EO for Africa Symposium 2024

23 - 26 September 2024

ESA | ESRIN, Frascati (IT)

The role of Earth observation and ancillary data to support fall armyworm monitoring for maize crop in Rwanda.

BY

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15/07/2024

2024

3.2.Predicting and drivers of risks of FAW infestation outbreak across Agro-ecological zones in Rwanda

4.CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

4.2.Recommendations

INTRODUCTION

Agriculture is the main stain of economy for many developping African countriesincluding Rwanda. (more than 62% employment)

Plant infection by Pest and deseases pose a serious threat to agriculture

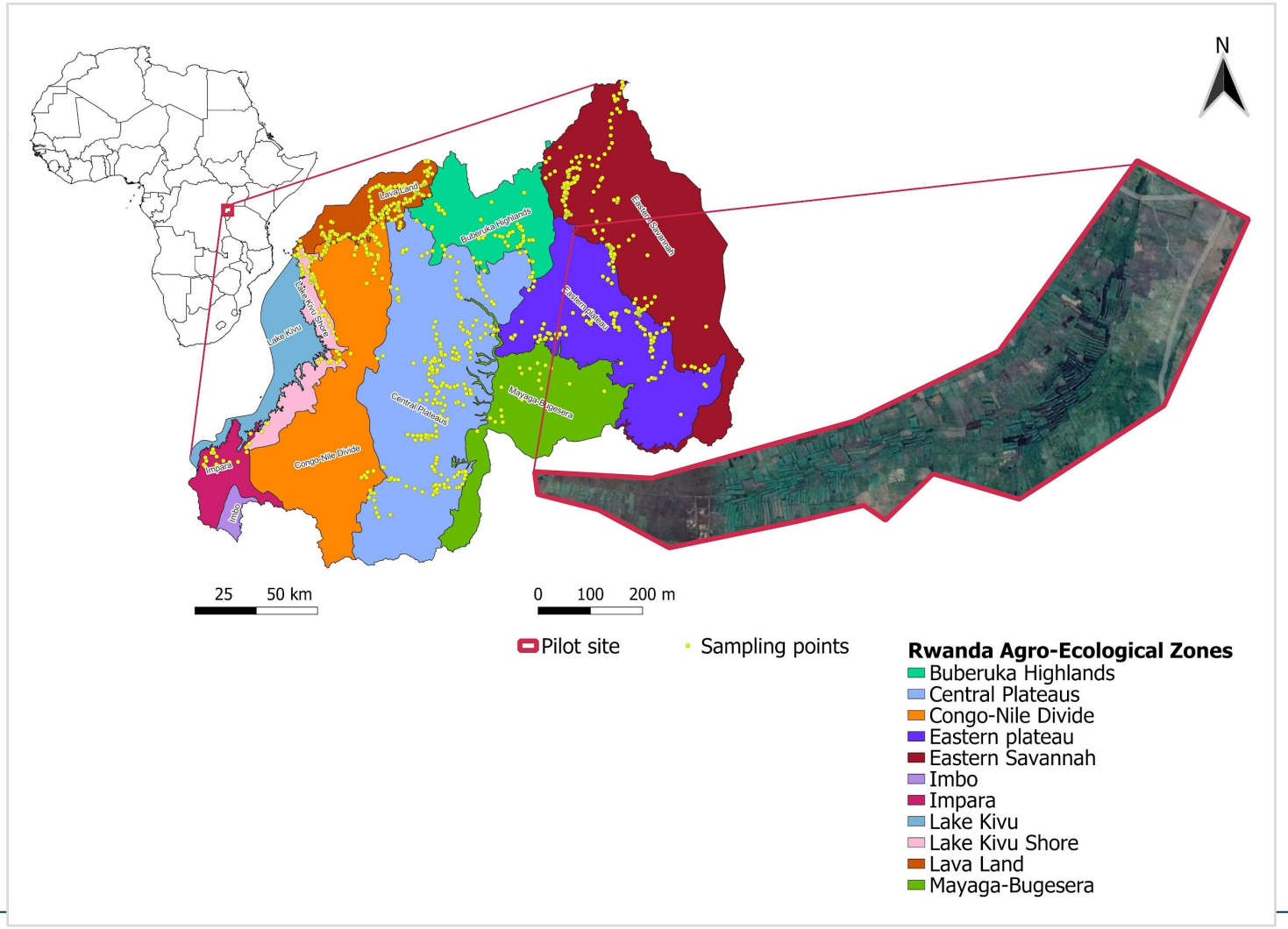
Fall armyworm (FAW) is one of the most destructive pests of cereal crops

Farming management and climate influence the extent of FAW in Rwanda. The IPM) Programme requires among others data on the level of FAW infection on Maize and other cereals.

