

ACTUAL ISSUES OF ENVIRONMENTAL ECONOMICS

Actual Issues of Environmental Economics

Edited by

Márton Czikkely, Prespa Ymeri, Nguyen Huu Hoang, Boglárka Herczeg,
Bálint Horváth *and* Dr. Éva Neubauer

Reviewed by

Dr. habil Csaba Fogarassy

Szent István University, Faculty of Economics and Social Sciences
Institute of Regional Economics and Rural Development
Climate Change Economics Research Centre

ISBN 978-963-269-770-3

Gödöllő, Hungary

2018

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CHAPTER 1: INTRODUCTION TO ENVIRONMENTAL AND RESOURCE ECONOMICS

“Environmental economics is a subset of economics concerned with the efficient utilization of resources. Because the environment provides both direct value and the raw material intended for economic activity, the environment and the economy are interdependent. For that reason, the way the economy is managed can have an impact on the environment that, in turn, may affect both welfare and the performance of the economy.

*One of the best-known critics of traditional economic thinking about the environment is Herman Daly. In his first book, *Steady-State Economics*, Daly suggested, “enough is best”, arguing that economic growth leads to environmental degradation and unequal distribution of wealth. He asserted that the economy is a subset of our environment, which is finite. Therefore his notion of a steady-state economy is one in which there is an optimal level of population and economic activity which leads to sustainability. Daly called for a qualitative improvement in people’s lives—development—without perpetual growth. Today, many of his ideas are associated with the concept of sustainable development.” (*The Environmental Literacy Council, 2015*).*

Article 1: Top 10 Environmental Problems of the Planet

1. Over Population

Without a doubt, the biggest issue facing the environment is over population of humans. All other major environmental issues flow from the very fact that we are over populating the planet. The world’s population has tripled in the last 60 years, placing stress on every aspect of the environment. More land is developed every day to accommodate the urban spread. In 1950 the population stood at 2,555,982,611 compared to over 7,382,200,400 this 2015. The actual math is that the world’s population has increased by almost 3 times. That is staggering when you think about it. That figure is increasing even as we speak!

2. Climate Change

The most controversial and political of the top 10 environmental issues is climate change. Recently, an overwhelming majority of climate scientists believe that human activities are currently affecting the climate and that the tipping point has already been passed. In other words, it is too late to undo the damage that climate change has done to the environment. At this stage the best we can do is regulate the further impact upon the environment by developing

more environmentally friendly methods of energy production by reducing the mining and burning of fossil fuels.

3. Loss of Biodiversity

The loss of biodiversity on the planet can be directly related to the behaviors of human beings. Humans have destroyed and continue to destroy the habitats of species on a daily basis. When we exterminate one species, it has a knock on effect in the food chain which in turn upsets the ecosystems interdependent on one another. The catastrophic impact of loss of biodiversity is likely to affect the planet for millions of years to come. The current loss of biodiversity is also being named “The Sixth Extinction”.

4. Phosphorous and Nitrogen Cycles

Although the effect of human activities on the carbon cycle is better known, the lesser known effect on the cycle of Nitrogen actually has a greater impact on the environment. The human race’s use and abuse of nitrogen has been one of the most beneficial technologies for our own species for decades. Every year, humans convert an estimated 120 million tons of nitrogen from the atmosphere into reactive forms such as nitrates, mainly in the production of nitrogen-based fertilizer for crops and in the use of food additives. The run off from crops into our oceans has a negative effect upon phytoplankton which is responsible for the production of most of the oxygen in our air.

5. Water Supply

Many experts believe that in the near future water will become a commodity just like gold and oil. Some experts’ say that wars will be fought over who owns the water supply. Currently, one third of humans have inadequate access to clean, fresh water. The number is expected to increase by to up to two thirds by 2050. That is, that two thirds of the world’s population will not have access to clean water! Over population, demand and pollution from industry is to blame.

6. Ocean Acidification

This is a direct effect of excessive CO₂ production. The oceans absorb as much as 25% of all human carbon dioxide emissions. The gas then combines with other elements to form compounds such as carbonic acid. Over the last 250 years, surface acidity of the ocean has increased by an estimated 30%. The acidity is expected to increase by 150% by year 2100. The effect of over acidification of the oceans on sea creatures such as shellfish and plankton is similar to osteoporosis in humans. The acid is effectively dissolving the skeletons of the creatures. The effect of ocean acidification may soon challenge marine life on a scale that the planet has not seen for millions of years.

7. Pollution

Pollution of air, water and soil by chemical compounds take many years to break down. Most of these chemicals are the bi-products of our modern lifestyle, and are created by industry and motor vehicle exhaust. Pollution isn't just limited to the air. Soil is another place where pollution is starting to take hold. Common toxic substances include heavy metals, nitrates and plastic. A lot of the plastics that are discarded by humans end up in the ocean. These plastics tend to go unseen by humans, as the pollution is usually blown out to sea by prevailing winds.

8. Ozone Layer Depletion

Depletion of our ozone layer has been mainly attributed to the release of chemical pollution containing the chemicals Chlorine and Bromide. Once the chemicals reach the upper atmosphere, they cause ozone molecules to break apart causing a hole to form, the largest of which is over the Antarctic. The atmosphere blocks many of the harmful UV rays from the sun that can damage living tissue. In an effort to reduce this process, CFCs have been banned in many manufacturing processes and products. According to the Environmental Protection Agency, one atom of chlorine can break down more than 100, 000 ozone molecules.

9. Overfishing

It is estimated that by 2050 there will be no fish left in the sea. The extinction of many fish species is due to humans over fishing the oceans to supply an ever increasing population's demand for seafood. The collapse of the Atlantic Cod Fishery is one such example of how humans have exploited the planet's natural resources to the brink of extinction.

10. Deforestation

Since 1990, half of the world's rain forests have been destroyed. The clearing of forests continue at an alarming rate. To add to the worry, a recent phenomenon has been added to the list. Trees are now dying globally at a rate never before seen.

Article 2: Air Pollution



Here's what you need to know about the warming planet, how it's affecting us, and what's at stake.

Smog hanging over cities is the most familiar and obvious form of air pollution. But there are different kinds of pollution—some visible, some invisible—that contribute to global warming. Generally any substance

that people introduce into the atmosphere that has damaging effects on living things and the environment is considered air pollution.

Carbon dioxide, a greenhouse gas, is the main pollutant that is warming Earth. Though living things emit carbon dioxide when they breathe, carbon dioxide is widely considered to be a pollutant when associated with cars, planes, power plants, and other human activities that involve the burning of fossil fuels such as gasoline and natural gas. In the past 150 years, such activities have pumped enough carbon dioxide into the atmosphere to raise its levels higher than they have been for hundreds of thousands of years.

Other greenhouse gases include methane—which comes from such sources as swamps and gas emitted by livestock—and chlorofluorocarbons (CFCs), which were used in refrigerants and aerosol propellants until they were banned because of their deteriorating effect on Earth's ozone layer.

Another pollutant associated with climate change is sulfur dioxide, a component of smog. Sulfur dioxide and closely related chemicals are known primarily as a cause of acid rain. But they also reflect light when released in the atmosphere, which keeps sunlight out and causes Earth to cool. Volcanic eruptions can spew massive amounts of sulfur dioxide into the atmosphere, sometimes causing cooling that lasts for years. In fact, volcanoes used to be the main source of atmospheric sulfur dioxide; today people are.

Industrialized countries have worked to reduce levels of sulfur dioxide, smog, and smoke in order to improve people's health. But a result, not predicted until recently, is that the lower sulfur dioxide levels may actually make global warming worse. Just as sulfur dioxide from volcanoes can cool the planet by blocking sunlight, cutting the amount of the compound in the atmosphere lets more sunlight through, warming the Earth. This effect is exaggerated when elevated levels of other greenhouse gases in the atmosphere trap the additional heat.

Most people agree that to curb global warming, a variety of measures need to be taken. On a personal level, driving and flying less, recycling, and conservation reduces a person's "carbon footprint"—the amount of carbon dioxide a person is responsible for putting into the atmosphere.

On a larger scale, governments are taking measures to limit emissions of carbon dioxide and other greenhouse gases. One way is through the Kyoto Protocol, an agreement between countries that they will cut back on carbon dioxide emissions. Another method is to put taxes on carbon emissions or higher taxes on gasoline, so that people and companies will have greater incentives to conserve energy and pollute less.

Source: <http://environment.nationalgeographic.com/environment/global-warming/pollution-overview/> (downloaded: 06-10-2016)

Article 3: What Causes Global Warming?

Scientists have spent decades figuring out what is causing global warming. They've looked at the natural cycles and events that are known to influence climate. But the amount and pattern of warming that's been measured can't be explained by these factors alone. The only way to explain the pattern is to include the effect of greenhouse gases (GHGs) emitted by humans.

To bring all this information together, the United Nations formed a group of scientists called the Intergovernmental Panel on Climate Change, or IPCC. The IPCC meets every few years to review the latest scientific findings and write a report summarizing all that is known about global warming. Each report represents a consensus, or agreement, among hundreds of leading scientists.

One of the first things scientists learned is that there are several greenhouse gases responsible for warming, and humans emit them in a variety of ways. Most come from the combustion of fossil fuels in cars, factories and electricity production. The gas responsible for the most warming is carbon dioxide, also called CO₂. Other contributors include methane released from landfills and agriculture (especially from the digestive systems of grazing animals), nitrous oxide from fertilizers, gases used for refrigeration and industrial processes, and the loss of forests that would otherwise store CO₂.

Different greenhouse gases have very different heat-trapping abilities. Some of them can even trap more heat than CO₂. A molecule of methane produces more than 20 times the warming of a molecule of CO₂. Nitrous oxide is 300 times more powerful than CO₂. Other gases, such as chlorofluorocarbons (which have been banned in much of the world because they also degrade the ozone layer), have heat-trapping potential thousands of times greater than CO₂. But because their concentrations are much lower than CO₂, none of these gases adds as much warmth to the atmosphere as CO₂ does.

In order to understand the effects of all the gases together, scientists tend to talk about all greenhouse gases in terms of the equivalent amount of CO₂. Since 1990, yearly emissions have gone up by about 6 billion metric tons of "carbon dioxide equivalent" worldwide, more than a 20 percent increase.

Source: <http://environment.nationalgeographic.com/environment/global-warming/gw-causes>
(downloaded: 06-10-2016)

Article 4: Does Air Pollution Reduce Cycling's Health Benefits?

Columbia University scientists use innovative tools to investigate how vehicle exhaust impacts cyclists.

Watch: Could biking in a city be hazardous to your health? Most cyclists have been there: peacefully pedaling one minute and sucking bus exhaust the next. In the moment, all you can do is keep riding and shrug off the blast of smoke. But now a growing body of research



suggests breathing this pollution can have both short-term and long-term health consequences. A team of researchers from Columbia University has started using a suite of state-of-the-art personal monitoring devices to gather more details about how air pollution affects cyclists' health.

The new study—a joint undertaking by scientists in the Mailman School of Public Health and the Lamont-Doherty Earth Observatory—aims to show minute-by-minute health and pollution data. The researchers have equipped volunteer bike commuters with a skintight biometric shirt, a mesh vest stocked with air pollution monitors, a location tracking system that liaises with smartphone GPS software, and a blood pressure monitor. Combined, the instruments will characterize exactly where a rider inhales pollution and how his or her lungs and heart respond.

“We’re really trying to quantify the health impacts of commuting by bicycle in a dense urban setting,” says Darby Jack, an environmental health scientist at Columbia University and part of the study’s brain trust.

A Pollution Problem

In New York City alone, health officials estimate that fine particulate matter (known as PM_{2.5}) contributes to nearly 2,000 premature deaths and more than 6,000 hospital visits per year. The young and old are particularly susceptible, as are people who suffer from asthma and other respiratory disorders or heart disease.

“We have internal combustion engines that emit particles, we put them out a tailpipe, and then we drive along our sidewalks. And we sort of emit this stuff right into our breathing zones,” says Arden Pope, a professor of economics and an epidemiologist at Brigham Young University who is not involved in the Columbia study. As these particles—particularly the fine ones—spew from tailpipes, they are inhaled and accumulate in lungs. Most of these particles are black carbon, but vehicles also discharge nitrogen oxides and polycyclic aromatic hydrocarbons (PAH).

Research has shown that long-term exposure to these pollutants increases the risk of heart and lung disease, and short-term exposure can trigger heart attacks.

The problem is amplified by exercise. During workouts, respiration increases and more air enters the lungs. Jogging, for example, can increase the volume of air by three to four times, and strenuous exercise can push the volume even higher. All this extra air also brings more pollutants into the body. This creates a conundrum for bike commuters in the city: At what point does exercise hurt your health more than help it?

It is generally thought that the benefits of exercise outweigh the hazard of air pollutants, and a recent study suggests this is true in "the vast majority of settings." In a city like New York, with background PM_{2.5} concentrations below the global average, a healthy person without heart or lung problems would need to cycle for hours and hours a day before the adverse impacts of pollution outweigh the health benefits of exercise. At that point, the only health effect you're likely to suffer is a sore bum from riding all day.

However, Jack says looking at background concentrations alone may not tell the full story. "You can really underestimate the exposure for folks exercising in urban settings," he says. Pollution varies by location—it is not static or evenly distributed. And as we move through a city, exposure differs depending on the setting.

"Using a single number for PM_{2.5} to represent an entire city isn't really true exposure," explains Patrick Ryan, an epidemiologist at the Cincinnati Children's Hospital Medical Center who is not involved in the research. "We know that you interact with air pollution over the course of the day ... and it really changes your exposure."

Furthermore, exposure fluctuates based on our level of physical activity. Cranking up a hill behind a belching garbage truck is much different than a casual cruise on the Manhattan Waterfront Greenway.

Gearing Up

As cycling grows in popularity—over a million New Yorkers ride a bike every month—health and safety are growing concerns for bike advocates. Advocacy groups are mostly focused on preventing crash hazards and vehicle collisions, but pollution data would dovetail nicely with their cause, according to Paul Steely White, the executive director of New York's Transportation Alternatives. Safety and pollution trends are mutually reinforcing, he explains, and the group is watching the research carefully.

The research is in its pilot phase, and Jack and his colleagues are focused on convincing themselves—and their funders—that both health and pollution data can be collected simultaneously, in real time.

The team is working with about 30 cyclists—men and women commuters from all corners of the city—but they hope to expand the research to hundreds of cyclists within a few years. Eventually Jack hopes the data can be incorporated into a smartphone app to help cyclists optimize their bike routes based on pollution data. For now, however, the team is focused on perfecting their measurements and tinkering with the equipment to best capture life on a bike in New York City.

Source: <http://news.nationalgeographic.com/2016/08/bicycles-air-pollution-health-new-york-city-columbia-university/> (downloaded: 06-10-2016)

Article 5: Predicting the World’s Next Water Pollution Disaster

From mining messes to hydraulic fracturing contamination



A worker samples water from a well at a coal bed methane drill site. When an estimated 184 million gallons (697 million liters) of industrial waste spilled into Hungary’s Marcal River in early October, arsenic and mercury threatened to taint water supplies and degrade rivers, both at the site and for hundreds of miles downstream. In

some ways, Hungary’s toxic mud disaster was a wake-up call, shining a spotlight on potential water pollution hotspots around the globe. *Where might disaster strike next?*

Mining Impacts

Only a tiny fraction of the ore miners exhume contains gold, copper, lead, zinc, or the other metals they’re after. The rest is waste, or tailings, full of large quantities of metals and minerals ranging from benign to very toxic. These fine-grained wastes are often held in tailings ponds that can cover many square miles.

Unfortunately the dams holding tailing ponds aren’t always examples of high-level engineering and, in some countries, may be made by simply bulldozing the tailings themselves into an embankment, explains geologist Johnnie Moore, of the University of Montana.

“There is the potential for huge amounts of [toxic waste] to move into a river system whenever any of those things break, and in fact it does happen,” he said.

Last summer a discharge of acidic waste escaped from a Fujian province copper plant run by China's largest gold producer, Zijin Mining Group Co. The accident poisoned enough Ting River fish to feed 70,000 people for a year and also contaminated their water supply, according to reports from the Reuters news agency. Two years earlier, runoff from a gold mine near Dadong contaminated the water supply for more than 200,000 people. Over the years, similar disasters have occurred in Spain, Peru, the Philippines, and elsewhere, and there are plenty of other sites in China that scientists have their eye on.

Other toxic processes that use mercury and cyanide to extract valuable minerals from rock create the potential for environmental disaster as well. In places like South America's Amazon Basin, where a gold rush continues, centuries-old techniques that use mercury are still in widespread use. The mercury, which neurologists warn causes nervous system problems, paralysis, and even death when consumed through fish, binds with gold, creating an amalgam that can be separated from other objects in pans or big sluice boxes.

"Unfortunately people aren't very careful with it," said Moore.

In the process much of that mercury ends up directly in the water. As a result, the long-lasting element is building up in waterways, and the food chain, at ever-increasing concentrations that are impacting human health, even downstream. Cyanide solution, another extraction method, is used on large leach pads to separate gold from ore and other materials. Ore is piled on a large pad, lined to prevent leakage, and "irrigated" by cyanide spray or drip systems. When such systems work properly, Moore said, the solutions are captured for reuse and environmental impact is minimal.

But, "if a cyanide pad breaks down, these materials can go rushing off into rivers," explained Moore. "And there have been some big disasters, like Guyana in 1995, where these things have broken and flooded rivers, and because they are full of cyanide they kill everything in the river. These things definitely still happen."

While preventing future disasters is a major concern, those of the past continue to contaminate rivers in the present.

The U.S. Environmental Protection Agency (EPA) estimates that 40 percent of all the watersheds in the western United States are impacted by mining pollution such as residual mercury and acid mine drainage—the acidic water that leaks from mines both active and long-abandoned when newly dug minerals are exposed to air and water.

Such problems are difficult or impossible to halt once the processes get going, and in some places remediation efforts must continue indefinitely.

“Here in Montana’s Clark Fork River Basin, after decades of work and millions of dollars of remediation there is still contamination in the floodplain. It will take thousands and thousands of years, even after all this effort, to get back to any kind of background level,” Moore said.

Coal Ash

Coal is a giant part of the world’s energy picture. Unfortunately when it’s burned it leaves behind a giant waste problem—coal combustion residuals, commonly known as coal ash.

When carbon is burned away to produce power toxic heavy metals like arsenic, cadmium, mercury, and thallium are left behind in highly concentrated forms throughout some 136 million tons of coal ash produced in the U.S. alone each year.

Much of that ash is landfilled in dry, lined compounds, but about a third of the nation’s coal ash storage sites are wet ponds.

““These are the ones that have the potential of a catastrophe such as we saw in Tennessee,” said Barbara Gottlieb, who directs the coal program Code Black for the Physicians for Social Responsibility.

In December 2008, an earthen dike at the Kingston, Tennessee, Fossil Plant failed, unleashing a billion-gallon sludge flood that buried homes and fields, swamped the Emory River, killed countless fish and other animals, and ignited anger and debate about the ecological and human health impacts of coal ash.

The Kingston site was not unique.

“EPA rates coal ash ponds in terms of potential for serious damage in case of a retaining wall rupture, and the possible damage or death to humans, ecosystems, and property values,” said Gottlieb. “They’ve identified 49 wet storage ponds [scattered across the country] as having a high hazard potential and another 19 as significant hazard potential.”

Even if those ponds don’t fail, environmentalists fear that over time they will leach containments into water systems.

But just how dangerous is coal ash? Industry groups, like the American Coal Ash Association stress that the substance isn’t currently considered a hazardous waste by the EPA. In fact, with government support, much of it is recycled into products like concrete, cement, wallboard, and construction fill.

Conrad Dan Volz, of the University of Pittsburgh’s Center for Healthy Environments and Communities, is among the many who believe the substance is hazardous.

“There are at least 20 peer reviewed scientific studies that clearly show that animals exposed to fly ash suffer genotoxic effects,” he said. “Salamanders, frogs, and toads have been shown

to have arsenic levels hundreds of times those of background, which affect growth, reproduction, and survival. There are very serious environmental problems with coal ash that can't be overlooked."

Volz stressed that cleaner coal emission technologies have actually made the ash byproduct more toxic. "We can't turn lead into gold," he added. "If there's so much arsenic or anything else in coal when you burn it, if it doesn't go out the stack it becomes more concentrated in the ash. That's the way it works, there's no free ride."

The Obama administration will soon come down on one side or another of the coal ash debate. Currently each state makes its own coal ash regulations, and they can vary widely from state to state. But two competing regulatory rules are under consideration at the federal level.

One would mandate federal disposal requirements for "hazardous" ash, while the other would label the ash non-hazardous and leave regulation to the states.

Could the massive clean-up response to the Tennessee spill tell which way the ruling might fall?

"Clearly the EPA knew that was very serious," Gottlieb said. "Workers wore hazmat suits, families were relocated, and they even bulldozed parcels of saturated soils and trucked them away for disposal."

Gas and Oil Extraction

The drive to drill for critical new sources of oil and gas is in motion around the world, but nowhere is it more frenetic at the moment than in the Marcellus region, which sits above a 389-million-year-old rock formation cutting a 95,000 square-mile (246,000 square-kilometer) arc across West Virginia, Pennsylvania, and New York.

The site is home to a natural gas reserve of between 50 trillion and 500 trillion cubic feet, potentially second in size only to the Pars field of Iran and Qatar, and lies in the energy-hungry eastern United States.

Development of the natural gas reserves in the region is in its infancy. The benefits of extracting all that gas include an enormous boost to local economies and an important domestic source of energy that could provide power for decades. But the future of freshwater is high among environmental concerns associated with The Great Shale Gas Rush. And the University of Pittsburgh's Conrad Dan Volz believes it starts with simply setting up the wells.

"People don't think about it very often but there are serious erosion and sedimentation issues that go along with clearing three- to five-acre well pads. And in Pennsylvania alone they are

talking about 100,000 wells or more over the next 20 to 30 years, in addition to the clearing of spaces for compressor stations, pipelines, and other infrastructure.”

Drilling also exposes sulfide-rich rock cuttings, Volz said, which once on the surface can react with air and water to produce a sulfuric solution somewhat akin to acid mine draining.

These aquatic impacts must be considered even when drilling proceeds according to plan. But, as oil spills in the Gulf and elsewhere have made quite clear, drilling does not always proceed according to plan.

“Every well has a potential to leak gas or oil over time,” Volz said, despite efforts to protect water supplies and prevent loss of gas by lining wells with steel and concrete casings. “Conduits for gas and liquid to escape and go into water aquifers appear over time everywhere oil and gas exploration occurs.”

Some residents and communities in shale regions have already experienced contaminated water, though it’s difficult to trace exactly where in the process such contaminations occurred.

Much scrutiny has been focused on the process that has recently made this mother lode of gas accessible—hydraulic fracturing or “fracking.” The technique blasts a cocktail of chemically laden water and sand into a well to create a mini-earthquake that fractures the shale and releases gas.

Fracking uses a lot of water, about 4 million gallons (15 million liters) of water for each frack. Some 20 to 50 percent of the watery fluid comes back out as ultra-salty brine that’s potentially laden with heavy metals. The Pennsylvania Department of Environmental Protection (DEP) has documented at least 130 spills since 2008.

The rest of the fluid stays deep in the shale layer at depths of 4,000 to 8,500 feet (1,220 to 2,590 meters). Industry officials say it’s harmless there and has never been proven to migrate back toward the surface, to the far shallower levels where drinking water wells are located—typically just several hundred feet below ground.

But the EPA seems less certain that the process is benign. The agency is currently conducting a peer-reviewed scientific study to investigate any possible relationships between the fracking process and drinking water.

“EPA agrees with Congress that there are serious concerns for citizens and their representatives about hydraulic fracturing’s potential impact on drinking water, human health, and the environment, which demands further study,” the agency notes on its website.

Rivers Run Toward an Uncertain Future?

“Rivers have been so critically important in history that we’ve overexploited them to a point now that the planet’s rivers are in crisis,” notes Texas Tech University toxicologist Ronald Kendall. “You have to go to remote areas like Siberia and Scandinavia to find great rivers that aren’t as impacted.”

Toxic threats such as mining tailings and coal ash are joined by many others, some inevitable and others largely preventable.

“The Yangtze is threatened by industrial pollution,” Kendall explained. “Infrastructure development on the Danube has destroyed wetlands and floodplains—that’s why the flooding issue is so critical there right now. We’re just overextracting water on the Rio Grande and the Colorado doesn’t even make it to its delta any more.”

But while the present picture is one of compromised water quality around the globe, Kendall stressed, the future doesn’t have to be that way if river systems are respected and protected.

“If you can cease the polluting and the over exploitation, nature can do a wonderful job in healing itself.”

Source: <http://news.nationalgeographic.com/news/2010/12/101221-next-water-pollution-disasters/> (downloaded: 06-10-2016)

CHAPTER 2: THE LAW OF DIMINISHING RETURNS

“The “law of diminishing returns” is one of the best-known principles outside the field of economics. It was first developed in 1767 by the French economist Turgot in relation to agricultural production, but it is most often associated with Thomas Malthus and David Ricardo. They believed human population would eventually outpace food production since land is an integral factor in that exists in limited supply. In order to increase production to feed the population, farmers would have to use less fertile land and/or increase production intensity on land currently under production. In both cases, there would be diminishing returns.

The law of diminishing returns—which is related to the concept of marginal return or marginal benefit—states that if one factor of production is increased while the others remain constant, the marginal benefits will decline and, after a certain point, overall production will also decline. While initially there may be an increase in production as more of the variable factor is used, eventually it will suffer diminishing returns as more and more of the variable factor is applied to the same level of fixed factors, increasing the costs in order to get the same output. Diminishing returns reflect the point in which the marginal benefit begins to decline for a given production process.” (The Environmental Literacy Council, 2015).

