MODELLING RAINFALL INTERCEPTION BY FORESTS: A NEW METHOD FOR ESTIMATING THE CANOPY STORAGE CAPACITY

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INTRODUCTION

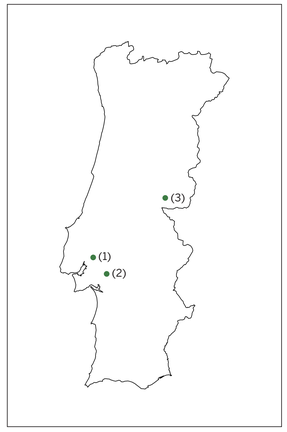
Evaporation of rainfall intercepted by forests is usually an important part of a catchment water balance. Recognizing the importance of interception loss, several models of the process have been developed. A key parameter of these models is the canopy storage capacity (S), commonly estimated by the so-called Leyton method. However, this method is somewhat subjective in the selection of the storms used to derive S, which is particularly critical when throughfall is highly variable in space. To overcome these problems, a new method for estimating S was proposed by Pereira *et al.* (2009), which uses information from a larger number of storms, is less sensitive to throughfall spatial variability and is consistent with the formulation of the two most widely used rainfall interception models, Gash analytical model and Rutter model. However, this method has a drawback: it does not account for stemflow (S_f). To allow a wider use of this methodology, we propose now a revised version which makes the estimation of S independent of the importance of stemflow.

METHODS

For testing this new method we used data from a maritime pine forest, a eucalyptus plantation and a traditional olive grove, all located in Central Portugal.

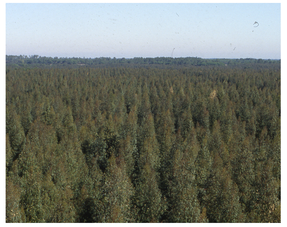
SITE	MARITIME PINE	EUCALYPTUS	OLIVE GROVE
Location	Pinhal da Carrrasqueira (38°50' N, 8°51' W)	Herdade de Espirra (38°38' N, 8°36' W)	Castelo Branco, east-central Portugal (39°49' N, 7°29' W)
Age (years)	60 (in 1993)	7, first rotation (in 1993)	80 – 90
Tree density (trees/ha)	312	1010	70 – 100
Canopy cover fraction	0.639	0.603	0.194
Climate	Mediterranean	Mediterranean	Mediterranean under continental influence

(3) Traditional olive grove



Portugal

(1) Maritime pine forest



(2) Eucalyptus plantation

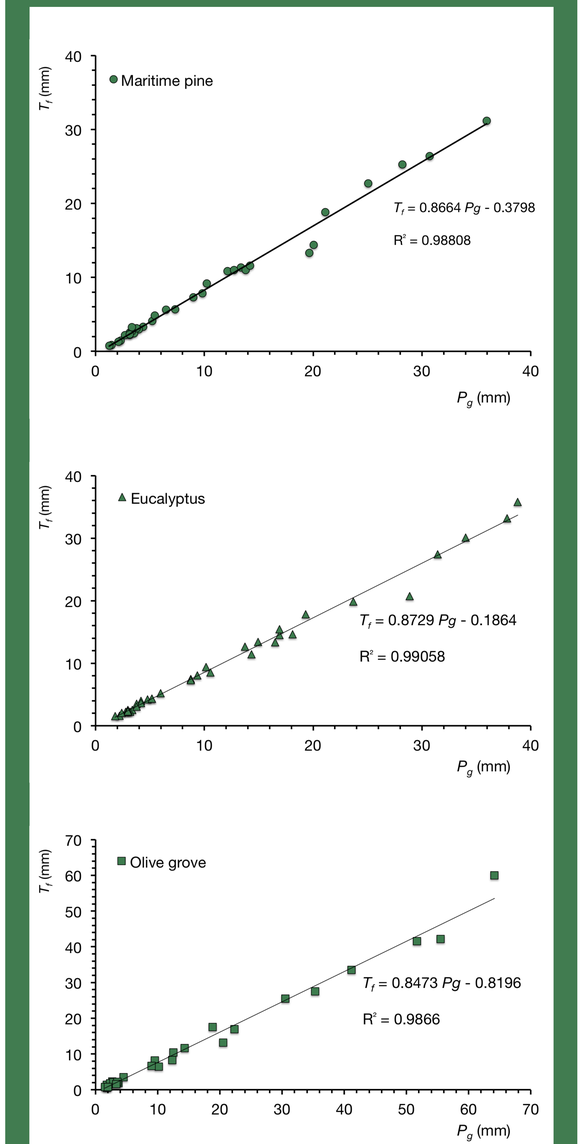
For the application of this new version we only need to establish a linear regression of throughfall (T_f) vs. gross rainfall (P_g) using data from all storms large enough to saturate the canopy.
Two of the parameters used by the Gash and the Rutter models, p_d (the drainage partitioning coefficient) and S, are then derived from the regression coefficients (slope and intercept represented as a and b, respectively): p_d is firstly estimated (Eq. 1) allowing then the derivation of S (Eq. 2) but, if S_f is not considered, S can be estimated making $p_d = 0$.

$$p_d = \frac{a - 1 + c\frac{\bar{E}_c}{\bar{R}}}{c\frac{\bar{E}_c}{\bar{R}} - 1} \qquad (\text{Eq.1})$$

$$S = \frac{b}{\ln\left[1 - \frac{\bar{E}_c}{\bar{R}}\left(1 - p_d\right)\frac{\bar{R}}{\bar{E}_c} - 1\right]} \qquad (\text{Eq.2})$$

RESULTS AND DISCUSSION

This new method was tested using data from a eucalyptus plantation, a maritime pine forest and a traditional olive grove, all located in Central Portugal.



RESULTS AND DISCUSSION

For both the eucalyptus and the pine forests p_d and S estimated by this new approach were comparable to the values derived in previous studies using the standard procedures. In the case of the traditional olive grove, the estimates obtained by this methodology for p_d and S allowed interception loss to be modelled with a normalized averaged error less than 4% For comparison and using the same standard procedures, p_d and S were estimated for the olive grove as 0.036 and 0.52, respectively.

SITE	MARITIME PINE	EUCALYPTUS	OLIVE GROVE
Canopy cover fraction	0.639	0.603	1
Mean evaporation rate	0.315	0.200	0.224
Mean rainfall rate	1.743	1.814	1.954
Throughfall vs. gross rainfall regression equation	$T_f = 0.8664P_g - 0.3798$	$T_f = 0.8729P_g - 0.1864$	$T_f = 0.8473P_g - 0.8196$
Estimates by the new methodology	p_d 0.035	0.113	0.043
	S 0.44	0.22	0.91
Estimates bycommon methods: Valente et al. (1997) for p_d Leyton et al. (1967) for S	p_d 0.008	0.032	0.036
	S 0.41	0.21	0.52

CONCLUSIONS

Globally, these results confirm that this new method is more robust and certainly less subjective than the most commonly used methods, providing adequate estimates for p_d and S which, in turn, are crucial for a good performance of the interception models.

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