THE IMPACT OF DRY AND WET PERIODS ON PROFILE SOIL MOISTURE CALIBRATION AND VALIDATION IN CATCHMENTS CHARACTERISED BY VERTICAL FLUXES

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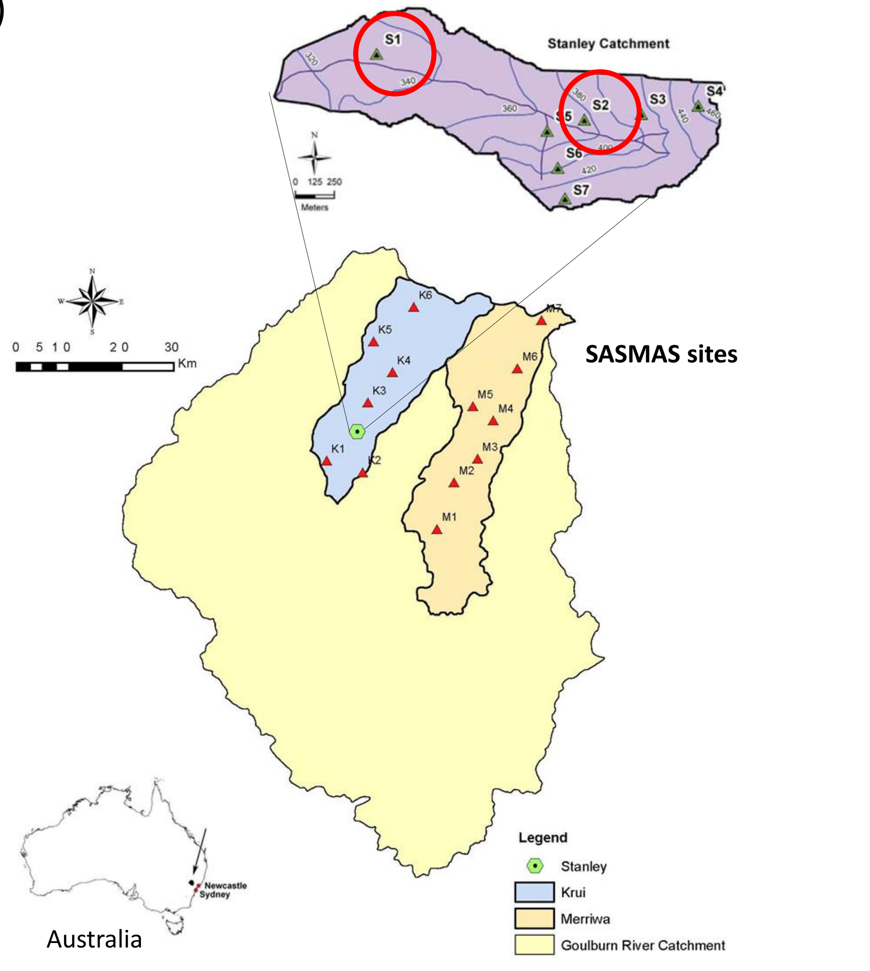
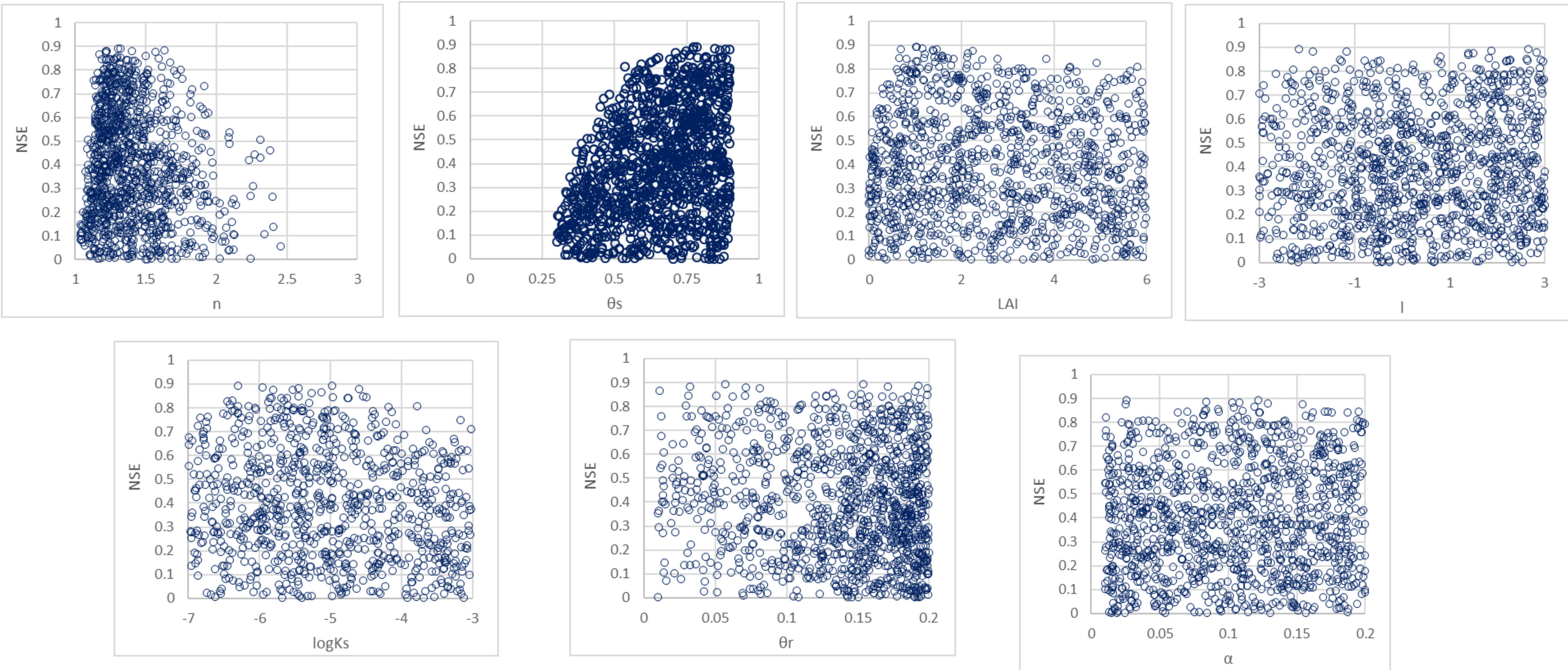
INTRODUCTION