Article 1: The Last, Best Refuge for North America's Bees

North Dakota, with its vast prairies, is perfect for raising honeybee colonies. But can its bees and their keepers, already facing so much stress, survive the widespread loss of grasslands?



Zac Browning, owner of Browning's Honey Company in Jamestown, North Dakota, examines a hive on June 11, 2016. His bees are moved to California by truck to pollinate in January and are returned to North Dakota for the summer honey flow.

Dressed in white and veiled in mesh, Zac Browning surveys his apiary, one of 500 beeyards he manages. Thousands of worker bees alight on stacks of wooden boxes, the tiny hair baskets on their hind legs heavy with pollen they collected from clovers, dandelions, and other wildflowers. A fourth-generation beekeeper, Browning moved here from Idaho a decade ago in search of better habitat for his

bees. He is one of hundreds of beekeepers who have flocked to North Dakota over the past several decades. About 250 billion bees—one in five colonies in the United States—spend the summer in the state, which produces about twice as much honey as any other in the country.

“North Dakota is the last, best place in North America to keep bees,” Browning says.

The state’s vast, open prairies with a sparse human population and scant agricultural development offer honeybees a safe haven. Buffered from farm pesticides, they can reap the nutritional benefits of pollen and nectar from a diverse array of flowering prairie plants.

But North Dakota is losing its prairie at an alarming rate.

For thousands of years, shallow wetlands—formed during the last Ice Age—have pocked this landscape, known as the Prairie Pothole Region. Originally stretching from Iowa north to Saskatchewan, it formed the largest grassland ecosystem on Earth. Today, a small fraction of this prairie remains, and what’s left has been splintered in the past decade.

Since 2006, North Dakota has lost more than half of the land that had been set aside for conservation in a federal program. Instead of leaving lands unplowed in exchange for payments, farmers increasingly are choosing to plant lucrative corn and soybean crops to meet the growing demand for biofuels.

Danielle Downey, director of operations for the nonprofit group Project Apis m., examines bees on a frame. Pathogens and parasites can kill colonies within a year if not identified, so regular



checkups are important. These losses aren’t unique to North Dakota. More than 2,000 square miles of grassland—an area nearly the size of the state of Delaware—were converted to corn and soybean cropping across the northern Great Plains between 2006 and 2011. The changes in land use have left beekeepers scrambling for scraps of disappearing habitat. Where Browning used to be able to house all of his hives within 70 miles of Jamestown, he’s now stretched out over a 150-mile radius in his search for viable land.

"In the past seven years, we've lost 200 good beeyards," he says. "We're having to move our hives onto increasingly more marginal landscapes."

Kids Learn Why Bees Are Awesome

Bees are vital to the world's food supply. To educate schoolchildren about the importance of honeybees, the Sweet Virginia Foundation is using a combination of classroom instruction and hands-on experience. The kids get up close and personal with the insects, donning beekeeper suits and actually interacting with



a buzzing hive. The White House is also working to inform the public about the importance of these pollinators—in 2014, First Lady Michelle Obama added a pollinator garden and honeybee hive on the South Lawn.

The Honeybee's Plight

Honeybees are facing a suite of challenges. New parasites and diseases, growing pesticide use, changes in agricultural and beekeeping practices, and the loss of flowered landscapes have taken a toll on bee health. In 2006, beekeepers began reporting unprecedented die offs—adult honeybees were vanishing from their hives. Experts coined the term Colony Collapse Disorder and concluded that the phenomenon was likely due to a confluence of stressors.

While bees declined everywhere, U.S. beekeepers, who often maintain huge operations of more than 10,000 colonies, experienced the greatest losses.

“It’s gotten really hard to keep bees alive,” says beekeeper John Miller. Like Browning, Miller is a fourth-generation beekeeper who got his start in Idaho. He moved the family business to North Dakota in 1968, when grains and potatoes began to dominate the agricultural landscape in southeastern Idaho, leaving little room for the bees.

Miller, who keeps about 20,000 colonies, says he now factors in hive loss as an annual business expense. “On a bad year, we might lose up to 40 percent,” he says.

Clint Otto, a research ecologist with the U.S. Geological Survey, prepares bee smokers before examining hives at Browning's Honey Company. The smoke masks the bees' alarm pheromones, allowing access to the hives.

Miller and Browning say the problems started decades before Colony Collapse Disorder. When Browning's grandfather and great-grandfather went into business in 1921, they could easily harvest a hundred pounds of honey per hive each year. The changes began after World War II. Commercial pesticides were introduced, farms got bigger and more mechanized. Larger farming equipment meant the fields could be leveled and drained more efficiently, with less left to fallow. Blooming crops such as alfalfa, which are a good food source for bees, were harvested and removed from the fields faster. By the late 1980s when Browning took over the family business, he struggled to pull in a 40-pound honey crop. He suspects the bees just couldn't find enough nectar to make their honey.



Browning, like many commercial beekeepers, now makes a living on providing pollination services for almonds and other flowering crops. Each winter, 1.8 million honeybee hives are trucked from around the country to California's almond orchards. The trip, however, takes a major toll on the hives: They are exposed to pesticides and disease.



"It's the worst thing we do to our bees every year," Browning says, "but it's become an economic necessity."

Bee Habitat and Health

Clint Otto removes a screen tray covered in tiny, mustard-colored pollen pellets from one of Browning's honeybee boxes. The bees will spend the next several weeks at the North Dakota apiary, foraging and getting "fat and happy," before moving later in the summer to pollinate canola blossoms in other parts of the state.

Otto, an ecologist at the United States Geological Survey's Northern Prairie Wildlife Research Center in Bismarck, is leading a study across several states to better understand how land use and habitat influence honey production. He collects pollen from bees in a variety of habitats, and then tests the pollen for plant DNA to figure out which flowers the bees are visiting. So far, Otto's detected genetic material from more than 260 different plant groups in pollen collected from North Dakota honeybees. Each type of flowering plant offers a slightly different set of nutrients. Bees, just like humans, need a variety of food choices for optimal health.

“Our provisional results highlight the importance of plant diversity for bee health and the need for maintaining landscapes with plants that flower at different times throughout the growing season,” Otto says. Otto isn’t the first to investigate the link between land use and bee nutrition. A study published earlier this year found that North Dakota beehives surrounded by uncultivated land produced more honey than colonies in areas with intensive agriculture. Colonies with more access to pollen also had higher levels of proteins and fats in their blood, which are indicators of good nutrition, says senior study author Marla Spivak, a bee researcher at the University of Minnesota. Bees with better nutrition were more likely to survive through the winter almond pollination.

“We ask a lot of the bees. We need to find ways to be more gentle on them,” says Danielle Downey, director of operations for Project Apis m., a California-based nonprofit that researches and promotes honeybee health. Preventing loss of prairie habitat won’t solve all of the honeybee’s problems, Downey says, but it can help mitigate losses now by providing them with sources of high-quality nutrition. Beehive frames are stacked from floor to ceiling inside the honey house at Browning’s Honey Company. Also essential are building more sustainable agricultural systems that require fewer pesticide applications and devising practices to keep hives free of parasites and disease, she says.



Last year, Downey’s organization piloted a program with Browning’s Honey Company and the hunters’ group Pheasants Forever. In an effort to preserve and improve pollinator habitat, the group pays farmers to grow wildflowers on unproductive scraps of land and provides them with a special seed mix designed to attract bees and butterflies. The program so far has enrolled 124 landowners in North and South Dakota, with each contract averaging about 15 acres, says Pete Berthelsen, a biologist with Pheasants Forever and director of the partnership. Next year, they’ll extend the program to six states across the Upper Midwest. Honeybees face extraordinary challenges, Berthelsen says. “There’s just one thing after another knocking them back. It’s like death by a thousand paper cuts,” he says. Yet he remains optimistic that the new partnership can help to offset some of the losses while preserving key habitat for a variety of wildlife species.

“You see beekeepers, conservationists, hunters, landowners all working toward a common goal, and that’s very hopeful. The glass is half full.”

Source: <http://news.nationalgeographic.com/2016/06/the-last-best-place-in-north-america-to-keep-bees/> (downloaded: 06-10-2016)

Article 2: Are Biofuels Worth the Investment?



Environmental scientists at Argonne National Laboratory, study potential biofuel crops. *(Photo by George Joch. Courtesy Argonne National Laboratory)*

Biofuels are at a crossroads. According to the International Energy Agency, global biofuels production has grown more than sixfold over the last decade, yet biofuels still account for just 3 percent of all road fuel energy. While it may seem preferable, in theory, to make fuel from plant matter rather than oil, the reality of producing biofuel comes with its own costs and questions.

Corn-based ethanol, the world's dominant biofuel, raises land, food, and water issues associated with growing more crops for fuel feedstock.

There has been a great deal of investment and hope placed in next-generation biofuels—cellulosic ethanol and other advanced plant- and waste-based fuels that could displace gasoline and diesel fuel in a big way without the resource constraints of ethanol. (See recent related stories about fuel from whisky and microbes.)

But advanced biofuels have not scaled up as quickly as many have hoped. In the United States, for example, there are moves to repeal or scale back a mandate requiring oil refiners to blend increasing amounts of biofuel into the U.S. transportation mix. Domestic production of cellulosic biofuel has not met the government's projections, and enthusiasm for continued ethanol subsidies is low.

Should we continue to invest in biofuels, despite what many view as slow progress so far, and the criticism that the business cannot stand on its own without government subsidies?

Source: <http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/big-energy-question/are-biofuels-worth-the-investment/> (downloaded: 06-10-2016)

Article 3: Are We Loving Yellowstone to Death?

As rural development pushes deeper into wild animals' habitats, the park's precious ecosystem is facing new threats.



Tom Miner Basin, north of Yellowstone National Park, is home to ranch land and also to predators that travel in and out of the park. Hilary Anderson cuts a classic figure riding the range above the family ranch, but her purpose is practical: to deter predators by keeping cattle bunched and by showing a human presence on the land.

Just a few miles south of Bozeman, Montana, in the rolling foothills of the Gallatin Range, spacious dream homes pepper the landscape. Forty years ago, wapiti, the Shawnee name for elk, poured out of the mountains in December and spent winters grazing in farmers' alfalfa fields.

Today an ever expanding human footprint weighs on these hills, as it does on many corners of the Greater Yellowstone Ecosystem, where public and private lands intersect. The Greater Yellowstone's 22.6 million acres include both Yellowstone and Grand Teton National Parks, plus national forests, wildlife refuges, and surrounding chunks of 21st-century America: highways, towns, parking lots, malls, and suburbs. Dennis Glick, founder of conservation group Future West, assesses the scene.

For the second half of the 20th century, he, like many U.S. conservationists, believed that if anything would destroy the integrity of Yellowstone and neighboring lands, it would be the noose of natural resource extraction tightening around the national park's borders. Hard-rock mining, conservationists believed, would foul the rivers. Oil and natural gas wells would fragment wildlife habitat; industrial-strength logging would lay waste to national forests; and livestock grazing on public lands would cause conflicts with grizzly bears, wolves, and other predators.

But Greater Yellowstone survived the era of natural resource extraction that swept across the West for a century. Ask Glick now to identify the most ominous threats facing the ecosystem, and he doesn't hesitate. "Number one would be the effects of climate change: droughts, big wildfires, and diseases that were never here before." But close on the heels of climate change is people.

“It isn’t that we are behaving callously,” he says. “Humankind may very well be loving this place to death.”

This band of 1,400 sheep spends the summer grazing season in the Gravelly Range of Montana. They’re tended by three ranchers along with a sheepherder and two Akbash guard dogs. Constant vigilance replaces bullets as a way of deterring predators that live in and around Yellowstone.



Visitors from around the world are swarming to the region in record numbers. Last year both Yellowstone and Grand Teton set visitation records, and they are expected to shatter those marks again in 2016. Meanwhile waves of others summoned by an instinct to live closer to nature—“lifestyle pilgrims,” as Glick calls them—are leaving cities and relocating to Greater Yellowstone.

“Greater Yellowstone management is on the map for doing things right,” Glick says, “protecting big pieces of public land so it now supports every major mammal species that was here before Columbus arrived on the continent.” But how people develop a few million acres of private land has huge implications for the ecological integrity of public land and the wildlife that depends on it. As long as adjacent private lands remain open and undeveloped, species can survive. For example, nine major elk herds pass through Greater Yellowstone on epic migrations. Although they spend a majority of their time on public land, they also spend crucial winter months on private ranches.



A state wildlife manager in Cody, Wyoming, checks on a problem grizzly that’s been tranquilized so it can be relocated away from people. Wyoming and other states around Yellowstone argue that grizzlies, still protected on the “threatened” list under the Endangered Species Act, have recovered enough for trophy hunting to be allowed.

Back in the day, Glick says, most population growth in this region occurred in existing communities or, if in rural areas, remained tucked into draws out of the wind or above the floodplain. “Nowadays,” he says, “rural sprawl has been the dominant development pattern, and it has ripple effects for public lands.”

Andy Hansen, a conservation biologist and professor at Montana State University, points out—in a study due to be published this summer—that the number of private land tracts with no homes or few homes is declining. And the number of parcels with one home per 40 acres increased 328 percent from 1970 to 2010, he says. By 2013, 30 percent of Greater Yellowstone was considered “developed,” and some wildlife migration pathways were believed to be imperiled. By 2020, between 5 and 40 percent of the ecosystem’s most biologically rich habitats will undergo conversion from ranch and farmland to exurban development.

Nic Patrick survived an attack by a grizzly bear at his own ranch. He recounts his story, holding no grudges.

Today Yellowstone and Grand Teton, plus Glacier National Park, located along the U.S. border with Canada, are the only national parks in the lower 48 states that support populations of three major North American predators: grizzlies, wolves, and mountain lions. In Yellowstone and Grand Teton this



success is due to the parks’ good neighbors: surrounding private lands that support habitat for the prey species—elk, deer, and pronghorn—that the predators eat.

But over time the severing of corridors will likely contribute to a decline in migratory elk, mule deer, and pronghorn populations inside the national parks. People are also pushing deeper into grizzly habitat, causing conflicts that typically result in bears being removed or killed. And climate change, a looming wild card, is expected to reduce the carrying capacity of public lands, making private lands on the periphery of Greater Yellowstone all the more important.



Kids having fun with guns, just north of Yellowstone National Park, or a sign of the times? The Yellowstone region, like much of the West, is uneasily divided over a fundamental question: Who should manage the land and its wildlife, and how, and to what end? In recent decades local land trusts have protected important parcels of private

land through conservation easements. But the process isn’t keeping up with the rate at which land is being steadily fragmented.

Foresighted federal environmental laws preserved Yellowstone and the national forests. But protecting private lands requires a different kind of thinking. And at a time when anti-regulation sentiments serve as an obstacle to community planning in the West, the coming decades will be critical. In the long term what will save Greater Yellowstone from experiencing the same fate as most other regions in the lower 48? “I’ll say it in one word: ‘restraint,’” Glick says. “In 1872 the creation of Yellowstone National Park was an exhibition of restraint against the prevailing forces of Manifest Destiny, and we are reaping huge benefits. What’s going to save Greater Yellowstone comes down to the same ethic. But I’m sorry to say I’m not seeing much of that these days. If we are going to act, the time is now.”



Four-year-old Elle Anderson chases a ball and a future near her family’s house on J Bar L Ranch in Montana. “A hundred years from now,” says Hilary Anderson, “I hope this place is a thriving ecosystem full of everything that should be here—wolves, bears, humans, livestock.”

Source: <http://www.nationalgeographic.com/magazine/2016/05/yellowstone-national-parks-land-use/> (downloaded: 06-10-2016)

CHAPTER 3: CARRYING CAPACITY

“Changes in population can have a variety of economic, ecological, and social implications. One population concern is that of carrying capacity the number of individuals an ecosystem can support without having any negative effects. It also includes a limit of resources and pollution levels that can be maintained without experiencing high levels of change. If carrying capacity is exceeded, living organisms must adapt to new levels of consumption or find alternative resources. Carrying capacity can be affected by the size of the human population, consumption of resources, and the level of pollution and environmental degradation that results. Carrying capacity, however, need not be fixed and can be expanded through good management and the development of new resource-saving technologies.

*Throughout the late 1960s and 1970s, Garrett Hardin and Paul Ehrlich, both authors on overpopulation, contended that the human population had already exceeded the carrying capacity. Hardin is best known for his paper *The Tragedy of the Commons*, in which he argues that overpopulation of any species will deplete shared natural resources. Ehrlich, who wrote *The Population Bomb* in 1968, predicted a population explosion accompanied by increasing famine and starvation. Although his prediction did not come true “in fact, in 1970 there was a slight decline in the population growth rate” Erlich was correct in pointing out that, with the exception of solar energy, the Earth is a closed system with limited natural resources.*

The standard of living in a region can also help to alter an area’s carrying capacity. Compared to areas with a lower standard of living, areas with a higher standard of living tend to have a reduced carrying capacity due to greater access to and demand for more resources. Nevertheless, there is the suggestion that beyond some point, increased income and environmental improvement often goes hand-in-hand. The effect of an individual or a population on an ecosystem is called an “ecological footprint” which can be used to measure and manage the use of resources throughout an economy. It is also widely used as an indicator of environmental sustainability. Carrying capacity often serves as the basis for sustainable development policies that attempt to balance the needs of today against the resources that will be needed in the future. The 1995 World Summit on Social Development defined sustainability as ‘the framework to achieve a higher quality of life for all people in which economic development, social development, and environmental protection are interdependent and mutually beneficial components’. The 2002 World Summit furthered the process by identifying three key objectives of sustainable development: eradicating poverty, protecting natural resources, and changing unsustainable production and consumption patterns.

While the exact value of the human carrying capacity is uncertain and continues to be under debate, there is a question as to the strain that population and consumption has placed on some societies and the environment. Economists, ecologists, and policy analysts continue to study global consumption patterns to determine what the human carrying capacity is and what steps can be taken to ensure it is not exceeded. In the meantime, actions to ensure natural resource recovery for the future will depend on an increase of sustainable development policies worldwide.” (The Environmental Literacy Council, 2015).

Article 1: How Do We Make Cities Sustainable?



Panama City glows at night...

The world's cities occupy 4 percent of the Earth's land area, yet they are home to more than half of the world's people. By 2030, that percentage will swell to 60 percent. Indeed, the United Nations projects that cities will absorb most of the world's population increase between now

and 2050—more than two billion people—with the vast majority of urban expansion taking place in the developing world. Growing urbanization can be a plus for the environment, because people who live in dense cities drive less, their living spaces use less energy, and they require fewer resources. But there are also troubling trends, like increased traffic congestion, smog, and blight. Beijing's per-capita greenhouse gas emissions are higher than China's national average, and many U.S. cities are surrounded by suburbs with large carbon footprints. It will be important to pay attention to how we build cities, if we want metropolitan areas that make the planet a better place. In your view, what is the most important thing we can do to make cities more livable and sustainable in their use of energy? Rate the ideas and comment below with your own.

Source: <http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/big-energy-question/how-to-make-our-cities-more-livable-and-sustainable/> (downloaded: 06-10-2016)

Article 2: The Great Energy Challenge

Building Smarter Cities: A Crucial Challenge



Zhou Zhengyu, deputy secretary-general of Beijing's municipal government, said his city was the first in China to impose a limit on the number of registered cars. It was one of many solutions discussed in a recent panel on smarter cities. *(Photograph by Pei Ling Gan)*

How can cities, especially those in developing countries, become more energy-efficient and sustainable? The recent World Cities Summit in Singapore brought no easy answers.

Dr. Isher Judge Ahluwalia from India highlighted during the conference's keynote plenary that her country needs to pump in some \$400 billion in the next two decades to improve its urban infrastructure including public transport, roads and sanitation.

Dr. Isher Judge Ahluwalia *(Photograph by Pei Ling Gan)*



"Some of the cities in India are ready to join the industrial world in [terms of] consumption standards but many of us are still dealing with the margins of existence," said the chairperson of Indian Council for Research for International Economic Relations. While Indian cities struggle to deal with slums and catch up on their infrastructure deficit, Chinese cities have had to resort to quotas to keep the unsustainable growth of car ownership in check.

Zhou Zhengyu, deputy secretary-general of Beijing's municipal government, shared during the discussion that the Chinese capital was the first to impose a cap last year, allowing only 240,000 cars to be registered annually. Previously, the number of cars in Beijing has grown by 500,000 in 2009 and 800,000 in 2010. Now, with the quota imposed in 2011, there are still more than five million cars in the city with a population of 20 million. After Beijing, Guiyang and most recently, Guangzhou have also enforced quotas on car ownership in a bid to curb traffic congestion and rising carbon emissions.

Jeremy Bentham, Shell's Global Business Environment Vice-President and one of the panelists at the keynote plenary, described prosperity as the "paradox of modern life."

Jeremy Bentham *(Photograph by Pei Ling Gan)*



“Prosperity is a wonderful thing, it’s improving the capability of hundreds of millions of people to lead good lives; at the same time, it’s creating pressures that can undermine the benefits of prosperity.

“If we look up to 2030, we could see these pressures building up in our ecosystems, with energy demand increasing by at least 30 percent,

water pressure 40 percent and food 50 percent,” said the economist.

These stresses do not act independently, but like a “nexus” in which they feed off each other and as a result, built up more quickly, in a non-linear fashion. He noted that it is in cities especially that these environmental pressures are aggregating, due to rapid urbanization.

“Business-as-usual is just not feasible,” said Bentham, who foresees an era of increased business, political and social volatility in the next few decades.

He stressed that urban planners need to make the right choices now, by designing compact cities that enable smarter mobility. Otherwise, poor choices will be locked in for the next 30 to 50 years, due to the massive scale and investment involved in infrastructure development.

Buenos Aires and Bogota are two examples of cities that have taken great pains to reduce the number of cars and improve public transportation. The Argentinian city administration drew a lot of flak when it first converted major roads in the city center into pedestrian streets. “We faced many critics and complaints. People wanted their cars, Buenos Aires Chief of Government Mauricio Macri recalled at the forum. “[But now] property values have increased...Those spaces are now safer, with more people walking.”

Mauricio Macri (*Photograph by Pei Ling Gan*)

Meanwhile, Bogota’s former mayor Enrique Penalosa increased the gasoline tax during his term from 1998 to 2000 and used half the revenue to fund a new bus system that now serves thousands of commuters daily. He also spearheaded the building of bike lanes and banned cars from the city’s main roads on Sundays and public holidays.

Still, Buenos Aires and Bogota remain isolated examples.

While many cities from developed countries are carrying out plans to go low-carbon and become climate-resilient, most cities in developing countries



like China and India have yet to catch up. As we move towards a more resource-constrained era, they will need to make the transition fast, and alleviate the environmental stresses that are building up by managing their energy, water and waste more efficiently. Bentham had helped Shell develop its future energy scenario outlooks: the world of scramble and the world of blueprint, which was released in 2008. The oil company has been using scenarios, detailed alternative views of the future, to assist in its business strategy development for more than 30 years. In the world of scramble, events outpace actions. Governments respond to extreme climate events without cohesion or consistency, and implement politically-straightforward policies to the detriment in the long-term.

“On the energy side, this is the world where you’ll see, for example, the continuing surge in the usage of coal,” Bentham said. More optimistic is the world of blueprint, where different levels of governments, businesses and civil societies find common interests and work with each other to find sustainable solutions to today’s problems. “Wealthy entrepreneurs might see the farmers’ concern with water and find a common interest. These common interests will bring patchwork of developments,” he elaborated. In this world, renewable energy options would be cost-competitive against fossil fuels, which are well managed with carbon capture and storage, by 2040s. This is the world where carbon emissions will be going down by mid-century.

“The [environmental] pressures are outstripping what we’re doing collectively. I would tell cities: Seize the day!...Don’t be complacent!” Bentham concluded at the end of the plenary session.

Source: <http://energyblog.nationalgeographic.com/2012/07/31/building-smarter-cities-a-crucial-challenge/> (downloaded: 06-10-2016)

Article 3: Reflections on Sustainability, Population Growth, and the Environment by Prof. Al Bartlett

Carrying capacity

The term "carrying capacity," long known to ecologists, has also recently become popular. It "refers to the limit to the number of humans the earth can support in the long term without damage to the environment." (Giampietro, et. al. 1992) The troublesome phrase here is "without damage to the environment." One damages the environment when one kills a mosquito, builds a fire, erects a house, develops a subdivision, builds a power plant, constructs a city, explodes a nuclear weapon, or wages nuclear war. Which, if any, of these things takes place "without damage to the environment?"

The concept of carrying capacity is central to discussions of population growth. Since the publication of the original paper, the concept has been examined by Cohen in a book *How Many People can the Earth Support?* (Cohen 1995) Cohen makes a scholarly examination of many past estimates of the carrying capacity of the Earth, and concludes that it is not possible to say how many people the Earth can support. Furthermore, any calculated estimate of the carrying capacity of the Earth may be challenged and will certainly be ignored.

Human activities have already caused great change in the global environment. May observes that (May 1993): ...the scale and scope of human activities have, for the first time, grown to rival the natural processes that built the biosphere and that maintain it as a place where life can flourish.

Many facts testify to this statement. It is estimated that somewhere between 20 and 40 percent of the earth's primary productivity, from plant photosynthesis on land and in the sea, is now appropriated for human use.

An impact on the global environment of this magnitude is properly the cause for alarm.

We note that growing populations require growing numbers of jobs and growing rates of consumption of resources, and the satisfaction of these requirements is almost always at the expense of the carrying capacity of the environment.

The inevitable and unavoidable conclusion is that if we want to stop the increasing damage to the global environment, as a minimum, we must stop population growth.

It won't be easy. Jerome B. Wiesner was President of M.I.T. (1971-1980) and was Special Assistant for Science and Technology for Presidents Kennedy and Johnson. He made a very sobering observation about the conflict between the needs of humans and the needs of the environment if we are to maintain the carrying capacity of the Earth. (Wiesner 1989)

There are no clear-cut ways to reconcile economic growth with the measures needed to curb environmental degradation, stretch dwindling natural resources and solve health and economic problems.

