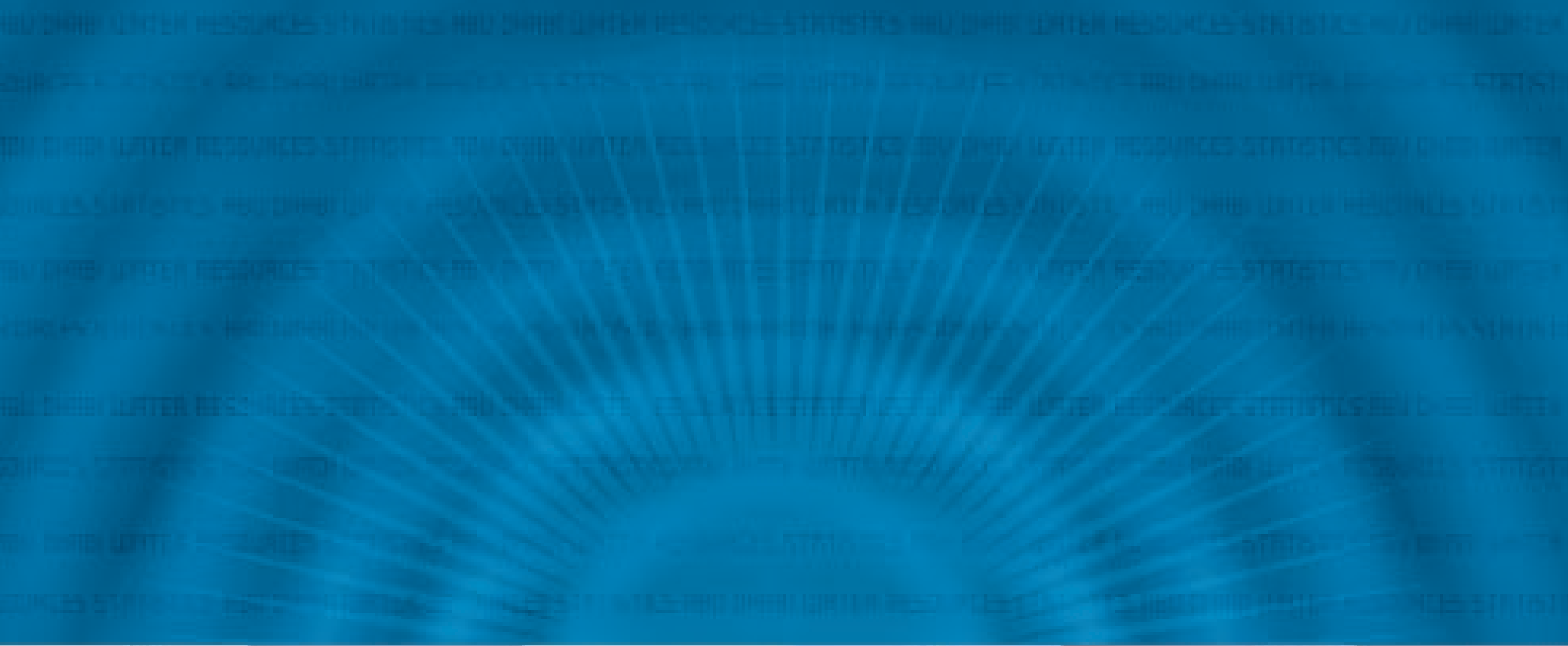


دراسة إحصائية

لمصادر المياه في إمارة أبوظبي ٢٠٠٦

ABU DHABI EMIRATE WATER RESOURCES

STATISTICS 2006



الإدارة العامة للبيئة  
Environment Agency  
Abu Dhabi  
الإدارة العامة للبيئة  
Abu Dhabi



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Abu Dhabi



**INTRODUCTION**

The vision of the Environment Agency – Abu Dhabi (EAD) is to work “towards a sustainable environment for a sustainable future”.

Our strategic goal in Water Resources Management is to develop and implement a plan to help “manage the overall water resources of the Emirate of Abu Dhabi in a sustainable, economically viable and environmentally sound way that will allow the long-term socio-economic development of the Emirate of Abu Dhabi”.

**KEY ISSUES**

The Emirate has an arid/hyper arid climate with less than 100mm/yr rainfall, a low groundwater recharge rate (c.4% of total annual water used) and no reliable, perennial surface water resources and yet, currently, one of the highest per capita water consumptions in the world. Overall water scarcity and ongoing depletion and potential for pollution (especially Nitrates from the extensive use of inorganic fertilizers) of the Emirate’s useable, natural (ground) water resources, which have arisen from rapid social /economic development in the last four decades has placed considerable stress on sectoral water use. Unplanned and uncontrolled groundwater withdrawals, especially in the agriculture and forestry sectors, now total over 2 billion cubic meters per year and have resulted in declining groundwater levels and quality in many areas. The water policy in the Emirate has been largely based on supply, rather than demand management, and now relies on large, expensive desalination plants to supply drinking water.

In the past, lack of regulation and control on the development of water resources has been largely responsible for the current poor water situation, and since no single authority had the mandate for water resources management, water resources development has been largely adhoc and unplanned, and duplication of efforts has led to wasted resources.



## THE FUTURE

Recent changes in assigned responsibility for the various aspects of water resources development and management in the Emirate has now created the opportunity for improved Integrated, Water Resources Management (IWRM) and the outlook is much brighter.

In 2005, the newly formed Environment Agency – Abu Dhabi (EAD) was assigned total responsibility for groundwater management and during 2005 and 2006, the new and enlarged water resources department have commenced projects which focus on the following activities, all of which are essential to effective IWRM:

- Protection, conservation and monitoring of water resources
- Continuous monitoring for the exploitable groundwater aquifers
- Planning, policy-making and regulation of water use
- Water well inventory and registration
- Water Well Drilling Permitting
- Management of data and information on water (establishment of a centralized water resources database)
- Coordinated groundwater exploration and assessment
- Capacity-building and institutional development within the water sector
- Local, regional and international cooperation and collaboration
- Management of strategic emergency water resources

As a major step towards controlling groundwater development, a water well drilling Law was established in March 2006 and the well permitting policy is managed by EAD. As an integral part of controlling groundwater development and well permitting, a system for registering the water well drilling contractors and consultants was established. In late 2005, EAD also established a groundwater monitoring network and in May, 2006, work commenced on the development of a comprehensive water resources database for the Emirate. In JANUAR 2007, an Emirate wide program of water well inventory and registration commenced.

