*Supplementary Material S1*

This Supplementary Material contains the VBA code for IrrigTool.

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Private Sub IRRIGATION_Click()
Dim i, j, frL, frC1, frC2 As Integer ' indexes and sheet cells counters
' READ INPUT DATA
Dim Pu(1 To 12), tn(1 To 12), K1(1 To 12), Kp(1 To 12), Af(1 To 12) As Single
' Pu - the monthly water contribution from precipitation
' tn - the monthly average temperature
' K1 - coefficient that depends on the zone latitude, function of the hours of light
' Kp - coefficient that depends on the crop type
' Af - the water contribution from groundwater
frL = 2: frC1 = 8
' location of the line and the column for reading data, mean values (Pu, t) from sheet S1
For i = 1 To 12
    Pu(i) = Sheets("Pu, t (S1)").Cells(frL + 1, frC1 + i) * 10 ' read Pu
    tn(i) = Sheets("Pu, t (S1)").Cells(frL + 2, frC1 + i) ' read tn
    If Pu(i) = "" Or tn(i) = "" Then
        Cells(1, 1) = "Missing data in the table Pu, t (S1)"
        GoTo LAST
        Exit For
    End If
Next i
frL = 3: frC1 = 2 ' location of the line and the column for writing data (Irrigation S1)
For i = 1 To 12
    Cells(frL + 1, frC1 + i) = Pu(i) ' write Pu
    Cells(frL + 2, frC1 + i) = tn(i) ' write tn
Next i

For i = 1 To 1000 ' read K1 values
    If Sheets("K1").Cells(3 + i, 1) = "" Then
        Cells(1, 1) = "Missing data in the table < K1 >"
        GoTo LAST
    Else
        If Cells(4, 17) = Sheets("K1").Cells(3 + i, 1) Then
            For j = 1 To 12
                If Sheets("K1").Cells(3 + i, j + 3) = "" Then
                    Cells(1, 1) = "Missing data in the table < K1 >"
                    GoTo LAST
                End If
                Cells(frL + 3, frC1 + j) = Sheets("K1").Cells(3 + i, j + 3) ' write K1
                K1(j) = Cells(frL + 3, frC1 + j) ' record K1
            Next j
            Exit For
        End If
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        End If
    Next i

    For i = 1 To 1000 ' read Kp
        If Sheets("Kp").Cells(3 + i, 1) = "" Then
            Cells(1, 1) = "Missing data in the table < Kp >"
            GoTo LAST

        Else
            If Cells(5, 17) = Sheets("Kp").Cells(3 + i, 1) Then
                For j = 1 To 12
                    If Sheets("Kp").Cells(3 + i, j + 3) = "" Then
                        Cells(1, 1) = "Missing data in the table < Kp >"
                        GoTo LAST
                    End If
                    Cells(frL + 4, frC1 + j) = Sheets("Kp").Cells(3 + i, j + 3) ' write Kp
                    Kp(j) = Cells(frL + 4, frC1 + j) ' record Kp
                Next j
                Exit For
            End If
        End If
    Next i

    For i = 1 To 1000 ' read Af
        If Sheets("Af").Cells(3 + i, 1) = "" Then
            Cells(1, 1) = "Missing data in the table < Af >"
            GoTo LAST
        Else
            If Cells(6, 17) = Sheets("Af").Cells(3 + i, 1) Then
                For j = 1 To 12
                    If Sheets("Af").Cells(3 + i, j + 3) = "" Then
                        Cells(1, 1) = "Missing data in the table < Af >"
                        GoTo LAST
                    End If
                    Cells(frL + 5, frC1 + j) = Sheets("Af").Cells(3 + i, j + 3) ' write Af
                    Af(j) = Cells(frL + 5, frC1 + j) ' record Af
                Next j
                Exit For
            End If
        End If
    Next i

    Dim ETRM(1 To 12) As Single ' ETRM computation (m³/ha) - formula (3)
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If Cells(9, 17) = "AUTO" Or Cells(9, 17) = "auto" Or Cells(9, 17) = "Auto" Then GoTo
ETRM_CALC
For i = 1 To 1000 ' read ETRM values if ETRM-code = AUTO
    If Sheets("ETRM").Cells(3 + i, 1) = "" Then
        Cells(1, 1) = "Missing data in the table < ETRM >"
        GoTo LAST
    Else
        If Cells(9, 17) = Sheets("ETRM").Cells(3 + i, 1) Then
            For j = 1 To 12
                If Sheets("ETRM").Cells(3 + i, j + 3) = "" Then
                    Cells(1, 1) = "Missing data in the table < ETRM >"
                    GoTo LAST
                End If
                Cells(frL + 6, frC1 + j) = Sheets("ETRM").Cells(3 + i, j + 3) ' write Af
                ETRM(j) = Cells(frL + 6, frC1 + j) ' record ETRM
            Next j
            GoTo ETRM_MAN
        End If
    End If
Next i

