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Presentation of the Book

Food Scarcity Unavoidable by 2100 ? Impact of Climate Change and Demography

Raoul A. Weiler & Kris Demuyneck

Agriculture is born with the emergence of the human species on the planet earth. Food is critical to the survival for the living societies and evidently for their civilizations. Therefore enough food for all is a sustainable issue per excellence. The collapse of societies has been commented in the literature extensively and has illustrated the importance of geographical locations and the impact of the human behavior on the environment.

This publication gives an overview of work in progress and applies some **original tools** to analyze the food situation in the current century on the terrestrial planet.

First. For a better description the **Climate Classification System** from **Wladimir Köppen** and **Rudolf Geiger** is applied. This climate system has been developed more than a century ago but has been updated with satellite observations of the last decades. It has the considerable advantage to address climate phenomena independently from national borders and countries. The climate zones are well defined with threshold values for temperature and precipitation, allowing precise boundaries of territories and the evolution over time due to climate change. It provides a strong framework for agriculture purposes.

This approach is distinct from usually defined borders based on juristic applied by international organizations. It is much closer to climate change phenomena and therefore more appropriate to the objectives of this research.

Some **25 climate zones** are used in this publication, covering some **150 countries** and **five continents**. Small islands are included in neighboring zones, simplifying the further analyses. To larger countries several climate zones are attributed. The countries are linked to their continent, providing a very useful cross reference.

Second. The application of the **New Science of Networks** allows to visualize correlations between climate zones, continents and countries and essential food components such as **crops**: wheat, rice, maize and **meat** species: beef, pigs, poultry, sheep/goats, and the **basic resources** for their production : **land for agriculture** and **water-withdrawal for agriculture**. The data are taken from the *FAO Statistical Yearbook 2013*.

'Open source' software has been used such for exploring the inter-linkage, **Gephi** (The Open Graph Viz Platform) and the program language, **R**, for statistical analyses. Both tools made graphical exploration possible and are inspired by **Graph Theory**. With the help of own programming with **R** the following diagrams have been obtained : **adjacency matrix**, **dendrograms**, **decision trees** and the **Kamada Kawei algorithm**. All help to look after correlations and clusters among Climate Zones and the agricultural parameters.

Third. The **demographic increase** of the 21st century, requires to look in a different way to the significance for the survival of the human species. Demographic data are taken from *UN ECOSOC Population Division* and cover the period from 1950 up to 2300 as well as for the different continents. In the present publication a time limit is chosen at 2100, the curves of population growth show an endpoint in planetary demographic increase and evolves thereafter to a plateau or even decline. The demographic evolution is additionally listed per continent over the entire time frame, which is very appreciable. A special focus is given in this publication to the African continent, which increase shows a factor 2.83 over the century, whereas the European continent will decrease by some 25 %.

Fourth. Analyses of **Climate Change** and **Global Warming** have been taken from *IPCC reports*. The effects on the climate zones are discussed as much as possible. However, the evolution of the zones at the scale of a century or even several ones remains extremely difficult. Some estimations indicate a linear correlation of temperature, other of quadratic evolution. Globally its is accepted that the temperature increase shifts northerly in the northern hemisphere and the reverse in the southern one, and that the desertification will increase as well. These estimations are conform with daily observations, however lack -up to now- extensive quantitative data.

A voluminous amount of data have been gathered by scientists all over the planet. However, the dynamics of climate change and global warming phenomena remain dependent of the overall progress of knowledge and understanding to enlighten the impact, in the long term, of climate change on food production. Nevertheless from observations the global warming phenomenon appears to happen faster than expected by scientists and their models have predicted.

A number of **overarching recommendations** -in the field of food production- are formulated at the end of the publication. They address practical applications, but

certainly not easy to implement. Enough food for all is a *sine qua non* condition for survival. Missing this objective opens the gate for massive social unrest and important and significant political instability. The question is raised if an appropriate **world governance body** should be set up for dealing with this very complex challenge? Food is existential, and is getting even more critical than ever before, therefore massive attention and investment have to be envisioned. Food for every body is a **humanistic objective** never reached in history. Given the huge challenge of demographic increase, global warming effects on food output, an urgent dramatic but strong and systematic support and for the **African continent**, as well as for some parts of the Asian one is necessary.

Other recommendations are enumerated, one with special attention to **breeding** techniques, introduced by Prof **Norman Borlaug** -*Nobel Prize for Peace 1970*- for improving sustainable efficiency of specific vegetable output. The other can be formulated as follows:

- Improve management of **water-withdrawal** globally and in particular for agriculture, **biological soil** quality and **fertilizer** use;
- Converting land for meadows and pastoral to **land for crops**;
- **Discontinue** the use of food and feed resources for **Bio-fuel** production;
- Increase crop production through generalized **breeding**, applying **endogenous GMO** techniques, increasing **C4 photosynthesis**; the latter absorb higher quantities of GHG and showing better adaptability to changing weather conditions (drought) and/or environmental ones (salinity);
- Intensive **animal husbandry** reduces the use of basic resources of land (meadows/pastures) and water, liberating allowing the land for crops production;
- **Massive investment** in mechanization and capacity building for increasing locally and regionally agriculture output is a must for **Africa** to cope with a population increase of a factor 2.83 resulting in a population of >2.1 billion people.

The food '*problématique*' has been, and still is, analyzed and commented extensively in literature. A considerable effort has been deployed here to have a **holistic** and **innovative** analysis and approach. *Graph Theory* as part of the *Science of Networks*, here introduced require further research. Indeed, agriculture and food availability is a complex and huge domain for scientific investigation, which is **existential** for the **human species**.♦ **Optimism is not enough!**