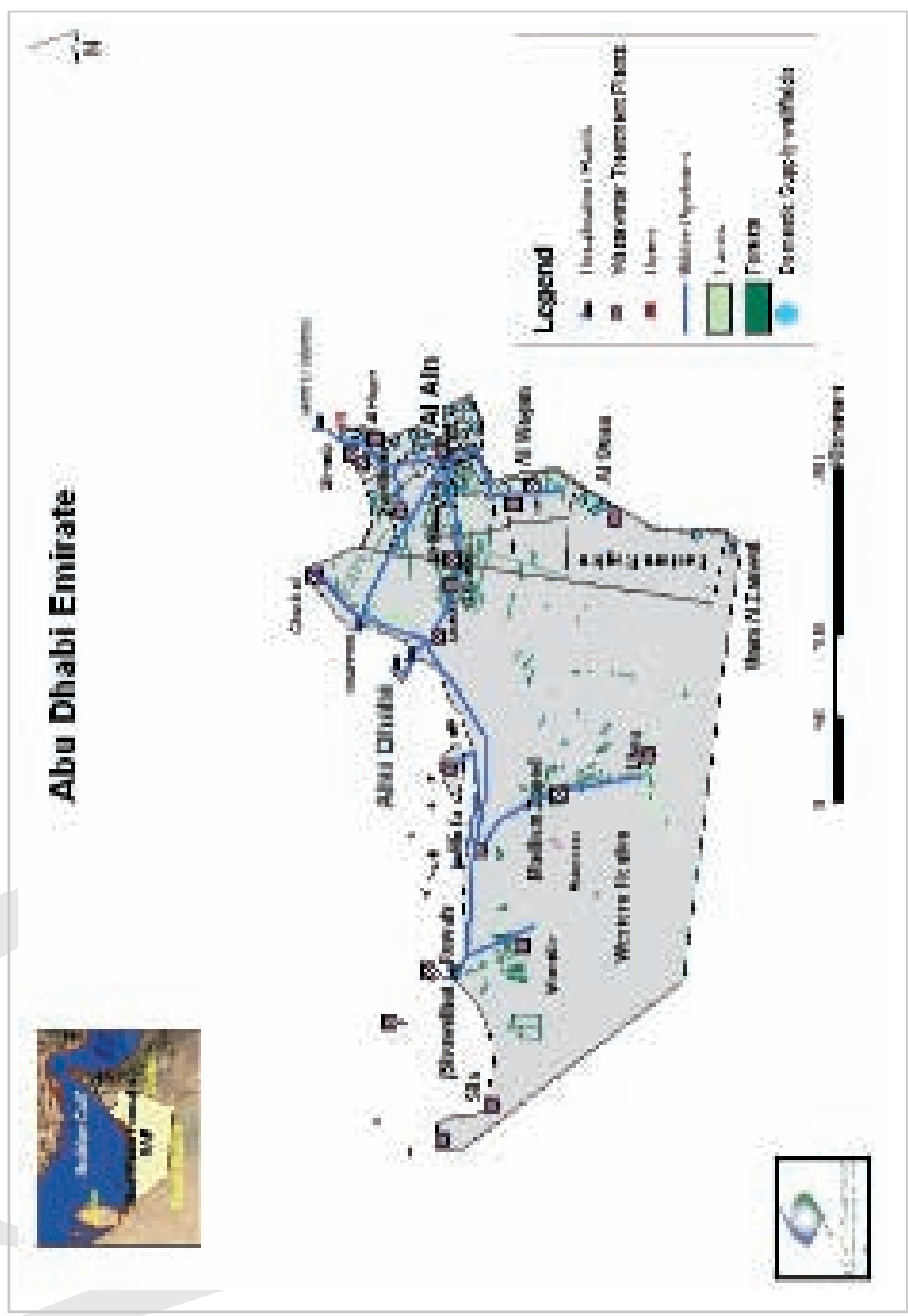
Other important actions to be considered as priority for improving the current water situation are:

- Replacing the use of inorganic fertilizers with organic farming
- Revision of the agriculture and forestry policy in the light of dwindling groundwater resources and increasing reliance on desalinated water.
- Re-structuring tariffs (price increases as consumption increases) in order to curb water waste and reduce per capita consumption
- Raising the public awareness on water conservation and efficient water use.
- Encouraging industrial water users in water recycling and reuse of treated wastewater in activities that don't require potable water.
- Special care should be given to monitoring, evaluating, modeling and sustainable development of groundwater resources, especially to stabilize the over-exploited aquifers.
- Implementing artificial recharge to enhance groundwater storage.

This Bulletin for the year 2006 is the fourth to be issued by EAD. The purpose of the publication is to disseminate important, basic information on water resources sources and users in the Emirate of Abu Dhabi. As such, it is intended to benefit a wide audience, ranging from the general public to scientific research organizations.

EAD wishes to thank all stakeholders involved in our water resources management project who contributed data and information necessary for the publication of this bulletin.

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**ABU DHABI EMIRATE GENERAL INFORMATION**

<b>Area</b>	67 340 km <sup>2</sup>
<b>Maximum Elevation Point</b>	1163 mamsl, Jebel Hafeet
<b>Population*</b>	
<b>Western Region - Abu Dhabi</b>	858650
<b>Eastern Region - Al Ain</b>	422340
<b>Islands</b>	11129
<b>Total Area</b>	1292119
<b>Annual Population Growth 2001-5*</b>	3.70%
<b>Annual Rainfall, 2005**</b>	
<b>Abu Dhabi City (Airport)</b>	20.4mm
<b>Al Ain City</b>	33.8mm
<b>Annual Temperatures** (min/max)</b>	
<b>Abu Dhabi City (Airport)</b>	10.6 / 47.4 °C
<b>Al Ain City</b>	8.8 / 48.8 °C

\* Statistical Yearbook 2003, Department of Planning, Abu Dhabi  
 \*\* Dept Civil Aviation, Abu Dhabi



Jebel Hafit, Al Ain.

## BACKGROUND

Water resources development within the Emirate can be traced back to the Stone Age, commencing 3000 BP, through the Iron Age, the Islamic period and pre-oil times to the present day.

Historically, sustainable use of water resources was achieved by developing groundwater obtained from shallow hand dug wells, the traditional falaj system and rainfall harvesting methods.

Over the last three decades, however, rapid economic development, coupled with sharp population increases and the development of a large agricultural sector, substantially supported by government subsidies, has led to large increases in water demands.

