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Supplementary Information for

Water resource utilization regimes at a basin scale: transition framework and development traps

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This PDF file includes:

Supplementary text
Figs. S1 to S9

Supporting Information Text

This supplementary document consists of three sections and 10 figures. Firstly, we introduced our study area, the Yellow River Basin, in the section Methods S1. Definition of study area. Then, we give a detailed description of used datasets and analysis their uncertainties in the section Methods S2. Detailed information on dataset and processing. Finally, the index along with corresponding indicators are introduced in the section Methods S3. Water Utility Regime Index.

Methods S1. Definition of study area

Region divisions of Yellow River Basin. The study area is the Yellow River Basin (YRB), which has experienced the most intense water exploitation and the most dramatic shifts of management regime in China. According to the Yellow River Conservancy Commission, an administrative government directly under the Ministry of Water Resources at the basin level, the upper, middle and lower reaches of the Yellow River can be distinguished by characteristic of river. However, there is another scheme suggesting that the upstream only refers to river source areas with little human disturbance and high water retention capacity. Anyhow, since the socio-economic and natural conditions were considered in this study, we integrated the two schemes above and divided the Yellow River Basin into four regions, which can be distinguished by three important hydrological control stations (see Fig. S1). Previous studies have also shown that such a division is valid when both social water use and the natural conditions of the basin are considered, as the regions exhibit strong heterogeneity among themselves (see Fig. S2):

- **Source Region (SR):** Over 50% of natural runoff was produced in this region. The most ecology function here is water conservation, as sparsely populated and less economically developed.
- **Upper Region (UR):** With the highest per capita irrigated land area, there are numbers of large irrigation lands in this region. However, because of backward production methods, efficiency of irrigation are used to be very low.
- **Middle Region (MR):** Crossing Loess Plateau, famous rich-sand area, Yellow River loads most of its sediments here with the highest soil erosion risk. To reverse this situation, the grain for green project changed the water utilization here strikingly.
- **Lower Region (LR):** With dense population and the traditional agricultural trajectory, lower region used to be the largest water use region. However, as the industrial transformation going, proportion of agriculture keeps decreasing, but LR is still the largest water use region in each aspect.

In general, there are inter-regional differences in the economic layout, distribution of water resources, distribution of water consumption, and population distribution of the Yellow River Basin. On the basis of these fundamental differences, social development and watershed management continue to influence and reshape their changes, making the Yellow River Basin the world's most intimately connected and dramatically changing large river basin. Thus, as a case study for analysing the evolution of the human-water relationship, it possesses typicality.

Importance of water resource to society within the YRB. Water resources make an irreplaceable contribution to the development of society in the watersheds constituted by the four heterogeneous regions mentioned above.

Historic and recent river basin management practices have strong impacts on water utilization.

Changes brought from human activities on the YRB. Humans are constantly modifying the water cycle processes in the watersheds as society develops.

Methods S2. Detailed information on dataset and processing

Since the Yellow River Basin consists of ten provincial areas, the above division can also maintain broad consistency with administrative divisions. Add a materials' subsection if you need to.

Methods S3. Water Utility Regime Index

Add a methods subsection if you need to.

Stress: SFV-index. Various metrics, therefore, proposed for water stress (e.g. water scarcity, water stresses index, scarcity-flexibility-variability index), where the dimensions of human impact are increasingly valued. Among of them, by taking changes of water flexibility and variability into account, the scarcity-flexibility-variability (SFV) index focus more on dynamic responses to water resources in developing perspective, which considered a valid indicator of temporal changes in water stresses.

Tendentiousness: Non-provisioning share.

