

Deep Learning in Greenhouse Gases Emissions from Agriculture Activities in Rwanda using Long Short Term Memory Recurrent Neural Network

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Abstract - Climate change has been paramount a subject of the research. Various data mining techniques have been used to predict carbon dioxide emissions in the future. However, most of the researchers considered the energy consumption as the main source of carbon dioxide and used traditional methods for future prediction. This paper is about deep running in emissions of greenhouse gases from agriculture activities in Rwanda by applying a Long Short Term Memory recurrent neural network model. It will present the analysis of data obtain from Food Agriculture Organization's Website and discuss the results after predicting the emission values to dig out the new insight of emissions of greenhouse gases from agriculture activities In the future. After the application of a Long Short Term Memory model to data, the analysis has shown that each activity will contribute differently to the greenhouse emissions in the future and the conclusion was that there is a need to take measures to activity emission contribution according to its trends in the future. This is helpful as it applies a more accurate method for prediction.

Key Words: Long Short Term Memory, Greenhouse gases

1. INTRODUCTION

Climate change is an issue that regards all the countries including developed and developing countries. Rwanda is one developing country that is vulnerable to climate change as the main source of employment is agriculture at 80% and agriculture is the most risk to climate change [1]. Climate change is a global issue and must be addressed on a global scale. The causes of the climate change are emissions of Green House Gases like Carbon Dioxide (CO₂), fluorinated gases, Nitrous Oxides and Methane. According to United States, Environments Protection agency (2017) Carbon Dioxide (CO₂) constitutes 81% of All Greenhouse Gases. The new times (June 06, 2019) published that Agriculture contributes 70.4% of Green House emissions in Rwanda. FAO has tried to provide the methods for African countries by providing a system that will report its forestations, deforestation and reforestation by using the data from Foris tool. They hold training with the initiative of common effort to land-use change. According to third National communication (2019), there is a high chance that Rwanda can become an emitter of Carbon dioxide in 2022 if it does not follow the proposed mitigation option. This is a rationale to carry out deep learning on the main activities that are involved in agriculture contribution to Greenhouse gases to

provide insight so that measures can be applied to control these activities to hinder Rwanda in becoming an emitter of Green House Gases in The future. The main activities of agriculture in Rwanda that contribute to greenhouse gases are: Enteric Fermentation, Manure Management, Rice Cultivation, Manure applied to Soils, Crop Residues, Cultivation of Organic Soils and Burning - Crop residues [3]. All these activities contribute differently to emissions of greenhouse gases According to D.Kunda (2017) 80% of greenhouse gases are from the burning of fossil fuels mainly from industries or transportations whoever in Rwanda GHG mainly emanates from agriculture and burning oils for electricity Generation [3].[4] Has explained how machine learning can be applied in talking climate change by making predictions basing on existing data. They concentrated on explaining the source of carbon dioxide and other greenhouse gases and explaining theatrically how machine learning can be used in climate change analysis. However, the climate is affected by all the countries all over the world individually the researcher has not precise any case study and an appropriate approach that can be applied to the case to mitigate its contribution to the climate change. [5] Has contributed to fighting against climate change by proposing a support vector machine model to predict the emissions of carbon dioxide. They considered energy consumption like electrical energy and burning coal as the main input variable that directly affects increasing in carbon dioxide emissions. He has used the cross-validation method to test the model and has come out with a lower root mean square of 0.004. The conclusion was that monitoring the consumption of energy can help in mitigating emissions of carbon dioxide. According to [6] forecasting times series data is an important subject and ARIMA(Auto Regressive Moving Average) has demonstrated its good performance precision and accuracy comparing to other traditional methods. The researcher carries out a comparison between ARIMA and LSTM (Low-Short- Term Memory) and concluded that LSTM has demonstrated 85% in the improvement of performance compared to ARIMA.

Not only that most the researchers concentrated on fighting against climate change by predicting carbon dioxide emissions, but also were considering energy consumption as the main source of carbon dioxide emissions which is not the same case in some countries like Rwanda. No one of the researchers has applied Low Short Term Memory in predicting Greenhouse gases emissions while [6] has

demonstrated that LSTM has a better performance to time series forecasting. LSTM recurrent Neural Network can bring a new insight into predicting greenhouse gases from agricultural activities in Rwanda. The purpose of this paper is to provide the new insight in greenhouse emission from agriculture activities in Rwanda by showing a future trend of each agriculture activity in contribution to the emission of greenhouse gases in Rwanda.