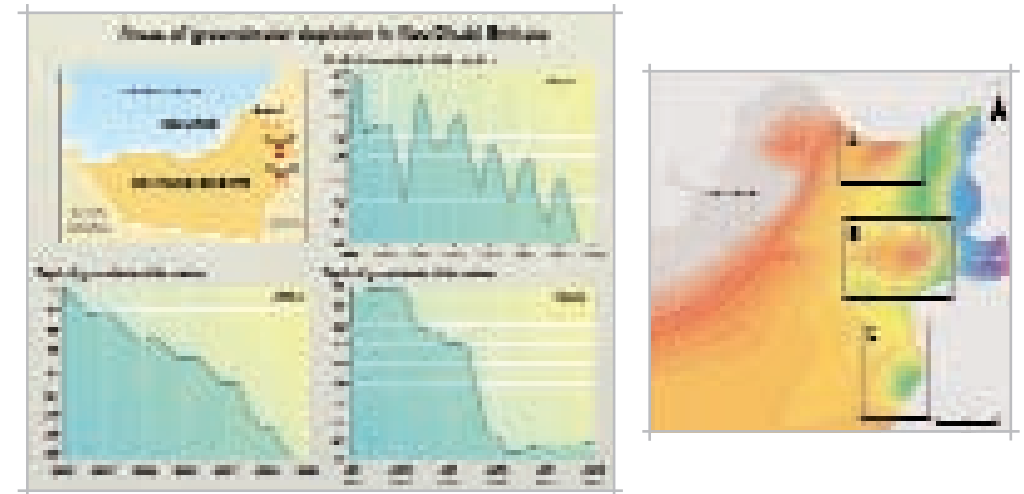


Early Islamic period well on Marawah Island

Al Aini Falaj, Al Ain



Eastern Region Farm



A reduction in the groundwater table has caused numerous shallow wells to go dry and the almost total cessation of natural groundwater flow within the aflaj systems. This has meant an increasing reliance on unconventional water resources, such as desalination and re-use of treated wastewater, and also the development of alternative conventional water supply measures, such as recharge structures and water transfers from other Emirates.

With water use now being twenty four times larger than the total annual renewable water resources of the Emirate, there is an urgent requirement to implement Integrated Water Resources Management in order to achieve Sustainable Development within the water sector.



Al Hayer Sewage Treatment Plant



Shwaib Wadi Diversion Channel

## WATER SOURCES

The water resources components found within the Emirate are as follows:

- Traditional or conventional: rainfall, springs, wadis, sabkhas, lakes, ponds and groundwater.
- Non-Traditional or unconventional: desalinated water and treated wastewater.

Groundwater occurs in the Emirate as either consolidated or unconsolidated surficial deposit aquifers or as bedrock / structural aquifers and contributes 71.2% to the total water demand, followed by desalinated water (24%) and treated wastewater (4.8%).

Groundwater supply is decreasing and the imbalance between supply and demand is being filled by ever increasing amounts of desalinated water.

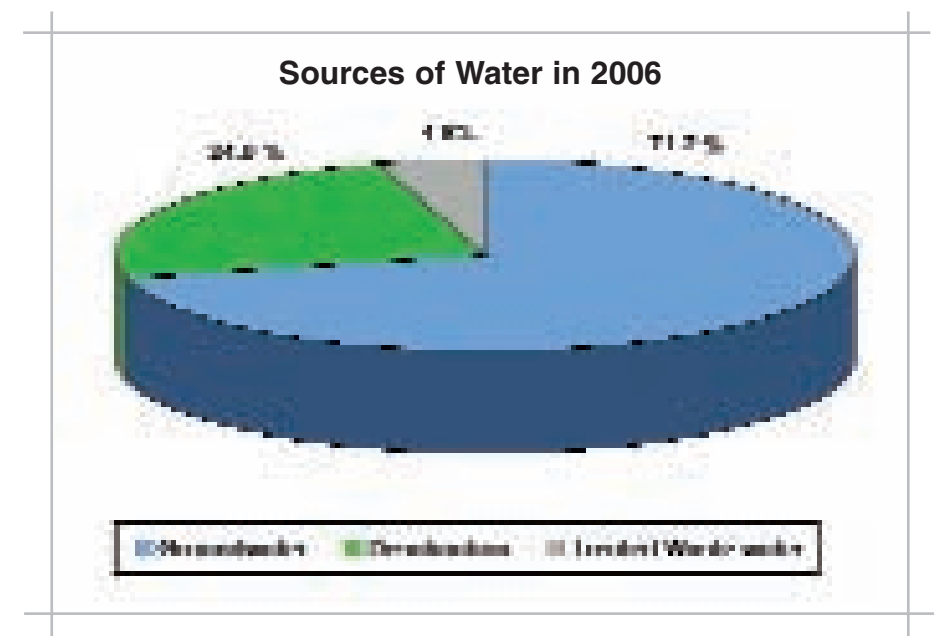


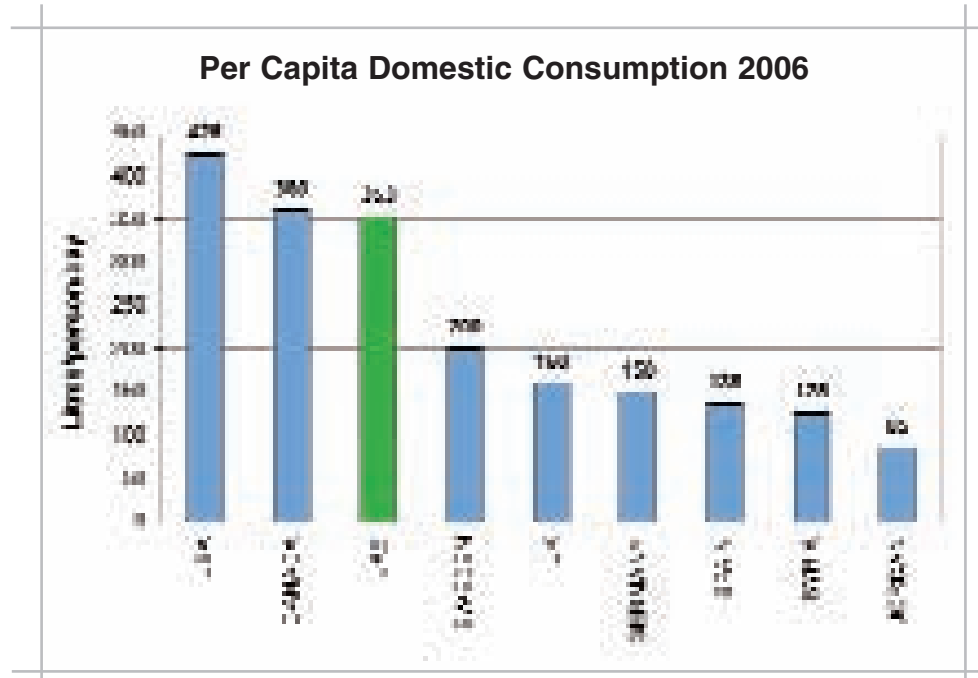
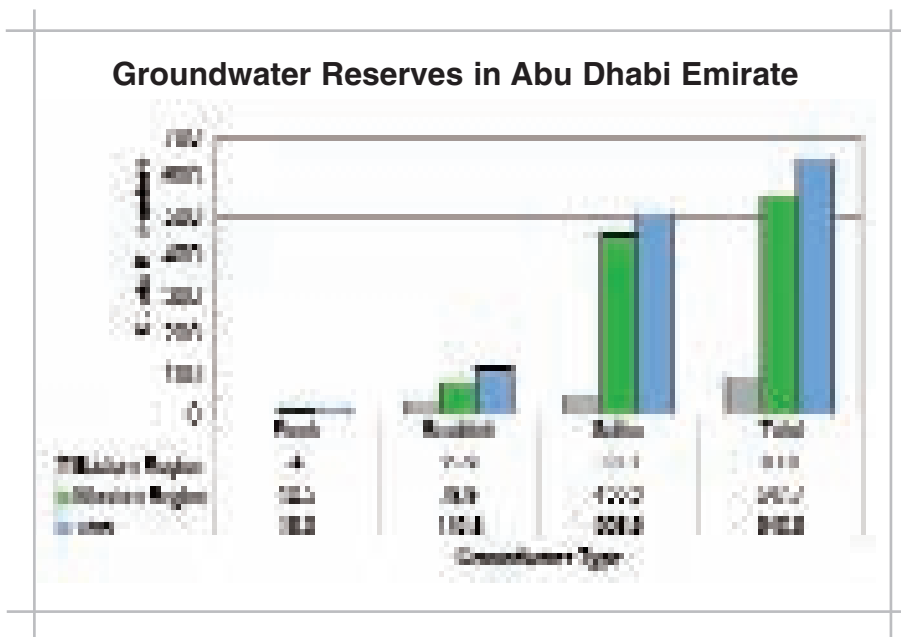
## Groundwater Use (Mm<sup>3</sup>)

