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Original Paper

Impact Of Climate Change On The Phytobiodiversity Of Tazekka National Park

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Abstract

The Tazekka National Park, created in 1950 on an initial area of 680 hectares, located in the mountain range of the Eastern, Middle Atlas, offers a great variety in terms of the landscape and the diversity of forest populations. However, studies have reported that the park's biodiversity is threatened due to anthropogenic and climatic factors. The aim of this work is to carry out a comparative study concerning the influence of climate change during the years 1985, 2007 and 2018 on the distribution of plant species in different stations of the Tazekka National Park (Ras al ma, Bab Boudir, Bab Azhar and Jbel Tazekka).

To carry out this work, several field trips were carried out. The results obtained in the form of GIS using the ArcGis 10.4.1 software have shown that climate change significantly influences the plant biodiversity of the Park. It is necessary to find assessment, monitoring and management strategies for these climate risks in order to preserve phytobiodiversity.

Keywords

Climate change, tazekka national park, phytobiodiversity, risks, strategies

1. Introduction

Currently, climate change is a reality and our planet's climate is very unstable. Indeed, the impact of climate change is unprecedented and biological responses to these changes are also rapid at the level of ecosystems, communities and species (Heino et al., 2009).

Morocco is one of the most original Mediterranean countries from a geographical, climatic and ecological point of view and, consequently, among the most interesting in terms of its wealth in biodiversity.

Several factors interact to provide a vast floristic diversity in the western Mediterranean basin. In order to protect this national heritage, the Kingdom of Morocco has identified a network of ten national parks including the Tazekka National Park (PNT) located in the mountain range of the Eastern Middle Atlas. It offers a great variety concerning the landscape and the diversity of forest stands. However, this national park suffers from many obstacles which are obstacles to its development. Indeed, human pressure and climate change are among the most important factors that condition the evolution of this flora, which is seriously threatened with extinction (Jinghua et al., 2014).

In this context, we have studied the effects of climate change on the phytobiodiversity of the PNT and proposed strategies to mitigate the risks associated with these changes.

The analyzes of the Landsat images of the years 1985, 2007 and 2018, carried out by the ArcGis 10.4.1 software, allowed us to highlight the spatio-temporal variations of the plant groups at the level of the Tazekka National Park (PNT).

2. Method

2.1 Geographical Setting

To conduct this study, several field trips were organized in different PNT stations (Ras al ma, Bab Boudir, Bab Azhar and Jbel Tazekka), (Figure 1). Comparison between climatic data from 1985, 2007 and 2018, was made using the ArcGis 10.4.1 software.

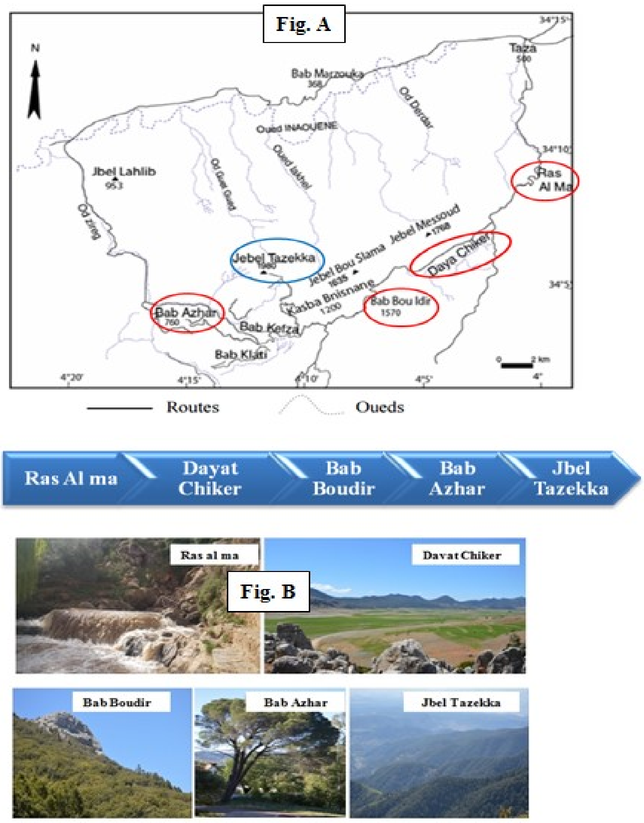

Figure 1. Figure A: Geographical Location of the Tazekka Massif in Northern Morocco (Fougrach et al., 2007); Figure B: The Various Stations and Limiting Zones of the PNT (Photos taken in 2017 PNT).

2.2 General Presentation of the Study Area (PNT)

In the Middle Atlas, particularly in the southwest of the town of Taza, is located the Tazekka National Park (PNT), which now covers 13,737 hectares and which is home to a plant biodiversity very rich in forest formations (Cedar, Oaks, pines...) and the vascular flora.

2.3 Climatic Data

The climate is characterized by its climatic elements, in a region determined. Indeed, these climatic elements are measurable (pressure, precipitation, humidity, winds, temperature,...) and which are influenced by local geographical factors: latitude, altitude, continentality, arrangement and characteristic of the relief , vegetation and also the urbanization.

For the various PNT stations, the Emberger rainfall climagram (Figure 2) shows that the bioclimatic encountered in the study area range from sub-humid to humid with variants ranging from cold to temperate.