So, instead of trying to calculate how many people the Earth can support, we should instead, focus on the question of why should we have more population growth. This is nicely framed in the challenge:

- Can you think of any problem, on any scale, from microscopic to global,
- Whose long-term solution is in any demonstrable way,
- Aided, assisted, or advanced, by having larger populations
- At the local level, the state level, the national level, or globally?

Denial of the population problem

There are prominent political leaders who believe that there is no population problem.

For example, when Jack Kemp, who was then the U.S. Secretary of Housing and Urban Development, was informed of a report from the United Nations that told of resource problems that would arise because of increasing populations, it was reported that he said, "Nonsense, people are not a drain on the resources of the planet." (Kemp 1992)

Malcolm Forbes, Jr. Editor of Forbes Magazine had a similar response to the reports of global problems resulting from overpopulation in both the developed and underdeveloped parts of the world. "It's all nonsense." (Forbes 1992)

Here are two presidential people who reject the notion of limits that are implied by the concept of sustainability. Their expressions are consistent with a prominent refrain in presidential politics: "We can grow our way out of the problems."

Contrast these two statements with the words of the biologist E.O. Wilson who has written that:

The raging monster upon the land is population growth. In its presence, sustainability is but a fragile theoretical construct. To say, as many do, that the difficulties of nations are not due to people but to poor ideology or land-use management is sophistic.

Population and the Environmental Protection Agency

The U.S. Environmental Protection Agency has done many constructive and beneficial things. The policies, actions, and leadership of the Agency are crucial to any hope for a sustainable society. In a recent report from the Agency, we read:

In view of the increasing national and international interest in sustainable development, Congress has asked the Environmental Protection Agency (EPA) to report on its efforts to incorporate the concepts of sustainable development into the Agency's operations.

The Report (EPA 1993) is both encouraging and distressing. It is encouraging to read of all of the many activities of the Agency which help protect the environment. It is distressing to search in vain through the Report for acknowledgment that population growth is at the root of most of the problems of the environment. While the Brundtland Report says that population growth is not the central problem, the EPA report avoids making this allegation. But the EPA report makes only a very few minor references to the environmental problems that arise as a direct consequence of population growth.

The EPA report speaks of an initiative to pursue sustainable development in the Central Valley of California: where many areas are experiencing rapid urban growth and associated environmental problems...

A stronger emphasis on sustainable agricultural practices will be a key element in any long-term solutions to problems in the area.

There is no way that "A stronger emphasis on sustainable agricultural practices" can stop the "rapid urban growth" that is destroying farmland! An emphasis on agriculture cannot solve the problem. To solve the problems, one must stop the "rapid urban growth" which causes the problems. It is pointless to focus on the development of "sustainable agricultural practices" when agriculture will soon be displaced by the "rapid urban growth." However, if "A stronger emphasis on sustainable agricultural practices" means "stop the conversion of agricultural land to urban or other developments," then there is logic to the second of the statements.

With our present social and value systems, it is almost impossible to maintain agriculture in the face of urban population growth.

In speaking of the New Jersey Coastal Management Plan for the management of an environmentally sensitive tidal wetland, the EPA report says:

The project involves balancing the intense development pressures in the area with wetlands wildlife protection, water quality, air quality, waste management, and other environmental considerations.

"Balancing" sounds nice, but it needs to be recognized that "balancing" generally means "yielding to."

In the Pacific Northwest:

The EPA... is an active participant in these discussions, which focus on sustaining high quality natural resources and marine ecosystems in the face of rapid population and economic growth in the area.

These quotations of minor sections of the EPA report make it clear that the EPA understands the origin of environmental problems. Thus it is puzzling that the Agency so carefully avoids serious discussion of the fundamental source of so many of the problems it is called on to address.

In this thirty page report on the Agency's programs, the term "sustainable development" is mentioned hundreds of times, and population growth, the most important variable in the

equation, is mentioned just these few times. It is as though one attempted to build a 100 story skyscraper from good materials, but one forgot to put in a foundation.

A proposal for the establishment of a "National Institute for the Environment" (1993) is being advanced. If the proposed institute is to be effective, its mission and charge must include, "Studying the demographic causes and consequences of environmental problems." This means "look at the numbers!"

The marginalization of Malthus

We have seen how major national and international reports misrepresent and downplay (marginalize) the quantitative importance of the arithmetic of population sizes and growth. The importance of quantitative analysis of population sizes was pioneered by Thomas Malthus two hundred years ago, (Appleman 1976) but the attempted marginalization of Malthus goes on today at all levels of society.

In an article, "The Population Explosion is Over" Ben Wattenberg finds support for the title of his article in the fact that fertility rates are declining in parts of the world. (Wattenberg 1997) Most of the countries of Europe are (1997) at zero population growth or negative population growth, and fertility rates in parts of Asia, have declined dramatically. Rather than rejoicing over the clear evidence of this movement in the direction of sustainability, Wattenberg sounds the alarm over the "birth dearth" as though this fertility decline requires some immediate reversal or correction.

The most extreme case is that of Julian Simon who advocates continued population growth long into the future. Writing in the newsletter of a major think tank in Washington, D.C., Simon says:

We have in our hands now - actually in our libraries - the technology to feed, clothe, and supply energy to an ever-growing population for the next 7 billion years... Even if no new knowledge were ever gained...we would be able to go on increasing our population forever. (Simon 1995)

It has been noted that a spherical earth is finite, but a flat earth can be infinite in extent. So if Simon is correct, we must be living on a flat earth. (Bartlett 1996)

Living at the limit

As populations grow and demands on resources increase, an aspect of the problem that is often overlooked is the fact that there are major fluctuations in the ability of the environment to satisfy our needs. In the case of municipal water, if we build new subdivisions sufficient to consume the limiting maximum output of our of our municipal water supply in wet years, then in dry years we will be seriously short. When one is living at the limit of a renewable resource,

small fluctuations in the annual yield of the resource can cause major dislocations. Prudence dictates that one should plan to consume no more water annually than the water supply can deliver during the driest years. This problem is even more critical with world food supplies, which are very dependent on the vagaries of global weather patterns.

The world's worst population problem

Echoing a view expressed earlier by the Ehrlichs (Ehrlich 1992) Bartlett points out that because of the high per capita consumption of resources in the U.S., we in the U.S. have the world's worst population problem! (Bartlett 1997) Many Americans think of the population problem as being a problem only of "those people" in the undeveloped countries, but this serves only to draw attention away from the difficulties of dealing with our own problems here in the U.S. It is easier to tell a neighbor to mow his / her yard than it is for us to mow our own yard. With regard to other countries, we can offer family planning assistance on request, but in those countries we have no jurisdiction or direct responsibility. Within our own country we have complete jurisdiction and responsibility, yet we fail to act to help solve our own problem. In a speech at the University of Colorado, then U.S. Senator Tim Wirth observed that the best thing we in the U.S. can do to help other countries stop their population growth is to set an example and stop our own population growth here in the U.S.

There can be no question about the difficulty that we will have to achieve zero growth of the population of the U.S. An examination of the simple numbers makes the difficulty clear. In particular, population growth has "momentum" which means that if one makes a sudden change in the fertility rate in a society, the full effect of the change will not be realized until every person has died who was living when the change was made. Thus it takes approximately 70 years to see the full effect of a change in the fertility rate. (Bartlett & Lytwak 1995)

Population growth never pays for itself

There are many encouraging signs from communities around the U.S. that indicate a growing awareness of the local problems of continued unrestrained growth of populations, because population growth in our communities never pays for itself. Taxes and utility costs must escalate in order to pay for the growth. In addition, growth brings increased levels of congestion, frustration, and air pollution.

In recent years, several states have seen taxpayer revolts in the form of ballot questions that were adopted to limit the allowed tax increases. These revolts were not in decaying rust-belt states; the revolts have been in the states that claimed to be the most prosperous because they had the largest rates of population growth. These limits on taxes were felt to be necessary to stop the tax increases that were required to pay for the growth. Unfortunately the growth

has managed to continue, while the schools and other public agencies have suffered from the shortage of funds.

How do we work on the local problem? Many years ago I was discussing population growth of Boulder with a prominent member of the Colorado Legislature. At one point he said:

"Al, we could not stop Boulder's growth if we wanted to!"

I responded: "I agree, therefore let's put a tax on the growth so that, as a minimum, the growth pays for itself, instead of having to be paid for by the existing taxpayers."

His response was quick and emphatic: "You can't do that, you'd slow down our growth!"

His answer showed the way: communities can slow their population growth by removing the many visible and hidden public subsidies that support and encourage growth.

The Tragedy of the Commons (Hardin 1968) makes it clear that there will always be large opposition to programs of making population growth pay for itself. Those who profit from growth will use their considerable resources to convince the community that the community should pay the costs of growth. In our communities, making growth pay for itself could be a major tool to use in stopping the population growth.

CHAPTER 4: SUSTAINABLE DEVELOPMENT

Article 1: Pictures: 10 Green-Tech City Solutions for Beating the Heat

City Forest, Singapore



Using plants and trees in a unique way, Singapore officials opened Gardens by the Bay this year. The 11-million-square foot (1-million-square-meter) complex—the size of nearly 250 U.S. football fields—aims to curb the heat island effect while bringing botanical bliss to urbanites.

The centerpiece of Gardens by the Bay is a glass atrium that houses approximately 220,000 types of vegetation, or 80 percent of the world's plant species, according to Singapore's National Parks Board. Outside the menagerie of plants is a grove of 18 “supertrees”—vertical gardens up to 164 feet (50 meters) tall that capture rainwater, filter exhaust, and are capped with solar panels that provide enough energy to light up the trees at night.

The heat island effect occurs in cityscapes characterized by pavement, asphalt, and concrete—all materials that can absorb warmth. The annual mean temperature of a city with one million people or more can be up to 5.4°F (3°C) warmer than surrounding rural areas, according to the U.S. Environmental Protection Agency (EPA). The effects cascade as summertime peak energy demands rise along with air conditioning costs and greenhouse gas emissions. The value of vegetation in urban areas goes beyond cooling and shade. City plantings can also help improve air and water quality through filtering mechanisms. A new study in the journal *Environmental Science & Technology* shows that grass, ivy, and other urban plantings, in addition to trees, can reduce levels of nitrogen dioxide and particulate matter by as much as 40 and 60 percent respectively. Both are pollutants that are potentially harmful to human health.

Greening Government Buildings, Berlin

The Reichstag, Germany's parliament building, was retrofitted in 1999 with a new dome that uses glass and mirrors to reflect daylight deep into the main chamber, reducing dependence on artificial lighting. It also employs a funnel to divert and collect rainwater.

Designed by British architect Norman Foster, the renovated Reichstag has become a Berlin tourist attraction and an energy saver. The dome-reflector system also draws warm air out of the building. This feature, combined with the fact that the building can make its own electricity from refined vegetable oil, as well as store excess heat underground, brings the building's carbon dioxide (CO₂) emissions down by 94 percent, according to the architect.



Green buildings have myriad benefits, including reductions in greenhouse gas emissions, water use, and toxic materials use, improved air and water quality, and relief from the heat. In the U.S. there is a debate brewing on Capitol Hill about how to define a green building. The U.S. government requires all new federal construction to follow the U.S. Green Building Council's (USGBC) requirements for a gold rating. USGBC ratings—certified, silver, gold, and platinum—are awarded based on several factors, including sustainable site development, water savings, energy efficiency, and materials selection.

But, to the disappointment of some chemical and plastics companies, the USGBC's rating system is expected to change next year and may discourage builders from using some products such as PVC piping. A coalition of chemical and plastics manufacturers is lobbying Congress to use another set of criteria.

Floating Food, New York



The Science Barge is a floating environmental education classroom and greenhouse on the Hudson River in New York.

Fueled by solar power, wind, and biofuels, the barge, which was built in 2007, has zero net carbon emissions.

Photograph By Tyrone Turner, National Geographic

Vegetables are grown hydroponically—with plants getting all of their necessary nutrients from water instead of soil—in an effort to preserve natural resources and adapt to urban environments, where healthy soil, or soil at all, is hard to come by. Rainwater and treated river water are used for irrigation, and pesticides are prohibited. The original owner of the barge—New York Sun Works—designed it as a prototype for closed-loop and self-sufficient rooftop gardens in urban areas.

Thousands of schoolchildren and adults have visited the barge, which is now operated by Groundwork Hudson Valley and docked in Yonkers, just north of New York City.

Sustainable Housing, Denmark

There are no official global standards for green buildings, but hundreds, if not thousands, of examples of sustainable construction are found internationally. 8 Tallet—Danish for 8 Houses—surpasses the capacity of most other green housing developments in Denmark, and the world.



Designed by the Bjarke Ingels Group, the suburban housing development—about a ten-minute train ride outside of Copenhagen—has nearly 500 apartments and incorporates a commercial district, so that residents don’t need to burn fossil fuels to shop for groceries or lounge at a cafe. The buildings, officially opened in 2010, are oriented to capture as much daylight as possible, and an elaborate 18,000-square-foot (1,700-square-meter) green roof helps to deflect harsh rays and keep the grounds cool. Traditional tar-based or black urban roofing materials contribute to the urban heat island effect by absorbing heat and raising city temperatures.

Solar Dominance, China



The Sun-Moon Mansion is headquarters for what could become the biggest solar energy production base in the world, or the Silicon Valley of solar. The office building, conference center, and training facility is the home of Himin Solar Energy, the world’s largest maker of solar water heaters. The company was founded by oil equipment engineer Ming Huang, a member of China’s

Parliament known as the “Sun King.” Huang has expressed concern about a fossil fuel-dependent economy, and is working to transform the area around the Sun-Moon building into China’s Solar Valley. The 807,000-square-foot (75,000-square-meter) headquarters also features insulation techniques that will help the structure achieve energy savings up to 30 percent higher than the national standard. China is on a mission to meet 15 percent of its energy needs with renewable sources by 2020. The country is currently at 9 percent.

Eco-Village, London

It takes a village ... to truly go green. Quality of life and sense of community are key at the BedZED eco-village in London. Private developers completed the mixed-use community in 2002, making it the first such community in the United Kingdom. The village comprises a hundred homes and enough office space for a hundred workers. With a rooftop garden, reclaimed building materials, efficient insulation, solar panels, ramped up recycling rates, and a very short commute, BedZED residents reduce their carbon footprint by nearly 50 percent, according to development partner BioRegional.



Air Tree, Spain



“Air trees” in the Madrid suburb of Vallecas are self-sufficient gardens that produce excess oxygen and energy. Made from recycled materials, the air trees provide respite from summer heat with shade and natural ventilation. Solar energy collected by photovoltaic panels on the trees’ canopy is used to power sprinklers and other aspects of plant maintenance. Additional energy is

fed back into the region’s electrical grid. The trees were first installed in 2007.

Wind Tower, Abu Dhabi

The Masdar Institute wind tower, just southeast of Abu Dhabi, is part of a planned city being built by the Abu Dhabi Future Energy Company with the help of government funding.

British architects at Foster + Partners aim to create a city that is 100 percent powered by renewable energy technology and produces zero waste. Masdar City, when completed, will be the “global center of future energy,” according to developers.

The wind tower circulates cool, carbon neutral, air throughout the grounds of the Masdar Institute of Science and Technology.



Low Carbon Campus, United Kingdom



The section of England's Northumbria University called City Campus East was one of the first buildings in Europe required to meet new green standards coming out of the United Nation's 1997 Kyoto Protocol to reduce greenhouse gases and combat climate change.

Opened in 2007, City Campus East provides housing for up to 9,000 students. In 2011, the building won the title of Low Carbon New Build Project of the Year—an award handed out by the U.K.-based Chartered Institution of Building Services Engineers.

An Eco-Village, United Kingdom

The Wintles estate in Shropshire, England, may look like your average suburban housing development, but the homes here are among the most energy efficient in the U.K.

Houses, apartments, and other residential dwellings account for just under 30 percent of the country's carbon emissions, so the government is encouraging people to live in eco-villages such as Wintles.



Source: <http://news.nationalgeographic.com/news/2012/07/pictures/120726-green-tech-city-building-solutions-urban-heat-island/>
(downloaded: 06-10-2016)

Article 2: The Sustainable Development Goals by the United Nations



Goal 1: End poverty in all its forms everywhere

While global poverty rates have been cut by more than half since 2000, one in ten people in developing regions are still living with their families on less than the international poverty line of US\$1.90 a day, and there are millions more who make little more than this daily amount. Significant progress has been made in many countries within Eastern and South-Eastern Asia, but up to 42% of the population in Sub-Saharan Africa continues to live below the poverty line.

Poverty is more than the lack of income and resources to ensure a sustainable livelihood. Its manifestations include hunger and malnutrition, limited access to education and other basic services, social discrimination and exclusion as well as the lack of participation in decision-making.

Economic growth must be inclusive to provide sustainable jobs and promote equality. Social protection systems need to be implemented to help alleviate the suffering of disaster-prone countries and provide support in the face of great economic risks. These systems will help strengthen responses by afflicted populations to unexpected economic losses during disasters and will eventually help to end extreme poverty in the most impoverished areas.

Goal 2: Zero Hunger

It is time to rethink how we grow, share and consume our food. If done right, agriculture, forestry and fisheries can provide nutritious food for all and generate decent incomes, while supporting people-centered rural development and protecting the environment.

Right now, our soils, freshwater, oceans, forests and biodiversity are being rapidly degraded. Climate change is putting even more pressure on the resources we depend on, increasing risks associated with disasters, such as droughts and floods. Many rural women and men can no longer make ends meet on their land, forcing them to migrate to cities in search of opportunities. Poor food security is also causing millions of children to be stunted, or too short for the ages, due to severe malnutrition.

A profound change of the global food and agriculture system is needed if we are to nourish the 815 million people who are hungry today and the additional 2 billion people expected to be undernourished by 2050. Investments in agriculture are crucial to increasing the capacity for agricultural productivity and sustainable food production systems are necessary to help alleviate the perils of hunger.

Goal 3: Ensure healthy lives and promote well-being for all at all ages

Ensuring healthy lives and promoting the well-being at all ages is essential to sustainable development.

Significant strides have been made in increasing life expectancy and reducing some of the common killers associated with child and maternal mortality, but working towards achieving the target of less than 70 maternal deaths per 100,000 live births by 2030 would require improvements in skilled delivery care.

Achieving the target of reducing premature deaths due to incommunicable diseases by 1/3 by the year 2030 would also require more efficient technologies for clean fuel use during cooking and education on the risks of tobacco.

Many more efforts are needed to fully eradicate a wide range of diseases and address many different persistent and emerging health issues. By focusing on providing more efficient funding of health systems, improved sanitation and hygiene, increased access to physicians and more tips on ways to reduce ambient pollution, significant progress can be made in helping to save the lives of millions.

Goal 4: Quality Education

Obtaining a quality education is the foundation to creating sustainable development. In addition to improving quality of life, access to inclusive education can help equip locals with the tools required to develop innovative solutions to the world's greatest problems.

Over 265 million children are currently out of school and 22% of them are of primary school age. Additionally, even the children who are attending schools are lacking basic skills in reading and math. In the past decade, major progress has been made towards increasing access to education at all levels and increasing enrollment rates in schools particularly for women and girls. Basic literacy skills have improved tremendously, yet bolder efforts are needed to make even greater strides for achieving universal education goals. For example, the world has achieved equality in primary education between girls and boys, but few countries have achieved that target at all levels of education.

The reasons for lack of quality education are due to lack of adequately trained teachers, poor conditions of schools and equity issues related to opportunities provided to rural children. For quality education to be provided to the children of impoverished families, investment is needed in educational scholarships, teacher training workshops, school building and improvement of water and electricity access to schools.

Goal 5: Achieve gender equality and empower all women and girls

While the world has achieved progress towards gender equality and women's empowerment under the Millennium Development Goals (including equal access to primary education between girls and boys), women and girls continue to suffer discrimination and violence in every part of the world.

Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world. Unfortunately, at the current time, 1 in 5 women and girls between the ages of 15-49 have reported experiencing physical or sexual violence by an intimate partner within a 12-month period and 49 countries currently have no laws protecting women from domestic violence. Progress is occurring regarding harmful practices such as child marriage and FGM (Female Genital Mutilation), which has declined by 30% in the past decade, but there is still much work to be done to completely eliminate such practices.

Providing women and girls with equal access to education, health care, decent work, and representation in political and economic decision-making processes will fuel sustainable economies and benefit societies and humanity at large. Implementing new legal frameworks regarding female equality in the workplace and the eradication of harmful practices targeted at women is crucial to ending the gender-based discrimination prevalent in many countries around the world.

Goal 6: Ensure access to water and sanitation for all

Clean, accessible water for all is an essential part of the world we want to live in and there is sufficient fresh water on the planet to achieve this. However, due to bad economics or poor infrastructure, millions of people including children die every year from diseases associated with inadequate water supply, sanitation and hygiene.

Water scarcity, poor water quality and inadequate sanitation negatively impact food security, livelihood choices and educational opportunities for poor families across the world. At the current time, more than 2 billion people are living with the risk of reduced access to freshwater resources and by 2050, at least one in four people is likely to live in a country affected by chronic or recurring shortages of fresh water. Drought in specific afflicts some of the world's poorest countries, worsening hunger and malnutrition. Fortunately, there has been great progress made in the past decade regarding drinking sources and sanitation, whereby over 90% of the world's population now has access to improved sources of drinking water.

To improve sanitation and access to drinking water, there needs to be increased investment in management of freshwater ecosystems and sanitation facilities on a local level in several developing countries within Sub-Saharan Africa, Central Asia, Southern Asia, Eastern Asia and South-Eastern Asia.

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy

Energy is central to nearly every major challenge and opportunity the world faces today. Be it for jobs, security, climate change, food production or increasing incomes, access to energy for all is essential. Working towards this goal is especially important as it interlinks with other Sustainable Development Goals. Focusing on universal access to energy, increased energy efficiency and the increased use of renewable energy through new economic and job opportunities is crucial to creating more sustainable and inclusive communities and resilience to environmental issues like climate change.

At the current time, there are approximately 3 billion people who lack access to clean-cooking solutions and are exposed to dangerous levels of air pollution. Additionally, slightly less than 1 billion people are functioning without electricity and 50% of them are found in Sub-Saharan Africa alone. Fortunately, progress has been made in the past decade regarding the use of renewable electricity from water, solar and wind power and the ratio of energy used per unit of GDP is also declining.

However, the challenge is far from being solved and there needs to be more access to clean fuel and technology and more progress needs to be made regarding integrating renewable

energy into end-use applications in buildings, transport and industry. Public and private investments in energy also need to be increased and there needs to be more focus on regulatory frameworks and innovative business models to transform the world's energy systems.

Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all

Roughly half the world's population still lives on the equivalent of about US\$2 a day with global unemployment rates of 5.7% and having a job doesn't guarantee the ability to escape from poverty in many places. This slow and uneven progress requires us to rethink and retool our economic and social policies aimed at eradicating poverty.

A continued lack of decent work opportunities, insufficient investments and under-consumption lead to an erosion of the basic social contract underlying democratic societies: that all must share in progress. Even though the average annual growth rate of real GDP per capita worldwide is increasing year on year, there are still many countries in the developing world that are decelerating in their growth rates and moving farther from the 7% growth rate target set for 2030. As labor productivity decreases and unemployment rates rise, standards of living begin to decline due to lower wages.

Sustainable economic growth will require societies to create the conditions that allow people to have quality jobs that stimulate the economy while not harming the environment. Job opportunities and decent working conditions are also required for the whole working age population. There needs to be increased access to financial services to manage incomes, accumulate assets and make productive investments. Increased commitments to trade, banking and agriculture infrastructure will also help increase productivity and reduce unemployment levels in the world's most impoverished regions.

Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation

Investments in infrastructure – transport, irrigation, energy and information and communication technology – are crucial to achieving sustainable development and empowering communities in many countries. It has long been recognized that growth in productivity and incomes, and improvements in health and education outcomes require investment in infrastructure

Manufacturing is an important driver of economic development and employment. At the current time, however, manufacturing value added per capita is only US\$100 in the least developed

countries compared to over US\$4,500 in Europe and Northern America. Another important factor to consider is the emission of Carbon Dioxide during manufacturing processes. Emissions have decreased over the past decade in many countries but the pace of decline has not been even around the world.

Technological progress is the foundation of efforts to achieve environmental objectives, such as increased resource and energy-efficiency. Without technology and innovation, industrialization will not happen, and without industrialization, development will not happen. There needs to be more investments in high-tech products that dominate the manufacturing productions to increase efficiency and a focus on mobile cellular services that increase connections between people.

Goal 10: Reduce inequality within and among countries

The international community has made significant strides towards lifting people out of poverty. The most vulnerable nations – the least developed countries, the landlocked developing countries and the small island developing states – continue to make inroads into poverty reduction. However, inequality persists and large disparities remain regarding access to health and education services and other assets. There is growing consensus that economic growth is not sufficient to reduce poverty if it is not inclusive and if it does not involve the three dimensions of sustainable development – economic, social and environmental. Fortunately, income inequality has been reduced both between and within countries. At the current time, the per capita income of 60 out of 94 countries with data has risen more rapidly than the national average. There has been some progress regarding creating favorable access conditions for exports from least developing countries as well. To reduce inequality, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations. There needs to be an increase in duty-free treatment and continuation of favoring exports from developing countries, in addition to increasing the share of developing countries' vote within the IMF. Finally, innovations in technology can help reduce the cost of transferring money for migrant workers.

Goal 11: Make cities inclusive, safe, resilient and sustainable

Cities are hubs for ideas, commerce, culture, science, productivity, social development and much more. At their best, cities have enabled people to advance socially and economically. With the number of people living within cities projected to rise to 5 billion people by 2030, it's

important that efficient urban planning and management practices are in place to deal with the challenges brought by urbanization.

