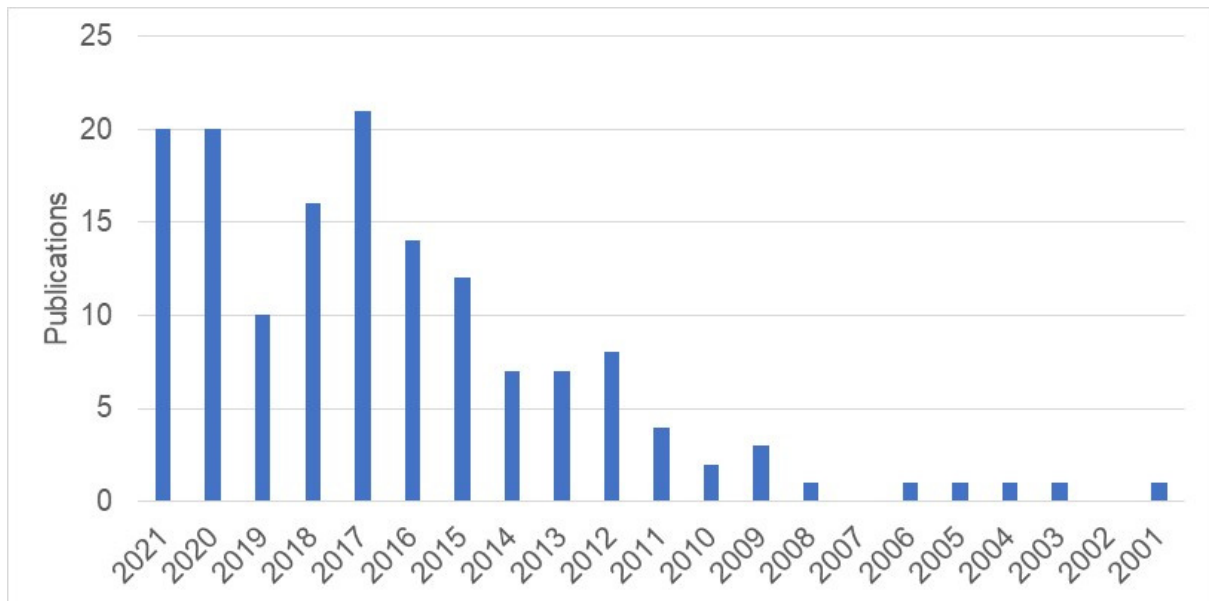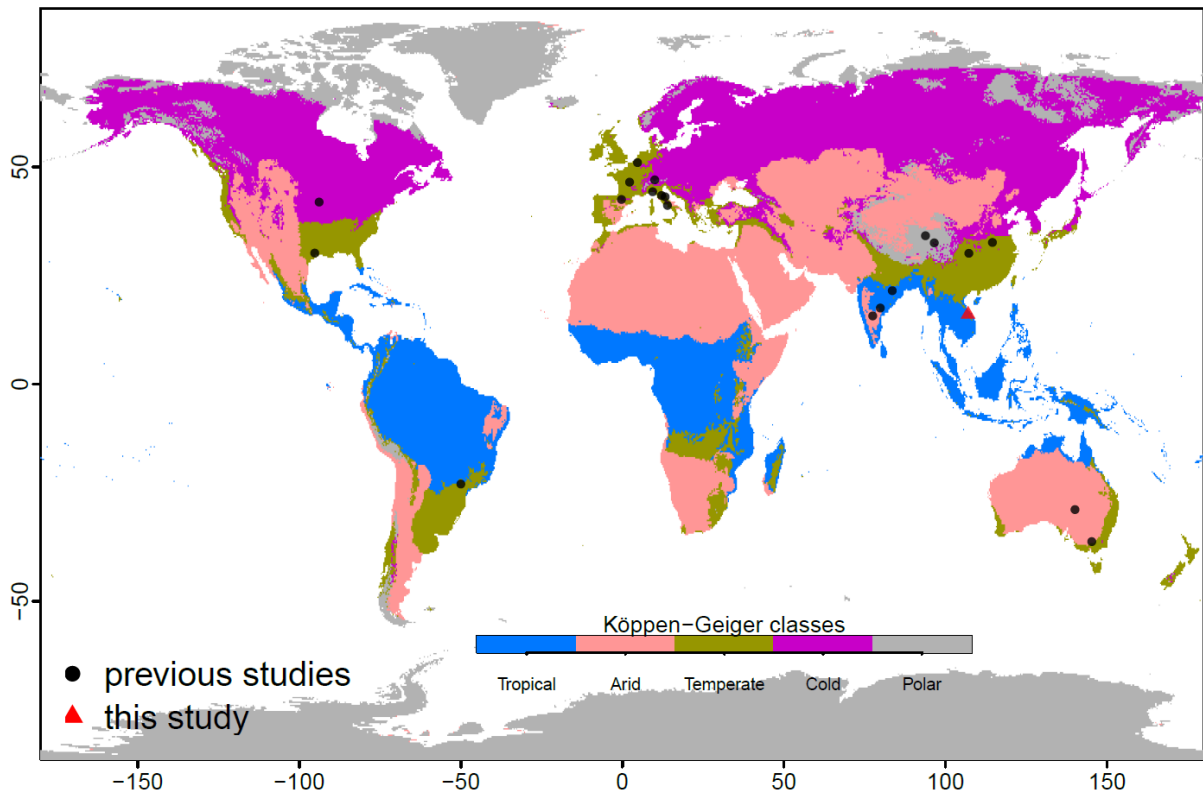**Supplementary Figure S1.** Publications (peer-reviewed articles) per year related to topic of soil moisture data assimilation in hydrological model. We obtained this result through Web of science searching engine (https://www.webofscience.com/). Keywords are "soil moisture" + "data assimilation" + "hydrological model". Subjects are constraint as water resources or geosciences multidisciplinary or environmental sciences or remote. We also consider peer-reviewed articles only.

