

SAND2012-7127C

Inherent Safety - Risk and Regulation

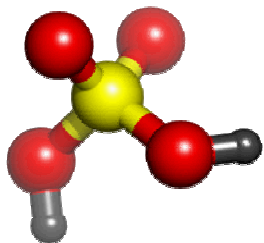
Nairobi, Kenya
September, 2012



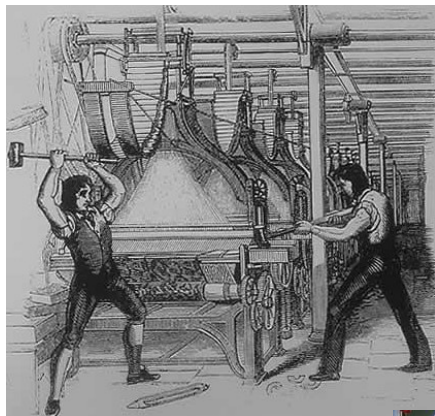
SAND No. 2012-7127C

Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.





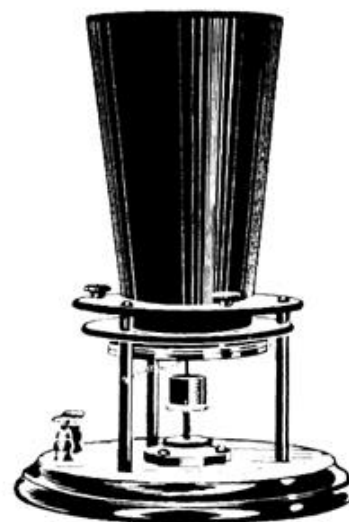
The world and its inventions are always changing



Luddite loom smashing



Rapier weaving machine

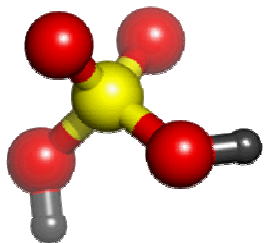


1876 - Bell's original telephone



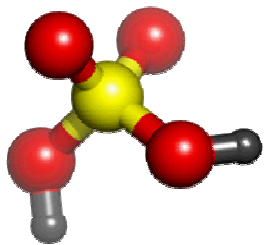
Smart phone

Photo Credits: Wikipedia – public domain



Chemical management is necessary to society

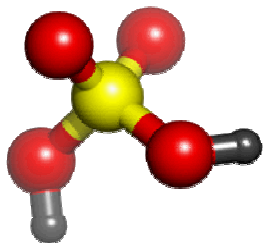
- ▶ New chemicals and chemical industries are part of modern life.
- ▶ Chemicals can provide an increased quality of life and an increased length of life
- ▶ Chemical hazards can also cause health and environmental damage.
- ▶ Informed chemical regulation can enhance the safety and security of chemical usage



Regulations are informed by natural science and public opinion

- Change must be managed
- Tradeoffs must be measured

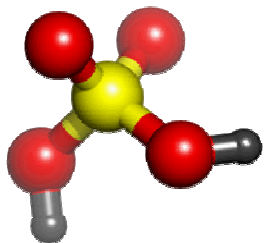




Economic trade and regulations are important factors

Discussion

- Can you give an example of unintended consequences due to trade practices?
- Can you give an example of unintended consequences due to regulations?
- What is risk transfer?



Examples of environmental risk transfer and unintended consequences

Transboundary shipment of waste

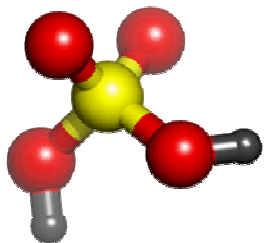
Cement production in Europe vs North Africa

Palm oil production for transboundary biofuel

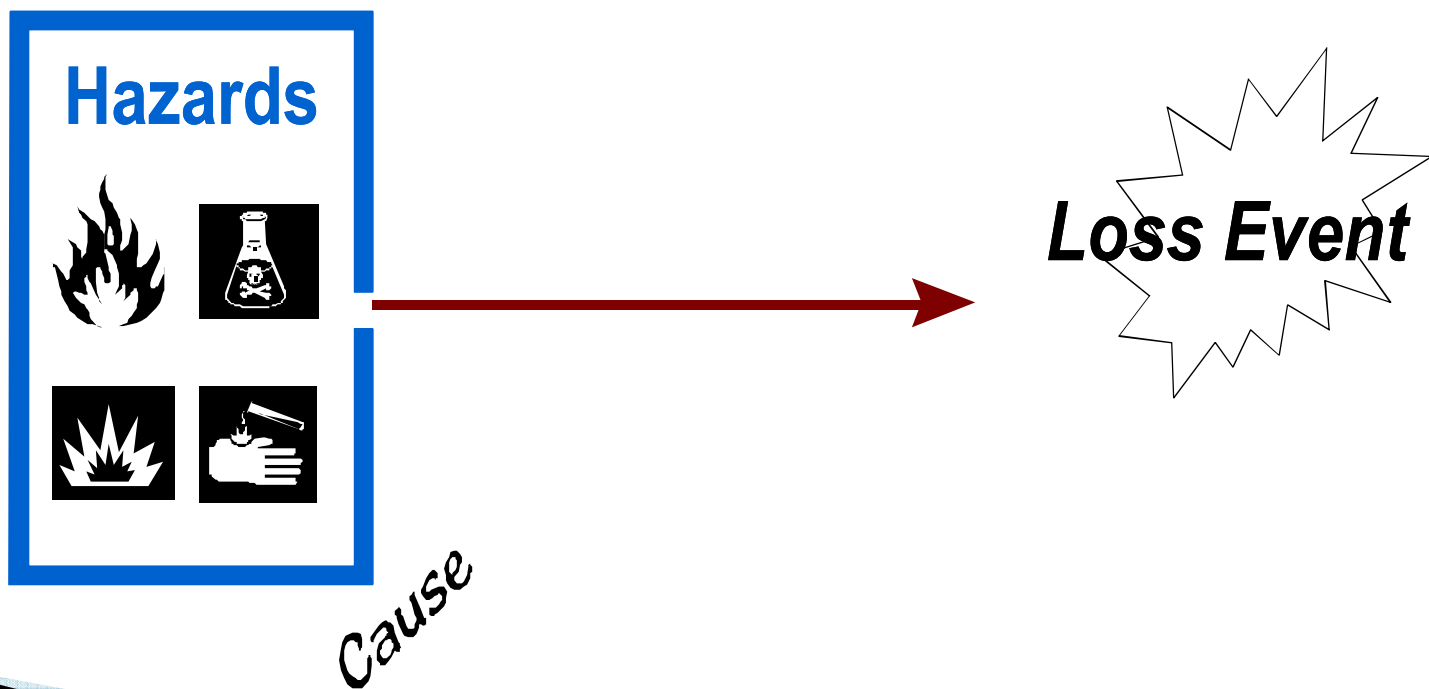
Ethanol fuel production from corn

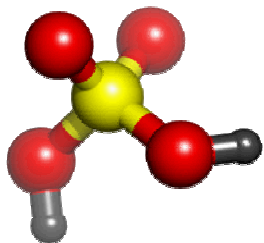
E-waste export and recycling

Risk can be transferred to a place where the ultimate risk increases or even decreases

