Tuesday Exercise 2

Consider Exercise 3 from Monday again, where we analysed uncertainty propagation through the USLE erosion model. This model had six uncertain inputs and output uncertainty was computed using the Taylor series method. We will now compute it using the Monte Carlo method and also quantify the uncertainty source contributions. We will compute the contributions in a slightly different and somewhat more robust way than defined in the lecture slides. There are even much more advanced ways, see the Saltetlli et al. (2008) book in the literature folder.

Open RStudio, copy the R script below and run it. Make sure you understand each step.

```
# Monte Carlo uncertainty propagation USLE model
n <- 1000
R <- rnorm(n,297,72); K <-rnorm(n,0.10,0.05)
L <- rnorm(n,2.13,0.05); S <- rnorm(n,1.17,0.12)
C <- rnorm(n,0.63,0.15); P <- rnorm(n,0.50,0.10)
E <- R*K*L*S*C*P
mean(E); sd(E); hist(E, col="LightBlue")

# Setting each uncertainty source to its mean, one by one
E_R <- 297*K*L*S*C*P
E_K <- R*0.10*L*S*C*P
E_L <- R*K*2.13*S*C*P
E_S <- R*K*L*1.17*C*P
E_C <- R*K*L*S*0.63*P
E_P <- R*K*L*S*C*0.50

# Uncertainty source contributions
C_R <- 1-var(E_R)/var(E); C_K <- 1-var(E_K)/var(E)
C_L <- 1-var(E_L)/var(E); C_S <- 1-var(E_S)/var(E)
C_C <- 1-var(E_C)/var(E); C_P <- 1-var(E_P)/var(E)
C_R; C_K; C_L; C_S; C_C; C_P

# Do they sum to one?
C_R+C_K+C_L+C_S+C_C+C_P
```

Answer the following questions:

1. Does the computed output uncertainty agree with that computed using the Taylor method on Monday? If not, why not? Which one do you prefer?
2. Is the uncertain model output normally distributed? If not, can you explain why it is not and can you explain why it is positively or negatively skewed?
3. Which is the main source of uncertainty? Could you have told this beforehand from just the means and standard deviations of the uncertain inputs?
4. Do the uncertainty contributions add up to one? If not, can you explain what is the cause of this?