ETRM_CALC:
Dim itn(1 To 12), II, a, x As Single
' ETRM CALCULUS
' ETRM - the water consumption by the plant evapotranspiration at the soil surface
' itn - the monthly thermic index
' II - the annual thermic index (I) – formula (4)
' a - coefficient defined by formula (5)
' itn calculus
For i = 1 To 12
    If tn(i) > 0 Then
        itn(i) = (tn(i) / 5) ^ 1.514
    Else
        itn(i) = 0
    End If
Next i
' II calculus
II = 0
For i = 1 To 12
    II = II + itn(i) ' annual thermic index calculus– formula (4)
Next i
' a calculus – formula (5)
a = 6.75 * 10^(-7)*II^3 – 7.71*10^(-5)*II^2 + 1.792*10^(-2)*I +0.49239
' ETRM values calculus – formula (3)
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For i = 1 To 12
    If tn(i) > 0 Then
        ETRM(i) = 160 * (10 * tn(i) / II) ^ (a) * K1(i) * Kp(i)
        Cells(frL + 6, frC1 + i) = Format(ETRM(i), "0###")
    Else
        ETRM(i) = 0
        Cells(frL + 6, frC1 + i) = "0"
    End If
Next i

ETRM_MAN:
' READ SOIL CHARACTERISTICS
Dim culture, location, texture, season As String
Dim Hw, DAw, C0w, Ccw, Dim hs, DAs, C0s, Ccs, ha as Single
Dim Rmin(1 To 12), Rmax(1 To 12) As Single
' Hw - the soil depth able to stock the water outside the vegetation period, given in tables
' hs - the depth of active layer, in vegetable period, given in table
' DA - he soil bulk density (t/m3)
' C0 - the faded capacity in field (%), corresponding to the depth Hw.
' Cc - the water capacity in field (%), corresponding to the depth Hw.
' Rmin - the minimum reserve of the water in the soil.
' Rmax - the maximum reserve of the water in the soil.
' Pemin - minimum admissible humidity.
For i = 1 To 1000 ' read data for soil in Winter (H , DA, C0, Cc)
    If Sheets("Soil").Cells(4 + i, 1) = "" Then
        Cells(1, 1) = "Missing data in the table < Soil >"
        GoTo LAST
    Else
        If Cells(7, 17) = Sheets("Soil").Cells(4 + i, 1) Then
            If Sheets("Soil").Cells(4 + i, 3) <> "Winter" Then
                Cells(1, 1) = "Wrong data in the table < Soil >"
                GoTo LAST
            End If
            location = Sheets("Soil").Cells(4 + i, 2) ' read location
            season = Sheets("Soil").Cells(4 + i, 3) ' read season
            culture = Sheets("Soil").Cells(4 + i, 4) ' read crop
            texture = Sheets("Soil").Cells(4 + i, 5) ' read texture
            Hw = Sheets("Soil").Cells(4 + i, 6) ' read Hw
            DAw = Sheets("Soil").Cells(4 + i, 7) ' read DAw
            C0w = Sheets("Soil").Cells(4 + i, 8) ' read C0w
            Ccw = Sheets("Soil").Cells(4 + i, 9) ' read Ccw
            If location = "" Or season = "" Or culture = "" Or texture = "" Or Hw = "" Or
DAw = "" Or C0w = "" Or Ccw = "" Then
                Cells(1, 1) = "Missing data in the table of soil characteristics table"
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                GoTo LAST
            End If
            Exit For
        End If
    End If
Next i

For i = 1 To 1000 ' read data for soil for the vegetation period (h , DA, C0, Cc)
    If Sheets("Soil").Cells(4 + i, 1) = "" Then
        Cells(1, 1) = "Missing data in the table < Soil >"
        GoTo LAST
    Else
        If Cells(8, 17) = Sheets("Soil").Cells(4 + i, 1) Then
            If Sheets("Soil").Cells(4 + i, 3) <> "Summer" Then
                Cells(1, 1) = "Wrong data in the table < Soil >"
                GoTo LAST
            End If
            location = Sheets("Soil").Cells(4 + i, 2) ' read location
            season = Sheets("Soil").Cells(4 + i, 3) ' read season
            culture = Sheets("Soil").Cells(4 + i, 4) ' read crop
            texture = Sheets("Soil").Cells(4 + i, 5) ' read texture
            hs = Sheets("Soil").Cells(4 + i, 6) ' read hs
            DAs = Sheets("Soil").Cells(4 + i, 7) ' read DAs
            C0s = Sheets("Soil").Cells(4 + i, 8) ' read C0s
            Ccs = Sheets("Soil").Cells(4 + i, 9) ' read Ccs
            If location = "" Or season = "" Or culture = "" Or texture = "" Or hs = "" Or DAs =
"" Or C0s = "" Or Ccs = "" Then
                Cells(1, 1) = "Missing data in the table of the soil characteristics table"
                GoTo LAST
            End If
            Exit For
        End If
    End If
Next i

