

AR 20P

# The Gas Disaster in Bhopal, India 1984 – too late for good epidemiology

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# Bhopal

Bhopal, in the middle of India, is the capital of Madhya Pradesh, and a railway junction.

In 1984, it had 700,000 inhabitants. Today, there are about 1.2 millions.

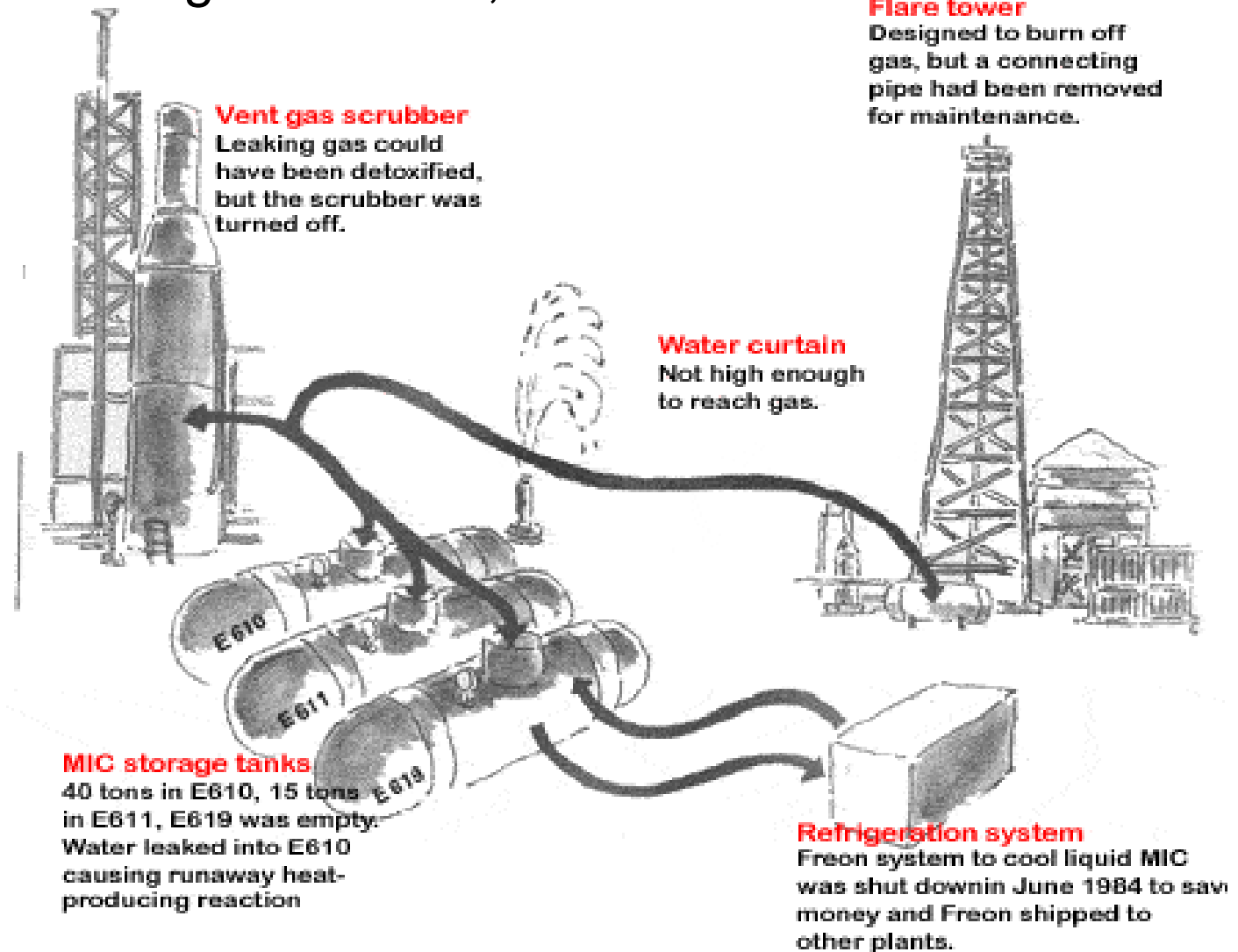


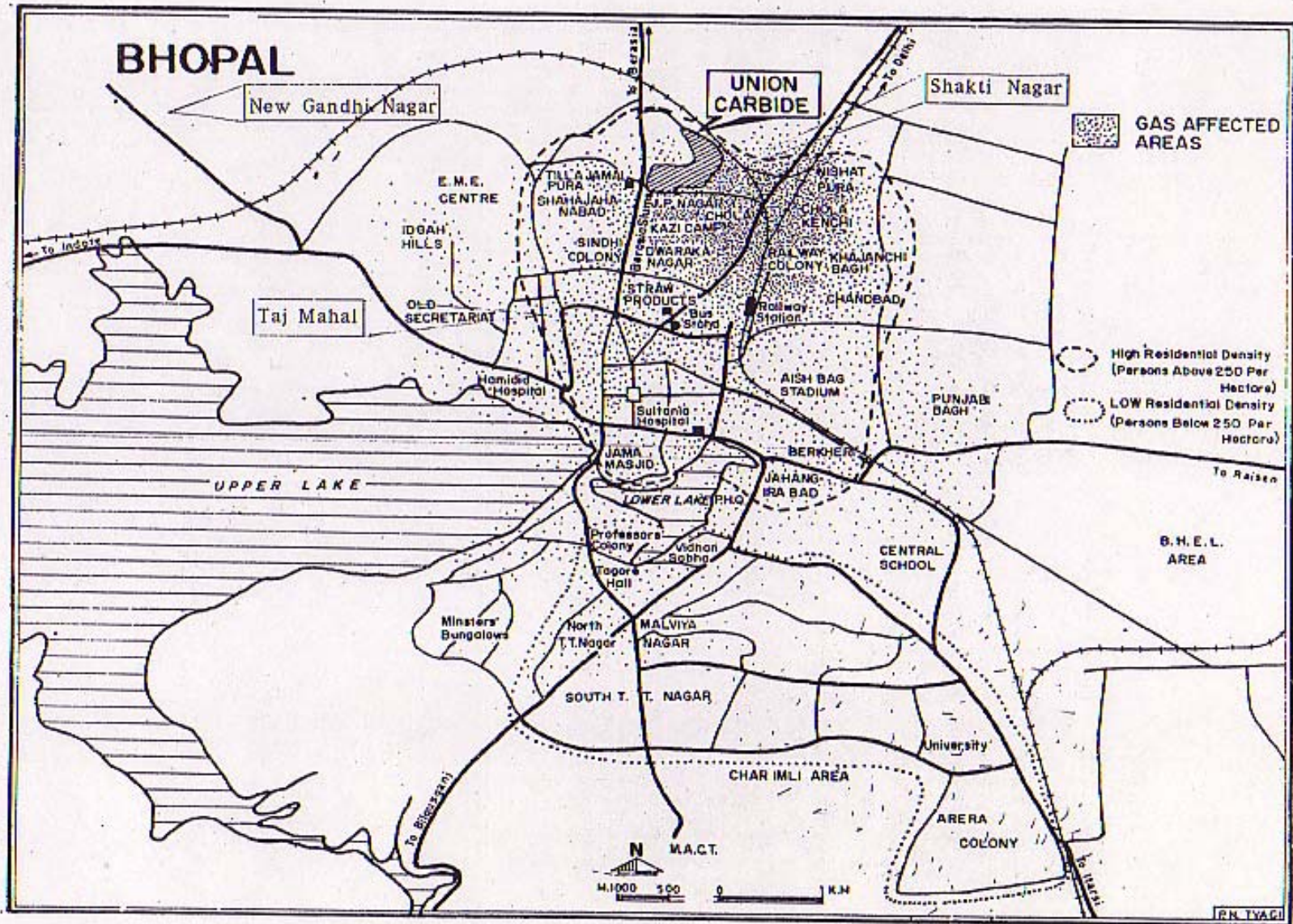
