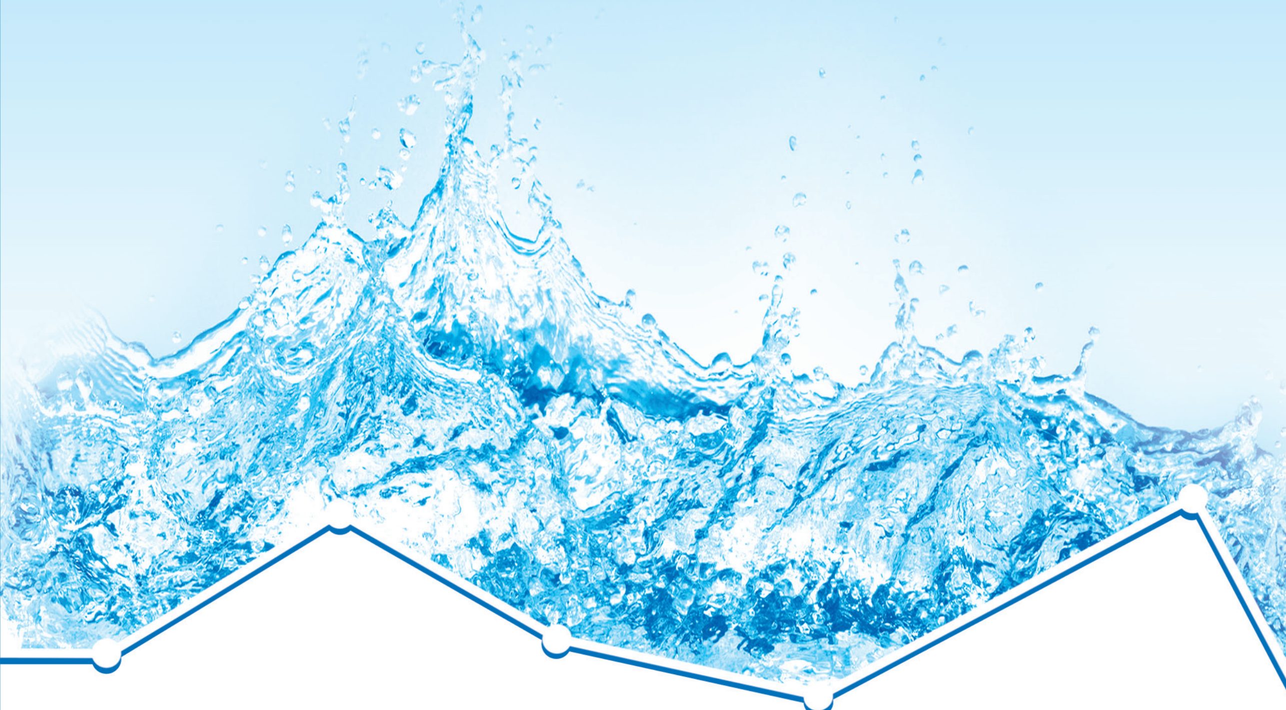
وزارة التخطيط التنموي والإحصاء

Ministry of Development Planning and Statistics

Water Statistics

In the state of Qatar 2013



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Foreword

Water is life!

Therefore, the protection of our national natural freshwater resources is part of our National Development Strategy.

Qatar's main source of water is desalination of seawater for drinking water supply and groundwater abstraction for agricultural purposes. The re-use of treated wastewater has already become an important alternative source of water for irrigation in agriculture and green spaces.

Important successes of Qatari water policies are the supply of safe drinking water to all of its residents, reduction of water losses to a minimum, the treatment urban wastewater to a high degree and also to re-use great proportions of the treated wastewater. Statistics also show that in most economic sectors water use efficiency has increased.

However, our fresh groundwater reserves are still being overexploited which leads to lower groundwater levels and increased salinity. This makes it difficult to use the groundwater for irrigation and drinking water supply in the future.

According to the available statistics there is still potential to increase the re-use of treated wastewater, to become more water efficient in private households and economic activities and also to further reduce water losses.

All these measures together will contribute to water security and food security and to sustainable development according to the Qatar National Vision 2030.

This first water statistics report gives a comprehensive overview on water sources and water uses in the State of Qatar. Publishing this report is an important step to support knowledge based decision making in the water sector.

Dr. Saleh Al-Nabit

Minister of Development Planning and Statistics

Table Contents

1.General information

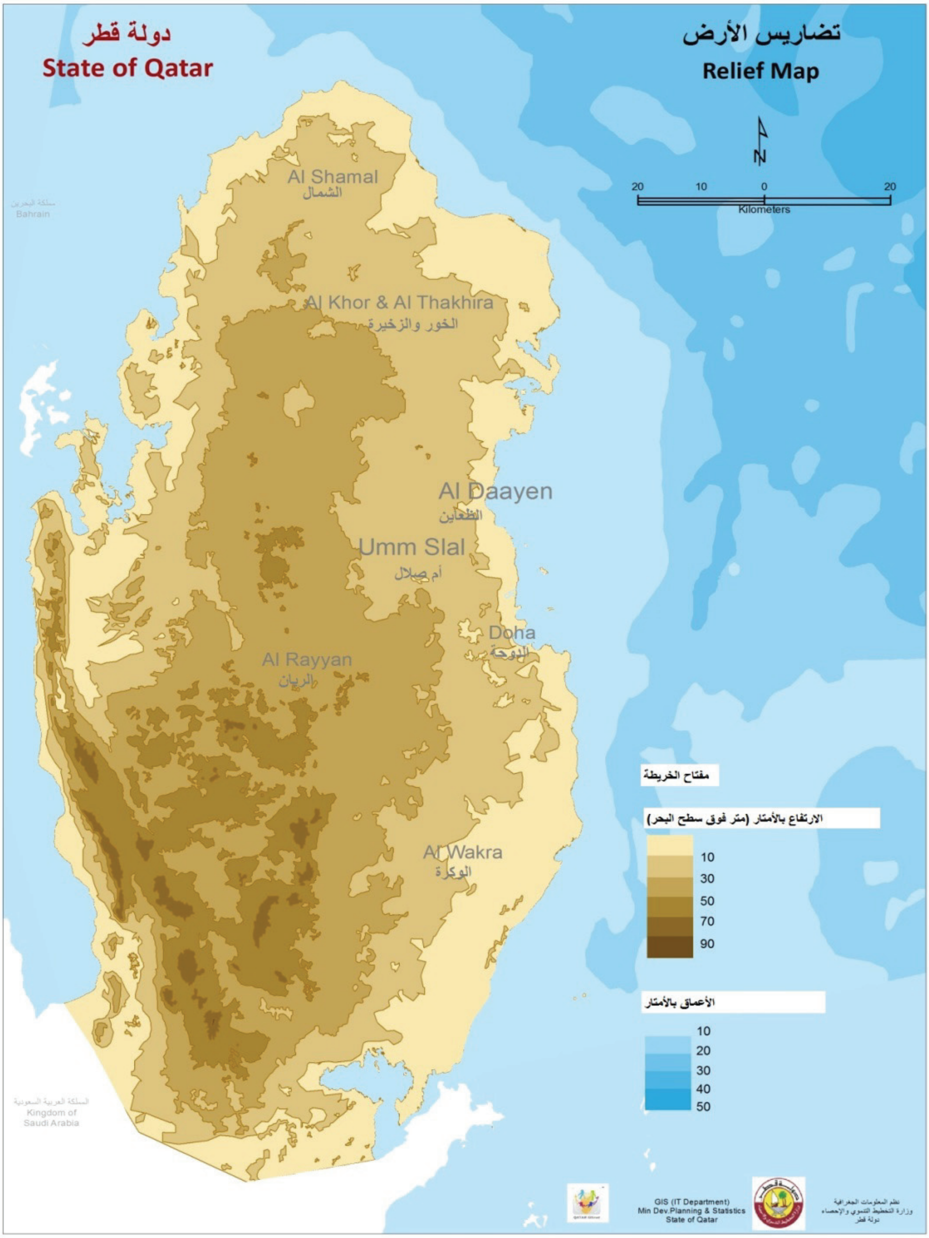
Qatar is situated midway along the western coast of the Arabian gulf between latitudes 24.27˚-26.10˚ North and longitudes 50.45˚ – 51.40˚ East. Its surface area is 11,651 km^2, which includes several small islands in the Arabian Gulf such as Halul, Shira'who, Al-Ashat and Al-Bishiria.

The peninsula is approximately 185 km in length and 85 km in width. The waters of the Arabian Gulf surround by far the majority of the country, while the only land border of about 60 km separates the country from the Kingdom of Saudi Arabia. The United Arab Emirates lie to the east and Bahrain to the northwest of the country.

Qatar generally consists of flat rocky surfaces. It does, however, include some hills which reach and altitude of 100 m above sea level. The majority of the country is sandy desert covered with scrub plants and loose gravel. Moving sand dunes, with an average height of about 40 meters, are found in the southern part of the country, and in the northeastern coast near Ras Laffan.

The northern part of Qatar is relatively low and rises gradually to the west and southwest. See also Map1-1.

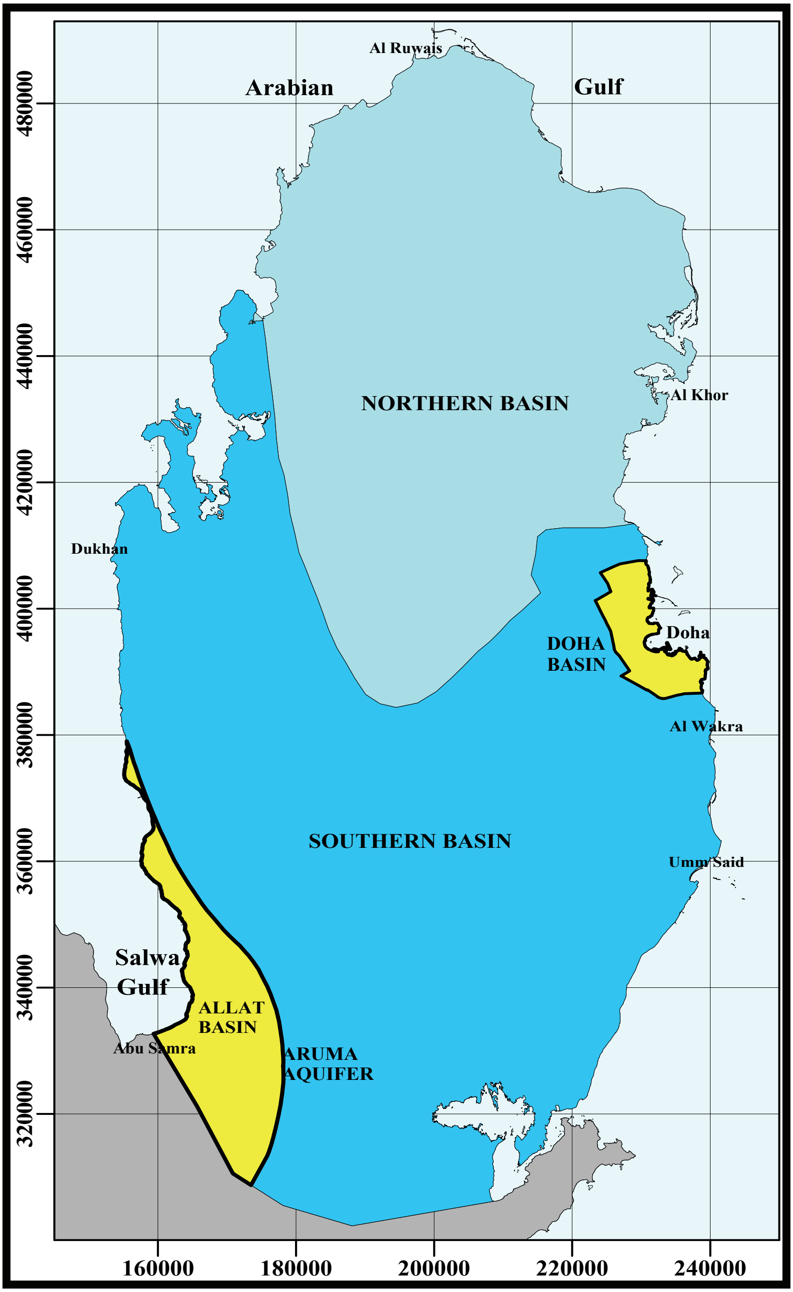
Map 1-1: Relief map of Qatar



Source: MDPS (2014)

Qatar's main groundwater basins are the Norther Basin, Southern Basin, Doha Basin and the Allat Basin. See Map 1-2.

Map 1-2: Qatar's Groundwater Basins



Source: MoE

2. Water resources

2.1 Rationale

Qatar's only natural freshwater resources are precipitation and groundwater. The conservation of the quality and quantity of the country's groundwater resources are one of the targets of the QNDS 2011-2016.

The natural long term water balance (1990 – 2012) of Qatar's groundwater aquifers is as shown in the Table 2-1. According to this the theoretical maximum exploitable groundwater volume is 47.5 million m^3 per year. However the current groundwater abstractions are about 250 million m^3 per year, thus causing a depletion of the aquifers with lowering of groundwater levels and increasing of salinity.

Table 2-1: Natural water balance of Qatar's aquifers (average annual values for period 1990-2012)

No.	Balance item	million m^3/year	Data source
1	Recharge of aquifers from precipitation	63.3	MoE (LTAA 1990-2011)
2	Inflow from Saudi Arabia	2.2	DAWR (2006) (LTAA)
3	Total renewable water resources	65.5	Calculation (1+2)*
4	Outflow from aquifers to sea and deep saline aquifers	18.0	MoE (LTAA 1990-2011)
5	Average annual water balance*	47.5	Calculation (3-4)

* According to FAO Aquastat, OECD, UNSD and Eurostat

** Without the returns from irrigation

Data source: MoE

There are also several projects ongoing to artificially increase the water recharge into aquifers (e.g. via recharge wells) and the artificial injection of TSE and desalinated water. In the total water balance, also the returns of irrigation water play an important role.