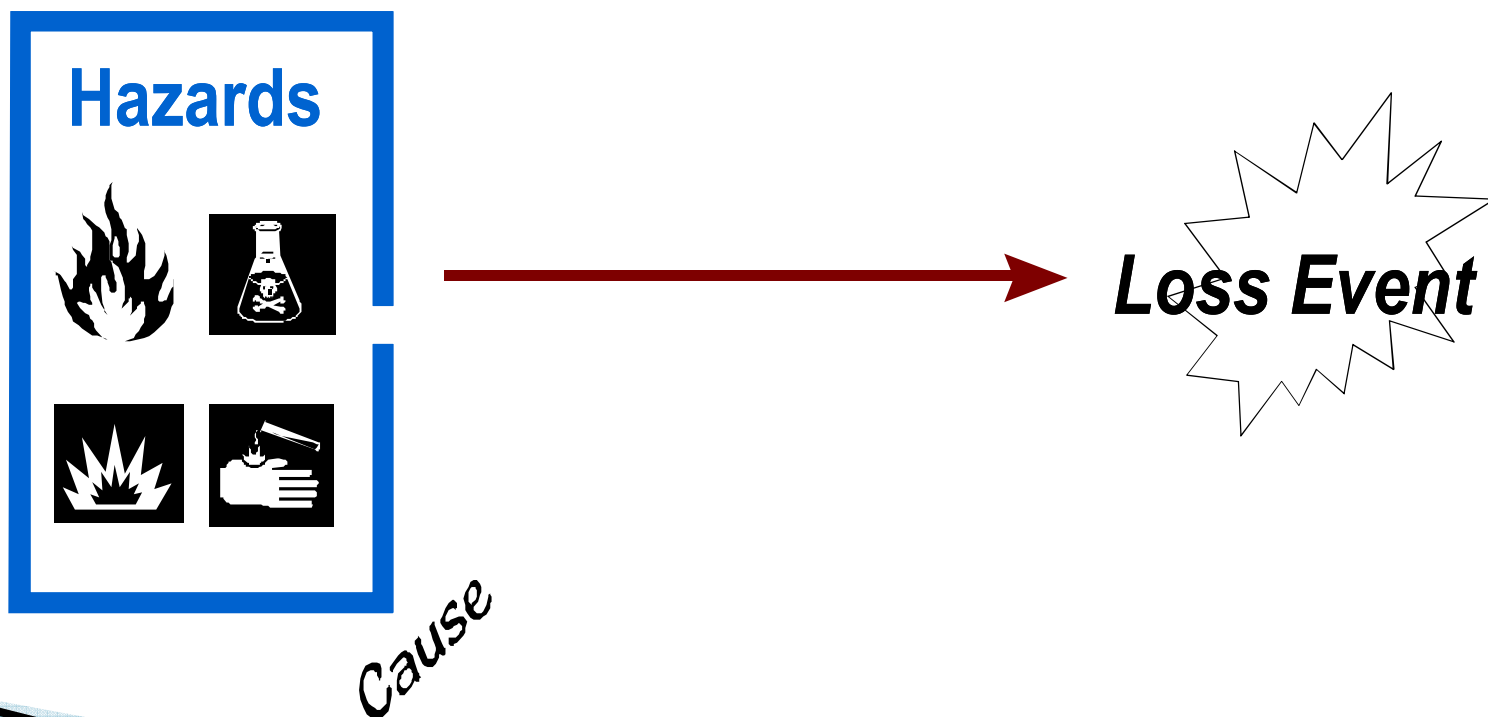


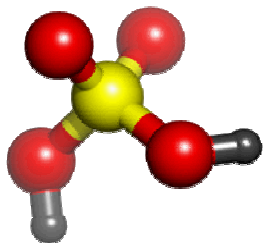
Risk increases with increasing hazard



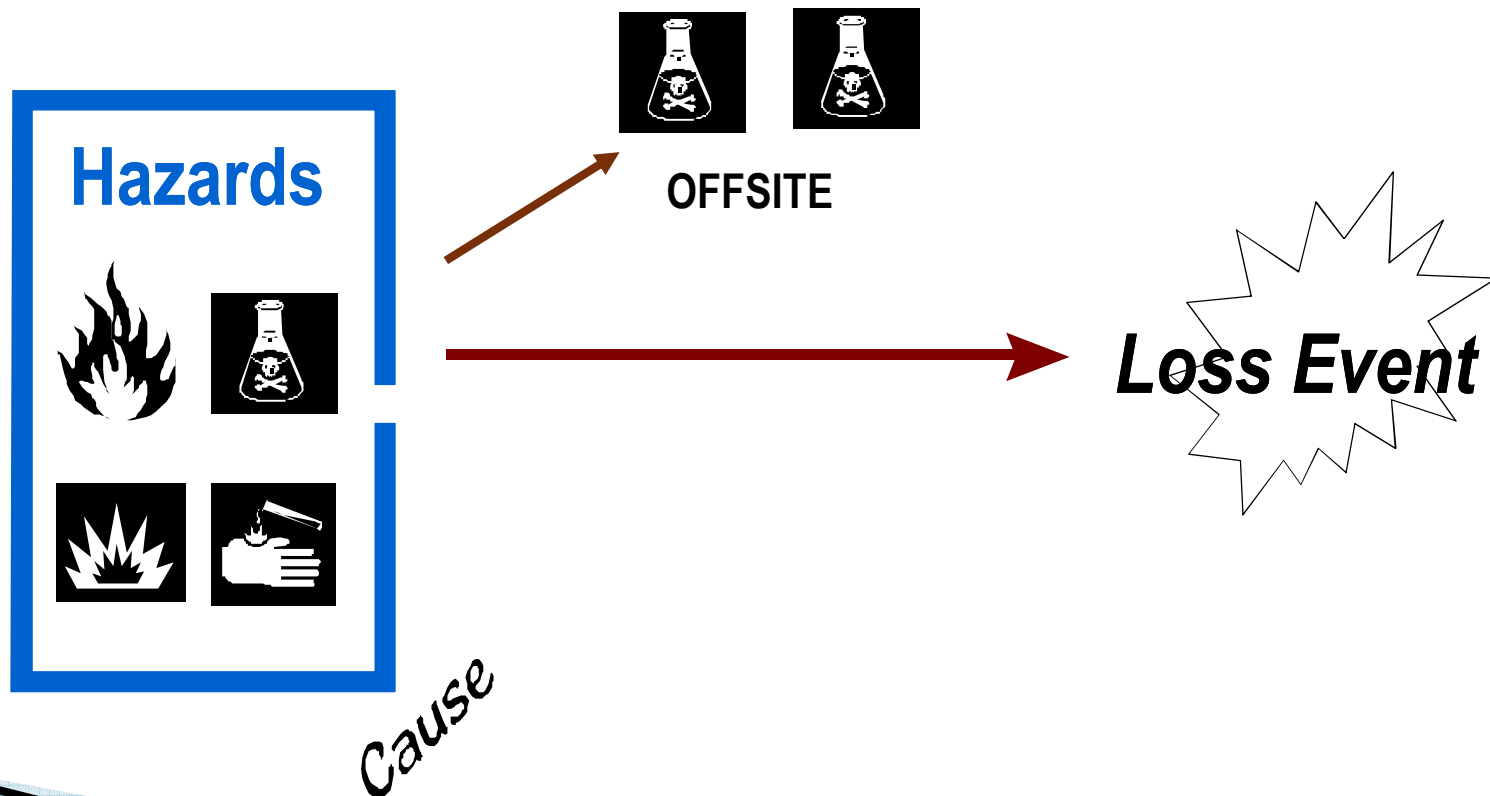


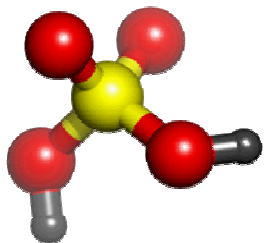
Risk decreases with decreasing hazard



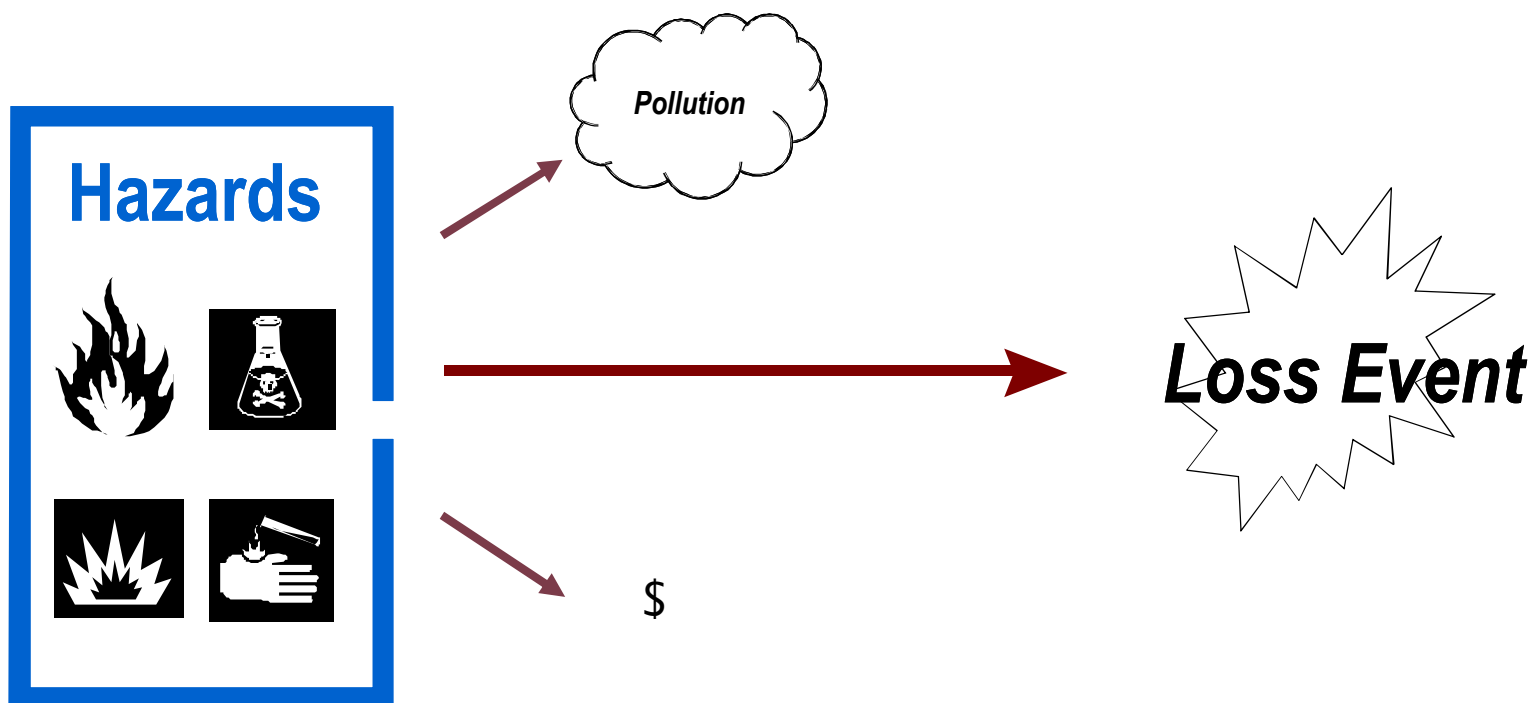


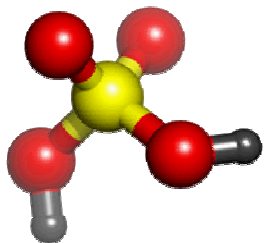
Risk can be transferred from one place to another





Risk can be transferred from one type to another





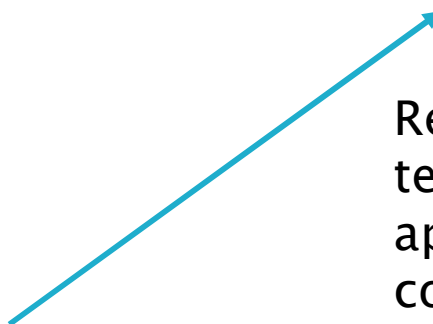
The natural history of a technology



Discovery of benefit—
widespread adoption



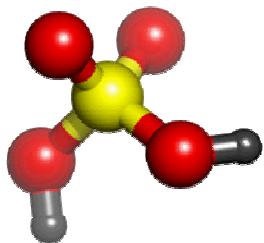
Problem discovered –
legislation to limit or
eliminate



Re-adoption of
technology with
appropriate
control (or
alternative found)

