The Central Problem of Our Time:

Cumulative Impacts of Human Activities

Peter Montague, Ph.D.
(peter@rachel.org)
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These slides are available online at http://goo.gl/or1Wd

References within these slides can be found in an online bibliography (which has links to most of the primary sources).

http://goo.gl/AKMc

Part 1:

The predicament we find ourselves in

Cumulative impacts of economic activities in N.J., the U.S. and the world are:

** degrading the global ecosystem

** damaging human health

** ruining the planet as a place suitable for human habitation

1. How *not* to degrade the global ecosystem –

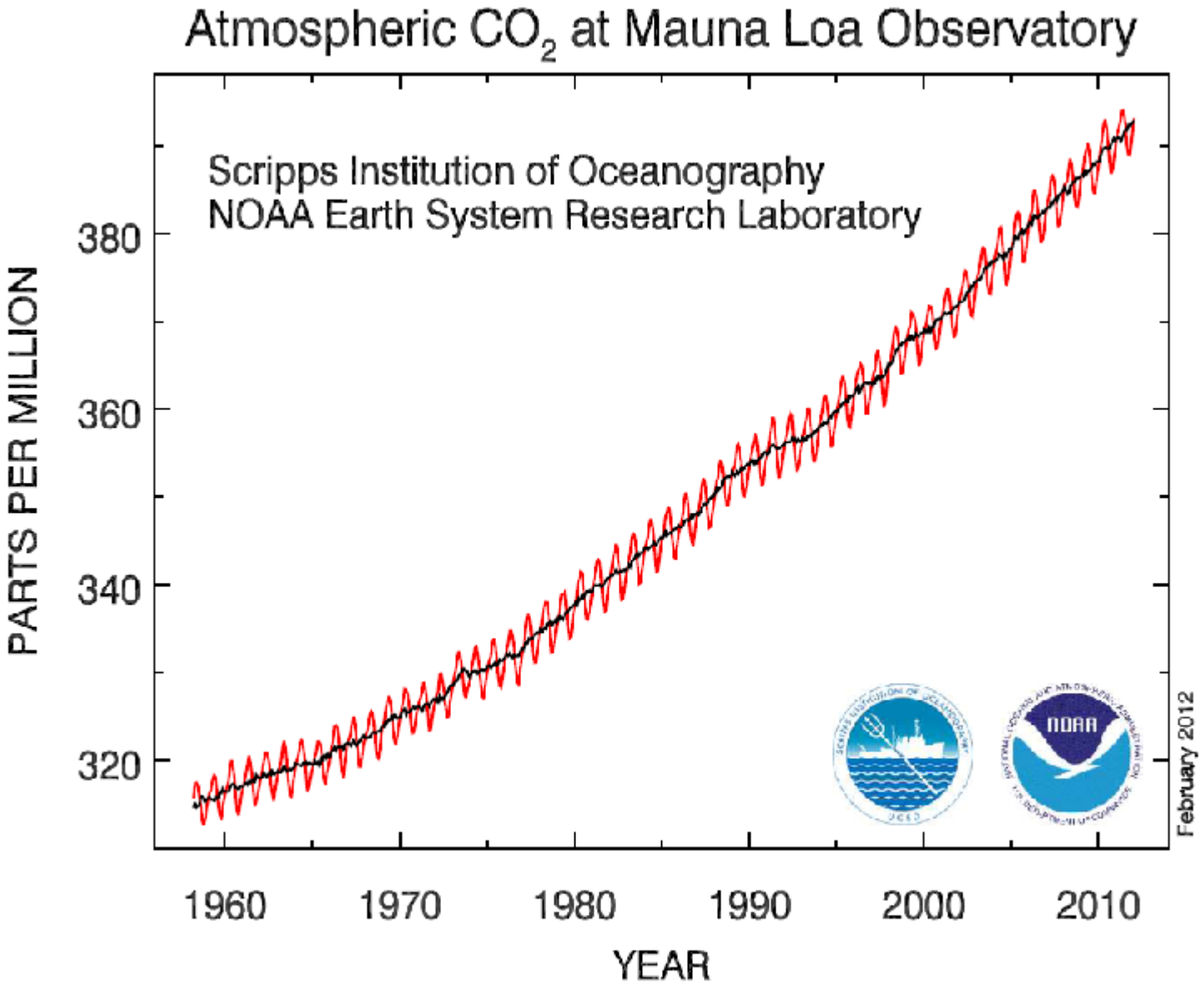
Learning to live within reasonable boundaries.

