boxes, the other half will be supplied by rainwater impoundments. The number of spring boxes required depends on the average discharge of the springs. *Table 5-4* gives the details.

One rainwater impoundment is estimated to supply 7,200 m^3 water per year (measure 8.4, see Annex A). The number of rainwater impoundments needed to meet the remaining water demand in the Central Cebu uplands is given in detail in *Table 5-5.*

Table 5-4 Number of spring boxes needed to meet 50% of the increasing household water demand in the Central Cebu upland area as a function of average spring discharge

Discharge (l/s)	Discharge (mcm/yr)	Number of springs required		
		2010	2020	2030
1	0.032	11	38	70
0.5	0.016	22	75	141
0.3	0.009	37	126	235
0.1	0.003	111	358	705
Production volume (mcm)		0.35	1.19	2.23

Table 5-5 Number of rainwater impoundments needed to meet 50% of the increasing household water demand in the Central Cebu upland area

	Number of impoundments required		
	2010	2020	2030
Number of impoundments needed	50	165	310
Production volume (mcm)	0.35	1.19	2.23

5.4.3 East coast, non MCWD service area

The water demand in the non MCWD service area along the east coast is rather limited. The domestic and public demand as well as the industrial and commercial demand will more or less double in 2030 (see *Table 5.1*) but will remain small at 5.2 mcm/yr. The groundwater potential of the area is substantial. Safe yields are estimated at 21.5 mcm/yr. After supplying water to meet the present local demands there is still 16.3 mcm/yr available. The measures proposed to meet the increasing demand in this area are therefore the same as those proposed for the west coast: increase groundwater abstraction, either by private wells (measures 9.3, 9.4 or 9.5) or by production wells (measures 9.1 and 9.2). With regard to the west coast, preference should be given to production wells (industry and population concentrations), while private wells will be used in rural areas.

Table 5-6 and *Figure 5-5* gives an overview of the safe yields and demands in the WRMU's of the area.

Table 5-6 Present groundwater potential and <u>local</u> gross demands (in mcm/yr) for the coastal area's of the WRMUs on the Central Cebu east coast outside the MCWD area

WRMU	Total potential	Demand	Demand	Demand	Demand	Remaining
		2005	2010	2020	2030	2030
Carmen	8.0	0.8	0.9	1.2	1.6	6.4
Danao	6.0	1.3	1.5	2.0	2.6	3.4
Luyang	5.4	0.3	0.3	0.4	0.5	4.9
Pangdan	2.1	0.3	0.4	0.5	0.6	1.6
Total	21.5	2.7	3.1	4.1	5.2	16.3

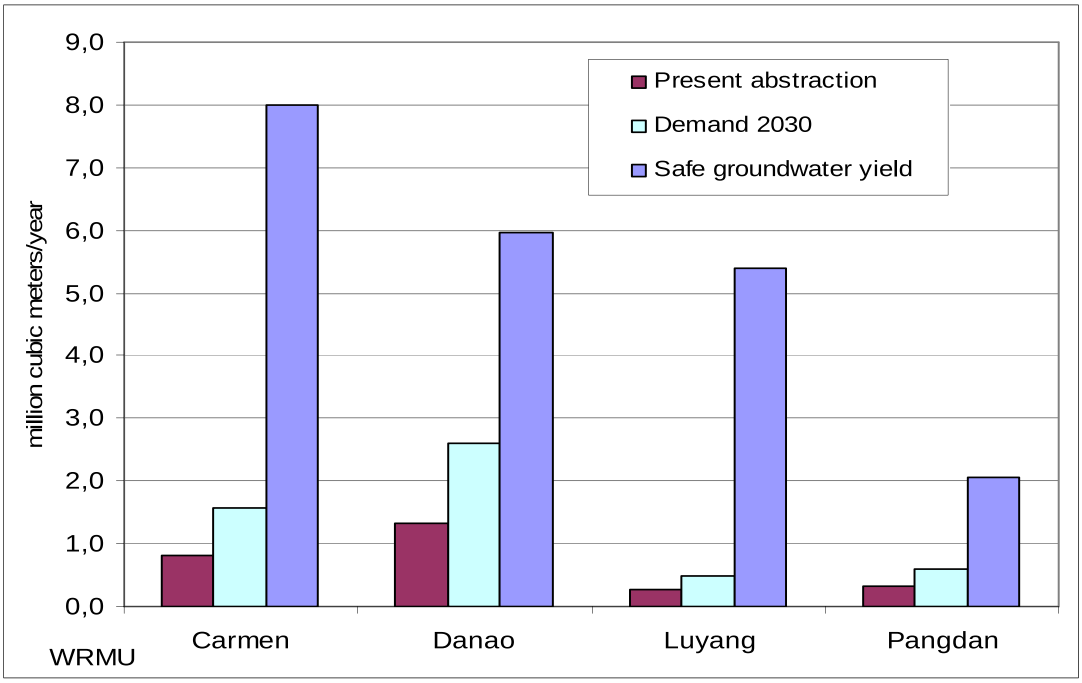


Figure 5-5 Safe yields, present abstractions and future gross local water demand in the coastal areas of the east coast WRMU's outside the MCWD service area

5.4.4 East coast, MCWD service area

The MCWD service area covers Cebu City, Talisay City, Mandaue City, Lapu-Lapu City and the municipalities of Consolacion, Liloan and (partly) Compostela. Since the network does not serve all, private and government wells provide the water supply for those areas that are not served by MCWD. Reference is made to Section 4.1 for an overview of the present water supply situation in the MCWD service area. Since the private and MCWD wells abstract from the same aquifer, the deficit of MCWD and non-MCWD users are summarized and compared according to the potential of the aquifer. The MCWD service area corresponds with the WRMUs, from North to South: Compostela, Kotkot, Liloan, Cansaga, Butuanon, Cebu City, Mananga and Minglanilla/ Talisay in Cebu island, and WRMU Mactan in Mactan island. The water demand in the MCWD service area is expected to increase steeply, basically as a result of the increasing population and economic activities in the Metro Cebu area. *Table 5-7* provides an overview of the expected demands by WRMU in relation to the groundwater potential of the WRMUs. The table shows that WRMUs Cebu City (already in the present situation), Butuanon (by 2020), Mactan (by 2020) and also Mananga (by 2030) are not 'self-sufficient' in groundwater anymore and will have to rely on the import of water from other WRMUs or the use of surface water or other supply means such as desalination. The import of water from other WRMUs is done by trunk pipelines of MCWD. *Figure 5-6* illustrates the situation.

Table 5-7 Present coastal groundwater potential and local gross demands (in mcm/yr) for the coastal area's of the WRMU' on the Central Cebu East coast inside the MCWD area - shading indicates higher demands present than locally available. Additional supply from other sources is not shown.

WRMU	Total potential	Demand	Demand	Demand	Demand
		2005	2010	2020	2030
Butuanon	26.9	22.1	26.6	38.4	51.3
Cansaga	12.4	4.5	5.4	7.8	10.7
Cebu City	42.6	68.3	79.9	107.8	137.3
Compostela	15.9	2.2	2.6	3.9	5.7
Kotkot	4.0	0.4	0.4	0.6	0.8
Liloan	9.7	2.5	2.9	4.2	6.1
Mactan	27.1	22.4	26.3	36.4	48.7
Mananga	4.4	2.2	2.5	3.5	4.8
Minglanilla-Talisay	9.5	3.4	3.8	4.9	6.5
Total	152.5	127.9	150.5	207.4	272.1

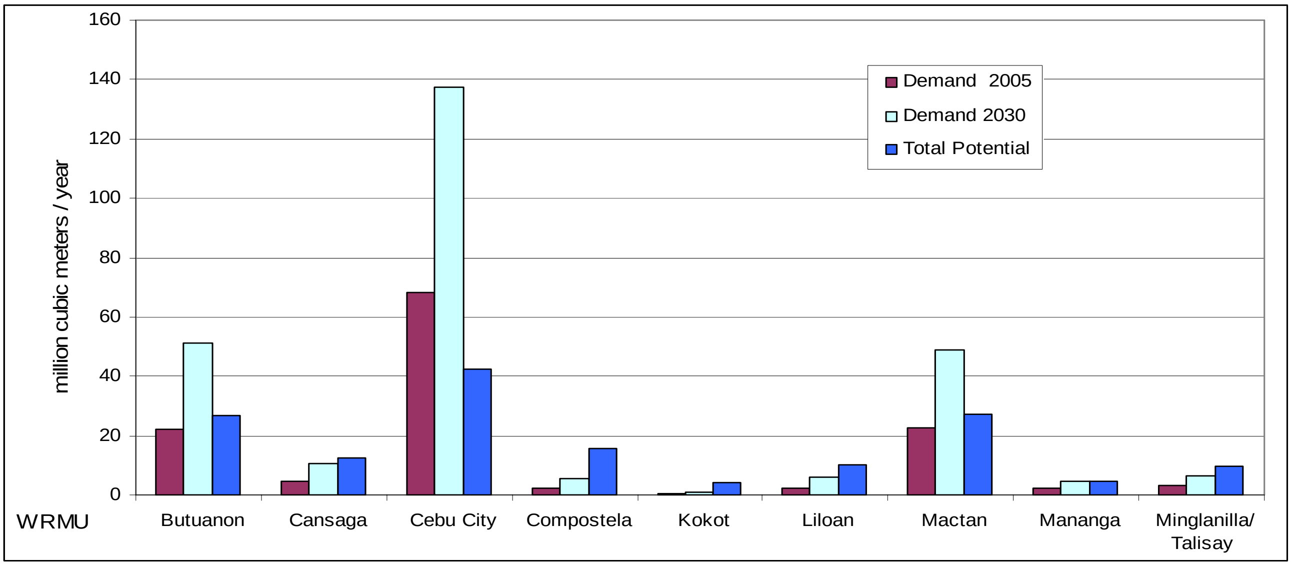


Figure 5-6 Safe yields and gross demands 2005 and 2030 in the coastal areas of the east coast WRMU's in the MCWD service area (the potential of Cebu City and Mactan excludes the supply from other resources)

Table 5-7 shows that Cebu City is already at present ‘importing’ 25.7 mcm/yr. This water comes partly from coastal aquifers in other WRMUs (15.7 mcm/yr), partly from other sources (1.8 mcm/yr from Buhisan and 8.2 mcm/yr from Jaclupan). Since Mactan is abstracting less groundwater than the safe yield, it is also importing water (3.3 mcm/yr). Besides, 2.2 mcm fresh water is produced in Mactan every year by desalination. The imports are being covered by additional groundwater withdrawals in WRMUs Butuanon, Cansaga, Kotkot, Liloan, Mananga and Minglanilla-Talisay and is delivered to the MCWD network.

The present situation of the flows between the WRMUs and the present additional sources (Buhisan, Jaclupan and desalination) are given in *Table 5-8.* In the future these flows will change somewhat because surpluses will first be used to meet the growing local demands. Export of water will only take place if there is still a surplus after the local demands have been met.

In the following sections a description will be given of how the strategy ‘Water for all Cebuanos’ will deal with these shortages. A distinction will be made in:

- the part of the east coast that is not serviced by MCWD (Section 5.4.4.1)
- the actual MCWD serviced area (Section 5.4.4.2)
- Mactan (Section 5.4.4.3)

The present and future water demands of these 3 areas are given in *Table 5-9.*

Table 5-8 Present situation water supply flows (in mcm/yr) in service area MCWD

WRMU	Total potential	Present abstraction	Present export	Present import	Additional sources	Demand 2005	Remaining 2005
Butuanon	26.9	26.9	4.9			22.1	0.0
Cansaga	12.4	12.4	7.9			4.5	0.0
Cebu City*	42.6	42.6	0.0	15.7	10.0	68.3	0.0
Compostela	15.9	2.2	0.0			2.2	13.7
Kotkot	4.0	1.3	1.0			0.4	2.7
Liloan	9.7	3.9	1.4			2.5	5.8
Mactan**	27.1	16.9	0.0	3.3	2.2	22.4	10.1
Mananga	4.4	4.4	2.3			2.2	0.0
Minglanilla-Talisay	9.5	5.0	1.6			3.4	4.5
Total	152.5	115.6	19.0	19.0	12.2	127.9	36.9

*) WRMU Cebu City extracts 42.6 mcm/yr groundwater, imports 15.7 mcm/yr from coastal aquifers from other WRMU’s and receives 10.0 mcm/yr from other sources: 1.8 mcm/yr from Buhisan and 8.2 mcm/yr from Jaclupan

**) WRMU Mactan extracts 16.9 mcm/yr groundwater, uses 2.2 mcm/yr from desalination plants, while 3.3 mcm/yr is imported from the coastal aquifers from Cansaga, Kotkot and Liloan

Table 5-9 Distribution of gross water demand (in mcm/yr) of MCWD area over non-served, served main island and Mactan

Area	Demand	Demand	Demand	Demand
	2005	2010	2020	2030
East, excl. Mactan, non-MCWD served	58.5	60.6	61.7	59.1
East, excl. Mactan, MCWD served	47.0	63.6	109.3	164.3
Mactan	22.4	26.3	36.4	48.7
Total	127.9	150.5	207.4	272.1

5.4.4.1 East coast MCWD service area (excl. Mactan), not MCWD serviced

Industrial water demand in the MCWD service area which is not MCWD serviced will decrease in the future based on MCWD's plan to increase their coverage from the present 50% to approximately 65% (see *Table 5-10*). MCWD's coverage of domestic/public water supply is perceived to grow to approximately 75%. Nevertheless the total demand that is not MCWD serviced will increase somewhat due to the sharp growth in population. Tourism demand increases slightly with a total 1 mcm/yr. Tourist facilities are assumed to choose to be independent from a supplier by installing their own wells.

For Metro Cebu a 'stand still' policy regarding new groundwater abstractions is in force. However, if domestic/public and tourist facilities increase abstraction keep pace with the required volumes, the total abstractions will still increase with 2.1 mcm/yr in 2010 and 3.2 mcm/yr in 2020. However, by 2030 the demand will have declined again by 2.5 mcm/yr. This means that the net additional installed pump capacity for the period 2005-2030 will ultimately be only 0.6 mcm/yr.

The proposed measure to meet domestic/public and tourism demand in this area is therefore to increase the capacity of a limited number of selected production wells or install a limited number of new production wells near the demand locations. If hydrogeological surveys indicate that this local solution is not possible, it has to be considered to connect these specific, well defined, demand locations to the MCWD distribution net.

5.4.4.2 East coast MCWD service area (excl. Mactan, MCWD serviced

As mentioned above, the water demand in this category is expected to increase steeply which is also given in *Table 5-11*. The demand will more than triple from the present demand of 47.0 mcm/yr to 164.4 mcm/yr in 2030.

Groundwater from three different sources is still available to be abstracted and supplied to the MCWD service area. A first 'internal' groundwater resource, still not completely exploited, is the groundwater in the MCWD area itself, partly in the north (WRMU's Compostela, Kotkot, Liloan) and partly in the south (WRMU Minglanilla-Talisay). Reference is made to *Table 5-8* which indicates the available volumes. The available volumes for supply to MCWD will decrease over time because of the increase in local demand of the WRMU's themselves. The remaining volumes for the years 2010, 2020 and 2030 are given in *Table 5-12* The safe yield for Minglanilla-Talisay is constant up until 2020 because by then the export of water to Cebu City will decline to satisfy the local water demand growth first instead of installing new wells. However, for Cebu City new sources must be found to compensate the reduction.

The second source area is the east coast non-MCWD service area. As shown in Section 5.4.3 the safe yields in this area are larger than the projected (2030) local demands, and water could be 'exported' to the MCWD service area. Total amounts available, i.e. safe yields minus local demands, north of the MCWD service area (WRMUs Luyang, Carmen and Danao) and south of the MCWD service area (WRMU Pangdan) are given in *Table 5-13.*

Table 5-10 Present and future gross demands (in mcm/yr) for the non-MCWD serviced part in MCWD area (excl. Mactan)

User groups	Supply 2005	Demand 2005	Demand 2010	Demand 2020	Demand 2030
Population and public	37.9	37.9	39.9	41.8	42.4
Industry and commerce	20.0	20.0	19.9	18.7	15.1
Tourism	0.6	0.6	0.8	1.2	1.6
Total	58.5	58.5	60.6	61.7	59.1
Additional demand		-	+2.1	+3.2	+0.6

Table 5-11 Present and future gross demands (in mcm/yr) for the MCWD serviced part in MCWD area (excl. Mactan)

User groups	Supply 2005	Demand 2005	Demand 2010	Demand 2020	Demand 2030
Population and public	41.5	41.5	56.7	97.7	144.9
Industry and commerce	5.5	5.5	7.0	11.6	19.5
Total	47.0	47.0	63.7	109.3	164.4
Additional demand		-	+16.7	+62.3	+117.4

The third source of water for the MCWD service area is the groundwater resource South of Central Cebu in the municipalities of San Fernando and Carcar. The measure, known as 'Southern Wells' (measure 10, see Annex A) actually involves the development of 4 separate well fields. The total safe yield that can be produced by these Southern Wells is 14.6 mcm/yr.

Groundwater quality in the MCWD service area is presently still acceptable, but nitrate concentrations in some locations are approaching the maximum allowable concentrations. Problems related to contamination with E-coli bacteria are also reported with increasing frequency. Increasing water use in the area will raise the return flow of contaminated sewage and thus the nitrate concentrations and E-coli contents of the groundwater.

This implies that for the 'Water for all Cebuanos' strategy, construction of sewage systems, capable of removing at least the additional return flow volume of water that would otherwise infiltrate towards the aquifer (compared to the present situation) is a pre-requisite. The construction of sewage (and treatment) systems has to be made part of construction and development regulations. Further information on these measures will be given in Section 5.6.2. Having sewage systems in place means also that the return flow towards the coastal aquifer of the *additional supplied* water is assumed to be zero. The recharge from the present supplied water is assumed to be 25% of the return flow from water used by industry/commerce, and 50% of the return flow from water used by households and in the public sector. On average 32% of the water supplied returns to the groundwater again. For the WRMUs in the MCWD service area this amounts to 41.4 mcm/yr.

Table 5-12 Volumes of groundwater available internally in the MCWD service area

Source area	Available safe yield, in mcm/y (after subtraction local use)			
	2005	2010	2020	2030
North (Compostela, Kotkot, Liloan)	22.2	21.8	20.2	16.4
South (Minglanilla-Talisay)	4.5	4.5	4.5	3.0
Total	26.8	26.3	24.7	19.5

Table 5-13 Volumes of groundwater available 'export' to the MCWD service area

Source area	Available safe yield, in mcm/y (after subtraction of local use)			
	2005	2010	2020	2030
North (Luyang, Carmen, Danao)	17.0	16.6	15.7	14.7
South (Pangdan)	1.7	1.7	1.6	1.5
Total	18.7	18.3	17.3	16.2

Figure 5-7 Overview fluxes between WRMUs and cities/municipalities – East Coast (in 2005)

Present (2005)

At present water transport across WRMUs is mainly taking place to Cebu City and Mactan. As indicated in *Table 5-8* the main suppliers are WRMUs Cansaga and Butuanon with small contributions from WRMUs Kotkot, Liloan, Mananga and Minglanilla-Talisay. Other WRMUs only abstract water for local supply. *Figure 5-7* illustrates the fluxes between the supplying WRMUs and the demanding cities and municipalities.

Figure 5-8 Overview fluxes between WRMUs and cities/municipalities — East Coast (in 2010)

Short term (2010)

By minimizing the export WRMUs Cansaga and Butuanon can still be self supportive for the short term, despite the fact that they have already reached the maximum potential abstraction volume of their local coastal aquifer. WRMUs Kotkot, Liloan, Mananga and Minglanilla-Talisay will also have to reduce their export to improve local supply.
Water shortages in the area in 2010 will only occur in the WRMU Cebu City. The shortage in WRMU Cebu City, 16.9 mcm/yr, can be solved by bringing in water from the internal source in the northern part of the MCWD service area, where there is still 21.8 mcm/yr available (see *Table 5-12*). This means that the resource available in the southern part of the area, Minglanilla-Talisay (4.5 mcm/yr) is not yet needed. The measure should be by installing production wells in Liloan, Kotkot and Compostela. This should be done in this order, that is to say, starting with using the sources closest to the demand area. New transmission pipelines or upgrading of the distribution network are necessary if it appears that the present distribution cannot transport the water to Cebu City.