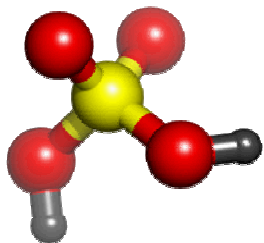


Elimination may result
in risk transfer or lost
opportunity

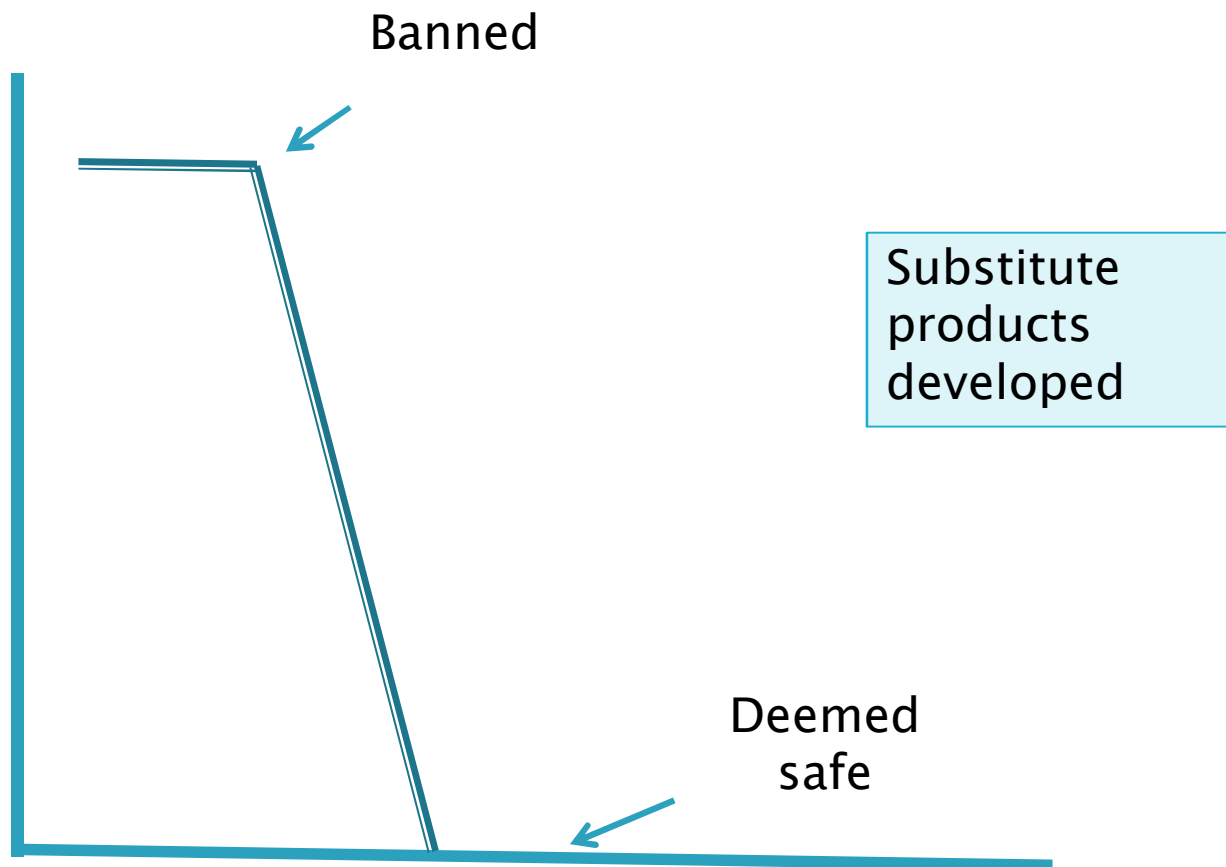


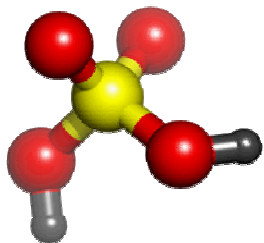
Discussion question

- ▶ Can you identify a particular chemical that was accepted by society and then determined to be hazardous ?
 -
 -
 -
- ▶ What was eventually done?



Cyclamates (artificial sweetener)

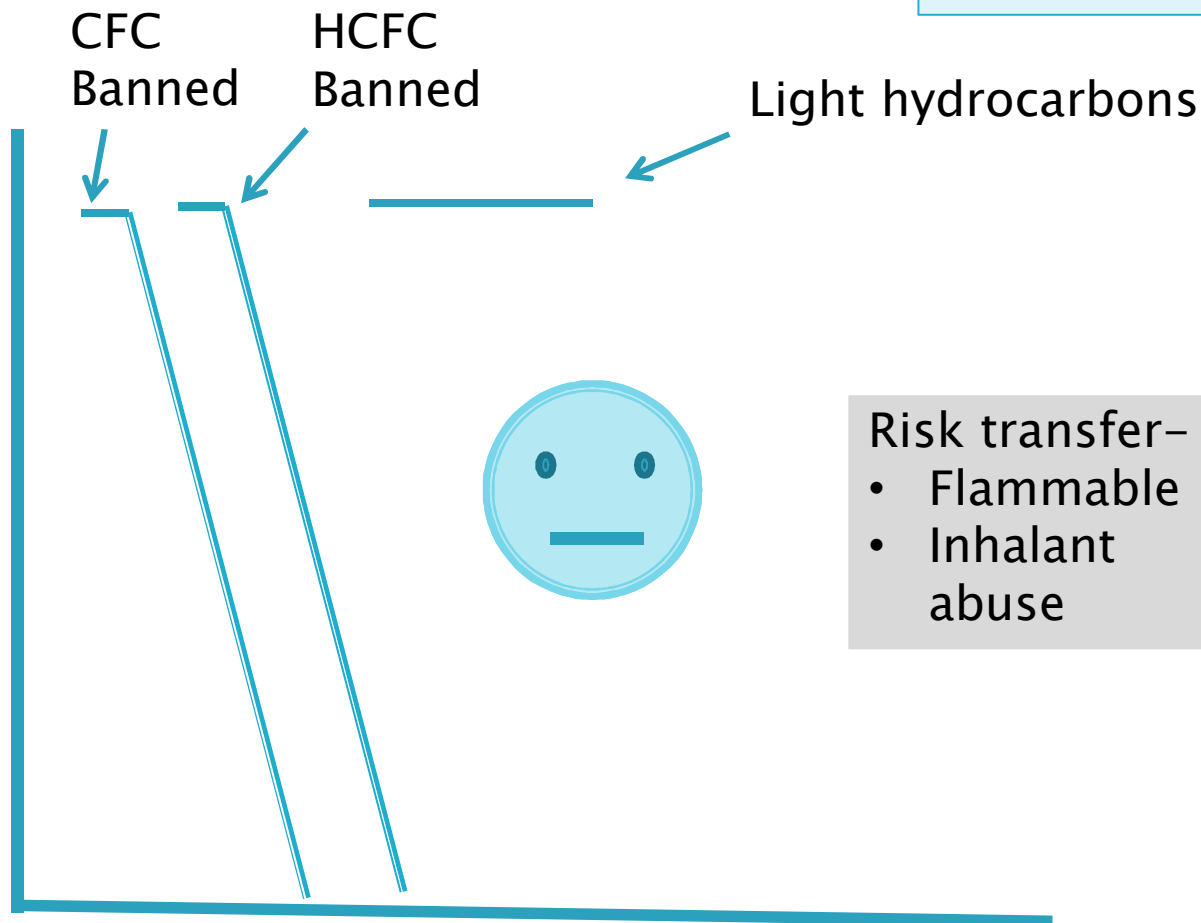


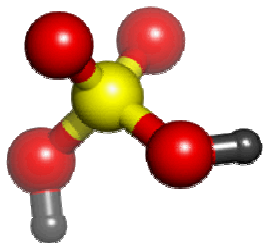


Propellants (spray can)