2.2 Key messages

a) Rainfall is most likely in the months of November - May.

b) In the years 2008 – 2013 the total precipitation (monitored at Doha International Airport) was lower than the long-term average rainfall (1962-1992). In the year 2013 the total rainfall was 55% of the long-term average.

c) Water abstraction from fresh groundwater is mainly for agricultural purposes (about 230 million m^3 per year in recent years, corresponding to about 92% of total groundwater abstractions).

d) The annual water deficit (mainly caused by groundwater abstraction) varied from 103 million m^3/year and 164 million m^3/year in the years 2008 – 2012.

e) Artificial recharge of groundwater aquifers by TSE injection, recharge wells and recharge from irrigation have become the dominating source for the national groundwater stocks (59% of the annual additions to the groundwater stocks. 39% are recharge from rainfall and about 1% inflow from Saudi Arabia.

2.3 Statistics and Indicators

2.3.1 Rainfall

Compared to the long-term average (1962-1992) 2013 was a relative dry year with a total precipitation of 41.6 mm at Doha International Airport. This is only 55% of the long-term average rainfall.

In 2013 the highest annual rainfall was measured in Al Ruwais (98.3 mm) and the lowest in Umm Said (36.6 mm).

No rainfall was observed throughout Qatar from June – August 2013. See Table 2-2.

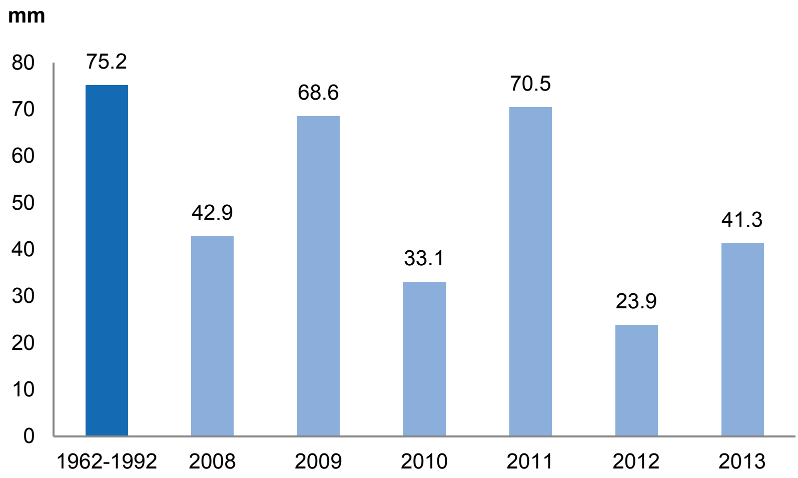
Table 2-2: Rainfall (mm) at selected monitoring stations in Qatar in 2013 and the long-term averages (1962-1992) for Doha International Airport

Station (rainfall in mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Doha International Airport (1962-1992)	13.2	17.1	16.1	8.7	3.6	0	0	0	0	1.1	3.3	12.1	75.2
Doha International Airport (2013)	0	0	0.9	2.2	14.4	0	0	0	0	0	24.1	0	41.6
Al Karanaaha (2013)	0	0	2.4	19.6	7	0	0	0	1	0	26.3	0	56.3
Dukhan (2013)	1.2	0.4	9.1	5	6.8	0	0	0	0	0	32.2	0	54.7
Al Ruwais (2013)	3.4	2.4	6.2	6.6	7.6	0	0	0	0	0	72.1	0	98.3
Umm Said (2013)	0	1.2	2.6	5.6	0	0	0	0	0	0	27.2	0	36.6

Data source: QMD

Figure 2-1 shows that the annual rainfall in all years from 2008 – 2013 was lower than the annual average precipitation (1962-1992).

Figure 2-1: Annual rainfall at Doha International Airport 2008-2013 compared with the long-term annual rainfall (1962-1992)



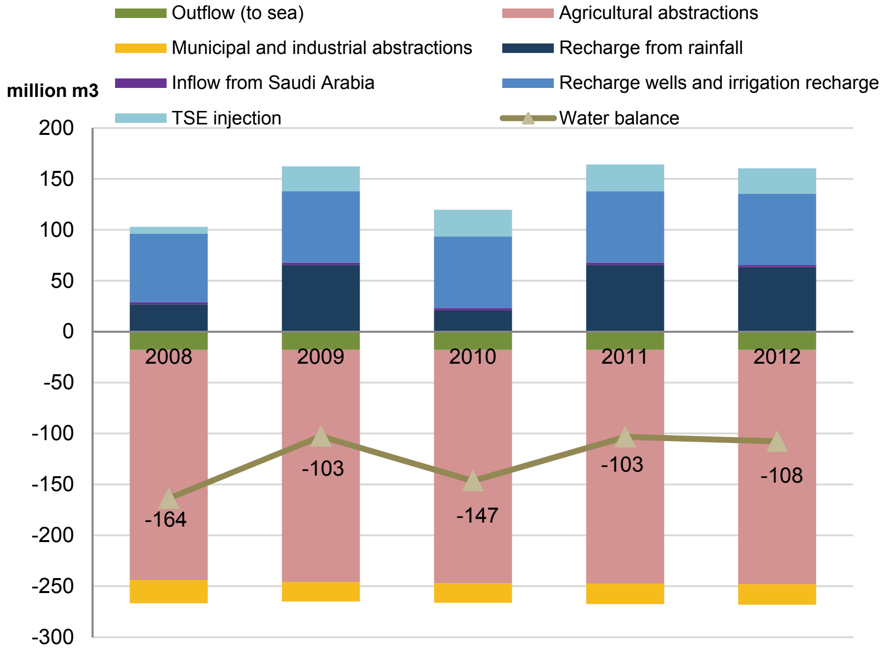
Data source: QMD

2.3.2 Water Balance

The following Figure 2-2 presents the water balance from 2008 – 2012. The total increases in stocks (sum of recharge from rainfall, inflow from Saudi Arabia, artificial recharges, TSE injection and irrigation returns) vary between. 164 million m^3 (2011) and 103 million m^3 year (2008). Decreases in stocks are relatively constant between 263 and 265 million m^3 per year. This results in an annual water deficit between 164 million m^3 (2008) and 103 million m^3 (2009 and 2011).

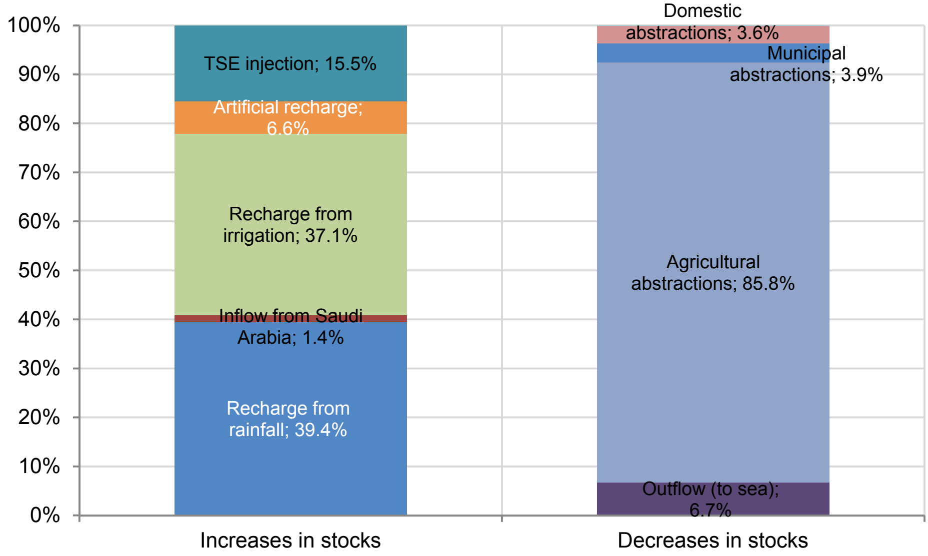
The largest component of additions to water stocks is artificial recharge and irrigation returns whereas the decreases in water stocks are dominated by abstractions for agriculture. Figure 2-3 shows the share of increases and decreases in water stocks for the year 2012.

Figure 2-2: Water balance 2008 - 2012



Data sources: MoE, Ashghal, Kahramaa; Calculated by MDPS

Figure 2-3: Increases in decreases of groundwater stocks in percentage of total (year 2012)



Data sources: MoE, Ashghal, Kahramaa; Calculated by MDPS

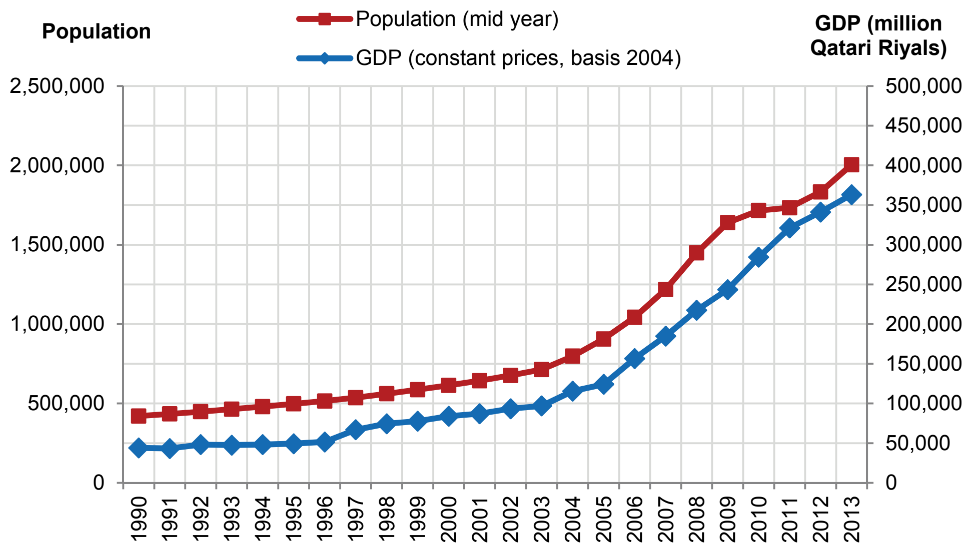
3.Water production, abstraction and water use

3.1 Rationale

Qatar is a rapidly growing economy with a still growing (mainly immigrant) population. The following Figure 3-1 shows that from 1990 until 2013 the population has increased from 420,779 to 2,003,700 (+376%) and the annual GDP has increased from 43,977 million QR to 363,065 million QR (+726%) for the same period. This corresponds to an average annual growth rate of 10% for the population and 7% of the GDP.

Measures to address the water needs of that growing economy include the production of more water, increase of water reuses and increased water use efficiency.

Figure 3-1: Growth of population and GDP from 1990 - 2013



Data source: MDPS

Water made available for use originates currently from the following sources

- Abstraction of fresh and saline groundwater
- Seawater desalination
- Re-use of Treated Sewage Effluent

Potential future water sources for use include water generated by the GTL Process, which is currently only recycled within industries and excess water is discharged without further use. Data about the amount of freshwater produced by the GTL process are currently not available.

3.2 Key messages

a) The total water production (desalination + fresh groundwater abstraction + re-use of TSE) rose from 218 million m^3 in 1990 to 766 million m^3 in 2012

b) The water demand has been coupled with economic growth and population growth. GDP growth is slightly higher than the growth of water demand

c) Since 2005 abstractions from groundwater aquifers remain at the same annual level and do not show a significant growth.

d) Total water losses of desalinated water have been reduced from 32% in 2008 to 19.5% in 2013.

e) With the exception of agriculture in all economic activities water productivity of used has increased.

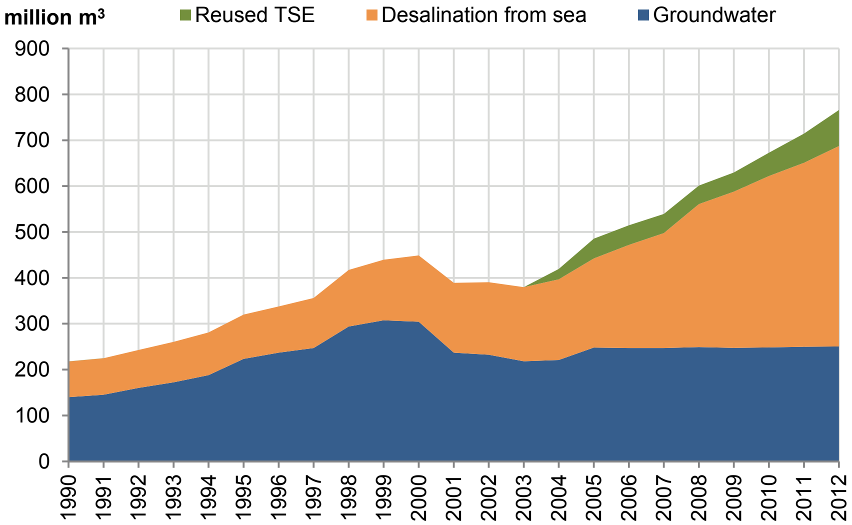
3.3 Statistics and Indicators

3.3.1 Water production and water re-use

The following Figure 3-2 shows that in the year 1990 Qatar's only sources of water were groundwater abstractions (64%) and desalinated seawater (36%). Since the year 2004 additionally treated wastewater (treated sewage effluent, TSE) is reused for irrigation purposes in agriculture and green spaces. In the year 2012 the total water production was dominated by desalinated sea water (57%), followed by abstractions from groundwater (33%).

The total annual water production and re-use rose from 218 million m^3 (1990) to 766 million m^3 (2012), not including water produced (i.e. desalinated) by industries for their own uses.