	2003	2006	% Change
<b>Municipal</b>	25.78	12.26	-52
<b>Aflaj</b>	5	5	0
<b>Forestry</b>	607.3	362.38	-40
<b>Agriculture</b>	1949.36	1741.43	-11
<b>Amenity</b>	114.19	104.85	-8
<b>TOTAL</b>	2701.63	2225.92	-18

There has been an 18% overall reduction in groundwater supply since 2003.

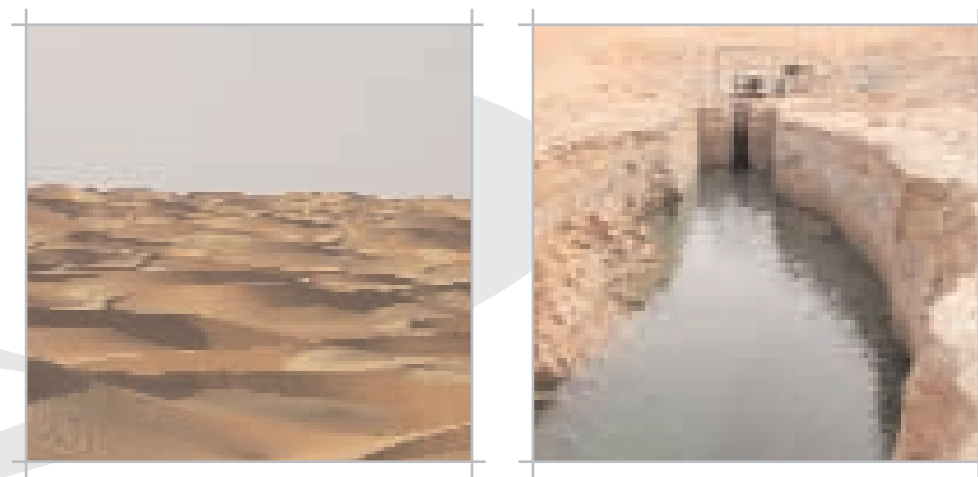
It is estimated that there is still 641 km<sup>3</sup> groundwater resources available, but less than 3% is fresh and, based on current abstraction rates, both fresh and brackish reserves will be depleted within 50 years.





Numerous wellfields abstract groundwater of various qualities and in some areas massive over-abstraction has resulted in alarming groundwater declines and a severe deterioration in groundwater quality. The water policy in the Emirate has been largely based on supply, rather than demand management, through the construction of numerous, expensive desalination plants and domestic wellfields. This policy has led to the current high levels of per capita water consumption in the Emirate (353 l/c/d), which is more than double that of developed, European countries which have much greater water resources availability.

Aflaj, the centuries old, traditional irrigation canal networks irrigate 350 hectares of Oasis plantations in the City of Al Ain, but of the eight still in operation, only two have natural flow and all aflaj are supported by varying mixtures of pumped groundwater from wells, imported desalinated water from Qidfa desalination plant, Al Fujairah and, more recently, from treated sewage effluent. Combined, it is estimated that they consume about 10 Mm<sup>3</sup>/yr of water.



The Emirate has continued with its development of excellent waste – water treatment facilities. There are now 28 sewage treatment plants (STP), split equally between the Western and Eastern regions. Combined, they produce about 150 Mm<sup>3</sup>/yr (4.8% of total water demands). The Al Ain Al Zakher and Abu Dhabi Mafraq plants produce 95% of all treated effluent, which is mostly used for irrigation of parks, gardens and other recreation amenity areas. The other STPs are quite small, but because of remote urban expansion, some are now over-loaded and are presently being prepared for upgrading.

