



Depleted Uranium: a scientific approach to the question of its environmental impact

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Roma, Italian Senate, July 2011



STRUCTURE OF THE PRESENTATION

Yugoslavia 1999: probably NOT depleted uranium...

Properties of Depleted Uranium

Military use of Depleted Uranium

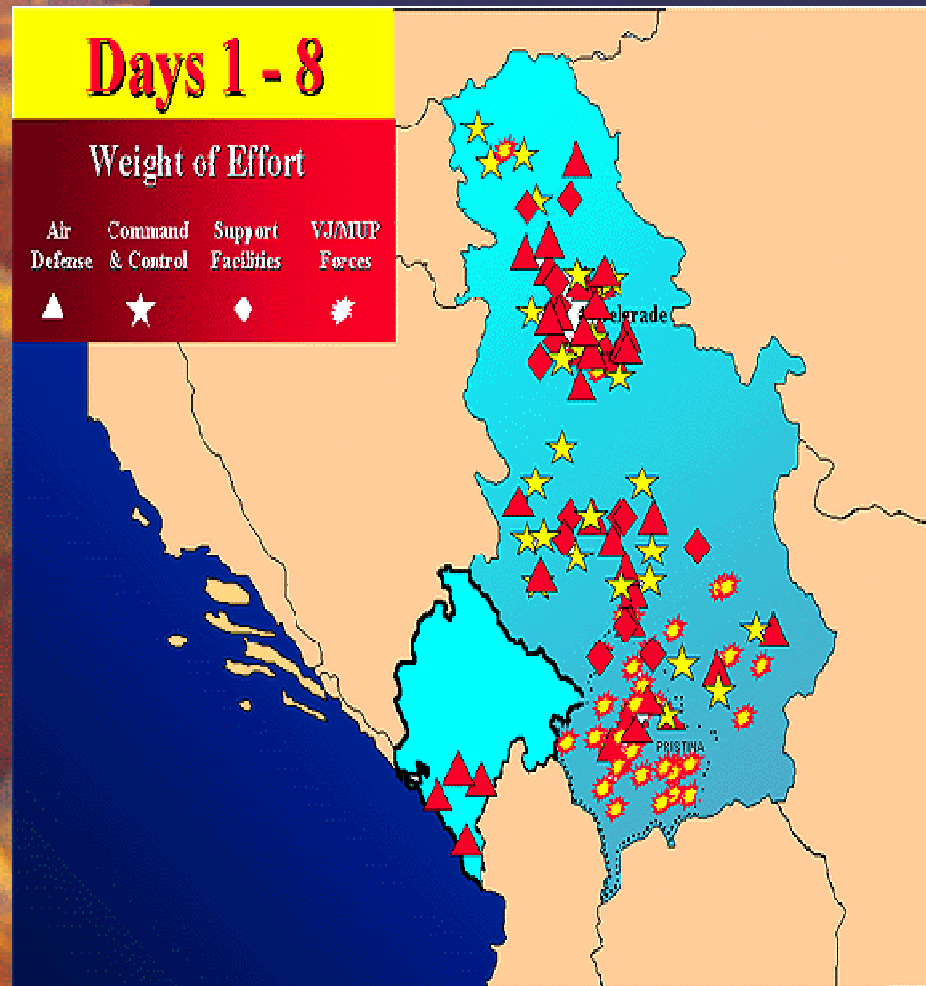
Health effects of Depleted Uranium

Conclusions

Jugoslavia 1999



Some data about the war in Yugoslavia, 1999



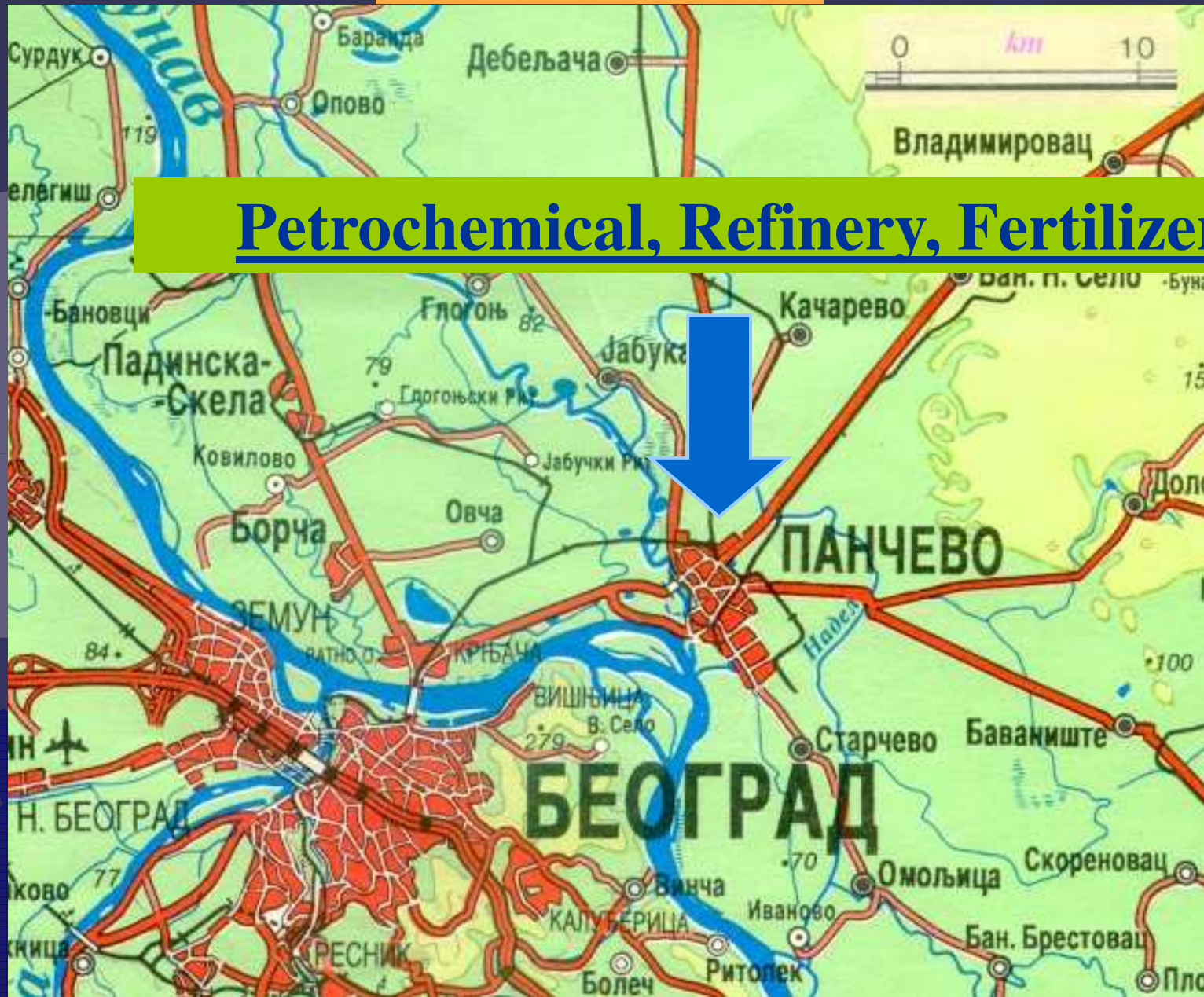
fi 7000 missions,
of which 2300 bombings,
In total 20000 flights.