To define a “safe operating space” for human activities, an international group of scientists in 2009 identified 9 ecosystem boundaries, none of which can be safely breached.

See http://goo.gl/NGeN and http://goo.gl/8iwK

1. **Climate change is already happening.**

It is being caused by human activities that emit CO2, methane (“natural gas”) and nitrous oxide (N2O) into the atmosphere. ***Skeptics, please see*** **http://goo.gl/Ph2O**


Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
February 2012

The planet has warmed 1.4 degrees Fahrehheit in the past 100 years, most of that since 1970. We are <u>now</u> experiencing larger storms and storm surges, plus more intense rainfall and snowfall, plus greater floods, droughts, wildfires, and insect infestations plus loss of glaciers.

Wetter areas are getting wetter and dryer areas dryer. http://goo.gl/4FXI

The western U.S., and parts of India, China, and Australia are experiencing multi-year drought.

Loss of glaciers means loss of fresh water supplies for at least half a billion people in Asia and South America. (Rockstrom, 2009b)

These are some of the reasons why the Pentagon takes global warming very seriously even as Congress pretends it is not happening.

http://goo.gl/BEMBw and http://goo.gl/KhGJW

Suggested boundary #1:

350 parts per million (ppm) CO2 in the atmosphere.

In 1750, CO2 was 280 ppm; today it is 390 ppm and rising about 1.1 ppm per year.

See James Hansen, *Storms of My Grandchildren* (2010) http://goo.gl/rxIrQ

2.

Ocean acidification caused by excessive CO2 in the atmosphere.

CO2 from human activities has increased the acidity of the oceans from pH 8.25 to pH 8.14, so the oceans are about 30% more acidic that they were before industrialization.

Ocean acidification: **(Rockstrom, 2009b)**

Many creatures that require a calcium carbonate shell will find (are finding) their shells dissolving, or not forming in the first place. Some of these creatures (pteropods) lie at the bottom of the marine food chain.

Corals are being affected, too.

Thomas Lovejoy, the executive director of the Heinz Center for Science, Economics and the Environment, says acidification of the oceans is

“The most profound environmental change I've encountered in my professional career.“ **http://goo.gl/jvGT**

Dr. Lovejoy says, the effects of acidification on ocean life are "shaking the biological underpinnings of civilization.“

In what ways might healthy oceans be essential for civilization?

Death of corals – (Rockstrom, 2009b)

75% of world's corals are dead or threatened http://goo.gl/lZoGs

Global warming is driving this trend.

“Although [coral] reefs cover a minuscule fraction (0.1%) of seabed, they are second only to rainforests in biodiversity, sheltering or nourishing up to 9 million species -- a third of all known marine life forms -- including 4000 kinds of fish.”

--*Science Magazine* May 4, 2007, pg. 678.

Boundary #2

Boundary for ocean acidification -- aragonite saturation should not fall below 80% of pre-industrial value. (Aragonite is one form of calcium carbonate.)

Cumulative impact: Overfishing: (MEA, 2005; GEO-4, 2007)

** 75% of ocean fisheries are overfished or fully depleted

** 90% of the large fish (by weight) are gone

** Humans are fishing lower on the food chain, threatening the integrity of the food chain itself

3. Stratospheric ozone filters out deadly ultraviolet radiation from the sun, thus allowing life to flourish on the surface of the Earth.

Stratospheric ozone depletion was/is caused by DuPont chemicals called chlorofluorocarbons or CFCs and by their replacements, HCFCs.

Three lessons learned:

1. We almost made the surface of the planet uninhabitable for humans *completely unexpectedly*;

2. International agreement (the Montreal Protocol) saved the day and reversed the devastating trend.

3. When flying blind, go slowly. http://goo.gl/fii4e

Boundary #3:

Stratospheric ozone in a column of air should not be reduced by more than 5% below the 1964-1980 average.

4. Interference with global nitrogen and phosphorus cycles. (Caused mainly by use of fertilizer on farms and lawns, and in some detergents.)

Humans now mobilize 4 times as much nitrogen as all non-human natural processes combined.

Excessive nitrogen is causing “dead zones” in oceans worldwide. Currently 15% of ocean areas are considered “anoxic” – meaning, deprived of adequate oxygen.

