
TECHNICAL NOTE

**ENVIRONMENTAL ISSUES IN AREAS RETAKEN FROM ISIL
MOSUL, IRAQ**

**RAPID SCOPING MISSION
JULY - AUGUST 2017**

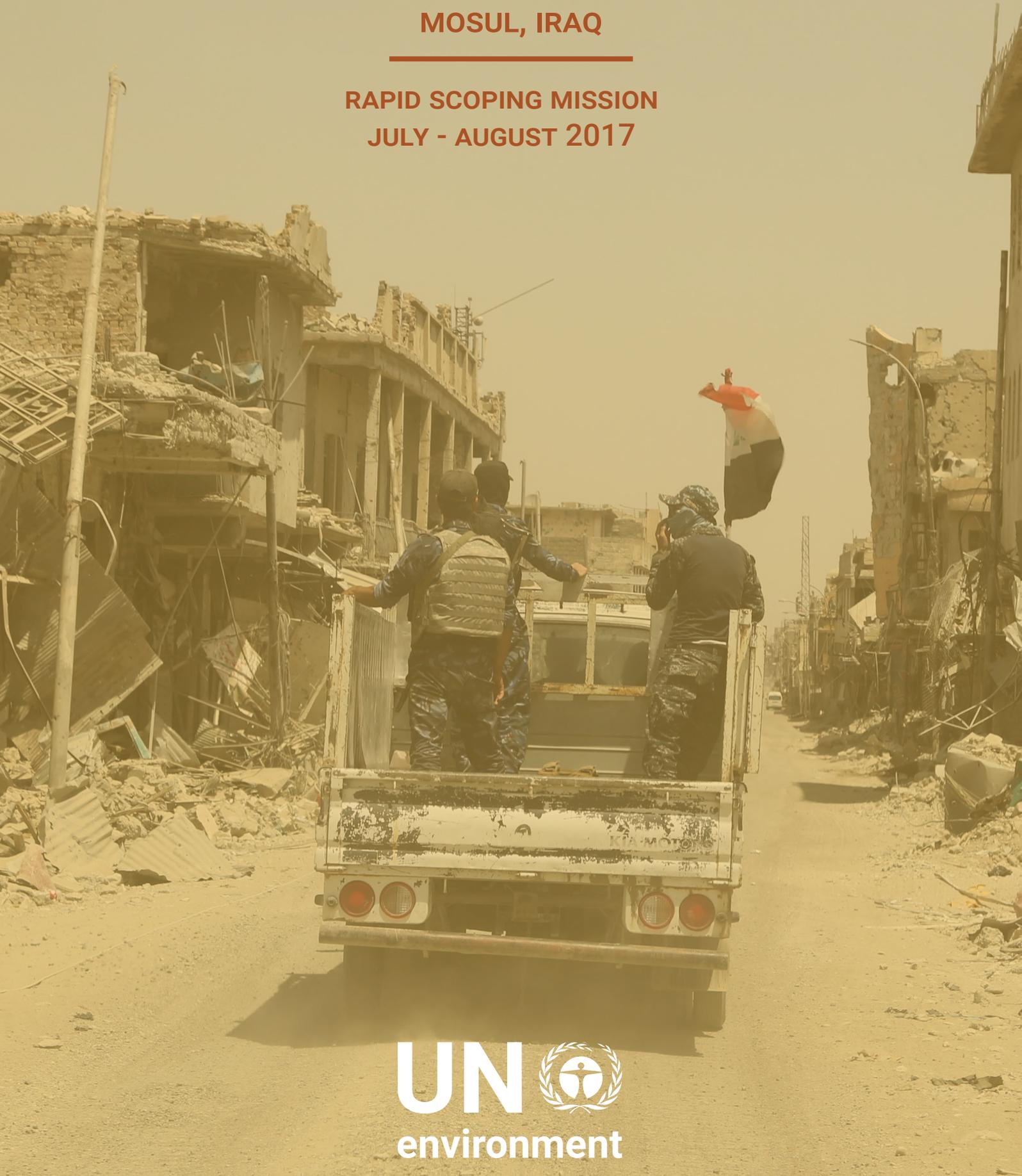


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Summary Highlights

General

- ❖ Iraq has experienced widespread destruction of civil and industrial infrastructure from systematic and extensive sabotage and looting by ISIL (so-called Islamic State in Iraq and the Levant, alias Daesh), as well as from airstrikes and military operations to recapture these areas.
- ❖ Destruction of major investments in new infrastructure made prior to the fall of northern and western Iraq to ISIL constitute a substantial economic and development setback.
- ❖ Meanwhile, there has been widespread looting - from oil resources to archaeological artefacts - by mafia-like organized crime during the period under ISIL control.
- ❖ It will take time to fully comprehend the level of environmental damage given the lack of institutional memory over what occurred during the three years of ISIL occupation. New contaminated sites are likely to be reported as inaccessible areas open up.

Mosul Debris

- ❖ The quantity of conflict debris in Mosul is estimated at **11 million tonnes**. Equivalent to three times the Great Pyramid of Giza or four times the Eiffel Tower.
- ❖ UN Environment is working with Mosul Municipality, UN-Habitat and technical partners to refine debris quantification estimates and develop **operational management scenarios** for recovering and recycling the enormous quantity of rubble.
- ❖ In collaboration with partners, UN Environment plans to organize a workshop with Mosul Municipality to help develop an **optimal debris management plan** in late 2017.

Contaminated Sites

- ❖ Burning for 9 months, the 18 oil wells set alight by ISIL in Qarrayah created such thick black smoke that locals refer to the darkened skies as the '**Daesh winter**'.
- ❖ **Al-Shuhadaa neighbourhood** was devastated by the blasting of an oil well lying in its midst. The interior of many homes is covered in toxic soot and residents complain that noxious fumes from the oil pools and smouldering fires have made the settlement uninhabitable.
- ❖ ISIL set alight a ~50,000 tonne stockpile of pure sulphur at the **Mishraq Complex**, creating a dense white cloud of toxic sulphur oxides that reached Baghdad and neighbouring countries.
- ❖ An approximately **two million tonne pile of sulphur waste** is at risk of future sabotage attempts or accidents in the inadequately guarded site.
- ❖ A wide range of sites from factories, workshops and warehouses to private homes and schools were converted by ISIL into **ammunition manufacturing plants** and are now littered with explosives and potentially toxic chemical products.
- ❖ There is a high risk of **toxic PCB contamination** from the extensive damage to Mosul's electricity network. At the main electricity station supplying western Mosul, heavy calibre rounds were deliberately fired by ISIL into a block of power transformers filling the basement of the building below with up to 3 metres of transformer oil.
- ❖ **Artisanal oil refining** on the outskirts of both eastern and western Mosul is another important legacy of the conflict. Makeshift refineries use rudimentary practices creating a localized but a potentially significant pollution footprint.
- ❖ Mosul airport, Ghizlani military camp and Western Mosul's central garages reportedly contain large amounts of **hazardous asbestos**.