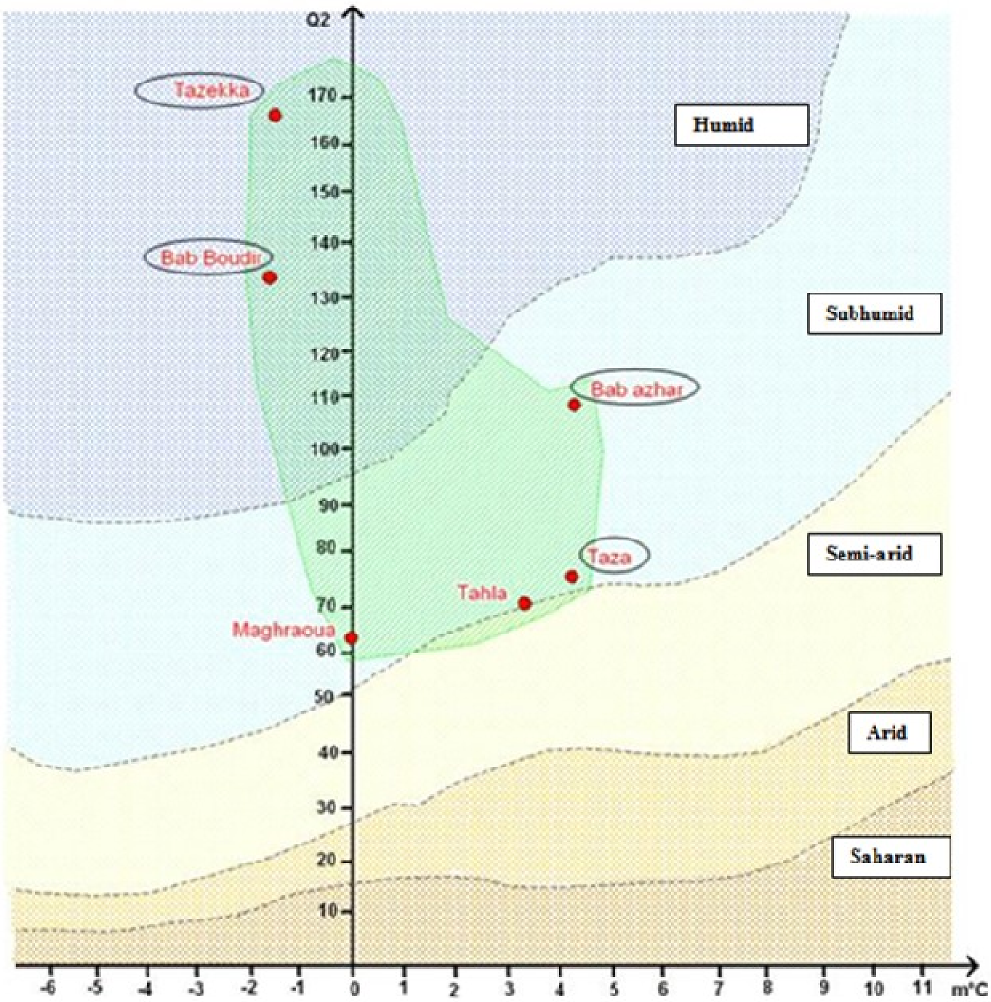

Figure 2. Situation of Climatic Stations on a Pluviothermal Climagramme of Emberger "Toba Study Office / Methodological Report - April 2016"

According to Figures 3 and 4, there is a very clear difference in the temperatures and precipitation measured at Taza during the years 1985, 2007, 2017, 2018 and 2019. This certainly has an important influence on the distribution of plants species at the level PNT.

