Supplement of

Basin-scale multi-objective simulation-optimization modeling for conjunctive use of surface water and groundwater in northwest China

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Table S1 The control parameters and hypervolume metric obtained for ε-MOMA on $M$-objective DTLZ1 and DTLZ3 problems

| Problem | $M$ | $N_{dv}$ | $N_{pop}$ | $N_{eval}$ | $\varepsilon_{obj}$ | $rp$ | $HV_{rs}$ | $HV_{as}$ | $HV_n$ |
|---------|-----|---------|-----------|------------|---------------------|-----|----------|----------|-------|
| DTLZ1   | 3   |         | 100,000   |            |                     |     | 0.14575  | 0.14480  | 0.9935 |
|         | 4   | $M+9$  | 150,000   | 0.01       | 0.55               |     | 0.0883   | 0.08828  | 0.9939 |
|         | 5   |         | 200,000   |            |                     |     | 0.05000  | 0.04982  | 0.9964 |
|         | 6   |         | 400,000   |            |                     |     | 0.02763  | 0.02759  | 0.9985 |
| DTLZ3   | 3   |         | 100,000   |            |                     |     | 0.63507  | 0.61857  | 0.9740 |
|         | 4   | $M+9$  | 150,000   | 0.01       | 1.05               |     | 0.89568  | 0.85577  | 0.9554 |
|         | 5   |         | 200,000   |            |                     |     | 1.08860  | 1.03550  | 0.9512 |
|         | 6   |         | 400,000   |            |                     |     | 1.23140  | 1.19210  | 0.9681 |

Note: $M$ = number of objectives; $N_{dv}$ = number of decision variables; $N_{pop}$ = population size; $N_{eval}$ = number of function evaluations; $\varepsilon_{obj}$ = epsilon value for each objective; $rp$ = the value of reference point for each objective; $HV_{rs}$ = hypervolume of Pareto reference set; $HV_{as}$ = hypervolume of Pareto approximate set; $HV_n$ = the normalized hypervolume.
Table S2 Multisource data for the model build-up

| Category                               | Data                                      | Data Time                  | Spatial Resolution      |
|----------------------------------------|-------------------------------------------|----------------------------|-------------------------|
| **Initial parameterization and resolution** |                                           |                            |                         |
| DEM                                    | 2008                                      | 90×90 m                    |
| River network                          | 2009                                      | (Google Map)               |
| Aqueducts                              | 2009                                      | (Reports)                  |
| Hydrogeology Map                       | 1977                                      | 1:200000                   |
| Lake topography                        | 1977                                      | 1:200000                   |
| Bottom of aquifer                      | 1977                                      | 1:200000                   |
| **Dynamic data and resolution**        |                                           |                            |                         |
| Boundary river inflow                  | 2003-2012 (monthly)                       | 1 station                  |
| Boundary groundwater inflow            | 2009 (yearly)                            | (Reports)                  |
| Boundary groundwater level             | 2003-2013 (non-irrigation and irrigation periods) | 5 monitoring wells       |
| Meteorological observations           | 2003-2013 (monthly)                       | 3 stations                 |
| Surface water diversion                | 2003-2013 (non-irrigation and irrigation periods) | 11 aqueducts              |
| Groundwater pumping                    | 2003-2013 (yearly)                       | 11 irrigation districts    |
| Lake artificial pumping                | 2003-2013 (monthly)                       | 1 station                  |
| **Calibrated data and resolution**     |                                           |                            |                         |
| Streamflow                             | 2003-2012 (monthly)                       | 2 stations                 |
| Groundwater level                      | 2003-2013 (non-irrigation and irrigation periods) | 7 wells (2003-2013)      |
| Lake level                             | 2003-2013 (monthly)                       | 14 wells (2012-2013)      |
|                                        |                                           | 1 station                  |
Fig. S1 The Ecological Water Conveyance Project
Fig. S2 The calibrated results of the transient model showing (a) observed vs. calibrated runoff at Yanqi station over time, (b) observed vs. calibrated runoff at Baolangsumu station over time; (c) observed vs. calibrated lake level over time; (d) comparison of observed and calibrated groundwater heads at all observation wells, and (e) observed vs. calibrated groundwater heads over time at three typical observation locations as labeled in Fig. 3.