The present study (EO4A/ESA) used:-field surveys, sentinel 2 and ancillary 2 data to analyse the level of FAW.

II.MATERIAL AND METHODS

II.1. Study areaEASTER SAVANNAH



II.2.Data collection 1

The RAB has conducted a survey on FAW infection level from 06/ 2018 to 09/ 2023.

During this survey biophysical, climate, phenological parameters, landscape, FAW level (using HMLN). DNA sequencing test from leaf samples and identification of pests and disease characteristics.

The survey was repeated 3 times (3 years). RS, climate and soil data helped in this analysis. For RS, we used the copernicus Sentinel-1 SAR data (S1) and Sentinel-2 multispectral data (S2) operated by ESA. Data gaps were filled using Land Sat 8 dataset .

II.3. Data processing and analysis

In detail, the methods proposed by: Zheng et al., 2018; Liu et al., 2020; Meena et al., 2020 v. Here, we computed five VIs including the

Soil Adjusted Vegetation Index (SAVI),

Modified Soil-Adjusted Vegetation Index (MSAVI),

Normalized Difference Red Edge Vegetation Index (NDRE),

Normalized Difference Vegetation Index (NDVI),

Red-Edge Chlorophyll Vegetation Index (RECI) (Table 1).

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III. MATERIAL AND METHODS (NEXT 4)

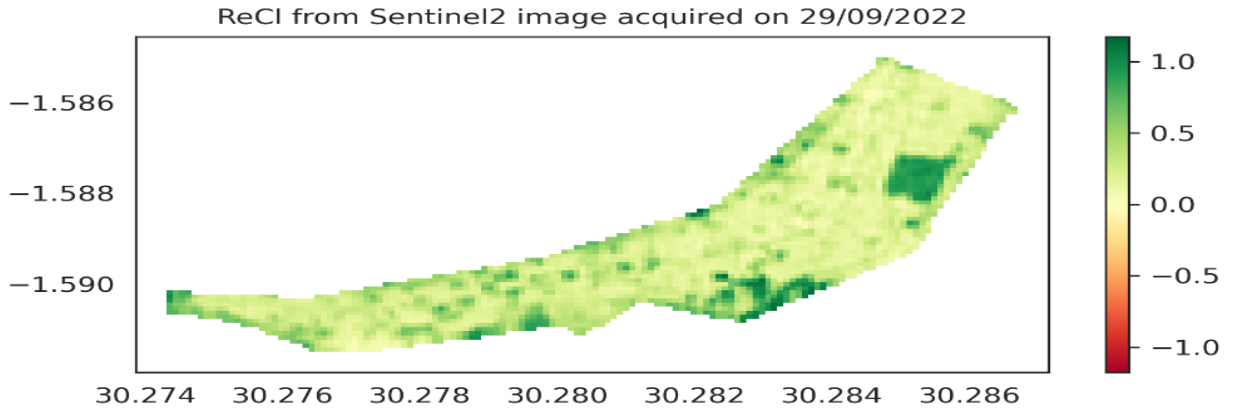
Vegetation indices, climate and soil data with ground truth data are combined to develop a dataset.

