

Horizon Scanning: Identifying emerging chemical issues & trends



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What is horizon scanning?

The systematic search for incipient trends, opportunities, challenges and constraints that might affect the probability of achieving societal goals and objectives, such as those related to the maintenance of public health and sustainable ecosystems (Depledge, 2012, modified from Sutherland, *et al.*, 2012).



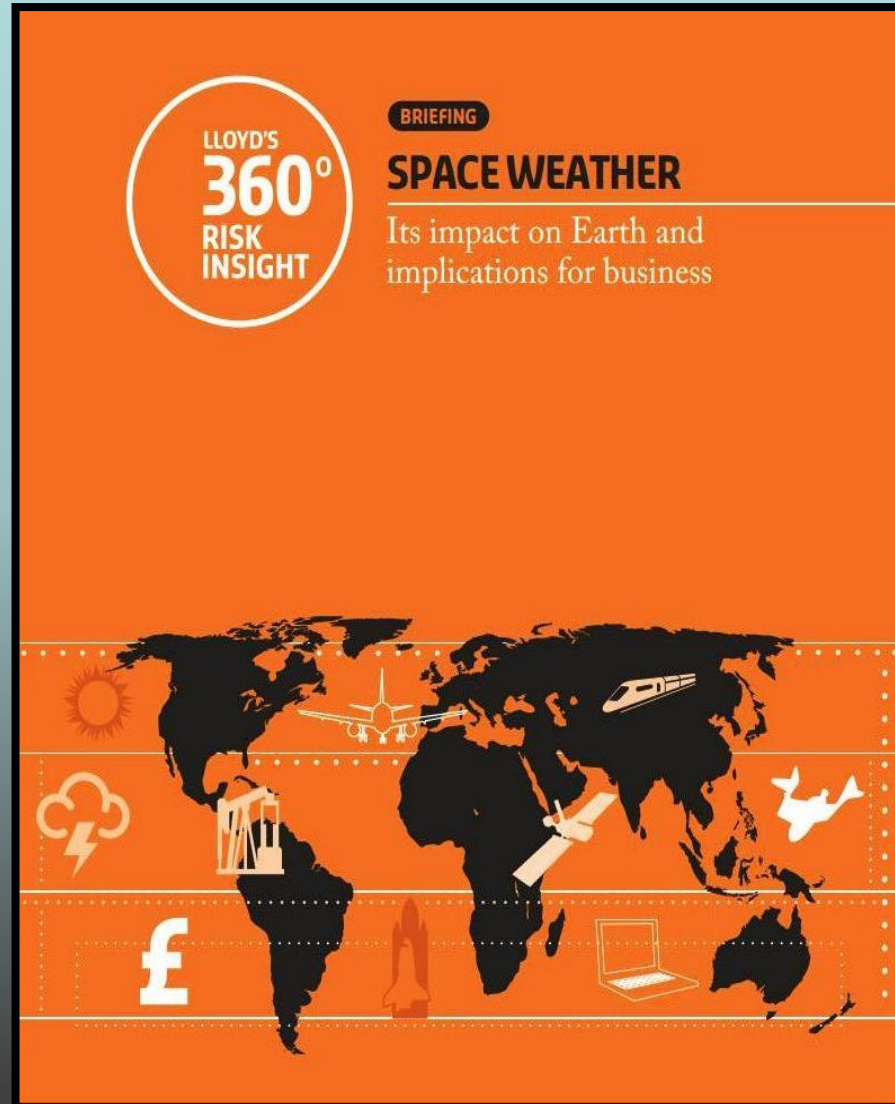
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Approaches to Horizon Scanning

- **Conventional Delphi Approach:**
Emerging issues identified through meetings & informal networking.
- **Web-based approach:**
Emerging issues are identified through the World Wide Web.
- **Combined Delphi & Big Data approach:**
Augments personal interaction with the use of electronic information sources (WWW), social media, blogs, NLP, diverse data sources.



Lloyd's Emerging Risks Group



A comparison of conventional and web-based approaches

	Lloyd's Emerging Risks Group	
	Very relevant	Relevant
Week 1	3	1
Week 2	2	1
Week 3	0	1
Week 4	3	1



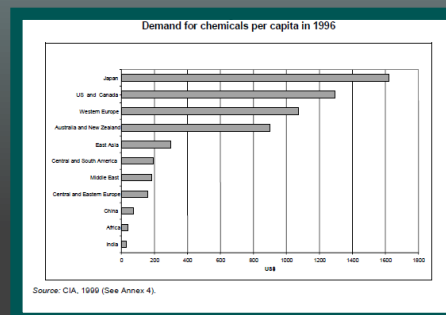
A comparison of conventional and web-based approaches

	Lloyd's Emerging Risks Group		Exeter 's Web-based Horizon Scanning	
	Very relevant	Relevant	Very relevant	Relevant
Week 1	3	1	29	66
Week 2	2	1	19	64
Week 3	0	1	11	74
Week 4	3	1	5	74

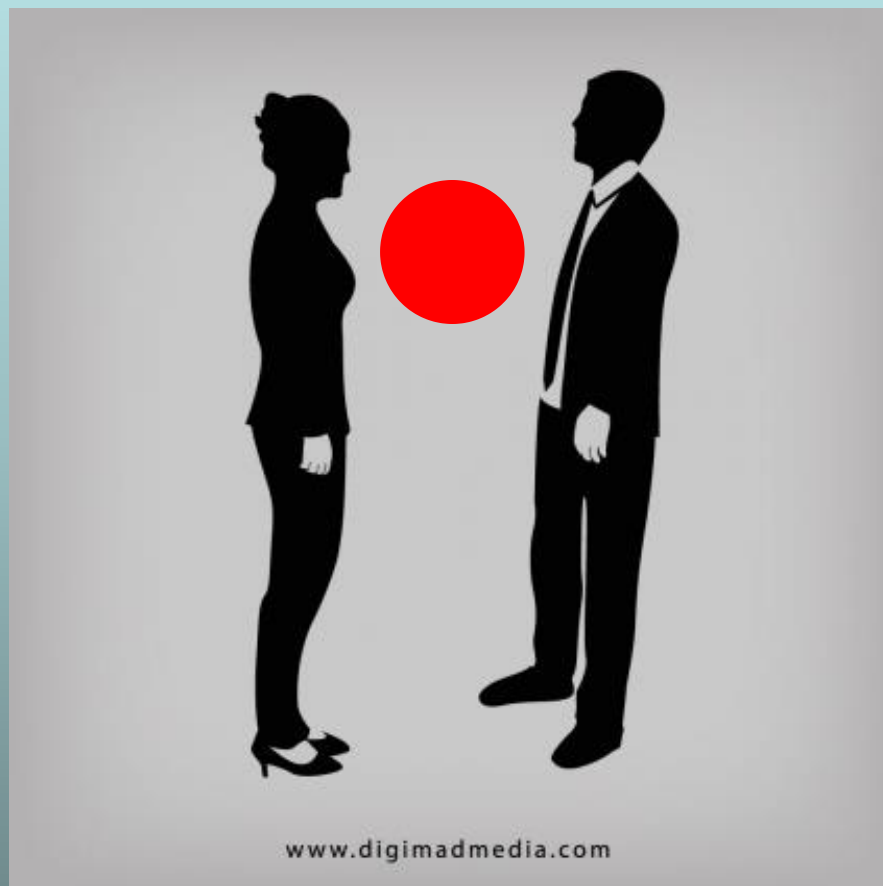


A photograph of three baboons resting on a rocky ledge. The baboon in the center is looking towards the camera, while the other two are looking away. They have reddish faces and chests and are surrounded by a blue sky and some greenery in the background.

