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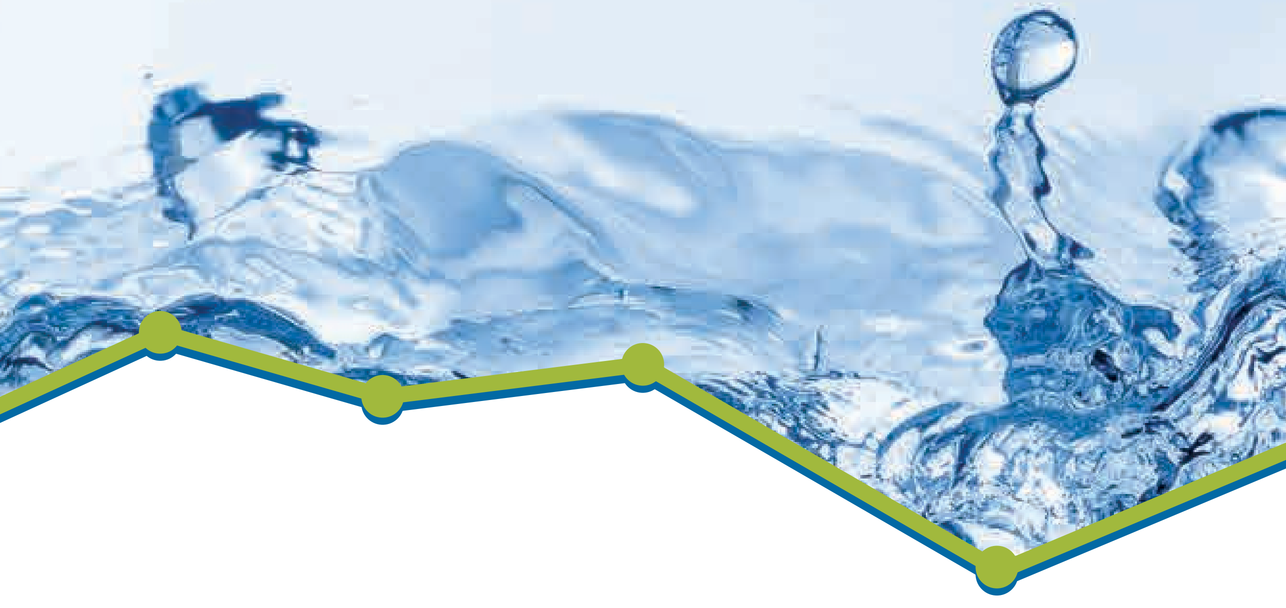
Planning and Statistics Authority

Water Statistics

In the state of Qatar 2017



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Planning and Statistics Authority

WATER STATISTICS
In the state of Qatar, 2017

December, 2018

H.H. Sheikh Tamim Bin Hamad Al-Thani

Emir of the State of Qatar

Preface

Allah the Exalted said in Holy Quran: "We made from water every living thing"*. Hence, water is life!

The protection of our national natural freshwater resources is part of our National Development Strategy.

Qatar relies on seawater desalination as the primary source for drinking water and on groundwater abstraction for agricultural purposes. The re-use of treated wastewater has become an important alternative source of water for agricultural and green spaces irrigation.

Water policies of Qatar have achieved several successes, including safe drinking water for all population, minimum water loss, high-level treatment of urban wastewater and re-use of large proportions of treated wastewater. Statistics show that water use efficiency has increased in most economic sectors.

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

According to available statistics, there is still the potential to increase the re-use of treated wastewater, so that household and economic activities will become more efficient in water consumption and reduction of water loss.

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

This 3rd Water Statistics Report gives a comprehensive overview on water sources and uses. Publishing this report is an important step to support knowledge based decision-making in the water sector.

Dr. Saleh bin Mohamed Al-Nabit

President of Planning and Statistics Authority

(*) Sura Al-Anbiyaa (The Prophets), Verse 30

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1. General information

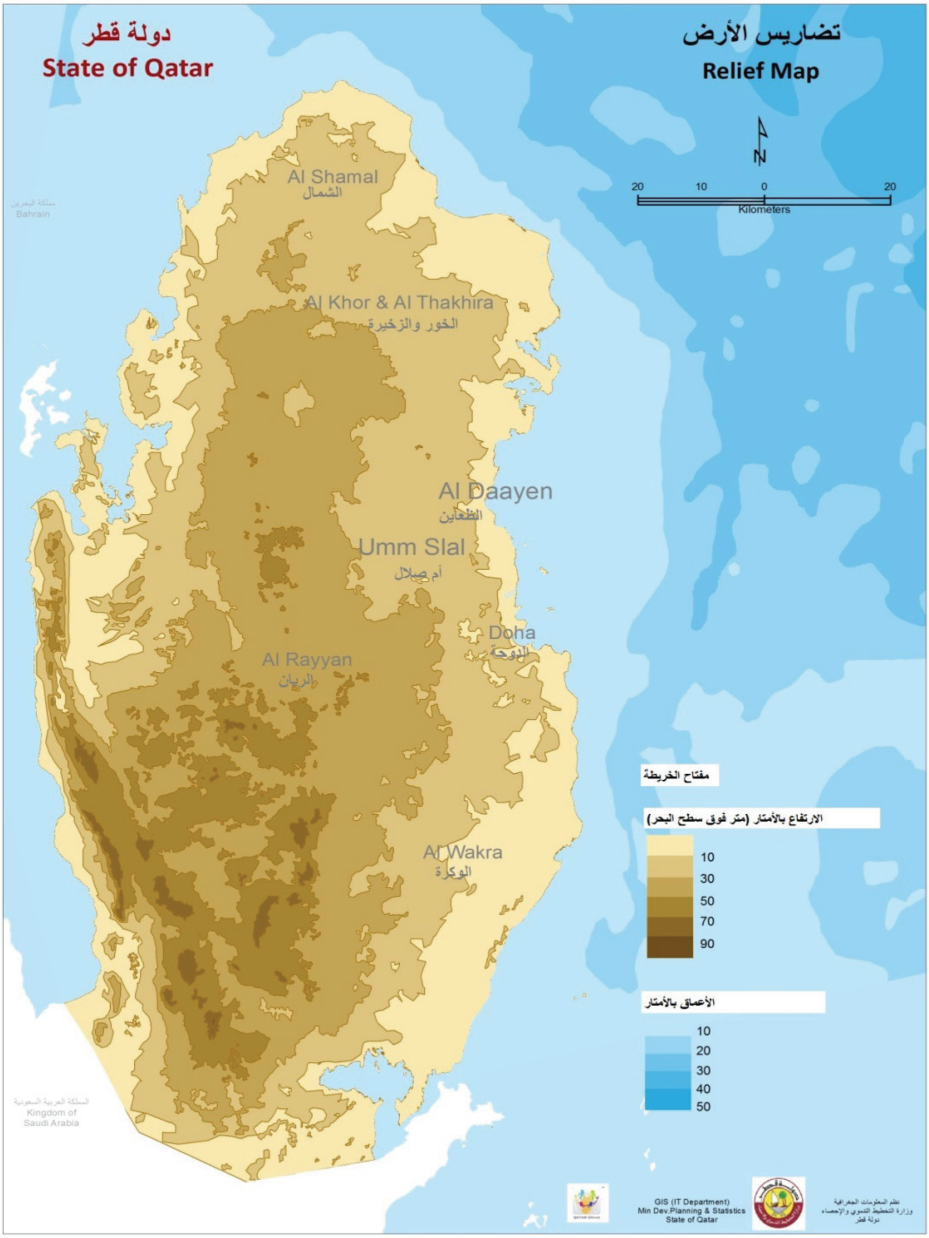
Qatar is situated midway along the western coast of the Arabian Gulf between latitudes 24.27˚-26.10˚ North and longitudes 50.45˚ – 51.40˚ East. Its surface area is 11,651 km2, which includes several small islands in the Arabian Gulf such as Halul, Shira'who, Al-Ashat and Al-Bishiria.

The peninsula is approximately 185 km in length and 85 km in width. The waters of the Arabian Gulf surround 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. Most of the country's land 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).

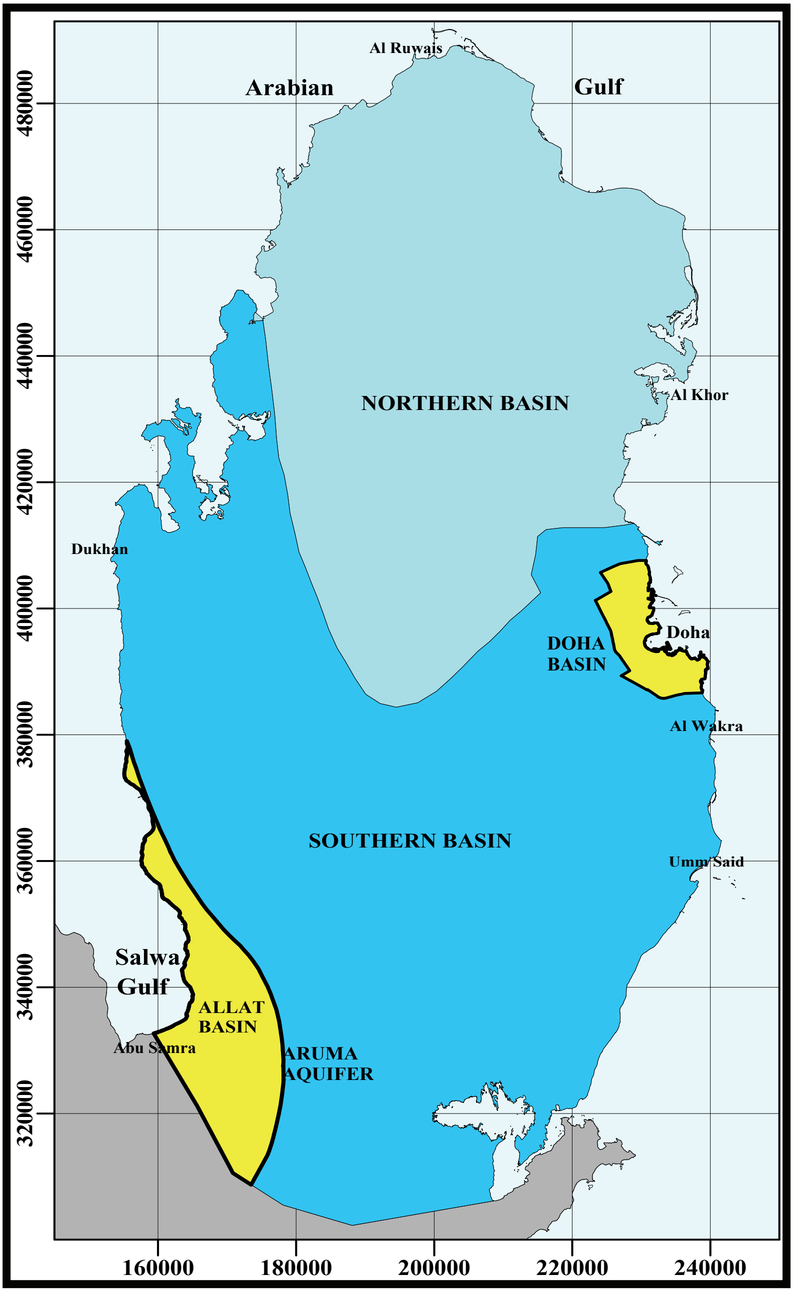
Map 1-1: Relief Map of Qatar



Source: Planning and Statistics Authority

Qatar's main groundwater basins include the Northern Basin, Southern Basin, Doha basin and the Allat Basin. (See Map 1-2).

Map 1-2: Groundwater Basins in the State of Qatar



Source: Ministry of Municipality and Environment

2. Water Indicators in Sustainable Development

Table 2-1: Water Indicators in Sustainable Developments (2012-2017)

Goal	Objective	Indicator	Indicator Name	2012	2013	2014	2015	2016	2017
3	**Ensure healthy lives and promote well-being for all at all ages**								
3	3.9	3.92	Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)	0	0	0	0	0	0
3	Mortality rate attributed to environmental risks per 100,000 population (2012-2016)		Unsafe water	0	0	0	0	0	0
			Unsafe water	0	0	0	0	0	0
			Lack of hygiene materials	0	0	0	0	0	0
6	**Ensure availability and sustainable management of water and sanitation for all**								
6	6.1	6.1.1	Proportion of population using safely managed drinking water services	100%	100%	100%	100%	100%	100%
6	6.2	6.2.1	Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	100%	100%	100%	100%	100%	100%
6	6.3	6.3.1	Proportion of wastewater safely treated	86.7%	89.8%	93.9%	99.1%	99.1%	
6	6.3	6.3.2	Proportion of bodies of water with good ambient water quality	...	...	...	...	...	...
6	6.4	6.4.1	Change in water-use efficiency over time	Water Efficiency in the Agricultural, Industrial and Commercial Sector (QR / L)					
			GDP in commercial activities (constant prices 2004 & 2013) (QR) / Quantity of water used in agriculture sector (liters)	0.002	0.002	0.003	0.003	0.003	
			GDP in commercial activities (constant prices 2004 &2013) (QR) / Quantity of water used in industrial sector (liters)	49.8	50.3	50.5	46.5	51.5	
			GDP in commercial activities (constant prices 2004 &2013) (QR) / Quantity of	1.34	1.94	2.10	2.09	1.29	

Goal	Objective	Indicator	Indicator Name	2012	2013	2014	2015	2016	2017
			water used in commercial sector (liters)						
6	6.4	6.4.2	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	100.0 %	91.4%				
6	6.5	6.5.1	Degree of integrated water resources management implementation (0-100)					82%	82%
6	6.b	6.b.1	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	100%	100%	100%	100%	100%	100%

...: Unavailable from the source

Source: Sustainable Development Goals Report Qatar 2017

3. Water resources

3.1 Rationale

Qatar's only natural freshwater resources are rainfall and groundwater. The conservation of the quality and quantity of the country's groundwater resources is one of the targets of Qatar's NDS 2011-2016 and Qatar's NDS 2018-2022.

The Table 3-1 shows the natural long term water balance (1998 – 2016) of Qatar's groundwater basins. The groundwater safe yield amounted to 55.8 million m^3 per year. However, the current groundwater abstraction reached 250.8 million m^3 per year, leading to depletion of aquifers, low groundwater levels, and increased salinity.

Table 3-1: Natural water balance of Qatar's aquifers (Annual average 1998-2016)

No.	Water balance	Million m^3/year	Data source
1	Recharge of aquifers from rainfall	71.6	Kahramaa and Ministry of Municipality and Environment (Long-term annual average 1998-2017)
2	Inflow from Saudi Arabia	2.2	Al Dour Zone (Long-term annual average 2006)
3	Total renewable water resources*	73.8	Total (1+2)
4	Groundwater outflow into sea and deep saline aquifers	18.0	Kahramaa and Ministry of Municipality and Environment (Long-term annual average 1998-2017)
5	Average annual water balance (groundwater safe yield) **	55.8	Subtraction (3-4)

* According to FAO Aquastat, OECD, UNSD and Eurostat

** Without the returns from irrigation

Data source: Ministry of Municipality and Environment, and Kahramaa

There are also several ongoing projects to artificially increase the water recharge into aquifers (e.g. via recharge wells) and the artificial injection of TSE and distilled water. The irrigation return flow plays a significant role the overall water balance.

3.2 Key messages

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

b) In 2008 – 2017, the total rainfall (monitored at Doha International Airport) was lower than the long-term average rainfall (1962-2017), with an exception to the total rainfall in the years 2016 and 2015. The average rainfall in the year 2017 in Doha International Airport formed a percentage of 92.3% 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; 92% of total abstracted groundwater).

d) The annual water deficit (mainly caused by groundwater abstraction) varied from 97 million m^3/year and 158 million m^3/year during the period 2008 – 2016. Thus the deficit decreased by 38.6%.

e) Artificial recharge of groundwater aquifers by TSE injection, recharge wells and recharge from irrigation is the chief source for the national groundwater reserve (54.6% of the annual additions to the groundwater reserve; 43.4% of which from rainfall and about 2% from inflow from Saudi Arabia.

