

# THE BHOPAL SAGA - Causes and Consequences of the World's Largest Industrial Disaster

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- International Medical Commission on Bhopal, 1994
- Visited Bhopal > 15 times
- Interviewed key persons
- Studied > 200 books and documents
- Followed the work at Sambhavna since start

# THE PRE-EVENT PHASE

## 1950 – 1984 November

The process that led to the  
leakage

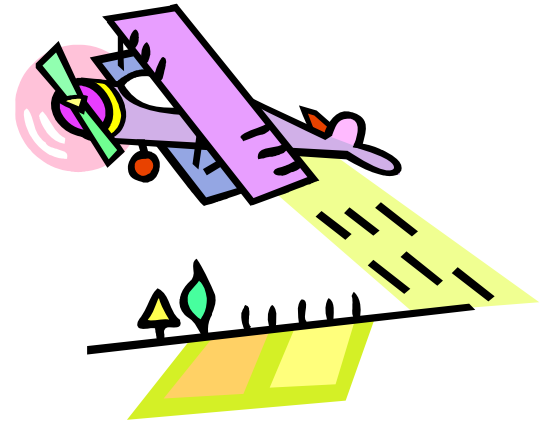
# India in the 1950:s

- Failure of the crops
- Attacks by insects
- Famines



# The Green Revolution

- Irrigation
- Fertilizers
- Pesticides





# Pesticide production

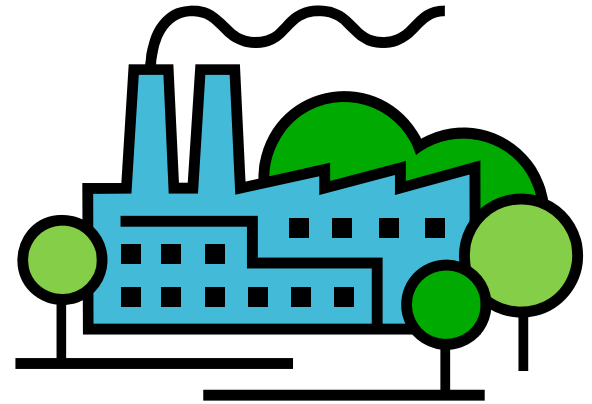
1969 Union Carbide Indian Limited (UCIL ) built a plant in Bhopal

- 51% was owned by Union Carbide Corporation (UCC)
- 49% was owned by Indian authorities

# 1979 MIC-unit was added:

## "The beautiful plant"

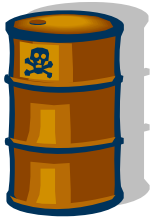
Went at a loss from start ...



# Design of the MIC-unit



1. MIC was used instead of less toxic but more expensive materials



2. Storing of large amounts of MIC in few large tanks instead of several small tanks



3. Safety system inadequate



4. Location close to a densely populated area



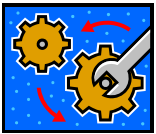
5. The alarm system not addressing the inhabitants



# Management



1. Safety rules not followed



2. Maintenance of plant bad



3. Staff reduced, uneducated

# Previous warnings



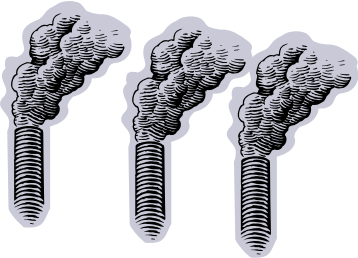
1974 Contaminated well, cows died



1978 Trade union wrote letter to managers and MP government



1978 Large fire



1981-1984 Many leaks, workers injured, also died. Articles published.