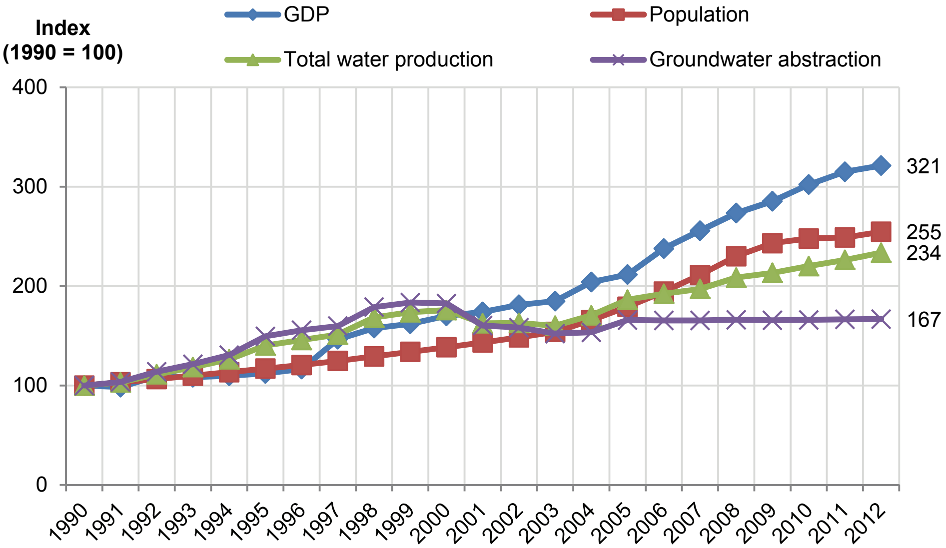
Figure 3-2: Total water production and re-use from 1990 - 2012



Data sources: MoE, Ashghal, Kahramaa

The following Figure 3-3 shows that the total water production is coupled with both the economic and the population growth. There is a slight decoupling of GDP growth from total water production (groundwater abstractions + desalinated sea water + reused TSE). Since 2005 groundwater abstractions do not show a significant growth and remain at the same level.

Figure 3-3: Index showing the growth rates of GDP (constant prices), population, total water production and groundwater abstraction from 1990 - 2012

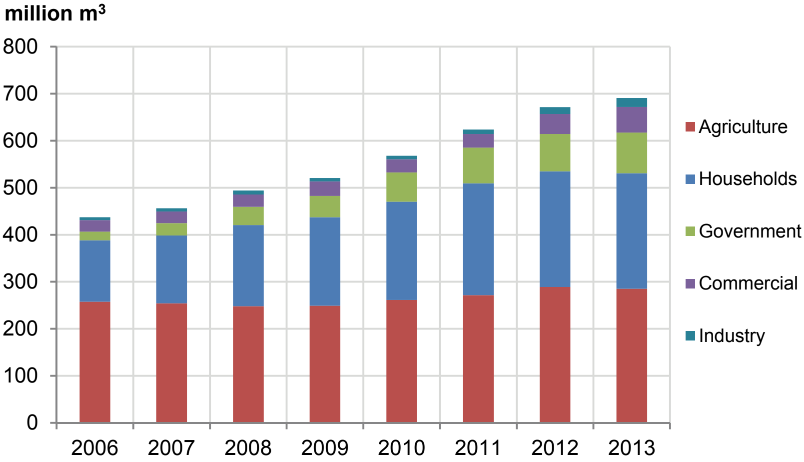


Data sources: MDPS, MoE, Ashghal, Kahramaa; calculated by MDPS

3.3.2 Water uses per economic sector

Water uses (net of losses) have increased from 437.40 to 740.77 million m³ per year in the period 2006 – 2013. Figure 3-4 shows that the dominating water uses have been agriculture and private households. However, from 2006 - 2013 the highest growth rates can be seen in government (+ 371%) and industry (+214%), whereas the water use of agriculture grew only by 11% in the same period of time (see Figure 3-53-5).

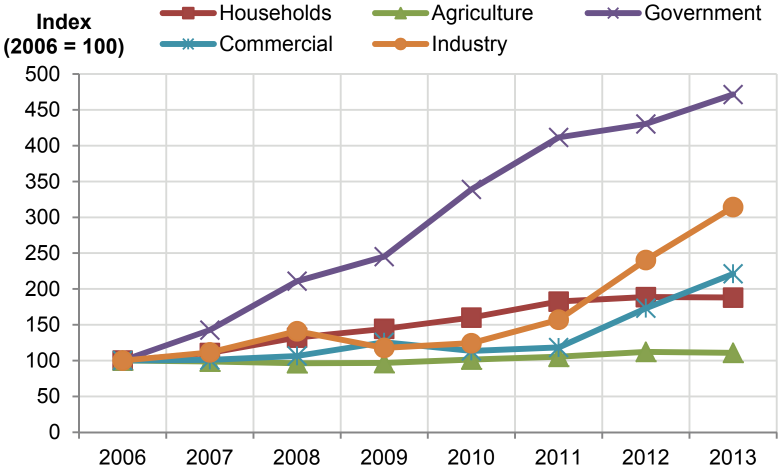
Figure 3-4: Water use per economic activity (net of losses) 2006-2013



*Industry includes only water supplied by Kahramaa and supply from industrial wells

Data sources: Ashghal, Kahramaa, MoE; calculated by MDPS

Figure 3-5: Growth rates of water uses per economic activity (and private households) from 2006 – 2013 (expressed as index with base year 2006)



Data sources: Ashghal, Kahramaa, MoE; calculated by MDPS

3.3.3 Water losses

Water losses occur in the transfer of drinking water, in wastewater sewers, septic tanks and in the distribution of TSS.

As for desalinated water Kahramaa has figures for the so-called apparent losses and real losses (according to the classification of the International Water Association IWA). Apparent losses and real losses are defined by IWA1 as follows:

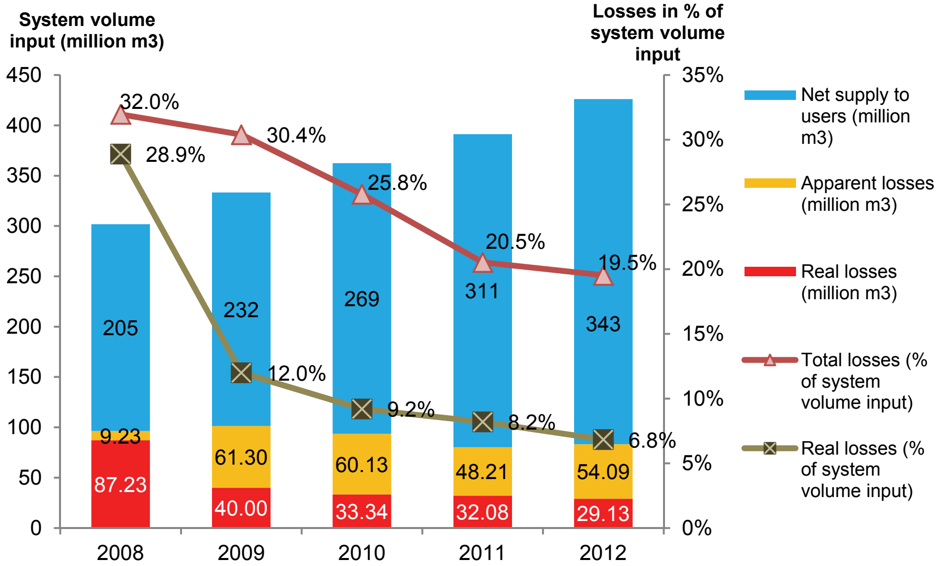
> **Apparent losses** consist of unauthorized consumption (theft or illegal use), and all types of inaccuracies associated with production metering and customer metering. Under-registration of production meters, and over-registration of customer meters, leads to under-estimation of real losses. Over-registration of production meters, and under-registration of customer meters, leads to over-estimation of Real Losses.
>
> **Real losses** are physical water losses from the pressurized system, up to the point of customer metering. The volume lost through all types of leaks, bursts and overflows depends on frequencies, flow rates, and average durations of individual leaks.
>
> **Total losses** are the sum of apparent losses and real losses.

For analysis and indicators it is extremely important to be explicitly clear which losses (total, real, apparent) are in discussion.

The following Figure 3-6 presents the development of real losses and total losses from 2008 – 2012. Total losses have decreased from 32.0% to 19,5% and real losses from 28.9% to 6.8%. This figure also shows that the total system volume input has increased from 301.83 million m^3 to 426.15 million m^3 and that since 2008 the real losses in terms of volume were reduced from 87.23 million m^3 to 29.13 million m^3.

(1)http://www.iwahq.org/contentsuite/upload/iwa/all/Documents/Utilities/blue_pages_water_losses_2000.pdf

Figure 3-6: Losses in distribution of drinking water



Data source: Kahramaa

For losses in wastewater sewers in the State of Qatar currently only estimates exist. In terms of water quantity the issue of infiltration of groundwater into the sewer seems to be of a larger concern than the actual losses. Leakage into the sewer mains may be responsible for the relatively high salinity of TSE of around 1,000 mg/l measured at Doha wastewater treatment plants (see Ashghal & Schlumberger, 2013).

3.3.4 Water use in agriculture

Water sources for agriculture are groundwater and reused TSE.

In the year 2005 34 out of 260 million m^3 (13%) water used in agriculture were reused TSE whereas in the year 2013 already 55 out of 285 million m^3 (19%) originated from TSE. According to a study of Ashghal and Schlumberger (2013) salinity of about 1,000 mg/l can be measured at Doha wastewater treatment plants, which is a potential major concern for re-use in agriculture.

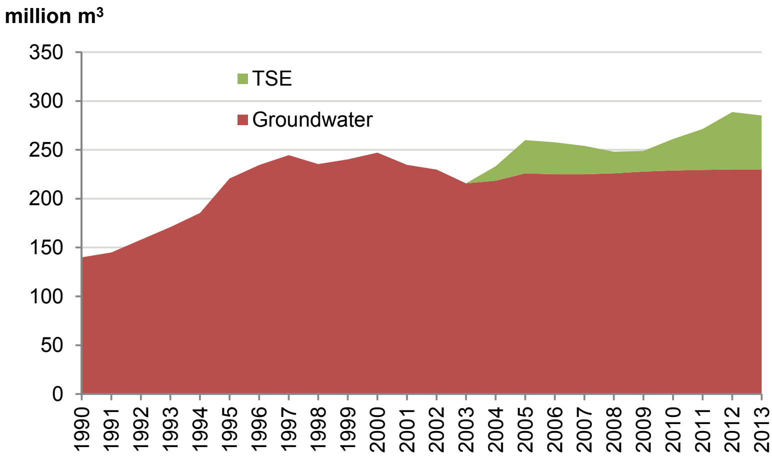
From 2005 until 2013 the agricultural GDP has increased from 249 million Qatari Riyal to 510 million Qatari Riyal (constant prices, base year 2004). See Tale 3-1.

Table 3-1: Water used in agriculture (per source) and GDP of agriculture from 2005 - 2013

Agriculture	2005	2006	2007	2008	2009	2010	2011	2012	2013
Groundwater (million m^3)	226.00	225.00	225.00	226.00	227.80	228.88	229.47	230.05	230.05
TSE (million m^3)	34.03	32.69	29.05	22.15	21.09	32.28	41.98	58.71	55.23
Total (million m^3)	260.03	257.69	254.05	248.15	248.89	261.16	271.45	288.76	285.28
GDP (million QR, constant prices)	249	290	319	436	362	433	457	477	510

Data about water use in agriculture is available since the year 1990. The following Figure 3-7 shows that the annual total water use in agriculture has increased from 140 million m^3 (1990) to 285 million m^3 (2013). However, groundwater abstraction for agricultural purposes has been staying on about the same level since 2005 (225 – 230 million m^3/year) and additional demand has been covered since 2004 by reused TSE.

Figure 3-7: Water use in agriculture 1990 - 2013



Data sources: MoE, Ashghal

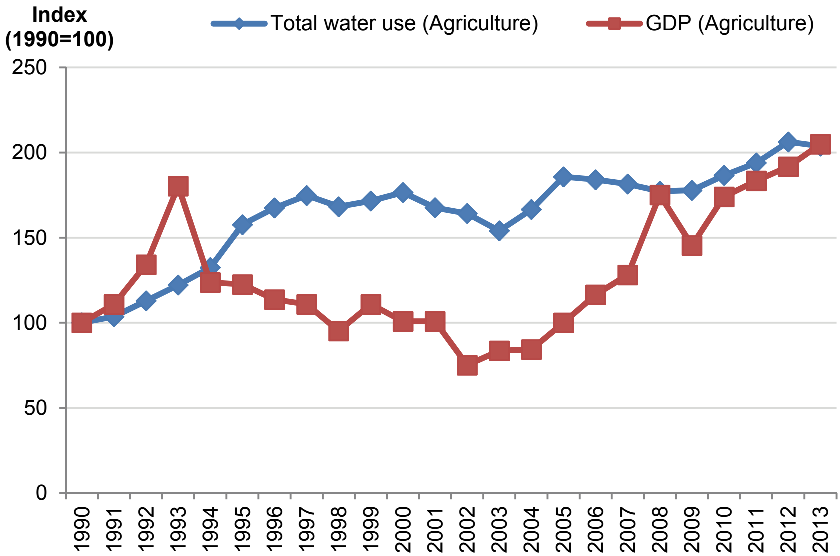
Figure 3-8 shows that there is no decoupling from the GDP growth in agriculture from the water used in agriculture.

Water efficiency in agriculture: In 1990 562.25 liters of water were needed to produce 1 Qatari Riyal of GDP in agriculture. In 2013 559.21 liters of water were needed to produce 1 Qatari Riyal of GDP.

Water productivity in agriculture: The water productivity of the year 2013 is on the same level as the water productivity of the year 1990: One liter of water contributed to roughly 0.002 Qatari Riyal of GDP in agriculture.

