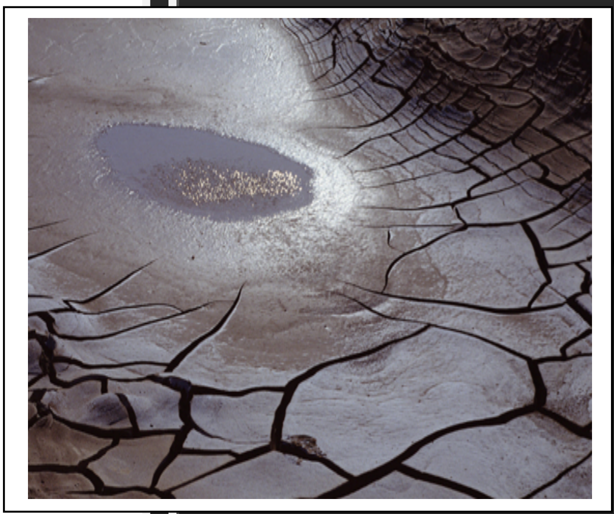
Future Issue

Scarcity



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Scarcity in Brief

Scarcity will have a direct effect on the governments and industry within the next two decades. While the current discourse focuses almost exclusively on energy, it misses the broader picture of global scarcity. Water, minerals and even food are at risk in addition to energy resources. The increased demands from rapidly developing countries puts tremendous pressure on global resources increasing the cost of copper, phosphorous, cement, grain and a wide array of other resources to near or beyond record levels. Foresight analysis projects that this rising trend will not abate in the near future and the interaction of these various forms of scarcity may exacerbate the problem. As a result, there will be an increased risk of resource conflicts and economic downturn. Yet as troubling as this scenario may seem, it provides a wide array of opportunities to exploit. The ability to be flexible and innovative is central to taking advantage of the situation. Resource management is an especially important field. The ability to create new methods of utilizing existing resources and reprocess existing ones is a vital business opportunity in the near future.

The Big Picture

The analysis of foresight studies demonstrates that scarcity will directly impact a diverse array of constituencies. Public health, economics, the environment as well as migration and geopolitics will all be affected by the inevitable shortage of broadly utilized resources. The analysis of foresights reveals oil, water, food and mineral scarcity as particularly relevant factors.

Indicators
Water shortage; mineral shortage; food prices; energy prices
Drivers / Underpinning mechanisms
Growing world population; growing demand due to economic growth; insufficient investment in alternative energy production; urbanisation; interaction between various forms of scarcity
Impact on security / business
Increased probability of conflict; Innovation possibilities; Potential for government joint ventures

Energy Scarcity

The long term trends indicate that states will likely continue their movement away from fossil fuels and toward renewable energies. Market liberalisation, demographics, politically unstable suppliers and increasing energy demands all play a role in this development but are not the central driver in its evolution. Energy scarcity, primarily in oil in the next quarter century is undoubtedly the transformative element in the system.[1] Cheaply processed light crude is increasingly at risk with reserves in the Middle East potentially at exhaustion prior to 2040 especially in the context of high economic growth.[2] Additionally, increasing political instability in oil rich regions such as Latin America, Russia and Asia have heightened the costs associated with extraction while not decreasing the overall output from these regions. In spite of this increased level of extraction, global reserves of oil will continue for at least 30 years beyond 2040 as alternative extraction of heavy crude in such areas as the Canadian tar sands become increasingly viable.[3]

The short term trends are more problematic as the accelerating demand for oil continues to advance on available supplies. Non-OPEC countries, which account for nearly 60% of the annual global oil production, are expected to increase by 1.5 mb/d, from 2006 through 2008, due to increased production from Eastern Europe and Central Asia. Meanwhile the older reserves from non-OPEC states are increasingly in decline, most visibly seen by the drops in production in the North Sea and in Mexico.[4] OPEC, in which 75% of global reserves exist, is predicted to increase production by 1.7 mb/d through 2008. Increasing demand for oil has continued with a predicted rise of 2.5 mb/d through 2008. Predicted oil demand beyond 2008 will likely lead to an increase of 1.1 – 2.2 mb/d annually.[5]

The increased use of motor vehicles by the developing world will assist in the demand for crude oil. Currently, there are only 24 vehicles per 1,000 people in China. By contrast, there are 786 vehicles per 1,000 people in the United States. By 2010, Chinese car ownership will increase by 67% to 40 vehicles per 1,000 people.[6] This will increasingly stress the global supply of oil. A divergence between the predicted supply and demand will likely to lead to a shortage of 12.5 mb/d by 2015, under the assumption of constant growth.[7] Figure 1 demonstrates the long term development of this trend.

This shortage is partially a result of depleting reserves but also the lack of an increasing level of investment necessary to maintain output at such high levels. The lack of refinery capacity, which exists predominantly in the developed world, is increasingly stressed by the demands for more gasoline. Figure 2 demonstrates the refinery versus reserve capacity. This stress can result in large temporary spikes to gasoline prices as the refineries are unable to keep up with demands.[8]