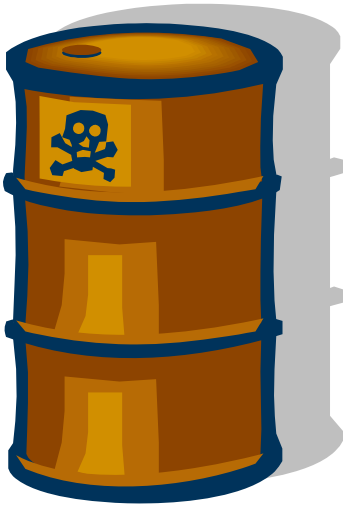


Sept 1984 Safety audit by UCC found several shortcomings

# THE EVENT PHASE

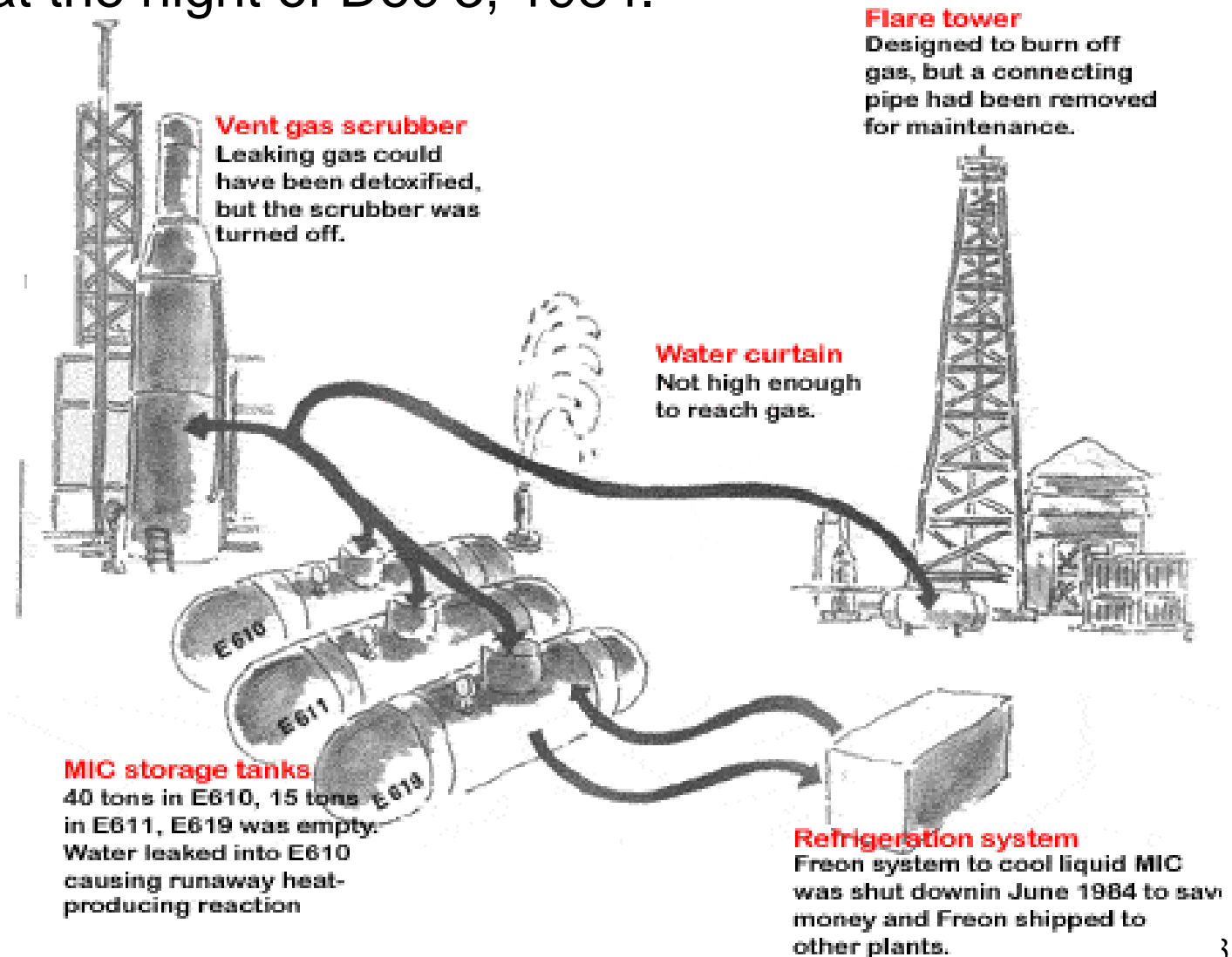
## December 1984

# The situation Dec 2



Tank 610 contained 43 tonnes  
MIC, much more than allowed  
according to safety rules

