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Climate change and desertification in the semiarid region of northeastern Brazil

Eberson Pessoa Ribeiro[(1)]*, Elvis Bergue Mariz Moreira[(2)], Deivide Benicio Soares[(2)], Alexsandro Bezerra Correia Bilar[(3)] and Maria Salomé de Lima[(4)]

[(1)] Federal Institute of Education, Science and Technology of Pernambuco, Vitória de Santo Antão, Pernambuco, Brazil.
[(2)] Department of Geography, Universidade Federal de Pernambuco, Recife, Brazil.
[(3)] Department of Management, Rural Federal University of Pernambuco, Serra Talhada, Brazil.
[(4)] Pernambuco Secretary of Education, Recife, Brazil.
* E-mail: eberson_pessoa@yahoo.com.br

ABSTRACT

The most discussed scientific debates of today are climate change and desertification process. However, although they represent major challenges for humanity, mostly studies of these phenomena are realized in isolation. Both because global warming is still an uncertainty in academia where two chains are facing bitterly about this issue. Therefore, this paper aims to carry out a review of the literature, trying to analyze the complex and contradictory discourses surrounding climate change and its effects on the process of desertification in northeastern Brazil (NEB), in order to evaluate different scientific contributions on this topic, as well as raising the gaps. Although studies are scarce on the issue, the evidence of climate change (greater variability in rainfall and increased frequency of extreme events - droughts and floods) and intensification of desertification processes with the expansion of the Areas Susceptible to Desertification are sharp in NEB. Thus, this study aimed to contribute to the understanding of the complex phenomena of the discussion above, as well as highlighting the need for more research to planning the activities of the society.
Keywords: Global warming, areas susceptible to desertification, environmental degradation.

INTRODUCTION

Global climate changes have occurred since the origin of the atmosphere with the natural cycles of ice ages (cooling) and interglacial (warm). However, human activities since the Industrial Revolution (1750) has affected the natural variability of the Earth's climate more intensely, because the increase in greenhouse gas concentration, among which stand out carbon dioxide (CO_2), methane (CH_4) and nitrous oxides (NO_x), prevents the

dissipation of heat radiated, providing a significant increase in the temperature of the atmosphere (NOBRE, 2011).

According to the Intergovernmental Panel on Climate Change and the Intergovernmental Panel on Climate Change (IPCC), in the last century occurred an average temperature increase of the atmosphere of approximately 0,6°C since the heating projections have revealed that between 1900 and 2100 the temperature global can be between 1,4-5,8ºC (IPCC, 2007). The rapid growth of temperature in a short time suggests that "the observed changes are consistent with responses estimated due to a combination of anthropogenic effects and natural forcings" (MARENGO, 2006, p.26).

For many researchers (RUBIO; RECATALA, 2006; MARENGO, 2006; IPCC, 2007; RUBIO, 2007; among others), climate change poses an unprecedented challenge to humanity, since the impacts and environmental degradation promoted by heating global are increasingly intense, especially in the most vulnerable areas such as areas Susceptible to Desertification (ASD) (PERNAMBUCO, 2011).

Others go against this current, because they say not truthfully know the agents that cause this phenomenon and evaluate that global warming cannot be imposed on human activities. "For these scientists, the large amount of carbon dioxide sent into the atmosphere by forests decaying and oceans also contributes significantly to climate change" (CASAGRANDE; SILVA JUNIOR, MENDONÇA, 2011, p.35).

In Brazil, the Caatinga is among the most vulnerable biomes to these changes and their effects. In semiarid climate, the region has accelerated desertification process as related to climate issues, human activities of land use and occupation, as well as the native vegetation removal are increasing the pressure on aridificação (NOBRE, 2011).

Therefore, by adopting the United Nations Convention to Combat Desertification (UNCCD), during the preparation of the National Action Program to Combat Desertification and Mitigating the Effects of Drought (PAN-Brazil) in 2004, it was determined Brazilian ASD, which employ the aridity index (AI), developed on the basis of climate classification Thorntwaite (1941).

That index is determined by the ratio rainfall and evapotranspiration precipitation. The categorization of this index is as follows: when the ratio is between 0,05 and 0,20, the climate is considered arid; in the range between 0,21 and 0,50, the climate is characterized as semiarid; when between 0,51 and 0,65, it is considered dry sub-humid and; Finally, above this amount, sub-humid wet or damp (BRAZIL, 2007).