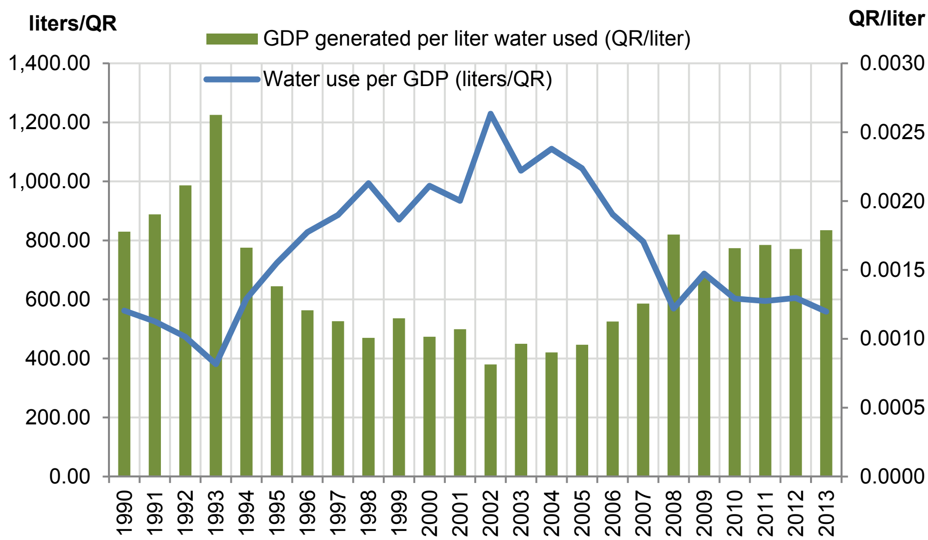
See Figure 3-9

Figure 3-8: Water use in agriculture and GDP (constant prices) 1990-2013 as index



Data sources: MDPS, Ashghal

Figure 3-9: Water use efficiency (liters per Qatari Riyal GDP) and water use productivity (GDP produced per liter of water used) in agriculture 1990 – 2013. GDP in constant prices (basis 2004)



Data sources: MDPS, Ashghal

3.3.5 Water use in the industrial sector and construction

For simplification (and to address the actual data availability) under "industrial sector" the following economic activities are aggregated:

- Mining and Quarrying (Include Oil & Gas)
- Manufacturing
- Electricity and Water
- Building and Construction

Industries in Qatar have three main sources of freshwater, which is water supplied by Kahramaa, water from industrial groundwater wells and seawater desalinated by industrial desalination plants. For the latter (industrial desalination) no data is available. Therefore, analysis can only be done for that part of water which originates from groundwater (self-abstraction by industries) and water supplied by Kahramaa.

From 2005 – 2013 the annual industrial water use has increased from 10 million m^3 to about 19 million m^3. From 2005 – 2013 the GDP (constant prices, base 2004) of the industrial sector has increased from 138 million Qatari Riyal to about 342 million Qatari Riyal.

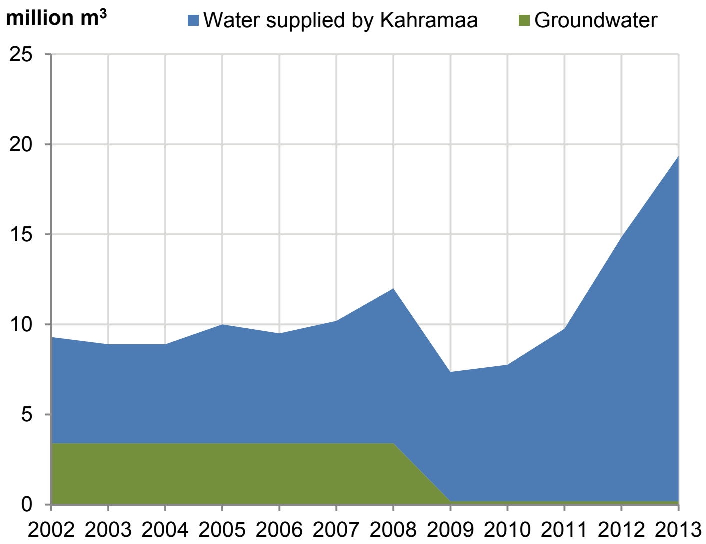
Table 3-2: Water used in industry (per source) and GDP of industry from 2005 - 2013

Industry	2005	2006	2007	2008	2009	2010	2011	2012	2013	Remarks
Water supplied by Kahramaa (million m^3)	6.6	6.1	6.8	8.6	7.18	7.58	9.58	14.66	19.18	2013 data from World Bank Report (mentioning as data source "Kahramaa"), 2012 data interpolated
Industrial groundwater wells (million m^3)	3.4	3.4	3.4	3.4	0.18	0.18	0.18	0.18	0.18	
Total water use (million m^3)	10	9.5	10.2	12	7.36	7.76	9.76	14.84	19.36	Excluding industrial desalination
GDP (million QR, constant prices)	138,078	157,582	181,961	215,754	226,017	285,552	328,661	337,514	341,724	Mining and Quarrying (Include Oil & Gas), Manufacturing, Electricity and Water, Building and Construction

Data sources: MDPS, MoE, Kahramaa

The total water use in industry has increased from about 9 million m^3 in 2002 to 19 million m^3 in 2013, with the biggest growth rates in the years2011 – 2013. See Figure 3-10

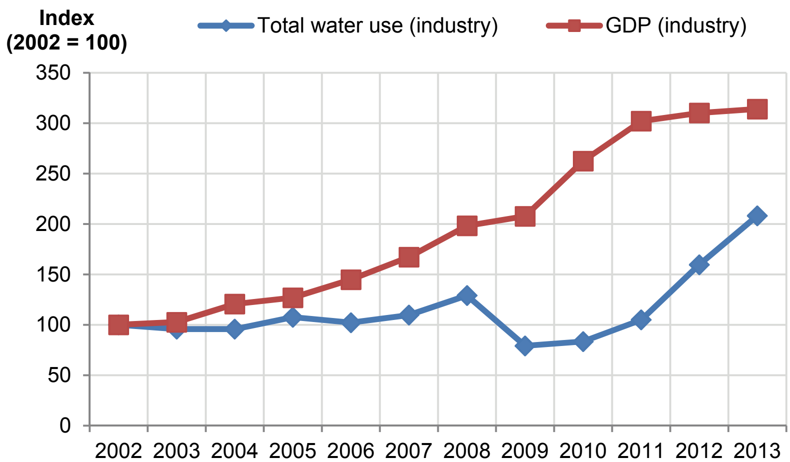
Figure 3-10: Water use in industry 2002 - 2013



Data sources: MoE, Kahramaa

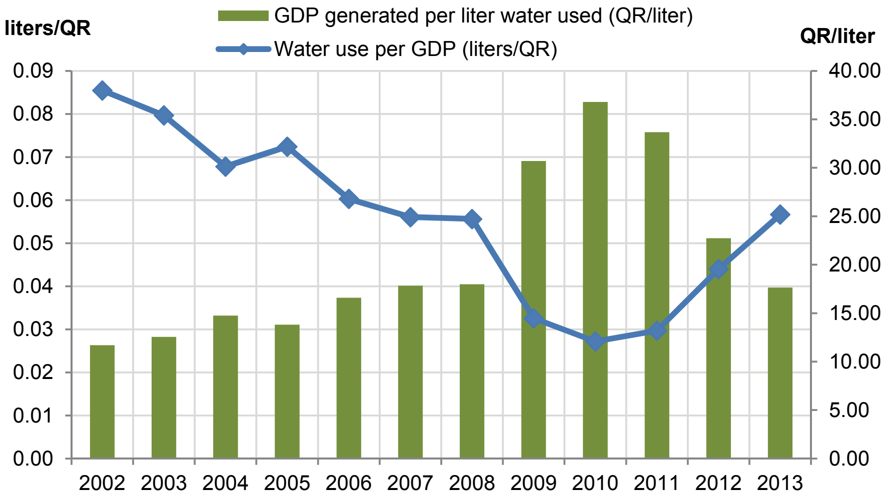
Following Figure 3-11 shows that GDP growth in industry is coupled with water use, even if the water efficiency and the water productivity have improved. In 2002 0.09 liters of water were used to produce 1 Qatari Riyal of industrial GDP whereas in 2013 only 0.06 liters of water were needed to produce the same GDP. In other words this means that in 2002 the productivity of one liter of water was 11.70 Qatari Riyal of industrial GDP whereas in 2013 the water productivity has increased to 17.65 Qatari Riyal industrial GDP per liter. See Figure 3-12.

Figure 3-11: Water use in industry and GDP (constant prices) 2002-2013 as index (base year 2002)



Data sources: MDPS, MoE, Kahramaa

Figure 3-12: Water use efficiency (liters per Qatari Riyal GDP) and water use productivity (GDP produced per liter of water used) in industry 2002 – 2013. GDP in constant prices (basis 2004)



Data sources: MDPS, MoE, Kahramaa

3.3.6 Water use in the commercial sector

For simplification (and to address the actual data availability) under "commercial sector" the following economic activities are aggregated:

- Trade, Restaurants & Hotels
- Transport and Communications
- Finance, Insurance, Real Estate & Business Services
- Household Services

Kahramaa water supply is the only known water source for the commercial sector.

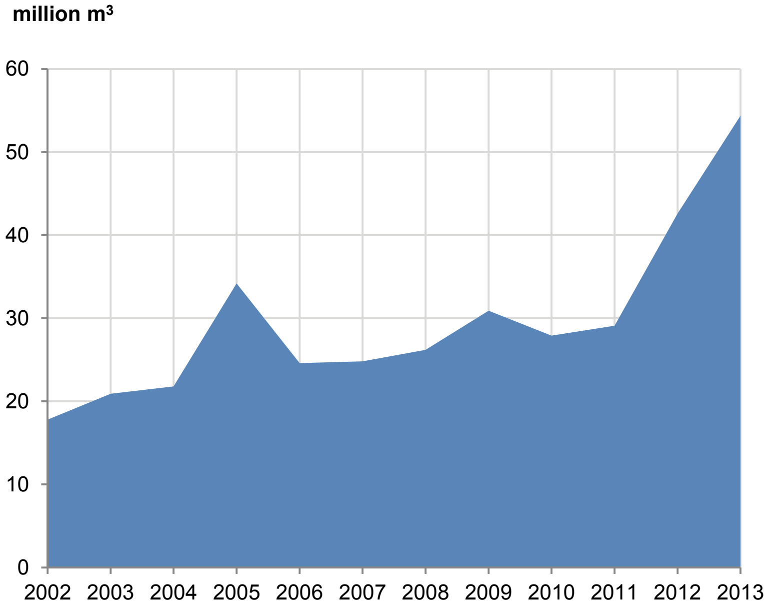
Table 3-3: Water used in commercial activities and GDP of commercial activities from 2005 - 2013

Commercial	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total water use (i.e. water supplied by Kahramaa) million m^3	34.20	24.60	24.80	26.20	30.90	27.90	29.10	42.58	54.38
GDP (million QR, constant prices)	24,233	38,873	49,314	56,916	69,022	73,478	80,537	87,251	99,858

Data sources: MDPS, Kahramaa

The total water use in the commercial sector has increased between 2002 and 2013 from around 18 million m^3 per year to about 43 million m^3 per year. See Figure 3-13.

Figure 3-13: Water use in the commercial sector 2002 - 2013

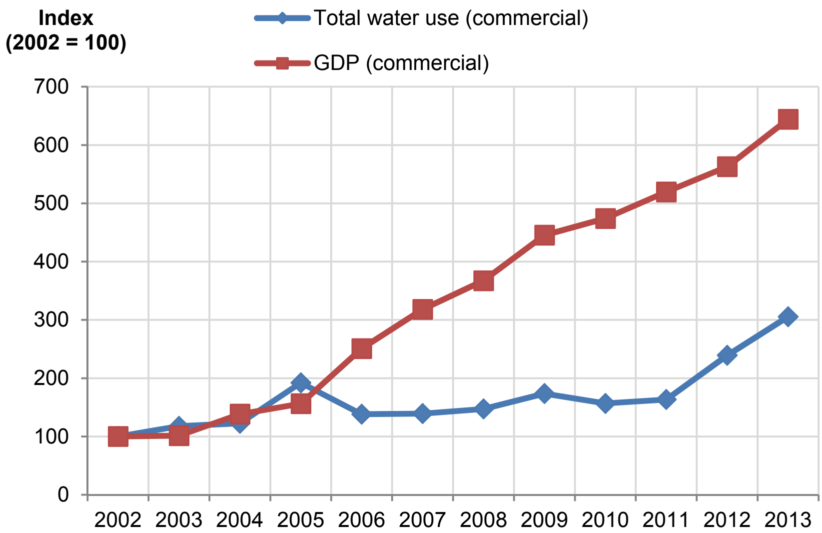


Data sources: MDPS, Kahramaa

Following Figure 3-14 shows that since 2006 the growth of GDP in the commercial sector is decoupled from water use.

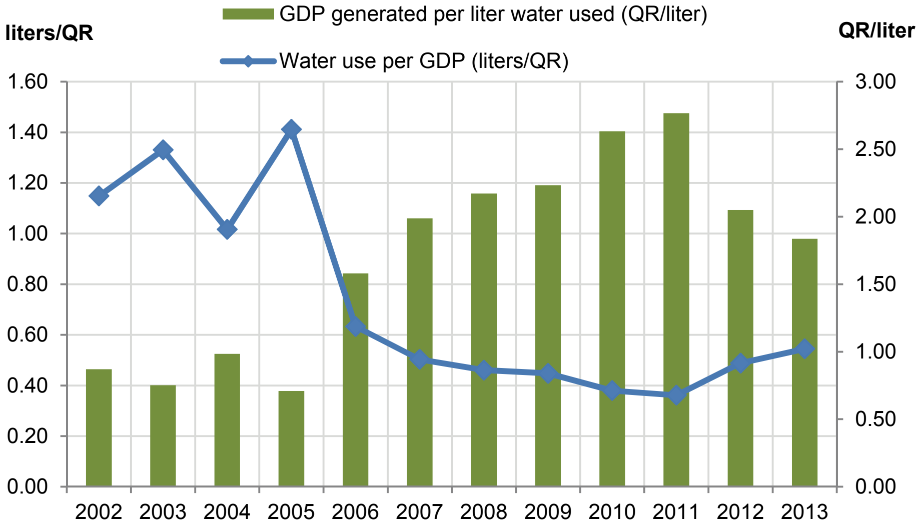
In the year 2002 1.15 liters of water were necessary to produce 1 Qatari Riyal of commercial GDP whereas in 2013 only 0.54 liters of water were necessary to achieve the same GDP. In other words, one liter of water used by commercial activities produced 0.87 Qatari Riyal of GDP in 2002 and in 2013 one liter of water already produced 1.84 Qatari Riyal of GDP (constant prices, base year 2004). See Figure 3-15.