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



# Direct cause - theories



1. Water entered the tank when workers washed pipelines – most plausible theory



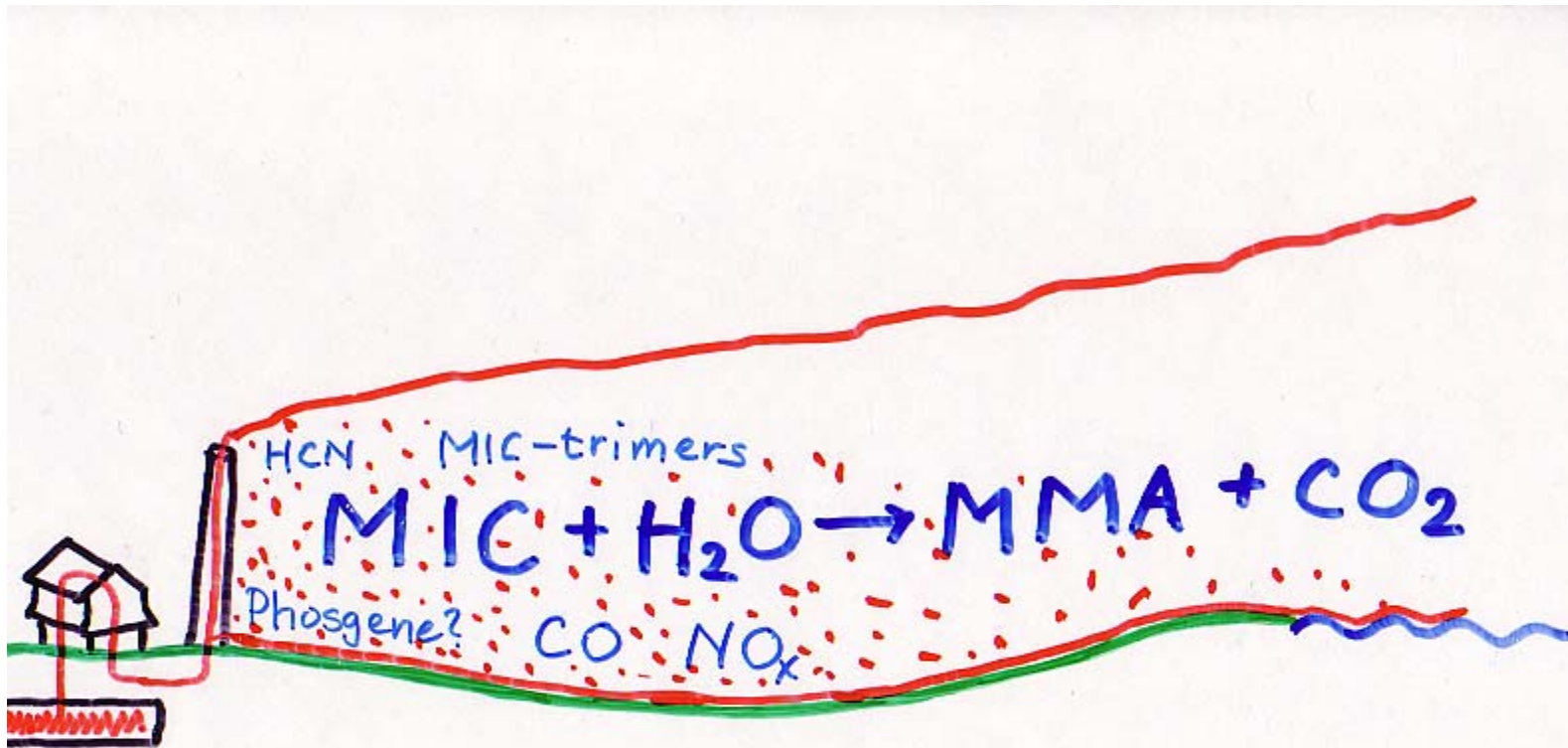
2. Direct entry theory (sabotage) – UCC:s theory



(3. The economy theory)



(4. The warfare test theory – leftish organisations)



The cloud contained a mixture of substances. Concentrations were higher close to the plant. The gases were heavier than air, displacing oxygen.

# Content of gases

- Methyl isocyanide (MIC) reacts with water to form mono methylamine (MMA) and carbon dioxide (CO<sub>2</sub>)
- Hydrogen cyanide (HCN) blocks the oxygen receptors and is extremely toxic
- Phosgene was used as a war gas during World War I
- Carbon monoxide (CO) is toxic
- Nitrogen oxides (NO<sub>x</sub>) causes lung injuries
- All gases were heavier than air and thus replaced oxygen





# The disaster

- 9.00 PM Water cleaning of pipes start.
- 10.00 PM Water enters 610. Reaction starts.
- 11.30 PM Gases coming out from the VGS-tower.
- 00.30 AM The large siren sounds and is turned off.
- 00.50 AM The siren is heard within the plant area. The workers escape.

# Outside plant

- 11.30 PM First sensations. Suffocation, cough, eyes, vomiting.
- 1.00 AM Police alerted. People escaped.  
UC-director denied.
- 2.00 AM The first reached Hamidia hospital.  
Half blind, gasping for air, frothing at the mouth, vomiting.
- 2.10 AM The alarm was heard.
- 4.00 AM The gases reduced.
- 6.00 AM The police's loudspeaker: everything is normal.

