الإدارة الملكية لحماية البيئة
RANGERS

Public security directorate

Monitoring Methane (CH4) and other Green House Gas (GHG) emissions in the sector of Wastewater in Jordan.

WCC-SF6 Education and Technical courses and 7th GAW Workshop on GHGs

(Oct 22-23,2015)

Organized by: **Climate Change Monitoring Division**
Korea Meteorological Administration (KMA)
republic of Korea

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Country overview: General information about JORDAN:

- **Location & area:** located in the heart of the middle east JORDAN is a middle income country shaped by its geography, history, geopolitics & scarcity in natural resources .Jordan is located about 80km to the east of the Mediterranean sea with a predominantly Mediterranean climate , hot & dry summers , wet & cool winters.

Jordan is also characterized by a unique topographic nature, where the western part represents the world lowest valley .

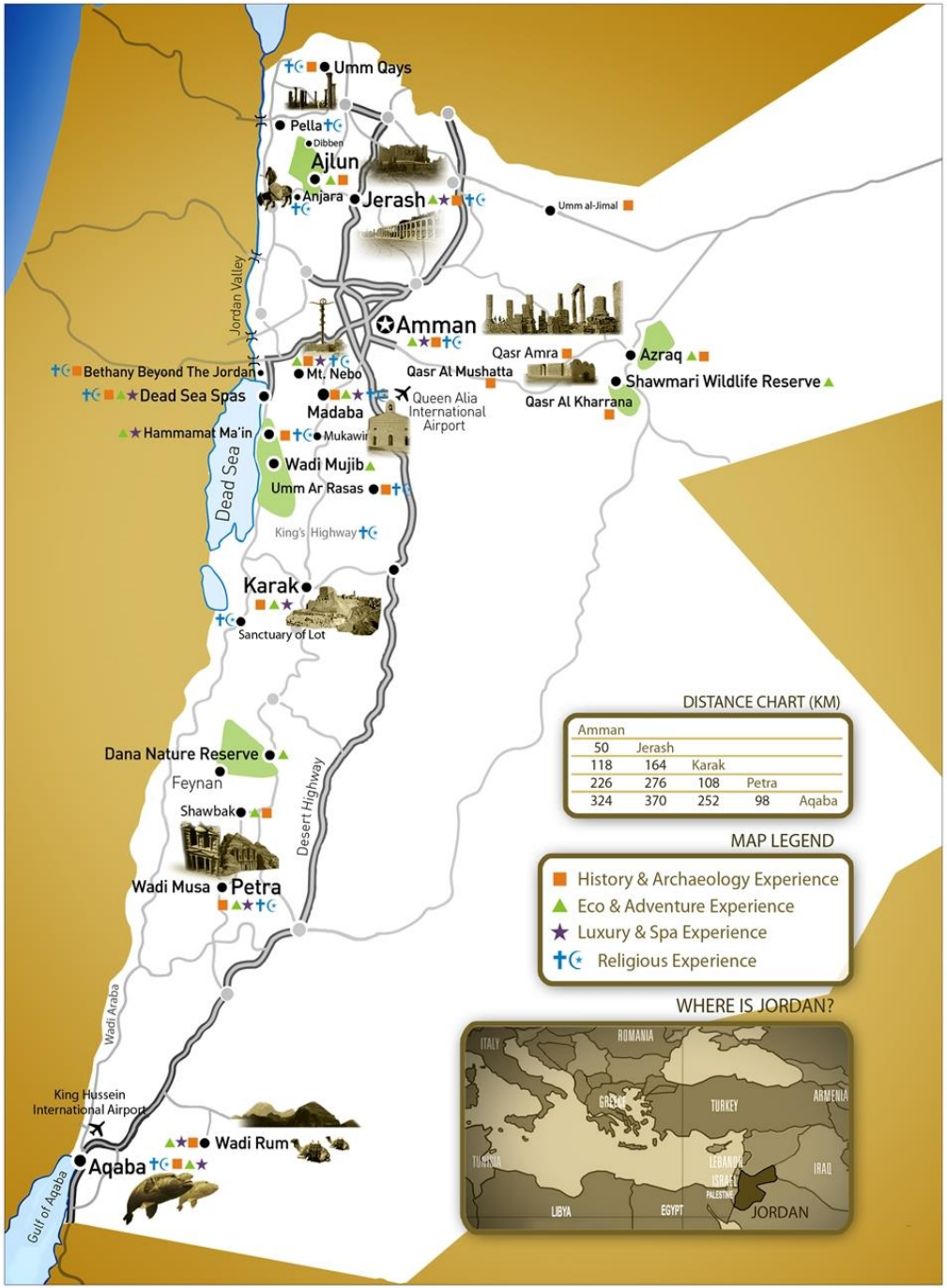
Jordan borders Syria, Saudi Arabia, the red sea, Palestine, Israel,& Iraq, covering some 89.342 sq.km, it is located at 31 00 N,36 00 E.

