Climate Change from the Perspective of Physics and Geology

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Part 1

> It is by no means improbable that 'the pride of creation' will once be part of this planet's history as the one life-form which created itself problems to such an extent, that extremely severe global crises became unavoidable. And this will have been why it proved to be impossible to bridge the discrepancy which existed between great intellectual capabilities and biologically achieved behaviour patterns.
> [worded after a thought of Konrad Lorenz]

1. Some Introductory Remarks.:

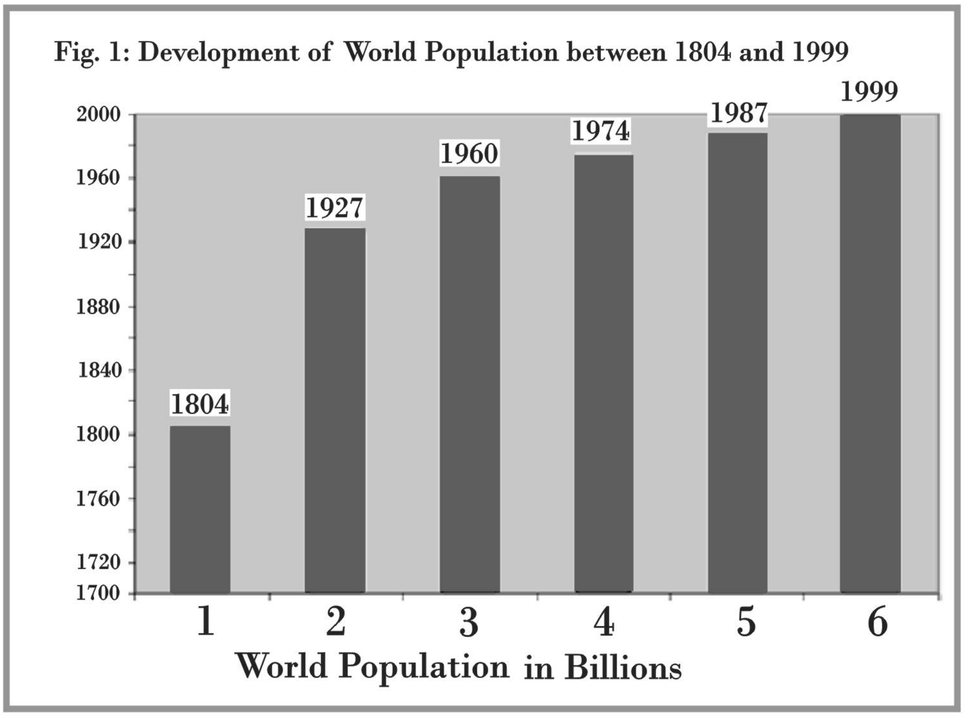
The rapidly rising consumption of non-renewable resources in parallel with a relentlessly growing world population, means that a limit to growth is inevitable.. It is unknown when this tipping-point will arrive,, but when it does, the consequences which will be very painful for many people (and entire nations). Such pessimism is encouraged by information received daily, and which might generate a continually uncomfortable personal feeling: indeed it might be described as a state of fear. In reality, we are not aware of these events all the time, since we are sidetracked by our normal daily business which takes most of our attention and which is not in general connected to any particular environmental problem. The inexorable deforestation that is occurring in the rain forests, the over-fishing of the oceans, the threat to preserving the diverse multitude of species are the most striking single features coming to our minds. More subtle aspects which are less apparent stem from (a) our materialistic demands (some of which are oriented on a more national basis) and (b) from a certain sense of justice (which is more globally focussed). With regard to (a) we hit a contradiction: on the one hand there are (national) commitments aimed at reducing the consumption of fossil fuels. But on the other hand the same (national) politics confers at least the impression that the community cannot do justice to her social obligations appropriately if there were no growth of the national economy! All right, but when such "growth fetishism" among the wealthy industrialized nations (or most of them) alone forms an obstacle to the laudable endeavour of creating a happy balance between man and – finite – nature on this planet, how can we then judge accordingly the desire to improve the quality of life in the developing countries, given their populous nature? The situation is reflected by the following example: The WEC (World Energy Council) has deduced that global energy consumption will double by 2050. One of the reasons for this conclusion is that approximately 2 billion people (from roughly 6.7 billion today) have no access to electrical power. WEC aims at reducing this number to a half. Therefore, according to this WEC view, it would be impossible to imagine that the rise in worldwide (energy) consumption could be stopped in the shorter term.. This applies also to rising CO_2-emissions. In principle, the latter may be reduced by a rapid a global introduction of more nuclear power, or more renewable energy in its various forms, and of the CO_2-free conversion of coal into electrical energy, involving capital-intensive carbon capture and storage (CCS) technology.

