Evolution of air quality in Morocco before and during the COVID-19 pandemic; comparative study

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Abstract. The epidemic of coronavirus is spreading all over the world, which is not only a health problem, but also affects the social sector, politics, the environment in various ways and the world economy. In response to the rapidly changing international epidemiological situation of COVID-19, several governments have imposed restrictions on the movement of people and vehicles and suspended industrial activities as a safety measure to reduce the spread of the virus and protect human health. This study aims to compare the state of air quality in Morocco, before the pandemic and during the lockdown situation of the Moroccan territory between March 2020 and June 2020.

1 Introduction

The Covid-19 is an emerging pandemic of an infectious new disease, caused by the coronavirus SARS-CoV-2, which appeared in Wuhan on November 17, 2019[1], before spreading around the world. The World Health Organization (WHO) first alerts the People's Republic of China and its other member states and then declares a public health emergency of international concern on January 30, 2020 [2]. The Covid-19 epidemic was declared a pandemic by the WHO on March 11, 2020, which calls for essential protective actions to prevent overcrowding in intensive care units and to strengthen preventive hygiene [3]. This global pandemic is causing a series of cancellations of sporting and cultural events around the world, the implementation by many countries of containment measures to curb the formation of new outbreaks of contagion and the closure of borders in many countries [4]. It also has effects in terms of social and economic instability due to the uncertainties and fears it brings to the global economy [6].

2 The influence of COVID-19 pandemic on air pollution in Morocco

The lockdown due to the health situation in the world and in Morocco linked to COVID-19 has reduced air and road traffic, resulting in lower energy consumption and lower demand for oil. These changes in transport activities and oil demand have a significant impact on the quality of the environment [7], indeed since the start of containment Morocco has

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experienced a change in the very significant reduction rate of atmospheric pollutants and an improvement. appreciable air quality, it is clearly improved, a preliminary assessment of the air quality has been drawn up at the level of the city of Marrakech and covering the period from November 2019 to April 8, 2020. The first results of this balance sheet show significant reduction rates. Air pollutants, in particular a decrease of 55% for nitrogen dioxide (NO₂), 70% for carbon monoxide (CO) and 67% for suspended particles [8]. One of the consequences is the establishment of lockdown measures to limit the spread of the virus should widely modify anthropogenic emissions of pollutants, both in terms of mass emitted and temporal variations. The change in these emissions should modify the concentrations of surface pollutants observed in the world and also in Morocco. This has been observed since the start of the lockdown, in particular through the analysis of the measurements resulting from the monitoring of air quality [9].

3 Materials and Methods

3.1 Study area

Morocco is an African country located in the extreme northwest of the continent (fig.1). It has a coastline on both the North Atlantic Ocean to the west and the Mediterranean Sea to the north. The capital is Rabat and the largest city is Casablanca. Morocco spans an area of 710 850 km² and has a population of over 36 471 769 inhabitants (2019) [10]. This assessment, based on the analysis of data from air quality monitoring stations, before, during and after the state of health emergency [11]. This assessment will allow for a more detailed analysis of the air pollution situation, including the baseline, to draw lessons and make recommendations to limit post-COVID19 air pollution [12].

Fig.1. Map of Morocco.

3.2 Methodology

The Ozone Monitoring Instrument is a Dutch and Finnish image spectrometer for ozone monitoring (Table 1). The instrument is designed to distinguish ozone from other atmospheric species. The OMI sensor has a spectral region of 264 - 504 nm, a spectral resolution of 0.42 nm - 0.63 nm, and a resolution of 0.125×0.1250 . The high spectral and spatial resolution of the instrument is key to the detection of urban-scale air pollution. The acquisition of measurements of the tropospheric and stratospheric levels of the Earth's atmosphere is the main objective of the instrument's mission. MERRA-2 stands for Modern-Era Retrospective analysis for Research and Applications version 2. The MERRA project focuses on historical climate analyses for a wide range of weather and climate time scales and places the NASA Earth Observation System of Systems (EOS) series of observations in a climate context [13].