- **Population:**

•according to the last statistics of population the number is 6.5 million but now it is expected that it will reach 10 million during this year .

- **Climate & geography:**

- Jordan has a combination of Mediterranean & arid desert climates, with Mediterranean prevailing in the north & west of the country while the majority of the country is desert. The lowest point: is the Dead Sea -408 meters while the highest point is Jebel Rum 1734 meters .


Umm Qays
Pella
Dibbin
Ajlun
Anjara
Jerash
Umm al-Jimal
Jordan Valley
Amman
Qasr Amra
Azraq
Bethany Beyond The Jordan
Mt. Nebo
Qasr Al Mushatta
Shawmari Wildlife Reserve
Dead Sea Spas
Madaba
Queen Alia International Airport
Qasr Al Kharrana
Hammamat Ma'in
Mukawir
Wadi Mujib
Dead Sea
Umm Ar Rasas
King's Highway
Karak
Sanctuary of Lot
Dana Nature Reserve
Feynan
Desert Highway
Shawbak
Wadi Musa
Petra
Wadi Araba
King Hussein International Airport
Wadi Rum
Aqaba
Gulf of Aqaba
DISTANCE CHART (KM)
Amman
50 Jerash
118 164 Karak
226 276 108 Petra
324 370 252 98 Aqaba
MAP LEGEND
History & Archaeology Experience
Eco & Adventure Experience
Luxury & Spa Experience
Religious Experience
WHERE IS JORDAN?
ITALY
ROMANIA
GREECE
TURKEY
ARMENIA
TUNISIA
LEBANON
ISRAEL
PALESTINE
IRAQ
LIBYA
EGYPT
JORDAN

The Royal Department for Environmental Protection

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- Assist the authorities in monitoring and control of offences constituting violations of the environment (water, air, soil – the most striking event of grazing, poaching and encroachment on wildlife and forest wealth as well as distribution, drainage and waste water and follow-up on it).

• Assist the competent ministries on environmental awareness raising among citizens in all parts of the Kingdom in collaboration with various media.

• Implementation of decisions of the competent ministries of conditions that are hazardous to the environment or in emergency situations by imposing environmental fines and/ or closing off specific areas as well as to arrest alleged perpetrators

• Assist and support competent departments in identifying violation mechanisms of environmental conditions.

• Conduct investigations, collect information to detain suspects who are involved in illegal trade and poaching of wildlife

• Surveillance and monitoring of chemically manufactured products without license.

Jordan and Climate change Current status:

- Jordan is a mere contributor to the global GHG emissions with only a marginal emission rate of 0.01% of total global emissions, However, committed to its role and reputation as a global pioneer in the implementation of the various UN conventions.

- Jordan believes it has a major responsibility in addressing Climate Change challenges while adhering to its national priorities and developmental objectives.

- Jordan released "climate change policy of the Hashemite Kingdom of Jordan 2013-2020" which is the first of its kind in the region.

