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the future of the world
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foreword

This paper started as the opening address of a conference in 2012 in Las Palmas, Spain. The participants were scientists, engineers, attached to areas where the conduct of research had changed enormously in preceding decades. Brought about by the war, a multitude of new developments had seen the light, new technologies, new scientific knowledge, for obvious reasons with little visibility and isolated from each other. Integrating it as a whole and bringing it to all in the fast developing world is what had given rise to that community which I was fortunate to be part of. It played an important role in the world's post war industrial-scientific development, though it is by now losing its visibility, having accomplished what needed be done, and as members of the traditional disciplines have learned to deal with the new developments on their own. But it had for the few decades that it lasted been unique, by necessity both international and multidisciplinary, something with no precedent. And it is difficult to imagine circumstances under which this may happen again.

Among the many things they were involved with came, in the 1970's, studies of what was happening to the fast developing world that had emerged. Participant were from Europe, the US, Japan, jointly known as "the Club of Rome", assisted with the newly born electronic computers to do more substantially with numbers and mathematics what had previously been done with words and philosophy (Malthus). Though very different in nature, the new studies also predicted an unsettled world to come, not theoretical, qualitative predictions, but this time rational, quantitative descriptions of the mechanism of what leads to this new world.

¹ www.imacs-online.org

a new era

Often illustrated by Watt's proverbial steam engine with the discovery that the energy contained in fossil fuels could be converted to mechanical power, the industrial revolution we live started toward the end of the 18th century, in that part of the world referred to now as "the West" (Europe, North America). But its significant impact, its extension in size and global coverage really came one and a half century later, prompted by World War II. A large amount of new science, technology, industrial manufacturing know how had been developed for the military, later converted to the private sector and leading to an industrialization of the world that has changed forever the way we live. Much of these developments took place at first in the US where, by the luck of its geographical location many of the manufacturing and research facilities had been located, left undamaged. This post war conversion came, at least in the free world, to be in the hands of a rising private industry, of multinational corporations, with not much participation of the governmental establishment. It was and is still pretty much a Darwinian evolution process, an evolution with winners and losers more so than an organized process planned from the top² (which is what communism was attempting to do, history having shown that it does not work).

Together with industrialization came an unprecedented increase of the world's population, both beginning soon to create problems. Gloomy predictions of the past became visible realities. What Malthus and other philosophers of the early 19th century had predicted was not enough food for too large a population. But while a somewhat somber future is indeed with us today, it is not as Malthus had predicted. With increased population food may indeed be a problem in some parts of the world, but definitely more important are other problems, also related to growth but of an entirely different nature, many of them related to material, societal, political matters. The whole nature of human civilization that had evolved on Earth over millennia has changed at a scale for which there was no precedent in history, for which humanity was not prepared. With steam mechanization came a drastic reduction of rural, agriculture related jobs, an increase in urbanization together with, other than food, a rise in the manufacturing of a variety of new products, not necessarily because those products were needed, but perhaps more so to create jobs to replace those in agriculture that did not exist anymore. New institutions were needed, in all a restructuring of the world's society. And new interactions between its many parts, interactions that do not always work very well.

² I remember Bill Joy, in a talk in Princeton about technological development saying that Darwinian evolution often works better than formal planning (which may explain why western capitalism has accomplished more than communism).

The industrial revolution is often credited for having been a positive step for humanity, a view abundantly documented in books, journal articles and the like. But what they document is the short term, limited to the developed countries (in population about 10 percent of the world) and concentrating on too much of a good thing. As for the long term and for the entire world, what it has brought has not always been only good, and some of what is taking place may well mitigate this positive view. Overpopulation and industrialization have taken over, leading to political and social mahem, environmental damage, their many consequences and little prospect for the ability to stop te process.

transportation : the mobility revolution

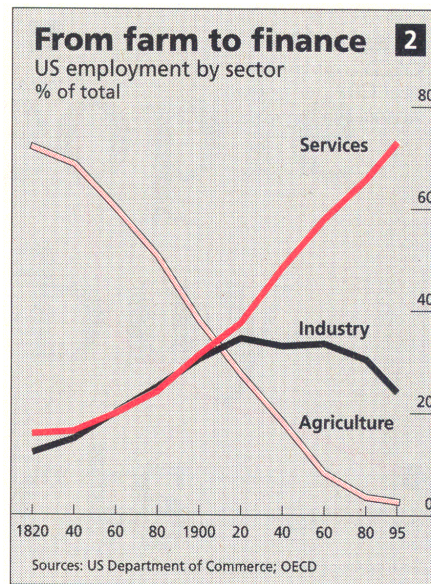
What is the most visible, quantifiable indicator of change is today's population explosion. Not sufficiently mentioned is that what has brought this about is the appearance of mechanical transportation, including in particular the large maritime network that emerged as a leftover of World War II. It was by orders of magnitude larger than anything that had existed on Earth, allowing for the transportation over large distances of people as well as all kinds of merchandises, including food, something Malthus had not foreseen. The world's population had been limited in numbers by the natural necessity to live sufficiently close to food resources, and it is the elimination of this constraint that has led to population growth, not only in the developed countries but maybe more significantly in other places on Earth, those that were called *undeveloped*, have now become *developing*.



