LEADING ARTICLE

Health Risks Related to Depleted Uranium Contamination in Iraq

Souad N. Al-Azzawi, Associate Professor in Environmental Engineering
Email: souad.al.azzawi@gmail.com

ORCID:http://orcid.org/0000-0001-6159-914X

Introduction

       To assess any population's health risks related to radioactive isotopes like depleted Uranium (DU) munitions we need to know several factors - where they have been used, type and mass of the radioactive radionuclides dispersed, contaminated residential areas, and the mechanism of internal and external exposure to the human body. The US and UK armed forces used Depleted Uranium (DU) munitions for the first time in recent history during the First Gulf War in 1991. The weapons were extensively used close to populated areas in Southern Iraq like Basra and its vicinity. About one million bullets, projectiles and missiles were fired along the "Highway of Death" leading from Kuwait City to Basra, then up to Nasiriya, and other Iraqi cities in 1991 [1] , figure 1 shows these places.
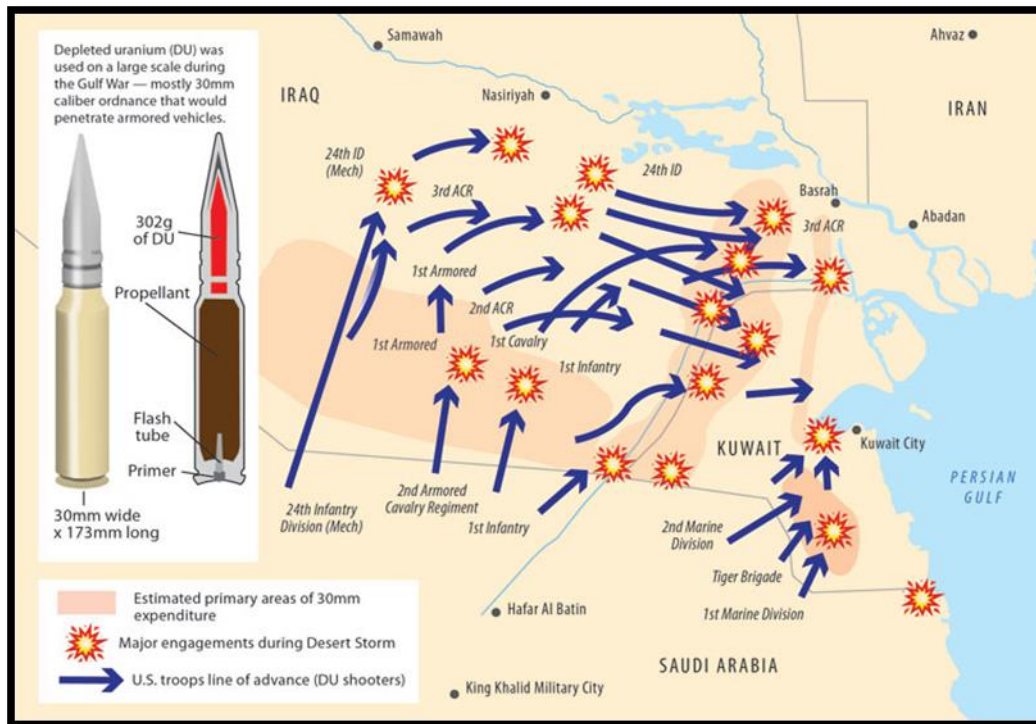

Figure 1: Areas where DU munitions used in Gulf 1 war, 1991

The Pentagon, following a delay of several years, admitted to using some 320 tons of DU munitions in the first Gulf War, but to this day they refused to specify the exact locations where these radioactive weapons were use. Other sources indicated that the amount exceeds 800 metric tons [1]. Site measurements and laboratory tests in southern Iraq proved that DU contamination was dispersed to an area as large as (1718) square kilometers in western Basra city [2].