1. Methods S4. Water Management Practices

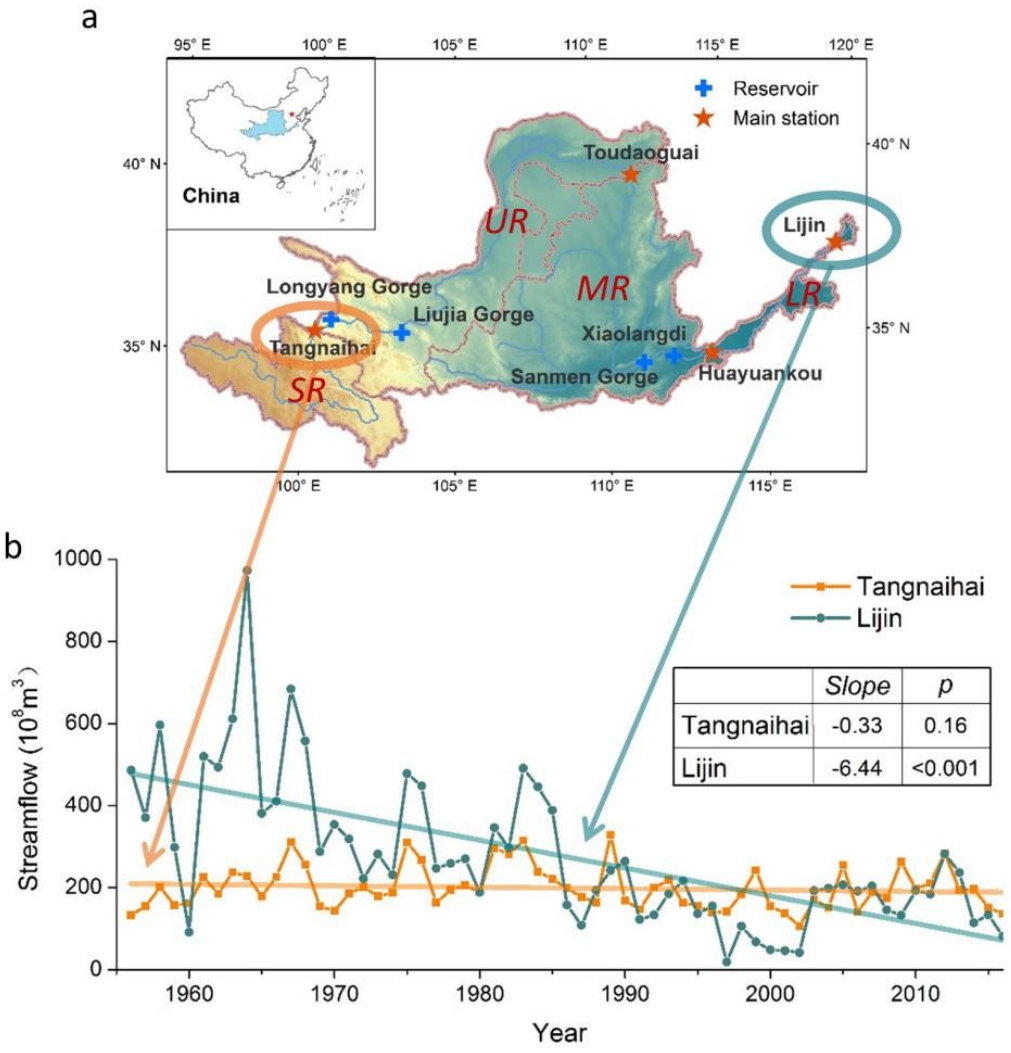

Fig. S1. Yellow River Basin