3.3 Statistics and Indicators

3.3.1 Rainfall

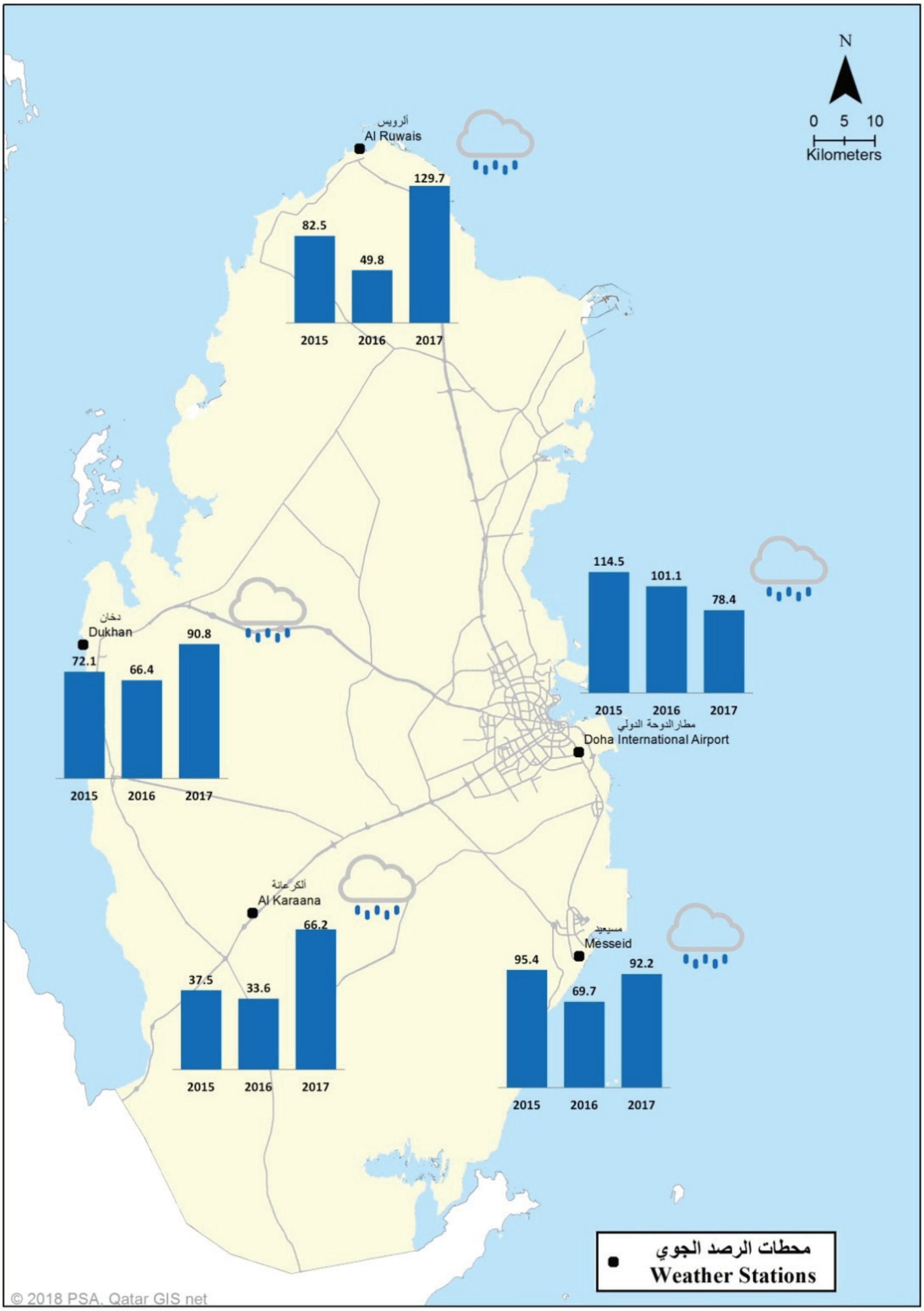
Compared to the long-term average (1962-2017), the year 2017 is considered relatively less rainy with a total rainfall of 78.4 mm at Doha International Airport Station; i.e. 92.3% of the long-term average rainfall. In 2017, the highest annual rainfall was recorded at Al-Ruwais Station vis-à-vis the other monitoring stations. The lowest rainfall (66.2 mm) was recorded in Al-Karaana. As for the rainfall by month, no rainfall recorded in Qatar during June-August 2017. (See table 3-2).

Table 3-2: Rainfall (mm) at selected monitoring stations in Qatar 2010-2017

Station (mm)	2010	2011	2012	2013	2014	2015	2016	2017
Umm Said	24.8	30.3	17.6	36.6	73	95.4	69.7	92.2
Al-Ruwais	33.8	93.8	40	98.3	56.5	82.5	49.8	129.7
Dukhan	10	33.8	35.8	54.7	44.6	72.1	66.4	90.8
Doha International Airport	33.1	70.5	23.9	41.6	52.4	114.5	101.1	78.4
Al-Karaana	27.1	22.0	32.9	56.3	53.4	37.5	33.6	66.2

Data source: Civil Aviation General Authority – QMD

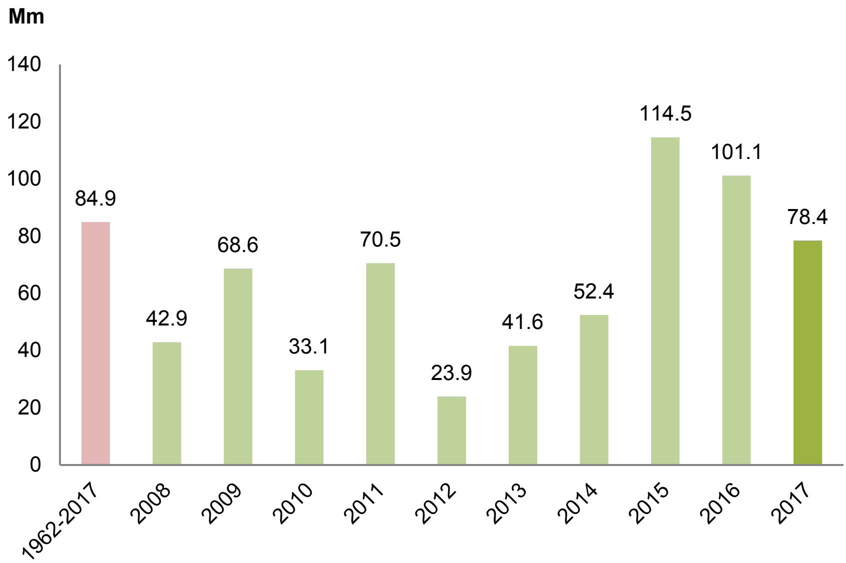
Map 2.2: Rainfall by years and selected stations (mm) 2015-2017



Source: Planning and Statistics Authority

Figure 3-1 shows that the annual rainfall for the period (2008 – 2017) was lower than the long-term annual average of rainfall (1962-2017), except for 2015 and 2016. The annual rate dropped in 2017.

Figure 3-1: Annual rainfall at Doha International Airport Station 2008-2017 compared to the long-term annual average rainfall (1962-1992)

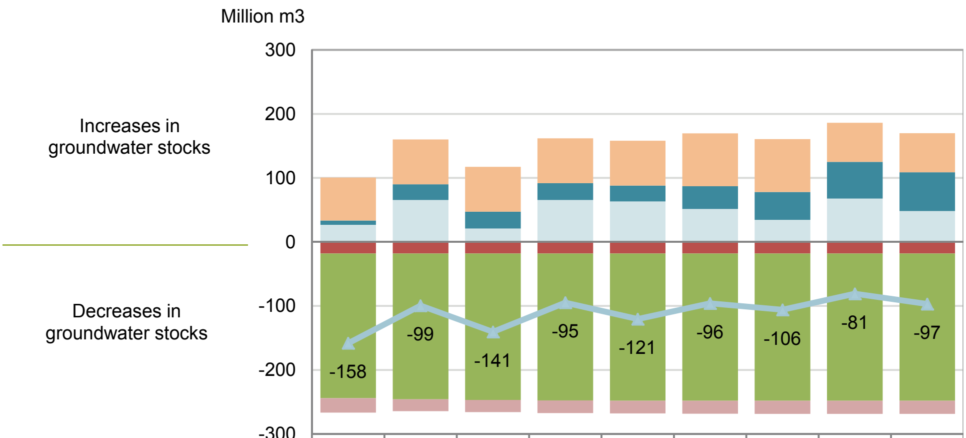


Data source: Qatar Civil Aviation Authority, QMD

3.3.2 Water Balance

Figure 3-2 displays the water balance from 2008 to 2016. The total increase in stocks (total recharge from rainfall, inflow from Saudi Arabia, artificial recharge, and irrigation returns) increased from 108 million m^3 in 2008 to 172 million m^3 in 2016. However, the water balance decrease remained relatively unchanged between 266 and 269 million m^3 per year for the same period. Consequently, an annual water deficit ranging from 158 million m^3 and 97million m^3 came into being during the period 2008-2016.

Figure 3-2: Water balance 2008 - 2016

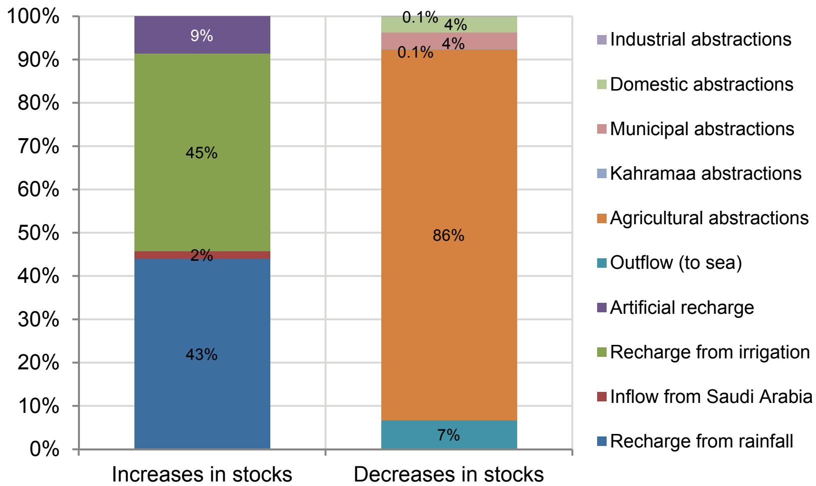


	2008	2009	2010	2011	2012	2013	2014	2015	2016
Municipal and industrial abstractions	-23	-19	-19	-20	-20	-20	-21	-21	-21
Agricultural abstractions	-226	-228	-229	-229	-230	-230	-230	-230	-230
Outflow (to sea)	-18	-18	-18	-18	-18	-18	-18	-18	-18
Recharge wells and irrigation recharge	67	70	70	70	70	83	83	61	61
TSE injection	7	24	26	26	25	36	43	57	61
Recharge from rainfall	27	66	21	66	63	52	35	68	48
Water balance	-158	-99	-141	-95	-121	-96	-106	-81	-97

Data source: Ministry of Municipality and Environment, Ashghal, Kahramaa; computations of PSA

The artificial recharge and irrigation returns represent the largest source of additions to water reserve. The decrease in water reserve is attributed to the water withdrawal for agricultural purposes. Figure 3-3 shows the increase and decrease proportions in water reserve for 2016.

Figure 3-3: Increase and decrease in groundwater reserve as a percentage of total water 2016



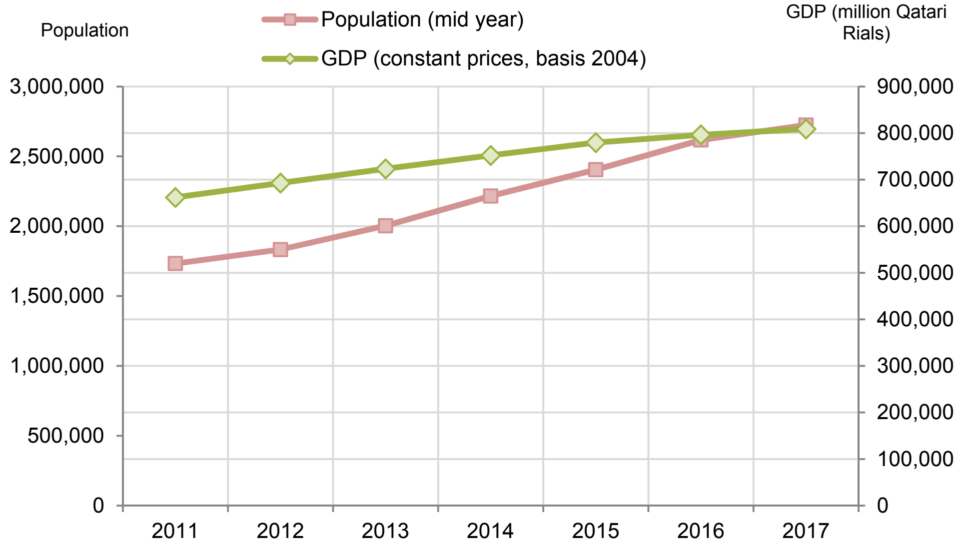
Data source: Ministry of Municipality and Environment, Ashghal, Kahramaa; computations of PSA

4. Water production, abstraction and use

4.1 Rationale

Qatar's economy is a rapidly growing with an ongoing population growth (mainly expatriates). Figure 4-1 shows that during the period 2011-2017 the population rose from 1,732,717 to 2,724,606; an increase of (+ 57%). The annual GDP increased from QR661,794 million to QR808,858 million; a rise of (+ 22%) for the same period, i.e. the average annual growth rate is 7.8% for the population and 3.4% for the GDP. The measures taken to meet the water needs of Qatar's growing economy include the production of more water, increase of water reuses, and increased water use efficiency.

Figure 4-1: population Growth and GDP 2011 – 2017



Data source: Planning and Statistics Authority

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 include water generated by the GTL process, which is currently recycled in industries. Excess water is discharged without use. Data about the quantity of freshwater produced by the GTL process are currently not available.

4.2 Key messages

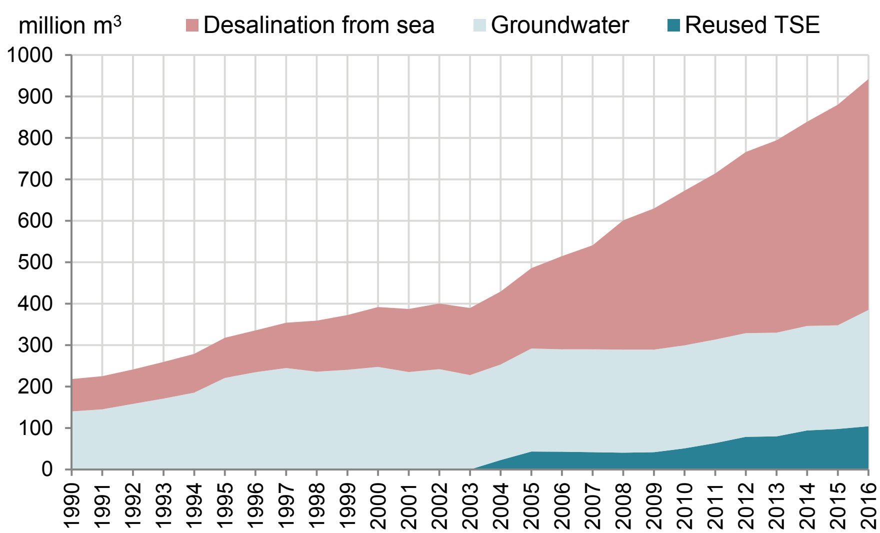
a) Total water production (desalination + fresh groundwater abstraction + re-use of TSE) rose from 220 million m^3 in 1990 to 912 million m^3 in 2016.
b) Water demand is accompanied with economic and population growth. GDP growth is slightly higher than the growth of water demand
c) Since 2005, abstraction from groundwater aquifers remain at the same annual level and has not shown a remarkable growth.
d) Total water loss of desalinated water was reduced from 29% in 2008 to 4% in 2016.
e) Productivity of water used in the entire economic activities has increased.

4.3 Statistics and Indicators

4.3.1 Water production and re-use

Figure 4-2 shows that in 1990 Qatar's only sources of water were groundwater abstraction (65%) and desalinated seawater (35%). Treated wastewater for agriculture and green spaces irrigation purposes (5%) entered into use in 2004, and increased to 13% in 2016. It is noteworthy that the main source of total water production is sea water desalination (61%), followed by groundwater abstraction (25%) in 2016. The total annual water production and re-use rose from 220 million m^3 in 1990 to 912 million m^3 in 2016, in addition to the water produced (i.e. desalinated) by industries for their own uses.

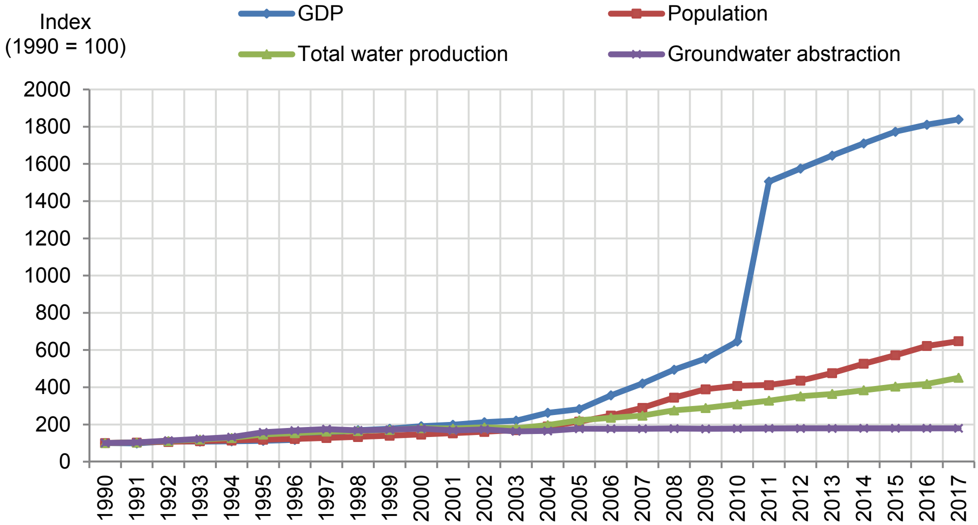
Figure 4-2: Total water production and re-use by source of water (million m^3) 1990 – 2016



Data source: MME, Ashghal, Kahramaa

Figure 4-3 below shows that the total water production is closely related to the economic and population growth. There is a slight divergence between GDP growth rate and total water production rate (groundwater abstraction + desalinated sea water + reused TSE). In 2005, it was clear that there was no relation between the growth rate of GDP and groundwater abstraction, and remained unchanged at the same level until 2016.