# Introduction

- At midnight Dec 3, 1984, at the Union Carbide pesticide plant in Bhopal, water entered the tank 610, containing 43 tonnes of methyl isocyanate (MIC). A run away reaction started.
- 520,000 or more people were exposed to the gases, of whom 200,000 were below 15 years of age and 3,000 pregnant mothers.
- Most likely, 8,000 died during the first weeks.
- It is estimated that more than 100,000 have permanent injuries.

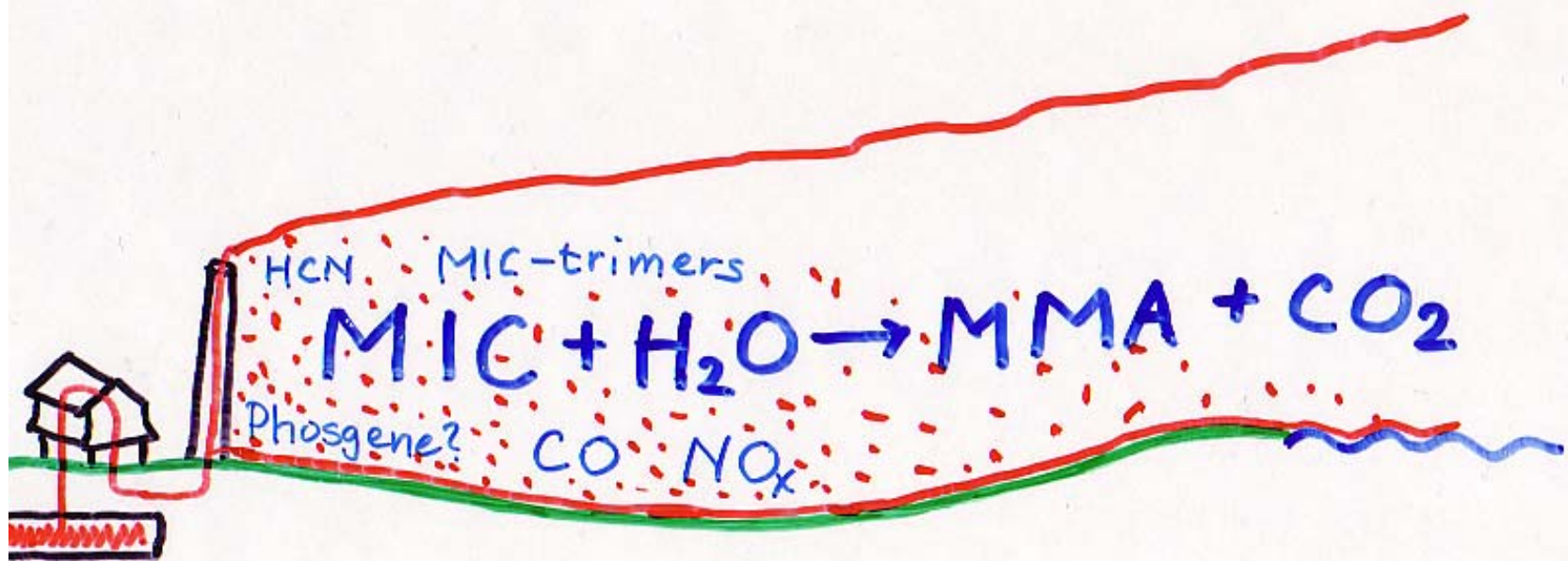


Most of the safety systems were out of function at the night of Dec 3, 1984.





The gas aerosol spread over the densely populated area and was felt far away from the plant.



The gases were released at different heights. Thus the aerosol contained a mixture of substances, at different concentrations, depending on distance and height. The gases were heavier than air, displacing oxygen.



