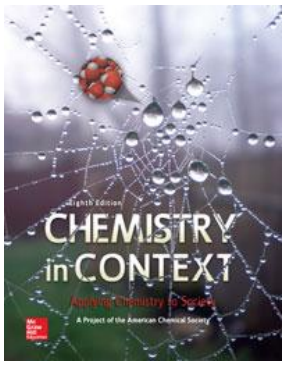

Environmental Chemistry

Chemistry 102
Fall 2014

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Analytical Chemistry
Instrumentation
General Chemistry
Environmental Chemistry

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Textbook web site

Textbook web site

Assignments web site

What Makes the Earth an Unusual Planet

-Life (based on carbon -- over 1.5 million species)
-Atmosphere (79% nitrogen, 20% oxygen, 1% argon, variable amounts of water vapor, carbon dioxide)
-Presence of large amounts of liquid water. Geologically active erosion by water
-Plate tectonics-metamorphism, deformation, granitic rocks
-Few impact craters visible
-Strong Magnetic Field for such a small Planet
-Has an Unusually Large Satellite in Proportion to Its Size

Human Population ~ 7 billion (today) - *tripled in past century.*
…….. 2050 + 2-3 billion

http://www.uwgb.edu/dutchs/planets/earth.htm

How many species are known to currently exist in the world?

Category	Species	Totals
Vertebrate Animals		
Mammals	5,490	
Birds	9,998	
Reptiles	9,084	
Amphibians	6,433	
Fishes	31,300	
Total Vertebrates		**62,305**
Invertebrate Animals		
Insects	1,000,000	
Spiders and scorpions	102,248	
Molluscs	85,000	
Crustaceans	47,000	
Corals	2,175	
Others	68,827	
Total Invertebrates		**1,305,250**

Species are connected in some way ..
and the connections are breaking *fast*

Deviation from 'normal'! or baseline.

http://www.currentresults.com/Environment-Facts/Plants-Animals/number-species.php

Shifting baselines of the Environment:

What is 'normal' today is different from 'the normal' a generation (or less) ago and would be different in the next 'generation' (or half a generation).

This is true for ecosystems and the environment in particular.

Reason for concern:
Human activity and most importantly *the rate of change of human activity.*

'Normal' is constantly changing, problem is the rate of change!

All human activity consumes resources and produces of waste.

Human activities:

Manufacture of materials
Transportation
Dwellings
Food production
Entertainment
.
.

Uses resources (materials extracted from the ground, air and water) and energy.

Eventually produces ***waste***, sometimes highly unfriendly to the environment; destroys habitat at an alarming rate.

Multiplying any miniscule, 'inconsequential' individual human *activity* by factor of millions makes *it* a significant global activity.

Multiplying any miniscule individual human *activity* by a factor of millions makes *it a significant global activity*.

Sustainable use of resources is the key to making the earth livable.

The cumulative effect of individual contributions in large cities to the pollution of the environment is evidenced by the correlation to the health problems the inhabitants of cities encounter.

Accelerated rate of extinction of species.

Waste generation is primarily related to production of energy.

Sustainability:

"Meeting the needs of the present without compromising the ability of the future generations to meet their needs."

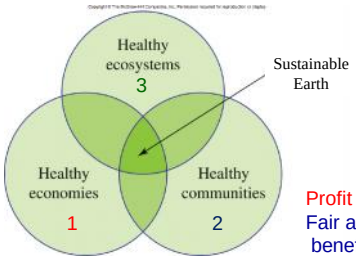
Improve efficiency, use renewable resources, minimize/prevent waste – conservation.

Change the current unhealthy and unsustainable practices.

The solutions and approaches to achieve sustainability of the earth would **require application of chemical principles** to understand and solve the current issues along with other disciplines.

Chemistry for a Sustainable World

Success of an enterprise: The Triple Bottom Line



Profit
Fair and beneficial to the larger society
Protect the environment.

Cradle to Grave?: (Familiar paradigm)

Life cycle of a manufactured item.

Start: Raw materials → → → → → → → Disposal.

Earth

[waste]

[Raw Material]

= manufactured item (aluminum can)

Where individuals play a part

Your Turn 0.3 **The Can That Holds Your Beverage**

People tend to think of an aluminum can as starting on a supermarket shelf and ending in a recycling bin. There is more to the story!

a. Where on the planet is aluminum ore (bauxite) found?
b. Once removed from the ground, the ore usually is refined to alumina (aluminum oxide) near the mining site. The alumina is then transported to a production facility. What happens next to produce aluminum metal?
c. The metal is then shaped into a beverage can. See if you can find where the can was filled and how far it was transported to land on the shelves of your neighborhood store.
d. What happens to the can after you recycle it?