The interaction between the supply of the WRMUs and the demand of the cities and municipalities for the short term is illustrated in *Figure 5-8*.

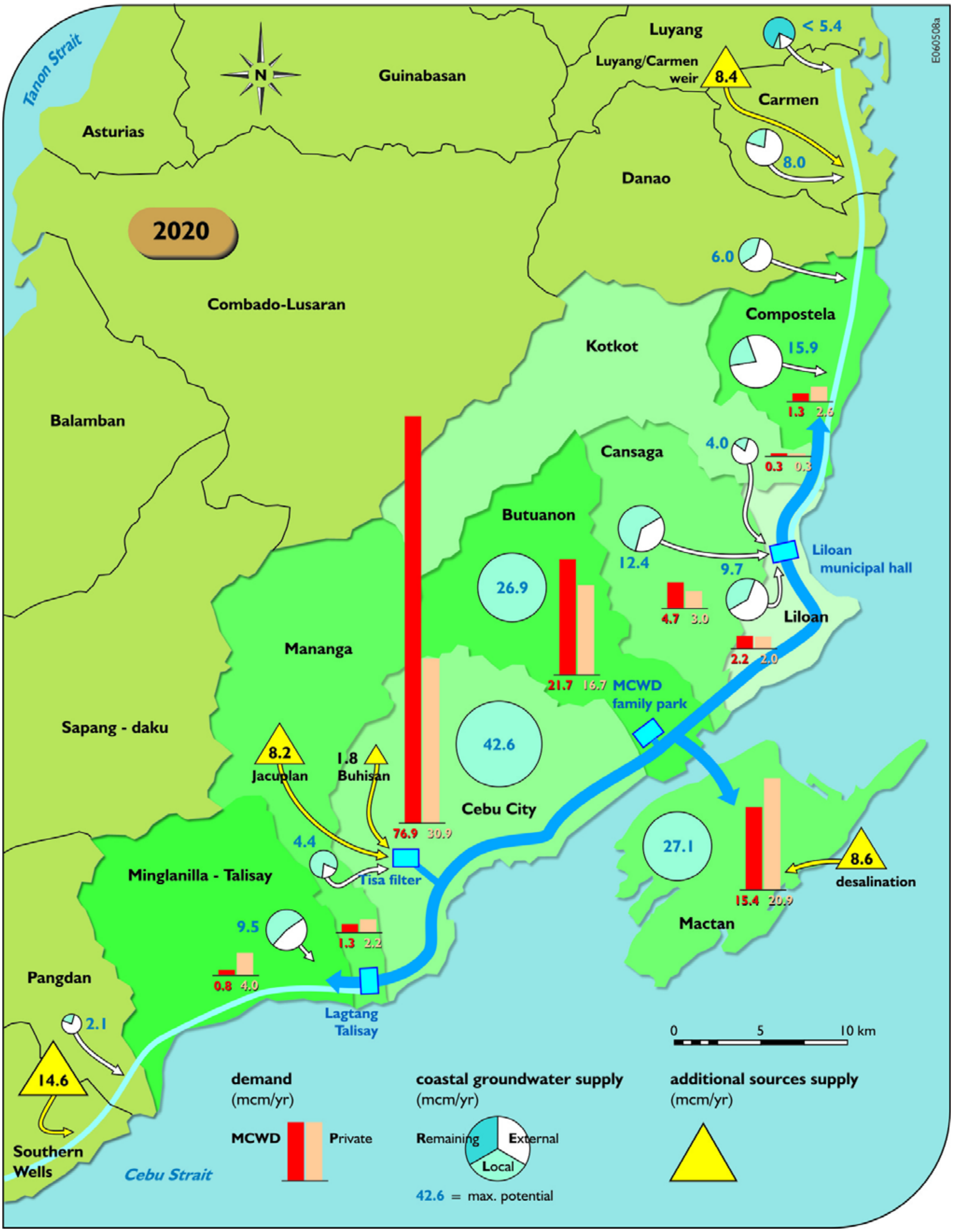


Figure 5-9 Overview fluxes between WRMUs and cities/municipalities — East Coast (in 2020)

Mid term (2020)

In 2020 water shortage is not only concentrated in Cebu City, but also in the nearby Butuanon and in Mactan Island. Local supply can no longer meet the demand (see *Table 5-7*). In total 67.4 mcm/yr needs to be 'imported': 49.5 mcm/yr for Cebu City, 11.5 mcm/yr for Butuanon and 6.4 mcm/yr for Mactan. Internally there is still 20.2 mcm/yr available in the Northern area (Liloan, Kotkot and Compostela). This resource will have to be used to full capacity (measure already included in the 2010 solution). Production wells (measure 9) have to be installed in the area north of the MCWD service area: the WRMUs Luyang, Carmen, Danao. From this source another 15.7 mcm/yr can be supplied. South of WRMU Cebu City, groundwater can still be abstracted in WRMUs Minglanilla-Talisay (4.5 mcm/yr) and in Pangdan, outside the MCWD service area (1.6 mcm/yr). Finally, the Southern Wells (measure 10) have to be brought into production (14.6 mcm/yr). The total available volume should then be 56.6 mcm/yr. However, to make maximum utilization of the Luyang watershed and cost-efficient pipeline infrastructure the Luyang-Carmen rubber weir (measure 4) is also implemented in addition to the well fields. To gain a reliability comparable with the high reliable groundwater sources, the low yield option for the weir is implemented, supplying 8.4 mcm/yr. The production of the Luyang wells is partly reduced due to the impact of the upstream infrastructure. However, the total production of the combination scheme for Luyang will be higher. The total available volume is now 61 mcm/yr and would be sufficient for Metro Cebu.

This implies that by 2020, assuming the above described zero return flow of the additional (since 2005) supplied water, all the available groundwater resources of the east coastal aquifer will be used to their maximum and that further increase in demand will have to be met by using surface water resources.

The strategy described here assumes primarily a gradual extension of the groundwater extraction in the northern direction, followed by an extension in the southern direction. A trunk pipeline connected to the MCWD distribution system has to be gradually extended to the north up to Luyang, followed by a construction of a trunk pipeline in the southern direction, first to Minglanilla-Talisay, then extended to Pangdan in a next phase, and finally to the Southern Wells field.

Figure 5-9 again illustrates the fluxes between WRMUs and cities/municipalities for this time horizon.

Figure 5-11 Overview fluxes between WRMUs and cities/municipalities — East Coast (in 2030)

Long term (2030)

By 2030, the additional demand of Cebu City has increased to 83.0 mcm/yr, Butuanon requires 24.4 mcm/yr and also Mananga has now a shortage of 0.4 mcm/yr. In total 107.8 mcm/yr has to be supplied from outside these areas. The exchange of water between WRMUs which presently takes place will have stopped almost completely: present pump capacity (and even more) is needed for local supply. Exceptions are WRMUs Cansaga and Kotkot where 2.2 mcm/yr is still available for transfer to Cebu City and Mactan.

In total 16.4 mcm/yr can be supplied internally from the northern MCWD service area (WRMUs Liloan, Kotkot and Compostela, measures already included in the 2010 solution). WRMUs Luyang (including the weir), Carmen and Danao can supply another 19.0 mcm/yr. Minglanilla-Talisay can supply 3.0 mcm/yr, while Pangdan still has 1.5 mcm/yr available. The Southern Wells will need to produce 14.6 mcm/yr. The total supply from these sources is 54.7 mcm/yr which means that still another 53.1 mcm/yr will be required.

This additional demand can only be supplied from surface water resources. In 2030 one or more storage reservoirs with a total minimum capacity of around 53 mcm/yr will have to be fully operational. It also has to be taken into account that water availability in the 'export areas' north and south of the MCWD service area, and in the 'internal supply areas' will further decrease after 2030, because local demand will increase. This decrease can roughly be set at 7.5 mcm/yr over a ten year period (1.5 mcm/yr in the north and 6.0 mcm/yr internally supplying area). In other words, surface water will gradually have to take over the role of groundwater as a source for the water supply in Cebu City, Butuanon and Mananga. Beyond 2030 other WRMUs of Metro Cebu will possibly have to rely also on surface water as well, since local surpluses elsewhere will become smaller. The most logical choices for the surface water reservoirs seem to be the Kotkot and the Lusaran dams (more economically feasible than e.g. the Mananga High Dam thanks to a lower dam and combined pipeline option to MCWD inlet). However, further detailed studies may still alter the choice for the required future surface water utilization whereby the socio-economic advantages of a Mananga High Dam may then prevail.

The analysis and prioritization of these measures are described in Chapter 4. A summary of the fluxes for 2030 is given in *Figure 5-10*.

5.4.4.2 Mactan island, MCWD and non-MCWD serviced

Present water demand in Mactan, MCWD and non-MCWD combined, amounts to 22.4 mcm/yr (see *Table 5-4*). Of this amount 16.9 mcm/yr is abstracted from groundwater, 2.2 mcm/yr comes from desalination and 3.3 mcm/yr is imported from the WRMUs Compostela, Kotkot and Liloan. The total groundwater potential in the island is 27.1 mcm/yr.

In 2010 non-MCWD demand will be 1.6 mcm/yr higher than in 2005, which means the MCWD demand will have risen by 2.4 mcm/yr. Delivery from the WRMUs Compostela, Kotkot, Liloan area will decrease to 1.8 mcm/yr (1.5 mcm/yr less), meaning that in total an extra 5.5 mcm/yr will be needed. This water can be abstracted from the groundwater with production wells, preferably horizontal wells and shallow wells (measure 11).

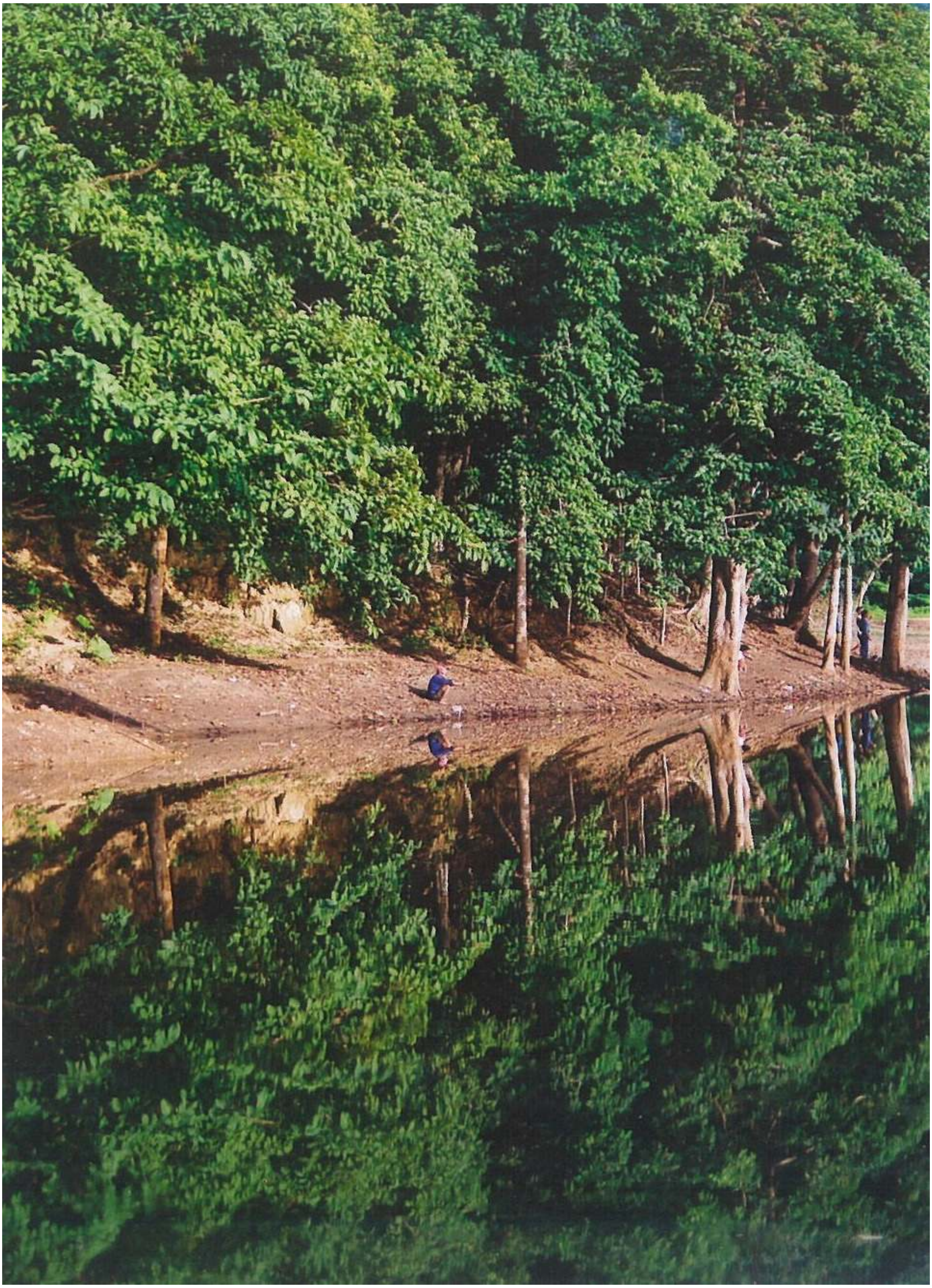
In 2020 non MCWD demand will be 4.2 mcm/yr higher than in 2005, MCWD demand will have increased by 9.7 mcm/yr compared to 2005. The delivery from WRMUs Compostela, Kotkot, Liloan will be 2.7 mcm/yr lower than in 2005. On balance: total demand will be 36.3 mcm/yr, groundwater abstractions can be maximized to 27.1 mcm/yr, 2.2 mcm/yr is produced by the existing desalination plants and 0.7 mcm/yr is still supplied from the Kotkot area. Additional volume that will be needed is 6.3 mcm/yr. This amount will be supplied from new (seawater) desalination plants (measure 13.1), bringing the total desalination plant capacity to 8.5 mcm/yr. This is almost 80% of the combined industry/commerce demand (11.0 mcm/yr), so it is more realistic to assume that part of the water (7.1 mcm/yr) has to be of drinking water quality (measure 13.2) and will be supplied to the fast growing domestic use and tourism facilities.

Between 2020 and 2030 total MCWD and non MCWD annual demand will increase by another 12.5 mcm/yr. By comparison the reservoirs in Cebu Island have a surplus to the water demand in the area (8.4 mcm/yr). For the benefit of Mactan an additional pipeline connection between the two islands must be established. The remaining supply can be produced by desalination plants (measure 13). In 2030 a total capacity of 12.8 mcm/yr will be operational.

The above strategy for the Mactan water supply is based on the assumption that all additional return flow created by additional supply after 2005 that would otherwise infiltrate the aquifer again will leave the system as collected waste water, i.e. the return flow of water used for domestic, tourism and industrial purposes is assumed to be zero.

Table 5-14 Present and future gross demands (in mcm/yr) for Mactan (MCWD and non-MCWD served)

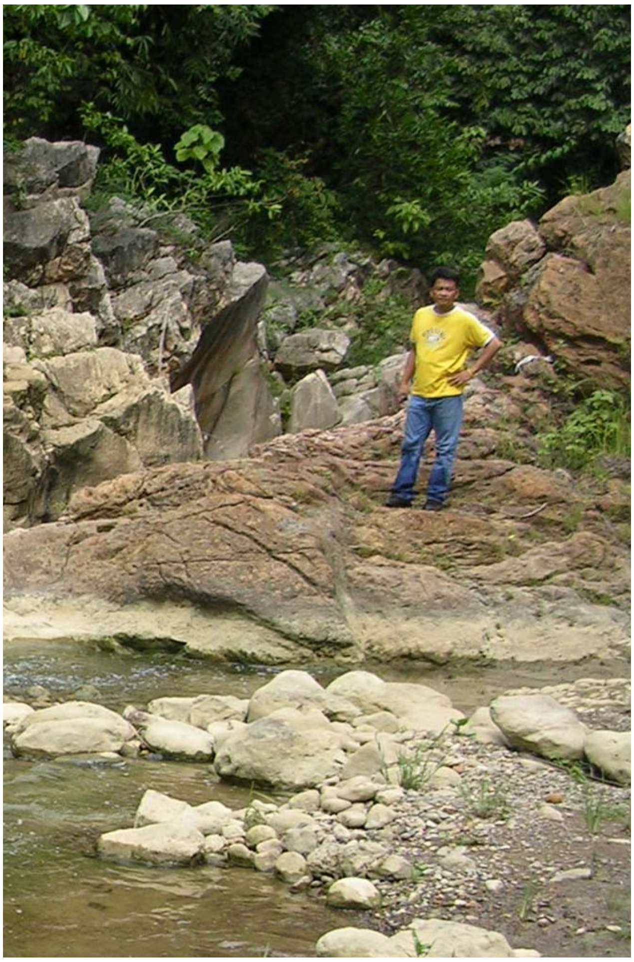
User groups	Supply 2005	Demand 2005	Demand 2010	Demand 2020	Demand 2030
Population and public	12.4	12.4	15.7	24.2	35.0
Industry and commerce	9.4	9.4	9.9	10.9	12.3
Tourism	0.6	0.6	0.8	1.2	1.5
Total	22.4	22.4	26.4	36.3	48.8
Additional demand		-	+4.0	+13.9	+26.4



5.4.5 Summary of the proposed strategy

The ‘Water for all Cebuanos’ strategy for Central Cebu is summarized in *Table 5-15* and *Figure 5-11*. The table and figure show that the strategy is based on optimizing the available groundwater resources in the coastal zone, gradually moving to areas further away from Metro Cebu. The water demand in the MCWD area will more than double between 2005 and 2030 from 128 to 272 mcm/yr, while the coastal abstraction can only support a growth of 15% (from 116 to 133 mcm/yr), with an option of further growth up until 32% by maximum utilization of the coastal aquifer (viz. 19.5 mcm/yr coastal aquifer potential is still available and can be transported to the high demand areas). By increasing abstractions in the Kotkot, Compostela, Liloan in the north, water supply until 2010 could be guaranteed. In the period 2010-2020 groundwater resources further to the north (Carmen, Danao and Luyang) and further to the south have to be taken into production (Minlanilla-Talisay, Pangdan and the Southern Wells). In the Luyang watershed, wells are combined with water intake from the Luyang river. A limited amount of water has to be supplied by desalination plants in Mactan.

In the period 2020-2030 all groundwater resources will be used to their maximum sustainable yields and growing demand can only be met by bringing surface water to the Metro Cebu area. Construction of surface water reservoirs large enough to supply together at least 53 mcm/yr for Cebu island is needed. In addition, mainly to keep pace with the growing demand in Mactan Island, the desalination capacity has to increase to about 11 mcm/yr in 2030 on top of the supply provided by surface water reservoirs on Cebu island.