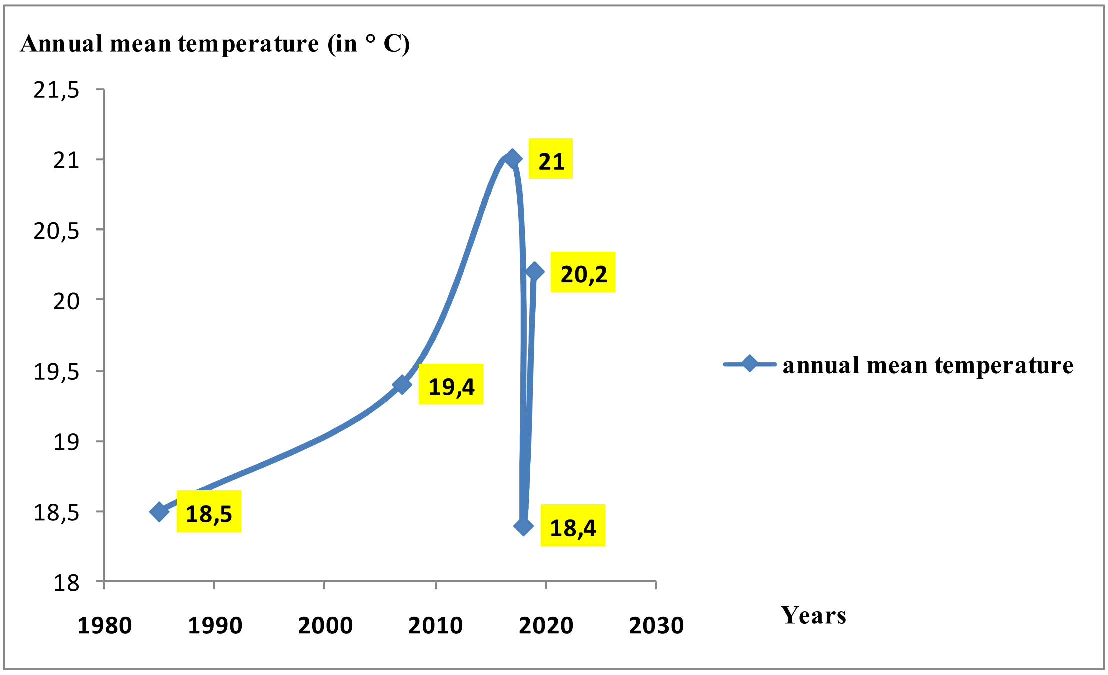

Figure 3. Monthly Temperatures of Taza during the Years 1985, 2007, 2017, 2018 and 2019

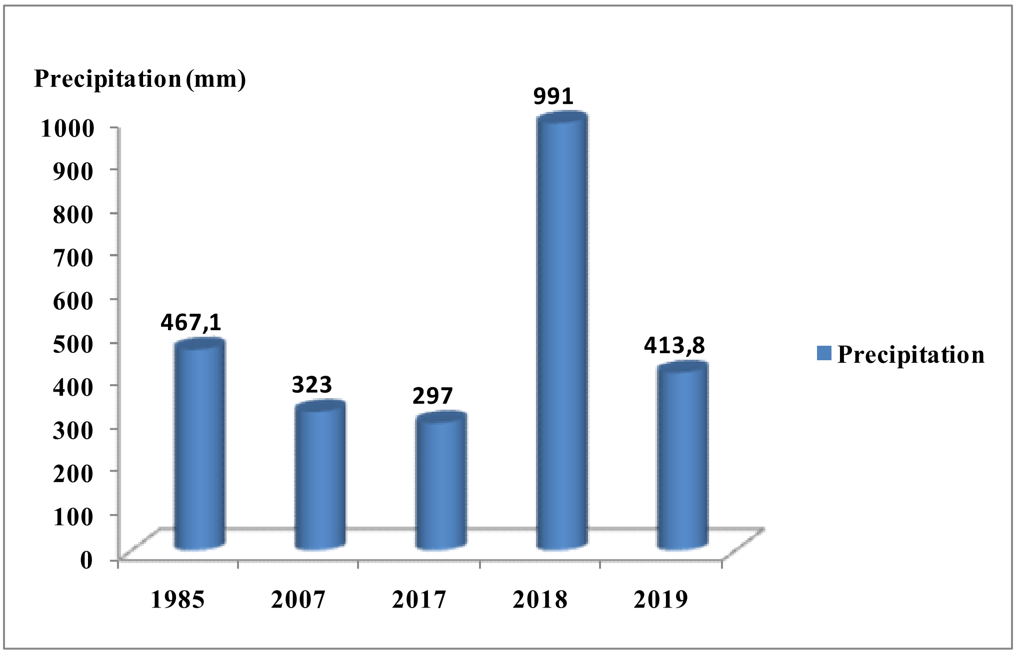

Figure 4. Monthly Precipitation (mm) of Taza during the Years 1985, 2007, 2017, 2018 and 2019

* Edaphic data Tazekka National Park covers, to the south-west of Taza, the northern part of the Middle Atlas and dominates the southern Rif corridor. Several types of soil can be observed in the Park, which falls into four classes (DEFCS/BCEOM-SECA, 1994).

• Soils containing iron sesquioxides
• Poorly evolved soils
• Calcimagnesium soils
• Modal brunified soils

2.4 Methodology

We have three Landsat satellite images from 1985, 2007 and 2018 to follow the spatio-temporal evolution of the natural vegetation cover in the PNT. The methodology consists of dereferencing the images, combining the spectral bands, classifying the plant groups and recognizing the chlorophyll activities of the vegetation. There are several clues to study the evolution of chlorophyll activity. The NDVI is the most widely used for mapping plant environments. Developed by (Rouse and al., 1973), it reflects the different reflectances of the vegetation. The result of a NDVI takes the form of a new image, the value of each pixel being between 0 (bare soil) and 1 (maximum vegetation cover), (Hountondji et al., 2004).

3. Results and Discussions

According to the outings carried out in different PNT stations, the tree stratum includes several species classified into two categories according to their abundance. We distinguish between major forest species and secondary forest species.

Among the major forest species we mention the Atlas cedar (Cedrus atlantica), we also mention the holm oak (Quercus rotundifolia), the cork oak (Quercus suber), comes the zeen oak (Quercus faginea). Finally, the kermes oak (Quercus coccifera) which is very rare.

The essences foresters qualified as secondary, we can mentionthe oxyhedron juniper (Juniperus oxycedrus), mixed with the aformentioned major forest species. The strawberry tree (Arbutus unedo) is also very abundant. Also, we note the presence of the wild olive tree (Olea oleaster), the carob tree (Ceratonia siliqua), the holly (Ilex aquifolium), the dimorphic ash and oxyphylle (respectively Fraxinus xanthoxyloides, F. angustifolia) and thuja (Tetraclinis articulata)).