fig 1

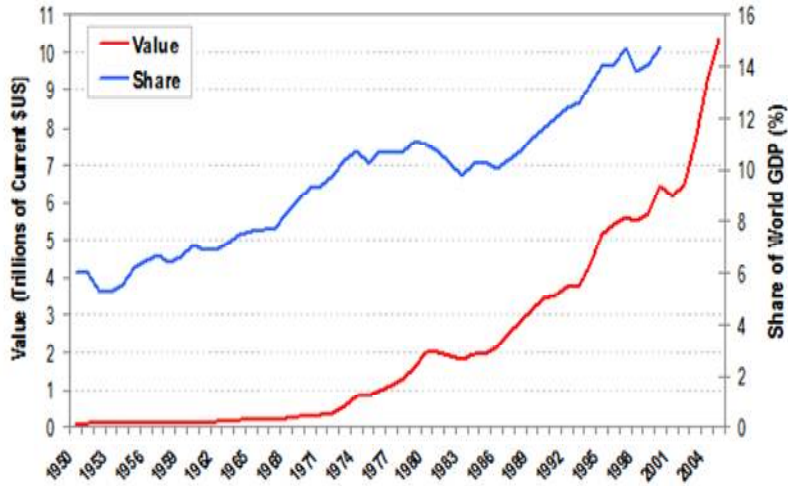
Another important result of the industrial revolution was the mechanization of agriculture. In the early 1800's, those employed in agriculture and living in rural settings represented over 90 percent of the population. It is now down to less than half that much worldwide, down to about 3 percent in parts of the developed world, with a few billion of people having had to move from rural to urban living where jobs had to be created to keep them employed³. Which is also illustrated by the appearance of service jobs (fig 2), jobs that provide employment but do not produce food or essential consumable goods.

fig 2



Increase in industrial production and trade inevitably followed. Compared with what it is today, the amount of trade between countries, between continents had been very small, growing slowly in the early 20th century. A significant increase came following Nixon's visit to China in 1972, after which transpacific relationships were normalized. Before that, the US were considered as a foe by China. This marked the beginning of the economic relationship between East and West, part of it consisting in extending industrialization to other parts of the world, the beginning of large scale outsourcing (developed countries using cheap labor in other places on Earth), something that has become a major institution of modern times. But all the conditions were right, and the same would have happened, had Nixon not visited China.

³ not so different from what has been happening in China today, the need to create manufacturing jobs, not necessarily profitable, but to keep occupied a large population.



Source: WTO.

World Exports Of Merchandise, 1950-2005

fig3

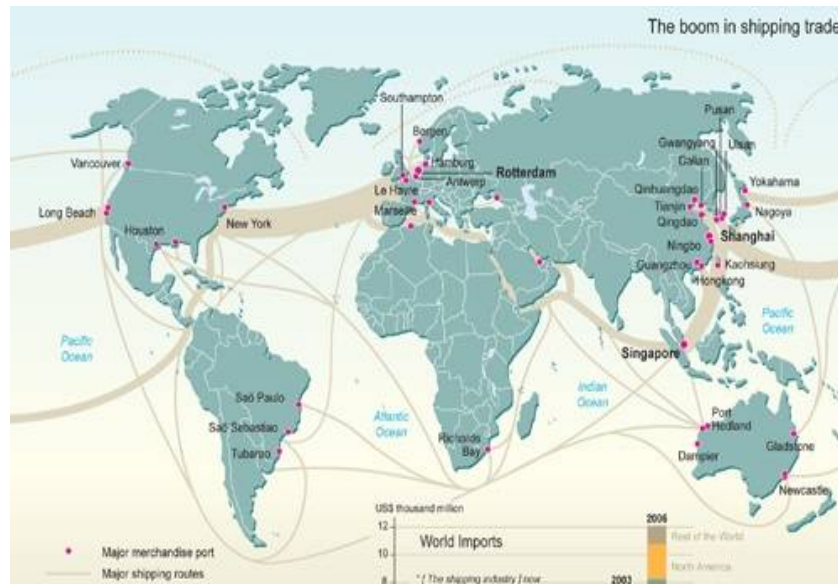


fig4

warnings of things to come

It did not take long before these post war developments began to draw the attention of learned communities of the world. With population and industry increase and their consequences well documented, attempts to predict the future came to be elaborated, in particular in a body of research abundantly described in reports, articles and

books, all published by no coincidence in the same early 1970's time period, based on new results that had been obtained with the assistance of computers whose power had just become high enough to assist in this kind of investigation (remember Moore's law). The inspiration, unrelated to computers, had come from an international group of intellectuals calling themselves the *Club of Rome*, founded in 1968 (in Rome, as the name suggests) under the leadership of the Italian scholar and industrialist Aurelio Peccei, a club engaged in a project on "*The Predicament of Mankind*". The encounter of their ideas with the emergence of computers must be credited to Jay Forrester, a professor at the MIT who had been a leader in computers development during the war, in 1969 went to Bern, Switzerland to meet with members of the *Club*. He brought their ideas back to Cambridge, Mass. where he had initiated a methodology for the study, with computers, of the dynamics of certain social systems. Computers were new and everything had to be invented. I remember meeting with him in 1968, he was working at the time on an urban planning problem having, he told me, been asked by John F. Collins then retired mayor of Boston to find an explanation for an upsurge of slums in parts of the town^{4,5}.

Most quoted of this research in Cambridge was the Meadows et al.'s book appropriately entitled "*The Limits to Growth*" (30 million copies were sold)⁶. There were other contributions to this research, some in the UK at the University of Sussex published in a book entitled "*Models of Doom*"⁷ that, while criticizing details of *Limits to Growth* essentially confirmed the essence of what it said. And in the same vein contributions from Japan. I still have some of the reports they gave me when I met with them at the time. The publications of these computer assisted results were abundantly commented upon by the media. It was the first time that the public was told, credibly supported with numbers and graphs instead of opinions and theory, that we were approaching the limits of the ability of the earth to sustain the ongoing growth, and that bad times were to come soon, in a few decades. Even *Playboy* magazine had an article on the subject and *The New York Times Books Review* devoted the front page and leading articles of one of its issues to the question (April 2,1972).