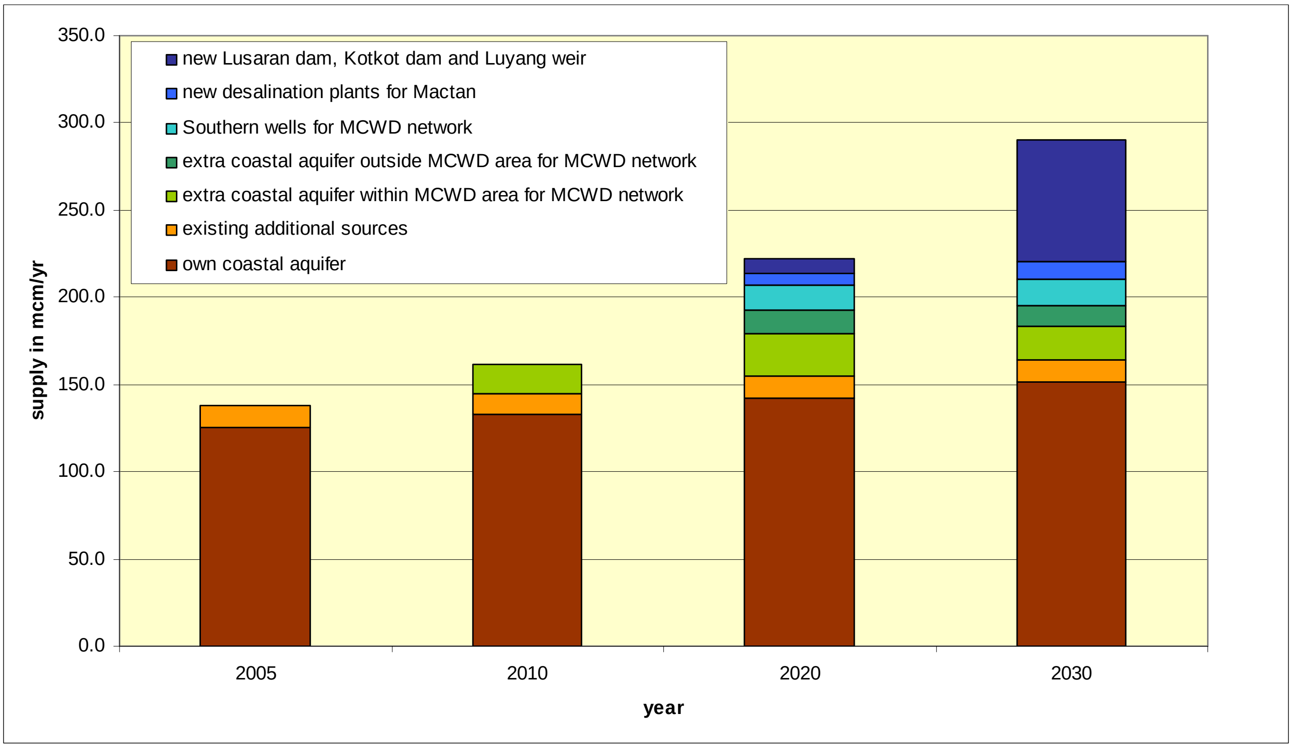


Figure 5-11 Development of gross demand and supply sources Central Cebu

Table 5-15 Supply and demand and required measures in 'Water for all Cebuanos' (in million m^3 per year)

I West Coast	2005	2010	2020	2030
Total demand	7.2	8.1	10.4	13.3
Supply from coastal aquifers				
Asturias	0.4	0.4	0.5	0.7
Balamban	1.9	2.2	2.8	3.6
Cabiangon	1.0	1.1	1.6	2.1
Combado-Lusaran	0.5	0.5	0.6	0.8
Guinabasan	0.3	0.3	0.4	0.5
Mangoto	0,8	1.0	1.3	1.6
Sapang-daku	0.9	1.0	1.3	1.6
Toledo	1.4	1.6	1.9	2.4
Total supply	7.2	8.1	10.4	13.3
II Central Cebu Uplands				
Total demand	5.0	5.7	7.4	9.5
Supply from spring boxes and rainwater impoundments (+ trucking in dry periods)	5.0	5.7	7.4	9.5
III East Coast non-MCWD area				
Total demand	2.7	3.1	4.1	5.3
Supply from coastal aquifers				
Carmen	0.8	0.9	1.2	1.6
Danao	1.3	1.5	2.0	2.6
Luyang	0.3	0.3	0.4	0.5
Pangdan	0.3	0.4	0.5	0.6
Total supply	2.7	3.1	4.1	5.3
IV East Coast MCWD area				
Total demand (excl. uplands and agriculture)	127.9	150.5	207.4	272.1
Supply from coastal aquifer for local use				
Butuanon	22.1	26.6	26.9	26.9
Cansaga	4.5	5.4	7.8	10.7
Cebu City	42.6	42.6	42.6	42.6
Compostela	2.2	2.6	3.9	5.7
Kotkot	0.4	0.4	0.6	0.8
Liloan	2.5	2.9	4.2	6.1
Mactan	16.9	22.3	27.1	27.1
Mananga	2.2	2.5	3.5	4.4
Minglanilla-Talisay	3.4	3.8	4.9	6.5
Supply from coastal aquifer for export to other WRMU's (reduction due to local demand growth)				
Butuanon (to Cebu City)	4.9	0.3	0.0	0.0
Cansaga (to Cebu City and Mactan)	7.9	7.0	4.6	1.7
Kotkot (to Mactan)	1.0	0.9	0.7	0.5
Liloan (to Mactan)	1.4	0.9	0.0	0.0
Mananga (to Cebu City)	2.3	1.9	1.0	0.0
Minglanilla-Talisay (to Cebu City)	1.6	1.2	0.1	0.0
Total supply from coastal aquifers for local use	115.6	121.4	127.8	133.0
Supply from existing additional sources				
Buhisan (within Cebu City)	1.8	1.8	1.8	1.8
Jacuplan (from Mananga to Cebu City)	8.2	8.2	8.2	8.2
Desalination (to Mactan)	2.2	2.2	2.2	2.2
Total supply from additional sources	12.2	12.2	12.2	12.2
Extra abstraction within MCWD area for supply high demand areas				
Compostela		8.4	12.0	10.2
Kotkot		2.7	2.7	2.7
Liloan		5.8	5.5	3.6
Minglanilla-Talisay			4.5	3.0
Abstraction, non-MCWD area for supply high demand areas				
Carmen			6.8	6.4
Danao			3.9	3.4
Luyang			0.9	0.8
Pangdan			1.6	1.6
Abstraction outside Central Cebu for supply high demand areas				
Southern wells			14.6	14.6
New desalination plants Mactan				
industry			2.1	3.5
potable			4.3	7.1
Surface water reservoirs abstraction for supply high demand areas				
Lusaran 63 m dam				41.0
Kotkot 25 m dam				20.5
Luyang-Carmen weir - low yield			8.4	8.4
Total supply by measures for high demand areas		16.9	67.4	126.8
Total supply	127.9	150.5	207.4	272.0

5.5 Water demand reduction

5.5.1 Benefits of demand reduction

The action plan treats demand as exogenously determined (e.g., something over which we have no control), then adjusts supply to meet this ever-increasing demand. But what if it is possible to exercise some influence on demand through a set of measures that include pricing, awareness raising, recycling/re-use of water, and much more? There is a school of thought suggesting, although supply-side measures were very successful in the past, as supply become increasingly remote and expensive to exploit, it is far cheaper and easier on the environment to do a better job of managing the water we are already using rather than keep on adding new sources of water. Collectively, the measures are known as the demand side management (DSM).

The benefits of DSM are significant. Were DSM to be used to reduce demand for water in the MCWD area, fewer supplies would be required and the action plan would cost less to implement. With no influence on demand, the action plan proposes a set of projects to meet the increasing demand over a 25-year period. The investment cost is estimated at PhP 17.6 billion. The sum of recurrent costs adds another PhP 14.2 billion to this for a total expected expenditure of PhP 31.8 billion.

A study of water demand in California estimated that savings of 30% were available with existing technologies and policies. Keeping in mind that per capita consumption in California is much higher than in Central Cebu, it is instructive to re-estimate the costs of the action plan on the assumption that demand is reduced by 10%. The impact of a 15% reduction is tested as well. The results appear in *Table 5-16*.

A 10% reduction in demand means that neither the Mactan Wells nor the Kotkot Weir need to be built. Savings of 13% in total cost would be realized. A 15% reduction in demand means that the Lusaran Dam, Mactan Wells and Potable water desalination plants don't need to be built. Savings of 30% in total cost would be realized. This is an interesting result because the first 10% in demand savings result in 13% in cost savings while the next 5% in demand reductions result in an additional 17% in cost savings. The exercise shows that because the supply facilities proposed for the MCWD area are large, there are demand thresholds that require major expenditures such as the investment in the Lusaran Dam.

To cite just one example of the impact of a DSM in the context of Central Cebu, we may look at the impact on consumption of a price increase. MCWD increased water rates by 12% in September 2005, then observed that consumption fell as a result. The information provided allows us to estimate the price elasticity of demand for water; that is to predict the response in quantity demanded to a price increase of a given amount. Based on the information provided by MCWD, we estimated price elasticity to be -0.16. In other words, a 10% price increase will lead to a 1.6% decrease in the quantity of water demanded.

5.5.2 Rainfall harvesting

Rainwater harvesting (see measure 12 in Annex A) from roof catchments is a measure that augments the fresh water availability at the local level (household or commercial/ industrial enterprise, schools etc.). Rainwater harvesting is proposed both to augment the number of point sources, and thus the water availability in rural areas, and to reduce water demand from MCWD in urban areas with large roofs and high water use.

Rainwater can be used for drinking water only when technical precautions are taken (including intensive maintenance of storage facilities), or if water is treated. In international practice, rainwater is often recommended for non-drinking uses, which account for most of the domestic water demand by far: toilet flushing, garden watering and cleaning. Maintaining a quality suitable for bathing and cooking purposes is also possible, though not always recommended.

Although there exists city ordinances which mandates the collection of rainwater in cisterns for new buildings, rainwater harvesting is presently not very popular on Cebu, the common perception of the measure is that the quality of the collected water is not very good and that it increases the mosquito menace. Further implementation of the measure would require a well organized and convincing information campaign and/or regulation, which would clearly demonstrate the economic benefits of the system.

Rainwater harvesting could reduce the household piped water demand by as much as 30 - 50% in the wet period. A clear disadvantage is that the supply of rainwater is unreliable and very low in the long dry period. In rural areas, rain-

Table 5-16 Impact of demand reduction in Action Plan cost

	Demand Unchanged		10% Reduction		15% Reduction	
	Amount PHP billion	Amount US$ million	Amount PHP billion	Amount US$ million	Amount PHP billion	Amount US$ million
Facilities No Longer Required	All action plan facilities required		Kotkot Weir Mactan Wells		Lusaran Dam Mactan Wells Potable Desal. Plants	
Investment Cost	17.6	$352	16.1	$322	12.7	$254
Recurrent Cost	14.2	$284	11.6	$231	9.7	$194
Total Cost	31.8	$636	27.7	$555	22.4	$448
Savings %	0%	0%	13%	13%	30%	30%

[1] Gleick, P. H. et al *"Waste Not Want Not – The Potential for Urban Water Conservation in California"*. Pacific Institute. 2003.

water collection is only possible on metallic or ceramic roofs as rainwater collection on grass roofs produces colored or turbid water.

The Water REMIND project calculated amounts of water that could be harvested in urban barangays, rural barangays and using large public/industrial buildings. In total 3.8 mcm/yr. could be collected, but the costs involved are substantial. The total investment required, however, is high: 515 million PhP. The breakeven price of the collected water is in the order of 18 PhP/m³ for urban and rural houses and around 40 PhP/m³ for public/industrial buildings.

5.5.3 Reduction losses in the MCWD distribution system

The losses from the supply network of MCWD are estimated at some 28% of the total amount that enters the net (51.1 mcm/yr). These losses are caused by a combination of factors: part of the distribution system is over a century old, the high pressure needed to provide water to elevated areas, and many more.

MCWD has already embarked on a major 8-year program to reduce these losses (see measure 14 in Annex A). The program includes rehabilitation of transmission pipes and leak repairs and is designed to reduce the losses each year with 1%, ultimately resulting in an 8% reduction of the losses. The savings involved (4.1 mcm/yr) are substantial and in the same order of magnitude as for example desalination plants and some of the supply from aquifers outside the MCWD area (*see Table 5-15*).

The costs involved as well are substantial. The total investment of this 8-year program is about 820 million PhP. In combination with the recurrent O&M costs (see Annex C) the breakeven price of the saved water will be in the order of 40 PhP/m³. However, it should be kept in mind that there are more aspects involved in the on-going rehabilitation program, both positive (e.g. to stop a further increase in losses) as well as negative (e.g. part of the 'lost' water is available again for local / private groundwater withdrawals and is not really lost after all). A further technical and economical analysis is recommended on these aspects.

5.5.4 Adequate and differentiated pricing

The use of adequate and differentiated pricing of water aims to provide an effective economic incentive to encourage efficient use of water. MCWD already has a differentiated pricing system in place (see measure 20 in Annex A). This system includes a blocked pricing based on volumes consumed as well as a differentiated connection fee depending on the size of the connection. For regular connections the price for the first 10 m³/month is 12.24 PhP/m³, increasing to 15.75 PhP/m³ up to 30 m³/month. Above 30 m³/month the price increases sharply to 43.20 PhP/m³. For communal faucets the sharp price increase starts only when more than 173 m³/month is used.

In principle it can be concluded that the differentiated pricing system of MCWD provides the needed incentive structure (Annex C). The question is how far the applied blocks and prices can be further optimized. The lower prices seem rather low (12.24 and 7.63 PhP/m³ for resp. regular and communal connections) while 30 m³/month (1000 liter/day) seems rather high as the threshold for the higher rates.

Another point of attention is the one-time connection fee that MCWD charges. Despite an accommodating installment plan (allowing a first down payment followed by monthly charges) the connection fee has the effect of discouraging lower income people from connecting to the system. Instead they will often make use of illegal connections. As such illegal connections are by definition not metered (and not charged for) the use is often larger than in the case of a legal and metered connection.

It is recommended to make a detailed study on the water pricing mechanism of MCWD. This study should include the following elements:

- the threshold level for the higher prices for regular connections and communal faucets;
- the lower and higher price levels, taking into account the willingness of the customers to pay, the required overall financial performance of MCWD and required investments to keep meeting the demand;
- the connection fee and related installment plan, taking into account the willingness of the lower income groups to pay;
- a pricing system based on peak load pricing (i.e. higher water tariffs during summer months when water demand is higher and supply is lower).

The progressive character of the water tariff structure of MCWD should also be maintained for purposes of cross-subsidizing the poor and encouraging water conservation. However the wide differences in water tariffs between households and industry / commercial users should be narrowed to reduce incentives for groundwater pumping by commercial and industrial firms.

5.5.5 Promoting water saving equipment and measures in industry

The use of water saving equipment and measures will not only reduce the demand but in general ultimately also the costs. Despite this incentive, practice shows that industries should be stimulated to implement such measures. This can be done by increasing awareness (showing them the advantages), awarding bonuses or subsidies or by improving the enforcement of regulations. The most promising water saving measures for the industry appear to be:

- reduction of discharge of unused water by adapting working procedures, by education and by proper instruction to the employees
- recycling of water within the industry
- timely detection and repair of leaks
- good operation and maintenance of equipment to prevent wasting of water
- reduce water use by optimizing the industrial process and installing equipment that economizes water use

From the viewpoint of the Action Plan the following measures can be taken:

- stimulation of industries with low water use, e.g. by providing subsidies or tax reductions
- promotion of the installation of water economic equipment by giving subsidies or issuing regulations
- enforce efficient water use by water pricing: high water use will be punished with a higher water price (see Section 5.5.3)

The first kind of measure should be taken at the level of the cities and municipalities. Those last two measures can be taken by MCWD.

5.5.6 General and dedicated awareness campaigns domestic use

Domestic and public use are by far the greatest water user in Central Cebu. This category accounts for more than 80% of the total water demand (see Chapter 3). Hence, reduction in demand in this category will have a major impact. Water can be conserved by the public in 3 different ways:

- using less water by not letting water run down the drain unused or only partly used (e.g. closing the taps, only using only fully loaded washing machines, taking shorter showers);
- wasting less water by detecting and repairing leaks in hoses, pipelines and connections; and
- using water saving equipment such as low-flow showerheads and toilets.

Conservation behaviour can be encouraged by subsidizing the installation of water saving equipment and/or penalizing the users that use much water by applying higher water prices (see also Section 5.5.3). It is expected that also public awareness campaigns will also contribute to this behaviour. Two specific awareness campaigns are recommended:

1. A general awareness campaign for the whole Central Cebu (see measure 23 in Annex A), including billboards, radio and television ads:

    - expected reduction in water use: 3.1 mcm/yr
    - costs for 10 years at 6.9 million PhP/yr: 69 million PhP/yr
    - breakeven price of saved water: 3 PhP/m^3

2. A specific awareness campaign for selected high-consuming neighbourhoods in the MCWD area (see measure 22 in Annex A), including radio, television, cinema and mobile ads:

    - expected reduction in water use: 0.24 mcm/yr
    - costs for 5 years at 2.6 million PhP/yr: 13 million PhP/yr
    - breakeven price of saved water: 6 PhP/m^3

The economics involved show that these measures are very promising. However, this will depend heavily on how far the projected demand reduction will indeed be realized. The expected reductions seem rather high.

5.5.7 How does the strategy 'Water for all Cebuanos' deal with these demand reducing measures?

Reducing the demand is a very promising approach. The savings can be very substantial, both in terms of the demand itself as well as the reduction in the required investments. Questions remain on the assumptions made, in particular with respect to how much water will actually be saved. Moreover, there are major social and socio-economic aspects involved. It must be ensured that also the low-income groups will have good access to safe drinking water. The conclusion for the strategy 'Water for all Cebuanos' is that such measures should be implemented, however some of these measures need further analysis to determine which level these have to be implemented.

Given the uncertainties involved, it was decided not to include the possible resulting water savings already now in the supply analysis as given in Section 5.4. These uncertainties not only relate to the savings but also to the unit demands that are used in the calculation of the total demands in Chapter 3. In case the savings indeed will materialize this will mean that certain measures can be postponed somewhat. This can be assessed in subsequent rounds of planning which will result in an update of the Action Plan. In Section 5.9 some analysis will be carried out that indicated what the consequences can be in the lifespan of the strategy if the demand turns out to be lower than expected.

5.6 Protecting the resources

The previous two sections dealt with the supply and demand (reduction) aspects of the strategy 'Water for All Cebuanos'. This section addresses the resources itself and the measures included in the strategy that aim to protect the resource and ensure that the available water will be of sufficient quality. Not all measures have a direct impact on the water supply for Central Cebu. However, from the viewpoint of IWRM and the general objective to develop a sustainable and environmentally sound water resources system these measures are very important nevertheless. Some measures included do have a direct impact, in particular the measures that are oriented at protecting the quality of the groundwater which, as described in Section 5.4, is the main source for the water supply of Central Cebu.

Most measures in this component of 'Water for All Cebuanos' have strong links with the general governmental responsibility for spatial planning. Improving the spatial planning (and enforcement) capacity of provincial and city/municipal governments would substantially contribute to protecting the resources. However, this is outside the scope of the Action Plan.

5.6.1 Watershed management - land use practises

The watersheds in Central Cebu are very prone to degradation due to a combination of steep slopes, deforestation and shifting cultivation farming methods. This has resulted in very high erosion rates and frequent land slides. Having well-managed watersheds is important for many reasons. High sediment yields in rivers result in loss of storage capacity in reservoirs and an increased risk of flooding. Degraded watersheds also show generally poor hydrological conditions with increased flood risks and lower dry season flow. Soil conservation practices and reforestation are often regarded to contribute significantly to water conservation. As mentioned in Section 2.2.5 this is not always the case as trees will also increase the evaporation in the watershed, leaving less water available for the average runoff. Not afforestation scrubland will 'prevent' an increase in evapotranspiration of up to 400 mm annually. In catchments the size of Mananga or Kotkot, this amounts to more than 10 mcm/yr in discharge.

The measures (see also measure 30 in Annex A) that can be taken to control and prevent erosion can be categorized in three separate but related pathways:

- maintenance and enhancement of soil cover, to protect the soil against the erosive power of raindrops
- maintenance and enhancement of infiltration capacity, to reduce surface runoff
- reducing flow velocities, to prevent flows from becoming erosive

The actual measures can be natural/biological (such as maintaining and restoring the forest cover, mulching, planting of hedge rows) and physical (e.g. contour ploughing, terracing, strip cultivation).

A specific kind of watershed management measure is the construction of Gabion dams (see measure 31 in Annex A). The dams are built across gullies or flows to stabilize them, to arrest sediment and to improve infiltration. Their impact on water management in particular is their capacity to reduce the sediment inflow in reservoirs that would increase the lifetime and effectiveness of existing (and planned) reservoirs.