Figure 4-3: Growth rates of GDP (constant prices), population, total water production and groundwater abstraction (index base year 1990) 1990 - 2017

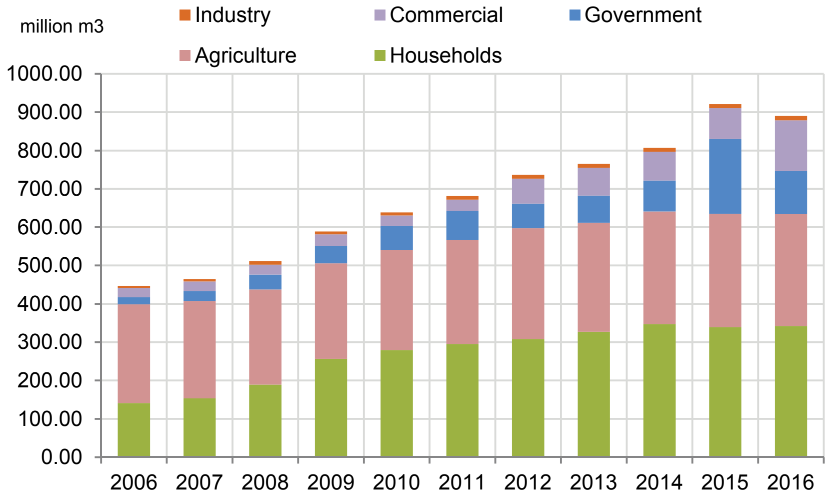


Data source: MDPS, MME, Ashghal, Kahramaa; calculated by PSA

4.3.2 Water use by economic sector

Statistics indicate that used water quantity (net of loss) increased from 447.27 to 890.24 million m^3 per year in the period 2006 – 2016. Figure 4-4 shows that most water uses were allocated for agricultural and domestic purposes. However, the highest growth rates could be seen during the period 2006-2016 in government sector at (+20%) and commercial sector at (+18%), whereas the growth of water use for agriculture amounted to (1.2%) (see Figure 4-5).

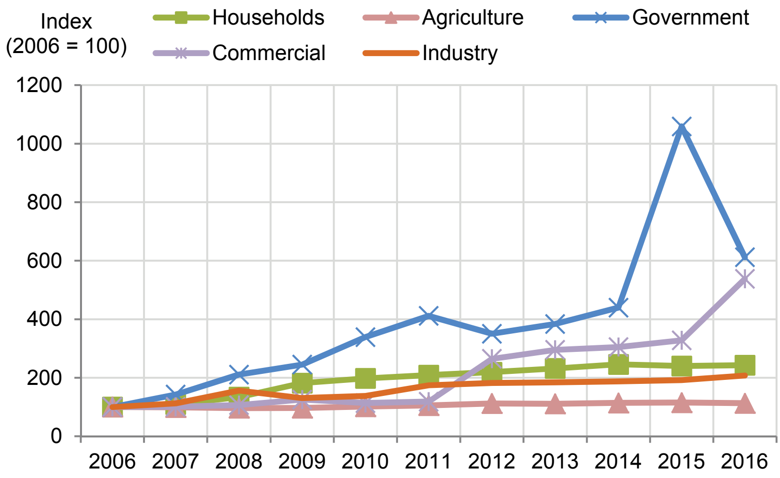
Figure 4-4: Water use by economic activity (million m^3) (excluding loss) 2006-2016



*Industry includes water supplied by Kahramaa and by industrial wells

Data source: Ashghal, Kahramaa, MME; calculated by PSA

Figure 4-5: Growth rates of water use by economic activity 2006 – 2016*
(Index base year 2006)



Data sources: Ashghal, Kahramaa, MME; calculated by PSA

* Data of 2017 not available from the source

As for the per-capita water use in different sectors except the agricultural sector (domestic, industrial, commercial and governmental sectors) Kahramaa statistics (see Table 4-1) indicate the presence of several values of this index according to the total water production, to the authorized consumption (including and excluding water loss), and to the water volume sent to the network (excluding real water loss).

Table 4-1: Annual per capita water consumption in different usages(M3/Year/Per capita) 2010-2016

	Per capita total water production	Per capita total water transported to the network (including loss)	Per capita consumption of the authorized volume of water transported to the network (excluding loss)	Per capita consumption of water transported to the network (excluding real loss)
2010	228	221	164	214
2011	228	223	177	204
2012	238	232	187	216
2013	227	222	176	208
2014	221	216	170	202
2015	220	214	179	203
2016	216	208	186	199

Data source: Kahramaa

4.3.3 Water loss

Water loss occurs during the transport of drinking water, or in wastewater sewers, or septic tanks, or during evacuation and transport septic tank's wastewater.

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

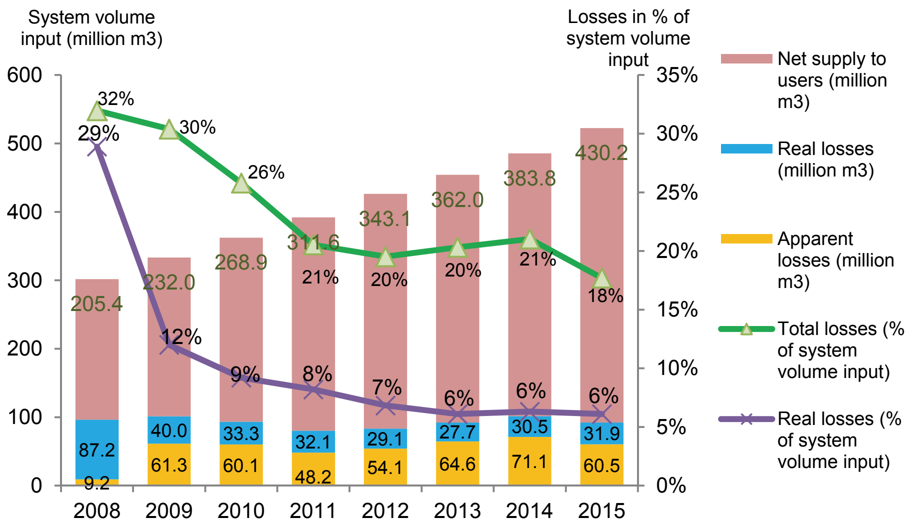
Apparent loss consist of unauthorized consumption (theft or illegal use), and all types of inaccuracies associated with production metering and customer metering. Under-registration of production meters, and over-registration of customer meters, leads to under-estimation of real losses. Over-registration of production meters, and under-registration of customer meters, lead to over-estimation of real loss.

Real loss is a physical water loss 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 loss is the sum of apparent loss and real loss.

With respect to analysis and indicators, it is extremely important to be explicitly clear which losses (total, real, apparent) are in discussion. The following Figure 4-6 presents the development of real loss and total loss from 2008 to 2015. Total loss has decreased from 32.0% to 17.7% and real loss from 28.9% to 6.1%. The Figure also shows that the total system volume input increased from 301.5 million m^3 in 2008 to 520 million m^3 in 2015. Meanwhile, the real loss in terms of volume slumped from 87 million m^3 in 2008 to 32 million m^3 in 2015.

Figure 4-6: Loss in distribution of drinking water 2008-2015*



Data source: Kahramaa

* Data of 2016-2017 not available from the source

Currently, there are no statistics on loss in wastewater sewers in the State of Qatar; however, only estimates exist. In terms of water quantity, the issue of groundwater leakage into the sewer seems to be of a larger concern than the actual water loss. 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).

4.3.4 Water use in agriculture

Water sources for agriculture consist of groundwater and reused TSE.

Statistics of Table 4.2 indicate that the total treated wastewater used for agriculture amounted to 32.7 million m^3 (12.7%) of the total water used for agriculture which accounted for 257.7 million m^3 in 2006. Whereas it reached 66.3 million m^3 (22%) out of total water used for agriculture which was 296.3 million m^3 in 2016, According to a study of Ashghal and Schlumberger (2013), water salinity at Doha wastewater treatment plants attains 1,000 mg/l, which is a major concern for water re-use in agriculture. From 2006 to 2016, the agricultural GDP increased from million QR 290 to million QR1020 (constant prices of 2004 and 2013).

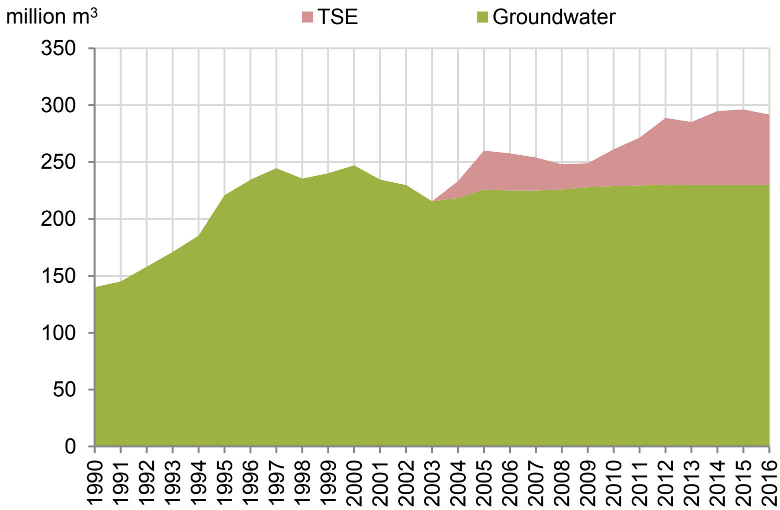
Table 4-2: Water used in agriculture by source and GDP of agriculture (Constant prices 2004 and 2013) 2006 – 2016

	Abstracted groundwater (million m3)	TSE (million m3)	Total (million m3)	GDP (million QR, constant prices, 2004 & 2013)
2006	225	32.69	257.69	290
2007	225	29.05	254.05	319
2008	226	22.15	248.15	436
2009	227.8	21.09	248.89	362
2010	228.88	32.28	261.16	433
2011	229.47	41.98	271.45	627
2012	230.05	58.71	288.76	656
2013	230	55.23	285.23	695
2014	230	64.92	294.92	869
2015	230	61.7	291.7	936
2016	230	66.29	296.29	1020

Data source: PSA, MME, and Ashghal.

Data about water use in agriculture is available since 1990. The following Figure 4-7 shows that the annual total water use in agriculture rose from 140 million m^3 in 1990 to 296 million m^3 in 2016. However, groundwater abstraction for agricultural purposes has roughly remained unchanged at the same level since 2005 (226 – 230 million m^3/year) and additional demand has been covered by TSE since 2004.

Figure 4-7: Water use in agriculture by source of water (million m^3) 1990 - 2016

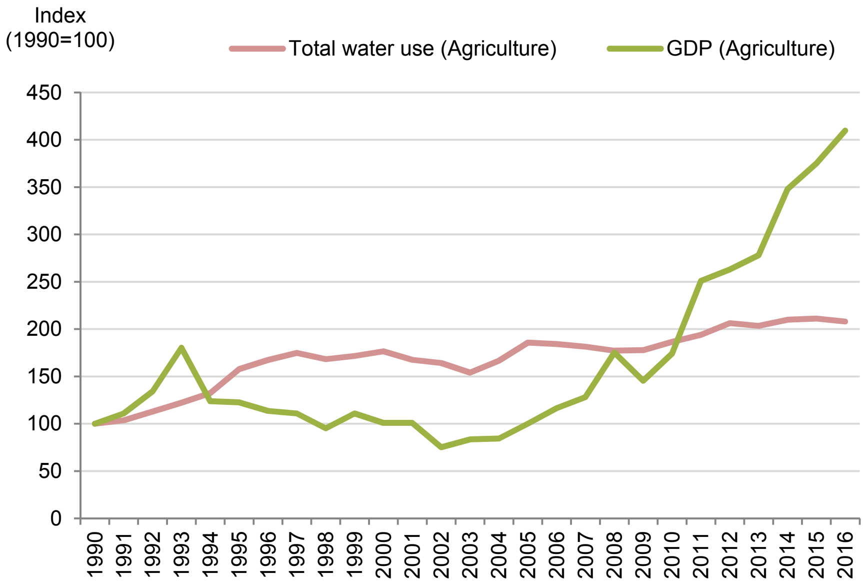


Data source: MME, Kahramaa and Ashghal

Water efficiency in agriculture: the 1990 statistics show that 562.25 liters of water were needed to produce 1 Q.R of GDP in agriculture. Whereas 287.01 liters of water were needed to produce 1 Q.R of GDP in 2016.

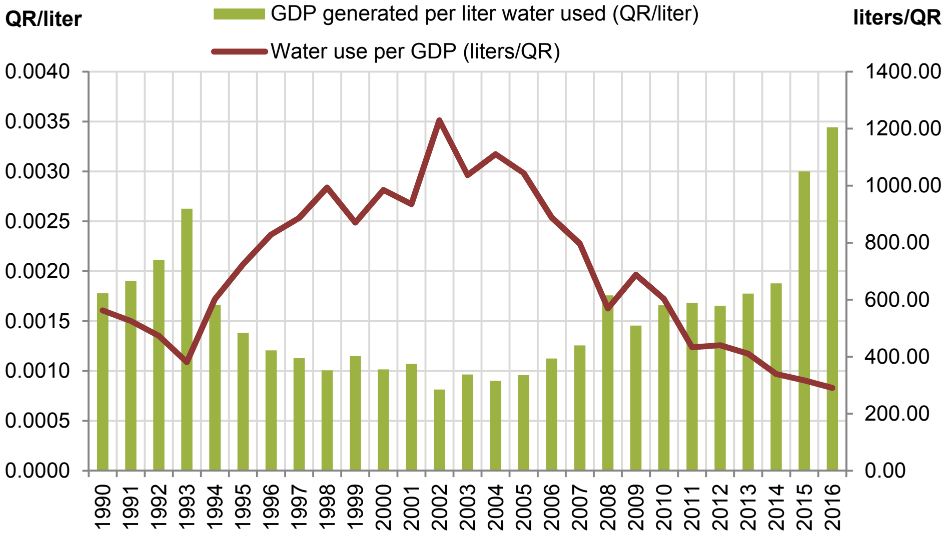
Water productivity in agriculture: water productivity of 2016 remained at the same level as the water productivity of 1990; one liter of water contributed to roughly QR 0.003 of GDP in agriculture. (See Figure 4.9)

Figure 4-8: Growth rate of water used in agriculture, and GDP (constant prices 2004 and 2013) 1990-2016 (index base year 1990)



Data sources: PSA, Ashghal, Kahramaa; Calculated by PSA

Figure 4-9: Water use efficiency (liter per Q.R of GDP) and water use productivity (GDP per each liter of water used) in agriculture 1990 – 2016 (in constant prices 2004 and 2013)



Data sources: PSA, Ashghal, Kahramaa; Calculated by PSA

4.3.5 Water use in the industrial sector and construction

For the sake of simplification (and in line with the actual data availability), the following economic activities are aggregated under the category of “industrial sector”:

- Mining and quarrying (include oil & gas)
- Manufacturing
- Electricity and water
- Building and construction

Industries in Qatar rely on three main sources of freshwater. They include water supplied by Kahramaa, water from groundwater wells for industrial purposes, and seawater desalinated in industrial establishments. For this latter type (desalination), data is unavailable. Therefore, analysis can only be done for that part of water which originates from groundwater (self-abstraction by industries) and water supplied by Kahramaa.

Statistics of Table 4.3 indicate an increase in the annual water used in industrial sector during the period 2006 - 2016 from 8.3 million m^3 to about 11.62 million m^3. In addition, the GDP (constant prices of 2016) of the industrial sector rose from 99,969 million Q.R to 540,060 million Q.R in 2016.

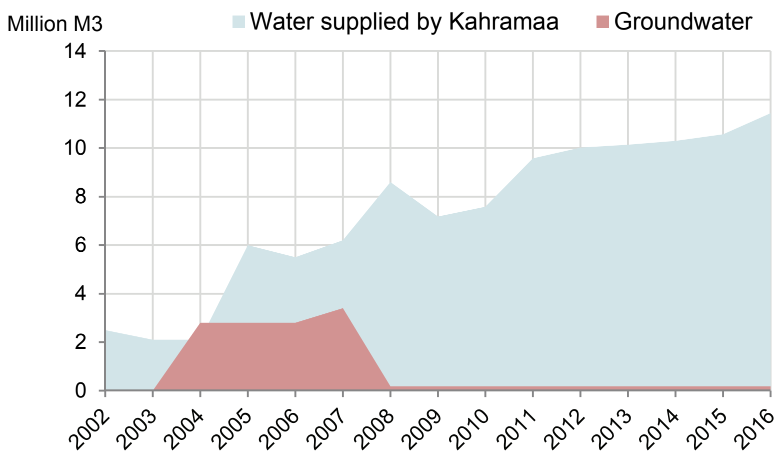
Table 4-3: Water used in industrial sector by source of water and GDP of industry (constant prices 2004 and 2013) 2006 – 2016

	Water supplied by Kahramaa (million m3)	Industrial groundwater wells (million m3)	Total water use (million m3)*	GDP (million QR, constant prices 2004 & 2013)**
2006	5.5	2.80	8.30	99,969
2007	6.2	3.40	9.60	115,349
2008	8.6	0.18	8.78	141,251
2009	7.18	0.18	7.36	149,909
2010	7.58	0.18	7.76	184,975
2011	9.58	0.18	9.76	160,292
2012	10.02	0.18	10.20	507,743
2013	10.14	0.18	10.32	519,149
2014	10.3	0.18	10.48	528,986
2015	10.57	0.18	10.75	553,494
2016	11.44	0.18	11.62	540,060

*: Excluding desalinated industrial water
**: Mining and quarrying (including oil and gas), manufacturing, electricity and water, and construction
Data sources: PSA, MME, Kahramaa

The total water used in industrial sector increased from about 2.5 million m^3 in 2002 to 11.62 million m^3 in 2016; the highest growth rates were registered during the period 2011 – 2016. (See Figure 4-10).