However, ASD have a geographical context very heterogeneous in environmental characteristics, as well as socioeconomic occupation process. Thus, studies to date of the state of desertification in Northeastern Brazil (NEB) not yet have a consistent baseline that allows monitoring of the dynamics of this process. In this way, the Environment Mystery, recognizing the limits of multiple methodologies employed, instituted occurrence categories in very serious, severe, moderate and desertification nuclei (PERNAMBUCO, 2009).

So part of it is assumed that one of the intensification factors of desertification in the NEB

is climate change and its implications, with increasing water deficit resulting from more intense and prolonged drought and high rates of evapotranspiration as a result of high temperatures donate. These problems have been causing serious socio-economic and environmental implications that limit the sustainable development of the region.

Faced with the above, this work is important to contribute to the understanding of the complex discussion of the above phenomena, but also highlight the need for more research for planning and development control measures, mitigation and adaptation to the effects thereof, through appropriate public policies for the activities of the society.

Therefore, the aim of this article was to conduct a literature review, trying to analyze the complex and contradictory discourses of the climate change and its effects on the desertification process in NEB, in order to assess the different scientific contributions on the subject, as well as raising the gaps.

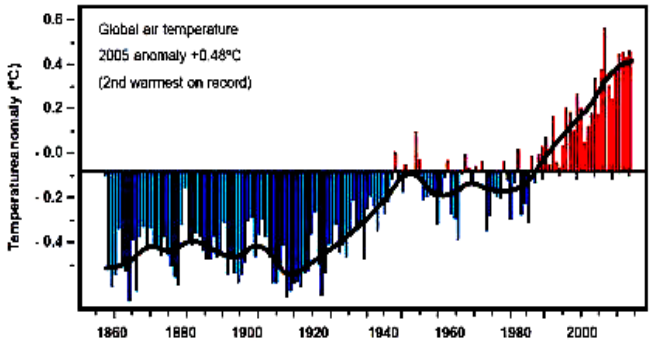
2. Global climate change

2.1. Anthropogenic global warming

Concerns about global warming and its consequences are intensified in the late 1980s with the evidence of increased temperature in the Earth's atmosphere. This increase has worsened in the 1990s and is considered the hottest since the first measurements made in 1861, in which the year 1998 was the hottest with 0,54ºC above the historical average of 1961-90. In 2005 and 2003 they have returned to air temperature at the global level above the historical average in the greatness of 0,48ºC and 0,44ºC respectively (MARENGO, 2006; 2009; MENDONÇA; DANNI-OLIVEIRA, 2007).

The average air temperature deviations on the globe from 1860 to 2005 are shown in Figure 1 where it can be observed increased by around 0,7°C in the average temperature of the atmosphere.

Figure 1 - Deviations of average air temperature in the globe from 1860 to 2005. Source: Marengo (2006, p. 26).



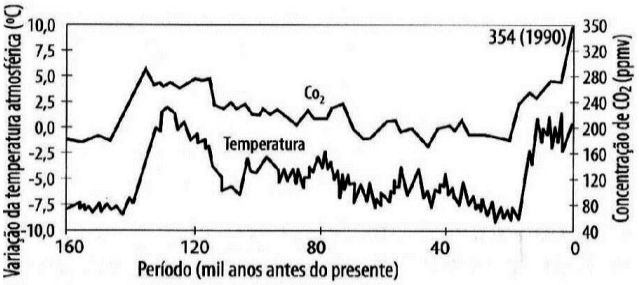
The 0,5°C increase in average temperature of the atmosphere of the planet in recent decades corresponds to the increasing use of fossil fuel in this period, showing that human activities, especially the emission of Greenhouse Gases are key to atmospheric warming earth. Among these gases, carbon dioxide or carbon dioxide (CO_2) is a key compound for the intensification of this phenomenon.

The CO2 is a natural part of the atmosphere is essential to life, but the content of this gas has been changing throughout the Earth's history with a strong growth trend in recent centuries. This growing proceeds, as already mentioned, the population explosion and economic activities, especially with the advent of the Industrial Revolution. CO_2 concentrations in the atmosphere passed 277 parts per million (ppm) in 1760 to 317 ppm in 1960. Only from 1960 to 2005 the increase in carbon dioxide content in the atmosphere was 54

ppm, obtaining a total of 379 ppm. The rate of increase in carbon dioxide concentration during this period was 1,4 ppm per year. In 2010, CO_2 concentrations already exceeded 390 ppm (IPCC, 2007; MARENGO, 2009; NOBRE, 2012).