- ❖ Adaya and Al-Jazira, are two high risk sites from Iraq's former **nuclear decommissioning programme** whose status remains unknown.

Cessation of Environmental Governance and Education

- ❖ **Niniveh Environment Directorate** was immediately disbanded by ISIL and its offices, laboratories and assets confiscated. Ordered not to return to work, its 140 staff were jobless for three years.
- ❖ Converted by ISIL into one of their command centres and suspected to have been used as an ammunition making workshop, the Environment Directorate's **offices were set on fire** by ISIL and are no longer useable.
- ❖ Mosul University's **College of Environmental Sciences and Technology was abolished** and its brand new building transformed into a command centre for ISIL leadership. The college was thoroughly ransacked and the building structurally sabotaged by ISIL prior to their eviction in January 2017.

Weaponization of water management infrastructure

- ❖ ISIL seized control of critical dams and barrages to exert **hydrologic hegemony** over downstream cities and rural areas by either cutting off water supplies or releasing a flood wave to drown government controlled areas. The 2014-2015 'drought' in central and southern Iraq was largely a result of ISIL blocking water flows.
- ❖ ISIL also used water facilities as a **battlefield weapon** to flood and impede government troop movements or to create defensive positions. A prime example was the flooding in 2014 of hundreds of square kilometres of agricultural land downstream of Fallujah which displaced thousands of people, reaching Abu Ghraib near Baghdad.
- ❖ Iraq's water battle was mainly played out on the **Euphrates River** where ISIL's command extended into Syria. At one point, ISIL controlled all of the water infrastructure along the Euphrates River from Tabaqa dam in Syria to Fallujah Barrage near Baghdad. Only Haditha, Iraq's second largest dam, remained under government control through airlift support.
- ❖ An initial assessment by the Ministry of Water Resources estimates direct damages to hydraulic infrastructure at **USD 600 million dollars**. Although water installations have now returned under government control they need urgent rehabilitation and maintenance.

1. Background

During his visit to Iraq in May 2017, Erik Solheim responded positively to the government's request for support in conducting an assessment of the environmental impacts in areas formerly occupied by ISIL (so-called Islamic State in Iraq and the Levant, alias Daesh). The Head of UN Environment witnessed first-hand the devastating environmental impacts affecting the inhabitants of Qayarrah town, 60 kilometres south of Mosul, from oil wells deliberately set on fire. ISIL's scorched earth tactics provide a dramatic illustration of how pollution from conflicts and deliberate sabotage and looting of industrial facilities and civil infrastructure can affect people's health and livelihoods for decades, and impede reconstruction and peacebuilding efforts.

Two weeks after the Iraqi Government declared the liberation of Mosul on 9 July 2017, UN Environment deployed staff to Iraq to design and plan with the Environment Ministry an environmental assessment of the city and surrounding areas. Iraq's second or third largest city (estimates vary) with a pre-conflict population of around 1.4 million people, Mosul is today at the centre of one of the world's largest and most complex humanitarian operations with over one million displaced persons. An important commercial and industrial hub, Mosul is also where environmental impacts are considered to be of greatest concern given the high level of infrastructure destruction, the large number of hazardous sources, and the potential size of the exposed population.

UN Environment's reconnaissance assessment of the environmental impacts in areas retaken from ISIL is carried out in close coordination with and support from the UN System in Iraq. This work is also embedded within the UN Recovery and Resilience Programme for conflict affected areas currently being developed by the UN at the request of the Iraqi government, which will be presented in the upcoming Kuwait donor conference.

2. Assessment Planning

A technical meeting was held at the Environment Ministry in Baghdad on 27 July 2017 with experts from eight line ministries to identify the contaminated sites of most concern. With a dedicated Contaminated Site Assessment Department established following UN Environment's 'Hot Spots Assessment' project (2004-2007), the Environment Ministry has a young and professional team comprising 15 staff. Of the 60 polluted sites identified prior to the ISIL conflict, 40 have so far been assessed. Furthermore, the Environment Ministry's Central Environment Laboratory has an accumulated experience of over 30 years and is well equipped to conduct organic, inorganic, physical and bacteriological analysis. The laboratory, however, currently lacks international accreditation and does not participate in laboratory intercomparison programmes. Analysis of duplicate samples may therefore be required to ensure quality assurance of laboratory results.

At the abovementioned meeting, the government decided to set-up a joint task force comprising experts from the ministries of environment, oil, and industry and minerals, to lead the assessment of the priority contaminated sites from the ISIL conflict. UN Environment will provide technical guidance on contaminated site assessment and reporting. Fieldwork is planned to take place in October 2017.