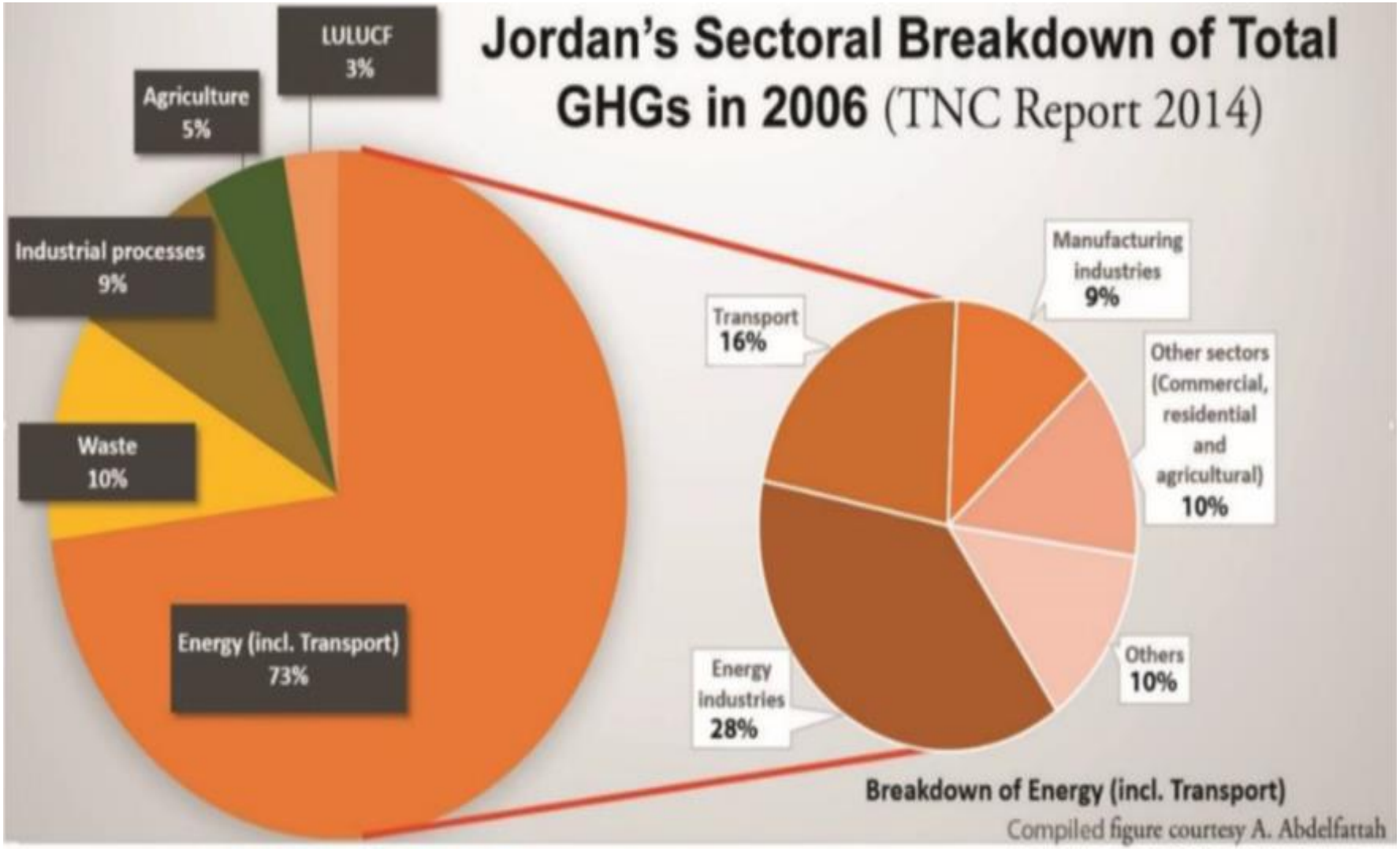
GHGs Inventory in Jordan

The total emissions in 2006: 28,717 Million tones of CO2 equivalents, compared to 20,14 MT in 2000. Emissions breakdown:

- Energy 72.9%
- Waste 10.6%
- Industry 8.9%
- Agriculture 4.6%; and
- Landuse, Landuse Change and Forestry (LULUCF): 3.0%