Figure 1: Crude Oil Production and Shortage
1990 – 2030

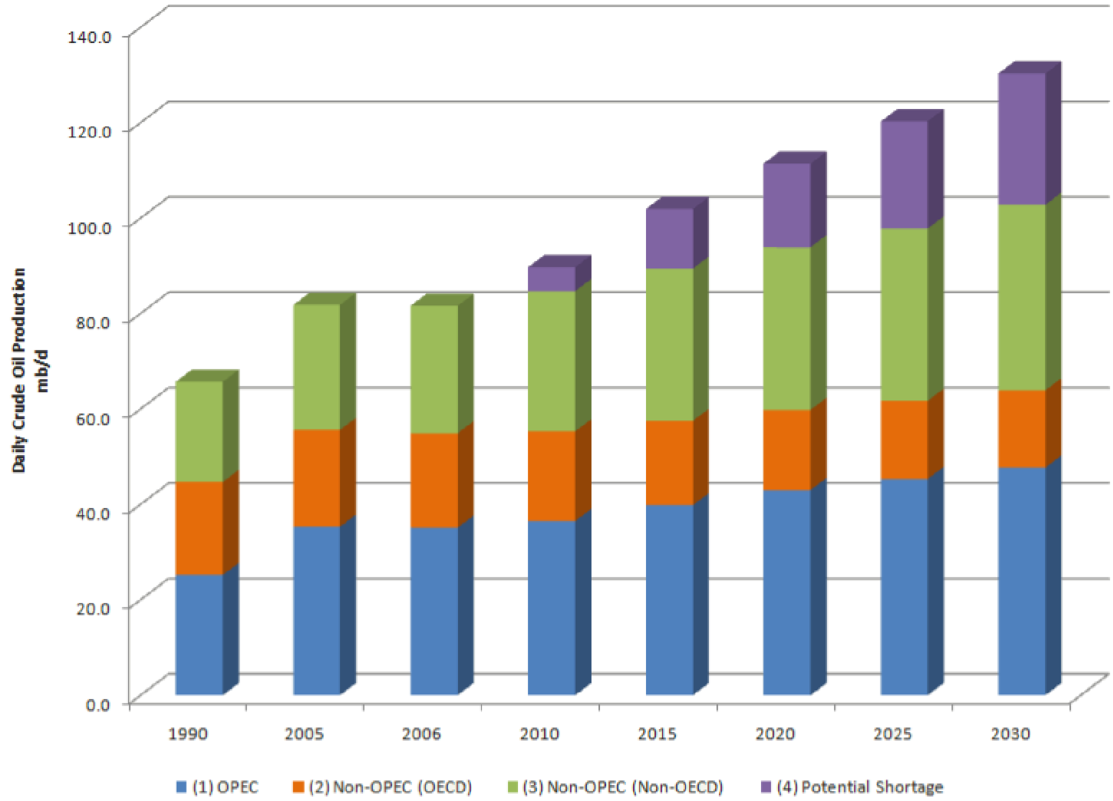
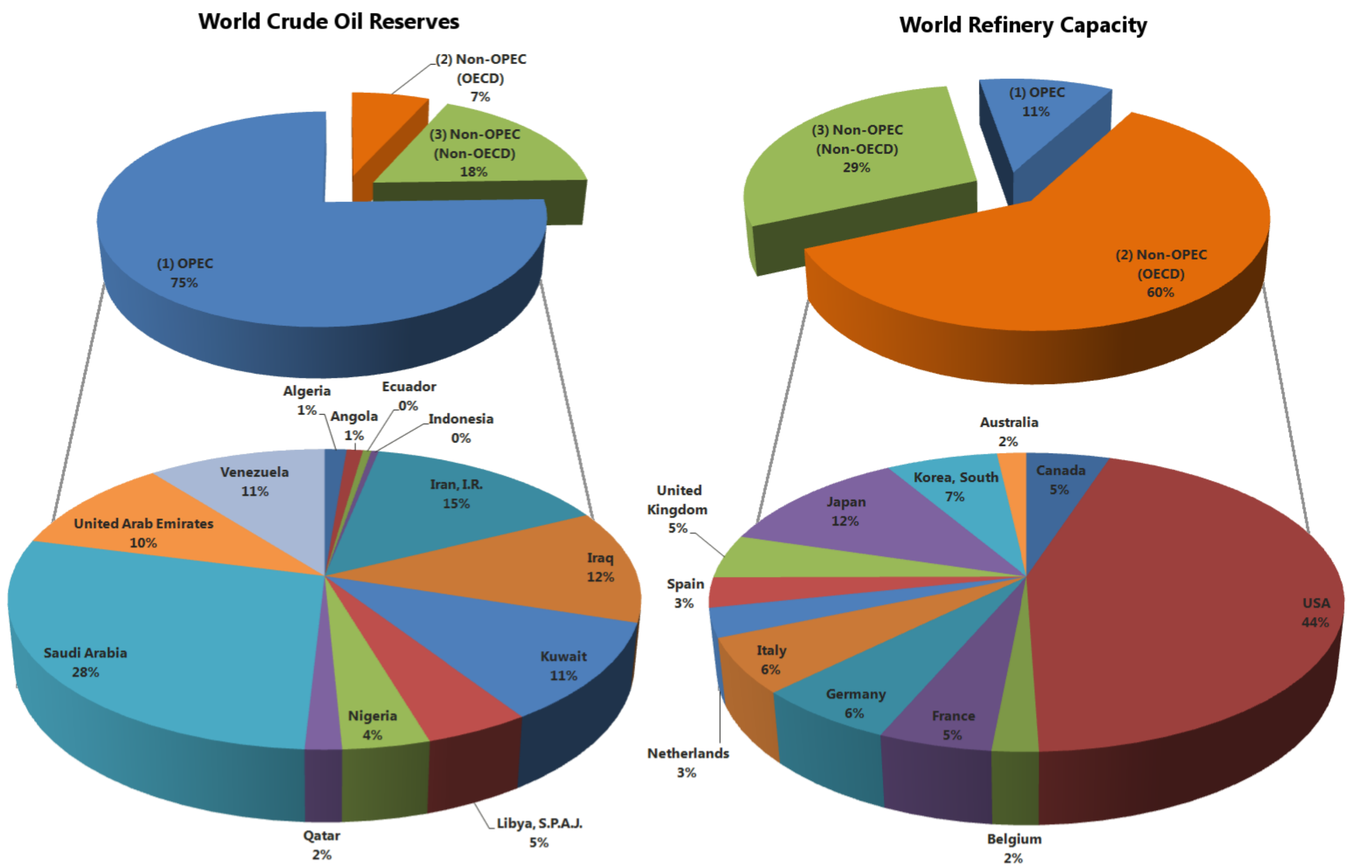


Figure 2: World Crude Oil Reserves and Refinery Capacity



All indicators point to an increasingly competitive market as established consumer countries attempt to maintain imports at levels that sustain economic growth. Meanwhile large industrializing countries, like China and India, increasingly encroach on those supplies. This is likely to result in more countries attempting to secure oil through bilateral agreements thus circumventing the uncertainty of the global market. Many of these agreements will be with developing countries in Africa and Asia who have unstable political regimes. They will be instigated predominantly by rapidly developing countries, especially ones whose economic growth depends on the manufacture and export of goods.[9] While this will undoubtedly alleviate some of the instability for the purchasing states, it is also likely to amplify the instability in the exporting regimes as the internal factions struggle for their share of energy revenues.

Ultimately, this is likely to inflate oil prices as this increased instability leads to speculation about whether these countries can guarantee exports. Further, it is likely to change the global energy market by introducing increasing rigidity and creating zones of unfair competition around suppliers with weak governments.

Threats and Opportunities

In spite of these grim short-term predictions, little progress has thus far been made by governments to avoid a scarcity problem in the near future. Governments have generally taken the approach that the problem will resolve itself. Renewable energy continues to account for only a tiny fraction of the global energy output at 6% of total energy production. It will not likely play a significant role until 2020, when alternative energy output may increase by 25%.[10]

However, the majority of this output will come from the development of new large-scale hydroelectric projects in China and India. High energy consumer countries in Europe and the United States will likely instead focus their attention toward wind and solar to increasingly fulfil their needs. The technologies required to avoid a global energy shortage, such as sustainable and stable fusion reactors or a safe method for the disposal spent nuclear fuel rods, appear to be decades away from reality. Furthermore, the time needed to adequately apply these types of large-scale technologies makes their implementation in the short term questionable.

