Global Scarcity – A Challenge to Technology

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Abstract- **An assumption of general scarcity is at the heart of conventional economics. Binary economics, however, denies this assumption. Professor Amartya Sen argued that starvation is primarily due to lack of money in the hands of the starving and not the absence of food. To him, human practices and institutions are at fault. According to him improved technology can overcome the problems of food shortage. Our cited evidences suggest that human activities and natural phenomena, by constantly destroying resources, lead to global scarcity and will also pose a challenge to technology. In this paper, the real world is briefly looked at. We look at the availability of land, food supply, energy, natural causes of resource destruction and the weaknesses of some instruments that have been applied by many nations against scarcity. Certain signs such as inflation, corruption and wars suggest that global scarcity is there and that the growing technology may not be adequate to insure continuous growth in the long-run. Entrepreneurship that creates technology, may be subject to diminishing returns, just like any other factor of production.**

Key words: corruption, fertilizer, inflation, land resources, natural disasters, population growth, scarcity, technology, war

I

World resources are scarce in the sense that they do not support the growing population. Land is naturally scarce and becomes scarcer by natural phenomena and calamities. Examples of natural disasters include the Mount Merapi eruption in Indonesia (October 26, 2010), the Australian flood (January 10, 2011), the Brazil mud-slide (January 17, 2011), the New Zealand earthquake (February 22, 2011), the Japan tsunami (March 11, 2011), the Iowa tornadoes (April 9, 2011), the Chinese hailstorm (April 23, 2011), the Pakistan and India floods (September 2011), and the Turkey earthquake (October 23, 2011), just to mention a few. More serious phenomena like persistent erosion, deforestation, plant diseases, shortage of fresh water, global warming, etc. enhance scarcity. The growth of World population makes the lives of average people even more difficult.

More than seven billion humans now inhabit the Earth [1]. The human population has increased nearly ten-fold over the past three centuries. We can expect it to become 13 billion by 2067 if current growth (a little over one percent per year) continues [2]. In 2009, the world's women, on average, were giving birth to 2.5 children over their lifetimes. This is marginally above the global replacement fertility of 2.33 [3]. The average human life-span is about 65 years today and it is expected to rise to 75 years by 2050. Population growth coupled with rising life expectancy continues to put pressure on land resources although the average life-span has been reflected downward in parts of Africa by infectious diseases such as AIDS, malaria, cholera, tuberculosis and parasitic infections as well as and by internal conflicts. Currently, world population grows by approximately 80 million people per year [4]. Most of the growth will take place in the less developed regions, where today's 5.3 billion population is expected to increase to 7.8 billion by 2050 and make these regions over-populated. Overpopulation does not depend on the size or density of the population alone, but also on the ratio of population to available sustainable resources such as clean water, clean air, food, shelter and other resources needed to sustain life.

The Earth's biosphere provides food, wood, pharmaceutical, oxygen, and the recycling of many organic wastes. The land-based ecosystem depends upon top soil and fresh water from the land as well as labor to work on the land. Our Earth's area is 510 million square kilometers, of which 70.8 percent is under water [5]. The 29.2% not covered by water consists of mountains, deserts, plains, plateaus and other morphologies. The land surface includes 13.13% arable land, 4.71% permanent crops, 26% permanent pastures, 32% forests and woodland, 1.5% urban area and nearly 30% others [6]. Population ratio to arable land which is an important index of scarcity is ten times higher than the overall population density. Perhaps about 17 % of the global land area is degraded by human interventions. Only in South America 14% of land has been degraded by human misallocation practices [7] Geographic Information System (GIS) shows that about 29.45% of the Earth's ice-free land surface is too dry for sustainable human habitation. About 15.46% of the land occurs in the cold tundra zone, which are not easily amenable to normal agriculture. There are additional constraints which

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prevent the use of soils for agriculture. Saline and alkaline soils, for example, occupy 2.4% of the land surface, and soil acidity affects 14.1% of the total land. There are sloppy lands, sandy soils and soils with low water or low nutrient-holding capacity. Globally, only 17% of agriculture is under some form of irrigation. An earlier assessment by the Food and Agriculture Organization suggests that to sustain the human population at an acceptable level, about 0.5 ha of cropland per capita is needed [8].

Land scarcity has become a serious issue in construction according to First National Bank property economist John Loos [9]. A shortage of new houses has contributed to soaring property prices in the UK and rising homelessness [10]. In Morocco despite the introduction of a wide range of government initiatives (including tax rebates for private developers), there remains an estimated shortfall of 600,000 affordable homes [11]. In Kabul, Afghanistan, the shortage of residential land is so acute that in Shahr-e-nao an acre costs 2,000,000 US dollars and in karta-e-char, it costs one million dollars, whereas the per capita income in Afghanistan is hardly $500 per year [12]. In India, the total shortage of housing was estimated at 24.71 million units in 2007 [13]. In China's Shanghai 20 million residents, some 2 million to 3 million are thought to be part of the city's "floating population." There are jobs for them but no living accommodations [14]. The Saudi Arabian property market, housing shortage threatens the country to face high inflation [15]. About 1.5 million Canadian households need an affordable housing. Housing affordability is putting home ownership outside of the reach of many Canadians [16]. Statistics in America indicate that about 636,000 people were homeless in 2011 [17]. The United Nations Commission on Human Rights in 2005 noted that an estimated 100 million people world-wide live in unhealthy and unacceptable conditions; over 100 million people around the world have no shelter whatsoever [18]. According to another report, 500 million people world-wide have been homeless or residing in low-quality housing and are in danger of becoming homeless [19]. India alone is home to 63% of all slum dwellers in South Asia. This amounts to 170 million people, 17% of the world’s slum dwellers [20].

Consequences of homelessness are severe. Homeless adults are poor and in need for health care. Studies find that between one-third and one-half of homeless people have mental health disorders and approximately two-thirds have either a mental health or substance use disorder. Psychiatric disorders exacerbate many types of problems, including housing instability, morbidity and mortality. Homelessness damages people's capability through loss of skills. Homelessness also damages people's resilience, self-esteem and self-confidence. In short, the scarcity of residential land which limits home construction produce dire consequences for the human race especially in the long-run. This phenomenon, in turn, contributes to further scarcity, scarcity of human mental and physical strength.

II

Despite the fact that farms employs 40% of the world's population, agricultural production accounts for less than six percent of the world output [21]. 870 million people in the world do not have enough to eat [22]. The two regions most affected by rural poverty are Africa and South Asia [23-24]. In the Asian, African and Latin American countries, well over 500 million people are living in what the World Bank has called "absolute poverty". According to the United Nations Children Fund (UNICEF), nearly 9 million children younger than 5 will die needlessly, more than half from hunger-related causes [25]. According to Global Hunger Index, twelve Indian states have “alarming” levels of hunger and Madhya Pradesh has an “extremely alarming” level of hunger [26-27]. Nearly one in five people, (or 1.3 billion), lives on less than $1 per day. Three billion people in the world today struggle to survive on US $2/day [28]. In Bangladesh alone, around 30 million of the country's 150 million people could go hungry. This approximation does not include the millions who suffer in silence and will go hungry unnoticed. According to UN, 65 million Bangladeshis cannot meet their basic food needs [29]. The U.N. Chief believes that World food production must rise by 50 percent by 2030 to meet the growing population [30].

