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REVIEW

Impacts of Climate Change in Portugal: Common Perception of Causes and Consequences in Forest Development

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ABSTRACT

Presently the world faces what most likely will be the greatest challenge humanity has ever faced. Climate change is a phenomenon, or rather a set of phenomena, that directly influences the daily lives of human populations all over the planet. However, this influence normally negative also affects ecosystems, with emphasis on agroforestry systems, of which human populations are directly dependent on food and in a large number of primary raw materials. It is with this premise as a starting point that this work makes an analysis on the current state of climate change in Portugal, since, being a country of Mediterranean climate influence, it should be one of the territories where changes will be felt with more intensity and severity. In this work, the current position on energy production in Portugal regarding Green House Gases (GHGs) emissions and the evolution prospects for the near future, namely in the perspective of the impacts caused on forest resources, are discussed.

1. Introduction

The world today is facing a number of problems for which it is not yet able to envisage solutions, particularly regarding the impacts caused by environmental issues. For example, climate change, which is itself a major problem, leads to a huge number of other problems [1, 2, 3].

It is now undeniable that climate change is a reality that directly affects the daily living of societies, wherever they may be, since it is a globally occurring situation, it does not affect only a few disadvantaged groups [4, 5, 6]. It is a planetary problem which, while affecting all regardless of latitudes or stages of development, is not caused by everyone with the same degree of responsibility and intensity [4, 7].

However, although it is a fairly democratic phenomenon in its dispersion and consequences, it is also well known that those most affected will obviously be those who, because they have less capacity for reaction and adaptation, will feel more intensely the effects of this new reality. That is, those who live in regions where climatic extremes are most easily felt, where water is scarce, or where pests and outbreaks of disease can occur more insistently and frequently [5, 8, 9, 10].

Of course, they will be the first inhabitants of Earth to suffer the damage caused by climate change, either directly through the occurrence of extreme weather events, or indirectly through the changes brought about by the reac-

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tion of terrestrial systems to the new reality [9]. As a result, many systems are unlikely to be able to adapt and evolve in the face of this new situation, most likely contributing to the mass extinction of species and to the emergence of invasions of certain ecosystems by other species, occupy-ing the emptiness left by those who died out [11, 12].

This is the background for the beginning of a research that is considered innovative in terms of approaches and perspectives due to its evaluation of the impact of climate change in the forest, at the same time that it tries to relate this phenomenon with other occurrences. For example, this is the case for the fires that occur in rural environment and forest fires [13, 14, 15], but also with the dispersal of invasive species, which greatly benefit from the post-fire situation due to their heliophilous behavior, quickly occupy open clearings and preventing the recovery of other less resilient species [16, 17, 18].

This article intends to review the current state of the art regarding the impact of climate change in Portugal, focusing on the changes that are already somehow occurring in the forest. For this review, are analyzed articles made available in the media channels such as TV channels, newspapers, news agencies, news websites, among others, and that shape the opinion of the populations and the way they understand the environmental phenomena and their impact on the daily activities, mainly those directly related with electricity production as being considered one of the most important contributing sector for carbon dioxide (CO_2) emissions.

2. Approaching The Problem

It will be in the context of a world in transformation that mankind will have to adapt and evolve, especially from the perspective of daily activities, to reach a collective consensus that aims to minimize the damage caused up until the present moment [19, 20]. That is, assuming a cause-effect relationship between anthropic activity and climate change as the binomial responsible for the current situation, man not only is the dominant species—but also as the one that can potentially suffer the effects which are expected to occur more—must act in response to two different perspectives [6, 21, 22].

The first perspective has to do with the need. If it is not possible to reverse the situation quickly, we must at least contribute effectively to its reduction and mitigation, since it is also expected that the current trend of intensification of the occurrence of anomalies can be achieved in a short time [23, 24]. This difficulty in achieving consensus when everything would indicate otherwise has much to do with the nature of man, who in his constant search for power and wealth almost always neglects his own survival, since the risk is not immediate [25]. That is, the thought that con-tinues to proliferate is the one where there is still time, only we do not know how much [21, 26].

The second perspective has to do with the need to change the energy paradigm on a global scale, which is considered as the main cause of climate change [27]. However, valid measures of the use of renewable energy sources on a very small scale, or with some megalomaniac projects, but which in fact do not contribute much to the overall calculation of the mitigation of CO_2 emissions, are a concern. Decisive steps towards the substitution of fossil fuels still seem far from being taken, since the alternative solutions have not yet shown the capacity to be functional alternatives that are both available and efficient [28, 29].

In fact, the great problem of mankind is related to the need for energy to be continually created, due to becoming totally dependent on it for the accomplishment of almost all the tasks of our day-to-day activities [30]. Our excessive reliance on transport facilities and technological equipment in industrialized or developing countries means that dependence is also a reason to define the degree of autonomy and independence of a country, relative to the exterior. An example of this is the frequent military and diplomatic conflicts that have oil, natural gas, or even coal as their causes [31].