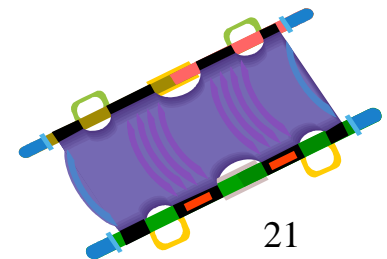
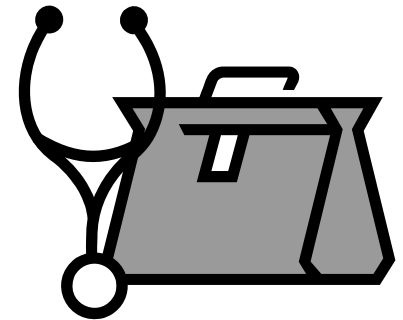
# Next day

- Thousands of dead bodies on the streets. Everyone on the railway station died.
- The corpses were collected and dumped into Narmada river, mass funerals, mass cremation.
- 2 000 buffaloes, goats etc dead. Collected, buried.



## Next day

- 170,000 were treated at hospitals and temporary dispensaries.
- 700 doctors, 250 nurses, 870 others.
- The health care staff became exposed to the gases.
- Stop at 550 registered dead.
- UC's doctor: "It is like tear gas."



# Within the next few days

- The leaves went yellow, fell off.
- Business stopped. Food did not get into town. Fishing was forbidden.
- The town was invaded by health care staff and American lawyers.
- Contradictory information from the authorities.

# The second exodus: Operation Faith

- Residues in tank 611.
- The inhabitants did not obey the authorities and went inside – instead they fled the town.
- There were 22 tonnes of MIC in tank 611 that should have been empty.

# Acute effects

- **Airways:** Burning like chili, cough, broncho constriction, bronchiolitis, pulmonary oedema etc.
- **Eyes:** Severe irritation, blepharospasm (could not open eyes), corneal ulcers.
- **Reproduction:** Miscarriages, death of foetus, increased infant death rate.
- **Autopsy:** Oedema of brain, kidneys swollen, necrotic.



# Treatment

- Symptomatic. No information on curing or mitigating treatment.
- Contradictory recommendations from UCC and Gol on antidote sodium thiosulphate (NaTs) → not acute treatment.

# Magnitude of the disaster

## Exposed:

- 520,000 – 730,000
- > 200,000 were below 15 years of age
- > 3,000 were pregnant women

## Dead:

- > 8,000 (16,000?) during first weeks
- > 3,000 below 15 years
- 8,000 (?) died since

## Permanent injuries:

- 100,000 – 200,000

# Affected

- The poorest, who lived closest to the plant, were hit hardest.
- The shortest (the children) were hit hardest.

# Exposure had been less if the inhabitants

- had been warned earlier by the alarm
- covered their faces with a wet cloth
- stayed indoors if they lived in good houses
- walked in stead of run
- had moved in right angle to the wind instead of in the same direction

But they did not know ...

# THE POST-EVENT PHASE

## 1985 →

# Data collectors

- The TATA-institute
- Indian Council of Medical Research (ICMR)
- Centre for Rehabilitation Studies (CRS)
- India Toxicology Research Centre (ITRC)
- Defense Research Development Organ (DRDO)
- Indian Council of Agricultural Research (ICAR)
- National Environment Engine Research Institute (NEERI)
- Bhopal Cancer Register
- Council for Scientific and Industrial Research (CSIR)
- Hospitals and clinics
- Independent national and international institutions

