**Session 2: Validation of TAMSAT-ALERT for Impact-based Forecasting - Transcript**

Slide 1:

Hello everyone, and welcome back to the TAMSAT-ALERT training course. I’m Vicky Boult and in this session we will be exploring the relevance of TAMSAT-ALERT for impact-based forecasting.

Slide 2:

This session will be split into two activities. Firstly, you should listen through this narrated presentation, advancing to the next slide in your own time. Alternatively, if you can’t listen along, you can read through the transcript provided. This presentation will take you through what is needed for effective impact-based forecasting, and will then explore whether TAMSAT-ALERT meets these needs. After you have finished with the presentation, you should check your understanding by completing the questions provided. The answers to these questions are also provided, but we encourage you to try completing the questions without help first, and then you can check your answers. We can discuss the answers to any questions you were unsure of at the end-of-week check-in clinic.

Slide 3:

This session aims to meet the first learning objective outlined in the welcome presentation. By the end of this session, you should be able to explain the relevance of TAMSAT-ALERT for impact-based forecasting. Specifically, you should understand that TAMSAT-ALERT soil moisture metrics relate closely to the impacts of drought and that TAMSAT-ALERT forecasts provide sufficient lead-time to allow for early action. You should also be aware of the caveats associated with TAMSAT-ALERT soil moisture forecasting.

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TAMSAT-ALERT forecasts the mean seasonal soil moisture for a location or region of interest. These forecasts can be updated regularly in the run-up to, and during a particular season. Using TAMSAT-ALERT’s historic soil moisture dataset, which spans 1983 to the present day, we can compare the forecast against observed soil moisture values in previous years to give us an idea of whether this season is likely to be above normal, normal or below normal.

The top figure shows a TAMSAT-ALERT soil moisture forecast issued on the 15th April this year for Kitui county in Kenya. The forecast is presented as a percent anomaly of the climatological mean soil moisture. The blue colours shown across Kitui county indicate that the TAMSAT-ALERT forecast is predicting that soil moisture will be above average for this season.

The lower plot shows a time series of soil moisture averaged across Kitui county. Each of the grey lines shows soil moisture experience during one year in the historic dataset. The black line shows soil moisture for 2020. The red line show soil moisture in 1998, following an exceptionally wet OND season in 1997.

Agricultural drought is defined by a soil moisture deficit that inhibits plant growth. Soil moisture is therefore a very relevant metric in drought forecasting and could be useful for supporting forecast-based actions in the agricultural and humanitarian sectors. However, to effectively support forecast-based action initiatives, TAMSAT-ALERT forecasts must meet some important requirements.

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What is forecast-based action? This image is taken from the Red Cross and nicely demonstrates the forecast-based action process. Firstly, a forecast is issued indicating that there is a high probability that an extreme event will happen, for example, a forecast might indicate a high likelihood of drought. Second, based on this forecast, funds are released so that organisations like the Red Cross can take action to prepare for the extreme event. Individuals too may act upon a forecast. In the case of drought, humanitarian organisations might mobilise food aid and people may begin water sparing practises. Third, these actions mean that people are prepared before the extreme event hits. So that finally, when the event does occur, preparations mean that less lives and livelihoods are impacted. Preparing for an event before it occurs based on a probabilistic forecast is what we call forecast-based action.

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There are two key requirements for a forecast to effectively support forecast-based action. Firstly, the metric which is being forecast must relate to the impacts of the extreme event. In the case of drought, the impacts of interest would be food insecurity. It seems likely that soil moisture, which supports crop growth, will relate to food insecurity, but this must be confirmed before soil moisture forecasts can be employed in drought FbA. Second, the forecast must be provided in time to allow for preparatory actions to take place. If forecasts are issued too late, there will be insufficient time to prepare for the drought.

We tested whether TAMSAT-ALERT soil moisture forecasts met these requirements. I’d like to show you the results.

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We carried out the validation of TAMSAT-ALERT soil moisture forecasts for two countries, Kenya and Zimbabwe. We were particularly interested in soil moisture during the rainy seasons, since these seasons are most important for crop growth and therefore food security. In Kenya, we therefore assessed soil moisture forecasts in both the short rainy season from October to December and the long rains spanning March to May. In Zimbabwe, we considered the single longer rainy season from December to mid-April.

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To assess whether TAMSAT-ALERT soil moisture related to food insecurity, we considered what causes food insecurity. Both Kenya and Zimbabwe produce crops and livestock for food. We therefore compared TAMSAT-ALERT soil moisture to pasture availability and crop yield. We estimated pasture availability using the Vegetation Condition Index or VCI. VCI provides a standardised measure of the ‘greenness’ of the Earth’s surface. VCI has been shown to relate strongly to pasture biomass and productivity, and so here we used it to estimate the pasture available for grazing livestock. For crop yield, we obtained yield and harvested area data for maize from the FAO database.

We compared mean seasonal VCI (or pasture availability) to mean seasonal TAMSAT-ALERT soil moisture. Additionally, we compared total annual maize yield to mean seasonal WRSI. WRSI stands for the water resource satisfaction index and is a measure of the soil moisture available to a crop based on the crop rooting depth throughout the growing season.

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Let’s look at some of the results. This figure shows the relationship between the seasonal mean values of soil moisture and WRSI, with VCI and yield respectively, averaged across each country. The left column shows the relationship between soil moisture and VCI, whilst the right column shows the relationship between WRSI and yield. Each row is for a different region and season. The top row is Kenya’s MAM season, the middle is Kenya’s OND season, just to note here that we didn’t compare WRSI and yield in Kenya’s OND season because this is not a major crop growing season for most of Kenya. And the bottom row is for Zimbabwe. Above each plot we have provided correlation statistics for each relationship.