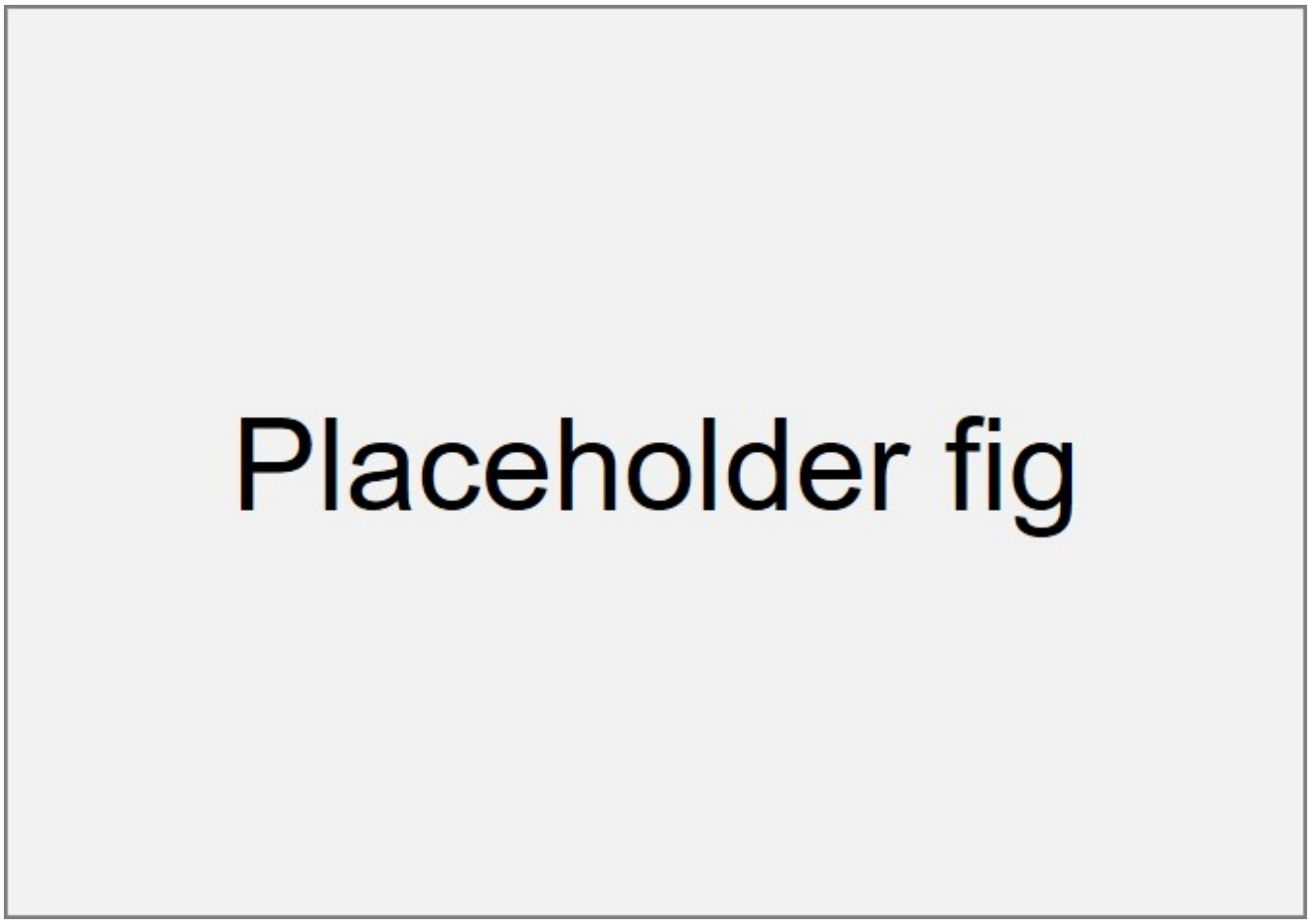

Fig. S2. Different regions