The ability to adapt and be flexible is central to exploiting the opportunities surrounding energy scarcity. The technological developments that are likely to determine the future standards are those that are able to take advantage of the current infrastructure while providing increasing efficiency and energy. There is an increasing focus on renewable bio-fuels. Ethanol production has been at the centre of this discourse, with everything from sugarcane to corn being converted into fuel. Investment in the production of switchgrass has increased in recent years. Unlike corn or sugarcane, switchgrass can survive in poor climates, requires less water and pesticide and provides twice as much ethanol per ton of mass.[11] There has also been a push to use algae to create biocrude, a renewable equivalent to petroleum that can utilize the existing refinery infrastructure to create everything from plastic to gasoline.[12]

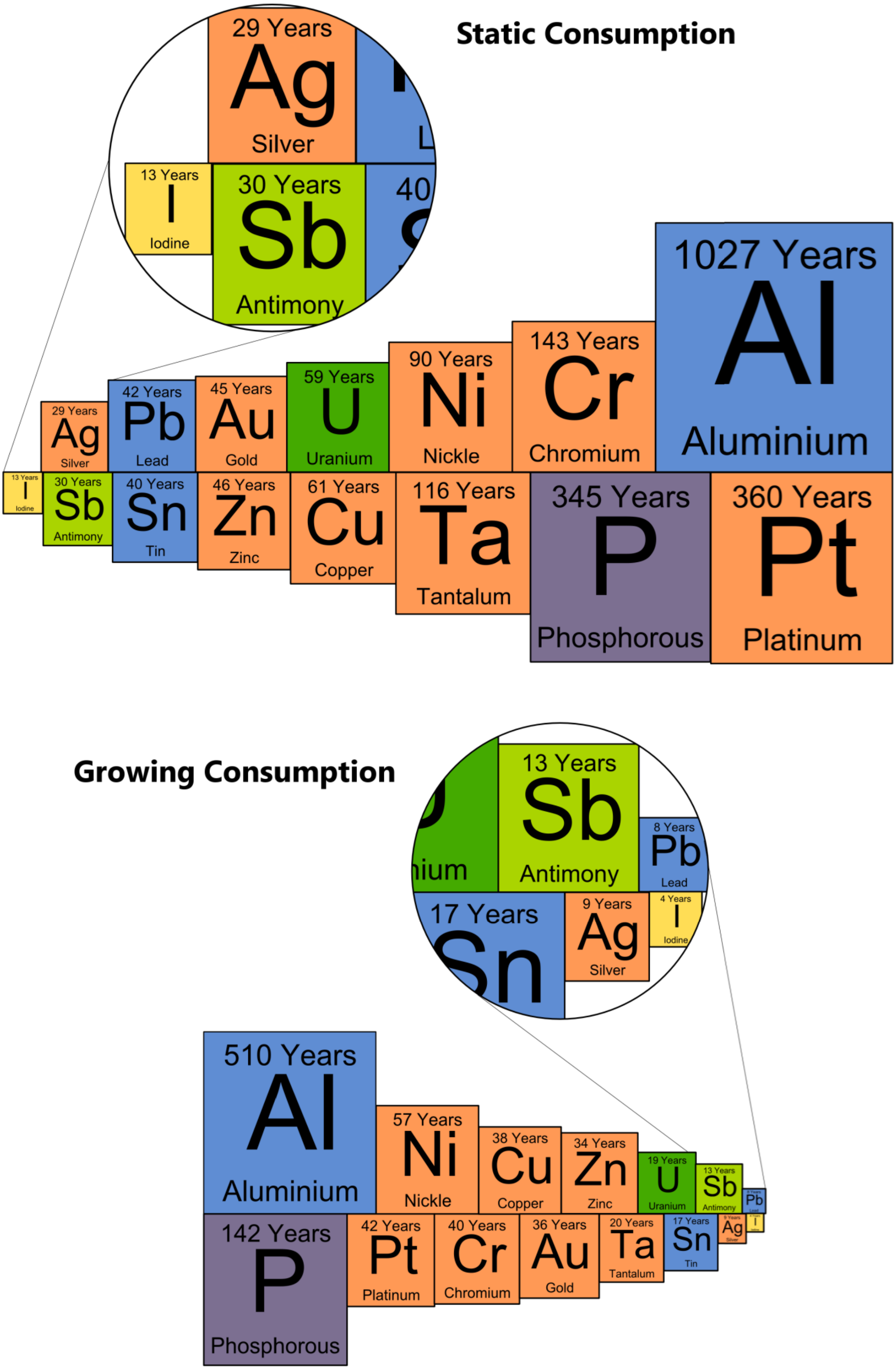
Electrical generation has also seen an influx of innovation in the production of energy. Recent investment in solar cells has led to a dramatic decrease in the cost of solar panels as well as almost a doubling of their overall efficiency. Solar allows for energy generation farms but also gives individual consumers the ability to offset their demands on central power stations. There have also been developments in the gasification of biomass which allows for the cheap production of synthesis gas which can be used for electrical generation on a small scale and is remarkably carbon neutral.

The current energy infrastructure is in real jeopardy from a prospective oil shortage. There are an estimated 400 million vehicles on the road in both the United States and Europe, the vast majority of which run exclusively on gasoline.[13] The effort to reduce oil dependence by converting vehicles to hydrogen or some other non standard fuel largely ignores the investment and time needed to transform the existing infrastructure to accommodate such a fuel. Far more likely is increasing movement toward flexible fuel vehicles that can use ethanol, methanol, gasoline or a mixture of these fuels.[14] These vehicles would allow the retention of the current infrastructure while newer technologies are developed and increasingly integrated. Overall, a wide array of business opportunities exists to take advantage of the current state of energy scarcity.

Materials and minerals

As economic growth in developing countries increases, the per capita consumption of minerals and materials does as well and will eventually strain limited natural resources. The OECD expects global demand for minerals to double over the next 25 years.

Figure 3: Years Remaining of Mineral Consumption



Asian consumption, most notably that of China and India, currently comprises half of world mineral demand and will grow even further if growth levels are sustained. China's demand for metals has increased by 17% per year over the past five years, and has accounted for 70% of global demand growth for several key metals, such as aluminium, copper, lead, and zinc.[15] This trend is likely to continue in the short run, and will drive the price of raw materials up. What is not certain, however, is whether higher prices also reflect increased scarcity. Complete data on mineral scarcity is difficult to acquire as mining companies carefully guard data on the capacities of existing mines and rates of mineral extraction. In spite of this limited data, global trends of consumption can be evaluated to determine the potential for mineral scarcity as the phenomenon is affected by geological, technological, economical and political factors.[16] With this in mind Figure 3 demonstrates the estimated remaining years of mineral consumption depending on static or growing consumption.