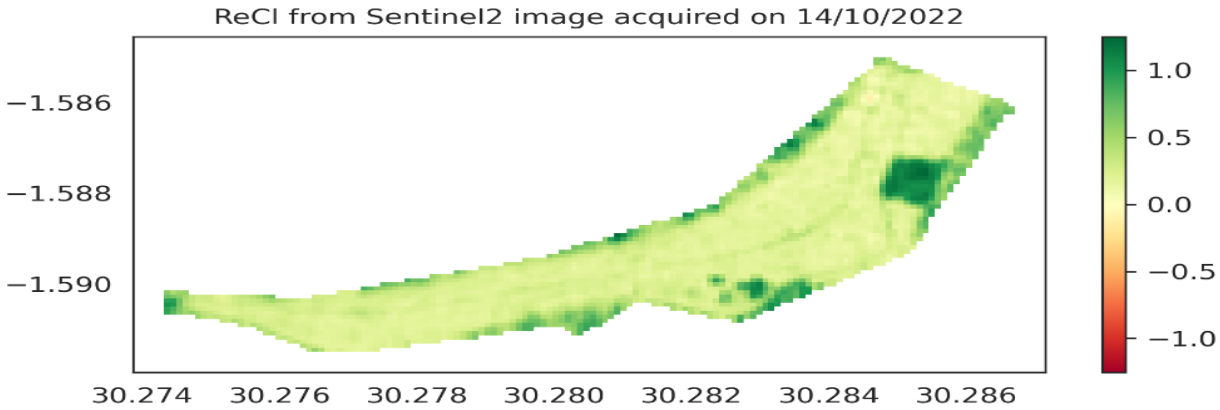
We evaluated different models including :

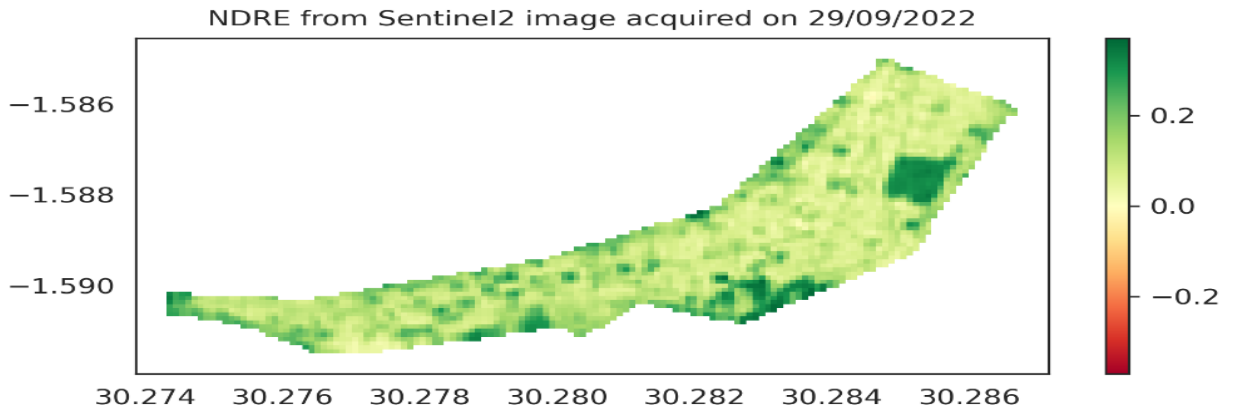
Adaptive Boosting, .

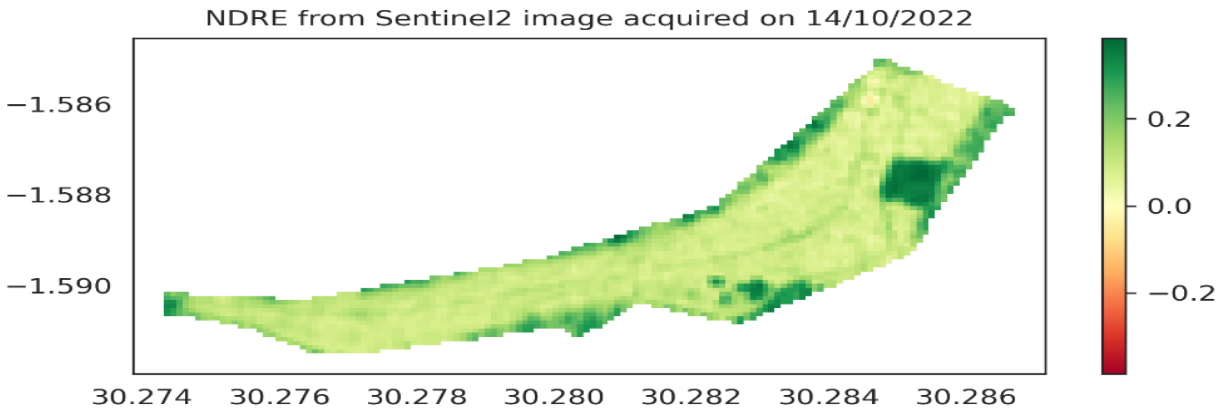
III.1Vegetation health for infested maize fields