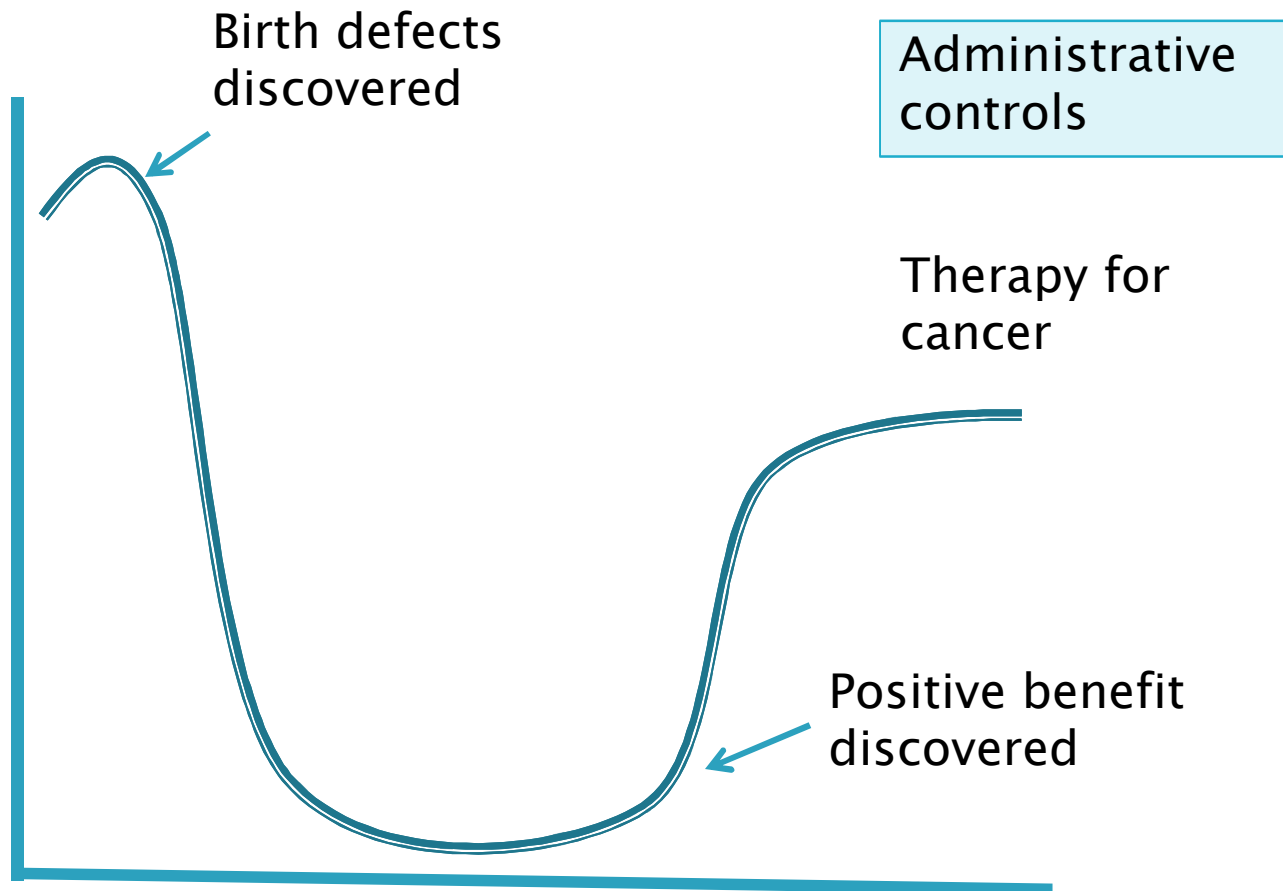
Substitution

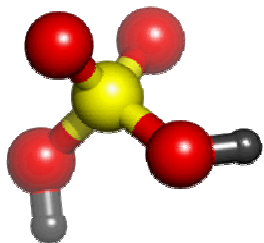
Montreal Protocol



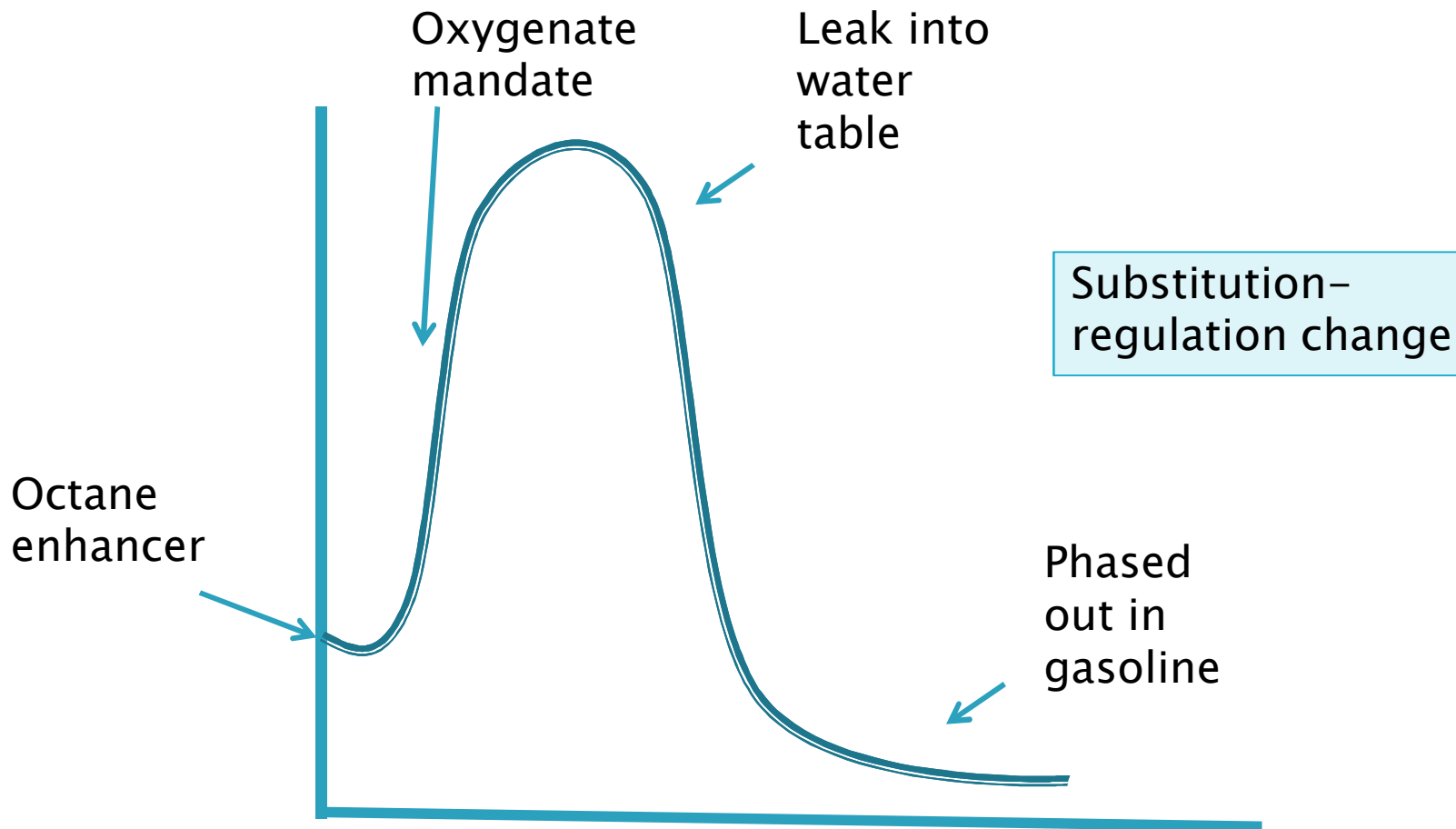


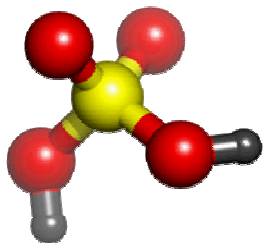
Thalidomide (therapy drug)



