Text S1. *ROS–PSO algorithm:*

Step 1: The reservoirs are numbered and grouped based on the water resource allocation network diagram and ROS, and then divided into subgroups. The algorithm parameters are prepared and the attribute data of each reservoir and the water consumption unit classified.

Step 2: Randomly initialise decision variables (reservoir supply and supply's increase velocity) $x_i^{(0)}$ $v_i^{(0)}$, evaluate the fitness of $x_i^{(0)}$ and $v_i^{(0)}$, and determine the values of $P_i^{(0)}$ and $P_G^{(0)}$.

Step 3: Update the position and velocity of the particle based on Eq.11 and Eq.12. Then, the satisfied degree of water supply, close degree of ecological and flow, and comprehensive benefit objective function based on Eq.1–Eq.5 can be obtained.

Step 4: Evaluate the fitness of $x_i^{(n+1)}$ and $v_i^{(n+1)}$ if the performance is better (larger the value of the comprehensive benefit objective function), replace $P_i^{(n)}$ and $P_G^{(n)}$ by the new solution ($P_i^{(n+1)}$ and $P_G^{(n+1)}$).

Step 5: If n < N or ε < ε$_{max}$, then n = n + 1, and return to step 3; otherwise, the optimisation is terminated.
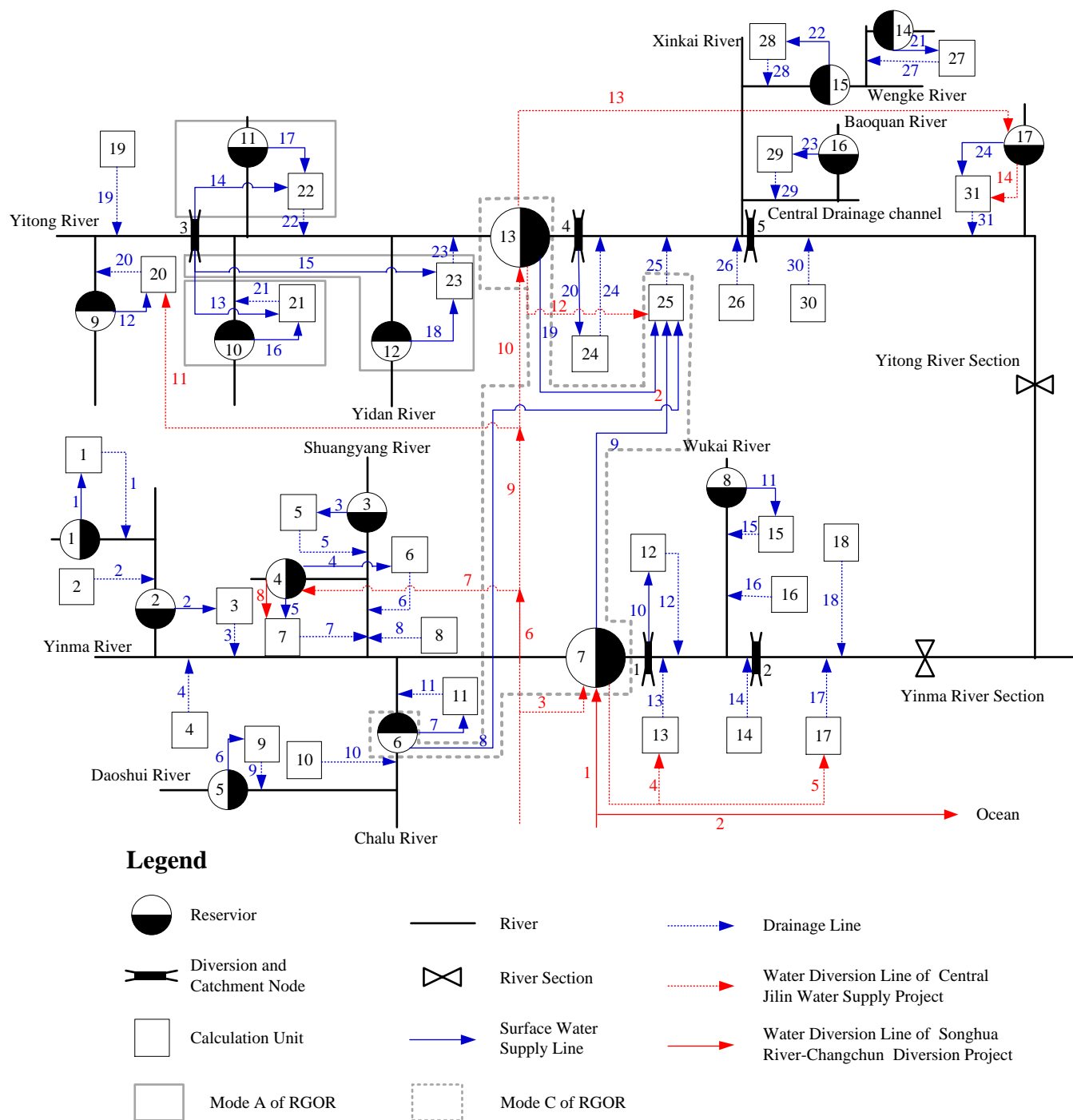
Figure S1. *Generalised figure of reservoir group operation in YRB.*