Figure 4-10: Water use in industry by source of water (million m^3) 2002 – 2016

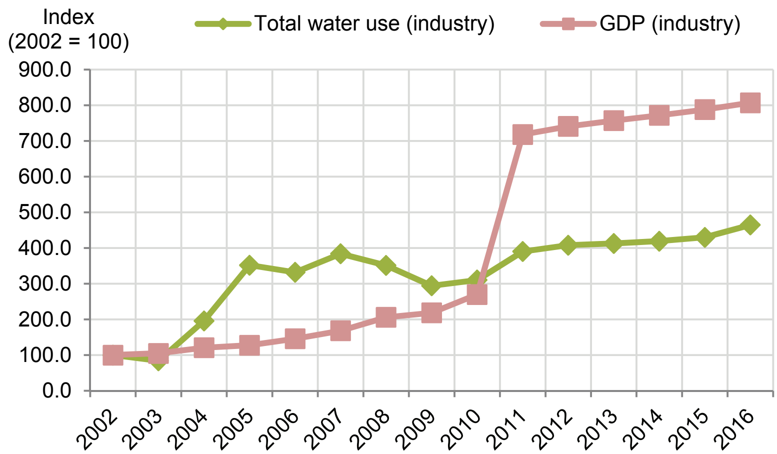


Data source: MME, and Kahramaa

Figure 4-11 shows that GDP growth in industry is related to some extent to water use. In 2010, about 0.042 liter of water was needed to produce 1 Q.R of industrial GDP, whereas 0.021 liter of water was needed to produce 1 Q.R of the same GDP in 2016. In other words, this means that the productivity of one liter of water was worth 23.84 Q.R of industrial GDP, whereas in 2016 the water productivity value increased to 47.63 Q.R of industrial GDP per liter. (See

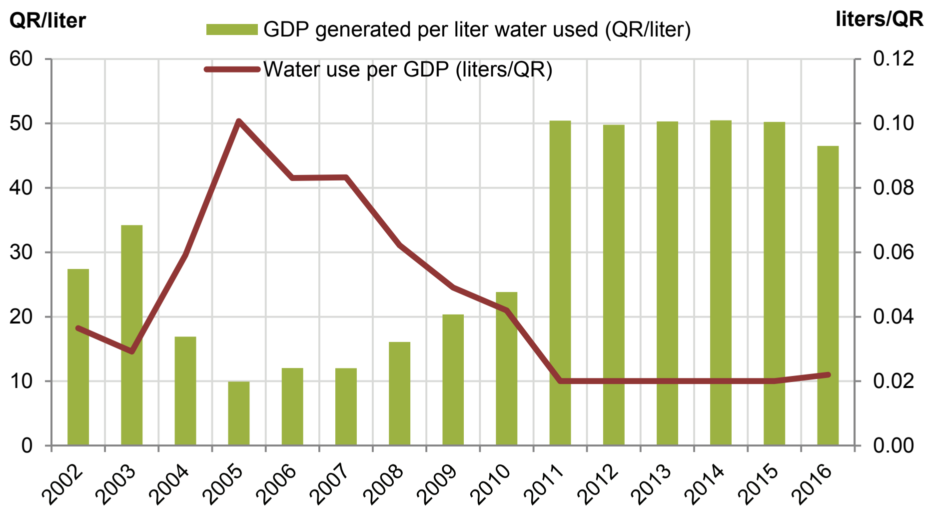
Figure 4-12).

Figure 4-11: Growth rate of water use in industry and GDP (constant prices 2004 and 2013) 2002-2016 (index base year 2002)



Data source: PSA, MME, Kahramaa, Calculated by PSA

Figure 4-12: Water use efficiency (liter/ QR GDP) and water use productivity (GDP per liter of water used) in industry 2002 – 2016 (constant prices of 2004 and 2013)



Data source: MDPS, MME, Kahramaa, Calculated by MDPS.

4.3.6 Water use in the commercial sector

For the sake of simplification (and in line with the actual data availability), the following economic activities are aggregated under the category of "commercial sector":

- 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.

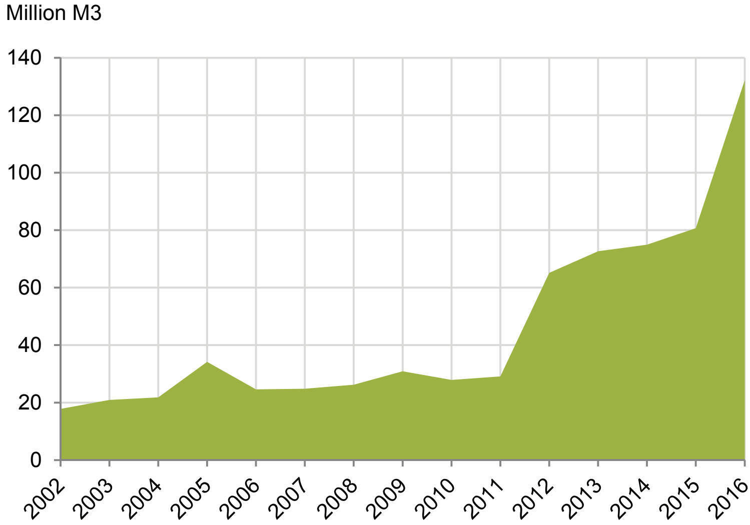
Table 4-4: Water used in commercial sector and commercial GDP (constant prices 2004 and 2013) 2006 – 2016

	Total water use (i.e. water supplied by Kahramaa)	GDP (million QR, constant prices 2013)
2006	24.6	38873
2007	24.8	49314
2008	26.2	56916
2009	30.9	69022
2010	27.9	73478
2011	29.1	11706
2012	65.2	126867
2013	72.7	140839
2014	74.97	157153
2015	80.65	168737
2016	132.25	171018

Data sources: PSA, Kahramaa

Figure 4-13 shows that the total water use in the commercial sector increased between 2002 and 2016 from 18 million m^3 per year to 132.25 million m^3.

Figure 4-13: Water use in the commercial sector (million m3) 2002 – 2016

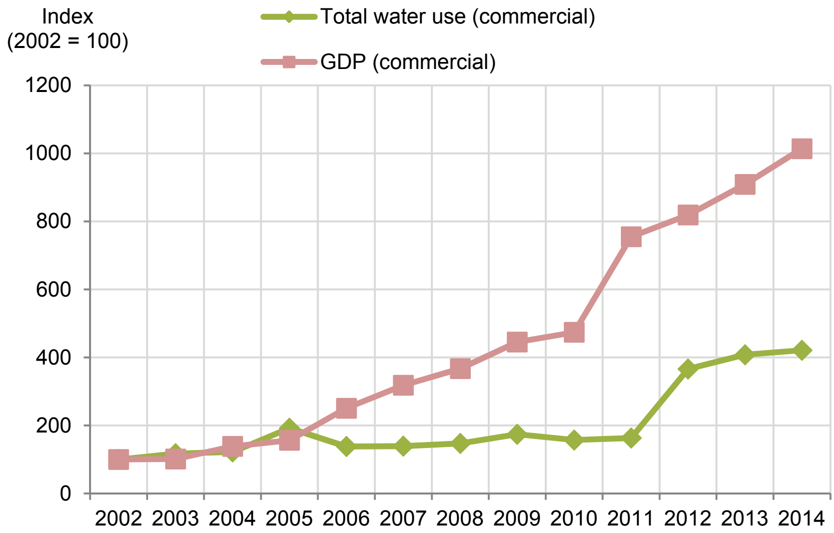


Data source: Kahramaa

Figure 4-14 shows that the growth of GDP in the commercial sector has not been related to the water use quantity since 2006.

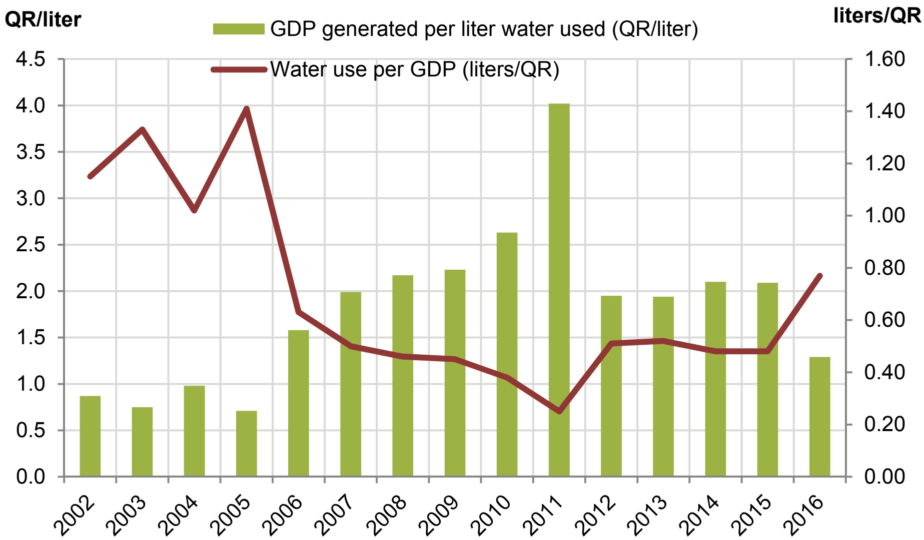
shows that about 1.15 liters of water were needed to produce 1 Q.R of commercial GDP in 2002, whereas only 77 liter of water was needed to achieve the same GDP in 2016. In other words, one liter of water used by commercial activities produced 0.87 Q.R of GDP in 2002, while one liter of water produced 1.29 Q.R of GDP in 2016 (constant prices of 2004 and 2013).

Figure 4-14: Growth rate of water use in commercial sector and GDP in commercial activities (constant prices 2004 2013) (index base year 2002) 2002-2016



Data sources: PSA, Kahramaa, Calculated by PSA

Figure 4-15: Water use efficiency (liter/ QR GDP) and water use productivity (GDP per liter of water used) in commercial sector 2002 – 2016 (constant prices of 2004 and 2013)



Data sources: PSA, Kahramaa

4.3.7 Water use in government sector

Water supplied by Kahramaa and TSE used for the irrigation of green spaces are the main water sources for the government sector. Statistics of table 4 5 and Figure 4-16 show that the water use in the government sector increased from 18 million m^3 in 2006 to 112.55 million m^3 in 2016. The percentage of 38% of the water used by government originated from re-used TSE in 2016 (used for the irrigation of green spaces).

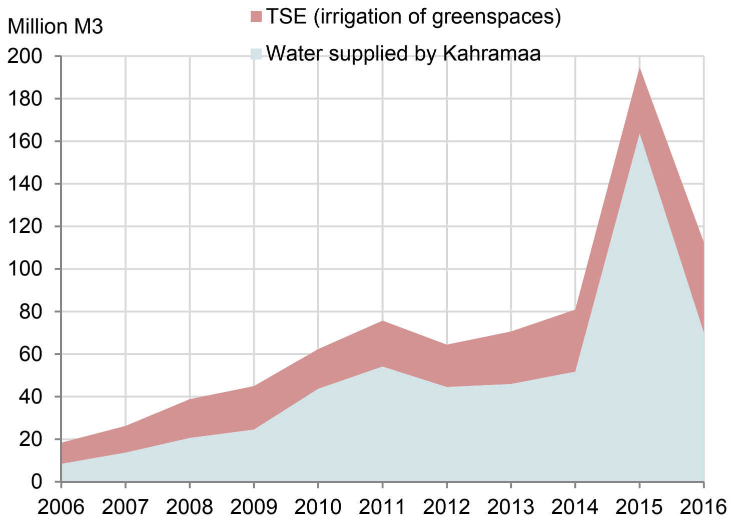
As the government sector is mainly a consumer of goods and services, a comparison-based analysis of water use with GDP in the government sector (like it was done for agriculture, industry and services) would not be useful, even if there are certain governmental services which are included in the GDP computation.

Table 4-5: Water used in government sector by source of water 2006 – 2016

	Water supplied by Kahramaa	TSE for irrigation of green spaces) (million m3)	Total water use million m3
2006	8.40	9.99	18.39
2007	13.70	12.53	26.23
2008	20.60	18.17	38.77
2009	24.50	20.57	45.07
2010	43.70	18.63	62.33
2011	54.10	21.58	75.68
2012	44.51	19.91	64.42
2013	45.9	24.67	70.57
2014	51.76	29.09	80.85
2015	163.67	31.09	194.76
2016	70.07	42.48	112.55

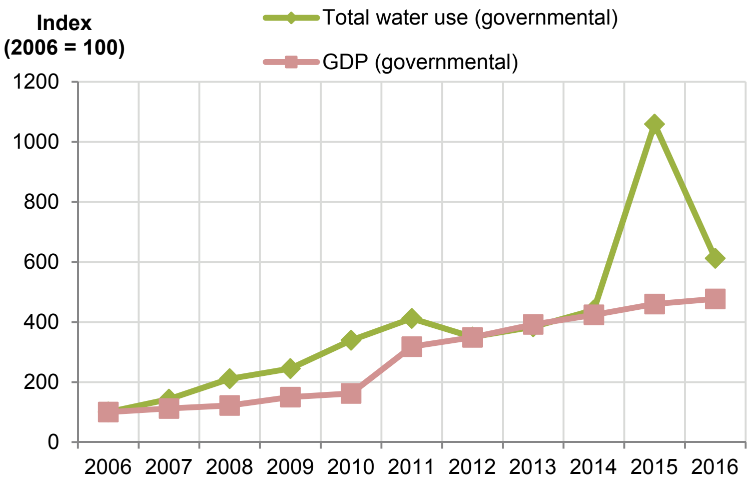
Data source: Ashghal, Kahramaa

Figure 4-16: Water use in government sector by source of water (million m3) 2006 - 2016



Data source: Ashghal, Kahramaa

Water growth rate used in the government sector and GDP (constant 2013) 2006 - 2016 (base year 2006)



4.3.8 Water used by household

The water used by household depends mainly on Kahramaa water supply. However, there are also domestic wells and municipal wells, which mainly provide water for domestic use.

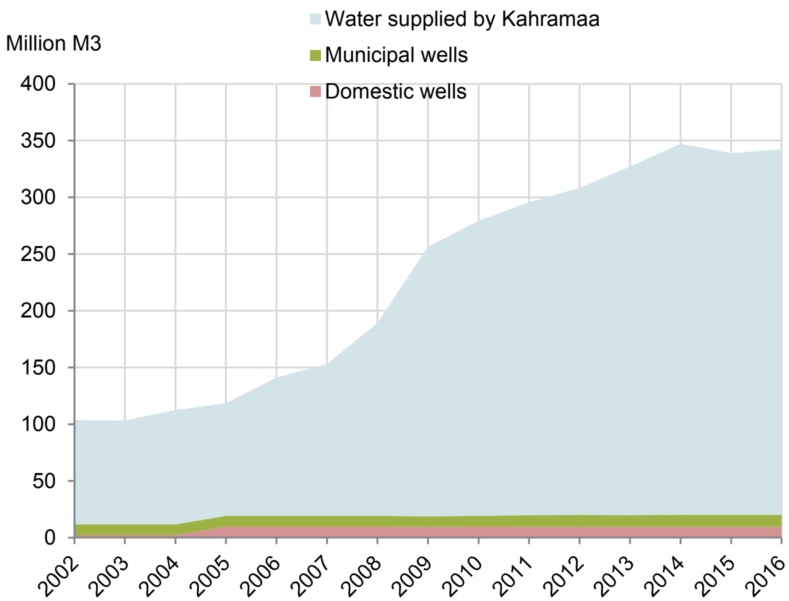
Data of water supplied by Kahramaa in Table 4- and Figure 4-17 show that water used by household increased fourfold during the period 2002 - 2016. In 2002, household used about 92 million m^3, whereas it used about 322.21 million m^3 of water in 2016.

Table 4-6: Water used by household by source of water 2006 – 2016

	Water supplied by Kahramaa (million m^3)	Domestic wells (million m^3)	Municipal wells (million m^3)	Total water use (million m^3)
2006	121.90	9.9	9.3	141.10
2007	133.96	9.9	9.3	153.16
2008	170.09	9.9	9.3	189.29
2009	237.66	9.57	9.34	256.57
2010	260.23	9.82	9.34	279.39
2011	275.68	9.69	10.19	295.56
2012	288.70	9.6	10.38	308.68
2013	308.02	9.7	10.2	327.92
2014	327.49	9.7	10.4	347.59
2015	318.81	9.7	10.4	338.91
2016	322.21	9.7	10.4	342.31

Data source: Ministry of Municipality and Environment, Kahramaa

Figure 4-17: Water used by household by source of water (million m3) 2002 - 2016



Data sources: Ministry of Municipality and Environment, Kahramaa

4.3.9 Water use balance

The water quantity that was available for use in 2016 amounted to 1014.71 million m3, including desalinated water (prior to the computation of loss), abstracted groundwater, and treated and untreated urban wastewater.