3. Reconnaissance Field Visits

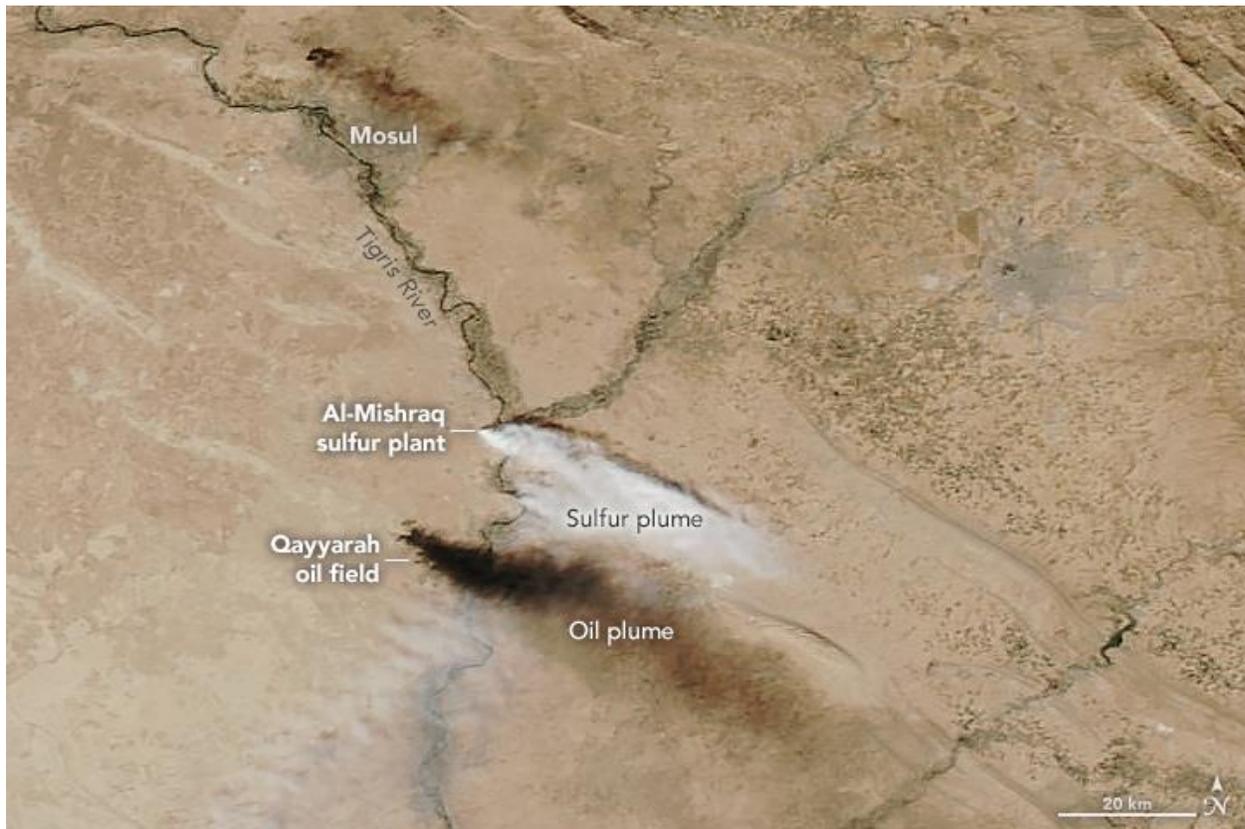
Scope and Purpose

UN Environment staff conducted fact-finding visits to obtain a general understanding of the nature and scale of the major environmental issues in areas retaken from ISIL. This included field visits to: i) the two priority oil and mining sites of Qayyarah and Mishraq torched by ISIL; and ii) the City of Mosul. Site visits were accompanied by staff from the Environment Ministry (Niniveh Environment Directorate) and oil and mining state companies.

Methodology

This rapid scoping assessment is primarily based on observational walkover surveys, and focus group discussions and interviews with government experts, academics and UN agencies. Identification of potentially contaminated sites was informed by the Mosul Environmental Hazards Assessment map prepared by the UN Environment/OCHA Joint Unit and UN-Habitat in May 2017, and consultations with the Niniveh Environment Directorate and line ministries in Baghdad. A total of 23 'grab samples' (soil, water) were collected to obtain an indicative measure of potential contamination. Samples will be analysed by Spiez and Bachema laboratories in Switzerland, and AI Control Laboratory (ASL) in the UK.

Map of sites visited during the UN Environment scoping mission



© NASA Earth Observatory

Preliminary debris quantification in Mosul city was derived from an initial damage assessment based on satellite imagery from 8 July, 2017, carried out by UN Environment in collaboration with UN-Habitat, Disaster Waste Recovery and Urban Resilience Platform.

Security and Operational Constraints

The high-risk security environment restricted both the locations visited and the length of time spent on-site. As a 'military controlled zone', travel to and within Mosul requires special permission and complex logistical arrangements including dedicated security escorts. The risk of explosive hazards, not only from unexploded ordnance and landmines, but also from improvised explosive devices and booby traps, is another important constraint. In certain areas, site visits were accompanied by experts from the UN Mine Action Service.

3.1 Qayarrah Oil Field



Large pools of crude oil pollute the landscape © UN Environment

- Qayarrah oil field is located around 60 kilometres south of the city of Mosul, and directly adjacent to Qayarrah town with an estimated population of approximately 23,000. Uncontrolled human settlements have encroached inside the oil field since 2006. The area fell to ISIL in June 2014.
- Operated by the government owned North Oil Company, Qayarrah oil field extends over an area of around 50 square kilometres. It contains 90 oil wells with an installed production capacity of approximately 30,000 barrels per day.
- An oil refinery is located on the south-eastern outskirts of the town, with an installed capacity of 34,000 barrels of heavy crude (asphalt), and 20,000 barrels of light crude per day.

- Eighteen of the 25 wells rigged with explosives and blown-up by ISIL in June 2016 caught fire, creating a vast black cloud stretching over tens of kilometres. So thick was the toxic black smoke that it obscured the sun. Locals refer to the darkened skies as the 'Daesh winter'.



Thick clouds of smoke blocked out the sun for months prompting locals to dub it the 'Daesh Winter' © Iraq Ministry of Oil

- The last oil well was put out 9 months later on 28 March 2017 (similar period to the Kuwait oil fires of 1991). An additional 16 wells were damaged but did not catch fire.
- Estimations of the total volume of oil loss is in the range of 1.4 to 2 million barrels according to government sources.
- The circumstances of controlling the fire were exceptional in that it took place on an active frontline. Underequipped and understaffed, the fire fighters worked under direct sniper and missile fire, and in a high risk zone not properly surveyed for landmines.
- Given the unconventional situation, the fire fighters improvised by modifying and retrofitting their heavy equipment so that it can withstand intense heat. They worked around the clock in eight-hour shifts. One firefighter was killed and five others seriously injured while extinguishing the oil fires.
- A problematic site is well 46 as it lies in the middle of an informal settlement (Al-Shuhadaa neighbourhood). Although this well was not operational, it was nevertheless detonated by ISIL.
- Oil from well 46 flowed into the streets of Qayarrah and Al-Shuhadaa neighbourhood remains highly contaminated over wide areas with oil sumps. Seeping into the ground, the oil has formed a thick layer (15-30 cm) of oil crust over wide areas. Fresh liquid oil mixed with soil as well as large pools of oil were also visible in the neighbourhood.

- Scores of homes were burnt and residents complained that the settlement was no longer habitable due to the noxious fumes emanating from the oil pools and smouldering fires that break out intermittently. The interior of many houses are covered in soot. The very fine particulate matter containing polycyclic aromatic hydrocarbons (PAHs) and heavy metals (lead) represent an indoor air quality health risk to residents.



Working under enemy fire, firefighters retrofitted their heavy equipment to withstand intense heat © Iraq Ministry of Oil

- The refinery was targeted by coalition forces as it was used by ISIL and is severely damaged. The oil depot made up of 18 storage tanks with a total capacity of 40,000 m³ was also impacted in combat operations. Twelve tanks were destroyed or damaged and several melted under the extreme temperatures. The total amount of burned and spilt oil cannot be ascertained but is estimated by experts from the oil ministry at 20,000 m³. Several storage tanks were flooded in pools of liquid oil, which is likely to have seeped into the ground.
- Despite the refinery's destruction, ISIL was reportedly able to continue to produce oil by installing loading stations directly on the wells.
- Refinery capacity was expanded under recent renovation efforts before the ISIL takeover, and its destruction represents an important economic loss. One unit of the heavy oil (asphalt) refinery is now repaired and back in production.
- In general, the land area impacted around each well is variable depending on the topography but can be estimated to range around 1 to 1.5 square kilometres. Tens of thousands of barrels of oil flowed on land and into the wadis, creating reportedly at least 23 large lakes. In certain areas, the oil spill reportedly reached within 200-300 metres of the Tigris River.

- The population of Qayarrah town depends on the Tigris River for its drinking water and there is limited use of groundwater, which is partially used for agriculture and household chores. Nevertheless, oil pollution can contaminate the Tigris River following rains and over the medium to long-term the polycyclic aromatic hydrocarbons (PAHs) can migrate to the ground water.
- Grab water samples taken by UN Environment showed elevated levels of mercury and lead in both drinking and groundwater. Follow-up monitoring is required to confirm the source of this pollution.
- Extensive tracts of grazing land and dryland farming were impacted by oil pollution and large numbers of livestock (mainly sheep) were covered in soot and reportedly lost, jeopardizing the local population's livelihoods.