Threats and Opportunities

The development of mineral scarcity is highly dependent on world economic performance, most notably developing nations China and India, whose sizable populations and strong economic growth levels cause substantial increases in demand for basic raw materials such as iron and steel, phosphates and potash for fertilizers, and metals used in the electronics industry, such as indium, gold and gallium.[17]

The likelihood of conflict over natural resources is destined to increase, as countries with few of resources strain under high costs brought about by scarcity. Disputes over mining rights will destabilize developing countries, and high cost of fertilizer due to higher prices of potash and phosphates will disrupt food supply. In the long run however, market and technological innovations are likely to decrease the demand for scarce raw materials. Should this growth falter, demand will also decline, as it has during the Depression and the 1973 oil embargo.[18] Eventually, mineral demand in developing countries is expected to stabilize, as it has in industrialized nations.[19]

Mineral scarcity is a relative scarcity. The Earth's crust still contains enough minable deposits for centuries of extraction. The main problem arises from a requirement for increasing amounts of energy to mine the lower grade ores as existing mines are depleted. The difficulty in mining fresh deposits combined with the rise in energy costs due to oil and gas scarcities will, at least in the short term, exponentially increase the price of primary production of minerals.[20] This creates greater opportunities in technological innovations related to mining, treatment and refining sectors, on recycling of mineral commodities and on finding substitutes for expensive materials. An example of technological innovation driving prices down is indium, which is used for the production of light emitting diodes (LEDs). It has shot up from $60 per kilogram in 2003 to $1000 in 2006.[21] Much of this jump has been caused by a market shift away from CRT screens and toward LCDs and flat-screen TVs. This market pressure has fuelled technological improvements lowering the price to under $1000 in 2007.

While not all minerals can readily be recycled due to difficulties in recycling processes, some can. Scrap steel and scrap aluminium only need 25% and 5%, respectively, of the energy normally required to extract new minerals. Half of total steel use in OECD countries is already derived from recycled material, and will grow to an even larger proportion as prices rise.[22] Additionally, marine mining, the harvesting of mineral deposits such as gold, silver, copper, and zinc from the ocean floor near so-called black smokers, has been attempted since the late 1960s as a cheaper and less environmentally damaging way of extraction than traditional deep mining. Recent technological improvements have made deep sea mining increasingly economically viable.[23]

Food Scarcity

According to the UN, global food production will keep track by increasing demands for food by 2030.[24] As a result the global population will be increasingly well fed with 3050 kcal being available to each person daily versus 2800 kcal daily available today. Additionally, there is increasingly a shift toward higher quality, protein rich foods. The annual average consumption of meat will increase from 37kg to 45kg by 2030. The annual average consumption of dairy will also increase from 45kg to 66kg. Figure 4 demonstrates this trend. Overall, the number of hungry people in the world will decline to 440 million in 2030 from 777 million today.

Threats and Opportunities

Current food projections do not take into account the possibility of disruption to many of the required elements of production. The projections assume that the current level of food production can be maintained indefinitely. This makes the entire system susceptible to shocks due to the scarcity of fuel, water or minerals.

Figure 4: Changing Rate of Food Consumption in kg/person/year

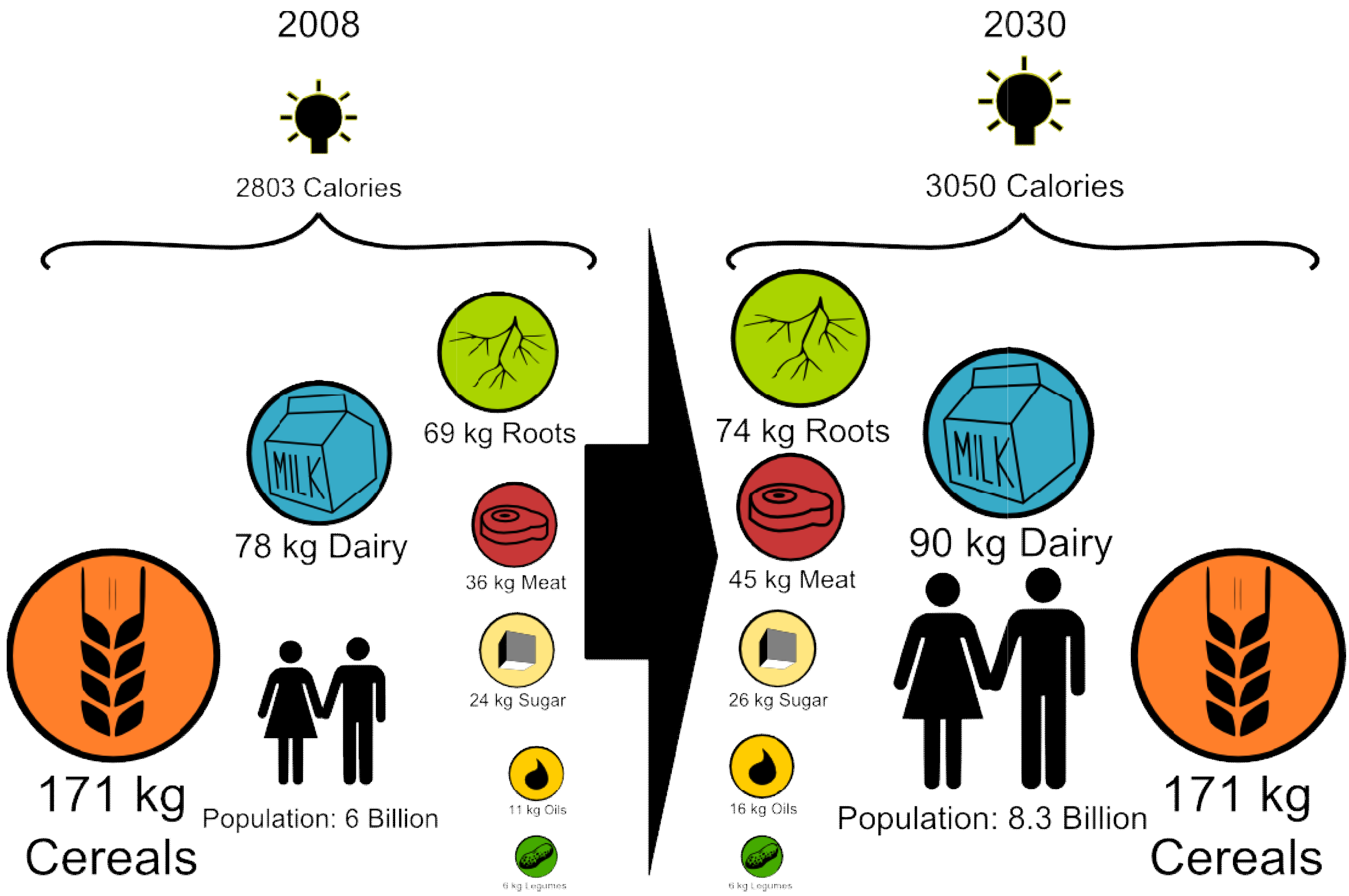
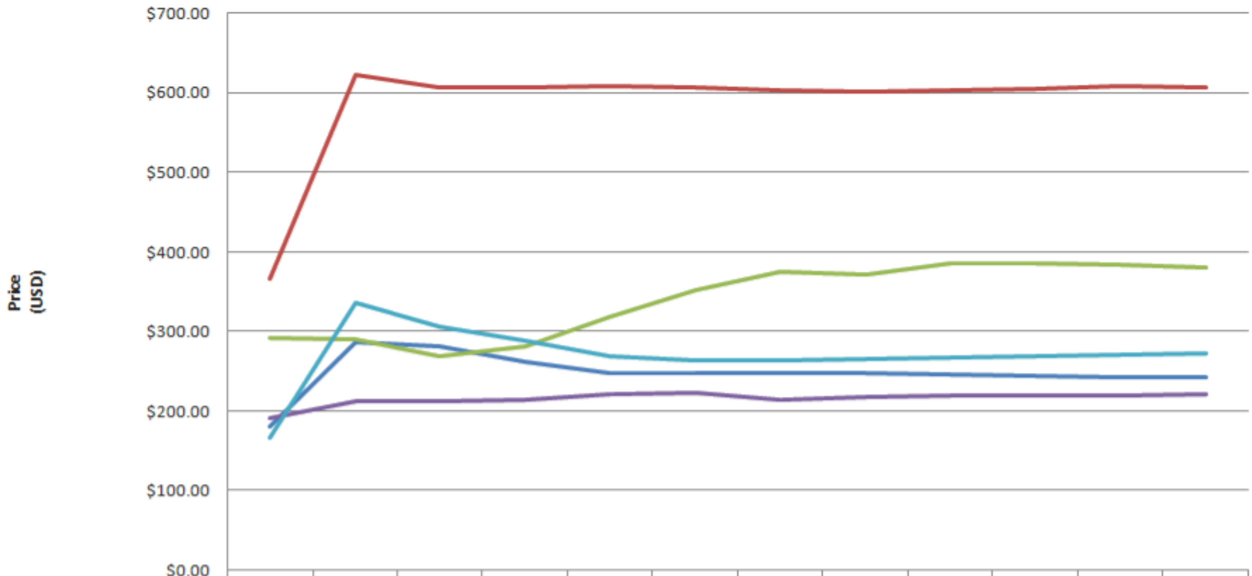