The water quantity used by the final users (including agriculture, industry, commercial, government and household) is the water available for use minus water loss and minus wastewater discharged without re-use. Injection of TSE into aquifers is a mean to substitute over-exploitation but not a final use, and thus it is shown separately in the aggregated water balance (Table 4-8).

Table 4-7: Aggregated water use balance (million m3) 2016

Description	Million m^3/year
Water potentially available for use (a)	1014.71
Water loss (b)	21.78
Discharge of wastewater without reuse (c)	102.15
Quantity of water injected into aquifers	60.36
Water used by final consumers (=a – b – c)	910.21

The following Table 4-8 displays the details of the water use balance.

Table 4-8: Details of water use balance (water balance million m3) 2016

Description	Water potentially available for use	Water use and loss	Remarks
Desalinated water	557.57		Water supplied by Kahramaa
Fresh groundwater abstraction	250.80		Including agricultural, municipal, domestic and industrial wells. Data of 2014
TSE	204.40		Wastewater discharged by urban wastewater treatment plants
Wastewater discharged without treatment	1.94		Discharge of untreated wastewater into lagoons
Total water potentially available for use	1014.71		Water available before loss
Untreated wastewater		1.94	
Total desalinated water losses		21.78	Total losses
TSE discharged into lagoons		39.17	
TSE discharged into sea		.68	
TSE injected into deep aquifers		60.36	
Water used in agriculture		291.70	Groundwater and TSE

Description	Water potentially available for use	Water use and loss	Remarks
Water used in industries and commercial activities		143.69	Water supplied by Kahramaa, water supplied by industrial wells, and water supplied by Kahramaa, including big industrial complexes and hotels.
Water used by households		342.31	Water supplied by Kahramaa, domestic wells, and municipal wells.
Water used in government sector		112.55	Water supplied by Kahramaa and TSE for irrigation of green spaces
Total water use and loss		1014.18	

5. Urban Wastewater Production, Collection, Treatment and Discharge

5.1 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).

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

5.2 Key Messages

a) The capacity of urban wastewater treatment plants increased from 54,000 m^3/day in 2004 to 827,860 m^3/day in 2017.

b) All wastewater treatment plants in Qatar are equipped with at least a secondary treatment level of a wastewater treatment levels. The largest operational plant is Doha West (244 m^3/day), which provides tertiary treatment for nitrogen and phosphorus removal.

c) Urban wastewater treatment plants remove more than 99% of organic pollution.

d) In 2017, 99% of urban wastewater generated was treated at UWWTPs.

e) In 2017, 30% of TSE was used for agriculture irrigation and 27% for green space irrigation.

5.3 Statistics and Indicators

5.3.1 Urban Wastewater Collection and Treatment Infrastructure

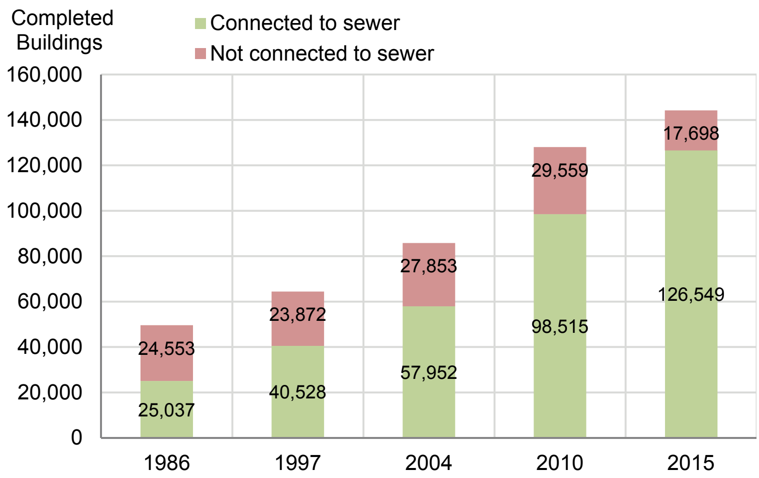
According to statistics from Census (1986–2015), the number of completed buildings connected to public sewage increased from 25,037 (50.5% of total completed buildings) in 1986 to 126,549 (87.7% of total completed buildings) in 2015 (see Figure 5-1).

As for buildings not-connected to public sewage, they are served by tankers transporting wastewater to treatment plants and sewage lagoons.

Figure 5-2 shows that the highest percentage of buildings connected to public sewage according to Census 2015 was in Doha Municipality (99.9%), whereas the lowest percentage of buildings connected to public sewage was in Al Shamal Municipality (4.13%).

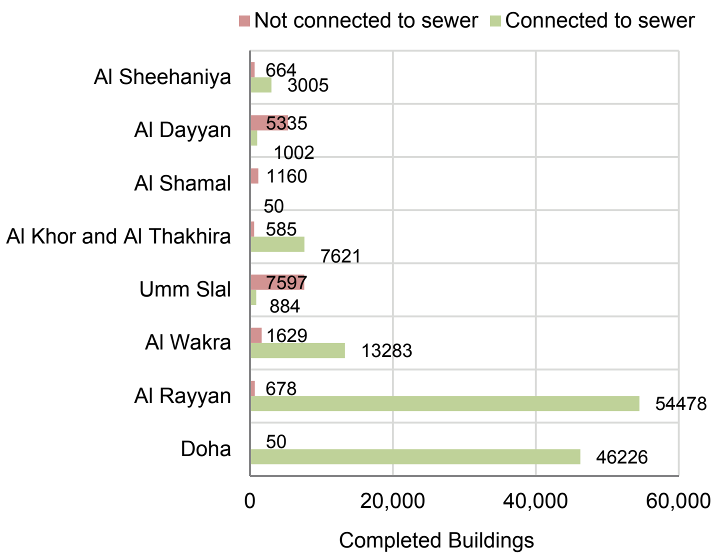
Since 2004, safe sanitation services are provided to all individuals in Qatar (refer to Qatar Sustainable Development Indicators Report, MDPS and Diplomatic Institute, 2015).

Figure 5-1 Number of completed buildings connected to public sewage according to Censuses 1986 - 2015



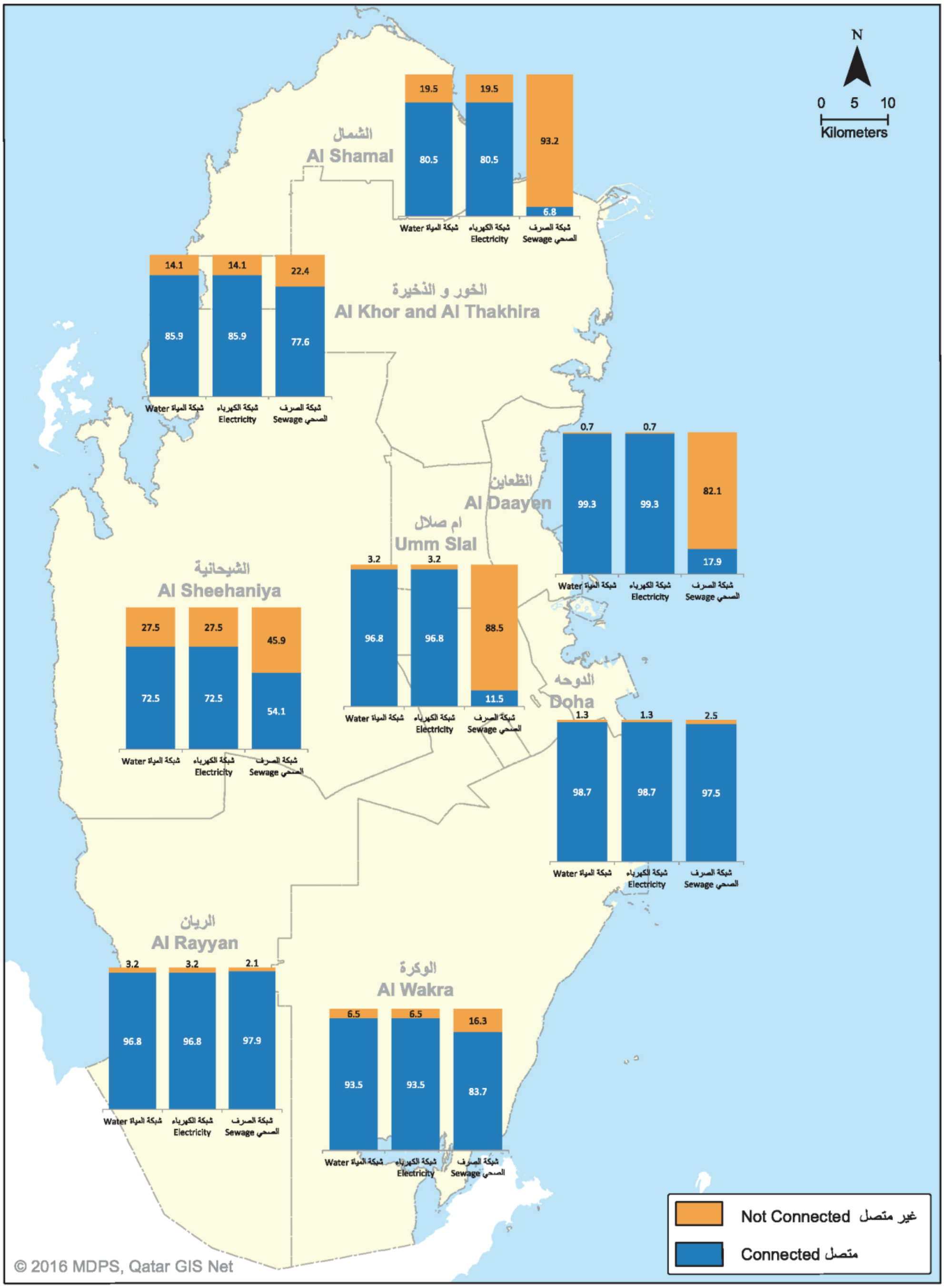
Data source: PSA

Figure 5-2: Number of completed buildings by connection to public sewage and municipality, Census 2015



Data source: PSA

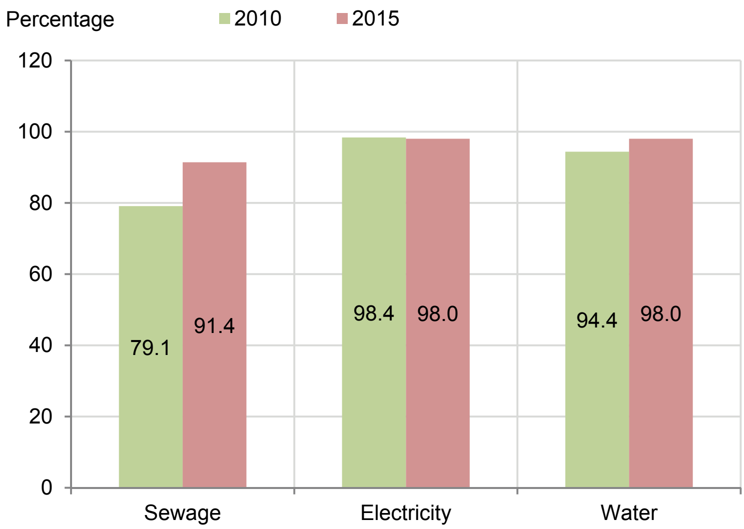
Map 5-1: Percentage of completed buildings by connection to public utilities Census 2015



Data source: PSA

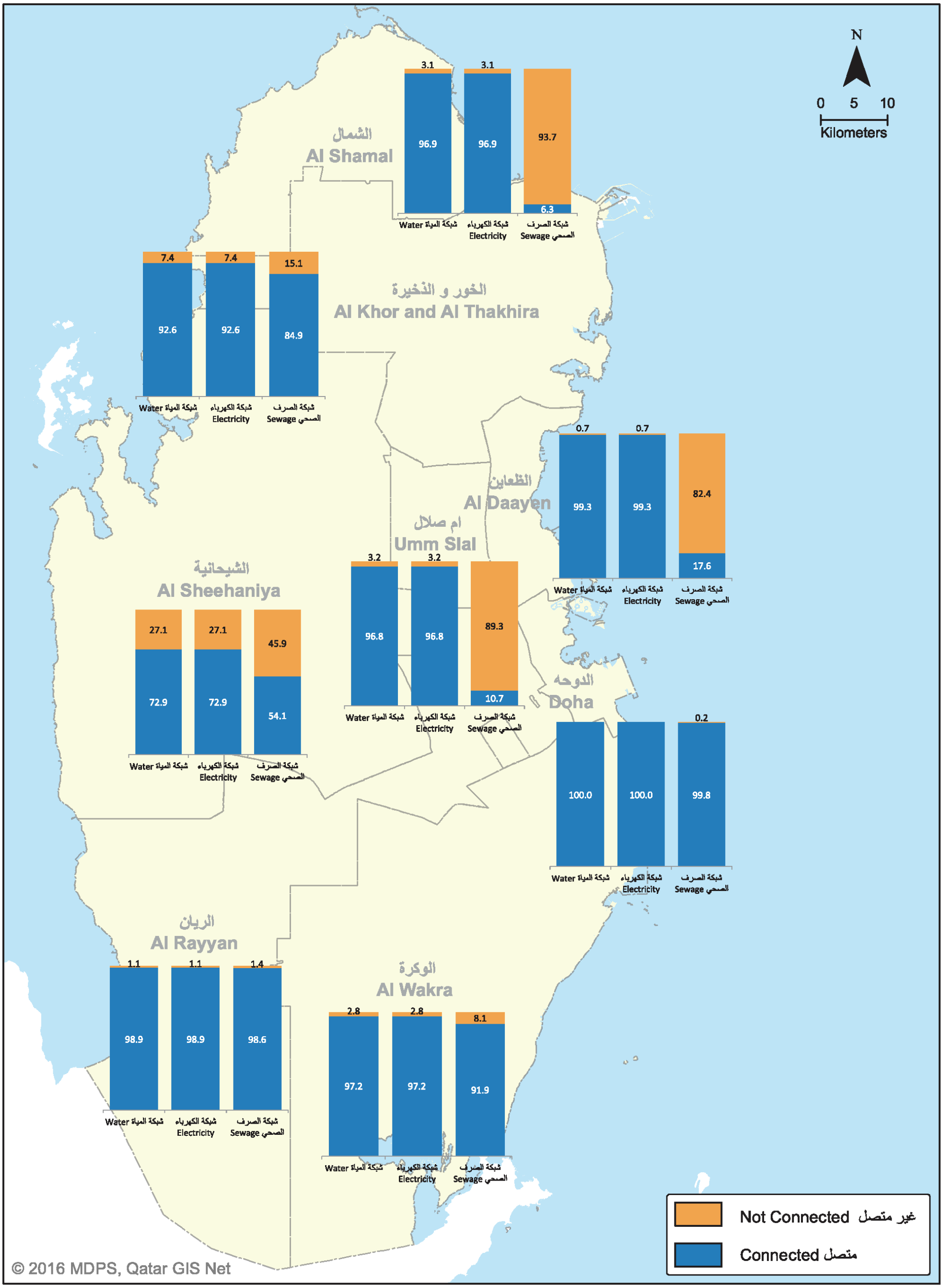
With regards to the housing units connected to public sewage, the census statistics for 2010 and 2015 indicate a significant improvement from 79.1% to 91.4%. Also, the indicators of housing units connected to electricity and water network were high during Censuses 2010 and 2015.

