



UCAM

UNIVERSIDAD CATÓLICA  
DE MURCIA

Different calibration strategies with SWAT+ Toolbox using  
remote sensing evapotranspiration data and streamflow

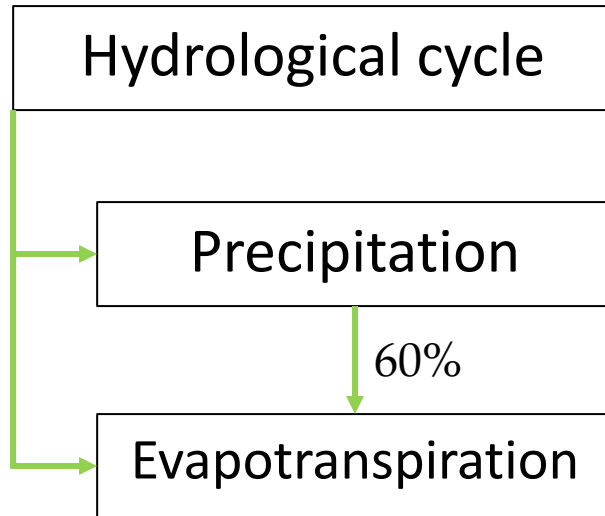


# SMARTLAGOON

Inmaculada C. Jiménez-Navarro, Jorrit  
Padric Mesman, Don Pierson, Dennis  
Trolle, Javier Senent-Aparicio



This project has received funding from the European Union's Horizon 2020  
research and innovation programme under grant agreement No 101017861.



### Multicalibration helps:

- Avoid equifinality
- Reduce uncertainty

### OBJETIVES:

- Try different calibration strategies in SWAT+ Toolbox
- Check if Erken Lake watershed can be calibrated with ET
- Check if adding ET can help develop a better model



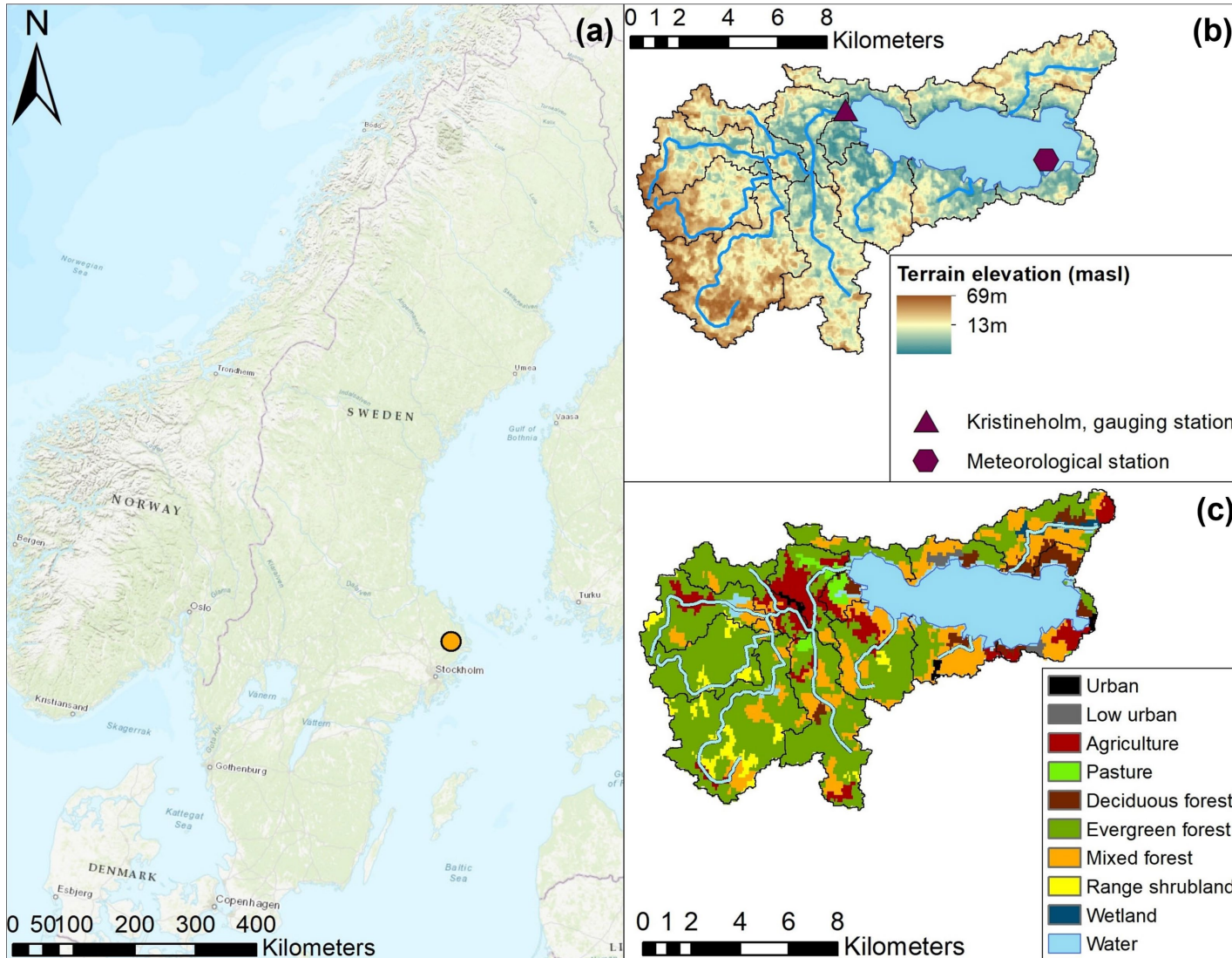
Global Land Evaporation  
Amsterdam Model