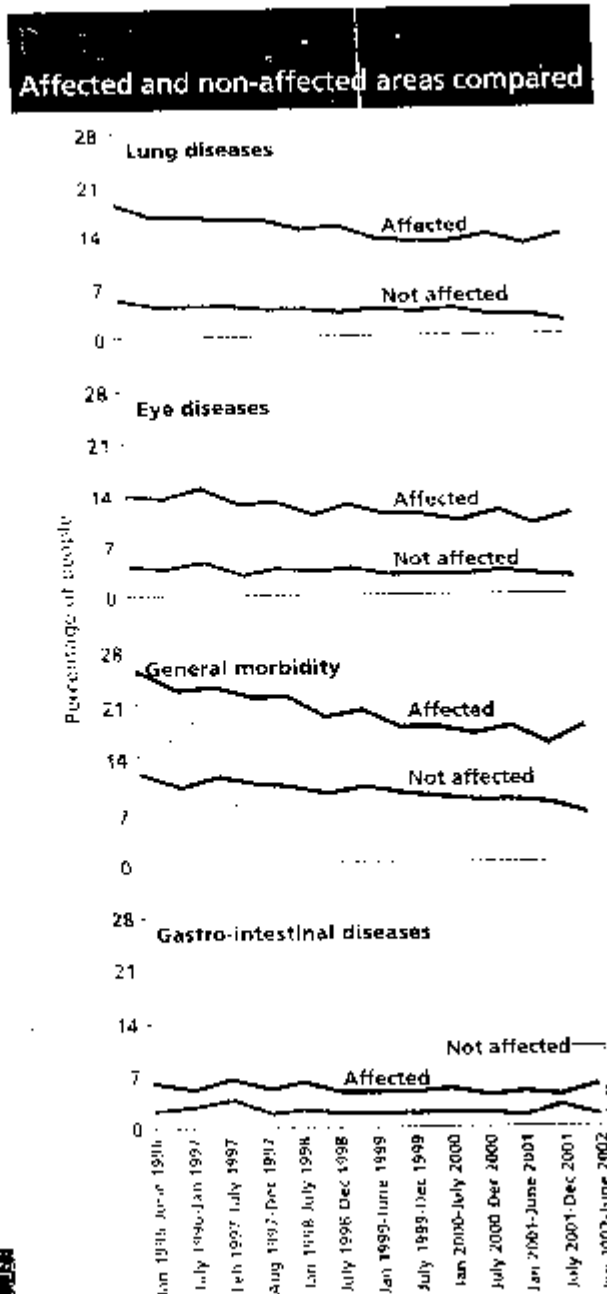
# Long term effects

- Eyes
- Respiratory system
- Cardiac failure secondary to lung injury
- Immune system
- Neurological system
- Psychological effects
- Women's reproductive health
- Genetics
- General over morbidity



**HARDLY SMART**

To keep a tab on



The data from the ICMR cohort is taken over by CRS.

It shows declining morbidity for gas affected and control group.

General, lung, eye and gastrointestinal morbidity is higher for gas affected.



# ICMR: Missing fields

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

# ICMR: Clinical studies

- Uncontrolled observations on small populations
- Do not conclude causality

# Late effects

Late cases that might never be highlighted:

- respiratory insufficiency
- cardiac insufficiency
- cancer
- tuberculosis

# Conclusions Research

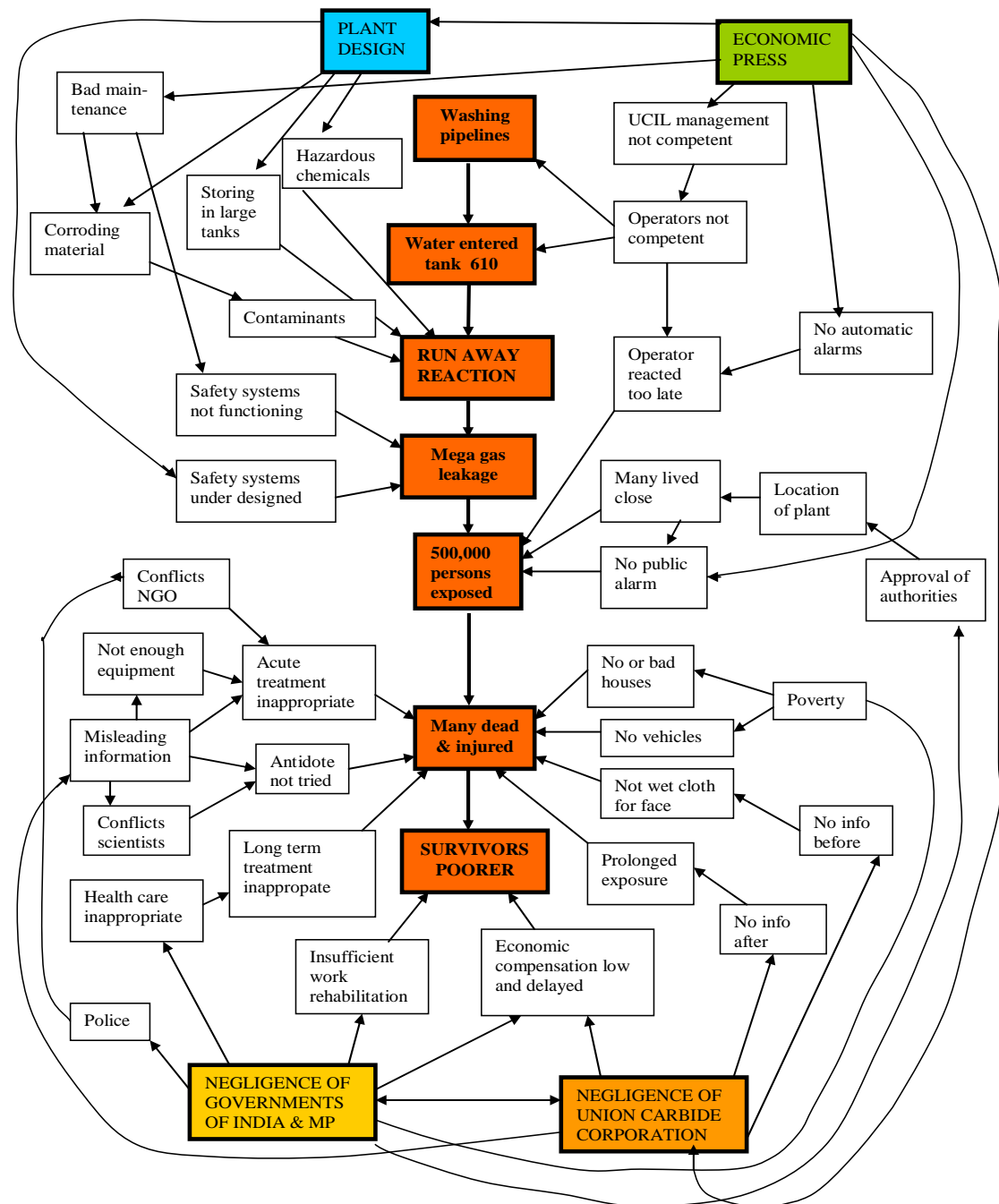
- The quality of the epidemiological and clinical research varies.
- However, the different reports support each other.
- The findings are also supported by animal experiments.