- FCC(F)(F)C(F)(F)C(F)(F)C(F)(F)C(F)(F)C(=O)O
-
- A skeletal structure diagram of perfluorooctanoic acid (PFOA). The molecule consists of a straight chain of eight carbon atoms. The first seven carbons are fully fluorinated, each bonded to two fluorine atoms. The eighth carbon is part of a carboxylic acid group, double-bonded to an oxygen atom and single-bonded to a hydroxyl (-OH) group.



Global Chemical Production



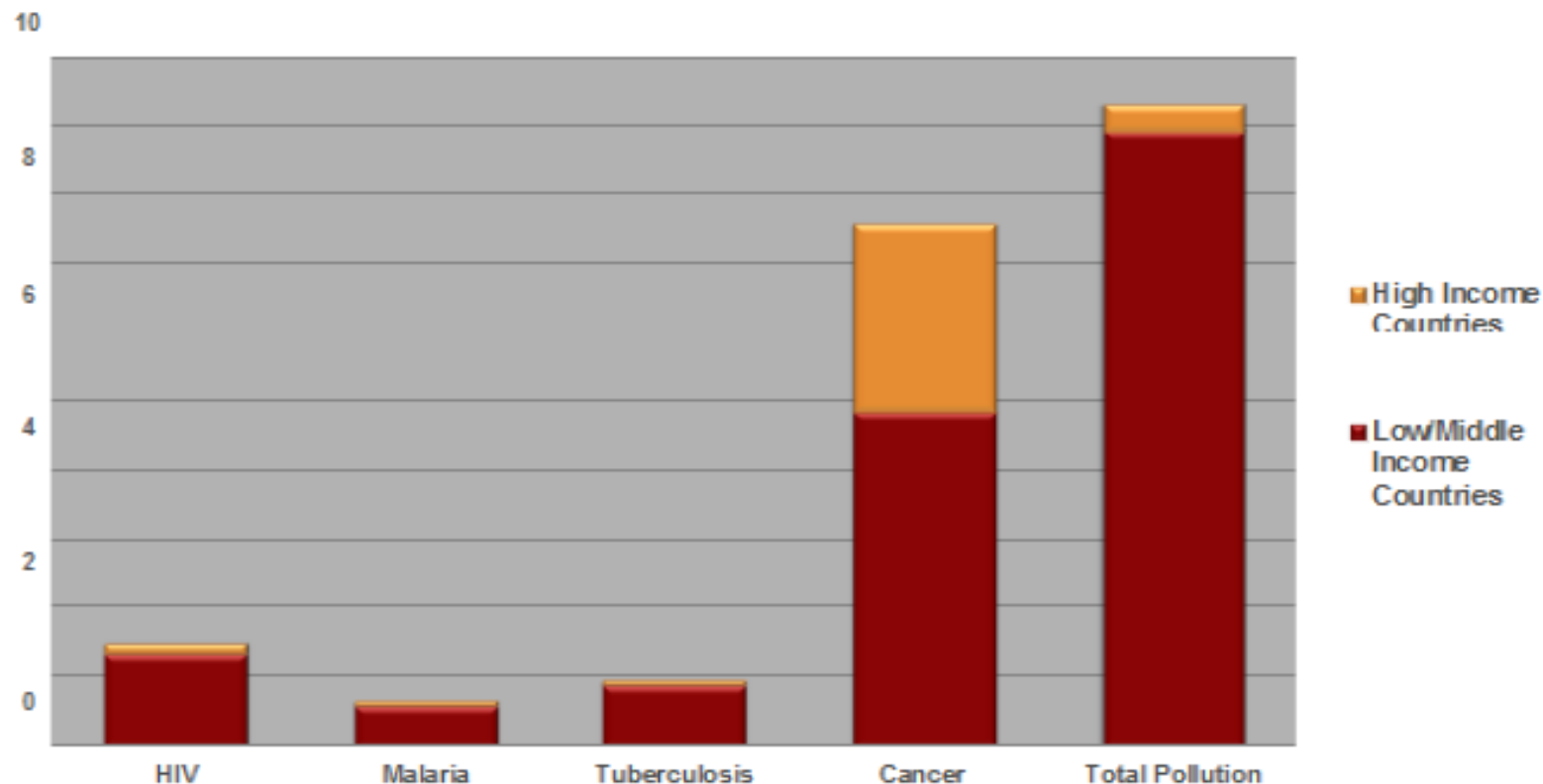
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Chemical Pollution and Disease