fi 21700 t of explosives, with
2900 bombs

fi 15 tons of Depleted
Uranium

PANCEVO

Petrochemical, Refinery, Fertilizers



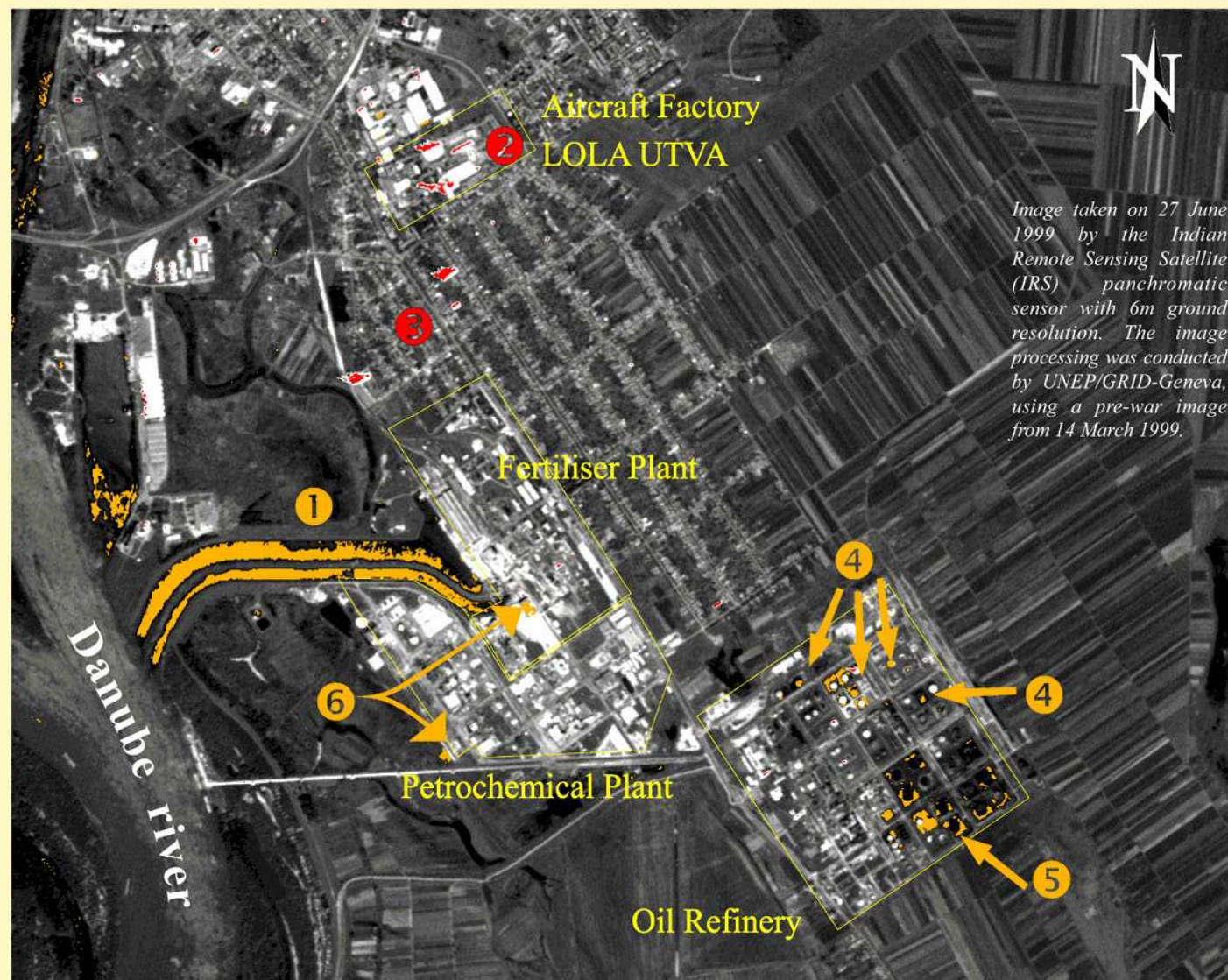


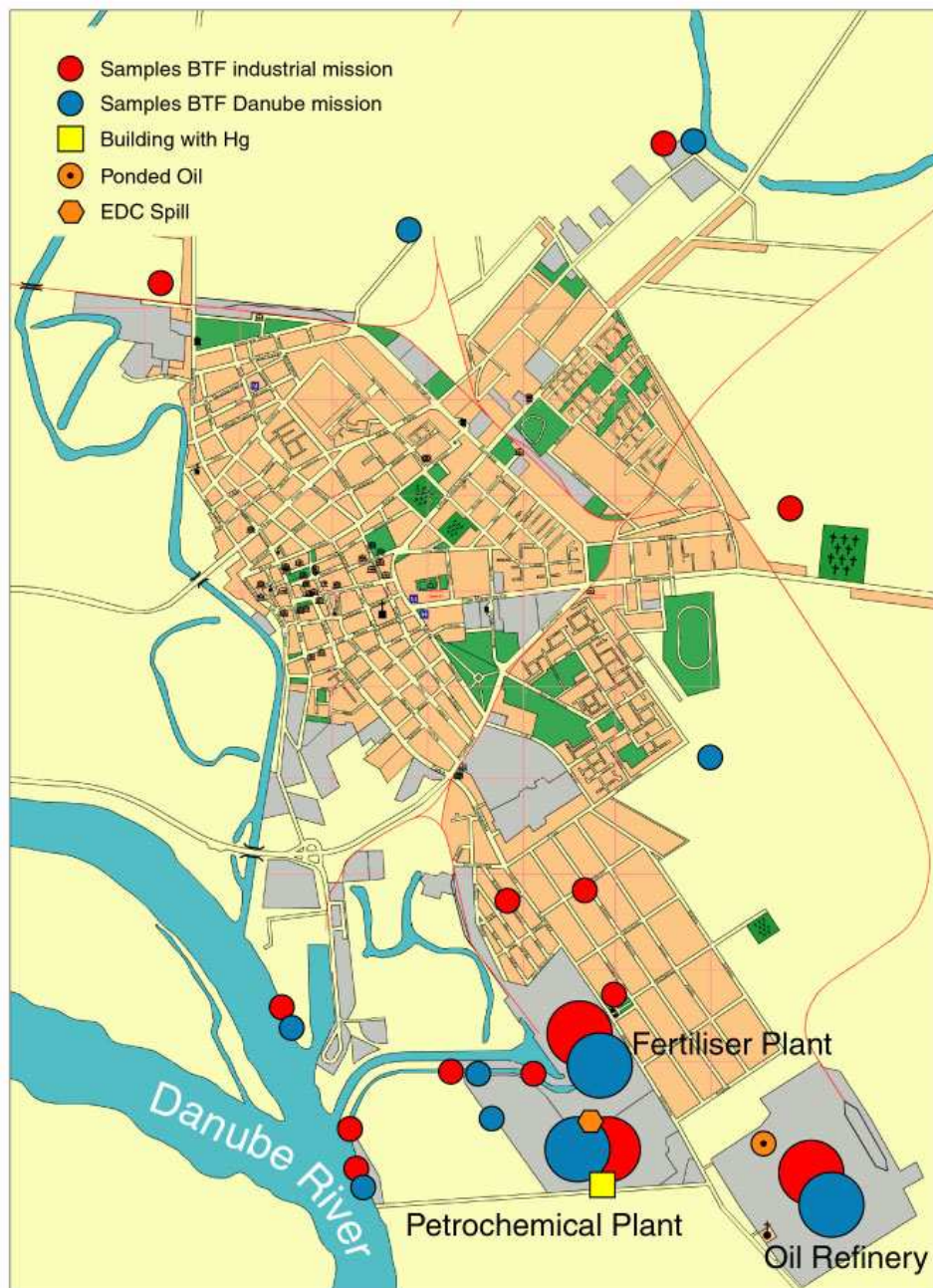
Legend

- Areas that appeared darker on the post-war image, (e.g. pollution, oil spills, missing oil tanks or buildings).
- Areas that appear brighter on the post-war image (e.g. bomb impacts).
- 1** Change in water quality in the canal collecting waste water from refinery, fertiliser and petrochemical plants.
- 2** Visible bomb impacts and destruction of buildings from the Agricultural Aircraft Factory LOLA UTVA.
- 3** Visible impacts on "unknown" buildings.
- 4** "Destroyed" Oil tanks.
- 5** Changes that may have resulted from oil spills.
- 6** "Destroyed" buildings in both fertiliser and petrochemical plants.