Within the framework of 'Water for All Cebuanos', watershed management is strongly recommended as a general measure without becoming specific on what actually has to be done and where. Reference is made to Chapter 6 in which this measure is proposed to be worked out in more detail for a next phase of the Action Plan.

5.6.2 Urban sewage systems and treatment

In the coastal lowlands of Cebu, all sewage is presently released untreated to surface water systems, from where it infiltrates to the groundwater aquifer. In the dry season, the process can be clearly seen (and smelled): effluent pipes release grey and black water in streams like Lahug, Butuanon and Cansaga. The effluent flows downstream along the channel for a couple of meters and then disappears. Since groundwater is the main source for water supply, the consequence of this situation is that a significant portion of the tap water in Cebu City is in effect recycled sewage water. Current treatment methods of MCWD usually suffice to bring the groundwater to an acceptable standard, but this will become increasingly difficult and costly as groundwater quality continues to deteriorate. Present private wells are often located in areas where alluvial deposits on top of the aquifer clean the water on its way down into the aquifer. However, nowadays urban extension not only takes place in the flat alluvial areas but also in areas where the soil has far less filtering capacity which entails a higher risk of pathogen pollution. Nitrate pollution is already a major concern.

In view of the above it is inevitable that in the near future a sewage collection system and treatment system has to be implemented in Metro Cebu. This is not only needed to protect the aquifers, but also the general health and environmental aspects which require such systems. JICA[1] has carried out a pre-feasibility study for the provision of a complete sewerage collection and treatment system for the highly populated areas of Cebu City, Mandaue City, Talisay City and Lapu-Lapu City. Three levels of implementation can be distinguished:

- The construction of a full sewage and treatment system at central locations with a discharge of the effluent to the sea, industry (as grey water) or the aquifer (see measure 39 in Annex A). This is the long-term option proposed by JICA
- The establishment of a comprehensive septage management system for Metro Cebu: hauling of septic with hauler trucks and treatment at a treatment plant, the construction of communal toilets in clustered poor communities and the improvement of the urban drainage systems (see measure 38 in Annex A). These are the short-term options proposed by JICA
- The inclusion of sewage requirements (pipes and possible treatment) in building requirements, taking care that all new developments can easily be connected to the overall sewage and treatment system that will be developed over time. This is a measure that can be implemented immediately

It is noted that the implementation of a sewage system will greatly improve the quality of the groundwater and at the same time will also reduce the recharge of the aquifer which in turn will reduce the safe yield. These consequences will be discussed in Section 5.9.1.

5.6.3 Sanitary programs in uplands

The present sanitary condition in the Uplands is poor. Most households (70%) do not have a formal defecation area. Septic tanks are rare and if present they are usually improperly constructed (i.e. only partially sealed to unsealed, not having a chamber). Pour-flush toilet facilities could be provided to individual households and connected to one communal septic tank, for 5 households. As a starting point, even a provision of simple and cheaper pit latrines would be an improvement over the current situation. Lack of sanitation awareness and its inter-relationship with health and the environment among the upland dwellers is one of the main reasons that led to the very poor sanitary conditions in the uplands. Incidence of sanitation related diseases in these areas is frequent, yet people do not give priority to constructing toilets. Cost is also a constraint, and so is the lack of water supply in these areas.

Sanitary programs in the uplands, i.e. provision of toilet facilities, two water resources management related functions: (1) protecting the local water resource (surface water and groundwater); and (2) protecting the downstream water resource (surface water). In the present situation these relations are weak and the main reason for implementing sanitary programs in the Uplands is health related.

[1] JICA, 1995, Pre-feasibility study Metropolitan Cebu sewerage and sanitation project

The specific measure proposed to be included in the strategy 'Water for All Cebuanos' is to start such sanitary programs in combination with the Uplands water supply projects (Level 2 spring boxes and small impoundments) as described in Section 5.4.2. The preferred solution will be very location specific and might include the pour-flush toilet facilities, communal septic tanks or pit latrines as mentioned above (see also measure 40 in Annex A). The measure will have to be worked out in more detail in the Phase II of the Action Plan (see Chapter 6). In the present strategy, no costs are included for the measure.

5.6.4 Well head protection

The strategy 'Water for All Cebuanos' relies strongly on groundwater as the main source for the water supply. Preventing contamination of the resource is of utmost importance as explained earlier. This should be done in a general sense such as by introducing urban sewage systems and treatment (measure 38) and by solid waste management (measure 34) but also specific around the well heads. The measure described as the well head protection (measure 35 in Annex A) aims to protect the water winning areas, i.e. the areas that contribute water to the aquifers (recharge) that supply water to groundwater wells. Many MCWD wells and all private wells are located close to residential areas, commercial establishments or industrial areas and have a high risk of contamination of the groundwater resource with bacteria (e-coli), petroleum products and pesticides.

Well head protection is much more a program than a specific measure. It entails many activities and instruments. The main instrument is land use planning, taking into account groundwater vulnerability and ensuring that possible contaminating activities are not taking place in the water winning area. It can include the establishment of protection buffers around the well fields, public education and awareness raising programs, traps for runoff and spillage areas where possible contaminants are entrained, etc.

The combination of activities and the many stakeholders involved make it necessary to pay due attention to the institutional and legal aspects involved. The roles and duties of communities, property owners and government within the well head protection area should be clearly defined.

5.6.5 Improved solid waste management

As in all major cities in the Philippines, the level of solid waste production in Cebu is high and increasing, and most urban areas and rivers are littered with waste. The enforcement of the Ecological Solid Waste Management Act has been very low. This can be attributed to lack of awareness of the real need for implementation of the measure, lack of technical knowledge of the local government units (LGUs), lack of resources, and/or simply because of other priorities and concerns. The barangay LGUs play a very crucial role in the enforcement of this law.

From the experiences of the Philippine Business for Social Progress (PBSP), Barrio Luz LGU, and other organizations, it appears that given adequate attention and support, solid waste management projects at barangay level can be implemented and sustained.

Linked to this measure are measures that reduce the volume of the solid waste. Although this receives little attention, it can be very effective since domestic waste nowadays consists of packaging materials, which have increased in volume and changed in nature over time. In some countries in the world, groceries are packed in so many plastic bags. Fast food also comes accompanied with so many plastic attributes. In western countries, packaging nowadays is limited by law or by agreements with industry. An agreement with the industry in Cebu could result in reduced packaging quantities and a switch to the use of biodegradable materials like paper.

The measure involves the enforcement of waste separation at the household level and encouraging the community to re-use and recycle (see also measure 34 in Annex A). The main components are:

- mobilization and capacity building of the barangay leaders
- community information and education
- promotion of income generating projects by using waste materials.

The measure will most likely be implemented at the barangay level as it requires a high degree of active participation from the community.

From the perspective of IWRM and sustainable development of Central Cebu this measure is considered to be very important. During the development of the Action Plan, resources and time were lacking to develop this measure in more detail. Hence, it is included as a general measure only, to be worked out in more detail in the next phase of the Action Plan.

5.6.6 Implement strict effluent permitting

Infiltration of poor quality surface water into the ground threatens the groundwater aquifers that are used for drinking water production. Hence, reducing the effluent discharges to surface water has a direct impact on the supply side of the system. Having surface water of good quality is needed anyway to provide a healthy environment for people and ecosystems. The Clean Water Act of 2004 provides sufficient facilities to control the effluents such as industry-specific standards, a permitting system and the possibility to collect waste water discharge fees. The revenues generated are used for operational costs, monitoring, enforcement and special campaigns. The discharge permit specifies the quantity and quality of the effluents that is allowed to be discharged, as well as the validity of the permit, compliance and monitoring requirements.

Having the legal setting in place will be needed to implement the system. The measure as proposed by DENR consists of the creation and operation of a multi-sectoral governing Board for water quality monitoring and surveillance within their jurisdiction. The governing Board will formulate strategies necessary for the effective implementation of the Clean Water Act. Furthermore they will establish multi-sectoral groups for the implementation of water quality surveillance and monitoring. The governing board will ensure that these sectoral groups do not unnecessarily duplicate the regular monitoring activities of other (local) government agencies. Inspections conducted by the multi-sectoral group shall be duly authorized by the chairman or co-chairman of the board. Members of the inspection team will be adequately trained and formally deputized.

5.6.7 Preventing sand and gravel mining in river beds

The measure aims to enforce existing regulations to prevent sand and gravel quarrying in river channels. Due to the booming construction business in Cebu, there is a big need for sand and gravel which are abundant in most riverbeds of Cebu. However, the removal of the sand and gravel from the river results in strong erosion of the river banks and the channel bottom. Besides the negative impact this has on the stability of bridges and other construction along and in the river, the channel erosion also results in a decrease in the recharge of the groundwater and/or an increase of the drainage of valuable groundwater reservoirs. This will have a very negative impact on the safe yields of the groundwater reservoirs that the water supply depends on.

The required regulation of DENR and the LGUs to prevent quarrying in the river beds exist. What is needed is to enforce these regulations. As part of the Action Plan a review by the concerned agencies, together with various stakeholders will be carried out to identify and remove possible bottlenecks for this enforcement.

5.7 Water governance

Effective water governance is a pre-requisite for the implementation of all measures in the strategy 'Water for All Cebuanos'. For most of the issues mentioned adequate laws, regulations and plans are already available. What is lacking is the political will at LGU level (province, cities and municipalities and barangays) to enforce the laws and regulations and to cooperate and coordinate. Sufficiency of funds plays of course also a major role.

In this section the activities are described that aim to improve the water governance in Central Cebu. Included are organizational measures as well as regulation and control measures.

5.7.1 Institutional setting for the implementation of IWRM

The measure (measure 50 in Annex A) aims at the implementation of a powerful, efficient and accountable Water Resources Management Board and a strong Technical Secretariat to support IWRM, see *Figure 5-12*. Only by efficient management and development of its Water Resources, is Cebu envisioned to be able to sustain its steadily growing need for water. The institutional model proposed here replaces the current system of 'politics of the day' and decision-making based upon lack of sound information. Moreover, only with an institutional model in place could the Action Plan presented here, be effectively implemented. The proposed institutional setting is described in more detail in Annex D, Institutional Development, and has to be subject to further study.

Basically only four key-institutions are considered: on the strategic level a stakeholders committee and an executive WRM Board, on the operational level the LGUs and supportive to both layers a WRM Institution. The WRM institution will have a technical (experts, MIS, etc) and a financial base (own income from revenues) to enable them to assist the Board and facilitate the necessary implementations in the LGUs. This Institution will be independent and non-political and just provide the right information for others to act upon.

The WRM board will function as Board of Directors for the implementation of strategic decision-making in Cebu and at the same time as Board of the WRM Institution. The Board will deal with strategic issues (WRM development, policies, regulations, etc) and the resolution of conflicts between actors if these arise in the development and management of the resources. The WRMB will guide the development and implementation of 2-yearly (updated) Actions Plans. The board will be supported by the WRM Institution. The operational aspects (implementation, daily management, maintenance) of the WRM systems remain with the LGUs that can organize themselves into water districts or associations if needed. The LGUs will be supported by the WRM Institute.

As part of the measure, a comprehensive study to define the most applicable institutional model for Cebu Province is proposed, as is a study to define the required legal arrangements to institutionalize the WRM model. Next, the legal requirements have to be implemented and a strong WRM institution has to be set-up and operated. Finally the Board Members have to be trained and the Water Institute has to be managed.

Risks threatening the sustainability, efficiency and effectiveness of the institutional model are related to the influence that the local political setting (personalities, terms of officials, election time) may have and to the fact that the proposed responsibilities and activities may conflict with the local government code, water code, clean water act, NIPAS act, local ordinances, etc. However, it is believed that, with the right political will, the institutional model can be fully implemented and become operational within one year.

The costs involved in developing a new institutional setting relate to a consultancy study / support of one year and the initial set-up of the Water Institution and amount to 2 million PhP: 1 million will be for the preparation studies (legal assistance, organizational and technical assistance) and 1 million for the actual set-up of the WRM Institution (purchase of hardware, software, furniture, etc.). Operational costs (incl. salaries) are not considered here and will have to be charged to the consumers / tax payers.

5.7.2 Water withdrawal quantity and quality control

Water resources development related decision-making in Cebu is hampered by a lack of knowledge on private well abstractions in the coastal areas. Total amounts of extracted groundwater are unknown. As a result a complete water balance, the base for any appropriate water resources management, can not be made. To improve this situation existing data need to be enhanced and serious attempts should be made to identify non-registered wells.

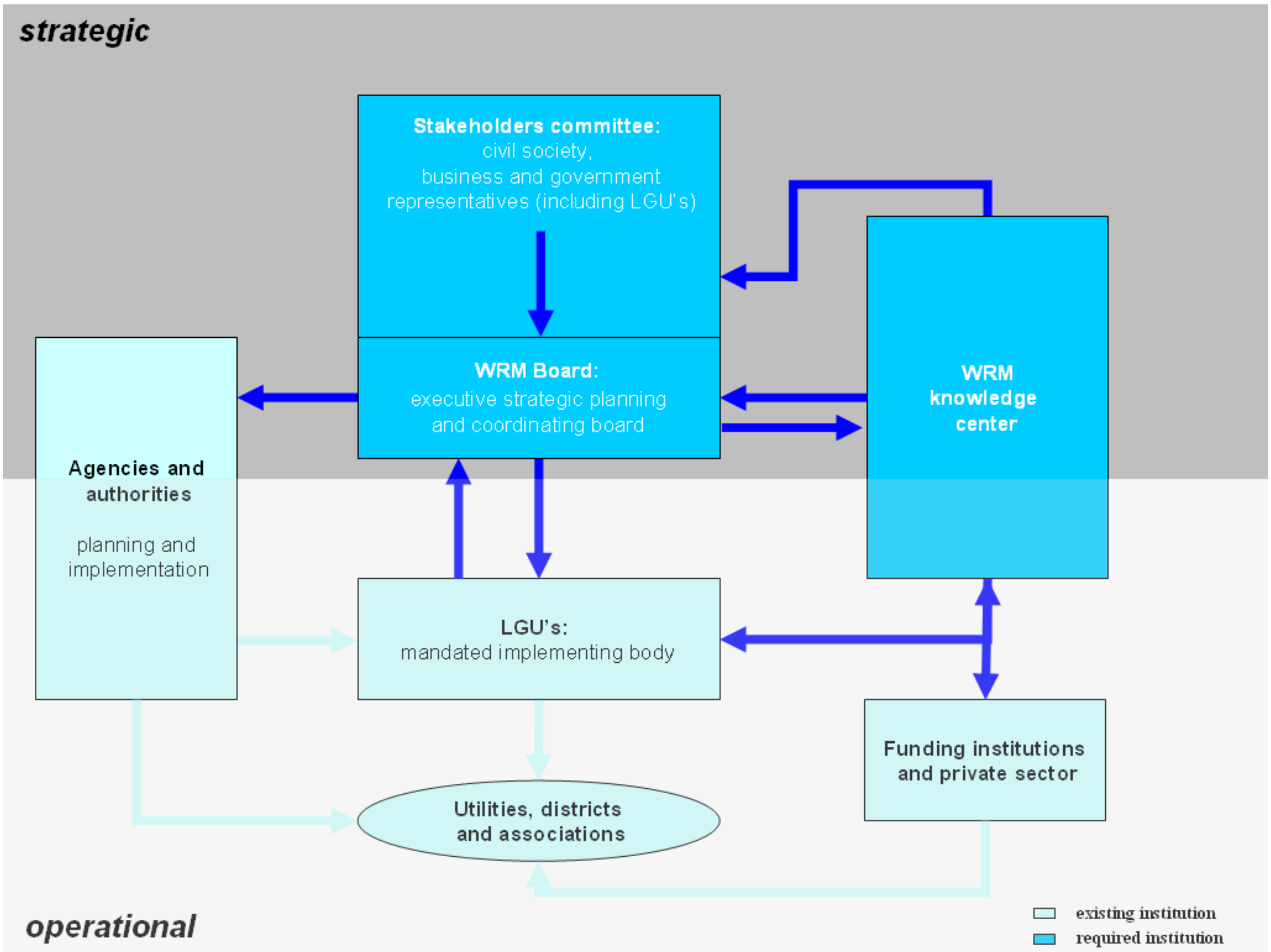


Figure 5-12 Proposed institutional model for Metro Cebu

Assessing water resources, specifically on the quality and available quantity for allocation to users, is the mandate of the National Water Resources Board (NWRB). Although the NWRB mandate is clear, lack of resources and absence in the region has prevented a strict implementation. An assessment on the Water Resources in Metro Cebu carried out by NWRB in 2003/2004, has not yielded the expected result and the available information is still far from complete. The following actions are recommended:

- improvement of existing well information. It is advised that all existing data on private wells be thoroughly studied and possibly verified (including pumping tests, quality data and the like). At the same time it is recommended to include all this data in the Management Information System set up by the Water REMIND project.
- identification of non-registered wells. Aquifer management is complicated by the aggregate impact of the actions of many individuals. Even though each individual may have a negligible impact when taken alone, the sum total can be of major importance. One well has little effect on the total water supply, but thousands of wells can quickly deplete an aquifer. Establishing effective policies to regulate water abstraction by these many small-scale, scattered decision-makers is exceedingly difficult. In addition, more rigid steps should be taken to identify non-registered wells. To facilitate the registration process a number of ideas are presented including the involvement of pump dealers / manufacturers, close cooperation with LGUs and issuance of official permanent registration plates. In addition, it is recommended to involve the limited number of drilling companies and make it mandatory that the permit requests are (also) submitted by them.
- improvement of quality and quantity data on water abstraction. To properly describe all future private wells the involvement of the drilling companies seems obvious. However, in Central Cebu and even within metro Cebu small wells (<100 mm diameter) are still drilled by non-registered drillers, connected to pump dealers. In this respect registration of the drilling companies themselves must have highest priority.

In accordance with the Water Code NWRB may deputize any official or agency of the government to perform any of its functions or responsibilities. As of now, registration is a delegated task to MCWD for the MCWD franchise area and to the Province for the remaining municipal areas. Ideally, if NWRB can not be present, it should delegate a full registration, permitting and monitoring task to an organization with police power like the LGUs.

To assure local drinking water quality control (groundwater and surface water), enforcement of Presidential Decree 856 need to be initiated. This includes the establishment of local drinking water quality / quantity monitoring committees and the conduct of surveys of high-risk supply sources.

5.7.3 Spatial planning - implementation and enforcement

Spatial planning in Cebu has always been haphazard: the location for development of new industries and subdivisions is usually chosen without much regard for water availability. Local short-term politics and interests usually prevail over long-term impacts, resulting in industrial and housing developments in unsuitable locations. When shortages become apparent the common response is that more water is sought for, or that shortages are simply accepted.

Improved spatial planning (measure 55 of Annex A) can greatly contribute to a better tuning between supply and demand in two different ways:

- by bringing future demand closer to existing water resources
- by moving away pollution sources from groundwater resources

To bring future water demand closer to future water resources, development of a water demand 'zoning' system is proposed. This requires the following actions:

- drafting of a 'water shortage vulnerability map' showing locations of future water shortages and 'excess'. The baseline information required for this is available with the Water REMIND project.
- development of a system to evaluate water requirements of expected future developments
- development of a system to compare the requirements with water availability
- putting in place (and enforcement of) regulations to limit developments in areas where the demand can not be met
- location of water-intensive activities in areas with ample water availability

Spatial planning has to guide developments at different levels: within urban areas (e.g. promoting certain industries on Mactan while discouraging them in Cebu City), within catchments (e.g. discouraging subdivision development in upland catchments where water supply can not be guaranteed), and even regional (between east and west coast). An example of the latter would be that highly water-demanding industries that produce mainly for export (and therefore do not have to be located close to their market), should preferably be located on the west coast, north of Danao City and further south of Carcar, and not in Cebu City. This requires a planning framework that allows a clearer, bigger and more pro-active role of provincial and even national planning organizations, at the expense of the role of the barangay and municipal organizations, in regulating local developments. The role of spatial planning in moving away pollution sources from groundwater resources has been discussed in Sections 5.6.4 (measure 35, well head protection–spatial planning of recharge areas) and 5.6.6 (measure 37, Implement strict effluent permitting).