SWAT+ Toolbox

Soil and Water Assessment  
Tool +





## ERKEN LAKE

(59°50'37"N, 18°35'38"E)

- Extension 24 km<sup>2</sup>
- Average depth 9m
- Stratified in summer
- Frozen in winter

## WATERSHED

- Area 141 km<sup>2</sup>
- Forest
- Non-aggressive farming





SWAT+ model of the  
Erken Lake basin



Sensitivity analysis for:

1. Discharge to lake
2. Evapotranspiration

Calibration with:

1. Discharge
2. Evapotranspiration
3. Both

## SCENARIOS:

Default scenario: uncalibrated

Flow calibration: use all streamflow-sensitive parameters with the observed streamflow

ET calibration: use all evapotranspiration-sensitive parameters with the with ET

Mix calibration: the parameters that by definition affect evapotranspiration are calibrated with ET, and the rest of the sensitive parameters are calibrated with streamflow.





	Parameters		Q		ET	
	Change	Range	Sensibility	Order	Sensibility	Order
Lat_ttime	Replace	1 - 180	0.6533	1 <sup>o</sup>	0.0000	-
<b>epco</b>	Relative	-500 - 1000	-0.3626	2 <sup>o</sup>	0.6413	1 <sup>o</sup>
flo_min	Replace	0 - 1	0.2884	3 <sup>o</sup>	0.0000	-
cn3_swf	Percent	-20 - 20	0.2246	4 <sup>o</sup>	0.0868	4 <sup>o</sup>
<b>cn2</b>	Percent	-20 - 20	0.1671	5 <sup>o</sup>	0.1418	2 <sup>o</sup>
revap_co	Percent	-20 - 20	-0.0721	6 <sup>o</sup>	0.0000	-
<b>awc</b>	Relative	-500 - 500	0.0504	7 <sup>o</sup>	0.0888	3 <sup>o</sup>
bd	Percent	-20 - 20	0.0284	8 <sup>o</sup>	0.0034	8 <sup>o</sup>
chn	Replace	0.5 - 2	-0.0160	9 <sup>o</sup>	0.0000	-
canmx	Relative	-0.05 - 0.05	-0.0990	10 <sup>o</sup>	-0.0178	6 <sup>o</sup>
revap_min	Replace	0.6 - 1	0.0094	11 <sup>o</sup>	0.0000	-
<b>k</b>	Replace	0 - 1	0.0047	12 <sup>o</sup>	0.0074	7 <sup>o</sup>
<b>latq_co</b>	Percent	-20 - 20	0.0035	13 <sup>o</sup>	0.0017	10 <sup>o</sup>
alpha	Replace	0.01 - 0.3	-0.0034	14 <sup>o</sup>	0.0000	-
esco	Replace	0.02 - 0.2	-0.0020	15 <sup>o</sup>	-0.0382	5 <sup>o</sup>
<b>perco</b>	Replace	0.3 - 1	0.0016	16 <sup>o</sup>	0.0029	9 <sup>o</sup>