Cumulative impact: Global warming is making this problem worse because warm water holds less oxygen than cool water.

Boundary #4: We should reduce our mobilization of nitrogen by a factor of 4.

(This at a time when human population will rise 30% or 40% from today's 7 billion to 9 or 10 billion this century.)

5. Rate of loss of biodiversity – i.e., speeding up extinctions.

Extinction is normal and natural. But humans have speeded up loss of species by somewhere between a factor of 100 and a factor of 1000.

(Rockstrom, 2009b)

Loss of species in the news:

-- Bats dying http://goo.gl/j8iv and http://goo.gl/cdbC

-- Bees disappearing http://goo.gl/68lz

-- Frogs and salamanders declining and disappearing worldwide http://goo.gl/BMi8

The U.N.'s GEO 4 report:

Earth has experienced five mass extinctions in 450 million years, the latest of which occurred 65 million years ago.

"A sixth major extinction is under way, this time caused by human behaviour." (GEO-4, 2007)

The Millennium Ecosystem Assessment says we will likely lose during this century:

-- 25% of all mammalian species

-- 12% of birds (in the U.S., 30%)

-- 33% of amphibians (MEA, 2005)

Boundary #5 -- for the rate of loss of biodiversity: 10 times the historical rate.

In other words the "safe" boundary is somewhere between 10 and 100 times <u>below</u> the current rate.

6. Global freshwater use. (Mainly by agriculture.)

25% of rivers (worldwide) now run dry before reaching the oceans because of human diversions of water.

Boundary #6: 4000 cubic kilometers of water for consumptive use. (Presently world consumptive use is 2600 cubic kilometers.)

“…the pressure on global freshwater resources is growing rapidly, mainly due to increasing food demands.”

7. Land system changes (mainly from agricultural expansion and intensification).

“Conversion of forests and other ecosystems to agricultural land… is the major global driver behind loss of ecosystem functioning and services.” **http://goo.gl/8iwK**

Boundary #7:

As a planetary boundary, we propose that no more than 15% of the global ice-free land surface should be converted to cropland.

“For humanity to stay within this boundary, cropland should be allocated to the most productive areas, and processes that lead to the loss of productive land, such as land degradation, loss of irrigation water, and competition with land uses such as urban development or biofuel production, should be controlled.”

http://goo.gl/8iwK

8. Aerosol loading (soot in the air, mainly from combustion)

This is a global change process for two reasons:

a. The influence of aerosols on the climate system; and

b. Adverse effects on human health at a regional and global scale.

Since 1750, humans have doubled the global concentration of most aerosols.

Aerosols reflect incoming solar radiation back into space, influence cloud formation and reflectivity, change the way precipitation forms in clouds, and influence circulation of the Asian monsoons. **http://goo.gl/8iwK**

Fine particles, also known as particulate matter 2.5 (or PM 2.5), kills by infiltrating the lungs, entering the blood stream, and causing heart attacks and strokes. PM 2.5 also causes lung cancer and initiates or promotes lung disorders such as asthma, chronic bronchitis, and chronic obstructive pulmonary disease (COPD).

Fine particles can affects humans in other ways as well, reducing crop yields, degrading forests, and causing loss of freshwater fish due to acid precipitation.

Boundary #8

It is not possible to set a numerical boundary for aerosols (fine particles).

9. Chemical pollution.

There are somewhere between 80,000 and 100,000 chemicals on the global market.

“Some toxicity data exist for a few thousand of these, but there is almost no knowledge of their combined effects.” **http://goo.gl/8iwK**

About 700 new chemicals are introduced into commerce each year, almost entirely untested for effects on human health or the environment.

http://goo.gl/7e32

Pharmaceuticals and personal care products are now found in all our finished drinking water (the water you get from your tap). **http://goo.gl/Y4CV and http://goo.gl/cHlA**

Examples of pharmaceuticals that can be measured in drinking water:

** pain killers
** anti-depressants
** antibiotics
** stimulants
** heart disease drugs
** veterinary preparations

Freshwater fish are now essentially all contaminated with mercury, PCBs, and industrial chemicals that mimic, or interfere with, hormones. http://goo.gl/NZwl

In all fresh waters of the U.S., male fish are turning into female fish. http://goo.gl/lXxQV

N.J. is no exception http://goo.gl/cNe8k

We are all exposed to industrial toxicants. The N.J. Department of Environmental Protection has described routine toxic exposures of the citizenry…

See handout.

