Desertification in Crete and the Effect of Global Warming

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Abstract: By definition the desertification is due to both climatic variation and human impact. The world sees nowadays an increasing global warming period which in its turn has been attributed to heliogenic and/or anthropogenic effects. In this paper we report on our first results on a correlation study between Sun activity and the appearance of drought periods in Greece for a period of 145 years (1860-2005) based on statistical available data in the literature. A dryness parameter d is defined and its correlation with sunspot number variation data is studied and commented. Also the expected Sun activity maximum of the year 2012 and further NASA forecasts for the coming years until the end of the 25th Sun cycle are presented and discussed. We show that the cycles of Nature are the most important but also that the anthropogenic effects could damage the sensitive balance which is the outcome of the interplay between the natural forces and Man, a balance which was kept in the long history of the mankind, but now in the last decades is seriously threatened.

Key-Words: desertification, global warming, climate change, sunspot cycles, Crete case-study

1 Introduction

At Rio, 1992, the world agreed that desertification was a very serious concern.

Desertification has been defined in the UNEP's United Nations Convention to Combat Desertification, Geneva 1994, as " land degradation in arid, semi arid and dry sub-humid zones arising from various factors including climatic variation and human impact". Desertification threatens many areas in the planet Earth, and the Mediterranean countries , due to their vicinity to the deserts of the North Africa, are especially vulnerable [1]. In an International Conference held in 1998 in Heraklion, Crete

The conclusion was that 50% of land in Crete and 35% of land in Greece was at high risk of desertification, with dire consequences for the country's economy and demographic. The conference was part of the "Desire" scientific programme, comprising 28 research institutes and universities from around the world.

The findings were judged worrying by those attending the conference, as they emerged from scientific studies of the phenomenon of desertification observed in many areas of the planet. In fact Crete, this island of the east-south Aegean, due to its high risk of desertification, is a pilot study area for Greece. According to the President of the National Committee for Combating Desertification, Professor of Soil Science Kostas Kosmas, east Crete is considered the area of Greece most at risk of desertification. There are two reasons for this: the warm climate with low rainfall, and human intervention. Today 35% of Greece is at risk of or partially subject to desertification, while ca 50% is at moderate risk of desertification. Also, more recently, in April 2007, Chania, Crete, the situation was not changed. The conclusion was that

"The island of Crete, is among the regions most threatened with desertification, the transformation of arable or habitable land into desert, as climate changes and accompanying extreme weather phenomena, in combination with human intervention the area, and will continue to do so".

In an interview of one of the present authors to a local newspaper followed by a radiophonic direct sending the main question was how the global warming affects the desertification phenomenon and to what extent the extreme climatic phenomena are the result of natural cyclic processes or to human actions responsible for the greenhouse effect, the ozon hole etc.

Due to a misinterpretation it has appeared in an internet site a selected part only of what it has been

discussed, leading to a false statement: "The temperature will increase in the future, predicted Gekas"

However this is a part what it was said, thereby falsifiying the truth and one of the aims of this study is at correcting the above statement.

The main aim is at giving the necessary information for a better understanding of the phenomena thus helping at the direction of taking the correct actions in order to inhibit as much as it is possible the invasion of the deserts in the southeast soils of the beautiful island of Crete.

2 Global Warming and its Causes

As it has been agreed upon by the experts in the area of desertification the extreme weather conditions due to the climatic changes influence dramatically the desertification process accelerating what human actions such as overgrazing, excessive irrigation, fire occurrences etc have started. But what is causing the global warming. Who is guilty? Is it the Sun? or is it Man? Is the origin of the phenomenon helio-genic or anthropo-genic?

There are two schools. Those believing that the main cause is the human intervention in the Environment, excluding or neglecting the Sun effect and those attributing the changes to the Sun activities. The moral output of those two extreme dogmas could be different and dangerously used. In the first case, there is an urgent need for human counter-action in order to possibly reverse the observed trend, in the second case there is the risk that politicians deny to tackle measures using the Sun as an excuse. The above are, to our opinion, simplified and superficial arguments.

2.1 Answer to the greenhouse gas theory adherents

Let us first talk to the fanatics of the first school, the "antropocentric" one:

You are perhaps aware of the fact that our planet carrying us humans, among other things, is indeed located inside the Sun, under its energetic gestalt, as shown in Figure 1.