2. METHOD

2.1 Data collection and data processing

Data used was found from <http://www.fao.org/faostat/en/#data> the data of emissions from agriculture activities were in gig grams in the investigation period from 1961 to 2017. The data was processed and the total of emissions in each year was saved in excel format. Because the tool used does not support the excel data format, the data was converted to Comma delimited Values (CSV) format which is supported by both R and Python. For a better analysis of the data, R studio was used to convert the times series data collected into data frame data. LSTM recurrent Neural Network Models was built for predicting the future emissions up to 2055 and the results were plotted on the same frame for analysis and discovering the trends of emissions from each activity in the future. The following paragraph explains how the LSTM model was constructed:

2.2 Model building /testing and Application

LSTM is a special recurrent neural network architecture that is used to predict the future accurately as it refers to the relationship between the previous inputs [7]. To build the LSTM model for predicting Greenhouse gases emissions the libraries like keras, tensorflow, numpy, matplotlib.pyplot, pandas, io and csv were imported in spyder(python3.7). The data was read and imported from csv in python. The whole data is 57 Univariate time series that correspond to emissions from 1961 to 2017. The data was scaled to fit python format. The training data structure of 22-time steps and one output was created to give the next 35 output results. The keras libraries like and packages like Sequential, Dense, LSTM, and dropout were imported. Then the layers and dropout regulations were added. After this, the model was used to predict the emissions of greenhouse gases of each agriculture activity in RWANDA. The model was applied to the data and has demonstrated high accuracy in prediction of 97.64% and 2.36 % in the loss.

3. ANALYSIS AND RESULTS INTERPRETATION

For a better understanding of historical data of emissions of carbon dioxide in Rwanda, the data from 1961 to 2017 was

converted in the data frame and plotted in R this is helpful when identifying the trends in future comparing to history.

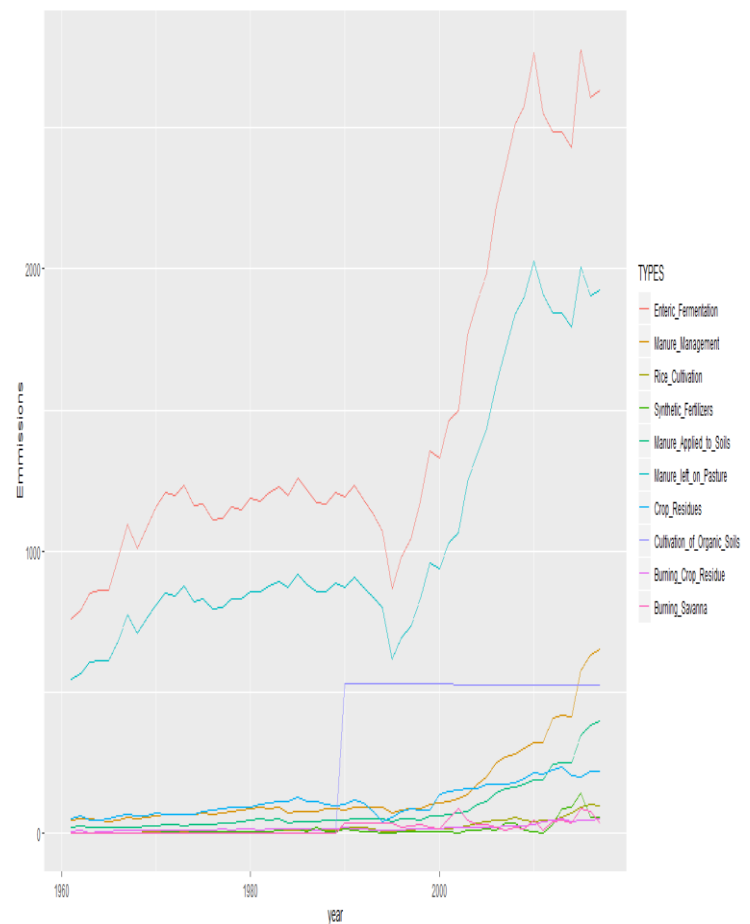


Fig1: Rwanda Green House Gases emissions from agriculture activities in 1961-2017