Also available at on the web: http://tinyurl.com/2gag37

New information about toxicants discovered in last 15 years:

**** Endocrine (hormone) disruption** http://goo.gl/uymR

**** Fetal programming** http://goo.gl/MTwj

**** Epigenetics** http://goo.gl/uymR

**** "Body burden" of toxicants found in all animals, especially the top predators, including humans** http://goo.gl/oU5J

Boundary #9:

It is not possible to set a numerical boundary for chemical contamination.

1. Climate change

2. Ocean acidification

3. Stratospheric ozone depletion

4. Interference with global nitrogen and phosphorus cycles

5. Loss of biodiversity (extinction of species)

6. Freshwater use

7. Land changes (e.g., deforestation, agriculture, desertification)

8. Aerosol loading (e.g., soot, dust in the air)

9. Chemical pollution

Human health:

** Asthma is increasing http://goo.gl/uZUG

** Diabetes is increasing, especially among children

http://goo.gl/LNzE

** Attention deficit/hyperactivity disorders (ADHD) are increasing

http://goo.gl/5BYX

**** Autism spectrum disorders are increasing** http://goo.gl/5BYX

**** Parkinson's disease is increasing**
http://goo.gl/Aohk

**** Several kinds of birth defects are increasing** http://goo.gl/V10gv

**** Childhood cancers are increasing**
http://goo.gl/NubH

And all of these health problems are worse among communities of color and communities of low income.

See handout.

And: http://goo.gl/YFQqc

The Cumulative Picture

The U.N.’s GEO 4 report says:

We are currently using 54 acres per person (worldwide), but the earth can only provide 39 acres.

We have exceeded Earth's "carrying capacity."

It is possible to exceed the Earth's "carrying capacity" temporarily but the result is permanent degradation of the global ecosystem.

For example, soils can be forced to produce more crops, but eventually they become exhausted – a loss borne by future generations.

The Global Footprint Network estimates that the human economy is currently exceeding Earth's sustainable capacity by 50%.

In other words, to live sustainably with our present numbers in our present lifestyles, we humans would now require 1.5 planet earths

If everyone on Earth lived the way we in the U.S. live, humans would require 4.5 planet Earths.
(http://goo.gl/Ulh2)

Human population is expected to increase 30-40% in the next 50 years (from 7 billion to 9 or 10 billion).

The human economy is poised for a new period of rapid growth, at least 3% per year, thus doubling every 23 years.

Millennium Ecosystem Assessment:

Of 24 ecosystems studied worldwide, 14 (60%) are being degraded by human activities. **(MEA, 2005)**

"We're undermining our ecological capital all around the world," says Robert Watson, chief scientist of the World Bank.

When the Millennium Ecosystem Assessment was released in 2005, the Board of Directors of the study issued this statement:

"At the heart of this assessment is a stark warning. Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted." **http://goo.gl/hyK7**

In sum:

The cumulative impacts of our economic activities are ruining the planet as a place suitable for human habitation.

We are wrecking our only home.

Part 2:

How did we get into this predicament?

And what can we do about it?

To stop the degradation of the ecosystem and restore human health, we will need to change the rules by which society makes decisions.

Our present way of making decisions developed during the 19th century, when the world seemed limitless.

Now that we are approaching (in some cases exceeding) ecological boundaries, our decision-making rules need to adapt to new conditions.

(Montague, 2009a; Rockstrom, 2009b)

Two aspects of our laws need to change:

First, our legal system is set up to promote perpetual economic growth. **(Guth, 2008a, 2008b, 2009)**

The law presumes that the benefits of economic growth always outweigh the costs, until a specific cost-benefit analysis shows otherwise.

Even when an economic activity is causing obvious harm, the burden of proof rests on those who want the activity modified or stopped.

They must show that the costs (harms) are "unreasonable," meaning the costs to society of the activity outweigh the benefits that the activity creates. **(Guth, 2008b)**

Proving that costs exceed benefits is a difficult burden to meet because the necessary information about costs and benefits is often not readily available and the proponents of an activity are under no obligation to provide the needed information.

Importantly, when we have scientific uncertainty or doubt, or the absence of information, the law defaults to its starting presumption:

Economic activity is presumed to provide net benefits (more benefits than costs) and so the law presumes that the activity should continue.