4 Jay W. Forrester "*Urban Dynamics*" The MIT Press (1968)

5 Jay W. Forrester "*World dynamics*" World Allen Press Inc. (1971)

6 D. Meadows *et al.* "*the Limits to Growth*" Potomac Associates – Universe Books New York (1972) the results of research at MIT, Cambridge Mass.

7 "*Models of Doom*", a reply to "*the Limits to Growth*". Universe Books New York (1973) the result of research at the University of Sussex, UK

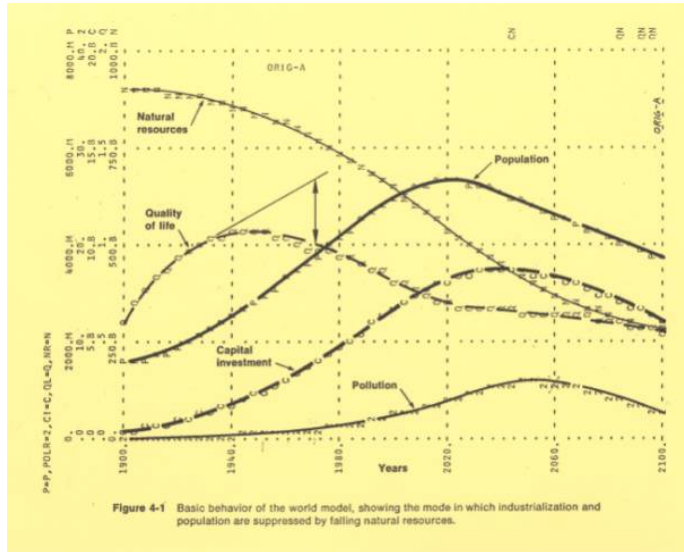


fig 5

Predictions of the future of the World - published in 1972 by J. Forrester's in "World Dynamics" (Club of Rome)

Predicted population numbers were reasonably close to what did happen for the next few decades in the West. Not known at the time is what was to take place to the rest of the world, that undeveloped countries would in no time join in the global development. The predicted timing of serious trouble to come (pollution, shortage of natural resources,....) in years approaching 2020 was remarkably accurate.

The United Nations wanted to have their own feedback on the subject and formed a committee consisting of well known members of academia and industry that only confirmed the whole thing, and later shared the Nobel Prize given to Al Gore following his "Inconvenient Truth" book. The World Bank did likewise, asking Princeton University to gather a group to look into the question and to replicate the computer simulations done initially at the MIT, a group I had the pleasure of being part of. I still have in my archives green and white computer output pages we generated at the time, even possibly a workable copy of Forrester and Meadow's computer programs. We all reached the same conclusions, predicting that population and industry would (initially) continue to grow, resulting in an increased use of natural resources, degradation of the environment, things that would eventually become too large for our finite earth to bear, bring trouble (fig 5).

The bottom line said simply:

".. enough ... stop the growth of population and industry on Earth, or else..."

.....Yet little was done, and the predictions of both population increase and environmental problems came to be verified, a feat of the hard sciences establishment that politicians and economists were unable to achieve, something worth thinking about. The

superiority did not come just from the fact that computers had been brought in, but that using them demands re-thinking what counts in describing the dynamics of a system being simulated, in this case that an a new approach, different from that of traditional politics-economics be used to describe the world's dynamics. It demanded replacing the classical studies of the long term of the world, that amounted to not much more verbally expressing opinions supported by a few numbers, with mathematical models expressed with quantifiable, measurable quantities, that a new paradigm expressed with calculus and equations be used. And significant is the fact mathematical models demand that all the influential components be taken into account to make sense (in the present case *population size, industry size, natural resources and pollution*), not one or two at a time as is typically done in traditional politics-economics debates that pretty much use the rationale of one discipline and ignore the others. By the way, the people involved in the *Club of Rome* 1970's studies were not just a few scientists in one place, but in all thousands of them, distributed on every continent, a community that still exists to this day with less visibility. By their very nature, the two approaches are very different, the new one describing evolution over reasonably long periods of time (decades), while the traditional approach, that documented by the daily media, is pretty much limited to the short term (months, a few years at most).

The new knowledge and recommendations that came out of these studies have hardly been applied, they reside in think tanks, academia and some NGO's that one may call "the greens", with little impact on what leaders are motivated by. Not much was done by those in government or industry. Doing otherwise (for example mandating a reduction of industrial growth) would have been incompatible with their own agenda, aiming before all at a positive (though short term) growth.

Which illustrates two cultures...

- *on the one hand that of leaders in government, leaders in industry, both by definition concerned with the short term and having much to do with ruling the world (those from industry more so than those in government).*

- *on the other those (to which belongs the Club of Rome) concerned with physical world and the long term, but that have little power on affecting what goes on in the world.*

There is a similarity with C.P. Snow's "*Two Cultures*"⁸ except for the fact that Snow's cultures were about academic, intellectual matters of the mid 20th century

⁸ C.P.; Snow "*The Two Cultures*" Cambridge University Press (1959) – Canto Edition with additions (1993)

western learned communities, whereas what we deal with today are concrete, real concerns that affect us all, real facts about the material, political, financial worlds.

But given human nature, there is no prospect for those divisions to disappear. They offer an explanation for what we see as evident difficulties (if not an impossibility) for humanity to function peacefully as a single community on Earth.

globalization

The possibilities brought about by the fossil fuels-to-steam discovery have had major consequences, most significantly contributing to population and industry growth, a growth that is reaching the limits of the Earth's capacity (and not necessarily food). It is in Europe and North America that industrialization had started, and was still pretty much there in the mid 20th century as illustrated by the establishment in 1960 of OECD, the *Organization for Economic Co-operation and Development*.... "to promote policies that will improve the economic and social well-being of people around the world". The OECD countries were pretty much those that had been the protagonists of the war, 20 countries covering in all only a small part of the Earth.

