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Mapping of Noise Pollution and Greenhouse Gases from Coastal Protection Works in Grand-Lahou (Ivory Coast)

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Abstract: To proposing measures to mitigate the impacts related to noise pollution and air quality resulting from work to protect the sandy coast of Grand-Lahou, research work was undertaken to assess the spatial impact of these pollution. To do this, several data from Grand-Lahou coastal sandy were used, such as the USGS Earth Explorer site (https://earthexplorer.usgs.gov/) and Earthdata, which are Landsat 8 OLI TIRS, Landsat 7 ETM and ASTER DEM images. As for the acquisition of wind speed data, they were acquired on the NOAA website https://fr.weatherspark.com. The digital processing of the data and the cartographic layout were carried out using the ARCGIS 10 software. "Buffer" application of ArcGis software will be used to map the spatial extent of noise pollution from the work zone. The spatial influence of gaseous emissions was defined by the wind rose and by the IDW spatial interpolation and ECN kriging methods. The results showed that in the opening zone of the future pass, noise pollution is between 73 and 79 dB(A) for an area of 82.08 m^2 and 67 dB(A) for an area of 59.88 m^2. Then that in the closure zone of the existing pass, buildings of 5248.80 m^2 will suffer noise pollution of between 73 and 79 dB(A) and other residential areas will suffer noise pollution of 69 to 73 dB(A) over a surface area of 5996.96 m^2. As for greenhouse gases, ECN quantities are low and vary between 10.64 and 193.19 in the opening zone of the new pass while in the closure quantities zone of the current pass, the village Ancien Lahou -Kpanda could be affected by gas and smoke discharges whose ECN values are estimated at more than 140, as for the carbon footprint evaluated at 2,796.27 tCO_2eq.

Keywords: Sandy Coast, Grand-Lahou, Noise Pollution, Greenhouse Gases, Spatial Interpolation

1. Introduction

Across the world, coastal ecosystems are under intense pressure, caused by relentless human activity, relentlessly changing climate trends, and extreme weather events. Coastal areas are among the most vulnerable ecosystems, and will be increasingly exposed to the impacts of climate change over the century (Intergovernmental Panel on Climate Experts [1]. With 566 km of coastline, Côte d'Ivoire faces significant issues relating to the management of its coastal zone. Indeed, the dynamics of its coastline is impacted by recurring episodes of storms and coastal flooding. This dynamic shows an evolution (erosion/accretion) of sensitive sectors such as the coastal areas of Grand-Lahou, Abidjan and Assinie [2-6], caused by developments carried out in these areas [7]. To do this, a resilience project for this coastal zone was initiated by the Ivorian Government and financed by the World Bank, called the WACA project (West Africa Coastal Areas project). One of the main activities of the project is to undertake works for the protection of the Grand-Lahou sandy coast, in particular the opening of a new pass and the filling of the existing pass by dredging of sediments. However, these works are not without harmful consequences on the environmental resources of this coastal zone.

Presentation of the study area

The study area includes part of the sandy coast of the city of Grand-Lahou, limited to the north by the Tagba lagoon, to the south by the Atlantic Ocean, to the east by the village of Braffédon and to the west by the village of Lahou-Kpanda (Figure 1).