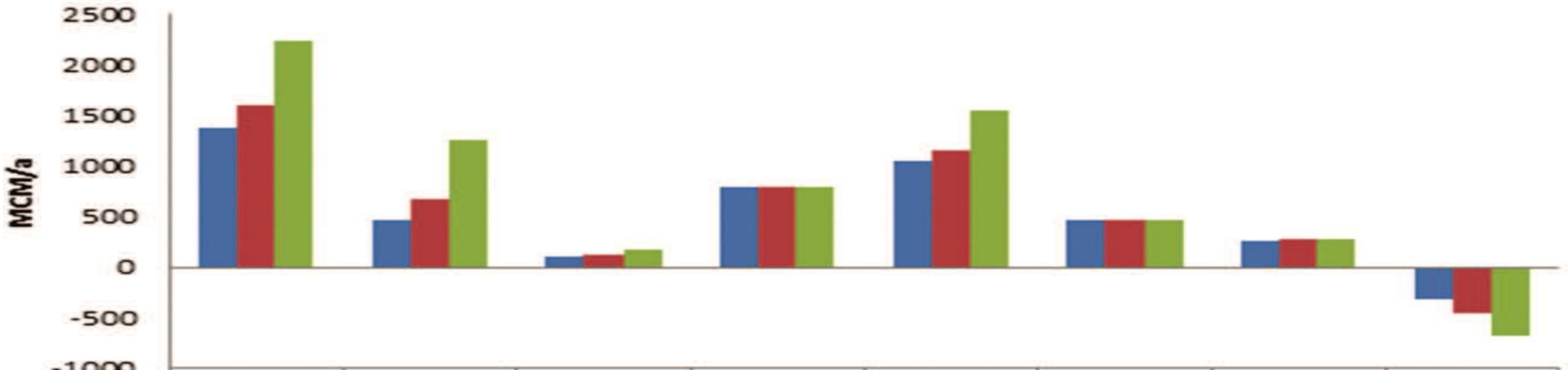
A breakdown of Jordan's total emissions on a GHG basis is as follows:

- Carbon dioxide (about 24003Gg CO2), 83.58%;
- Methane about (3087Gg CO2 eq.), 10.75%; and
- Nitrous oxide (about 1627Gg CO2 eq.), 5.67%.


Jordan's Sectoral Breakdown of Total GHGs in 2006 (TNC Report 2014)
LULUCF 3%
Agriculture 5%
Industrial processes 9%
Waste 10%
Energy (incl. Transport) 73%
Manufacturing industries 9%
Transport 16%
Other sectors (Commercial, residential and agricultural) 10%
Others 10%
Energy industries 28%
Breakdown of Energy (incl. Transport)
Compiled figure courtesy A. Abdelfattah