## SENSITIVITY ANALYSIS





## CALIBRATIONS

Parameters		Fixed values			
	Change	Q scenario	ET scenario	Mix scenario	
<b>epco</b>	Replace	0.911	0.943	0.996	ET
<b>esco</b>	Replace	0.742	0.995	0.995	
<b>cn3_swf</b>	Replace	0.894	0.942	0.694	
<b>bd</b>	Percent	10.651	15.247	-19.637	
<b>latq_co</b>	Replace	0.984	1.894	0.5	
<b>cn2</b>	Percent	-19.995	-18.75	-19.913	Q
<b>canmx</b>	Percent	19.407	18.728	-6.23	
<b>awc</b>	Percent	-19.84	9.395	-18.636	
<b>k</b>	Percent	18.412	-18.033	19.753	
<b>perco</b>	Relative	0.048	-0.049	0.044	
<b>Lat_ttime</b>	Replace	7.841		3.149	
<b>flo_min</b>	Relative	396.612		575.388	
<b>revap_min</b>	Relative	475.7		362.847	
<b>alpha</b>	Replace	0.415		0.897	
<b>chn</b>	Replace	0.297		0.051	
<b>revap_co</b>	Replace	0.067		0.123	

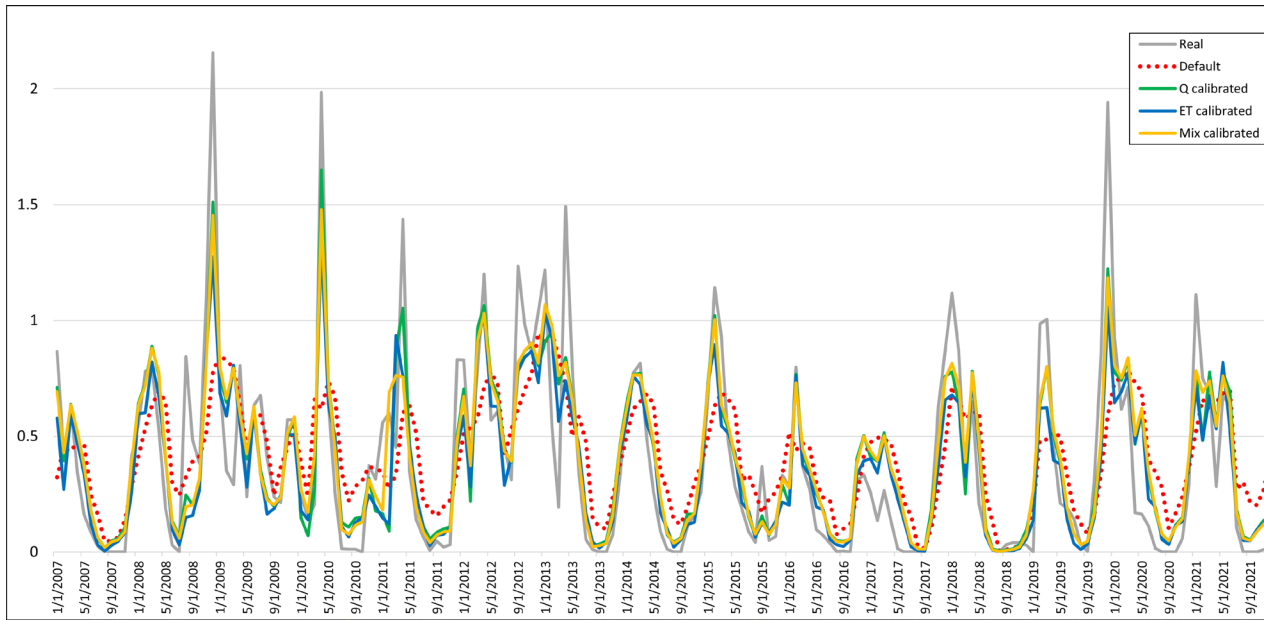




	Parameters		Q		ET	
	Change	Range	Sensibility	Order	Sensibility	Order
Lat_ttime	Replace	1 - 180	0.6533	1 <sup>o</sup>	0.0000	-
epco	Relative	-500 - 1000	-0.3626	2 <sup>o</sup>	0.6413	1 <sup>o</sup>
flo_min	Replace	0 - 1	0.2884	3 <sup>o</sup>	0.0000	-
cn3_swf	Percent	-20 - 20	0.2246	4 <sup>o</sup>	0.0868	4 <sup>o</sup>
cn2	Percent	-20 - 20	0.1671	5 <sup>o</sup>	0.1418	2 <sup>o</sup>
revap_co	Percent	-20 - 20	-0.0721	6 <sup>o</sup>	0.0000	-
awc	Relative	-500 - 500	0.0504	7 <sup>o</sup>	0.0888	3 <sup>o</sup>
bd	Percent	-20 - 20	0.0284	8 <sup>o</sup>	0.0034	8 <sup>o</sup>
chn	Replace	0.5 - 2	-0.0160	9 <sup>o</sup>	0.0000	-
canmx	Relative	-0.05 - 0.05	-0.0990	10 <sup>o</sup>	-0.0178	6 <sup>o</sup>
revap_min	Replace	0.6 - 1	0.0094	11 <sup>o</sup>	0.0000	-
k	Replace	0 - 1	0.0047	12 <sup>o</sup>	0.0074	7 <sup>o</sup>
latq_co	Percent	-20 - 20	0.0035	13 <sup>o</sup>	0.0017	10 <sup>o</sup>
alpha	Replace	0.01 - 0.3	-0.0034	14 <sup>o</sup>	0.0000	-
esco	Replace	0.02 - 0.2	-0.0020	15 <sup>o</sup>	-0.0382	5 <sup>o</sup>
perco	Replace	0.3 - 1	0.0016	16 <sup>o</sup>	0.0029	9 <sup>o</sup>