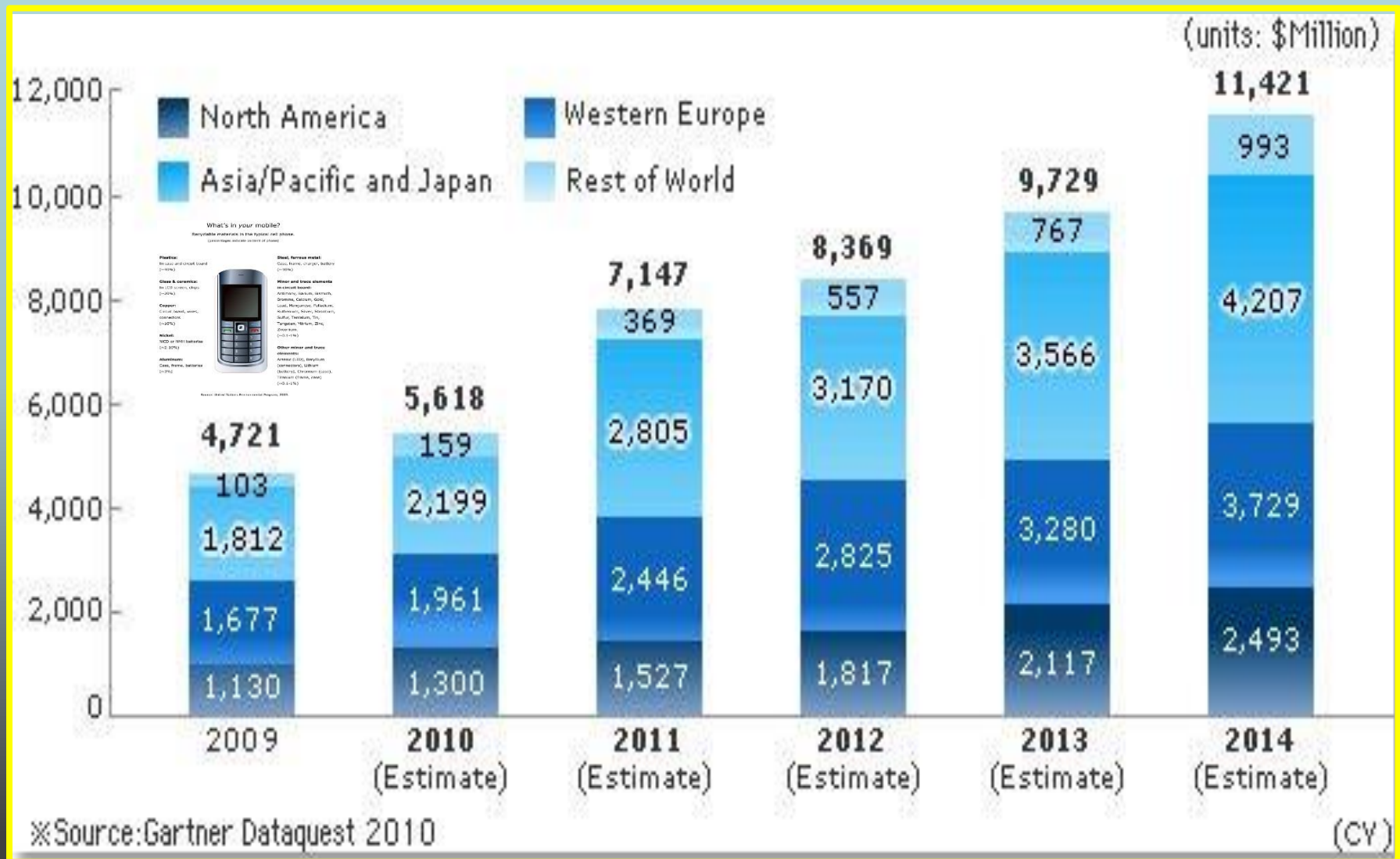
World – Millions of Deaths-2012



Source: WHO and GAHP databases



Smart Phone Sales



Body Burdens of Contaminants: Today and Tomorrow

Selenium

Exposure to high concentrations causes Selenosis, which can cause hair-loss, nail brittleness, and neurological abnormalities (i.g. numbness and other odd sensations in the extremities).¹²

Beryllium

Exposure can cause lung cancer and chronic Beryllium disease. Symptoms of chronic beryllium disease include: breathing difficulties, coughing, chest pain, and general weakness.

Mercury

Exposure through ingestion or inhalation can cause central nervous system damage and kidney damage.¹

Chromium (IV) - Hexavalent Chromium

Exposure can cause strong allergic reaction (linked to Asthmatic Bronchitis) and DNA damage to cells. Workers are exposed at disposal stage and Chromium (IV) can also be released into the environment from landfills and incineration.¹

Arsenic

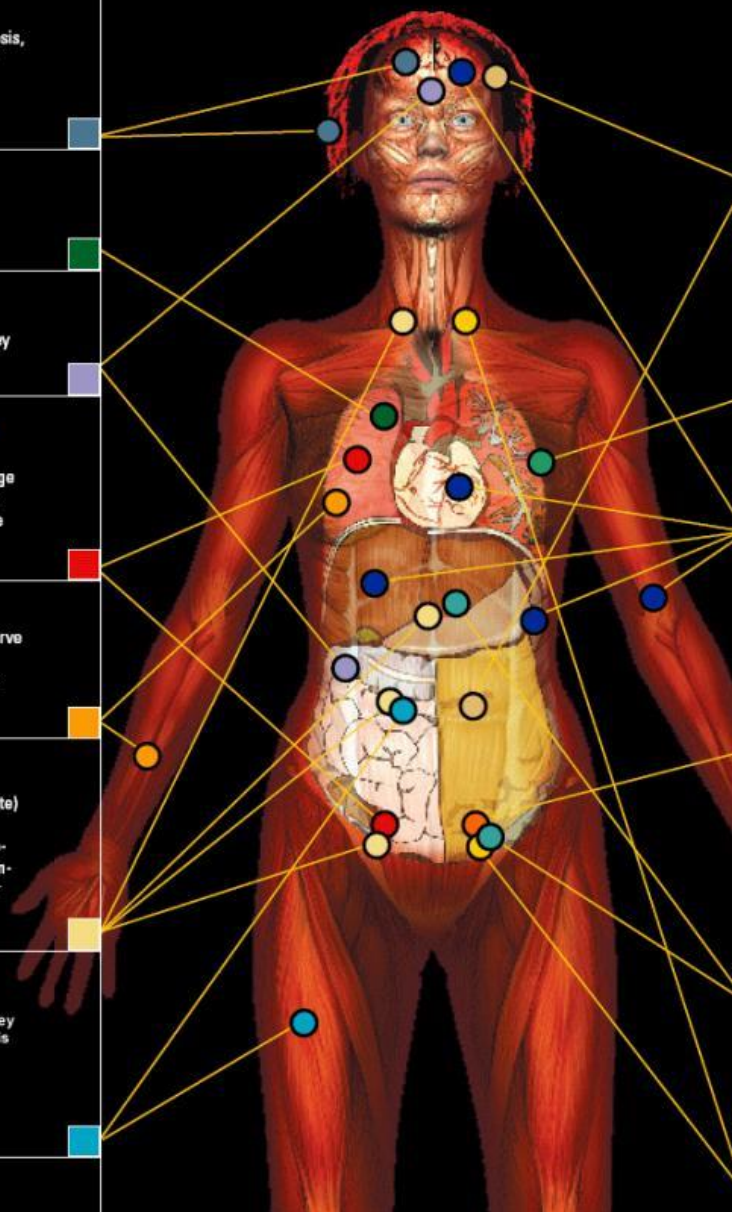
Long-term exposure may cause lung cancer, nerve damage and various skin diseases. Arsenic gas (AsH₃), used in tech manufacturing, is the most toxic form of arsenic.¹

Trichloroethylene (TCE)

Exposure to TCE (depending on amount and route) can cause liver and kidney damage, impaired immune system function, impaired fetal development, or death. Manufacturing workers and communities where TCE leaches into drinking water are at greatest risk.¹³

Cadmium

Long-term exposure to cadmium can cause kidney damage and damage to bone density. Cadmium is also a known carcinogen.



Lead

Lead exposure can cause brain damage, nervous system damage, blood disorders, kidney damage, and damage to fetal development. Children are especially vulnerable.

