Modeling the Water Balance Processes for Understanding the Components of River Discharge in a Non-conservative Watershed

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Introduction

The non-conservative watersheds where the surface watersheds are lying on a discontinuous impervious horizon may either leak (by losing water to neighboring watershed or to the sea) or gain water (originating from outside the watershed). The overall problem for application of SWAT model in a non-conservative watershed is how to simulate and validate the underground flux, because the underground flux can not be directly measured. Therefore, the main objective of this study is to test a method that can indirectly simulate the underground flux by SWAT model, and to further understand the components of the river discharge in a non-conservative watershed.

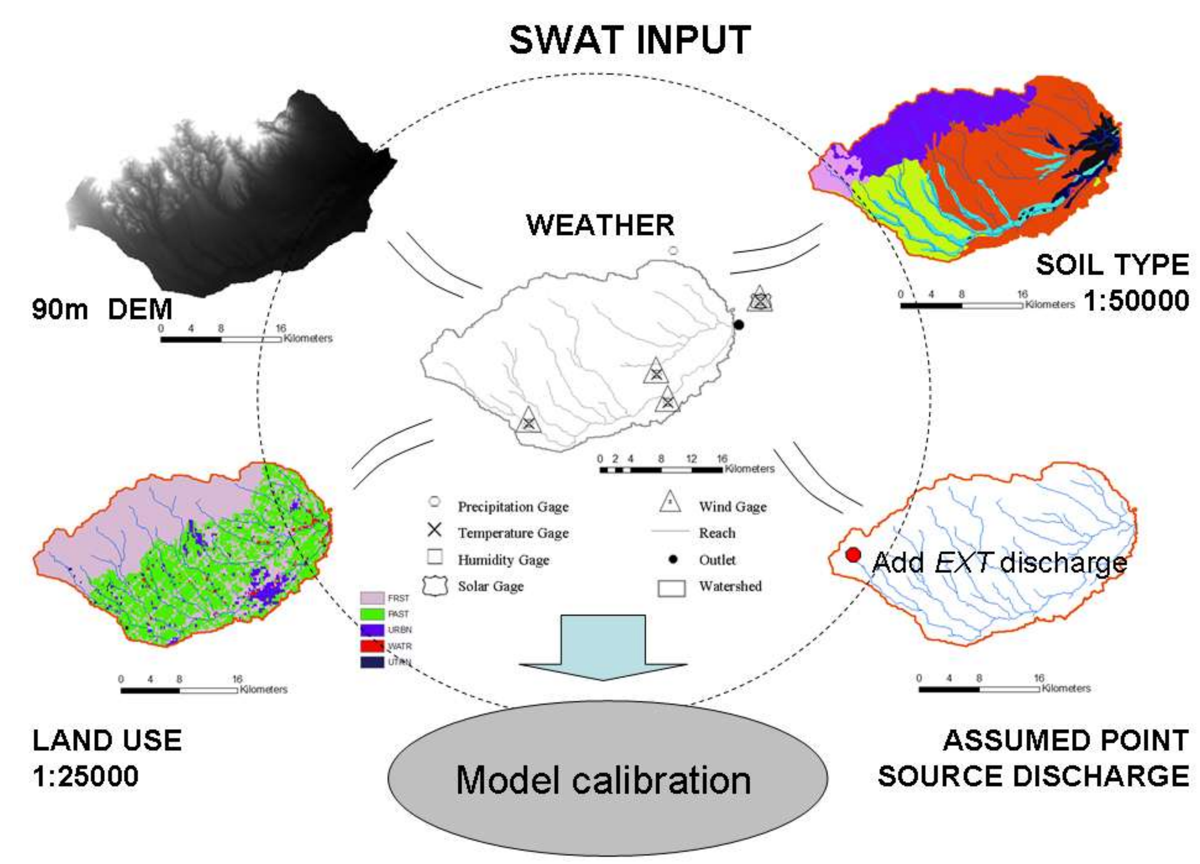
Methods

External contribution (EXT)

Year	Q_{obs} (mm)	P (mm)	ET*(mm)	Q=P-ET (mm)	Q_{obs}-Q (mm)	(Q_{obs}-Q)/P
1980	773.76	890	548.17	341.83	431.93	0.49
1981	1368.97	1441	546.01	894.99	473.98	0.33
1982	928.33	933	564.60	368.40	559.93	0.60
⋮						
2006	1642.43	1329	547.17	781.83	860.60	0.65
2007	1123.21	1038	613.96	424.04	699.17	0.67
2008	698.95	751	577.97	173.03	525.92	0.70
mean	1081.54	1128	546.63	581.85	504.32	0.47

The difference in the annual water balance (Qobs-Q) can be considered as an additional water contribution (underground flux) to that of precipitation. External contribution (*EXT*) is added by **point source discharge** in SWAT.