Figure 3-14: Water use in commercial sector and GDP (constant prices) 2002-2013 as index (base year 2002)



Data sources: MDPS, Kahramaa

Figure 3-15: Water use efficiency (liters per Qatari Riyal GDP) and water use productivity (GDP produced per liter of water used) in commercial activities 2002 – 2013. GDP in constant prices (basis 2004)



Data sources: MDPS, Kahramaa

3.3.7 Water use in the governmental sector

Main water sources for the government sector are Kahramaa water supply and the re-use of TSE for the irrigation of greenspaces. The following Table 3-4 and Figure 3-16 presents that the water use in the governmental sector has increased from 18 million m^3 in the year 2006 up to 87 million m^3 in 2013. In 2013 28% of the water used by government originated from re-used TSE (used for the irrigation of greenspaces).

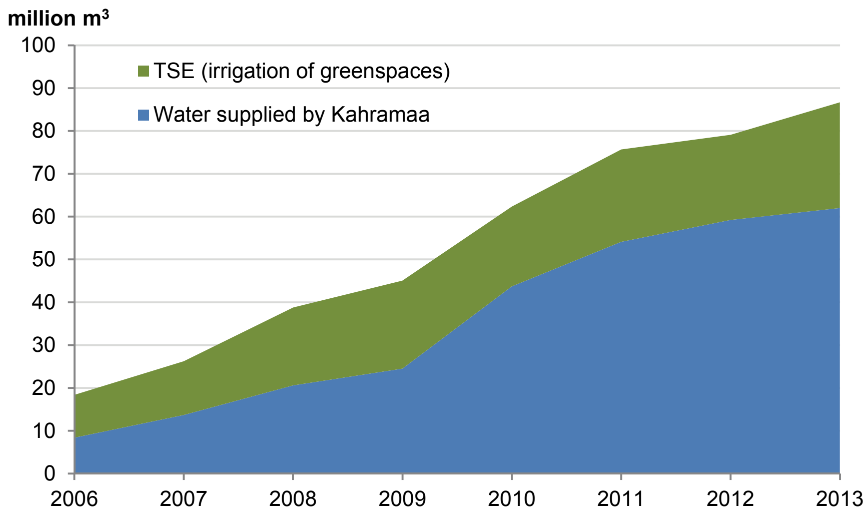
As the government sector is mainly a consumer of goods and services an analysis of water use versus GDP (like it was done for agriculture, industry and services) is not useful, even if there are certain governmental services which are considered in Qatar's GDP.

Table 3-4: Water used in government (per source) from 2005 - 2013

Governmental	2005	2006	2007	2008	2009	2010	2011	2012	2013
Water supplied by Kahramaa (million m^3)	NA	8.40	13.70	20.60	24.50	43.70	54.10	59.21	62.00
TSE (irrigation of greenspaces) (million m^3)	9.22	9.99	12.53	18.17	20.57	18.63	21.58	19.90	24.67
Total water use million m3	NA	18.39	26.23	38.77	45.07	62.33	75.68	79.11	86.67

Data sources: MDPS, Kahramaa, Ashghal

Figure 3-16: Water use in in the government 2006 - 2013



Data sources: MDPS, Kahramaa, Ashghal

3.3.8 Water used by households

The water used by private households originates mainly (92% in 2012) from Kahramaa water supply. However, there are also domestic wells and municipal wells, which mainly serve the water needs of private households.

Water use by households has increased by about 2.5 times between 2002 and 2013. In 2002 private households used about 100 million m^3 and in 2013 they used about 245 million m^3 of water. See Table 3-5 and Figure 3-17.

As large proportion of the expatriate population lives in labor camps it is not possible to calculate per capita household water uses. Water used in labour camps is included in commercial water uses. However, data on population leaving in households is available for the year 2010 and based on this a per capita household water use of 735 liters per day was calculated for the year 2010. See Table 3-5

Table 3-5: Water used by households (per source) from 2005 - 2013

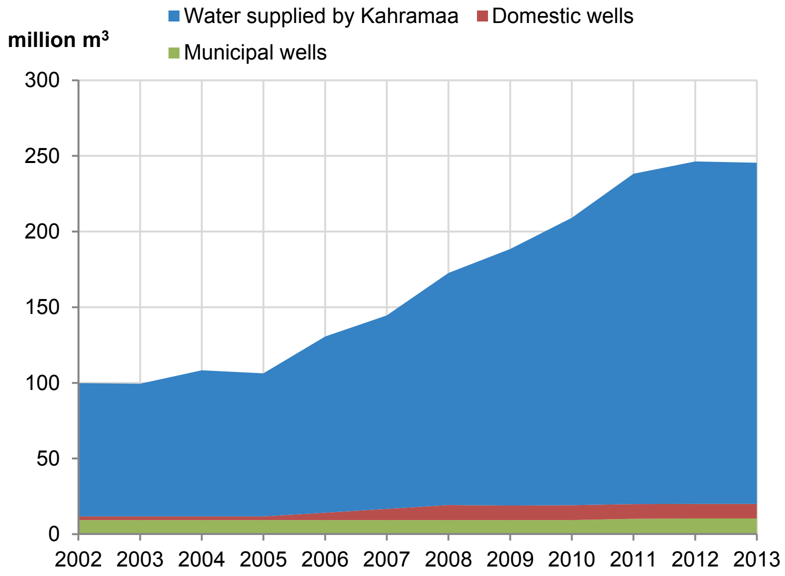
Households	2005	2006	2007	2008	2009	2010	2011	2012	2013
Water supplied by Kahramaa (million m^3)	94.58	116.42	127.85	153.37	169.61	189.92	218.29	226.34	225.52
Domestic wells (million m^3)	2.40	4.90	7.40	9.90	9.57	9.82	9.69	9.60	9.60
Municipal wells (million m^3)	9.30	9.30	9.30	9.30	9.34	9.34	10.19	10.38	10.38
Total water use (million m^3)	106.28	130.62	144.55	172.57	188.52	209.08	238.17	246.32	245.50
Residents leaving in households	NA	NA	NA	NA	NA	779,426*	NA	NA	NA
Per capita household water use (liters per day)	NA	NA	NA	NA	NA	735	NA	NA	NA

* According to Census 2012, see also

http://www.qsa.gov.qa/eng/publication/annabs/2012/1_Population2012.pdf

Data sources: MDPS, MoE, Kahramaa

Figure 3-17: Water use by households 2002 - 2013



Data sources: MDPS, MoE, Kahramaa

3.3.9 Water use balance

In the year 2013 about 873 million m^3 of water were potentially available for use. This included desalinated water (before losses), all abstracted groundwater and all urban wastewater generated (treated and untreated wastewater).

The water which is used by the final users (i.e. agriculture, industry, commercial, government and private households) is the water potentially available for use minus water losses and wastewater discharged without re-use. As injection of TSE into aquifers is a way to substitute over-exploitation but not a final use it is shown separately in the aggregated water balance (Table 3-6).

Table 3-6: Aggregated water use balance 2013

Year 2013	million m^3/year
Water potentially available for use (a)	872.68
Water losses (b)	92.31
Discharges of wastewater without use (c)	89.35
of which injection into aquifers	35.46
Water used by final consumers (=a – b – c)	691.02

The following Table 3-6 presents the details of the water use balance.

Table 3-7: Detailed water use balance (2013)

Water use balance 2013 (million m³)	Water potentially available for use	Water uses and losses	Remarks
Desalinated water	453.21		System Volume Input of Kahramaa
Fresh groundwater abstraction	250.21		Agricultural, municipal, domestic and industrial wells; data of 2012 used
Treated wastewater	151.22		Wastewater discharged by urban wastewater treatment plants
Wastewater discharged without treatment	18.04		Discharge of untreated wastewater to lagoons
Total water potentially available for use	**872.68**		**Water available before losses**
Wastewater discharged without treatment		18.04	
Losses of desalinated water		92.31	Total losses
TSE discharged to lagoons		35.391	
TSE discharged to sea		0.23	
TSE injected into aquifers		35.462	
TSE unknown destination		0.23	RO and discharge by tankers
Water used by agriculture		285.28	Groundwater and TSE
Water used by industries		19.18	Water supplied by Kahramaa and industrial wells
Water used by commercial activities		54.38	Water supplied by Kahramaa, including big industrial complexes and hotels
Water used by private households		245.50	Water supplied by Kahramaa, domestic wells and municipal wells
Water used by government		86.67	Water supplied by Kahramaa and TSE for irrigation of greenspaces
Total water uses and losses		**872.68**	

4. Urban wastewater generation, collection, treatment and discharge

4.1 Rationale

In the State of Qatar the collection and treatment of urban wastewater is an important measure to re-use this water for irrigation, cooling and recharge and to protect the environment from adverse impacts of water-borne pollution.

Furthermore, this infrastructure is essential to provide appropriate sanitation services for all individuals throughout the state (also one of the Millennium Development Goals).

With one of the world's lowest level of rainfall and going towards integrated water resources management, treated wastewater (treated sewage effluent – TSE) is an important alternative to desalination of seawater and abstraction of Qatar's limited fresh groundwater resources. Use of TSE is an important measure to achieve more sustainable water use (see also Qatar National Development Strategy).

4.2 Key messages

a) The capacity of urban wastewater treatment plants has increased from 54,000 m^3 per day in 2004 to 450,000 m^3/day in 2013.

b) All urban wastewater treatment plants of Qatar are equipped with at least secondary treatment level. The largest operational urban wastewater treatment plant is Doha West (175.500 m^3/day) and it provides additionally nitrogen and phosphorus removal.

c) Urban wastewater treatment plants remove more than 90% of the organic pollution.

d) In 2013 90% of the urban wastewater generated was treated in UWWTPs.

e) In 2013 37% of the TSE were used for irrigation in agriculture and 16% for irrigation of greenspaces.

4.3 Statistics and Indicators

4.3.1 Urban wastewater collection and treatment infrastructure

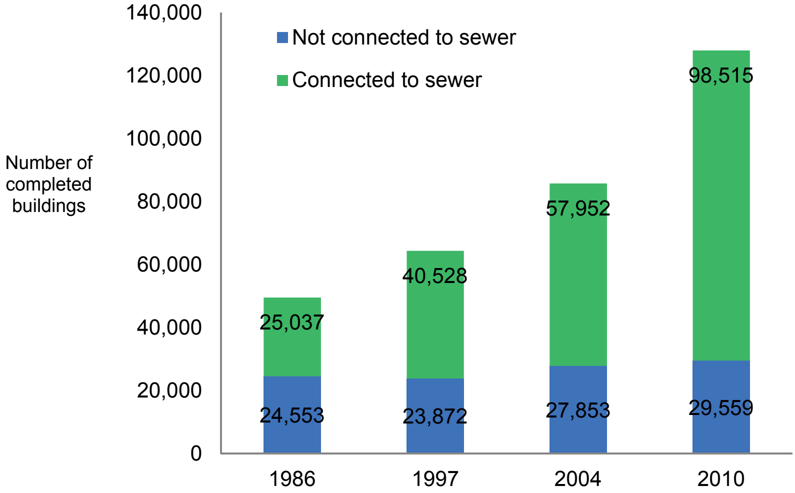
According to statistics from Census (1986 – 2010) the number of completed buildings connected to public sewerage increased from 25,037 (50.5% of the completed buildings) in 1986 to 98,515 (76.9% of the completed buildings) in 2010 (see Figure 4-1).

Population living not-connected buildings were served by tankers transporting the wastewater to wastewater treatment plants and sewage lagoons.

In 2010 the highest degree of buildings connected to the public sewerage was in Doha (94.1%), whereas the municipalities of Al Shamal and Al Rayyan were not connected at all. See Figure 4-2.

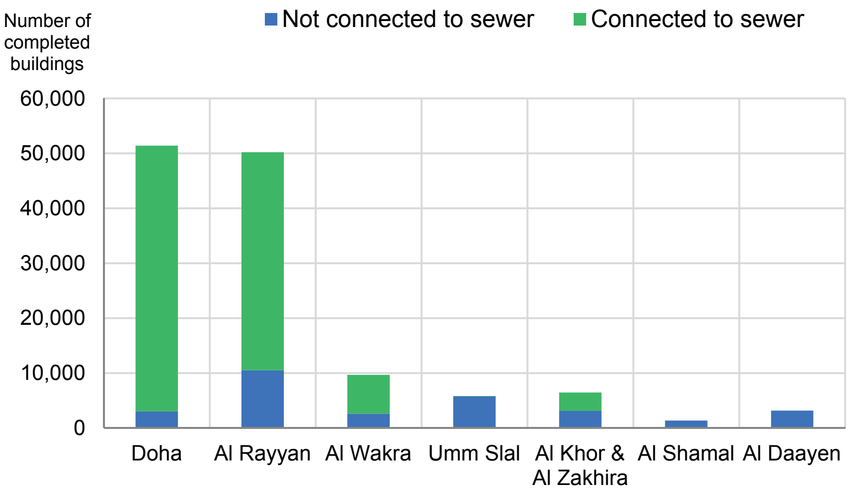
Since 2004 safe sanitation is provided to all individuals in Qatar (see Qatar Statistics Authority and Diplomatic Institute, 2012).

