Environmental Damages from Minefields

Desert Storm brought Iraqi Forces to Kuwait and, with them, mines. Aerial diagrams illustrate the areas of Kuwait still littered with landmines. Landmines are causing significant short- and long-term damage to the environment, resulting in soil erosion, destruction of vegetation and topsoil and negatively impacting wildlife.

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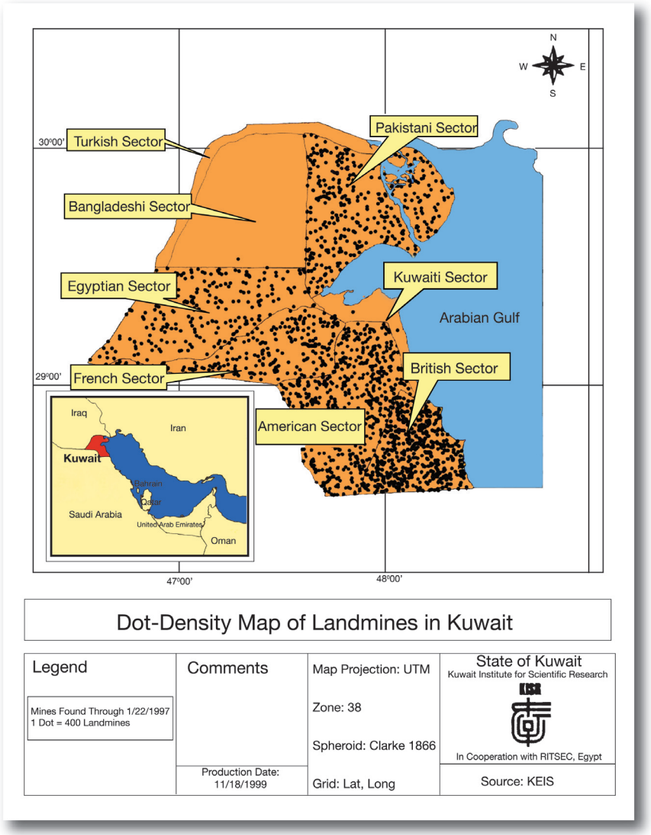
Immediately after the deployment of the Iraqi Forces on Kuwait on 2 August 1990, they started taking their defensive garrisons, preparing ground fortifications and laying mine belts. The Iraqi Forces, while occupying Kuwait, depended upon mines to establish an integrated system of barriers and obstacles due to the fact that the desert—particularly southern regions—is almost void of natural rugged barriers such as ridges, cliffs or *wadis*. Their aim was to protect themselves from the expected attack of the Allied Forces from the south.

The Iraqi troops established a well-fortified strategic defense line extending along the whole country for 10 to 15 kilometers[1] to the northern border with Saudi Arabia. This strategic defense line spanned from the Arabian Gulf coast in the east to Wadi Al Batin in the west, a distance of about 175 kilometers. The width of this line ranged between one-and-a-half and two kilometers and was composed of anti-personnel and anti-tank minefields, open trenches and fire emplacements that controlled the minefields.

Aerial photographs and satellite images of Kuwait taken in 1991 and 1992, and the map of dangerous areas prepared by the Ministry of Defense and Kuwait municipalities in 1991, show two major mine belts left behind by Iraqis in the southern parts of Kuwait. The first mine belt was advanced in the front, extending along the border with Saudi Arabia for a distance that ranged between three and 15 kilometers north of the Saudi border. The second was behind the first, extending to the north of the front belt in the depth of Kuwaiti territory for a distance ranging between 15 and 21 kilometers.

Right after the liberation of Kuwait in February 1991, the Ministry of Defense signed contracts for mine clearance with several companies and governments. For mine-clearance purposes the country was subdivided into eight sectors (see Figure).

Eight working teams were charged to undertake field tasks to clear these sectors from mines and explosives. A total of 1,646,926 landmines had been cleared from Kuwait by September 2000, including 1,078,966 anti-personnel mines and 567,960 anti-tank mines.[2] The teams destroyed 95.7 percent of AP mines and 91.4 percent of AT mines in the field. The remainder were stored.[3]



Aerial distribution of landmines (dot-density).
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Research and studies on the environmental disaster resulting from the Iraqi invasion of Kuwait did not tackle the immediate and long-term environmental impact of landmines on the terrestrial resources of Kuwait.

Number and Density of Mines

Data and statistics provided by the Ministry of Defense on the strategic mine belts at the southern parts of Kuwait along the border with Saudi Arabia indicate the following:

- The total length of mine belts was approximately 504 kilometers, of which 168.2 kilometers (33.3 percent of total length) were in the American sector, 111.7 kilometers (22.1 percent of total length) in the Egyptian sector and 224 kilometers (44.5 percent of total length) in the British sector.
- The number of mines cleared from the strategic mine belts is approximately 1,068,782 mines, representing about 65 percent of the total number of cleared mines from Kuwait, which is around 1,646,926.
- The highest number of anti-personnel mines along longitudinal lines was in the Egyptian sector (1,682 mines) followed by the British sector (1,384 mines). The lowest was in the American sector (917 mines).
- The number of anti-tank mines along longitudinal lines varied clearly. The highest number was in the British sector (1,473 mines) and the lowest was in the French sector (771 mines).
- Total number of mines cleared from various sectors:
  - o 194,237 mines (UK sector), 3,001 mines/km
  - o 114,220 mines (American sector), 930 mines /km
  - o 288,974 mines (French sector), 3,397 mines/km
  - o 291,188 mines (Egyptian sector), 3,608 mines/km

Considering the lengths of the mine belts, relatively higher numbers indicates a severe degree of surface disruption. The UK, French and Egyptian sectors can be considered as severely affected (more than 3,000 mines/kilometer). The American sector is less affected (about 900 mines/kilometer).