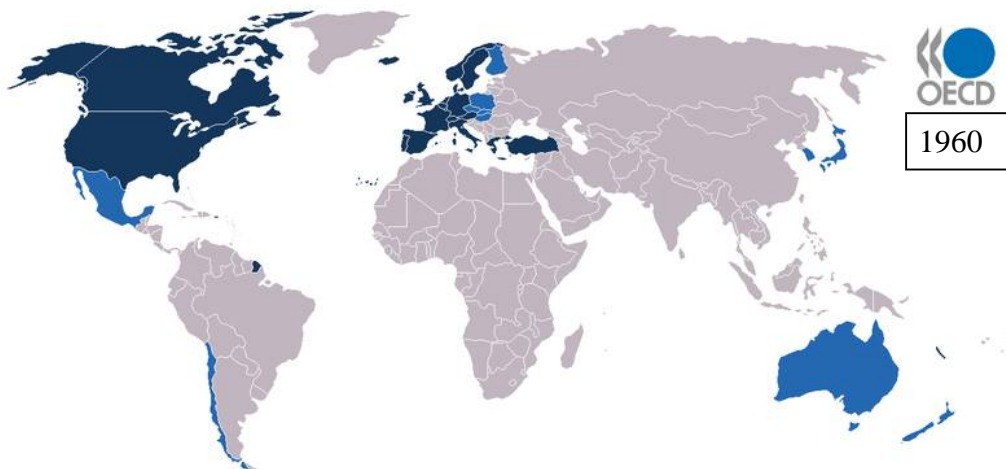


fig 6

Later in the century, essentially with the advent of massive means of transportation generated by world war II came an enormous increase in global population. Which, unpredicted, took place mostly in what had been undeveloped countries (fig 7).

UN Population projections, by continent (millions)

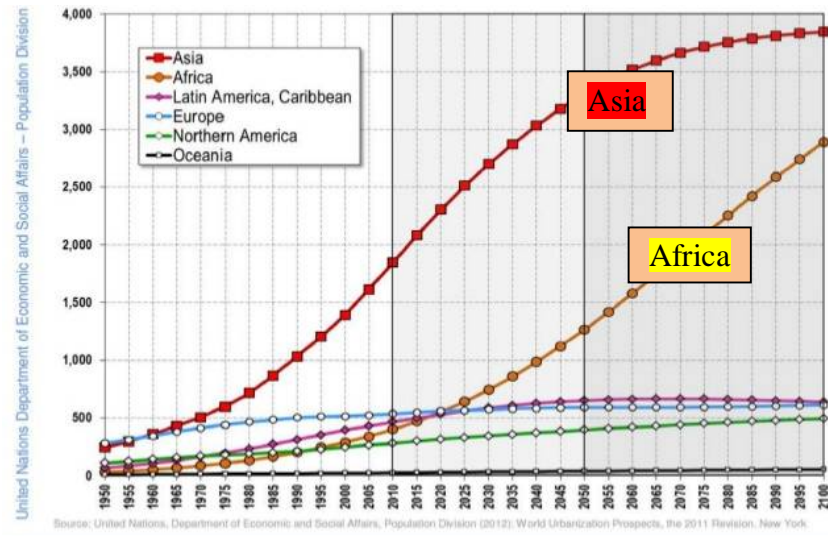


Fig 7

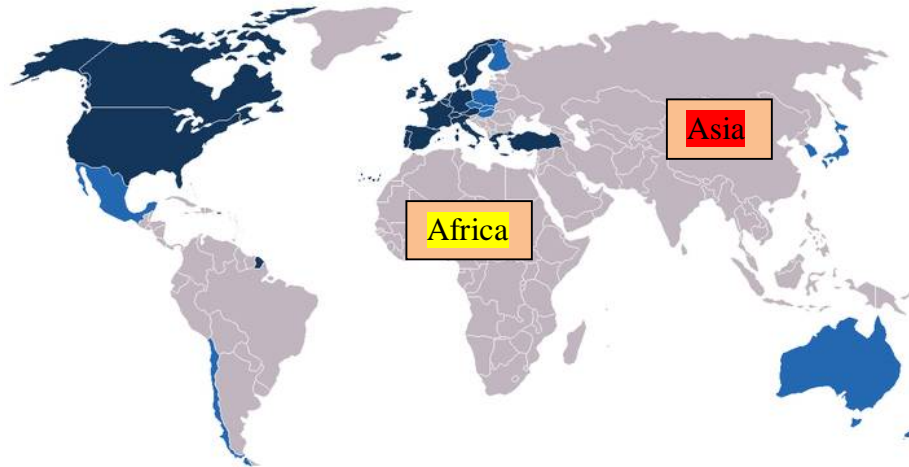


Fig 8

As a result, it is predicted that the population in Asia and Africa will by 2100 be some 90 percent of the world's population, located outside of the *Old World*, outside of where the nations engaged in the great industrialization of the world were in the 1950's, the original OECD territory (the dark areas in Fig 8).

How this materializes itself may be identified with the following :

- first that the West became conscious of the fact that there were places on Earth where populations were living in very poor conditions, and that it had become possible to bring them humanitarian aid, food in particular. Which was felt as an ob-

ligation, entered as such in the charter of the United Nations established in 1946, without much thought given as to how, as to what this might lead to.

