Proposed input format for climate-induced temporal outbreak patterns. Input parameters vary depending on selection of OutbreakPattern. Examples using the Cyclic functions are provided at the end of the document.

>>-------- Regional Outbreak Inputs --------  
OutbreakPattern Climate << CyclicNormal or CyclicUniform or Climate  
ClimateLibrary Filename << Not sure yet what form this will take  
VariableName PDSI << Any variable from the climate library  
StartMonth 1 << Numerical month  
EndMonth 12 << Numerical month  
Function mean << min or max or mean   
LogicalTest “< -2.0” << outbreak threshold  
OutbreakLag 3 << years  
TimeSinceLastClimate 1 << years - optional  
TemporalType pulse << pulse or variablepulse  
MinROS 0 << background level (0-3)  
MaxROS 3 << maximum level (0-3)

This approach is designed to achieve maximum flexibility when applied to the climate library being developed, and at the same time be able to be implemented for the immediate need to just link BDA to PDSI. It’s not clear yet how the BDA extension will find the climate data or what format that will take, but we presume that the climate data will be available on a monthly basis for each ecoregion for each simulation time step. The inputs above give the user the flexibility to use annual, single month, or multiple-month evaluations and multiple functions when looking for outbreak thresholds, and apply them at a landscape scale (future development may enable using ecoregion scale logical tests). The example inputs above would use the annual (months 1-12) mean landscape PDSI value, and if that value is < -2.0, then an outbreak would be triggered in 3 years from the current time step. The design would also allow uses such as minimum January and February temperature that may be important in other future applications. The OutbreakLag is used to reset the BDA’s internal counter that tracks time to next outbreak. The time since the last Climate event (TimeSinceLastClimate) is an optional input to allow outbreaks to occur in the first years of simulation before the outbreak lag has passed. If TimeSinceLastClimate > OutbreakLag or TimeSinceLastClimate is excluded, then no outbreak will occur until OutbreakLag has passed.

An additional consideration needs to be made to allow multiple outbreaks to occur within a timespan less than OutbreakLag. For example, 2 consecutive drought years should trigger outbreaks in consecutive years. If the OutbreakLag is used to simply overwrite TimeToNextDisturbance, then it will not handle consecutive outbreaks correctly (only the second would occur). A possible solution to this is to construct a continuously updated list of time steps that meet the LogicalTest (this would be an agent parameter). Then that list is consulted each time step when the TimeToNext has the opportunity to be updated. So, when a new TimeToNext is assigned, it does not cancel out any pending outbreaks.

Ecoregion-scale considerations (future development):

Due to spatial differences among ecoregions (see below), the time to next outbreak may need to be tracked as a site variable or potentially an ecoregion variable. The spatial differences among ecoregions create some challenges to applying the BDA. The RestrictionMethod input above attempts to get at how the spatial differences in climate at the ecoregion level would impact an outbreak. This input is only used when FuntionScale = ecoregion. When using the landscape FunctionScale there are no ecoregion differences. Assuming that climate is calculated at an ecoregion level, then some portions of the landscape may cross the climate threshold while others do not. This would then create a spatial mask for areas that do meet the threshold by altering the ecoregion modifiers. Using the first RestrictionMethod (‘Initiation’), those modified values could be applied to limit only the initiation of new outbreak epicenters (if using dispersal), which would restrict epicenters to ecoregions meeting the threshold, but allow an outbreak to spread into areas not meeting the climate threshold. The second RestrictionMethod option (‘Disturbance’) is designed to also restrict the spread of disturbance to areas meeting the climate threshold, so that the outbreak is completely limited to areas meeting the threshold (all ecoregion modifiers not meeting threshold set to -1.0). If not using the dispersal functions, then the Disturbance option is the only logical choice.

Example input formats for the Cyclic OutbreakPatterns:

>>-------- Regional Outbreak Inputs --------  
OutbreakPattern CyclicNormal << CyclicNormal or CyclicUniform or Climate  
Mean 20 << mean years between outbreaks  
StDev 15 << standard deviation (years)  
TimeSinceLastEpidemic 20 << years  
TemporalType pulse << pulse or variablepulse  
MinROS 0 << background level (0-3)  
MaxROS 3 << maximum level (0-3)

>>-------- Regional Outbreak Inputs --------   
OutbreakPattern CyclicUniform << CyclicNormal or CyclicUniform or Climate  
MaxInterval 20 << maximum years between outbreaks  
MinInterval 15 << minimum years between outbreaks  
TimeSinceLastEpidemic 20 << years  
TemporalType pulse << pulse or variablepulse  
MinROS 0 << background level (0-3)  
MaxROS 3 << maximum level (0-3)