Polyvinyl chloride (PVC)

PVC is the most used plastic, found in everyday electronics. When burned it produces large quantities of hydrogen chloride gas, which combines with water to form hydrochloric acid (HCl). Inhaling HCl can cause respiratory problems. Production and incineration of PVC creates dioxins.¹⁴

Barium

Exposure may lead to brain swelling, muscle weakness, damage to heart, liver and spleen, or increased blood pressure.¹

Brominated flame retardants (BFRs)

Suspected of hormonal interference (damage to growth and sexual development), and reproductive harm, BFRs are used to make materials more flame resistant. Exposure studies reveal BFRs in breast milk and blood of electronics workers, among others.⁴

Polychlorinated biphenyls (PCBs)

Toxic effects of PCBs include immune suppression, liver damage, cancer promotion, nervous damage, reproductive damage (both male and female), and behavioral changes. PCBs were widely used (prior to 1980) in transformers and capacitors. Though banned in many countries, they are still present in e-waste.¹⁵

Dioxins and Furans

skin disorders; liver problems; impairment of the immune system, the endocrine system and reproductive functions; effects on the developing nervous system and some types of cancers.



Are environmental chemicals altering the incidence and pattern of diseases?

Association of Urinary Bisphenol A Concentration With Medical Disorders and Laboratory Abnormalities in Adults

Iain A. Lang, PhD

Tamara S. Galloway, PhD

Alan Scarlett, PhD

William E. Henley, PhD

Michael Depledge, PhD, DSc

Robert B. Wallace, MD

David Melzer, MB, PhD

BISPHENOL A (BPA) IS ONE OF the world's highest production-volume chemicals, with more than 2 million metric tons produced worldwide in 2003 and annual increase in demand of 6% to 10% annually.¹ Bisphenol A is used extensively in epoxy resins lining food and beverage containers and as a monomer in polycarbonate plastics in many consumer products. Widespread and continuous exposure to BPA, primarily through food but also through drinking water, dental sealants, dermal exposure, and inhalation of household dusts, is evident from the presence of detectable levels of BPA in more than 90% of the US population.²⁻⁴

Most studies of the health effects of BPA have focused on well-documented

Context Bisphenol A (BPA) is widely used in epoxy resins lining food and beverage containers. Evidence of effects in animals has generated concern over low-level chronic exposures in humans.

Objective To examine associations between urinary BPA concentrations and adult health status.

Design, Setting, and Participants Cross-sectional analysis of BPA concentrations and health status in the general adult population of the United States, using data from the National Health and Nutrition Examination Survey 2003-2004. Participants were 1455 adults aged 18 through 74 years with measured urinary BPA and urine creatinine concentrations. Regression models were adjusted for age, sex, race/ethnicity, education, income, smoking, body mass index, waist circumference, and urinary creatinine concentration. The sample provided 80% power to detect unadjusted odds ratios (ORs) of 1.4 for diagnoses of 5% prevalence per 1-SD change in BPA concentration, or standardized regression coefficients of 0.075 for liver enzyme concentrations, at a significance level of $P < .05$.

Main Outcome Measures Chronic disease diagnoses plus blood markers of liver function, glucose homeostasis, inflammation, and lipid changes.

Results Higher urinary BPA concentrations were associated with cardiovascular diagnoses in age-, sex-, and fully adjusted models (OR per 1-SD increase in BPA concentration, 1.39; 95% confidence interval [CI], 1.18-1.63; $P = .001$ with full adjustment). Higher BPA concentrations were also associated with diabetes (OR per 1-SD increase in BPA concentration, 1.39; 95% confidence interval [CI], 1.21-1.60; $P < .001$) but not with other studied common diseases. In addition, higher BPA concentrations were associated with clinically abnormal concentrations of the liver enzymes γ -glutamyltransferase (OR per 1-SD increase in BPA concentration, 1.29; 95% CI, 1.14-1.46; $P < .001$) and alkaline phosphatase (OR per 1-SD increase in BPA concentration, 1.48; 95% CI, 1.18-1.85; $P = .002$).

Conclusion Higher BPA exposure, reflected in higher urinary concentrations of BPA, may be associated with avoidable morbidity in the community-dwelling adult population.

JAMA. 2008;300(11):1303-1310

www.jama.com



ENVIRONMENTAL
HEALTH
PERSPECTIVES

ehponline.org

Association Between Serum Perfluorooctanoic Acid (PFOA) and Thyroid Disease in the NHANES Study

David Melzer, Neil Rice, Michael H Depledge,
William E Henley, Tamara S Galloway

doi: 10.1289/ehp.0901584 (available at <http://dx.doi.org/>)

Online 20 January 2010

Lang, I.A., Galloway, T.S., Scarlett, A., Henley, W.E., Depledge, M.H., Wallace, R.B. and Melzer, D. (2008). Association of Bisphenol A concentration with medical disorders and laboratory abnormalities in adults. *Journal of the American Medical Association*, 300(11), 1303-1310.