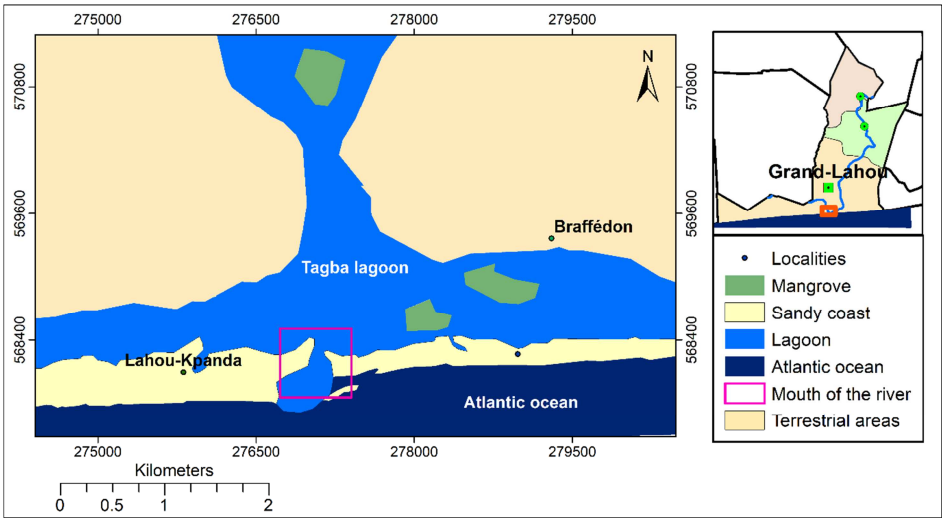

Figure 1. *Location of the study area.*

2. Methodology

2.1. Datas

As part of this study, several data were used, such as the USGS Earth Explorer site (https://earthexplorer.usgs.gov/) and Earthdata, which are Landsat 8 OLI TIRS, Landsat 7 ETM and ASTER DEM images. Indeed, LANDSAT images will make it possible to determine the evolution or change observed in a given area over time. As for the ASTER images (ASTER Global Digital Elevation Model 1 arc second), they are referenced in the geodetic coordinate system (WGS 84) on the 1996 Earth Gravitational Model (EGM 96) geoid and make it possible to observe the relief, the courses of in order to define the surface and depth volumes according to reference points. Theses datas will make it possible to assess the volumes of the right-of-way of the works. Other data comes from the Google Earth Pro application. These are aerial images acquired on January 17, 2020, downloaded from Google Earth Pro, seen at 871 m from the CNES Airbus sensor and constituting data elements recorded in the WGS 84 system. Seven images were recorded with a maximum resolution (4800×2803) marked by twenty-eight (28) points including four (04) per image. The digital processing of the data and the cartographic layout were carried out using the ARCGIS 10 software. Regarding the wind speed data acquisition, they were acquired on the site https://fr.weatherspark.com, with reference to airport meteorological stations and the integrated surface databases (ISD) of the NOAA. These monthly average data collected from 2011 to 2020 constitute the annual average wind speed in Grand-Lahou.

2.2. Methodology

Method for determining noise levels

The noise levels are determined by the forecast method proposed by the Blois Regional Laboratory [8]. This method makes it possible to estimate LAeq levels, according to the following formula:

$$LAeq = LWA - C_d + C_{tf} - C_e + C_r \quad (1)$$

with:

LWA: (power level)

Cd: (distance correction)

Ctf: (operating time correction)

Ce: (screen correction)

Cr: (correction due to the presence of reflector)

Method for determining greenhouse gas emissions

Greenhouse gases being significant in the evaluation of emissions on the climate [9], its determination was made according to the following formula:

$$ECN = FE \times A \quad (2)$$

with:

E (Emission);

FE (Emission factor);

A (Activity).

The emission factor of the activity considered is estimated as follows:

$$FE = FE_{CO_2} \times PRG_{CO_2} + FE_{CH_4} \times PRG_{CH_4} + FE_{N_2O} \times PRG_{N_2O} \quad (3)$$

The spatial extent of noise and gas emissions was defined by the wind rose and by the IDW spatial interpolation and ECN kriging methods.

3. Results

3.1. Mapping of Noise Pollution

In the opening area of the future pass, the noise pollution map presents all the residences impacted by noise, with a low traffic. These nuisances are between 73 and 79 dB(A) for an area of 82.08 m^2 and 67 dB(A) for an area of 59.88 m^2 (figure 2).

