



The Socrates Award Lecture 2006

Top Ten Most Polluted Areas in the World

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Principles of Environmental Toxicology

Solving pollution problems in the developing world.

World's Worst Polluted Places >> **The Top 10** as voted by the Blacksmith Technical Advisory Board.

World's Worst Polluted Places 2006

Overview
Sponsor a Site
Founder's Network
Global Database
Nominate a Site
Search & Statistics

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Basic Risk Assessment Process



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The Selection Process

The scoring system considered these criteria:

- The size of the affected population.
- Severity of the toxin or toxins involved.
- Impact of children's health and development.
- Evidence of a clear pathway of contamination.
- Existing and reliable evidence of health impact.

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Voting for Top Ten Most Polluted

- Focus mainly on developing countries with little money.
 - Over 300 nominations for polluted places, 35 were selected from which to develop the Top 10.
 - Most do not have multinational involvement.

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Diagnosis of Polluted Places: Complications

- Many of these places are not well known to outsiders, and many times forgotten by their own governments.
- Data difficulties
- Not "ranked" 1 though 10

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Diagnosis of Polluted Places: Complications

- The selected sites are *representative* of the scope and scale of sites that document the global span of such problems.
- Unfortunately they are by no means isolated or unique.

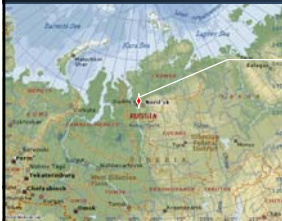
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Top Ten

- Dzerzhinsk, Russia
- Norilsk, Russia
- Rudnaya Pristan, Russia
- Chernobyl, Ukraine
- Mailuu-Suu, Kyrgyzstan
- Ranipet, India
- Linfen, China
- La Oroya, Peru
- Kabwe, Zambia
- Haina, Dominican Rep.

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Norilsk, Russia



Potentially affected people:
134,000

Pollutants: SO₂, Sr-90, Cs-137
Type: Air, Water, Soil
Source: Platinum Plant, mills
Cleanup effort: Unknown
Active

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Norilsk, Russia

- World's largest heavy metals smelting complex; over 4 million tons annually of Cd, Cu, Pb, Ni, As, Se, and Zn are dispersed into the air.
- Since November 2001, Norilsk has been shut to foreigners
- One of 90 "closed towns" in Russia where Soviet-levels of secrecy persist.



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Norilsk, Russia

"Where the snow is black, the air tastes of sulfur and the life expectancy for factory workers is 10 years below the Russian average."

Health

- High respiratory diseases in children around this area

Cleanup Activity

- Unknown

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Haina, Dominican Republic



Potentially affected people:
85,000

Pollutants: Pb
Type: Soil
Source: Battery Recycling
Legacy
Cleanup effort: None

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Haina, Dominican Republic

- The contamination is caused by the past industrial operations of the nearby Metaloxa battery plant.

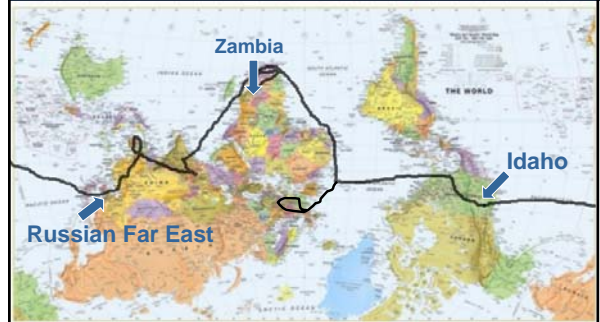


Health

- 1997 study: 5% with lead levels >79 µg/dL, and only 9% were under the WHO regulated 9 µg/dL.
- Birth deformities, eye damage, learning and personality disorders, and in some cases, death from Pb poisoning have been documented.

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Bunker Hill; Rudnaya Pristan, RFE; Kabwe, Zambia




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Bunker Hill; Rudnaya Pristan, RFE; Kabwe, Zambia

- Provide overview of the challenges of international environmental health problems.
- Discuss the role of the developed world in attacking these problems.

