water

MDPI

Article

A Framework to Assess the Reliability of a Multi-purpose Reservoir under Uncertainty in Land Use

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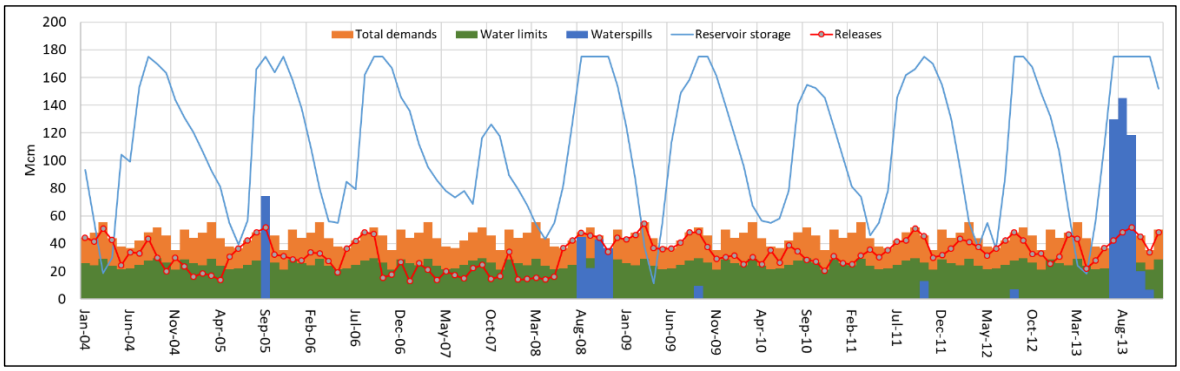
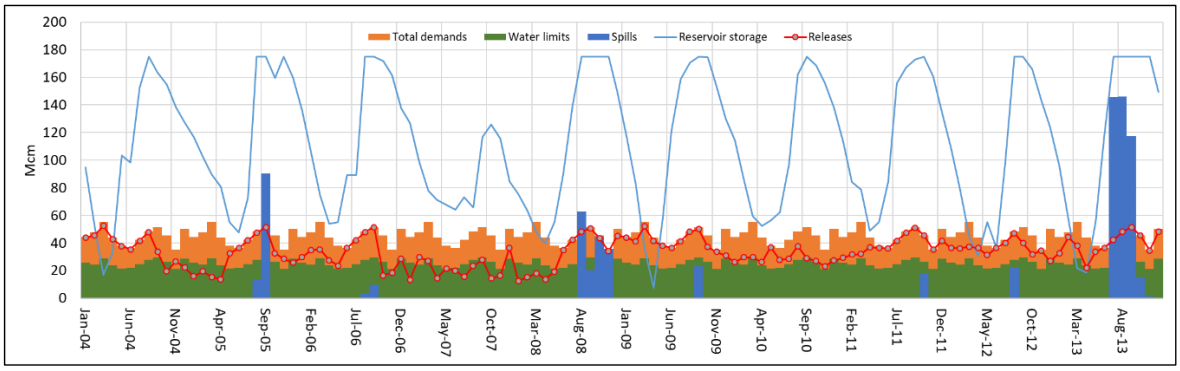
Supplementary Materials