From figure 1 Greenhouse gases emissions match with Rwanda history, where from 1961 to just before 1993 or 194 the emissions were stable and almost constant. This corresponds to the fact that Rwandese had not enough mindset on hardworking and there was no mutilation about hard working. In year 1993 to 1994 the emissions decreased as the country was in political instability and Genocide against Tutsi so agricultural activities were not intensified at that time. From 1994 to around 2010 emissions has dramatically increased and were dominated by enteric fermentation and manure left on the pasture but emissions from cultivation of organic soils remain constant. After this you cannot identify the behavior of emissions from each activity. The figure below shows the prediction of emissions for the future 38 years

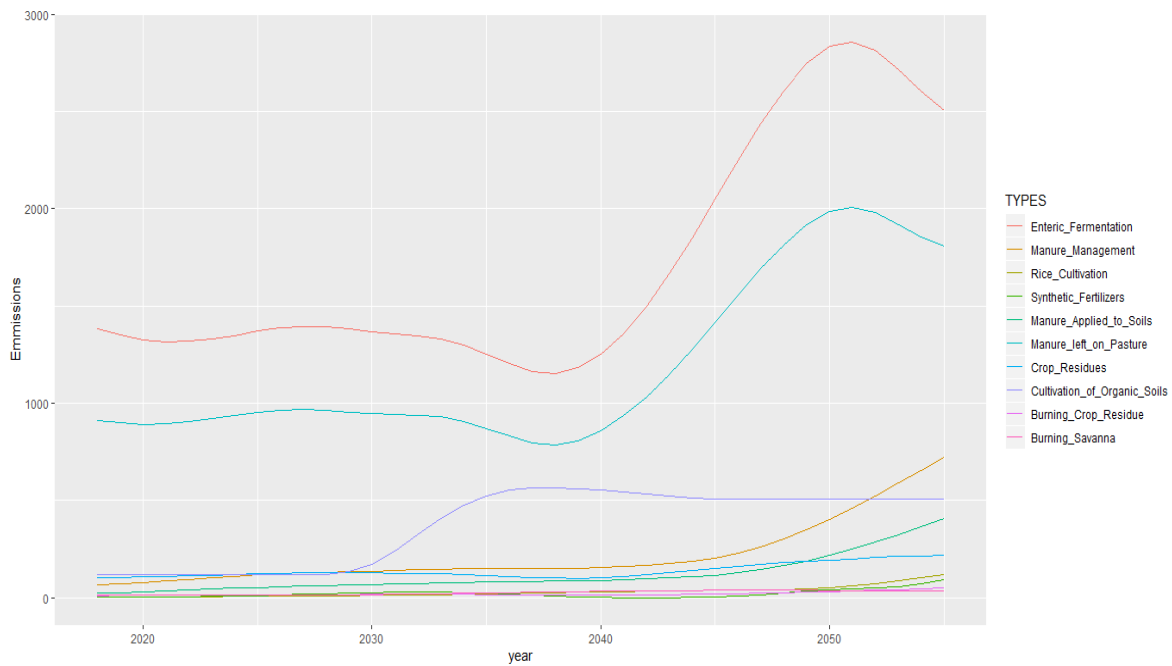


Fig2: Prediction of Rwanda Green House Gases emissions from agriculture activities in 2018-2055