Supplementary Figure S2. The most currently studies (2015-present) on soil moisture data assimilation in hydrology using remotely sensed soil moisture as observed soil moisture in updating the model state variable. For studies that employed data assimilation framework for more than one catchment, approximately mean values of longitude and latitude is provided.

Supplementary Table S1. Description of optimized SWAT model parameters for each basin.

Parameter Name	Default	gvo	aho	bye	slu	chu	gso	nka	xla
CN2.mgt	74	50	50	50	50	50	40	47	65
SURLAG.bsn	4	7.58	7.58	4	4	7.58	7	7	41.5
HRU_SLP.hru	0.217	0.212	0.215	0.21	0.217	0.217	0.025	0.217	0.096
GW_REVAP.gw	0.02	0.02	0.02	0.2	0.2	0.02	0.02	0.15	0.02
ESCO.hru	0.95	0.85	0.85	0.95	0.33	0.85	0.8	0.8	0.95
CH_N2.rte	0.014	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.28
CH_K2.rte	0	15	15	150	150	15	5	5	4.5
SOL_AWC(..).sol	0.1112	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.11
SOL_K(..).sol	7.113	7.1	7.1	7	7	7.1	7	7	6.83
ALPHA_BF.gw	0.048	0.9	0.95	0.95	0.95	0.9	0.9	0.9	0.56
GW_DELAY.gw	31	200	200	200	200	177	50	50	192
GWQMN.gw	1000	200	200	5000	5000	200	50	4000	1065
RCHRG_DP.gw	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Supplementary Table S2. Description of best guess error defined values for EnKF-SM9 model for each basin.

Error defined	gvo	aho	bye	slu	chu	gso	nkh	xla
Observed soil moisture coefficient	120	80	80	180	120	120	100	200
Precipitation error coefficient	1	1	1	1	0.2	0.5	0.1	1
Field capacity for soil layer 1 coefficient	0.45	0.3	0.3	0.45	0.45	0.3	0.45	0.3
Field capacity for soil layer 2 coefficient	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Field capacity for soil layer 3 coefficient	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Soil moisture error standard deviation for layer 1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Soil moisture error standard deviation for layer 2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Soil moisture error standard deviation for layer 3	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Curve number error standard	1	1	1	3	1	1	1	1

Supplementary Table S3. Description of best guess error defined values for EnKF-SM1 model for each basin.

Error defined	gvo	aho	bye	slu	chu	gso	nkh	xla
Observed soil moisture coefficient	30	50	120	180	200	120	80	200
Precipitation error coefficient	1	1	0.5	1	0.2	0.5	0.5	0.5
Field capacity for soil layer 1 coefficient	0.45	0.3	0.3	0.45	0.45	0.3	0.45	0.3
Field capacity for soil layer 2 coefficient	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Field capacity for soil layer 3 coefficient	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Soil moisture error standard deviation for layer 1	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02
Soil moisture error standard deviation for layer 2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Soil moisture error standard deviation for layer 3	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Curve number error standard	5	1	1	3	1	1	1	1