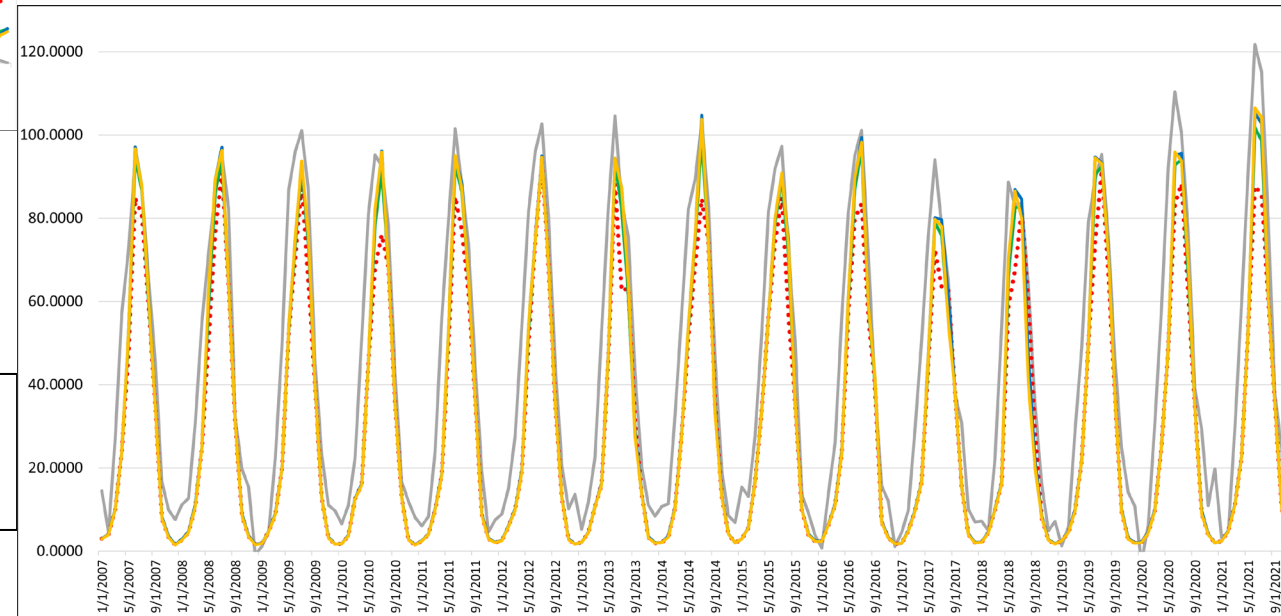
## SENSITIVITY ANALYSIS





## Streamflow comparision

## Evaporation comparision

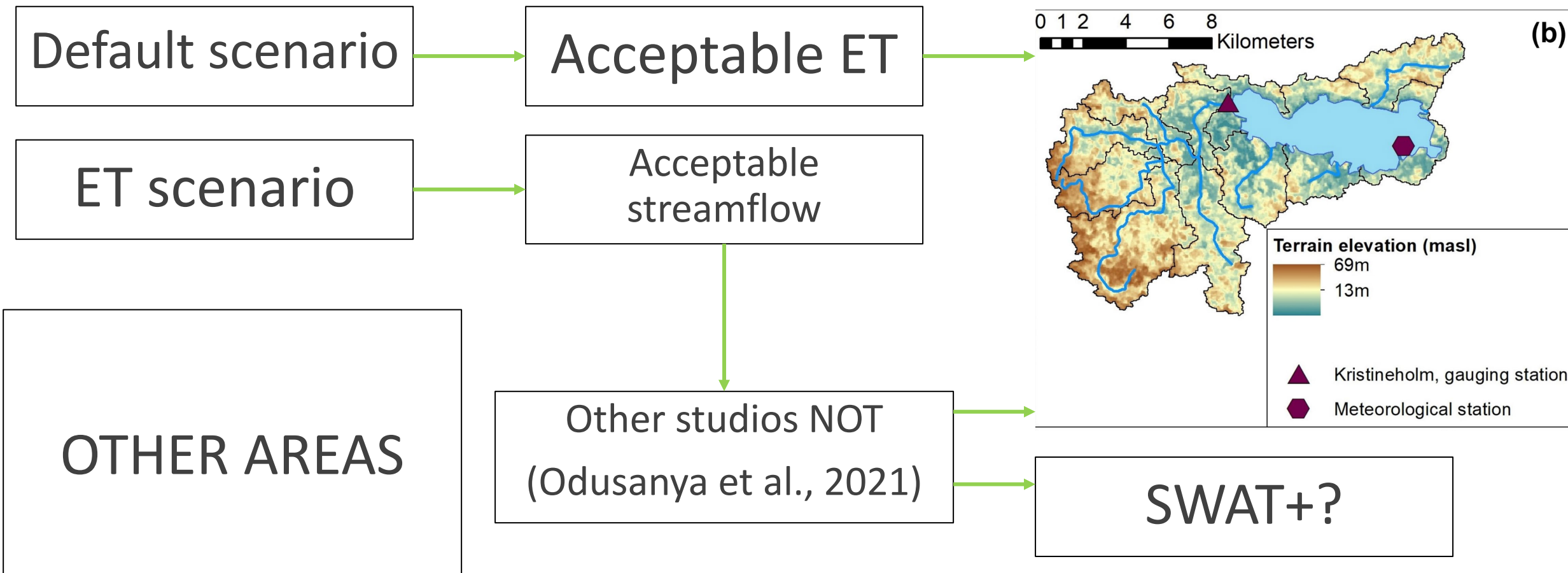






Scenario	Statitics	Q		Et	
		Calibration	Validation	Calibration	Validation
default	NSE	0.400	0.406	0.764	0.727
	PBIAS	-3.659	-5.525	30.416	31.663
	RSR	0.775	0.771	0.486	0.523
flow	NSE	0.771	0.773	0.801	0.765
	PBIAS	-0.128	-1.539	26.450	28.490
	RSR	0.478	0.476	0.446	0.485
et	NSE	0.707	0.712	0.809	0.779
	PBIAS	8.740	7.680	25.096	26.586
	RSR	0.542	0.537	0.437	0.471
mix	NSE	0.759	0.764	0.806	0.771
	PBIAS	-0.768	-2.437	25.472	27.625
	RSR	0.491	0.486	0.441	0.479







# SMARTLAGOON

## BIBLIOGRAFÍA:

- Parajuli, P. B., Jayakody, P., & Ouyang, Y. (2018). Evaluation of using remote sensing evapotranspiration data in SWAT. *Water resources management*, 32, 985-996. <https://doi.org/10.1007/s11269-017-1850-z>.
- Arnold, J.G., Moriasi, D.N., Gassman, P.W., Abbaspour, K.C., White, M.J., Srinivasan, R., Santhi, C., Harmel, R. D., van Griensven, A., Van Liew, M. W., Kannan, N., & Jha, M. K. (2012). SWAT: model use, calibration, and validation. *Transactions of the ASABE*, 55, 1491-1508. <https://doi.org/10.13031/2013.42256>.