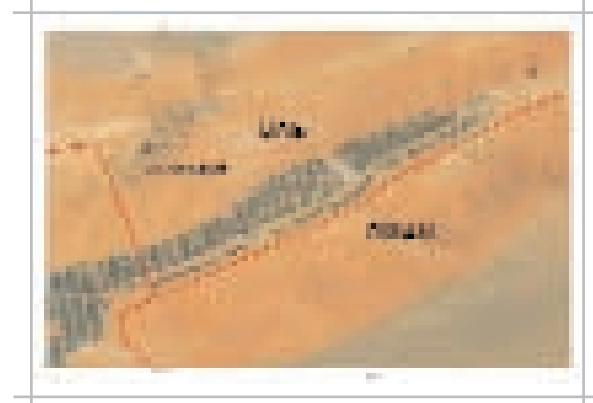
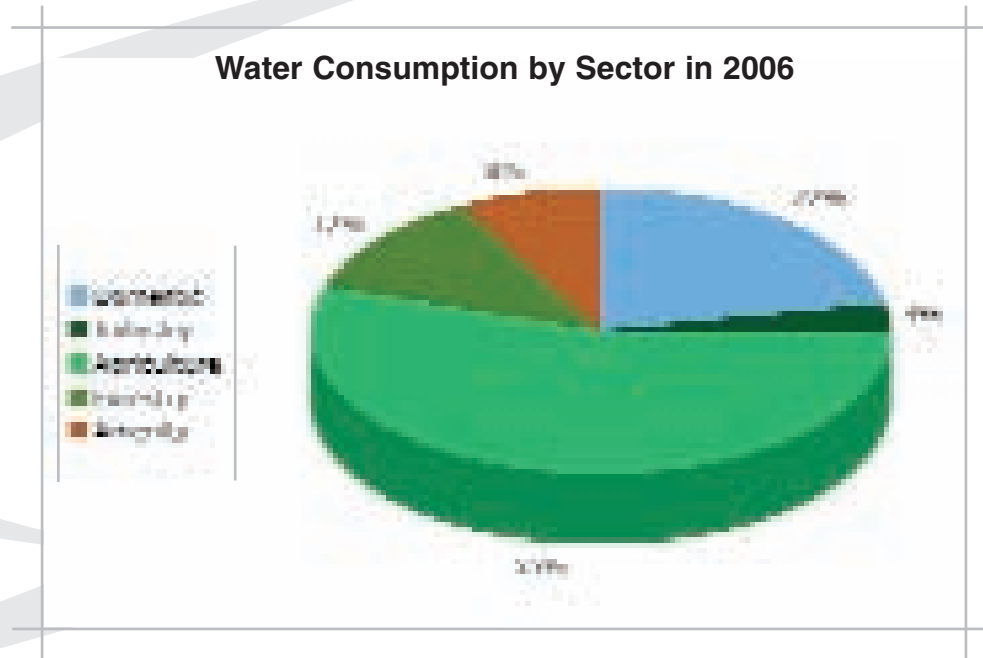
In 2005, the management of all STPs became the responsibility of the newly formed Abu Dhabi Sewage Services Company (ADSSC), under the regulatory control of the Abu Dhabi Regulation and Supervision Bureau, which is also responsible for regulating the potable water and electricity sectors.

## WATER USE

Irrigation in the agriculture, forestry and amenity plantation sectors accounts for a massive 76% of the total Emirate water use, the remainder is taken up with domestic and industrial consumption, both of which is supplied in bulk by the Abu Dhabi Water and Electricity Authority (ADWEA).

## WATER CONSUMPTION BY SECTOR IN 2006

	EAST	%	WEST	%		%TOTAL	% Change - 2003/2006
	(Mm <sup>3</sup> )		(Mm <sup>3</sup> )		(Mm <sup>3</sup> )		
Domestic	111.53	3.57	607.06	19.44	718.59	23.01	7.57
Industry	9.48	0.30	58.26	1.87	67.74	2.17	0.45
Agriculture	979.80	31.37	761.59	24.38	1741.39	55.75	-1.89
Forestry	124.98	4.00	237.40	7.60	362.39	11.60	-6.36
Amenity	107.16	3.43	126.04	4.04	233.20	7.47	0.22
TOTAL	1332.95	42.68	1790.35	57.32	3123.30	100.00	
					3123.30		



Citizen's farms in the Al Dahira area Eastern Region

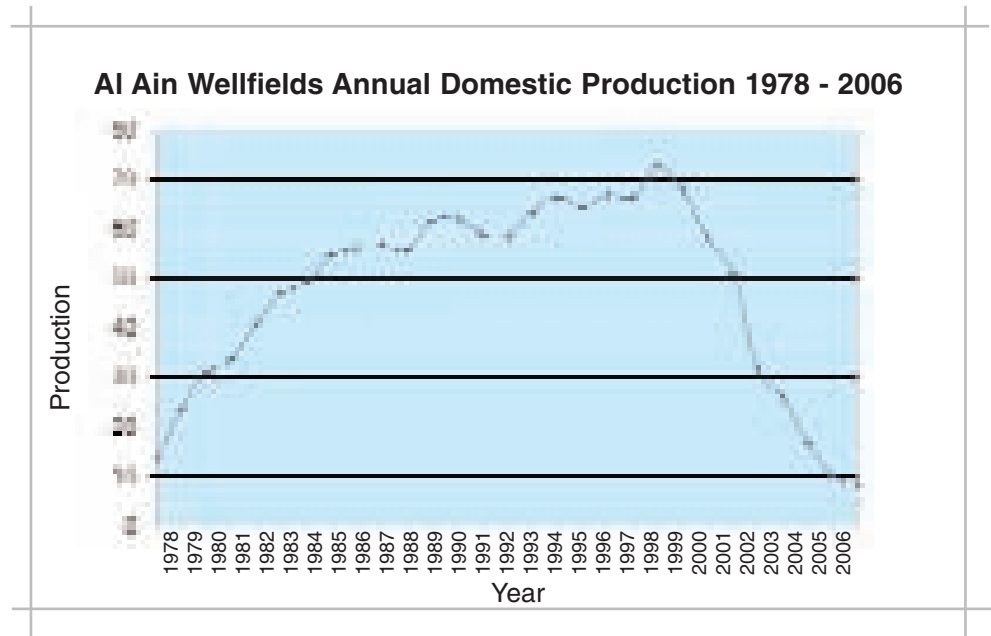
Total water used in 2005 is 8% less than that used in 2003; this is brought about by a corresponding 18% reduction in groundwater used due to aquifer depletion under a general regime of unsustainable development.

## DOMESTIC SECTOR

Domestic wellfields in the western region have now closed due to water quality concerns, leaving only 10 producing wellfields in the eastern region which only contribute 1.5% of the total domestic demand. The last seven years have witnessed an 86% reduction in annual production due to declining yields and increases in groundwater salinity.