Many challenges exist to maintaining cities in a way that continues to create jobs and prosperity without straining land and resources. Common urban challenges include congestion, lack of funds to provide basic services, a shortage of adequate housing, declining infrastructure and rising air pollution within cities.

Rapid urbanization challenges, such as the safe removal and management of solid waste within cities, can be overcome in ways that allow them to continue to thrive and grow, while improving resource use and reducing pollution and poverty. One such example is an increase in municipal waste collection. There needs to be a future in which cities provide opportunities for all, with access to basic services, energy, housing, transportation and more.

Goal 12: Ensure sustainable consumption and production patterns

Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.

At the current time, material consumption of natural resources is increasing, particularly within Eastern Asia. Countries are also continuing to address challenges regarding air, water and soil pollution.

Since sustainable consumption and production aims at “doing more and better with less,” net welfare gains from economic activities can increase by reducing resource use, degradation and pollution along the whole life cycle, while increasing quality of life. There also needs to be significant focus on operating on supply chain, involving everyone from producer to final consumer. This includes educating consumers on sustainable consumption and lifestyles, providing them with adequate information through standards and labels and engaging in sustainable public procurement, among others.

Goal 13: Take urgent action to combat climate change and its impacts

Climate change is now affecting every country on every continent. It is disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow. Weather patterns are changing, sea levels are rising, weather events

are becoming more extreme and greenhouse gas emissions are now at their highest levels in history. Without action, the world's average surface temperature is likely to surpass 3 degrees centigrade this century. The poorest and most vulnerable people are being affected the most.

Affordable, scalable solutions are now available to enable countries to leapfrog to cleaner, more resilient economies. The pace of change is quickening as more people are turning to renewable energy and a range of other measures that will reduce emissions and increase adaptation efforts. Climate change, however, is a global challenge that does not respect national borders. It is an issue that requires solutions that need to be coordinated at the international level to help developing countries move toward a low-carbon economy.

To strengthen the global response to the threat of climate change, countries adopted the Paris Agreement at the COP21 in Paris, which went into force in November of 2016. In the agreement, all countries agreed to work to limit global temperature rise to well below 2 degrees centigrade. As of April 2018, 175 parties had ratified the Paris Agreement and 10 developing countries had submitted their first iteration of their national adaptation plans for responding to climate change.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources

The world's oceans – their temperature, chemistry, currents and life – drive global systems that make the Earth habitable for humankind. Our rainwater, drinking water, weather, climate, coastlines, much of our food, and even the oxygen in the air we breathe, are all ultimately provided and regulated by the sea. Throughout history, oceans and seas have been vital conduits for trade and transportation.

Careful management of this essential global resource is a key feature of a sustainable future. However, at the current time, there is a continuous deterioration of coastal waters owing to pollution and ocean acidification is having an adversarial effect on the functioning of ecosystems and biodiversity. This is also negatively impacting small scale fisheries.

Marine protected areas need to be effectively managed and well-resourced and regulations need to be put in place to reduce overfishing, marine pollution and ocean acidification.

Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss

Forests cover 30.7 per cent of the Earth's surface and, in addition to providing food security and shelter, they are key to combating climate change, protecting biodiversity and the homes

of the indigenous population. By protecting forests, we will also be able to strengthen natural resource management and increase land productivity.

At the current time, thirteen million hectares of forests are being lost every year while the persistent degradation of drylands has led to the desertification of 3.6 billion hectares. Even though up to 15% of land is currently under protection, biodiversity is still at risk. Deforestation and desertification – caused by human activities and climate change – pose major challenges to sustainable development and have affected the lives and livelihoods of millions of people in the fight against poverty.

Efforts are being made to manage forests and combat desertification. There are two international agreements being implemented currently that promote the use of resources in an equitable way. Financial investments in support of biodiversity are also being provided.

The Lion's Share Fund

On 21 June, 2018, the United Nations Development Programme (UNDP), FINCH and founding partner Mars, Incorporated, announced the Lion's Share, an initiative aimed at transforming the lives of animals across the world by asking advertisers to contribute a percentage of their media spend to conservation and animal welfare projects. The Lion's Share will see partners contribute 0.5 percent of their media spend to the fund for each advertisement they use featuring an animal. Those funds will be used to support animals and their habitats around the world. The Fund is seeking to raise US\$100m a year within three years, with the money being invested in a range of wildlife conservation and animal welfare programs to be implemented by United Nations and civil society organizations.

Goal 16: Promote just, peaceful and inclusive societies

The threats of international homicide, violence against children, human trafficking and sexual violence are important to address to promote peaceful and inclusive societies for sustainable development. They pave the way for the provision of access to justice for all and for building effective, accountable institutions at all levels.

While homicide and trafficking cases have seen significant progress over the past decade, there are still thousands of people at greater risk of intentional murder within Latin America, Sub-Saharan Africa and around Asia. Children's rights violations through aggression and sexual violence continue to plague many countries around the world, especially as under-reporting and lack of data aggravate the problem.

To tackle these challenges and build a more peaceful, inclusive societies, there needs to be more efficient and transparent regulations put in place and comprehensive, realistic government budgets. One of the first steps towards protecting individual rights is the implementation of worldwide birth registration and the creation of more independent national human rights institutions around the world.

Goal 17: Revitalize the global partnership for sustainable development

A successful sustainable development agenda requires partnerships between governments, the private sector and civil society. These inclusive partnerships built upon principles and values, a shared vision, and shared goals that place people and the planet at the centre, are needed at the global, regional, national and local level.

Urgent action is needed to mobilize, redirect and unlock the transformative power of trillions of dollars of private resources to deliver on sustainable development objectives. Long-term investments, including foreign direct investment, are needed in critical sectors, especially in developing countries. These include sustainable energy, infrastructure and transport, as well as information and communications technologies. The public sector will need to set a clear direction. Review and monitoring frameworks, regulations and incentive structures that enable such investments must be retooled to attract investments and reinforce sustainable development. National oversight mechanisms such as supreme audit institutions and oversight functions by legislatures should be strengthened.

NOTE:

You can find more information of each development goals (with facts and figures, action plans and statistical data's of each problems) on the following page.

<https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

CHAPTER 5: HOW MARKETS WORK – SUPPLY AND DEMAND

Article 1: Growing Food Demand Strains Energy, Water Supplies

Excessive water pumping has strained both water and energy supplies in India, China and other hot spots around the world. Here, people gather to get water from a huge well in a village in the western Indian state of Gujarat.



The northern region of Gujarat State in western India (map) is semi-arid and prone to droughts, receiving almost all of its rain during the monsoon season between June and September. But for the past three decades, many crop and dairy farms have remained green—even during the dry season.

That's because farmers have invested in wells and pumps, using massive amounts of electricity to extract water from deep aquifers. The government has artificially propped up the agricultural sector through power subsidies and price supports. The pumping hasn't occurred without dire environmental impacts. Groundwater tables have fallen precipitously, 600 feet below the ground in some places, requiring even more powerful pumps to bring water to the surface. Over-consumption has taxed the power grid, constraining the electricity available for others.

Rising Thirst for Energy on Farms

North Gujarat is a well-documented, extreme example of groundwater depletion and an unsustainable agricultural sector. But there are many other hot spots in places such as India, China, and the Middle East where energy demands are rising so enough water can be pumped to produce food. In essence, experts warn, agriculture in those areas is in peril because of its unsustainable relationship with energy and groundwater.

Potential impacts include not only dry aquifers and failing farms, but increased soil salinity and carbon dioxide emissions. Climate change exacerbates the situation. Poor farmers often are

hit the hardest, because they can't afford to invest in expensive technologies to drill wells and pump water from them.

"I think what is forgotten—the farmers themselves [in Gujarat] are facing constraints," said Vijay Modi, a professor at the Columbia Water Center, part of Columbia University's Earth Institute. "This is their livelihood, so figuring out a way that is a win-win-win for the farmer and the utility and the environment is key."

Modi said there is reason for concern, but he believes the problem can be fixed. The challenge for Gujarat and other areas lies at what is commonly known these days as the water-energy nexus. Broadly speaking, the term refers to the ways in which water and energy resources are interdependent.

The goal is to find solutions to the constraints of both—to optimize resource use and eliminate the "slack," or inefficiencies in the system, said Holger Hoff, senior research fellow at the Stockholm Environment Institute (SEI), an independent international research institute. The knowledge largely is there, "but implementation is very difficult," Hoff said, given the long history of the energy and water sectors, as well as various government ministries, sticking within their own silos rather than working together.

Meanwhile, as world population burgeons, demand for resources continues to rise. Agricultural production will need to increase by about 70 percent by 2050, and primary energy by 50 percent by 2035, barring significant changes to the way food and energy are produced and consumed on the planet, according to an SEI briefing paper and data by the U.N. Food and Agriculture Organization.

An Unsustainable Trend

In China, the use of groundwater to irrigate crops has grown more than tenfold since 1950, according to research released in March by the University of East Anglia in England. The researchers estimated that pumping systems—operating from an average depth of 230 feet (70 meters) in some areas—emitted more than 30 million tons of carbon dioxide a year, roughly equivalent to the amount emitted in all of New Zealand every year. The researchers blamed the massive expansion of groundwater pumping on cheap energy and improved access to pumping technology.

In India, the largest groundwater user in the world, agricultural electricity consumption increased more than 25-fold between 1970 and 2009, more than twice the pace of overall electricity consumption, according to government figures. New research by the International Water Management Institute characterizes nine states in India, including Gujarat, as having

"critical" groundwater condition, where pumping exceeds the long-term recharge of the aquifers.

"Agriculture, groundwater and electricity sectors in much of India are now bound in an invidious nexus of mutual dependence where the growth of one sector (agriculture) is being supported by unsustainable trends in the other two sectors (groundwater and electricity), so much so that even growth in agriculture is now threatened," wrote IWMI senior researcher Aditi Mukherji in Delhi.

The phenomenon is driven by the use of millions of electric pumps that run on cheap power. Farm power subsidies in India are estimated at \$9 billion annually, up from \$6 billion a decade ago. In Gujarat, tariffs have been raised over the years, but farmers still pay only about 20 percent of the true cost of electricity, according to Modi of the Columbia Water Center. Jon Strand, senior economist for the World Bank's environment and energy team, said in a policy research working paper that the optimal scheme to combat aquifer depletion would be tariffs that cover the full cost of electricity, with an extra charge to cover the "external cost" of groundwater pumping. That refers to the additional electricity costs to bring groundwater to the surface as water tables fall because of over-pumping.

"When a groundwater basin is exploited by a large number of farmers, acting independently, each farmer has little incentive to practice conservation that would primarily benefit other farmers," Strand wrote.

India's government is in the process of revising its national water policy, and a draft recommends changing the "heavy under-pricing of electricity" to more closely reflect actual costs. But if farmers in north Gujarat paid for the full cost of their electricity, the agricultural sector wouldn't be economically viable, according to Columbia Water Center.

Stemming the Flow

In north Gujarat, changes have occurred, although it may be too early to draw firm conclusions. A decade ago, the region was marked by rapidly depleting aquifers, a nearly bankrupt utility, and an agricultural lobby strong enough to fight efforts to meter electricity. Electricity theft and unreliable power were issues. Researchers at the International Water Management Institute recommended a scheme to supply uninterrupted power on a rationing schedule designed to match the supply to irrigation needs as closely as possible.

The state government of Gujarat acted on IWMI's recommendation by investing about \$260 million for separate electrical feeder lines for farming and non-farm uses. While that may seem like a wasteful investment to make, the "Jyotigram Yojana" or "Lighted Village" initiative met

the government's goal of developing rural electrification to stimulate the region's economy. The feeder lines also were metered to curb theft.

"While the economics of the Jyotigram program is unclear, it is certainly smart politics," Madar Samad, IWMI principal researcher for water policy and institutions, said of the investment to split the electricity lines.

The scheme made it possible for farmers to keep to certain irrigation schedules and, at least theoretically, conserve water depending on how much they pumped during the rationing period. Gujarat experienced 9.6 percent annual growth in its gross domestic product from agriculture between 2000 and 2007—the highest in India—compared with less than 3 percent for India as a whole, according to a joint publication by IWMI and the International Food Policy Research Institute.

But groundwater continues to be depleted, and the Institute for Resource Analysis and Policy in Hyderabad, India, countered that the growth was more the result of a strong recovery from a "major dip" in production that had occurred during droughts of 1999 and 2000. The institute argued that the "real growth" in agricultural production in Gujarat already had occurred between 1988-1999.

Additional efforts are being made to improve the groundwater situation in Gujarat. The Columbia Water Center, for example, has been advising a local utility and government on a pilot project that meters water and energy use (meters are attached to wells) and rewards farmers who cut consumption to a certain historical baseline. The project, which started last year, also helps farmers identify ways to save water, such as using tools to measure moisture content in soil, drip irrigation, and planting crops more suitable to the area. More than 800 farmers have agreed to be part of the project. Preliminary results are encouraging, but Modi of the Columbia Water Center is cautious. He said that before conclusions are reached, the project must measure rigorously the energy use of a larger group of farmers over multiple years. That's now under consideration by the utility. Hoff of the Stockholm Environment Institute and Potsdam Institute for Climate Impact Research also is cautious when it comes to solving such water-energy nexus issues as groundwater depletion. He recently attended the Planet Under Pressure conference in England where, he said, one message was that there's about a 10-year window of opportunity to deal with some of these problems.

He said he wants to be optimistic, but "my experience tells me that action only happens if things become urgent."

Source: <http://news.nationalgeographic.com/news/energy/2012/04/120406-food-water-energy-nexus/> (downloaded: 06-10-2016)

Article 2: U.S. Demand for Premium Gas Is Going Up. Why?

Gas prices are low, but that doesn't tell the whole story of why drivers are upgrading at the pump.

A customer prepares to pump fuel at a Go Mart Inc. gas station in Rockbridge, Ohio, this past February. Thanks to a glut of oil that has spurred refiners to make as much fuel as they can, pump prices nationwide are down about 26 cents a gallon from a year ago.

More U.S. drivers are springing for premium gasoline, and part of the trend has nothing to do with oil's slump. Though gas prices have dipped to the lowest levels since 2009, automakers are also making fundamental changes to how cars run. Those changes, according to a recent government analysis, will have "widespread implications" for future fuel markets.

Pushing the higher octane button at the pump no longer necessarily means you're driving a luxury car. New versions of the Honda Civic, smart fortwo, MINI Cooper, and other affordable models either require or recommend premium. Stricter fuel economy standards meant to reduce greenhouse gas emissions are driving big shifts toward auto designs that favor the more expensive fuel—at the same time, some drivers are upgrading when they don't really need to.

Paying More of a Premium for Premium

Premium's current share of overall gasoline sales is relatively small—about 11 percent—but that's the highest in a decade. The number is rising in part because gas prices have dropped, making it easier to splurge on premium gas.

"Some people mistakenly believe they're 'treating' their car by buying premium gasoline," says Michael Green, spokesperson for the motorist group AAA. Premium gas only makes sense for engines designed to use it, but for drivers who don't realize this, he says, "It's like taking their car to the day spa."

The luxe association makes sense. Premium gas is pricey, and getting pricier: The U.S. national average per gallon is currently \$2.69, a full 47 cents above regular. That's a shift from previous years, when the gap between fuels was lower.

"There was a time when premium was only 15 to 20 cents per gallon more than regular," says Green, "but those days have long passed us by." The gap persists because premium gas buyers aren't as price-sensitive as those for regular, Green says, adding that domestic oil supplies are better suited to refining into regular fuel.

Designing for the New Fuel Economy Rules

Charged with achieving an average of 50 miles per gallon by 2025, U.S. automakers are making a variety of changes to car designs. One of those is to use smaller engines, adding a turbocharger to boost power. Turbochargers force compressed air into an engine's cylinders, allowing for a bigger burst of power when the fuel ignites.

The higher octane rating of premium fuel, which allows it to withstand more compression before it will ignite, makes it well suited to turbocharged engines. If fuel detonates prematurely, it creates "knock," which can damage the engine.

And automakers argue that the U.S. needs to raise the octane in its gasoline supply. "Higher octane is necessary for better engine efficiency," said one GM executive at a recent SAE conference.

Currently, regular U.S. gas gets an 87 octane rating, while premium gets 93. An MIT study in 2014 argued that raising octane levels to 93 and 98, respectively, would result in cars burning up to 4.5 percent less gasoline, in turn more than 35 million tons of carbon dioxide emissions a year—an amount equivalent to what the state of Montana contributes.

Even at current octane ratings, premium is proving more appealing to manufacturers. "As automakers produce more vehicles with turbocharged engines, it is likely they will recommend or require more light-duty vehicles to use higher-octane gasoline," the Energy Information Administration said in its recent analysis.

Turbochargers can boost efficiency up to 6 percent, according to the U.S. Department of Energy. That will seem like small potatoes to someone paying some 45 percent more for premium fuel. Are drivers really going to be stuck paying more to fill up their cars in the name of fuel economy?

It isn't quite that simple. "A lot of the turbocharged engines being released now are perfectly fine running on regular fuel," says Kevin Riddell, manager with the research firm LMC Automotive, adding that when premium is called for, "it's not necessarily [for] the fuel economy itself—it's more of the power aspect."

In other words, premium can help automakers meet stricter efficiency standards while delivering the power some drivers demand. People are "used to a certain power level in their vehicles," says Gary Pollak, program manager for the industry engineering association SAE International. "Manufacturers are trying to meet that power level while still trying to use design to increase the fuel economy."

Both Riddell and Pollak note that car computer systems have become sophisticated enough to sense what type of fuel is coming into the engine. So while a sensitive driver might feel a

slight downgrade in performance using regular fuel in a premium-recommended engine, cars that don't require premium fuel are still going to run just fine without it.

Since an overhaul of U.S. octane levels isn't likely anytime soon, automakers are looking at a whole host of ways beyond engine design to improve fuel economy. Pollak notes that lighter materials and improved aerodynamics are two potential sources of efficiency gains. As for downsized engines coupled with turbochargers, he says, "I think the trend will continue."

Source: <http://news.nationalgeographic.com/energy/2016/05/160520-increased-demand-for-premium-gasoline/> (downloaded: 06-10-2016)

CHAPTER 6: EXTERNALITIES

Article 1: California tobacco smoke 'toxic'

California has become the first US state to classify second-hand tobacco smoke as a toxic air pollutant. The decision by the California Air Resources Board puts drifting smoke in the same category as diesel exhaust, and could lead to tougher regulation. The agency said many scientific studies had linked passive smoking to a range of cancers and respiratory diseases. California pioneered smoking bans in the workplace, and later in restaurants and bars. John Froines, chairman of the Air Resources Board's Scientific Review Panel, said Thursday's ruling put "California way ahead".

The decision to declare second-hand smoke as a pollutant relied on a September report that found a sharply increased risk of breast cancer in young women exposed to it. It also linked second-hand smoke to premature births, asthma, and numerous health problems in children. The study found that about 16% of all Californians smoked, but that 56% of adults and 64% of adolescents were exposed to second-hand smoke.

Some health experts say the ultimate impact of California's decision to classify second-hand smoke as a toxin could reach beyond the US.

Source: <http://news.bbc.co.uk/2/hi/americas/4652878.stm> (downloaded: 06-10-2016)

Article 2: Vehicle fumes 'stunt lung growth'

Living too near a busy road could stunt a child's lung development, US research involving 3,677 children suggests. Children who lived within 500 metres of a major road, such as a motorway, were shown to have lung impairment in tests. Many children live and go to schools near to busy roads and could be at risk, the University of Southern California authors warn in *The Lancet*. Experts already know toxic traffic fumes can trigger lung conditions such as asthma.

Stunted development

But the latest work suggests pollution can stop the lung from growing to its full potential - even in children who are otherwise healthy.

As background air quality did not alter the picture, children living in the countryside but close to a main road would also be at risk, the researchers add.

Children living close to big roads in cities with high levels of background air pollution were likely to be at a greater risk of lung problems however because of the double effect on their lungs, they suggest.

The study

They examined the lung function of 3,677 children annually from the age of 10 until they reached 18 - when the lungs are fully developed. Those who had lived within 500 metres of a motorway had much poorer lung function at the age of 18 than those who had lived 1,500 meters away or more, even when factors such as smoking in the home were taken into account.

Dr John Peters and colleagues say fumes from cars, bikes and lorries are to blame. They recommend more work to identify the exact culprits in vehicle exhausts. Scientists do not know exactly how air pollution hampers lung development, but they believe lung inflammation in response to daily irritation by air pollutants may play a role.

Stephen Holgate, Medical Research Council clinical professor of immunopharmacology at the University of Southampton, said: "The finding builds on accumulating knowledge that the chemicals that are contained in the exhaust emissions of modern vehicles adversely effects the development of the lung through childhood.

"This is probably through their powerful oxidant effect on lung development in the first five to eight years of life."

Oxidative stress is caused by the toxic effect of highly reactive oxygen molecules, called free radicals, which damage cells and DNA. Liberal Democrat health spokesman Norman Lamb said the work reinforced the case for reducing vehicle emissions.

"This report will be disturbing reading for many parents."

"As road usage continues to increase, this issue will have to be taken seriously."

A government spokeswoman said they would consider the evidence and whether further investigations were needed.

Source: <http://news.bbc.co.uk/2/hi/health/6297701.stm> (downloaded: 06-10-2016)

Article 3: Food movement 'harms environment'

The distribution of food across the UK in cars and lorries adds to pollution, congestion and climate change, a report by the government says.

It said the environmental cost of moving food was as much as £9bn a year, around half of it due to congestion. The quantity of food moved by road has doubled since 1974, the report said. The Department for Environment, Food and Rural Affairs report said 25% of all miles covered by heavy goods traffic was to move food.

'Food miles' debate

And it showed consumers now travelled an average of 898 miles per year by car to shop for food. Defra said the impact costs per year of food transportation break down as £5 billion due to road congestion, £2 billion due to road accidents, £1 billion due to pollution and £1 billion due to other factors. The draft Food Industry Sustainability Strategy is part of a plan to help achieve a 20% reduction in the environmental and social costs of food transport by about 2012.

The report said the mode, timing, location and efficiency of food transport was as important as the distance covered. Defra minister Lord Bach said: "This study is an interesting contribution to the 'food miles' debate.

Consumer 'pointers'

"It shows that the issue is complex and that a range of factors have an effect on the overall impacts of food transport, not purely the distance travelled by individual products.

"It provides some pointers for consumers. For example, internet buying and home delivery can cut vehicle kilometres and reduce road congestion."

Lord Bach said buying local products had the potential to reduce the distance covered, but that those benefits could be compromised if the methods of distribution were inefficient and caused congestion.

The report also suggests better monitoring of air transport of food, because it was more responsible for the highest carbon dioxide emissions per tonne of cargo and was the fastest-growing sector.

Source: http://news.bbc.co.uk/2/hi/uk_news/4684693.stm (downloaded: 06-10-2016)

Article 4: Oil sands boom swamps the Canadian wilderness

Environmentalists want tougher laws to halt the damage, writes Tim Webb

Todd Dahlman scoops up a handful of oily sand and smiles. 'This is the money - it even smells like money,' says the manager of Shell's Muskeg River oil sands mine in the Athabasca region of North Alberta in Canada.

We are standing in the middle of a pit 50m deep that giant diggers have hollowed out of the earth. Some 150m beneath our feet lie almost a billion barrels of oil.

With Brent crude at \$131 a barrel on Friday, the oil sands frenzy is in full swing. Canada holds estimated reserves of 179 billion barrels of oil, the majority from oil sands, putting it second only to Saudi Arabia. Currently, Canada's oil sands produce just over a million barrels per day but this is set to triple by 2020, making the country one of the largest producers in the world.

Shell, which operates the mine with Chevron and Marathon Oil, has 20 billion barrels of potential reserves in the sands, representing a third of its entire potential reserve base. It currently produces about 150,000 barrels a day from its oil sands operations, around 5 per cent of total production, but plans to increase this figure fivefold.

For oil majors who are finding it difficult to locate new reserves, the attraction of Canada's oil sands is strong. Resource nationalism, where countries bar foreign companies from their oil, is on the rise, as shown by BP's spat with its Russian partners over its joint venture TNK-BP. The issue of reserves is particularly sensitive for Shell, which had to downgrade almost a quarter of its booked proven reserves four years ago, a scandal that led to the ousting of then chief executive Phil Watts.

But development is controversial. Untreated oil sands have the same consistency as peanut butter. Steam is pumped into the sludge to separate the oil from the sand and water. Huge upgraders are needed to treat the oil before it can be refined conventionally, and the process creates at least three times as many greenhouse gas emissions as conventional oil production. The environmental organisation, the Pembina Institute, estimates that by 2030 the emissions produced by the industry in Canada could total more than a quarter of the UK's current emissions. Production also devastates the boreal forests and wetlands which cover northern Alberta.

Increasingly, Shell - and other oil sands operators - are being targeted by environmentalists. The First Nations tribes - around 6,000 native Indians live in the Athabasca Region - are taking legal action against some companies. And the US is passing an environmental law which could restrict imports of the most polluting types of fossil fuels such as oil sands.

George Poitras is a former chief of the Mikisew Cree, the largest First Nation tribe in the Athabasca region. Now he negotiates on their behalf when they lease land to oil companies. His office is in Fort McMurray, an hour and a half away by plane from Calgary, and the epicentre of the oil sands boom. With the highest GDP per capita in Canada, locals have dubbed their town 'Fort McMoney'.

Poitras says the development of the oil sands is poisoning the Athabasca River. He says the fish taste different since development began 40 years ago. 'We think the water is giving us cancer.'

The three deposits of oil sands in the province, of which the one in Athabasca is the largest, lie in 149,000sq km, covering a quarter of the province. Not all of this will be extracted, and much will be extracted using 'in-situ' methods where the material is pumped out of the ground, rather than mined, and so less forest has to be cleared. The industry says 420sq km of forest has been 'disturbed' so far. Meanwhile, the Pembina Institute says that 2,000sq km of forest is likely to be affected.