- Bieger, K., Arnold, J. G., Rathjens, H., White, M. J., Bosch, D. D., Allen, P. M., Volk, M., & Srinivasan, R. (2017). Introduction to SWAT+, a completely restructured version of the soil and water assessment tool. *Journal of the American Water Resources Association*, 53, 115-130. <https://doi.org/10.1111/1752-1688.12482>.
- Chawanda, C. J. (2021). SWAT+ toolbox: User manual; SWAT+: Soil & Water Assessment Tool. Accessed online on 16 June 2023. <https://www.openwater.network/assets/downloads/SWATplusToolboxUserManual.pdf>.
- Moriasi, D. N., Gitau, M. W., Pai, N., & Daggupati, P. (2015). Hydrologic and water quality models: performance measures and evaluation criteria. *Transactions of the ASABE*, 58(6), 1763-1785. <https://doi.org/10.13031/trans.58.10715>.
- Odusanya, A. E., Schulz, K., Biao, E. I., Degan, B. A., & Mehdi-Schulz, B. (2021). Evaluating the performance of streamflow simulated by an eco-hydrological model calibrated and validated with global land surface actual evapotranspiration from remote sensing at a catchment scale in West Africa. *Journal of Hydrology: Regional Studies*, 37, 100893. <https://doi.org/10.1016/j.ejrh.2021.100893>.