While the herbaceous layer in each station of the park is very diverse in plant species which belong to several botanical families.

The results obtained by use of the ArcGis 10.4.1 software and by comparison between climatic data from 1985, 2007 and 2018, showed the consequences linked to the variations of certain environmental factors on ecosystems (Figures 3 and 4) of precipitation and temperatures as well as Figures (5, 6, 7, 8, 9 and 10) by using ArcGis 10.4.1).

Figure 5 shows the distribution of different plant species in the Tazekka National Park.

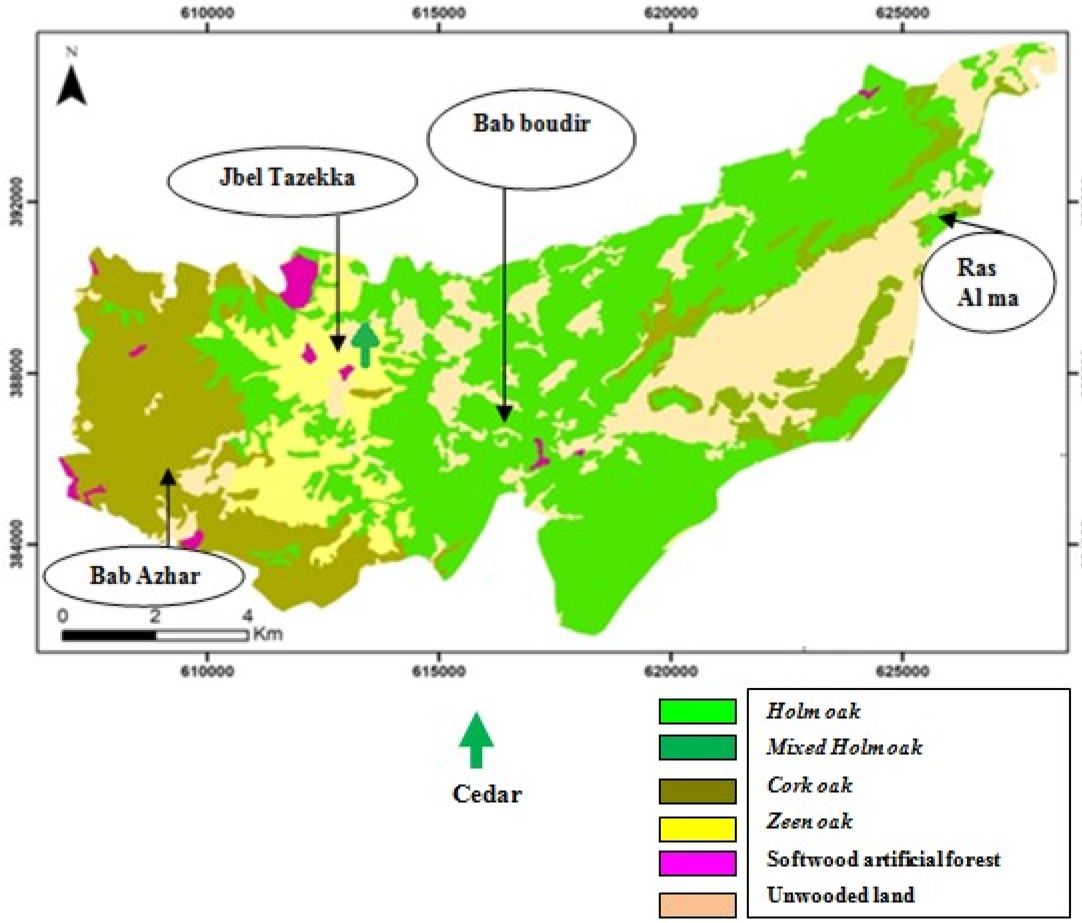

Figure 5. Representative Map of the Vegetation Distribution at the NPT Level "by Using ArcGis 10.4.1"

In the **Ras el ma** resort we find the presence of **holm oak** and **mixed holm oak** accompanied by **unwooded land**.

At the level of **Bab boudir** we see that it is the **holm oak** which dominates with a weak presence of the **artificial resinous forests** which contain the **cedar**.

Concerning **Jbel Tazekka** it is the **cedar** which dominates with the presence of the **zeen oak**.

Within the **Bab Azhar** zone, **cork oak** dominates with the presence of small spots of **coniferous forests**.

Currently, vegetation growth and biomass production are monitored regionally using NDVI.

When the normalized vegetation index (NDVI) is between 0 and 1, the vegetation is therefore denser. Conversely, when the NDVI is between -1 and 0, the vegetation is light and moderately dense.

The integration of the images of Figures 6 and 7 which represent images of the INDV of the years 1985 and 2007 gives the map represented in the figure 8 and those of Figure 9 (maps A and B) gives the map represented in the Figure 10.