- To analyse the impact of climate, vegetation and soil parameters on profile soil moisture in order to explore the factors involved in profile soil moisture dynamics
- Two climate periods were identified: dry (2005-2006) and wet (2008-2010) for calibration
- Scaling and Assimilation of Soil Moisture And Streamflow (SASMAS) is a soil moisture field study site in Australia (Rüdiger et al., 2007)
- In this first analysis, it will be analysed two stations separated in 1250 meters
- The stations (S1 and S2) are located in a grassland area in the Stanley microcatchment



MODEL SENSITIVITY

The model used is HYDRUS-1D. It uses the modified Richards Equation to calculate the water flow. The model was proved to be suitable for the area by Chen et al (2014), that is characterised by vertical fluxes. The vegetation in the model is expressed by the leaf area index (LAI).
To calibrate the model for the two climate periods, a Monte Carlo based approach of the Generalized Likelihood Uncertainty Estimation (GLUE) approach was associated to HYDRUS-1D.
10000 runs generated parameter sets that where analysed using the R^2, the scaled root mean squared error (sRMSE) and Nash-Sutcliff model efficiency coefficient (NSE).
The dotty plots of the soil parameters for the period of calibration S2 dry (2005-2006) show which parameters are more sensitive to the model calibration.

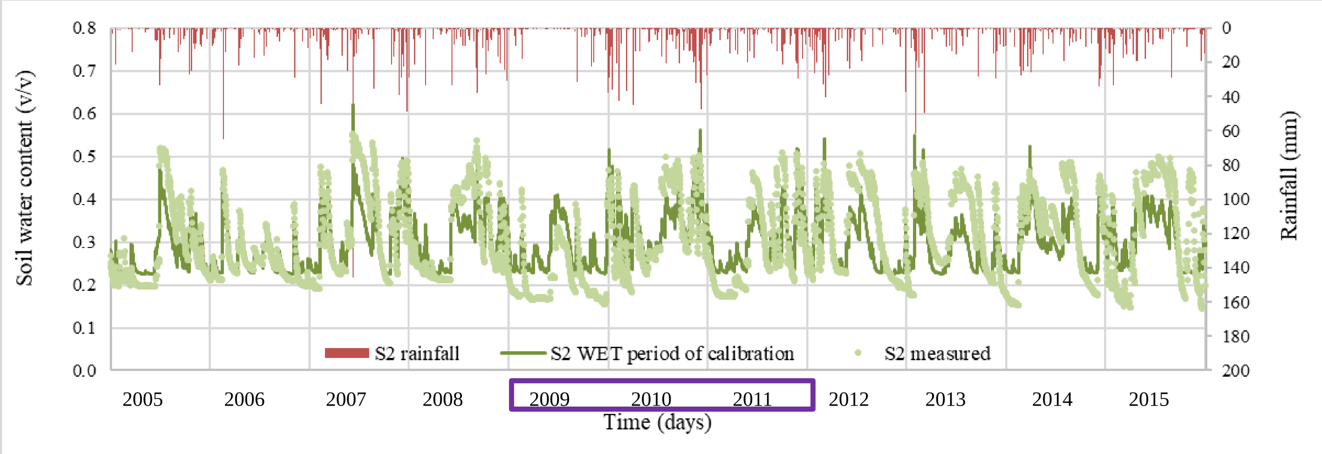


The parameters that are more sensitive in the model are the saturated water content (θs), parameter related to soil-pore distribution (n) and leaf area index (LAI).

DRY AND WET PERIODS SIMULATIONS

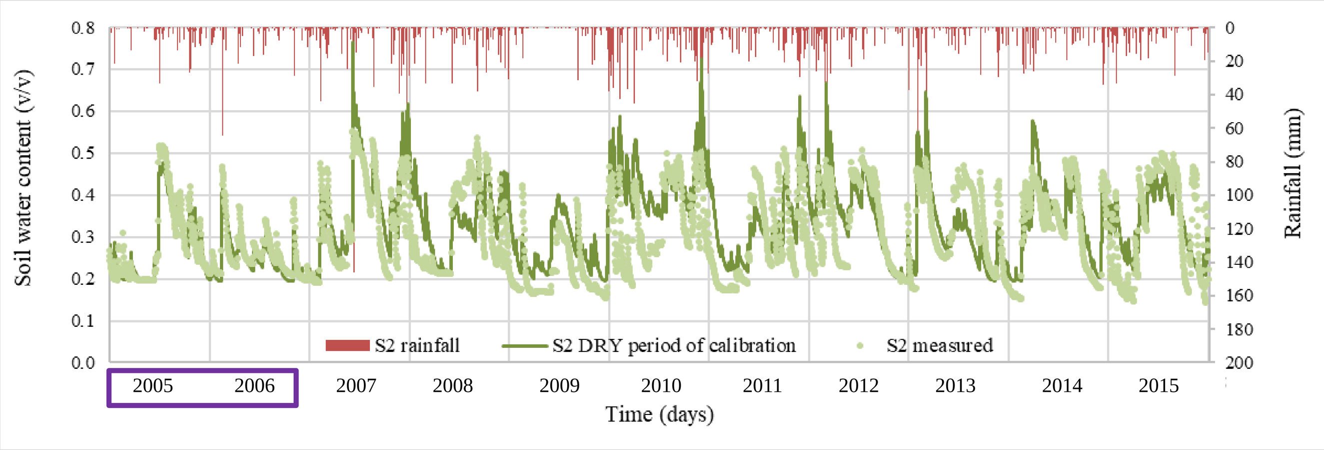
The parameters set that generated the best Nash for the simulations were used to simulate the entire period (2005 - 2015). As the S1 station had missing soil, the NSE calculation was made for the days with data only. That is the main reason why S1 showed poorer fits.