5.7.4 Family planning and migration control

This measure seeks to slow down the increase in water demand by reducing the rate of population growth. This, of course, is the most effective water demand reduction measure in the long term, as population growth is one of the main causes of demand increase.

Widespread resistance to contraception in the Philippines has resulted in one of the highest fertility rates in the world outside Africa, with Filipino women having an average of 3.5 births – significantly higher in poor rural areas. Adolescents are a large and growing segment of the population. The obvious tool to achieve population growth reduction is family planning.

Executive Order No. 307 signed in 1996 implements the Philippine Family Planning Program (PFPP) at the Local Government Level. It directs local governments, specifically governors and mayors, to implement the PFPP, to make available information on methods of family planning, and to ensure that family planning is practiced on a voluntary basis.

Family planning can only be successful if accurate information on sex and reproduction is part of basic education and if access is given to contraceptives and other reproductive health services. Most family planning efforts to date have focused on adults and married couples. Focusing on adolescents is urgently needed as their access to information and contraceptives is most limited. Emphasis should be on:

- providing information to adolescents, including information campaigns on early and unintended pregnancy
- providing services to adolescents and families alike, including contraception
- advocating public support of adolescent reproductive health

The proposed measure (measure 54 in Annex A) includes activities such as collecting base data, developing goals and objectives, establishing a coalition, identifying key audiences, developing persuasive messages, working with the media, and measuring success.

5.7.5 Priority allocation rules during dry periods

Cebu has distinct dry and rainy seasons. The dry season usually lasts from mid February until the end of May. Extended dry seasons have not been uncommon in Cebu. Such conditions usually coincide with El Nino events, which occur every seven years. The impact of water shortages during drought events can be mitigated by allocating water to specific uses and users according to certain rules (measure 56, see Annex A). Social impacts are reduced by ensuring a minimum water supply to vulnerable social groups: the poor and those without backup options. Economic impacts are reduced by ensuring sufficient water supply to industries that are economically most important or that are most vulnerable. In order to be able to meet these priority demands, less water must be made available to other water users.

Cutting supplies can best start as soon as shortages become apparent, but are not yet severe. The measure has to be implemented step-wise: starting with reducing water supply to the lowest-priority uses and users and generally move on to higher-priority uses and users. Abstractions have to be reduced gradually rather than abstracting at 'normal' maximum rate until the resources are severely depleted (as is the current MCWD practice). Water allocation measures work best as part of an overall strategy that aims to reduce overall demand and develop alternative sources. These may include measures like organizing public information and awareness campaigns, rainwater harvesting, leakage reduction, construction of desalination plants etc. that are discussed elsewhere.

More specific: each LGU has to work out water supply priorities for shortage periods and formulate a drought management contingency plan on what to do during dry spells. Through local ordinances necessary steps can be taken. Formulation of the laws require cooperation among the various stakeholders: MCWD, the LGUs, the industry/business sector and a number of NGOs.

5.8 Research and Development

The implementation and further development (phase II and III, see Chapter 6) of the strategy 'Water for All Cebuanos' require a strong backing by research and development. The Technical Secretariat as proposed in Section 5.7.1 will need adequate tools to carry out their tasks. Furthermore, many questions have remained, e.g. on the performance of the surface and groundwater system, expected socio-economic developments, etc. This section describes these required activities.

5.8.1 Improved data collection, analysis and presentation

To be able to assess water availability more accurately, the knowledge on the natural resource system, including both the surface and the groundwater resources, has to improve. The same is valid for the water demand assessment: only with improved knowledge on the socio-economic system, including demographic and economic development, better predictions on future water demands can be made.

To improve this system knowledge, it is recommended to carry out a number of research and data collection programs. The most important ones are:

- continuation and possible extension (areal coverage) of improved time-series collection, encoding and analysis for a well-defined number of (geo)hydrological, water quality and watershed management related parameters. The recommendations have been described in a number of technical mission reports of the Water REMIND project. Research should be carried out to further automate the collection of highly variable data (precipitation, water level readings) through utilizing the telemetry function of the pressure transducers. This information may also be very helpful in better timing the monitoring of high flows
- collection and analysis of critical data in the decision-making process such as private well abstractions and water consumption by households and industry. In combination with improved insights in demographic and sectoral developments, significant fine-tuning on the water demands and required supply or demand reduction can be obtained
- research to better understand and describe important field processes. Technical studies of the Water REMIND

Table 5-17 Overview scenario analysis for water demand and water availability

Scenarios	Impact
Water demand	
1. No expansion MCWD coverage	Urbanization and connection to running water systems increase water use dramatically. When there is no growth in the coverage area still the percentage of MCWD consumption in Metro Cebu will increase due to the annual increased consumption per service water level.
2. Five percent reduction due to implementation of awareness program	To study the impact on the entire area an overall 5% reduction is applied and no further consumption increases are assumed. In practice this is most likely only to be established in the dense high consumers areas.
3. Improved leakage reduction MCWD network to 85% efficiency.	Reduction from existing constant 30% loss to 15% loss in the MCWD distribution network
4. Unlimited population growth	Extrapolation of historic growth during the next 25 years
5. Higher industrial (3.2%) development	Increase of industrial growth from existing 0.69% to sectoral growth of 3.2% (assuming water consumption increases with new industrial activities)
Water availability	
6. Full immediate implementation of a sewerage system in highly urbanized areas	No recharge of groundwater by domestic/industrial waste water and re-use of this water
7. No implementation of a sewerage system at all	Recharge of groundwater by domestic/industrial waste water is maximized and also includes the return flow of the additionally (after 2005) supplied water
8. Reduced precipitation (90%)	Both wet and dry season run-off and direct recharge is reduced to 90%

project identified a clear need for more information on the various fluxes determining the groundwater balances: site-specific groundwater recharge, the wastewater return flows, lateral flows between different hydrological defined areas, outflow to the sea. In this respect the knowledge can be expanded by increasing the number of monitoring wells (well designed in terms of spatial coverage and vertical depth).

Close interaction with the stakeholders is very necessary to incorporate the various interests and sector views in the most efficient way. This sort of information can be obtained through well-organized consultation meetings and questionnaires. At the same time it must be realized that there should be a continuous information campaign to update the stakeholders with the latest information. As a first step presentation methods should be developed to better communicate technical monitoring data. Examples are annual reports and immediate and comprehensive overviews of highly variable information through website or newspaper announcements (water levels, water quality of surface water systems, etc.).

A less concrete but equally important matter is to improve insights in the most efficient incorporation of new knowledge into decision-making. This relates to efficient information dissemination to existing institutions, knowing their mandates and planning related activities (e.g. land use plan) and effectively dealing with the rules of the games of the local politics and institutional cooperation.

5.8.2 Improving decision support tools

The Water REMIND project has put in place a number of management tools that need continuous updates with the latest knowledge and data. Present tools relate to tabular and spatial data base management (HYMOS and GIS), and water balance and allocation descriptions (RIBASIM and steady state models), water demand and multi-criteria analysis. What are still lacking are tools to better describe groundwater. Attempts so far all clearly demonstrated that a good description of local phenomena is very difficult given the heterogeneous hydrogeological conditions and the absence of complete and accurate datasets to support a good calibration and validation. It is therefore recommended to start with the development of a small well-defined coastal area model and combine the work with a detailed data collection program. As soon as more experience is gained on the description of these groundwater systems a regional groundwater flow model may be developed.

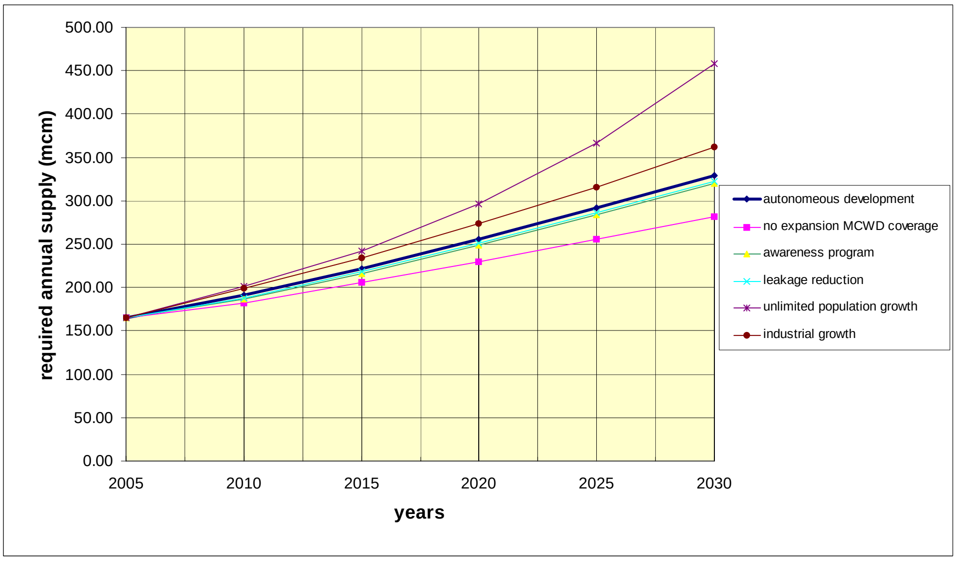


Figure 5-13 Water supply scenario's - total supply needed for Central Cebu

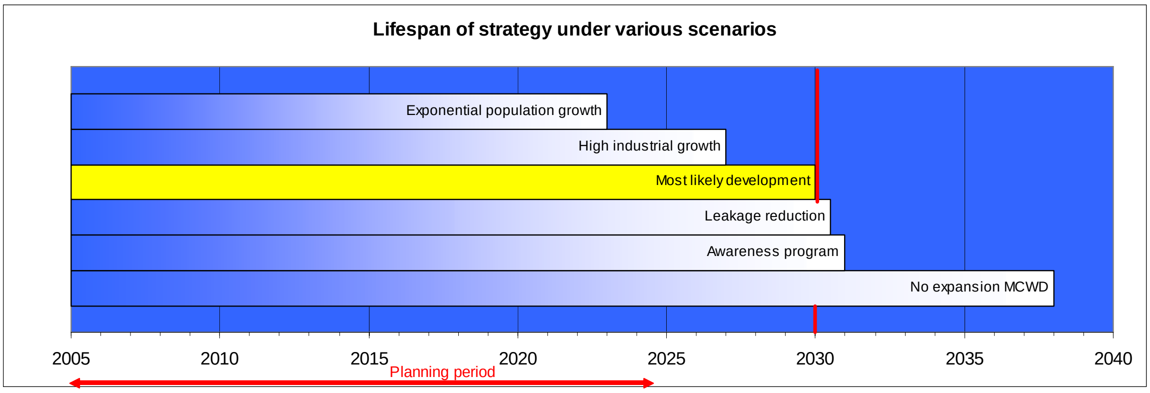


Figure 5-14 Lifespan of strategy 'Water for all Cebuanos' under various scenarios

To be successful and distinguish oneself from typical academic research exercises, it is strongly recommended to immediately involve the possible end-users (for transfer of knowledge and future acceptance reasons), to make use of existing well-established and well-described software systems that have been used in similar coastal systems, and to have the exercise supervised by an expert team of experienced groundwater modelers.

Another development could be the set-up of a comprehensive operational water management tool for the MCWD distribution system. Once combined with an updated market survey on real local water demands and expansion possibilities, water supply and demand related decision making can be more efficient and refined.

Again, use should be made of well-established software systems. The tool and survey will help to combine long term supply and demand management options with consequences and cost assessments for the operational management aspects (water distribution).

5.9 What will happen if ...?

The strategy 'Water for All Cebuanos' was developed for the most likely scenario on how the future will develop. This was based on a number of assumptions such as population and industrial growth, MCWD coverage, climatic conditions, etc. In order to judge the robustness of the proposed strategy or the sensitivity of the strategy to scenario or system assumptions, an analysis was carried out on what would be the result if we made different assumptions. That analysis responds to the question: 'what if ...?' *Table 5.17* gives an overview of the scenarios that were investigated in this analysis. The results will be described next.

5.9.1 Changes in demand

The first 5 categories of *Table 5.17* will result in an increase or decrease in demand for water. The resulting changes in demand are given in *Figure 5.13*. Unlimited (extrapolated) population growth will have a major impact: demand will rise to 428 mcm/yr in 2030, as compared to 300 mcm/yr according to the 'most likely development scenario'. Increased industrial growth also increases demand, but much less so: to 333 mcm/yr compared to 300 mcm/yr in 2030. Of the scenarios that result in a reduction of the demand only 'no expansion of the MCWD coverage' reduces the demand in 2030 considerably, from 300 mcm/yr to 253 mcm/yr. The other demand reducing scenario's, leakage reduction and increased awareness have only a marginal effect: demand in 2030 is reduced with less than 10 mcm/yr.

A higher demand does not mean that the 'Water for All Cebuanos' strategy has to be changed completely, it merely implies that we will have to increase the speed of implementation of the proposed measures. Groundwater wells have to be put in operation earlier, desalinization plans should be commissioned sooner and also the surface water projects (Kotkot and Lusaran reservoirs) have to be implemented well before 2030. A lower demand on the other hand will enable postponement of certain measures for a number of years. The strategy 'Water for All Cebuanos' has taken the year 2030 as the long-term time horizon and developed its scheduling of projects in such a way that the supply follows the demand exactly until that year. In case the demand will change the time horizon has to shift as well, meaning that all included measures should be implemented earlier (in case of a higher demand) or later (in case of a lower demand) than that date.

This is illustrated in *Figure 5-14*. The figure shows that to keep pace with the demand under the 'unlimited population growth scenario' implementation of the strategy has to be finalized by 2023. To be able to meet the demand in 2030, additional surface water storage facilities will have to be built probably in combination with the construction of additional desalination plants in Mactan. On the other way around: under the 'no expansion of MCWD coverage' scenario, the strategy has only to be implemented completely by 2038. The other scenarios have much less influence on the required implementation times: minus 3 years for the 'higher industrial development' scenario and not more than plus 1 year for the 'increased awareness' and 'leakage reduction' scenarios.

Table 5-18 Percentage of demand under the high demand scenario's met by implementing the 'Water for all Cebuanos' strategy

Year	Supply (mcm/yr)	Demand (mcm/yr)			
		Unlimited population growth		High industrial growth	
		Total	% of demand met	Total	% of demand met
2010	167.4	177	95	175.3	95
2020	229.2	269.9	85	247.3	93
2030	300.1	428.9	70	333	90

Table 5-19 Groundwater recharge from domestic/industrial waste water return flows (in mcm/yr) for the four highly urbanized WRMU's: Butuanon, Cansaga, Cebu-City and Mananga

Year	2005	2010	2020	2030
Supply	97	114.5	157.4	204.1
Recharge from return flow				
As assumed in strategy	32	32	32	32
No sewerage at all	32	38.3	53.9	70.7
With a full sewerage system in place	0	0	0	0

Table 5-20 Groundwater recharge from domestic/industrial waste water return flows (in mcm/yr) for Mactan

Year	2005	2010	2020	2030
Supply	22.4	26.3	36.4	48.7
Recharge from return flow				
As assumed in strategy	6.6	6.6	6.6	6.6
No sewerage at all	6.6	8	11.6	16
With a full sewerage system in place	0	0	0	0

5.9.2 Reliability of system under changed conditions

The previous section assumed that if demand will turn out to be higher or lower than predicted this will result in a shift in the lifespan of the strategy 'Water for all Cebuanos'. A different approach is to keep the implementation schedule the same and consider the impacts on the reliability of the supply. A higher demand will in that case result in a lower reliability of the performance of the system while a lower demand will correspond with a higher reliability. 'Water for all Cebuanos' was designed for a reliability of 90%, i.e. that the system (for the 25-year hydrological time series that was considered) will always deliver at least 90% of the demand.

For the short and medium term the higher demand can easily be met by installing new wells depending on the extra supply needed. These are flexible measures and require short implementation time. These measures are already included in the strategy but should be implemented earlier in case of fast growing demand. For the long term surface water sources and/or desalination will be needed as the coastal aquifer will be fully utilized. These measures are new, need more construction time and are less flexible. In that sense the strategy is more robust up till the medium term than for the long term.

By simply comparing the supply available in 2010, 2020, and 2030, assuming implementation of the strategy as worked out for the 'most likely scenario', with the demands for these years under the high demand scenarios, 'unlimited population growth' and 'higher industrial growth', it becomes clear which percentage of the demand cannot be met. The details are given in *Table 5-18*. It has to be noted that this calculation is based on supply during an average hydrological year. In reality water availability in dry years will be lower and an additional 4 to 5% of the demand may not be met.

Table 5-18 shows that under the unlimited population growth scenario, and implementing the 'Water for all Cebuanos' strategy as developed for the most likely scenario, only 70% of the demand (in volume) can be met in 2030. Under the high industrial growth scenario still 90% of the demand can be met.

Changes in water availability

The categories 6 through 8 in *Table 5-17* do not result in a change in water demand, but in a change in water availability. The scenario's given in the table effect water availability either by a change in recharge of the coastal aquifer, or by a change in climatological conditions.

Two scenarios for sewerage treatment have been studied: the full and immediate implementation of a sewerage system in highly urbanized areas, meaning no recharge of the groundwater by the return flow of domestic/industrial waste water, and, the other way around, a scenario which assumes no implementation of a sewerage system at all. The latter implies an increase in return flow of domestic/ industrial waste water, and subsequent recharge to the groundwater , as a result of increased water use in the area.

The analysis of the hydrological performance of the system is based on historical records of rainfall, evaporation and river flow of 25 years. This time period is assumed to give a sufficient representation of the variability of the climate in Cebu with dry and wet years. However, in statistical terms this time series should be considered as rather short and it is quite possible that more extreme conditions might occur in future due to climate change. Therefore it has also been analyzed what the consequences would be if Cebu would suffer from a reduction in precipitation (both wet and dry season) of 90% of the present daily values.

Effects of presence or absence of a sewerage system

In the development of the 'Water for all Cebuanos' strategy the assumption was made that future extra return flow in highly urbanized areas, caused by new supply, was not available anymore for recharge to the coastal aquifer. The return flow will be collected and transported to a waste water treatment plant with the effluent being discharged into the sea. In 2030 the capacity for the proposed sewerage system and treatment plants should be 38.7 mcm/yr for the high population density areas of Butuanon, Cansaga, Cebu City and Mananga and 9.4 mcm/y in Mactan (see *Table 5-19* and *Table 5-20*). From the present supply groundwater recharge is assumed at 37.5% of the domestic water use and 18.75% of the industrial water use.

The tables show that in case no sewerage system is implemented, the recharge of the coastal aquifer in the highly urbanized area of Cebu will increase with nearly 40 mcm/yr by the year 2030, due to the increasing supply. In Mactan the increase is nearly 10 mcm/yr. As a result the safe yield of the aquifers will increase considerably and supply from local sources could be increased. This would mean that in the 'Water for all Cebuanos' strategy the need for inclusion of surface water supply measures would be much lower: the construction of the Lusaran – 63 m High Dam would not be needed, in Mactan new desalination plants to produce potable water would not be needed (see *Table 5-15*).

However, the amount of heavily polluted water, as a fraction of the of the total recharge of the aquifer, will increase considerably as well. It is very likely that the quality of the groundwater resource in the area will deteriorate to such a condition, that treatment of the abstracted groundwater is needed before it can be distributed to the water users. Nitrate and e-coli levels will certainly rise to values above the maximum allowable concentrations.

Although investment in new infrastructure such as dams could be postponed due to the higher quantitative potential of groundwater, the need for extra treatment facilities will probably offset this advantage.

On the other side of the spectrum full coverage of the highly urbanized areas with a sewage system will reduce the safe yields of the aquifers. In this case not only the additional supply volume (compared to the 2005 situation), but also the 2005 supply volume itself are not contributory to the recharge of the aquifers. This results to a decrease of local available groundwater in the 4 highly urbanized WRMUs of Cebu with 32 mcm/yr. In Mactan groundwater availability will decrease with 6.6 mcm/yr, once a complete sewerage is implemented.