- second, that private, mostly US manufacturing companies found out that there were populations elsewhere whose standard of living was well below that of the West and willing to work for low wages, that they were able to manufacture products that, thanks to the global transportation network that had emerged after the war, could be shipped back cheaply. This led (beginning in the 1970's) to large scale outsourcing, then off-shoring, leading new parts of the world to become part of the West's economics/industrial establishment.

The first of these contributed to population growth by bringing food to chronically or occasionally starving communities in the world (the 19th century Irish potato famine that killed a million would not happen again). The second by providing employment to undeveloped communities that had also been restricted in size by how much means of subsistence there were locally, providing them now with employment and a financial income allowing for subsistence to be brought in from elsewhere. It is outside of the west, outside of the *Old World* that most of this took place, that most of the subsequent population growth has occurred. Whereas the original population of Europe and North America has increased little since the 1950's (with most of the increase due to immigration anyway) those of Africa and Asia have practically quintupled (fig 7) leaving a world with a population very different in numbers and distribution than was the case a century ago. Worth mentioning is that other than for importing merchandises made elsewhere, the outsourcing countries (from the west) are in return exporting jobs to the producing ones, ending up themselves with decreased employment and impoverished middle classes. Jobs, employment have become a real commodity in this new world, of importance to those at the governmental level, not to those part of the manufacturing and trade community who have much to do with outsourcing.

With the growth of population in new places on Earth came interactions between communities that were separated in the past. The world consisted of distinct regions, subcontinents, separate countries that other than for occasional contacts and a small amount of trade (e.g. the *silk road*, the *spices road* of earlier times) had materially, economically, culturally been on their own. But most have by now become part of a global community, depending materially, including food on each other. But the places where industries, in particular those producing today's food are located are not necessarily where they were needed, the world now depending on transportation between the two (beating Malhus's prediction and replacing it with a huge transportation, logistics problem).

It is about those new interactions and dependencies that globalization is all about, . Many of the new problems come also with the human side of the story, differences in

culture, differences in material standards of living, differences that did not count when they were each living, functioning on their own. That industrial-economic interaction between distant countries would become significant and that part of what had been the undeveloped world would develop fast and play an important role had not been considered. Quoting in that respect from J. Stiglitz⁹:

“The proper name of the World Bank – the International Bank for Reconstruction and Development – reflects its original mission; the last part, Development, was added almost as an afterthought. At the time [the 1940’s] most of the countries in the developing world were still colonies, and what meager economic development efforts could or would be undertaken were considered the responsibility of their European masters”.

Countries of the then undeveloped world had not been taken into account in the 1940’s planning¹⁰ or in the 1970’s “Club of Rome” studies, but it is in those countries that most of the population growth is taking place today, accompanied by urbanization. E.g. Beijing’s population went from 8 million in the 1960’s to over 20 million in 2014, that of Seoul from 5 to 25 million over the same time span and Nairobi from 250,000 to 3 million. All three of them, by the way, surrounded by slums.

In all, humanity finds itself in the position of the *Sorcerer’s Apprentice*. It has, with the discovery of the potential of fossil fuels and the sorcery of science and technology, brought in the mechanization of agriculture, of transportation, liberating populations from the necessity to live near agricultural sites that not only employed them but also limited their numbers by how much food could be produced nearby. This was one of nature’s stabilizing factors and it is its removal that allowed for today’s unsustainable increase in the world’s population, a population that was less than 1 billion when industrialization began in the 18th century, is over 7 billion today with an increase of 4.5 billion in the 20th century alone. And even higher growth for the industrialization of the world, contributing to bringing harm to the environment, degrading the quality of life for many.

Interesting to note is the waning role of international politics, of governmental powers in affecting long term changes of the world. That this was coming was implicitly

⁹ in “ *Globalization and its Discontents* “ Pub Allen Lane (2002) by Joseph Stiglitz, Nobel Prize laureate and former Chief Economist of the World Bank.

¹⁰ Bretton Woods-1944, the United Nations-1945

foreseen in the *Club of Rome's* studies by the very fact there is no place for politics and opinions in the mathematics describing the dynamics of population, natural resources, industrial growth, etc..., those measurable quantities that were at the core of the thinking of the world as a multivariable system, that used in the computer simulations. Returning to the *New York Times Review of Books* I mentioned before we find, after comments on *Meadows et al.'s "Limits to Growth"* :

"If it doesn't blow everybody's mind who can read without moving his lips" writes "Up the Organization" - man Robert C. Townsend, "then the earth is kaput". Anthony Lewis of the New York Times deems it "likely to be one of the most important documents of our age" and learns from it "the complete irrelevance of today's political concerns" to the world's long-term travail.

This forecast, that has indeed come to be true meant that politics, those commented upon daily by the *New York Times* and such, would have little to do with the *long term* (meaning decades, centuries) *dynamics* of the world. It is the private multinational industrial establishment that has taken over, with manufacturing and trade to a large extent out of political, governmental control. Borders between countries and political/military power to defend them do not have the importance they once had. I found an interesting illustration of this situation by looking at what goes into the manufacturing of the Boeing 787 airplane, that notorious product of today's American manufacturing industry : the central part of the wings is made by Mitsubishi in Japan (Mitsubishi was building the *Zero* fighter planes that were prominent in Pearl Harbor), the engines are interchangeably from GE (US) or Rolls Royce (UK), the horizontal stabilizers are made in Italy, cargo doors by SAAB in Sweden (SAAB still makes airplanes), floor beams in India, some of the wiring and the landing gear in France and the UK, the wheel wells in South Korea. And one of the first demonstration flights had to be postponed following the Fukushima nuclear disaster : the passenger seats were coming from Japan and their delivery had been delayed. Then Boeing and Airbus (France) are, other than to the West, competing for the sale of their airplanes to such places as Saudi Arabia, Abu Dhabi, Australia, South America, Japan...

