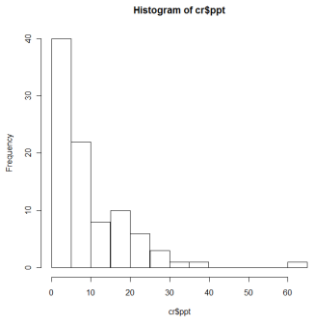
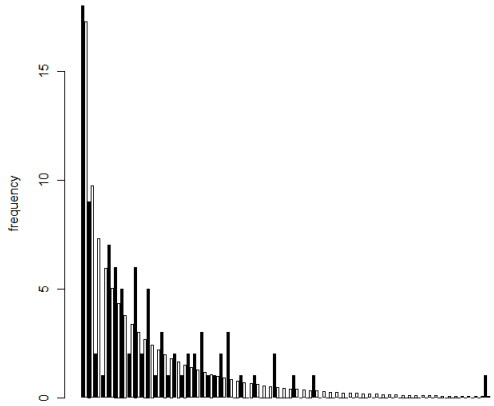
Problem: How to change, independently, the quantity of total rainfall and the frequency of rainfall.

This seems initially like an easy problem to solve. We could just calculate the average rainfall per day and number of rainy days from long-term data, and then have the rain fall twice as often but half as much per rainfall event if we wanted to change the frequency independently of the mean. Or have the rain fall twice as much on rainy days if we wanted to have the total amount change independently of the frequency.

The trouble is that these approximations would lead to a very unnatural rainfall, even for our ambient scenario, because rainfall amount is so very variable between days. In the Costa Rican data, 9mm a day falls on average, but this might be 1mm on one day and 30 mm on the next, definitely not 9mm a day! Furthermore, in this dataset, 76 out of 92 days had rain (technically >0.5 mm of rain), which doesn't give us a lot to play with in terms of increasing the frequency of rainy days. The distribution of rainfall has many small rain events and a few large rain events, typical of a negative binomial (i.e. more skewed than a Poisson). In this dataset, only 18 out of 92 days had no rain (technically, <1 mm of rain).



Below, you will see that a negative binomial (open bars) with parameters mean ("mu") = 9.15 and k = 0.6 fits the observed data (dark bars) reasonably well. The parameter k is called the dispersion coefficent (or clumping parameter), and is inversely related to the variance. The more k increases the greater the number of zero rainfall events and extreme rainfall events (curve gets more L-shaped).



So I propose that we could manipulate the mean and frequency of rain independently by (1) fitting the negative binomial to existing precipitation data for the site (for the experimental months only) and calculating mean and k - I have the R-code now, and (2) changing the mean and k independently as shown in the following table. The example graphs on the next page (please note that the x-axis, precipitation in mm, is very different between graphs) are random runs for negative binomials with the parameters corresponding to particular treatments (based on Costa Rican data). I arbitrarily looked at a range in the mean rainfall/day from 0.1 x current to 3 x current, and a 0.5 x to 2 x change in k...simply because these created large changes in rainfall distribution patterns with the Costa Rican dataset.