More than 150 million people in the world depend directly on fisheries for their livelihood. Fish stocks are being depleted and more than a billion people living in 40 developing countries risk being deprived of their main source of protein [31]. Food and Agriculture Organization of the United Nations (FAO) estimates that over 70% of the world's fish species are already either fully exploited or depleted [32]. Since 1990, over the same period that the increase in the grain crop has slowed, the oceanic harvest has stagnated and as human numbers continued to increase the catch per person has dropped [33]. It appears that

due to limited stocks and overfishing the rising demand cannot be met by catching wild fish alone [34].

Globally, the scarcity of fresh water is the most compelling reason to worry about food supplies. National Geographic April 2010 issue was devoted to a single topic — fresh water. Consider these stark realities, it says: A mere 3 percent of Earth's water is fresh, 2 percent is locked up in snow and ice, while just 1 percent is liquid surface water and ground water available for consumption. Water use has grown at more than twice the rate of population increase over the last century. Worldwide, 1.1 billion people do not have access to adequate clean water to meet their basic daily needs [35]. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stress conditions [36]. An inadequate supply of water causes geopolitical instability, social strife and even armed conflicts particularly in regions such as the Middle East and Africa [37].

Water use in agriculture is recognized as one of the major drivers of ecosystem degradation, causing habitat loss, drying up of rivers, and reduction in groundwater levels. Some commentators believe that China may soon become a major food importer because the supply of water needed to grow food for the rising population is inadequate. It is estimated that 400 of 669 Chinese cities experiences water shortages, with 100 of them described as "serious" and 20 million hectares of farmland are affected by drought that cut grain production by 28 million tons. About 85 percent of all water in China is used for irrigation [38].

Another country, Italy, has experienced a 14% drop in precipitation in the last five decades. A study from the Goddard Institute for Space Studies of the National Aeronautics and Space Administration (NASA) in the United States showed that roughly 4500 km^2 of Italian coastal areas are at risk of floods. Water tables are falling in the key food producing regions, including the southern Great Plains of the United States and several states in India and Pakistan [39]. A study by the International Water Management Institute found that India is drawing underground water at twice the rate of recharge [40]. If current trends continue it is estimated that by 2025 between 2.6 billion and 3.1 billion people will be living in either water-stressed or water-scarce conditions [41]. Millions of children are forced to spend hours collecting and carrying water, restricting their opportunities and their choices. Water-borne infectious diseases are holding back poverty reduction and economic growth in some of the world's poorest countries [42]. Water stress could increase by 25% during this century according to World Health Organization (WHO)[43]. The seriousness of the matter has called for a World Water Day, March 22nd set by the United Nations. A sobering fact on World Water Day points out that coal-fired power plants use approximately 1.5 trillion gallons of water a year in the USA. Coal-fired plants typically throw up their chemically polluted waste water into rivers, poisoning the drinking water [44]. Quite simply, renewable fresh water, cropland and fisheries are growing increasingly scarce in and around many of the world's poorest countries.

Energy, particularly oil, is becoming scarce too. The quantities of commercially recoverable crude oil is estimated around 1,200 billion barrels or $190\times10\text{^}9$ m^3 [45]. It is not easy to discover and recover oil. The International Energy Agency believes peak oil will come perhaps by 2020. According to Mr. Gabrielli, the CEO of Petrobras, world oil capacity, including bio fuels, should have peaked by 2010 [46].

Practically all oil reserves are located in 17 countries, namely Saudi Arabia, Canada, Iran, Iraq, Kuwait, United Arab Emirates, Venezuela, Russia, Libya, Nigeria, Kazakhstan, United States, China, Qatar, Algeria, Brazil and Mexico. The total of top seventeen reserves is 1,243 billion barrels which at the current consumption rate of 63.5 billion barrels per year would last 54 years. The US reserves of 21 billion barrels in 2007 would meet her consumption demand for only 8 years [47]. Unconventional sources, such as heavy crude oil, oil sands, and oil shale, not counted as part of oil reserves, are more labor and resource intensive to produce.

Agriculture and food production heavily depend on oil for fuel and fertilizers. In the US, for instance, it takes the direct and indirect use of about six barrels of oil to raise one beef steer [48]. The construction of an average car consumes the energy equivalent of approximately 20 barrels (840 gallons) of oil; the making of an average desktop computer consumes ten times its weight in fossil fuels. Global oil demand is now expected to hit 83.3 million bpd. The relative scarcity of oil which threatens the security of many economies, namely in USA and Western nations, leads to military conflicts at times, as discussed later.

Liquid fuels such as oil and natural gas are the slowest growing energy sources, and their consumption is projected to increase at an annual rate of 1.2 percent by 2030. Worldwide oil production in the year 2030 will be the same as it was in 1980. Consequently, worldwide demand for oil will outpace worldwide production of oil by a significant margin. Natural gas fuels electric power generators, heats buildings and is used as a raw material in many consumer products, such as fertilizers. Many countries do not have enough natural gas. The world's largest proven gas reserves are located in Russia, with 4.757×10^{13} m^3 (1.6×10^{15} cu ft.). Major proven resources with year of estimate in billion cubic meters are, world 175,400 (2006), Russia 47,570 (2006), Iran 26,370 (2006), Qatar 25,790 (2007), Saudi Arabia 6,568 (2006) and United Arab Emirates 5,823 (2006) [49].

Coal, like natural gas and nuclear became the fuels of choice for electricity generation. From 2003 to 2008, coal was the fastest growing fossil fuel. There are over 847 billion tons of proven coal reserves worldwide. Coal reserves last over 130 years at current rates of production whereas proven oil and gas reserves are equivalent to around 42 and 60 years at current production levels. USA, Russia, China, India and Australia are the top five coal producers [50].

Nuclear technology is an important option for world to meet future energy needs. In 2005 nuclear power accounted for 6.3% of world's total primary energy supply [51]. Nuclear power plants need less fuel than the plants which burn fossil fuels. One ton of uranium produces more energy than is produced by several million tons of coal or several million barrels of oil [52]. This is one area where technology is a partial answer to global scarcity of energy.

Worldwide hydroelectricity consumption reached 816 Gigawatt (GW) in 2005 [53]. China is the largest producer of hydroelectricity, followed by Canada, Brazil, and the United States [54]. The construction of hydro plants has stagnated in certain places due to environmental concerns. Developers need to invest in detailed analysis and expensive hardware to prevent adverse effects on fishing. There are perceived conflicts with river-based leisure interests, and it is needed to prove that there will be no impacts to the river bed, river banks, flora and fauna [55].

Biomass, organic matter such as timber and crops, generate heat and power. The most popular crops in this case are willow and poplar, elephant grass, reed, canary grass and oil seeds, not found in many corners of the World. Biomass is used to produce bio-fuels. These fuels are used to run vehicles (Brazil has the highest proportion of road vehicles designed to run on bio-fuels which peaked at 90% in the 1980s) or powering fuel cells [56]. Problem with this type of energy production is its cost. The best biomass-based power plants cost approximately $2,000 per kilowatt of electricity to build, with a thermal efficiency of about 40 percent, while large coal-fired stations cost about $1,500 per kilowatt, with a thermal efficiency of approximately 45 percent [57]. The bio-fuels produced from grains have raised food prices between 70 to 75 percent [58].