When we leaf through any newspaper these days (as it was in 2007), notions such as 'climate (change)', 'environmental protection' or 'CO_2-emissions' are mentioned (directly or indirectly) almost on a daily basis.. With regard to CO_2 emissions, the news is focussed mainly in two areas: (a) who emits CO_2 where, and how much? (b) Where, how and to what extent can energy be saved and, correspondingly, the CO_2-output be reduced by our actions on an individual basis? [We note that 80% of total energy consumption each year roughly depends on fossil resources.] Undoubtedly, such figures may be of particular significance to an industrialised country which has defined for itself CO_2-reductions as distinct percentages of the current total amount (e.g. for the UK and for Germany); reductions within the next 10, 20 or 30 years which exceed the limits proposed by an international agreement called the Kyoto-protocol to which a selection of countries has agreed. The notable exception is the United States who refuse to sign-up to Kyoto on the grounds that to do so will ruin the national economy. Developing nations, particularly China and India, which are undergoing an unprecedented phase of industrialisation, are exempt from Kyoto, which leads some in the west to conclude that our efforts to curb CO_2 emissions will be overwhelmed by those from these unrestricted and expanding economies. It is clearly necessary that all the major industrial nations act in concert to achieve a positive outcome. Certainly, one may be comforted by the thought that actions taken which will reduce CO_2-emissions (being investigated & propagated by the IPCC) will be in any case beneficial to using less of the available but irreplaceable fossil resources by saving energy and using less of them. We all are of the conviction that these resources are inalienable to maintain a reasonable quality of human life into the far future, and that these resources therefore should not be simply burned away! Fossil materials such as oil, gas and coal are not only essential as sources of fuel but to provide chemical feedstocks for industry, ranging from the manufacture of plastics to pharmaceuticals, and once they are gone or are so expensive that it is economically impractical to use them, it is hard to see what alternatives might take their place in the interests of maintaining civilization.

Hence, we are forced to confront certain characteristics of human nature which may act to counteract all the said well-meant single efforts to protect the environment. These are characteristics which humans in principle share with every other life-form, as has been hinted at already (see above "K. Lorenz"). It is interesting that standard methods of population analysis can be applied as well to human population growth as to the multiplication of bacteria growing in a Petri-dish. In the latter example, rather than the projected increase in the population from 6.7 billion now to in excess of 9 billion by 2050, one such analysis indicated instead that, globally, the population will peak at 7.1 billion in2024, and there after decline to one third of that (2.5 billion) by 2100. If this proves correct with hindsight, it will most likely be caused by global resources being unable to maintain pace with human demand for them. Each of the many life-forms on planet Earth has been given vital behaviour patterns by nature in order to guarantee the "survival of the species" - the evolutionary code. Such survival means on one hand the maximization of the number of individuals which belong to a single species as far as the naturally given circumstances, resources and the number of predators allow. On the other hand it includes material life conditions, which at least allow sufficient time for a number of individuals of a species to reproduce. So-called natural limits to a life-form are present in so far as competition exists between one species and others in view of a restricted habitat and/or food supply. Something similar results from specific demands for climatic conditions that a given life-form is undeniably dependent on. If (world) climate changes so slowly – a slowness which investigations in the field of earth's geological history suggest to be the normal case – that either adaptation or avoidance thus becomes possible, then such a change does not actually pose a threat to a certain species. All in all there was a long lasting 'quasi-stable' equilibrium, and – on the whole – every species obeyed the maxim "In harmony (better 'accordance') with Nature thou shalt live!" It should be noted that, terms like "fit for adaptation" or "ready for alternatives" suggest definitions which separate a mere "climate change" from a solid "climate catastrophe".