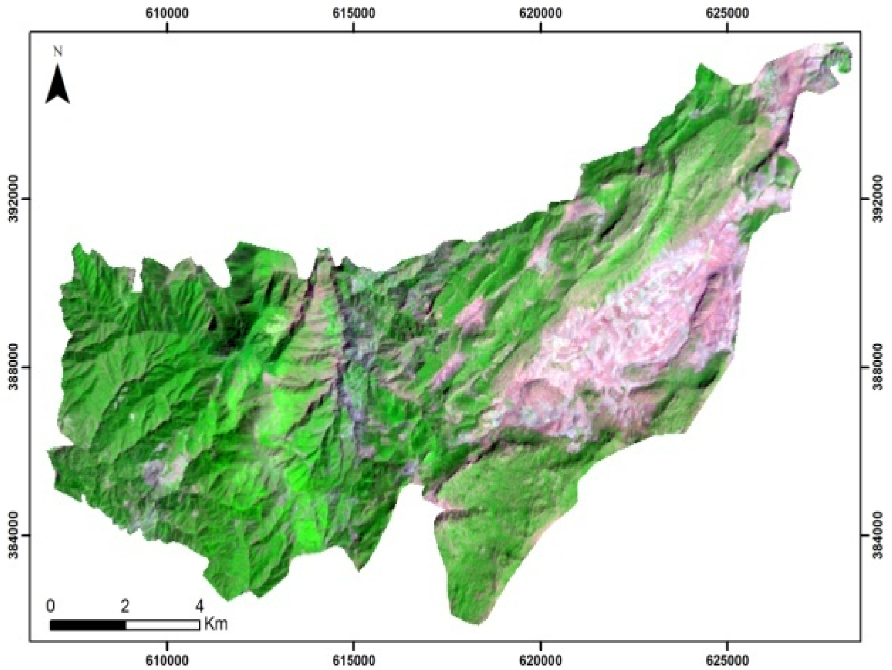

Figure 6. NDVI Image from 1985

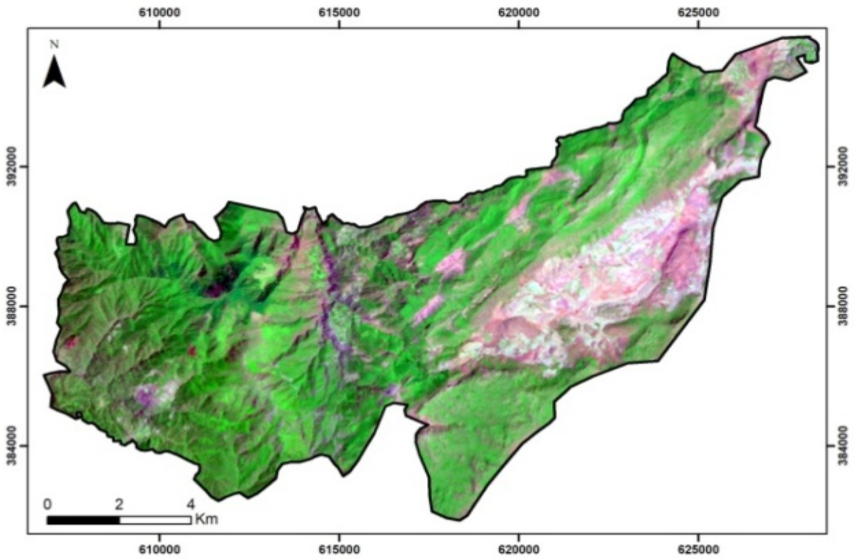

Figure 7. NDVI Image of the Year 2007

Indeed, figures (8 and 10) represent the distribution of vegetation on satellite images of Tazekka National Park (PNT) under the influence of climate change during the years (1985, 2007 and 2018), by using Landsat satellite images on ArcGis 10.4.1 software. In other words, each image in figures (8 and 10) represents the chlorophyll evolution of a period between 2 years.

According to Figure 8 (1985-2007), there is a very clear difference concerning the 4 stations of the PNT.

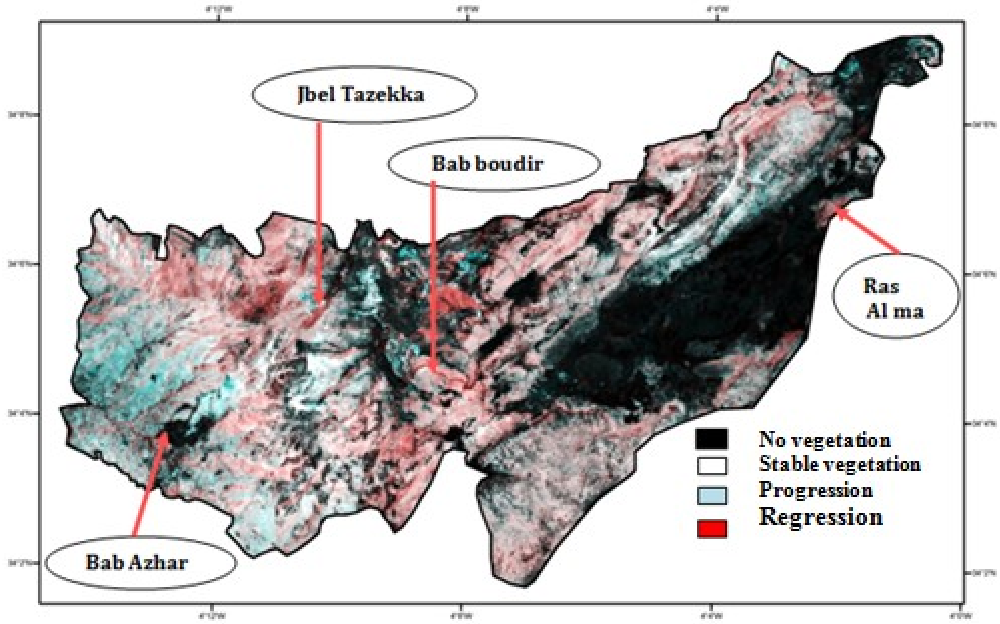

Figure 8. The Distribution of Vegetation at PNT Level under the Influence of Climate Change between 1985 and 2007 (ArcGis 10.4.1)

For Rass al ma:

We find that there is a slight disappearance of the coloring but which will be replaced by blue and light red which means that there is a progression accompanied by a vegetative regression.