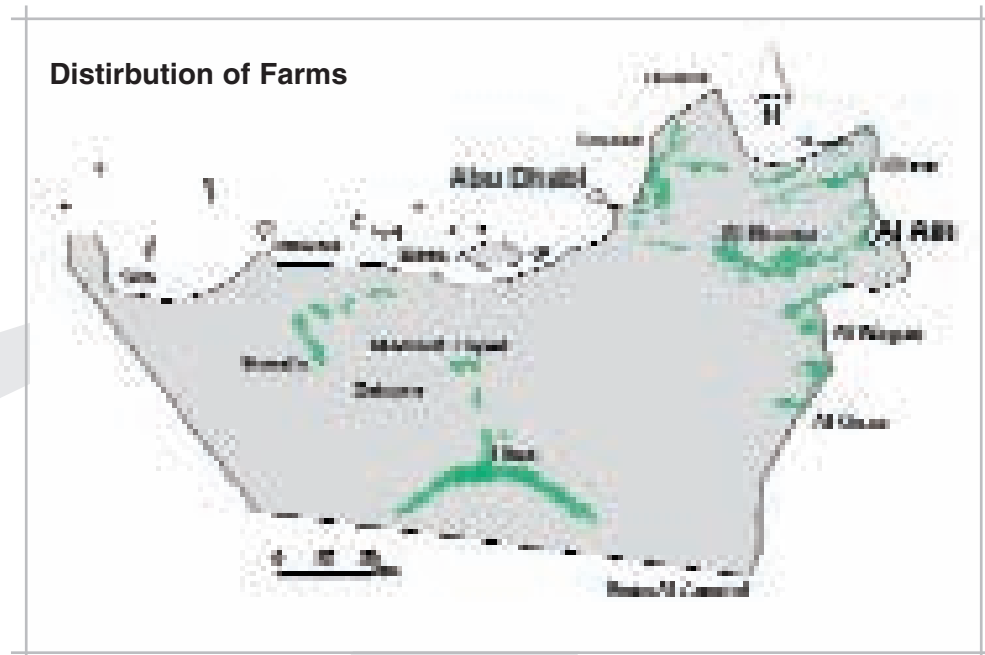
Forestry in the Eastern region



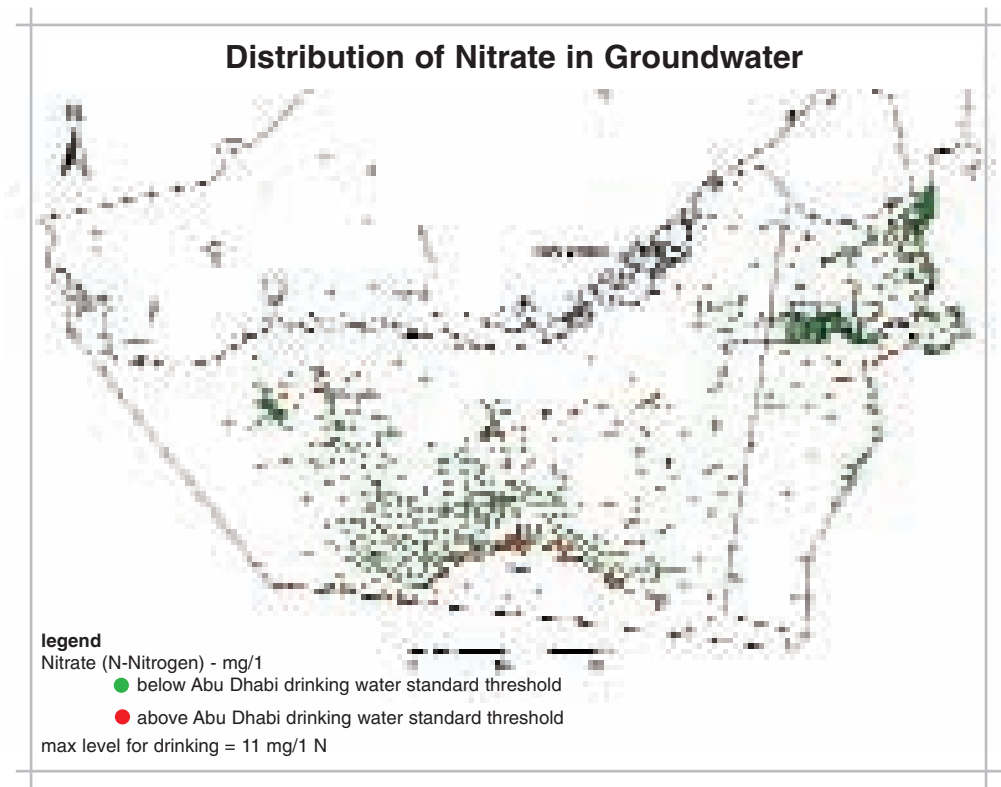
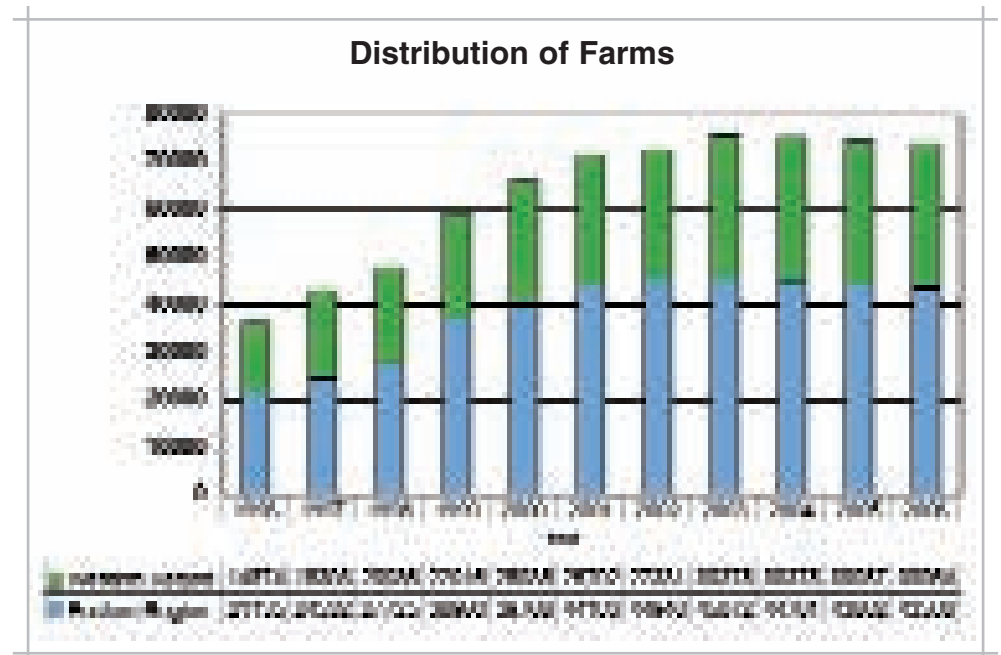
Total domestic demands have increased by 6.3% since 2003. (an increase of 155 Mm<sup>3</sup>/yr). 98.5% of all requirements are met from desalinated water (742 Mm<sup>3</sup>/yr), the remainder from dwindling municipal wellfield supply. 10% of Al Ain's drinking water supply, however, is still supplied from wellfields.

### AGRICULTURE SECTOR

Around 25,000 citizen's farms consume 1741Mm<sup>3</sup>/yr (56% of total demands) of mostly brackish groundwater and many wells are currently going dry. Compared with 2003, there has been a 10% reduction in groundwater availability as wellfields become increasingly stressed and wells fail. The total area of farming has reduced by 1.6% compared to 2004, the largest reduction taking place in the Eastern region. The number and area of government farms has continued to decrease. In the Nahel farms area, desalinated water from Qidfa, Fujairah, is blended with ground-water to produce a higher quality irrigation water.