0 0.5 1 Km

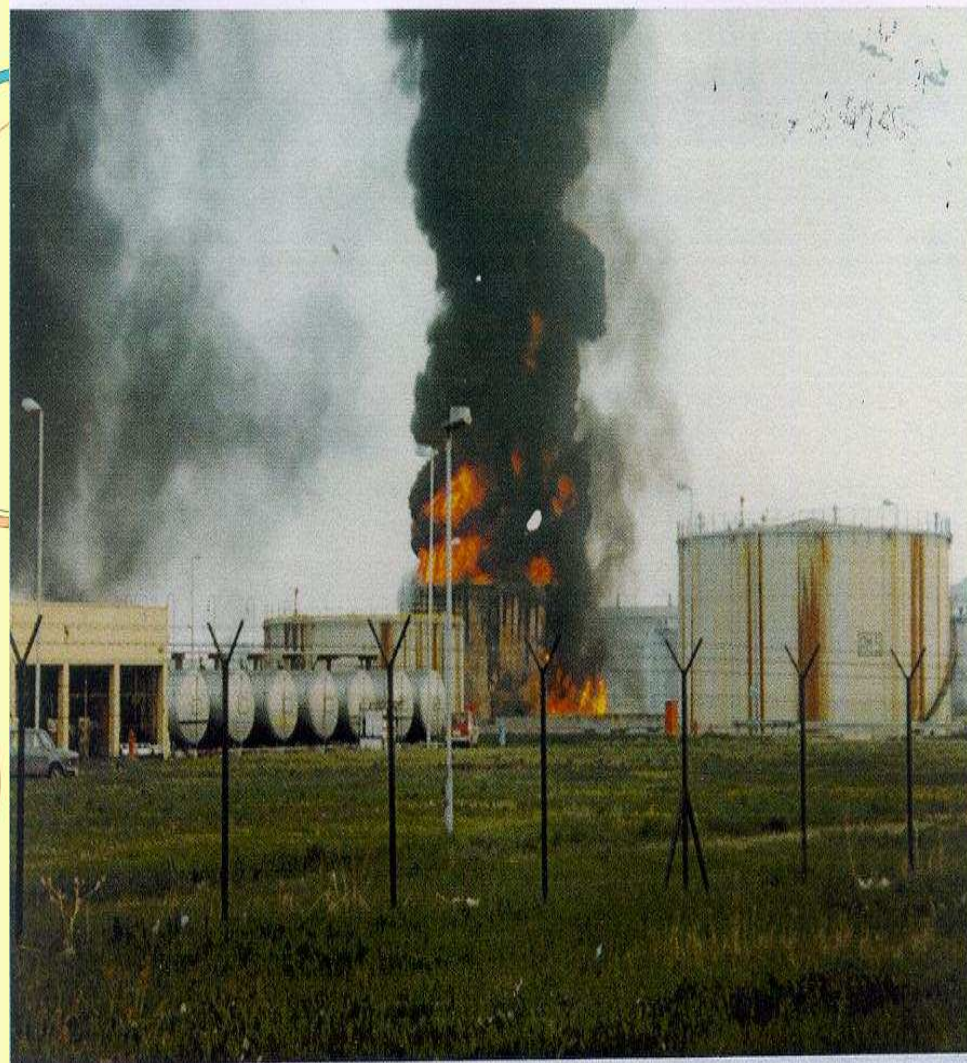
Remote Sensing Assessment of Major Impacts at Pancevo, FRY





Detailed Map of Pancevo with BTF sampling sites

MAP (7)



Фот. 7. Ракетирање постројења "НИС ЈУГОПЕТРОЛ",
Смедерево



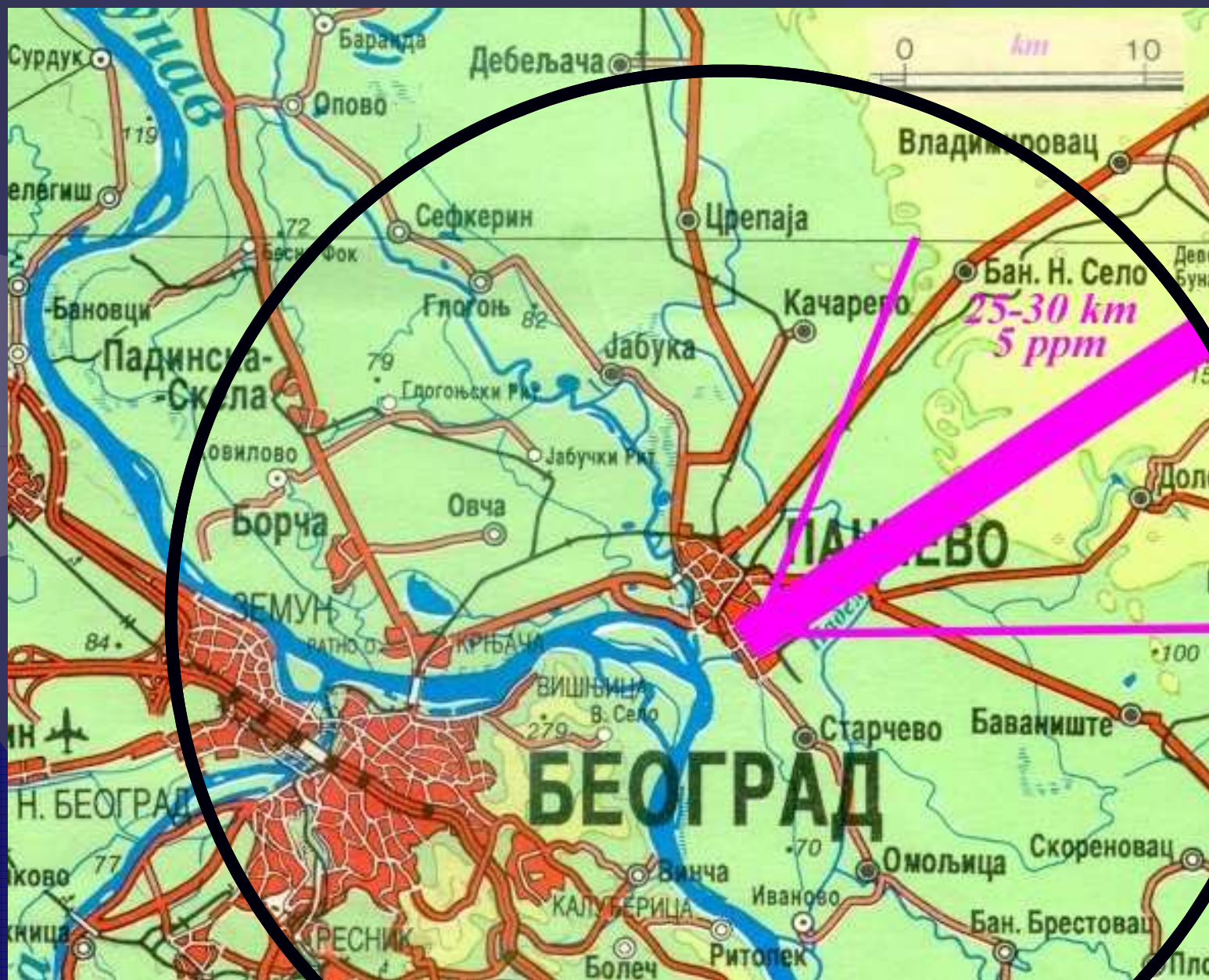
RELEASED CHEMICAL SUBSTANCES

- Ethylene chloride (EDC): 21000 t
- Mercury and its composites: 8 t
- Burned oil: 80000 t
- Ammonia: 250 t
- Vinyl Chloride Monomer (VCM): 250 t

