

**Building a flood warning framework for ungauged locations using low resolution, open access remotely sensed surface soil moisture, precipitation, soil and topographic information**

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**1. Introduction**

The following supplementary materials contain Table S1 showing a list of the 65 hydrologic reference stations (HRS) in Murray-Darling basin (MDB) used in this study, along with descriptions of a set of scripts written in MATLAB (hereafter refer to as Toolkit) for the parameter optimization, simulation over the 25-year validation period and plotting results from six selected HRSs as examples (marked with asterisks in Table S1).

**2. List of 65 HRSs**

Table S1. List of Hydrologic Reference Stations in Murray-Darling basin used in this study

No.	Station ID	Name	<sup>a</sup> Lat. (°)	<sup>b</sup> Lon. (°)	<sup>c</sup> Ele. (m)	Area (km <sup>2</sup> )	<sup>d</sup> R
1	401009	Maragle Creek @ Maragle	-35.93	148.10	509	217	0.55
2	401015	Bowna Creek @ Yambla	-35.92	146.98	312	290	0.53
3	401203	Mitta Mitta River @ Hinnomunjie	-36.95	147.61	609	1519	0.47
4	401208	Cudgewa Creek @ Berringama	-36.21	147.68	597	351	0.68
5	401210	Snowy Creek @ Below Granite Flat	-36.57	147.41	453	416	0.53
6	401212	Nariel Creek @ Upper Nariel	-36.45	147.83	614	252	0.50
7	401216	Big River @ Jokers Creek	-36.93	147.47	984	357	0.50
8	401217	Gibbo River @ Gibbo Park	-36.76	147.71	598	390	0.45
9*	402204	Yackandandah Creek @ Osbornes Flat	-36.30	146.91	172	284	0.63

10	402206	Running Creek @ Running Creek	-36.54	147.04	311	128	0.43
11*	402213	Kinchington Creek @ Osbornes Flat	-36.32	146.89	173	124	0.64
12	403214	Happy Valley Creek @ Rosewhite	-36.58	146.82	306	138	0.52
13	403221	Reedy Creek @ Woolshed	-36.31	146.60	304	206	0.60
14	403222	Buffalo River @ Abbeyard	-36.91	146.70	576	415	0.60
15	403226	Boggy Creek @ Angleside	-36.61	146.36	176	108	0.58
16	403232	Morses Creek @ Wandiligong	-36.75	146.98	581	124	0.54
17	404207	Holland Creek @ Kelfeera	-36.61	146.06	190	448	0.65
18	405205	Murrindindi River @ Murrindindi Above Colwells	-37.41	145.56	415	106	0.48
19	405209	Acheron River @ Taggerty	-37.32	145.71	281	629	0.52
20	405215	Howqua River @ Glan Esk	-37.23	146.21	375	374	0.59
21	405217	Yea River @ Devlins Bridge	-37.38	145.47	307	361	0.60
22	405218	Jamieson River @ Gerrang Bridge	-37.29	146.19	312	364	0.55
23*	405219	Goulburn River @ Dohertys	-37.33	146.13	587	700	0.60
24*	405227	Big River @ Jamieson	-37.37	146.06	348	627	0.63
25	405238	Mollison Creek @ Pyalong	-37.12	144.86	298	164	0.55
26	405248	Major Creek @ Graytown	-36.85	144.91	152	288	0.42
27	405251	Brankeet Creek @ Ancona	-36.97	145.79	305	122	0.66
28	405263	Goulburn River @ U/S of Snake Creek Junction	-37.46	146.25	570	329	0.52
29	405264	Big River @ D/S of Frenchman Creek Junction	-37.52	146.08	440	335	0.57
30	405274	Home Creek @ Yarck	-37.11	145.61	306	187	0.68
31	406213	Campaspe River @ Redesdale	-37.02	144.54	287	634	0.62
32	406214	Axe Creek @ Longlea	-36.77	144.43	173	237	0.58
33	406224	Mount Pleasant Creek @ Runnymede	-36.55	144.64	139	246	0.53
34	407214	Creswick Creek @ Clunes	-37.30	143.79	336	300	0.48
35*	407215	Loddon River @ Newstead	-37.11	144.06	194	1029	0.68

36	407220	Bet Bet Creek @ Norwood	-36.99	143.63	225	361	0.61
37	407230	Joyces Creek @ Strathlea	-37.16	143.96	252	156	0.61
38	407253	Piccaninny Creek @ Minto	-36.45	144.47	137	652	0.50
39	408200	Avoca River @ Coonooer	-36.44	143.30	141	2677	0.74
40	408202	Avoca River @ Amphitheatre	-37.18	143.41	316	83	0.52
41	410057	Goobarragandra River @ Lacmalac	-35.33	148.35	536	668	0.60
42	410705	Molonglo River @ Burbong	-35.34	149.31	616	509	0.56
43	410730	Cotter River @ Gingera	-35.59	148.82	1191	130	0.43
44	410731	Gudgenby River @ Tennent	-35.57	149.07	742	672	0.46
45	410734	Queanbeyan River @ Tinderry	-35.61	149.35	883	564	0.45
46	410761	Murrumbidgee River Below Lobbs Hole Creek	-35.54	149.10	669	5158	0.36
47	412028	Abercrombie River @ Abercrombie	-33.95	149.33	506	2631	0.51
48	412050	Crookwell River @ Narrawa North	-34.31	149.17	591	762	0.52
49*	412066	Abercrombie River @ Hadley No.2	-34.11	149.60	618	1630	0.57
50	415207	Wimmera River @ Eversley	-37.19	143.18	327	305	0.58
51	415226	Richardson River @ Carrs Plains	-36.74	142.79	152	125	0.55
52	415237	Concongella Creek @ Stawell	-37.03	142.82	222	244	0.60
53	416003	Tenterfield Creek @ Clifton	-29.03	151.72	667	553	0.64
54	416008	Beardy River @ Haystack	-29.22	151.38	587	908	0.42
55	418005	Copes Creek @ Kimberley	-29.92	151.11	644	249	0.46
56	418014	Gwydir River @ Yarrowyck	-30.47	151.36	906	835	0.59
57	419005	Namoi River @ North Cuerindi	-30.68	150.78	585	2532	0.47
58	422202B	Dogwood Creek @ Gilweir	-26.71	150.18	301	2882	0.54
59	422306A	Swan Creek @ Swanfels	-28.16	152.28	668	83	0.48
60	422313B	Emu Creek @ Emu Vale	-28.23	152.23	603	153	0.35
61	422319B	Dalrymple Creek @ Allora	-28.04	152.01	565	256	0.70