Al-Qayarrah residents complain of noxious fumes from oil spills next to their homes © UN Environment

3.2 Mishraq Sulphur Complex



A large stockpile of purified sulphur was set on fire by ISIL © UN Environment

- The General Mishraq Sulphur Company is located around 45 kilometres south of Mosul and 3 kilometres from the juncture of the Tigris and Great Zab rivers. The complex is situated in a rural setting with five villages located within a 3-5 kilometre radius. It covers a 17 square kilometre area and consists of a sulphur mine, a sulphuric acid plant and an alum plant.
- The ore body is over 10 square kilometres in area and is considered to be one of the largest sulphur deposits in the world, containing at least 100 million tons of elemental sulphur.
- In 2003, a fire set by arsonists to stockpiles of purified sulphur and adjacent waste piles led to the largest single manmade release of sulphur, estimated at 600,000 tonnes.
- Using explosives and vehicle tyres, ISIL set alight a ~50,000 tonne stockpile of refined sulphur on 21 October 2016. An estimated 30,000-35,000 tonnes of which was reportedly consumed, generating a thick white cloud of toxic sulphur dioxide and sulphur trioxide reaching Baghdad and neighbouring countries.
- The Ministry of Health and World Health Organization reported treating over 1,500 people for suffocation symptoms in the Iraqi towns of Qayyarah, Makhmour and Ijhalah.
- The fire was put out on 27 October 2016 by Civil Protection units, and staff from Ninewah Governorate and Mishraq company.
- The footprint of the area impacted by the sulphur cloud is estimated to extend over 200 kilometres (depending on wind direction), which would theoretically require to be assessed.

- The sulphuric acid processing plant was also torched by ISIL creating a stream of melting sulphur flowing in a large ditch that feeds into the Tigris River.
- A high risk site is the approximately two million tonne sulphur waste pile, comprising around 80 per cent sulphur mixed with bitumen.
- Given the site is not fully fenced and is lightly guarded, future sabotage attempts or accidents continue to be a source of concern for company management.

3.3 Mosul City

The impacts of the conflict on eastern and western Mosul are incomparable. Indeed, in terms of level of destruction it is more appropriate to speak of two cities. Eastern Mosul is well on the road to recovery. The level of devastation in western Mosul, however, is so great that reconstruction will take years, if not decades. It is important to underline that military combat and airstrikes against ISIL were not the only source of damage. Planned and systematic sabotage of infrastructure and looting of assets by ISIL is one of the major hallmarks of the devastation. Finding suitable solutions to the enormous quantity of debris generated from the conflict is one of the central issues in the city's stabilization and reconstruction.

3.3.1 Eastern Mosul

Eastern Mosul was retaken by Iraqi Security Forces in January 2017, and damage is relatively limited in scope and is site specific. The majority of the destruction and damage is to government buildings; sixty percent of which were reportedly ruined according to the Mayor of Mosul. This includes public directorates, Mosul University, and utility buildings. By and large, signs of normal life have returned to eastern Mosul including lively markets and restaurants, well-stocked shops, police are manning traffic intersections, municipal city cleaners are sweeping the streets and there is a regular waste collection service.

Contaminated sites:

- Identification of contaminated sites is complicated by the fact that ISIL had converted many workshops and unsuspected sites, such as dairy plants and food warehouses, into ammunition manufacturing factories. Many of these sites were targeted by coalition air strikes, and are themselves booby-trapped and/or littered with unexploded ordnance and unknown chemical products.
- There is a high risk of toxic polychlorinated biphenyl (PCB)¹ contamination from the high level of damage to Mosul's electricity network. According to the Electricity Directorate, all 37 power substations (33_11 KV) in both eastern and western Mosul have suffered some damage, of which at least 14 are seriously damaged or irreparable. In addition, an estimated 1,400 small distribution transformers (11_416 V) are damaged.²

¹ The Stockholm Convention to which Iraq is a signatory, mandates parties to take measures to eliminate the production and use of polychlorinated biphenyls, more commonly known as PCBs.

² According to the Ministry of Electricity, most of the 24 power substations (kV 132) in Niniveh Governorate were destroyed including in Western Mosul, Eastern Mosul, Tel Awainat, and Sinjar.

- The central electricity storehouses in Karama serving eastern Mosul were bombed and sabotaged and oil from scores of transformers are visibly leaking, which may contain PCBs.



Industrial facilities, such as this food processing warehouse, was used for weapon manufacturing by ISIL and is littered with ordnance and explosive hazards © UN Environment

- Artisanal oil refining on the edge of the city was relatively widespread and is another important legacy of the conflict. Makeshift refineries use rudimentary practices creating a localized but potentially significant pollution footprint. Land contamination and groundwater pollution may be an issue. However, many of these sites are distant from population centres so do not appear to pose an immediate risk to the population.
- The pharmaceutical manufacturing complex north of Mosul was bombed by coalition forces on suspicion of conversion into a chemical weapons manufacturing facility. The plant is under military control and is not accessible.



Proliferation of artisanal oil refining poses a significant risk of localized pollution © UN Environment

3.3.2 Western Mosul

The situation in western Mosul is completely different from the eastern bank. The old city – an area of 2.5-3 square kilometres and a pre-conflict population of over 100,000 people is almost completely destroyed; more than 90%. At the time of UN Environment's field visit on 2 and 3 August, it was a military zone deserted of people and daily skirmishes were taking place. The stench from decomposing corpses in the rubble (up to three thousand according to the Mayor) was evident, and is a health concern to the authorities. The old city is also heavily contaminated with booby traps and mines. The underground situation below the old city itself remains unknown due to extensive tunnelling by ISIL. Other than some historic landmark buildings which may still be partially saved, it is evident that the old city will need to be rebuilt anew.

The sector immediately north and west the old city (Al-Rabee district) is also heavily damaged (around 60-70% destroyed). Nevertheless, people are gradually returning and some businesses are opening in New Mosul sector (south west of the old city) and also on the edges of the city that were retaken earlier.

Contaminated sites:

Strict restrictions on movement by the military, risk of explosive hazards and the fact that certain areas were levelled beyond recognition - including to the personnel of the Niniveh Environment Directorate - restricted investigation of polluted sites.



