total emissions, accounting for just 8%.

Carbon Footprint and Solar and Wind Energy Potential in Senegal

Introduction

Senegal's recent discovery of significant offshore oil and gas reserves presents environmental challenges linked to fossil fuel exploitation, even as the country strives to reduce its greenhouse gas (GHG) emissions. To meet its climate commitments, transitioning to renewable energy sources is essential. Increasing GHG emissions pose a threat to sustainable development and highlight the need for a comprehensive understanding of historical and sector-specific emission patterns.

This study seeks to examine both the sectoral breakdown and trends in GHG emissions in Senegal from 1940 to 2022, as well as the progression of solar and wind energy production over time

1. Distribution of average GHG emissions from 1940 to 2022 in Senegal

Between 1940 and 2022, the sectoral analysis of greenhouse gas (GHG) emissions in Senegal reveals that agriculture and energy are the leading contributors, accounting for approximately 43% and 23% of total emissions, respectively. Agricultural emissions stem mainly from livestock, soil management, and fertilizer application. The energy sector's emissions are primarily associated with electricity generation, transportation, and industrial activities. Meanwhile, the waste sector contributes around 12% of emissions, largely due to organic waste decomposition in landfills, as well as wastewater treatment and other disposal methods.

Figure 1: Distribution of average greenhouse gas emissions from 1940 to 2022 by sector

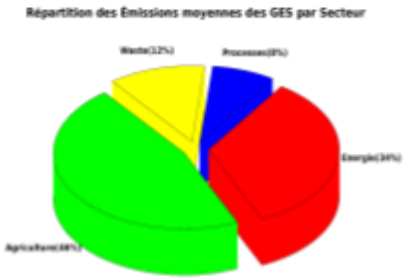
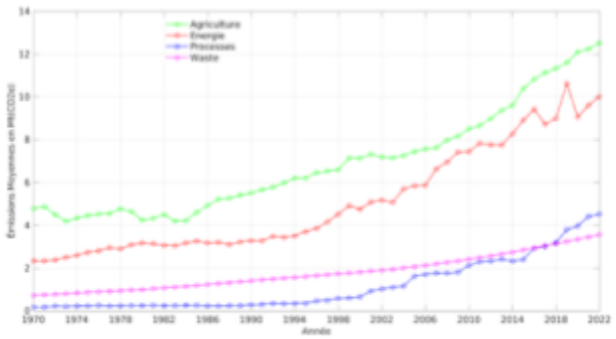


Figure 2 represents the average greenhouse gas emissions (in Mt (CO_2e) from four different sectors (Agriculture, Energy, Processes, and Waste) in Senegal between 1940 and 2022.

This figure highlights a substantial rise in greenhouse gas emissions across all sectors in Senegal since 1940. The agriculture sector remains the dominant source, reaching 12.4 $MtCO_2$ in 2022, followed by the energy sector with 10 $MtCO_2$. Although emissions from industrial processes are comparatively lower, they have shown a consistent upward trend, growing from 0.5 $MtCO_2$ in 1940 to around 3.8 $MtCO_2$ in 2022. Waste sector emissions remained modest – approximately 0.2 $MtCO_2e$ – from 1940 to 1998, but began a steady increase from 2002, reaching 4.3 $MtCO_2e$ by 2022.

Figure 2: Evolution of average greenhouse gas emissions from 1940 to 2022 by sector



2) Solar and wind production :

Renewable energy production records indicate climatological averages of 49.44 kWh for solar power and 33.05 kWh for wind power

2.1. Spatio-temporal trends in solar production

Senegal's average solar potential is declining at a rate of -0.124 kWh per year, which contrasts with the observed increases in temperature and solar radiation. This decline is most pronounced in the southeastern regions of the country, where intense warming negatively affects solar panel efficiency (Figure 3a). Interestingly, in regions experiencing a reduction in solar radiation, solar potential shows an upward trend (Figure 3b). These patterns highlight the significant influence of meteorological factors – especially surface temperature distribution – on solar energy potential.

2.2. Spatio-temporal trends in wind power production in Senegal

Africa – particularly Senegal – also possesses considerable wind energy resources. To better understand this potential, we analyzed wind energy capacity across the country to identify high-potential zones and compare them with solar potential. In contrast to solar energy, wind production closely follows the same trend as surface wind speeds. On average, wind energy production in Senegal has been increasing by approximately 0.048 kWh per year (Figure 4a)

Nonetheless, this overall trend is not uniform across Senegal's regions (Figure 4b), reflecting the spatial variability of wind patterns. Because wind energy production is positively correlated with wind speed, the southern half of the country shows an upward trend in wind potential, with the highest increases observed in the southeast. Conversely, the Dakar–Saint Louis corridor exhibits a strong negative trend. Besides the southern regions, the northeastern areas—particularly Podor and Matam—also display a growing trend in wind energy potential over the study period.