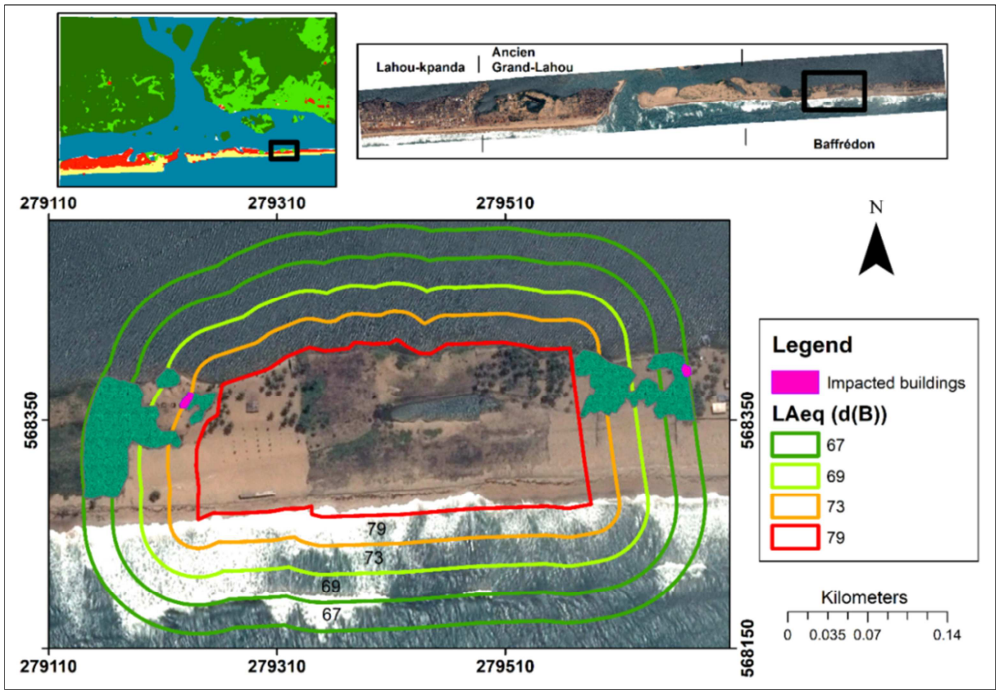

Figure 2. *Spatial impact of noise pollution in the opening zone of the new pass.*

In the existing pass area buildings of 5248.80 m^2 will be subject to noise pollution of between 73 and 79 dB(A). Also we will find residential areas built on an area of 5996.96 m^2 which will be impacted from nuisances of 69 to 73 dB(A). Other buildings of 7249.92 m^2 and 7363.90 m^2 will also be impacted (figure 3).

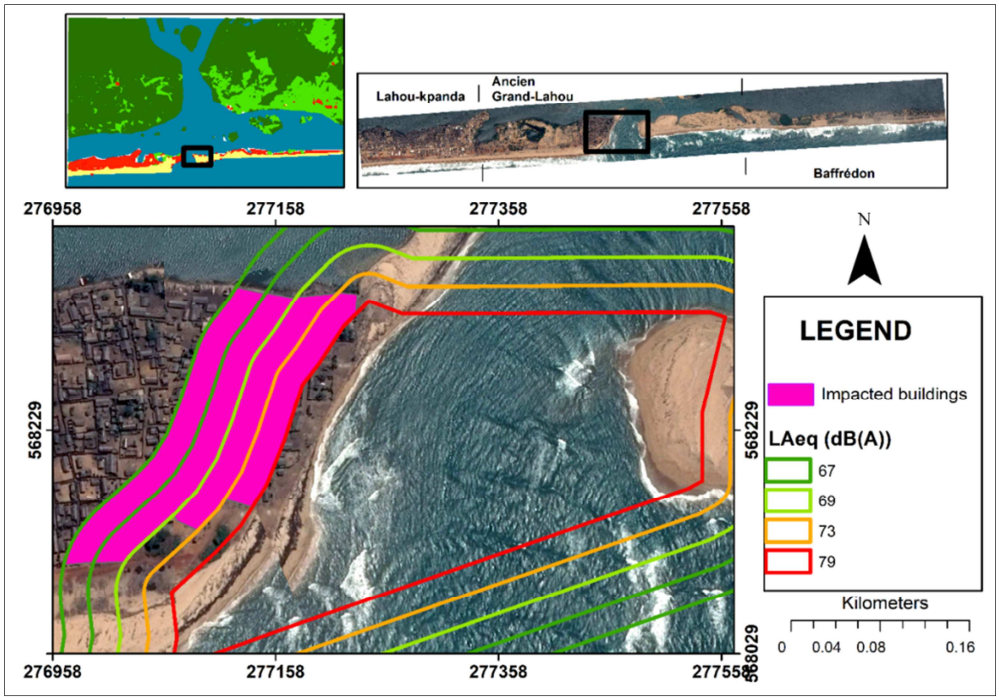

Figure 3. *Spatial impact of noise pollution in the closure zone of the current pass.*