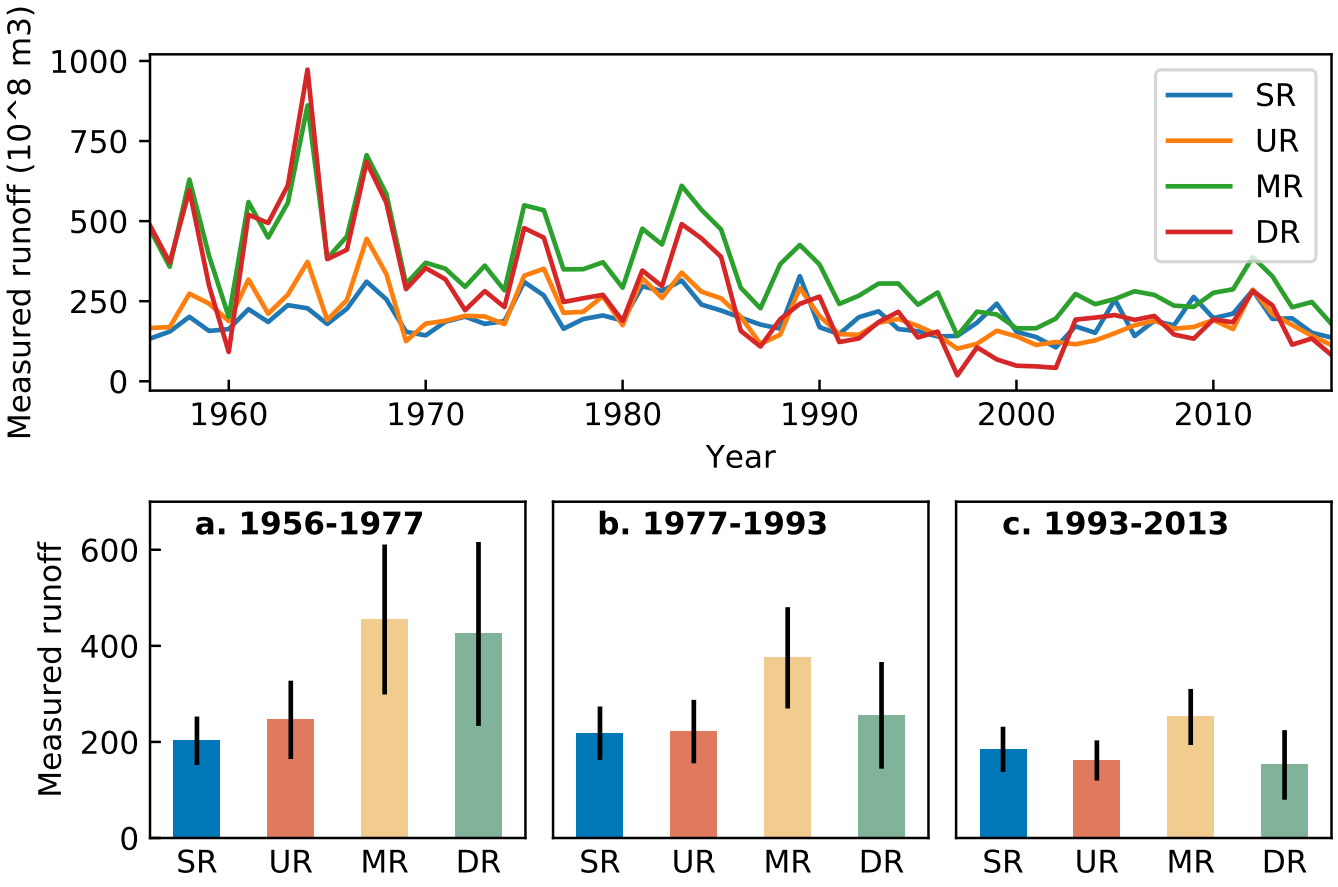

Fig. S3. Natural measured runoff of Yellow River within different periods.