Figure 3. Temporal evolution of solar production (PVP), averaged over Senegal (a) spatial trend of PVP over the period 1940-2023 (b)

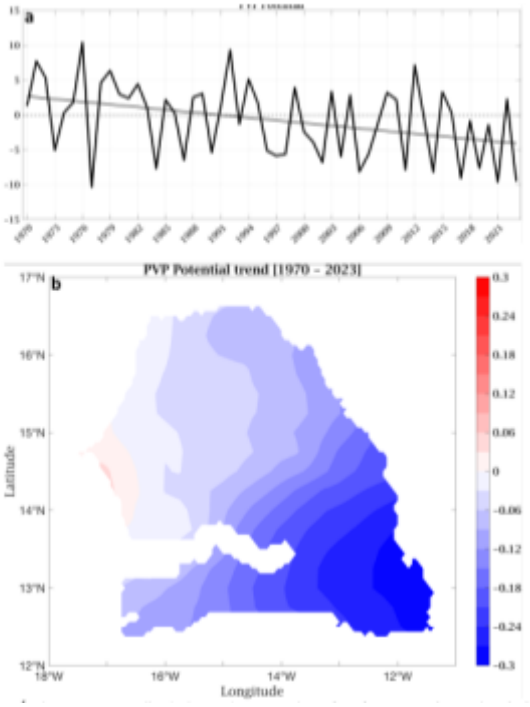
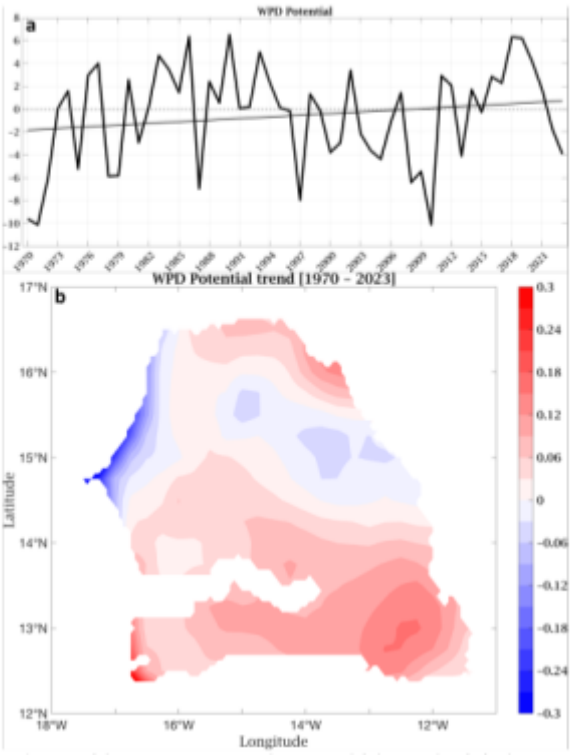


Figure 4: Temporal evolution of wind production, average over Senegal (a) spatial trend of wind production over the period 1940-2023 (b)



Conclusion

This study underscores the notable rise in greenhouse gas emissions in Senegal, driven primarily by the agriculture and energy sectors. All sectors have experienced growth in emissions, with the most pronounced increases observed in agriculture and energy. Simultaneously, the analysis reveals divergent trends in Senegal's renewable energy potential. While solar energy remains significant—with a climatological average of 49.44 kWh—it is declining at a rate of -0.124 kWh/year, largely due to rising temperatures, especially in the southeast. In contrast, wind energy potential, averaging 33.05 kWh, is on the rise (+0.048 kWh/year), with the most favorable conditions found in the southeastern and northeastern parts of the country.

Recommendations

To strengthen energy transition efforts and reduce greenhouse gas emissions, the following key actions are recommended:

- Enhance the management of emissions from the agricultural sector
- Develop a centralized national database for tracking GHG emissions
- Create detailed national maps identifying areas with high solar and wind energy potential
- Expand the use and accessibility of renewable energy sources
- Improve energy efficiency across sectors
- Invest in and support research, innovation, and development initiatives