Table S1. List of calibrated ranges of parameters

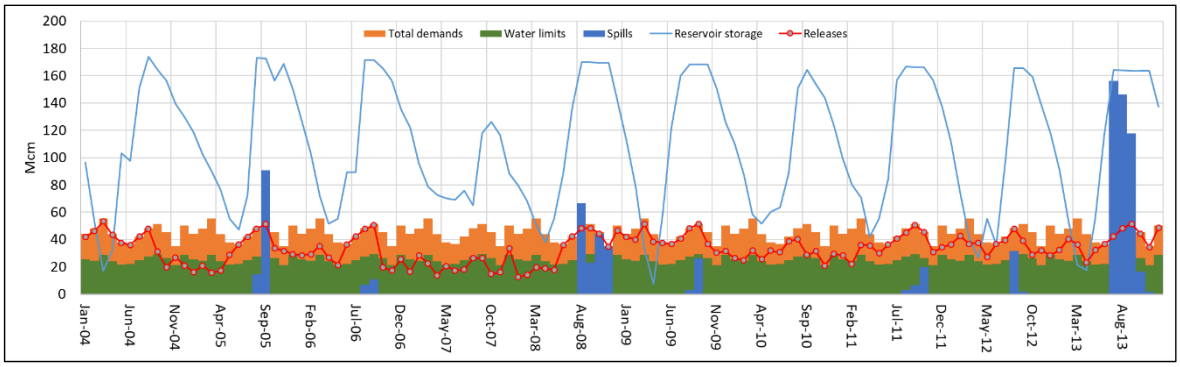
Parameter	Initial value/ range	Min	Max	Scaling type	Note
CN2	Depend on land use	- 0.21	0.09	r	Relative change in percent
ALPHA_BF	0 – 1	0.023	0.070	v	Replace the range of value
RCHRG_DP	0 – 1	0.008	0.67	v	Replace the range of value
GWQMN	0 – 5000	1466	4408	v	Replace the range of value
SOL_AWC	0.16	- 0.09	0.5	r	Relative change in percent



(a) Time series of reservoir operation when sediment was not considered – Baseline



(b) Time series of reservoir operation when sediment was not considered under S3



(c) Time series of reservoir operation when sediment was considered under S3

Figure S1. Time series of the reservoir over 10-year period

Table S2. t-test for the reliability when sedimentation was not included over 10-year simulations

Independent sample t-test Reliability (%) Sedimentation not included			**BL_NoSED**		**S1_NoSED**		**S2_NoSED**		**S3_NoSED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			73.3	1.56	74.91	1.32	75.58	1.30	75.78	1.29
BL_NoSED	**M**	73.3			t(358) = -10.6 P=0.00 ✓		t(358)= -15.08 P=0.00 ✓		t(358): -14.232 P=0.00 ✓	
	SD	1.56								
S1_NoSED	**M**	74.91					t(358) = -4.815 P=0.00 ✓		t(358) = -6.27 P=0.00 ✓	
	SD	1.32								
S2_NoSED	**M**	75.58							t(358) = -1.449 P=0.148 ✗	
	SD	1.30								
S3_NoSED	**M**	75.78								
	SD	1.29								

M: Mean; SD: Standard deviation; ✗: Insignificant difference; ✓: Significant difference

Table S3. t-test for the reliability when sedimentation was included over 10-year simulations

Independent sample t-test Reliability (%) Sedimentation included			**BL_SED**		**S1_SED**		**S2_SED**		**S3_SED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			73.16	1.49	74.6	1.32	75.3	1.32	75.2	1.29
BL_SED	**M**	73.16			t(358)= -9.90 P=0.00 ✓		t(358)= -14.45 P=0.00 ✓		t(358)= -13.81 P=0.00 ✓	
	SD	1.49								
S1_SED	**M**	74.6					t(358)= -4.84 P=0.00 ✓		t(358)= -4.07 P=0.00 ✓	
	SD	1.32								
S2_SED	**M**	75.3							t(358)= 0.809 P=0.42 ✗	
	SD	1.32								
S3_SED	**M**	75.2								
	SD	1.29								

Table S4. t-test for the reservoir reliability between scenarios with and without sedimentation over 10-year simulations

Independent sample t-test Reliability (%) Sedimentation included			**BL_SED**		**S1_SED**		**S2_SED**		**S3_SED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			73.16	1.49	74.6	1.32	75.3	1.32	75.2	1.29
BL_NoSED	**M**	73.3	t(358)= 0.85 P=0.40 ×							
	SD	1.56								
S1_ NoSED	**M**	74.91			t(358)= 1.98 P=0.05 ✓					
	SD	1.32								
S2_ NoSED	**M**	75.58					t(358)= 1.96 P=0.05 ✓			
	SD	1.30								
S3_ NoSED	**M**	75.78							t(358)= 4.26 P=0.00 ✓	
	SD	1.29								

Table S5. t-test for the water releases when sedimentation was not included over 10-year simulations