Oil companies are required by law to 'reclaim' the land after they cease operations there, and promise to plant native species of grass and trees and reintroduce wildlife. Poitras is scathing. 'Our elders laugh when the industry says this. Who do they think they are - God or the creator?'

Campaigners say environmental regulations covering the industry are inconsistent and ineffective. The Alberta government requires companies to reduce the greenhouse gas emissions' 'intensity' per barrel produced by 12 per cent, but there are no limits on reducing overall emissions which will mushroom as operations expand. The federal government has proposed tougher laws and higher levies for companies that miss their targets. It is not clear whether these will take precedence over Albertan regulations.

Shell has put forward proposals to equip the Scotford Upgrader - which treats the oil from the Muskeg River mine - with carbon capture and storage technology to reduce emissions. Even if this happens, it would only cut emissions from the upgrader, when it is expanded, by a fifth.

David Collyer, vice president for sustainable development at Shell in Canada, says that regulations will get tougher. Shell has already made a voluntary commitment to reduce emissions from its existing Muskeg River operations by 50 per cent by 2010 through greater energy efficiency, technologies like carbon capture and offsets. Collyer says this would make oil sands no dirtier compared to other oil imports and so would appease US lawmakers. Shell and other operators know that they must raise their environmental standards to head off tighter laws. The company, which last week flew a group of journalists out to visit its Muskeg River Mine, also wants to build a proper visitor centre there. Canadian oil companies trade body

CAPP has also recently launched a public relations offensive in an attempt to stem criticism of oil sands development.

But how tough environmental regulations become remain to be seen. The US is in no position to choose what kind of oil it gets when the alternatives suppliers are unstable countries like the Middle East or Venezuela, points out Lawrence Poole, an analyst from research firm Global Insight. And the Canadian government is loathe to do anything to kill off the oil sands golden goose. Shell and other companies will have to do more to reduce their environmental impact, but like it or not, oil sands are here to stay.

Source: <https://www.theguardian.com/business/2008/jul/20/oil.canada> (downloaded: 06-10-2016)

CHAPTER 7: NET PRESENT VALUE

Article 1: Time Value Of Money: Determining Your Future Worth

If you were offered \$100 today or \$100 a year from now, which would you choose? Would you rather have \$100,000 today or \$1,000 a month for the rest of your life?

Net present value (NPV) provides a simple way to answer these types of financial questions. This calculation compares the money received in the future to an amount of money received today, while accounting for time and interest. It's based on the principle of time value of money (TVM), which explains how time affects monetary value. (For background reading, see *Understanding The Time Value Of Money*.)

The TVM calculation may look complicated, but with some understanding of NPV and how the calculation works, along with its basic variations: present value and future value, we can start putting this formula to use in common application.

Time Value of Money

If you were offered \$100 today or \$100 a year from now, which would be the better option and why?

This question is the classic method in which the TVM concept is taught in virtually every business school in America. The majority of people asked this question choose to take the money today. But why? What are the advantages and, more importantly, disadvantages of this decision?

There are three basic reasons to support the TVM theory. First, a dollar can be invested and earn interest over time, giving it potential earning power. Also, money is subject to inflation, eating away at the spending power of the currency over time, making it worth less in the future. Finally, there is always the risk of not actually receiving the dollar in the future - if you hold the dollar now, there is no risk of this happening. Getting an accurate estimate of this last risk isn't easy and, therefore, it's harder to use in a precise manner.

Illustrating the Net Present Value

Would you rather have \$100,000 today or \$1,000 a month for the rest of your life?

Most people have some vague idea of which they'd take, but a net present value calculation can tell you precisely which is better, from a financial standpoint, assuming you know how long you will live and what rate of interest you'd earn if you took the \$100,000.

Specific variations of time value of money calculations are:

- **Net Present Value** (lets you value a stream of future payments into one lump sum today, as you see in many lottery payouts)
- **Present Value** (tells you the current worth of a future sum of money)
- **Future Value** (gives you the future value of cash that you have now)

Determining the Time Value of Your Money

Which would you prefer: \$100,000 today or \$120,000 a year from now?

The \$100,000 is the "present value" and the \$120,000 is the "future value" of your money. In this case, if the interest rate used in the calculation is 20%, there is no difference between the two.

Five Factors of a TVM Calculation:

1. Number of time periods involved (months, years)
2. Annual interest rate (or discount rate, depending on the calculation)
3. Present value (what do you have right now in your pocket)
4. Payments (if any exist. If not, payments equal zero)
5. Future value (the dollar amount you will receive in the future. A standard mortgage will have a zero future value, because it is paid off at the end of the term)

Many people use financial calculators to quickly solve these TVM questions. By knowing how to use one, you could easily calculate a present sum of money into a future one, or vice versa. The same goes for determining the payment on a mortgage, or how much interest is being charged on that short-term Christmas expenses loan.

Applying Net Present Value Calculations

Net present value calculations can also help you discover answers to other questions. Retirement planning needs can be determined on an overall, monthly or annual basis, as can the amount to contribute for college funds. By using a net present value calculation, you can find out how much you need to invest each month to achieve your goal. For example, in order to save \$1 million dollars to retire in 20 years, assuming an annual return of 12.2%, you must save \$984 per month. Try the calculation and test it for yourself.

Below is a list of the most common areas in which people use net present value calculations to help them make decisions and solve their financial problems.

- Mortgage payments
- Student loans

- Savings
- Home, auto or other major purchases
- Credit cards
- Money management
- Retirement planning
- Investments
- Financial planning (both business and personal)

The Bottom Line on Net Present Value

The net present value calculation and its variations are quick and easy ways to measure the effects of time and interest on a given sum of money, whether it is received now or in the future. The calculation is perfect for short- and- long-term planning, budgeting or reference. When plotting out your financial future, keep this formula in mind.

Source: <http://www.investopedia.com/articles/fundamental-analysis/09/net-present-value.asp>
(downloaded: 06-10-2016)

Article 2: Advantages & Disadvantages of Net Present Value in Project Selection



The net present value calculation considers the time value of money.

Net present value, or NPV, is one of the calculations business managers use to evaluate capital projects. A capital project is a long-term investment or improvement, such as building a new store. The NPV calculation determines the present value of the project's projected future income. In the calculation, the present value of the project's cost is subtracted from the present value of future income. A positive net present value usually means you should accept or implement the project. Business owners who compare two or more projects tend to favor the one with the higher net present value.

Value

An advantage of using the NPV method is being able to determine whether the project will increase your firm's value. The NPV calculation reveals the dollar amount that the project will produce. A five-year project with an NPV of \$100,000 will increase profits by \$100,000. Projects with a negative NPV will decrease a firm's profitability. The NPV reflects the amount of income that the project will produce at a predetermined rate of return. For instance, your firm requires a return of 10 percent on the investment. The present value of the project's income is discounted at the 10 percent rate.

Cash Flow

The NPV method considers when the project will earn income. For example, some projects may not have a positive cash flow until the third year. Some projects will start contributing to profits in the first year. The NPV method also shows what the amount of that income will be each year. A three-year project may have projected cash flows of \$5,000 in year one, \$10,000 in year two and \$15,000 in year three. The NPV method reveals how soon a project will start producing income and how significant that income will be.

Estimations

A disadvantage of the NPV calculation is that it requires you to make projections. You must estimate the dollar amount of the project's cost as well as its future income. In most cases, the NPV calculation will not be 100 percent accurate. A project may incur unforeseen costs that

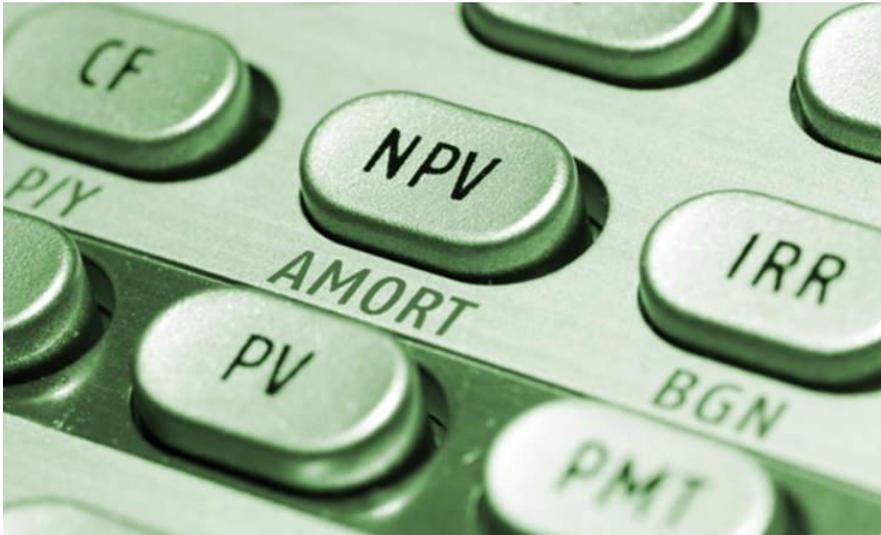
decrease its profitability. Income projections are difficult to determine with exact precision. In addition, a project may incur a negative cash flow instead of the projected positive one.

Return Percentage

The present value of a project is expressed in a dollar amount. Some business managers would rather see a percentage or rate of return. Although the NPV calculation discounts future cash flows using a required rate of return, it does not reveal the project's actual return. The calculation only reveals whether the project will return the required rate. A project may have a positive net present value, but the return may turn out to be less than desired. Higher dollar amounts do not necessarily translate into higher returns.

Source: <http://smallbusiness.chron.com/advantages-disadvantages-net-present-value-project-selection-54753.html>

Article 3: Why sustainability pros hate net present value?



We need a new business language to talk to about the future. Not just because we are moving into new territory, with new business models and opportunities, but because how we talk about things affects how we think about

things. So if we want to think about things differently, there's a strong argument for talking about them differently as well.

Let me back up a little.

Small talk being what it is, I get asked this question a lot: What did you study to get into this line of work? My answer tends to take people aback: "Well, my undergraduate was in philosophy, but then I trained as an accountant."

Yes, later I did get a more relevant masters degree. Yes, I do like that answer because it's both true and a little weird, but both have turned out to be a great grounding for thinking about sustainability and the future. Talking and thinking about net present value is an interesting place where they intersect.

A quick primer on undergraduate second year logical philosophy: We often assume that the function of language is to put names on things that we experience in the world, such as a book, chair or table, and the relationships between them. In that case, the difference between languages would be different words for the same things. When you study languages, however, you find that there isn't a universal structure of language.

For example, different languages treat colors differently, such as not distinguishing between blue and green or treating colors as adjectives or verbs. Philosophers therefore have argued that the way that the language you use treats things affects how you perceive the world. So if your language doesn't distinguish between blue and green, then neither can you. Neuroscientists now also show this to be the case. One study found that "linguistic representations normally meddle in even surprisingly simple objective perceptual decisions."

The significance of this is that rather than language reflecting what we see in the world, the language we use will often shape what we see.

I grappled with those concepts as a second year philosophy student. A few years later as a second year accountant, I had my first encounter with that sustainability bugbear, the net present value (NPV) calculation. For those who didn't spend interminable weeks being made to manually calculate NPV, they estimate costs forward into the future and then use a discount rate to account for the time value of money, in order to calculate the total value of the project today.

Sustainability is about meeting the needs of both current and future generations, whereas NPV says that the time value of money means that the cost or benefit in the far future (beyond about five years) isn't worth much to decision-makers today. This is at the root of poor decision-making for sustainable outcomes, because it discounts what happens in the future. And this is before we even factor in how badly NPV deals with resource price volatility and other uncertainty. So broadly speaking, finance people like NPV for its usefulness in decision-making, while sustainability folks hate NPV because of its poor treatment of the future.

Now to bring these two things together and to get to my point about language. If language shapes the way that we see the world, this suggests that finance directors may like NPV because it's a useful tool for calculation, but also that it's shaping how they actually view the future. The future looks like today to them because that's what CPA and MBA courses taught them, and that it's heavily discountable. So it's not just that NPV is unhelpful from a sustainability calculation perspective, but that even more problematically, it's shaping the thought processes of key stakeholders to bias them against sustainability.

If this bit of speculation is correct, then the barrier we're facing in the dominance of NPV and similar cultural tools in decision-making isn't just procedural, it's deeper than that — and harder to overcome.

At Forum for the Future, we describe our work using a six-step change curve, and it's easy to get enticed by the exciting things that happen at the middle of the curve — the pioneering practice, the tipping points and so on. But the first step on the curve, "experience the need for change," is really fundamental, and for some, not easy. But if we want to create significant change, we can't skip this step.

What can be done? The first step is start exposing your finance colleagues to some of your thinking about the future, include them in those conversations before you ask for an investment decision. Help them understand why tomorrow doesn't look like today, why costs aren't linear and why substantial threats are coming for the business model. Don't preach to them, and don't ask them to let go of their financial models just yet, but put in the groundwork so they

eventually will want to do it themselves. We need to work with them to find a common business language for the future.

Source: <https://www.greenbiz.com/blog/2014/02/26/why-sustainability-hate-net-present-value>

(downloaded: 06-10-2016)

CHAPTER 8: ECOSYSTEM VALUATION

Article 1: Assessing the value of Singapore's mangrove swamps



Is Singapore losing its heritage through redevelopment of buildings and loss of its coastline? It is time to develop a more robust way to assess heritage and ecosystems, to prevent their destruction.

The coastline generally associated with Singapore is one of harbours, ships, artificial beaches and concrete seawalls, all contributing to - and a product of - economic activity. But hidden among the cranes and refineries is a different coastal Singapore, a coast teeming with life.

This is a coastline fringed by intertidal mangrove forests and subtidal seagrass meadows, a coast that is home to crocodiles, dolphins, otters, and some of the most biodiverse coral reefs in the world.

However, Singapore's coastal ecosystems have declined rapidly with urbanisation. While data varies, the country may have lost almost 90 per cent of its mangroves since the 1950s due to land reclamation in the north and south-west. Other coastal ecosystems continue to decline, with recent research suggesting that over 40 per cent of intertidal coral reefs and almost 38 per cent of mudflats and sandflats have been lost in only the last 20 years.

If threatened ecosystems are to be conserved, it may become necessary to show their value to society, in comparison to other alternative land uses. It is simple to show the economic value of a reclaimed shoreline or a harbour terminal, but how much is the country's hidden natural coastline worth, and how do we, and should we, put a value on nature?

Increasingly, conservationists, and some businesses and policymakers are pitching their tent on the paradigm of "ecosystem services" as a way of increasing awareness of the importance of ecosystems, and potentially as a way of quantifying their value - economic, or otherwise.

"Ecosystem services" refer to the roles and benefits that ecosystems provide to humans. This is potentially an attractive concept as it can allow ecosystem value to become part of the

decision-making process, and widens the scope of conservation to appeal to people and donors who may not otherwise consider themselves environmentalists.

This new approach is controversial, as valuing ecosystems for their benefits to humans puts people front and centre in our view and perception of the environment. It represents a paradigm shift away from traditional protectionist conservation approaches, where ecosystems are protected for their inherent intrinsic or existence value.

Ecosystem services come in all shapes and sizes. The Millennium Ecosystem Assessment - a ground-breaking international report released in 2005 - was commissioned by the United Nations to understand the impact of environmental change on human well-being. This report was one of the most high-profile attempts to describe the wide range of ecosystem services that human populations rely on.

One way in which ecosystems benefit people is through "provisioning services", where people can physically extract products from an ecosystem, such as fish and other foods, building materials, minerals and medicinal resources. These are direct, tangible and physical ecosystem services, which can be easily understood and monetised.

Other ecosystem services "regulate" or "support" the environment, and can include processes by which ecosystems purify water, trap pollutants, produce nutrients and regulate local climates.

For example, carbon sequestration (the removal of carbon dioxide from the atmosphere) is an ecosystem service that is currently high on the international agenda in international climate negotiations.

In Singapore, seagrass meadows and mangrove forests

use up atmospheric carbon dioxide for photosynthesis, so can offset a proportion of the country's carbon dioxide emissions and thus offset our contribution to global climate change. However, these ecosystem services are largely invisible and less tangible.

The way ecosystems benefit people through "cultural services" is perhaps the most abstract, but may be the most important in Singapore's context. Cultural services include the use of ecosystems for recreation and education. Tens of thousands of people visit the mangroves at Sungei Buloh Wetland Reserve every year, which has recently expanded in area and has constructed new visitor facilities.

Other cultural services are much more abstract and intangible, and include spiritual, aesthetic, and "sense of place" services.

Current research shows that the types of cultural services valued in Singapore are changing; in the 1950s, communities valued mangroves for intrapersonal reasons such as spiritual and religious value, especially for kampung communities that had a strong personal link to the coast. However, today people in Singapore have become more dislocated from their coastline, and place more value in interpersonal services such as recreation and education.

Despite their importance, Singapore's remaining fragments of hidden coastline face an uncertain future. The Urban Redevelopment Authority's 2013 Land Use Plan and the 2014 Master Plan suggest further land reclamation - expansion that is needed to maintain economic production and house a growing population in a land-challenged Singapore.

This begs the question of how ecosystem services can be used to balance socioeconomic demands with environmental concerns. Yet, we already implicitly use the ecosystem-service approach in land use planning, with Singapore's Garden City concept driven by an acknowledgement of the importance of natural and managed green spaces in improving livability in a densely populated nation, through recreation and aesthetic value.

Exploring the potential of ecosystem services such as climate regulation, coastal protection and carbon sequestration may provide decision-makers with the evidence to make informed management decisions that incorporate and utilise the varied benefits of the country's hidden coastline, to ensure a sustainable Singapore in the future.

Source: <http://www.straitstimes.com/opinion/assessing-the-value-of-singapores-mangrove-swamps> (downloaded: 06-10-2016)

Article 2: Does it help conservation to put a price on nature?

Assigning an economic value to the benefits which nature provides might not always promote the conservation of biodiversity, and in some cases may lead to species loss and conflict, argues a University of Cambridge researcher.

„There is a risk that traditional conservation strategies oriented toward biodiversity may not be effective at protecting the economic benefits of an ecosystem, and vice-versa”

- Bill Adams

Putting a price on the services which a particular ecosystem provides may encourage the adoption of greener policies, but it may come at the price of biodiversity conservation. Writing today (30 October) in the journal *Science*, Professor Bill Adams of the University's Department of Geography argues that assigning a quantitative value to nature does not automatically lead to the conservation of biodiversity, and may in fact contribute to species loss and conflict.

While assigning a monetary value to the benefits of an ecosystem can be an essential tool in the environmental planning process, unequal access to those benefits, particularly where there are differences in wealth and power, can lead to poor trade-offs being made, both for the ecosystem itself and those who rely on it.

“Putting a price on what nature provides is not in itself a conservation measure,” said Adams. “There is a risk that traditional conservation strategies oriented toward biodiversity may not be effective at protecting the economic benefits of an ecosystem, and vice-versa.”

For example, when stream channels in the US state of Maryland were re-engineered to provide a means of natural flood control, it ended up causing the loss of trees which had been growing next to the water and were unable to adapt to their new, drier environment.

The ways in which we depend on our natural environment are increasingly expressed as ‘ecosystem services’, or the range of benefits we get from nature for free. These benefits include the provision of food and clean water, erosion control and carbon storage. Quantifying the value of nature in this way is meant to allow policymakers to consider the potential economic and social impacts of altering a particular habitat.

This approach does sometimes lead to win-win scenarios, where the value of ecosystem services is dependent upon a high level of biodiversity. One example is in the coffee plantations of Costa Rica, where the retention of forest habitat in areas around the plantations doubled the amount of pest control of coffee berry borer beetle provided by birds, which benefitted the coffee farmers while protecting biodiversity.

However, consideration of ecosystem services when making decisions does not automatically lead to retention of biodiversity. “In many cases, trade-offs are made,” said Adams.

Several factors cause tension between biodiversity conservation and ecosystem services. One problem is that the biological and physical processes that guarantee the supply of specific ecosystem services may be different from those that support valued species. An ecosystem that is managed to deliver particular services may not support particular elements of biodiversity.

A second problem is that there are often no markets for some vital services, such as soil formation and nutrient cycling, and while payment schemes can be created to create market-like structures, the value assigned to ecosystem services depends on market prices, which are subject to change.

A third problem arises from the institutional and political processes linking economic benefits from ecosystems and human wellbeing. “Unequal access to benefits, for example where there are differences in wealth and power among stakeholders, can lead to trade-offs being made, with negative impacts for the ecosystem itself and those who rely on it,” Adams comments “It’s not enough to identify the net benefits of ecosystem services; it also matters who gets them.”

For example, in Nepal, research has shown that forests managed by the local community, rather than by the state, yielded benefits of clean water, tourism and harvested wild goods. However, these forests restricted poorer people’s access to forest-derived products, creating hardship, illegal use and impacts on other areas.

“In a world run according to economic arguments, the survival of biotic diversity will depend on its price,” said Adams. “Sometimes economics will favour conservation and sometimes it won’t. But conservationists need to plan for both outcomes.”

Source: <http://www.cam.ac.uk/research/news/does-it-help-conservation-to-put-a-price-on-nature> (downloaded: 06-10-2016)

Article 3: Hidden value of nature revealed in groundbreaking study

The true value of nature can be shown for the very first time thanks to groundbreaking research by hundreds of UK scientists.



The research forms the basis of a major new independent report - the UK National Ecosystem Assessment (UK NEA) - which reveals that nature is worth billions of pounds to the UK economy. The report strengthens the arguments for protecting and enhancing the environment and will be used by the government to direct policy in future.

The UK NEA has used new approaches to estimate the value of the natural world by taking account of the economic, health and social benefits we get from nature.

While in the past people may have thought that caring for the environment meant extra financial burdens, the UK NEA shows that there are real economic reasons for looking after nature. The NEA also shows that the benefits we get to our health, well being and from the enjoyment of nature have not always been fully appreciated or valued.

The assessment provides values for a range of ecosystem services to help us fully understand the value of the natural environment and how the benefits to individuals and society as a whole can be better protected and preserved for future generations.

Examples include:

- The benefits that inland wetlands bring to water quality are worth up to £1.5billion per year to the UK;
- Pollinators are worth £430million per year to British agriculture;
- The amenity benefits of living close to rivers, coasts and other wetlands is worth up to £1.3billion per year to the UK; and
- The health benefits of living with a view of a green space are worth up to £300 per person per year.

The UK NEA shows that the tendency to focus only on the market value of resources we can use and sell, such as timber, crops and fisheries, has led to the decline of some ecosystems and habitats through pollution, over-exploitation, and land conversion.

It warns that continued population growth and climate change are likely to put additional pressure on ecosystems, and that actions taken now will have consequences far into the

future. It stresses the need for a more collaborative approach to enhancing our environment, with everyone playing their part to capture more of nature's benefits in a sustainable way. Six future scenarios have been developed showing how ecosystems could be affected over the next 50 years depending on what emphasis is given to environmental sustainability or economic growth.

Environment Secretary Caroline Spelman said:

“The natural world is vital to our existence, providing us with essentials such as food, water and clean air, but also other cultural and health benefits not always fully appreciated because we get them for free. The UK National Ecosystem Assessment is a vital step forward in our ability to understand the true value of nature and how to sustain the benefits it gives us.

“I want our children to be the first generation to leave the natural environment in a better state than it was left to them. In 50 years time I want them to be able to look back and see how much the value of nature has grown, not diminished. The findings of this assessment have played a big part in shaping our forthcoming Natural Environment White Paper that will help us revitalise our towns and countryside.”

Professor Bob Watson, Chief Scientist at Defra and co-chair of the UK NEA, said:

“There is an urgent need to better manage our ecosystems and the natural resources they provide us with. But until now there has been no clear way of valuing the full range of benefits they provide beyond what we can buy and sell. The UK NEA introduces groundbreaking approaches to measure the value of these services and how they will be affected in future if we do not make the right choices now.

“The NEA shows that we need a more integrated approach to ecosystem management, involving Government, the private sector, voluntary groups and the public working together to protect the services nature provides”

Professor Steve Albon, of the James Hutton Institute (formerly the Macaulay Land Use Research Institute), and co-chair of the UK NEA, said:

“The holistic approach we have taken to assessing the ways our well-being depends on the multitude of services delivered by UK ecosystems has reinforced the need to halt the degradation of our land, freshwater and seas. While we can now make more informed decisions to try to ensure the more sustainable use of natural resources we need to continue integrated research to understand how to adapt and mitigate the pressures of continuing population growth and climate change.”

Lord Selborne, Chair of the Living with Environmental Change Partnership, said:

“From enclosed farmland to open mountains and from freshwater streams to the seas, the terrestrial and aquatic ecosystems of the UK support a wealth of wildlife and contribute a range of services on which we ultimately depend. Yet too often we have paid insufficient attention to how these ecosystems should be managed so that they achieve multiple goals, such as the production of food, clean water and recreation. The UK NEA is a significant and important contribution to a better understanding on how we should safeguard our ecosystems and natural resources.”

The UK NEA examines the state of the full range of services provided across eight different habitats including marine, woodlands, wetlands and moorlands. It shows that while some ecosystems are getting better at delivering services, such as crop production from farmland and climate regulation by woodlands, over 30% of services assessed were found to be in decline, and others degraded, such as marine fisheries, wild species diversity and soil quality.

Source: <https://www.gov.uk/government/news/hidden-value-of-nature-revealed-in-groundbreaking-study> (downloaded: 06-10-2016)

CHAPTER 9: TRADE-OFFS

Article 1: The False Trade-Off between Economic Growth and Environmental Protection



In an excellent piece in the *New York Times*, Erica Goode summarized a recent report from the World Health Organization (W.H.O.). According to Goode:

The report, which compiled air quality readings from 3,000 cities in 103 countries, found that more than 80 percent of people in those cities were exposed to pollution exceeding the limits set by W.H.O. guidelines, above which air quality is considered to be unhealthy. And in poorer countries, 98 percent of cities with more than 100,000 inhabitants were out of compliance with the health organization's guidelines.