# Conclusions Health Effects

- The effects on health caused by the leakage should have been mitigated if the medical, social, and economic rehabilitation had been adequate.
- The effects on health caused by the leakage could have been mitigated if the environment rehabilitation had been adequate.

# ANALYSIS OF CAUSES AND CONSEQUENCES

# Problem tree according to LFA (Logical Framework Approach)





Plant design

Economic pressure



Washing pipelines,  
water entered tank 610



Many dead and injured,  
survivors poorer

Gov of India  
and MP

UCC



# Results

- Irrespectively of the direct cause to the leakage, it is only two parties that are responsible for the magnitude of the disaster: Union Carbide Corporation and the Governments of India and Madhya Pradesh.

1. To create the mega-gas leak, it was not enough that water entered the tank.
2. The most important factors for the leak were the plant design and the economic pressure.
3. The most important factor for the outcome of the leakage is the negligence of the Union Carbide Corporation and the Governments of India and Madhya Pradesh.

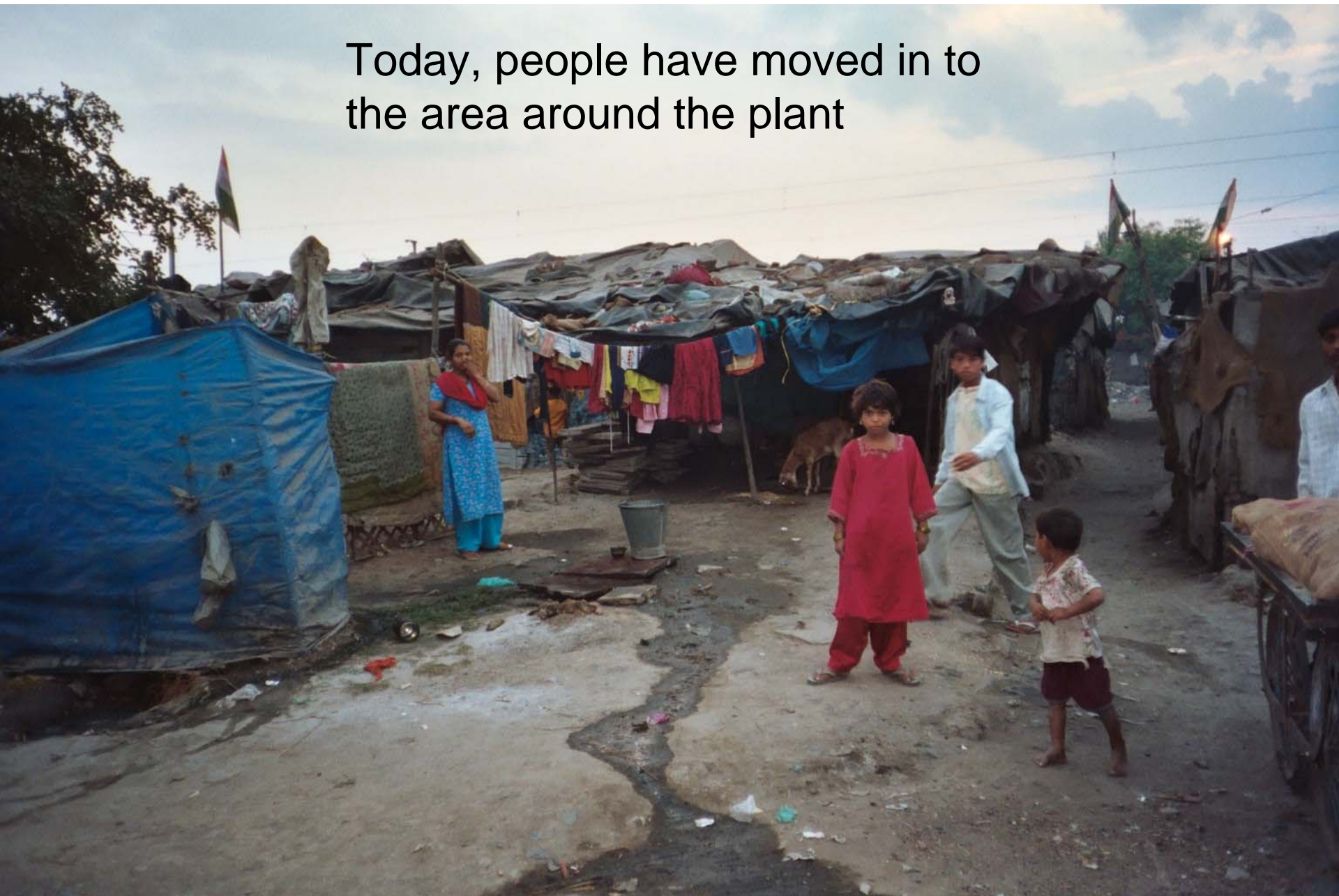
# Governments' responsibility

- Governments have a responsibility to protect their inhabitants from negative effects of "development".
- Coordination between governments and national organisations is necessary.

Today, the survivors are  
fighting their "own lawyer" to  
get their rights.