Misuse and over-use of fertilizer application has also caused significant, widespread Nitrate pollution in groundwater, although there appears to be no evidence of pesticide residues from a recently completed Emirate groundwater sampling project.

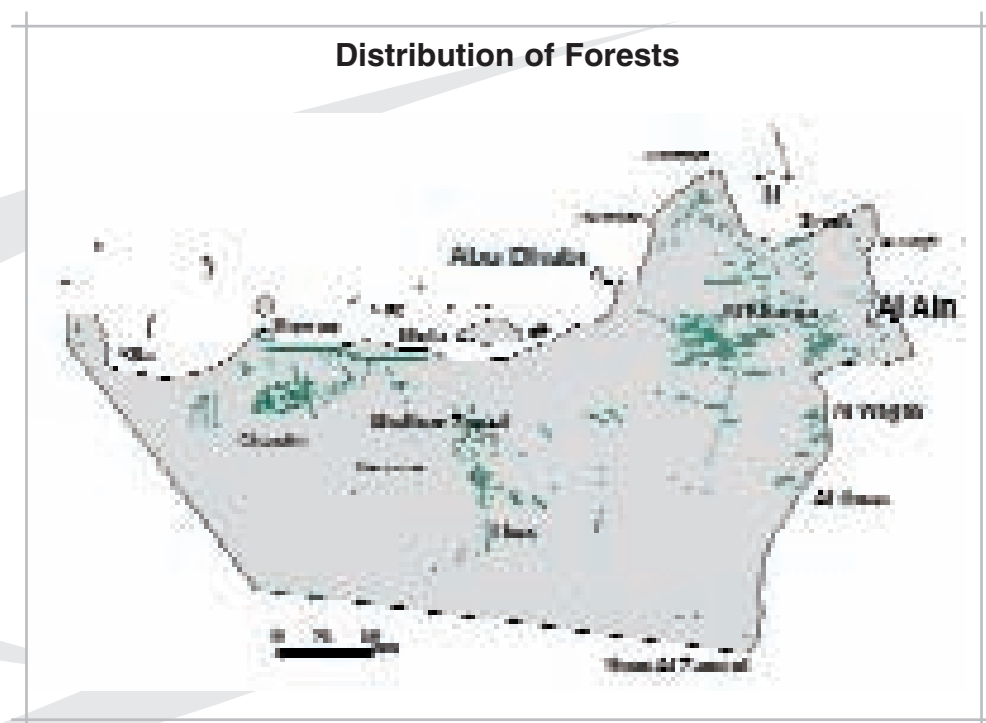


## FORESTRY SECTOR

The 259 forests use 362 million cubic meters per year of groundwater for a total area of 181169 ha. The largely brackish and sometimes saline quality groundwater causes many operational problems. There has been a 40% reduction in water use since 2003, due mostly to the down-scaling of the Uo El Dabsa plantation in the western region; conversely, there has been a 1.5% increase in the forestry water demand in the eastern region.

## AMENITY SECTOR

There has been a general expansion in the overall area of parks, gardens and recreation areas e.g. golf courses, sports fields etc. in line with an increasing urban population. There are now a total of 78 parks and gardens and numerous other recreation areas and road side plantations which also fall in this category of water use. The amenity sector uses a total of 254 Mm<sup>3</sup> /yr of water, 60% of which is estimated to be treated sewage effluent, the remainder is groundwater.



## Water Production

Municipal Wellfields			
Eastern Region <sup>1</sup>	Well Field	No. Producing wells	Production, Mm <sup>3</sup> /yr
(potable supply and blended with desalination water)	SHUWAIB NORTH	47	2.12
	SHUWAIB SOUTH	4	0.02
	AL KHADAR	3	0.07
	AL HAIYER	5	0.15
	AL KARAA	58	2.89
	BIDA BINT SAUD	39	0.95
	GHASHABA	*	0.00
	AL ZAROUB	*	0.00
	KASHONA	29	3.60
	AL HAIYER N. VILLAGE	4	0.21
	UM GHAFI	19	0.17
	AL ASHOOSH	*	0.00
	JABAL OHA	3	0.10
	AL SAA	*	0.00
	SABABA	*	0.00
	AL WAGAN	*	0.00
	AL QUAA	*	0.00
	AL ASLAB	*	0.00
	SEIH AL RAHEEL	*	0.00
		<b>Total</b>	<b>211</b>
<b>Western Region</b>	Busaddain, Liwa	17 out of 20 in operation	1.98
<b>Wellfields(non-potable)</b>	<b>Total</b>	<b>241</b>	<b>1.98</b>
<b>Total Water Production from Municipal Wells:</b>			<b>12.26</b>
Aflaj Systems (only present in Eastern Region) <sup>3</sup>			
	Aflaj Name	Number of Aflaj	
Partially supported by wells	Al Daoudi Falaj Al Aini Falaj (Al Ain City)	2	
Supported by variety of sources - groundwater wells, piped desalinated water and treated effluent	Al Mutared Falaj Al Mouajji Falaj Al Jimi Falaj Al Qattara Falaj Al Hili Falaj Maziad Falaj	6	
Not operating	Al Jahili Falaj Saa Falaj Al Mazimi Falaj Al Raki Falaj	4	
	<b>Total</b>	<b>12</b>	
		(estimated)	<b>10</b>
Forestry Wellfields			
Eastern Region			124.98
Western Region			237.40
Agriculture (wells & aflaj)			
Eastern Region			979.81
Western Region			761.62
Other Wellfield Production e.g amenity, recreation etc			
Eastern Region	} Calculated from balance of treated effluent production		86.18
Western Region			18.67