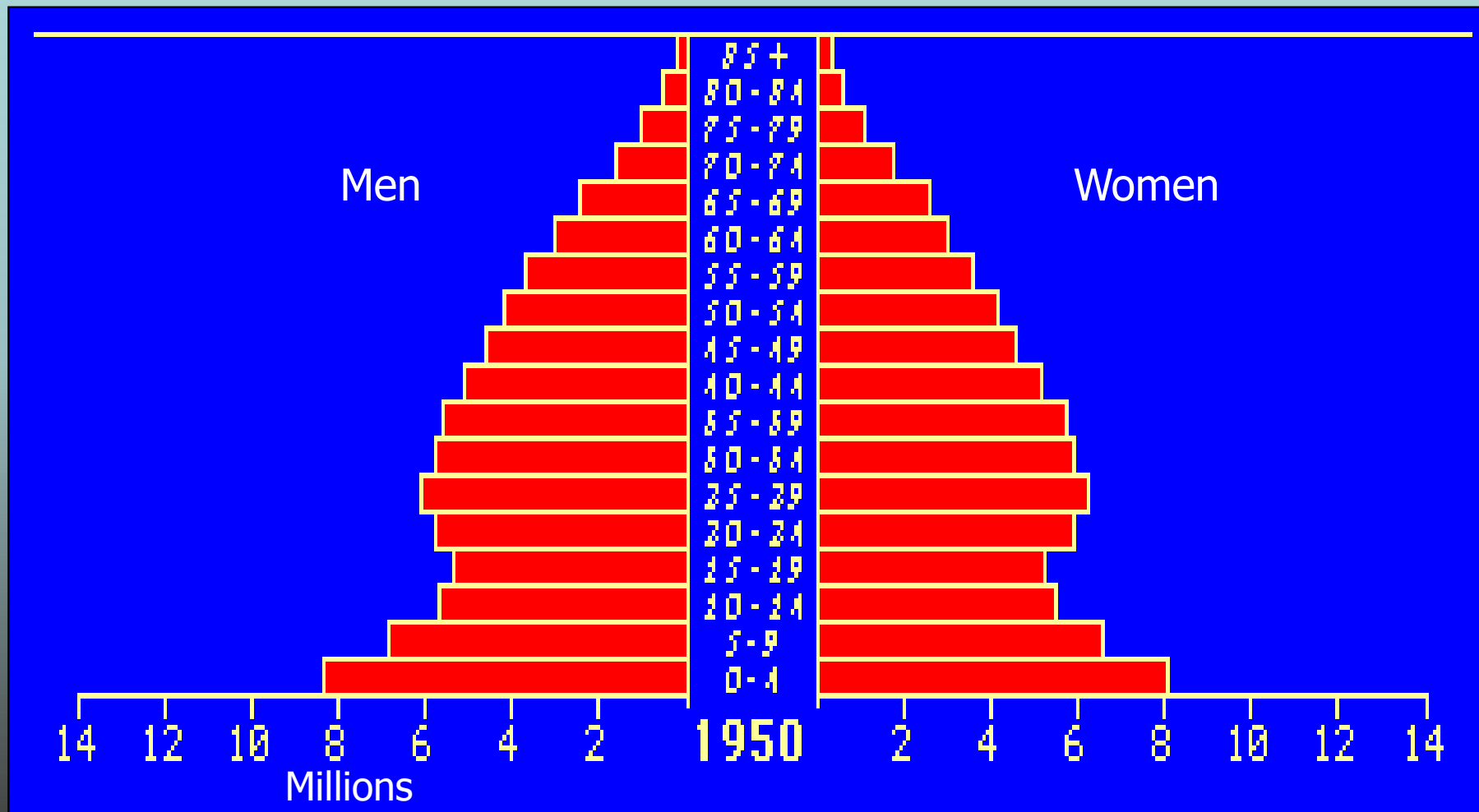
Melzer D, Rice N, Depledge MH, Henley WE, Galloway TS 2010. Association Between Serum Perfluorooctanoic Acid (PFOA) and Thyroid Disease in the NHANES Study. *Environ Health Perspect* :- doi:10.1289/ehp.0901584



