The Effect of Climate Change on Agriculture in East Africa

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In this white paper they highlight the impact of climate change on agriculture focusing on farmers in East Africa in particular. The white paper discussed how farmers can adapt to climate change and the importance of access to reliable weather forecasts in this process. This white paper also outlines the CROPMON project (Crop Monitoring Service) that aims to provide Kenyan farmers with information (including weather forecast) and help them make improved farm management decisions during the growing season. AgroCares is the lead partner of the CROPMON project that is funded by the Geodata for Agriculture and Water (G4AW) facility.

Chapter 1

What are the impacts of climate change in East Africa?

The consequences of climate change are numerous and can be observed all over the world. Main indicators of climate change include stronger variation of climate conditions, higher risk of biodiversity loss and acidification of oceans. Agriculture relies strongly on weather conditions and we see an increased variability of indicators such as rainfall and temperature in several parts of the world. It has been highlighted for East Africa by the paper written by Schreck & Semazz (see figure below) and this phenomenon directly impacts farmers. For example, it is more and more difficult for farmers in East Africa to forecast the beginning of the rainy season. If grains are sowed too much ahead of the first rains, only a few will come up. In this case, impacts on yields are tremendous. Farmers facing soil degradation especially suffer from these consequences.

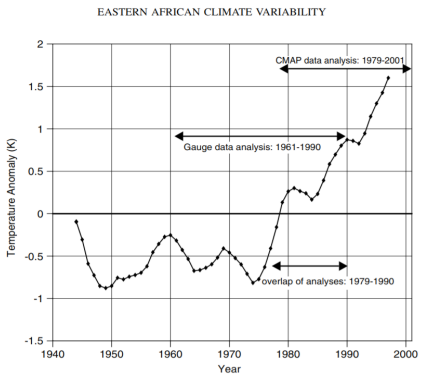


Figure 1. Global Climatic Research Unit (CRU) surface temperature averages

Source: C.J. Schreck & F.H.M. Semazz, Variability of the recent climate of Eastern Africa, 2004

The link between soil degradation and climate change

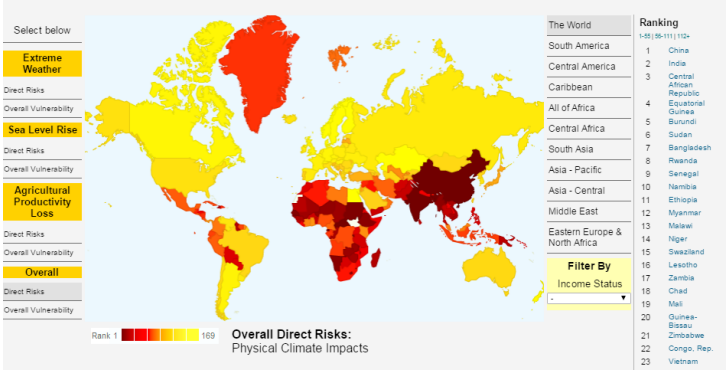
It is difficult to identify a direct causality between climate change and soil degradation.

However, a farmer with degraded soils is more vulnerable to climate change.

One of the common consequences of soil degradation is the decrease of the water holding capacity of the soil. The water holding capacity is the ability of a soil to store water and make it available for plants. It is crucial for farmers to have soils with sufficient water holding capacity to benefit from rainfall, especially in the context of growing rainfall variability. As previously explained, rainfall variability increases due to climate change. Therefore, soil degradation together with climate change increases the vulnerability of farmers. This is a concerning issue in East Africa.

Is climate change a stronger phenomenon in East Africa than in Europe?

Climate change is a worldwide phenomenon. Its impacts in Europe and East Africa are difficult to compare, as it depends both on the geographical and social situation of these areas. Weather data show that climate variability is higher in tropical countries than in areas with a more temperate climate such as Europe. It is very clear on the map from the Center from Global Development that overall direct risks of physical climate impacts are higher between the tropics.



Source: Center from Global Development

The impacts of climate change depend on the social situation of an area

The comparison between East Africa and Europe gives a good idea of how the impacts of climate change depend on the social situation of the area. Most people in East Africa are farmers relying on rainfed agriculture for their livelihood. In the Netherlands, on the other hand, farming represents less than 3% of the total employment and almost all agricultural lands are irrigated. Farmers in East Africa are more vulnerable to climate change because they rely more on weather conditions.

The way societies are organized and the degree to which they depend on weather conditions are crucial to understanding how large the impact of climate change can be.

The largest impacts will be measured in areas that are most depend on weather conditions, and that includes East Africa.

Chapter 2

How to adapt to climate change? Remote sensing and weather forecasts helping farmers in Kenya.

There are two paths for East African farmers to cope with climate change.

One solution is to become less dependent on the weather. Rainfed cropping systems are only successful with a sufficient and adapted water input from rain. Because natural rainfalls become less and less reliable, one solution to decrease risks is to transform rainfed cropping systems into irrigated or greenhouse cropping systems. However, in many cases water availability and access to capital are not sufficient to make such transformations.

The other path is to have a better insight in the variations of the climate. As explained in the previous chapter, it is more and more difficult for farmers in East Africa to forecast the beginning of the rainy season. It can have an enormous negative impact on yields. For example, if the rains start late and the farmer has already sowed his grains, there is a high risk that many will not sprout. To face situations like this, farmers need access to reliable weather forecasts.

Access to weather information

The most important source of information Kenyan farmers use is their own experience. However, this experience is challenged by increasing weather variability. There are different websites where weather forecasts can be found. Yet, available weather forecasts from different sources can be contradictory and often lack accuracy.