Figure 5: Future World Food Price



	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18
Grains (USD/t)	$181.10	$286.94	$280.98	$262.20	$248.55	$248.25	$248.89	$248.20	$246.33	$245.17	$243.58	$243.27
Oilseed (USD/t)	$366.81	$622.19	$605.69	$606.66	$607.68	$605.67	$602.67	$600.98	$602.48	$605.17	$607.91	$606.45
Refined Sugar (USD/t)	$291.15	$289.10	$268.08	$280.80	$317.80	$351.81	$374.50	$371.28	$384.88	$385.00	$383.45	$379.10
Meat (USD/100kg)	$190.81	$212.99	$212.49	$213.24	$221.09	$222.77	$213.17	$218.24	$219.35	$219.30	$219.30	$221.62
Dairy (USD/100kg)	$166.72	$335.64	$306.49	$287.32	$268.82	$262.78	$263.54	$264.64	$266.54	$268.97	$270.30	$271.94

Shortages of the mineral phosphorous, a critical element in the production of fertilizers, could have significant implications on predicted agricultural yields. The increased use of wheat, corn and other food products for the creation of biofuels resulted in a spike in food costs. Continued use of these foodstuffs for fuel may result in a sustained price increase. However current foresights suggest a stabilization of prices an Figure 5 demonstrates. Additionally, while the overall global production of food may increase, distribution will remain a significant problem. Developing countries, especially those in Sub-Saharan Africa and South Asia will continue to feel the effects of food scarcity. Between 2002 and 2030 the number of people facing food shortages in Sub-Saharan Africa will only drop by 11 million, the smallest decrease globally in the period.[25]

Climate change is likely to play a role in further stratifying the globe on the basis of food production. Developing countries which lack the ability to adapt their agricultural production to a changing climate are likely to face an increasing frequency of food scarcity. African grain production, for example, is expected to be depressed by 2-3% prior to 2020 which would leave approximately 10 million people at the risk of hunger.[26]

The potential for changes in global food production opens up numerous opportunities for innovators and investors. Performance improvements are central to any opportunities. Improving yields through synthetic soil supplements, the introduction of a wider variety of plant species that better accommodate to the conditions of the soil and the widespread application of pest management techniques have the ability to improve farm output by up to 20%.[27] Biotechnology, especially genetic modification (GM) of crops, is likely to increase. There is likely to be an increasing focus on the use of GM food to adapt to any effects of climate change. Yet, globally the use of GM has varied. In Europe and the United States, 45% of field trials related to GM plants were attempts at improving product quality and developing herbicide resistance and only 19% for insect resistance.[28] Meanwhile 90% of Chinese field tests for GM plants focused on insect resistance. Additionally, the development of different methods of genetic manipulation could revolutionize food production. Increased mapping and knowledge of the gene sequence of plant species could assist in activating the dormant genes of plants to make them more resilient. This method would allow for greater increases in production while decreasing the amount of cross species gene splicing that has seen GM foods resisted in many major markets.