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Human Demographics

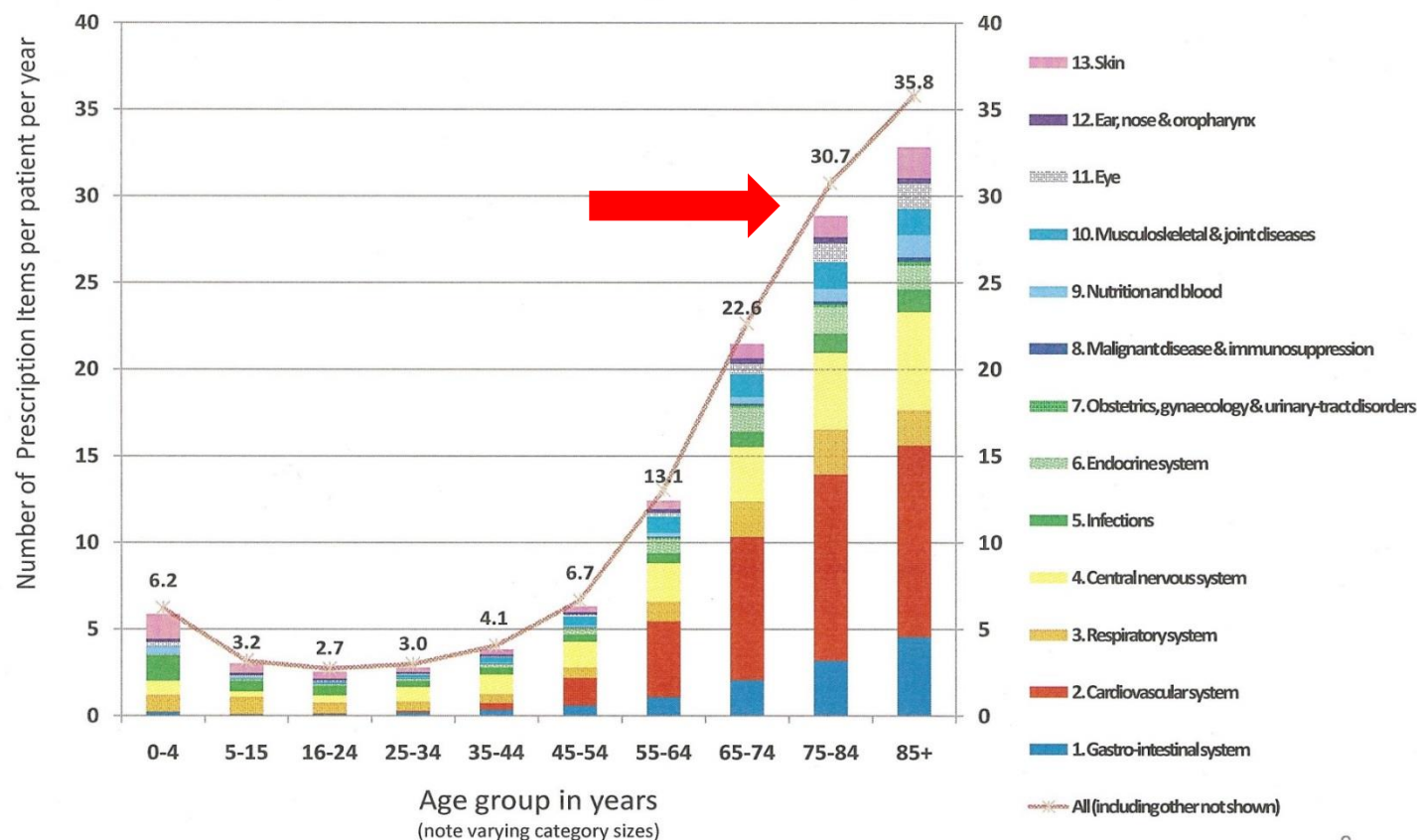
Population ageing e.g. USA



Pharmaceuticals and the Ageing Demographic

Annual prescribing rates by therapeutic group

Males, England & Wales, 1998



Data source: Department of Health, 1998

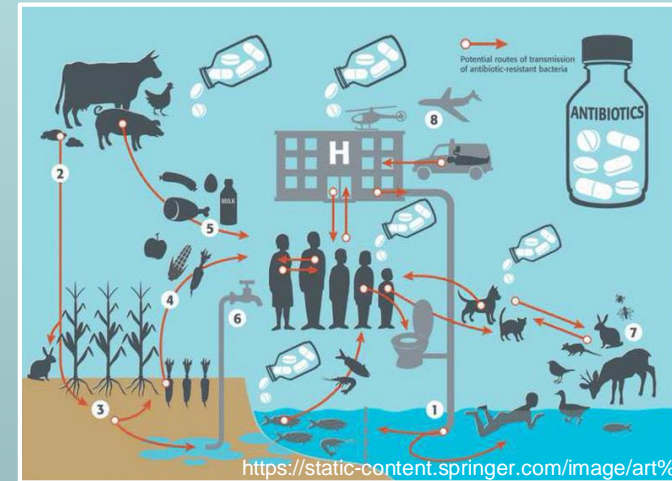
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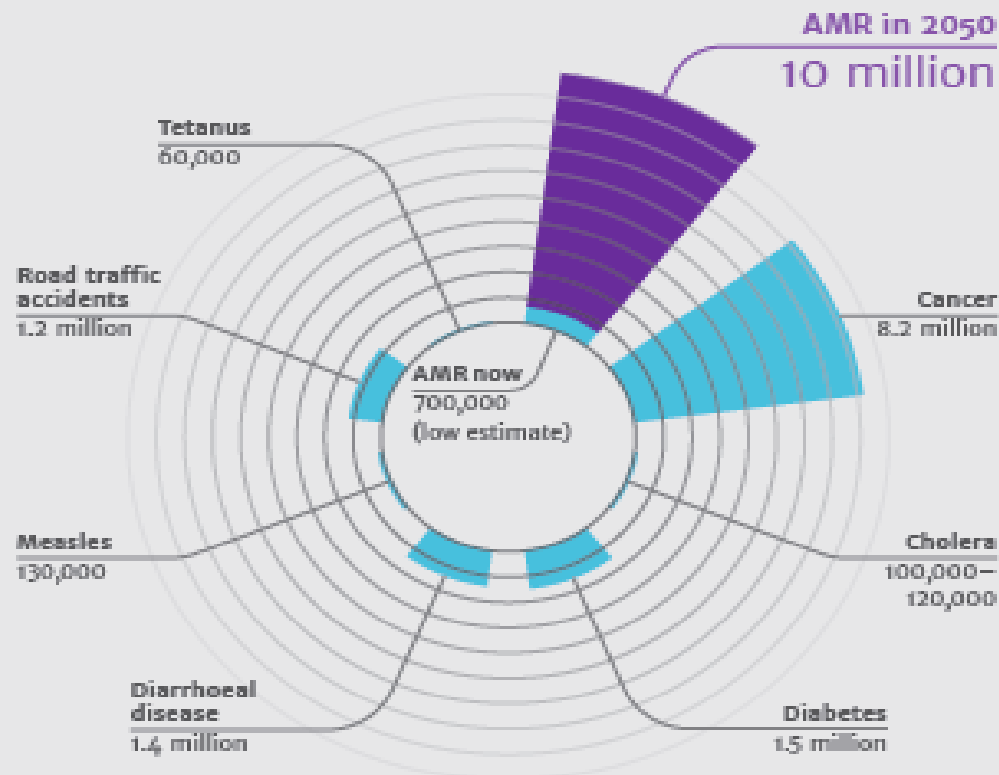
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Antimicrobial Resistance: an emerging environmental threat?

- Environment receives sewage discharges and agricultural runoff.
- Antimicrobial agents and their residues are present in increasingly large amounts.
- Derived from Medical use (~40%) and Veterinary Use (~60%)
- Exposure to low concentrations of antimicrobial agents selects for resistant strains (bacteria, viruses, fungi)
- Are people likely to become contaminated? (Florida studies)
- Does this result in AMR infections?