# Content of aerosol

- Methyl isocyanate (MIC)
- Mono methyl amine (MMA)
- Hydrogen cyanide (HCN)
- Phosgene (?)
- Hydrogen chloride (HCl)
- Nitrous oxides ( $\text{NO}_x$ )
- Carbon monoxide (CO)
- Carbon dioxide ( $\text{CO}_2$ )
- And others ...

No place for oxygen ...

# Method

- More than 200 references 1984-2003 studied: Books, articles, reports, submissions etc.
- ~ 50 of epidemiologic character
  - ~ 10 published in scientific papers
  - ~ 10 reports from scientific institutions



# Indian Council of Medical Research

## ICMR

### **Studies**

- 23 projects finalized within 10 years.
- Often uncontrolled small studies.
- Do not conclude causality.

### **The Cohort Study**

- From start 80,000 in affected area plus 16,000 in non-affected area.
- New members of families are included in the cohort to compensate for immigration, deaths etc.
- There is now 40 % attrition of sample.
- The same set of questions asked every 6 month since 1984.
- There are bias and confounding factors.
- Neurology is not included.
- The cohort was taken over in 1995 by the Centre for Rehabilitation Studies (CRS) that lacks funds, expertise etc.
- Since then, data are collected but not analysed.

# Other data collectors

## **The Tata Institute of Social Science (TISS)**

- TISS-survey on socio-economic factors, 25,000 families.
- Data not released.

## **Bhopal Cancer Registry**

- Not allowed to use the cohort.

## **The Tuberculosis Hospital**

- No research on gas victims.

## **Other hospitals and clinics**

- Very little systematic work done.

## **NGOs**

- Several small studies.
- Unscientific design, bias, small sample sizes and inadequate ascertainment of exposure.

# Reported acute health effects

- **Eyes**

Intense irritation, blepharospasm, eyelid oedema, corneal ulcerations.

- **Respiratory tract**

Rhinitis, pharyngitis, coughing, respiratory distress, breathlessness, choking, pulmonary oedema, pneumothorax, emphysema, fistulas, secondary infections etc.

- **Neurological system**

Cerebral oedema, partial paralysis

- **Kidneys**

Tubular necrosis

- **Liver**

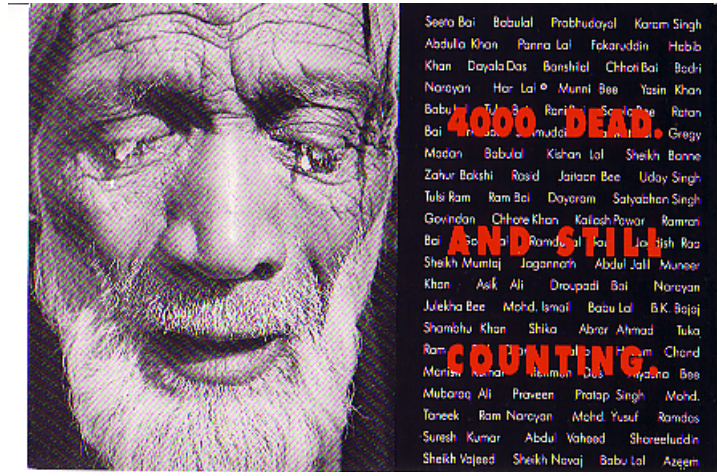
Fatty degeneration

- **Gastro-intestinal tract**

Necrotising enteritis

- **Women's reproductive health**

Stillbirth rate increased by 300 %, peri- and neonatal mortality 200 %, spontaneous abortions 300-400 %. Congenital malformations.