This carbon-based economy has led mankind to a path marked by the development of comfort conditions, albeit with marked asymmetries, but which have allowed a state of civilizational evolution to be achieved—especially after the industrial revolution made better living conditions possible for a very significant proportion of the world's population [32]. However, as a consequence, environmental issues related to the continuous and intensive exploitation and use of fossil energy resources, such as oil, coal and natural gas, are responsible for the release of GHGs, particularly CO_2 [33].

In this global perspective, where there are several factors that intervene in the development of climate change events, it is possible to find numerous articles in the media that address these issues [34, 35]. As expected, if some have a merely informative and often didactic role for the less educated populations in these technical-scientific subjects, other articles are mediatic and alarmist presentations, in which the events are extrapolated and presented in a sensationalist way [36]. Obviously, the latter lose all interest as vehicles of information transmission and are only channels of disinformation [37].

In the present work, were collected and analyzed the news available in recent years, where some events related to climate change in Portugal are reported, in order to build a sequence of interactions between the causes and

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consequences of the reported phenomena. Thus, the interconnection of CO_2 emissions from large-scale coal combustion for electricity production was analyzed, with the effects, some of which have already been verified, on the Portuguese forest and how it will evolve.

Although Portugal is a small country, it presents a considerable area of soil occupied by forest. This land occupation, which accounts for about 35% of the total area of the country, has a significant influence on the national economy, which, for example, has three of its main economic groups based on forestry activities. In addition to this macroeconomic perspective, it should be noted that rural populations, which account for a significant proportion of the Portuguese population (26%), depend directly or indirectly on economic activities related to the forest, usually as a complement to other agropastoral activities. In this way, any change in the normal development of the forest ecosystem will also change the way of life of these populations, and this change is greater the faster these changes, since everything depends on how fast they will occur [38].

3. Analyzing and Discussing the Facts

A report published on May 7, 2015, on the ZAP news site and based on the LUSA news agency, reported that "the concentration of CO_2 in the atmosphere reached a record level in March, with the monthly average worldwide concentration of CO_2 in the atmosphere exceeding for the first time the 400 ppm level", according to information provided by the North American Agency for the Oceans and Atmosphere (NOAA) [39, 40].

In the same news report, the chief scientist responsible for the monitoring of greenhouse gases at NOAA, Pieter Tans, stated that "this was a matter of time, since the agency's measurement stations had already signaled the Arctic in the spring of 2012 and in Hawaii in 2013. Now reaching the 400 ppm level in the world as a whole makes it very significant. Until the industrial revolution of the 19th century and the massive recourse to fossil fuels, the rate of CO_2 in the atmosphere will not have exceeded 300 ppm for at least 800,000 years, according to studies on polar ice, which shows that the combustion of coal and oil has caused an increase of more than 120 ppm in CO_2 concentrations since the pre-industrial era, half of which since 1980" [39].

However, while CO_2 is not the only GHG responsible for climate change, given its abundance and percentage increase in relation to the pre-industrial starting point, it is surely the main GHG responsible for the phenomena anomalies that are currently being observed [41].

On the same day as the news report above, but on the SIC NOTÍCIAS website, the International Energy Agency announced that "the increase in global CO_2 emissions from fossil fuel combustion had been interrupted in 2014, when it stabilized at the 2013 level, but stabilizing the rate of greenhouse gas emissions is insufficient to prevent climate change" [42].

According to James Butler, from NOAA, "it would be necessary to eliminate about 80% of the CO_2 emissions from fossil fuel combustion to actually stop the increase of CO_2 concentration in the atmosphere. Presently existing concentrations will not begin to decrease before further drastic reduction of CO_2 emissions and, even then, the decrease in atmospheric concentrations will be slow". To substantiate this information he indicated the NOAA data, which shows that the average rate of increase of CO_2 concentrations in the atmosphere has been 2.25 ppm per year from 2012 to 2014—the highest level ever recorded in three consecutive years [42].

For these reasons, it is already widely accepted that it is a matter of urgency to reduce carbon dioxide emissions, and the declarations of officials—mainly politicians—are frequently reproduced in the media, and in some cases highly restrictive measures are being announced which aim at, for example, a definitive ban on the use of coal for energy production [43].

This type of demonstration has also arrived in Portugal, with Environment Minister João Pedro Matos Fernandes declaring, on November 16, 2017, in an interview to SIC NOTÍCIAS television channel, that "Portugal will stop producing electricity using coal by 2030, until then, they must close the two thermoelectric power plants that exist in Portugal"[44].

These statements, issued in Bonn, Germany, when the Minister of the Environment participated in the Climate Summit, were subsequently repeated and confirmed in various situations, including by Prime Minister António Costa himself, who on his official TWITTER wrote on 12 December 2017 that "we are committed to abolishing coal-fired power generation by 2030 and to encouraging companies to reduce their use" [45].