If emissions continue at the current pace, dramatic-are estimated consequences for humanity, the main one is the worsening of global warming mainly because the temperature variations were successively linked to carbon dioxide changes in the atmosphere (Figure 2).

Figure 2 – Earth temperature and CO_2 concentration. CO_2 concentrations and changes in air temperature were deduced from the distribution of deuterium isotopes in ice cores from Vostok. Attention is called to the fact, 20.000 years, the increase of CO_2 in the atmosphere was 160 ppmv (parts per million by volume), and only about 90, 79 ppmv, almost half. Source: Bruce (1990 cited in MENDONÇA, DANNI-OLIVEIRA, 2007).



For the IPCC high levels of CO_2 concentration are already worrying, since they are producing disturbances in atmospheric dynamics and virtually no doubt about the anthropogenic influence. Estimates of Global average radiative forcing in CO_2 elements, CH_4, N_2O man-made as well as other important agents and mechanisms, together with the spatial scale, that is, the typical geographical extent of forcing (global, continental and local) and Scientific Understanding level are assessed at high, medium and low.

According to the results presented by the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) continued emissions of greenhouse gases at current rates or above would cause further warming and induce many changes in the global climate system during the twenty-first century, which will most likely be larger than those observed during the twentieth century.

Also according to IPCC-AR4, global warming average forecasts of surface air by 2100 is between 1,8°C and 4°C for B1 scenarios that range optimistic the likely range is 1,1°C to 2,9ºC; and the extreme scenario A1FI, pessimistic variant range with between 2,4°C and 6,4°C. The projections of future scenarios in AR4 use the average multimodelos and assessed ranges for surface warming (Figure 3), which are based on a larger number of climate models of increasing complexity and realism, as well as new information about nature of the carbon cycle feedback processes and constraints on climate response from observations (IPCC, 2007).

Figure 3 – Medium Multimodelos and Assessed Ranges for Surface Heating. Source: IPCC (2007, p.20).

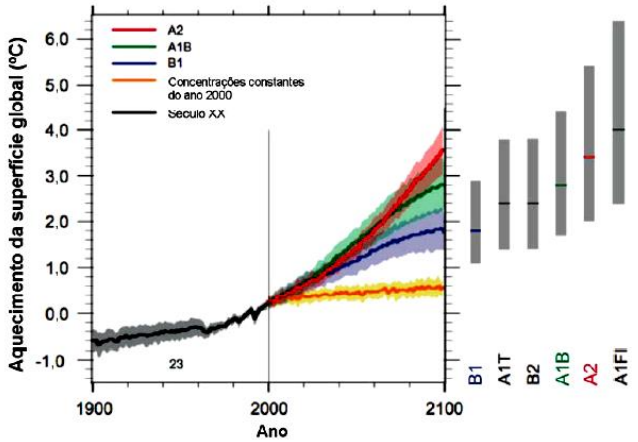


Figure 3 evaluates the six scenarios according emissions that orange line represents the

experiment in which the concentrations were held constant at 2000 values and shading denotes the range of ± 1 standard deviation for individual annual averages of models, such as also margins of uncertainty of temperature increase projections on the right side.

Nobre (2012, p. 26) argues that

> These models follow the laws of physics and represent the main proceedings, not with absolute perfection, but it would be impossible anyway. Thus, these computer models are the best tools available to project climate changes in the future. However, there really is not an absolute way to ensure that future projection is correct. The greater uncertainty, in fact, is not the imperfection of the models. The biggest uncertainty of projections of the IPCC is that we do not know the future path of emissions of greenhouse gases. (Emphasis added).

These scenarios sharply alter planetary environments with drastic consequences for the economic systems (agriculture, industry, transport, services) as well as social with health risks with the proliferation of pests, epidemics (malaria), in addition to threatening the food supply and water to cities. The projections of future scenarios are simulations of what society can come to grips with the effects of global warming, but there is no absolute certainty, since it is not known how will the trajectory of emissions of greenhouse gases, as well argued Nobre.