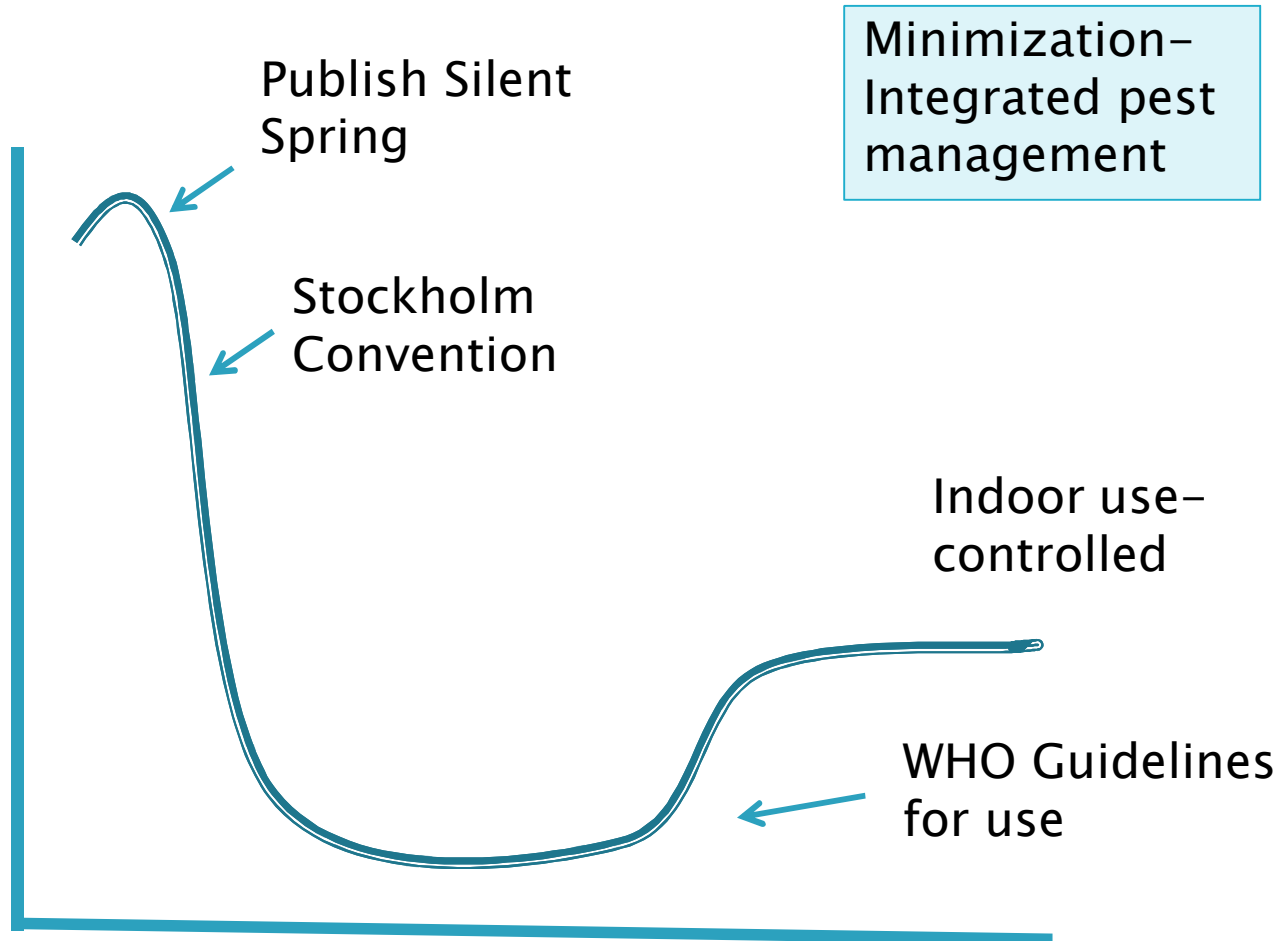


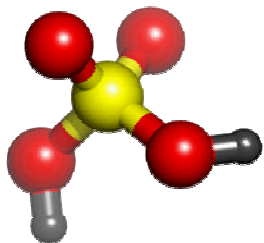
MTBE (gasoline additive)



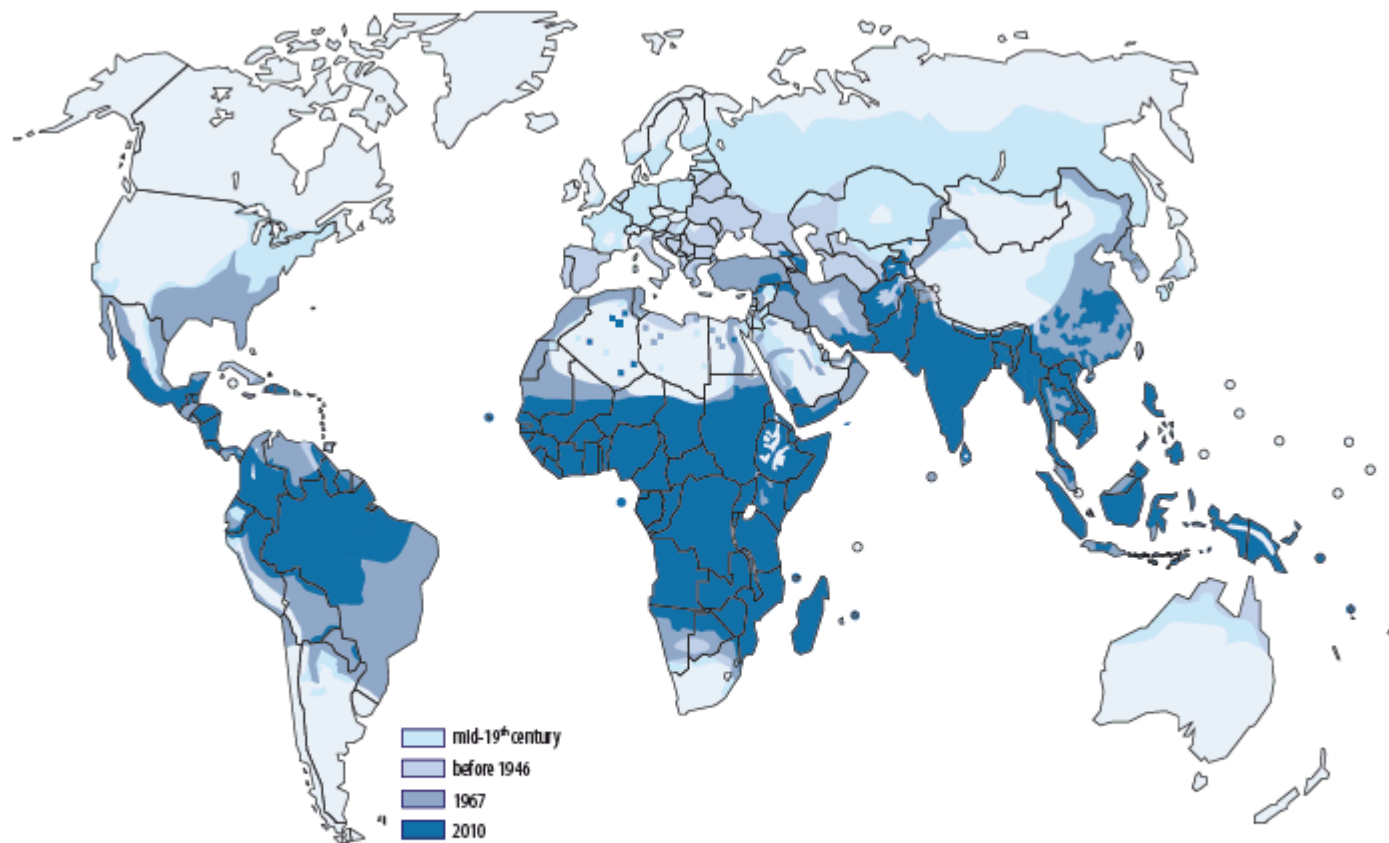


DDT (pesticide)