Yet, in order to begin widespread application of GM products, the current technological problems associated with the crops must be remedied. GM poses severe risks to biodiversity as these resilient crops can be blown outside of farms pushing out weaker natural plants. With the continued questionable legal status of patented GM plants, this type of pollination can result in years of litigation over who owns the plant-life on a piece of land. Additionally, there continue to be many lingering questions regarding the safety of cross-species GM foods. For example, GM corn has been shown to produce enlarged kidneys and changes in blood chemistry, while soybeans with genes from Brazilian nuts have caused allergic reactions. These fears have led to many African countries banning the import or planting of GM foods even with the very real risk of famine.[29]

Water Scarcity

Water scarcity is defined as annual water supplies falling below 1,000 m^3 per capita and occurring when the utilisation rate exceeds available supply, especially in areas where water sources are difficult or very costly to tap. Water stress occurs when annual per capita water supplies fall below 1,700 m^3 and can lead to harvest failures, food insecurity, intensified competition for water resources and frequent conflicts between users.[30] A decade ago, around 9% of the world's population lived in countries coping with water scarcity, while it is estimated that this will increase to 40% by 2050.[31]

Developing countries facing rapid growth in domestic and industrial demand show the largest decline in water supply. With economic development, water demand increases quicker than population as seen in Figure 6. This is exacerbated by poor water use efficiency, especially in the agricultural sector, caused by poor regulator enforcement, ineffective price signals and the lack of incentive for changes in water use. Thus, the water supply has to be increased not just redistributed. The irrigation water supply reliability index (IWSR) indicates the proportion of potential demand that is realised in actual consumption, whereby an IWST of 1.0 means that all potential demand is being met. The IWSR in 1995 was 0.82. By 2025 that number is expected to drop 0.78 as the actual worldwide consumption of water will increases.[32] Two major sources for water in Asia, the Haihe River basin in China as well as the Ganges River in India, are examples of this negative trend. Both are predicted to decrease substantially over the following decades, potentially creating problem for corn and

Figure 6: Comparison of Water Extraction and Population Increases

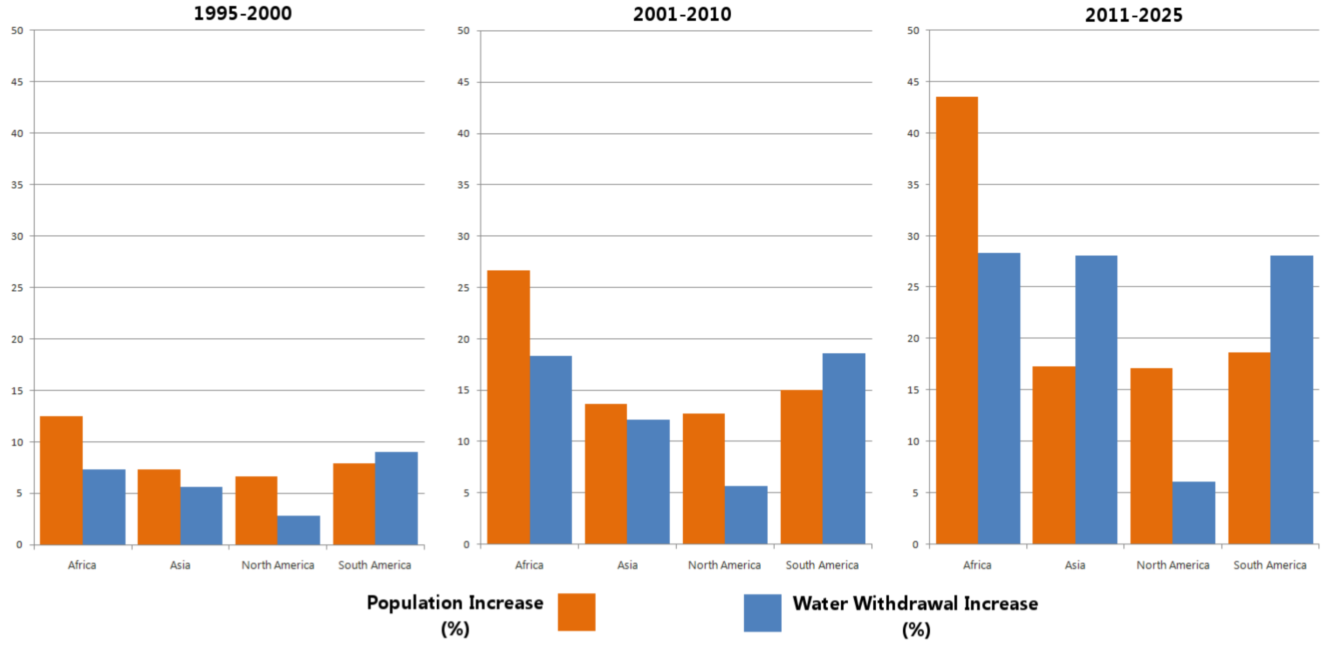
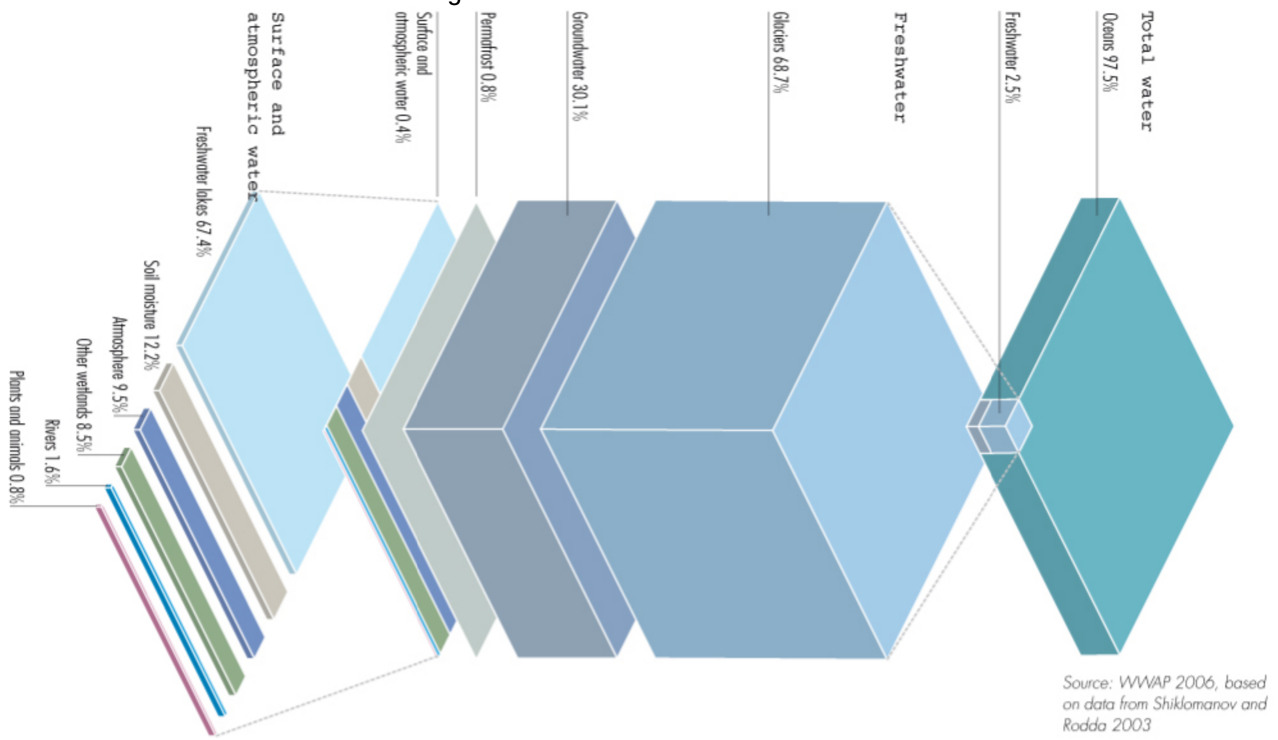