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	Idaho Bunker Hill 1974 Lead Levels	Current Standards
Children's Blood (µg/dl)	70	10
Ambient Air (µg/m ³)	17	1.5
Yard Soil (mg/kg)	7400	500-1000
House Dust (mg/kg)	12,000	500-1000

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Remediation of Yards



Remove "dirty" dirt



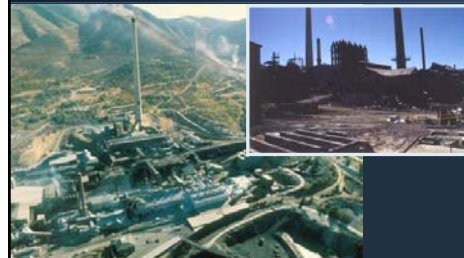
"Clean" yard



Replace with clean dirt

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Industrial Complex Demolished



Lead Smelter

Smelter
Demolition

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Conversion from Mining Town to Ski Resort

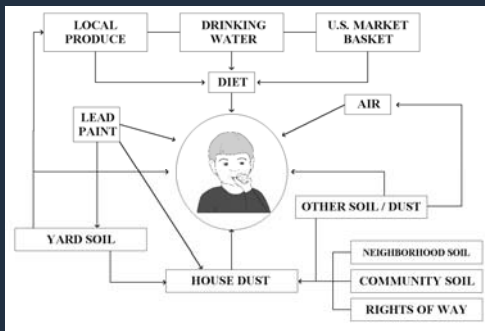


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Success at Bunker Hill

- Involvement of families, NGOs, and community leaders
- Scientists
- Risk-Based Cleanup: Solve health problems by understanding pathways of exposure and engineering remedies
- Economic development
- Ecological restoration
- \$500M (from legal actions against mining companies & gov't); expect \$350M more

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Rudnaya Pristan, Russia



Potentially affected people:
90,000

Pollutants: Pb
 Type: Soil
 Source: Lead mining
 Cleanup effort: None
 Legacy and Active

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Rudnaya Pristan, Russia

Soviet era lead smelter



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Far East St. Univ.
 Pac. Geog. Inst.
 Dalpolymetal Inc.
 Electrozarid Inc.
 International Lead Mngmt. Center
 Univ. of Idaho
 TerraGraphics
 Env. Engr., Inc.

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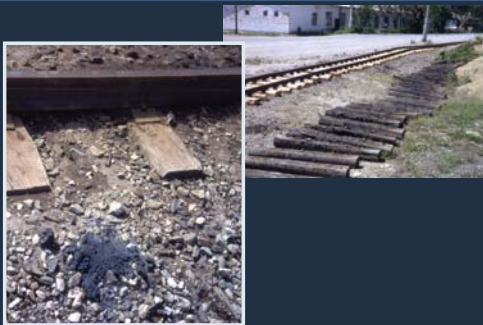
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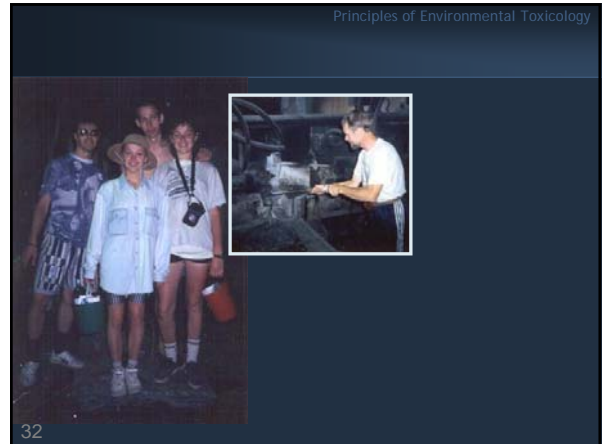
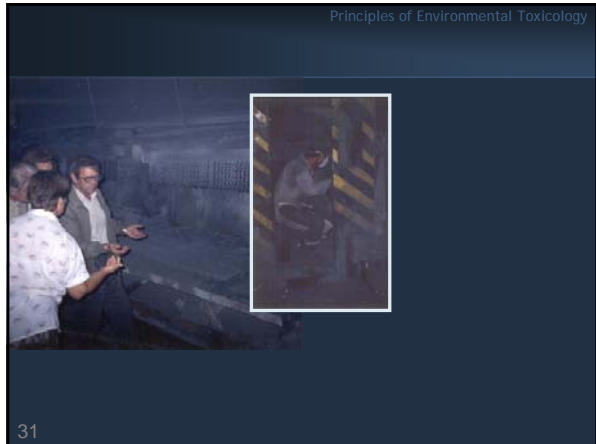
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Principles of Environmental Toxicology

Historical (Soviet Era) Studies

- Outside of smelter complex
- Metals levels: leaves, mollusks, sediments, precipitation, agric. products, soil, ambient air
- Dietary supplements (algal chelation)
- Not: air stack emissions, lead levels in workers or residents (“Soviet company is in compliance”)

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Principles of Environmental Toxicology