However, one cann't deny the various evidence of climate changes currently occurring, especially in extreme weather. Global warming evidence is observed in the increase of average temperatures, which increased by almost double the average over the past 100 years in the Arctic, causing widespread melting of snow and ice in this region - measurements made by balloon and satellite in low troposphere proved to be similar to those of the surface temperature record. The rising sea level was an average rate of 1,8 mm/year in the period 1961-2003 by the input of this melting and the warming of the oceans, which causes sea water molecules expand. In addition to the increase in global average temperatures and melting, extreme weather events are perceived as exceptional rainfall in most land areas, intensity of tropical cyclones, heat waves and more intense and prolonged droughts (IPCC, 2007).

Many scholars, represented here as Molion (2001, 2008a, 2008b), Baptist (2009) and Maruyama (2009), questioned the conclusions of the IPCC and stand against the global warming hypothesis claiming that the Earth moves towards a planetary cooling.

For these researchers, global warming by anthropogenic carbon dioxide is treated sensationalist and without the necessary scientific basis. There are doubts whether the more real cause of this phenomenon is the carbon dioxide increase, since it seems to have reached truly alarming levels. The simplified models of global climate simulation to evaluate only the growing presence of this gas in the atmosphere is a major mistake, so why not analyze, for example, the cyclical activity of the sun and the Milankovitch cycle as determinants of climate change on a global scale.

Molion (2001, 2008a) also argues that other factors internal to the Earth-atmosphere system affect the climate as variations of the planetary albedo, which controls the flow of shortwave entering the system. Thus, the planetary albedo addition, through clouds of variation, volcanic concentration of aerosols in the stratosphere and

the characteristics of the surface coverage decreases the incoming solar radiation and, consequently, the planetary cooling.

For Maruyama (2009), the issue of CO_2 as the villain of the intensification of global warming comes from research conducted in the icecap of Antarctica and glaciers of Greenland, which were found close links between methane and the amount of carbon dioxide as changes in indexes temperature.

The studies showed that in the last 400.000 years the average temperatures on Earth were higher coinciding with the high CO_2 levels found in the ice, confirming the Arrhenius theory that the greenhouse effect was intensified by CO_2. Another theory, among many, is the "paradox of the Dark Sun" in Carl Sagan in their analysis confirms that during the Archean Age, when the solar light was less than about 70% of the current, it was thought that the earth would be covered ice, however geological research revealed that there is no evidence planet from freezing at this time. Thus, it is concluded that this was only possible due to high CO_2 levels. However, it is uncertain whether the high CO_2 content increased the temperature of the atmosphere or otherwise.

Maruyama (2009) also questions the CO_2 theory as global warming caused and explains that when an increase in air temperature there is also a heating of ocean water causing large amounts of CO_2, before dissolved in oceans, escape to earth's atmosphere. Therefore it can be concluded that CO_2 is a consequence and does not cause heating. It also states that the amount of carbon dioxide produced by human activities is insignificant and can not be responsible for this phenomenon.

Molion (2008a, p.7) consistent to ensure that if any human influence on climate it is very small, making it impossible to detect because of the large natural variability. "Given this variability, it is very likely to occur global cooling over the next 20 years instead of a warm".

One of the criticisms that this current does is regarding the inefficiency of forecasting climate change. Forecasts are usually carried out by statistical methods and the simulation Global Climate Model (GCM), which can be induced by a number of variables that comprise it.

Statistical methods identify the possible cycles or periodicities in the long time series of data analyzed and the design for future scenarios. However, if based on the stationarity of the series. Therefore, it does not consider the natural climate variability, resulting in dynamic and complex interactions between physical and feedback processes that produce it.

With respect to the GCM are "computer programs which employ the equations or mathematical expressions to represent the direct physical processes and feedback and/or interaction ("feedback")" (MOLION, 2008a, p.16) among the multiple elements of the system land-ocean-atmosphere. Based on equations of the dynamics and thermodynamics conditioned by variable time, the representations are also limited by not simulate the direct physical processes and feedback properly.