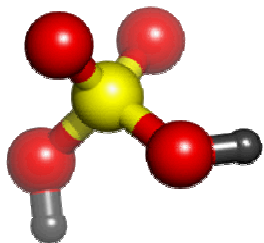


Malaria has retreated in the world

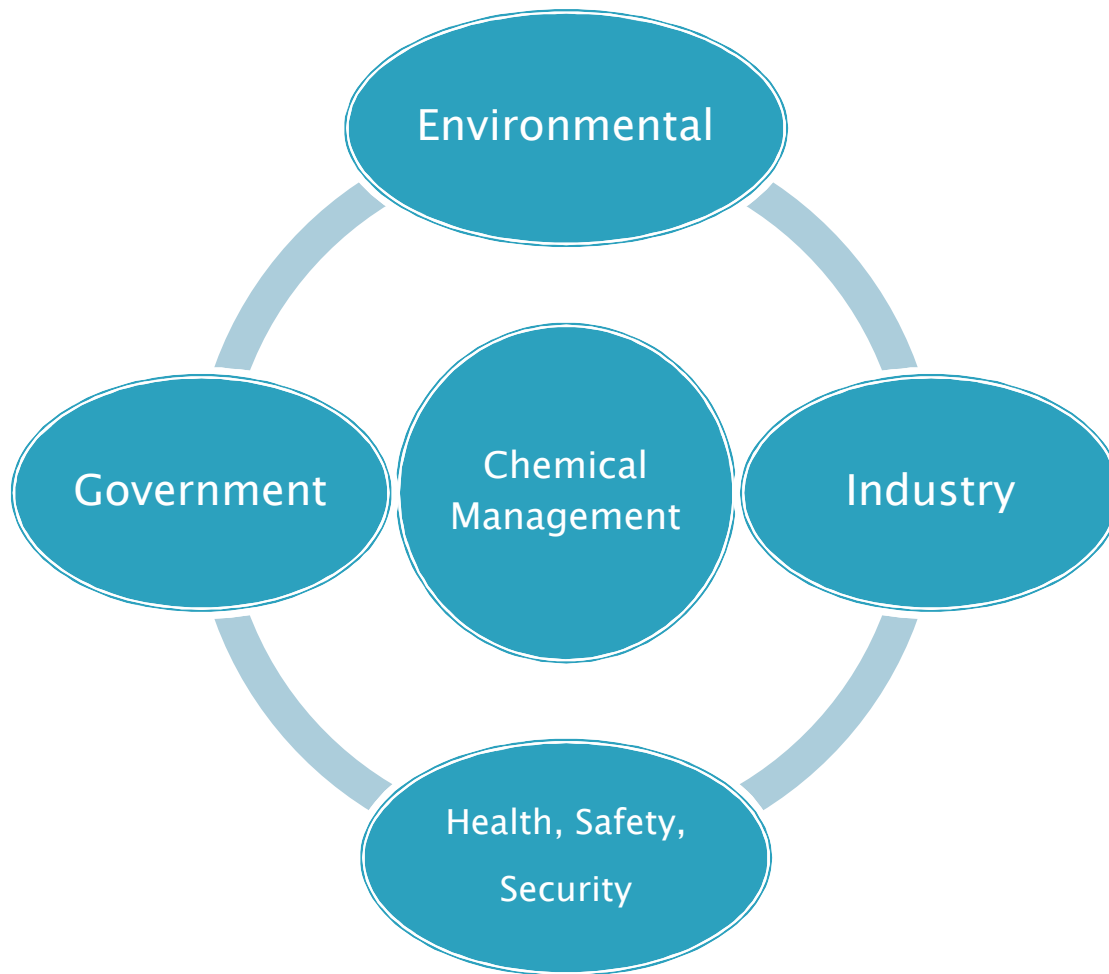


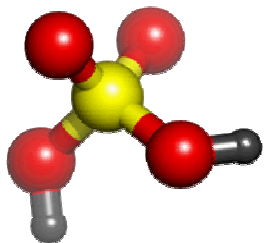
Note: This composite map does not claim to be complete. It is intended to illustrate where malaria transmission existed over the years.

Source: Mendis K, et al and WHO.



Regulation results in mandatory and voluntary improvement

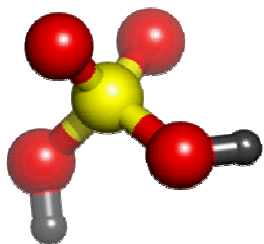




Various stakeholders in the chemical enterprise

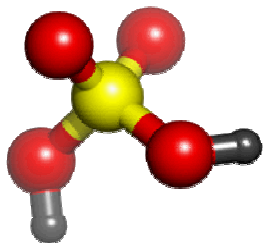
Government	Trade Associations	Professional Societies	NGO – Environmental
EPA, DHS, OSHA	ICCA, ACC, SOCMA	AIChE, ACS, RSC	Various
Legislation, implementation	Advocacy, implementation	Science, engineering	Advocacy
Compulsory – TSCA, SARA	Voluntary– Responsible Care	Voluntary	Voluntary

International Bodies –WHO, UNEP, FAO, OECD, ECHA



Regulation must also consider security (dual-use chemicals)

Chemical	Legitimate use	Illegitimate use
Ammonium Nitrate	Fertilizer, Explosive	Improvised Explosive
Sodium Cyanide	Mining, Jewelry	Poisoning, Coral reef fishing
Pseudoephedrine	Medicine	Drug making
Chlorine	Chemicals, disinfection	Poisoning



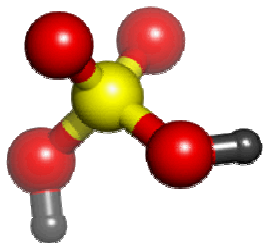
Dual-use chemical example: Pseudoephedrine

- ▶ Common ingredient in cold medicines
- ▶ Precursor to crystal methamphetamine
- ▶ Recipes on web



- ▶ Clandestine meth labs in US, 2002
 - ▶ -Caused 194 fires, 117 explosions, and 22 deaths
 - ▶ -Cost \$23.8 million for cleanup

US DEA, http://www.deadiversion.usdoj.gov/pubs/brochures/pseudo/pseudo_trifold.htm, viewed Dec 2007

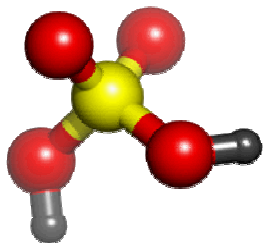


Pseudoephedrine – Regulation / Voluntary

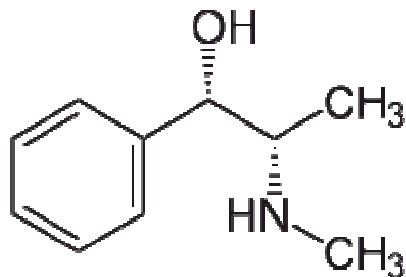
The two key precursor chemicals used in methamphetamine production, ephedrine and pseudoephedrine are not under international controls. However, they are included in a special monitoring list of chemicals not included in the 1988 UN Convention, but for which substantial evidence exists of their use in illicit drug manufacture. – 2012 International Narcotics Control Strategy Report