Need a Paradigm Change

A goal of **cradle to cradle** would be the ideal path to sustainability.

A regenerative approach to the use of materials in which the *end of one life cycle of one* item dovetails with the *beginning of the life cycle of another* rather than disposed as waste.

Ecological Footprint:

A measure of the earth's capital needed to support the way of life of an individual.

Calculated value - *estimates the biologically* ***productive space*** (land, water and sea surface; omit ice caps and deserts = 11 billion hectares) necessary to support a particular living standard.

Unit: hectares.

1 hectare = 2.47105 acre

An ecological footprint comparison
For average citizens.

Current nominal (global) average footprint (2010):

Total global population = 7×10^9

Total available productive land = 11×10^9 hectares

Carrying capacity (ecological footprint) of the earth:

$$\frac{11\times10^9 \text{ hectares}}{7\times10^9 \text{ people}} = 1.6 \text{ hectares per person}$$

Calculation of the (US) average footprint (2010):

Population = 310×10^6

Total available productive land = 3×10^9 hectares

US average footprint $= \dfrac{3\times10^9}{310\times10^6} = 9.7$ hectares per person

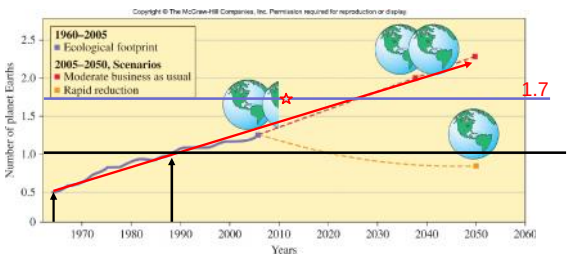
How many earths are needed to live like an average global citizen?

$$\frac{(7\times10^9 \text{ people})\times(2.7 \text{ hectares / person})\times 1 \text{ planet}}{11\times10^9 \text{ hectares}} = 1.7 \text{ planets}$$

Average citizen of the world is exceeding the carrying capacity of the earth already!!

How many earths are needed if all people live like an average US citizen?

$$\frac{(7\times10^9 \text{ people})\times(9.7 \text{ hectares / person})\times 1 \text{ planet}}{11\times10^9 \text{ hectares}} = 6.2 \text{ planets}$$



Current trend of ecological foot print is not sustainable.

Issues of interest for sustainability of the planet:

Air quality
Water quality
Food and nutrition
Public Health
Energy
..

To meet the challenges:
learn about the issues
develop a responsible behavior

Green Chemistry:

The design of chemical *products and processes* to use less energy, produce fewer hazardous materials and use renewables wherever possible.

Outcome: Less waste production and use of fewer resources.

ACS Green Chemistry Institute

Table 0.2	Principles of Green Chemistry

Table 0.1 Our Common Future (excerpts from the Foreword)

"A global agenda for change"—this was what the World Commission on Environment and Development was asked to formulate. It was an urgent call by the General Assembly of the United Nations.

In the final analysis, I decided to accept the challenge. The challenge of facing the future, and of safeguarding the interests of coming generations.

After a decade and a half of a standstill or even deterioration in global co-operation, I believe the time has come for higher expectations, for common goals pursued together, for an increased political will to address our common future.

The present decade has been marked by a retreat from social concerns. Scientists bring to our attention urgent but complex problems bearing on our very survival: a warming globe, threats to the Earth's ozone layer, deserts consuming agricultural land.

The question of population—of population pressure, of population and human rights—and the links between these related issues and poverty, environment, and development proved to be one of the more difficult concerns with which we had to struggle.

But first and foremost our message is directed towards people, whose well being is the ultimate goal of all environment and development policies. In particular, the Commission is addressing the young. The world's teachers will have a crucial role to play in bringing this report to them.

If we do not succeed in putting our message of urgency through to today's parents and decision makers, we risk undermining our children's fundamental right to a healthy, life-enhancing environment.

In the final analysis, this is what it amounts to: furthering the common understanding and common spirit of responsibility so clearly needed in a divided world.

Gro Harlem Brundtland, Oslo, 1987.