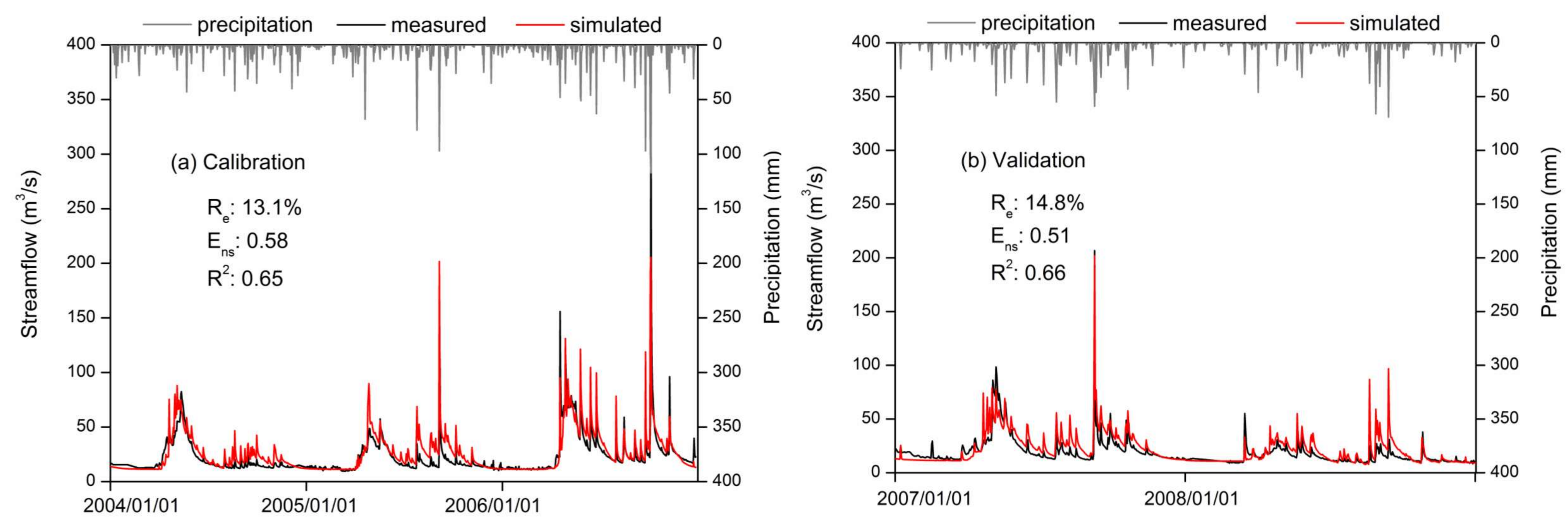
Methods – con't

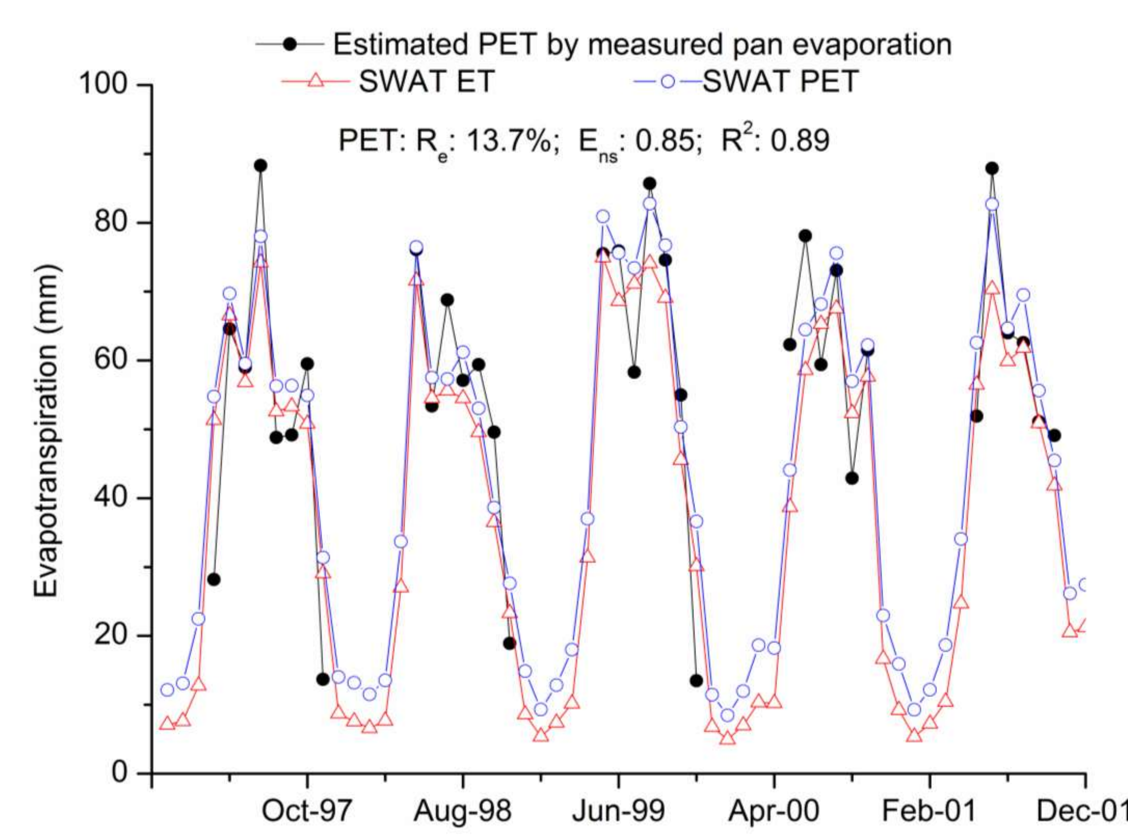


The determined optimal values for parameters

Parameter	Description	Lower bound	Upper bound	Optimal value
CN2	Initial SCS runoff curve number for moisture condition II	-25	25	-20
TLAPS	Temperature lapse rate (C/km)	-10	50	-6.5
ALPH_BF	Baseflow alpha factor (days)	0	1	0.05
REVAPMN	Threshold depth of water in the shallow aquifer for revap to occur (mm)	-100	100	50
SFTMP	Snowfall temperature (°C)	0	5	1
SMTMP	Snow melt base temperature (°C)	-25	25	20
SMFMX	Maximum melt rate for snow during years (mm/°C/day)	0	10	4.5
SMFMN	Minimum melt rate for snow during years (mm/°C/day)	0	10	0.5
TIMP	Snow pack temperature lag factor	0	1	0.9
ESCO	Soil evaporation compensation factor	0	1	0.75
CANMX	Maximum canopy storage (mmH_2O)	0	10	6
SOL_AWC	Available water capacity of the soil layer (mmH_2O/mm soil)	-25	25	3
SURLAG	Surface runoff lag coefficient	0	10	2
GW_DELAY	Groundwater delay (days)	-10	10	-10
CH_N2	Manning's "n" value for the tributary channels	0	1	0.4

Results





	Time period	Observation	R_e	E_{ns}	R^2
Added EXT	Calibration (2004-2006)	Surface runoff	-5.50%	0.82	0.82
as point	Calibration (2004-2006)	Streamflow	2.10%	0.89	0.89
source	Validation (2007-2008)	Surface runoff	30.80%	0.54	0.68
discharge	Validation (2007-2008)	Streamflow	2.90%	0.81	0.78
Without	2004-2006	Streamflow	-47.9%	0.23	0.9
adding EXT	2007-2008	Streamflow	-51.2%	-0.39	0.61

Acknowledgements

This presentation was supported by in part by Global COE Program "Establishment of Center for Integrated Field Environmental Science", MEXT, Japan.

Conclusions

SWAT model is limited to apply directly in a non-conservative watershed, in which the water balance is usually substantially underestimated. In this study, we added the EXT as point source discharge in SWAT to simulate the outlet streamflow and evaluate the capability of the SWAT applied in the Shibetsu watershed. Results showed the model simulation is robust, evaluated by streamflow and ET.