Figure 2: Spatial patterns of VIs in the study area









III. RESULTS PRESENTATION (NEXT 1)

Assessment of vegetation health for infested maize fields

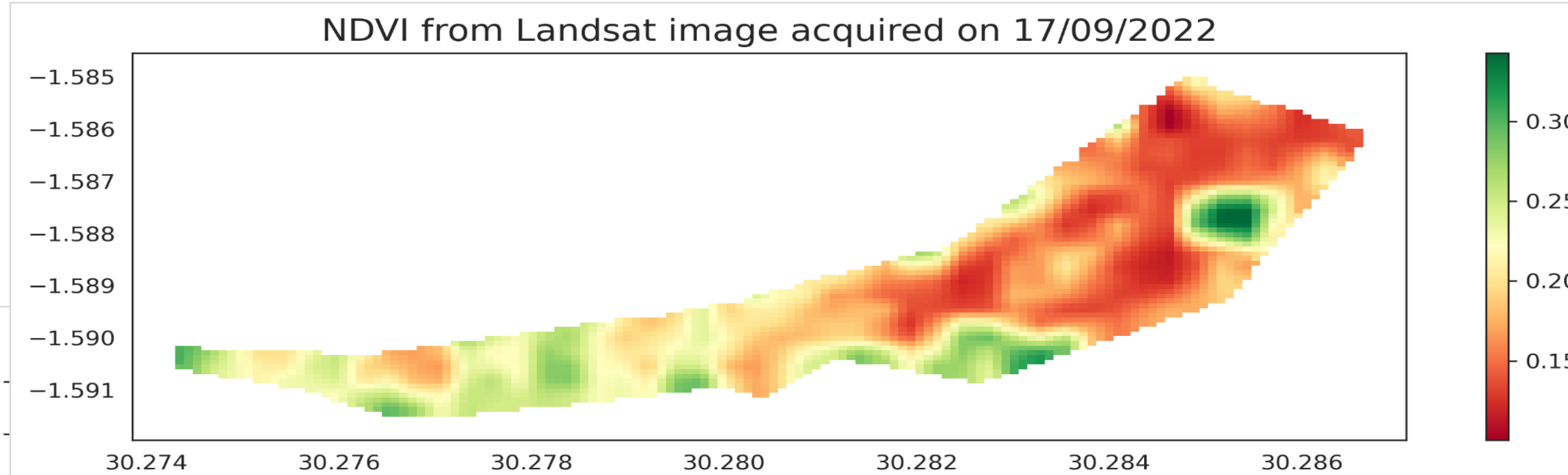
The analysis of variance combined with the bootstrap resampling method performed at 95 percent confidence interval ($p \leq 0.05$) showed:

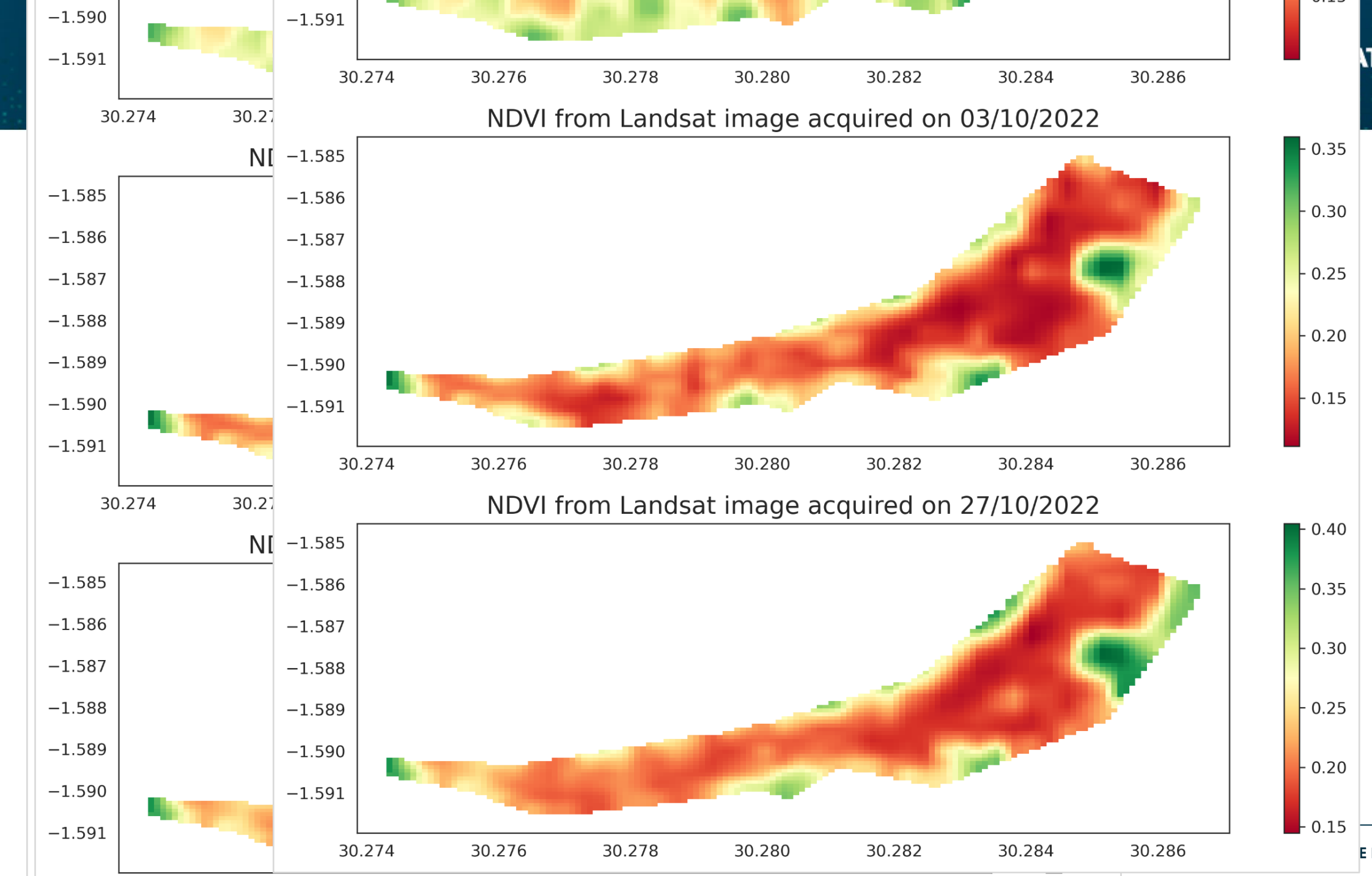
- A significant difference in vegetation health between the early growing stage (i.e. 17/09/2022) and at the early mid-growing stage (i.e. 27/10/2022) (Figure 2; Figure 3).

-The early situation was better than the mid-growth phase

Specifically, the ReCle and the NDRE indices derived from sentinel-2 showed a significant decrease between the two selected dates.