This is the main reason why the environmental movement has failed to stem the tide of ecosystem degradation despite 35 years of heroic effort.

As you can see, the legal and regulatory systems reward ignorance, uncertainty and doubt.

There is now a very substantial industry devoted to the manufacture of scientific uncertainty and doubt.

See: David Michaels, *Doubt is Their Product* (2008).

So the big change we need is to shift the overarching goal of our legal system from

Promoting economic growth

to

Protecting the integrity of the global ecosystem

The second change needed:

The law presumes that economic benefits and their related costs can grow forever, without limit, as if the Earth's capacity to absorb harm is infinite.

This is a crucially important (though incorrect and unscientific) assumption built into our laws.

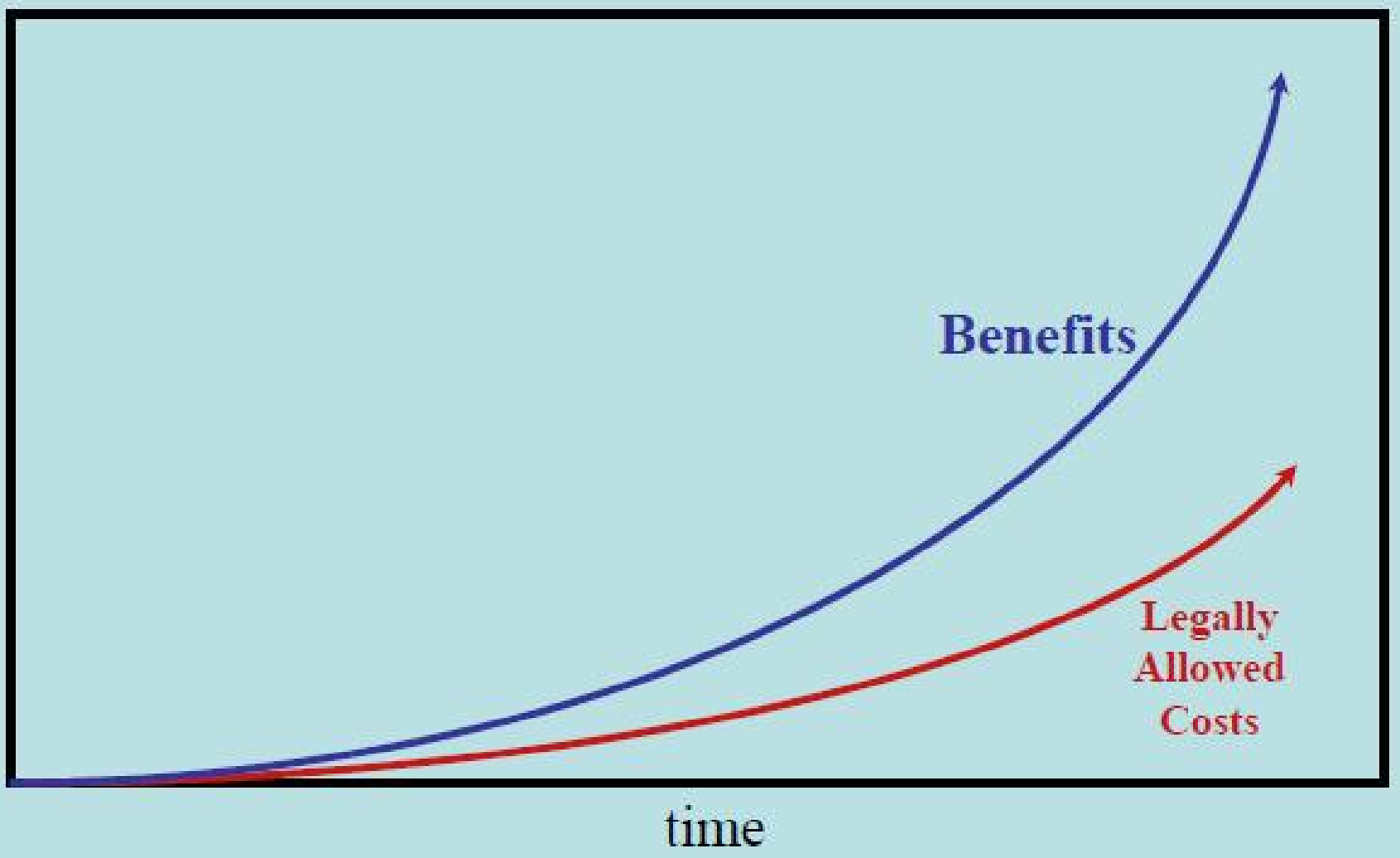


Figure 1: The law promotes all economic activity having a net benefit, allowing both benefits and costs to grow forever as the economy grows