This leads to a situation comparable with a situation of higher demand, as described in Section 5.9.1. The result is that the strategy has to be implemented at a faster pace, all measures have to be in place at around 2025. To still meet the 2030 demand, additional surface storage will have to be created, while in Mactan extra capacity for desalination is needed.

5.9.3 Effects of reduced precipitation

The effect of a reduction of the precipitation with 10%, both in the dry and in the wet season, has been simulated. The results of the simulation show that this scenario will slightly reduce the groundwater availability along the west coast. However, supply will still be ample and much larger than demand.

In the uplands a 10% reduction of precipitation may affect the discharges of springs somewhat, as well as the possibilities to harvest rainwater in rainwater impoundment areas. This reduction can be compensated by increasing the number of impoundment structures or by increasing their dimensions somewhat.

Availability of groundwater along the East Coast will be affected because recharge of the aquifers will reduce, not only because the flows of the rivers discharging into the coastal zone decrease, but also because the direct contribution to the groundwater of the rain falling in the coastal area will be lower. Calculations showed that the aquifer recharge in the MCWD service area will reduce with about 16 mcm/yr. In the non-MCWD serviced WRMUs along the east coast the recharge will reduce with approximately 3 mcm/yr. Taking into account other changes in the groundwater balance, e.g. a change in aquifer outflow to sea, the actual decrease in groundwater available for extraction along the east coast will be around 9 mcm/yr. This is an amount comparable to the amount of water that can be saved by leakage reduction or by increasing awareness.

Reduced river flows will not result in failure to fill the proposed reservoirs. Wet season runoff is still sufficient to have the proposed reservoir completely filled at the start of the dry season.

As such, a change in water availability as a result of changing climatological conditions will only have a slight influence on the strategy to be followed: to meet the demand the measures have to be in place about 2 years earlier than under the 'most likely scenario'.

5.9.4 Assessment of the robustness of the strategy

The strategy 'Water for all Cebuanos' is basically a rather simple strategy: each WRMU should first use its own groundwater resources, next import from neighboring WRMUs and if that is not possible anymore develop other projects. Most measures in the strategy are rather small scale actions and the strategy has a large flexibility to adapt itself to changed conditions. A higher demand will speed up the implementation while a lower demand will slow the implementation down. The same applies if there will be changes in the supply side, either because there will be less water available (e.g. because of climate change or because recharge is restricted by the implementation of sewage systems) or the water is not available anymore because of quality reasons. All these conditions mean that the implementation schedule of the strategy will have to change.

Table 5-20 Performance of the ‘ Water for all Cebuanos’ strategy

Performance after 25 years		
Sector reliability – industry and commercial water supply	96%	The percentage of the total volume has been achieved for a 25 yrs hydrological time-series.
Sector reliability – domestic water supply	96%	The percentage of the total volume has been achieved for a 25 yrs hydrological time-series.
MCWD coverage in Metro Cebu	73%	
Desalination as percentage of the total water supply	4.4%	
Groundwater as percentage of the total water supply	70.9%	
Surface water as percentage of the total water supply	24.7%	
Surface water utilization	9.9%	
Precipitation utilization for water supply (domestic and industrial / commercial) for Central Cebu	10.1%	for entire Central Cebu
Precipitation utilization for water supply (domestic and industrial / commercial) for East Coast	20.4%	for entire Central Cebu
Precipitation utilization for water supply (domestic and industrial / commercial) for MCWD area	27.4%	for entire Central Cebu
Precipitation utilization for water supply (domestic and industrial / commercial) for West Coast and East Coast (non-MCWD)	1.0 – 1.5%	for entire Central Cebu
Total volume of water loss in Central Cebu	49 mcm	
Total volume of water loss in MCWD distribution network	42 mcm	
Percentage sustainable yield of groundwater in Central Cebu	79.6%	percentage of possible groundwater supply
% of local water supply which is locally consumed	56.5%	including desalination
Change in run-off due to surface water utilization	74 mcm	

Flexibility Carmen Bulk water project developments

Another change in the supply side would be the ongoing developments of the Carmen Bulk water supply project of MCWD. This is the first major water supply project in Central Cebu using surface water. It involves the design, construction, financing and operation of a water treatment facility, which will extract water from the Luyang-Cantumog River and supply treated water to MCWD. A private contractor will supply at least 28,000 m^3 per day, with a maximum of 46,000 m^3 per day. A pipeline connection between the facility and the MCWD network is also included in the project. The project will be implemented on a 40 year, Build-Own-Operate-Transfer (“BOOT”) basis. The tentative implementation schedule of MCWD shows that the facility should be operational mid July 2009.

In the ‘Water for all Cebuanos Strategy’ the Luyang weir project is scheduled to be operational in the medium term, or more precisely in 2015. That is based on the condition that the northern well fields closer to the MCWD network are first fully utilized up to the safe yield. The length of the pipeline will gradually extend up till the surface water project in the far north of Central Cebu. In the design of the diameter of the pipeline future additional water transport should be accounted for.

In case the Carmen bulk water project pushes through and becomes operational in 2009, the impact on the ‘Water for all Cebuanos Strategy’ will be minor. It means that the implementing order in time of elements of the northern well field project will change and that instead of one pipeline, two pipelines are necessary (one for the private bulk water project and later on one for the well fields in Danao and Carmen). Economic analysis within the Water REMIND project has indicated that the additional costs are limited as a larger production volume will be brought on stream much earlier (compensating for the extra costs involved with the second pipeline). In about two years when the details about the bulk water will be clearer (volume, implementation schedule) the project can be included in the Base Case (autonomous development) subject to the periodically update of the Action Plan.

Flexibility other surface water supply projects

The only exceptions in the previously mentioned flexibility in implementation are the two main surface water projects Lusaran and Kotkot dams. However, these projects are only included as part of the long-term measures (2020-2030) and there is still a lot of time before the actual decision to implement these projects will be undertaken. This means that we can wait and see what the actual developments are and what the needs are to implement the projects.

The overall conclusion is that the proposed strategy ‘Water for all Cebuanos’ is very robust and provides sufficient flexibility for adjustments when the conditions develop differently than what is now expected.

5.10 Overall assessment of the performance of this strategy

The performance of the strategy after 25 years is expressed in a number of characteristic parameters (see *Table 5-20*).

6. IMPLEMENTING THE ACTION PLAN

6.1 Implementation framework

The strategy 'Water for all Cebuanos' described in the previous chapter included many policy decisions and measures that will be implemented in the coming years. Several authorities, and in particular the LGUs, are involved in this implementation and therefore careful planning and coordination is required. This chapter will describe how the plan should be implemented. Such an implementation plan will have an 'open' and a 'rolling' character, which means that it is neither static nor prescriptive, and leaves room for individual stakeholders to further elaborate according to their own responsibilities.

On the other hand, this implementation framework will be concrete by translating the strategy into specific activities and assigning clear responsibilities in carrying out the activities involved. It will also include the budgetary requirements for the implementation, including investments and recurrent costs. To summarize, the framework will specify:

- *what*: concrete actions that have to be taken
- *who*: stakeholders who will be primarily responsible and take the lead in the implementation of the action
- *how*: steps to be taken and the consultative process involved
- *when*: time plan

An overview of the implementation framework is given in *Figure 6-1*. The actual implementation of most of the measures will take place at the LGU level and their water-related utilities, districts and associations. When needed, feasibility and engineering studies will be carried out before the actual implementation and / or construction can take place.

Above the implementation level of the LGUs, there will be a kind of guidance and coordination level. The Technical Secretariat (TS) as explained in Section 5.9.1 will play a major supporting role in this level. However, the TS will only prepare various reports while the actual decision making will be done by the Partners. A monitoring report will be compiled by the TS twice a year about the progress made in implementing the measures of the Action Plan as well as the effectivity of these measures in terms of the objectives they aim to achieve. The question to be addressed, therefore, is whether the implemented measures indeed solved the problems.

When insufficient progress or effects lead to an adjustment of the Action Plan, the TS may provide assistance to the LGUs, i.e., supporting them in carrying out feasibility studies. However, this is up to the LGUs to decide. In any case, the TS will be able to support them by providing data and possibly other relevant information from their Management Information System (MIS).

6.2 Phased Approach — a rolling exercise

A planning approach for water resources development and management as advocated in the Action Plan is rather new for the region. At present, most developments take place on a 'project by project' basis. Introducing a full IWRM approach in which all aspects of water resources management are addressed at the same time is beyond the present institutional capacity. For this reason a phased approach is being followed in which the activities first (Phase I) will focus on the most urgent needs, i.e. the supply of sufficient and safe potable and industrial water and optimized demand management. At the same time the institutions will prepare themselves to include the other aspects such as improved watershed management practices, sanitation and full protection of resources in a later phase. Such preparation will involve the institutional development, capacity building, the collecting of technical and management information, and the like. In the next rounds of action planning (Phases II and III) these other aspects can be taken into account. Planning should be seen as a continuous process as indicated in *Figure 6-1*.

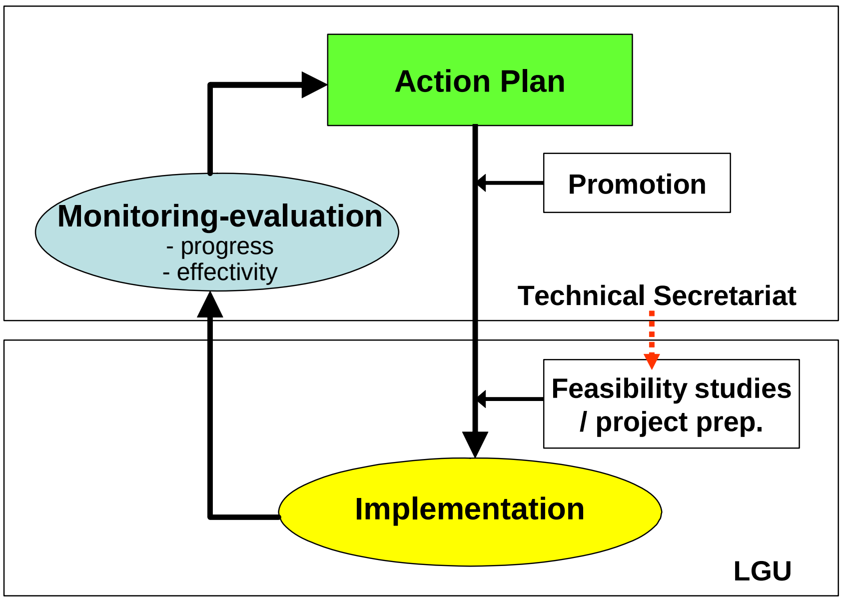


Figure 6-1 Implementation framework Action Plan

In the meantime, the TS is expected to develop an updated Action Plan every two years. The plan described in this document can be labeled as Action Plan 2006. Phase II will result in Action Plan 2008, Phase III in Action Plan 2010, and so forth.

These Actions Plans could develop as follows:

Action Plan 2006 (Phase I): the focus is on the drinking and industrial water supply

Action Plan 2008 (Phase II): this is an extension which will include sanitation aspects, particularly in urban areas in relation to surface water and groundwater quality

Action Plan 2010 (Phase III): a further extension with watershed management and spatial planning aspects

Given the time needed to prepare and implement certain measures (such as the construction of a reservoir), it is clear that the actual implementation of these plans will go well beyond the mentioned time horizons.

The plan was built upon a technical study which focused on describing the water balances in Central Cebu. Therefore, increased insight had been gained in knowing the available sources of water and the possible water supply measures. However, lack of knowledge on population and economic development in the region appeared very critical in the assessment of the total water demand and hence, the number of sources required addressing the needs in the planning period.

In addition, the choice discussed in this report, on whether to include a sewerage scheme or not, had a similar impact on the timing of the future water resources. In order to improve the timely planning of the various measures, it is strongly recommended to put emphasis on the periods preceding the scheduled updates of the action plan.

A good description of the Water Resources System is the first step towards better action planning. Water Resources Planning requires sound knowledge from various disciplines and expert databases. It follows that this integral approach need to be reflected in the composition of the Technical Secretariat.

6.3 Implementation plan

6.3.1 Implementation process

Implementing the Action Plan encompasses more than just the calculation of some technical measures. Although these are needed and are essential, technical measures will only be effective and sustainable if they are placed in a supportive institutional and social setting.

First of all, a proper **enabling environment** is needed. This will consist basically of the national, regional and local policies and the legislation that will empower the stakeholders concerned to play their respective roles in the development and management of water resources. These will also provide information and capacity building to facilitate and exercise effective stakeholder participation. The role of the government is therefore crucial in this respect.

Secondly, the **institutional roles** must be considered. In a dynamic institutional environment, the roles and functions of the organizations at different levels should be clearly described. These include the creation of an effective and coordinated mechanism among the different agencies as well as the development of financial structures that will enable these agencies to perform their tasks efficiently. The institutional development with a WRM Board and a stakeholder's committee (see Section 5.9.1 in Annex B) will provide such a setting.

Finally, the **actual interventions (measures**) in the system will have to be developed further. Most measures of the Action Plan are studied at pre-feasibility level. A more detailed feasibility and engineering studies will also be needed before actual implementation can take place. The same applies at the demand site. Surveys and market analyses will have to be made to determine exactly where the water should be supplied to.

The actions needed for an enabling environment, the institutional roles and the additional studies are included in this Action Plan. The development of the institutional, legal and financial measures mentioned should be given priority, in particular the establishment of the Water Resources Management Board.

6.3.2 Role of stakeholders

The Action Plan aims to stimulate the coordinated development and management of the water resources in Central Cebu. The measures involve and affect many stakeholders. They will have to be included in the implementation process in order to guarantee a successful implementation and a sustainable benefit of the measure with the following roles:

Responsibility: the stakeholder has the primary responsibility for the implementation of the measure but will cooperate, and/or consult with, other stakeholders in this process. In Figure 6-2 this is indicated by the symbol: **●**.

Co-operation: the stakeholder has an important say in the implementation of the measure but does not have the primary responsibility and is expected to work with other stakeholders in this matter. In the figure this is indicated by the symbol: ○

Consultation: the stakeholder has an interest in the implementation of the measure and will be consulted by the stakeholder with the primary responsibility. In certain cases permission will be needed before the implementation can take place. In the figure this is indicated by the symbol: **x**

Figure 6-2 provides an overview of the above defined roles of the stakeholders in the implementation of the various measures of the Action Plan.

6.3.3 Time schedule implementation

Implementing all these measures and actions will take time. Even after accepting the Action Plan as a formal decision, the various measures, actions and projects have to be

Recommended Measures			Phase	Institutions involved																					Implementation info		Phase I only			
				Province of Cebu	City of Cebu	MCWD	DENR, DOH, NWRB, LWUA, ..	City of Mandaue	City of Lapu-Lapu	City of Talisay	City of Toledo	City of Danao	Municipality of Naga	Municipality of Minglanilla	Municipality of Liloan	Municipality of Consolacion	Municipality of Balamban	Municipality of Pinamungahan	Municipality of Asturias	Municipality of Carmen	Municipality of Cordova	Municipality of Compostela	Private investment	NGO's, academe, church, etc.	No. of the measure	Type of measure	Total Investment (in MPesos)	Recurrent costs (MPesos/yr)	Starting year effective operation	Needed lead time (preparation + construction)
Develop more resources	West	Groundwater wells West	I				x				●						●	●	●				●	o	9	invest.	849	38	2006	-
	Uplands	Spring boxes + small impoundments + trucking for drought periods	I		●	o	x			●	●	●	●	●	●	●	●	●	●	●		●		o	8	invest.	737	126	2006	-
	East, non-MCWD area	Groundwater wells East	I				x					o	o	o						o		o	●	o	9	invest.	639	28	2006	-
	East-MCWD area, excl. Mactan	Groundwater production wells by MCWD	I		o	●	x	o		o					o	o						o			9	invest.	588	26	2006	-
		Groundwater wells MCWD area by private initiatives	I		●		x	●		●					●	●						●	●		9	invest.			2006	-
		Luyang-Carmen weir	I	o	x	●	o	x				x			x	x				o		x	●		4	invest.	3,169	124	2016	2+2
		Northern well fields: Liloan, Compostella, Kotkot, Danao, Carmen, Luyang (excl. Luyang weir)	I	o		●	x					o			o	o				o		o	?		9	invest.			2006	2+2
		Lusaran Dam	I	o	o	●	o					o					o					o	?		2	invest.	2,536	77	2027	6+2
		Kokot Dam	I	o	o	●	o								o							o	?		3	invest.	905	59	2022	6+2
		Southern well fields: Napo/Carcar river, Pangdan, Minglanilla	I	o		●	x			x			o	o									?		10	invest.	2,490	86	2014	2+2
	Mactan	Horizontal wells	I			●	x		x																11	invest.	51	5	2006	-
		Shallow fresh water wells	I			●	x		x															o	11	invest.	276	56	2008	-
		Shallow brackish water wells + reverse osmosis	I			●	x		x																13	invest.	80	42	2006	-
		Desalination by MCWD for industry	I			●	x		x														?		13	invest.	297	55	2010	2+2
		Desalination by MCWD for domestic use	I			●	x		x														?		13	invest.	1,393	167	2012	2+2
		Desalinaton by industry (private initiative)	I				x		x														●		13	invest.	297	55	2010	2+2
Water demand reduction	Reducing losses	Rainfall harvesting: urban, rural, industry	I	o	●			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	o	o	12	invest.	515	-	2006	-
		Leakage reduction / rehabilitation distribution system MCWD	I		o	●		o	o	o					o	o					o	o			14	invest.	820	41	2007	-
		Adequate and differentiated water pricing	I/II			●	x																		20	study	pm	pm	2007	1
		Promotion of water saving equipment and less consuming production	II			●	●																o	o	21	man.	-	-	-	-
	Awareness	Awareness raising high demand Cebu neighbourhoods	I		●	●		●	●	●														o	22	man.	0	2.6	2006	-
		Awareness raising - general	I	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	23	man.	0	6.9	2006	-
Protecting the resources	Watershed management	Land use practices / watershed management	I/II		o		●			o	o	o	o	o	o	o	o	o	o	o		o	o	o	30	reg.	-	-	-	-
		Gabion dams	III		●		o			●	●	●	●	●	●	●	●	●	●	●		●		o	31	invest.	-	-	-	-
	Water quality improvement	Improved solid waste management	II		●		o	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		o	34	man.	-	-	-	-
		Well head protection - spatial planning recharge areas	II	o	o	o	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	35	reg.	-	-	-	-
		Prevent sand and gravel mining in rivers (enforcement)	II	●	●		●	●		●	●	●	●	●		●	●	●	●	●		●	o		36	reg.	-	-	-	-
		Implement strict effluent permitting (EMB)	II		o	x	●	o	o	o					o	o					o	o	o		37	reg.	-	-	-	-
		Urban sewage systems in building requirements	I		●			●	●	●													o		38	reg.	0	0	2007	1
		Development of urban sewage systems and treatment	II		●	●	o	●	●	●													o		39	invest.	-	-	2010	3
		Sanitary programs in uplands	III		●		o			●	●	●	●	●	●	●	●	●	●	●		●		o	40	invest.	-	-	-	-
Water governance	Organi-sational	Development institutional setting for IWRM (integration and coordination - Board, TS etc.)	I	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	50	instit.	pm	pm	2006	0
	Regulation and control	Family planning and migration control (env. related)	I	●	●		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		●	54	man.	pm	pm	-	-
		Water withdrawal quantity and quality control	II				●																o		52	man.	pm	pm	2007	0
		Implement and enforce spatial planning (urban, industrial, etc.)	I	●	●		●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			55	man.	pm	pm	-	-
		Priority rules (allocation) during dry periods	I	o	o	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		56	reg.	pm	pm	-	-
Research and development		Improve data collection, analysis and presentation,improve decision support tools	II	●	●	●	●	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	61	capac.	pm	pm	2007	-
																											15,642	995		