For Bab Boudir:

It is observed that the red color covers the length of the territory of the zone which means a great regression concerning the vegetation.

For Jbel tazekka:

In this area there is an appearance of the red color which shows a more remarkable vegetative regression.

Bab Azhar:

For this station we note the presence of three colors (red, blue and black).

According to figure 10 (1985 - 2018), a very clear difference can be observed at the level of the 4 PNT stations. In fact, in this area we noticed that the blue color appears more and more, which explains the evolution of the vegetation in this region.

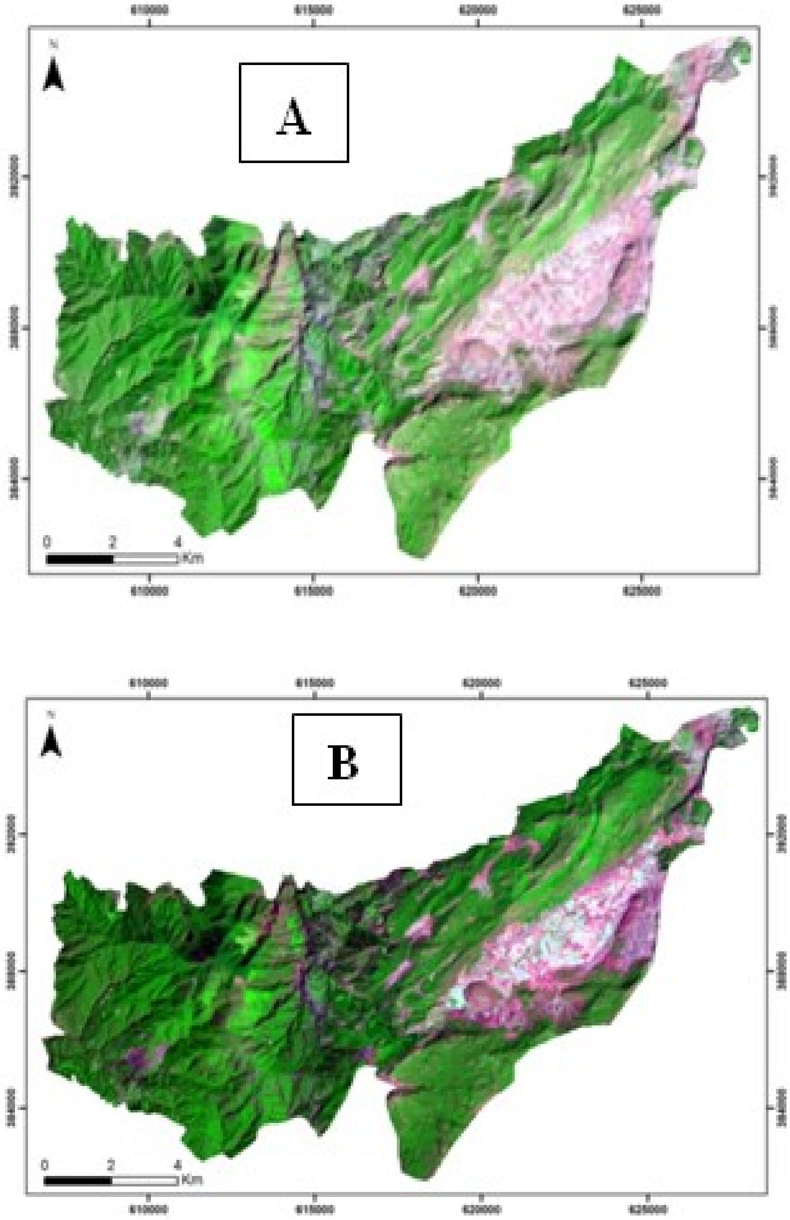

Figure 9. NDVI Image from 1985 (Map A) and 2018 (Map B)