Deaths attributable to AMR every year compared to other major causes of death



Sources

Diabetes

Cancer

Cholera

Diarrhoeal disease

www.who.int/news-room/fact-sheets/detail/diabetes

www.who.int/news-room/fact-sheets/detail/cancer

www.who.int/news-room/fact-sheets/detail/cholera

www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease

Measles

Road traffic accidents

Tetanus

www.who.int/news-room/fact-sheets/detail/measles

www.who.int/news-room/fact-sheets/detail/road-traffic-injuries

www.who.int/news-room/fact-sheets/detail/tetanus

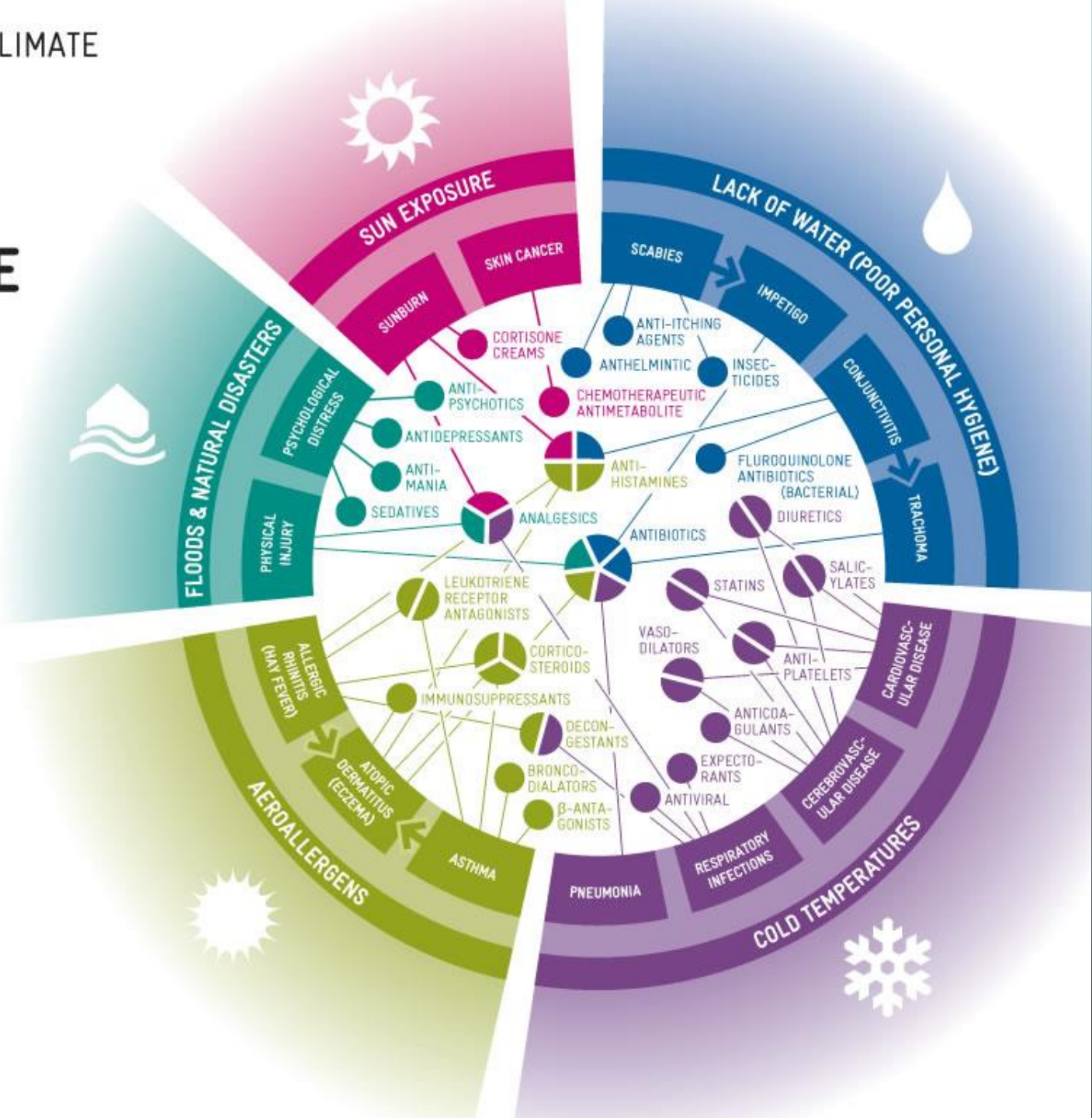


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ILLNESSES LINKED WITH CLIMATE
CHANGE AND ASSOCIATED
PHARMACEUTICALS

1) NON-
COMMUNICABLE
ILLNESSES

NUMBER OF HEALTH
CONDITIONS LINKED
TO PHARMECEUTICALS:



2) VECTOR-BORNE DISEASES

1 ●

2 ●

3 ●

4 ●

5 ●

6 ●

7 ●

8 ●

9 ●

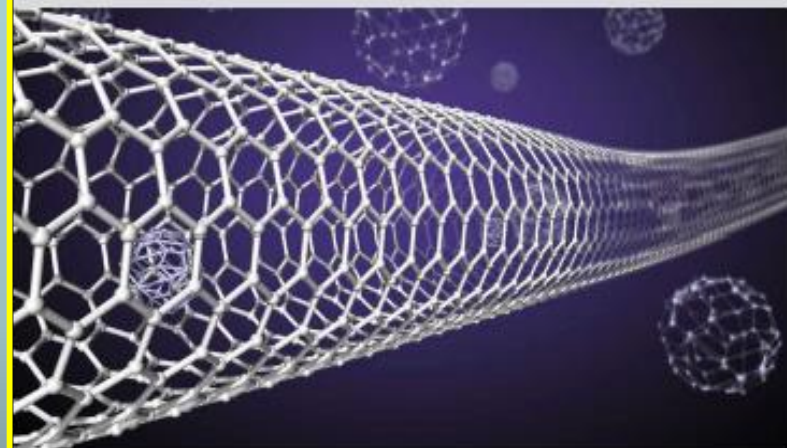
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ROYAL COMMISSION ON ENVIRONMENTAL POLLUTION

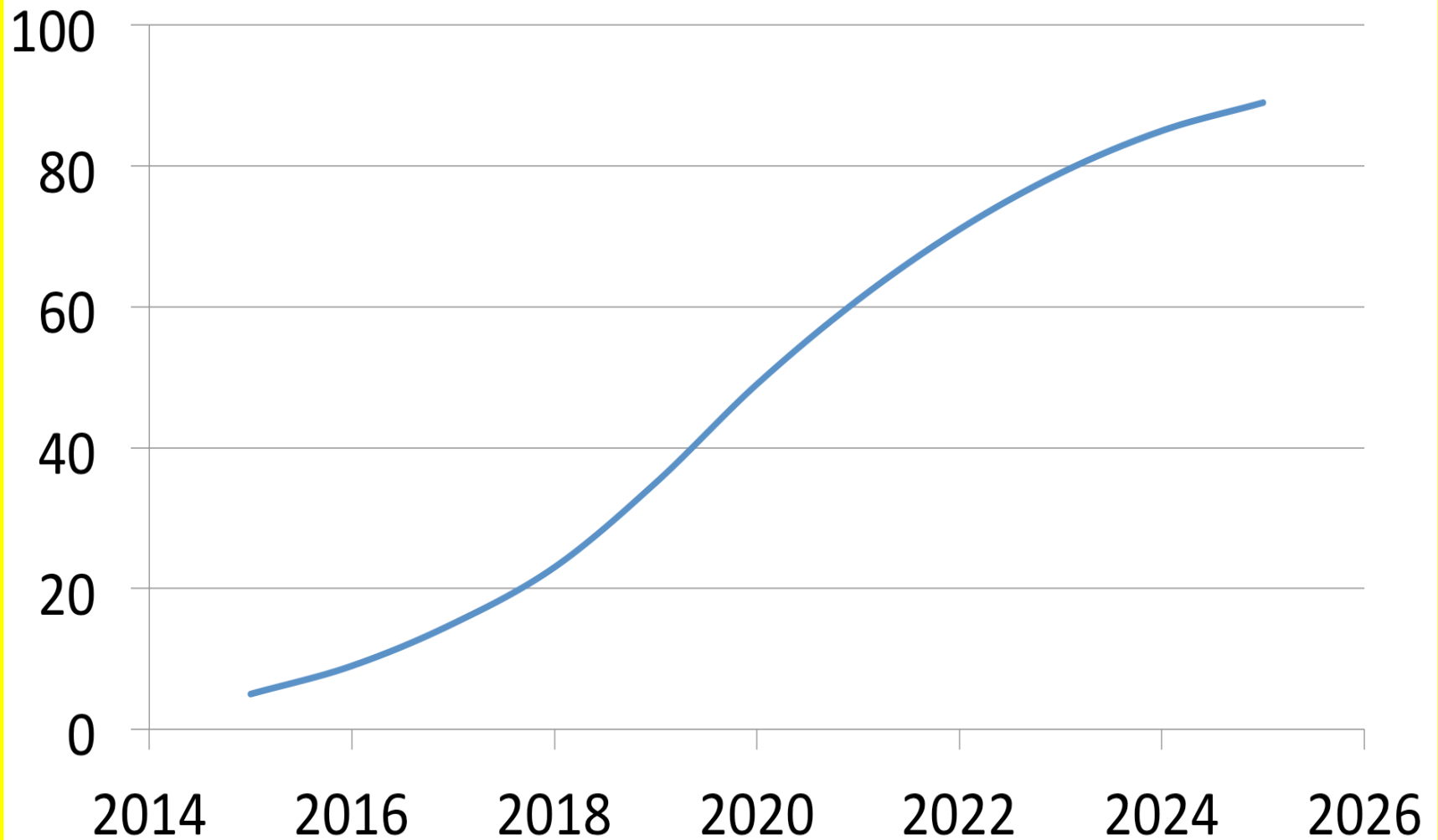
Novel Materials in the Environment: The case of nanotechnology