Figure 5-3: Percentage of housing units connected to public utilities by type of utility, Censuses 2010 and 2015



Data source: PSA

Map 5-2: Percentage of housing units by connection to public utilities Census 2015



Data source: PSA

Table 5-1: Wastewater at Sewage Plants 2010-2017

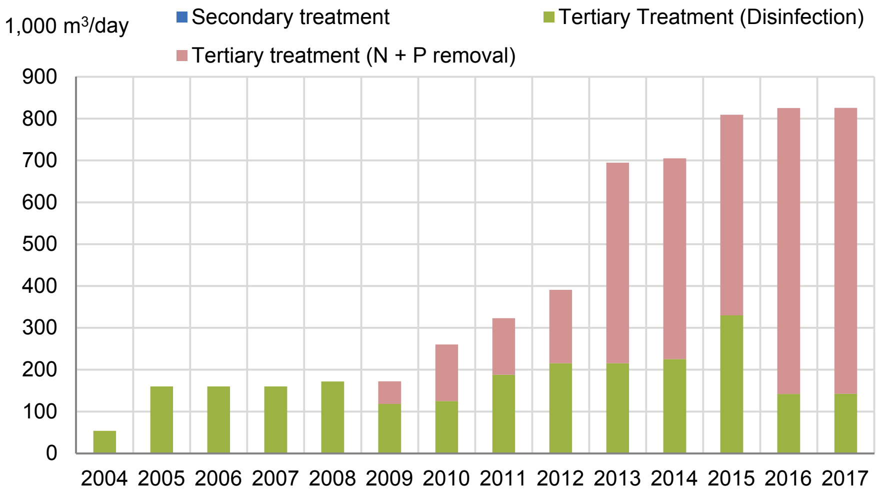
Description	2011	2012	2013	2014	2015	2016	2017
Number of sewage plants	18	20	22	23	23	23	24
Total design capacity of wastewater treatment plants (m3/day)	323	391	695	705	809	827	828
Amount of collected wastewater (1000 m3 /year)	123,887	142,339	158,792	173,933	197,492	209,518	231,473
Amount of treated wastewater (1000 m3 /year)	108,759	129,212	151,883	168,949	193,854	204,392	228.668
Percentage of treated wastewater to total wastewater	87.8%	90.8%	95.6%	97.1%	98.2%	97.6%	98.8%
Treated wastewater used for agriculture irrigation(1000 m3 /year)	41,979	58,707	55,233	64,920	66,289	61,699	69,508
Amount of treated wastewater used for green space irrigation (1000 m3 /year)	21,657	19,915	24,670	29,096	31,088	42,480	61,029
Amount of treated water used for injecting groundwater (1000 m3 / year)	26,212	30,854	35,599	43,465	57,291	60,364	63,859
Amount of treated water discharged into lakes (1000 m3 / year)	18,760	13,474	35,391	31,109	38,845	39,168	33,817
Amount of treated water discharged into the sea (1000 m3 / year)	268	293	234	358	350	681	455
Dry sludge from wastewater (ton/ year)	20,443	21572.983	27,575	32,352	40,099	40,857	40,805
Sludge from wastewater (1000 m3 / year)	263	372	303	550	224	196	222
Amount of wastewater not collected at sewage plant and is discharged into lakes (million cubic meters/ year)	16.4	21.9	18.0	11.3	1.7	1.9	2.4
Total surface groundwater discharged into the sea (million cubic meters per year)	76.3	68.7	64.4	63.0	75.7	89.7	95.4

...: not available
Data source: Ashghal

The number of wastewater treatment plants reached 24 by 2017. The statistics in Table 5-2 and Figure 5-3 indicate an increase in the design capacity of urban wastewater treatment from 54,000 m^3/day in 2004 to 809,340 m^3/day (an annual growth rate of 28%) in 2017. All urban wastewater treatment plants have been equipped with at least secondary treatment methods, ensuring, to a large extent, the elimination of organic pollution. The Doha South Station was upgraded in 2016 to be able to remove nitrogen and phosphorus, where the urban wastewater treatment capacity was increased to 204,000 m^3/day in 2015. In 2013, the Lusail treatment plant (wastewater delivered by tankers) began removing nitrogen and phosphorus. In 2016, the Doha

North plant was ranked as the largest in terms of design capacity, accounting for 29% of total plant design capacity (became operational in 2014), followed by Doha South plant with 25% and Doha West plant with 21% of total plant design capacity.

Figure 5-4: Hydraulic design capacity of wastewater treatment plants by type of treatment 2004-2017



Data source: Ashghal

Table 5-2: Hydraulic design capacity of operating wastewater treatment plants by type of treatment, (1,000 m3/day) 2005-2017

	Secondary treatment	Tertiary treatment (disinfection)	Tertiary treatment (N+P removal)	Total
2005	0.0	54.0	0.0	54.0
2006	0.0	160.0	0.0	160.0
2007	0.0	160.0	0.0	160.0
2008	0.0	172.0	0.0	172.0
2009	0.1	118.0	54.0	172.1
2010	2.2	123.0	135.0	260.2
2011	2.2	131.8	135.0	269.0
2012	2.0	159.4	175.5	336.9
2013	2.1	213.4	479.5	695.0
2014	2.1	223.4	479.5	705.0
2015	2.1	327.8	479.5	809.0
2016	2.1	141.8	683.5	827.4
2017	2.1	142.3	683.5	827.9

Data source: Ashghal

Table 5-3 below show all urban wastewater treatment plants in Qatar by type of treatment, design capacity and amount of wastewater received. Currently, Lusail plant relies only on wastewater received by tankers.

Table 5-3: Urban wastewater treatment plants by type of treatment, design capacity and amount of wastewater received 2017

UWWTP	Type of Treatment	Hydraulic Design Capacity		Amount of Wastewater Received (1,000 m^3/year)
		(1,000 m^3/day)	(1,000 m^3/year)	
Al-Jamiliyah PTP	Secondary (sterilization)	0.54	197.10	116.5
Al-Khuraib PTP		0.06	21.90	16
Al-Shamal PTP		0.15	54.75	118
Slaughter House PTP		0.81	296.00	84
Ras Abu Fontas PTP		0.54	197.10	102
Al-Dhakhira PTP	Tertiary (disinfection)	3.2	1168	1426
Al-Khor PTP		9.72	3547.80	4430
Barwa Al Baraha PTP		12.00	4380.00	4702
Barwa City STW		15.00	5475.00	1289
Barwa Msaimeer PTP		1.5	547.50	323
Barwa Sailiyah PTP		1.50	547.50	306
Barwa Village PTP		1.00	365.00	197
Doha West STW old plant		54.00	19710.00	21362
Duhail PTP		0.81	295.65	68
Industrial Area STW		30	10950	12508
Al Ghazal		.44	160.6	146
Al Shihaniyah		1.35	490.93	604
Umm Slal		1.50	547.50	57
Al Karanah		10.00	3650.00	3823
North Camp		0.25	89.43	140
Doha North STW	Tertiary (N and P removal)	244.00	89060.00	33526
Doha West STW		175.50	64057.50	66488
Doha South STW (4)		204	74460	69228
Lusail STW (2)		60.00	21900.00	10497
	Total (5)	827.86	302,168.9	231472.5

(1) Al Karanah PTP: is under test and is operated by tankers

(2) Lusail STW: It is operating on tankers.

(3) Al Ghazal: (operational in 2017)

(4) The station is updated for the removal of nitrogen and phosphorus

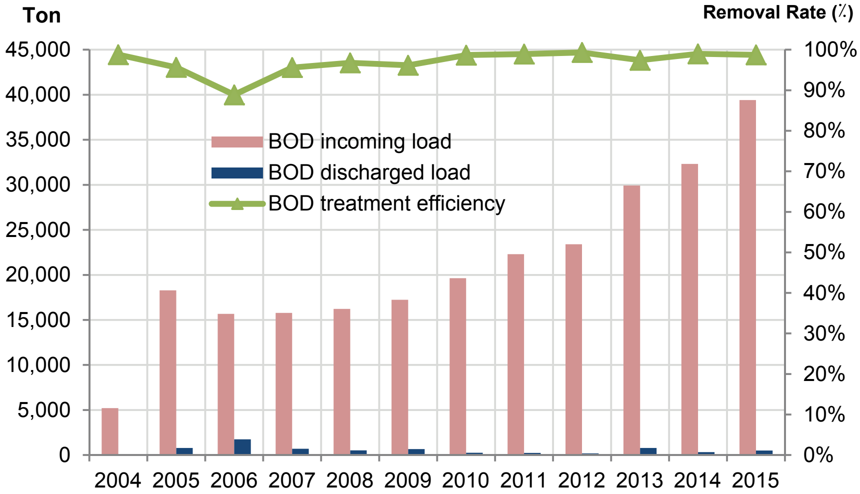
(5) Total: Excluding slaughter house.

Data source: Ashghal

5.3.2 Treatment Efficiency of Urban Wastewater Treatment Plants

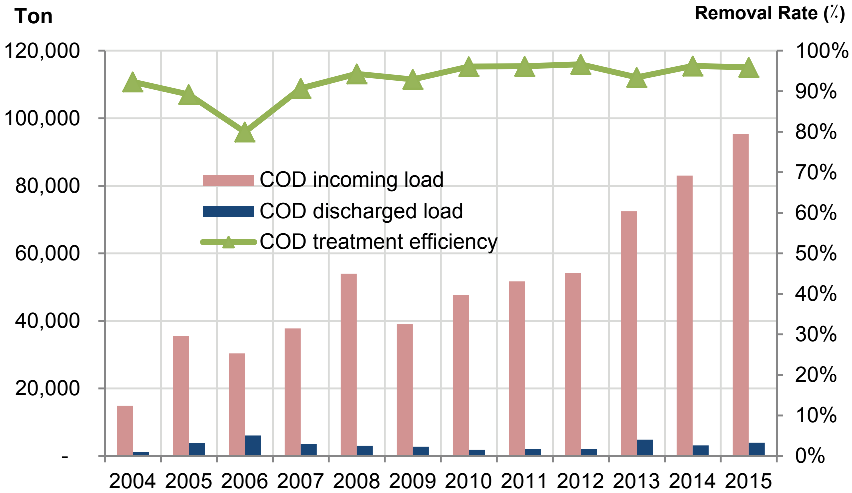
Figure 5-5 and Figure 5-6 show that Organic pollution in terms of BOD5 has been removed by more than 95% in most of the years during the period 2004-2017. In terms of COD, the removal rates reached more than 90% in most of the years during the period 2004-2017.

Figure 5-5: Treatment of BOD5 loads 2004-2017



Data source: Ashghal; calculated by PSA

Figure 5-6: Treatment of COD loads 2004-2017

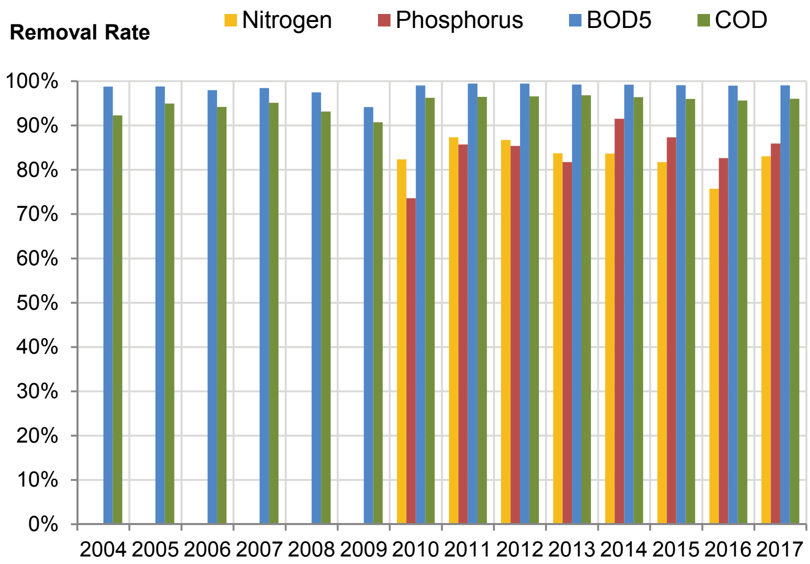


Data source: Ashghal; calculated by PSA

Doha North Plant, Qatar's largest UWWTP with its treatment capacity of 244,000 m^3/day, is equipped with nitrogen and phosphorus removal capacity since operation in 2014. In 2017, nitrogen removal rates in Doha North Station reached 78%, phosphorus removal rate reached more than 84%, the removal of Organic pollution in terms of BOD5 reached 98% and the COD reached 97%.

Next comes Doha South Plant, the second largest wastewater treatment plant in Qatar. It was upgraded to have the capacity to remove nitrogen and phosphorus. The design capacity is increased to treat wastewater from urban areas to 204,000 m^3/day in 2016. In 2017, the rate of phosphorus removal was 52%. The rate of Organic pollution in terms of BOD5 reached 99.1%, while the chemical oxygen removal rate was 97%. Doha West Plant is the third largest wastewater treatment plant in Qatar with a design capacity of 175,500 m^3/day, and is equipped with nitrogen and phosphorus removal capacity since 2009. Figure 5-7 indicates an increase in nitrogen removal rates at the plant starting from 2012, and the rate is continuously rising exceeding 80%. Also as of 2011, the phosphorus removal rate continuously increased to more than 85%.

Figure 5-7: Rates of BOD5, COD, total nitrogen and phosphorus removal at UWWTP Doha West 2004–2017



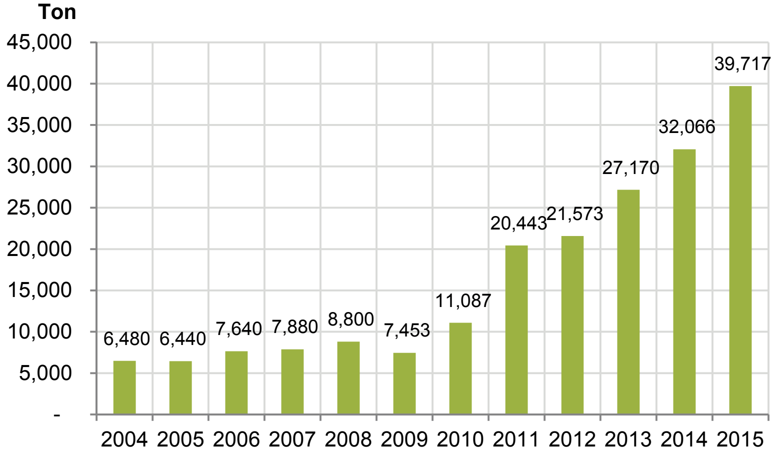
Data source: Ashghal; calculated by PSA

5.3.3 Sewage Sludge Generation

With the increase of treatment design capacity of the UWWTPs, the generation of sewage sludge has also increased.

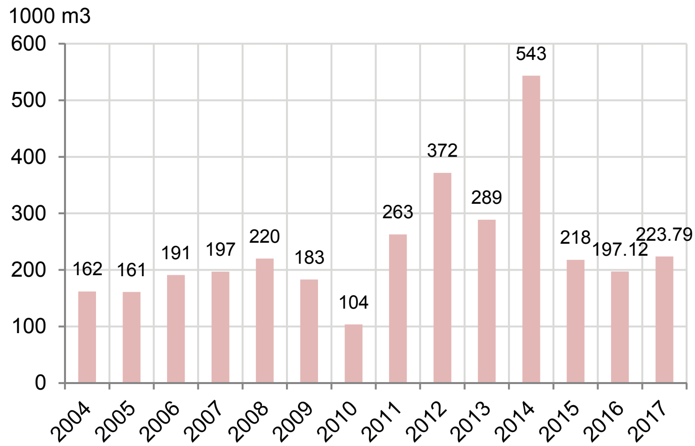
In 2004, 106,000 m^3 of sewage sludge were generated, amounting to 6,480 tons of dry solids (water content was about 96%). In 2017, the UWWTPs in Qatar already generated 233,790 m^3 of sewage sludge. Due to the reduced water content (about 81%), the sewage sludge contained 41,554 tons of dry solids. (See Figure 5-7 and Figure 5-8).

Figure 5-8: Generation of sewage sludge at urban wastewater treatment plants by mass (tons of dry solids) 2004-2017



Data source: Ashghal

Figure 5-9: Generation of sewage sludge at urban wastewater treatment plants by volume (1,000 m3) 2004-2017



Data source: Ashghal

5.3.4 Urban Wastewater Generated, Collected and Treated

In Qatar, the urban wastewater is collected by sewage network and by tankers. All of the wastewater connected to sewage is treated at UWWTPs. Also the wastewater generates from households which collected by tankers is treated at UWWTPs, whereas most of the wastewater collected by tankers is discharged into lagoons (lakes) without treatment, which were mainly collected from non-household sources.

