Sensitivity of soil water fluxes to changes in vegetation and root parameters

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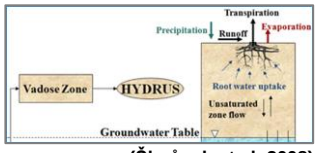
MOTIVATION

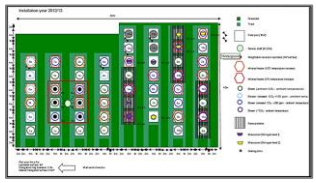
Climate change will cause changes to the vegetation cover and plant roots as well in soil water fluxes.

OBJECTIVE

In this work, the sensitivity of soil water fluxes to changes in vegetation and root parameters are examined using model scenarios implemented in Hydrus 1D.



(Šimůnek et al. 2008)



(Herndl & Pötsch 2013)

Reasonable ranges of
Leaf Area Index
crop coefficient and
root distribution parameters
for Alpine grasslands derived from:
- literature review and
- observations at the experimental ClimGrass site (Herndl and Pötsch, 2013).

MODEL DESCRIPTION

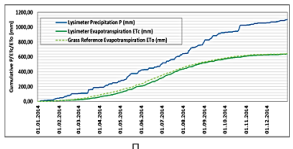
The HYDRUS program numerically solves the **Richards equation** for variably-saturated water flow (Šimůnek et al. 2008).

$$\frac{\theta(\Theta)}{\partial t} = -\frac{\partial q}{\partial z} = \frac{\partial}{\partial z}\left[K(h)\left(\frac{\partial h}{\partial z} + 1\right)\right] - S$$

- z = depth below soil surface (positive upward) [L]
- q = water flux [L T^{-1}]
- t = time [T]
- S = sink term (root water uptake) [T^{-1}]
- K(h) = soil hydraulic conductivity [L T^{-1}]
- h = pressure head [L]
- Θ = volumetric water content

- K(h) and θ(h) : Van Genuchten – Mualem (1980)
- root water uptake: Feddes approach (1978)

Initial conditions are set to a pressure head of -100 cm.
The water flow boundaries are controlled by atmospheric conditions, as well as free drainage boundary conditions.
The Time variable boundary conditions are specified by Lysimeter precipitation.



Weighable monolithic lysimeter, AREC Raumberg-Gumpenstein

Sensitivity study of soil water fluxes

Richards equation

Different crop parameters

Crop data:

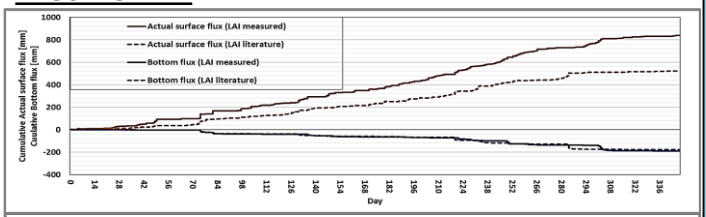
SCENARIO 1			
Measured values	**LAI []**	**Crop height [cm]**	**Root depth [cm]**
Minimal value	1,57	13	50
Maximal value	4,69	63	50
Literature values	**LAI []**		Albedo
Minimal value	0,69		0,23
Maximal value	1,88		0,23

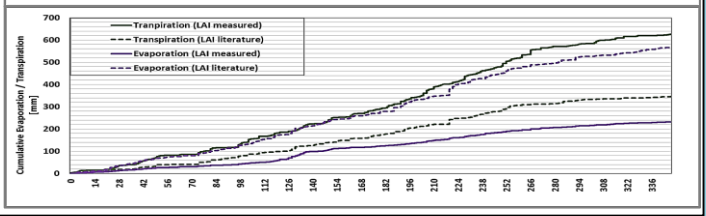
SCENARIO 2				
Measured values	**LAI []**	**Crop height [cm]**	**Root depth [cm]**	
Minimal value	1,57	13	50	
Maximal value	4,69	63	50	
Literature values		**Crop height [cm]**	**Root depth [cm]**	Albedo
Minimal value		63	100	0,23
Maximal value		113	100	0,23

SCENARIO 3				
Measured values	**LAI []**	**Crop height [cm]**	**Root depth [cm]**	
Minimal value	1,57	63	100	
Maximal value	4,69	113	100	
Literature values	**LAI []**	**Crop height [cm]**	**Root depth [cm]**	Albedo
Minimal value	3,72	63	100	0,23
Maximal value	6,69	113	100	0,23

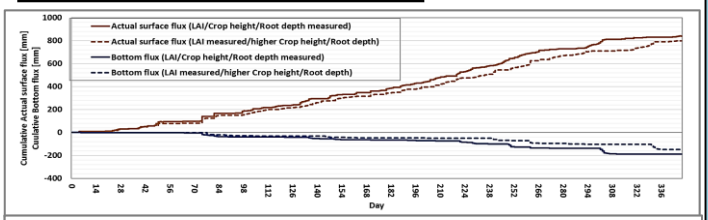
Ritchie (1972):
$E = ET\,e^{-k\,LAI}$ $\quad T = ET\,(1 - e^{-k\,LAI})$
E = Evaporation
T = Transpiration
ET = Evapotranspiration
K = radiation extinction []

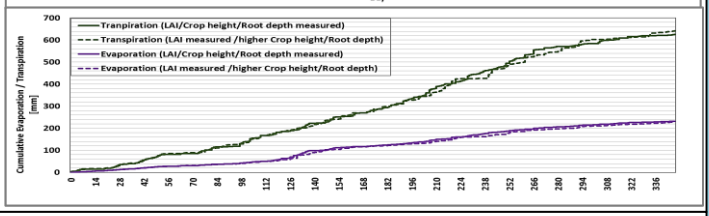
RESULTS – LAI



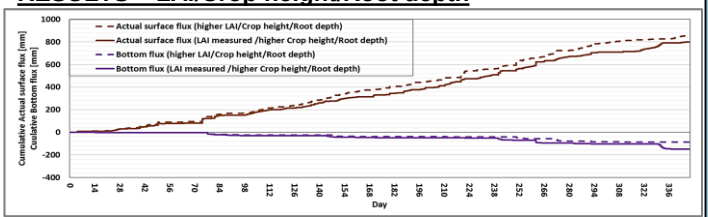


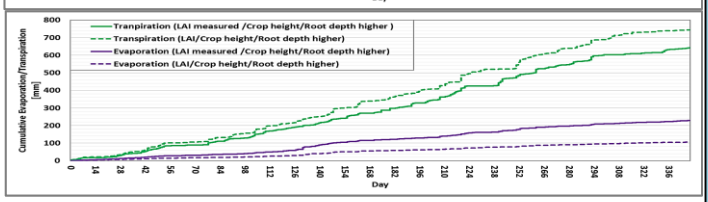
RESULTS – Crop height/Root depth





RESULTS – LAI/Crop height/Root depth





CONCLUSION

Transpiration: higher than **Evaporation**
LAI: Strong Influence on Actual surface flux, Evaporation, Transpiration
Crop height and Root depth: Less Influence on Soil water fluxes

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