The numbers in the figure correspond to Table S2

Table S1. Parameters of reservoirs in YRB

Name	Catchment area (km^2)	Total storage (10^{4}m^3)	Utilizable capacity (10^{4}m^3)	Dead storage (10^{4}m^3)	Normal water level (m)	Flood control level (m)
Yaji Reservior	135	0.22	0.09	0.01	312.7	310.85
Huanghe Reservior	784	0.36	0.22	0.01	94.5	93
Heiding Reservior	54	0.15	0.05	0.01	248.55	248.05
Shuangyang Reservior	221	0.76	0.21	0.03	218.86	218.62
Miaoling Reservior	37	0.1	0.08	0.01	394.5	393.45
Xinxinshao Reservior	845	2.65	0.94	0.21	245.5	241
Shitoukoumen Reservior	4944	12.64	3.84	0.44	189	188

Wuyi Reservior	163	0.44	0.16	0.05	216.53	216.53
Xiaoliaoqian Reservior	78	0.3	0.18	0.05	234.5	234.5
Shoushan Reservior	91	0.19	0.11	0.01	293.8	292.7
Sanlian Reservior	90	0.16	0.08	0.01	247.55	246.6
Shimenzi Reservior	124	0.28	0.19	0.02	264.5	263.3
Xinlicheng Reservior	1970	5.75	3.28	0.15	219.63	218.83
Pingyang Reservior	76	0.17	0.08	0.02	226.34	226.1
Taipingchi Reservior	1706	2.01	0.52	0.06	183.73	183.73
Gongqingtuan Reservior	114	0.11	0.07	0.01	184.4	183
Liangjiazi Reservior	150	0.14	0.04	0.006	172.1	172.1

Table S2. *Identification table of generalized project of ecological operation model in YRB*

Engineering properties	No.	Name	Identification
Reservior	1	Yaji Reservior	YAJI_R
	2	Huanghe Reservior	HUANGHE_R
	3	Heiding Reservior	HEIDINGZ_R
	4	Shuangyang Reservior	SHUANGY_R
	5	Miaoling Reservior	MIAOLING_R
	6	Xinxinshao Reservior	XINGXSH_R
	7	Shitoukoumen Reservior	SHITOUKM_R
	8	Wuyi Reservior	WUYI_R
	9	Xiaoliaoqian Reservior	XIAOLIAOQ_R
	10	Shoushan Reservior	SHOUSHAN_R
	11	Sanlian Reservior	SANLIAN_R
	12	Shimenzi Reservior	SHIMENZI_R
	13	Xinlicheng Reservior	XINLICH_R
	14	Pingyang Reservior	PINGYANG_R
	15	Taipingchi Reservior	TAIPINGC_R
	16	Gongqingtuan Reservior	GONGQT_R
	17	Liangjiazi Reservior	LIANGJIAZI_R
Diversion and Catchment Node	1	Down Node of Shitoukoumen	NKMX
	2	Dehui Node	NDHUI
	3	Up Node of Xinlicheng	NXLCS
	4	Down Node of Xinlicheng	NXLCX
	5	Nongan Node	NNA
Calculation Unit	1	Yaji Reservoir Irrigation Area	UYM_RYAJI
	2	Interval Between Yaji Reservoir and Huanghe Reservoir	UYM_OYJHH
	3	Huanghe Reservoir Irrigation Area	UYM_RHHE
	4	Interval Between Huanghe Reservoir and Shitoukoumen Reservoir	UYM_OHHKM
	5	Heiding Reservoir Irrigation Area	UYM_RHDING
	6	Shuangyang Reservoir Irrigation Area	UYM_RSYANG
	7	Shuangyang District	UYM_SHYANG
	8	Shuangyang River Interval	UYM_OSYANG
	9	Miaoling Reservoir Irrigation Area	UYM_RMLING
	10	Interval Between Miaoling Reservoir and Xingxingshao Reservoir	UYM_OMLXXS
	11	Xingxingshao Reservoir Irrigation Area	UYM_RXXSH