Independent sample t-test Water releases (Mcm) Sedimentation not included			**BL_NoSED**		**S1_NoSED**		**S2_NoSED**		**S3_NoSED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			3903.5	78.06	3989.4	66.5	4024.9	65.2	4035.4	64.4
BL_NoSED	**M**	3903.5			t(358) = -11.23 P=0.00 ✓		t(358)= -16.01 P=0.00 ✓		t(358): -17.48 P=0.00 ✓	
	SD	78.06								
S1_NoSED	**M**	3989.4					t(358)= -5.12 P=0.00 ✓		t(358)= -6.67 P=0.00 ✓	
	SD	66.5								
S2_NoSED	**M**	4024.9							t(358)= -1.54 P = 0.125 ×	
	SD	65.2								
S3_NoSED	**M**	4035.4								
	SD	64.4								

Table S6. t-test for the water releases when sedimentation was included over 10-year simulations

Independent sample t-test Water releases (Mcm) Sedimentation included			**BL_SED**		**S1_SED**		**S2_SED**		**S3_SED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			3896.3	75.16	3974.7	66.59	4010.5	3896.28	4004.58	65.48
BL_SED	**M**	3896.3			t(358)= -10.48 P=0.00 ✓		t(358)= -15.3 P=0.00 ✓		t(358)= -14.58 P=0.00 ✓	
	SD	75.16								
S1_SED	**M**	3974.7					t(358)= -5.12 P=0.00 ✓		t(358)= -4.29 P=0.00 ✓	
	SD	66.59								
S2_SED	**M**	4010.5							t(358)= 0.86 P=0.39 ×	
	SD	3896.28								
S3_SED	**M**	4004.58								
	SD	65.48								

Table S7. t-test for the water releases between scenarios with and without sedimentation over 10-year simulations

Independent sample t-test Water releases (Mcm) Sedimentation included			**BL_SED**		**S1_SED**		**S2_SED**		**S3_SED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			3896.3	75.16	3974.7	66.59	4010.5	3896.28	4004.58	65.48
BL_NoSED	**M**	3903.5	t(358)= 0.90 P=0.37 ×							
	SD	78.06								
S1_NoSED	**M**	3989.4			t(358)= 2.10 P=0.04 ✓					
	SD	66.5								
S2_NoSED	**M**	4024.9					t(358)= 2.08 P=0.04 ✓			
	SD	65.2								
S3_NoSED	**M**	4035.4							t(358)= 4.51 P=0.00 ✓	
	SD	64.4								

Table S8. t-test for the water spillage when sedimentation was not included over 10-year simulations

Independent sample t-test Water spillage (Mcm) Sedimentation not included			**BL_NoSED**		**S1_NoSED**		**S2_NoSED**		**S3_NoSED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			663.63	62.37	722.37	60.73	754.75	62.49	763.56	62.35
BL_NoSED	**M**	663.63			t(358) = -9.05 P=0.00 ✓		t(358) = -13.84 P=0.00 ✓		t(358) = -15.20 P=0.00 ✓	
	SD	62.37								
S1_NoSED	**M**	722.37					t(358) = -4.98 P=0.00 ✓		t(358) = -6.35 P=0.00 ✓	
	SD	60.73								
S2_NoSED	**M**	754.75							t(358) = -1.34 P=0.18 ×	
	SD	62.49								
S3_NoSED	**M**	763.56								
	SD	62.35								

Table S9. t-test for the water releases when sedimentation was included over 10-year simulations

Independent sample t-test Water spillage (Mcm) Sedimentation included			**BL_SED**		**S1_SED**		**S2_SED**		**S3_SED**	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			677.69	63.69	738.33	61.56	776.47	62.28	809.13	64.54
BL_SED	**M**	677.69			t(358)= -9.18 P=0.00 ✓		t(358)= -14.88 P=0.00 ✓		t(358)= -19.45 P=0.00 ✓	
	SD	63.69								
S1_SED	**M**	738.33					t(358)= -5.84 P=0.00 ✓		t(358)= -10.65 P=0.00 ✓	
	SD	61.56								
S2_SED	**M**	776.47							t(358)= -4.88 P=0.00 ✓	
	SD	62.28								
S3_SED	**M**	809.13								
	SD	64.54								