At Western Mosul's main power station, heavy calibre rounds were deliberately fired into a block of power transformers filling the basement of the building below with up to 3 metres of potentially toxic transformer oil © UNDP

Based on information gathered so far, a number of sites stand out as potentially hazardous:

- The Medical complex comprising a dozen buildings, strategically overlooking the Tigris River, and completely destroyed including the X-Ray Hospital and the health waste incinerators;
- Electrical installations, notably: (i) the 400 kv Supergrid at Al-Sahaje which is the key pass-through mechanism to power the western neighbourhoods; and (ii) the central electricity storage facility. In both sites, there is significant spillage of transformer oil that may be contaminated with toxic PCBs.
- At the 400 kv station, heavy caliber rounds were deliberately fired into the block of power transformers consisting of 12 single phase 132 KV power transformers. The resulting oil spillage filled the basement below the Gas Insulator Switchgear building with up to three metres of transformer oil, which may be contaminated with PCBs.
- Mosul airport, Ghizlani military camp and central garages reportedly contain large amounts of asbestos. Field verification is needed to confirm the extent of contamination.
- There are also two high risk sites located around 50 kilometres west of Mosul (Adaya and Al-Jazira) from Iraq's former nuclear decommissioning programme where waste materials were stored. Their status is currently unknown, and the locations were not accessible at the time of the scoping mission due to ongoing military operations in the area.
- There are reportedly many artisanal oil refineries located on the western outskirts of Mosul. It was not possible to access these sites, however, as they are located on the road to the city of Tel Afar, where military operations were ongoing.

4. Mosul Debris Management



Developing a management plan for the more than ten million tonnes of debris created by the conflict is a central element of Mosul's reconstruction © UN Environment

- Debris clearance is a central issue in Mosul's crisis response and future reconstruction. Based on a preliminary debris assessment coordinated by UN Environment, the quantity of debris generated is conservatively estimated to be in the order of 11 million tonnes (see debris map).
- For a sense of scale, this amount of debris is equivalent to three times the Great Pyramid of Giza or four times the Eiffel Tower. Moreover, this is likely to be an underestimate as a significant amount of rubble will be produced from demolition works. For example, ISIL structurally damaged multi-story buildings by blowing-up their foundational pillars.
- Around 75 percent of the estimated total debris (~8.1 million tonnes) is located in western Mosul. The remaining 25 percent (~2.7 million tonnes) is in eastern Mosul.
- Debris clearance is the responsibility of Mosul Municipality. In a meeting with the Mayor of Mosul, Mr. Abdel-Satar Habo stressed that the municipality's top priority is the speedy removal of debris to improve road access and allow people to return and rebuild their homes and businesses. This position is fully understandable and indeed a predictable one in the wake of destruction at this scale.
- During the scoping mission to eastern Mosul from 1-3 August, much of the debris appeared to have been cleared from the streets but less so from damaged buildings. Residents were also reportedly clearing their homes and businesses of debris, where feasible. In western Mosul, debris clearance had only just begun.

- Debris recovery is being carried out in a spontaneous and ad-hoc manner with the rubble largely dumped in seasonal wadis or gullies, aggravating the risk of future flooding. Hasty debris disposal means that today's solutions are likely to be tomorrow's problems.



The foundational pillars of these buildings were blown-up by ISIL, necessitating their demolition © UN Environment

- This narrow and localized "immediate needs" approach, however, has resulted in highly fragmented debris clearance operations. Driven primarily by speed, it lacks an overview perspective of the scale of the debris problem leading to major inefficiencies and lost livelihood as well as economic opportunities.
- The lack of an integrated debris management plan means that critical variables are ignored including cost-benefit analysis of alternative courses of action, debris recycling potential, livelihood and job creation opportunities, and environmental impacts. Management of debris from heritage buildings will require special procedures, particularly in the old city.
- Reconstruction works will create an enormous demand for local raw materials, namely sand, gravel and rock for use as aggregate material in reconstruction. This demand will be significantly increased if the debris is disposed of without any recycling.
- Mosul Municipality proposes to extract sand and gravel from the Tigris River. Riverbed quarrying, however, is banned under Iraq's environmental law as it is highly destructive. Moreover, the environmental sensitivity of the Tigris River is bound to substantially deteriorate in view of the impending impoundment of major upstream dams and the consequences of climate change.
- Poorly planned debris clearance is also resulting in the rubble being mixed with other waste, including hazardous materials. Asbestos is an important issue as it is reportedly found in Mosul

airport, Ghizlani military camp and the central garages which were damaged during military operations. It is important that hazardous materials are identified early on, and that health and safety measures are taken to protect workers and residents.



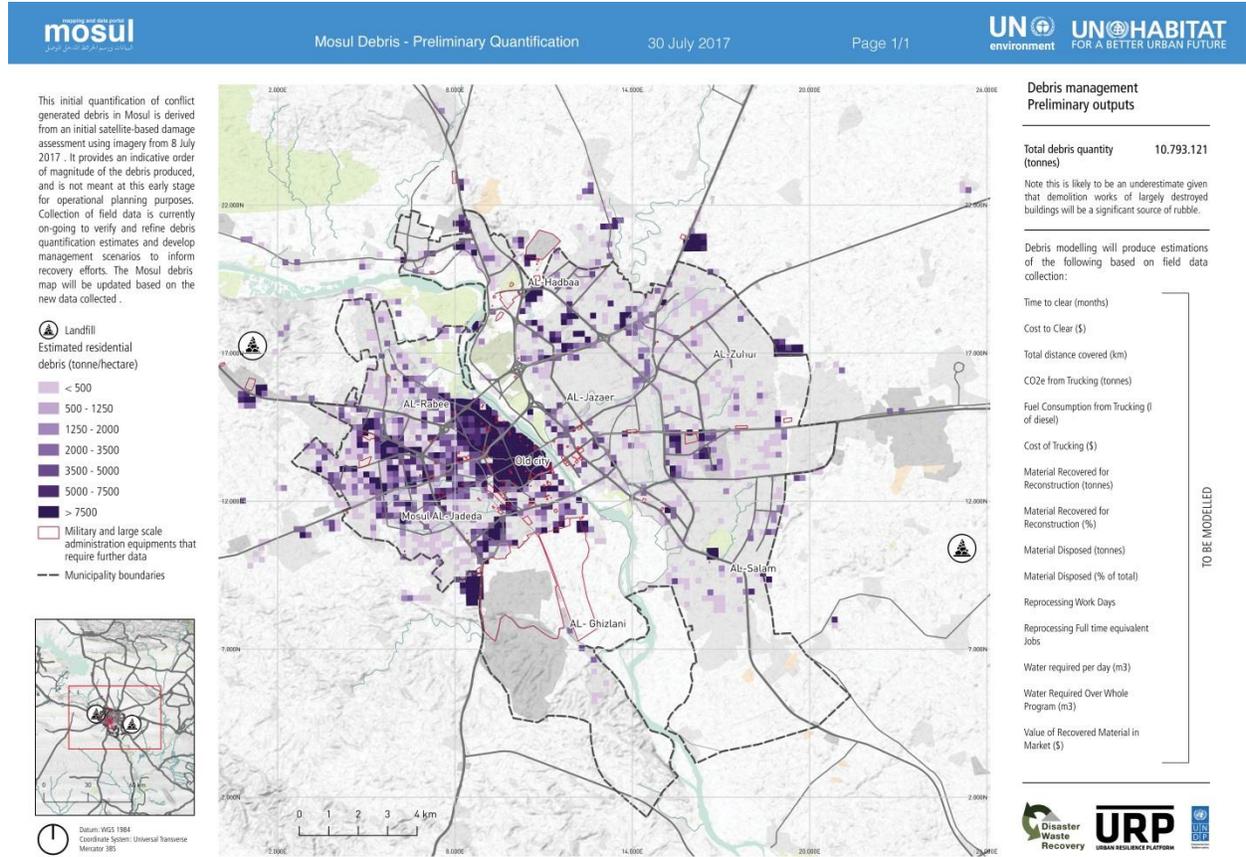
Debris recycling can realize significant cost savings, create jobs and reduce environmental pressure for new raw materials © UN Environment