Engineering properties	No.	Name	Identification
	12	Shitoukoumen Reservoir Irrigation Area	UYM_RSTKM
	13	Jiutai City	UYM_JIUTAI
	14	Interval Between Shitoukoumen Reservoir and Dehui Node	UYM_OKMDH
	15	Wuyi Reservoir Irrigation Area	UYM_RWUYI
	16	Wukai River Interval	UYM_OWHKE
	17	Dehui City	UYM_DEHUI
	18	Interval Between Dehui Node and Yinma River Estuary	UYM_ODHYMH
	19	Interval Above Xinlicheng Reservior of Yinma River	UYT_OXLCSH
	20	Yitong County	UYT_YITONG
	21	Shoushan Reservoir Irrigation Area	UYT_RSHSH
	22	Sanlian Reservoir Irrigation Area	UYT_RSLIAN
	23	Shimenzi Reservoir Irrigation Area	UYT_RSHMZ
	24	Xinlicheng Reservoir Irrigation Area	UYT_RXLICH
	25	Changchun City	UYT_CHCHUN
	26	Interval Between Xinlicheng Reservoir and Nongan Node	UYT_OXLCNA
	27	Pingyang Reservoir Irrigation Area	UYT_RPYANG
	28	Taipingchi Reservoir Irrigation Area	UYT_RTPCH
	29	Gongqingtuan Reservoir Irrigation Area	UYT_RGQITU
	30	Interval Between Nongan Node and YiTong River Estuary	UYT_ONAYTH
	31	Nongan County	UYT_NONGAN
Surface Water Supply Line	1	Yaji Reservior - Yaji Reservoir Irrigation Area	RYJ_AYJ
	2	Huanghe Reservoir - Huanghe Reservoir Irrigation Area	RHH_AHH
	3	Heiding Reservoir - Heiding Reservoir Irrigation Area	RHD_AHD
	4	Shuangyang Reservoir - Shuangyang Reservoir Irrigation Area	RSHY_ASHY
	5	Shuangyang Reservoir - Shuangyang District	RSHY_CYMSY
	6	Xingxingshao Reservior - Xingxingshao Reservoir Irrigation Area	RML_AML
	7	Xingxingshao Reservoir - Changchun City	RXXS_AXXS
	8	Shitoukoumen Reservoir - Changchun City	RXXS_CYTCC
	9	Down Node of Shitoukoumen - Shitoukoumen Reservoir Irrigation Area	RSTKM_CYTCC
	10	Wuyi Reservoir - Wuyi Reservoir Irrigation Area	NKMX_AKM
	11	Wuyi Reservoir - Wuyi Reservoir Irrigation Area	RWY_AWY
	12	Xiaoliaoqian Reservoir - Yitong County	RXLQ_CYTYT
	13	Up Node of Xinlicheng - Shoushan Reservoir Irrigation Area	NXLCS_ASS
	14	Up Node of Xinlicheng - Sanlian Reservoir Irrigation Area	NXLCS_ASL
	15	Up Node of Xinlicheng - Shimenzi Reservoir Irrigation Area	NXLCS_ASMZ
	16	Shoushan Reservior - Shoushan Reservoir Irrigation Area	RSS_ASS
	17	Sanlian Reservior - Sanlian Reservoir Irrigation Area	RSL_ASL
	18	Shimenzi Reservoir - Shimenzi Reservoir Irrigation Area	RSMZ_ASMZ
	19	Xinlicheng Reservoir - Changchun City	RXLC_CYTCC
	20	Down Node of Xinlicheng - Xinlicheng Reservoir Irrigation Area	NXLCX_AXLC
	21	Pingyang Reservoir - Pingyang Reservoir Irrigation Area	RPY_APY
	22	Taipingchi Reservoir - Taipingchi Reservoir Irrigation Area	RTPC_ATPC
	23	Gongqingtuan Reservoir - Gongqingtuan Reservoir Irrigation Area	RGQT_AGQT
	24	Liangjiazi Reservoir - Nongan county	RLJZ_CYTNA
	1	Shoushan Reservoir - Xinlicheng Reservoir	RSS_RXLC