Renewable energy comes from natural resources such as sunlight, wind, tides and geothermal heat. As of 2010, about 16% of global final energy consumption comes from renewables [59]. Wind power is generally the most economical source of renewable energy. It is sometimes cheaper than electricity from fossil fuels and nuclear power. According to the Global Wind Energy Council, the installed capacity of wind power increased by 27% from the end of 2006 to the end of 2007 to total 94.1 GW, with over half the increase in the United States, Spain and China [60]. Poorer countries find it hard to adopt the technology.

Solar energy has become an attractive alternative as it can be very efficient in a large area of the globe. Although the initial investment of solar cells may be high, once installed, they provide a free source of electricity. Less than 0.02% of available resources are sufficient to entirely replace fossil fuels and nuclear power as an energy source [61].

Geothermal power plants use steam produced from reservoirs of hot water found a couple of miles or more below the Earth's surface. The geothermal resources are theoretically more than adequate to supply humanity's energy needs. Output is growing by 3% annually. Earth's internal heat naturally flows to the surface by conduction at a rate of 44.2 terawatts (TW) and is replenished by radioactive decay of minerals at a rate of 30 TW. The largest group of geothermal power plants in the world is located at The Geysers in California. Geothermal power can be depleted though. For example, the three oldest sites, at Larderello, Wairakei and the Geysers have all reduced production from their peaks [62]. Moreover, the domain of geothermal energy is limited.

Depletion of world metals threatens development activities. Evidence of peaking is found for a number of minerals, e.g. mercury around 1962; lead in 1986; zircon in 1990; selenium in 1994; gallium in 2000 [63]. We may run short of gallium any time soon. Tellurium and selenium are two other minerals that underpin the semiconductor industry and it appears that their fall in production may also impact negatively on future technologies that are entirely reliant upon them. There are no obvious substitutes for these minerals with precisely equivalent properties. The concentration of some important metals in a few regions makes it costly to use them world-wide. For example, 88% of the world's platinum is produced from just two mines in South Africa and most of the rest (8%) from one other mine in Russia. For metals such as hafnium, indium, gallium, tellurium and selenium, recycling is the only way to extend the lifetime of critical sectors of the electronics industry. The supply of many other important minerals will be exhausted in a few decades such as Antimony in 30 years, Copper in 61 years, Germanium in 5 years (used for making solar cells), Golding 45 years, Lead in 42 years, Nickel in 90 years, Silver in 29 years,Tin in 40 years, Zinc in 46 years, Hafnium in 10 years, Indium in 5 – 10 years, Platinum in 15 years, Uranium in 30 - 40 years, and Zinc in 20-30 years, just to name a few [64].

Rare Earth Elements (RRE) are incorporated into many modern technological devices. Without rare earth elements, I Phones cannot be had, nor fiber optic cables, X-ray machines, hybrid vehicles such as the Toyota Prius. The RRE list includes Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Europium, Samarium, Gadolinium,Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium, Lutetium. China currently accounts for 97 percent of production of rare earth elements and more than 99 percent of the output for two of these elements, dysprosium and terbium [65]. Much of the modern technology depends on rare earth elements such as terbium, lanthanum and neodymium.

III

Nature imposes the limit to land supply and human and natural phenomena restrict land utilization. Nearly 99.7 percent of human food comes from cropland, which is shrinking by more than 10 million hectares (almost 37,000 square miles) a year due to soil erosion. One rainstorm can wash away 1 mm (.04 inches) of dirt. It would take 13 tons of topsoil - or 20 years if left to natural processes - to replace that loss on one hectare. Erosion leads to the loss of top soil, which is considered to be ten times more valuable than the subsoil. When soil is removed from a field it will affect the soil particles, nutrients, and water holding capacity. Erosion disposes soil from up-slope by burying more valuable land with less valuable soil. It also pollutes the land and reduces productivity. For example, if a soil lost 2.5 inches it would have a 5% - 15% decline in productivity and if the soil lost five inches, the decline in productivity would be 10% - 35% [66]. Soil erosion reduces the ability of soil to store water to support plant growth, thereby reducing its ability to support biodiversity.

The United States is losing soil 10 times faster, and China and India are losing soil 30 to 40 times faster, than the natural replenishment rate. The average daily amount of soil being transported downstream by the Mississippi River at Winona is about 302,000 tons per year or 827 tons per day [67]. Louisiana is losing 25 to 35 square miles of wetlands per year. At current land loss rates, nearly 640,000 more acres, an area nearly the size of Rhodes Island, will be under water by 2050 in the USA. In the USA the average annual loss of topsoil from all cropland today is about 12 tons per hectare. Floods may have caused up to $3 billion in crop losses in Iowa and $800 million in damages in Indiana [68].

At present, 40% of the total territory of Ukraine is now eroded land, and is growing at approximately 80,000 hectares annually [69]. Of India's total area of 328 million hectares, 90 million are affected by water erosion and 50 million by wind erosion. In Argentina, 13 percent of the cropland is affected by erosion from water and 16 percent from severe wind erosion [70]. Annually, 600,000 hectares of farmland in Iran are destroyed and 1.65 million hectares of land are added to deserts [71]. According to Dr. J Floor Anthoni, Scientists estimate the loss of soil in New Zealand, through erosion and transport by rivers to the sea, at 400 million tons per year. The loss is about 10 - 20 times the rate of natural soil formation [72]. Around the world cropland the size of Indiana is eroded every year. As a result of erosion over the past 40 years, 30 percent of the world's arable land has become unproductive. The economic impact of soil erosion in the United States costs the nation about $37.6 billion each year in productivity losses [73]. On a global scale, the annual loss of 75 billion tons of soil costs the world approximately $70 per person per year [74]. Land slide caused by erosion is quite destructive as

well. A small example is Bangladesh [75].

Desertification is another calamity. It affects more than 110 countries worldwide and threatens the livelihood of over 1.2 billion people. If left unchecked, arable land is expected to shrink by one-third in Asia, two-thirds in Africa and one-fifth in South America, exacerbating food insecurity, economic loss and mass migration from dry land rural areas where the world's poorest people reside [76]. According to the United Nations Convention to Combat Desertification (UNCCD), more than 250 million people are directly affected by land degradation and drought, and about 1 billion people in more than 100 countries are at risk [77].

Forests are highly important to human well-being. Timber and other products of forests provide employment and livelihoods for herbalists, rubber tappers, hunters and collectors of nuts, bamboo and berries. Forests are also sources of medicinal compounds, dyes and fabrics. Households' cooking and heating with wood fuels represent one third of the global renewable energy consumption. Some indigenous peoples are completely dependent on forests. Surveys in Cameroon, Cote d'Ivoire, Ghana and Liberia found that forest wildlife accounted for 70 to 90 percent of the total animal protein consumed (FAO 1993) [78]. Trees protect the soil against erosion and help avoid landslides and avalanches. They may increase the rate that rainwater recharges groundwater as well as control the rate that water is released in watersheds. They help to sustain freshwater supplies. Forests affect the climate and are an important source of oxygen. Forests are our lung as President Roosevelt once said.