- The high level of unexploded ordnance and land mine contamination, and the wide array of booby-traps used in Mosul, means that debris and explosive hazard clearance will need to be carefully coordinated. Specific procedures will need to be put in place to deal with the explosive risks in debris removal. The UN Mine Action Service estimates that it will take 3-4 years and cost USD 60-80 million to clear Mosul from explosive remnants of war.
- The UNDP managed Funding Facility for Stabilization (USD 420 million) is providing significant support to Mosul Municipality on debris removal by contracting local service providers. As a stabilization effort aimed at the immediate next 6-12 months, however, the Stabilization Fund is strictly focused on facilitating population return and generating income for the local population, where possible. Consequently, its present planning horizon does not allow for addressing medium to longer-term debris management options.
- It is critical that the UN, financial institutions, donors and national authorities, learn from past lessons and that support is provided to Mosul Municipality to develop a long-term vision and operational plan on debris management.
- In collaboration with UN-Habitat and Disaster Waste Recovery/ Urban Resilience Platform, UN Environment is leading the process of collecting field data to refine debris quantifications. Using these data sets, debris modelling scenarios will be developed to help advise Mosul Municipality in planning and leading rubble clearance efforts. These scenarios will compare the option of disposing

of the rubble with and without recycling in terms of cost, speed, job creation opportunities and environmental impact.

- Debris management scenarios will be presented to Mosul Municipality at a workshop that UN Environment plans to organize in end 2017 and which will involve UN agencies, donors, line ministries and the private sector. The aim is to help Mosul Municipality develop an optimal debris management action plan tailored to its local context and supported by a wide range of key partners.

Mosul Debris Map



MOSUL DEBRIS CHALLENGE

QUANTITY

10

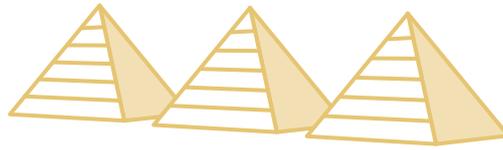
MILLION TONS OF DEBRIS

=

3 GREAT PYRAMIDS

=

4 EIFFEL TOWERS



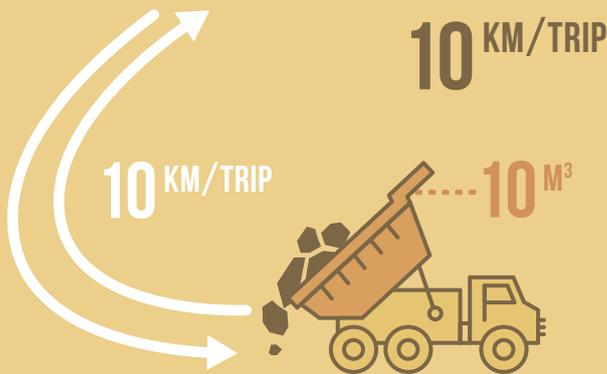
Debris quantity in Mosul of more than 10 million tons is equivalent to the 3 Great Pyramids or 4 Eiffel Towers.

TRANSPORT



Moving more than 10 million tons of debris to a dumpsite ca. 10 km outside the city in 10 m³ trucks is the equivalent of 12½ million truck kilometres...

...which is the same as 16 times to the moon and back.



10 KM/TRIP

=

TOTAL OF

12½

MILLION KM



16×

COST

250
MILLION US\$

Cost of moving all of the debris outside the city



100%

175
MILLION US\$

Cost savings of at least 30% by recycling half of the debris within the city



50%

5. Cessation of Environmental Governance and Education

ISIL dismantled Mosul's governance system and created a new administration. The title and mandates of technical directorates were changed and their reporting lines reorganized. In the case of the Niniveh Environment Directorate, it was immediately disbanded.

5.1 Niniveh Environment Directorate



The offices of the Niniveh Environment Directorate were gutted by fire, and are strewn with unknown chemical products © UN Environment

With 140 staff, Niniveh Environment Directorate was reportedly Iraq's largest and top rated provincial environmental administration. The acting head of the Environment Directorate reported that the department was immediately dissolved by ISIL, and staff given orders not to report to work again. All the Directorate's assets were comprehensively confiscated down to laptops and personal diaries. A modern environmental laboratory including four mobile van laboratories, vehicles, boats for measuring water quality and river discharge, air quality and radiation monitoring stations, and the office archives were looted and lie in ruin.

The Environment Directorate's office buildings were taken over by ISIL and converted into one of their command centres. Prior to their withdrawal from Eastern Mosul, the main offices were set on fire by ISIL and are no longer useable. During UN Environment's inspection of the gutted premises, the offices were littered with a wide range of chemical bottles. Environment Directorate staff suspect that the building may have been transformed into an ammunition manufacturing workshop. A displaced family from western Mosul is currently living on the premises.

At the time of UN Environment's visit, Environment Directorate staff were provisionally hosted at the Centre for Special Needs run by the Ministry of Labour and Social Affairs; where they have been

allocated one large office room. However, they were requested to vacate and now plan to rent new offices following authorization from the Environment Ministry in Baghdad. Staff started to formally report to work in June 2017 but clearly the Environment Directorate needs to be fully re-equipped in order to effectively resume its functions. It is also noteworthy that staff had not received salaries over the past two years, and it was only recently that their pay was restored.

5.2 College of Environmental Sciences and Technology, Mosul University



Mosul University's Environmental College was ransacked by ISIL who used it as one of their command centres
© UN Environment

The College of Environmental Sciences and Technology was established under a joint initiative by Mosul University and the Environment Ministry in 2006. Offering bachelor, graduate and doctoral degrees, the college seeks to produce a qualified cadre of environmental specialists to address Iraq's growing environmental challenges. In 2013, a new multi-million building was inaugurated to accommodate the growing student body, which had reached an enrolment of around 450.

Under ISIL every department in Mosul University was abolished except medicine and certain sections of the engineering department. The environmental college did not escape this fate, and its brand new building was reportedly transformed into a command centre for ISIL leadership. Moreover, its laboratories were reportedly used to manufacture weapons. The college was thoroughly ransacked and the building structurally sabotaged by ISIL prior to their eviction in January 2017. Underground tunnels were also uncovered inside the main building, which were pointed out to UN Environment during its site visit. Despite the massive destruction, clean-up and rehabilitation of the environmental college is well underway, and it is scheduled to reopen for the new academic year in October 2017.