3.2. Mapping of Gas Releases into the Air

The presence of heavy machinery during the work could cause changes in the ambient air through discharges and emissions of gases such as carbon dioxide (CO_2), sulfur dioxides (SO_2), nitrates (NOx) and particulate matter (PM). As the work area is on the seaside, these gases will be oriented according to the preferred direction of the wind. Given that the work area is located along the sea, the wind direction is from the sea towards the coast. So we deduce that the wind goes

from South to North. The engines of vehicles whose maintenance is not regular will emit black smoke into the air containing the aforementioned emissions. Thus in the area of the opening of the new pass, the quantities of Ec_N vary between 10.64 and 193.19 and the impacts related to the release of gas into the atmosphere are less perceptible because there are no homes in the area. On the other hand, in the closure zone of the current pass, the village Ancien Lahou-Kpanda could be affected by gas and smoke discharges whose E_{CN} values are estimated at more than 140 (figures 4 and 5).

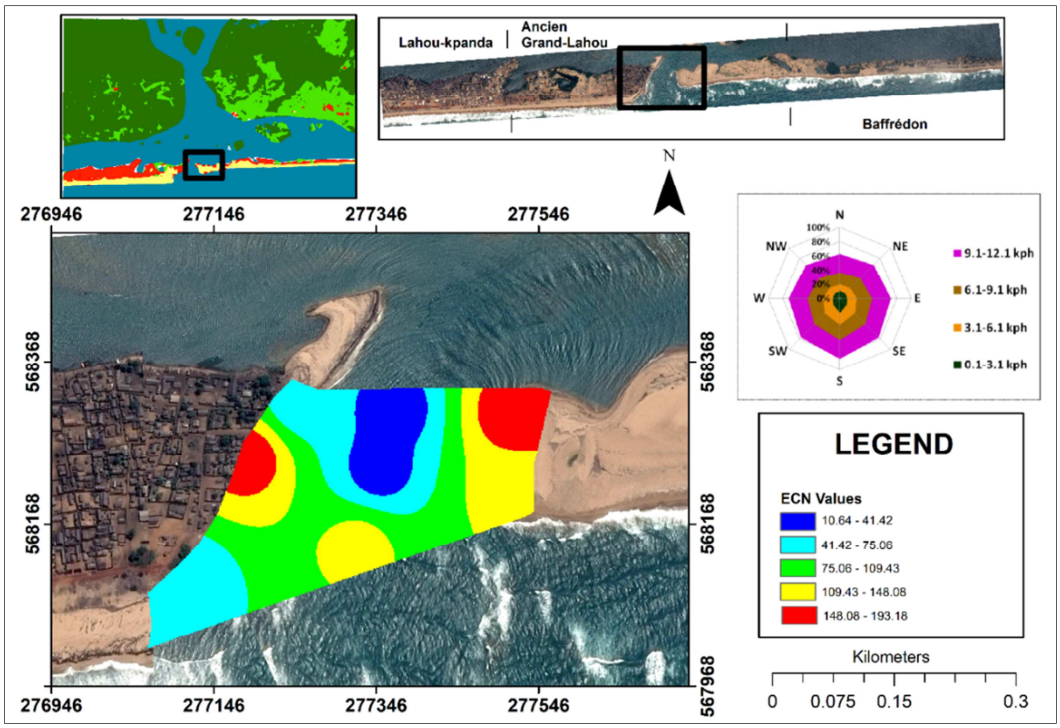

Figure 4. *Spatial distribution of ECNs in the opening zone of the future pass.*

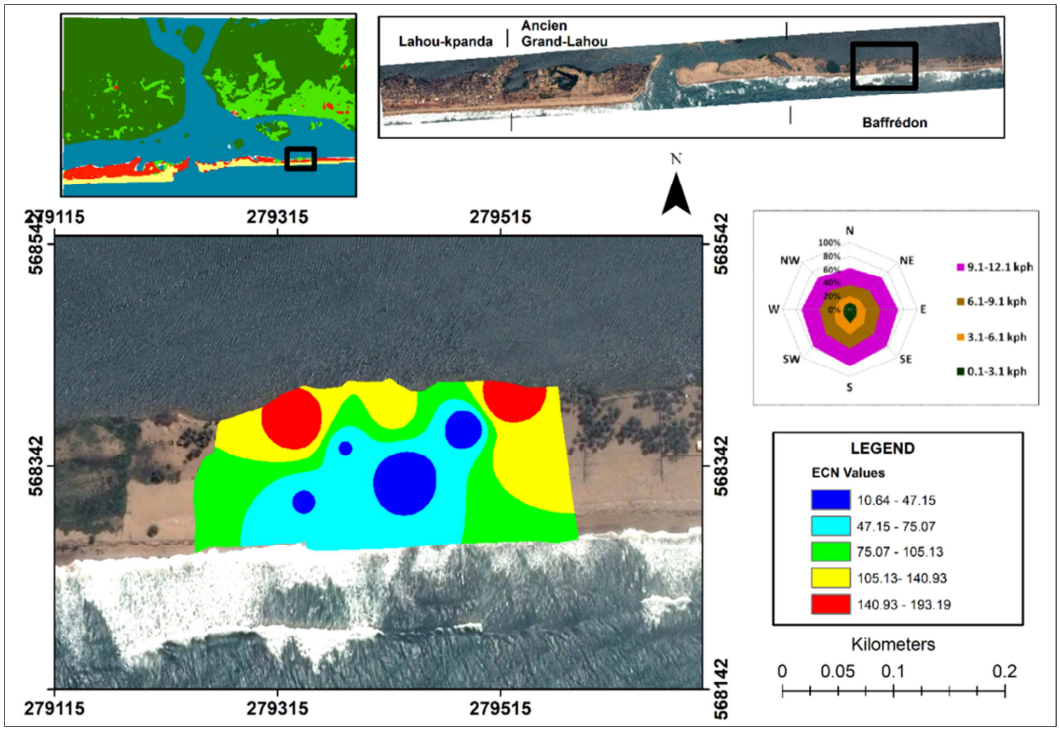

Figure 5. *Spatial distribution of ECN in the closure zone of the existing pass.*

4. Discussion

The use of Google Earth Pro made it possible to mosaic several images of the work area at very high resolution. These images provided extensive supports for traditional land cover mapping and verification of results [10]. The mapping of noise and gaz pollution was done by photointerpretation by carrying out analytical monitoring of the environmental components [11]. Construction works in coastal engineering projects produce noise pollution, e.g. ex. by rock handling for sea walls, pile driving for jetties, dredging and hydraulic rock breaking (approximately 78 dB at 10 m), crushing (approximately 82 dB at 10 m), concrete mixing, the pumping of water and fuel, the production of electricity from generators (approximately 61 dB at 10 m) and the use of construction vehicles. Sound effects are mainly associated with the construction phase. As for air quality, it includes the chemical, physical, biological