Firstly, you can see that all relationships are significant and positive. This means that as soil moisture or WRSI increases, so does pasture availability and crop yield. The relationship between soil moisture and pasture availability is generally higher than the relationship for WRSI and yield, and this is likely because there are many other factors, in addition to soil moisture, which impact yield.

To summarise this plot, this plot shows that when averaged over a season and country TAMSAT-ALERT soil moisture and WRSI relate closely to mean seasonal VCI and total annual maize yield.

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We also considered how the relationship between soil moisture and pasture availability changes across space. This plot shows in the first column, the soil moisture climatology for each region and season, in the second column, the VCI climatology for each region and season, and in the final column, it shows the correlation between soil moisture and VCI for each grid cell. In the correlation maps, darker blue colours show a strong positive correlation, whilst red colours show a negative correlation.

What this shows us is that the relationship between soil moisture and VCI varies across space. In Kenya, the correlation is highest in the arid and semi-arid counties in the northeast. The relationship is weaker in western Kenya and poor across Kenya’s central highlands. In Zimbabwe, the relationship is strongest in the south and weaker in the north.

We were not able to do this for the relationship with yield because we do not have spatial information on crop production, rather we just have an annual total for each country.

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So to summarise those results, they tell us that TAMSAT-ALERT soil moisture and WRSI are indeed metrics which are relevant to the impacts of drought. Soil moisture is a good predictor of pasture availability when averaged across a region and season. This relationship is particularly strong in arid and semi-arid regions. In addition, WRSI is a good predictor of maize production, although production is influenced by additional factors which should also be taken into account.

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Given that we now know that TAMSAT-ALERT soil moisture and WRSI are relevant to the impacts of drought, the next question is whether we can reliably forecast seasonal mean soil moisture and WRSI with sufficient lead-time to allow actions to take place before a drought occurs.

The TAMSAT-ALERT forecasting system was used to generate hindcasts of seasonal mean soil moisture and WRSI for each year in the climatological period (15 years: 2003-2017). Hindcasts were generated every week from the beginning to the end of the season. The resulting forecasts were compared to historic observations of seasonal soil moisture and WRSI.

Forecasts were also used to calculate the probability of seasonal mean soil moisture and WRSI being below the 20th percentile. Comparison of the forecast probability with observed classifications was used to calculate the hit and false-alarm rates. These were subsequently used to generate ROC scores to assess the skill of forecasts in identifying drought years.

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Here are those results. In the left column we show the correlation between the forecast and the observed seasonal soil moisture and WRSI. In the right column, we show the ROC scores to indicate the skill in the forecasts in correctly identifying drought years. ROC scores are calculated by comparing the true-positive rate, which itself accounts for forecast hits and misses, and the false-positive rate, which accounts for false-alarm and correct rejection rates. Any correlation or ROC score above 0.8 is considered to be highly skilful. Again, each row indicates a country and season. Each plot shows the progression through the season on the x axis, from the beginning of the season, until the end. This is presented as lead time before the end of the season, when the impacts of drought emerge.

As you can see from the plots, the correlations and ROC scores generally increase as the season progresses. This indicates the increasing skill in TAMSAT-ALERT forecasts through the season. At the beginning of the season, TAMSAT-ALERT forecasts of soil moisture and WRSI are not as skilful in correctly identifying drought years. By mid-season however, high skill is achieved.

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To summarise the results of the validation of TAMSAT-ALERT for drought impact-based forecasting, we can conclude that:

Firstly, TAMSAT-ALERT soil moisture and WRSI are relevant to the impacts of drought. Soil moisture and WRSI relate strongly to pasture availability and maize yield. This relationship holds at a national scale, but it should be noted that, for some localities, particularly at high altitudes, the relationship between soil moisture and pasture availability is poor.

Second, we have seen that TAMSAT-ALERT forecasts relate closely to observed soil moisture and WRSI well ahead of the end-of-season. This implies that TAMSAT-ALERT forecasts can be reliably used to trigger early-action ahead of a drought. Because the skill of the forecasts increases throughout the season, TAMSAT-ALERT should be used to trigger less-costly, no regret action early in the season, but can be used to trigger more risky actions by mid-season.

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Given the assessed suitability of TAMSAT-ALERT soil moisture forecasts for drought forecast-based action, regular TAMSAT-ALERT forecasts can be monitored to inform decision-making ahead of likely droughts.

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This session aimed to meet the first learning objective outlined in the welcome presentation. We covered the relevance of TAMSAT-ALERT soil moisture and WRSI to the impacts of drought and saw that TAMSAT-ALERT can reliably forecast these metrics with sufficient time to allow for action. However, we also saw that for some locations, TAMSAT-ALERT soil moisture is not such a good predictor of pasture availability, and TAMSAT-ALERT forecasts have limited skill early in the season.

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Now that you’ve listened to this presentation, you should test your understanding by completing the questions provided. You can then check your responses against the answers that are provided.

If you have any questions about anything covered in this session, then please call-in to chat with us during the end-of-week clinic on Friday 8th May at 10am. Alternatively, you can drop me an email.

Next week, Professor Emily Black will be taking you through the methods behind the TAMSAT-ALERT soil moisture forecasts.

I hope you enjoyed this session. Bye.