So much for the industrial/economic identity of separate countries, for the role of the *military*, of *hard power* to defend borders. In spite of which we continue hearing governments brag about the military superiority (or not) of their respective country, something that might have to do with the possible outcome of possible future wars that may never come by anyway. That China took the significant place it has in today's economics (the *soft power* world) had nothing to do with *military, hard power* that they did not have in the 1970's anyway. What they had and still have today is *soft power*, they have a large manpower that is socially educated, having for centuries, millennia

been part of well structured empires¹¹. And likewise for India, though with significant cultural differences between the two.

regional problems

Future problems predicted by the Club of Rome studies were concerned with the material side of the story (population size, use of natural resources, pollution, ...). They have been found to indeed hold qualitatively true for the entire world. But growth has also generated problems of a different nature, in particular those concerning the human, the societal consequences of global growth. They take place in regions where population numbers have increased where they should not, regions that are no more self sufficient, where population growth is not paralleled by a consistent increase in local resources and where survival has come to depend on food brought in from elsewhere. That this leads sporadically to discontent and violence is not surprising, as was illustrated by the 2010-2011 Arab Spring. It is not that North Africa-Middle East populations turned all of a sudden against too restrictive regimes. They were against unemployment, poverty, and assumed that it was the reigning leaders fault. There was nobody to tell them (or wanted to tell them) that it was not so, that it was that their numbers had increased (see table 1) with no corresponding increase in industrial development, in jobs and income producing investments, all of it resulting in millions of work seekers having nothing better to do than generating unrest. It was poor living conditions resulting from local overpopulation that, beginning in Tunisia, led to bloody manifestations, revolutions. Toppled down governments are followed by elections, with the naïve belief that change in governments will solve the problems. And governments that manage to stay in place become the focus of most destructive wars, Syria the best example thereof. The same applies to many other places on earth. For instance, today's Yemen with a population that has grown from around 4 million in the 1950's to 25 million in 2014 has over 90 percent of its food imported. And Africa whose population reached over 1.1 billion in 2014, more than four times what it was in the 1950's, has become the world's largest food importer per capita. This is not a healthy situation, it depends on government administrations, on private sector interests and relationship between distant countries, things that do not always work well.

¹¹ one outcome of this is China's ongoing colonization of Africa which takes place with *soft power*, for instance Chinese individuals and their family acquiring and running small businesses all over the continent with no intention to return to China. Their number in Africa exceeds one million today.

Table 1: North Africa/Middle East population increase 1950 – 2013(millions)

	1950	2013
Afghanistan	8.1	30.55
Tunisia	3.5	10.89
Morocco	9.34	33.01
Algeria	8.9	39.21
Libya	<1.	6.2
Egypt	21.2	82.06
Syria	3.5	22.85
Iraq	5.2	33.42
Iran	16.4	77.45
Turkey	21.1	74.93
Eritrea	1.4	6.3
Saudi Arabia	3.9	28.83
	~104 million	~ 446 million

What would improve the situation in those countries are of course additions to employment, jobs coming with industrial development funded by investments coming from elsewhere. This the multinational industrial establishment has the power to do, but will only do where there is reasonable political stability and where financial profit is in sight, both iffy in this part of the world. Nor is there much local governments can do in that respect, be they authoritarian or democratic. Rebellions are followed by elections, but other than for being welcome by the media that has something to talk about and pictures to show, the only thing those elections do is give local populations and the rest of the world the false impression that things will improve. Which does not happen, with maybe a very few unrelated exceptions.

Not only is this the case in North Africa/Middle East, but also in other parts of the world where jobless populations induce instability and bloody conflicts that are not even called wars. That the recent violence in Nigeria (where, by the way, “*Boko Haram*” means something like “*Western, Non Islamic Education is a Sin*”) is undeniably related to the increase of its population, something not mentioned by the media even though the country went from 38 to 180 million inhabitants between 1950 and 2014.

in search of living space : migrants

A significant problem brought about by overpopulation is that of mass migrations. There may well have been movements of populations in earlier times, but there is no possible comparison with the scale of what is taking place now, of what started toward the end of the 20th century. Although the millions of migrants coming from North Africa and the Middle East to Europe (only a fraction of what is happening word wide, by

the way) are too often attributed to regional wars, the fundamental cause is the same as that of regional wars, it is again overpopulation in inappropriate places on Earth. This was illustrated in a recent TV news report showing a migrant, in Greece, complaining about inadequate local help because, so he said, “*there is no place for me to protect my seven children against bad weather*” (the fertility rate in Greece is 1.3 child per woman !). The contribution of transportation’s to this state of affairs may, by e way, be seen in the ubiquitous Toyota and other pickup trucks in the background of video reports of Middle East and North Africa happenings.

Migrants are becoming a major problem. But Instead of talking of overpopulation in the general areas those migrants come from, when the press and governments talk about them (not only in the Middle East-Europe that happen to be within easy reach for media reporters) they attribute the cause of migration to wars, to politics, to ISIS and the like. Hardly mentioned is that Syria’s population that was 3.4 million in the 1950’s had grown to over 23 million in 2015 with close to 20 percent of that population unemployed. And likewise for adjoining countries, where many of those unemployed have no real option than to join a jihadist movement or become migrants. The latest official UN number for world international migrants (those who have made it to another country) is around 250 million , of which between 1 and 2 million, or 0.5 percent of them made it to Europe in 2015 creating all the political and humanitarian turmoil we have seen. The actual numbers, including those having left their home but not made it to another country may be twice as much. In all, “displaced” people represent today around 5 percent of the world’s population !