Phase I: part of Action Plan 2006
Phase II: to be developed for Action Plan update 2008
Phase III: to be developed for Action Plan update 2010

● initiative for implementation measure
o co-operating partner for implementing the measure
x to be consulted for permission or information

Figure 6-2 Institutions involved in implementing the strategy

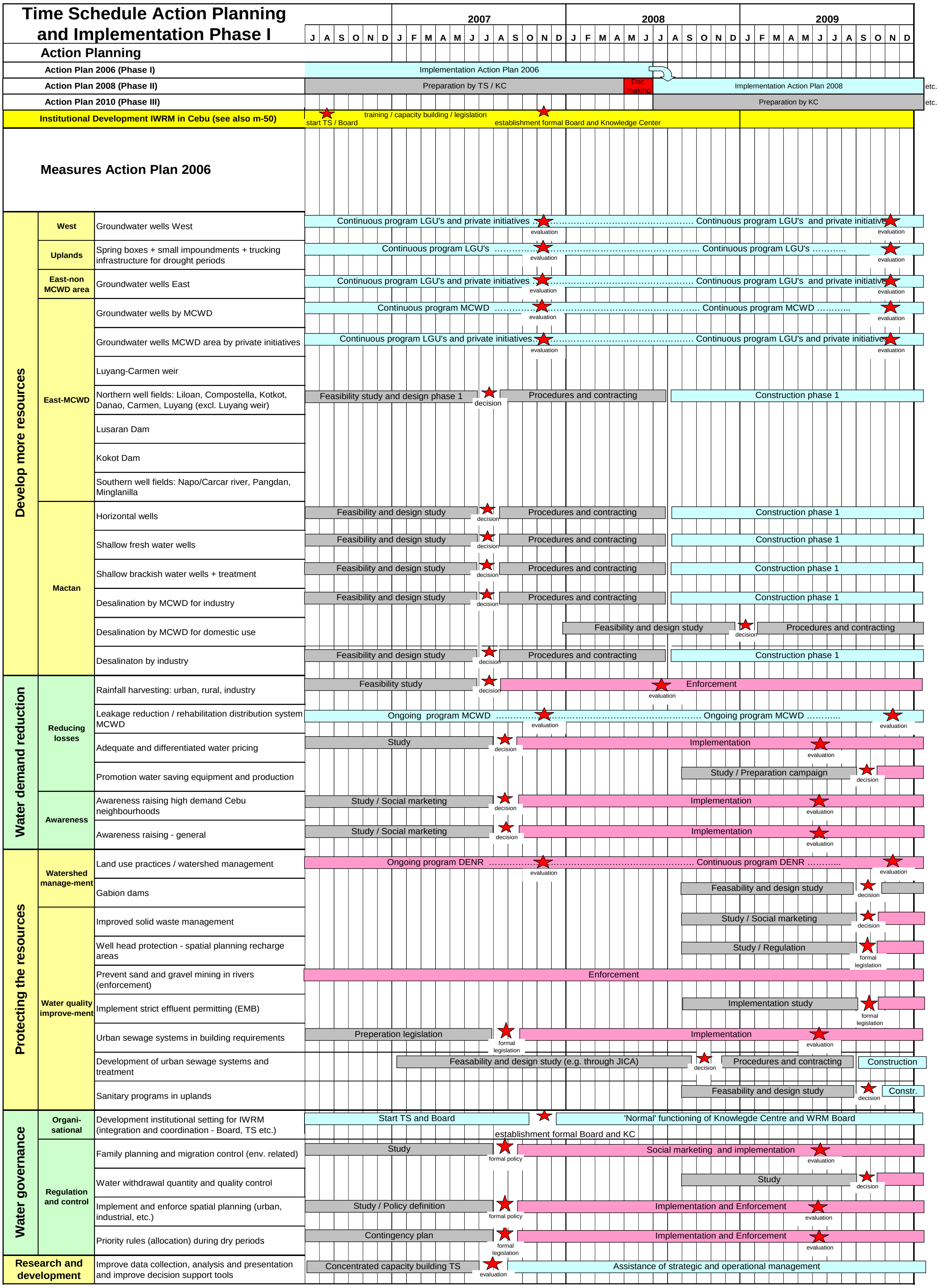


Figure 6-3 Time Schedule Action Planning and Implementation of Phase I

prepared or designed. Moreover, permissions have to be asked and funds have to be sourced out for its implementation. *Figure 6-3* gives an overview of the phasing and milestones involved in the implementation of the plan for 2006 - 2009.

The top part of the figure presents the phasing of the Action Plan. Phase I starts with May-June 2006 indicating the time when decisions are being made, followed by the implementation stage. At the same time the preparation of the next Action Plan will take place, addressing the Phase II activities. This will be followed by the decision making part for the Phase II of the Action Plan which will be done in 2008 and so forth.

The top part of the figure also shows the timeline of the Institutional Development in the region. This is crucial for the implementation of the Action Plan as well as the further development of the water sector Action Plan in the future. The following two milestones are important:

- The creation of the Technical Secretariat and a kind of temporary partner Board in the second half of 2006

- The establishment of a formal Board in late-2007 and the related 'upgrading' of the TS into a Provincial Knowledge Institution on Water Resources Management

Since majority of the projects to be implemented are designed for the Metro Cebu area, the present process of dealing with unsolicited BOT proposals for the development of water supply projects (Bohol, Southern Wells, Luyang, Malubog, and the like) is far from ideal. Unsolicited BOT proposals are typically more costly and less transparent. The public sector must be more vigilant in ensuring competition and invest more resources for water supply project planning, feasibility studies and monitoring of the implementation. If the public does not become pro-active and instead only respond to unsolicited proposals, they will end up in situations that completely go beyond their control (due to lack of insight information, time delays as a result of little transparency during contract negotiations, and so forth). It should be the public sector who should be full in control to address the water demand through competitive bidding processes.

Details on the implementation of the various measures are given in Annex A.

6.4 Monitoring

As mentioned in Section 6.1, the actual implementation of most of the measures of the Action Plan will be done at the LGU level. However, problems may arise in practice, such as constraints in the availability of budget, unexpected technical obstacles or procedural delays. An efficient, coherent system of monitoring and progress reporting is of paramount importance, particularly for identifying bottlenecks at an early stage and for keeping the implementation process on the right track.

All LGUs are expected to inform the Technical Secretariat about their progress. This will enable the TS to conduct an overall evaluation of the implementation of the plan. Monitoring and annual progress reporting will also provide feedback on the impacts of the implementation on the water resources system. It will then contribute to the next round of planning. An overall evaluation will help define the next issues that should be addressed, and if needed, adjust the priorities.

The development of a coherent monitoring and progress reporting system that will be accepted and applied by all stakeholders is a crucial element in the implementation. This will facilitate aggregation and exchange of information. Such 'info-structure' will be a powerful means for water resources management both at the policy and operational levels. It will be essential for an effective overall coordination by the Partners supported by the Technical Secretariat.

More specifically, the following steps are identified in monitoring, progress reporting and evaluation:

1. Monitoring on progress will be done by the LGU primarily responsible for the measure. Each measure will include:

   - a quantified statement on what the measure aims to achieve
   - the progress of the implementation of the measure (what has been completed)
   - an assessment on how far the underlying objective of the measure has been addressed including the monitoring of certain indicator values and in particular, the ones that are related to the WRM objectives
   - identification of any bottlenecks that could hamper the progress of implementation

2. The LGUs will submit a report on the progress of 'their' own measures to the TS twice a year, which will include:

   - a 1-page report per measure, containing the above elements
   - conclusions on the overall progress of the implementation of their measures

3. The TS will consolidate the progress reports of the LGUs into an overall progress report of the Action Plan, including:

   - a consolidation of the main policy lines of the Action Plan (such as developing more resources, reducing the demand, etc.) and identifying the progress and the bottlenecks
   - a consolidation of all measures in one table, providing quantitative information on the progress
   - an assessment on how far the policy objectives are being met,
   - an overall conclusion with respect to the progress
   - recommendations for decisions and directions made by the Partners
   - the detailed progress reports of the stakeholders will be included as annexes

4. The Partners will discuss this TS report and, when needed, make the proper decisions and provide directions.

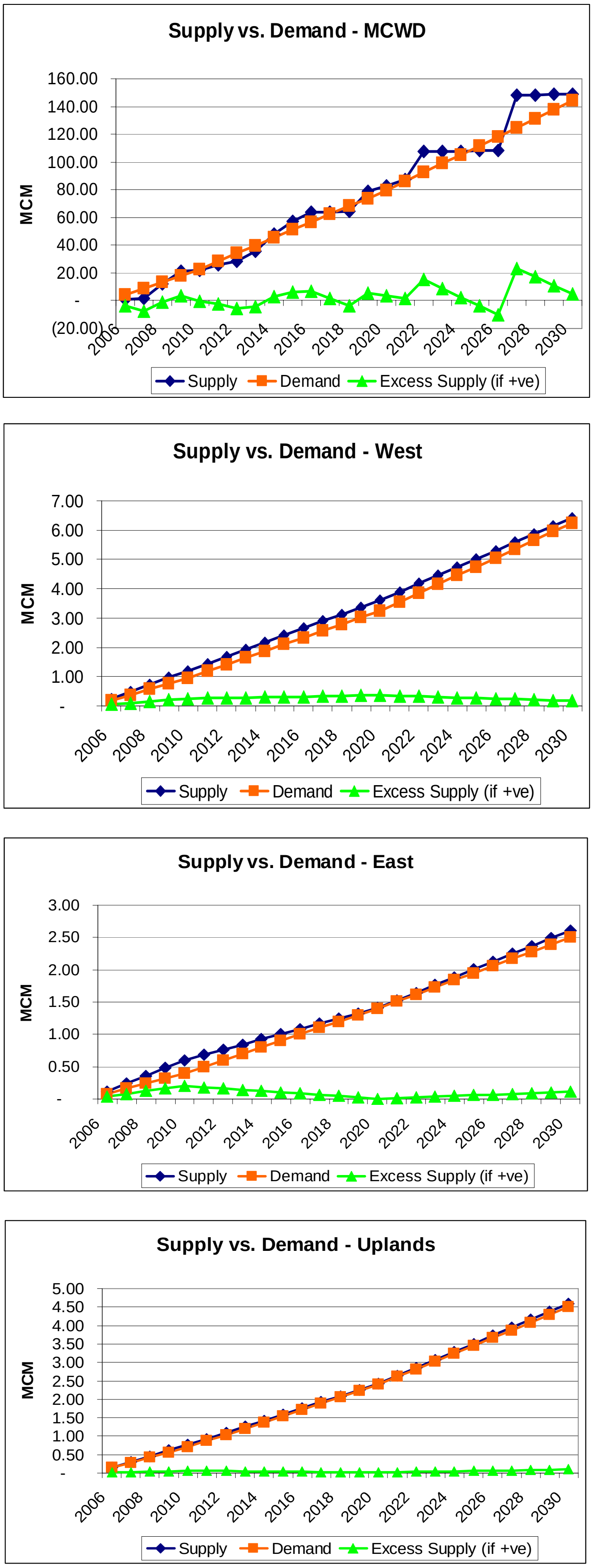


Figure 6-4 Supply and demand of water - 4 Areas

6.5 Financial—Economic consequences

6.5.1 Scheduling the projects: finding the supply-demand balance

The action plan estimates demand for water over time, then designs a strategy to meet the increasing demand by bringing on new supplies in a carefully-staged manner. Staging ensures both that the populace doesn't suffer through supply shortfalls and that water supply infrastructure is not over-built at an excessive cost. The adjustment of supply to meet demand was conducted for four areas of Central Cebu; namely, the MCWD Area, East, West and Uplands. As the economic analysis looks at the cost and revenue implications of the ensemble of projects that together make up these strategies, the analysis begins with a presentation of cumulative water supply and demand in *Figure 6-4*.

Several observations are in order:

Where the water goes: A glance at the vertical axis of the four charts confirm that a vast majority of water is required in the MCWD area. By 2030, the incremental water demand for Central Cebu will be 157.4 mcm/yr. About 91% of the total increment is needed in the MCWD Area while the west, east and upland areas require about 4%, 2% and 3% respectively.

Balancing supply & demand: In the west, east and uplands, small production wells (capacity: 550 m^3/day), spring boxes and rainwater impoundments are used to increase supply over time. As each unit is small, it is easy to add just enough wells to ensure that water supply and demand are kept in balance. In the MCWD area, relatively large water supply projects are required to meet the massive demands for water. Though demand increases in a largely linear fashion, supplies increase in steps as large scale wells and dams are brought on stream. As a consequence, it is more challenging to maintain the supply–demand balance. The result is short term supply or demand shortfalls.

6.5.2 Required investments and related recurrent costs

Ensuring that supply and demand remain in balance has implications for investment costs, recurrent costs and unit costs. These are summarized in *Table 6-1* for the four geographical areas of Central Cebu that are under study. Highlights of *Table 6-1* include:

Investment Cost: The bulk of the investment in water supply infrastructure takes place in the MCWD area. From the total of PhP 17.6 billion, 87% or PhP 15.4 billion will be spent in the MCWD area. MCWD receives 92% of the water for 87% of the investment cost because large water supply projects cost less per unit than small ones. The investment includes components such as desalination plants which, in all likelihood, will be financed by the private sector and split off to specific water users. Breakeven price is the price at which discounted cost equals discounted benefits. Because breakeven price takes time into account, it is always higher than the life cycle costs.

Recurrent Cost: Recurrent cost is influenced by the year in which new projects are implemented. The two largest individual projects, the Lusaran Dam and the Kotkot Dam are implemented late in the action plan period.

If implemented earlier, recurrent costs would increase accordingly. The order in which the action plan adds new sources of supply is a function of location (e.g., closer to Cebu City first, then moving farther away) and volume of water delivered so as to keep supply and demand in balance. This method could also be improved by developing the highly feasible projects first, especially if the private sector financing becomes available for them. Recurrent costs of MCWD projects account for 85% of the PhP 14.2 billion ($284 million) in cumulative recurrent costs.

Life Cycle Cost: Life cycle cost is the sum of cost over the life of the action plan divided by the sum of the volume of water delivered[1]. The life cycle cost is about PhP 16/m^3 in the west, PhP 29/m^3 in the east and PhP 40/m^3 in the uplands. For the MCWD area, the life cycle cost is PhP 15/m^3. This estimate overstates the actual life cycle cost because of the timing of major projects such as the Lusaran Dam. Bringing them later into the 25-year action plan means that all investment costs are captured while most of the stream of ensuing benefits are missed. A longer time period of 45 years addresses this problem. The 45 year life cycle cost for the MCWD area is PhP 10/m^3.

Breakeven Price: The breakeven price/m^3 for the west, east and upland areas is PhP 23, Php 39, and Php 46/m^3 respectively. At these prices, the projects that comprise the action plan are feasible by the standards of IFIs such as the ADB[2]. For the MCWD area, the breakeven price is PhP 23/m^3. However, this overstates the price at which sufficient time is given for all benefits to accrue by about PhP 3/m^3. Therefore, a price that averages PhP 20/m^3 over the life of the action plan will be sufficient to accommodate gradual increases to the price MCWD requires for water treatment and distribution, although the action plan does not make allowance for 'unaccounted' water.

6.5.3 Justification

In this analysis, justification refers to the financial justification of the action plan; that is, on the basis of revenues that accrue to the private proponents/implementers of the action plan. An economic justification that includes environmental and social benefits to the society is not part of this exercise.

Three measures of justification were used in the analyses of the four geographical areas. The results are summarized in *Table 6-2.*

The unit price of water was set so that NPV > 0, BCR > 1 and IRR > 12%. As a result, the most interesting results concern the unit price of water. For the MCWD area, a price of PhP 25/m^3 was sufficient to generate the NPV, BCR and IRR minimums. In the West, East and Uplands, the unit price of water was 24, 39 and 47 PhP/m^3 respectively. Other observations:

Ceiling price: The unit prices for water are maximums for two important reasons: a) revenues from water sales are the only financial benefit. The inclusion of other financial benefits would allow this unit price of water to decrease; b) a 25 year time horizon for MCWD has the effect of including 100% of investment costs but less than 100% of benefits. The result is a unit price of water for the MCWD area that is unnaturally high by about PhP 3/m^3; and

Discount rate: NPV and BCR are a function of the discount rate used in the calculation. The initial analysis uses a discount rate of 12%. However, this is very high for infrastructure projects. A discount rate of 6% would have a major positive impact on NPV and BCR, or alternatively on the unit cost of water. With the unit selling price of water set at PhP 25/m^3, a 6% discount rate would cause NPV for the MCWD area

Table 6-1 Action Plan - Cost Implications - 4 Areas

Category	Units	MCWD [1]	West	East	Uplands
25-yr Investment cost	PhP millions	15,387	849	639	737
25-yr Recurrent cost		11,968	458	331	1,460
25-yr Total cost		27,355	1,307	970	2,197
25-yr Water supply	mcm	1,829	81	33	55
25 yr Life cycle cost	PhP	15	16	29	40
25 yr Breakeven Cost		23	23	39	46

(1) the investment cost includes socio-economic costs such as the cost of relocation, loss of property, land, etc.

[1] Life cycle cost does not take time into account. For this reason, economists believe that it understates the true unit cost of water supply.

[2] That standard is a minimum IRR of 12%

Table 6-2 Action Plan: Justification – 4 Areas

Category	Units	MCWD	West	East	Uplands
Unit Price of Water	PhP/m^3	24	23	39	47
Net Present Value @ 12%	PhP millions	216	4	3	8
Benefit: Cost Ratio	PhP1 of benefit per PhP1 of cost	1.03	1.01	1.01	1.02
Internal Rate of Return	Percent	13	12	13	13

to increase to PhP 4.0 billion and BCR to increase to 1.30. Alternatively, it would allow the price charged for water to be reduced to PhP 20/m^3 while maintaining an IRR > 12%. Both the investment costs and the recurrent costs along with the benefits of the action plan are illustrated for the four areas of Central Cebu in *Figure 6-5*.

6.5.4 Financing—General

The World Commission on Water estimated[1] that to ensure water security by 2025, investment needs would increase from the current level of about $70 billion a year to $180 billion/year. While public funds will remain dominant and indispensable, the required infrastructure cannot be built with these funds alone. The private sector has an important complementary role to play in financing water resources infrastructure.

In the past decade, the private sector invested $700 billion in infrastructure in developing countries[2]. However, only a small portion of this amount went into water-related *infrastructure*: about 5% into water and sanitation; and another 5% into hydropower. Likewise, only 5% of water *services* are currently provided through the private sector. To stimulate private investment, the World Bank sees a need for a more collaborative public-private partnership. This approach will necessarily include:

- Options assessment and project identification, including hydrologic, economic, environmental and social assessments.
- Investing in public goods. Projects that produce both private benefits (e.g., water sales) and public benefits (e.g., flood protection) cannot be solely financed privately.
- Managing risks. The public sector can assist the private sector in mitigating risk in several areas, for example, the management of foreign exchange risk.
- Legal and regulatory frameworks. It is up to the public sector to develop a stable enabling environment with effective and predictable rules and institutions.
- Output-based aid. Greater use should be made of output-based aid, with funds disbursed on the basis of actual services delivered.