6. Weaponization of water management infrastructure

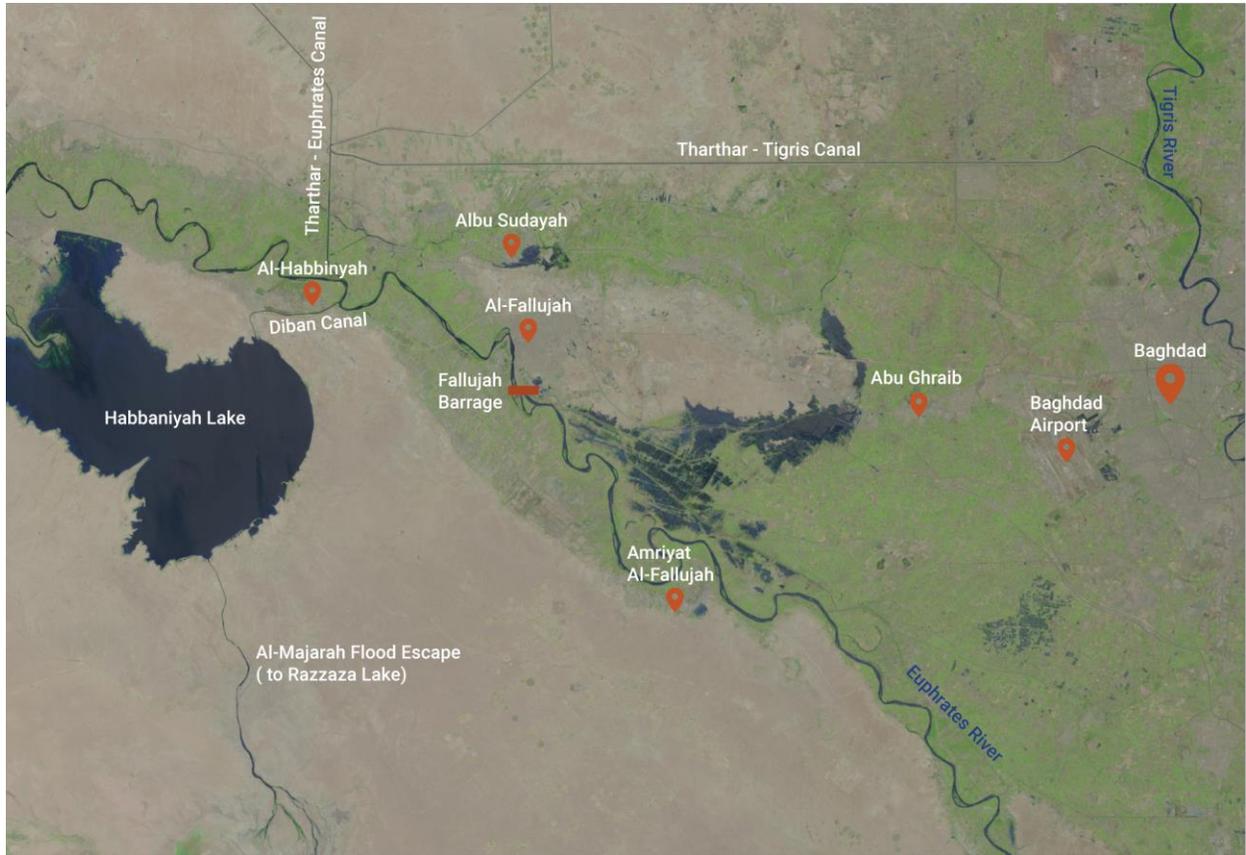
Water management infrastructure³ was used by ISIL as both a strategic and tactical weapon in its conflict with the Government. ISIL sought control over critical water facilities to exert hydrologic hegemony on government controlled central and southern Iraq. Tactically, it used water as a battlefield weapon to flood and thwart government troop movements and in other instances to drown or besiege government controlled towns and rural areas.

- Spanning the Tigris River, the Mosul dam – Iraq's largest - was captured by ISIL for less than two weeks in August 2014 raising public concern due to a long-standing risk of failure. As the workers operating the dam fled, so grouting operations to maintain ground stability below the dam were halted, heightening the threat of a catastrophic collapse. When Kurdish forces regained control of the dam, its equipment were looted and destroyed.
- Iraq's water battle, however, was mainly played out on the Euphrates River. The battleground extended from the Tabaqa dam⁴ - approximately 40 kilometres upstream of Raqqa in Syria - and through the entire expanse of Al-Anbar Governorate from the point that the Euphrates River enters Iraq near Al-Qaim to the Fallujah barrage, nearly 65 kilometres west of Baghdad.
- To a lesser extent, ISIL was also able to exercise its influence over the Tigris River during certain periods when it gained control of Samarra barrage from 2014-2016, disrupting the water transfer scheme from the Tigris to the Euphrates rivers via the Tharthar Reservoir and associated control structures and canals.
- Haditha, Iraq's second largest reservoir dam which regulates the Euphrates River for the whole country, was never occupied by ISIL. Nonetheless, the group completely besieged the dam for over a year and half from 2015-2016, assaulting it repeatedly. Indeed, the government was only able to maintain its hold of the dam through airlifts.
- For a 6-month period from March – October 2015, through its control of the Tabaqa dam in Syria, ISIL practically cut off Euphrates River flow to Iraq. This not only disrupted agricultural livelihoods and accentuated the risk from water-borne diseases such as cholera, but low water levels also threatened to damage the turbines of the Haditha dam which generated up to a third of the country's electricity in normal times.
- Nevertheless, the Iraqi Water Ministry reportedly maintained secret communication with certain staff at the Tabaqa dam inside Syria who continued to work under ISIL, and arranged for emergency water releases to protect the turbine system in Haditha dam.
- In April 2014, ISIL seized control of Fallujah barrage which is a critical diversion structure regulating water supplies to millions of people in central and southern Iraq. Initially, ISIL cut off water supplies leaving communities along the middle Euphrates without water and causing large swathes of the

³ Namely dams, barrages and canal regulators.

⁴ Also known as Euphrates or Al-Thawrah dam, the Tabaqa dam was seized by ISIL in 2013 and captured by the Syrian opposition in May 2017 with support from the US led coalition.

Central and Hammar marshes to dry out. ISIL then proceeded to flood hundreds of square kilometres of agricultural land reaching the town of Abu Ghraib near Baghdad. Over 12,000 families were evacuated and the canal network and agricultural landscape was seriously degraded by the uncontrolled inundation.



