Monday Exercise 3 – answers

1. Application of the Taylor series method requires partial derivatives of E with respect to each of the six inputs. The partial derivatives are then evaluated for the means of the inputs, squared and multiplied with the variance of the uncertainty about the particular input. Finally, the sum of all six contributions is taken. For instance, $\frac{\partial E}{\partial S} = R \cdot K \cdot L \cdot C \cdot P$, which equals 19.93. This is squared and multiplied with the variance of S, yielding $19.93^2 * 0.12^2 = 5.72$. Doing this for all six contributions gives 15 ton/ha as overall uncertainty (sd) of E.

   Results summarised:

	mean	sdev	cv
R	297	72	24
K	0.10	0.05	50
L	2.13	0.05	2
S	1.17	0.12	10
C	0.63	0.15	24
P	0.50	0.10	20
estimate	23.31		
variance	226.4		
sdev	15.0		
cv	65		

2. Relative uncertainty is 65% (see table above). It is greater than the relative uncertainties of any of the inputs, so an increase of uncertainty in this respect.
3. The pdf will not be a normal distribution because we are multiplying, not adding, normally distributed variables. As a result of the multiplication it will be a pdf that has a positive skewness (tail on the right-hand side).
4. Positive correlation in input uncertainties would lead to a larger uncertainty in E. This is because we multiply uncertain inputs, so if all uncertain inputs are jointly larger (smaller) than their mean then this will lead to a much larger increase (decrease) in E than when some are larger and some are smaller than their mean. This finding will be confirmed by evaluating the Taylor method equation for correlated inputs: it will show that the extra covariance terms that are included are positive.
5. We ignored model uncertainty. It is likely large, because the USLE is a highly simplified representation of the true erosion process.