Water demand

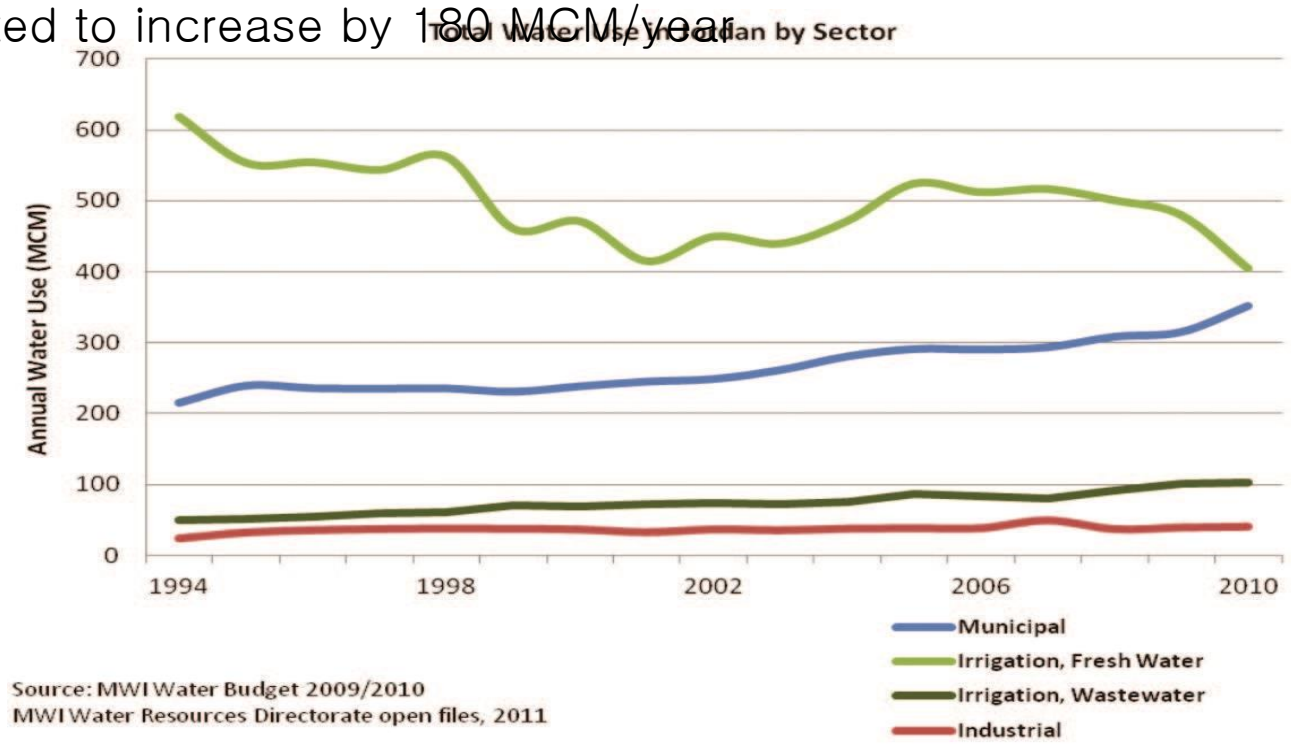
Being one of the four driest countries in the world, Jordan suffers from a severe water scarcity problem. Available water resources per capita are falling, while water demand and the water shortage will drastically increase in the future due to population growth and anticipated socio-economic development. Water management in Jordan is supply-based and, despite significant improvements in water-supply infrastructure, a critical and serious supply demand imbalance remains. the potential decreasing precipitation in Jordan as a result of climate change could worsen the existing problems



	Total water demand	Domestic	Industrial	Irrigation	Total water supply	Surface water	Ground water	Water deficit total
2010	1383	477	110	796	1054	470	271	-329
2020	1602	670	130	802	1152	470	277	-451
2040	2236	1263	170	803	1549	470	277	-687

Water use in Jordan

Over the past two decades Jordan's Government has made substantial efforts to convince agricultural producers to use treated wastewater as an additional resource, by ensuring that treatment levels comply with agricultural re-use standards, and convince consumers of the safety of food produced from reclaimed water blended with freshwater. The use of treated
wastewater in the Northern and Middle Jordan Valley has increased from about 40% in 2000 to about 56% in 2010. By 2015. Treated wastewater is expected to increase by 180 MCM/year.



Source: MWI Water Budget 2009/2010
MWI Water Resources Directorate open files, 2011

Waste water in Jordan

The handling of wastewater streams with high contents of organic material, including domestic and commercial wastewater and some industrial wastewater streams can emit significant amounts of methane.

Methane has the second largest share of Jordan's greenhouse gas emissions. CH4 emissions were estimated to be **147Gg** at 10.8 % of Jordan's total greenhouse emissions in the year 2006.

The contribution of the domestic and commercial wastewater was estimated to be around 1.4% of the total (around 2Gg CH4) generated methane

For domestic and commercial wastewater and sludge, this is indicated by the Biochemical Oxygen Demand (BOD); for industrial wastewater, the Chemical Oxygen Demand (COD) is used. The BOD indicates the amount of carbon that is aerobically biodegradable, whereas the COD indicates the total amount of carbon, biodegradable and non-biodegradable that is available for oxidation.

Sludge is produced as a by-product of certain wastewater handling systems, and can produce methane under anaerobic conditions.