Engineering properties	No.	Name	Identification
Generalized River	2	Sanlian Reservior - Xinlicheng Reservoir	RSL_RXLC
	3	Shimenzi Reservior - Xinlicheng Reservoir	RSMZ_RXLC
	4	Xinlicheng Reservoir - Down Node of Xinlicheng	RXLC_NXLCX
	5	Gongqingtuan Reservoir - Nongan Node	RGQT_NNA
	6	Taipingchi Reservoir - Nongan Node	RTPC_NNA
	7	Pingyang Reservoir - Taipingchi Reservoir	RPY_RTPC
	8	Liangjiazi Reservoir - Yitong River Section	RLJZ_BYTH
	9	Yaji Reservior - Huanghe Reservoir	RYJ_RHHE
	10	Huanghe Reservoir - Shitoukoumen Reservoir	RHH_RSTK
	11	Heiding Reservoir - Shitoukoumen Reservoir	RHD_RSTK
	12	Shuangyang Reservoir - Shitoukoumen Reservoir	RSY_RSTK
	13	Miaoling Reservoir - Xingxingshao Reservoir	RML_RXXSH
	14	Xingxingshao Reservoir - Shitoukoumen Reservior	RXXS_RSTKM
	15	Shitoukoumen Reservoir - Down Node of Shitoukoumen	RKM_NKMX
	16	Wuyi Reservoir - Dehui Node	RWU_NDHUI
	17	Up Node of Xinlicheng - Xinlicheng Reservoir	NXLCS_RXLC
	18	Xinlicheng Reservoir - Down Node of Xinlicheng	RXLC_NXLCX
	19	Down Node of Xinlicheng - Nongan Node	NXLCX_NNA
	20	Nongan Node - Yitong River Section	NNA_BYTH
	21	Yitong River Section - Ocean	BYTH_SEA
	22	Down Node of Shitoukoumen - Dehui Node	NKMX_NDHUI
	23	Dehui Node - Yinma River Section	NDH_BYMH
	24	Yinma River Section - Ocean	BYMH_SEA
Water Diversion Line	1	Songhua River - Changchun　Diversion Project - Shitoukoumen Reservior	DYSN_RSTK
	2	Songhua River - Changchun　Diversion Project - Ocean	DYSN_SEA
	3	Central Jilin Water Supply Project - Shitoukoumen Reservior	DZBYN_RSTK
	4	Shitoukoumen Reservior - Jiutai City	DRSTK_YMJT
	5	Shitoukoumen Reservior - Dehui City	DRSTK_YMDH
	6	Central Jilin Water Supply Project - Shuangyang Water Diversion Project	DZBYN_SYFS
	7	Shuangyang Water Diversion Project - Shuangyang Reservoir	DSYFS_RSY
	8	Shuangyang Reservoir - Shuangyang District	DRSY_YMSY
	9	Shuangyang Water Diversion Project - Xinlicheng Water Diversion Project	DSYFS_XLCF
	10	Xinlicheng Water Diversion Project - Xinlicheng Reservoir	DXLCF_RXLC
	11	Xinlicheng Water Diversion Project - Yitong County	DXLCF_YTYT
	12	Xinlicheng Reservoir - Changchun City	DRXLC_YTCC
	13	Xinlicheng Reservoir - Liangjiazi Reservoir	DRXLC_RLJZ
	14	Liangjiazi Reservoir - Nongan County	DRLJZ_YTNA
Drainage Line	1	Yaji Reservoir Irrigation Area - Huanghe Reservoir	OYJ_RHH
	2	Interval Between Yaji Reservoir and Huanghe Reservoir - Huanghe Reservoir	OYJHH_RHH
	3	Huanghe Reservoir Irrigation Area - Shitoukoumen Reservoir	OHH_RSTKM
	4	Interval Between Huanghe Reservoir and Shitoukoumen Reservoir - Shitoukoumen Reservoir	OHHKM_RKM
	5	Heiding Reservoir Irrigation Area - Shitoukoumen Reservoir	OHD_RSTKM
	6	Shuangyang Reservoir Irrigation Area - Shitoukoumen Reservoir	OSY_RSTKM
	7	Shuangyang District - Shitoukoumen Reservoir	OYMSY_RKM
	8	Heiding Reservoir Irrigation Area - Shitoukoumen Reservoir	OSYA_RSTKM