The US/UK armed forces repeated (DU) use during and after the 2003 invasion and occupation of Iraq during military operations [2]. UNEP estimated the amount closer to, "The total amount of DU ammunition used during the conflict in 2003 is still unknown, but speculative figures from various studies range between 170 and 1,700 metric ton" [3].

Populated areas and cities like Baghdad, Basra, Najaf, Amarah, Samawa, Tikrit, Karbala, Falluja and Baaquba have been exposed to more radiological contamination during and after the occupation of Iraq military operations in 2003 [4]. Figure 2 shows where US/UK forces fired DU munitions in most densely populated cities during the occupation of Iraq military operations [4].

What are Depleted Uranium Weapons?

Depleted Uranium (DU) is a man-made, radioactive and toxic heavy metal extracted from uranium ore. It is a by-product of the uranium enrichment process to produce spent fuel for nuclear reactors. Due to its highly pyrophoric and spontaneously ignitable properties, the DU penetrator ignites on impact with the target and generates extremely high temperatures. This explains its attraction to western military industries as an armor penetrating munitions (like tanks). However, as the DU projectile pierces its target, it leaves its jacket behind thereby dispersing DU oxides dust into the environment during the impact [2].

The quantity of the DU oxides aerosol produced is proportional to the DU mass within the projectile and the hardness of the impact. It is estimated that up to 70 per cent of DU in a projectile is aerosolized (turning into a gaseous state) when the impact of DU catches fire [4]. The resulting explosion generates high temperatures of 3000–6000°C and the DU oxides aerosol ceramic insoluble particles are smaller than 5μm. These ceramic Nanoparticles act more like gas than particles. The DU aerosols remain windborne for an extended period, and this is the most dangerous pathway on to the civilian population found in and around the battlefield. It has been suggested that DU aerosols can travel up to 26 miles [2], with some studies suggesting even further distances. One milligram of U-238 generates 1,007,000 alpha particles in a single day. Each alpha particle releases over 4.17 million electron volts (MeV) of energy [5]. There are three major routes of internal contamination with uranium: 1) gastrointestinal system; 2) skin and wounds; and 3) inhalation and Trans alveolar transfer to the blood stream [6].
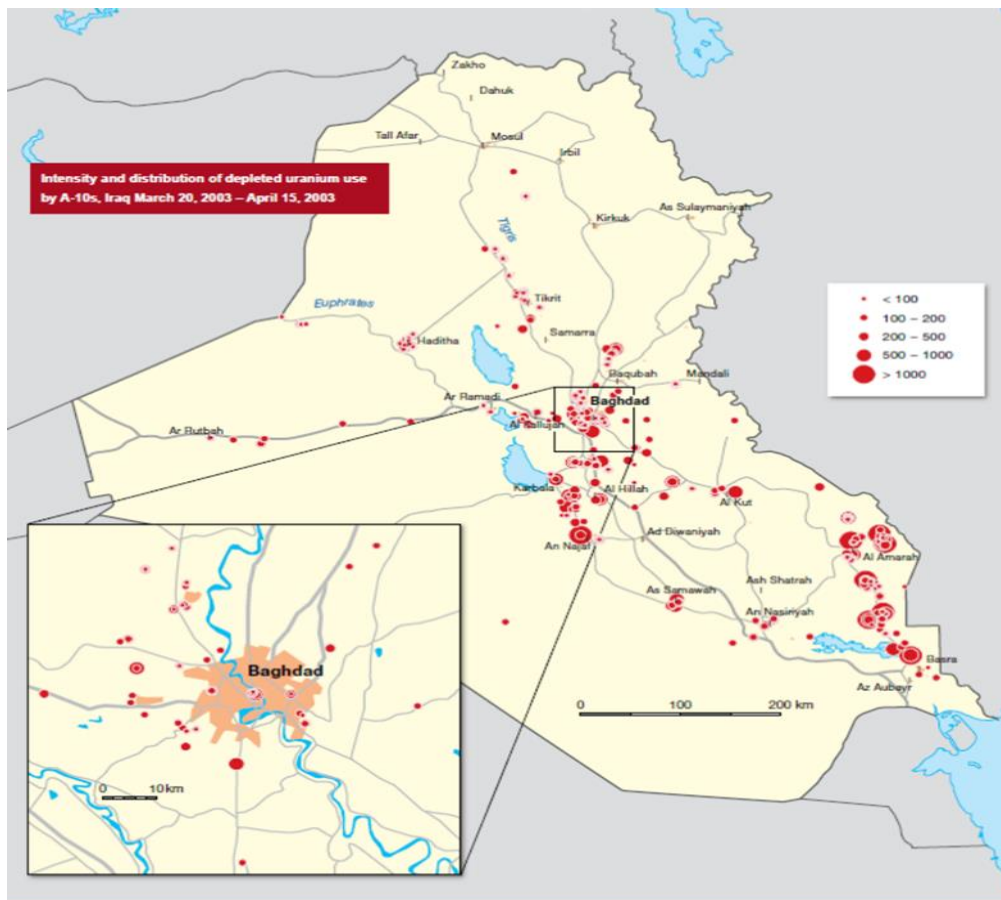
Figure 2: Areas where US/UK used DU munitions during and after 2003 [4].