Her story noted that while most of the disparity was between wealthy nations and poorer ones, Europe's dependence on diesel-fueled autos has resulted in pollution levels that are far higher than those in North America. In Europe, 60% of those living in cities breathed air that did not meet international standards; in North America, that number was 20%. The World Health Organization's report indicates that public policy and economic choices can lead to higher or lower levels of pollution; that there is no trade-off between economic growth and air pollution; and that the wealthiest countries tend to have the cleanest air.

One standard response to the presence of cleaner air in the developed world is to argue that these countries have exported their largest polluters—dirty, heavy industry—into the developing world. While the export of manufacturing is undoubtedly true, most air pollution comes from generating electricity and from vehicles, so the real story is a failure to regulate power plant and auto emissions. Given what we have learned about Volkswagen's attitude toward emissions monitoring, it is easy to understand why Europe's air is not as clean as America's or Canada's.

Government may not always be an efficient mechanism of program delivery, but when it comes to setting rules and enforcing standards, they are really the only game in town. Without the rule of law and rigorously enforced air pollution regulation, there seem to be too many incentives for trading off long-term benefits for short-term gains. Nevertheless, I am sure we could develop a market mechanism to reinforce air pollution standards and that market incentives

would drive compliance with clean air rules even higher. Innovative policy designs to reduce pollution should always be explored. But there is no substitute for rules that express a nation's sense of values and for those national values to include preservation of the planet.

I am not arguing that securing clean air does not require sacrifices and trade-offs. There will certainly be old dirty factories that are not cost effective unless they pollute, but those factories should either clean up or close down. The workers who are harmed by these changes should be compensated for their loss and offered alternative means of employment. The efforts to reinforce the trade-off between environmental protection and economic development are shortsighted and terribly manipulative. For example, union members eager for construction jobs are told that without a gas pipeline or coal-fired power plants there will be no jobs. That is only the case if our nation decides not to invest resources and build the high-tech businesses of the 21st century. There will be plenty of jobs if our political leaders exhibit the political courage to invest in our roads, bridges, ports, mass transit, energy efficiency and water supply. Our infrastructure is characterized by a massive amount of deferred maintenance. No one wants to pay the user fees or taxes needed to maintain modern energy, water or transportation infrastructure. But once we decide that we are willing to invest public treasure for public goods, construction jobs will return.

Our transportation infrastructure is falling apart. Last week I went from my office on Broadway and 114th Street to the National Science Foundation offices near the Ballston-MU Metro Station in the suburbs of Washington, D.C. I took the subway to Penn Station, the Amtrak to Washington, D.C., and the D.C. metrorail to Ballston. My hotel was directly connected to the metro station. I didn't travel by train because it used less energy than other means; I did it because it was the easiest way to travel. But I must tell you, the best piece of infrastructure I travelled on was the NYC subway—and that is nothing to brag about. Penn Station in New York is a dump and the Amtrak trains could certainly use modernization. Union Station in D.C. is a wonderful, beautiful and (I hope) thriving commercial hub, but the D.C. metrorail is a depressing disaster. I worked in Washington when the metro was new and I thought it was the subway of the future. Sadly, the cars seem to have the same carpet and seats today that they had back in the 1980s. There is plenty of work to do if someone wants to fix up the metro (I'd suggest putting a few more escalators in the NYC subway and building a bullet train from D.C. to New York).

The trade-off between environmental protection and economic growth has been discussed for half a century. What we have learned is that government regulations requiring pollution control are "technology forcing" and encourage the modernization of industry and infrastructure. A marginal business that can't afford pollution control technology would not last very long anyway. But the investment in environmental clean-up often stimulates other upgrades that

enable businesses to more effectively compete in a global economy. Moreover, a clean environment reduces illness and that reduces the need for expensive health care. Clean air also attracts businesses, residents and tourists. Dirty air discourages visitors and investment.

The idea that wealth has nothing to do with ecology is idiotic. Humans are living beings requiring the food, air and water that can only be generated by thriving ecosystems. The wealthy cannot build a walled community to keep the foul air out of their plush estates. Perhaps they can filter their homes and reduce particulates, but some toxics will still get through, and eventually even a wealthy person must leave their cocoon and breathe along with the rest of us.

The rich may know they can't hide from air pollution, but American workers have been convinced that they won't have jobs if they don't help extract fossil fuels. Donald Trump claims he will re-open America's coal mines. People who oppose fracking and pipeline projects are considered anti-growth and anti-labor. We cannot "make America great again" by trying to return to the industrial era of the mid-twentieth century. As Bruce Springsteen wrote in "My Hometown": "They're closing down the textile mill across the railroad tracks. Foreman says these jobs are going boys and they ain't coming back." It is cynical and manipulative to claim that we can return to the mid-twentieth century; we can't. Agriculture and manufacturing are becoming more automated and modular construction is the wave of the future. Employment will need to be based on the economy of the future, not our dreams of the past.

The data demonstrates that a clean environment is an economic asset. The trade-off between jobs and environment is propaganda. I don't know when it will leave our political dialogue, but it's clear it will last through this cycle. Perhaps I should get some hats made—"Make America Smoggy Again." Something in gray with a touch of orange and brown.

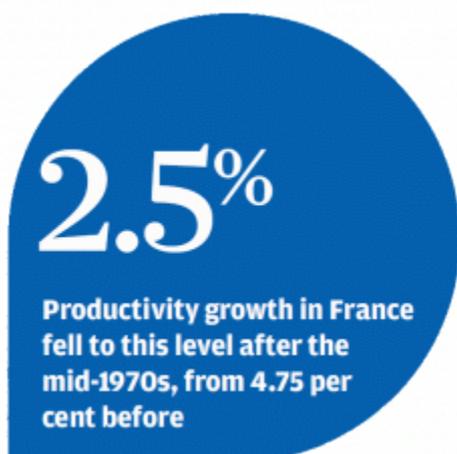
Source: http://www.huffingtonpost.com/steven-cohen/the-false-trade-off-between-b_10030370.html (downloaded: 06-10-2016)

Article 2: Trade-off between productivity gains and job losses isn't so simple

While some have blamed recent job losses on productivity gains, spurning innovation is a recipe for slower growth and even decline

A popular view these days is that robots and labour-saving technologies are destroying jobs and creating a growing group of disillusioned people who harbour a deepening sense of alienation from society.

If true, the future indeed looks bleak.



The personal costs of prolonged joblessness are immense, and the consequences of mass unemployment and polarised societies should frighten us all.

If jobs must be traded off for improved productivity, decision-makers are in an unenviable bind. If they pursue productivity growth, embrace new technologies, and foster innovation, they can climb aboard the express train to expansion. Or they can sacrifice modernity and progress to save jobs.

The debate is livelier in industrialised economies than in emerging and developing ones, but it is relevant to all of them.

"If jobs must be traded off for improved productivity, decision-makers are in a bind"

Most economists believe the notion of a technology trade-off is ill-founded and flies in the face of more than 200 years of historical evidence, where productivity and employment growth have - most of the time - gone hand in hand. They would argue there is no such thing as jobless growth, except in the short term.

But the contrary view has been gaining traction of late. Unemployment has remained persistently high in many industrial countries, especially following the 2008 recession, which was triggered by mismanagement of the financial sector. Yet many economies have bounced back, along with corporate profits. The most recent divergence between productivity and employment growth can be traced back to 2000.

When one looks at national data over a slightly longer period, however, the relationship between labour-saving efficiency gains and jobs can be murky. Work undertaken by three leading economists shows that in France, for example, productivity grew by about 4.75 per cent a year and unemployment averaged 2 per cent in the 15 years up to the mid-1970s. Then

for the subsequent 15 years, productivity growth averaged 2.5 per cent per year and unemployment rose to more than 10 per cent. This suggests that complex linkages and many influences are at play.

Those who believe that the historical link between productivity growth and job growth has been broken base their case on the experience of the last decade and a half. They argue that the job-killing nature of productivity growth today is unprecedented, affecting a much wider range of occupations than before and taking its toll at record speed. Digital technologies are raising productivity and replacing jobs in both blue- and white-collar occupations, from warehousing and despatching to retail, accounting, legal and other business services.

Artificial intelligence, 3-D printing and driverless cars are just some of the emerging technologies that will reinforce the jobless economy. The effect of productivity changes on jobs will be influenced by output trends as well as the pattern of demand. Output has been sluggish in recent years, and it is difficult over a short period to disentangle macroeconomic factors from the impact of productivity growth.

Productivity increases typically lower prices, encouraging increased demand. Technological change and innovation are at the heart of the creation and destruction that underlies economic progress and wealth creation. Existing jobs will be destroyed and new jobs created. Services typically become more important as a source of income and jobs as economies advance.

None of this detracts from the reality that adjustment can be very painful, the fallout more prolonged than necessary - and even permanent in the worst-case scenarios. Governments bear much of the responsibility for aggravating adjustment costs. The absence of adequate long-term investments in appropriate infrastructure, education and health is a fundamental cause of prolonged unemployment, especially in industrial countries.

In the perennial political struggle between taxing and spending preferences, those elements of spending that can be cut without upsetting powerful lobbies will be at the front of the queue. The electoral cycle is too short to induce enough longer-term thinking. This near-term view of the world exacts its price on key sections of the population, especially the young, but does not necessarily damage the electoral prospects of governments.

Inflexible labour markets can do more than technology and innovation to keep unemployment high and job opportunities for new labour market entrants scarce. Efforts to deal with this problem, however, may well seal a government's electoral fate. Seen this way, joblessness is not always a consequence of productivity growth.

Emerging economies seeking to overcome the middle-income trap, and poorer economies attempting to diversify away from excessive dependency on a few sectors, have just as high a

stake in fostering productivity as do the richest countries. Spurning productivity growth in order to protect jobs is a sure recipe for slower growth, reduced opportunity and, for some, decline.

Source: <http://www.scmp.com/business/economy/article/1431062/trade-between-productivity-gains-and-job-losses-isnt-so-simple> (downloaded: 06-10-2016)

Article 3: Farmers locked in food production vs. pollution trade-off



Agriculture remains a major threat to water quality in Europe, according to the latest report by the European Union's environmental agency. But farmers and EU policymakers are also quick to highlight the trade-off between

conservation objectives and pressure to increase food production.

At a time when other sources of pollution have cleaned up their act, the European Union's environmental watchdog reports that intensive farming practices are contributing to "significant loads of pollutants" in surface water. The European Environment Agency, in a new assessment, reports that 48% of streams and lakes in the EU will fail to meet good ecological status by 2015 as required by the 2000 Water Framework Directive.

Excessive nutrients from fertilisers are a leading problem, the EEA report says, with one consequence being the growth algae that chokes off oxygen to fish and plant life in lakes, streams and bays.

"Agricultural production is becoming increasingly intensive, with high input of fertilisers and pesticides, in turn resulting in significant loads of pollutants to the water environment through diffuse pollution," the EEA says in a new report on Europe's water status.

The European Commission's Water Blueprint, released a day later on 15 November, calls for better enforcement at the national level of EU laws designed to reduce pollution "from nutrients and/or other chemicals from agriculture, households and industry."

Lifting food supplies

But the fight against pollution is destined to run head-on with concern about food security. There is growing pressure, in Europe and internationally, for farmers to be more productive to address tighter food supplies, rising prices and a population forecast of 9 billion – from 7 billion today – by mid-century.

In recent years, severe droughts in the United States, Australia, Russia and East Africa fuelled commodity speculation and food price rises, but also exposed the vulnerability of supplies and

the need for longer-term supply certainty. In the European Parliament, these concerns have struck a chord with key policymakers.

“Unlike my green colleagues, I understand the value of nutrients,” British MEP George Lyon, a Scottish farmer and Liberal-Democrat member of the European Parliament’s agriculture committee, said at a recent round-table on fertilisers and food security. “If it hadn’t been for nutrients, agricultural production today would be below World War II levels.”

Farm, fertiliser and crop protection groups say the smart use of nutrients and pesticides can boost yields while minimising harm to the environment. In October, the Fertilizers Europe industry association launched its ‘DAN’ campaign – directly available nitrogen fertilisers – to encourage the measured use of nitrate and ammonium forms of nitrogen, which the industry says can improve yields and reduce leaching of minerals into fresh water. Pesticide groups have launched similar campaigns for farmers.

The industry also says better use of fertilisers pays another environmental dividend –improved productivity reduces the need to clear forests and fallow land for farming, especially in rapidly growing developing countries. Sub-Saharan Africa, for example, has among the world’s least productive farmland yet food demand forces farmers to clear forests or natural grasslands. Scientists say it’s not entirely a human-made problem – the continent has vast areas of desert and marshland that are unsuitable for crops or grazing, and in many other areas soils are high in salinity and acids.

A newly published United Nations Human Development Report on Africa, which focuses on food security, also cites crop failure and low productivity, scarce fertilisers and rudimentary irrigation practices as leading factors in food shortages in Sub-Saharan Africa. UN figures show that African farmers on average remove four times more nitrate nutrition during harvests than they return to the soil – a recipe for the gradual destruction of farmland’s productivity.

Environmentalists are wary of intensifying agriculture in both advanced and developing countries, arguing that reducing food waste is a better way to ensure sufficient supplies and that chemical nutrients not only have consequences for freshwater supplies, but also eventually harm the soil.

Growing pains

Some experts say there has to be a mix of practices to both feed and protect a growing planet.

Ben Woodcock of the British National Environment Research Council advises farmers – and policymakers – to mix intensive farming with the development of buffer areas and natural habitats that can protect water bodies, improve soil quality and nurture wildlife work as pollinators and prey on pests.

“The problem is it can’t go both ways. If you keep damaging crop land, if you keep reducing the overall area of semi-natural habitats, these ecosystem services will actually decline,” he told EurActiv.

Woodcock, of the council’s Centre for Ecology and Hydrology, said that the post-second world war green revolution, the use of chemical fertilisers and pesticides brought about an initial increase in yields, “but what’s happening more and more now is that this is gradually levelling off.”

“If we are going to continue to increase crop yields over the future,” he said, “we’re going to have to make use of more than just conventional management practices – so pesticides, fertilisers, this kind of thing. We’re going to have to make increasing use of other ecosystem services, so that’s going to be natural pest control, pollination and all of these are ... likely to add notable increases in crop yields over the long term.”

Tim Benton, a University of Leeds professor of population ecology, sees environmental advantages to using fertiliser to boost farm output.

“The biggest environmental cost of agriculture is the conversion of new land, and that also has the biggest climate change consequences and the biggest biodiversity consequences,” said Benton, who serves as Britain’s Champion for Global Food Security.

He said getting more production out of land can work in advanced countries as well as in developing nations, which are squeezed by the double pressure of feeding more people and a rapidly rising middle class.

“It all comes down to being smart about things,” he told EurActiv. “We’re pushing in Europe for increased precision agriculture, resource-use efficiency, and so on, to limit [environmental] damages, and there is no reason why you can’t be sensible about it anywhere in the world, including small-holder agriculture.”

Source: <https://www.euractiv.com/section/agriculture-food/news/farmers-locked-in-food-production-vs-pollution-trade-off/> (downloaded: 06-10-2016)

CHAPTER 10: MARGINAL COSTS AND BENEFITS

Article 1: The Rise of the Internet of Things and the Race to Zero Marginal Cost Society

The bulk of the energy we use to heat our homes and run our appliances, power our businesses, drive our vehicles and operate every part of the global economy will be generated at near zero marginal cost and be nearly free in the coming decades. That's already the case for several million early adopters in the European Union who have transformed their homes and businesses into micro power plants to harvest renewable energy onsite. Currently, around 25 percent of the electricity powering Germany comes from renewable energies. By 2020, the country aims to increase that to 35 percent.

The quickening pace of renewable energy deployment is due, in large part, to the plunging cost of solar and wind energy harvesting technologies. The fixed costs of solar and wind harvesting technologies have been on exponential curves for more than 20 years, not unlike the exponential curve in computing. In 1977, the cost of generating a single watt of solar electricity was more than \$76. By the last quarter of 2012, the cost of generating a watt had fallen to \$0.50, and by 2017 the cost is projected to fall to \$0.36 per watt. After the fixed costs for the installation of solar and wind are paid back — often in as little as 2 to 8 years — the marginal cost of the harvested energy is nearly free. Unlike fossil fuels and uranium for nuclear power, in which the commodity itself always costs something, the sun collected on rooftops and the wind traveling up the side of buildings are free. In some regions of Europe and America, solar and wind energy is already as cheap, or cheaper, than fossil fuel or nuclear generated energy.

The impact on society of near zero marginal cost solar and wind energy is all the more pronounced when we consider the enormous potential of these energy sources. The sun beams 470 exajoules of energy to Earth every 88 minutes — equaling the amount of energy human beings use in a year. If we could grab hold of one-tenth of 1 percent of the sun's energy that reaches Earth, it would give us six times the energy we now use across the global economy. Like solar radiation, wind is ubiquitous and blows everywhere in the world — although its strength and frequency varies. A Stanford University study on global wind capacity concluded that if 20 percent of the world's available wind was harvested, it would generate more than seven times more electricity than we currently use to run the entire global economy. The Internet of Things will enable businesses and prosumers to monitor their electricity usage in their buildings, optimize their energy efficiency and share surplus green electricity generated on-site with others across nations and continents.

The Energy Internet is comprised of five foundational pillars, all of which have to be phased in simultaneously for the system to operate efficiently.

1. Buildings and other infrastructure will need to be refurbished and retrofitted to make them more energy-efficient so that renewable energy technologies — solar, wind, etc. — can be installed to generate power for immediate use or for delivery back to the electricity grid for compensation.

2. Ambitious targets must be set to replace fossil fuels and nuclear power with renewable energy sources. To achieve this goal, feed-in tariffs need to be introduced to encourage early adopters to transform buildings and property sites into micro power generation facilities. The feed-in tariffs guarantee a premium price above market value for renewable energies generated locally and sent back to the electricity grid.

3. Storage technologies including hydrogen fuel cells, batteries, water pumping, etc., will need to be embedded at local generation sites and across the electricity grid to manage both the flow of intermittent green electricity and the stabilization of peak and base loads.

4. Advanced meters and other digital technologies will need to be installed in every building to transform the electricity grid from servo-mechanical to digital connectivity in order to manage multiple sources of energy flowing to the grid from local generators. The distributed smart electricity infrastructure will enable passive consumers of electricity to become active producers of their own green electricity, which they can then use off-grid to manage their facilities or sell back to the Energy Internet.

5. Every parking space will need to be equipped with a charging station to allow electric and fuel cell vehicles to secure power from the Energy Internet, as well as sell power back to the electricity grid. Millions of electric and fuel cell vehicles connected to the Energy Internet also provide a massive backup storage system that can send electricity to the grid during peak demand, when the price of electricity has spiked, allowing vehicle owners to be appropriately compensated for contributing their electricity to the network.

The phase-in and the integration of the above five pillars transforms the electricity grid from a centralized to a distributed electricity system, and from fossil fuel and nuclear generation to renewable energy. In the new system, every business, neighborhood and homeowner becomes the producer of electricity, sharing his or her surplus with others on a smart Energy Internet that is beginning to stretch across national and continental landmasses.



An electric car charging station in Maine. (Photo by Whitney Hayward/Portland Press Herald via Getty Images)

The democratization of energy is forcing electricity companies to rethink their business practices. A decade ago, four giant vertically integrated

electricity-generating companies — E.ON, RWE, EnBW and Vattenfall — produced much of the electricity powering Germany. Today, these companies are no longer the exclusive arbiters of power generation. In recent years, farmers, urban dwellers and small and medium-sized enterprises established electricity cooperatives across Germany. Virtually all of the electricity cooperatives were successful in securing low-interest loans from banks to install solar, wind and other renewable energies onsite. The banks were more than happy to provide the loans, assured that the funds would be paid back by the premium price the cooperatives would receive — via feed-in tariffs — from selling the new green electricity back to the grid. Today, the majority of the green electricity powering Germany is being generated by small players in electricity cooperatives.

While these traditional vertically integrated power companies proved quite successful in generating relatively cheap electricity from traditional fossil fuels and nuclear power, they have not been able to effectively compete with local electricity cooperatives whose laterally scaled operations are better at managing energy harnessed by thousands of small players in broad collaborative networks. Peter Terium, CEO of RWE, the German energy company, told Reuters that a massive shift is taking place in Germany from centralized to distributed power, and said that the bigger power and utility companies “have to adjust to the fact that, in the longer term, earning capacity in conventional electricity generation will be markedly below what we’ve seen in recent years.”

A growing number of electricity-generating companies are coming to grips with the new reality of democratized energy and are changing their business models to accommodate the new Energy Internet. In the future, their income will increasingly rely on erecting and operating the Energy Internet managing their customers’ energy use. The electricity companies will mine Big Data across each of their clients’ value chains and use analytics to create algorithms and applications to increase their aggregate energy efficiency and productivity, and reduce their

marginal cost. Their clients, in turn, will share the efficiency and productivity gains back with the electricity companies in what are called “performance contracts.” In short, power companies will profit more from managing energy use more efficiently and selling less rather than more electricity.

The Automated, GPS-Guided Transportation and Logistics Internet

The meshing of the Communication Internet and the Energy Internet makes possible the build-out and scale-up of the automated Transportation and Logistics Internet. The convergence of these three Internets comprise the kernel of the Internet of Things platform for managing, powering and transporting goods in a Third Industrial Revolution economy. The automated Transportation and Logistics Internet is made up of four foundational pillars, which, like the Energy Internet, have to be phased-in simultaneously for the system to operate efficiently.

- 1. As mentioned previously, charging stations will need to be installed ubiquitously across land masses, allowing cars, buses, trucks and trains to power up or send back electricity to the grid.
- 2. Sensors need to be embedded in devices across logistics networks to allow factories, warehouses, wholesalers, retailers and end users to have up-to-the-moment data on logistical flows that affect their value chain.
- 3. The storage and transit of all physical goods will need to be standardized so that they can be efficiently passed off to any node and sent along any passageway, operating across the logistics system in the same way that information flows effortlessly and efficiently across the World Wide Web.
- 4. All of the operators along the logistics corridors need to aggregate into collaborative networks to bring all of their assets into a shared logistical space to optimize the shipment of goods, taking advantage of lateral economies of scale. For example, thousands of warehouses and distribution centers might establish cooperatives to share unused spaces, allowing carriers to drop off and pick up shipments using the most efficient path on route to their destination.

Container ship Josco View of Hong Kong, and Panama’s container ship Mol Earnest sail through a port in Yokohama, southwest of Tokyo. (AP Photo/Koji Sasahara)



The Internet of Things platform will provide real-time logistical data on pick-up and delivery schedules, weather conditions, traffic flows and up-to-the-moment information on warehouse storage capacities en route. Automated dispatching will use big data and analytics to create algorithms and applications to ensure the optimization of aggregate efficiencies along the logistical routes and, by so doing, dramatically increase productivity while reducing the marginal cost of every shipment.

By 2025, at least some of the shipments on roads, railways and water will likely be carried out by driverless electric and fuel cell transport, powered by near zero marginal cost renewable energies, and operated by increasingly sophisticated analytics and algorithms. Driverless transport will accelerate productivity and reduce the marginal labor cost of shipping goods toward near zero on a smart automated Transportation and Logistics Internet.

The erection of the automated Transportation and Logistics Internet also transforms the very way we view mobility. Today's youth are using mobile communication technology and GPS guidance on an incipient automated Transportation and Logistics Internet to connect with willing drivers in car-sharing services. Young people prefer "access to mobility" over ownership of vehicles. Future generations will likely never own vehicles again in a smart, automated mobility era. Larry Burns, the former executive vice president of General Motors and now a professor at the University of Michigan, did a study of mobility patterns in Ann Arbor, a mid-sized American city, and found that car-sharing services can reduce the cost of traveling a mile by 80 percent compared to privately owned vehicles. He also found that a "shared fleet provides almost instantaneous access to a vehicle with a fleet of only 15 percent of the number of privately owned vehicles that would have been used for these trips."



A traffic jam in heavy smog, Beijing. (ChinaFotoPress via Getty Images)

There are currently at least a billion cars, buses and trucks crawling along around the world. Gasoline-powered internal combustion vehicles were the

centerpiece of the Second Industrial Revolution. The mass production of these vehicles devoured vast amounts of the Earth's natural resources. Cars, buses and trucks also burn massive amounts of oil and are a major contributor to global warming gas emissions. Burns' study suggest a large number of vehicles currently on the road are likely to be eliminated with widespread adoption of car-sharing services over the course of the next generation. Those that remain will be electric and fuel cell transport, powered by near zero marginal cost renewable energy. Those shared vehicles, in turn, will be driverless and running on automated, smart road systems.

The long-term transition from ownership of vehicles to access to mobility in driverless vehicles on smart road systems will fundamentally alter the business model for the transportation industry. While the big auto manufacturers around the world will produce fewer vehicles over the course of the next 30 years, they will likely increasingly reposition themselves as aggregators of the global automated Transportation and Logistics Internet, managing mobility services and logistics.

The convergence of the Communication Internet, renewable Energy Internet, and automated Transportation and Logistics Internet in an operating kernel becomes the global brain for an Internet of Things cognitive infrastructure. This new digital platform fundamentally changes the way we manage, power and move economic activity across the numerous value chains and networks that make up the global economy. The digitalized Internet of Things platform is the core of the Third Industrial Revolution.

Distributed Manufacturing

Virtually every industry will be transformed by the Internet of Things platform and the ushering in of a Third Industrial Revolution. For example, a new generation of micro-manufacturers are beginning to plug in to the incipient Internet of Things and dramatically increasing their productivity while reducing their marginal costs, enabling them to outcompete the formerly invincible global manufacturing firms, which are organized around vertically integrated economies of scale. It's called 3-D printing, and it is the manufacturing model that accompanies an Internet of Things economy.