Table S10. t-test for the water spillage between scenarios with and without sedimentation over 10-year simulations

Independent sample t-test Water spillage (Mcm) Sedimentation included			BL_SED		S1_SED		S2_SED		S3_SED	
			M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
			677.69	63.69	738.33	61.56	776.47	62.28	809.13	64.54
BL_NoSED	**M**	663.63	t(358)= -2.12 P=0.03 ✓							
	SD	62.37								
S1_NoSED	**M**	722.37			t(358)= -2.48 P=0.01 ✓					
	SD	60.73								
S2_NoSED	**M**	754.75					t(358)= -3.30 P=0.00 ✓			
	SD	62.49								
S3_NoSED	**M**	763.56							t(358)= -6.81 P=0.00 ✓	
	SD	62.35								

Table S11. t-test for the reliability, water releases and water spillage when sedimentation was and was not included over 40-year simulations

Reservoir indicators	M	SD	t	p-value	Statistically difference
Reliability (%)					
S3_noSED	76.04	0.69	28.1	0.00	✓
S3_SED	73.4	0.63			
Water releases (Mcm)					
S3_noSED	16199	144.5	28.17	0.00	✓
S3_SED	15639	136.7			
Water spillage (Mcm)					
S3_noSED	3039	166.1	-27.7	0.00	✓
S3_SED	3700	170.3			

Table S12. t-test for the reliability, water releases and water spillage when sedimentation was included over 40-year simulations

Reservoir indicators	M	SD	t	p-value	Statistically difference
Reliability (%)					
S3_SED_40yr	73.4	0.63	17.23	0.00	✓
S3_SED_10yr	75.79	1.22			
Water releases (Mcm/year)					
S3_SED_40yr	390.98	3.41	12.39	0.00	✓
S3_SED_10yr	400.37	6.77			
Water spillage (Mcm/year)					
S3_SED_40yr	92.51	4.26	-15.491	0.00	✓
S3_SED_10yr	80.99	6.09			