Toxic plume – Concentration after one hour



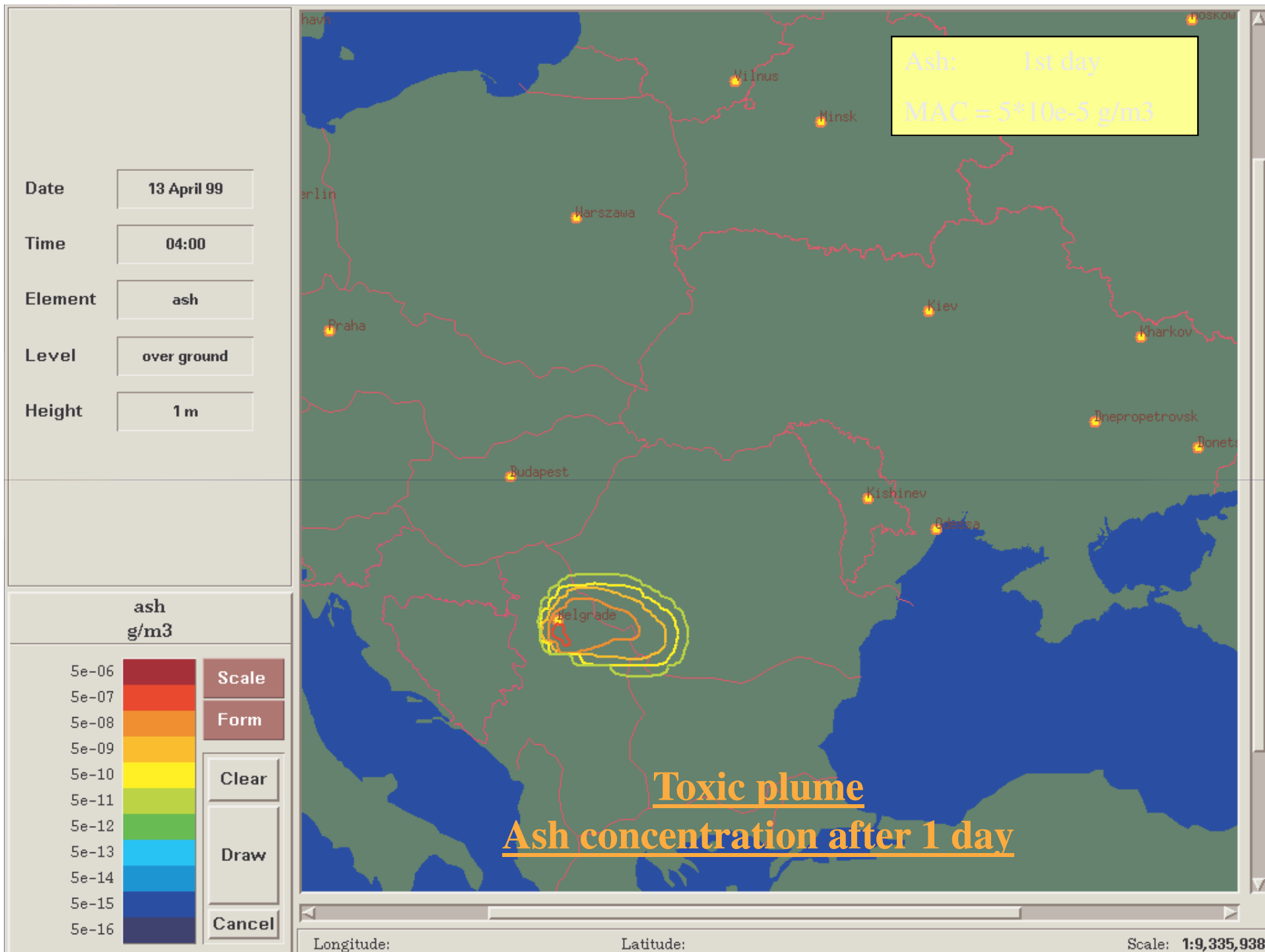
Toxic plume – Concentration after three hours