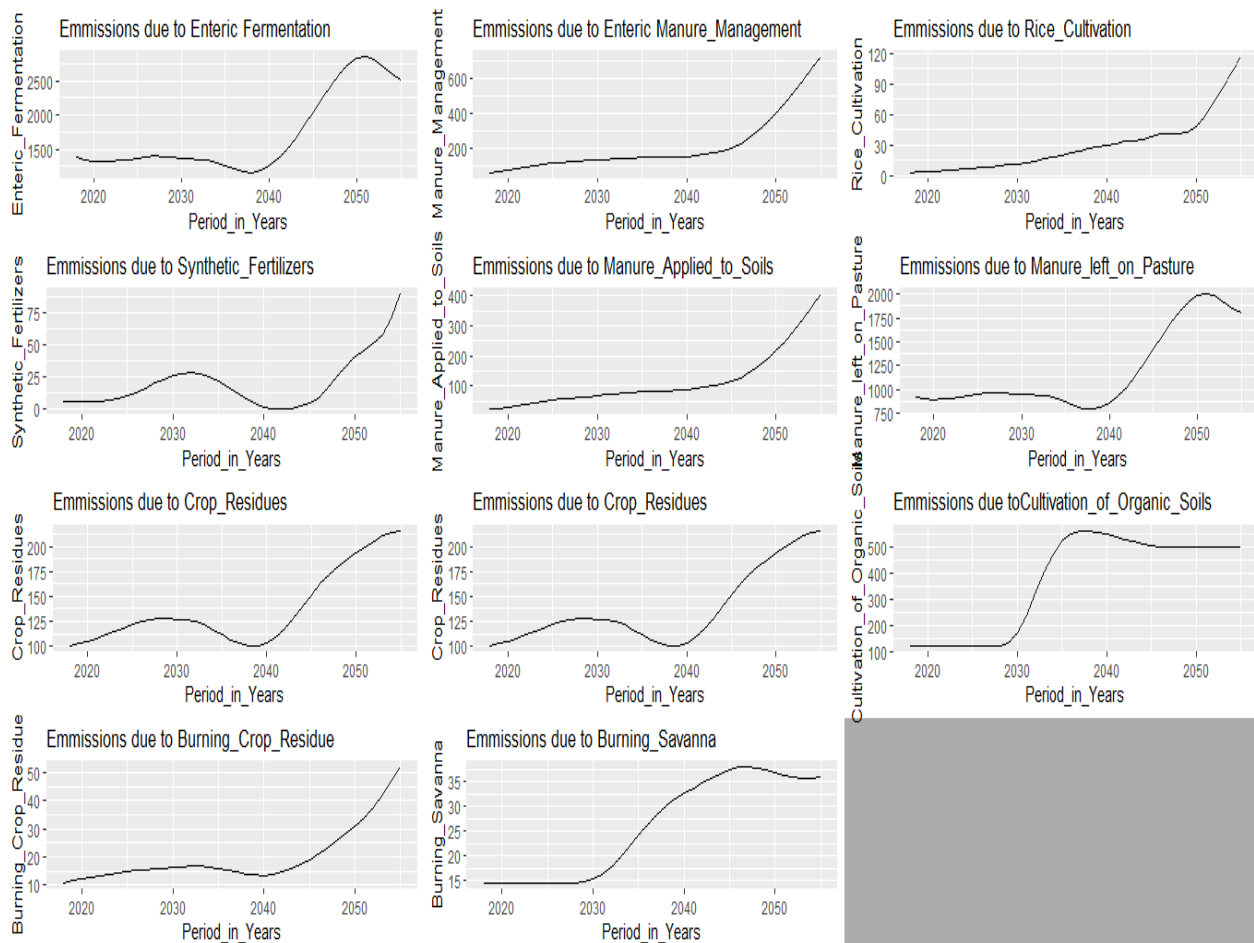


Fig 3: predicted emissions plotted on the same frame

Results show that the emissions due to enteric fermentation and emission due to the manure left to the pasture will continue to decrease in next 20 years and almost other emissions from other activities will increase except emissions due to burning savanna which seems to be constant in next ten years. The emissions from activities like enteric manure managements, Rice cultivation, and manure applied to the soil shows a continuous increasing. Emissions due to the synthetic fertilizers will increase in the next ten years.

4. CONCLUSIONS

Rwanda's contribution to the emission of greenhouse gases can be controlled. As the trend of each activity contribution has been identified. Results show that measures taken to reduce the most two Rwandan dominant agriculture activities (enteric fermentation and emission due to the manure left to the pasture) contribution to emissions of greenhouse gases can be kept in the next 20 Years. Then new measures can be taken for the activities that show continuous trends like enteric manure managements, Rice cultivation, and manure applied to the soil.

The future researchers can extend the work by considering each individual greenhouse gas prediction and give advice on how the policy can be formulated to mitigate the increase in greenhouse gases production after the next 20 years.

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