' Rmax and Rmin calculus outside the vegetation period, Hw
For i = 1 To 6
    Rmax(i) = 100 * Hw * Ccw * DAw
    Rmin(i) = 100 * Hw * C0w * DAw
    Cells(frL + 7, frC1 + i) = Format(Rmax(i), "0###")
    Cells(frL + 8, frC1 + i) = Format(Rmin(i), "0###")
Next i

' Rmax and Rmin calculus for the vegetation period, hs
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Dim Pemin As Single
'Pemin computation
If texture = "light" Then
    Pemin = C0s + 1 / 3 * (Ccs - C0s)
ElseIf texture = "medium" Then
    Pemin = C0s + 1 / 2 * (Ccs - C0s)
ElseIf texture = "heavy" Then
    Pemin = C0s + 2 / 3 * (Ccs - C0s)
Else
    Cells(1, 1) = "This texture doesn't exist"
    GoTo LAST
End If

For i = 7 To 12
    Rmax(i) = 100 * hs * DAs * Ccs
    Rmin(i) = 100 * hs * DAs * Pemin
    Cells(frL + 7, frC1 + i) = Format(Rmax(i), "0###")
    Cells(frL + 8, frC1 + i) = Format(Rmin(i), "0###")
Next i

Dim m, Ri(1 To 12), RF(1 To 12), RFa(1 To 12), NU(12), n(100) As Single
' m - the water application rate – equation (11)
' Ri - the initial water reserve in the soil
' RF - the final water reserve in the soil
' RFa – the total water volume used in a month as a function of the watering number
' NU - the irrigation rate – equation (1)
' n - watering number
    m = 100 * hs * DAs * (Ccs - Pemin) ' calculus of m – equation (12)
    NU(0) = 0

Dim RezIni As Single
'RezIni = Cells(14, 14) ' Read the final water reserve from the month IX
RezIni = Cells(10, 17) ' Read the final water reserve from the month IX
Range("C4:N16").Select
Selection.ClearContents
 Range("A3:A3").Select

If Cells(10, 17) = "0" Then
    Ri(1) = 100 * Hw * DAw * Pemin ' equation (9)
Else
    Ri(1) = RezIni ' If the initial water reserve is introduced by the user
End If

    RF(1) = Pu(1) + Af(1) - ETRM(1) + Ri(1) ' equation (11)
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    For i = 1 To 12
        If i > 1 Then Ri(i) = RF(i - 1)
 ' the initial water reserve in month i+1 is equal to the final reserve from the month i.
        If i = 7 Then Ri(i) = RF(i - 1) / Hw * hs
' reducing Ri by Hw/hs for the first month of the vegetation period (April)
' according to [41], p. 46
        If Ri(i) >= Rmax(i) Then Ri(i) = Rmax(i) ' condition for the initial water reserve
        RF(i) = Pu(i) + Af(i) - ETRM(i) + Ri(i)
' computation of the final water reserve for a month – equation (11)
        If RF(i) >= Rmax(i) Then RF(i) = Rmax(i) ' condition for the final water reserve
        n(i) = 0

        Do While RF(i) + RFa(i) <= Rmin(i)
' watering until the minimum water reserve is exceeded
            n(i) = n(i) + 1
            RFa(i) = RFa(i) + m
        Loop

        NU(i) = NU(i - 1) + n(i) ' water used for watering during a month
        If n(i) > 0 Then ' if at least one watering has been done
            Cells(frL + 9, frC1 + i) = Format(n(i) * m, "0#")
        Else
            Cells(frL + 9, frC1 + i) = "0"
            Cells(frL + 12, frC1 + i) = n(i)
        End If
        Cells(frL + 10, frC1 + i) = Format(Ri(i), "0###")

        If RFa(i) > 0 Then ' if water has been added by irrigation
            Cells(frL + 11, frC1 + i) = Format(RF(i) + RFa(i), "0###")
            RF(i) = RF(i) + RFa(i) ' update the final reserve
        Else
            Cells(frL + 11, frC1 + i) = Format(RF(i), "0###") ' write the final water reserve
            Cells(frL + 12, frC1 + i) = n(i) ' write the watering number
        Next i
        Cells(frL + 13, frC1 + 1) = Format(m * NU(12), "0###") ' write the irrigation rate
        MsgBox "WELL DONE!", vbInformation
    Exit Sub
LAST:
MsgBox "Calculation aborded!", vbCritical
End Sub
```