Thus, Molion (2008b, p.118) argues that

> Among many of the problems presented by GCMs is the representation of the physical processes with spatial scale less than the three-dimensional grid of GCMs, as training-development of clouds and precipitation, turbulent vertical transport of heat and moisture in and out of the planetary boundary

> layer, heat transport by sea currents, which must be parameterized, i.e., represented by empirical mathematical algorithms - it is assumed - describe the physics of the processes satisfactorily. Such algorithms, however, are based on current scientific knowledge and should be considered simple approaches or "best estimates" of these processes.

Also according to the author, to the achievement of weather forecasts should use a combination of techniques, considering the knowledge of the phenomena of the climate system of low frequency (multidecadal) associated with regional analyzes ordered by the GCM or statistical methods being updated to as new global data become available.

Another issue to be considered is the urban growth around the world. Urban sprawl, with its microclimate effects, has influenced the time series of climatic elements, since the weather stations, most of them are located in urban or near their centers. Thus, the records tend to be due to the sum of the heat of human activities, higher temperatures (MOLION, 2001; TEODORO; AMORIM, 2008).

So, there are questions about global warming, both because there are a number of factors that influence the historical series and create obstacles for comparisons and conclusions, such as the spatial and temporal heterogeneity, changes of instruments and transfers of local weather shelters (MOLION, 1995).

To Casagrande, Silva Jr. and Mendonça (2011) the main controversies and current uncertainties about global warming are in accordance with the anthropogenic share of global warming; the possibility (or not) to minimize this phenomenon and how it can be done; temporality of the consequences of global warming on society and the environment; and the severity of these effects.

With regard to these questions, as we have seen, for the IPCC the main cause of global warming is the emission and concentration of greenhouse gases in the atmosphere resulting from burning fossil fuels.

However, according to the scientists mentioned above, among others as Suguio and Suzuki (2010) and Leroux (2013), states that the increase in global average temperatures cannot be imposed on human action, since it has already happened several times heating and cooling on Earth before the Industrial Age, not to mention the uncertainties of the agents that cause them. Thus, for the Panel should seek to reduce emissions and maximize energy efficiency alternative, but do not consider the CO_2 emissions released into the atmosphere by forests and oceans.

For the IPCC evidence of global warming are already visible with the great droughts, blizzards and storms and more intense and frequent hurricanes, melting of ice caps and rising sea levels, assuming that the severity of these events will be intensified in the coming decades. As for the skeptics changes in the systems on a global scale are part of the natural changes in the System Earth and argue about the adaptive capacity of mankind on the severity of such events.

Analysis of geological records of the last 2 million years reveal that the glacial and interglacial periods reproduced in cycles of approximately 100.000 years interlayered with short interglacial intervals of 10.000 years. So for this current, presumed that there is a tendency to global cooling, since the last ice age concluded about 10 thousand years. Thereafter, the

temperature started to have positive and negative variations indicating the end of the current interglacial cycle. Measurements carried out by the Earth indicate that in some areas, warming actually occurred. However atmospheric temperature records report that may even be occurring cooling (SUGUIO, SUZUKI, 2010).

According to Mendonça & Danni-Oliveira (2007, p.186) uncertainties regarding climate and environmental simulations for future scenarios is of the impossibility of contemporary models predict the performance of all the mechanisms of self-regulation of the globe, which can either minimize or enhance the effects of global warming. So global warming by anthropogenic actions requires more research and debate on the theme.

3. Desertification process

The term desertification began to be used in 1949 by the French forester Andre Aubreville to indicate areas where degradation pathways, due to human action, with face like a desert expanding. Aubreville points as the main causes of this process soil erosion (laminar or gully) due to deforestation and worsening drought determined by the greater exposure of the soil to the action of dry winds and solar radiation (SOAREAS, 2001; CONTI, 2005).

So with the recognition by the international community, the existence of desertification processes on a global scale comes up constituting crucial challenge for all countries and in particular for those developing (MATALLO JÚNIOR, 2001), as this process along with degradation "affect 33% of the earth's surface, where about 2,6 billion people (42% of the total population)" (BRASIL, 2005, p.4), affecting mainly the poor countries of Africa, Asia and Latin America.

Realizing the extent and seriousness of the problem, the United Nations (UN) held in 1977 in Nairobi in Kenya, the United Nations Convention to Combat Desertification (UNCCD), which conceptualizes desertification as a process of land degradation in arid, semiarid and dry sub-humid areas resulting from various factors, including climatic variations and human activities (BRASIL, 1997).