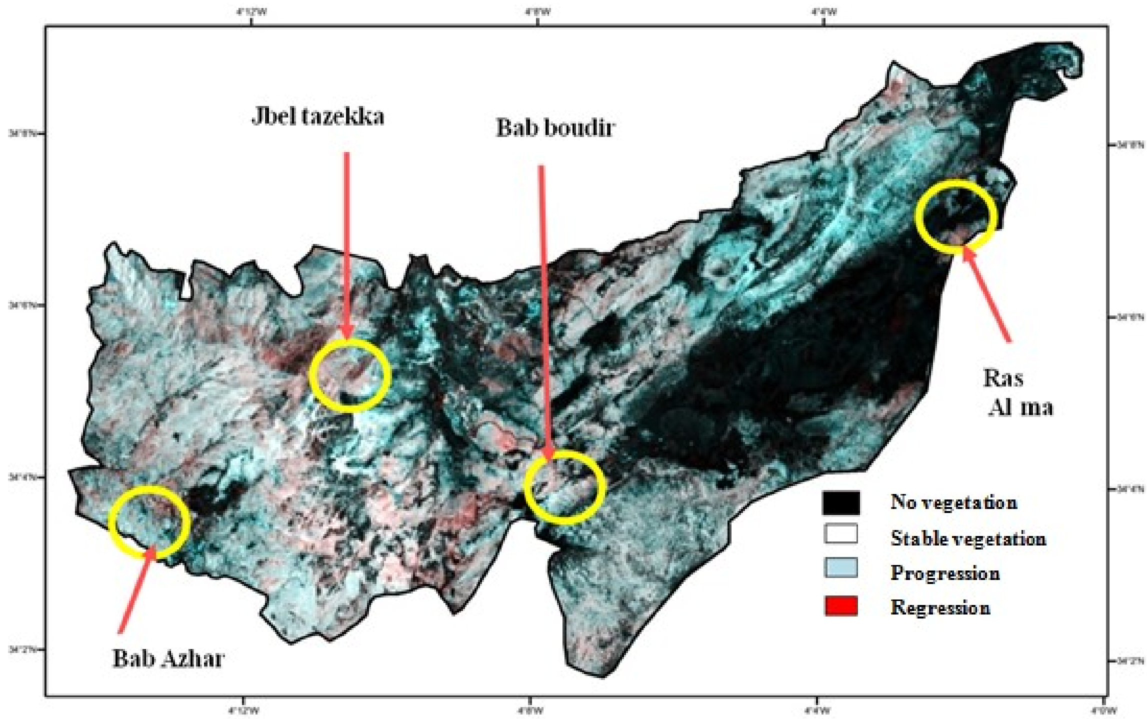

Figure 10. The Distribution of Vegetation at PNT Level under the Influence of Climate Change between 1985 and 2018 (ArcGis 10.4.1)

At the Ras Al ma station, we notice that it is the black coloring which dominates in this region which explains the almost total absence of vegetation accompanied by a small vegetative evolution indicated by the blue coloring of the Holm oak.

At **Bab Boudir**, we note the presence of white and light blue. Therefore, the white coloring indicates that the vegetation remains stable without any progression and the light blue coloring indicates a weak evolution which affects the flora and which is distributed along the region (presence of arboretum).

In Jbel tazekka station, we notice that there is a dominance of two colors (black and blue). So we almost have a balance between evolution and the absence of vegetation. In addition, we also have a small patch of red coloring which signifies vegetative regression (Holm oak and Zeen oak).

Meanwhile, in the area of **Bab Azhar** we observe multiple colors (blue, red and black) with dominance of blue and white. Therefore, the vegetation is present along the area with a rather weak evolution (presence of the cork oak).

Therefore, from 1985 until 2007, the vegetative diversity of these stations experienced a more significant regression which is marked by the color red.

From 2007 until 2018 a progressive evolution of the vegetative territory appears in all the stations and which is more remarkable by the blue coloring.

Vegetative regression and progression are due to human activity and climate change (temperature and precipitation).

Several studies (Bigot et al., 2005; Cecchi et al., 2009; Soro et al., 2013) have shown that the dynamics of land use is closely linked to several factors, whether it be climatic (type of climate, temperature, humidity, etc.), topographical (altitudes, slopes, exposure of the slopes, etc.), the nature of the soil and finally human action.

Therefore, the applications of space techniques using the ArcGis software make it possible to establish maps of land use and its evolution according to different spatial and temporal scales and to issue an early warning in the event of drought based on various indices. spatial as the vegetation index by normalized difference.

All of these results provide proof that plants are migrating with current climate change to maintain the temperatures necessary for their survival. The different migration speeds between trees and herbaceous plants can also increase competition between plant species, and should lead to a change in the composition of plant communities and their relationships with the animal species that interact with them (Lenoir et al., 2008).

Climate change therefore corresponds to long-term modifications of one or more elements of the climate, mainly temperature and precipitation (Stucki et al.,1998).

This therefore leads to a transformation of the environment which results in the disappearance and appearance of certain habitats and, more generally, by the displacement of the geographical area which hosts the habitats necessary for a species.

A Kenyan study has shown that the risks of floods and droughts have the greatest effects on Kenyan society and that the country urgently needs a series of measures to tackle current and future vulnerabilities from climate change (Samwel, 2017).

Other research has already shown that there is a generalized change in the natural calendars (phenology) of plants and animals, as well as changes in the distribution of some species (Lovejoy, 2008).

Some tree species may be able to adapt to climate change, allowing trees to survive in many nature reserves, but some cannot (Jinghua et al., 2014). Indeed et al. (2020) showed that climate change may lead to an increase in abundance of one plant species by reducing the abundance of another.

Therefore, for many plants, climate has indirect effects and most studies have generally agreed that variation in environmental factors (including climate change) dominates the deterrent processes for changes in the composition of plant communities (Heino et al., 2010; Mykrä et al., 2007; Victorero & al., 2018). This will increasingly contribute to the disruption of the earth’s natural ecosystems and lead to the extinction of plant species.