Mankind now demonstrates its self-appointed place as "pride of creation" by the phrase "man AND nature": as if mankind were somehow separate from the community of living beings on this planet, though truly we are "only <u>one</u> species among a considerable number of other admirable animals" (K. Lorenz). Thanks to his great intellectual capabilities which have provided very efficient tools for mastering the "struggle for life" man has actually developed into the dominant species; into a species for which natural (local) restrictions in the sense referred to above, no longer exist. However it is only quite recently that another kind of limits instead came into man's view. These limits are those of global nature, and were not generally realized hitherto. It was not until 1972 when the first Club-of-Rome report was published (entitled "The Limits to Growth"), containing admonitions with regard to finite resources and to the frightening exponential growth of population, that a wider public audience became increasingly aware of dangers "of the formerly unknown kind" to be awaited in the future. That happened, however, without subsequent counter-acting measures being perceptible on a global (or any) level/scale at that time. The situation may have been changing somewhat since the climate debate had become more visible in the 80's or 90's, but the following remains true:

* Population growth rises as mentioned above. Growth has developed to a present level which had indeed been predicted very precisely by The Club of Rome around 4 decades ago. Predictions for our present future are 2010/11 → 7 billions, ~2019/20 → 8 (mostly poor and very poor) billions, and so on. However, noting the caveat that an inability to produce enough natural resources may instead cause the population to peak at just over 7 billion by 2024, and then fall. The figures just mentioned assume that resources can keep pace with population growth. Population can only grow if there is sufficient for it to "feed" on, according to the s-shaped curve that describes populations as complex as humans or as simple as bacteria, in resource-limited environments.
* Due to progress in the natural sciences and technology, scope for material improvements grows: i.e. for demands which mostly and ultimately depend on finite earth-bound resources of many kinds. The material possibilities we speak of today far exceeds that minimum which one would consider as necessary for a survivable existence.
  In terms of demand on resources, both (a) the population of consumers and (b) the scale of consumption per capita need to be considered. (a) and (b) are <u>independent</u> parameters which effectively determine the extent to which we may transform the environment on a global scale. They would indeed be entirely independent from one another if the attainment of the limits to growth remained a long way off, as people imagine is the case, albeit without justification.



Source: ZIRP

Annotations to Fig. 1:
What this figure shows especially clearly is the shortening time interval between adjacent numbers of “man-milliards” (= -billions). We should add: ”**7** in 2010/11” which seems to be certain.
Citations in this context:
>> From one of my friends (he is of Turkish origin and a professor for national economics in San Francisco) came the succinct remark that there is no single one among the various dangers threatening mankind today as a whole, that we cannot attribute ultimately to population explosion, and also none of them which could be avoided more effectively than by education.<< [K. Lorenz/K.L. Mündl in “Noah would have set sails”]

>> Man’s equipment of physical urges suffers from the fact that this equipment doesn’t include any inhibition with regard to over-exploiting the environment. “*Be fruitful and multiply. Take the world and subjugate it to you!*” These are the maxims men are told, but they all are lies (in the sense of rules/commandments which should be refused).<<
[K. Lorenz in the German “Der Spiegel”-magazine]

The last supplement in ( ): Koewius

We all know of the components which belong to the environment on a global scale. It is not only the land-continents inhabited by us and all the oceans. It is the atmosphere, too. The latter appears as a most astonishing/admirable thing, especially as it has less than a one millionth part of the total mass of the Earth. Inter alia it not only provides oxygen to allow animals to breathe, but it also contains enough carbon dioxide to permit all the photo-synthesis in land-based plants and sea-borne phyto-plankton. The present atmosphere has the following composition (ignoring the presence of water vapour and all other trace gases): 21 % O_2, 78 % N_2, and ~1 % Ar. In previous geological eras, the composition was quite different, however. From Wikipedia we obtain the following instructive data):

∗ There was N_2 in the atmosphere at least when the oceans started to come into being some 3.4 billion years ago (the earth is ~4.6 billion years old).

∗ The generation of oxygen, O_2 , started at least ~3.5 billion years ago, as a result of photosynthesis by cyano-bacteria in the ocean waters, according to paleo-geologists. However, it took another ~ 1.5 billion years until the effect of O_2-outgassing into the air was apparent. ~ 1 billion years later that the atmospheric O_2-content exceeded 3 volume-%, from which the build-up of the ozone layer is thought to have been enabled, the latter being a prerequisite for the existence of life on the land. Thanks to abundant plant growth in the Carboniferous era the O_2-content rose to ~35 volume-% some 300 million years ago, thus enabling dragon-flies to come into being which had giant wing-spans of around 70 cm. It was only after several rather strong oscillations that atmospheric O_2-content reached the level we are accustomed to. This content seems to have been practically constant for some 25 million years.