Therefore the Sun activities, which as it is known by the astronomers and solar physicists occur periodically, influence directly the climate of our Earth and the earth-like Planets with more or less the same periodicity. A good indicator of the magnetic activity of the Sun is the sunspots. A large number of sunspots means a high magnetic activity, a small number or near to zero number of sunspots means extremely cold climate for the Earth, affecting also areas which are normally close to the tropical ones. Known also it is the Wolf number. The idea of computing sunspot numbers was originated by Rudolf Wolf in 1849 in Zurich Switzerland and, thus, the procedure he initiated bears his name (or place). The combination of sunspots and their grouping is used because it compensates for variations in observing small sunspots. This number has been collected and tabulated by researchers for around 300 years. They have found that sunspot activity is cyclical and reaches its maximum around every 9.5 to 11 years (note: Using data from SIDC for the last 300 years and running a discrete Fourier transform function on the data gives an average maximum at 10.4883 years/cycle). This cycle was first noted by Schwabe in 1843.

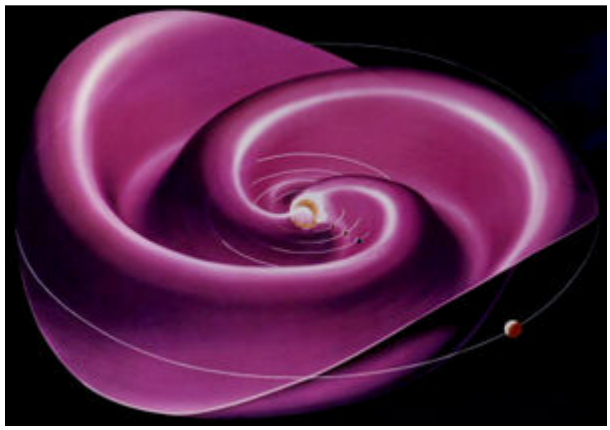

Fig.1 Planet Earth as well as the other small planets from Mercury up to Mars lie inside the heliospheric sheet, the magnetic field of the Sun

From other scientific fields, for example palaeontology, palaioclimatology, palaioceanography and others we learn that our planet has suffered periodically from periods of extreme hot respectively etreme cold climate. There are data which show that there have been several periods during which sunspots were rare or absent, most notably the Maunder minimum (1645-1715), and less markedly the Dalton minimum (1795-1820). Figure 2 shows the sunspot occurrence periodicity and the above mentioned little ice periods. During the Maunder minimum the proportional concentration of radio-carbon (14C) in the Earth's atmosphere was slightly higher than normal, causing an underestimate of the radio-carbon date of objects from those periods. By means of the premise of excess 14C concentrations in independently dated material (such as tree rings), other minima have been found at times prior to direct sunspot observations, for instance the Sporer minimum from 1450 to1540.

Data from 8,000 year-old bristle-cone pine trees indicate 18 periods of sunspot minima in the last 7,800

years [1]. This and other studies have shown that the Sun (as well as other stars) spends about a quarter of its time with very few sunspots. There is another well-known, super-imposed variation of annual sunspot numbers, of about 85 years. This irregular variation affects the length of the sunspot cycle, ranging from 9.8 to 12.0 years. Maxima of sunspot-cycle length occurred in 1770, 1845 and 1940.