4. Conclusion

The main objective of this study was to show the evolution of the climate in the Tazekka National Park over three periods during the years 1985, 2007 and 2018 and its influence on the distribution of plant species in the different stations of the park.

In fact, the results obtained by the ArcGis software have shown that there is really a climate change which influences the plant biodiversity of the Park. Among the effects of this phenomenon, the shift in the range of these species towards the poles and higher altitudes.

Also, many species have adjusted or adapted to the modification of their living conditions. Other species or taxa have not adapted, which has caused their total or partial disappearance in the geographical air of the Park.

Climate change therefore modifies the abiotic factors of the environment in which living organisms evolve: light, temperature, soil and air humidity, chemical composition of water, atmospheric and hydrostatic pressure, physical and chemical structure of the substrate. These changes can have significant impacts on the structure and functioning of ecosystems, by modifying the biology or behavior of organisms (plants, animals, microorganisms).

For that, it is very necessary to develop research in this field and to multiply the efforts in order to propose solutions and new strategies which make it possible to attenuate the factors which accelerate climate change in particular, the use of renewable energies, practice climate-smart agriculture and preserve forests.

References

Bigot, S., Yao Brou, T., Oszwald, J., & Diedhiou, A. (2005). Factors of rainfall variability in Côte d'Ivoire and relationship with certain environmental changes. *Science and planetary changes (John libbey)*, *16*(1), 5-13.

Cecchi, P., Gourdin, F., Koné, S., Corbin, D., Etienne, J., & Casenave, A. (2009). Small dams in the north of Côte d'Ivoire: Inventory and hydrological potential. *Science and planetary changes (John libbey)*, *20*(1), 112-22. https://doi.org/10.1684/sec.2009.0164

DEFCS/BCEOM-SECA. (1994). *Tazekka National Park, plan director for development and management* (Vol. 1 & 2). Rabat, Maroc.

Fougrach, H., Badri, W., & Malki, M. (2007). Rare and endangered vascular flora of the Tazekka massif. *Bull Inst Scient (Rabat), Life Sciences section*, (29), 1-10.

Heino, J., Mykrä, H., Kotanen, J., & Muotka, T. (2010). Ecological filters and variability in stream macroinvertebrate communities: Do taxonomic and functional structure follow the same path? *Ecography*, (30), 217-230. https://doi.org/10.1111/j.0906-7590.2007.04894.x

Heino, J., Virkkala, R., & Toivonen, H. (2009). Climate change and freshwater biodiversity: Detected patterns, future trends and adaptations in northern regions. *Biological reviews*, *84*(1), 39-54. https://doi.org/10.1111/j.1469-185X.2008.00060.x

Hountondji, Y. C., Ozer, P., & Nicolas, J. (2004). Highlighting of areas affected by desertification by low resolution remote sensing in Niger. *Cybergeo: European journal of geography*, (291).

Jinghua, Y., Chunjing, W., Jizhong, W., Shijie, H., Qinggui, W., & Siming, N. (2014). A model-based method to evaluate the ability of nature reserves to protect endangered tree species in the context of climate change. *Forest ecology and management*, (327), 48-54. https://doi.org/10.1016/j.foreco.2014.04.020

Lenoir, J., Gégout, J. C., Marquet, P. A., Ruffray, P., & Brisse, H. (2008). A Significant Upward Shift in Plant Species Optimum Elevation During the 20th Century. *Science*, *320*(5884), 1768-1771. https://doi.org/10.1126/science.1156831

Li, T., Xiong, Q. L., Peng Luo, P., Zhang, Y. B., Gu, X. D., & Lin, B. (2020). Direct and indirect effects of environmental factors, spatial constraints, and functional traits on shaping the plant diversity of montane forests. *Ecology and Evolution*, (10), 557-568. https://doi.org/10.1002/ece3.5931

Lovejoy, T. (2008). Climate change and biodiversity. *Rev Sci Tech*, *27*(2), 331-338. https://doi.org/10.20506/rst.27.2.1808

Mykrä, H., Heino, J., & Muotka, T. (2007). Scale-related patterns in the spatial and environmental components of stream macro invertebrate assemblage variation. *Global Ecology and Biogeography*, *16*(2), 149-159. https://doi.org/10.1111/j.1466-8238.2006.00272.x

Rouse, J. W., Haas, R. H., Schell, J. A., & Deering, D. W. (1973). Monitoring vegetation systems in the great plains with ERTS. In: Third earth resources technology satellite-1 symposium. *National Aeronautics and Space Administration*, (1), 309-330.

Soro, T. D., Djè, K. B., Ahoussi, K. E., Soro, G., Kouassi, A. M., Kouadio, K. E., Oga, Y. M. S., & Soro, N. (2013). Hydroclimatology and land use dynamics of the Haut Bandama watershed in Tortiya (North of Côte d'Ivoire). *VertigO - the electronic journal in environmental sciences*, *13*(3), 1-22.

Stucki, E., & Rognon, P. (1998). The Ormonts Valley facing climate change and natural disasters. *PNR 31 summary report*, 68.

Victorero, L., Robert, K., Robinson, L. F., Taylor, M. L., & Huvenne, V. A. I. (2018). Species replacement dominates megabenthos beta diversity in a remote seamount setting. *Scientific Reports*, *8*, 4152. https://doi.org/10.1038/s41598-018-22296-8