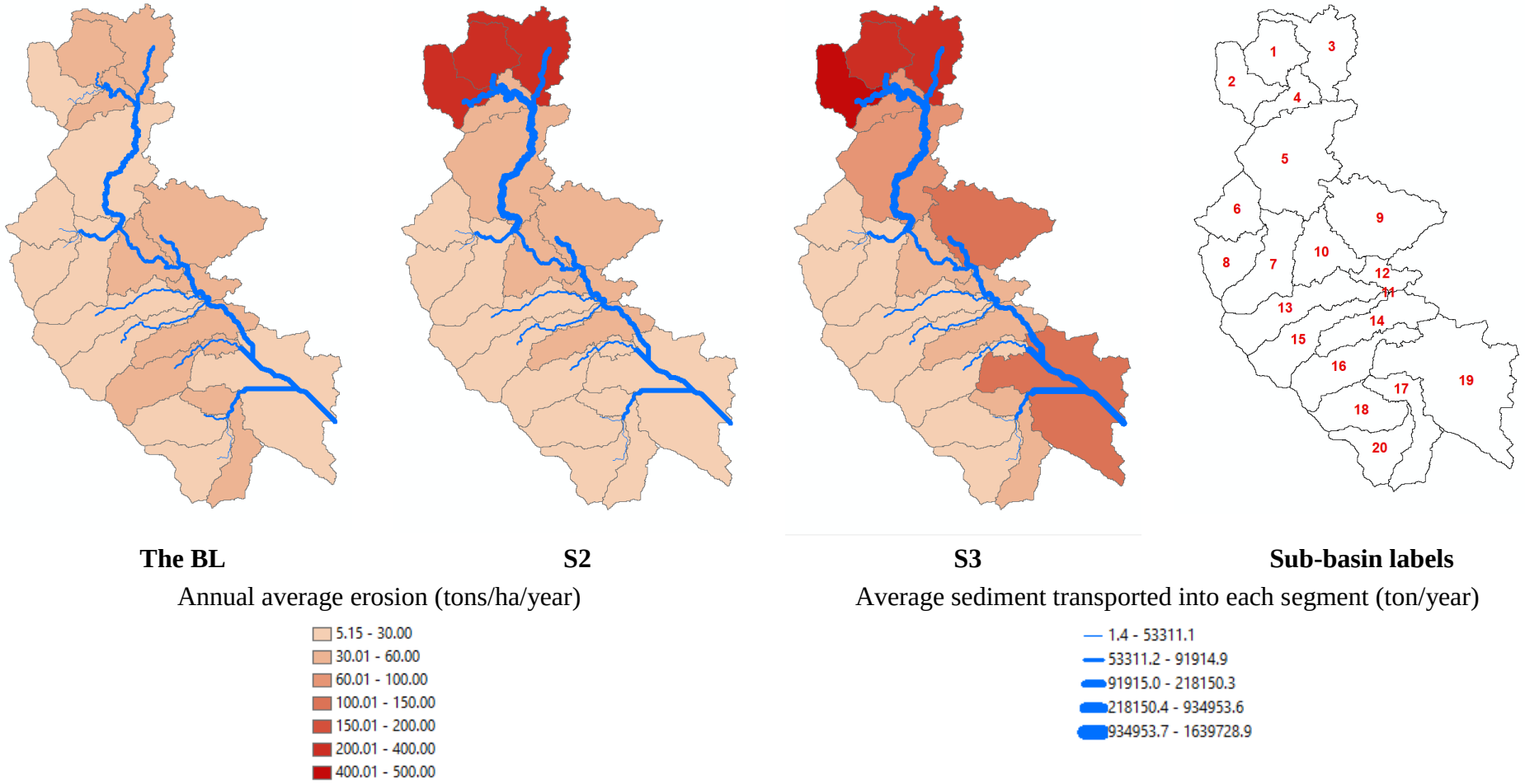


Figure S2. The median values of water and sediment flows in the sub-basins of the case study

Table S13. Growth phases of crops

No.	Parameters	Description	FRSE (Forest)		ORCD (Tea tree)		RICE (Paddy)		AGRR (Annual vegetable)		RNGB (Range Bush)	
			Default value	Modified value	Default value	Modified value	Default value	Modified value	Default value	Modified value	Default value	Modified value
1	BLAI	Maximum potential leaf area index (m^2/m^2)	5	5	4	2.5	5	3	3	3	2	2
2	FRGRW1	Fraction of the plant growing season corresponding to the 1st point on the optimal leaf area development curve	0.15	0.15	0.1	0.03	0.3	0.3	0.15	0.15	0.05	0.05
3	LAIMX1	Fraction of BLAI corresponding to the 1st point on the optimal leaf area development curve	0.7	0.7	0.15	0.15	0.01	0.01	0.05	0.05	0.1	0.1
4	FRGRW2	Fraction of the plant growing season corresponding to the 2nd point on the optimal leaf area development curve	0.25	0.25	0.5	0.14	0.7	0.7	0.5	0.5	0.25	0.25
5	LAIMX2	Fraction of BLAI corresponding to the 2nd point on the optimal leaf area development curve	0.99	0.99	0.75	0.75	0.95	0.95	0.95	0.95	0.7	0.7
6	DLAI	Fraction of growing season when leaf area begins to decline	0.99	0.99	0.99	0.83	0.8	0.8	0.7	0.7	0.35	0.35
7	CHTMX	Max canopy height (m)	10	6	3.5	1.2	0.8	0.8	2.5	1	1	0.5
8	Year to maturity	Years for plants to reach maturity	30	30	10	5	0	0	0	0	0	0
9	Others			Default		Default		Default		Default		Default
Related to sediment												
1	USLE_C		0.001	0.005	0.001	0.073	0.03	0.02	0.2	0.2	0.003	0.002
2	Spcon		0.0001	0.0005	0.0001	0.0005	0.0001	0.0005	0.0001	0.0005	0.0001	0.0005