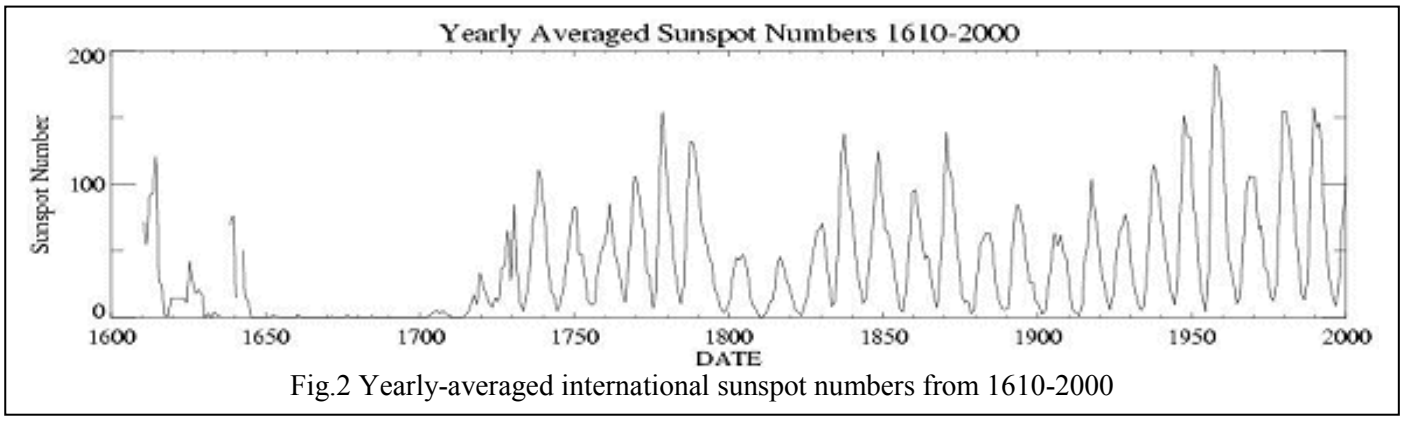

Fig.2 Yearly-averaged international sunspot numbers from 1610-2000

More recently it was discovered that the sunspot number during 1861-1989 shows a remarkable parallelism with the simultaneous variation in northern hemisphere mean temperatures. There is an even better correlation with the length of the solar cycle, between years of the highest numbers of sunspots. For example, the temperature anomaly was - 0.4 K in 1890 when the cycle was 11.7 years, but + 0.25 K in 1989 when the cycle was 9.8 years. Some critics of the theory of man-induced global warming have seized on this discovery to criticize the greenhouse gas theory [2].

2.2 A correlation study concerning rainfall data in Greece vs sunspot numbers in the surface of the Sun

Rainfall data in Greece have been collected by Baloutsos, Barletsikas and Gouma in a recent study of the National Institution of Agronomy Research for the time period 1860-2005 [3]. Plotting the rainfall height as a function of the time (in years) a clear periodicity is observed with a period of approximately 10 years. The above authors did not attempt any correlation with sunspot data or with any other kind of data.

In our laboratory of Transport Phenomena & Applied Thermodynamics we have performed such a correlation study using the statistical tool of MATLAB®. We have first defined the dryness- (d-) factor as the difference of the rainfall height from its mean value over the 1860-2005 period

$$d=h_m-h$$

h being the height (mm) in a given year and h_m (mm) the mean rainfall value for the studied time period.

Next, we have plotted the d-factor as a function of the time (in years) for the studied time period 1860-2005. The results are depicted in Figure 3. It can be observed that the drought peaks coincide with the peaks in sunspot numbers. For example the sunspot maximum of the year 1898 coincides with the most dry period in the history of the modern Greece. Also the drought of the year 1959 follows just after the peak in helio-spheric activity of the cycle number 19 in 1958, as depicted in Figure 4. The correlation study shows a good correlation coefficient. So that it is

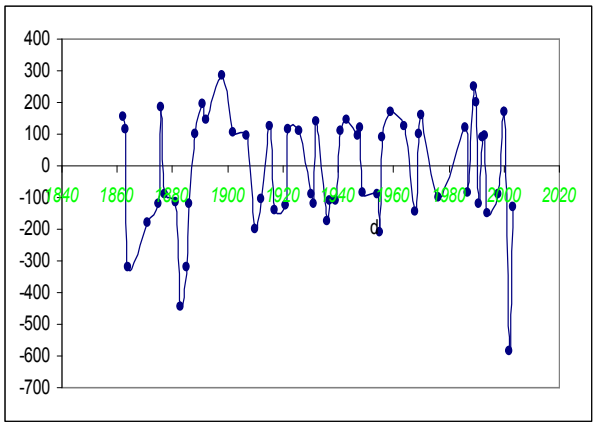

Fig.3. Plot of the dryness factor d over the years 1860-2005

difficult not to accept the obvious influence of the Sun on Earth's climate.

2.3 Predictions for the year 2012 and beyond

Since the year 1775 the cycles of the Sun activity are

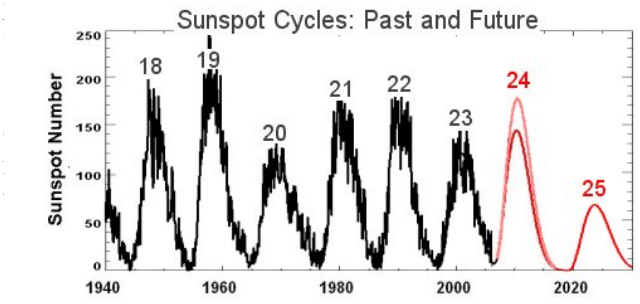

Fig.4. The cycles of Sun activity since 1940. Prediction beyond 2007

cold and extreme hot climatic periods. This is especially true for very sensitive areas, such as Crete and other islands of the south Aegean. Indeed Crete and the other islands they retain a mild climate, while areas of the same geographical latitude but there are already deserts in the north of the nearby continent Africa. Factors that have prevented Crete and the other Aegean islands from becoming deserts are the surrounding sea, the zephyr winds and the respectful attitude of the habitants towards Nature , because they new the cycles and they knew also that they were living in the edge between Order and Chaos.