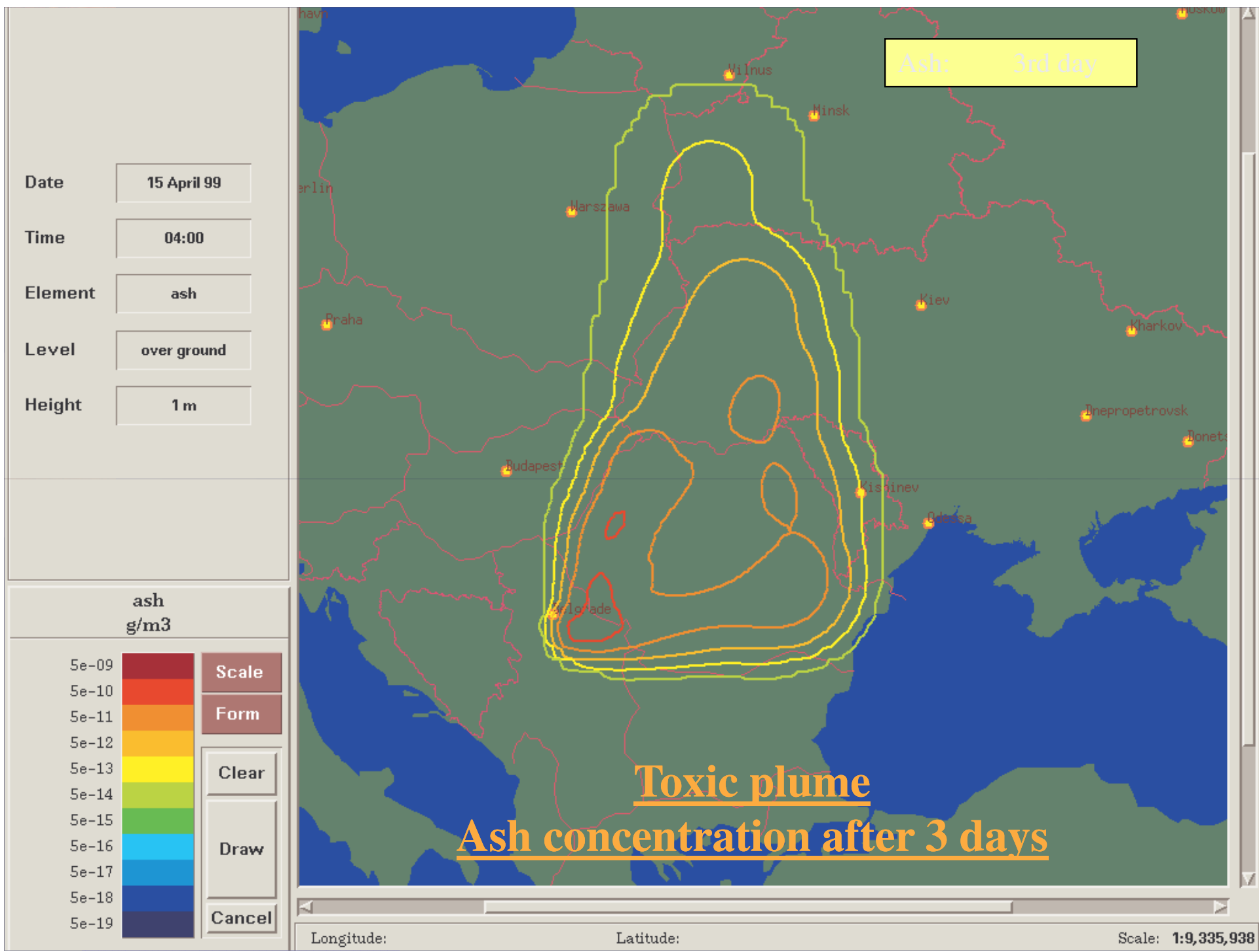












Polycyclic Aromatic Hydrocarbons
Benzo (a) piren: 1st day

Date	13 April 99
Time	04:00
Element	B(a)P
Level	over ground
Height	1 m

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B(a)P
mkg/m3

1e-07

1e-08

1e-09

1e-10

1e-11

1e-12

1e-13

1e-14

1e-15

1e-16

1e-17

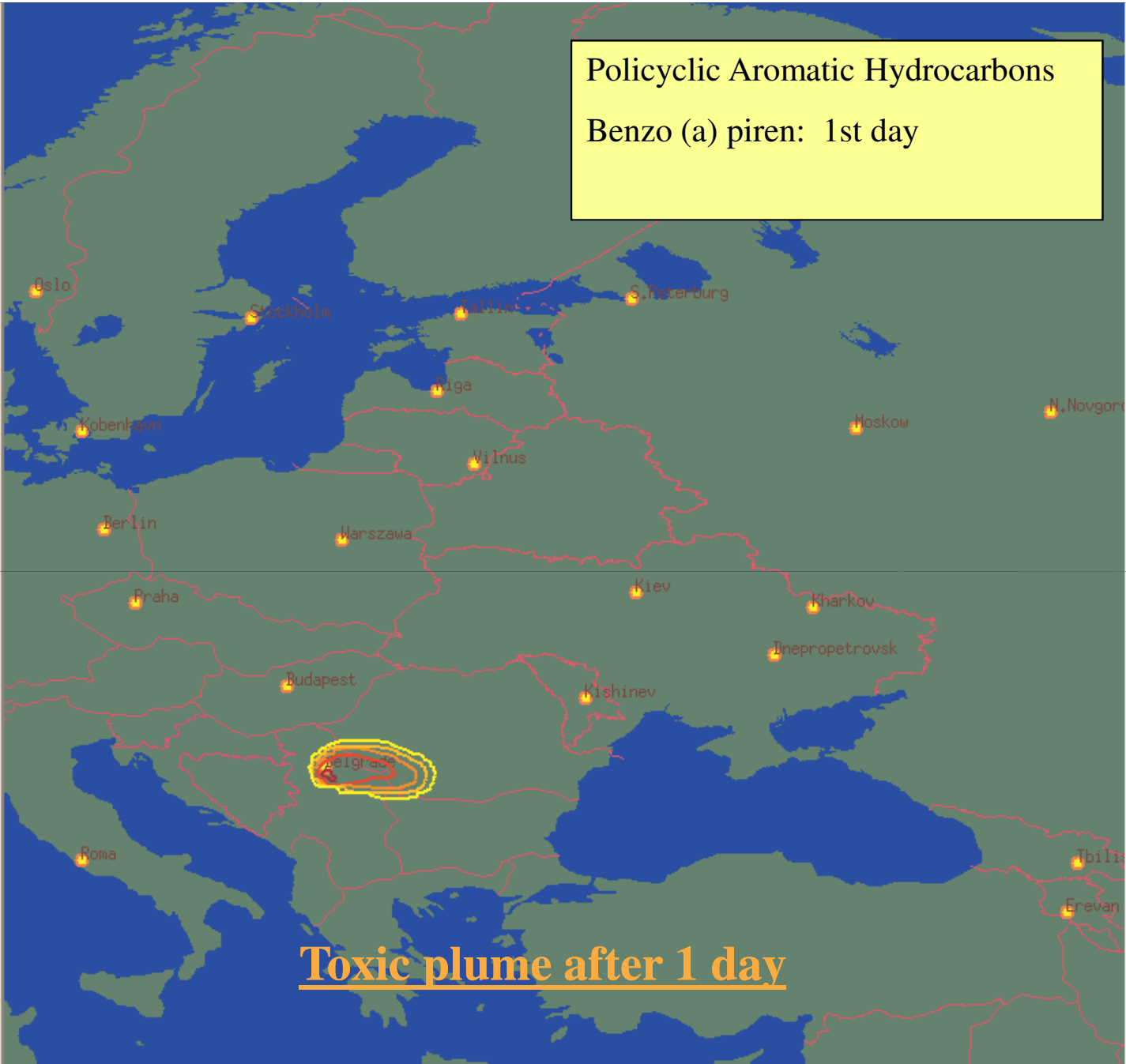
Scale

Form

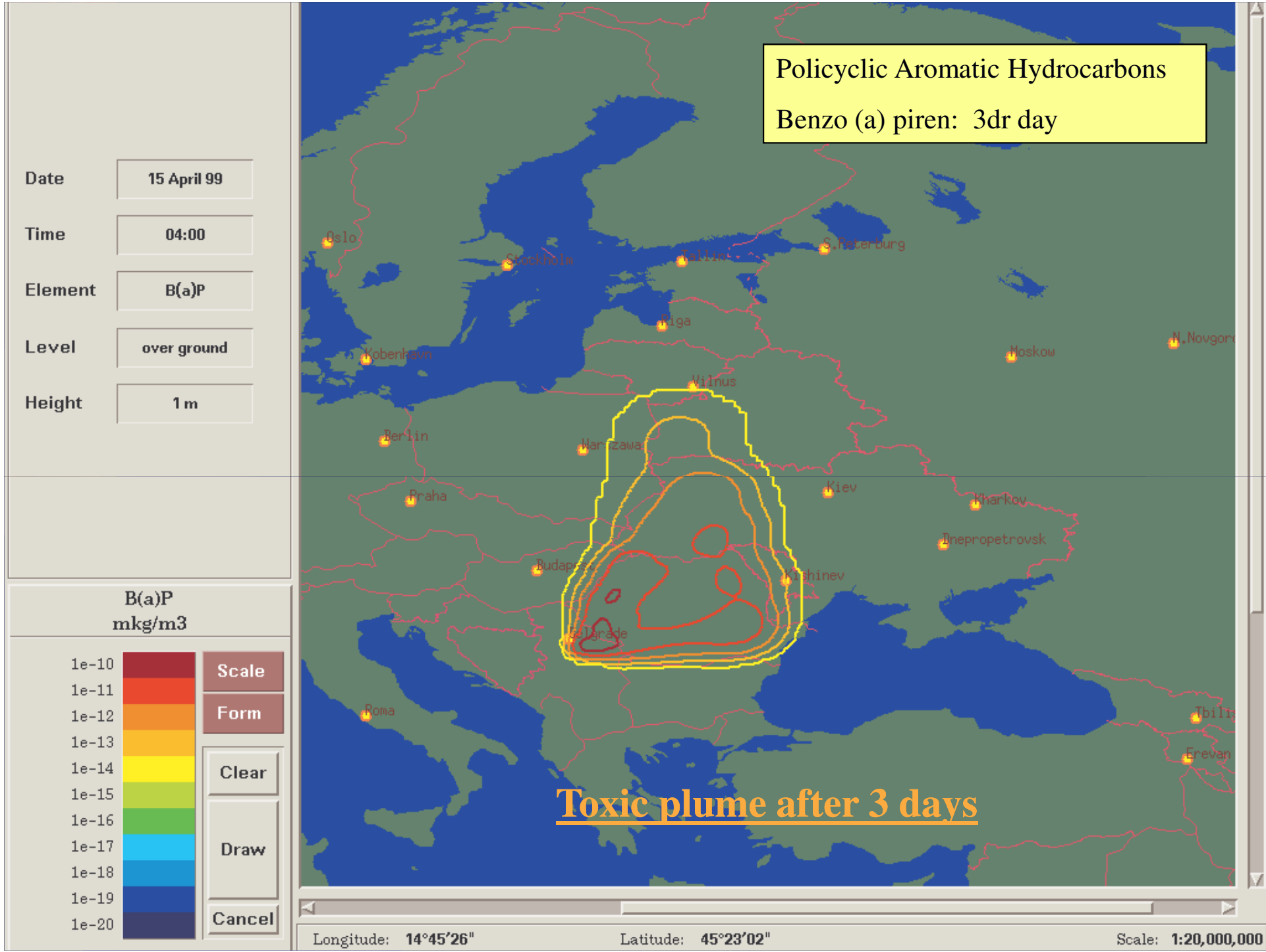
Clear

Draw

Cancel



Longitude:	Latitude:	Scale: 1:20,000,000
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Consequences

- fi Rise of tumors in former Yugoslavia population exposed to bombings
- fi Rise of some special kind of tumors (Hodgkin lymphoma) in the Italian soldiers occupying the Kosovo region



DU and Italian soldiers casualties

- fi Depleted Uranium (DU) has been widely blamed for casualties in Italian troops occupying Kosovo
- fi During the Balkan War, however, so many chemical substances were released (many of them genotoxic), that DU is just 1 among 100 possible causes.

Italian Government and DU

- fi The Italian Senate promoted many inquiries on the DU question and the problem of dying Italian soldiers
- fi Being appointed as scientific advisor of the Senate and then of the Ministry of Defence, I propose “*Let’s follow a scientific approach*”...



Depleted Uranium

- fi **Depleted Uranium is a nuclear material known since the forties**
- fi **It has become famous since it has been used in the Gulf War (1991), in the Balkans (Bosnia 1995 e Kosovo 1999), in Afghanistan e again in Iraq in 2003, for certain ammunitions types that turned out to be very effective ones.**



Depleted Uranium

- fi In fact, the first study of the military use of radioactive powders is as old as nuclear age
- fi The Report “Use of Radioactive Materials as a Military Weapon” was compiled by **James Conant**, a leading member of the Manhattan project, and transmitted to general Leslie Groves, the head of the project, in 1943.

Depleted Uranium

- fi DU is mainly composed by U-238, it is a radioactive material with extremely long half-life, and it is mainly an α emitter, with a weak emission of beta and gamma rays.
- fi External exposure hazards mainly regard military personnel using tanks with DU shields, while it is negligible in other occasions.
- fi The most important pathways for DU exposure are therefore in case of ingestion or inhalation.



Depleted Uranium

- fi Personnel in or near an armored vehicle at the time these vehicles are struck by depleted uranium munitions can receive significant internal DU exposures.
- fi On the other hand, army officials believe that DU-related health risks are greatly outweighed by the risks of combat.
- fi This is not the case, however, for the exposure of public due to DU contamination, or for peace-keeping actions after war.

DU HAZARDS

- fi Uranium dust is known to be dangerous since the fifties, when inhalation of uranium dust caused minor problems to workers of the nuclear industry, and in particular of fuel fabrication plants
- fi That problem was easily solved controlling the quality of air, in particular the concentration of dust particles
- fi Literature from the fifties confirms that uranium dust can be a risk if inhaled.