The 1974 floods in Bangladesh, which brought about severe famine by reducing the rice harvest, were caused in part by deforestation in Nepal and eastern India. According to FAO, 53,000 square miles of tropical forests and other were destroyed each year during the 1980s. Of this, 21,000 square miles were deforested annually in South America, most of this in the Amazon Basin. Based on these estimates, an area of tropical forest large enough to cover North Carolina is deforested each year [79]. Looking at a different angle, every second 1.5 acres of rainforests are being lost. Rainforests once covered 14% of the earth's land surface; now they cover only 6% [80]. If the current rate of deforestation continues, the world's rain forests will vanish within 100 years [81].

Over the years, scientists watched some forests grow more slowly without knowing the reason. The trees in these forests do not grow at a healthy pace and leaves and needles turn brown and fall off. Sometimes individual trees or entire areas of the forest totally die off. Researchers now know that acid rain causes slower growth, injury, or death of forests. In most cases, the impacts of acid rain on trees occur due to the combined effects of acid rain and other factors such as air pollutants, insects, disease, drought, or very cold weather [82].

"Climate change is rapidly emerging as one of the most serious threats that humanity may ever face," said the President of the conference, Kenyan Environment Minister Kivutha Kibwana [83]. Global warming is believed to be the result of the greenhouse effect. About 50% of the sun's energy is absorbed at the Earth's surface and the rest is reflected or absorbed by the atmosphere [84]. Rice paddies and livestock production are the most important anthropogenic sources of the greenhouse gas methane. Rising sea levels brought on by global warming have the potential to threaten much fertile agricultural land, the purity of freshwater supplies and the survival of some nations. Since the late 1800's, the global average temperature has increased about 0.7 to 1.4 degrees Fahrenheit (F) or 0.4 to 0.8 degrees Celsius (C). Many experts estimate that the average temperature will rise an additional 2.5 to 10.4 degrees F (1.4 to 5.8 degrees C) by 2100 [85]. According to NY Times, in Tibet, the glacier, named Zepu, has lost more than 100 yards of thickness, all in the last three decades. Between 1850 and 1960, the glaciers around the globe retreated 7.5 percent. Between 1960 and 2000, there was a further 7 percent retreat. In other parts of the Himalayas, large newborn lakes are accumulating behind dams of ice that could break, unleashing deadly flash floods [86]. Mountain glaciers store some 75 percent of the world's fresh water in glacial ice [87]. It is believed that the Mediterranean basin, western USA, southern Africa, and north-eastern Brazil, would suffer a decrease in water resources due to climate change [88].

The World Health Organization (WHO) says global warming could lead to a major increase in insect-borne diseases caused by ticks which carry encephalitis, Lyme disease and sand flies which carry visceral Leishmaniasis. WHO estimates 150,000 deaths annually "as a result of climate change", of which half in the Asia-Pacific region [89]. The global cost of climate change is projected to be up to 5% of gross world product by the end of this century. Thus, poverty may not be eliminated while environmental

degradation exacerbates malnutrition and waterborne diseases [90].

Human agricultural activities contribute to greenhouse gas through land use in many ways. Deforestation releases carbon dioxide; rice cultivation adds methane; fertilizer application releases nitrogen, and cattle also pollutes the air by releasing enteric fermentation. Some experts believe that 54 % of methane emissions, roughly 80 % of nitrous oxide emissions, and virtually all carbon dioxide emissions are tied to land use [91]. Livestock and livestock-related activities, deforestation and increasingly fuel-intensive farming practices are responsible for over 18% of human-made greenhouse gas. Agricultural byproducts cause 8% of greenhouses gases and residential and commercial activities another 10 percent [92].

Besides the immediate ecological and economic impact, the huge dead forests provide a fire risk as the climate becomes very warm. The 10-year average of boreal forest burned in North America, after several decades of around 10,000 km², has increased steadily since 1970 to more than 28,000 km^2 annually [93]. Over a span of two decades, warming temperatures have caused annual losses of roughly $5 billion for major food crops, according to a study by researchers at the Carnegie Institution and Lawrence Livermore National Laboratory. Between 1981 and 2002, warming reduced the combined production of wheat, corn, and barley by 40 million metric tons per year [94]. An authoritative international study of the impacts of global warming on food security concludes that as many as 63 to 369 million additional people could be at risk of hunger in 2060 [95].

The opposite of global warming is global dimming, a reduction of heat reaching the earth. In the mid-1980s, Astumu Ohmua, a geography researcher at the Swiss Federal Institute of Technology, found that solar radiation striking the Earth's surface had declined by more than 10% over the three previous decades [96]. Others have believed that the amount of solar energy overall declined by 1-2% globally per decade between the 1950s and the 1990s [97]. Due to global dimming the reflection of heat makes waters in the northern hemisphere cooler, a phenomenon that leads to rainfall reduction in places like the Sahel in Northern Africa, resulting in drought and famine. The 2011 drought in Somalia is termed by the UN as the "worst humanitarian disaster" in the world [98]. More than 12.4 million people suffer from the famine, drought and lack of food in Somalia, Kenya, Ethiopia, and Djibouti. Perhaps the most influential is the droughts in Australia, in particular the fertile Murray-Darling Basin, which produces large amounts of wheat and rice [99]. The recent drought (2010) in Central Russia, an area twice as large as Switzerland, has affected wheat fields and potatoes crops severely, causing over one billion dollars of damage to Russian farmers. Other events that have negatively affected the price of food include the 2006 heat wave in California's San Joaquin Valley, which killed large numbers of farm animals, and the unseasonable 2008 rains in Kerala, India, which destroyed swathes of grain. The effects of Cyclone Nargis on Burma in May 2008 caused a spike in the price of rice. The storm surge inundated rice paddies up to 30 miles inland in the Irrawaddy Delta, rose concern that the salt could make the fields infertile.

Ozone depletion, another issue of concern, describes a slow and steady decline of about 4 percent per decade in the total volume of ozone in Earth atmosphere [100]. The main public concern regarding the ozone hole has been the effects of increased surface UV and microwave radiation on human health. Ozone depletion damages crops, trees and other vegetation as well.

IV

As natural forces keep destroying resources, human beings are constantly striving to come up with solutions to compensate for losses and to increase production. The application of fertilizers has been one of the ways for enhancing productivity. Fertilizers contain nutrients that when properly applied to soil will increase land's capacity to produce more and healthy plants. About 1.2 % of the world's annual energy usage goes into the production of fertilizers [101]. Nitrogen (N), phosphorus (P), potassium (K) and sulfur (S) are the most important nutrients for crop growth and some plants. Many of these nutrients are found naturally in soils but become depleted and the soil under cultivation frequently requires fertilizing before being used successfully again. Fertilizers are responsible perhaps for 40-60% of world food production. It is estimated that about 1/2 of the fertilizer applied to US farmland is necessary just to replace nutrients that are lost with soil erosion. For China in 1995, it was estimated that 30% of the N and 22% of the K applied simply went to replace nutrients lost with erosion [102]