For the study of total column ozone, the TOMS-like OMTO3e product has been used. It selects the best pixel data from the good quality level-2 total column ozone data (OMTO3). This product data falls in the 0.25×0.25 -degree global grids. For the study of the tropospheric column, NO2OMNO2d data product has been selected. It is a Level-3 Gridded Product where pixel-level data of good quality are falling into 0.25×0.25 degree global grids [14].

4 Results and Discussion

4.1 Vicissitudes in NO₂ emissions

Nitrogen Dioxide (NO₂) is one of a group of gases nitrogen oxides (NO_x). It is a dangerous pollutant in and of itself. Also while all of these gases are harmful to human health and the environment, NO₂ is of greater concern. And also contributes to the formation of PM_{2.5} and ozone, two of the most dangerous forms of air pollution. Therefore, NASA has tracked by satellite and recorded the level of NO₂ in the air (NASA, Global Nitrogen Dioxide Monitoring Home Page, 2020). NASA tracks two cities of Morocco mainly, Rabat, and Laayoune. Therefore, this study shows the satellite detected of the NO₂ in the air across these cities to investigate the decline in the emission that is relatively correlated to the pandemic [15].

4-1-1 NO₂ measurement

NO₂ emission mostly originates after the burning of fuels and the consumption of automobiles. Therefore, to systematically evaluate whether the COVID-19 pandemic has an opposing effect on the concentration of NO₂ in the air in three cities, NO₂ was used as an estimation indicator [16].

NASA is responsible for expressing and realizing research in planetary science by using the ozone monitoring instrument (OMI) to collect the vicissitudes in Morocco's NO₂ level before and after the pandemic.

Figure 2 illustrates the NO₂ level in the air of the two cities over four years. The NO₂ concentrations in the troposphere over cities show that the concentrations as of the end of 2019 are still the same as in 2018

(A)

Fig. 2. Vicissitudes in NO₂ emission levels in (A) Rabat, and (B) Laayoune, from 2015 to 2019. Source (NASA- Rabat, and Laayoune, Morocco OMI data, 2020).

4-2- NO₂ emissions in Morocco before, during, and the pandemic

NO₂ emissions in Morocco before, during, and after the pandemic gouvernements moroccan applied quarantine to avoid and control the spread of the COVID-19. Figures 3, 4, and 5 show the tropospheric screen on the OMI of NASA's Aura satellite composed of information on the NO₂ level in the air of Morocco between January 1, 2020 and September 15, 2020. Rabat shows the highest NO₂ emission before the pandemic compared to other city laayoune due to the emission from the industriels activities and Traffic. Before the effect of the pandemic in the period between January 15, 2020 and mars 15 , 2020, the figures show that NO₂ emission level in Morocco is high (fig.2.(A)). The effect of the pandemic is apparent on the reduction of NO₂ in Rabat due to stop industriels activities and due to the transportation restriction. One possible reason for this finding was that during the pandemic, the vehicle exhaust and industry emission slowed down. [17]. The results of the examination show that the pandemic is seriously threatened public health; however, in the meanwhile, it contributes to reducing NO₂ emissions significantly. This reduction as Morocco imposed strict restrictions to fight the pandemic, with the entire country closed. These restrictions not only slow local economic progress, nevertheless also efficiently condensed greenhouse gas (GHG) emissions. However, it is early to predict the long term of the contribution of COVID-19 pandemic on air pollution [18].

Fig. 3. Vicissitudes in NO₂ emission levels in Rabat from January 15, 2020 to September, 2020.
Source (NASA-Rabat OMI data, 2020) [19].

Fig. 4. Vicissitudes in NO₂ emission levels in Laayoune from January 15, 2020 to September, 2020. Source (NASA-Laayoune OMI data, 2020).

5 Conclusion

This study provides an analysis of air quality changes in Morocco during the COVID-19 pandemic for the period from March to June 2020. Satellite data comparing the levels of dioxide of azote concentrations after stopping savings indicate steep reductions. Data from the Sentinel 5-P satellite shows that, in confined areas, the average levels of NO₂ between March 15 and May 15, 2020 were lower than the concentrations of June 2020 after lockdown. So we conclude that traffic restrictions applied during the quarantine for COVID-19 pandemic in Morocco were remarkably convincing in reducing emissions of NO_x. This reduction in ozone precursors reduces ozone.

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