Station S2 using calibration in S2 for the WET period



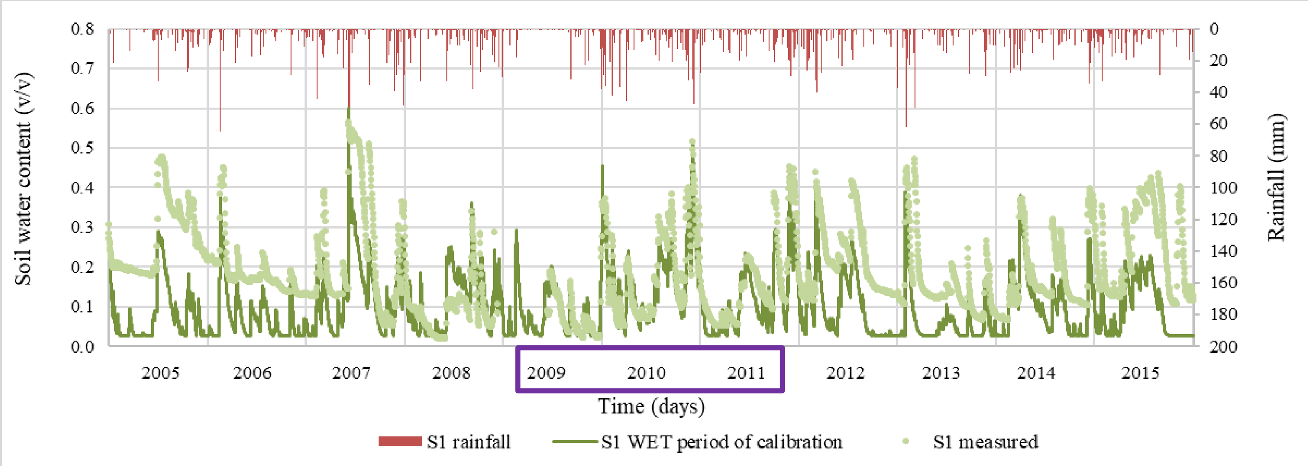
Using parameters of wet calibration period for simulating the eleven years of soil moisture worked well for S2. It over estimated a few peaks (e.g. Jun of 2007 – an extreme event, Jan 2013) and underestimated in the winter (Jun/Jul) of 2008, 2012, 2013 and 2015, but overall could illustrate the peaks and recessions for the entire period. The NSE obtained in the calibration period (2008-2011) was 0.62.

Station S2 using calibration in S2 for the DRY period



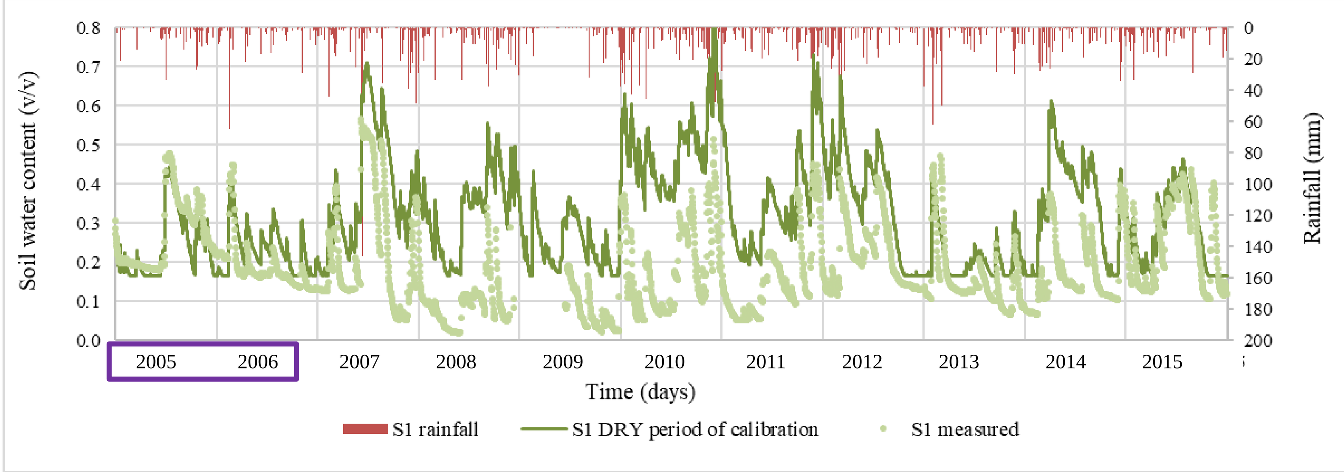
The parameters found for the dry period calibration could represent well the drying curves of the eleven years, but it generated significant overestimations on the peaks, which is reasonable that a calibration made in a dry period will be able to describe better the lower values of soil water content. NSE obtained for the calibration period (2005-2006) was 0.89.

Station S1 using calibration in S1 for the WET period



For the calibration period (2009-2011), the NSE obtained for the longest period of soil moisture data (from Jun 2010 to Dec 2011) was 0.89. But this parameter set generated a poor NSE (0.28) for the first part of the data (Jan to Sept 2008). Thus, the simulations did not have good results. The graphs show how the simulations underestimated the recessions.