Health effects of Depleted Uranium:

If Depleted Uranium Oxides aerosols are swallowed or inhaled, this much energy will hit up to six nearby cells in the impacted tissue or organ. Just 6–10 electron volts (eV) of energy are needed to cleave the nuclear DNA strand in a human cell. Dr Rosalie Bertell, 2006, an epidemiologist with 30 years of experience in the field of low-level radiation, explains potential harm from DU to the human body, stating that: After inhalation of (DU) oxides, Nano-particle aerosols cross the lung-blood barrier and gain entrance to the cells, they create free radicals.

As a heavy metal, DU toxicity attacks the proteins in the cell, which normally fight the free radicals, and creates extra free radicals. This number of free radicals creates total oxidative stress in the human body. This stress causes failure to protective enzymes, leaving cells vulnerable to viruses and mycoplasma, damage to cellular communication system and the mitochondria [5]. DU also replaces the magnesium normally found in the organ's molecules that function as antioxidants, resulting in the destruction of the body's repair mechanisms. The consequences of this destruction include chronic diseases and increased tumors. Free radicals can also disrupt the folding process and manufacturing of the molecule proteins within cell DNA. Such proteins are

sequenced by DNA and manufactured by the RNA. Some of the diseases resulting from misrouted proteins include cystic fibrosis, diabetes insipidus and various cancers [5].

Gulf War veterans have manifested many of the symptoms of these neurodegenerative diseases. Other health effects of DU within the human body include the following: Lou Gehrig's disease is twice as commonly diagnosed in Gulf War veterans as expected, immune and hormonal system damage, disturbance of thyroid function, mycoplasma invasion into human cells, initiation or promotion of cancer, teratogenic toxicity which causes mental retardation, congenital malformations, and miscarriages [6]. Gulf War veterans were twice-three times as likely to report children with birth defects as their counter partner who did not serve in the first Gulf War. Same findings by Hindin et al. (2005) [7] emphasized that; 'In aggregate the human epidemiological evidence is consistent with increased risk of birth defects in offspring of persons exposed to DU'. Miller et al. (2005) [8,9] concluded that Internalized DU resulted in development of bladder carcinoma in 75 per cent of all animals exposed within 90 days of initial DU exposure. These results suggest that long-term exposure to internalize DU could be critical to the development of neoplastic disease in humans.

How do we know it can do this?