However, it should be considered that this definition was designed on the basis of the characteristics of African countries (Senegal, Mauritania, Mali, Bukina-Faso, Niger and Chad) affected by desert formation due to expansion of the Sahara in the Sahel (SAMPAIO et al ., 2003) and the socioeconomic and environmental scenarios that region are quite different from Northeastern Brazil (NEB). Thus, several scientists began researching the desertification process in the NEB semiarid analyzing its peculiarities and proposing new conceptual bases.

A pioneer in desertification studies in northeast Brazil, Vasconcelos Sobrinho (1982, 2002) provided great contribution to identify the main causes of this process, for example, geoecological predisposition or unstable equilibrium resulting from climatic, edaphic and topographical factors; the different types of human actions, direct or indirect, with its genesis in the elimination or degradation of the coating plant, triggering the commitment of the other components of the ecosystem and beginning the formation of nuclei of desertification; as well as its consequences and possible containment methodologies, discussing the biophysical and socio-economic indicators.

Said researcher also defines desertification as the process of progressive degradation of natural

resources, as a result of climatic and soil conditions and/or human action, leading to destruction of the primary ecosystem, reduced productivity and loss of soil self-healing capacity (VASCONCELOS SOBRINHO, 2002).

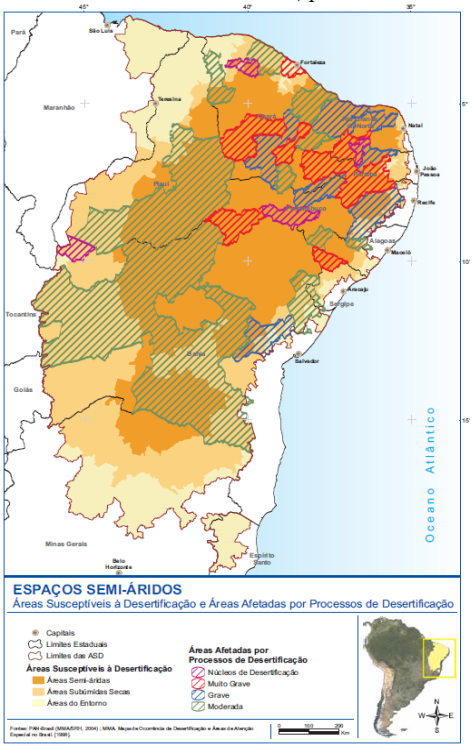
For Conti (2011) desertification comprises a complex set of dynamic phenomena that can be worsened if it coincides with the occurrence of severe and frequent droughts as a result of climate change determined by natural causes or by the pressure of human activities on fragile ecosystems, drastically reducing water stock, ie, modifying the physiographic features of certain regions, making them similar to deserts.

Thus, Abraham (2006) and Santos (2011) exposed the difficulty of systematically understand the relationship between human and natural systems, which determine the mentioned process. This problem leads to the adoption of inappropriate policies to fight causes of desertification by government institutions and organized civil society, that because its effects have connections with agricultural activities, land degradation (salinization), species, demographic phenomena (migration and negative impacts on health) and cultural aspects.

The initial actions of research and to combat desertification began to treat environmental issues in isolation studies of the processes occurring in natural systems and the planning of actions was designed from the top down with little participation of local communities. This is a traditional and lasts considered view of the development procedure applied to countries whose natural and social base appeared deeply affected by such environmental problems.

Therefore, to obtain a more accurate diagnosis and combating desertification more appropriately have set the Areas Susceptible to Desertification (ASDs) Brazil, which have a territorial extension of 1338.076 km², including 1.482 municipalities. DSAs were divided by the National Action Program to Combat Desertification and Mitigate the Effects of Drought - PAN-Brazil in the following categories: Semiarid Areas, Dry Sub-humid Areas and Surrounding Areas. Given these categories, the Mystery of the Environment, based on studies conducted by the Desert Center for CONSLAD in 1994, as well as the works of Sá et al (1994), and Torrico (1994) for the Project Arid Areas, prepared the Map the Areas Susceptible to desertification and affected areas desertification processes (Figure 4), with these occurrences classified as very serious, serious, moderate and desertification nuclei (BRASIL, 2005; 2007; PERNAMBUCO, 2009).

Figure 4 – Areas susceptible to desertification and areas affected by desertification. Source: Brazil (2007, p.27).