and aesthetic characteristics of the air. Maintaining good air quality and reducing emissions protect the health and comfort of populations, as well as the environment at large. Indeed, coastal engineering projects have little capacity (unlike energy and industrial projects) to have a negative effect on air quality. These effects are generally limited to dust and gaz emissions during the construction phase from construction machinery, excavation and disposal of materials, pile driving, vehicles and generators. mobile, as well as crushing dredged material for aggregate and concrete plants. If the impacts of work linked to noise and gas pollution are limited in time and space, they could have negative impacts on marine life, in particular on fish and cetaceans.

Indeed, the *Underwater Piling* Noise Guidelines on underwater pile driving noise prepared by the South Australian Government. The Department of Planning, Transport and Infrastructure are a useful document for understanding the impacts and potential mitigation measures. They are currently being reviewed and updated, the most recent should be published here https://www.dit.sa.gov.au/documents/EHTM. Likewise, with regard to the impacts of light, we can refer to the *National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds* prepared by the Commonwealth of Australia, 2020.

5. Conclusion

The study made it possible to show the spatial extent of the potential impacts due to noise pollution and greenhouse gases from the protection work on the Grand-Lahou sandy coast in Ivory Coast. Noise pollution is low but which could impact the marine ecosystems of the study area. As for the carbon footprint, they were evaluated at 2,796.27 tCO_2eq taking into account carbon sequestration due to the planned revegetation. The question that arises is the quantity of carbon from the work absorbed by the ocean. In any case at the national level, the impacts on the climate will be direct and relatively small compared to the 37 million tons of CO_2-equivalent of greenhouse gases which would be emitted nationally according to the Nationally Determined Contributions (NDC) defined in 2020.

Conflicts of Interest

No conflict of interest for this article**.**

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