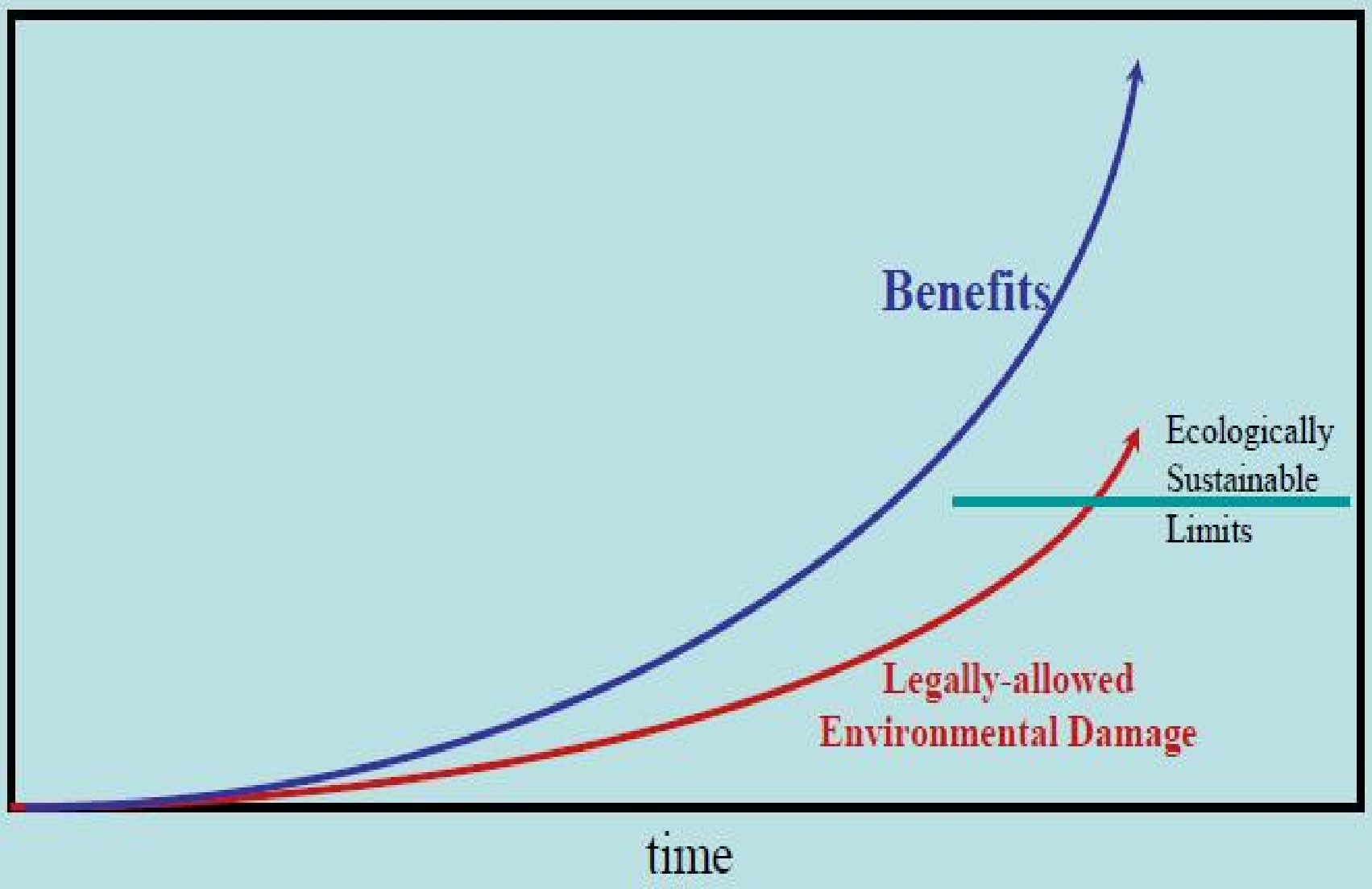


Figure 2: As the economy grows, cumulative environmental damage must eventually surpass the Earth's ecologically sustainable limits

Ecosystem limits do exist, as we have seen with the 9 planetary boundaries.