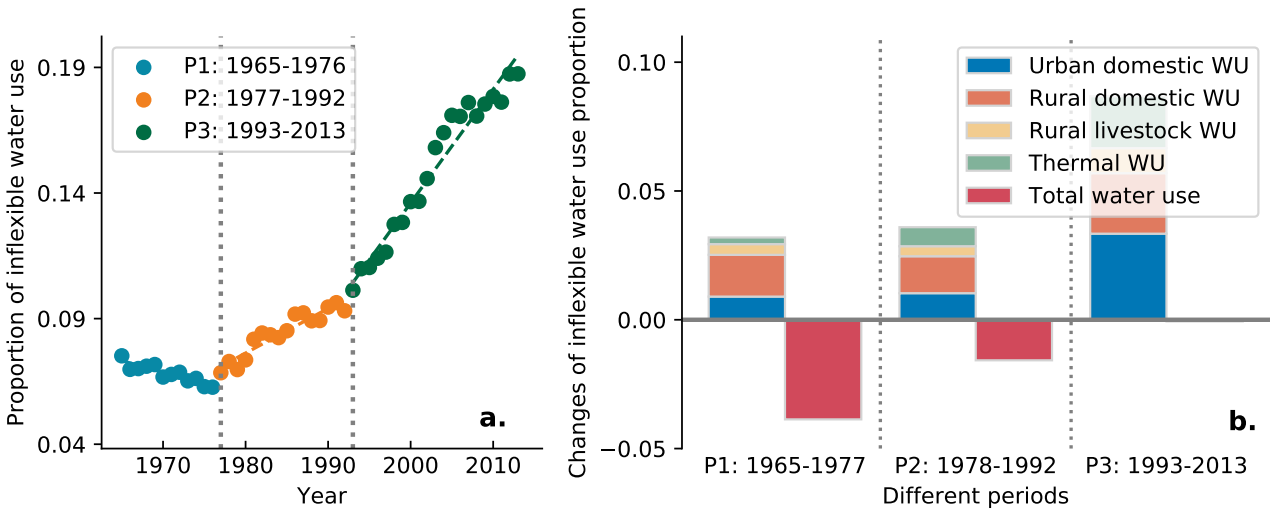

Fig. S4. Flexibility

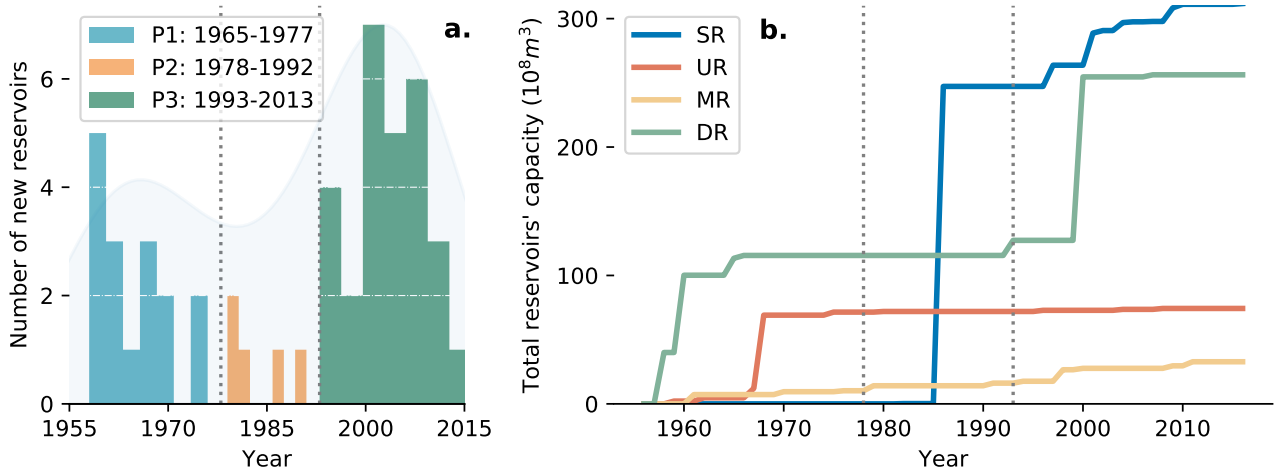

Fig. S5. Reservoirs and accumulated storage

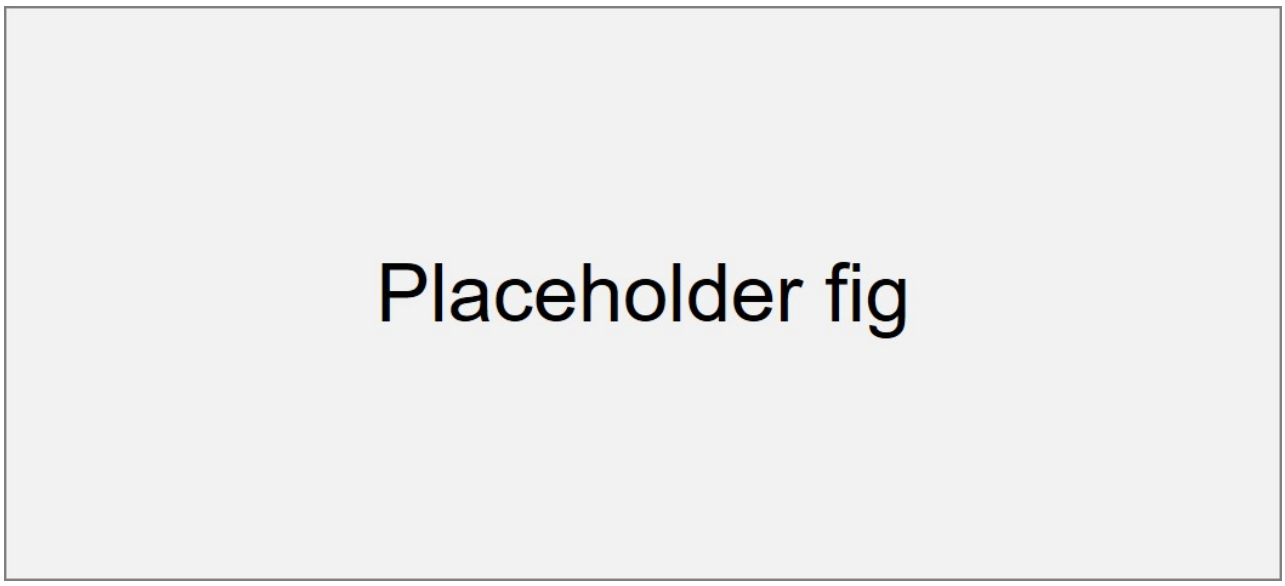