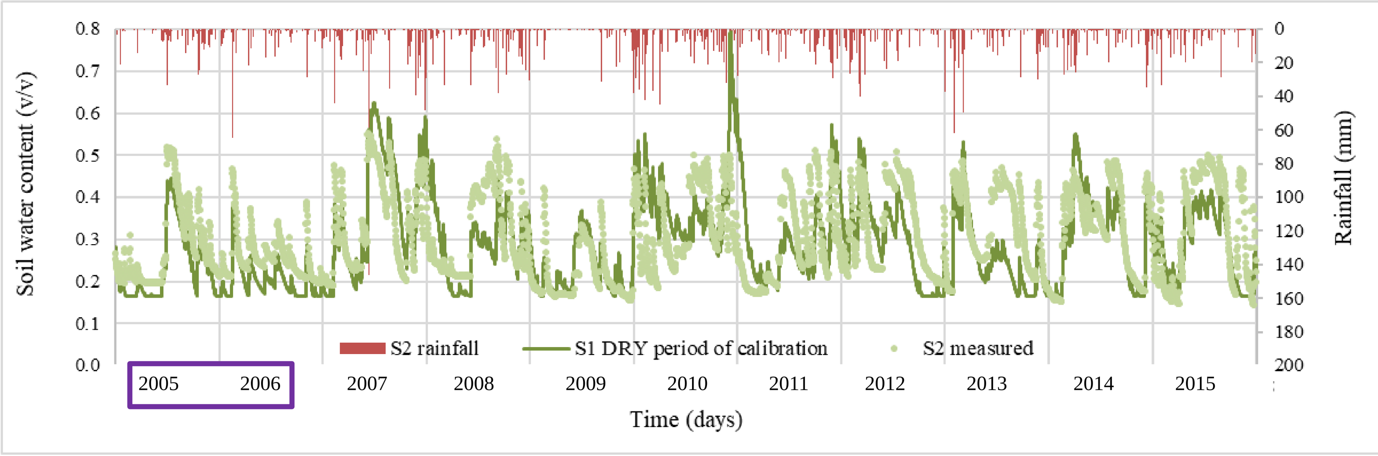
Station S1 using calibration in S1 for the DRY period



For the dry calibration, there was a big overestimation of the peaks in rainy periods. The NSE found for the calibration period (2005-2006) was 0.74 for the first yean and 0.14 for the second.

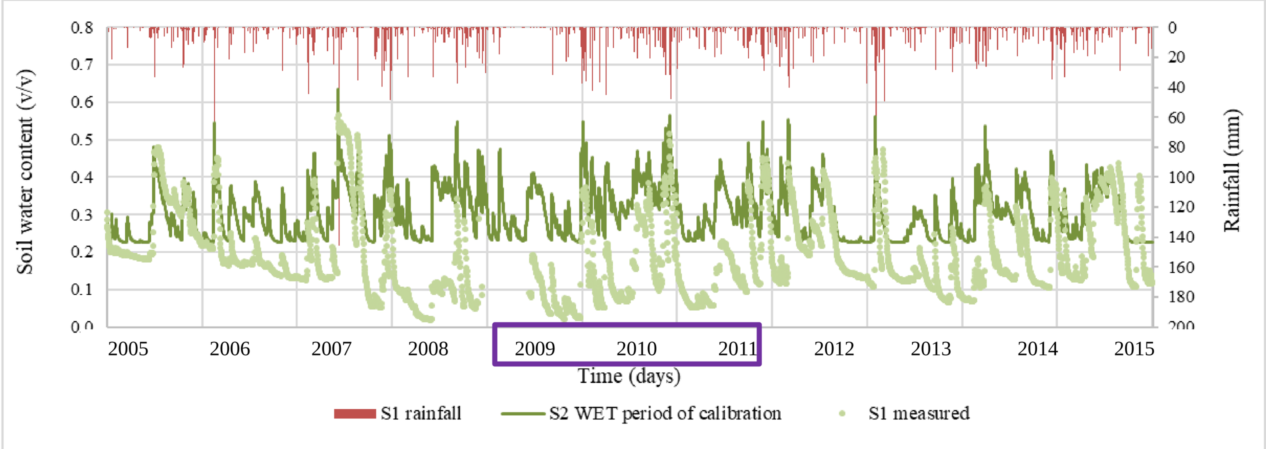
CROSSED COMPARISONS

Station S2 using calibration in S1 for the DRY period



The S1 dry period of calibration fitted better in the S2 station. The simulation made a big overestimation in Dec 2010. That year was wet and the model did not account for enough drying in soil moisture.