62	422334A	Kings Creek @ Aides Bridge	-27.93	151.86	518	648	0.72
63	422394A	Condamine River @ Elbow Valley	-28.37	152.14	586	328	0.59
64	424002	Paroo River @ Willara Crossing	-29.24	144.46	106	35239	0.44
65	424201A	Paroo River @ Caiwarro	-28.69	144.79	133	22885	0.41

\*: selected HRSs for Toolkit examples, a: latitude, b: longitude, c: elevation above sea level, d: temporal correlation coefficients between discharge and simulation during the 10-year calibration period

### 3. Descriptions on Toolkit

Software Requirements:

- Microsoft Windows 7 or later release
- MATLAB 2015b or later release

Toolkit Information:

- Toolkit is written in MATLAB
- The terrain processing steps are performed using TopoToolbox (<https://topotoolbox.wordpress.com/download/>), which must be installed prior to using SMART
- Toolkit is distributed under the GNU Public License Version 3 (Version 1.0, December 2017, <https://goo.gl/GYQzws> (temporary link, to be confirmed))

Toolkit File Structure:

The Toolkit folder contains six sub-folders (Figure S1). The contents of each folder are described in the following sections.

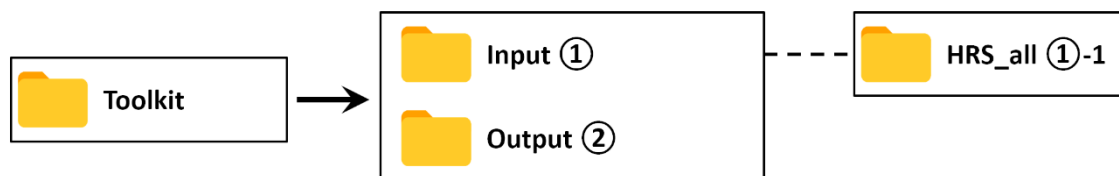


Figure S1. Toolkit folder structure

#### 3.1. Input Folder

The input folder (① in Figure S1) contains the input datasets including soil moisture and rainfall data over both 10-year calibration and 25-year validation periods, detailed information and raw discharge data of HRSs (under **HRS\_all** folder, ①-1 in Figure S1),

maps of Curve Number (CN) and Digital Elevation Model (DEM), and files for generating a date list. A summary of the input files is outlined in Table S2.

Table S2. Summary of Toolkit input files

<b>Data</b>	<b>File(s)</b>	<b>Description</b>
Soil moisture	<b>SM_CCI_cal_10.mat</b> (for 10-year calibration) <b>SM_CCI_val_25.mat</b> (for 25-year validation)	See 3.2.1 in the manuscript
Rainfall	<b>P_AWAP_cal_10.mat</b> (for 10-year calibration) <b>P_AWAP_val_25.mat</b> (for 25-year validation)	See 3.2.2 in the manuscript
HRS discharge	<b>HRS_all\*.csv</b>	See 3.1 in the manuscript
CN	<b>HWSD_CN_MD.tif</b>	See 3.2.3 in the manuscript
DEM	<b>MD_005.tif</b>	See 3.2.3 in the manuscript
Ancillary	<b>dateyear365.mat</b> <b>dateyear366.mat</b>	For generating a date list by <b>genDateList.m</b>

### 3.2. Output Folders and MATLAB scripts

The output folder (② in Figure S1) contains results from the MATLAB scripts. A summary of the output files and related MATLAB scripts is outlined in Table S3. Further details were provided in each MATLAB script or function.

Table S3. Summary of Toolkit outputs and MATLAB scripts

<b>Script</b>	<b>Function(s)</b>	<b>Outputs (Output\*.*)</b>	<b>Description</b>
<b>step1_opt_para.m</b>	· <b>fun_opt_para.m</b> - <b>upSlopeldx.m</b> - <b>m2v.m</b> - <b>TopoToolbox</b>	<b>Optimised_pars.mat</b>	Optimizes the three parameters (alpha, beta and p) over HRSs
<b>step2_sim_valPeriod.m</b>	· <b>fun_sim_valPeriod.m</b> - <b>genDateList.m</b> - <b>m2v.m</b> - <b>upSlopeldx.m</b> - <b>TopoToolbox</b>	<b>Output\Station #).mat</b>	Simulates Q for the validation period using three parameters over HRSs
<b>step3_calScores.m</b>	-	<b>Output\Scores.mat</b>	Calculates contingency table based skill scores
<b>step4_plot_CDF_TS.m</b>	-	<b>Output\CDF_*.tif, TS_*.tif)</b>	Plots CDFs and time series of observed and simulated Q