In 3-D printing, software directs molten feedstock inside a printer to build up a physical product layer by layer, creating a fully formed object, even with movable parts, which then pops out of the printer. Like the replicator in the Star Trek television series, the printer can be programmed to produce an infinite variety of products. Printers are already producing products from jewellery and airplane parts to human prostheses, and even parts of cars and buildings. And cheap printers are being purchased by hobbyists interested in printing out their own parts

and products. The consumer is beginning to give way to the prosumer as increasing numbers of people become both the producer and consumer of their own products.

Three-dimensional printing differs from conventional centralized manufacturing in several important ways. To begin with, there is little human involvement aside from creating the software. The software does all the work, which is why it's more appropriate to think of the process as "infofacture" rather than "manufacture."

Visitors tour 3-D-printed houses at Suzhou Industrial Park in China. (ChinaFotoPress via Getty Images)



The early practitioners of 3-D printing have made strides to ensure that the software used to program and print physical products remains open source, allowing prosumers to share new ideas with one another in do-it-yourself hobbyist networks. The open design concept conceives of the production of goods as a dynamic process in which thousands — even millions — of players learn from one another by making things together. The elimination of intellectual property protection also significantly reduces the cost of printing products, giving the 3-D printing enterprise an edge over traditional manufacturing enterprises, which must factor in the cost of myriad patents. The open-source production model has encouraged exponential growth.

The 3-D printing production process is organized completely differently than the manufacturing process of the First and Second Industrial Revolutions. Traditional factory manufacturing is a subtractive process. Raw materials are cut down and winnowed and then assembled to manufacture the final product. In the process, a significant amount of the material is wasted and never finds its way into the end product. Three-dimensional printing, by contrast, is additive infofacturing. Software is directing the molten material to add layer upon layer, creating the product as a whole piece. Additive infofacturing uses one-tenth of the material of subtractive manufacturing, giving the 3-D printer a dramatic leg up in efficiency and productivity. 3-D printing is projected to grow at a blistering rate in the future.

3-D printers can print their own spare parts without having to invest in expensive retooling and the time delays that go with it. With 3-D printers, products can also be customized to create a single product or small batches designed to order, at minimum cost. Centralized factories, with their capital-intensive economies of scale and expensive fixed production lines designed for mass production, lack the agility to compete with a 3-D production process that can create a single customized product at virtually the same unit cost as producing 100,000 copies of the same item.

Making 3-D printing a truly local, self-sufficient process requires that the feedstock used to create the filament is abundant and locally available. Staples — the office supply company — has introduced a 3-D printer, manufactured by Mcor Technologies in its store in Almere, in the Netherlands, that uses cheap paper as feedstock. The process, called selective deposition lamination, prints out hard 3-D objects in full color with the consistency of wood. The 3-D printers are used to “infufacture” craft products, architectural designs and even surgical models for facial reconstruction. The paper feedstock costs a mere 5 percent of previous feedstocks. Other 3-D printers are using recycled plastic, paper and metal objects as feedstock at near zero marginal cost.

Someone with a 3-D printer can also power his or her fabrication lab with green electricity harvested from renewable energy onsite or generated by local producer cooperatives. Small and medium-sized enterprises in Europe and elsewhere are already beginning to collaborate in regional green electricity cooperatives to take advantage of lateral scaling. With the cost of centralized fossil fuels and nuclear power constantly increasing, the advantage skews to small and medium-sized enterprises that can power their factories with renewable energies whose marginal cost is nearly free.

Marketing costs also plummet in an Internet of Things economy. The high cost of centralized communications in both the First and Second Industrial Revolutions — in the form of magazines, newspapers, radio and television — meant that only the bigger manufacturing firms with integrated national operations could afford advertising across national and global markets, greatly limiting the market reach of smaller manufacturing enterprises. In the Third Industrial Revolution, a small 3-D printing operation anywhere in the world can advertise infufactured products on the growing number of global Internet marketing sites at nearly zero marginal cost.



A 3-D-printed prosthetic arm is fitted to a potential user in Okayama, Japan. (Trevor Williams/Getty Images)

Plugging into an Internet of Things infrastructure at the local level gives the small infofacturers one final, critical

advantage over the vertically integrated, centralized enterprises of the 19th and 20th centuries: they can power their vehicles with renewable energy whose marginal cost is nearly free, significantly reducing their logistics costs along the supply chain and in the delivery of their finished products to users.

The new 3-D printing revolution is an example of “extreme productivity.” The distributed nature of manufacturing means that anyone and eventually everyone can access the means of production, making the question of who should own and control the means of production increasingly irrelevant for a growing number of goods.

Many of Europe’s global manufacturing enterprises will continue to flourish, but will be fundamentally transformed by the democratization of manufacturing, which favors a high-tech renaissance for small and medium-sized enterprises. Europe’s manufacturing giants will increasingly partner with a new generation of 3-D-printing, small and medium-sized enterprises in collaborative networks. While much of the manufacturing will be done by SMEs that can take advantage of the increased efficiencies and productivity gains of lateral economies of scale, the giant enterprises will increasingly find value in aggregating, integrating and managing the marketing and distributing of products.

The peer-to-peer nature of the Internet of Things platform allows millions of disparate players — small and medium-sized businesses, social enterprises and individuals — to come together and produce and exchange goods and services directly with one another, eliminating the remaining middle men that kept marginal costs high in the Second Industrial Revolution. This fundamental technological transformation in the way economic activity is organized and scaled portends a great shift in the flow of economic power from the few to the multitudes — the democratization of economic life.

It is important to emphasize that the transition from the Second to the Third Industrial Revolution will not occur overnight, but, rather, take place of over 30 to 40 years. Many of today's global corporations will successfully manage the transition by adopting the new distributed and collaborative business models of the Third Industrial Revolution while continuing their traditional Second Industrial Revolution business practices. In the coming years, capitalist enterprises will likely find more value in aggregating and managing laterally scaled networks than in selling discrete products and services in vertically integrated markets.

Source: http://www.huffingtonpost.com/jeremy-rifkin/internet-of-things_b_8306112.html
(downloaded: 06-10-2016)

Article 2: Gold Drops Below Cash Cost, Approaches Marginal Production Costs

The marginal cost of production of gold (90% percentile) in 2013 was estimated at between \$1250 and \$1300 including capex. Which means that as of a few days ago, gold is now trading well below not only the cash cost, but is rapidly approaching the marginal cash cost of \$1125... Of course, should the central banks of the world succeed in driving the price of gold to or below its costs of production (*repressing yet another asset class into stocks*) then we fear there percussions will backfire from a combination of bankruptcies, unemployment, and as we have already seen in Africa - severe social unrest (especially notable as China piles FDI into that region).

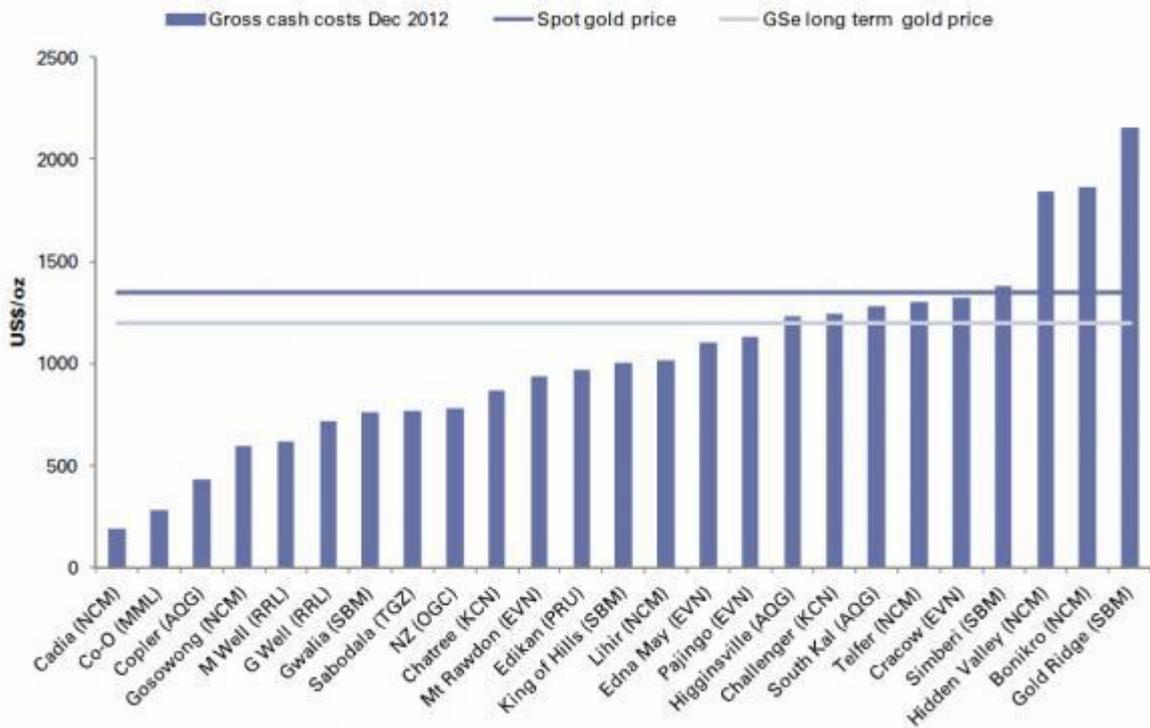
Figure 1: Gold prices have tumbled towards marginal cash costs



Source: Company reports, Bloomberg, Barclays Research

Which means that of the following mines which make up the gold cost curve, one by one, starting on the right and going left, production is going to go dark, even without the recent demand by South African gold miner labor unions to have their wages doubled. Until eventually virtually no gold will be produced.

Exhibit 1: Mines with by-product credits naturally feature at the lower end of the curve



Source: Company data, Goldman Sachs Research estimates.

It is at that point where one must apply the New Normal supply and demand curve, when one can predict a \$0 per ounce price for gold, as physical demand continues unabated, while actual physical, not paper, production has now started going offline.

Joking aside, not even Bernanke, Yellen, or all the paper Gold ETFs in the world will be able to do much to suppress gold prices from reaching their fair value when gold production hits a standstill, and when demands, especially by China, is still in the hundreds of tons each year.

Source: <http://www.zerohedge.com/news/2013-12-02/gold-tumbles-towards-marginal-production-costs> (downloaded: 06-10-2016)

CHAPTER 11: COST BENEFIT ANALYSIS

Article 1: Trump's wall and the cost-benefit analysis of immigration



Two of the top GOP presidential contenders each claim professional creds that trump political experience (pun intended).

Trump's empire, according to him, has a net worth of US\$10 billion and is the only line on his CV that

counts. "If you can run a huge business, you can run a country," he seems to be saying.

Carly Fiorina seems to be claiming the same thing as she touts her experience as the CEO of Hewlett-Packard (though some might add "into the ground" to that first phrase).

Both of these candidates (and every other Republican candidate) has an opinion on how to curb/reduce/eliminate undocumented immigrants. Given the business experience of the top candidates, their strategies for handling the issue are puzzling. "Let's build a higher wall – and have Mexico pay for it." "Let's eliminate birth-right citizenship." "Let's use technology to rid the US of undocumented immigrants."

These policies fail to meet the standards of Business 101 because they ignore the cost-benefit equation of immigration. Here's how.

What's the equation?

If a business owner, business strategist or chief operations officer is able to understand the marginal costs of an action relative to its marginal benefits, she or he can make better decisions. That is, the company should build the next unit only if, all things being equal, the marginal benefit exceeds the marginal cost.

Trump likely does such economic analyses all the time (or hires others to do it). He knows well that a core tenet of economics and finance is that capital earns a return and thus should be allocated to earn the highest one possible.

We see this play out in the market all the time. The owner of an acre of land will use it to maximize revenue, by building a skyscraper instead of a one-story convenience store or constructing condos rather than office space.

Although the example above regards physical capital, these same decisions are made with human capital. For example, The Donald commands \$100,000 or more to deliver a speech. So what's the best use of his time? He hires a bunch of economists and finance gurus to run the numbers on prospective deals while he spends more time talking because he receives a higher return for public appearances (and continues to increase the value of his "brand").

The numbers in the equation

Let's imagine another Donald. Not the real estate mogul we know, but rather his Mexican namesake, a construction worker, who wasn't born into wealth and power.

The average monthly salary for construction laborers in Mexico is the equivalent of \$235. The average monthly wage for a construction worker in the US is \$2,499. This comparison is lopsided for any number of professions, from university professors (\$827 v \$5,747) to police officers (\$670 v \$4,734), according to federal statistical data from both countries.

The Mexican Donald interested in emigrating north asks the following question: "Is it worth it for me to cross the border into the US?" He assumes the benefit is higher wages – approximately \$2,264 more per month. But what are the costs?

We start counting the costs by assuming that we are talking about sneaking across the US border, since the odds of securing a legal way across are relatively slim.

The costs of immigrating can be divided among those that are explicit, implicit and tied to opportunity. The explicit costs include, for example, hiring a truck to transport you from one location to another, while the implicit costs include the disconnection from community or family when moving from an originating location to a new destination. Opportunity costs include any lost wages incurred while the move is taking place or lost productivity as a result of being in a new market or having skill sets that do not immediately translate into productive work.

An undocumented Mexican Donald, sneaking across the border into California or New Mexico, for example, will have the direct costs of a "coyote" (guide) and other direct costs associated with trekking from one country to another (food, clothing, shelter, transportation and identification), and indirect costs associated with removal from one community and insertion into another, and, of course, the costs associated with the possibility of assault, sexual assault or murder.

Costs of migration

This table illustrates many of the costs an illegal immigrant bears in coming to the US. It does not indicate the implicit costs or the opportunity costs of migrating. These costs are real, although they are difficult to quantify.

Item	Approximate Cost
Guide	\$550
Lodging/day (x5)	\$11.50
Bribes: gangs	\$100
Bribes: police	\$400
Bribes: drug cartel	\$275
Driver	\$175
Boatmen	\$100
Stash house/day (x 5)	\$20
Identification	\$100
Total	\$1857.50

Source: [Daily Mail](#)

These costs can vary from several hundred to multiple thousands of dollars. A quick smuggle from Tijuana, for example, might cost \$500, while a trek from Southern Mexico might run upwards of \$10,000.

The table at right illustrates these costs for a Mexican immigrant from a town/area within 500 miles of the US border requiring five days and nights to get to the border and a five-day stay at a stash house once across the border.

The cost-benefit analysis

In order for someone to migrate from Mexico to the US, he or she must identify that the stream of benefits (wages) net of all the costs (direct and indirect) is greater than the benefits of staying in place.

In the scenario suggested, we have a construction worker who will have a wage differential of approximately \$2,264 per month and would clear about \$280 a month after living expenses. This immigrant will make the move as long as he has a strong belief that he will be staying in the US for at least a year or two.

And, if he thinks he will stay for five years, he has a positive net present value of \$12,712, assuming he saves that \$280 every month during the first year and increases savings by 3% each subsequent year. The net present value, as you might recall, is a calculation that converts future benefits into present benefits. Considering that the wage for this person is \$235 per month in Mexico, even if he were able to save \$100 per month it would have taken 127 months, or nearly 10.5 years to accumulate the same amount of money. Under these assumptions, the cost-benefit analysis suggests the person should come to the US.

Changing the calculation

So how do Trump's and other Republicans' policies change the calculation? Building higher walls (or electric fences? per Fiorina's technology push) and removing naturalized citizen status might increase the costs of immigrating.

Obviously, higher walls are harder to climb. But, given that crossing deserts brings a slow miserable death to a number of these immigrants (and others will suffocate in the back of cargo trucks or be murdered by smugglers), a few more feet to climb is probably going to deter only a small number of potential immigrants.

Repealing the 14th amendment, which provides US citizenship to anyone born here, might decrease the stream of benefits. This benefit was not included in the analysis above. If I had included this, the stream of benefits would outweigh the costs by even more, though it would be difficult to put a value on what it's worth to a Mexican mother or father.

However, the data reveal that the number of foreign-born Mexican women giving birth in the last 12 months (presumably within the US) is only 7% of all foreign-born women Mexican immigrants. Removing this "benefit" directly affect only 400,000 of more than 11.3 million foreign-born Mexican immigrants in the US. That is, it is a benefit that doesn't affect a huge share of the immigrant population at large.

So what if Trump wanted to change the calculation?

If these "business" candidates for president want to reduce or eliminate undocumented immigrants, they have to tackle this problem from the benefit side.

The benefits used in the calculation assume that the immigrant will have a 100% chance of landing a job at the going wage. But that's not the case in Arizona, which requires businesses to use E-verify, a system in which businesses electronically verify that the documentation

presented by a potential employee has matching information between the name and the social security number (securing proof of eligibility to work). That's a big hurdle that gives an undocumented immigrants a much smaller chance at landing a job.

Whether it's a good policy or not, if more states adopted systems like E-verify, the cost-benefit calculation for immigrants from Latin America would look decidedly grimmer for the immigrant. If the chances of finding a job become very small, it would become much harder to justify making the treacherous trek (the costs would out weight the benefits).

All the same, like the value of giving your child US citizenship, it's hard to put a price tag on the benefits of achieving the "American Dream." This suggests that no matter what policy Trump or others pursue to increase the cost of immigration, it will be hard pressed to work as long as the US remains the proverbial "land of opportunity."

Source: <http://theconversation.com/trumps-wall-and-the-cost-benefit-analysis-of-immigration-47199> (downloaded: 06-10-2016)

Article 2: The Economist explains

Why doing a cost-benefit analysis is harder than it looks?



WHEN it comes to assessing the viability of a large project, governments are increasingly likely to commission a cost-benefit analysis (CBA). The aim is to provide an impartial, evidence-based judgment of

the costs and benefits of a particular policy or project, without regard to its political ramifications. The British government is particularly keen on CBAs: having pioneered their use in the 1960s it has recently relied on them to make the case for HS2, a controversial high-speed rail link between London, Birmingham and Manchester, and to justify a cull of badgers in the countryside. In theory, putting together a CBA is simple: you simply tot up the costs in one column and the benefits in another. But the reality is rather more complex. With large amounts of money at stake and projects that can last for decades, economists have to use a number of wonkish techniques, some of which are controversial, to come up with a decent CBA. How do they do it?

The simplest and most important concept is a dull economic term: “consumer surplus”. This is the difference between what you are willing to pay for something and what you end up paying. If you’re willing to spend £1 on an apple, but get it for 40 pence, your consumer surplus is 60 pence. Consumer surplus is important because big projects like railways are often not sustainable from a purely commercial perspective. In the case of HS2 one estimate puts the expected revenue from fares at £15 billion, but the overall costs at £25.5 billion. But that is potentially a narrow way at looking at the benefits of such a project. Governments can also look at what they are saving citizens. Consider the case of someone who is used to paying £100 to get from Manchester to London. If HS2 is built, they could pay £40. The commercial benefit of the project is a mere £40; but the CBA will take into account the £60 worth of consumer surplus as well (because that sum is, in effect, unlocked to be spent on other things). Big infrastructural projects often make economic sense only when consumer surplus is taken into account.

To make costs and benefits fully comparable, further economic trickery is needed. Adjusting for inflation is an obvious first step. Then you must convert the calculated costs and benefits at various times to values at a single point in time, so that they can be compared. Economists refer to this as “net present value”. Wonks also need to think about how money invested in a project might be better spent. The government could just choose to shove the money into a bank account and gather the interest, or invest instead in another project that offers higher returns. Economists call this idea the “opportunity cost of capital”. There are no golden rules for choosing the appropriate rate—sometimes called the “discount rate”, though it often corresponds to what people could get by buying government bonds. In an analysis of the badger cull the British government went for 3.5%. The higher the discount rate, the smaller the future benefits will seem. Some worry that those opposed to big investment projects deliberately exaggerate discount rates.

As CBA has become integral to large projects, the limitations to its methodology have come under greater scrutiny. CBAs struggle to put monetary values on things like environmental quality. Crafty economists try to get around this problem by calculating “willingness to pay”: working out how much money someone would spend to clean the air or purify water. In addition, no two CBAs are alike, so it is hard to compare different studies. And sometimes the assumptions can be heroic, to say the least. An early analysis of HS2 claimed that people did not do any work on trains, thereby increasing the benefit of shorter journey times. This idea was subsequently scrapped and the focus became more on the economic benefits to the north. But despite being controversial CBAs are popular. Governments will rarely approve a big project without first submitting their proposal for wonkish scrutiny.

Source: <http://www.economist.com/blogs/economist-explains/2014/04/economist-explains-13>
(downloaded: 06-10-2016)

Article 3: Environmental Cost-Benefit Analysis Spreads to Developing World

Cost-benefit analysis, while embraced by both political parties over the course of the past three decades, is still feared by many progressives in the United States. But as environmental concerns have spread around the world, this tool is lighting a path in many developing countries toward a new generation of environmental policies to protect public health, climate stability, and natural resources. This new role for cost-benefit analysis challenges the sometimes stale and suffocating way in which discussions over cost-benefit analysis are often framed here at home.



Over the course of the next several decades, an increasing share of global economic productivity will come from the developing world, as massive powerhouses like China, India, and Brazil, and smaller but dynamic economies like South Korea and Chile continue to grow. But, of course, pollution problems follow quickly on the heels of rapid

industrialization, as China's recent extreme air pollution numbers highlight. It is also well known that, to address the problem of climate change, countries like India and China must control their emissions. To help strike an informed balance between environmental protection and other competing priorities, developing nations are starting to turn to cost-benefit analysis.

In my recent book edited with Richard Revesz, *The Globalization of Cost-Benefit Analysis in Environmental Policy*, contributing authors from countries as diverse as Indonesia, Liberia, and Mexico examine how economic analysis is being deployed to help justify stronger levels of environmental protection. We found that cost-benefit analysis is being used to make the case for environmental protection across the globe on everything from biodiversity loss due to road-building in the Amazon, to the educational benefits of recycling grey water in rural schools in India, and to air quality improvements from low-sulfur gas in Mexico.

This shouldn't come as a major surprise to those familiar with environmental economics. The first units of environmental protection are often the cheapest, and they also deliver the greatest benefits. Grasping the low hanging fruit is always easy to defend in economic terms. It is only in the more advanced economies, which have worked their way up the cost curve, that protections become harder to justify. But even in the United States, with our relatively more

stringent environmental policies, a recent rule by the Obama administration to reduce mercury pollution from power plants will deliver up to \$8 in health benefits for every \$1 of financial costs. In developing countries, where pollution problems are more severe and less costly solutions are available, the returns will often be even greater.

This does not mean that cost-benefit analysis is uncontroversial, or that it can always be applied easily in the context of developing countries. In the United States, we have substantial resources to devote to analysis; it is not a major challenge to throw dozens of economists, engineers, lawyers, and scientists at difficult regulatory problems. Many developing countries are hard-pressed to find the resources necessary to carry out even basic cost-benefit analysis. And when environmental problems are especially urgent or problematic, the delay associated with analysis can come at a heavy cost.

In addition, methodological challenges arise when analytic tools are applied outside the advanced economies in which they arose. For example, distributional issues are typically not addressed in cost-benefit analysis, with the assumption that the tax-and-transfer system is the most efficient mechanism to achieve society's egalitarian goals. But some countries lack effective means to address inequality through the tax system, and to avoid causing unnecessary suffering to the world's least well-off populations extreme poverty it may be necessary for policies or projects to be designed directly with distribution in mind.

Further challenges include how to incorporate factors like foreign investment, employment, and economic growth into cost-benefit analysis. The tradition has, again, been to leave these issues to the side, assuming that macroeconomic policy is the most efficient means to address them. But, in countries with less government capacity, and more exposure to the prevailing global economic winds, a more capacious version of cost-benefit analysis may be necessary.

These challenges have not stopped committed analysts, activists, and public servants from using cost-benefit analysis in many countries around the world. As this global expansion continues, experiences outside the United States can also help inform how we continue to use this important tool here at home.

Source: <http://www.regblog.org/2013/05/13/13-livermore-cba-globalization/> (downloaded: 06-10-2016)

CHAPTER 12: ENVIRONMENTAL IMPACT ANALYSIS

Article 1: Largest-Ever Study Reveals Environmental Impact Of Genetically Modified Crops



According to new research from University of Virginia economist Federico Ciliberto, widespread adoption of genetically modified crops has decreased the use of insecticides, but increased the use of weed-killing herbicides as weeds become more resistant.

Ciliberto led the largest study of genetically modified crops and

pesticide use to date, alongside Edward D. Perry of Kansas State University, David A. Hennessy of Michigan State University and GianCarlo Moschini of Iowa State University. The four economists studied annual data from more than 5,000 soybean and 5,000 maize farmers in the U.S. from 1998 to 2011, far exceeding previous studies that have been limited to one or two years of data.

“The fact that we have 14 years of farm-level data from farmers all over the U.S. makes this study very special,” Ciliberto said. “We have repeated observations of the same farmers and can see when they adopted genetically modified seeds and how that changed their use of chemicals.”

Associate economics professor Federico Ciliberto co-led the largest research study to date examining how genetically modified soybeans and maize have impacted pesticide use in the U.S. *(Photo by Dan Addison, University Communications)*



Since 2008, genetically engineered crops have accounted for more than 80 percent of maize and soybean crops planted in the U.S. Maize seeds are modified with two genes: one kills insects that eat the seed and one allows the seed to tolerate glyphosate, a herbicide commonly used in weed killers like Roundup. Soybeans are modified with just one glyphosate-resistant gene.

Unsurprisingly, maize farmers who used the insect-resistant seeds used significantly less insecticide – about 11.2 percent less – than farmers who did not use genetically modified maize. The maize farmers also used 1.3 percent less herbicide over the 13-year period.

Soybean crops, on the other hand, saw a significant increase in herbicide use, with adopters of genetically modified crops using 28 percent more herbicides than non-adopters.

Ciliberto attributes this increase to the proliferation of glyphosate-resistant weeds.