## Water Production ... continued.

Desalination Production				
Eastern Region <sup>1</sup>	Desalination Plant	Number of Plants		Production, Mm <sup>3</sup> /yr
Note all plants in Eastern region closed on 1/3/03	In Al Wagan	11 units (de-commissioned)		0
	In Al Quaa	12 units (de-commissioned)		0
	In Um Al Zamool	3		0.32
	<b>Total</b>	<b>3</b>		<b>0.32</b>
Central and Western Region <sup>4</sup> :	Desalination Plant	Company	Process Type	Production, Mm <sup>3</sup> /yr
	Abu Dhabi steam turbines	Bainounah Power Company	MSF	16.32
	Umm Al Nar Power Plant	Arabian Power Company	MSF, MED	200.65
	Taweelah B	Al Taweelah Asia Power company	MSF	119.91
	Shuwaihat Power Plant	Shuwaihat CMS International Power Company	MSF	102.22
	Mirfa Power Plant	Al Mirfa Power Company	ADWDA GDs	19.40
	Taweelah A1	Gulf Total Tractabl Power Company	MSF, MED	99.28
	Taweelah A2	Emirates CMS Power Company	MSF	79.10
Inter-Emirate Water Transfer	Qidfa Fujairah	Union Water & Electricity Company	Only production sold to Abu Dhabi Emirate shown	105.20
<b>Exports to Al Ain</b>				100.93
Total desalinated water production				742.41
Treated Wastewater Production				
Eastern Region <sup>5</sup>	Sewage Treatment Plant			Production, Mm <sup>3</sup> /yr
	Al Ain STP-M4 (Al ZAKHER)			28.76
	Al Khazna WWTP			0.27
	Al Hayer WWTP			0.438
	Sweihan WWTP			0.248
	Shuwaib			0.310
	Seih Gharaba (Package Treatment Plant)			0.020
	Wadi Flaie WWTP			0.226
	Al Quo'a WWTP			0.383
	Al Wagan WWTP			0.365
	Al Faqah WWTP			0.090
	Al Dhahira WWTP			0.098
	Seih Geherba WWTP			0.014
	Remah WWTP			0.146
	Bu karriyyah WWTP			0.091
	Al Araad			0.020
	Al Sa'a			Under Construction
	<b>Total</b>			<b>31.519</b>

## Water Production ... continued.

Treated Wastewater Production				
Central and Eastern Region <sup>5</sup>	Sewage Treatment Plant			Production, Mm <sup>3</sup> /yr
	Mafrq			113.51
	Madinat Zayed			1.793
	Bainoona			0.239
	Sweihan WWTP			0.248
	Mirfa			1.079
	Canning Factory Mirfa			0.083
	Ghayathi Ww T Plant			0.462
	Delma Island			0.324
	Al Khatim			0.116
	Ghantoot			0.171
	Sir Bani Yas Island			0.082
	Abu Al Abyad Island			0.082
	Liwa			Under Construction
	Bayya-Sila			0.372
	Ghuwaifat			0.060
	<b>Total</b>			<b>118.373</b>
<b>Total Treated Waste Water Production</b>				<b>149.89</b>
<b>Total Water Production</b>				<b>3123.22</b>

- 1 Al Ain Distribution Company
- 2 Abu Dhabi Distribution Company
- 3 Al Ain Municipality, Falaj Section
- 4 ADWEC,
- 5 Abu Dhabi Sewage Services Company

MSF=Multi Stage Flash  
 MED=Multi Effect Distillation  
 RO=Reverse Osmosis

## Water Consumption

Domestic Consumption <sup>1</sup>		
Eastern Region	Water type	Consumption, Mm <sup>3</sup> /yr
	Municipal from Wells	10.28
	Municipal Desalinated (from local plants <sup>5</sup> )	0.32
	Municipal Desalinated (from Taweelah, Umm Al Nar and Qidfa Imports)	100.93
Western Region	Municipal from Wells	None, no potable wellfields
	Municipal Desalinated	607.6
<b>Total Domestic Consumption<sup>1</sup> (-incl 10% for Industry)</b>		<b>718.59</b>

Water Consumption ... continued.

Agricultural Consumption		
Eastern Region <sup>2</sup>	Water Use	Consumption, Mm <sup>3</sup> /yr
Citizens Farms irrigated by 45640 wells (64% producing)	11529 farms occupying 43,882 ha	890.81
Government Entities	9 State Fodder Farms - 3,897 ha	79
Traditional Date Gardens (Oases) - 350 ha	7 separate Al Ain Date plantations Oases	10
<b>Western Region:</b>		
Citizens Farms	13285 farms occupying 30087 ha	609.79
Government Entities - 1790 wells, pumping 12 hrs/day in 23 wellfields	Farms and Forestry	151.80
<b>Total Agricultural Consumption</b>		<b>1741.39</b>
Forestry Consumption		
Eastern Region <sup>2</sup>	Water Use	Consumption, Mm <sup>3</sup> /yr
84 No. Plantations established since 1970- 62470 hectares, irrigated by over 2800 groundwater wells	Forestry plantations covering 62470ha	124.98
<b>Western Region<sup>2</sup></b>		
175 No. Plantations established since 1969 - 118699 hectares, 3709 groundwater wells	Forestry plantations covering 1189699 ha	237.40
<b>Total Forestry Consumption</b>		<b>362.38</b>
Amenity and Recreation Consumption <sup>2</sup>		
Eastern Region	Parks, Gardens, Road-side plantations, Golf courses etc.	107.16
Western Region		126.04
<b>Total Amenity Consumption</b>		<b>233.2</b>
Industrial and Commercial Consumption <sup>4</sup>		
		<b>Consumption, Mm<sup>3</sup>/yr</b>
Eastern Region	Cooling, Processing etc.	9.48
Western Region		58.262
<b>Total Industrial &amp; Commercial (incl. in ADWEC bulk consumption)</b>		<b>67.742</b>
TOTAL EMIRATE CONSUMPTION 2003		
Eastern Region		<b>1332.95</b>
Central & Western Region:		<b>1790.35</b>
<b>ABU DHABI EMIRATE TOTAL ALL WATER SECTORS</b>		<b>3123.30</b>

<sup>1</sup>ADWEC. Operating results, 2005

<sup>2</sup>From Municipalities and Agriculture and Mott Macdonald

<sup>3</sup>Abu Dhabi Municipality Agriculture Dept

<sup>4</sup>Estimates based on 10% of domestic demand, this sector included in Domestic for total

## INDUSTRY / COMMERCE SECTOR

This sector is currently estimated to use only 2.4 % of the total water consumed in the Emirate, but the proportion will increase as expansion in the industrial sector is brought about by the development of a number of new industrial estates in Abu Dhabi, Al Ain, Ruwais and elsewhere. This sector uses the smallest amount of water of all sectors: estimated to be 75 Mm<sup>3</sup>/yr. The water source is largely desalinated sea water, although a few industries have private groundwater supplies.

## CONCLUSION IN BRIF

Generally, operational difficulties, due to poor groundwater quality and resources depletion, are commonplace in the municipal, agriculture and forestry sectors and in the latter two, sound water resources management practices have not generally been followed.

In the past, lack of regulation and control on the development of water resources has been largely responsible for the current poor water situation, and since no single authority had the mandate for water resources management, water resources development has been largely adhoc and unplanned, and duplication of efforts has lead to wasted resources. Recent changes in assigned responsibility for the various aspects of water resources development and management in the Emirate has now created the opportunity for improved Integrated, Water Resources Management and the outlook is much brighter.