III. RESULTS PRESENTATION (NEXT 2)

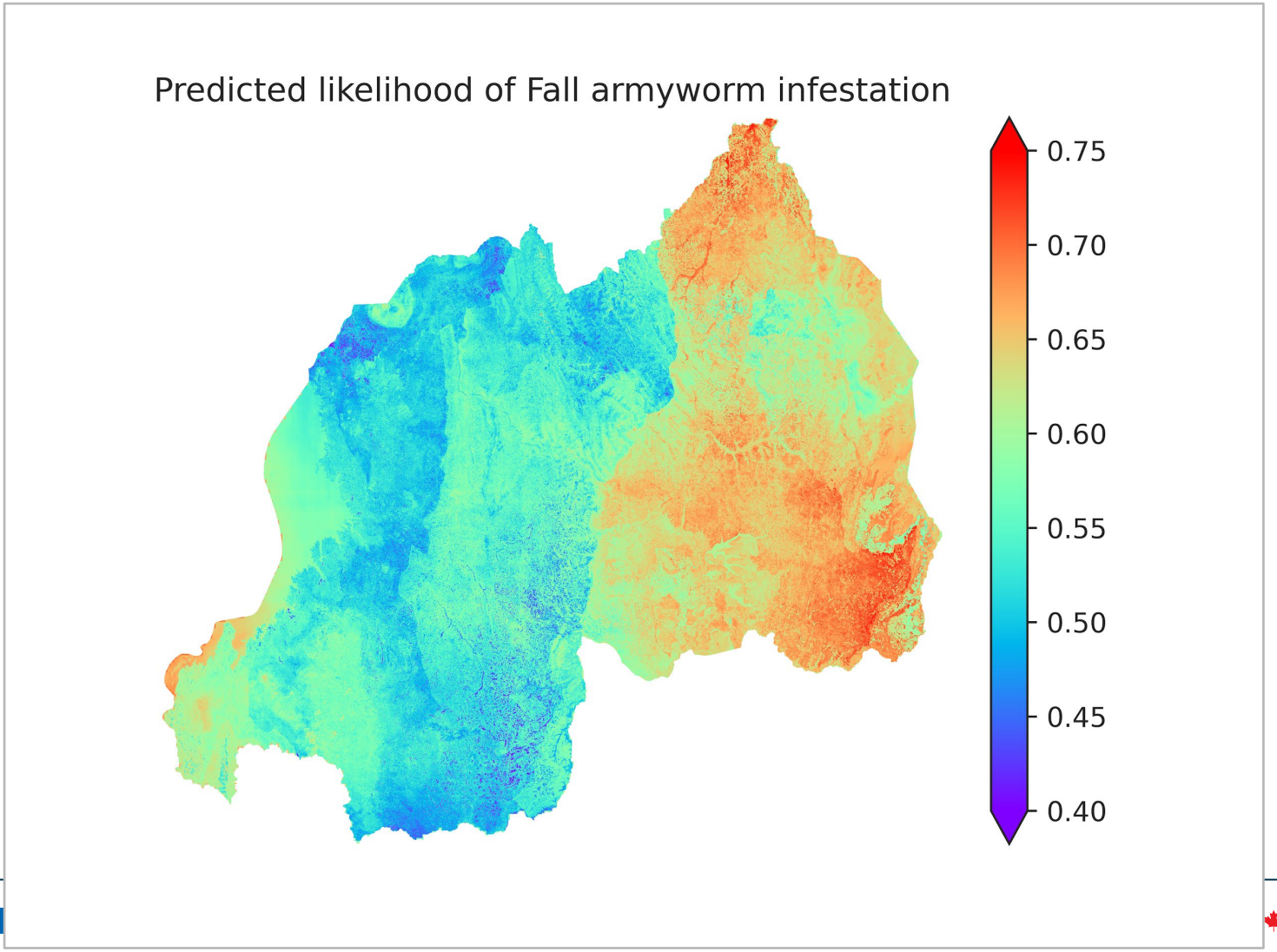



NDVI from Landsat image acquired on 03/10/2022
NDVI from Landsat image acquired on 27/10/2022
−1.585
−1.586
−1.587
−1.588
−1.589
−1.590
−1.591
30.274
30.276
30.278
30.280
30.282
30.284
30.286
0.35
0.30
0.25
0.20
0.15
0.40

Predicted- and distribution of risk likelihood of fall armyworm across Rwanda (FIGURE 4 and 5).