A real tragedy, thousands of migrants from the Middle East risking their lives to make it to Europe looking for a better future. Also a tragedy for Europe since the newcomers are not only too many but they do not integrate well, they are mostly Muslims while Europe is mostly Christian leading to conflicts brought about by the incompatibility of the two cultures, an historical incompatibility illustrated by the Crusades ten centuries ago. Prophetically, a prominent bronze statue erected in Brussels in 1848 is that of an armed horseman with a plaque that says “*Godefroid de Bouillon 1060-1100, First King of Jerusalem*”. Hopes expressed by some that those incompatibilities can be eliminated with education are unrealistic : one cannot change the culture of populations in a matter of decades, cultures that have taken centuries if not millennia to establish themselves.

natural resources and the environment

The problems identified in Forrester’s 1971 *World Dynamics*, in Meadows *et al.*’s 1972 *Limits to Growth* had little to do with food, they were mostly concerned with material issues, depletion of physical resources and increased pollution. But most of what I talked about so far was more about problems of society in a world whose material rules of the game are changing. I felt they were more important for now, more visible as to their consequences. But there are others that are all too important for the long term. The increased population and urbanization inevitably led to an increased global demand for natural resources, in particular energy. Significant is the fact that eighty percent of that used today comes today from fossil fuels. I like to quote in that respect from Charles Galton Darwin (1953)¹² :

„...at the present rate of demand for mechanical power, the estimates are that oil will be all gone in about a century, and coal probably in a good deal less than five “A thing that will assume enormous importance quite soon is the exhaustion of our fuel resources. Coal and oil have been accumulating in the earth for over five hundred million years. For the present purpose it does not matter if these are under-estimates; they could be doubled or trebled and still not affect the argument. Mechanical power comes from our reserves of energy, and we are squandering our reserves, our energy capital quite recklessly”...

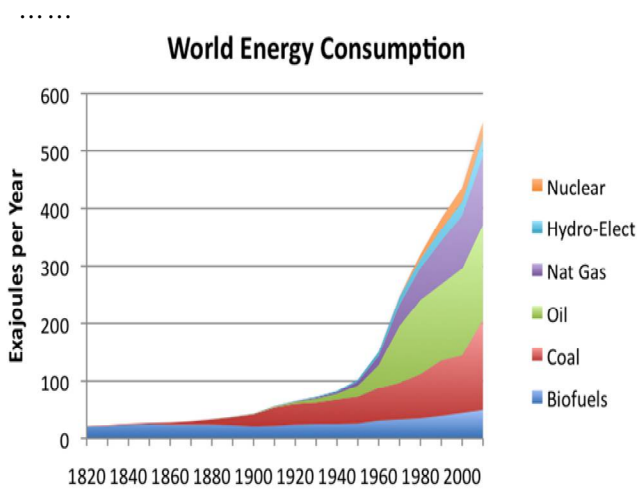


fig 9a

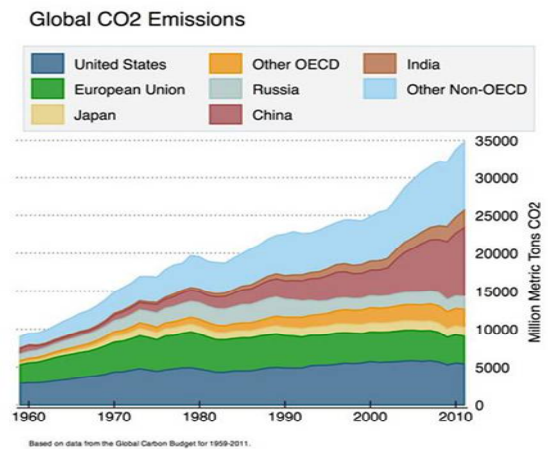


fig 9b

¹² in “The Next Million Years “ (1953). Charles Galton Darwin was the grandson of Charles Darwin of evolution fame.

Then comes of course the resulting pollution. A significant factor of atmospheric pollution is CO₂, whose emission amounts are directly related to energy use, itself proportional to population-industry size. It is a global problem. Thanks to the media (the smog in Beijing makes the headline news in Paris and New York) consequences have as of late become sufficiently publicized to catch the attention of the general public, that of governments. The Paris COP21 conference in December 2015 drew some 47,000 participant, including 140 heads of state as was widely reported world-wide. But it was only the 21st in a series on Climate and the Environment conferences organized by the United Nations beginning with Berlin in 1986, with Paris-2015 hoping to achieve more than its 20 predecessors with a view to accelerating the reduction of global greenhouse gas emissions. One must however note that that the world emission of CO₂, as well as the world's population where it comes from has increased by more that 50 percent between the two conferences (fig 9).

Official declarations and agreements between heads of state that ended the conference are not much more than wishful thinking. There are two ways in which the emissions of CO₂ could be reduced 1: one is cutting the size of industry, the other cutting the size of the world's population, noting however that one cannot reduce one without the other. But both are unfeasible, given the complexities of global politics, and more importantly the response of human communities to requests for change imposed by distant ruling authorities. Other than that, the much publicized efforts to create more ecologically friendly ways of living may possibly apply to populations in the established developed countries, (pretty much those that founded OPEC) but not easily to the rest of the world that is growing and will soon contain around 90 percent of the total population (figs.7, 8).

The industrial revolution we live came with fossil fuels - that will last for another century or two (cf. Charles Galton Darwin cited before). It may well come to be labeled as the "*fossil fuels bubble*" in future history books. Another industrial revolution will follow, not based on fossil fuels that be no more, moving to other sources of energy, most probably solar. This will imply major changes of the infrastructure, not only that of energy production and distribution, but also to that of most of the industrial establishment.