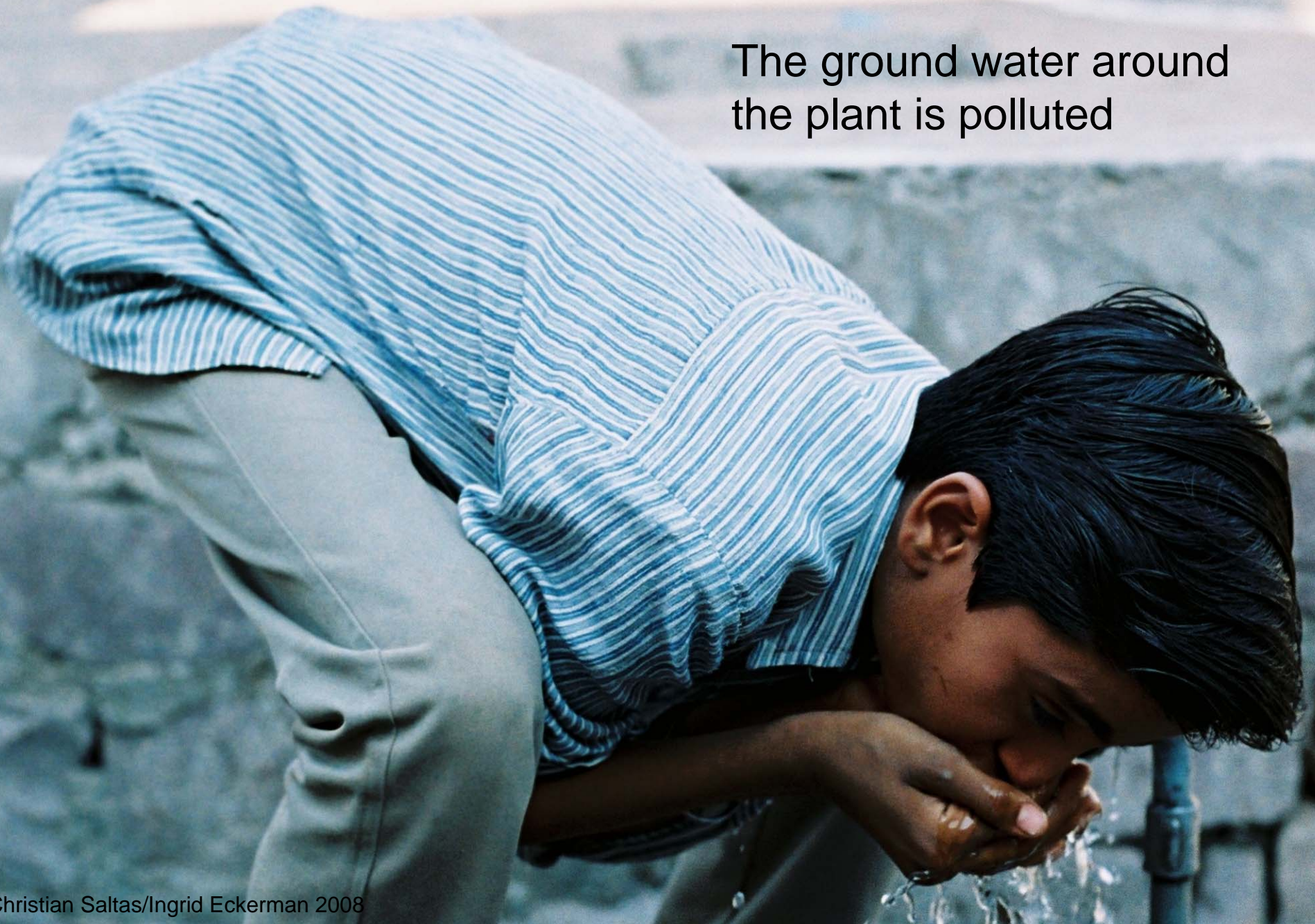


Today, people have moved in to  
the area around the plant



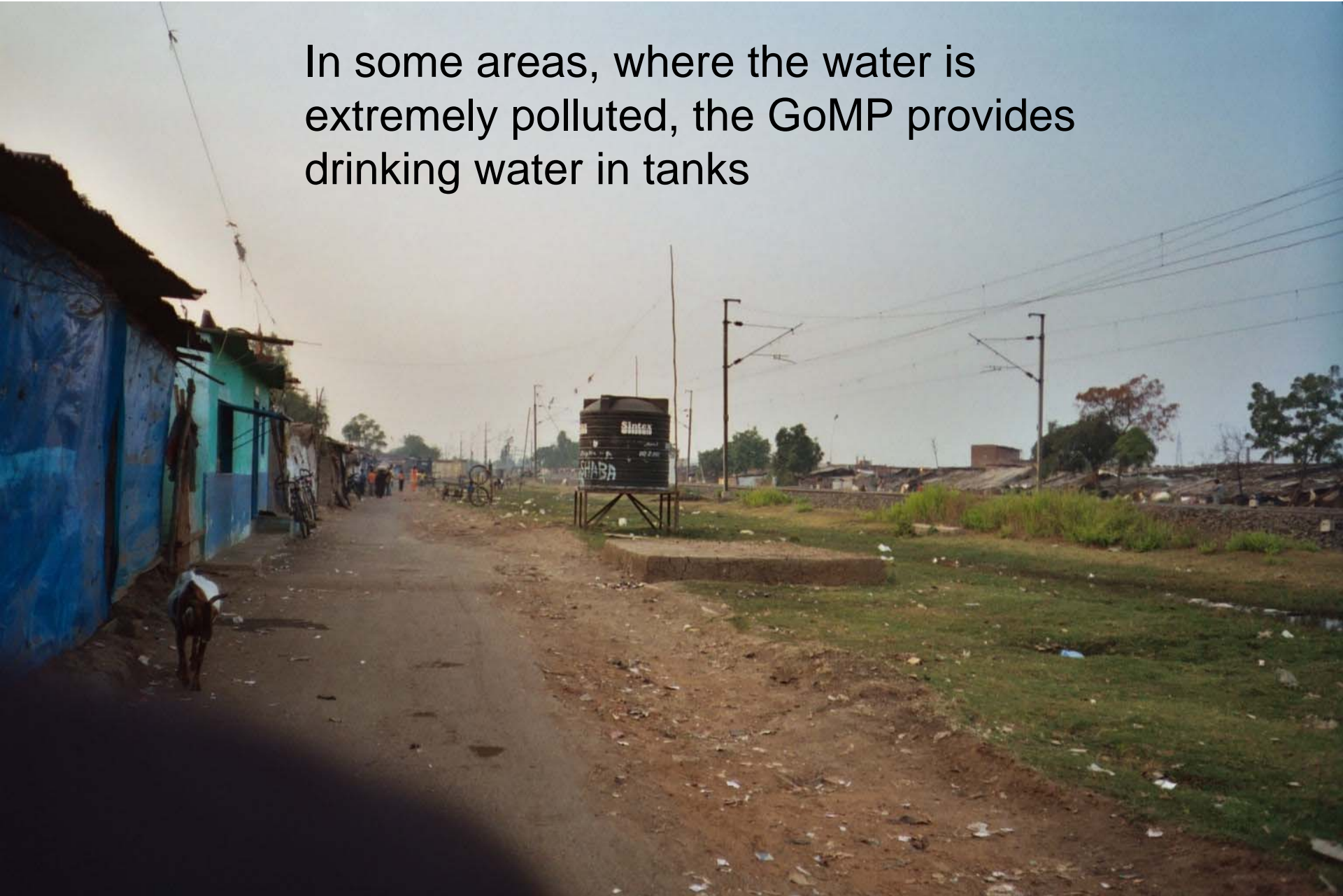


The ground water around  
the plant is polluted





In some areas, where the water is extremely polluted, the GoMP provides drinking water in tanks





The extra ordinary BMHRC, financed by the shares sold by UCC, gave free health care to gas victims only for eight years







Today, the MIC-plant is falling apart. Is this a picture of chemical industries' future?

# FUTURE

Oil prices are increasing ...  
Can we afford the chemical society?