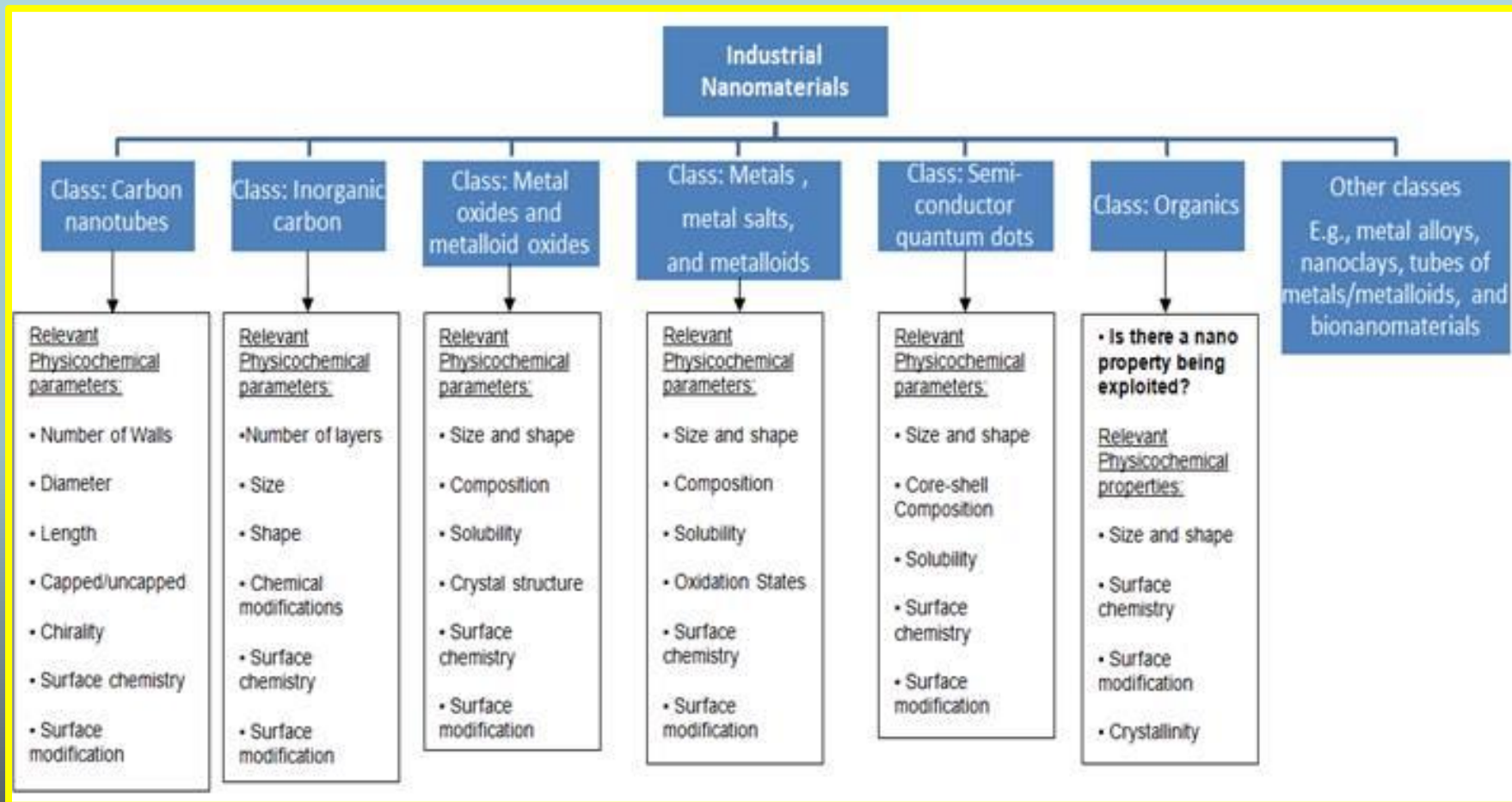
Nanotechnology and human health: Scientific evidence and risk governance

Report of the WHO expert meeting
10–11 December 2012, Bonn, Germany

Nanotechnology Market (\$bn)



How can we keep track of nanomaterials?



Chemicals Policy in Europe

Integrated impact!

***Industrial
Chemicals,
Pesticides,
Plastics,
Pharmaceuticals,***

***Air
Pollutants,
Fertilizers,
Radioisotopes,
Nanomaterials,***

Other emerging chemicals.



July 31, 2012

Automotive giants turn to bioplastics worldwide

BRUSSELS (July 31, 12:15 p.m. ET) — Although attracted initially by environmental benefits, car makers and their suppliers are also asking what added functionality they can get from non-compostable, bio-based materials. One advantage is of course lighter, more cost-effective vehicles. A rule-of-thumb is that 5 percent less weight means average fuel savings of 3 percent, according to industry association Plastics Europe.



Automated Agricultural Vehicles and Precision Agriculture.



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The Future of the Chemical Industry

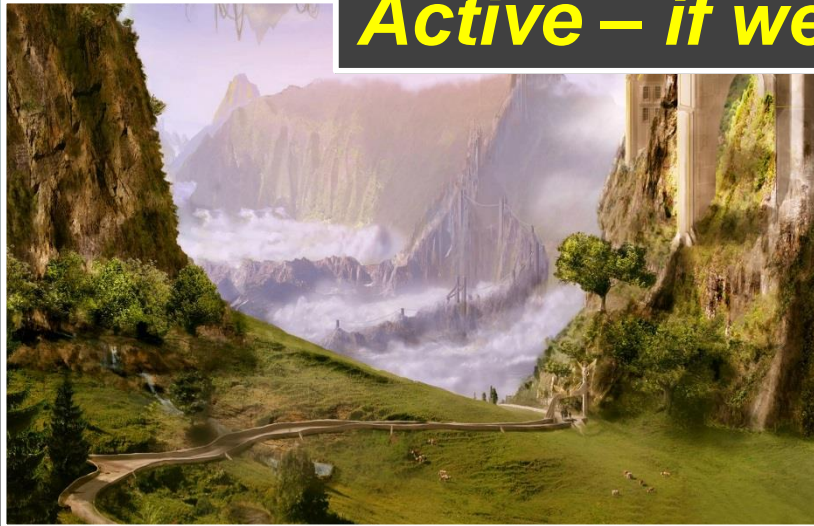


- Doubling of chemical sales in the last 10 years. (US\$ 5.2 trillion in 2013)(China growth largest).
- 2/3 growth old chemicals – volume issues.
- Re-tooling with intense competition.
- Future growth in developing markets (6-10% vs 2-3%).
- Local vs International companies.
- Embracing digital transformation.
- By 2020 – 50 billion devices connected to the Internet.
- Internet of things, 3D printing, etc.

Utopia and the Future



***Passive – what will happen....
Active – if we have a vision....***



Identifying emerging chemical issues & trends.



*“Nothing in life is to be feared,
it is only to be understood.
Now is the time to understand
more, so that we may fear
less.”*

Marie Curie (1867-1943)