UCAM

UNIVERSIDAD CATÓLICA  
DE MURCIA

Different calibration strategies with SWAT+ Toolbox using  
remote sensing evapotranspiration data and streamflow



# SMARTLAGOON

Inmaculada C. Jiménez-Navarro, Jorrit  
Padric Mesman, Don Pierson, Dennis  
Trolle, Javier Senent-Aparicio



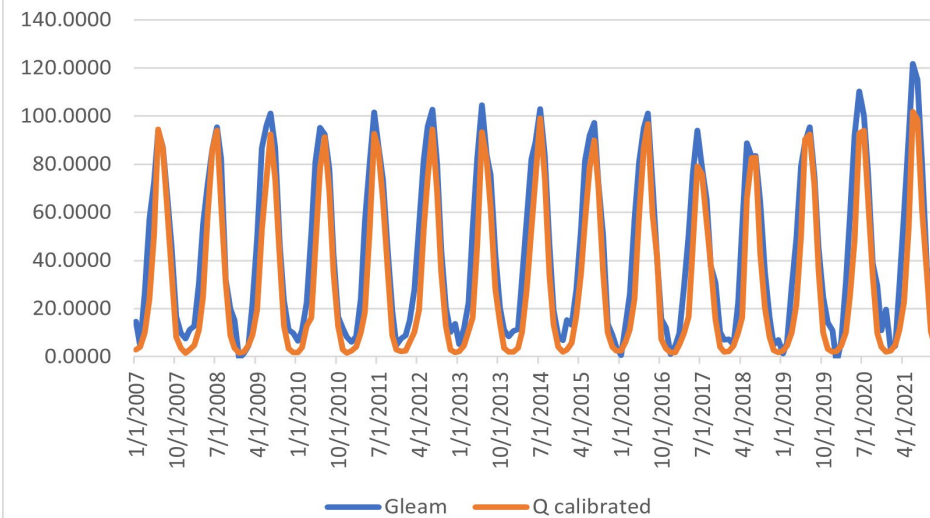
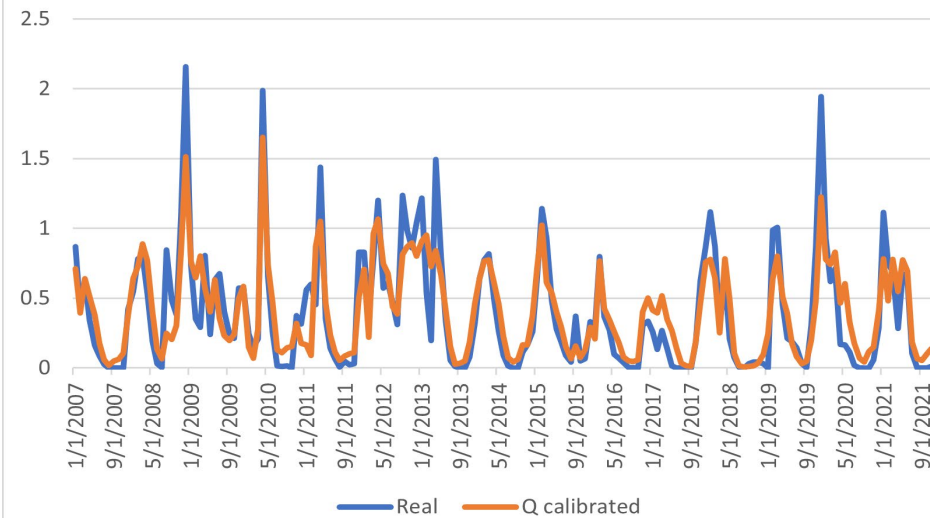
This project has received funding from the European Union's Horizon 2020  
research and innovation programme under grant agreement No 101017861.



