How to Calculate Rate of Spread

The rate of spread of a fire front through an area can be calculated if you know the times that the fire reached three different points in the landscape. The examples here will show you how to do this with an experimental set-up using electronic timers. Keep in mind the video clips and figures that you have seen already.

Three timers (or temperature-residence-time meters – TRTMs) are used to calculate the rate of spread of a fire front through an imaginary triangle. By using the rate of spread for a number of triangles a mean rate of spread can be calculated for the whole. It is important to calculate the mean, since the rate of spread can change over short distances with small-scale changes in fire weather, topography and fuel load.

In the examples for the Territory Wildlife Park and Kapalga, the TRTMs are placed at the apices of equilateral triangles (see the rate of spread fire clip for more information on how the timers are activated and where they are placed). Once the fire has moved across the triangle the data from the timers can be collected.

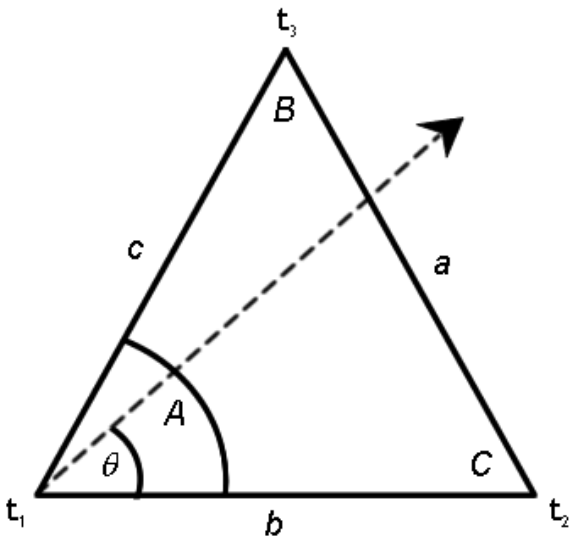
The rate of spread is calculated using the following formulae:

$$\theta = \tan^{-1}\left[\left(\frac{t_3 - t_1}{t_2 - t_1}\right)\left(\frac{b}{c\sin A}\right) - \left(\frac{1}{\tan A}\right)\right];\ t_2 \neq t_1 \qquad (1)$$

$$r = \frac{D\cos\theta}{t_2 - t_1};\ t_2 \neq t_1 \qquad (2)$$

where,
t_1, t_2, t_3 = times that a fire arrives at the first, second and third vertices of an equilateral triangle,
D = distance between the points,
θ = the angle of spread relative to a base line between t_1 and t_2, and
r = rate of spread

The figure below shows you the angles and distances that are important for calculating the rate of spread.



For more detailed information on the theory behind the calculation see Simard et al (1984).

Territory Wildlife Park experiment plot: Early dry season burn, June 2005, plot C3

Let's now look at an example burn from the Territory Wildlife Park fire study.

Open up the example calculation in the Excel workbook //trtm_calculation.xls and make sure that the comments are visible. (If they aren't, click on >VIEW>COMMENTS in the Excel toolbar).

In the first spreadsheet (labelled "Data") you will find the times recorded by the timers (TRTMs) and information about where and when the fire took place. If you have a look at the times that it took for the fire front to reach the timers you will notice that the fire reached apex A6 first. This meant that the fire was advancing from the south-east (refer again to the website illustrations to see how the TRTM set-up is positioned in the experimental burn plots).

The second spreadsheet labelled "Calculations") shows you one way of using the equations to calculate the rate of spread (ROS). In the example, three equilateral triangles from the TRTM set-up are used to calculate three ROS measurements, one for each triangle (refer again to the website illustrations to see how the TRTM set-up is positioned in the experimental burn plots). Looking at the results you'll notice that there is some variation in the ROS among the three triangles. The mean ROS for this particular fire is 0.019 m/sec (or 0.069 km/h) which is very slow.

You will notice that the **intensity** of the fires has not been calculated in this example. But you can use Byram's fire intensity equation to calculate the intensity of the fires if you know the amount of fuel consumed. Keep track of the units used in the calculations. This is often where mistakes can creep in.

These calculations can also be done without an experimental set-up but this will require slightly different formulae (see Simard et al. 1984).

Reference

Simard A.J., Eeningenburg J.E., Adams K.B., Nissen R.L. and Deacon A.G. (1984) A general procedure for sampling and analysing wildland fire spread. *Forest Science* **30**: 51-64.