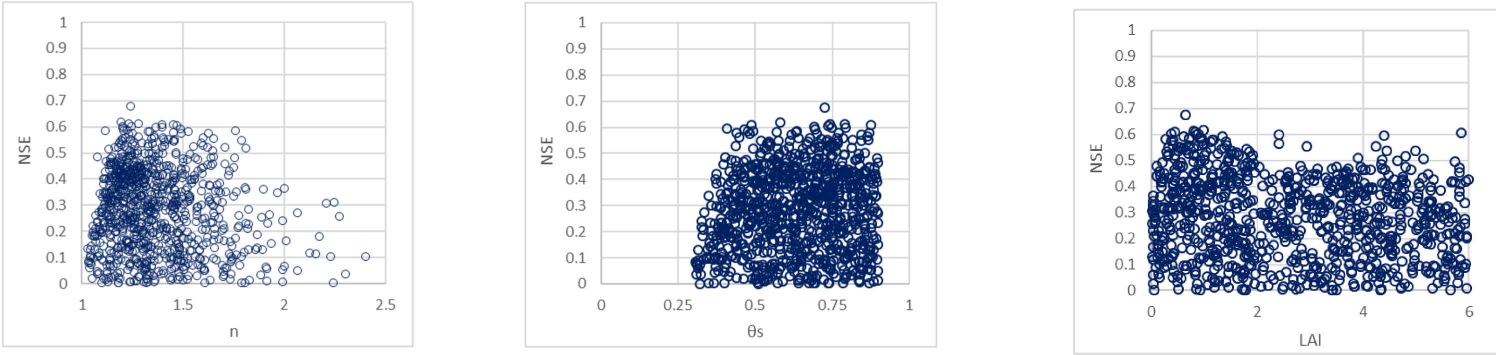
Station S1 using calibration in S2 for the WET period



This simulation did not fit well mostly because S1 presented abnormal downs in a large period (2008-2011), going even lower than in the dry years (2005 and 2006). This low values are likely to be due to failure in soil moisture sensors in some periods of the day. A part from that, it could represent well some peaks (2005 and 2015).

CALIBRATED PARAMETERS

Dotty plots for the period of calibration S2 dry (2005-2006):



From looking at the dotty plots of the sensitive parameters it was possible to obtain visually the range of parameter representing the best NSE values.

Best parameter range:

	θs	n	LAI
S1 dry	0.6 – 0.8	1.3 – 1.5	1 - 5
S1 wet	0.4 – 0.7	1.4 – 1.8	1 - 3
S2 dry	0.7 – 0.9	1.2 – 1.4	0.75 – 1.50
S2 wet	0.6 – 0.8	1.1 – 1.3	0.25 – 1.25

Interestingly, the value of LAI for the optimal parameter set in S2 for the dry period was higher than for the wet. It is expected that in more humid period, there is more vegetation life, thus a higher LAI. This will be further explored when using the stations located in the north part of catchment. The S1 ranges were broader because as the calibration was not so good as S2, it was hard to find a more defined peak representing the higher NSE.
The ranges overlap each other in each station for the wet and dry periods. And as S1 and S1 are close, it was expected not big differences in parameters. When using stations with more vegetation the differences between dry and wet period may appear.

CONCLUSIONS

- It is still very difficult to draw conclusions on the influence of vegetation and soil in soil moisture, since only two stations for now had been explored. The station S2 obtained good fit in both the dry and wet calibration and when using S1 dry calibration.
- In future analysis it will be possible to explore better the influence of vegetation by using all stations for the analysis. Although the majority of the catchment is characterised by grassland areas, the northern part are located in a denser vegetated area.
- To define the range of parameters, it will be used a more refined analysis, that will allow to obtain a better relation between soil parameters and soil moisture.

REFERENCES

Chen, M., Willgoose, G. R., & Saco, P. M. (2014). Spatial prediction of temporal soil moisture dynamics using HYDRUS-1D. *Hydrological Processes*, 28(2), 171-185. doi:10.1002/hyp.9518
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