Fig. S6. technological solutions and water conservation practices

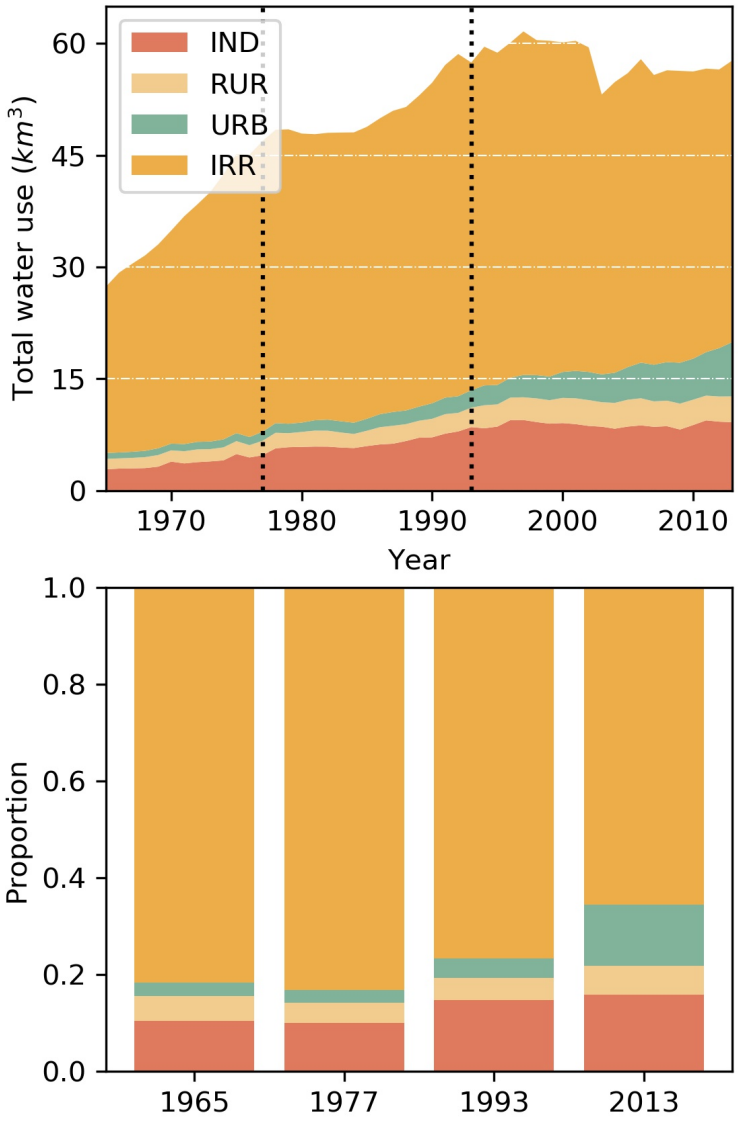

Fig. S7. Proportions of water use between the different sectors

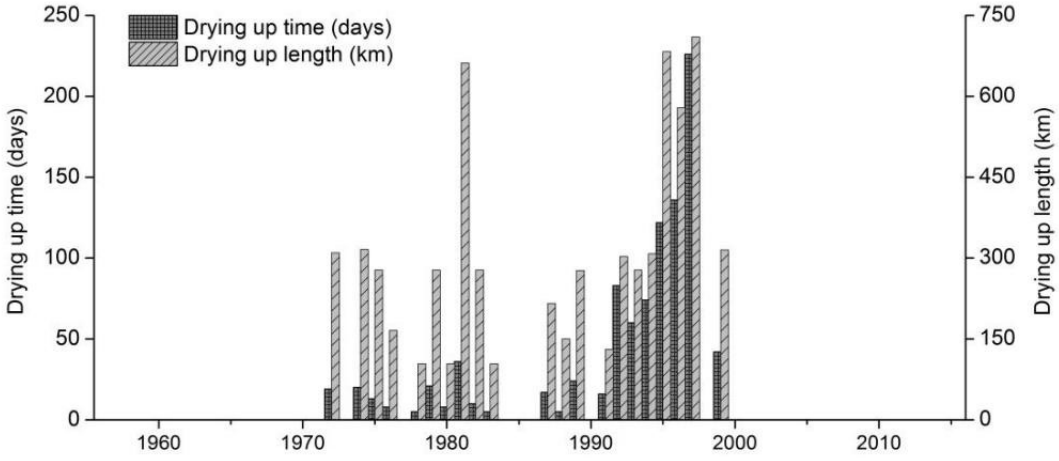