Figure 7: Global Water Distribution



wheat production in the regions surrounding the rivers.[33] Africa is expected to see the lowest increases in the extraction of irrigation water. Based on current estimates, only 20% of the continent will have access to irrigation water by 2030.

Europe and the United States are also likely to also see a gradual thinning of water resources as supplies become increasingly exploited and polluted. Yet, this is unlikely to lead to water stress in the developing world as water efficiency and recycling continues to improve. Still a basic distribution problem exists. The countries of southern Europe, such as Cyprus and Malta, are entirely dependent on the imported water. The water quantity and quality of these countries is particularly sensitive to the availability of water in Northern Europe.[34] However, assuming adequate investment in alternative water management technologies the developed world is likely to avoid any dangers associated with water stress.

Threats and Opportunities

Increased water scarcity will lead to competition for resources within and between countries, which could potentially lead to security threats. Although many developed countries have improved water use efficiency rates in recent years, population growth have led to net increases in total water use.[35] It is predicted that in most countries this trend will continue and that due to the pollution and inadequate sanitation, the level of per capita available water resources is likely to decline even further in the near future. As a result, by 2020 over one-quarter of a billion people are expected to be living under high water stress, representing an increase of 75% from 1995 levels.

The projected continued increases in total water use are likely to exacerbate water scarcity in areas of low water resources and high demand. This will result in increasing pressures on a number of factors. Human health will be detrimentally affected as the availability of water for human consumption and sanitation in some areas begins to deteriorate. The economies of affected states may also suffer as increasing restrictions of various economic activities. Agriculture is especially at risk leading to the potential for food shortages. Finally, the environment is affected as increasingly water-based ecosystems are disrupted and coastal aquifers are flooded with salinated water.

Water scarcity could severely worsen if policy and investment commitments from national governments, international donors and development banks weaken further. Current trends will cause dramatic reductions in food production, and skyrocketing food prices that force declining per capita food consumption in much of the world. Uncertainty about increases in industrial and domestic demand, in terms of water-saving technology improvements, policy reform, and political will, could induce non-irrigation water demand to grow even faster than projected, further compounding water scarcity. This means that countries that currently have sufficient water resources to meet their needs will have to increase water supplies through additional storage, conveyance, and regulation systems by at least 25% or more to meet their needs in 2025. Otherwise, these countries will face severe financial and capacity problems in meeting their water needs.[36]

While the issue scarcity might not pose an immediate threat to the daily business practices of large multinational corporations, its effects in the next decade may well change market segments, create new product opportunities, and alter the rules of operation for these companies. The issue of scarcity has become much more globalised and politicised in the last years and can impact firms in various ways, even if the firm is not active in the water business.[37] For example, concerns about energy use have driven car and appliance manufacturers to label their products in terms of energy ratings. The same account for products requiring a lot of 'virtual water', which ultimately may require a 'virtual water' sticker on everything from clothing to electronics and plastic bags. Virtual water is the water embedded in the production of commodities, and in a water-stressed world, it has implications for manufacturing processes, materials, and even trade policies.

Additionally, numerous opportunities exist in ensuring a stable supply of water. Efforts are being made all over the world to utilize fresh water stocks more efficiently. The dispersal of irrigation technologies will likely become increasingly important in developing countries. For example, in India and Pakistan alone, there are tens of thousands of irrigation channels in which more than 50% of the water used is lost through leakage and evaporation.[38] The desalination of water, as salt water is so abundant, also presents an opportunity as demonstrated by Figure 7. While still expensive, technological breakthroughs in the near future are expected to dramatically drop the costs associated with the method. Newer technologies that allow the harnessing of solar energy for desalination are increasingly under development.