Figure 4-1 Completed buildings connected to the public sewerage according to Censuses 1986 - 2010



Data source: QSA

Figure 4-2: Connection to public sewerage in April 2010 (Census 2010) by municipalities



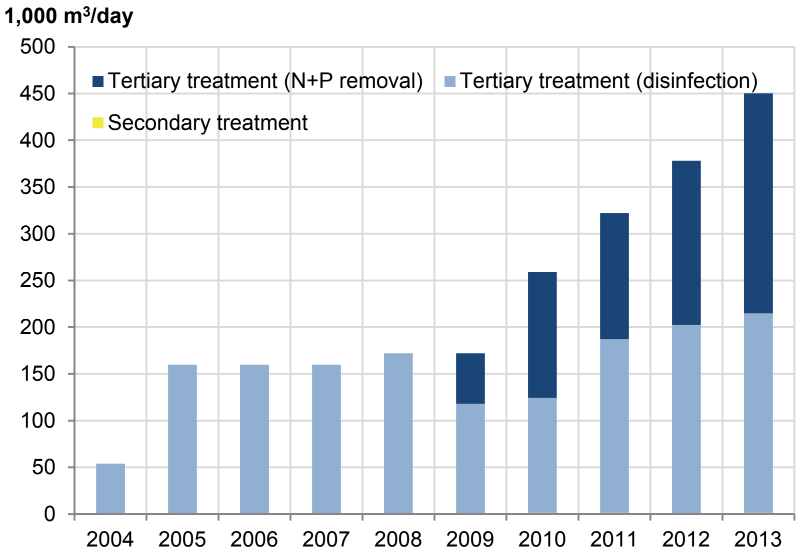
Data source: QSA

Since 2004 the capacity for treatment of urban wastewater increased from 54,000 m^3/day up to 450,000 m^3/day in 2013 (operational wastewater treatment plants only). All existing wastewater treatment plants are equipped with secondary treatment, thus removing organic pollution to a great extent. In 2009 Doha West was upgraded with nitrogen and phosphorus removal and in

2013 Lusail wastewater treatment plant started to operate (served by tankers) with nitrogen and phosphorus removal.

See Figure 4-3 and Table 4-1.

Figure 4-3: Hydraulic design capacity per treatment type of operational wastewater treatment plants from 2004 - 2013



Data source: Ashghal

Table 4-1: Hydraulic design capacity (1,000 m^3/day) of operational wastewater treatment plants 2004 - 2013

Hydraulic Design Capacity (1000 m^3/day)	2005	2006	2007	2008	2009	2010	2011	2012	2013
Secondary treatment	0.0	0.0	0.0	0.0	0.0	0.1	1.3	1.3	1.2
Tertiary treatment (disinfection)	54.0	160.0	160.0	160.0	172.0	118.0	123.0	185.8	201.4
Tertiary treatment (N+P removal)	0.0	0.0	0.0	0.0	0.0	54.0	135.0	135.0	175.5
Total treatment capacity	54.0	160.0	160.0	160.0	172.0	172.1	259.3	322.1	378.1

Data source: Ashghal

The following Table 4-2 shows all urban wastewater treatment plants of Qatar as of the year 2013 with their type of treatment, hydraulic design capacity and wastewater received. The UWWTP of Doha North is not in operation yet and Lusail is currently only served by tankers.

Table 4-2: All urban wastewater treatment plants of Qatar (operational and not operational, year 2013)

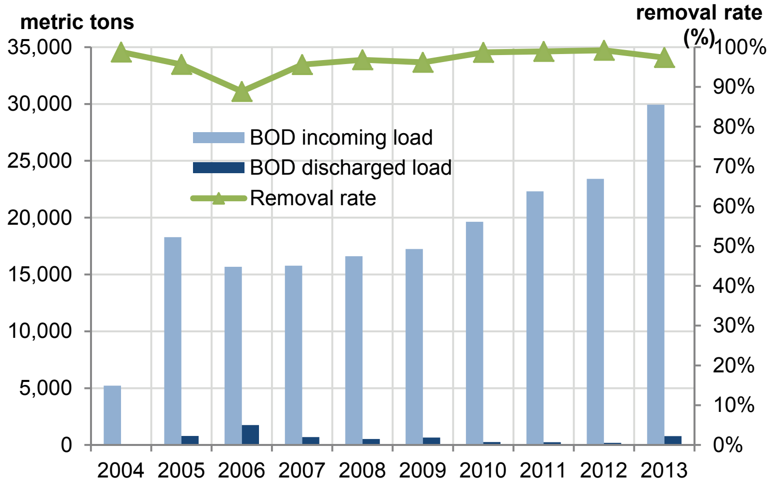
Name of UWWTP	Type of treatment	Design capacity (1,000 m^3/day)	Design capacity (1,000 m^3/year)	Wastewater received (1,000 m^3/year)	Remarks
Al-Dhakhira PTP	Tertiary (disinfection)	1.60	585	860	
Al-Jamiliyah PTP	Secondary	0.54	197	128	
Al-Khor PTP	Tertiary (disinfection)	4.86	1,774	1,593	
Al-Khuraib PTP	Secondary	0.06	22	16	
Al-Shamal PTP	Secondary	0.15	55	36	
Barwa Al Baraha PTP	Tertiary (disinfection)	12.00	4,380	1,175	
Barwa City STW	Tertiary (disinfection)	15.00	5,475	960	
Barwa Msaimeer PTP	Tertiary (disinfection)	1.50	548	325	
Barwa Sailiyah PTP	Tertiary (disinfection)	1.50	548	268	
Barwa Village PTP	Tertiary (disinfection)	1.00	365	181	
Doha North STW	Tertiary (N and P)	244.00	89,060		Not in operation yet (expected in the course of 2014)
Doha South STW	Tertiary (disinfection)	106.00	38,690	59,766	
Doha West STW	Tertiary (N and P)	175.50	64,058	68,029	
Doha West STW old plant	Tertiary (disinfection)	54.00	19,710	15,094	Served by tankers and overflow from Doha West STW
Duhail PTP	Tertiary (disinfection)	0.81	296	162	
Industrial Area STW	Tertiary (disinfection)	12.00	4,380	4,459	
Lusail STW	Tertiary (N and P)	60.00	21,900	4,691	Currently served by tankers
North Camp PTP	Tertiary (disinfection)	0.25	89	25	
Ras Abu Fontas PTP	Secondary	0.54	197	90	
Shahaniyah PTP	Tertiary (disinfection)	1.35	491	505	
Umm Slal PTP	Tertiary (disinfection)	1.50	548	431	
Total		**694.15**	**253,365**	**158,792**	

Data source: Ashghal

4.3.2 Treatment efficiency of urban wastewater treatment plants

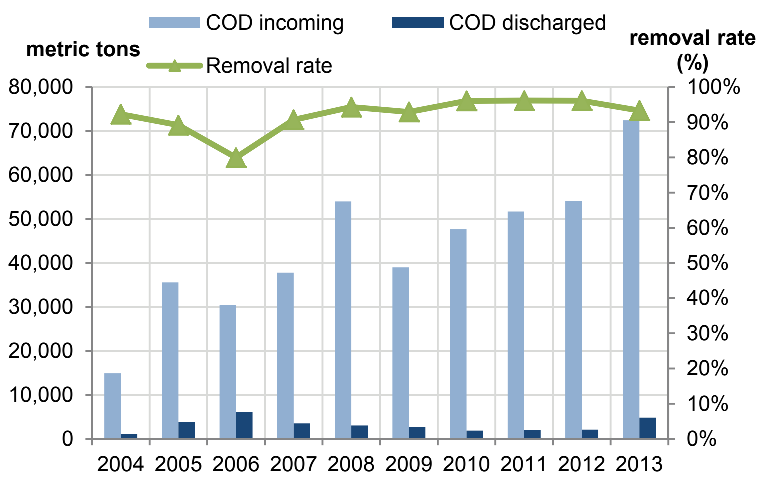
Organic pollution in terms of BOD5 has been removed by more than 95% in most of the years since 2004. In terms of COD the removal rates achieved more than 90% in most of the years since 2004. See Figure 4-4 and Figure 4-5.

Figure 4-4: Treatment of BOD5 loads from 2004 - 2013



Data source: Ashghal; calculated by MDPS

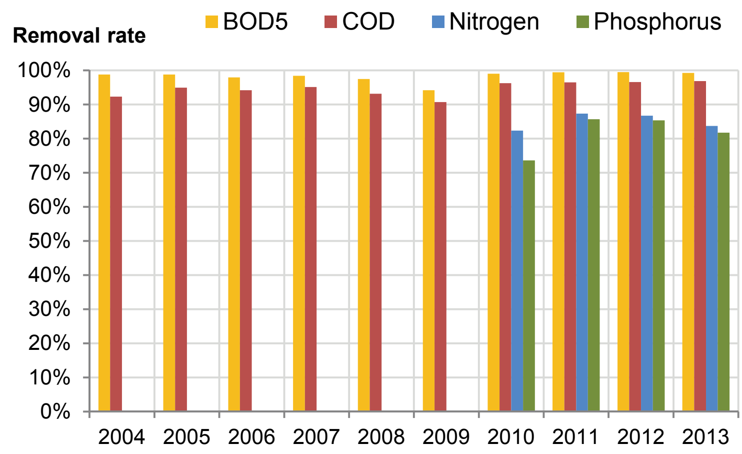
Figure 4-5: Treatment of COD loads from 2004 - 2013



Data source: Ashghal; calculated by MDPS

Qatar's largest operation UWWTP Doha West (treatment capacity 175,500 m^3/day) is equipped with nitrogen and phosphorus removal since 2009. Since 2012 nitrogen removal rates are above 82% and the removal rate of phosphorus has increased to more than 85% since 2011. See Figure 4-6.

Figure 4-6: Removal rates of BOD5, COD, total nitrogen and total phosphorus at UWWTP Doha West (2004 – 2013)



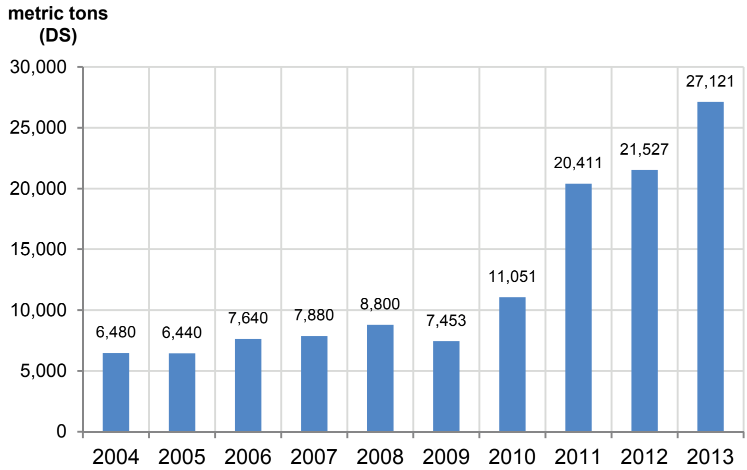
Data source: Ashghal; calculated by MDPS

4.3.3 Sewage sludge generation

With the increase of treatment capacity the generation of sewage sludge has increased.

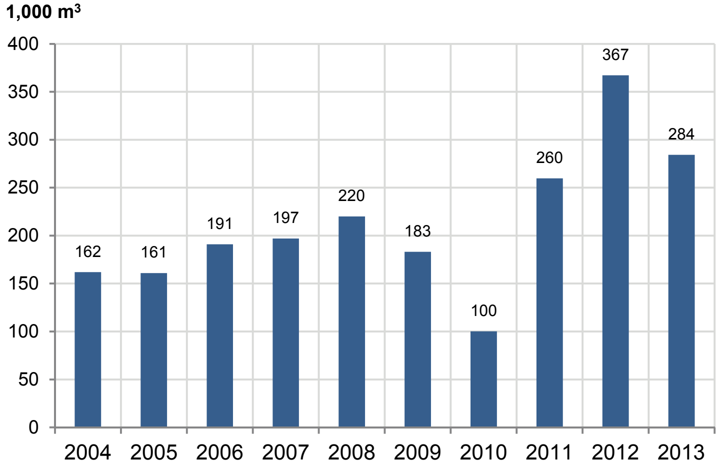
In the year 2004 106,000 m^3 of sewage sludge were generated with a content of dry solids of 6,480 tons (water content about 96%). In 2013 the UWWTPs of Qatar already generated 284,000 m^3 of sewage sludge. Due to the reduced water content (about 90%) this corresponds to 27,121 tons of dry solids. See following Figure 4-7 and Figure 4-8.

Figure 4-7: Generation of sewage sludge in urban wastewater treatment plants in terms of mass (metric tons of dry solids)



Data source: Ashghal

Figure 4-8: Generation of sewage sludge in urban wastewater treatment plants in terms of volume (1,000 m³)



Data source: Ashghal

4.3.4 Urban wastewater generated, collected and treated

In Qatar the urban wastewater is collected by sewerage and by tankers. All of the wastewater connected to sewerage is treated in UWWTPs, whereas most of the wastewater collected by tankers is discharged in on open lagoon without treatment, mainly which were collected from non-household sources.

Table 4-3 shows that the total generation of urban wastewater has increased from 122 million m^3 in 2010 to 176 million m^3 in 2013. In 2013 about 10% of the total wastewater generated (18 million m^3) were discharged to open lagoons without any further treatment.

Table 4-3: Urban wastewater generated, treated and discharged without treatment

Urban wastewater (million m^3/year)	2010	2011	2012	2013
Total urban wastewater generated	**121.73**	**140.31**	**164.24**	**176.19**
of which treated	101.65	123.89	142.34	158.79
of which secondary treatment	0.20	0.20	0.25	0.27
of which tertiary treatment	101.45	123.69	142.09	157.89
of which discharged without treatment	20.08	16.43	21.90	18.04

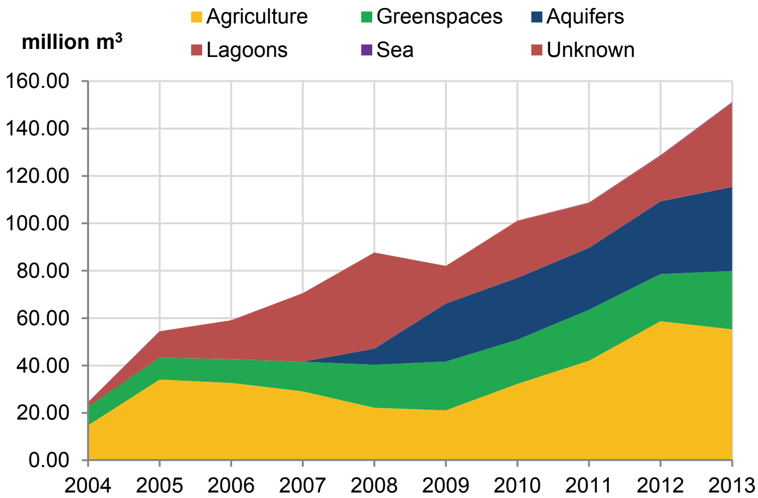
Data source: Ashghal

4.3.5 Discharge and re-use of Treated Sewage Effluent (TSE)

With the expansion of the capacities of wastewater treatment since 2004 the production of treated sewage effluent (TSE) has increased by about 5 times from about 25 million m^3 (2004) to about 151 million m^3 (2013). Agriculture has become the most important user of TSE (37% in 2013), followed by the government (16% of TSE used for irrigation of greenspaces). About 23% of the wastewater were used for deep injection into aquifers and about the same amount of treated wastewater were discharged to an open lagoon without further use in 2013.