The extent of CH4 production depends primarily on the following factors: Wastewater Characteristics, Handling Systems Temperature ,BOD vs. COD

Industrial waste

Methodology:

There are three industrial zones in Jordan, each zone has its own wastewater treatment facility using activated sludge – extended aeration treatment method.
MCF was made as an assumption of 5% as the method used in the three zones is activated sludge – extended aeration (aerobic treatment). Wastewater Handling Facility Efficiency and Output Aerobically treated may be subject to anaerobic conditions due to poorly managed and functioning facilities.

Max. Methane producing capacity was taken as default 0.25 KgCh4/Kg BOD.(The default (theoretical) value for Bo is 0.25 kg CH4/kg BOD for wastewater and for sludge (Lexmond et al., 1995)

If sludge is disposed of in landfills then the resulting emissions are already accounted for in the IPCC/OECD SWDS emission methodology. In this case, to ensure that emissions are not counted twice an “MCF” of zero should be used in this methodology for sludge disposed in SWDSs.

Industrial waste

Amman-Zarqa region is the largest urban center in Jordan and the largest industrial congregation, where the majority of the Jordanian industry is located. The ratio of water used in the industrial to the total use is very small (5 %). the Jordanian standard defined the maximum allowable concentrations of the treated industrial wastewater to be discharged to Wadis, rivers, reuse for irrigation, groundwater recharge (Jordanian Standards 202/2006) or to be connected to the sanitary sewer system (Water Authority of Jordan Regulations No. 18/1998).

Most of the industries in Jordan are small and medium enterprises (SMEs). They are located within Industrial Estates, Qualified Industrial Zones or located separately. Regarding the treatment of the generated industrial wastewater from the industries, it can be summarized as following:

- Industries have their own treatment plants and the treated wastewater is used for irrigation or for internal use (cooling, cleaning, reuse, etc.).
- The industries located within the Industrial Estates conduct pretreatment for its industrial wastewater before discharging it to the central treatment plant that exists within the estate.

Estimation of emission factor for wastewater handling systems					
A Wastewater handling system	B Fraction of wastewater treated by handling system	C Methane conversion factor (MCF)	D Product	E Maximum methane producing capacity (Kg CH_4/Kg BOD)	F Emission factor for industrial wastewater source (Kg CH_4/Kg BOD)
			D = (B * C)		F = (D * E)
Activated sludge	100%	5%*			
		MCF Aggregate	0.05	0.25	0.0125

Estimation of emission factor for sludge handling systems					
		Step 3			
A sludge handling system	B Fraction of sludge treated by handling system	C Methane conversion factor (MCF)	D Product	E Maximum methane producing capacity (Kg CH_4/Kg BOD)	F Emission factor for industrial sludge source (Kg CH_4/Kg BOD)
			D = (B * C)		F = (D * E)
Landfill	100%	0.00			
		MCF Aggregate	0.00	0.25	0.00

Estimation of methane emissions from industrial wastewater and sludge

	A Total organic product (Kg BOD/yr)	B Emission factor (Kg CH4/Kg BOD)	C Methane emission without recovery/flaring	D Methane recovered and/or flared (Kg CH_4)	E Net methane Emissions (Gg CH_4)
	Worksheet 6-3 sheet 1	Worksheet 6-3 sheet 2&3	C = (A * B)		E = (C-D) *10^{-6}
Wastewater	809157.4	0.0125	10114.5	0.00	0.01
Sludge	5728817.6	0.00	0.00	0.00	0.00
				Total	**0.01**

Domestic and commercial wastewater

65% of Jordan population is connected to the sewer system, the other 35% discharge their sewage either to the treatments plants by tanks (those will be calculated with influent of the treatment plants), or discharge it illegally. There were 22 working treatment plants in Jordan in 2006 managed by Water Authority of Jordan which aim to Develop and protect water sources, provision of water and sewerage services to ensure the requirements of citizens, and improvement of infrastructure to preserve environment and public health.