∗ Carbon dioxide, CO_2, is a “veteran” in earth’s atmosphere, however, having been everything
but a trace gas in the early geological past. Even before the formation of the oceans, massive volcanism in the comparatively thin crust of the earth ensured CO_2-contents of ~10 % in earth’s hot atmosphere, with temperatures above 100° C. The remainder was predominantly water vapour (~80 %) and hydrogen sulphide (up to ~7 %).. After formation of the oceans by condensation from the atmosphere, enormous amounts of CO_2 were dissolved in the water which caused CO_2-gas mixing ratios in the air to drop well below 280 ppm_v at times. It is

accepted by geologists now that the atmospheric concentration of CO_2 did not exceed ~300 ppm_v during the last 500 000 years, i.e. during a time interval within which several ice-ages (cycles of glacial and interglacial periods) occurred. It seems likely that the present (2006) "anthropogenic" value of ~380 ppm_v was probably never exceeded during the last 1 or 2 million years.

While it is not surprising that a relatively inert gas like N_2 has experienced no relevant change in earth history, the above noted constancy of ~21% atmospheric oxygen seems to represent an as yet undisclosed riddle. We would like to emphasize: free O_2, be it dissolved in water or be it present as a gas in the atmosphere, is of photosynthetic origin. The same is true for oxygen which is bound in many minerals, at least those present at the earth's surface. Plants of every kind produce O_2 based upon the assimilation of CO_2-gas, whether the latter is a constituent of the atmosphere or is dissolved in water. Such oxygen did not in fact arise from any chemical-physical processes. With regard to the said constancy of its concentration we can state that plants send as much O_2 into the air as breathing animals (mankind included) consume within the same time, the two kinds of life being in symbiosis. If we further assume that the global volume of active biomass remaining overall is a constant, then the O_2-content of the air should decrease (at least by a marginal rate)***)**, when the number of 'oxygen breathers' grows and/or the growing activities of the latter need so much energy, that fossil resources have to come into play thus transforming a surplus of O_2 (together with C) into a surplus of CO_2.

The assumptions to this scenario however do not lead to consequences of this kind with regard to CO_2. Our flora in its present condition and extent presumably relies on a CO_2-content in the atmosphere which is at least around 280 ppm_v, i.e. around the "natural", pre-industrial value, which appears to be sufficient for plants to survive, and substantially lower levels are probably not admitted to maintain their growth. It is not the plants living today that are the cause of the present atmospheric CO_2 levels, but this is rather due to events which lie far into the earth's past when volcanism played a major role as a source for CO_2. We can envisage a scenario when there was no carbon dioxide in the air. As a consequence there were no plants on this globe and accordingly no animals including humans, because (autotrophic) plants provide the food supply for (heterotrophic) animals. However, the plant world normally does <u>not</u> depend on the existence of (higher**)) animals, mankind included. In this context we can ask the question: if there were solely a plant world on earth, it would probably be able to produce enough CO_2 for its continual existence, doing so by steady-state death/decay and processes which by their perpetual nature do not affect the atmospheric CO_2-content overall. On the other hand, if CO_2-levels should rise substantially in consequence of events outside their sphere of influence, plants would experience no damage, and indeed their growth may be encouraged!

In summary: If we take into consideration that

* every life-form on this planet is based upon carbon compounds
* autotrophic beings, as plants are, rely on the assimilation of gaseous CO_2 (be it an atmospheric constituent or as dissolved in water) in order to produce the required carbon compounds
* atmospheric oxygen primordially came from cyano-bacteria in the primitive oceans (former designation 'blue algae') through photo-synthesis; these bacteria, based on CO_2 came into being well over 3 billions years ago, i.e. long before plants occurred.
* the existence of animals is bound to free oxygen in the atmosphere and so to the presence of plants, too,

we cannot imagine any other substance which is (and always has been) of greater importance to life than carbon dioxide! It might be said that we are “children of carbon dioxide”, by modifying a title which Hoimar v. Ditfurth (= a well known German scientific writer,) gave to one of his great books***), some 25 years ago.

In this lengthy ‘preface’ we have set the stage for many matters that are prerequisite to our existence. We now proceed to the actual subject of this article, and first of all to some details of the background to the complex phenomenon which is called “Climate Change”. It should be no surprise that CO_2 belongs to the crew of principal actors here again.

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*) After this article had been printed in Germany we learnt from an American source that this is indeed the case. The corresponding facts measured had already been published in the U.S. Rev. Geophys. Vol. 33 Suppl., © 1995

**) in the sense of ‘being on the top of evolution’ and also ‘big in size, bigger than e.g. bacteria, etc.’

***) Its title is Kinder des Weltalls. Der Roman unserer Existenz; Hoimar von Ditfurth, ISBN-13: 978-3423330305 or Children of the universe: the tale of our existence (translated from the German), ISBN - 0689105886