DU HAZARDS

- fi When DU bombs detonate, uranium oxide is formed in particulates of [0.5-5] microns. These can be windborne, inhaled and taken into the lungs.
- fi DU oxides contained in the body are subject to various degrees of solubilization: once dissolved in blood, about 90% will be excreted by the kidney in urine within 24-48 hours.

DU HAZARDS

- fi The 10% that is not excreted and it is retained by the body (insoluble uranium oxides) can remain in the lungs for years, and slowly pass into the mediastinum lymph-nodes and in small part in the skeleton
- fi Pathologies caused by DU are essentially tumors; in particular, to lymph-nodes (Hodgkin and Non-hodgkin lymphomas), leukaemia, lung tumors

DU HAZARDS

- fi Concerning chemical toxicity, Uranium, being an heavy metal, is known to have toxic effects on specific organs in the body: in particular, the kidney.
- fi The uranyl-carbonate complexes decompose in the acidic urine in the kidney.
- fi The effects on the kidney from uranium resemble the toxic effects caused by other heavy metals, such as lead or cadmium



USE OF DU

- fi DU has been used for military purposes, in order to increase the weight of bullets utilised by tanks and airplanes, and in tanks armours.
- fi Some thousands of tons of DU have been used to produce weapons. This is a quite small fraction of the DU made available by the nuclear industry

FABRICATION OF DEPLETED URANIUM (DU)

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graph TD; A[Nuclear fuel cycle: Uranium enrichment process] --> B[Depleted uranium]; A --> C[Enriched uranium]; B --> D[DU bullets]; C --> E[Nuclear Fuel];
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**Nuclear fuel cycle:
Uranium enrichment process**

Depleted uranium

Enriched uranium

DU bullets

Nuclear Fuel

DEPLETED URANIUM CHARACTERISTICS x MILITARY USE

NUCLEAR INDUSTRY SCRAP

LOW COST

WIDE AVAILABILITY

2 \$/Kg

HIGH DENSITY (One liter = 19 kg)

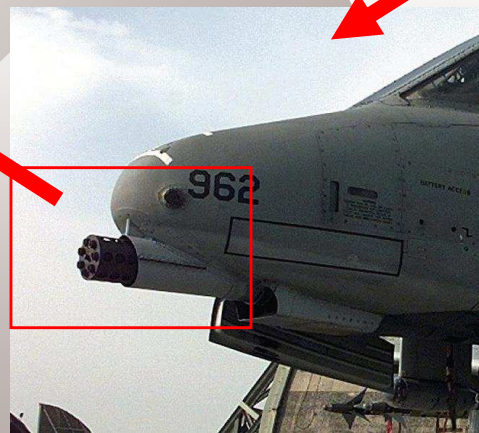
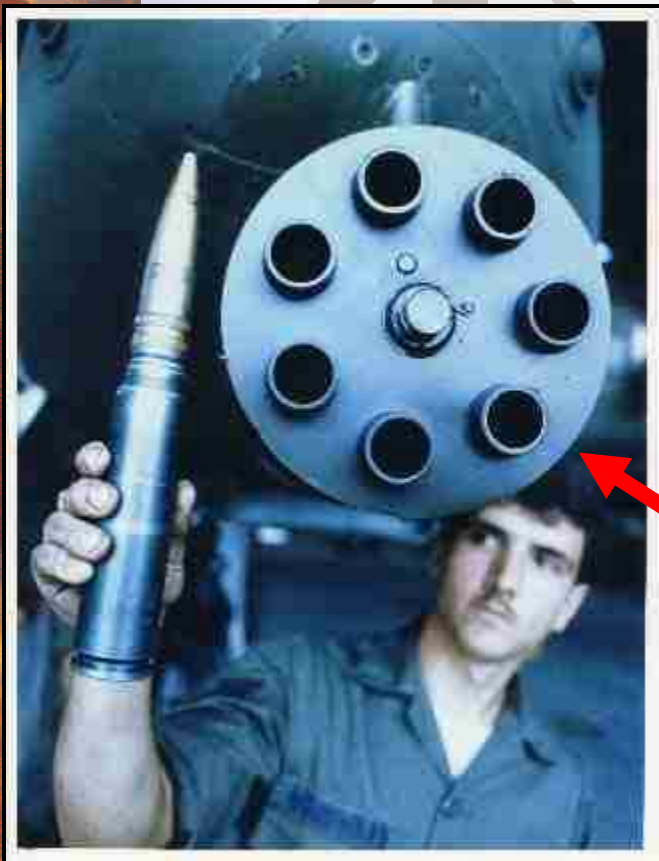
PYROPHORIC

SELF-SHARPENING PROPERTIES

RADIOACTIVITY

MILITARY USE OF DU

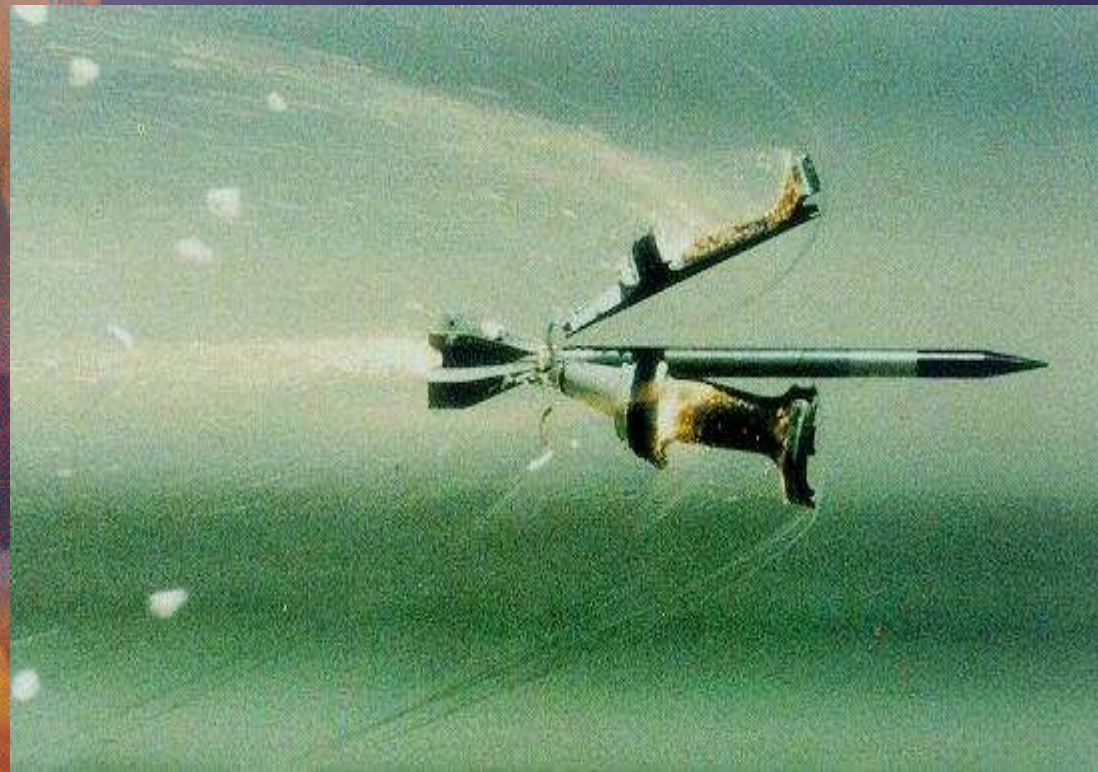
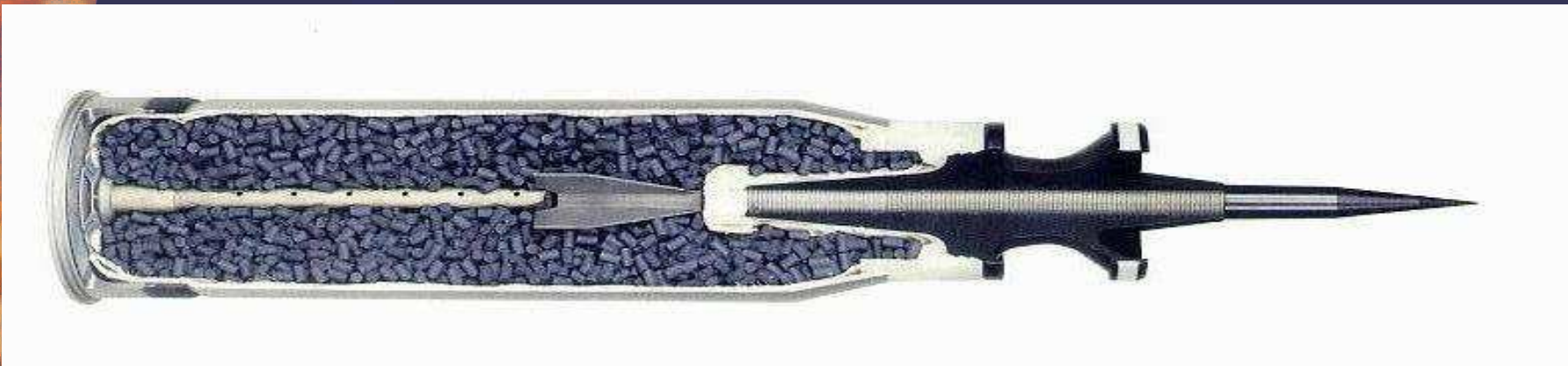
**30 mm BULLETS:
AIRPLANE A-10 Warthog e
120 mm bullets and armour
for M1(A1 e A2) tanks**