Fig. S8. Severe runoff outages and groundwater depletion

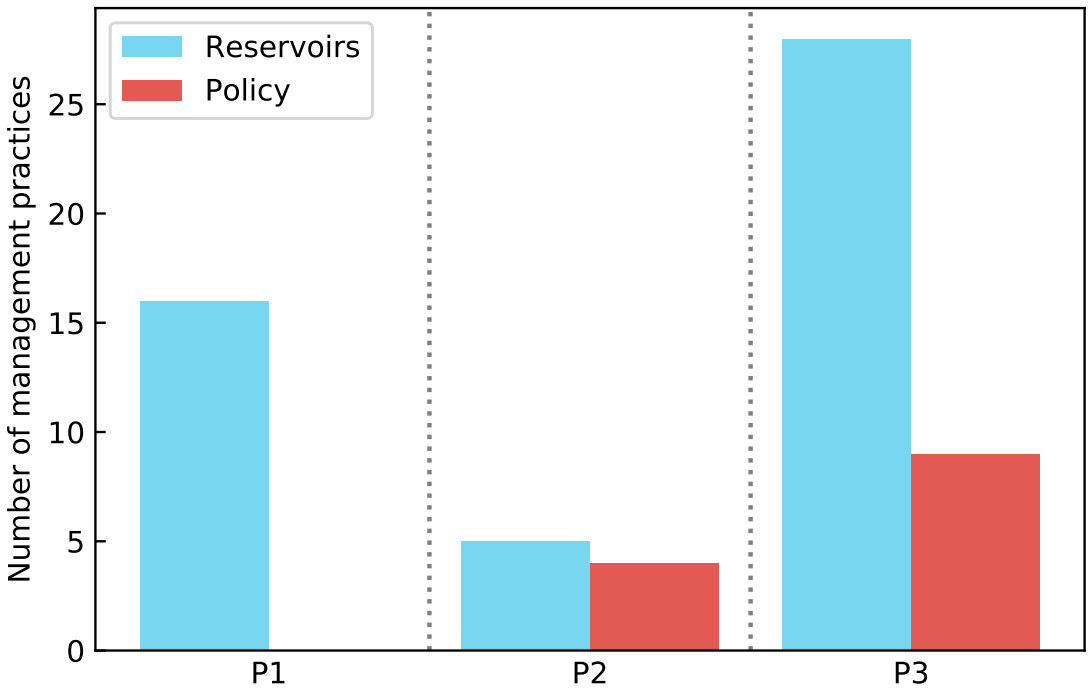

Fig. S9. Number of management practices in different periods, including policy and reservoirs.