## STREAMFLOW CALIBRATION

Parameter	Fixed value
-----------	-------------

Lat_ttime	7.841
flo_min	396.612
cn3_swf	0.894
cn2	-19.995
awc	-19.84
bd	10.651
revap_min	475.7
k	18.412
latq_co	0.984
perco	0.048
esco	0.742
alpha	0.415
canmx	19.407
chn	0.297
revap_co	0.067
epco	0.911



Statics	Calibration	Validation
NSE	0.771	0.773
PBIAS	-0.128	-1.539
RSR	0.478	0.476

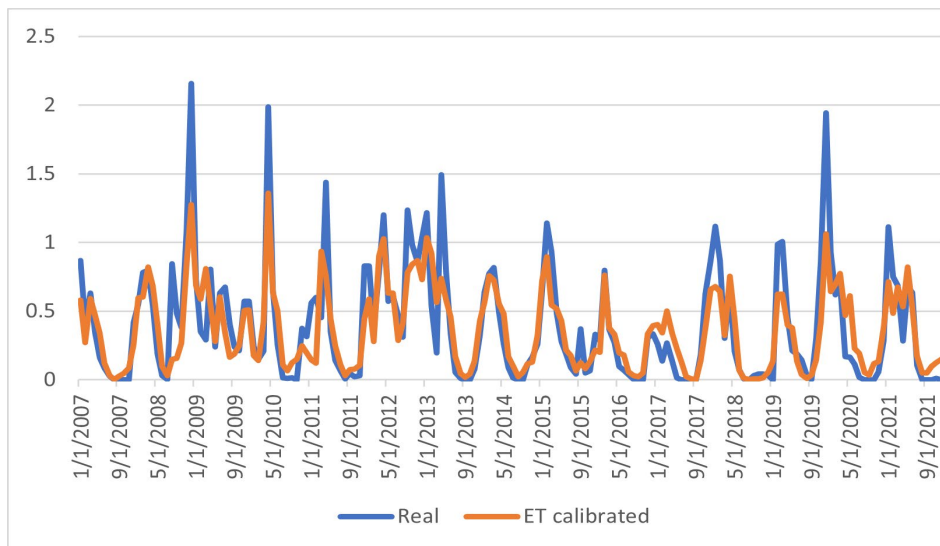
Statics	Calibration	Validation
NSE	0.801	0.765
PBIAS	26.450	28.490
RSR	0.446	0.485



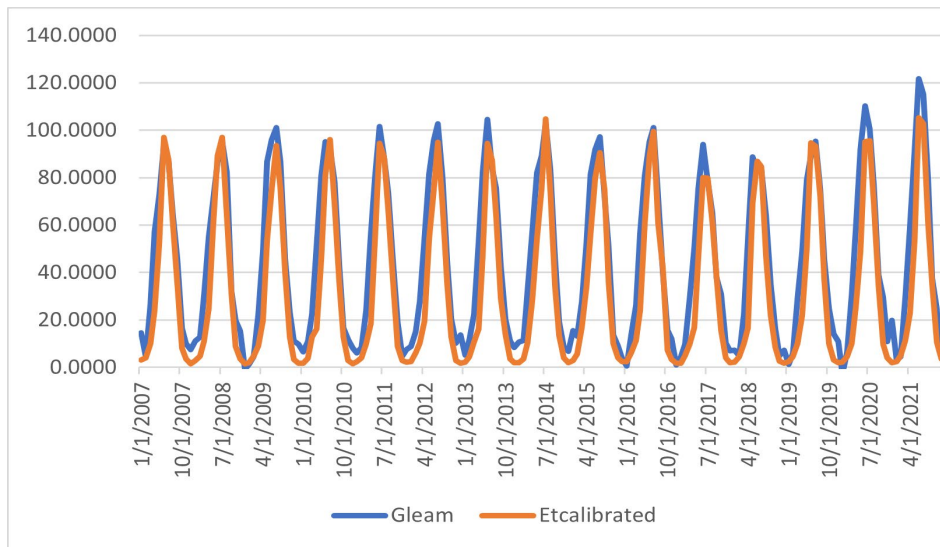


## EVAPOTRANSPIRATION CALIBRATION

Parameters	Fixed value
epco	0.943
cn2	-18.75
awc	9.395
cn3_swf	0.942
canmx	18.728
k	-18.033
bd	15.247
latq_co	1.894
perco	-0.049
esco	0.995