WHAT HAPPENS WHEN A DU BULLET IMPACTS ON TARGET?

-  **TARGET DESTRUCTION**
-  **FIRE: OXIDATION AND PULVERIZATION**
-  **ATMOSPHERICAL DISPERSION**
-  **DEPOSIT TO SOIL AND POSSIBLE RESUSPENSION**
-  **RADIOACTIVE CONTAMINATION**



HEALTH EFFECTS OF DU INHALATION



CHEMICAL TOXICITY: EARLY EFFECTS

RADIOLOGICAL TOXICITY: LATE EFFECTS

**Synergistic effect
between chemical and radiological toxicity**



BYSTANDER EFFECT

Recent studies have demonstrated the so-called “bystander effect”, in which unirradiated cells close to irradiated cell populations can exhibit genetic alterations.

The bystander effect is predominant at low tissue doses, where few cells experience an alpha particle passage.

For this reason, uranium particles, which emit few alphas, would have a greater chance of inducing effects through the bystander mechanism than expected applying the ICRP models.



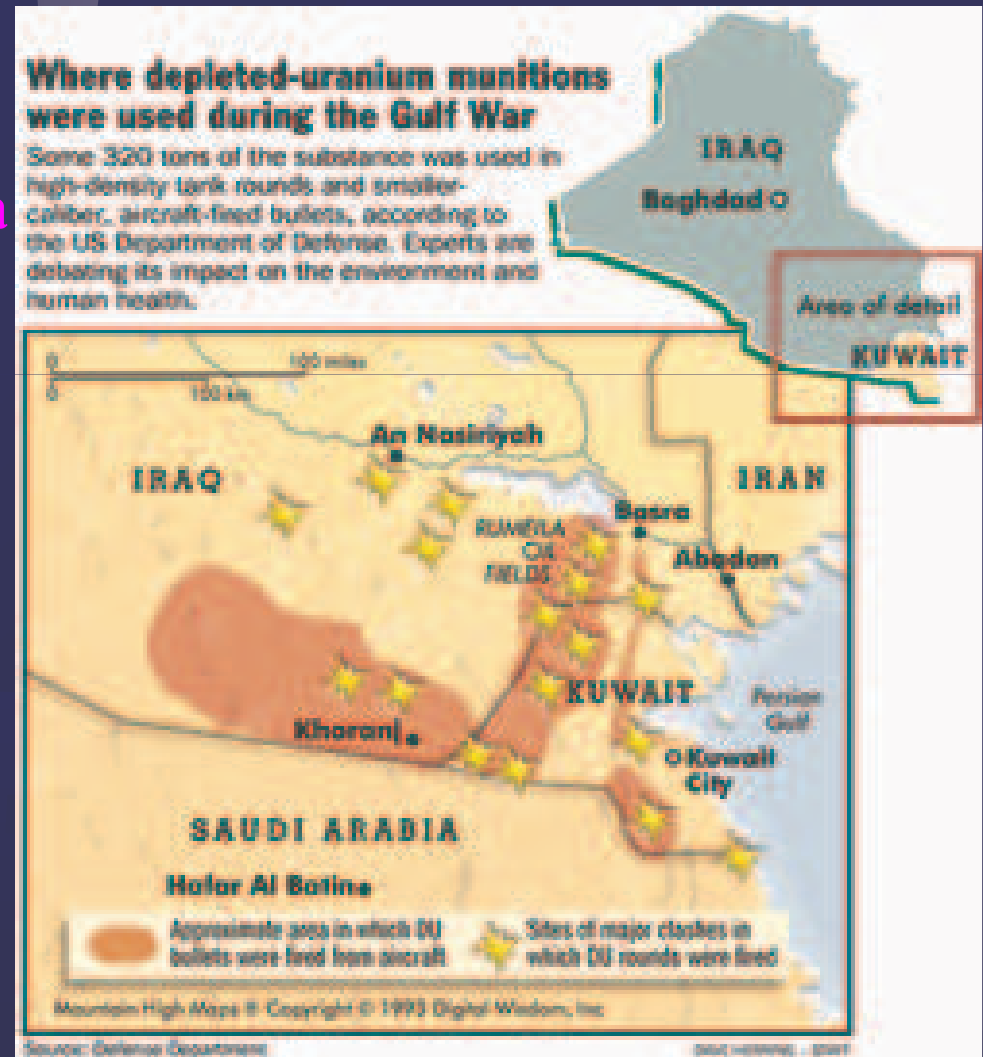
Summary of recent findings

The implication of the combined chemical and radiological transforming capability of uranium particles and of the bystander effect, means that in estimating depleted uranium significance in causing cancer, the simple assumptions, based on committed effective dose, i.e. following the ICRP standard model, would probably underestimate risks.

IRAQ AND DEPLETED URANIUM

In the Gulf War in 1991, about 90000 uranium bullets have been used, for a total weight of about 300-400 tons of DU

In the 2nd Iraq War in 2003, other hundreds of tons of DU have been used (estimates vary from 200 to 2000 tons), mostly within the cities