Figure 8: Commodity Price Index

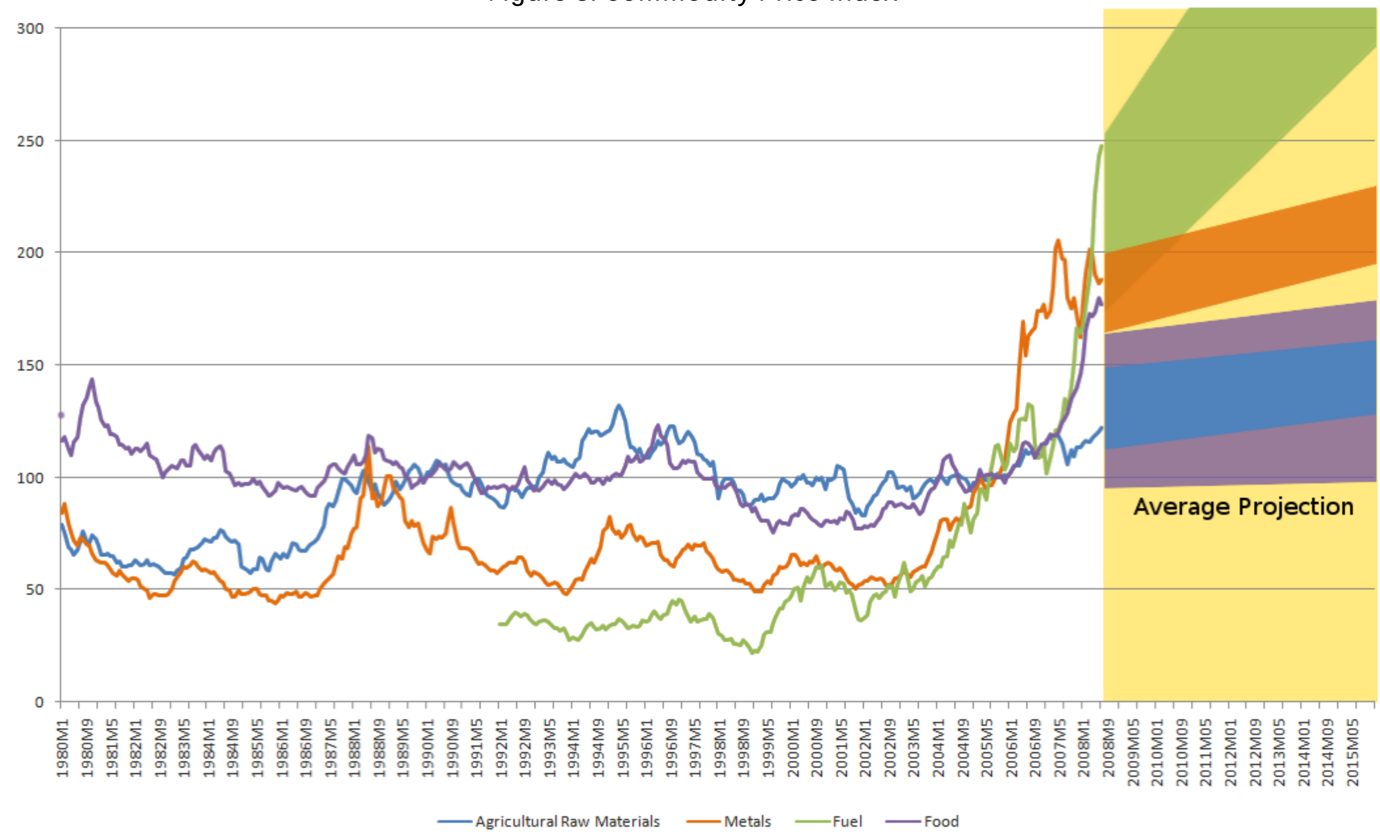
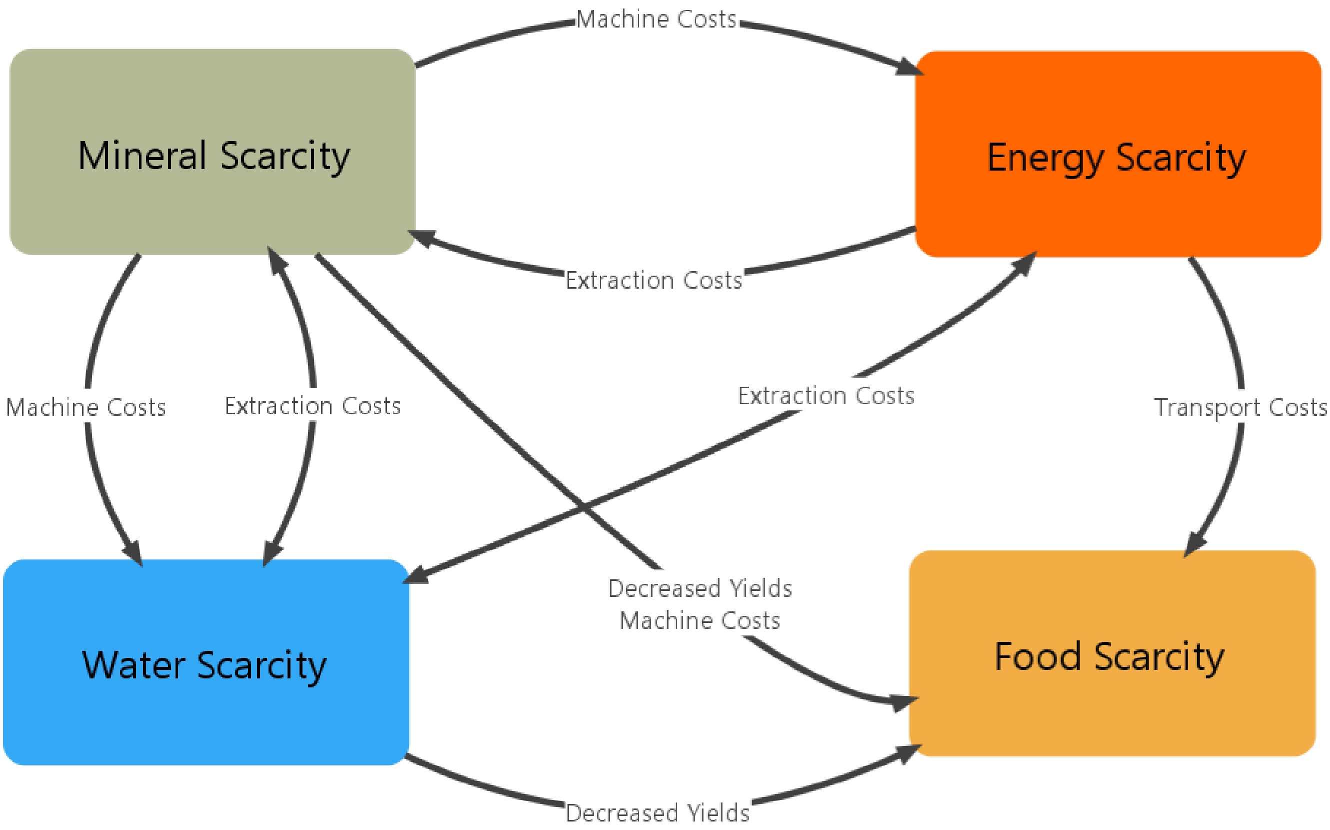


Figure 9: Interaction Effects of Scarcity



Interaction and Consequences

The relationships between the various forms of scarcity are complex. Yet, all are fundamentally related and a shortage in one type will generally have a negative effect on the cost of the others. Scarcity in energy will increase the cost of drilling new irrigation wells, increase the cost of extracting ore for minerals and decrease the availability of food. The same is true of water scarcity which decreases food yields as well as increasing the cost of energy and mineral extraction costs. Food scarcity results in lost productivity and increases the cost of water, energy and mineral extraction. Mineral scarcity decreases farm yields due to shortages in agricultural chemicals. It also increases the cost of tools made from scarce metals increasing the cost of energy and water extraction. Figures 8 and 9 demonstrate the level of interaction between energy, water, mineral and food scarcity in terms of costs. Due to this level of interaction, it is important to view scarcity as an integral problem.

There is a long-standing debate over the extent to which resource scarcity leads to conflict. While some believe scarcity alone can lead nations to attack one another, others argue that its primary effect is to act as a trigger of conflict among countries that face pre-existing social, economic, and political tension. Regardless, it seems undeniable that severe scarcity is likely to escalate the degree of global conflict.[xxxix] Yet, resource scarcity is not an existential threat. It is a predominantly a problem of management. In an attempt to prevent its consequences from negatively affecting their countries, governments have increasingly expanded their search for additional resources. Meanwhile, industry has been increasingly moving toward new methods of exploiting those currently available. This movement continues to offer a wealth of opportunities for innovation and business development.

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