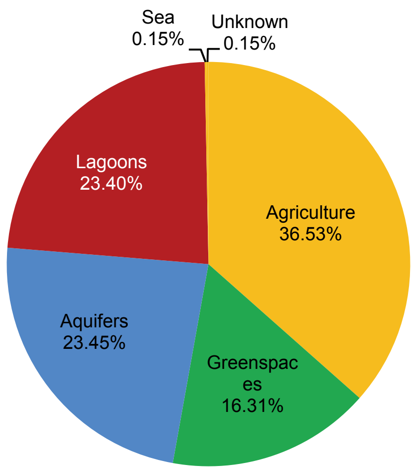
See following Figure 4-9 and Figure 4-10.

Figure 4-9: Use and discharge of treated sewage effluent (TSE) from 2014-2013



Data source: Ashghal

Figure 4-10: Use and discharge of treated sewage effluent (TSE) in 2013



Data source: Ashghal

5. Groundwater quantity and quality

5.1 Rationale

One of the key concerns of water management in Qatar is the ongoing depletion of its groundwater aquifers due to abstraction and pollution. The groundwater depletion can be monitored by changes of groundwater levels and changes of water quality. Overexploitation of groundwater can lead to intrusion of seawater and deep saline groundwater into freshwater aquifers and thus increase the salinity and concentration of dissolved substances. High concentrations of salinity and dissolved substances can make the water unusable for drinking water and agricultural purposes.

According to FAO water can be classified according to its salinity as shown in the following Table 5-1.

Table 5-1: Classification of saline waters according to FAO

Type of water	Electrical conductivity (dS/m)	Salt concentration (mg/l)	Water class
Drinking and irrigation water	<0.7	<500	Non-saline
Irrigation water	0.7 - 2	500 - 1,500	Slightly saline
Primary drainage water and groundwater	2 - 10	1,500 - 7,000	Moderately saline
Secondary drainage water and groundwater	10 - 25	7,000 - 15,000	Highly saline
Very saline groundwater	25 - 45	15,000 - 35,000	Very highly saline
Seawater	>45	>45,000	Brine

Under conventional irrigation practices, water salinity less than 0.7 dS/m usually causes no problems. When the salinity is greater than 3.0 dS/m, serious problems often arise with most crops, which result in reduction of yield or even abandonment of farms (see Water and Agricultural Vision for Qatar by 2020).

In order to present the level of groundwater degradation this chapter presents statistics on groundwater levels, salinity (conductivity) and total dissolved substances (TDS) of the major groundwater aquifers of Qatar.

For the analysis the Ministry of Environment provided groundwater quality data for the period April 1998 – September 2012. There are two sampling campaigns each year, one in April and one in September.

5.2 Methodological aspects

Extreme values may have a strong influence on the overall results of the assessment of groundwater salinity and groundwater depletion.

Therefore, the statistical assessments are done on the following basis:

1. Calculation of median (50 percentile) values of salinity and conductivity for each aquifer. This assures that single extreme values do not have an influence on the overall assessment.
   a. Calculation including the results of all monitoring wells
   b. Calculation excluding monitoring wells in coastal areas (area code “K”)
2. Calculation of mean values of salinity and conductivity
   a. Including all monitoring wells
   b. Excluding wells with area code “K”
3. Calculation of number of wells which fall into the different FAO salinity classes and presenting also which ones of them fall into the area code “K”

5.3 Key messages

1. The percentage of wells with non-saline water diminished from 8% in 1998 to 0% in 2012.
2. The percentage of wells with high salinity increased from 17% in 1998 to 20% in 2012.
3. The highest percentage of wells with slightly saline water (lowest salinity class which can be found in Qatar) are in the aquifers Doha, South Qatar and North Qatar, whereas the highest percentage of wells with high salinity are in the aquifers Wadi al Urayq, Al Masahabiya, but also in South Qatar.
4. Most of the aquifers show an increasing trend regarding salinity.
5. Groundwater levels in Central Qatar and North Qatar show no significant trend and are slightly above sea level. However, the groundwater levels of Al Mashabiya are significantly below sea level with a decreasing trend.

5.3.1 Statistics and indicators

5.3.1.1 Salinity

The following Figure 5-1 presents the percentage of wells in Qatar per FAO salinity class from observation period April 1998 – September 2012. Figure 5-2 presents the same information without considering wells in coastal zones (sub-catchment code K).

It can be seen that in that from April 1998 – September 2012 the percentage of non-saline wells has diminished from 8% to 0%. The percentage of slightly saline wells (classified by FAO as irrigation water) has decreased from 19% to 11% (20% to 12% in Figure 5-2) whereas the total percentage of wells classified as highly saline or higher has increased from 17% to 20% (14% to 19% in Figure 5-2).In the year 2012 69% (70% if coastal areas excluded) of the wells were classified as moderately saline, which makes the water harmful to more sensitive crops and causes soil salinity and sodicity hazard (see Water and Agricultural Vision for Qatar by 2020).

Figure 5-1: Percentage of all wells in Qatar per FAO salinity class from April 1998 – September 2012

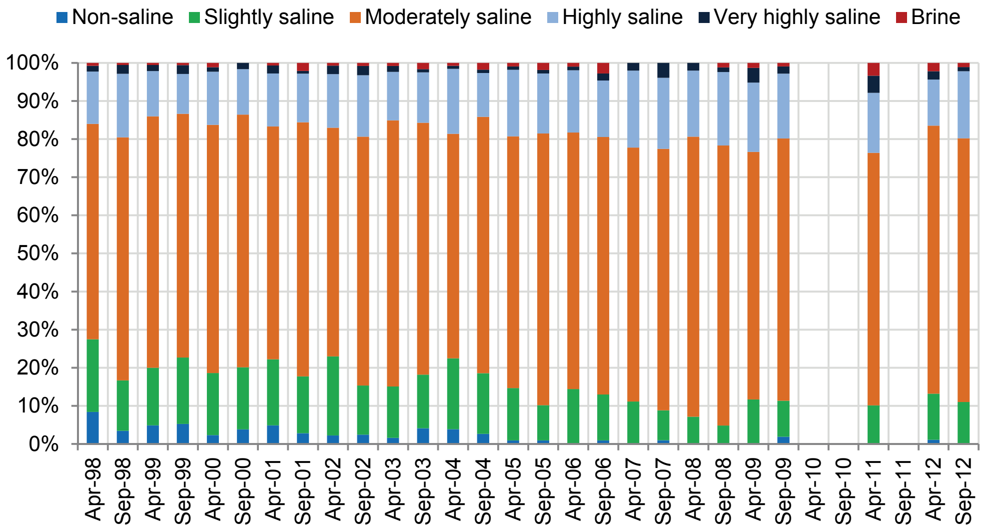
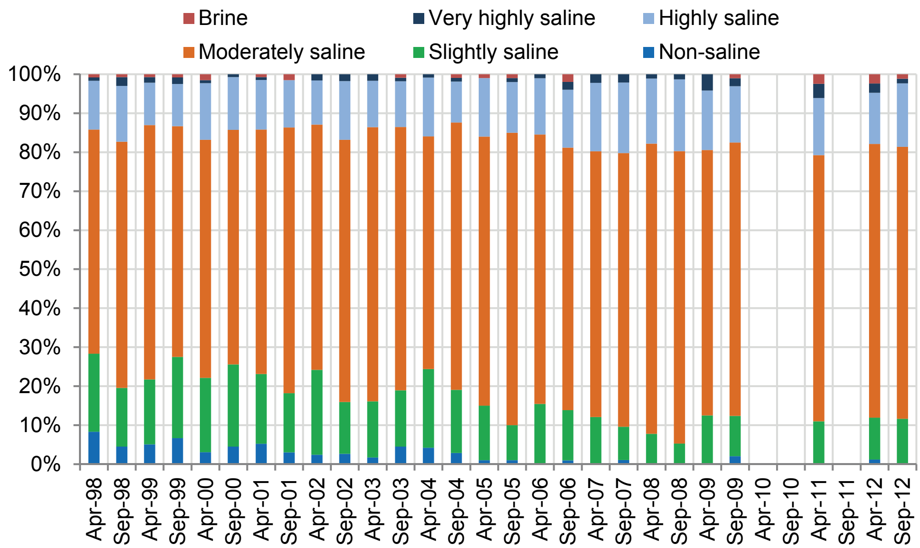


Figure 5-2: Percentage of all wells in Qatar, excluding those in coastal sub-catchments, per FAO salinity class from April 1998 – September 2012



The following example presents the trend of salinity according to FAO salinity classes in North Qatar and Al Mashabiya:

- In North Qatar since 2008 no well has provided non-saline water. The percentage of wells with highly saline water, very highly saline water and Brine has increased from 11% in April 1998 to 17% in September 2012. In September 2012 no well was non-saline, 9% slightly saline, 74% moderately saline, 13% highly saline and 4% brine. See following Figure 5-3.
- In Al Mashabiya since 1998 not one single well provided non-saline water. The percentage of wells with highly saline water, very highly saline water and Brine was 31% in April 1998 and in September 2012, with seasonal variations in the years in between. In September 2012 no well was non-saline or slightly saline, 69% moderately saline, 25% highly saline and 6% very highly saline. See following Figure 5-4.

Figure 5-3: Percentage of al wells in North Qatar per FAO salinity class from April 1998 – September 2012

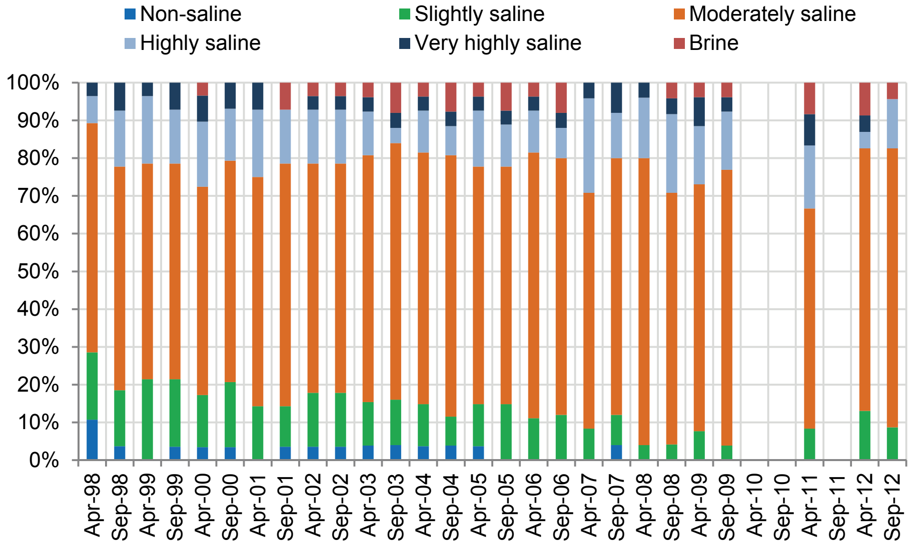
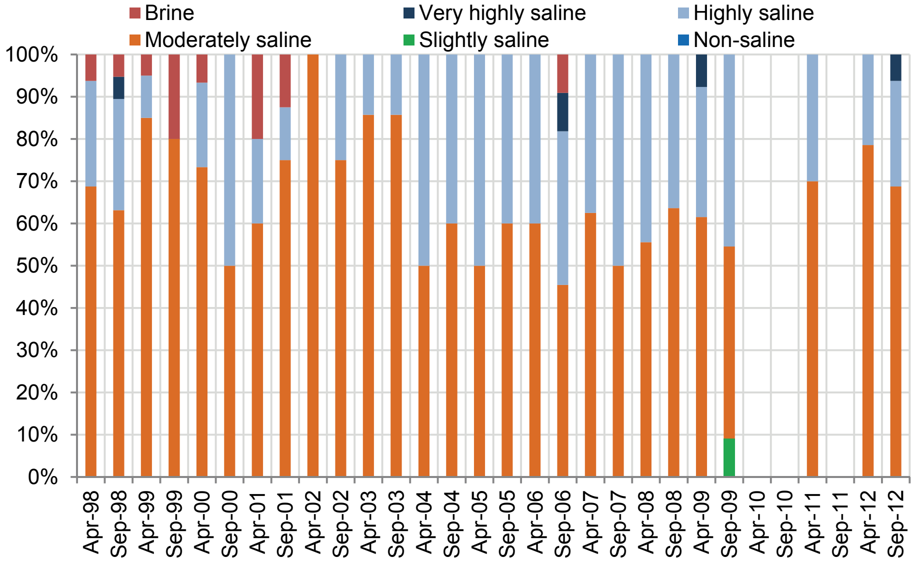
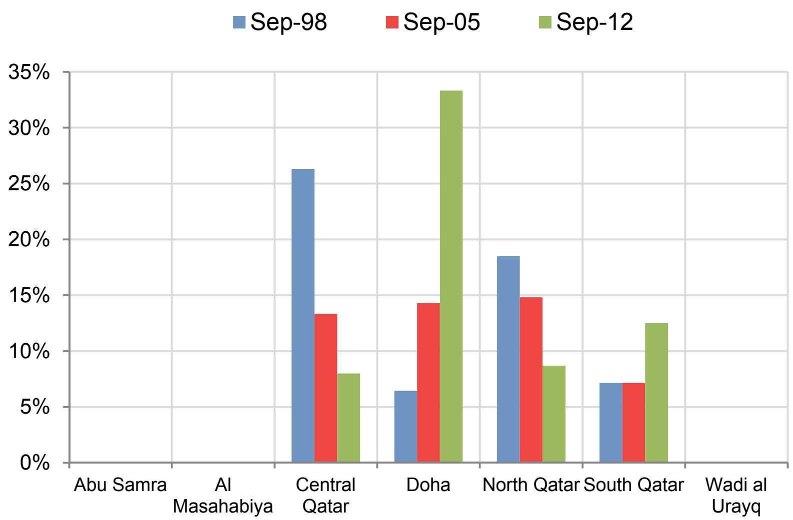


Figure 5-4: Percentage of al wells in Al Masahabiya per FAO salinity class from April 1998 – September 2012



The following Figure 5-5 presents the percentage of wells classified as non-saline or slightly saline in different areas of Qatar from September 1998 – September 2012. In 3 areas (Abu Samra, Al Masahabiya and Wadi al Urayq) all wells are moderate saline or higher. The percentage of wells with slightly saline or non-saline water has decreased in two areas (Central Qatar and North Qatar) whereas it has increased in Doha and South Qatar. However, in September 2012 none of the wells had non-saline water.