Statistics of

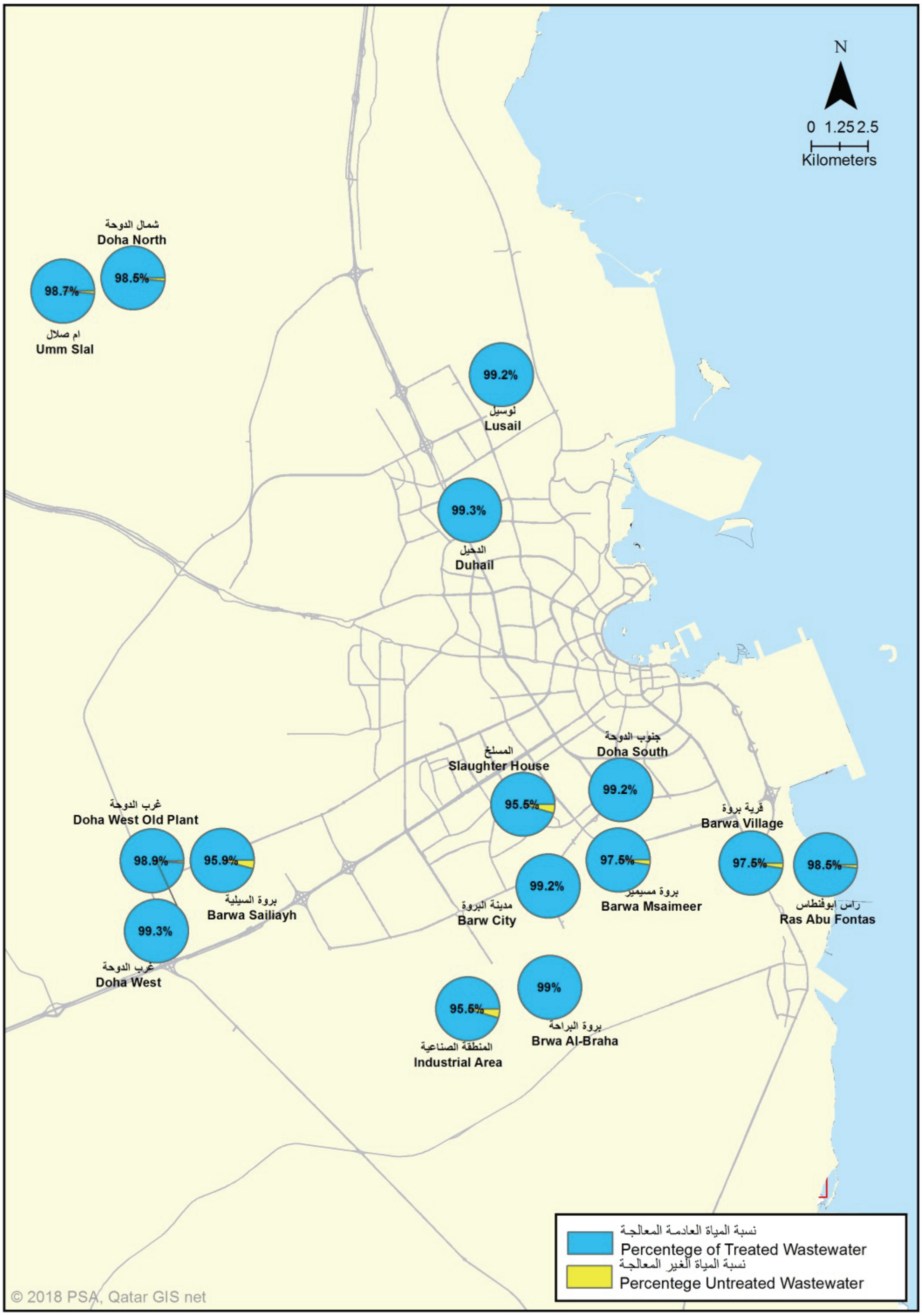
Table 5-4 show that the total generation of urban wastewater increased from 211.46 million m^3 in 2010 to 233.91 million m^3 in 2017, where about 1% of total wastewater generated (2.44 million m^3) was discharged into lagoons without any treatment in 2017.

Table 5-4: Urban wastewater generated by method of handling and discharge without treatment (million m3) 2010-2017

Urban Wastewater (million m^3/year)	2010	2011	2012	2013	2014	2015	2016	2017
Total urban wastewater generated	121.73	140.31	164.24	176.83	185.24	199.19	211.46	233.91
of which treated	101.65	123.89	142.34	158.79	173.93	197.49	209.52	231.47
of which secondary treatment	0.20	0.20	0.25	0.27	0.30	0.31	0.27	0.35
of which tertiary treatment	101.45	123.69	142.09	157.89	168.65	193.54	209.24	231.12
of which discharged without treatment	20.08	16.43	21.9	18.04	11.3	1.7	1.94	2.44

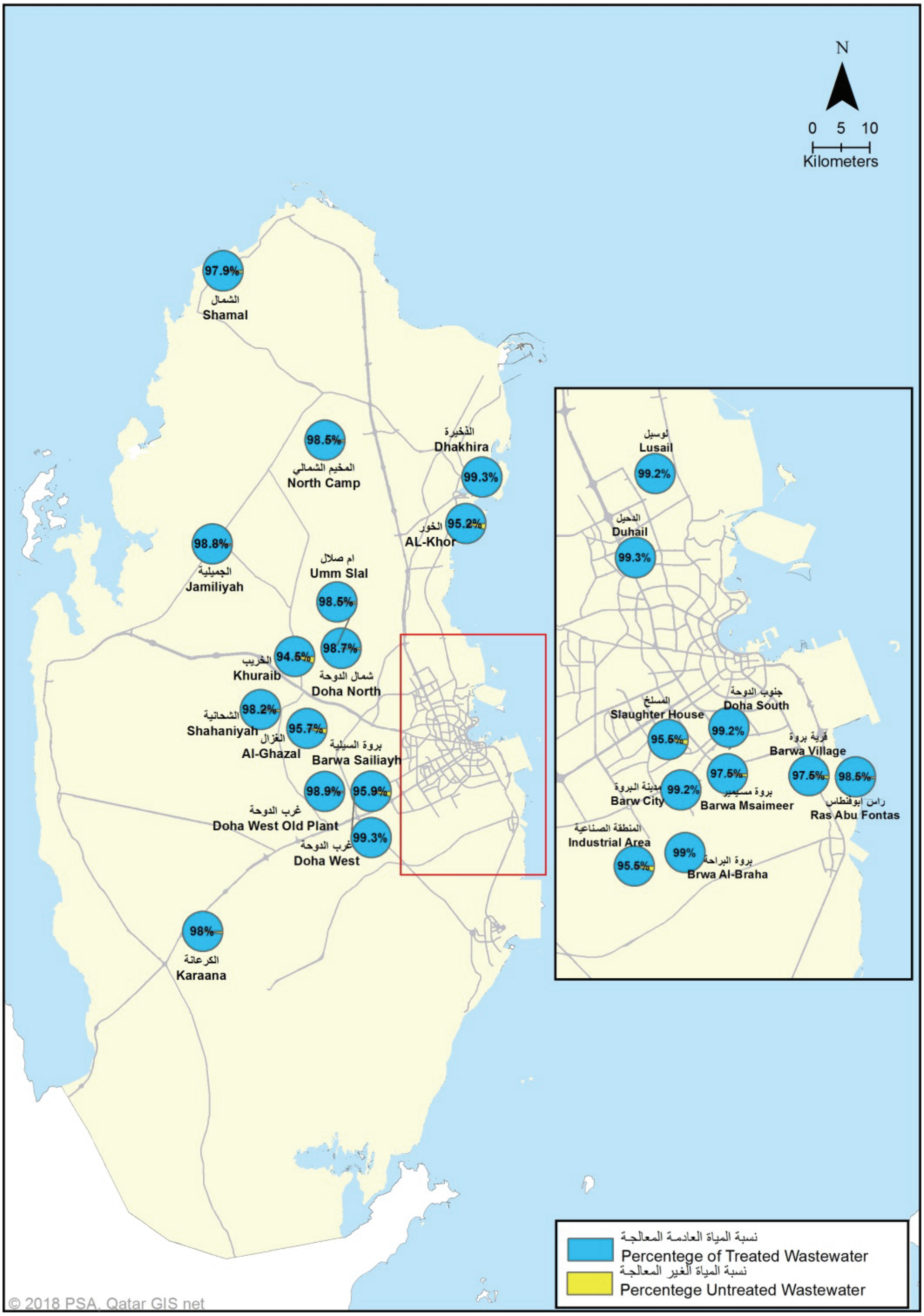
Data source: Ashghal

Map 5-3: Percentage of treated wastewater to total wastewater by UWWTPs 2017



Source: PSA

Map 5-4: Percentage of treated wastewater to total wastewater by UWWTPs for Doha Municipality, 2017

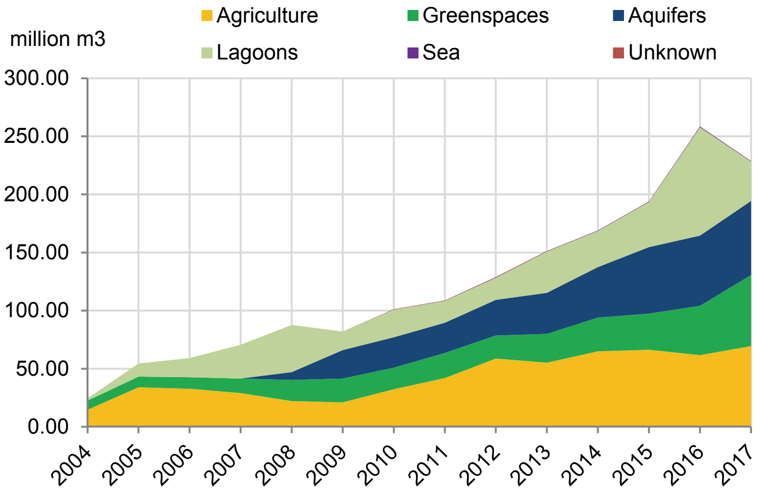


Source: PSA.

5.3.5 Discharge and Re-Use of Treated Sewage Effluent (TSE)

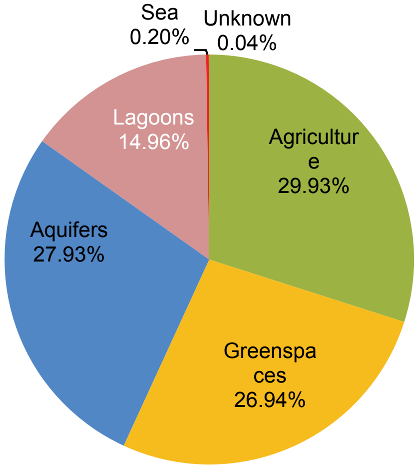
With the expansion of the wastewater treatment design capacity since 2004, the production of treated sewage effluent (TSE) increased by about 8 folds from around 25 million m^3 in 2004 to about 229 million m^3 in 2017. Agriculture has become the most important user of TSE (30% in 2017), followed by the governmental sector (27% of TSE used for green space irrigation). In 2017, about 28% of wastewater was used for deep injection into aquifers and about 15% was discharged into lagoons unused. (See Figure 5-10 and Figure 5-11).

Figure 5-10: Use and discharge of treated sewage effluent (TSE) (million m3) 2004-2017



Data source: Ashghal

Figure 5-11: Use and discharge of treated sewage effluent (TSE) 2017



Data source: Ashghal, calculated by PSA

6. Groundwater Quantity and Quality

6.1 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 and agricultural purposes. According to FAO, water can be classified by salinity concentration as shown in Table 6-1 below.

Table 6-1: Classification of saline waters according to FAO by conductivity, salinity concentration and water quality

Water Quality	Salinity Concentration (mg/l)	Conductivity (dS/m)	Type of Water
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

Water salinity of less than 0.7 dS/m does not usually cause a problem in traditional irrigation methods. But when water salinity is higher than 3.0 dS/m, serious problems often arise with most crops, causing yield reduction or farm abandonment (see Water and Agriculture Vision for Qatar by 2020).

To demonstrate the level of groundwater degradation, this chapter reviews statistics on groundwater levels, salinity (conductivity) and total dissolved substances (TDS) in the main aquifers in Qatar.

Qatar Electricity and Water Corporation has provided us with the latest data on groundwater quality during the period from April 2012 to September 2014 in order to analyze the results. There are no sample collection campaigns on an annual basis, but samples are collected once in April and again in September.

6.2 Methodological Aspects

Extreme values may have a strong influence on the overall results of the assessment of groundwater salinity and depletion. Statistical assessments are therefore conducted on the following basis:

1. Calculation of median (50 percentile) values of salinity and conductivity for each aquifer. This assures that single extreme values will not influence 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 that fall under the different FAO salinity classes and presenting also which ones of them fall into the area code "k".

6.3 Key Messages

1. According to FAO salinity classification, all wells in Qatar were classified as medium salinity during the period 1998-2014.
2. The percentage of high saline wells declined from 17% in 1998 to 16% in 2016.
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 and North Qatar, whereas the highest percentage of high salinity wells are found in Wadi Al-Urayq and Al-Mashabiya aquifers, as well as in South Qatar.
4. Most of the aquifers show an increasing trend towards high salinity.
5. The groundwater levels in Central and North Qatar do not show any clear trend. They are slightly above sea level. However, the groundwater level in Al-Mashabiya is significantly below sea level with a tendency to decrease.

6.3.1 Statistics and Indicators

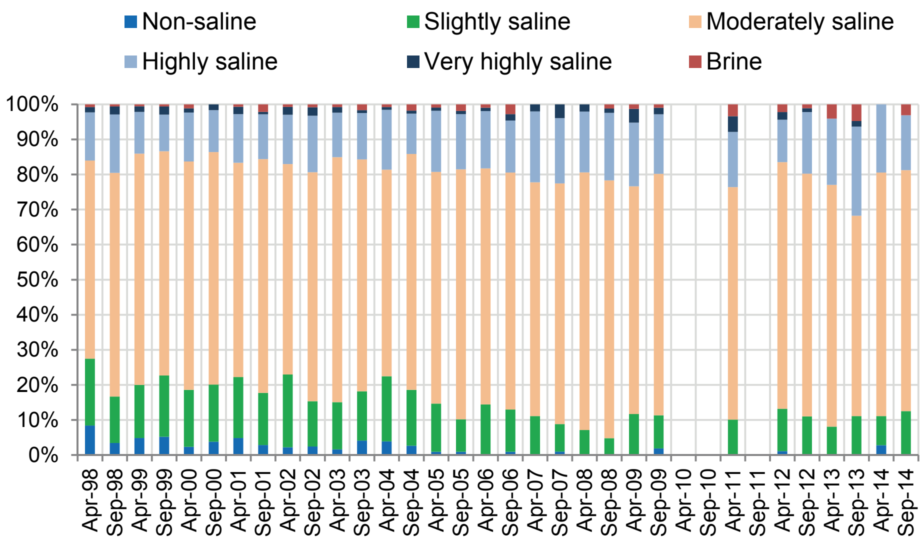
6.3.1.1 Salinity

Figure 6-1 below presents the percentage of wells in Qatar according to FAO salinity classification for the observation period April 1998 – September 2014. Figure 6-2 presents the same information without considering wells in coastal zones (area code K).

Statistics indicate that from April 1998 to September 2014 the percentage of non-saline wells diminished from 8% to 0%. The percentage of slightly saline wells (classified by FAO as irrigation wells) decreased from 19% to 11% (20% to 12% according to Figure 6-2), whereas the percentage of wells classified as highly or very highly saline increased from 17% to 20% (14%

to 19% according to Figure 6-2). In 2012 [(1)] , 69% (70% if coastal areas excluded) of wells were classified as moderately saline, making their waters harmful to sensitive crops, causing high soil salinity and increasing the risk of higher sodicity (see Water and Agriculture Vision for Qatar by 2020).

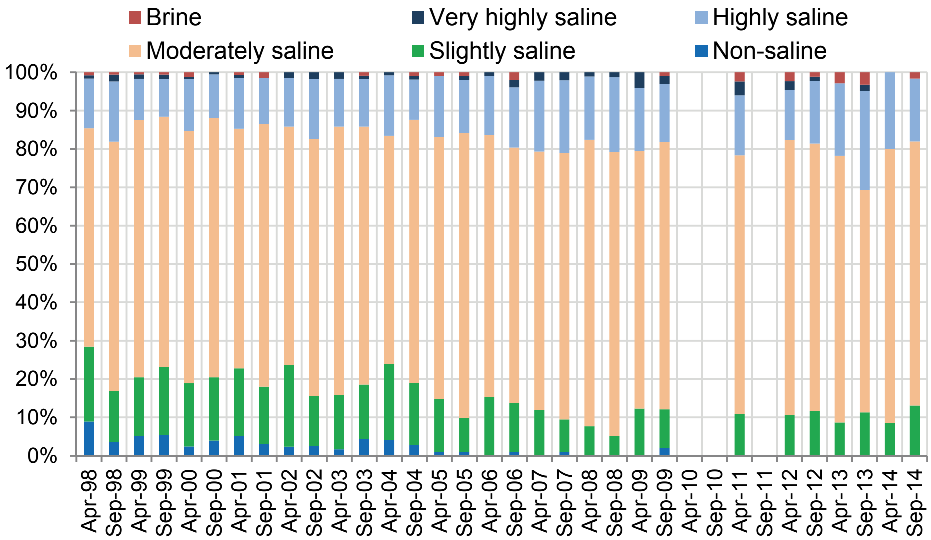
Figure 6-1: All wells in Qatar by FAO salinity classification April 1998 – September 2014



* Data of 2015 and 2017 are not available from the source

(1) Data of 2013 and 2014 are not available from the source about wells classified with area code K

Figure 6-2: All wells in Qatar, excluding those in coastal sub-catchments, by FAO salinity classification, April 1998 – September 2012 *



* Data of 2013 - 2017 are not available from the source about wells classified with area code K

The following example demonstrates the salinity trend according to FAO salinity classification in North Qatar and Al-Mashabiya:

- In North Qatar, no well ever produced non-saline water since 2008. The percentage of wells with highly saline water, very highly saline water and brine has increased from 11% in April 1998 to 13% in September 2014. Also in September 2014, no well was non-saline, while 25% were slightly saline, 50% moderately saline, 13% highly saline and 13% brine. (See Figure 6-3 below).
- In Al-Mashabiya, no well ever produced non-saline water since 1998. The percentage of wells with highly saline water, very highly saline water and brine was 40% in April 1998 and in September 2014, with seasonal variations in the years in between. In September 2014, no well was non-saline or slightly saline, while 60% were moderately saline and 40% highly saline. (See Figure 6-4 below).