Scientists have shown that DU is genotoxic in several different ways. As well as adducts, which have been observed in hamster cells, several experiments have shown that exposure to DU can cause breaks in the strands of DNA [10]. Several studies have shown that DU exposure can cause mutations in rats and in cells in the laboratory. Exposure to DU has been shown to cause oxidative damage to DNA in rats and several kinds of small fish. Experiments in human bone cells and in mice have shown that exposure to DU can cause genomic instability in immature human bone cells and in mice. Genomic instability means that cells are more likely to undergo changes. The offspring of the mice exposed to DU were more likely to have mutations in their DNA, meaning that genomic instability was passed from parent to child.

A number of studies show that DU exposure can cause different changes to chromosomes in human cells. Chromosomes are the structures formed by the coiled DNA within cells. The changes DU exposure causes in the chromosomes are often used by scientists to identify whether cells have been exposed to a genotoxic substance or effect. Biological indicators like this which are known to be associated with a given effect are called 'biomarkers [10].

Most significant Health Impacts of DU toxicity

DU's chemical toxicity presents another danger to health in the short term (several weeks or months) after exposure. The kidney is considered the target organ for uranium's chemical toxicity. The following presentation of these impacts is from Vladimir, 1999 [11]: Kidneys filter about 160 - 200 L of blood per day, 20 - 25% of the cardiac output. The basic morphological unit of kidney is a nephron (figure 3). Each kidney contains about 2 million nephrons. The most important function of the glomerulus is to serve as a sieve for plasma: Small ions and molecules such as water, sodium ions, glucose, and amino acids are filtered, while larger molecules such as proteins are not filtered. The proximal tubule actively reabsorbs 66% of sodium Na^+ ions and water by means of so-called sodium-potassium-adenosine triphosphatase

(Na^+-K^+-ATPase) pump, with chlorine Cl^- ions passively following the sodium ions. Reabsorption of 70% calcium Ca^{2+} ions parallels reabsorption of the sodium ions.
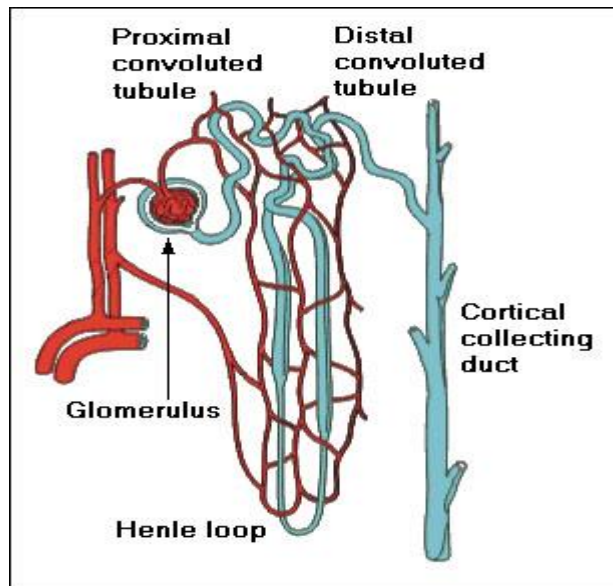
Figure 3: Nephron -the basic morphological unit of kidney [1110].

The Na^+-K^+-ATPase pump provides energy to reabsorb 100% of glucose and amino acids, 90% of bicarbonate (HCO_3) $^-$ ions, and other electrolytes. Up to 50% of urea is reabsorbed as well. The thin descending limb of Henle loop reabsorbs water and drives up the osmotic pressure of NaCl. The ascending limb of Henle loop reabsorbs passively (in the thin limb) and actively (in the thick limb) 25% of Na^+ ions, 20% of Ca^{2+} ions, but no water. The distal tubule and the collecting duct actively reabsorb most of the remaining Na^+ and Ca^{2+} ions, so that over 99% of both ions is reclaimed, and a variable amount of water. The active reabsorption of sodium ions and water is tightly controlled by a variety of stimulating and suppressing hormones, acting primarily at the distal tubule and collecting ducts, in order to maintain blood levels of sodium and calcium within narrow limits [11].