Nitrogen can be produced by some plants, such as soybeans and other legumes that can be recovered directly from the atmosphere or from the soil in a process known as "fixation". Nitrogen is commercially recovered from the air as ammonia, which is normally produced by combining nitrogen in the atmosphere with hydrogen from natural gas. An average of 85 percent of the ammonia produced in the United States is used in fertilizers. About 11.5 million metric tons per year of nitrogen in all forms is used in fertilizers in the United States. The United States is the world's second largest ammonia producer and consumer following China. She imports significant quantities of ammonia primarily from Canada, Trinidad, Tobago, and Russia. Phosphate rock is the only economical source of phosphorus for manufacturing phosphoric fertilizers and chemicals. Deposits are widely distributed throughout the world. The United States is the world's largest producer of phosphate rock, with annual production of about 45 million metric tons (Mt) of marketable rock, accounting for more than 30 percent of total world production. Overall, more than 50 percent of the phosphoric acid produced in the United States is exported as finished fertilizers or commercial acid. The United States accounts for more than 50 percent of global inter-regional trade in phosphates. Potassium is produced at underground mines, from solution-mining operations, and through the evaporation of lake and subsurface brine. The United States produces about 3 million Mt/yr. of potash. Canada is the largest potash producer in the world [103]

The increased use of fertilizers with little or no sulfur has resulted in lower soil sulfur content and soil sulfur deficiencies worldwide. Nearly 60 percent of all sulfur consumption is in the production of phosphate fertilizers. Nearly 10 percent of additional consumption is used in other agricultural applications, including the production of nitrogenous fertilizers and plant nutrient sulfur. The largest sources of elemental sulfur are petroleum refining and natural gas processing facilities. Canada is the largest sulfur producer and exporter in the world [104].

Even though in some regions of the world, crop production is still constrained by too little application of fertilizers, by using formula fertilization technology the output of wheat increased by 10%, rice 9.7%, corn 8.2% and cotton 8.2% [105]. Between 1960 and 1995 global use of nitrogen fertilizer increased sevenfold, and phosphorus use increased 3.5 fold. Further increases in nitrogen and phosphorus application are unlikely to be as effective at increasing yields because of diminishing returns. C*eteris paribus*, the highest efficiency of nitrogen fertilizer is achieved with the first increments of added nitrogen. Efficiency declines at higher levels of addition. Today, only 30 to 50 percent of applied nitrogen fertilizer and 45% of phosphorus fertilizer is taken up by crop [106]. A significant amount of the applied nitrogen and a smaller portion of the applied phosphorus are lost from agricultural fields. Nitrogen oxides emitted from agricultural soils and through combustion increases tropospheric ozone, a component of smog that impacts human health and agricultural crops. Finally, nitrogen inputs to agricultural systems contribute to emissions of the greenhouse gas nitrous oxide.

Production and application of fertilizers consume large amounts of energy. In 1972, agriculture used about 3.5 percent of the world's commercial energy. Of the total energy used in agriculture 2 percent was used in the production and application of pesticides. On average, production of pesticides takes four to five times more energy per pound than nitrogen fertilizer production. It is sad to notice that by combining more and more fertilizer with ever higher-yielding varieties does not necessarily increase production significantly. The shifted cultivators are the typical farmers of Central America, the Amazon, parts of West Africa, the Philippines and Indonesia. At times, these groups have moved to ecosystems unfamiliar to them where many of their traditional practices are not applicable. Their farms are on soils not suitable for sustainable farming regardless of the type and quantity of fertilizers used. Moreover, resources for the production of chemical fertilizers are to be found largely in a few rich countries such as the USA and Canada.

Because the land supply is constrained, some form of redistribution of land may arguably improve production. The concentration of land in the hands of few large landowners was a kind of rule in the ancient times and remained so through the Middle Ages and the Renaissance. The French Revolution introduced land reform to France, and the Russian Revolution instituted collectivization of agriculture. Land reform took place in some other parts of the world as well, notably China and India, with doubtful results.

In the Russian case, a turning point was 1861, the date of the Emancipation Act. Prior to this date, the Russian rural economy was feudal in character, with serfs bound to their landlords. The Emancipation Act

introduced a long period of agrarian reform through the Bolshevik Revolution of 1917. During this period, there was gradual reallocation of land, although preservation of the village (Mir) as a communal form of local decision making limited the extent of agricultural modernization. During the period of New Economic Policy (NEP), Stalin changed the institutional arrangements on Soviet agriculture beginning in 1928. The introduction of the collective farms (kolkhoz), the state farms (sovkhoz) and the private subsidiary sector fundamentally changed the manner in which agriculture was organized. Markets were replaced by state control and mechanization of agriculture especially the introduction of the Machine Tractor Stations was instituted. Most importantly, in the latter years of the Soviet era, the focus became agricultural-industrial integration, an effort to reap the benefits of Western "agricultural-business" types of arrangements in production and marketing [107]. When the Soviet Union collapsed in 1991 primarily due to the exhausting war with Afghans, the era of socialist agriculture and socialist agricultural policies came to an end. Throughout the 1990s, the emphasis has been on the creation of a corporate structure in farms and the conversion of these farms to various forms of private equity arrangements. However, given the very slow emergence of land reform, and specifically the slow development of a land market in Russia, fundamental change in the Russian rural economy continues to be at best very slow.

In China, land reform programs were designed to break the power of traditional village elite, recruit new village leaders from among the peasants, and distribute wealth from the elite to the poor. China underwent land reform between 1946 and 1953 and a wholesale transfer of land to small peasants. Attempts were made to amalgamate peasant cooperatives into larger communes. The effort to establish socialist agriculture, the communes proved inefficient, causing stagnation in agricultural productivity. Land reform failed and by 1980 China was rapidly returning land to individual smallholders and promoting market-oriented agriculture [108].

India, at independence from Britain, inherited a semi-feudal agrarian system. The ownership and control of land was highly concentrated in a few landlords and intermediaries who made all the efforts to extract maximum rent from tenants. Tenant farmers were lacking incentive to develop farmland for increased production. The situation led to a reduction in agricultural productivity [109]. The first few five-year plan of India allocated substantial amounts for the implementation of land reforms in an attempt to abolish intermediaries, protect the tenants, and to impose a ceiling on land holdings. More than half century down the line, a number of problems are still far from being resolved. Inequality has increased rather than decreased. The number of landless labor has gone up and the top ten percent monopolizes more land now than in 1951 [110]. Land reform, therefore, did not produce an answer to India's agricultural problems that stem from land scarcity.

Land reform took place in several others parts of the world as well: Japan during the Meiji Restoration (1868-1912), South Africa, Zimbabwe, Mexico (1917), Bolivia (1952) and Cuba, where land reform was one of the main platforms of the revolution of 1959. In Iraq and Syria, in the 1970s, Baathist governments redistributed land and created fully functioning cooperatives. Attempts to reform land tenure were made also in Yemen, Algeria (1972), Tunisia (1956), in Iran (1962) where especially after the Iranian Revolution (1979), in the early days of the Islamic republic, considerable amounts of land changed hands as Pahlavi officials were expropriated. However, the redistribution of land has been a complex and slow process. For example, the process began in South Africa in 1994, but by the end of 2001 less than 1% of formerly white-owned land had been transferred to the black population. In many cases production fell as a result of land reform. China, Zimbabwe, Algeria, Tunisia, and Yemen are some of the examples where ultimately expanding reliance was placed on the private sector in both farm production and marketing, as well as on reduced regulation of farm prices. In Afghanistan, the Soviet installed government of Khalki-Parchami that assigned a priority to land reform, ended up in a total collapse.