Statics	Calibration	Validation
NSE	0.707	0.712
PBIAS	8.740	7.680
RSR	0.542	0.537



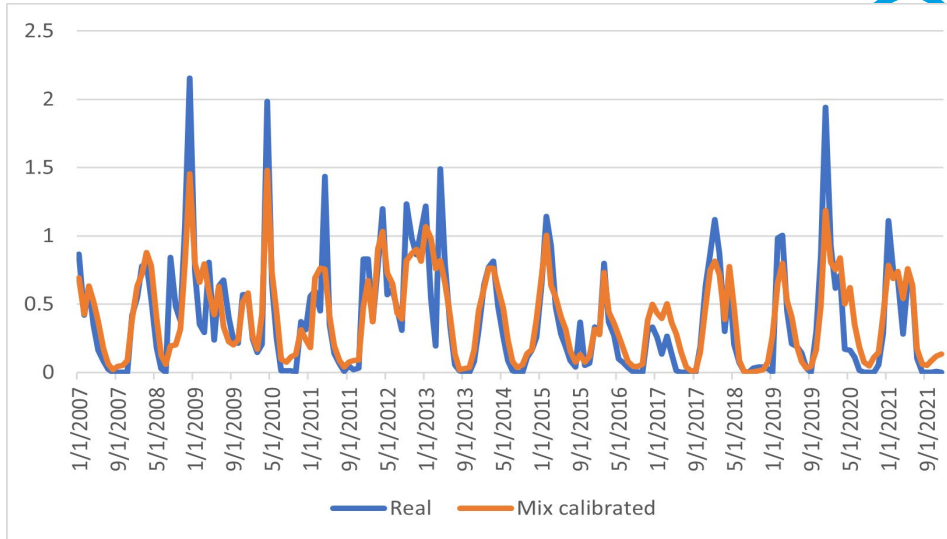
Statics	Calibration	Validation
NSE	0.809	0.779
PBIAS	25.096	26.586
RSR	0.437	0.471



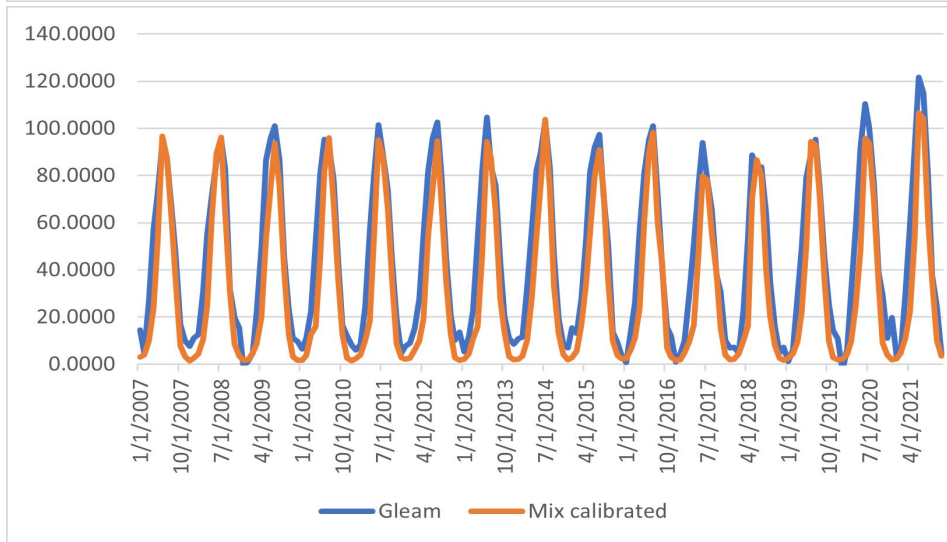


## MIX CALIBRATION

Calibration	Parameter	Fixed value
ET	esco	0.995
	epco	0.996
	bd	-19.637
	latq_co	0.5
	cn3_swf	0.694
Q	cn2	-19.913
	alpha	0.897
	flo_min	575.388
	revap_co	0.123
	awc	-18.636
	perco	0.044
	revap_min	362.847
	chn	0.051
	lat_ttime	3.149
	k	19.753
	canmx	-6.23



Statics	Calibration	Validation
NSE	0.759	0.764
PBIAS	-0.768	-2.437
RSR	0.491	0.486



Statics	Calibration	Validation
NSE	0.806	0.771
PBIAS	25.472	27.625
RSR	0.441	0.479