However, reality shows that this will be a very difficult goal to fulfill if the paradigm of electric energy production is not changed. As proof of this difficulty, it is sufficient to present the consumption of coal in 2017, which according to the newspaper PÚBLICO of June 15, 2018, signed by the journalists Luís Villalobos and Ana Brito, increased "71% compared to 2016, reaching 444 million euros" [46].

In fact, this is a trend that has been confirmed in recent years, with a few exceptions. The growing need for more energy, especially from the industrial sector and perhaps fueled by economic growth after the end of the Troika

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period, led to an increase in coal consumption in the two thermoelectric plants in Portugal, namely the Central of Sines, owned by EDP – ELETRICIDADE DE PORTUGAL, and the Central do Pego, owned by TEJO ENERGIA. These stations consume approximately 5.5 million tons of coal monthly, imported from places such as Colombia, Venezuela, or South Africa [47].

Although the growing need for electricity needs to be met, it seems that the way to do so is through moving towards decarbonizing the economy, since, as already mentioned, policy makers continue to refer to the permanent notices that come mainly from sources involved in the sector, such as the one presented in a piece signed by the journalist Ana Batista on January 11, 2016, in the financial information website DINHEIRO VIVO. In this, Nuno Ribeiro da Silva, from ENDESA, states that "to this happen we need to use more combined cycle and natural gas powerplants in Europe, which is not as cheap as in the US. In fact, it is more expensive than coal. To produce a MWh with gas it costs $70.00 USD and with coal it costs $40 to $45 USD" [47].

However, is it the case that Portugal can only withstand renewable energies? This is a question for which the answer may seem obvious but, nevertheless, the arguments that can be put forward by proponents of coal continuity and advocates for the exclusive use of renewable energy sources can be as valid on the one hand as on the other. For example, in the same report of DINHEIRO VIVO mentioned above, to justify the importance and necessity of using coal, in addition to what has already been presented and related to the cost of production, it is argued that "although Portugal is an example in renewables, to produce all the national consumption it was necessary to have even more wind and dams and solar power stations (than those needed to supply the totality of the need). Because time is unpredictable, and a coal-fired power station is the most predictable there is". That is, with renewable energy as the only energy source for the country, Portugal runs the risk of not having the structures capable of meeting needs in case of failure when it is not possible to produce electricity with the wind, sun, or water resources [47].

4. The Near Future

The arguments available are many and varied, but all pointing in the direction of environmental benefits—notably the reduction in Greenhouse Gases emissions and its contribution to mitigating the phenomenon of climate change, despite coal having a clear economic advantage, including with respect to the use of natural gas [48, 49]. Any renewable energy source suffers from the same disadvantage, since all depend on the climatic conditions, and can fail at any time by any change in the normal conditions of sun exposure, intensity and direction of the wind, or precipitation [50].

As already mentioned, there may always be a need to remedy the lack of energy in periods when it is not possible to use renewable sources [51]. For these situations, either by the absence of energy production or by the occurrence of unexpected consumption spikes, it is necessary that the power grid be supported by back-up units, which can be activated whenever more power is requested to the grid, and that can match quickly and with enough quantity to respond to the demand [52].

It may be at this point that biomass power plants can play a very important role, since, as part of the renewable energy source segment, they could be an alternative to coal-fired power plants. In some situations, there may also be the possibility of converting the units to coal for biomass, thus ensuring continuity of the energy supply so that the supply is maintained at critical times [53, 54].

However, the use of biomass is also not without its problems, as it depends on a natural resource in constant evolution, and on those most likely to be the most affected by climate change. From this perspective, the influence that climate change may have on forest development and its evolution could determine if the resource remains unchanged, or if, on the other hand, it changes and acquires new characteristics [55]. For example, the diversity of forest species in a given region can be altered by replacing certain species with others which are more adapted to the new circumstances, even if they are all indigenous but can migrate from other regions where edaphoclimatic conditions are closer to the new reality. On the other hand, the new conditions may allow and stimulate the substitution of native species for exotic species, which may even assume an invading behavior [56].

5. Conclusions

These changes in the forest cover must be analyzed in addition to the problems caused by the loss of biodiversity, since in such a situation the economic issues arising from the use of the natural resource will be quickly felt, especially by populations that depend directly on the forest and on the resources available in the forest space.

Examples are the dispersion of exotic species such as acacias in areas traditionally occupied by native species providing some kind of yield, such as oak providing good quality timber for the furniture industry, trees that provide pine nuts, or even areas of various species that are used for the production of honey. Should these examples be replaced by a species such as acacia trees, they would no

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longer yield any profit.

Additionally, the increase in the probability of the occurrence of forest fires is associated with the phenomenon of climate change, since there is a trend towards favorable conditions for the occurrence of fires, especially with the increase in the fuel load caused by exotic species.

The combination of all these factors, which are associated with others of a demographic and cultural nature, increases the risk of occurrence of fires that cause destruction of the forest heritage, and are therefore of interest of those who work and research in the development of the forestry sector. In a relatively short space of time, Portugal can expect to experience profound changes in this important sector of its economy.

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