By controlling the levels of blood electrolytes (such as sodium and bicarbonate ions), kidneys maintain the acidity of blood between pH 7.35 - 7.45. When the pH value falls below this level, the condition is called acidosis, and when the pH is above, it is called alkalosis. The major effect of mild acidosis is depression of the central nervous system, disorientation, and fatigue. The major effect of mild alkalosis is hyperexcitability of the nervous system, spontaneous stimulation (spasms) of muscles, and extreme nervousness . All these symptoms are among the top 10 problems reported by the Gulf War veterans [11].

Health Impacts of DU weapons in Iraq:

At a conference put on by the Nuclear Policy Research Institute at the New York Academy of Medicine in New York City in June of 2003, Dr. Thomas Fasy reported on epidemiological studies done by Drs. Alim Yacoub (an epidemiologist, formerly Dean of the Basra Medical College), Jenan Hassan (a neonatologist) and scientists at the

University of Basra. In their retrospective study they used hospital and treatment records combined with census data to develop incidence rates [12].

The Women and Children's Hospital where Dr. Hassan works, diagnoses all children under fifteen who live in the governorate of Basra for malignancy or suspected malignancy. Their findings for malignant disease were, an incidence rate of 3.98 cases per 100,000 in 1990 which increased in 2001 to 12.6 cases per 100,000, an increase which had quadrupled. Furthermore, in 1990, 13 percent of leukemia cases in children under five had increased to nearly 60 percent by 2001 (from 2 cases in 1990 to 41 in 2001). In 2002 the number of cases in children under five had risen to 53. Some of the highest incidence rates per department were in areas south and west of Basra where there had been heavy fighting during the first Gulf War. Dr. Yacoub and Dr. Hassan and their colleagues determined in their study that incidence rates of congenital malformations in infants had risen from 3.04 per 1,000 live births in 1990 to 17.6 per 1,000 live births in 2000 [12].

Another study carried out on breast cancer incidence in Iraqi women in the post-Gulf War period, between 2000 and 2009, showed a significant and marked increase of the overall incidence rate of female breast cancer in Iraq in the post-war period. In particular, the incidence rate of breast cancer ranged from 26.6 per 100,000 in 2000 up to 31.5 per 100,000 in 2009. Moreover, an intriguing finding was found regarding the age of insurgence of breast cancer in Iraqi women: 23,792 incident breast cancer cases, representing 33.8% of all breast cancers registered during 2000-2009,were diagnosed in young girls aged less than 15 years, revealing that breast cancer among Iraqi women affects younger age groups than their counterparts in developed countries [13].

These data taken together, suggest that pollution due to the gulf war, including the release of high amounts of DU on the soil and water, should be considered as a possible etiological factor related to the insurgence of breast cancer, particularly in very young Iraqi girls, and lays stress on the necessity of further epidemiological research studies aimed to examine possible causes and prevention measures.[13]

The Telegraph, 2:22 PM BST 10 Sep 2009
"Soldier died from exposure depleted uranium during Gulf War [14]

The death of a former soldier from colon cancer was "more likely than not" caused by his exposure to depleted uranium during the first Gulf War, an inquest has heard."The hearing in Smethwick, West Midlands, was told that Stuart Dyson died 17 years after being exposed to particles of the substance used in munitions during the 1991 conflict. Mr. Dyson, who served in the Royal Pioneer Corps, died aged 39 in June last year after a battle against colon cancer which spread to his liver and spleen.

Conclusion

The USA and UK continuously used Depleted Uranium weapons against the population and environment in Iraq in Gulf war 1991, and during the occupation of Iraq military operations in 2003.Exploration programs and site measurements proved

without a doubt that the existence of DU related radioactive contamination most of Iraqi territories. Published epidemiological studies in Basra and Falluja introduced a clear correlation between DU related exposure and the multifold increase of malignancies, congenital malformations, and multiple malformations among the population in DU contaminated areas. Other pathological and hematological studies indicated the existence of chromosomal and DNA aberrations and abnormalities in the 1991 Iraqi Gulf War veterans.

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