“In the beginning, there was a reduction in herbicide use, but over time the use of chemicals increased because farmers were having to add new chemicals as weeds developed a resistance to glyphosate,” Ciliberto said.

Maize farmers, he said, have not yet had to address the same level of resistance, in part because they did not adopt genetically modified crops as quickly as their counterparts in the soy industry. However, the study did find evidence that both maize and soybean farmers increased herbicide use during the last five years of the study, indicating that weed resistance is a growing problem for both groups.

From 2006 to 2011, the percentage of hectares sprayed with only glyphosate shrunk from more than 70 percent to 41 percent for soybean farmers and from more than 40 percent to 19 percent for maize farmers. The decrease resulted from farmers having to resort to other chemicals as glyphosate-resistant weeds became more common.

“Evidence suggests that weeds are becoming more resistant and farmers are having to use additional chemicals, and more of them,” Ciliberto said.

Insects do not appear to have developed a similar resistance, in part because federal regulations require farmers to have a “safe haven” in their fields that is free of genetically modified crops. Insects and worms in those safe havens have no need to develop resistance, and because they interact and breed with insects in other parts of the field, they help prevent the development of resistant genes.

Despite the decrease in insecticide use, continued growth in herbicide use poses a significant environmental problem as large doses of the chemicals can harm biodiversity and increase water and air pollution.

Ciliberto and his colleagues measured the overall environmental impact of the changes in chemical use that have resulted from the adoption of genetically modified crops, using a measure called the environmental impact quotient, or EIQ, to account for chemicals' impact on farmworkers, consumers and the environment. Comparing adopters to non-adopters, they found little change in the impact on farmworkers and consumers. However, the adoption of genetically modified soybeans correlated with a negative impact on the environment as increased herbicide use also increased contamination of local ecosystems.

Overall, Ciliberto said he was surprised by the extent to which herbicide use had increased and concerned about the potential environmental impact.

"I did not expect to see such a strong pattern," he said.

Source: <https://news.virginia.edu/content/largest-ever-study-reveals-environmental-impact-genetically-modified-crops> (downloaded: 06-10-2016)

Article 2: What's the carbon footprint of ... a newspaper?

Depending on what you read and whether you recycle, newspapers can be a green way to spend your time or a big contributor to your footprint

Since this blog series began, quite a few people have asked – both seriously and sarcastically – about the carbon footprint of eco-aware websites and newspapers. We tackled the emissions of the Internet a few weeks ago. But what's the carbon footprint of a newspaper?

For the reasons discussed earlier, it's impossible to answer this question with any great level of accuracy. As with other footprints, it all depends on how many of the economic ripples caused by the newspaper industry you attempt to capture.

To make matters more complex still, in the case of anything made of paper, the carbon footprint depends not just on production, printing and transport, but also whether the consumer recycles it after use. This is significant because sending paper to landfill not only produces the greenhouse gas methane but also increases the amount of virgin stock that needs to be produced.

Another factor is the simple amount of paper used. For his book *How Bad Are Bananas?*, Mike Berners-Lee used his kitchen scales to work out what the approximate carbon footprint of various newspapers would be if they all used averagely carbon-efficient paper stock and printers. The results were as follows:

- 0.3 kg CO₂e the Guardian Weekly, recycled
- 0.4 kg CO₂e the Sun, recycled
- 0.5 kg CO₂e the Daily Mail, recycled
- 0.8 kg CO₂e the Guardian, recycled
- 1.8 kg CO₂e a 'quality' weekend paper, recycled
- 4.1 kg CO₂e a 'quality' weekend paper, sent to landfill

(If you added in all the journalism, too, such as offices and reporter travel, these figures would go up, though probably not by a huge amount.)

In reality, however, different paper sources vary widely. For example, the Guardian Media Group recently switched over to a Norwegian paper mill that – due to its low-carbon energy supply – has emissions which the Guardian estimates to be a staggering 100 times lower than that of a UK mill using exclusively recycled pulp, even once the longer-distance transport is included.

All in all, then, the carbon footprint of a newspaper depends on a whole host of factors. At the highest end of the spectrum, purchasing seven bulky papers each week, all of them printed on typical paper stock and ultimately sent to landfill, could create as much as a tonne of CO₂e each year. That's comparable to two short-haul flights. At the other end of the scale, a slim weekly newspaper printed on low-carbon stock and consistently recycled might add only a few kilos to your annual footprint – equivalent to a couple of cheeseburgers or driving just 5 to 10 miles in a typical car. That's not at all bad given the number of hours that you (and maybe your family, housemates or fellow train travellers) will spend reading it.

How does this compare with reading news online? According to Mike, if you browse for an hour a week on a 50-watt laptop, it comes out less than a weekly paper even if the direct electricity impact is scaled up by a factor of five "to take account of the production of the laptop, the running of your network and the electricity consumed by all the hubs and servers around the world that support the websites you browse".

Again, though, the true picture depends on a whole host of factors, including your computer (a modern laptop uses a fraction of the electricity that an older desktop requires) and the simple question of how many stories you read. Maybe people spend far more than an hour a week browsing online news.

Regardless of the format, a really thorough analysis of any of this would also need to consider the impact of the writing itself. On some level, an article claiming that climate change doesn't exist must have a much higher indirect carbon footprint than one which highlights the urgency of the latest science. But even I'm not foolish enough to attempt to quantify that.

Source: <https://www.theguardian.com/environment/green-living-blog/2010/nov/04/carbon-footprint-newspaper> (downloaded: 06-10-2016)

Article 3: Cannabis Carbon Footprint: Marijuana Industry's Environmental Impact

Debate over the War on Drugs and the legality of marijuana persists in the U.S., as thousands recently rallied in Seattle for legalization and millions of dollars have been raised in support of legalization measures in two states. Yet an often overlooked part of the debate is marijuana's environmental impact — what is the carbon footprint of cannabis?

According to a 2011 report, indoor marijuana growing may account for one percent of the entire country's electricity consumption. The independent report, by Lawrence Berkeley National Laboratory researcher Evan Mills, Ph.D., notes that this energy use costs about \$6 billion annually. The report also claims that the carbon dioxide pollution from this electricity use "plus associated transportation fuels equals that of 3 million cars."

The full report details the exact sources of energy consumption during marijuana cultivation. Mills writes:

Specific energy uses include high-intensity lighting, dehumidification to remove water vapor, space heating during non-illuminated periods and drying, irrigation water preheating, generation of CO₂ by burning fossil fuel, and ventilation and air-conditioning to remove waste heat. Substantial energy inefficiencies arise from air cleaning, noise and odor suppression, and inefficient electric generators used to avoid conspicuous utility bills.

Still, the annual energy use from indoor marijuana cultivation pales in comparison to other industries and activities. Mills' report explains that "the approximately 22 billion kilowatt-hours/year estimated for indoor Cannabis production is about one-third that of US data centers or one-sixth that of US household refrigerators."

The U.S. Senate Caucus on International Narcotics Control noted in 2011 that "approximately 4.5 percent of the domestic marijuana eradicated was from indoor grow sites" in 2010. California led the nation with the greatest number of indoor plants eradicated by law enforcement, while Florida "had more actual grow sites seized than any other state, including California."

Despite the prevalence of indoor marijuana growing operations in these two states, it should be noted that California and Florida rank first and third, respectively, for states with the most electricity generation from non-hydro renewable energy resources, according to the Department of Energy.

The *San Francisco Bay Guardian* argued last year that the solution to decreasing the energy intensity of marijuana cultivation may be to move it outdoors. They wrote, "the biggest barriers to moving most marijuana production outdoors are federal laws and the biases of pot

consumers.” Although indoor growers can harvest year-round and “produce the best-looking buds, which command the highest prices and win the top prizes in competitions,” the paper claims that, if done properly, outdoor cultivation does not inherently mean an inferior product for consumers.

Some advocates argue that by legalizing marijuana, more growing could be conducted outdoors, thus reducing its footprint. With legalization, *Fast Company* suggested, “people will actually cast a critical eye on its energy usage.” What do you think?

Source: http://www.huffingtonpost.com/2012/08/27/cannabis-carbon-footprint-environment_n_1832035.html (downloaded: 06-10-2016)

Article 4: Human water use 'greater than thought'

New calculations show that our already sizeable water footprint is 18% bigger than we thought.

The study is based on a century's worth of observational data drawn from 100 river basins across the world. It reveals a significant increase in the water being "lost" to the atmosphere as a direct result of human activity. This occurs through evaporation from land and water surfaces, and from plants as they transpire.

Based on data

The old estimates of human water consumption add up to a staggering number: 9,100 cubic km per year. This volume is about twice the size of Lake Michigan in the US.

Fernando Jaramillo and Georgia Destouni from Stockholm University in Sweden have now used freely available data to update these assessments, to reveal a more precise picture of how much humans are impacting the natural water cycle at the global scale. Their research suggests human water management strategies are responsible for an additional quantity of water the size of Lake Ontario being transferred to the atmosphere - a significant element of consumption that the earlier approaches had underestimated. It means the human water footprint is actually closer to 10,700 cu km a year.

"Previous assessments of human water consumption were mainly based on national statistics and global scale models. The novelty of this study is that it's based on data," Dr Jaramillo emphasized.

The team has published its work in *Science* magazine. A presentation was also made this week to the Fall Meeting of the American Geophysical Union - the world's largest annual gathering of Earth scientists.

Evaporation and transpiration



The irrigation techniques used in agriculture drive more water into the atmosphere

The authors explained that water consumption by humans goes beyond drinking water, industrial water, and water for municipalities.

Water that would normally be in rivers but ends up being in the atmosphere as vapour due to human activity has been largely overlooked, and this is what the authors focused on.

"The loss is from the landscape through the atmosphere and that leaves less water for both humans and other ecosystems in the landscape", Prof Destouni explained.

This displacement of water into the atmosphere occurs through water evaporation or through transpiration by plants. So the total flow of water to the atmosphere is given by evapotranspiration.

"We used a simple water budget: water lost by evapotranspiration is precipitation minus water runoff," Dr Jaramillo answered when asked how they used the data.

The footprint

Looking at their data, the scientists could see an increase in evapotranspiration when comparing the first and second halves of the last century.

The question they then asked was how much of this change was being driven by human activity.

They found that areas previously identified as having experienced the ecological consequences of dams and irrigation also showed the biggest increase in evapotranspiration.

"Dam and irrigation developments - even though local - have a big global impact on human water consumption. That's what has not been calculated before and what we've estimated in this paper," Prof Destouni said.

"The water footprint could be up to 20% larger than previously estimated," Dr Jaramillo revealed.

"In dry areas, reducing the water in the environment can have an enormous impact on humans and ecosystems. In a wet landscape, it is in relative terms not as big in the drier areas. Central Asia (Aral Sea), Middle East, areas around the Mediterranean - these are examples of most vulnerable."

Irrigation, dams, and ground water

The large water surface area created by a dam causes more evaporation

Dr Jaramillo explained how human water management leads to more evapotranspiration.

"With irrigation, we are moving water from one place to another - and part of this water will simply evaporate from the ground surface. These crops in order to grow, they take this water in and by respiration they send this water to the atmosphere.

"When you build a dam and make a reservoir, you're also consuming a lot of water. The water surface you create causes more evaporation; otherwise that water would be running on a river.



"Also if you increase the level of the water by say 90m, the groundwater on the hillsides will also increase by 90m. A lot of plants now have access to water that previously wasn't there. Those plants will also transpire more water."

Prof Destouni explained how evapotranspiration induced by human activity is linked to climate change and weather: "The atmosphere is warmer due to global warming and warmer air can hold more water vapour."

Transport of moisture in the atmosphere is also changed: "There is more vapour coming from the land rather than the sea. You get the effect that it rains more in other places.

"If we don't understand how transfer of water and water vapour happens, we will misinterpret things and then our measures for mitigating climate change or adapting to climate change will not be effective."

Uncertainty lingers

"In some regions, we just open the tap and water comes out. We don't think about it. How much water are we consuming?" Dr Jaramillo said, highlighting the worldwide uncertainty regarding the numbers on human water consumption.

"Our lack of knowledge is gigantic. We're lagging so much on studies on the water cycle and water consumption.

"It is serious that at this point in time people did not use all the data that was available to actually calculate this change. People continued to make estimates using old data," Prof Destouni commented.

The Stockholm University scientist emphasized the importance of using this openly accessible data to "continue to measure these kinds of things so that we can actually see these changes happening".

Source: <http://www.thehindu.com/sci-tech/energy-and-environment/its-possible-paris-agreement-can-enter-into-force-by-year-end-un-climate-body-chief/article9114641.ece>

(downloaded: 06-10-2016)

CHAPTER 13: REGULATORY POLICY VS. ECONOMIC INCENTIVES

Article 1: Paris Agreement can enter into force by year end: UN climate body chief



In an interview with The Hindu, Mexican diplomat Patricia Espinosa leading the UNFCCC, says phasing down of HFCs as the "climate's low hanging fruit" is their immediate target.

Mexican diplomat Patricia Espinosa, leading the UNFCCC since May, 2016, sees phasing down of HFCs as the "climate's low hanging fruit", their immediate target. On

September 16, 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer, was signed, which has seen success in addressing the damage to ozone layer from harmful chemicals. The next step is to phase down Hydrofluorocarbons that can also help mitigate the climate crisis. Excerpts from a telephonic interview with the diplomat based in the Bonn, Germany headquarters of the UN climate body.

In an opinion article on the phasing down of Hydrofluorocarbons (HFCs) recently, you wrote that this is the "climate's low hanging fruit". Are you positive that the nations meeting in Kigali, Rwanda, next month to discuss the Montreal Protocol (meant to protect the ozone layer) amendment on the matter would concur?

Yes, we have been following the negotiations at the Montreal Protocol. And we are confident that there is momentum building up to phase down HFCs. It has been evident how important this is for the countries and the huge impact it will have. So, I am optimistic that the amendment in the Protocol for phasing down HFCs will go through next month. With the exception of some countries, particularly warm countries that operate well only with air conditioners, the phase out time for all other countries will have to be worked out. Those will be parts of the agreement. There is general consensus that this goal must be pursued by the international community as a whole. These negotiations will make an important contribution to reducing greenhouse gas emissions as well and will help with the realisation of the Paris agreement. That is really the next step.

Till now 27 nations have ratified the Paris climate agreement, the latest being Brazil. Do you see the possibility that the Paris agreement will be ready to enter into force by the end of the year, and get the ratification of 55 member nations as required?

Currently, with Brazil, we have covered over 40 per cent of global emissions with the ratification of the Paris agreement. They are very good signals. This shows that countries are keeping up their political will to comply. On September 21, the UN Secretary General will hold an event to promote ratification and encourage important contributions from member countries in this regard. There is possibility that the Paris Agreement will enter into force by end of this year.

Does it worry you that most of the countries that have ratified the pact till now, except for US, China or Brazil, are all small nations with low GHG emissions and are threatened by the climate catastrophe and not those who are responsible for the emissions?

Small island countries are the first to ratify the agreement. Their existence is at stake with this issue. Bigger countries are also joining in ratification. In Europe, a number of countries have already finalised the ratification and the EU nations will be depositing their ratification instruments together. Even Latin America and Africa are speeding up the process. Mexico, the country I come from, has also taken up the matter of ratification in the Senate yesterday. They will be having it approved by Congress as soon as possible.

What would be the most important and urgent action points you are hoping to raise with member nations in Marrakesh at COP22 in November in this regard, since the summit will be focussing on implementation? An earlier UNFCCC report in April this year had pointed out that even if all the pledges covered by the Paris agreement were implemented, it would be insufficient to keep temperature rise within the 2 degree Celsius danger threshold...

For COP22 one of the foremost agendas is ensuring the treaty's entry into force. There has been a lot of movement on our side, on the part of the UNSG, and on the side of France and Morocco, the outgoing and incoming chairs of conference in this regard. First, we have to get as many people to ratify the agreement as that will allow it to come into force. If that happens we will have the first COP convention for building up the necessary machinery to become operational. We do have a lot of emphasis on action. We are also preparing a series of events focusing on ongoing efforts to fight climate change. We would like to show that countries can advance in solutions, be it technological or nature-based, to fight the impact of climate change. All relevant actors, government, and also non-state actors like private companies and civil society groups will be brought together. We will aim to bring all those actions on the ground and seek information from participants and get their inputs into the negotiations. This will help in making the agreement operational.

Christiana Figueres, the previous UNFCCC executive secretary, recently dropped out of the race for the top UN Secretary General job. Do you feel that having a woman as the next UNSG would make a difference in terms of delivering the stated goals of the organisation?

It is important that women have the same opportunity to assume leadership roles in the United Nations as men do. The United Nations stands for justice, human rights and social progress, and part of the agenda of the UN is the empowerment of women and girls, which is also crucial to achieve the newly adopted Sustainable Development Goals.

It is more than two decades since the UNFCCC entered into force in 1994. What is your assessment of the progress made so far in curbing the worst impacts of climate change? Many of the negative impacts are already being felt the world over, such as droughts, cyclones, and rising sea levels submerging islands.

International negotiations are slow, given all the different views that need to be taken into account. It is important to acknowledge the central achievement of Kyoto Protocol, which enabled those industrialised countries that ratified it – as a group – to limit their emissions to the levels they set themselves under the first commitment period. Last year we had a breakthrough with the Paris Agreement that has put the world on a firm trajectory towards low carbon and resilience. The Paris Agreement will help transform the global economy, and at the same time it provides the framework for governments to raise ambition and achieve their key objective set in Paris, which is to limit the global average temperature rise to as close to 1.5 degrees Celsius as possible. It is also important to keep in mind that the UNFCCC has developed and introduced many innovative ways of reducing emissions which are now bearing fruit. This includes carbon markets which are spreading all over the world, payments for maintaining forests, offsetting of emissions and various forms of innovative finance. Without the UN Framework Convention on Climate Change, it is unlikely that we would be looking at the same levels of investments in renewable energy – around 300 billion a year - that have meanwhile become the norm.

Source: <http://www.bbc.com/news/science-environment-35082422> (downloaded: 06-10-2016)

Article 2: We need incentives to save the climate — not just agreement

Green finance should focus on drawing in private capital to clean tech, writes Henry Paulson. If, as now seems likely, world leaders reach an agreement on climate change when they meet in Paris at the end of the month, they will have taken a momentous step towards protecting our planet. But it will still only be a start. To make true progress on climate change, we need new economic structures and new technology.

This will come at a price; developing countries in particular will have to balance the cost of environmental clean-up with the need for continued growth. But it will also bring benefits, creating new and more sustainable sources of prosperity. And, as so often in cases where progress depends on upfront investment, finance holds the key.

Green finance should not be another form of aid that wealthy nations will provide to poorer countries. Nor can it be state-backed project financing in disguise. Instead, the focus should be on harnessing market principles to draw in private capital so that clean technologies can be commercialised and financing shifted away from polluting industries that rely on wreaking environmental destruction without paying for it.

The required transformation in the financial system will not be easy. It will be especially difficult for developing countries that lack the mature, deep and liquid capital markets of advanced economies such as the US.

There are encouraging precedents. The Chinese government, with the UN, has put forward proposals to align its financial system with low-carbon growth. It has called for the creation of new lending institutions with specific environmental objectives, which would lower the funding cost for green projects. While this is a positive step, much more work remains to be done.

The issue is not that capital is scarce. It is rather that abundant capital needs to be allocated to low-carbon sectors that can also generate new sources of economic growth and create new jobs. The opportunity to deploy private capital in China for these purposes is enormous. To take just one example, buildings accounted for nearly 30 per cent of China's energy consumption in 2011. The problem extends beyond China. Humanity will swell by another 2bn or 3bn people in the coming decades — and most of this population increase will be absorbed by cities. Many of the countries that will see urban population growth are developing ones, which lack proper municipal finance systems to fund urban development. This is why the public sector has a role to play, too.

Public spending should aim to punch above its weight by harnessing private capital to every dollar spent. Government policies can also speed the change in financing and investment practices.

Green finance and policy choices will differ across nations. Some will opt to put a price on carbon. Others may opt for various combinations of taxes and subsidies — and regulation.

Whatever the mix of policies, they should be anchored in market incentives to encourage financial institutions, investors and lenders to account for externalities, such as emissions, when evaluating projects and businesses.

These ideas have already made some inroads, as green investor networks have emerged and certain European financial institutions have undertaken commitments to the Equator Principles, a framework for managing environmental risk. But to have an impact on carbon emissions, such green financing concepts need to be adopted widely. This is why, as China takes leadership of the G20 next year, there is an opportunity for the group to adopt green financing as a new agenda and create practical models for the developing world.

Global capital markets are powerful forces. Directed properly, they can alleviate the burden on governments and unlock a sustainable economic future.

Source: <http://www.ft.com/cms/s/0/8a64effc-8c6a-11e5-8be4-3506bf20cc2b.html#axzz4KWdWWsSc> (downloaded: 06-10-2016)

Article 3: Carbon tax v cap-and-trade: which is better?

Economists argue that, if the market is left to operate freely, greenhouse gas emissions will be excessive, since there is insufficient incentive for firms and households to reduce emissions. As such, they recommend applying the polluter pays principle and placing a price on carbon dioxide and other greenhouse gases. This can be implemented either through a carbon tax (known as a price instrument) or a cap-and-trade scheme (a so-called quantity instrument).

A carbon tax imposes a tax on each unit of greenhouse gas emissions and gives firms (and households, depending on the scope) an incentive to reduce pollution whenever doing so would cost less than paying the tax. As such, the quantity of pollution reduced depends on the chosen level of the tax. The tax is set by assessing the cost or damage associated with each unit of pollution and the costs associated with controlling that pollution. Getting the tax level right is key: too low and firms and households are likely to opt for paying the tax and continuing to pollute, over and above what is optimal for society. Too high and the costs will rise higher than necessary to reduce emissions, impacting on profits, jobs and end consumers.

By contrast, a cap-and-trade system sets a maximum level of pollution, a cap, and distributes emissions permits among firms that produce emissions. Companies must have a permit to cover each unit of pollution they produce, and they can obtain these permits either through an initial allocation or auction, or through trading with other firms. Since some firms inevitably find it easier or cheaper to reduce pollution than others, trading takes place. Whilst the maximum pollution quantity is set in advance, the trading price of permits fluctuates, becoming more expensive when demand is high relative to supply (for example when the economy is growing) and cheaper when demand is lower (for example in a recession). A price on pollution is therefore created as a result of setting a ceiling on the overall quantity of emissions.

In certain idealized circumstances, carbon taxes and cap-and-trade have exactly the same outcomes, since they are both ways to price carbon. However, in reality they differ in many ways.

One difference is the way the two policies distribute the cost of reducing pollution. With cap-and-trade, it has often been the case that permits are given out for free initially (known as "grandfathering"). This means cheaper compliance for industry in the early stages of the scheme, because they only pay for any extra permits bought from other firms – not for the initial tranche of permits given to them to cover most of their emissions under 'business as usual'. This approach is obviously popular with industry and explains why grandfathering has been used, since it helps get firms to accept controls on emissions in the first place. By contrast, with a tax there is an immediate cost for businesses to pay on every unit of

greenhouse gas produced, so there is a bigger initial hit to the balance sheet. But while grandfathering is better for near-term business profitability, it is not necessarily the best outcome for society. Indeed, it deprives the government of valuable revenues, which it could raise in auctioning the permits initially, and which could be used to reduce other taxes.

The mechanisms also differ in how they perform under uncertainty about the costs and benefits of reducing emissions. Under a tax, the price of emitting a unit of pollution is set, but the total quantity of emissions is not. Therefore a tax ensures everyone knows the price being paid (at least for the immediate future) for each unit of carbon dioxide emitted, but uncertainty remains about the actual quantity of emissions. Conversely, cap-and-trade provides certainty about the quantity of emissions (it cannot exceed the cap), but uncertainty about the cost of achieving these reductions. Which is preferred depends on how sensitive the level of environmental damage is to changes in emissions, compared with how sensitive the cost of reducing pollution is to the same changes. If the level of environmental damage is more sensitive, then it is important to be sure what the quantity of emissions is, which points to cap-and-trade. Conversely if the cost of reducing pollution is more highly sensitive to changes in emissions, it is better to be sure about the cost of cutting emissions, pointing to a tax.

What this means for climate change policy is debated. In the short term, most economists agree that uncertainty alone argues for a tax. Climate change depends on the stock of greenhouse gases in the atmosphere, and in each year the increase in that stock due to new emissions is small, so the environment is probably not that sensitive to the uncertainty about the level of emissions brought about by choosing a tax, at least over a year or two. On the other side of the ledger, the cost of reducing pollution is highly sensitive to changes in emissions, since it can be expensive to businesses to change their production methods abruptly. In the long term, however, it is less clear whether a tax is preferable, because big changes in the stock of greenhouse gases in the atmosphere may cause substantial environmental damage.

Some economists recommend a hybrid model that may offer the best of both worlds. This tends to comprise of a cap on emissions (to regulate the quantity of pollution), but with adjustment mechanisms such as a carbon price floor or ceiling, to keep the price of a permit within acceptable bounds. Hybrid schemes have their own problems, however, such as greater complexity and more intervention by the regulator in the permit market.

Whichever of these policies is favoured to place a price on carbon, they represent just one of a number of policies needed to cut greenhouse gas emissions.

Source: <https://www.theguardian.com/environment/2013/jan/31/carbon-tax-cap-and-trade>
(downloaded: 06-10-2016)

Publishing Supporter:

Szent István University, Faculty of Economics and Social Sciences

Institute of Regional Economics and Rural Development

Climate Change Economics Research Centre



Leader of Centre: Dr. habil Csaba Fogarassy, associate professor

E-mail: kekk@gtk.szie.hu

Published by Szent István University Publishing Centre

Páter K. street 1., 2100 Gödöllő, Hungary

Phone: +36-28-522-000 / 1282

ISBN 978-963-269-770-3