But that is another story, a problem for the next generations.

what to expect

The decades following the war were golden years, among others for science and technology with the new knowledge that had seen the light, with scientists, engineers, technicians engaged in its application to the world's development. Which led to the large international industrial establishment we have today, engaged in the production and trade of all kinds of goods. And, an integral part of it, an unprecedented increase of the world's population.

The main problem for the future is not really about food, as Malthus had predicted (and as many still believe in today). It is about material matters, global logistics, growth in industrialization and urbanization, exploiting the earth's resources with a degradation of the environment and significant damage to all kinds of life on the planet. And it is about social unrest resulting from human proximity brought about by population increase, some of it in places where it cannot be dealt with, resulting in local conflicts and wars. Today's world population is approaching 10 times what it was in James Watt's days, something human society and the earth's physical environment are not able to cope with.

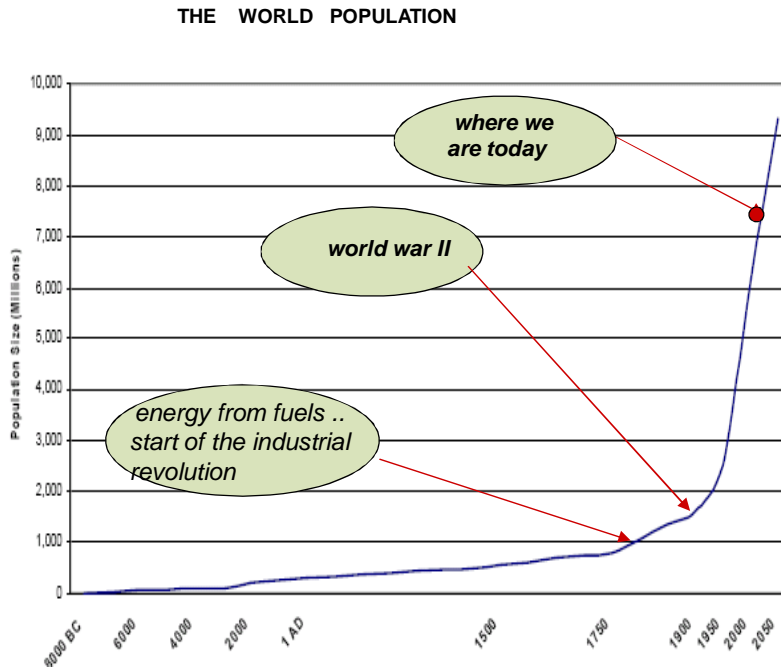


fig 9

Solving the problem by reducing the world's population to what it was say a century ago, less than 2 billion, is not a feasible proposition. Other than for those concerned generally opposed to the idea, growth is really influenced by factors over which governmental authorities have little authority. China's population did continue to grow in spite of their now abolished "one child" policy. Claims that the problem will be taken care of by educating women may well apply to some of the developed world, but not to the developing populations of Asia, Africa (the large majority of the world- see fig 7, 8) where the ability to educate those fast growing populations is unfounded optimism.

Nor is it feasible to reduce industry size. Industry growth is a short term plus for governments, but is to a large extent in the hands of the industry-trade multinational establishment, that of private corporations in the free world, that of authoritarian governments elsewhere, all acting pretty much for their own objectives, also short term and whose *motto* is essentially "grow", not "reduce". And there is no official organization, institution, governmental entity in the world commissioned, empowered to address, talk about the actual problem, that of population-industry having become too large for the existing resources on Earth and too large to be manageable by our existing institutions. Not national governments that have little control over the industrial establishment, that has the material power to do something, but has a different agenda. Not the United Nations that are not equipped with any form of real power, and are divided in a host of agencies, organizations, committees whose decision making process, with over 190 member states, is saddled with national interests displayed by the participating delegates. This is something I know well, having been for a few years chair of one of those committees, on "*bringing the benefits of new technology to developing nations*" in the 1970's with UNESCO in Paris.

So the problem of over population (and over industrialization that comes with it) has come to be the *elephant in the room*. The proverbial "they" that are responsible for and can solve all the problems of the world does not exist (except virtually in the expression that says ...if "they" can put a man on the moon, then why can "they" not .. etc..). What we see instead of global collaboration are blatant contradictions coming from incompatibilities between the belief, the culture of the multitude of ethnic, religious, national, political, even financial communities on Earth, incompatibilities that illustrate the impossibility of a rational world management. We were hunter gatherers, our numbers limited by nature as to how much means of subsistence existed nearby, with over 90 percent of the population having to work in agriculture. This all changed in the 1800's with the coming of industrialization, of mechanization with energy coming from fossil fuels, displacing populations from agricultural to industrial occupations, from rural to urban living. But it turns out that urban society needs *growth* to function (part of this related to demographics, having to provide employment for the

young while taking care of the needs of ageing populations). So that, and for no other good reason, *growth* has become a sign of success, the personal (almost by definition *short term*) objective of government as well as industrial leaders, ignoring the fact that this means an increase in population of which there is already too much, increased demands on natural resources and damage to the environment with consequences that (in the *long term*) manifest themselves in devastating ways.

The industrial revolution, that would better be called the “energy revolution”, has left us with an increasingly populated, increasingly resources consuming world. We are, less than 3 centuries after James Watt reaching the point where the magnitude of those problems has started to affect life on earth. But as in the Sorcerer’s Apprentice tale we do not know how to, we cannot stop what goes on. We live with increased instances of human misery (the migrants as of late, hundreds of millions of them), with pockets of violence all over the world (not just the Middle East, consider for instance Kashmir or Rwanda), with environmental pollution, global warming and their consequences (the polar cap is melting). And it is not a tale, it is reality with no end in sight, with no plan B as we were recently reminded of by Ban Ki-moon, Secretary General of the United Nations.

..... Brace yourself !

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