Capturing Fallujah barrage, ISIL flooded large swaths of land reaching Abu Ghraib on the outskirts of Baghdad (Landsat 8 image acquired on 17 May 2014, USGS)

- ISIL fighters reportedly attacked hydraulic infrastructure such as the Ramadi barrage and the main Tharthar regulator linking the Euphrates and Tigris rivers in early 2015, with explosive-laden vehicles and boats, or suicide car bombs, before engaging with Iraqi troops in firefights. Five engineers and technicians from the Water Ministry were reportedly killed during these operations. In certain cases, the Iraqi Army was also reportedly obliged to target hydraulic infrastructure to prevent ISIL from withholding water or flooding downstream communities.
- In a meeting with UN Environment, the Minister of Water Resources, Dr. Hassan Janabi, decried the extensive damage to Iraq's hydraulic infrastructure both from ISIL's operational misuse and armed attacks on water installations; namely reservoir dams, hydroelectric power plants, river barrages, and diversion canals.
- An initial assessment by the Ministry of Water Resources estimates direct damages to hydraulic infrastructure at USD 600 million dollars. Total losses including from serious disruption to annual agricultural seasons are likely to be significantly higher.

- When ISIL commanded control over most of the Euphrates River during 2013-2016, Iraq's Water Ministry essentially relied on using the Tigris River to manage the country's water needs. Although water installations have now returned under government control they need urgent rehabilitation and maintenance.
- The Water Ministry, however, is cash strapped as its budget declined from USD 1.7 billion to USD 50 million (due both to decline in oil prices and the war effort), which is mainly used for paying staff salaries. Nevertheless, Ministry engineers were reportedly able to carry out emergency rehabilitation works to a large part of the damaged hydraulic infrastructure using their proper means, allowing the provisional resumption of water management activities.

Annex 1

Summary of UN Environment engagement in response to the environmental impacts of the ISIL conflict in Iraq (2016/2017)

- Remote advice and back-office support on the appropriate chemical response measures to the Al-Mishraq sulphur fire, UN Environment/OCHA Joint Unit, October 2016.
- Desk study report 'A rapid overview of Environmental and Health Risks Related to Chemical Hazards in the Mosul Humanitarian Response', UN Environment/OCHA Joint Unit and UN Partners, November 2016.
- Deployment of two Environmental Field Advisors to northern Iraq by the UN Environment/OCHA Joint Unit from December 2016 to March 2017.
- Environmental Hazards Assessment map of Mosul, UN Environment/OCHA Joint Unit and UN-Habitat, May 2017.
- Visit by the Head of UN Environment Mr. Erik Solheim to Iraq including to conflict affected areas near Mosul, May 2017.
- Rapid Scoping Assessment Mission to Mosul, UN Environment, July – August 2017.

Annex 2

Key persons contacted during the Scoping Mission (22 July – 7 August, 2017)

Government of Iraq (Baghdad)

Dr. Jasim Humadi, Deputy Minister of Environment, Ministry of Health and Environment
Dr. Hassan Janabi, Minister of Water Resources
Ambassador Sundus Omar Ali, Ministry of Foreign Affairs
Mr. Yousif Muayad, Head, International Organizations Department, Environment Ministry
Mr. Mehdi Rasheed, Director, Dams & Reservoirs Agency, Ministry of Water Resources
Mr. Jamal Muhsin Ali, Director, Directorate of Planning and Follow-Up, Ministry of Water Resources
Mr. Luai Almokhtar, Director, Contaminated Sites Assessment Department, Environment Ministry
Mr. Hussein Khalaf, Director, Occupational Health, Safety & Environment Unit, North Oil Company
Mr. Mohammed Al-Maghazzachi, Head, Environment Department, Ministry of Industry and Minerals
Dr. Sabah Obaid Al-Shujairi, Director, Central Environmental Laboratory, Environment Ministry
Mr. Adnan Mohammed, Director, Centre for Research and Evaluation, Directorate of Treatment and Disposal of Hazardous Chemical, Biological and Weapons Waste, Ministry of Science and Technology
Mr. Mustapha Thaar Thabit, Environment Department, Ministry of Electricity
Dr. Ali Kareem Mohammed, Director, Environment Department, Ministry of Agriculture
Mr. Ahmed Adel Ahmed, Directorate of Planning and Monitoring, Ministry of Water Resources
Mr. Mazen Majeed Ahmed, Environment Department, Directorate of General Municipalities, Ministry of Construction, Housing, Municipalities and Public Works

Government of Iraq (Mosul)

Mr. Abdel-Satar El-Habo, Mayor of Mosul
Mr. Sinan Subhi, Head a.i., Niniveh Environment Directorate
Mr. Arshad Sadeeq, Assistant Director, Niniveh Environment Directorate
Mr. Ammar Mahgoub, Director, Contaminated Site Unit, Niniveh Environment Directorate
Mr. Zeidoun Abu Yazan, Environment Expert, Niniveh Environment Directorate
Dr. Qusay Kamal Al-Deen, Dean, College of Environmental Sciences and Technology, Mosul University
Mr. Ziad Abdel-Monem, Director, Mosul Urban Planning Directorate
Mr. Adnan Fathi Hassan, Director, Planning and Monitoring Directorate
Mr. Mohammed Khidr Hussein Ali, Head of Qayarra Refinery
Mr. Mohammed Dawood, Director, Environment Department, Northern Refineries, North Oil Company
Mr. Saad Jumah Sultan, Head, Fire Emergency Unit, North Oil Company
Mr. Muwafiq Hadi, Head, Engineering Inspection & Occupational Safety Unit, General Mishraq Sulphur Company

UN System

Ms. Lise Grande, Deputy Special Representative of the Secretary General (UNAMI), and Resident Coordinator and Humanitarian Coordinator for Iraq

Mr. David Joy, Head, UN Resident Coordinator Office and ICODHA

Mr. Erfan Ali, Head, UN-Habitat

Mr. Mounir Tabet, Country Director, UNDP

Mr. Peter Hawkins, Representative, UNICEF

Mr. Samir Ghattas, Director of Public Information, UNAMI

Mr. Tarik ul-Islam, Programme Manager, UNDP

Mr. Rene Nijenhuis, Deputy Head of Office, UNOCHA

Mr. Bedreldin Shutta Mahmoud, Regional Coordination Officer, ICODHA

Mr. Pehr Lodhammar, Programme Manager, UN Mine Action Service

Ms. Yuko Otsuki, Deputy Head of Iraq Programme, UN-Habitat

Mr. Hugo De Vries, Stabilization Specialist, Funding Facility for Immediate Stabilization, UNDP

Mr. Jim Sawatzky, Stabilization Specialist, Funding Facility for Immediate Stabilization, UNDP

Mr. Ivan Thung, Urban Data Analyst, UN-Habitat Iraq

Mr. Diyar Shekhani, ICODHA

Technical Partners

Mr. Martin Bjerregaard, Director, Disaster Waste Recovery

Mr. Aiden Short, Director, Urban Resilience Platform

Mr. Guilherme Marques Iablonovski, GIS Specialist, Urban Resilience Platform

Mr. Marc Stauffer, Head of Environmental Analysis Branch, Spiez Laboratory

Mr. Cédric von Gunten, Analytical Chemist, Environmental Analysis Branch, Spiez Laboratory



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