Engineering properties	No.	Name	Identification
	9	Miaoling Reservoir Irrigation Area - Xingxingshao Reservoir	OML_RXXS
	10	Interval Between Miaoling Reservoir and Xingxingshao Reservoir - Xingxingshao Reservoir	OMLXX_RXXS
	11	Xingxingshao Reservoir Irrigation Area - Shitoukoumen Reservoir	OXXS_RSTKM
	12	Shitoukoumen Reservoir Irrigation Area - Dehui Node	OSTKM_NDH
	13	Jiutai City - Dehui Node	OYMJT_NDH
	14	Interval Between Shitoukoumen Reservoir and Dehui Node - Dehui Node	OKMDH_NDH
	15	Wuyi Reservoir Irrigation Area - Dehui Node	OWY_NDH
	16	Wukai River Interval - Dehui Node	OWHA_NDH
	17	Dehui City - Yinma River Section	OYMDH_BYMH
	18	Interval Between Dehui Node and Yinma River Estuary - Yinma River Section	ODHYM_BYMH
	19	Interval Above Xinlicheng Reservior of Yinma River - Xinlicheng Reservoir	OXLCS_RXLC
	20	Yitong County - Up Node of Xinlicheng	OYTYT_NXLC
	21	Shoushan Reservoir Irrigation Area - Xinlicheng Reservoir	OSS_RXLC
	22	Sanlian Reservoir Irrigation Area - Xinlicheng Reservoir	OSL_RXLC
	23	Shimenzi Reservoir Irrigation Area - Xinlicheng Reservoir	OSMZ_RXLC
	24	Xinlicheng Reservoir Irrigation Area - Nongan Node	OXLC_NNA
	25	Changchun City - Nongan Node	OYTCC_NNA
	26	Interval Between Xinlicheng Reservoir and Nongan Node - Nongan Node	OXLNA_NNA
	27	Pingyang Reservoir Irrigation Area - Taipingchi Reservoir	OPY_RTPC
	28	Taipingchi Reservoir Irrigation Area - Nongan Node	OTPC_NNA
	29	Gongqingtuan Reservoir Irrigation Area - Nongan Node	OGQT_NNA
	30	Interval Between Nongan Node and YiTong River Estuary - Yitong River Section	ONAYT_BYTH
	31	Nongan County - Yitong River Section	OYTNA_BYTH

Table S3. *Prediction of annual water demand at different levels in YRB*

Water unit	No. in Fig.S1	Classification	Water demand in 2015 (10^4 m^3)		Water demand in 2030 (10^4 m^3)	
CC	25	Urban	43096		85504	
NC	31		3280		7153	
YC	20		1790		3453	
SD	7		1445	58933	3141	118558
JC	13		5249		11014	
DC	17		4073		8293	
SsRIA	21	Irrigation area	1695		1544	
SlRIA	22		171		156	
SmRIA	23		843		769	
PRIA	27		7		6	
XRIA	24		41		37	
TRIA	28		964	38478	829	35760
GRIA	29		99		90	
YRIA	1		796		743	
HhRIA	3		832		777	
MRIA	9		1001		935	
SyRIA	6		1614		1509	

HdRIA	5		443		414	
XRIA	11		7483		6978	
StRIA	12		21843		20369	
WRIA	15		647		604	
IAXRYR	19	River interval	6207	83600	7957	116954
IBXRNN	26		15455		24088	
IBNNYRE	30		13223		19891	
IBYRHR	2		3245		4210	
IBHRSR	4		12825		14798	
IBMRXR	10		3946		4409	
SRI	8		5600		7638	
WRI	16		4111		4890	
IBStRDN	14		14074		24061	
IBDNYRE	18		4914		5011	
Total			**181011**	**181011**	**271272**	**271272**