Rockstrom 2009a, 2009b, 2009c

This is why cumulative impacts are the central problem of our time.

They are ruining the Earth as a place suitable for human habitation, yet most of our laws fail to acknowledge that ecological limits exist and can be breached by cumulative impacts.

Why is any of this important?

So far as anyone knows, the Earth is the only place in the universe hospitable to human life.

If the Earth is our only home and our cumulative impacts are reducing its capacity to support human life, then we run the risk of an infinite loss – losing our only home in the universe.

***Under these circumstances*, justifying additional costs (harms) by balancing them against benefits no longer makes sense.**

***Under these circumstances*, cost-benefit analysis ceases to provide sound scientific guidance for policy.**

We are living in a new world, one that is approaching or exceeding ecological limits (which, in turn, is causing chronic human diseases to increase). (MEA, 2005; GEO-4, 2007; Rockstrom, 2009a, 2009b, 2009c)

Therefore, we need new rules for making decisions.

Specifically, we need to examine <u>every decision</u> that can impact the ecosystem (or human health) through the lens of a precautionary approach.

The four main ideas of a precautionary approach:

1. If we have evidence that harm is occurring or is about to occur, we have a duty to take action to prevent harm.

2. We shift the burden of proof to the proponents of a new product or project or activity. It is up to them to show…

(a) That their activity is being conducted in the least-harmful way possible; and

(b) That their activity will not degrade the ecosystem or human health.

3. Because of the certainty that we will make errors, after we make a decision, we monitor results carefully and stand ready to alter course (aka "adaptive management"). (USDOI, 2009)

Therefore, we aim to avoid irreversible decisions and irretrievable commitments.

4. We engage the public – *really* engage them – in decisions that affect their lives.

Wisdom and authority reside among the citizenry, not the experts, though of course experts have an important role as advisers.

At this point, we will discuss the handout, “An Ordinance to Protect Health.”

There are more slides in this presentation, which you can find on the web.

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Using a precautionary approach, uncertainty, scientific doubt and missing data become reasons to take precautionary action and to *not* just press ahead assuming that benefits will outweigh costs.

Cost-benefit analysis (and risk assessment) ask, How much harm is acceptable?

Precautionary action asks, How much harm is avoidable?

You may hear that the precautionary principle is vague, because there are many ways to define it. This not true.

In EVERY definition of the precautionary principle, there are three common elements:

1. When we have reasonable suspicion that harm is occurring or may occur

2. *and* we have scientific uncertainty

3. *then* we all have a duty to act to prevent harm. (Montague, 2008)

The precautionary approach does not tell us what action to take.

But advocates for this approach have suggested the following...

Eight kinds of precautionary action we can take:

1. Set goals (dream, then plan)

2. Engage the affected people in decisions; *really* engage them

3. Reverse the burden of proof. Assume that any action that affects the biosphere or human health will be harmful, until proven otherwise.

In other words, give the benefit of the doubt to nature and to public health. It is not up to the public to prove harm.

It is worth pointing out that we already take this approach with new pharmaceutical products.

New drugs are assumed to be harmful or useless or both until the drug company can show both safety and efficacy.

4. Examine all available alternatives for achieving the goal(s) and select the least-harmful way.

5. Consider all the evidence (no cherry-picking data, no ignoring inconvenient facts)

6. After a decision is made, monitor carefully (no sleep-walking)

7. Heed early warnings

Be prepared to alter course based on monitoring results.

8. Acknowledging that we may need to alter course implies that we should avoid irreversible decisions and irretrievable commitments

Precaution is not anti-science.

Rather than "overriding" science and data, this principle explicitly acknowledges the central role of scientific data (and scientific doubt) in decision-making.

Cost-benefit balancing for decisions is unscientific because is ignores the thousands of studies that show that ecological limits can be exceeded by the cumulative impacts of costs that are justified by benefits. **MEA 2005; Rockstrom, 2009a, 200bb, 2009c;**

We all use the precautionary principle every day in our own lives.

For instance, we may grow our own food, or buy organically grown food, because of a perceived risk from pesticides.

Even though we don't know everything there is to know about pesticides and our health, we may take precautionary action (grow or buy organically grown food) to avoid unintended consequences (getting cancer or other diseases).

