Transcript for TAMSAT-ALERT for Impact-Based forecasting: Session 2 Part 1

Slide 1
Welcome to the next session in our course on TAMSAT-ALERT for Impact-Based Forecasting. This session focuses on methodology. In Part 1, we will be looking at how we estimate soil moisture and the water resource satisfaction index, which is also known as WRSI.

Slide 2
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Slide 4
Our soil moisture model is based on the JULES (joint UK land environment simulator) land-surface model. JULES is also the land surface component of the UK met office climate model and so it has been applied globally and extensively tested and evaluated. The reading list at the end provides full details about JULES.

The key points here are that our model simulates all the key terrestrial elements of the water cycle including evaporation, infiltration, percolation and run off. The model is driven with observed meteorological data, and can be applied anywhere in the world. It accounts for variation in temperature and humidity, as well as in precipitation.

Additionally, the model accounts for the effect of soil texture and vegetation on soil moisture content.

Overall, the model provides a more comprehensive representation of terrestrial processes than models like Aquacrop.

A caveat with the application of our model over Africa, is that it is difficult to observe soil moisture directly. Other methods of validation were covered in the previous session.

The figure on the slide is a schematic of the JULES land surface model. JULES takes in prescribed fluxes of radiation and precipitation, as well as other inputs listed in full in the grey box. Depending on the vegetation and soil cover, water coming into the model is partitioned into evaporation, runoff and infiltration. JULES also includes a photosynthesis scheme, which determines plant transpiration. Our model is a simplified version of JULES.

Slide 5
The effect of drought on plants depends on the extent to which their roots can access the water they require to grow and develop. This is encapsulated by the Water Resource Satisfaction Index, which represents the soil moisture deficit in the root zone, cumulated over the growing season. The model described in the previous slides can be adapted to calculate WRSI.

The first stage is to adapt the soil moisture model to grow crops. With crops, the vegetation parameters (leaf area index, canopy height and rooting depth) vary according to the stage of growth. So a seedling has very shallow roots, whilst a mature plant has deep roots.

A common approach used by the FAO is to determine the crop development stage using growing degree days – see formula on the slide. For each day, the GDD is calculated as described above. The cumulative GDD can be used to determine the stage of the growing season. So for the example above, after 50-100 GDD, the plant emerges, after a further 600-900 GDD the plant reaches its flowering stage, and so on. The harvest date, and hence the growing season length is thus automatically calculated, depending on the required number of growing degree days and the daily temperature. In our model, the planting date is prescribed by the user. The number of growing degree days required for each development stage depends on the crop and the variety. Again, these quantities are prescribed by the user.

The second stage of our calculation of WRSI is to run the model with the varying rooting depth, canopy height and leaf area index derived in the first part of the process. The model calculates soil moisture deficit in the rooting zone and outputs it at a daily time step.

The final stage is to calculate the mean WRSI over the growing season. The dates of the growing season will vary spatially, depending on regional variations in temperature and planting date. In general, a WRSI of less than 50% is considered indicative of significant water stress on plants – in other words agricultural drought. By this definition, large parts of Africa experience agricultural drought in a high proportion of years.

Slide 6

To lead us into the next session, here are examples of some WRSI predictions made using the TAMSAT-ALERT system for the 2019-2020 southern Africa growing season. The plot on the left shows the predicted WRSI, and the plot on the right compares this prediction to the usual conditions (climatology). It can be seen that in the southern part of the region, WRSI is predicted to be low, while in the northern and eastern part of the region, we are not expecting severe agricultural drought. Conditions are near normal.

In the next session we will look at how the TAMSAT-ALERT system can be used to predict soil moisture and WRSI.