FDA continues to consider NDA-approved and over the counter monograph products containing pseudoephedrine as safe and effective for their intended uses. Measures restricting the sale of pseudoephedrine to achieve important public safety goals that would result from reduced product misuse should be balanced with the need to maintain access for legitimate use. –U.S. Senate Testimony– Dr. Charles Ganley – 2010

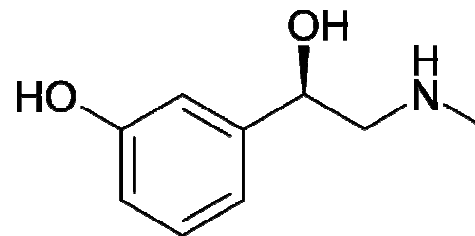
<http://www.state.gov/j/inl/rls/nrcrpt/2012/>



Pseudoephedrine – IST-Substitution



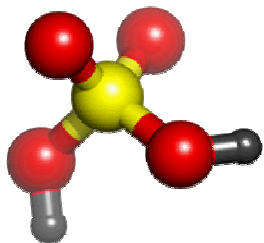
Pseudoephedrine



Phenylephedrine



The substitute is less effective because it is broken down in the stomach



Dual-use chemical example: Cyanide



Therence Koh/AFP/Getty Images

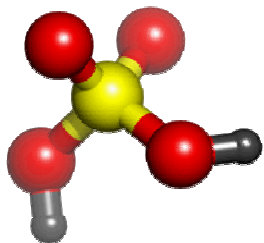


Wikipedia

- ▶ Widely used in mining and metal plating industries, but is also a well known poison.
- ▶ Product tampering–Tylenol capsules
- ▶ Used for illegal reef fishing
- ▶ Popular with criminals and terrorists because it is relatively easy to obtain
- ▶ HCN is CW agent AC



Cyanide fishing: squeeze bottle – ian.umces.edu/imagelibrary/



Cyanide Code - Voluntary

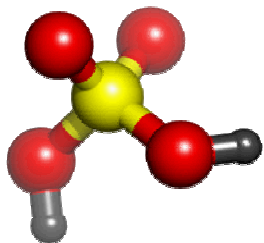
The "International Cyanide Management Code For The Manufacture, Transport and Use of Cyanide In The Production of Gold" is a voluntary industry program for the gold mining industry to promote:

- Responsible management of cyanide used in gold mining
- Enhance the protection of human health, and
- Reduce the potential for environmental impacts.

Signatories to the Cyanide Code must be audited by an independent third party to demonstrate their compliance with the Cyanide Code.

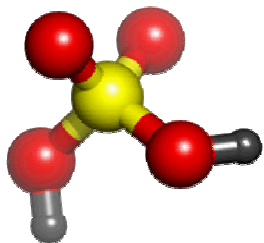
Audit results are made public.

<http://www.cyanidecode.org/>



Cyanide Mining- Regulation

[European Directive 2006/21/EC](#) on the management of waste from extractive industries. Article 13(6) requires "the concentration of weak acid dissociable cyanide in the pond is reduced to the lowest possible level using best available techniques", and at most all mines started after 1 May 2008 may not discharge waste containing over 10ppm weak acid dissociable (WAD) cyanide, mines built or permitted before that date are allowed no more than 50ppm initially, dropping to 25ppm in 2013 and 10ppm by 2018.



Cyanide IST

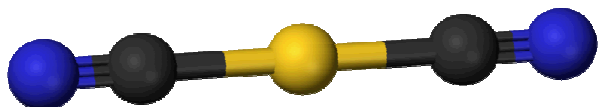
Substitution-Minimization

Gold Mining

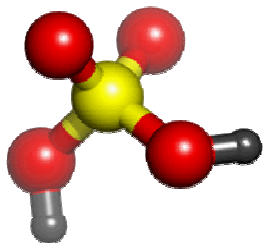
- Thiosulfate
- Proprietary Extraction

Metal Plating

- Reduce concentration
- ZnCN with ZnCl
- CuCN with CuSO₄



There are no easy substitutes for cyanide in mining gold or in some metal finishing applications.

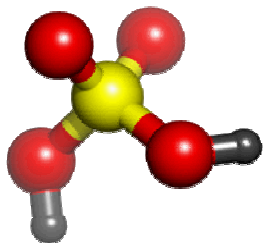


Dual-use chemical example: Fertilizer bomb



Photo: US DOD

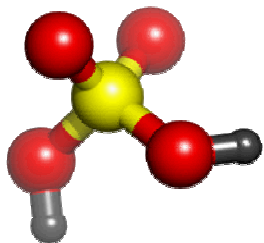
- ▶ Ammonium nitrate fertilizer and fuel oil (diesel, kerosene)
- ▶ Used to bomb building in Oklahoma City, OK, USA–April 1995
 - with nitromethane and commercial explosives
 - 168 dead, including children
- ▶ Favored by IRA, FARC, ETA, etc.



Ammonium nitrate : regulation

Proposed Rule: Ammonium Nitrate Security Program
Published August 3, 2011. Under the proposed rule, the Department of Homeland Security would regulate the sale and transfer of ammonium nitrate pursuant to section 563 of the Fiscal Year 2008 Department of Homeland Security Appropriations Act with the purpose of preventing the use of ammonium nitrate in an act of terrorism.

<https://www.dhs.gov/files/laws/ammonium-nitrate-regulations.shtm>



Ammonium nitrate : ISD Substitution

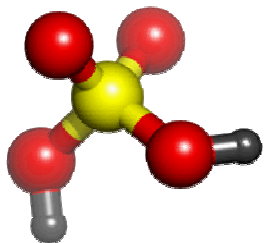
Fertilizer substitute

- Polymer coated urea
- Sulf-N[®] 26 -Ammonium nitrate/sulfate

Substitutes for ammonium nitrate are not possible for explosives applications

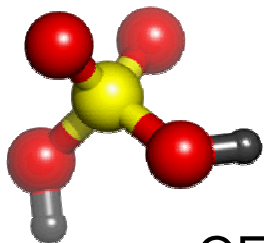


Slow release polymer coated urea



Some resources

- ▶ E-Chemportal – Global Information on Chemical Substances
http://www.echemportal.org/echemportal/index?pageID=0&request_locale=en
- ▶ National Environmental Methods Index
<https://www.nemi.gov/apex/f?p=237:1:1214478717879985>
- ▶ Organisation for the Prohibition of Chemical Weapons
<http://www.opcw.org/>



Some resources

- ▶ OECD- Environment, Health and Safety Publications

<http://www.oecd.org/env/chemicalsafetyandbiosafety/environmenthealthandsafetypublications.htm>

- ▶ UNEP Flexible Framework for Addressing Chemical Accident Prevention and Preparedness – A Guidance Document

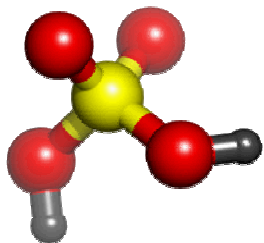
http://www.unep.fr/scp/sp/saferprod/pdf/UN_Flexible_Framework_WEB_FINAL.pdf

- ▶ U.S. Chemical Safety Board

<http://www.csb.gov/>

- ▶ Center for Chemical Process Safety

<http://www.aiche.org/ccps/>



Discussion topic

How can we measure tradeoffs when designing chemical legislation?

What practical legislative steps can be taken for chemical security?