Where did the precautionary principle come from?

Precaution grew out of grass-roots activists identifying problems -- chemical dumps, Superfund sites, polluted wells, polluted rivers, fish too toxic to eat, leaking landfills, radioactive waste, pesticide poisonings, sludge dumped on land, toxic waste left in poor communities and communities of color, rising disease rates, and so on.

Precaution came from activists opposing risk-based decisions.

Risk assessment asks, How much harm is acceptable?

Precautionary action asks, How much harm is avoidable?

Precaution developed in response to big mistakes of the past -- lead in gasoline and in paint; pesticides; destruction of the ozone layer, global warming... (Harremoes, 2001)

Precaution comes directly from the central principle of public health: primary prevention

Precaution derives from the guiding principle of clinical medicine: first do no harm

Precaution comes from the German *vorsorgeprinzip*: the principle of foresight or forecaring

The European Union adopted the precautionary principle in its founding document (The Maastricht Treaty of 1990)

Precaution comes directly from your grandmother:

** look before you leap

** better safe than sorry

** a stitch in time saves nine

How is the precautionary approach being used?

Many cities and a few states now take a precautionary approach to pest management in schools, playgrounds, parks, and public buildings. They have passed laws and regulations specifying that chemicals will be used only as a last resort, after all other alternatives have been tried.

Many cities in Canada have passed ordinances prohibiting the use of pesticides on lawns for cosmetic purposes.

The Supreme Court of Hawaii has ruled that the state must manage Hawaii's water resources using a precautionary approach, aiming to avoid harm to the resource, which the state holds in trust for present and future generations of Hawaiians.

Many nations (and a few states in the U.S.) have adopted a precautionary approach to the management of fisheries, to avoid harm from overfishing, habitat destruction, and pollution.

The City and County of San Francisco have adopted precaution as overarching governmental policy, guiding all their decisions

The Township of Lyndhurst, N.J. adopted the precautionary principle in 2008 to guide all municipal policies

See handout, and read the story here:

http://tinyurl.com/cc5wod

Several towns in rural Pennsylvania have taken a precautionary approach to local public health and corporate power: they have passed local laws prohibiting corporations from farming, mining, and putting sewage sludge on land, among other things. **http://www.celdf.org**

A model precautionary municipal ordinance is available. It takes into account both the precautionary approach, cumulative impacts, and the need to consider justice and fairness in decisions:

http://goo.gl/GPnHU

Using a precautionary approach, whenever we make any decision affecting the ecosystem, human health, or community well-being (including fairness and justice), we can do *seven things*:

1. **Consider all reasonable alternatives (including the alternative of doing nothing) with the intention of adopting the least harmful way**

2. Assume that any proposed changes will be harmful (including proposals for solving problems).

Proponents should have to provide reasonable evidence that their project will not make things worse (just as drug companies must provide evidence that their drugs are reasonably safe and beneficial before sale).

3. Consider the cumulative effects of this decision with previous decisions

Do *not* take actions or make decisions in isolation

4. Consider the effects of our actions on seven generations.

We can appoint an official guardian of future generations to help decision-makers consider the long-term consequences of their decisions.

5. Give state government, local governments, and affected neighborhoods the right to say "No" to projects they deem harmful to human health, the environment, or community well-being (just as they already can say “No” to liquor stores or pornography shops).

6. Consider how fairness and justice will be affected by every decision. Ask, who will get the benefits? Who will pay the costs? Who will be harmed?

7. Take into consideration the effects of decisions on burdened and vulnerable populations

More Burdened: (Montague, 2009c)

Living in cities with air pollution from traffic, deteriorated housing, toxic lead in the soil of play grounds, with housing built on or near toxic industrial sites, etc.

More Vulnerable: (Hynes, 2007)

Higher rates of pollution-related disease (cancer, diabetes, asthma, etc.); more stress from racism, joblessness, etc.

Low income = more people without health insurance, less access to healthy food, etc.

In New Jersey, Blacks and Hispanics fare worse than Whites on measures of asthma, diabetes, cardiovascular disease, infant mortality, and several kinds of cancer (including breast, cervical, colorectal, and prostate).

For more data, see http://goo.gl/YFQqc

So there you have it:

The precautionary principle is a new way of making decisions for a new time.

These days, when it sometimes seems as if the future itself is endangered, precaution offers us a way forward.

Precaution offers us hope.

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