Methane emissions from domestic and commercial wastewater and sludge treatment

estimation of organic wastewater and sludge

A Region Or City	B Total wastewater produced by each plant m3/yr.	C Degradable organic component (Kg BOD/m3 wastewater	D Fraction of degradable organic component removed as sludge	E Total domestic/commercial organic wastewater (Kg BOD/yr)	F Total domestic/commercial organic sludge (Kg BOD/yr)
All				E=[B * C*(1-D)]	F=(B * C*D)
			Total	**15,268,249.2**	**69,887,892.8**

Estimation of Emission factor for wastewater handling systems

A Wastewater handling system	B Fraction of wastewater treated by the handling system	C Methane conversion factor for the handling system	D Product	E Maximum Methane producing capacity (Kg CH_4/Kg BOD)	F Emission factor for domestic/ commercial wastewater (Kg CH_4/Kg BOD)
			D=(B*C)		F=(D*E)
SP	0.78	0.75*	0.585		
AS & Others	0.22	0.05**	0.011		
		Aggregate MCF	0.596	0.25	**0.149**

Estimation of methane emissions from Domestic/Commercial and sludge					
	A Total organic product (Kg BOD/yr.)	B Emission factor (Kg CH_4/Kg BOD)	C Methane emission without recovery/flaring	D Methane recovered and/or flared (Kg CH_4)	E Net methane emissions (Gg CH_4)
	From worksheet 6-2 sheet 1	From worksheet 6-2 sheet 2 and 3	C = (A * B)		E = (C-D) * 10^{-6}
Wastewater	15,268,249.5	0.149	2274969.2	0.00	2.27
Sludge	69,887,892.8	0.00	0.00	0.00	
				Total	**2.27**

Indirect Nitrous oxide emissions from human sewage

A Per capita protein consumption (protein in Kg/person/yr)	B Population No.	C Fraction of nitrogen in protein $Frac_{npr}$ (Kg N/Kg protein)	D Emission factor EF_6 (Kg N_2O- N/Kg sewage- N produced)	E Total annual N_2O emissions (Gg N_2O/yr)
				$E = (A * B * C * D) * 44/28 * 10^{-6}$
29.6	5,600,000	0.16	0.01	0.375

Uncertainty

The quality of CH4 emissions estimates for wastewater handling is directly related to the quality and availability of the waste management data used to derive these estimates.

- ✓ Organic Wastewater Quantity and Composition were available in all data sources considered in this report.
- ✓ Physical and Chemical Data Country-specific data on wastewater characteristics are available.
- ✓ Wastewater Handling Facility Efficiency and Output for Aerobically treated wastewater by handling plants may be subject to anaerobic conditions due to poorly managed and functioning facilities so MCF was made as an assumption of 0.05.
- ✓ MCF for domestic/commercial wastewater was taken default value.
- ✓ Max. Methane producing potential B0 was taken default value.

Climate change strategic objectives on reporting and monitoring of GHG emissions

• To improve the national capacity on aspects of the measurement and reporting of GHG emissions and the reporting of climate change actions in Jordan, with emphasize on aspect of measurement, reporting, and verification (MRV) in line with the Bali Action Plan provisions and post-2012 international climate change agreements

in this regard;

• To strengthen the knowledge on the current volume and sources of GHG emissions in the country

- To gain insight in the possible impact of future developments and policies on future GHG emissions as a basis for policy-making on

Adopt regulation to facilitate data collection from emitters, especially in private sector, to the purpose of the inventory

The National Climate Change Policy of the Hashemite Kingdom of Jordan 2013-2020

Strategic goals

- To support research-oriented programs and projects on improvement of the GHG inventory in Jordan, elaboration of GHG scenarios and assessment of mitigation options.

- To supports research-oriented programs and projects of observation, monitoring and estimation of climate change impacts on all affected sectors (water, agriculture/food security, biodiversity, desertification, health, tourism, coastal areas, infrastructure, etc.) including interactions between sectors and impact categories;

- To support research-oriented programs and projects on assessment of technology needs and technology transfer options in the Jordanian context (local R&D capacity, local markets)

- Strengthen Jordan's system for reporting and verification of emissions, mitigation potential and activities in line with any international obligations that Jordan has/will be committed to. The reporting and verification system will support the identification and assessment of mitigation priorities, emission projections/scenarios, as well as provide data for the monitoring and reporting