Environmental Damage Caused by Landmines

To identify the environmental damage to the terrestrial resources caused by landmines, it is necessary to review the different landmine-related events from the laying of mines by Iraqi Forces until the time they were cleared. These events follow.

Dense implantation of mines (August 1990–January 1991). During this event, Iraqi Forces mined the majority of Kuwaiti lands, especially along the borders with Saudi Arabia. No less than 36 percent of the total mines were planted in August and September 1990, as the soil and vegetation cover were dry. Such conditions accelerated soil erosion and wind dispersal of fine materials leading to depletion of soil fertility.

Destroying and exploding mines to open gaps (February 1991). During this event, the Allied Forces used aircraft and heavy land equipment to destroy mines to open gaps in the mine belts, enabling the attacking troops to penetrate the borders of Kuwait. The minefields were heavily bombed to enable secure corridors for the Allied Forces.[4] This activity had a negative impact on the fragile desert ecosystem and, in particular, the fragile desert crust, which is stabilized by mechanical, chemical and biological sources. Disruption of this crust resulted in the depletion of the biological potential of soils. In 1991, the United Nations Environmental Programme found that the most environmentally damaging of all the explosives used on land in the Gulf War were the fuel-air explosive bombs used to clear minefields.[5] The bombs pulverized whatever topsoil had formed in the affected areas and destroyed any vegetation that had established itself.[6]

Active mine-clearance and demining programs (March 1991–July 1993). During this phase, the following activities took place:

- Clearing different sectors
- Storing usable mines (about 5 percent of total cleared mines)
- Destroying damaged mines (about 95 percent of total cleared mines).

As a result of these three events, various environmental damages affected soil, vegetation cover and wildlife. Also, the destruction of the immense number of mines caused soil pollution by residual explosives.

Environmental damages are classified as either "immediate" or "long-term." Specific examples of "immediate" damage in Kuwait include:

- Soil pollution and changes in its chemical properties due to exploding and destroying mines, whether *in situ* or in holes specially prepared for this purpose, at depths ranging between one and three meters.
- Soil disruption during mine exploration, resulting in the drift of the fine, fertile soil particles; thus the soil productivity is weakened or completely depleted.
- Soil compaction due to running heavy equipment. Consequently, the rate of water infiltration into soils is reduced between 18.46 percent and 96.8 percent in comparison to unaffected soils, according to "Soil Compaction and Sealing in Al Salmi Area."[7] In this study, a soil compaction map was prepared for Al Salmi area. It shows three different classes of soil compaction: highly compacted (8.8 percent of the soil), slightly compacted (1.7 percent), and almost non-compacted (89.5 percent). The highly compacted soils are detected in the areas affected by mine implantation. The bulk density for the compacted soil (mine-affected areas) is high (1.6–1.7 grams per cubic centimeter) compared to slightly compacted soils (1.2–1.35 grams per cubic centimeter).
- Destruction of the vegetation cover of grazing value, e.g., *Haloxylon salicornicum* (located in the western area of the country), *Cyperus conglomeratus* (located in the southeastern area of the country) and *Stipagrostis* (located in Umm Omara on Salmi Road and its surroundings) plant species.

Specific examples of "long-term" damage in Kuwait include:

- Soil crusting and sealing as a direct result of vegetation degradation.
- Hydrological disruption and loss of rain and runoff waters during the wet seasons of 1993, 1995, 1996, 1997, 2000 and 2004 through evaporation (in areas of compacted soil where the infiltration rate is almost nil). As indicated by Al Sudairawi et al.,[8] the strategic minefields in the southern portion of Kuwait cross a number of land forms. These include, from east to west: the coastal flat, the southern sandy flat, Al Huwaimiliyah undulated plain, western calcrete plain and Wadi Al Batin. All these areas were damaged, to a certain degree, by mine emplacement and demining activities. The strategic minefields also destroyed several plant species, including *Zygophlum qatarense*, *Cyperus conglomeratus*, *Panicum turgidum* and *Rhanterium epapposum*.

In 1999, we surveyed the mine-affected surface sediments in the southern parts of Kuwait. These sediments include eolian deposits, lag deposits (desert pavement), clay deposits in depressions (Khabrat) and sabkhas (coastal and inland). Taking the Khabrat soils as an example, we concluded the following: Implantation of mines in Khabrat resulted in breaking up the muddy soil, which is the most fertile soil type in Kuwait. In addition, soil crusts were developed on the top soils of Khabrat. This crust prevents rainwater from infiltrating into soils, which results in deterioration of the biological potential of soils. Besides these damages, the vegetation cover in the Khabrat was destroyed as a result of mine emplacement and removal in a later stage. Studies conducted for *Damage Assessment of the Desert and Coastal Environment of Kuwait by Remote Sensing* mapped the strategic minefields using remote sensing and field investigations.[9]

Extent of Damage

The area contaminated with mines near the borders with Saudi Arabia (strategic minefields) extends from the Arabian Gulf coast in the east to

Wadi Al Batin in the west for a distance of about 175 kilometers. The width of the area ranges between 25 kilometers in the eastern parts to about eight kilometers in the western ones. Recent field visits to the affected area indicated that it still suffers environmental degradation as a result of mine emplacement. As mentioned before, environmental degradation is represented by lag rupture, soil disturbance, soil compaction and loss of biodiversity and deterioration of vegetation cover.

In order to control the environmental deterioration and the adverse impact on soil, vegetation, wildlife, micro-relief and surface hydrology, all measures to rehabilitate the mentioned area should be taken. Treating compacted soils to increase the rates of rainwater infiltration, limiting water erosion rates and, in turn, flourishing vegetation cover should have first priority.

See Endnotes, page 111

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