The social cost of land reform, especially via revolution, has been very high in certain countries. For example, forced collectivization under Stalin after 1929 took millions of lives. Other problems with land reform include fairness of compensation, adjudication of land ownership disputes, experience and competence of those receiving land to use it productively, competence of governmental entities to make decisions regarding agricultural productivity, demotivation of any property owners to invest in land that ultimately can be seized, and many other legal and philosophical issues, all of which slow down the process of success realization. The important point is that no matter ideologically how justified a land

reform may be, land reform does not alleviate the problem of global land scarcity that the World is confronted with. Land reform merely redistributes the existing fixed amount of land from experienced to inexperienced producers. Forced land reform violates the principle of "voluntary exchange", and is therefore unfair.

What fertilizer application and land reform cannot do, technology may be able to do, *i.e.* to fight off scarcity. Technology is the systematic application of scientific or other organized knowledge to practical tasks. Through technological development people will be able to create new and useful products, devices, machines, or systems. Technological breakthrough is believed to enhance productivity and therefore increase production without increased application of resources. In agriculture, high horsepower tractors, harvesters, wheat and rice reapers, water spraying machines, drip irrigation and trace irrigation systems, disk plow, seeder machinery, fertilizer sprayers, manure spreaders, and hundreds of other implements have improved efficiency remarkably in the developed economies. Moreover, the introduction of quality seed of new varieties, the development and use of nutrients and pest control products, have helped farmers to secure higher crop yield, mainly in North America and West Europe. The use of computational technology is used to re-mediate land that has been overused or misused through poor agricultural practices

Classical economic theory advocated primarily by Thomas Malthus, believing in diminishing returns, denies that an economy will experience a sustained growth of production possibilities. Malthus predicted that real GDP will remain at the subsistence level over time. He believed that population is more powerful than the Earth and, consequently, population will outstrip the food supply over the long-run. Technology had some importance to him but only a limited one. It was Professor Robert Solow of MIT who argued that as long as technology advances, the economy can continue to grow forever and scarcity will no longer be a factor. The original Solow study (1957) showed that technological change accounted for almost 90 percent of U.S. economic growth in the late 19th and early 20th centuries [111]. However, his Neoclassical theory of growth cannot explicitly determine how technological improvement could come about. The conceivable birth place of new technologies to him is *chance.* Thus, the causal connections between technological change and economic growth are still poorly understood. Professor Paul Romer of Stanford, proponent of the New Growth Theory, believes that people invent new technologies by *choice*, not by *chance*. People are naturally equipped with inherent desire to pursue advancement and profit. As competition eliminates profit, firms strive to locate new avenues to make money. People are naturally inventive according to him, and they are eager and able to create. Creativity is the main driver of technological development and is the substitute for scarcity. The Law of Diminishing Returns, therefore, becomes irrelevant according to him. To classical economists scarcity is the culprit, but to Professor Romer, scarcity is the virtue as it motivates people to find ways to alleviate it. The successful histories of catch-up in Japan early in the twentieth century, and Korea, Taiwan and Singapore toward the close of the twentieth century, show that it was technological innovation that drove their economies forward. Technological progress could have contributed as much as 65% to the economic growth of Japan in 1980s [112].The economic benefits of technological development are primarily reaped by the developed countries. The effective transfer of technology to the rest of the world has been rather slow. Developing nations need to become more receptive of changes and be willing to accept new technologies and learn how and when to apply them. At the same time, providers of technology must play a key role in facilitating the transfer process by helping the adopters reconstruct technology to suit their situations. Providers should try to transfer to the recipients resources and capabilities needed to use, modify and generate the technology.

Technology transfer should stimulate new innovation in the recipient countries so that today's recipients can be tomorrow's donors. To be a donor of technology, the recipients of technology should first possess the capacity to assimilate, adapt, and modify the imported technology through education and training and social and legal changes. For example, private ownership, pursuit of self-interest and voluntary exchange must be honored faithfully and pervasively. Unfortunately, many developing nations are still resistant to changes. An American Colonel who served the US Army in Afghanistan, upon her return told me that they tried hard to help Afghans learn how to make and use simple apparatus to increase efficiency by using solar energy technology. However, they failed in their attempts. Why? Because Afghans did not show interest in learning and adopting new technologies no matter how simple. They prefer their own traditional ways of doing things.

V

Our Earth provides us fixed amounts of core resources that are constantly consumed and or destroyed. Fertilizer application, land reform and technological development and other well-intended human efforts have safeguarded resources from total exhaustion thus far, but they may not save our limited resources for ever. Resources are becoming more and morescarce with the passage of time. In addition to a continuous destruction of resources by natural phenomena that make us approach global scarcity rapidly, there are three other elements that reflect signs of scarcity. These elements are inflation, corruption and wars.

Prices generally oscillate around a long run trend and the inflationary rate above the long-run trend with respect to certain products is usually a sign of scarcity of those products. It seems reasonable to think that the long-run inflationary trend itself is a sign of scarcity in general. Economists make a distinction between demand-pull inflation and cost-push inflation. The former is believed to be the effect of household, business, government, and foreign buyers collectively wish to buy more than the economy is capable of offering. This can be due to population growth. Demand-pull inflation is, perhaps wrongly, explained by "too much money in the economy chasing few goods". Increased money supply increases people's ability to make transaction once the willingness to spend the money exists. Increased money supply is assumed to increase demand when it causes to increase incomes and wealth. Looking at the correlation between money supply and inflation one may conclude that there is some relationship between the two. But this is a chicken and egg situation. One cannot definitely say whether the quantity of money precedes or follows inflation.

In an open auction buyers facing each other will compete price-wise. In the usual markets (shops for instance) buyers do not necessarily face each other; they only respond rationally to seller's determination depending on price elasticity of demand. The excess of quantity demanded over quantity supplied in a competitive market tends to raise the market price. This is so because suppliers initiate a higher price. As marginal cost rises due to scarcity that sellers perceive, sellers raise their prices perceiving that demand is there. A seller sets his/her asking price and a buyer responds to seller's decision. A particular buyer will pay the asking price if benefit derived exceeds the cost involved regardless of what other buyers may want. In a market economy goods and services are produced for those who pay the highest price. If a buyer is willing to pay 10% more for the product as determined by the seller, the next buyer may or may not follow the suit. If buyers are not willing to pay the asking price, sellers will respond to this and will adjust the price downward. Consumers' response to price is affected to a great extent by the degree of future shortage or scarcity in the market that buyers and sellers anticipate.

Cost-push inflation places responsibility for inflation directly on the shoulders of decreases in aggregate supply that generally result from increases in production cost. Resource cost rises because the actual or expected supply of a resource is feared to fall in the future. The culprit, therefore, is the actual or potential scarcity of resources. If the market does not perceive resources to become scarce, production cost does not have to rise unless productivity or efficiency drops. In the face of technological improvement which is frequently taking place particularly in competitive developed economies, loss of efficiency may not be a common occurrence.