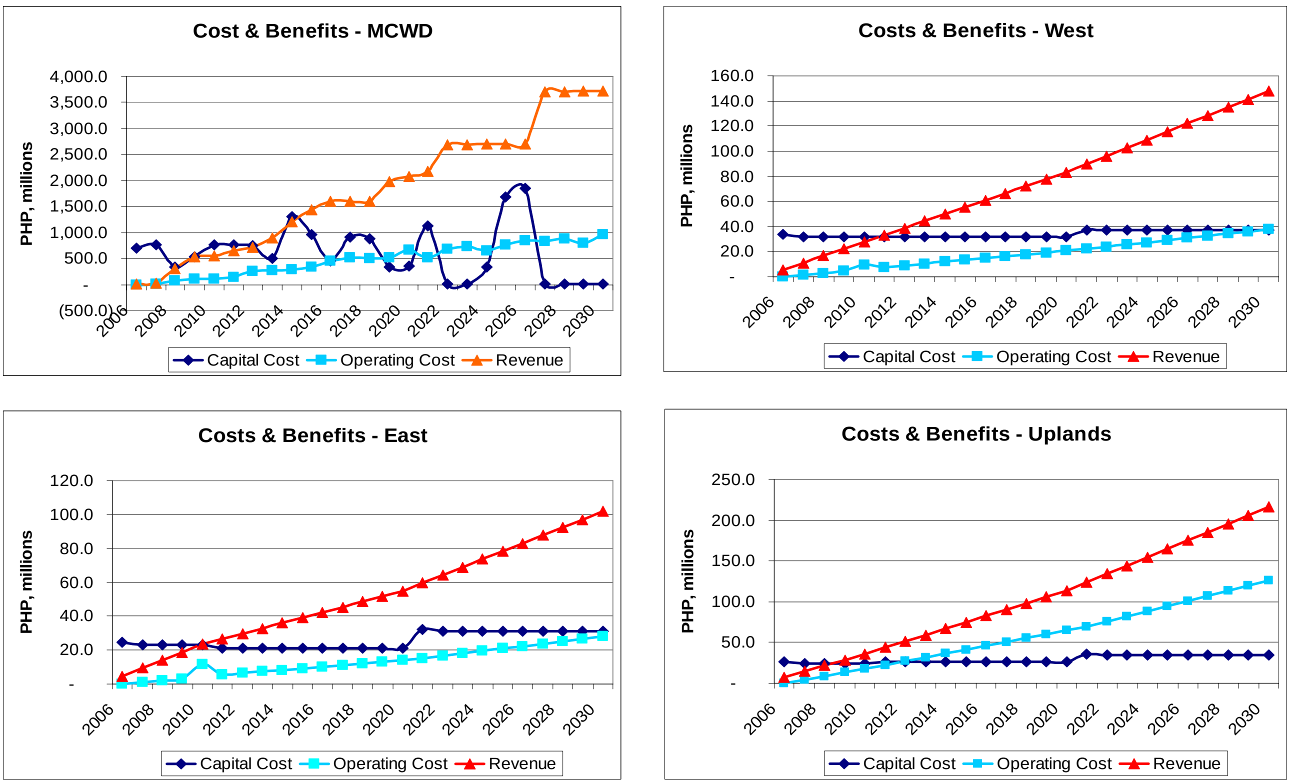


Figure 6-5 Costs and Benefits of Action Plan - 4 Areas

[1] See World Bank. “Water Resources Sector Strategy”. 2004. p. 43

[2] $17 billion for hydropower, $28 billion for water and sanitation and $25 billion for irrigation

Improved water resources management only happens when there are incentives for empowered actors to make things change. For example, water concession contracts in Manila put private operators in place. These concessionaires are a source of pressure to modernize the water rights system so that transfers can take place voluntarily and with compensation. Likewise, they have pushed for improved watershed management, recognizing that their investments depended on the quality of their bulk water.

6.5.5 Financing the Action Plan

Although the World Bank painted a gloomy picture of private sector financing possibilities worldwide, it cited the Philippines as a leader in involving the private sector in the finance, implementation and delivery of water supply projects. It is possible to conduct a sample exercise in which action plan components are linked to likely financing sources. Four financing sources are considered: public, private, public-private partnerships and local finance of small projects. Donor financing is not included specifically in this list. The reasoning is that ADB loans tend to be made to and paid back by governments. As a result, the public finance source could well include funds not just from the government budget but from IFI loans made to the government of the Philippines. The major characteristics of each source and action plan components likely to be financed by each one are outlined in *Table 6-3.*

Based on these assumptions, it is possible to estimate the percentage of the action plan that could be financed by the four sources of financing. The results appear in *Figure 6-6.*

In this example, the public financing of one dam and the southern and northern well fields would account for about 3/5 of the total while the private financing of the desalination plants and the smaller dam accounts for 1/5 of the total. Partnerships account for 11% of the total cost while local financing of private wells, spring boxes and rainwater impoundments equals 8%. In this example, private financing would account for up to 30% of the total requirement.

Table 6-3 Financing Sources - Characteristics

Financing Source	Major Characteristics
Public Financing	- “Big pipe” projects - As water is a commodity that can be sold, possibilities exist for private financing - Donor financing included
Private Financing	- Financed though not necessarily managed by private sector
Public-Private Partnership	- Hybrid projects with aspects of interest to both public and private sources
Local Finance	- Small-size, locally focused initiatives

Admittedly this is an ambitious goal given the World Bank's observation that worldwide private financing is in the range of 5%.

The above exercise is a theoretical one, however, unless certain development limitations are removed, especially if the goal is to maximize private sector involvement. One such limitation concerns the necessary reform of the Local Water Utilities Administration (LWUA), the regulatory body that was created in 1973 to oversee and regulate the activities of water districts in the LGUs nationwide.

6.5.6 Benefits and other impacts

The benefits and other impacts of the Action Plan are described in Section 5.9 on the strategy ‘Water for all Cebuanos’ in terms of the performance indicators. Reference is made to that section for an assessment of these benefits and other impacts. The ultimate benefit will be the increased welfare and well-being as a result of the supply of safe water to households, industry and tourism.

Households can expect an extended and more reliable drinking water supply, both with respect to delivery as well as quality. The costs involved are expected to be acceptable, given the increased services provided. Some subsidies, such as a cross-subsidy from industry and tourism, might be needed to protect the poor.

The impacts for **industry** are mixed. On the one hand, industry can expect a more reliable supply of good quality water. On the other, industry will face more constraints in the discharge of their pollutants in the water system, requiring them to make investments (even relocation) and/or requiring them to pay for the disposal of wastewater. Government subsidies can somewhat ease the pain. Part of the additional costs involved will be transferred to the end consumers. The overall conclusion for industry is that their production costs will increase and that some reduction in profit should be expected. This should be seen as a price that society will have to pay to create a healthy environment needed for Cebu's population, which includes owners and employees of the industries.

The impacts for **tourism** will be minor. Most of the bigger tourism facilities are expected to provide their own water supply by desalination. Although the costs of desalination are much higher than that of water from MCWD, tourism will prefer the desalination option because of its reliability and the fact that the costs involved are lesser compared to other cost components of their business. Small tourism facilities including those that are far away from the coast will be able to withdraw water from MCWD.

6.6 Risks and risk management

Two categories of risks are identified. The first kind is the risk that the implementation of the Action Plan, or parts thereof, will fail for various reasons. These are called the ‘implementation risks’ and will be dealt with in Section 6.6.1, as well as the way these risks can be mitigated. The second kind is the ‘resource risks’ i.e., what may happen to the resource as a result of unexpected or very uncertain events such as climate change of accidental toxic spilling. These risks are described in Section 6.6.2.

6.6.1 Implementation risks

There are several kinds of risks and constraints that might impede the successful implementation of this Action Plan. Most risks are multi-dimensional in the sense that more than one category of risk is involved and that mitigation measures should address all categories simultaneously. It should be noted that uncertainties about the future always lead to risks in implementing policies and strategies. Circumstances may develop in a different way than what was anticipated and priorities may change. This means that plans will have to be updated regularly. Reference is made to Section 6.2 that described the continuous and 'rolling' character of the Action Plan. Continuous planning makes it possible to deal with the risks involved by adapting the policies and strategies. In this way, one can cope with the different circumstances. It enables one to take actions to mitigate these risks.

Political and institutional risks

The first and utmost issue at stake here is the required cooperation at the provincial, city and municipal level. Without this cooperation it will be difficult to implement many of the measures of the Action Plan. The proposed WRM Board (see Section 5.7.1) has to play a major role in establishing this cooperation and to mediate any issues that may arise among the partners.

Another political and institutional risk concerns the acceptability of the elected official in implementing firm cost recovery schemes in their management structure. Cost recovery measures are often not popular and, without proper awareness raising campaigns, can lead to social unrest. However, cost recovery is indispensable in order to have the system perform adequately. Without this, it will not be possible to provide sufficient funds to cover all recurrent costs.

Social risks

Social risks have two dimensions. The first dimension is the awareness of the people that water should be dealt with carefully and that all individuals have a role in saving and protecting water. With respect to water quality, such awareness is at present rather low, or at least, actions to improve the situation got a low priority in the past. Some of the measures included in the Action Plan require a full cooperation of the population. Such cooperation depends on the second dimension of the social risks, which is the willingness and ability of the government to acknowledge the important role that the grass root level can play in the management of the water and that they should be properly informed and consulted about planned developments. Examples include introduction of the cost recovery principle, the polluter pays principle, the wise and regulated use of the natural resources, and the development of a community responsible for the operation and maintenance of their schemes.

Environmental risks

The most important environmental risk is that economic development and economic gains are considered to be more important than environmental quality. Violations of standards and rules are tolerated in lieu of a high priority for Cebu's industrial and housing developments. Awareness raising about the importance of a healthy environment should reduce this risk.

A second environmental risk is the insufficient awareness of the people that they play a key-role in safeguarding the quality of water. This risk was also mentioned previously under the social risks. Disposal of waste, both liquid and solid, in the surface water system should be considered as unwanted, or even unacceptable, in particular if this threatens the quality of the groundwater. Awareness programs are included in the Action Plan to convince the people that a proper disposal of waste will lead to a more healthy environment. The government should provide sufficient facilities to enable such proper disposal.

Related to the pollution of groundwater is the health risk involved in using this polluted groundwater as a source for drinking water production.

Financial risks

Financial risks involve both investment and recurrent costs. As far as investments are concerned, it will be necessary to involve donors or work through public-private partnerships. Funding from the donor community has political, social and environmental dimensions. In case the total funds will be insufficient than the assumed, the consequence will be that the implementation rate of measures will be slowed down. This will have no major consequences for the implementation of the Action Plan other than that the improved performance of the system will be achieved at a later date.

Recurrent costs represent a more serious risk. Much of the under-performance of existing facilities are the result of ineffective operation and maintenance due to lack of funds. Moreover, contributions from donors for investments will inevitably be linked to conditions of proper cost recovery schemes. The Action Plan recognizes this risk and places the responsibilities of the performance and the operation and the maintenance of the schemes firmly with the users. The governance structure should enable cost recovery, both legally and institutionally.

Technical risks

Nearly all technical measures of the Action Plan are based on proven technology in the Philippines. Examples are the groundwater development projects and dam construction. Also newer technologies such as desalination are already used extensively in the region. Hence, the direct technical risks involved are small.

Technical risks that have to be taken into account must be related to the assumptions that underlie the design of certain measures. In this study the most important uncertainties are involved in the estimated safe yields of groundwater systems and involved in the return flow through groundwater infiltration that is assumed to become available for re-use. However, although important by themselves, these risks are not crucial for the Action Plan. The reason for this is that, in case it turns out that less water is available from groundwater, this will only mean that the implementation of subsequent projects will have to be speeded-up and have to be implemented earlier.

A different kind of technical risk is associated with the availability and reliability of appropriate information and the willingness to exchange this information among the stakeholders. As mentioned under the institutional risks, it is anticipated that the WRM Board and Technical Secretariat will play a major role in this, in particular with respect to the exchange of information.

6.6.2 Natural risks and uncertainties

Geohazard risk

Cebu Province is seismically quiescent compared to the rest of the Philippines. According to the Philvolcs Earthquake catalogue, existing seismic records did not show any sizable earthquakes originating within Cebu from 1907 to the present. In addition, no major active earthquake had been identified in the island. As long as the infrastructure considered does not directly straddle a fault, it is considered safe from fault rupture hazards. Nevertheless the Mananga High Dam Feasibility Study (FS) recommended further studies to better evaluate the activity of the existing faults in the area. Any full FS study resulting from this action plan should be subject to further exhaustive geological and seismological investigations to rule out major risks and to better design the works.

Calamities – drought periods

Long drought periods might have serious impacts on the supply system: surface water runoff will decrease or even stop completely and groundwater reservoirs get exhausted. From a hydrological analysis, one can conclude that drought periods will indeed take place in Central Cebu. However, it will also show that these drought periods are relatively short followed by seasonal rains. The temporary shortages involved can be dealt with good management (such as operating the proposed reservoirs), temporary over-exploitation of groundwater reservoirs and temporary measures (such as trucking water).

Climate change

Climate change might result in less rain and higher evaporation. The effect will be similar to the described drought calamities. Given the fact that the total withdrawal in 2030 will only be 30% of the total available water in the region, it was concluded that the risk involved was small. There is sufficient water and the time-scale involved in climate change (50 - 100 years) allows us to take the proper measures to deal with it, particularly the increasing surface and groundwater storage.

Calamities – toxic spills

A final risk is the possibility that toxic spills are occurring in the river and reservoir systems. These spills will make the water unusable for drinking water purposes. These spills might be a result of an accident or from a willing act to dispose of the waste at an illegal but cheap way. All necessary precautions should be taken to avoid such spills but it can not be ruled out that such circumstances will happen. It is beyond the scope of the Action Plan to describe in detail the mitigating actions that should be taken in case spills happen. In general it will be needed to flush the spill into the Ocean, at the same time closing the intake points to avoid the spreading of the toxic substances into the system.

A toxic spill in the groundwater system is serious and will make the resource locally unsuitable for drinking water use for a long period. However, such spill will be local and can be dealt with by rearranging the withdrawals from groundwater.

6.7 Communication and public awareness

6.7.1 Communication

A well structured, transparent, user-friendly information exchange system is very important. It will encourage regional and local cooperation and will contribute to the mutual understanding of problems to be solved. Such a system is also important in enhancing the involvement of stakeholders and acquiring public support for the implementation of the Action Plan. An information exchange system can help make the public understand the reasons for certain measures and can facilitate the acceptance of such well balanced and cost-effective measures.

The measures for enhancing cost recovery in particular may appear to be sensitive. On the short term these may have a substantial socio-economic impact on individual households and companies. Many measures will not lead to concrete benefits immediately, and therefore the public will not observe these benefits, contrary to the immediate additional financial burden. Such cost recovery measures should be introduced in a very careful way with ample dissemination of information among the relevant target groups. In many cases a more gradual introduction of such measures will facilitate its accommodation.

A key role in communication will be played by the proposed WRM Board with its coordinating task. This Board is of paramount importance for safeguarding a coherent implementation of the Action Plan and inform the public about it. Newsletters, public hearings and the like are good means for such communication.

Achieving an effective implementation of the Action Plan will require everybody's effort and professional abilities, coupled with some patience and a persistent willingness for cooperation and communication with other stakeholders, NGOs and civil society. If the Action Plan would lead to a more regional and local cooperation, this would already give a very positive side effect.

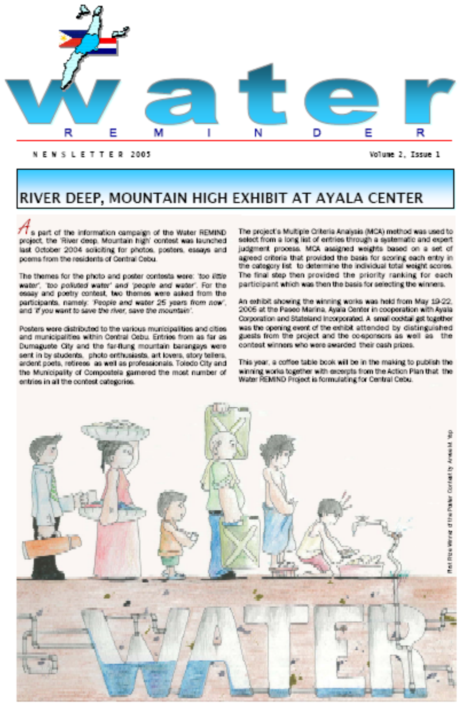
6.7.2 Public awareness and consultation

In the strategy ‘Water for all Cebuanos’, public awareness had been mentioned several times as a component of the activities needed to reach certain policy goals. A lot of investments and operational costs can be avoided if the water is used more efficiently and pollution is prevented. In the framework of the Implementation Plan a similar reason exists to inform the public and other institutions about the planned developments and to consult them on this matter. The success of many measures depends on the acceptance of these measures by the public and other institutions.

In developing the Action Plan various activities were initiated to increase public awareness and get the various interests involved in the process. The general public was informed about the process through the Water Reminder newsletter, website, and press releases. In addition, the contest 'River deep, Mountain high' was held which resulted in an exhibit at the Ayala Center in Cebu. These activities should be continued and should, preferably, be extended.

The same applied to the contacts with the Business Sector, particularly the organizations that have a strong interest in water. Effective means and methods for consultation with this sector included meetings, newsletters, magazines (of those organizations), conferences and many more.

The same applies for the non-profit sector, in particular the NGOs that cover issues on environment, education, health and gender equality. This cooperation could include making use of the communication channels of these organizations, jointly launching awareness campaigns and participating in conferences.



water REMINDER

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RIVER DEEP, MOUNTAIN HIGH EXHIBIT AT AYALA CENTER

As part of the information campaign of the Water REMIND project, the 'River deep, Mountain high' contest was launched last October 2004 soliciting for photos, posters, essays and poems from the residents of Central Cebu.

The themes for the photo and poster contests were: *'too little water'*, *'too polluted water'* and *'people and water'*. For the essay and poetry contest, two themes were asked from the participants, namely: *'People and water 25 years from now'*, and *'If you want to save the river, save the mountain'*.

Posters were distributed to the various municipalities and cities and municipalities within Central Cebu. Entries from as far as Dumaguete City and the far-flung mountain barangays were sent in by students, photo enthusiasts, art lovers, story tellers, ardent poets, retirees as well as professionals. Toledo City and the Municipality of Compostela garnered the most number of entries in all the contest categories.

The project's Multiple Criteria Analysis (MCA) method was used to select from a long list of entries through a systematic and expert judgment process. MCA assigned weights based on a set of agreed criteria that provided the basis for scoring each entry in the category list to determine the individual total weight scores. The final step then provided the priority ranking for each participant which was then the basis for selecting the winners.

An exhibit showing the winning works was held from May 19-22, 2005 at the Paseo Marina, Ayala Center in cooperation with Ayala Corporation and Stateland Incorporated. A small cocktail get together was the opening event of the exhibit attended by distinguished guests from the project and the co-sponsors as well as the contest winners who were awarded their cash prizes.

This year, a coffee table book will be in the making to publish the winning works together with excerpts from the Action Plan that the Water REMIND Project is formulating for Central Cebu.

ONCE, BEFORE

Lands aglow with trees so green,
Seas so deep, such wonders unseen,
Day by day, magic falls into place,
Putting a smile on each gloomy face.

Days go by, nights tinker on,
Where have all those happy days gone?
Spirit's hopes are fading fast,
Will this happiness never last?

Days so long and nights so sad,
All souls yearning to feel glad,
Bask in the sunshine once again,
Wade in the water, now and then.

No more time to go and see,
How the world once used to be,
Eyes so wide, and yet so blind,
Hands outstretched—and yet, unkind.

Twenty five years, it's no big deal,
Nothing will ever change how I feel,
Hopeless, hard-pressed, no way to go,
Distraught, repressed; doom will follow.

Wilting trees, no longer gay,
Slowly dying, like the sun's last ray,
Though sad as it might seem to be,
No one can save either you or me.

As murky waters rise above our knees,
Years of abuse lend no ear to our pleas,
Shattered hearts walk idly past,
All of them dreaming of a sweet repast.

Time's too late, all the hours gone by,
No use now to stop and ask why,
Twenty-five years sweep through the door,
As wishes erupt—that everything
were the way they were—once, before.

Photo and poster courtesy of 'River deep, Mountain high contest winners' Anastacio T. Laguna; Cleo-Ven B. Salutan; Alex R. Espaldon; John Anthony C. Navarro; Darby Vincent A. Alcoseba; Arvee M. Yap; Barcelisa R. Pepito; Ruth P. Cagang;

Other photos courtesy of: Clark D. Pelaez, Jr.;Allan L. Cuison and Water REMIND staff

Poetry courtesy of 'River deep, Mountain high' contest winner: Hazel Henrisha T. Chua