The extreme phenomena were above or under the baseline left to the influence of natural factors only,

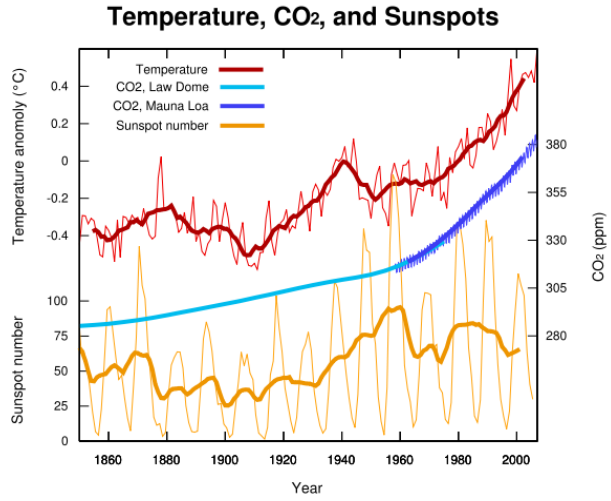

Fig.5. In the above graph the evolution of the sunspot number, the atmospheric CO_2 and the temperature anomaly in the period 1860-2000.

but in the past (at least the past for which we have data) the baseline did not deviate from a horizontal baseline. The worrying situation of the recent five decades or so, is that the baseline in the earth's temperature evolution has left its horizontal stable line and shows undoubtedly an augmentation tendency as presented in Figure 5.

It is clear that from the year 1960 and on, the mean temperature anomaly curve does not follow the curve of the mean sunspot numbers but the carbon dioxide curve instead. Then the mankind must reduce the emission of the greenhouse gases in order to avoid an even worse situation in the near future. The adherents of the heliogenic origin of the global warming should reconsider the opinion that the global warming is due to the Sun only. At last the either anthropogenic-only or heliogenic-only approach seems to be a pseudo – dilemma and immediate measures have to be taken.

3 Crete Desertification case study

We have undertaken in our laboratory a desertification study in Crete in cooperation with the local authorities. This implies a twofold action

- A characterization of the soil quality in the various areas of Crete using the internationally accepted desertification indexes of soil erodability, rain- and wind- erodability and crop coverage.
- Because this characterization takes time and the need for immediate action is crying , suggestion of measures that have to be taken in order to hinder the phenomenon. A multi-fold action has to proceed in parallel with the characterization study

The actions against desertification could be classified in three categories:

a. change of attitude of the habitants. Avoid the direct anthropogenic factors, i.e avoid over exploitation in the form of overgrazing , excessive irrigation , also: avoid high concentration of greenhouses in the threatened areas
b. wise management of the aqueous resources. There is water , as the mayor of the city of Ierapetra says but it disappears to the sea. Then water damp constructions, to keep the quantities of the water in land, is a necessity. If needed, enrichment of aquifers through desalinated water could also be applied.In the case of saline water intrusion of the sea to the land, desalination might be a solution but also cultivation of species that absorb salts, this is a phyto-remediation measure , which is the third category below:

c. phyto-remediation. The olive tree has a traditional history in these areas. In order to cultivate it in the meaning of combating desertification with a mediocre yield, and not with the purpose of maximizing the profit through intensive cultivation, one has to start with smaller vegetation species that are resistant in drought conditions and high temperatures. These low height species help towards soil remediation also they can be used against salt intrusion in the soils and they can serve as a useful substratum for the olive tree. People in Crete but also in other areas of the south European counties in the Mediterranean could learn from measures that are taken by the North African countries [4], in the other, the south coast of the Mediterranean sea. (Fig.6)

Fig. 6 Examples of xerophytes, cacti, peas and sunflowers

4 Discussion –Conclusions

This paper aimed at elucidating some important aspects of global warming and the influence on desertification of threatened areas, in particular Crete and other smaller islands of the south Aegean sea. Evidences are given proving that global warming is neither entirely due to the cycles of the Nature, nor to human activities. Global warming is affected by both natural and antropogenic superimposed factors.

Although we expect a colder weather after the 2012 maximum , the worrying observation of increasing the mean temperature base line in the last 50 years calls for immediate action in the threatened by desertification areas of our planet in general, in the more exposed areas such as Crete, in particular.

Change of the attitude of the population towards the environment is a pre-requisite. Overexploitation could lead to tragically serious damages of the human population themselves. Measures to combat desertification include good management of water resources and phyto-remediation. At last but not at least let us mention the negative feedback of the planet and its ability to self adjustment. Despite the fact that the ice of the Arktis particularly undergoes now a rapid smelting the effect of the subsequent ocean water salinity decrease will cause an inverse phenomenon of the warm stream in the North Atlantic causing a cold period for the north hemisphere.

Current theories indicate that melting ice caused by global warming could dilute northern seawater enough to reduce its density to that of southern seawater, thereby shutting down the ocean's Gulf Stream [5]. With no Gulf Stream to carry heat northward, northern temperatures would fall. Eventually something analogous could apply for the southern hemisphere. The question to answer is when this will occur and will the human being succeed to survive until then.

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