Inflation is a global episode. Data on price movement in most of the developing nations that make up the bulk of the world population do not seem to be reliable and do not go far enough for analytical purposes. Several nations, including Afghanistan, Uganda, Guinea, Tanzania, Venezuela, Ethiopia, Iran, Syria, Belarus, for instance. face double digit inflation according to competent sources. Developed nations have systematically compiled data on prices for many decades. In Canada, prices were moving at an average annual rate of 3.2 percent between 1915 and 2011 [113]. In England, since June 1948, during 768 months, in only 1.7% of time inflation was negative and in the remaining 98.3 % of the time prices were moving upward [114]. In the United States prices have increased at an average rate of about 3.6% annually during 1914-2012 period [115]. A dollar today purchases something that eleven cents could have purchased in 1950. A few examples help making the point clearer: A postage stamp in the 1950s cost 3 cents; today's cost is 43 cents (1,300% inflation); a gallon of 90 octane full-service gasoline cost 18 cents in the 50's; today it is $3.80 for self-service (2,111 % inflation); a house in 1959 cost $14,100; today's median price is $170,000 (1,100% inflation); a dental crown used to cost $40; today it's $1,100 (2,750% inflation); an ice cream cone in 1950 cost 5 cents, today it is $2.50 (4,900% inflation), etc. [116]. Rising prices of commodities are likely to persist in the future largely due to uncertainty on the supply side [117].

The UN data indicate that global food prices surged 3.4% in January for the seventh month on a row in 2011, making the highest rise since 1990 [118]. The rising price of food stuff has been alarming in some parts of the world where rioters took to the street. For example riots of 2008 in Haiti, Bangladesh, Burkina Faso, Cameroon, Senegal, Somalia, Indonesia and many other places were all about the rising food prices.

Robert Barro (1997) found in a cross-country study that an inflation rate 10 percentage points higher is associated with real growth 0.3–0.4 percentage points lower. Javier Andrés and Ignacio Hernando (1999), who studied OECD countries (Organization for Economic Cooperation and Development), report that lowering inflation by one percentage point will boost per capita Gross Domestic Product (GDP) by 0.5–2.0 percent [119]. By providing an adequate quantity of money to the economy, the major goal of a central bank is to promote economic growth. Other goals are full employment and price stability. A wise monetary policy maker will not engage in a policy to counter these basic goals. The Federal Reserve System, or the Bank of England or the Bank of Canada, for example, will not pursue inflation at the expense of economic growth. Money supply does not appear to be the fundamental cause of inflation. J.M. Keynes in his *The Economic Consequences of the Peace, 1919*, stated that: "There is no subtler, no surer means of overturning the existing basis of society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and does it in a manner which not one man in a million is able to diagnose". True, it is hard to trace the principal cause of inflation; however, the main hidden force beyond inflation is nothing more than actual or perceived scarcity. Inflation by raising the cost of living breeds corruption. Corruption has become a common practice in practically all countries. The US Attorney General said that according to World Bank, more than one trillion dollars in bribes are paid each year [120]. Forms of corruption vary, but include bribery, siphoning of revenue, extortion, scare tactic, cronyism, nepotism, patronage, embezzlement, blackmail, criminal graft, false accusation, kickbacks, smuggling, money laundering, false advertising, asymmetric information, adverse selection, moral hazard, over-billing, insider trading and many other types. A state of unrestrained political corruption is known as a kleptocracy, or rule by thieves.

Corruption slows down economic performances; it exacerbates scarcity by creating delays, misallocation of resources and curbing incentive to work diligently and efficiently, and it inhibits innovation and progress. Generally, in countries where poverty and scarcity exist, corruption spikes. Mo using ordinary least square method observed that a 1% increase in the corruption level reduces the growth rate by about 0.72% [121]. Moreover, Pellegrini and Gerlaugh found that one standard deviation increase in the corruption index is associated with a decrease in investments of 2.46 percentage points, which in turn decreases economic growth by 0.34 per cent per year. Again, a standard deviation increase in the corruption index is associated with a decrease of the openness index by 0.19, resulting in a decrease in economic growth by 0.30 percent per year [122].

The results of 2009 Global Corruption Index show that New Zealand, Denmark, and Singapore are the least corrupt, while Somalia, N. Korea and Afghanistan have very high corruption rates. Countries which are perceived to have the highest levels of corruption are generally those that are plagued by poverty [123].

In Somalia, businesses, for example, avoid taxes and sell expired food and drugs. The UN Monitoring Group reported that ministers sell visas and sign dubious deals, misuse revenues, cover for organized crime and piracy, etc. An anti-corruption committee established by the government did nothing to halt corruption [124].

A report produced by United Nations Office on Drugs and Crime (UNODC) states that: "it is almost impossible to obtain a public service in Afghanistan without greasing a palm: bribing is part of everyday life. During the past 12 months, one Afghan out of two pays at least one kickback to a public official. According to this report, in the aggregate, Afghans paid out $2.5 billion in bribes over the past 12 months, nearly a quarter of their GDP. Around 25% of Afghan citizens had to pay at least one bribe to police and local officials over the past year. Between 10-20% had to pay bribes to judges, prosecutors, doctors and members of the government. People believe that it is cheaper to bribe a judge than to hire a lawyer [125]. According to an Aid worker, for Afghan women and children, corruption is particularly deadly [126]. The climax is reached when the President himself receives bribe from the President of another country [127]. Mr. Karzai has admitted to have received millions in cash from the president of Iran.

The main condition that must exist in a country for corruption to be nurtured is scarcity of resources that leads to poverty. Means that support life and sustain

comfort are becoming increasingly scarce making people less certain about their future well-being. People who are not able to compete fairly will feel inclined to engage in cheating, particularly in poorer countries like Afghanistan, Pakistan and India, in order to survive. Food producing countries help poor nations, but sometimes with restrictive conditions. Food scarcity has become a political tool used to impose political conditions on the recipients [128].

The relative shortage of oil leads to military conflicts at times. Since the early part of the 19th century, Europeans vied to control the Middle East. Oil played a significant role in both World Wars. Iraq is created by Britain in the aftermath of World War I because of the growing importance of oil to the ebbing British Empire. The Allies occupied it during WWII for the same reason. During World War I oil was used to serve British navy and air force. As war continued, oil had become absolutely vital to Britain and the control of its supplies became a first priority [129].

Many people believe the United States and the United Kingdom waged war on Iraq for oil. President Bush's Cabinet agreed in April 2001 that Iraq remains a destabilizing influence to the flow of oil to international markets from the Middle East. The US military intervention was deemed necessary [130]. Even Greenspan, former chairman of the Federal Reserve, is taken to believe that Saddam Hussein posed a threat to the security of oil supplies in the Middle East. More astonishingly, Chris Mathews said that John McCain admitted or confessed that we went to war with Iraq for oil. John McCain is quoted to have said that following his energy policy, US will be prevented from sending the young men and women ever again to the Middle East. In a Business Week interview, Gov. Sarah Palin admitted that she believes the Iraq war was fought because of oil: We are a nation at war and in many [ways] the reasons for war are fights over energy sources, which is nonsensical when you consider that domestically we have the supplies ready to go [131].

Invasion of Kuwait is another illustration of war for oil. Kuwait was accused by Iraq of exceeding its OPEC quotas. The Iraqi Government claimed that Kuwait was slant drilling across the border into Iraq's Rumaila oil field. Iraq decided it was justified to go to war with Kuwait [132].