# Studied and reported long term effects on health

- **Eyes**

Chronic conjunctivitis, scars on cornea, corneal opacities, early cataracts

- **Respiratory tract**

Obstructive and/or restrictive disease, pulmonary fibrosis, aggravation of TB and chronic bronchitis

- **Neurological system**

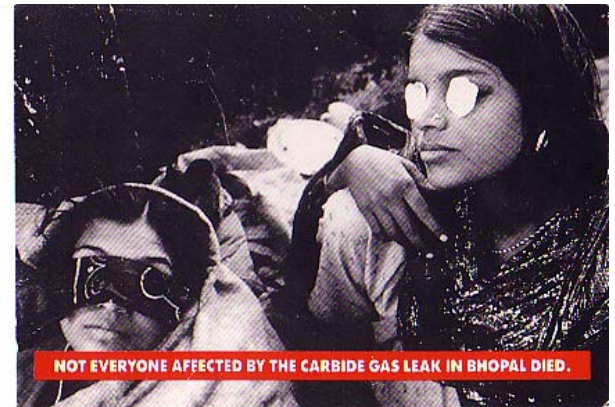
Impairment of memory, finer motor skills, numbness etc.

- **Psychological problems**

PTSD

- **Children's health**

Peri- and neonatal death rates increased.  
Failure to grow, intellectual impairment etc.



# Missing fields

- Female reproduction
- Chromosomal aberrations
- Cancer
- Immune deficiency
- Neurological sequelae
- Post traumatic stress disorder (PTSD)
- Children born after disaster

# Late cases that might never be highlighted

- Respiratory insufficiency
- Cardiac insufficiency (cor pulmonale)
- Cancer
- Tuberculosis

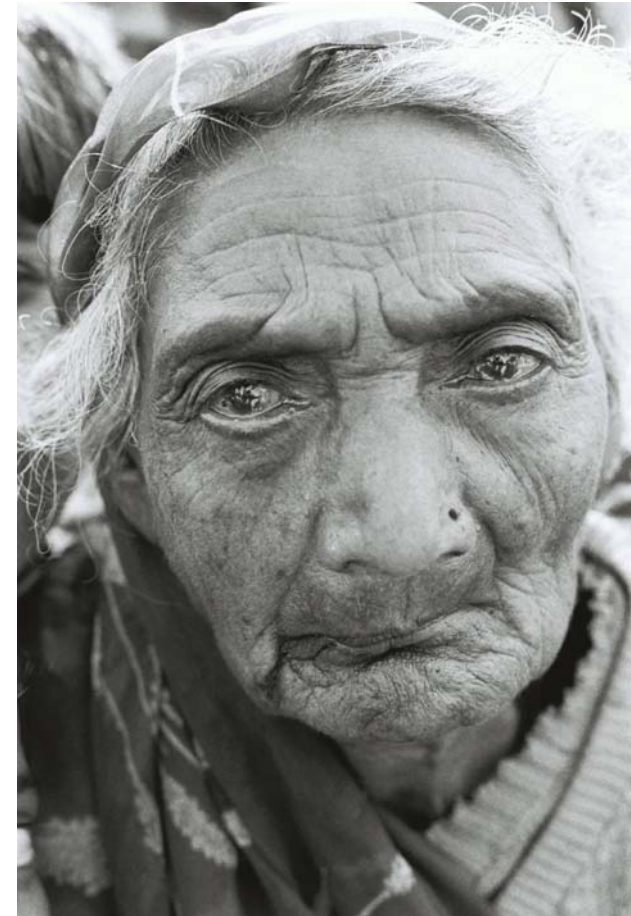


Photo: Christian Saltas

# Conclusions

- Although the quality of the epidemiological and clinical research varies, the different reports support each other.
- The findings are also supported by animal experiments.

# Outbreak disaster epidemiology

- A programme for “outbreak disaster epidemiology” should be drawn up. The WHO could be responsible.
- A structure for cohort studies with instructions on how to fulfil it should be developed.
- Short term as well as long term effects, including psychological symptoms, must be described, with special consideration taken to foetuses, children and reproductive health.
- Careful survey of exposure to chemical and/or radioactive compounds must be performed.
- Different organisations’ work should be coordinated and data bases should be possible to combine.



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