Moreover, many farmers do not have access to the internet. Smartphones are booming but not yet reaching all the population.

How can these farmers access reliable weather forecasts?

Most farmers have a feature phone and can receive SMS. Therefore, a way to reach them is to send weather forecasts directly on their phone via SMS.

SMS messaging is the best way to reach African farmers who do not have access to the internet.

AgroCares has been working on this for the past four years as part of a project in Kenya called **CROPMON**. The weather forecast service offered by CROPMON is combined with a field specific crop growth and crop health assessment using satellite data and a tailored farm management advice.

Using remote sensing to produce weather forecasts

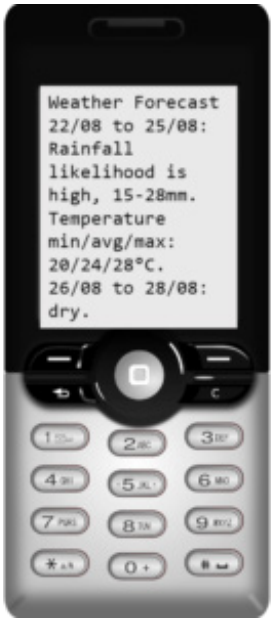
The fields of farmers need to be georeferenced. It means that we link the information we have on the fields to a geographic coordinate system. This is necessary to associate the field information to other data, such as remote sensing data and weather data provided by our respective partners NEO and Weather Impact.

With this methodology, we can provide a local weather forecast adapted to every farmer.

Providing weather information to over 50,000 farmers

Today thanks to the project, 50,000 farmers in Kenya receive a weekly local weather forecast by SMS. The SMS includes forecasts for two time frames. The first part details on the next three days and consists of temperature and precipitation predictions with a likelihood indication for rainfall. The second part is identical, but the forecasts are generated for the period of the four following days. The spatial resolution of the weather forecast is 10 km^2 for temperature, 5 km^2 for rainfall. This local weather forecast has a higher value for the farmers compared to national broadcasts. Farmers are satisfied with this service as it helps them to "catch the season" - in other words, to time their farm activities to maximize crop growth.

An example of an SMS message received by project participant is shown below.



Source: Weather Impact

Chapter 3

Innovation helps climate vulnerable farmers to monitor their crops

The risk of smaller yields is higher for farmers in a context of climate change. However, the overall problem is a decrease of resilience of the farming systems. Climate change triggers higher risks of smaller harvests, but an aggravating factor is that farmers are vulnerable to these consequences.

How can farmers become more resilient?

Farmers can greatly benefit from geodata. It can bring a direct benefit through better predictions of the start of the rainy season, but it can also be used as a tool to gain access to additional resources. For example, many remote farmers in East Africa do not have access to loans to buy fertilizers or crop insurance. Why not? Simply because until now it is hard for banks or insurance companies to predict the performance of a crop in a remote area, and therefore assess the risk to lend money or insure a crop. However, the use of geodata can solve this problem.

Predicting the performance of a crop with geodata

From a satellite, it is possible to estimate the biomass at the surface of the Earth. Here is an easy way to understand how: if you take a picture of a forest from the sky, the greener the picture looks the more trees there are.

Of course, you need to consider the type of trees, the season, and many other reference parameters if you want a relevant value. For a crop, it is the same idea. Once you register the field's geometry, you can compare the geodata of the present year to the data of the past years in the same field and conclude if a crop is performing well relatively to previous years. In the same way you can establish a crop specific reference for the achievable yield when soil, weather and farm management conditions are optimal and compare this to the actual geodata of a field to determine the so-called 'yield gap'.

How to explain crop underperformance?

Using satellite data, we can identify two main factors to explain crop underperformance. Chlorophyll is responsible for the green color of the plant. If a crop suffers from a lack of nitrogen, it triggers a low content of chlorophyll which results in an overall change of color of the plant. This change is something we can detect thanks to remote sensing. Another factor is water. Just like for a lack of nitrogen, the effect of drought on a crop can be detected with geodata and verified with weather data. As explained in the previous chapter, AgroCares is cooperating with Weather Impact in developing a system that produces weather forecasts in Kenya. Within the same CROPMON project and working together with NEO, we created a crop performance monitoring system for Kenyan farmers based on remote sensing.

Providing farmers with a crop performance report

Farmers subscribed to the CROPMON service currently receive two SMS messages per week. The first SMS is a weather forecast for the next 7 days that contains predictions and likelihoods for rainfall and temperatures. In the second SMS the farmer gets a crop specific performance report of his field with the explaining factors of the performance when available. For AgroCares, it is a first step towards an inclusive crop monitoring system. The mid-term idea is to combine remotely sensed data and farm management data with soil data extracted directly from the field with a Scanner or a Lab-In-The-Box and make it possible to know in real time what is limiting the performance of a crop.

AgroCares' ultimate goal for the CROPMON project is to increase agricultural yields with quicker, on the spot and real-time advice. This is even more crucial in the context of climate change.

Outlook for the future

In the future the impacts of climate change will be growing, but so will the opportunities for agriculture to be more resilient and for farmers to be less vulnerable to the changing climate. There is a lot of potential for yield increase in Africa. Remote sensing and geodata will play a big role in the development of a new way of farming.

Learn more:

More information about AgroCares, the Scanner and Lab-in-a-Box

More information on the CROPMON Project

A video about the CROPMON Project

Check more AgroCares white papers

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