Iraq-Iran War was also over oil. In 1979 Saddam Hussein taking advantage of the chaos caused by Iranian Revolution argued that the predominantly Arab population in Shatt al-Arab would prefer being part of the predominantly Arab state of Iraq. The April 1984 attack on a tanker by Iraq marked the beginning of the first phase of the "tanker war," which continued for 18 months.

The Afghan War may be related to oil as well. Some believe that interest lies in the oil and gas reserves in Central Asia. An eastward route would require the longest pipelines in the world. There are forbidding mountains also on the way. The other alternative is a shorter route to the south through Afghanistan and Pakistan. As reported by the Asia Times, in July 2001 a strategy to topple the Taliban and replace it with a broad-based government was discussed during the G8 summit in Genoa, Italy. Following within days a plan was set up for military strikes against the Taliban from bases in Tajikistan to be launched before mid-October 2001[133].

The case of Darfur, illustrates the new cold war over oil, where the rise in China’s oil demand to fuel its booming growth has led Beijing to embark on an active petroleum geopolitics. Africa is a major focus, and in Africa, the central region between Sudan and Chad is of paramount importance. Since 1999, China has invested at least $15 billion in Sudan. It owns 50% of an oil refinery near Khartoum with the Sudan government. The oil fields are concentrated in the south are partly financed by the United States [134-135].

Iran occupies a strategic location on the north side of the Persian Gulf and she is in a position to threaten oil fields in Saudi Arabia, Kuwait, Iraq, and the United Arab Emirates. Iran also sits athwart the Strait of Hormuz through which 40% of the world's oil exports pass every day. In addition, Iran is becoming a major supplier of oil and natural gas to China, India, and Japan, thereby giving Tehran additional clout in world affairs. It is perhaps these geopolitical dimensions of energy that shapes U.S. policy toward Iran. Yet, the issue of a possible war with Iran involves a great deal of uncertainty. No doubt, US will win but what about Israel and the small Gulf States which seem vulnerable to an Iranian attack in the event of a military conflict [136].

Natural gas at times has caused political rifts between nations, again because of scarcity. Michael Schwartz reported that the president of Belarus ordered a halt to the transit of Russian natural gas to Europe, escalating an energy conflict with Moscow over unpaid debts that he said was turning into a “gas war”. Similarly, serious dispute between Russia and

Ukraine began in March 2005 over the natural gas and transit prices. During this conflict Russia claimed Ukraine was not paying for gas, and diverting gas exported to EU from the pipelines. The dispute culminated on January 1, 2006, when Russia cut off temporarily all gas supplies passing through Ukrainian territory [137]. In October 2007, new disputes over Ukrainian gas debts began. These led to the gas supplies reduction in March 2008. During the last months of 2008 relations between Russia and Ukraine again became sour when Ukraine and Russia could not agree on the debts owed by Ukraine.

VI

The world has entered an era of scarcity. Each day more than 200,000 people are added to the world food demand. People in many parts of the world loitering around the streets are looking for food. As the world's population grows, land that was once used for farming is being converted into land used for housing. Experts estimate that 0.7 hectares (or about two acres) is the minimum amount of land needed for a person to live on a vegetarian diet. Nearly all of the world's productive land is already exploited. There are significantly fewer farmers today than there were in the 1950s. To ensure that food remains available for domestic consumption, countries such as China, Brazil, India, Indonesia and Egypt among others, have imposed strict export bans on rice. Some other countries including Argentina and Russia have imposed high tariffs against the export of wheat and other foodstuffs, driving prices further up for net food importing nations.

Water is also becoming a huge problem. Currently, 750 million people live in countries with a scarcity of water or stressed water supplies. Rising temperatures are contributing to famines that are depleting many sources of fresh water. In the area of energy, renewables met only 16 percent of global final energy consumption in 2010 [138].

Real Gross World Product per capita rose from $3000 in 1960 to $7600 in 2012, at a rate of 1.8% per year [139]. Given the rate of population growth to be 1.2%, Real Gross World Product increases by 3% per year. To what extent oil supply needs to rise to maintain 3% growth rate?. Gail Tverberg using regression analysis suggests that if we want the world economy to grow by 4% per year, world oil supply will need to grow by 3% per year. If we want world real GDP to grow by 3.0% per year, we need oil supply to grow by 2.2% per year. This is more than world oil supply has grown per year since the 1970s. If the annual percent change in oil supply persists at its current rate of 0.4%, the predicted annual increase in world real GDP is 0.2% per year using the 1970-2011 fit, or 0.3% using the 1983-2011 fit. **B**ased on Tverberg's equation ($y = 0.741 x + 0.0193$) if oil supply declines by 1.0% per year, world real GDP can be expected to decline by 0.7% per year. If world oil supply declines by 2.0% per year, the model would suggest world real GDP can be expected to decline by 1.5% per year [140].

A UN report has warned that "The world is running out of time to make sure there is enough food, water and energy to meet the needs of a rapidly growing population and to avoid sending up to 3 billion people into poverty" [141]. This means productivity must increase via technological improvement to such an extent as not only to maintain the current 1.8% growth of real World GDP per head, but also to compensate for the rate of decrease in the supply of usable land, water and oil (assumed to be around one tenth of percent per year). If an additional percent rise in the standard of living is also desired, then productivity through innovation and technological advancement should increase accordingly. Let us look at the production function $Y = Af(k,L)$ where Y stands for real output, K for the stock of physical capital and L for labor. "A" reflects productivity. If the rate of growth of real output equals 3%, the rate of growth of world capital equals 1.5 percent, the rate of growth of labor equals population growth rate of 1.2 percent, and the rate of growth of productivity equals 1.9 percent, and furthermore, if capital elasticity of output is 0.25 and labor elasticity of output is 0.75, then out of 3% rate of growth of output, 0.37 percentage point (0.25 x 0.015) is attributed to capital and 0.9 percentage point (0.75 x 0.012) is attributed to labor. The residual which is 1.6 percentage point is due to productivity increase. This way, the relative weight of productivity in the rate of growth of real output is 57%. This is perhaps mainly due to technology and innovation. The rate of growth of world per capita real GDP that may reflect the global standard of living is 1.8%. If the standard of living needs to increase by one percent per year, the growth rate of world output needs to be 4.55% and productivity should rise accordingly i.e. to 2.95%, assuming nothing else in the production function to change. Additionally, if the loss of resources enters the picture, say one tenth of one

percent per year, productivity should rise further by some 2% to 2.97% or roughly to 3%.

For how long can we rely on technology to meet this target is a matter of debate. According to Professor Solow, innovation is a random and unpredictable process. However, in the Western World, technological breakthroughs have been remarkable thus far, but not enough to improve human life all over the world. Innovation will flourish as long as sufficient funds and attention are devoted to educational and research institutions. A proper balance between expenditures on educational and non-educational items must be maintained in order to insure that human's inherent ingenuity is fully exploited and that technological development becomes a routine and predictable matter. At the same time, political, social, legal, financial and managerial frameworks should be improved world-wide in order to translate technological innovations into real output more efficiently and pervasively. More people should breed more technology as long as adequate quantities of resources are available. As it is, the galloping global scarcity and population growth do seem to pose a challenge to technological improvement.

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