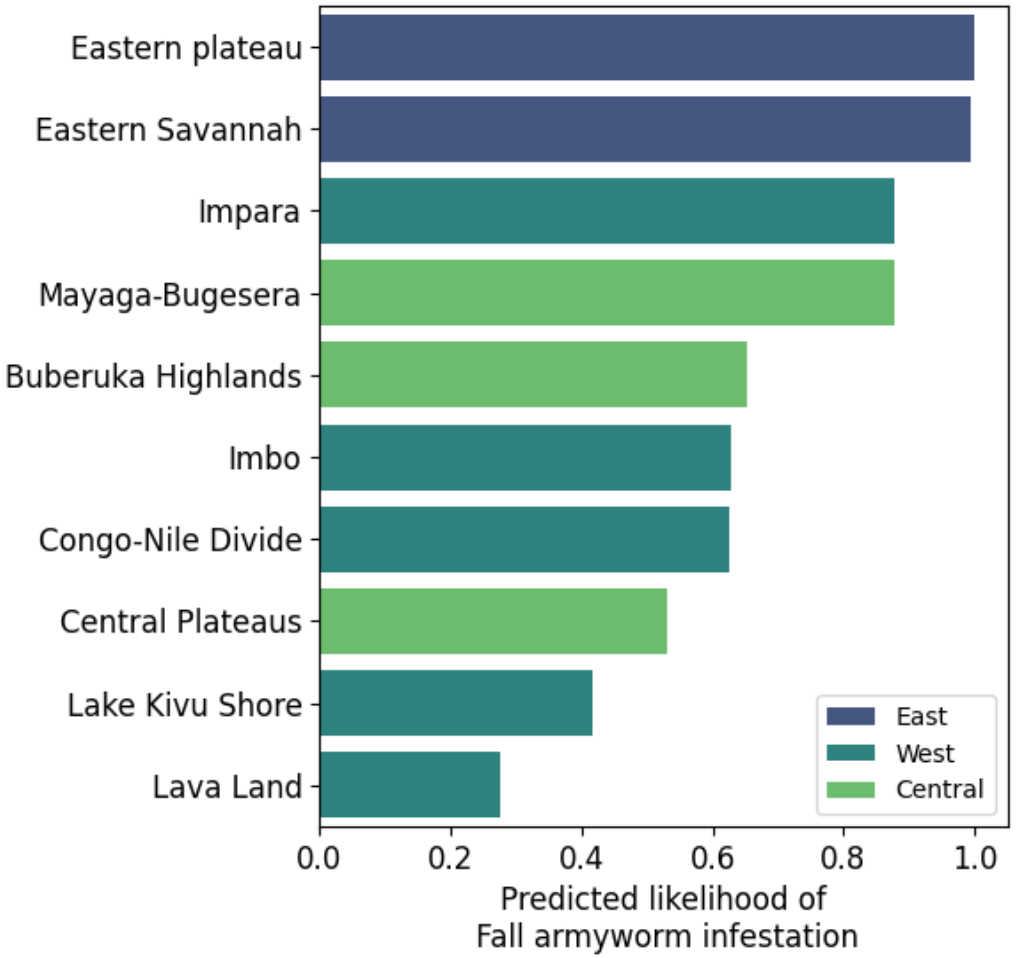
The risk was estimated as the probability of having fall armyworm in a region given a set climatic and biophysical parameters derived from sentinel images and other remote sensing data.

Figure 4. Predicted- and distribution of risk likelihood of fall armyworm across Rwanda



III.RESULTS PRESENTATION (NEXT 6)

FIGURE 5



IV. RESULTS AND DISCUSSION (NEXT 2)

Our analysis and field campaigns suggest that predicting risk for pest and/or disease outbreak in agriculture is complex

The nature and interrelationship of different factors driving smallholder tropical agriculture

In general, the results show that patterns of FAW riks follow predictable patterns related to agro-ecological zones, crop management, and climate factors

FAW higher in the Eastern plateau and Easter Savana agro-ecological zones and lower in the Lake Kivu shore and Lava land zones (Figure 4).

RESULTS AND DISCUSSION

Data by Van Tricht et al (2023) crop revealed higher maize crop cover in the Eastern region.

This situation is also influenced byLand Consolidation program as a result of National Land Reform.

More details from (Muhinda and Dusengemungu 2013; MINAGRI 2011; 2018).

Soil fertility Influences positively a better crop development which allow the crop resit to p FAW. (data from the Eastern plateau and the Volcanic AEZ)

CONCLUSIONS

Using variable importance metric, climate parameters are shown to be good indicators of FAW level prediction.(Rainfall, temperature, humidity, etc,...). This was also demonstrated by Skendžić et al., 2021 and Flanders et al., 2011

This study highlights the role of different data sources, specifically RS-based data to understand the level of FAW INFESTATION

- Climate change can affect the FAW INFESTATION

- The development of accurate predictive models requires integrating field survey data, and ancillary data

CONCLUSIONS

Our results show that FAW is a threat to maize crop especially in large scale monoculture maize cropping..

At country level, FAW infection level follows predictable patterns influenced by crop management, climatic conditions and soil fertility conditions.

The results suggest that longterm monoculture practised in the consolidated agriculture has significantly increased the risk of FAW across Rwanda.

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