These divisions are necessary because of the historical and geographical context is very

heterogeneous the NEB, and the complexity of the dynamics of desertification.

3.1. Climate change and desertification of the NEB

The semiarid region of Northeast Brazil (NEB) is geographically quite vulnerable to the impacts of climate change, rising global temperatures and decrease in annual rainfall totals, and the effects of desertification, and these suffer a strong pressure for those. It is understood in this way, the variability of natural systems and human activities are perceived particularly in regional and / or local level (NOBRE, 2011; COSTA, SOARES, 2012).

Melo (2001) states that the regions most affected by desertification are those associated with periodic droughts. These serve as developers and intensifiers degradation processes. Drought is a cyclical event in the NEB and under the United Nations Convention to Combat Desertification (UNCCD) is understood as a naturally occurring phenomenon when the recorded rainfall is significantly below normal recorded levels, causing serious hydrological imbalance that affects negatively dependent production systems of land resources (BRASIL, 1997).

Therefore, climate change can affect many supply stability parameters of goods and services it provides the ground. The overall deterioration of the soil affects the overall ecological functioning as earth biomass production and hence food.

In fact, the current trend of global warming focuses on the ground operating conditions, especially the drier regions, increasing the aridificação processes and therefore desertification. On the other hand, soil degradation can pass on important cycle regularization parameters of compounds that affect the chemical composition of the atmosphere, so the climate regulation, such as changes in albedo features and evapotranspiration, retention and emission of greenhouse gases, humidity changes in soil and condensation surfaces (RUBIO, 2007).

> Desertification processes include major climatic parameters main triggering mechanisms of degradation processes. These parameters are related to temperature, radiation, precipitation, rainfall erosivity, evapotranspiration, climate variability and drought. There are important mechanisms for feedback between the trend of global warming and desertification processes, among which include albedo changes, emissions and sequestration of greenhouse gases, changes in the radiation balance, loss of ability to provide vegetation cover, emission of dust particles and aerosols and change the evapotranspiration regime (RUBIO, 2007, p.31).

Studies by Rubio and Recatala (2006), considering the above parameters in Mediterranean environments detected a direct relationship between the trend of climate change and the development of soil degradation and desertification, since these environments with trends global warming, are more susceptible to these processes.

Studies by the IPCC (2007) in the NEB design scenarios warmer, dry and extreme events (droughts), indicating probable desertification. The criteria for assessment of these processes require the evaluation of interannual variability of rainfall through formulas that take into account the annual standard deviation of the phenomenon, in addition to performing spectral analysis of time series of precipitation, in order to detect ciclicidades, periodicities and trends (CONTI, 2008).

Climate change and desertification promote profound implications for agricultural planning and water supply management (MARENGO, 2006). Campos (2009, p.83) asserts to mention that

> In the Northeastern, in general, climate change will bring as consequences greater intensification of dry spells; the tendency to aridization; a high rate of evaporation can affect the level of dams and subsistence agriculture; water shortage; and migration from the countryside to the cities (climate refugees). Moreover, the poorest and worst development indicators will be the most vulnerable to climate change, which has intensified environmental, social and economic problems existing.

The future scenarios are fraught with uncertainty, thus the interactions between climate change and desertification require more knowledge about the impact of different climatic factors on the various soil degradation processes, and the ability of this minimize the global warming trend especially the NEB.

4. Final considerations

Climate change and desertification have been causing concern of government entities in local, state and national levels, as various studies and programs have been developed with a view their approaches, knowledge and confrontations.

The analysis of this phenomenon and process are complex and contradictory and there is no general consensus and absolute about the consequences of those on this, since the discussions on these issues are dealt with vehemence between the current defending global warming and skeptics. However, it is essential to carry out more studies integrating such events, since they are already taking place in various regions of the planet, including the NEB.

Evidence of climate change (greater variability in rainfall patterns and more frequent extreme events - droughts and floods) and intensification of desertification (expansion of ASDs) are sharp in the NEB. Thus, one should seek to understand the nature and extent of these phenomena and their impact on society in order to determine effective, efficient and effective policies to combat, mitigate and adapt to the effects thereof.

Despite urgent and fundamental to face the effects of climate change and desertification process and implementation of mitigation measures, public policies make up isolated actions and investments, actions and programs have proved little efficient and effective manner.

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