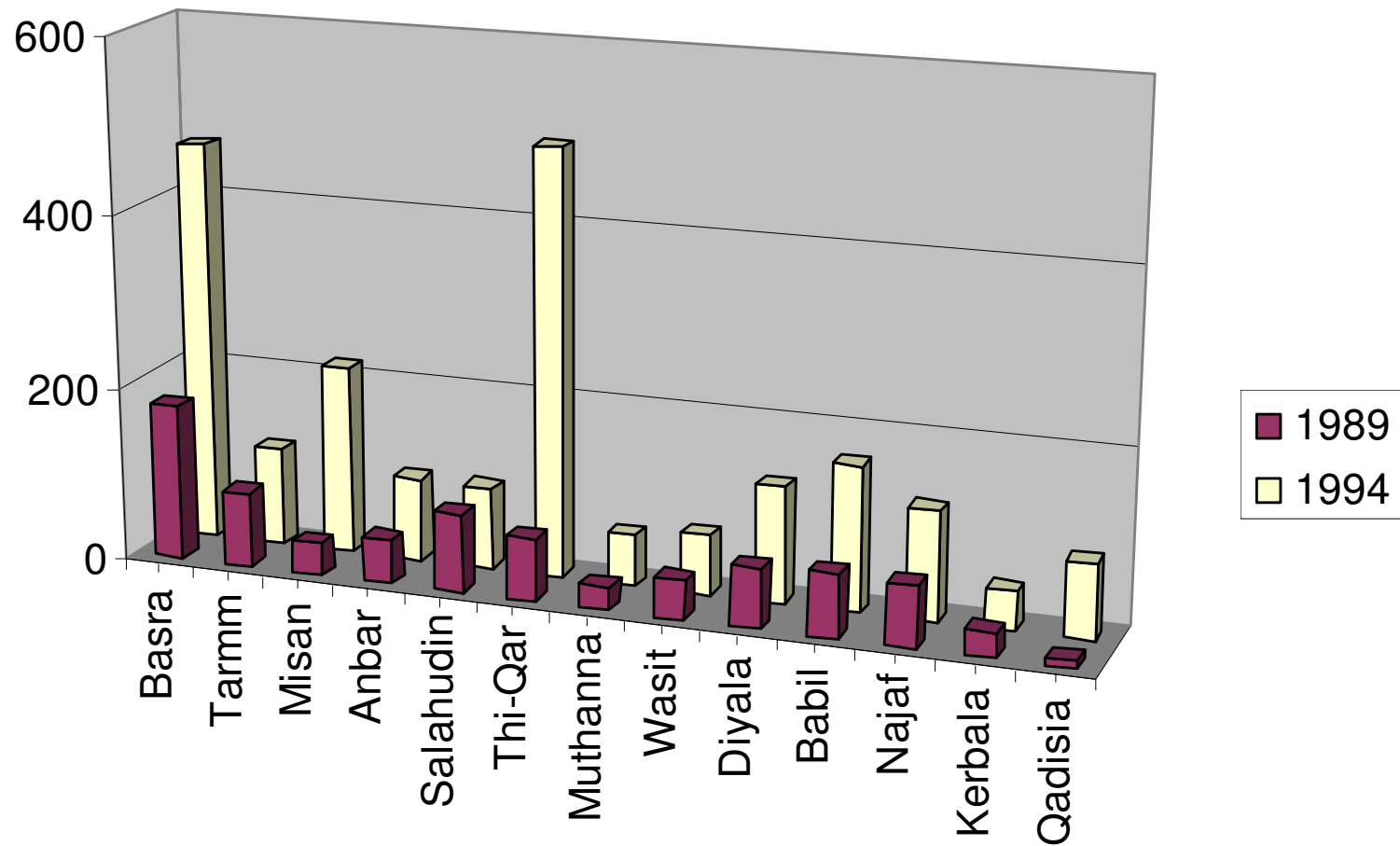
IRAQ AND DEPLETED URANIUM

The embargo that Iraq has had in the nineties caused a sharp rise of deaths in the country.

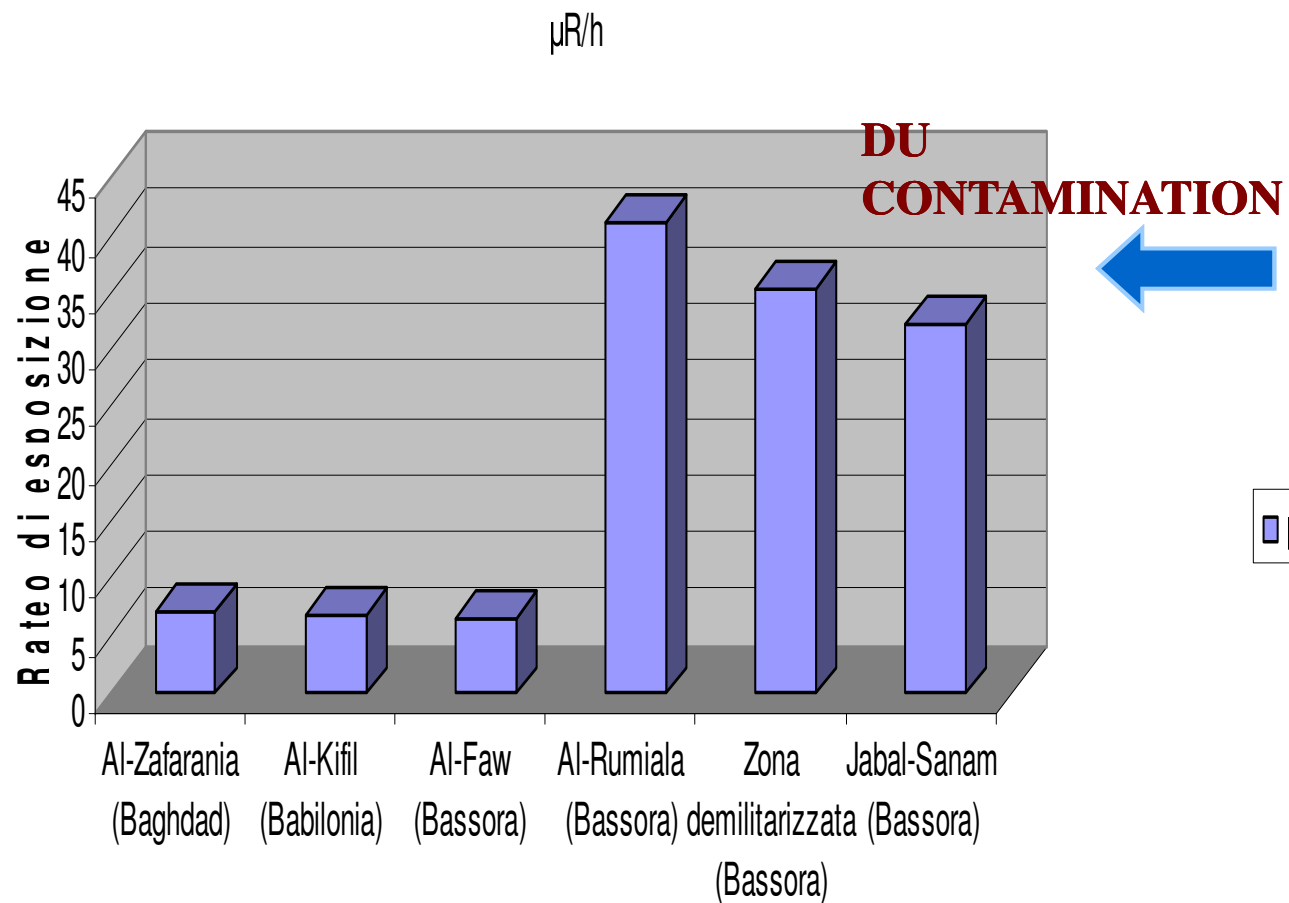
In such a situation it was difficult to identify the effects of Depleted Uranium on population's health from the epidemiological viewpoint.

A lot of Iraqi “scientific gray literature” was available, but again it was difficult to separate propaganda from scientific facts.

Tumors in some Iraq provinces in 1989 and 1994



Background Radioactivity



**NATURAL
BACKGROUND**

Data of the Tumors Register

- fi Tumors have shown, in the period 1989-1999, a sharp increment.
- fi An even sharper increment in the period 1999-2009.
- fi (Doubts still exist about the doping of the data by the former Iraqi regime)
- fi The highest rise has been for leukaemias
- fi Geographically, there is strong correlation with zones where war took place (south of the Country), while the data for the north of the country are almost normal.

Children malformations

- fi A sharp rise of newborn children malformations has been registered in southern Iraq in the last years.
- fi Robust statistical data and case studies are available, for instance, from the Oncology Center in Basrah, in the south of the country.
- fi They show that something unexpected and above normal is going on with Iraqi newborn children



Iraqi Health Effects and DU

- fi DU has again been blamed as the only cause of the health effects.
- fi Iraq, due to the 1991 and 2003 wars, has been polluted with both chemical and radioactive substances. Also, living standards and health care have dramatically worsened.
- fi DU – instead - is just one of the causes among many possible ones, but its fingerprints have been identified.

CONCLUSION

- fi It is important to gather data and results in the field of DU health effects, but with a “science first” approach, even if dealing with the health of people, especially children, is always a difficult matter.
- fi Activism should be kept, as much as possible, out.



CONCLUSION (cont'd)

- fi DU toxicity seems to have been, in the past years, under-evaluated by the scientific community.
- fi Synergetics effects of chemical and radiological toxicity, small dust particles effects modeling, bystander effect and other recent findings indicate that the simple ICRP model should be refined in this case.

CONCLUSION (cont'd)

- fi On the other hand, exaggerated and catastrophical claims by “para-science” activists have not contributed to create an environment permitting civil confrontation between opposite views
- fi Instead of solving the problem, they went into the opposite direction.

CONCLUSION (cont'd)

- fi Some say that Depleted Uranium could be a “moral radioactive tracer”, to help to unveil the aftermaths of a modern war on local population health. In this way, the “DU hysteria” could have been useful somehow.
- fi As usual, part of the attention devoted to evaluate radioactive DU pollution should be devoted to evaluate pollution due to other genotoxic chemicals, released during the war.

CONCLUSION (cont'd)

- fi Depleted Uranium is a heavy metal and a radioactive material that, released into the environment as a fine dust, contributes to its pollution and therefore it can be one of the causes of the long-term health effects on population living in that environment
- fi Following our well-established radioprotection principles and practices, its use is not justified and then it should be avoided.



THANKS FOR ATTENTION!

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