Natural Cleansing: Long Term Cycles

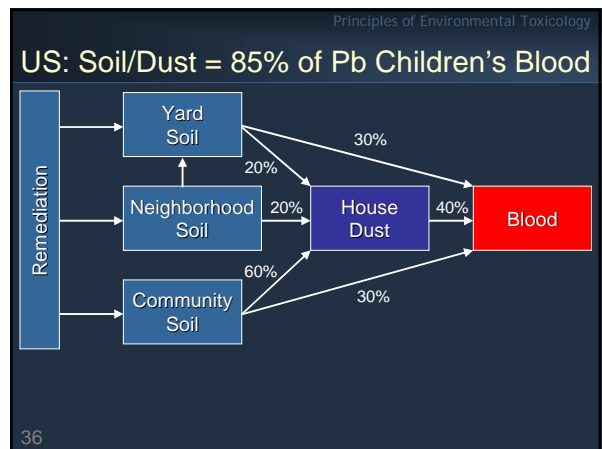
CONCLUDED:

- 1000's years to “clean”

DECIDED:

- Relocate residents
- Dietary supplements
- Demolish and rebuild smelter
- Then...1989

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Rudnaya Pristan, Russia Soil Pb

	Min mg/kg	Avg mg/kg	Max mg/kg
Gardens	476	2095	4310
Yards	896	2241	4610
Roadsides	2020	6119	22,900
Railroad	24,400	59,375	95,000
Beaches	610	3405	6200
River Banks	464	591	656



Rudnaya Pristan, Russia

- BLL: 1.6 – 56.7 ug/dl (avg. = 12.4 ug/dl)
- Potatoes grown in contaminated soil = 50% caloric intake.
- Educational programs in schools and health centers.




Future Needs/Plans

- Consider options to sever pathways
- Industrial modernization or demolition
- Revegetation
- Stable community
- Community education




Principles of Environmental Toxicology

Kabwe, Zambia



Potentially affected people:
250,000



Pollutants: lead
Type: Soil
Source: lead mine, smelter
Legacy
Cleanup effort: Early progress


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Principles of Environmental Toxicology



Kabwe, Zambia

Health

- On average, children's blood levels in Kabwe are 5 to 10X allowable levels.



Principles of Environmental Toxicology






Principles of Environmental Toxicology





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Principles of Environmental Toxicology

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Principles of Environmental Toxicology

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Kabwe, Zambia

Cleanup Activity

- NGO, Kabwe Environmental and Rehabilitation Foundation (KERF) for educational services.
- World Bank \$20 million grant, completed the scoping study, and initial clean-up begins 2007.

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Commitment to Success at Bunker Hill

- Risk-Based Cleanup
 - Solve health problems
 - Understand pathways
- 25 years
- \$500M to date; \$350M more expected
- Lessons Learned?

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Receptors, Pathways, and Technology



Lessons Learned

- Different sources – and quantities - of capital
- Legal systems
- Public “Interest”
 - Perception of “Rights” for health damages
 - Concern for health is universal
 - Involvement varies – activism, hopelessness, not apathy
- Need for local expertise
 - work on the next generation
- Level of technology, maintenance issues

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Science Needs for Understanding Pathways

- Sampling techniques
- Fate and transport of contaminants
- Barriers
- Environmental Media Modeling
- Ecotoxicology
- *In situ* groundwater passive treatment

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International Environmental Challenges

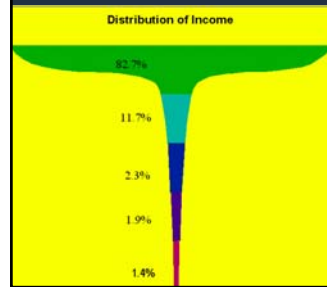
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- Need for local expertise
 - work on the next generation
- Level of technology, maintenance issues

The role of the developed world in attacking these problems

The majority of the world's population has little influence on regulation of the environment and quality of life.



The developed world controls the majority of resources required for development (i.e., raw material, energy and food surpluses) as well as the science, information sources and weapons.



Trends

- Collapse of colonialism
- Industrialization
- Multinational businesses
- Climate change, pollution, scarce resources --- pressures from socio-economic divisions, political conflicts

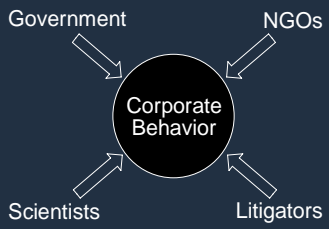
Key Players

- Local Communities
- Educational institutions
- NGOs
- Attorneys & legal system
- Health officials
- Scientists, engineers
- Importance of Networks



Primary Lessons Learned

- Do not underestimate what is possible
- Requires continual pressure
- Success drove industry overseas



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