Figure 5-5: Percentage of wells classified as non-saline and slightly saline in different aquifers from 1998 - 2012



The following Table 5-2 as well as Figure 5-6 and Figure 5-7 present the trend (median) of salinity, measured as conductivity (dS/m) and total dissolved solids (TDS in ppm) for the 4 aquifers Al Masahabiya, South Qatar, Central Qatar and North Qatar.

It can be seen that across the entire period from 1998-2012 all 4 aquifers are moderately saline and are increasing in salinity (conductivity). According to the available data TDS is slightly decreasing in Al Masahabiya, North Qatar and South Qatar.

Table 5-2: Salinity in aquifers monitored from 1998 – 2012: Minimum and maximum median values (median of all wells per aquifer and observation period) and trend.

Aquifer	Conductivity (dS/m)			TDS (ppm)		
	Min	Max	Trend	Min	Max	Trend
Al Masahabiya	5.70	10.22	Increasing	3780	7368	Slightly decreasing
North Qatar	4.25	6.01	Increasing	2550	3840	Slightly decreasing
Central Qatar	3.32	10.54	Increasing	1920	6330	Increasing
South Qatar	5.03	7.75	Increasing	3205	5280	Slightly decreasing

Figure 5-6: Trend of conductivity in selected aquifers (median)

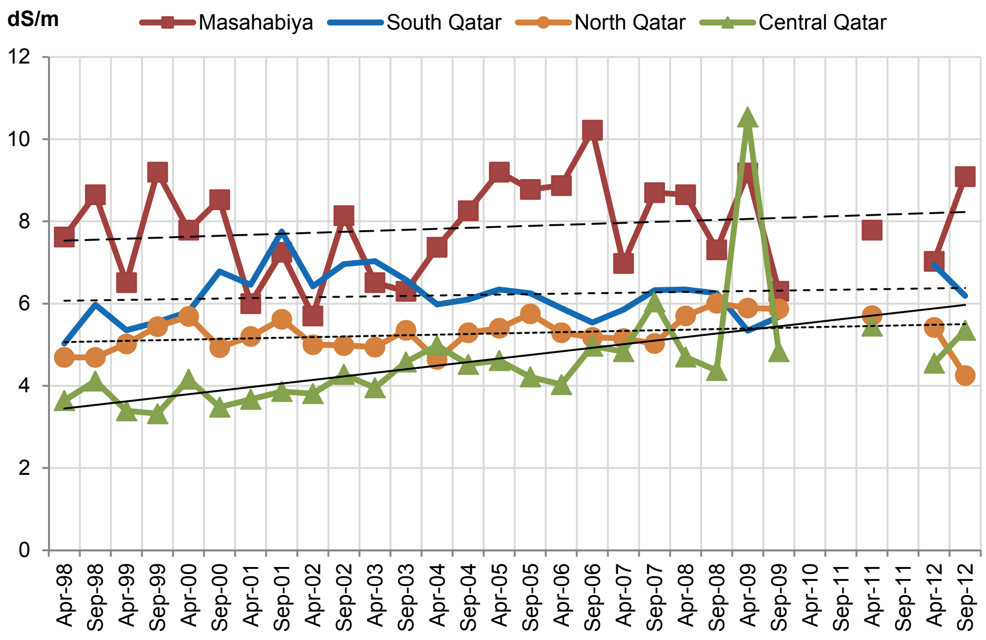
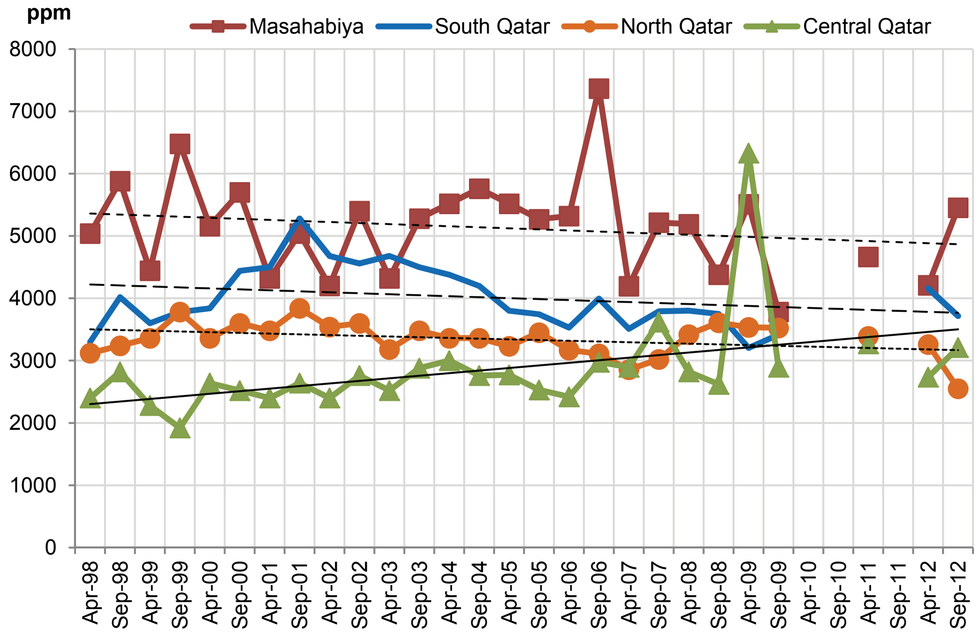


Figure 5-7: Trend of total dissolved solids (TDS) in selected aquifers (median)



The aquifers with the highest observed salinity (median of conductivity and TDS) in 2012 are Wadi Al Urayq, Masahabiya and South Qatar (see following Figure 5-8 and Figure 5-9).

Figure 5-8: Conductivity in September 2012 (median of all wells per aquifer), values for Doha and Wadi Al Urayq from April 2012.

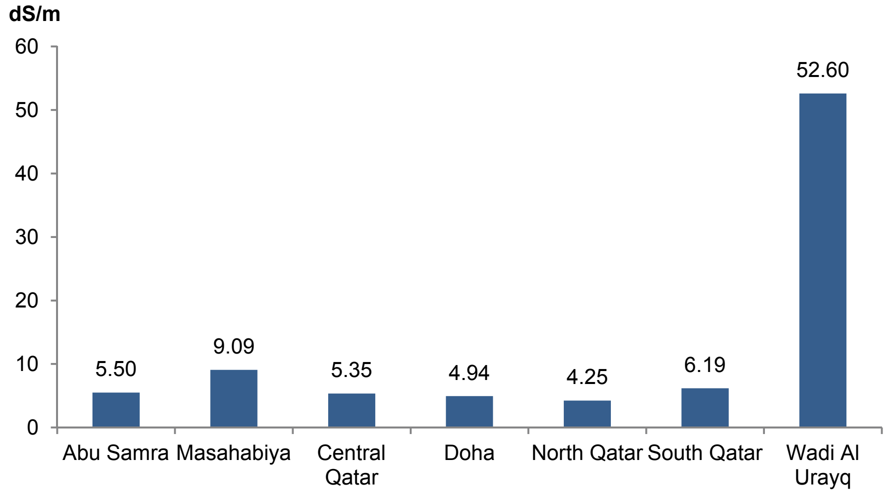
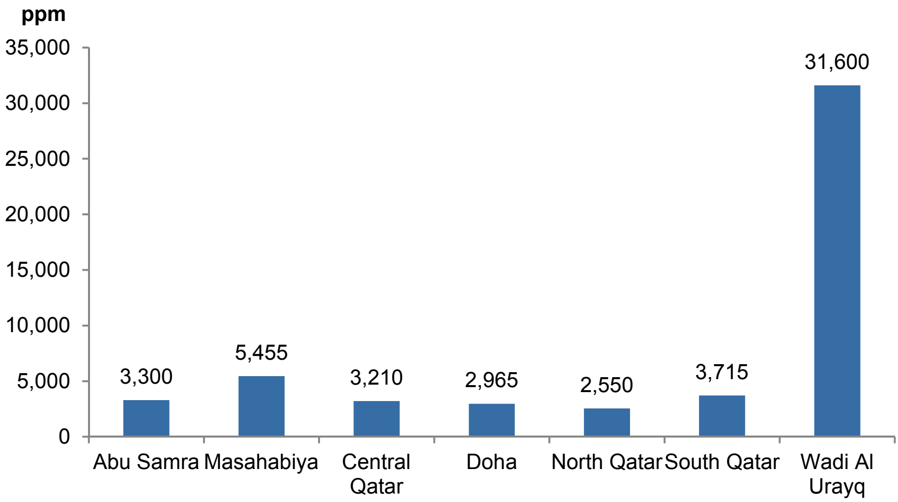


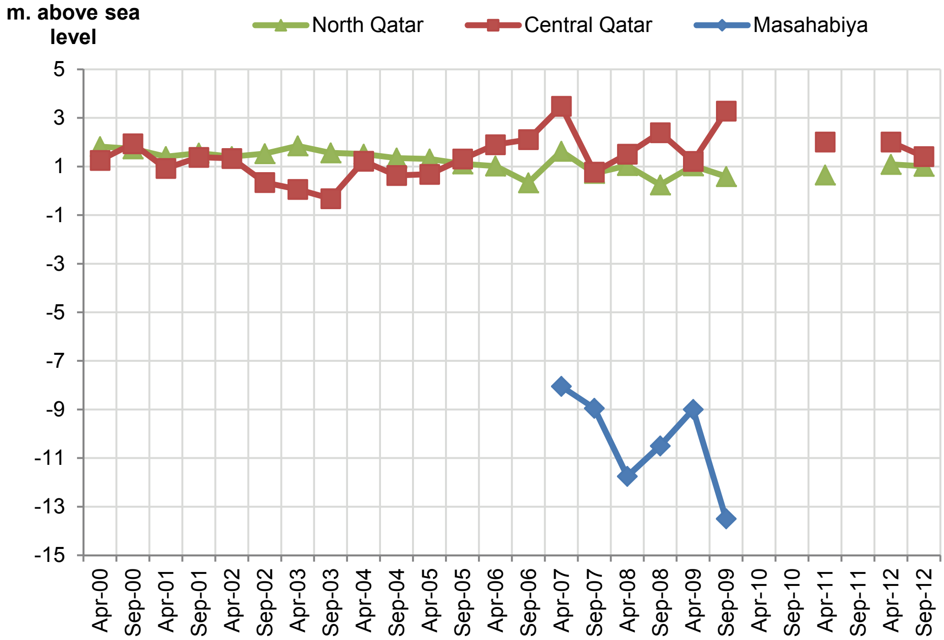
Figure 5-9: Total dissolved solids in September 2012 (median of all wells per aquifer), values for Doha and Wadi Al Urayq from April 2012.



5.3.2 Groundwater levels

Reliable time series for the levels of certain groundwater aquifers are available from April 2000 – September 2012. The following Figure 5-10 shows the median of the observed levels of groundwater aquifers of North Qatar, Central Qatar and Al Masahabiya. According to this Groundwater levels in North Qatar show a decreasing trend and were only 1 m above sea level in 2012 (median). The groundwater levels in Central Qatar are volatile over time but show no significant long-term trend (median). In the short observation period for Al Masahabiya a trend downwards can be seen. The median of the observed water levels was already 13.5 m below sea level in September 2009.

Figure 5-10: Time series of levels of groundwater aquifers in North Qatar, Central Qatar and Al Masahabiya (median of all available observations)



6. Glossary

BOD	Biological Oxygen Demand	الطلب على الأكسجين البيولوجي
COD	Chemical Oxygen Demand	الأكسجين الكيميائي الطلب
dS/m	Decisiemens per meter	وحدة قياس درجة السريان أو توصيل التيار الكهربائي (ديسي سيمنس لكل متر)
FAO	Food and Agriculture Organization of the United Nations	منظمة الأغذية و الزراعة للأمم المتحدة
GDP	Gross Domestic Product	الناتج المحلي الإجمالي
GSDP	General Secretariat for Development Planning	الأمانة العامة للتخطيط التنموي
LTAA	Long-term Annual Average	طويل الأجل المتوسط السنوي
MDPS	Ministry of Development Planning and Statistics	وزارة التخطيط التنموي والإحصاء
MMUP	Ministry of Municipality and Urban Planning	وزارة البلدية والتخطيط العمراني
MoE	Ministry of Environment	وزارة البيئة
MoEI	Ministry of Energy and Industry	وزارة الطاقة والصناعة
QMD	Qatar Meteorological Department	دائرة الأرصاد الجوية قطر
QSA	Qatar Statistics Authority	جهاز الإحصاء
UWWTP	Urban Wastewater Treatment Plant	محطة معالجة مياه الصرف الصحي في المناطق الحضرية
WHO	World Health Organization	منظمة الصحة العالمية
WMO	World Meteorological Organization	المنظمة العالمية للأرصاد الجوية

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