Sensitivity analysis of the Penman-Monteith model

The aim of a sensitivity analysis of a model (or equation) is to gain insight into how sensitive the model (or equation) outcome is to changes in the values of the input variables in the model. There are a number of ways to proceed when performing a sensitivity analysis. Whatever specific strategy you may adopt, performing a sensitivity analysis for a model (or equation) is always good practice.

You may perform a sensitivity analysis for one or more of the land use settings - forest, grassland or open water - by independently changing the values of the variables under the heading ‘Data’ in the Table 2.2 spreadsheet. You may thus change the value of air temperature *T* (°C) by, for instance, +5% and then by –5% to examine the effects that these changes have on evaporation (mm day^{-1}). You then reset *T* (°C) to its initial value and shift your attention to the next variable, relative humidity, *RH* (-): change the value of this variable again by +5% and then by –5%, and then, again, examine the effects that these changes have on evaporation (mm day^{-1}); and so on. (Please take care that your input values remain within appropriate bounds!)

Effects of climate change

If you are interested in the effects of climate change on evaporation, or if you are interested in the effects of a land use change for a certain climate setting, a number of variables in the Penman-Monteith model need to be set at relevant values.

In the Table 2.2 spreadsheet, the Penman-Monteith model is set for average climate conditions by using the following set of empirical variables:
$a_s = 0.25$
$b_s = 0.50$
$a_e = 0.34$
$b_e = -0.14$ kPa$^{-0.5}$
$a_c = 0.25$
$b_c = 1 - a_c = 0.75$

The values of these empirical values may be thought off as obtained from experimental studies using lysimeters.

For arid climates, Shuttleworth (1993) recommends to change the values of a_c and b_c as follows:
$a_c = 1.35$
$b_c = 1 - a_c = -0.35$

For humid climates, Shuttleworth (1993) recommends to change the values of a_c and b_c as follows:

$a_c = 1.00$
$b_c = 1 - a_c = 0.00$

For The Netherlands, one may use (Van den Akker en Boomgaard 1996):
$a_s = 0.20$
$b_s = 0.60$
$a_e = 0.47$
$b_e = -0.067$ kPa$^{-0.5}$
$a_c = 0.20$
$b_c = 1 - a_c = 0.80$

Interestingly, for The Netherlands we would expect the air temperature T (°C) as well as some or all of the variables that are linked to the incoming short wave radiation at the earth's surface S_t (MJ m^{-2} day^{-1}) to be important because these are the variables used in the Makkink equation, a simplified version of the Penman equation used by the Royal Dutch Meteorological Society (KNMI) that is reported to perform well for the Netherlands (Box 2.15).

References

Shuttleworth, W.J. (1993). Evaporation. In: Maidment, D.R. (ed.), *Handbook of Hydrology*. McGraw-Hill, New York.
Van den Akker en Boomgaard (1996). Hydrologie. Lecture notes, Faculteit der Civiele Techniek, Technische Universiteit Delft, The Netherlands.