Figure 6-3: Percentage distribution of wells in North Qatar by FAO salinity classification April 1998 – September 2014 *

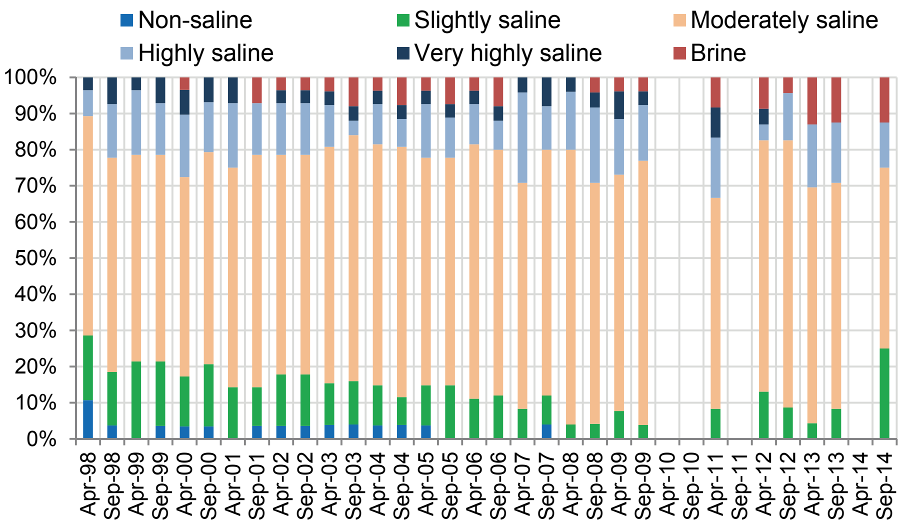
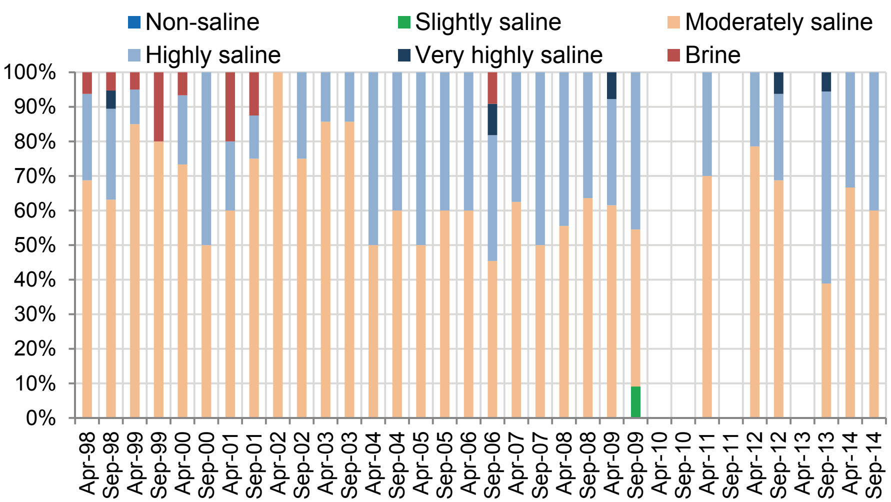


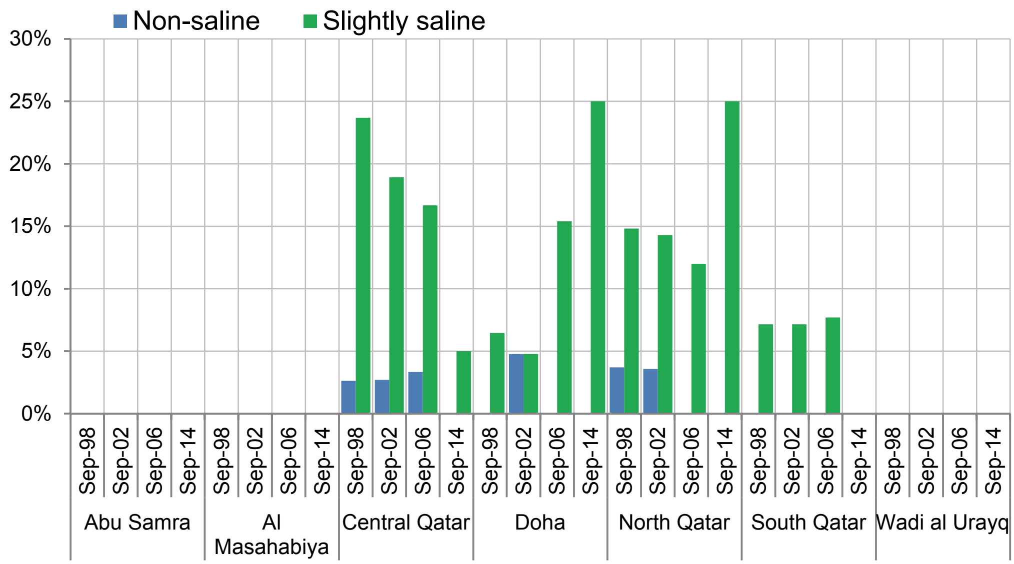
Figure 6-4: Percentage distribution of wells in Al-Mashabiya by FAO salinity classification April 1998 – September 2014 *



* Data of 2015 and 2017 are not available from the source

Figure 6-5 below indicates the percentage of wells classified as non-saline or slightly saline in different areas of Qatar from September 1998 to September 2014. It is noted that all wells located in three areas (Abu Samra, Al-Mashabiya and Wadi al Urayq) are moderately or highly saline. The percentage of wells with slightly saline or non-saline water decreased in two areas (Central and North Qatar), whereas it increased in Doha and South Qatar. However, in September 2014 there was no longer any non-saline well.

Figure 6-5: Percentage of wells classified as non-saline and slightly saline in different aquifers September 1998 – September 2014 *



* Data of 2015 - 2017 are not available from the source

The following

Table 6-2, as well as Figure 6-6 and Figure 6-7 show the median trend of salinity by conductivity (dS/m) and total dissolved solids (TDS in ppm) for four aquifers in Al Mashabiya, South Qatar, Central Qatar and North Qatar.

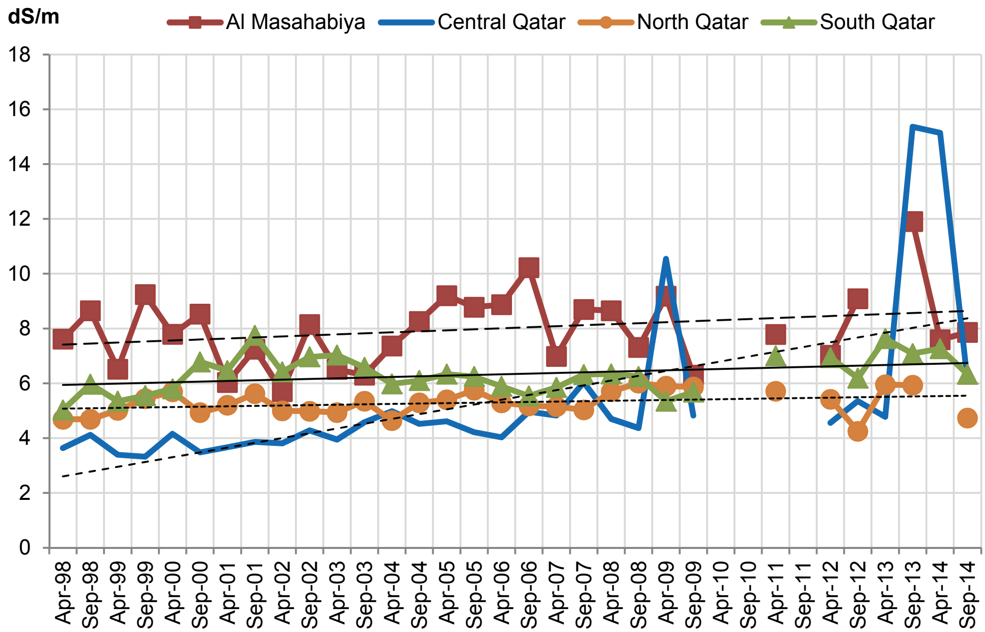
It can be noted that over the entire period 1998-2014, all four aquifers were moderately saline, but with a constantly rising salinity (conductivity). According to available data, TDS was slightly decreasing in Al Mashabiya, North Qatar and South Qatar.

Table 6-2: Observations of salinity in aquifers, 1998 – 2014*: Minimum and maximum median values (median of all wells per aquifer and observation period) and development trend.

Aquifer	Conductivity (dS/m)			TDS (ppm)		
	Min	Max	Trend	Min	Max	Trend
Al Mashabiya	5.70	11.91	Increasing	3780	7368	Slightly decreasing
North Qatar	3.32	15.36	Increasing	2420	9210	Increasing
Central Qatar	4.25	6.01	Slightly decreasing	2550	3610	Slightly decreasing
South Qatar	5.03	7.75	Increasing	3205	4580	Slightly decreasing

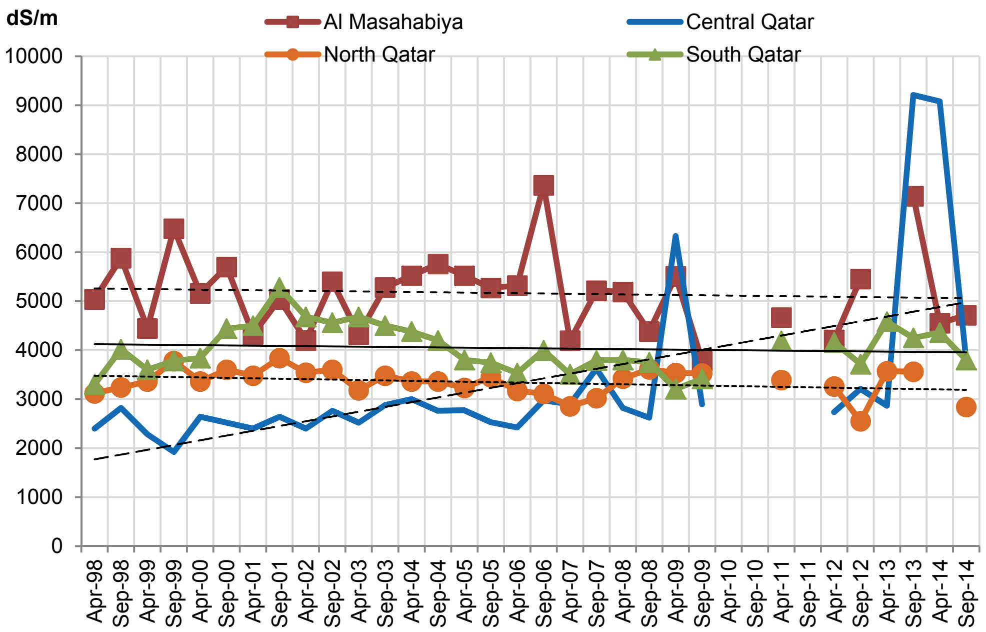
* Data of 2015 - 2017 are not available from the source

Figure 6-6: Trend of conductivity in selected aquifers (median)
April 1998-September 2014 *



* Data of 2015 - 2017 are not available from the source

Figure 6-7: Trend of total dissolved solids (TDS) in selected aquifers (median) April 1998 - September 2014 *



* Data of 2015 - 2017 are not available from the source

Figure 6-8 and Figure 6-9 below show that the aquifers with the highest observed salinity (median of conductivity and TDS) in 2014 were in Wadi Al Urayq, Al-Mashabiya and South Qatar.

Figure 6-8: Conductivity in September 2014 (median of all wells per aquifer)

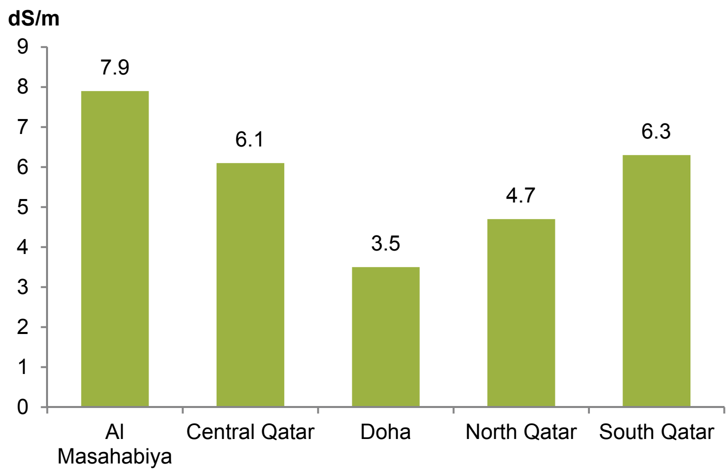
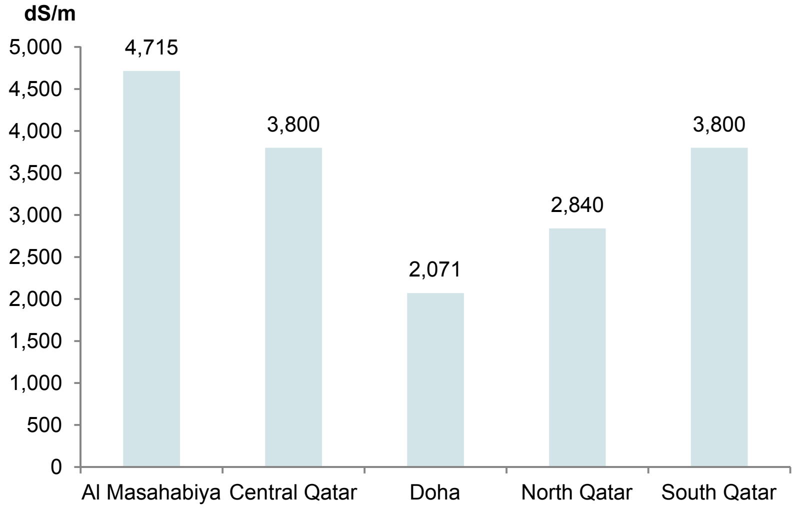


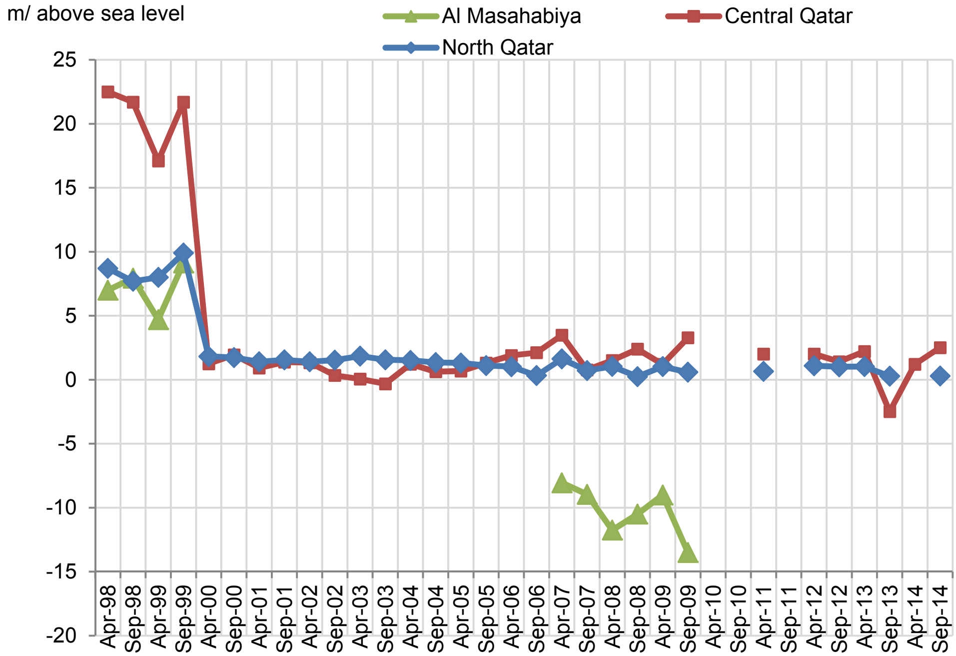
Figure 6-9: Total dissolved solids (TDS) September 2014 (median of all wells per aquifer)



6.3.2 Groundwater Levels

Reliable time series for the levels of groundwater from sea level in selected aquifers are available from April 1998 to September 2014. The following Figure 6-10 shows the median of the observed levels of groundwater from sea level in aquifers in North Qatar, Central Qatar and Al Mashabiya. Accordingly, the groundwater level in North Qatar shows a decreasing trend as it was only 1 m above sea level in 2012 (median). The groundwater level in Central Qatar was volatile over time, but it showed no significant long-term trend (median) and recorded two and a half meters higher than sea level in September 2014. In the short observation period for Al-Mashabiya, a downward trend can be seen as the median of the observed groundwater levels was already 14 meters below sea level in September 2009.

Figure 6-10: Levels of groundwater aquifers in North Qatar, Central Qatar and Al-Mashabiya (median of all available observations), April 1998 – Sep. 2014*



* Data of 2015 - 2017 are not available from the source

Glossary

BOD5	Biological Oxygen Demand	الطلب البيولوجي على الأكسجين (٥ أيام)
COD	Chemical Oxygen Demand	الطلب الكيميائي على الأكسجين
dS/m	Deci Siemens 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 (فاو)
GDP	Gross Domestic Product	الناتج المحلي الإجمالي
LTAA	Long-term Annual Average	المتوسط السنوي طويل الأمد
PSA	Planning and Statistics Authority	جهاز التخطيط والإحصاء
MME	Ministry of Municipality and Environment	وزارة البلدية والبيئة
MoEI	Ministry of Energy and Industry	وزارة الطاقة والصناعة
QMD	Qatar Meteorological Department	إدارة الأرصاد الجوية
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
GTL	Gas –to-liquids	تسييل الغاز
TSE	Treated Sewage Effluent	مياه الصرف الصحي المعالجة

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