Spatiotemporal water yield variations and influencing factors in the Lhasa River Basin, Tibetan Plateau

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Introduction

The spatiotemporal variation of water yield often leads to the challenge of how to allocate water resources between different seasons, and between upstream and downstream areas. Understanding the spatiotemporal variation in water yield as well as its driving factors is critical for developing water resources management strategies under the combined influence of climate change and human activities. In this study, we used the InVEST Seasonal Water Yield Model to assess the spatiotemporal water yield changes of China's Lhasa River Basin between 1990 and 2015, and analysed its influencing factors.

Methods

Seasonal Water Yield Model

Released as a module in InVEST 3.3.1 version in 2016, it is able to compute spatial indices that quantify the relative contribution of a parcel of land to the generation of baseflow, local recharge and quick flow.

Baseflow separation

The automated Web-Based Hydrograph Analysis Tool (WHAT) was used to estimate the baseflow from observed streamflow data.

Sensitivity analysis

The Morris screening method was applied to test the sensitivity of model inputs.

Quantifying relative contributions of influencing factors

Three scenarios were simulated during three time periods in which each time only one factor was changed: (1) only precipitation changed, (2) only land cover changed, and (3) only NDVI changed.

Results

Sensitivity analysis and model validation

- Precipitation and CN are the two most sensitive factors for baseflow and local recharge. For quick flow, besides precipitation and CN, rain events are also relatively sensitive.
- Although the model can only compute the relative contribution of a pixel to water yield rather than the actual amount, it is validated by observed stream flow data.

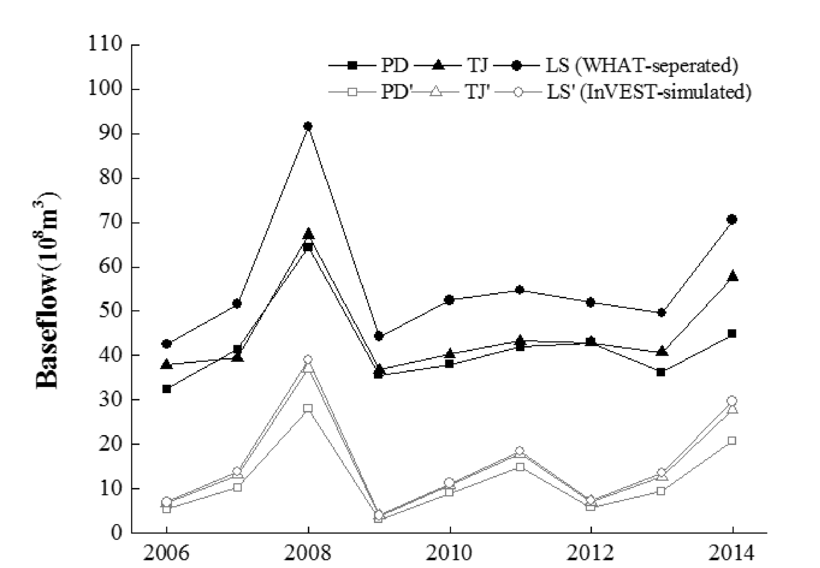
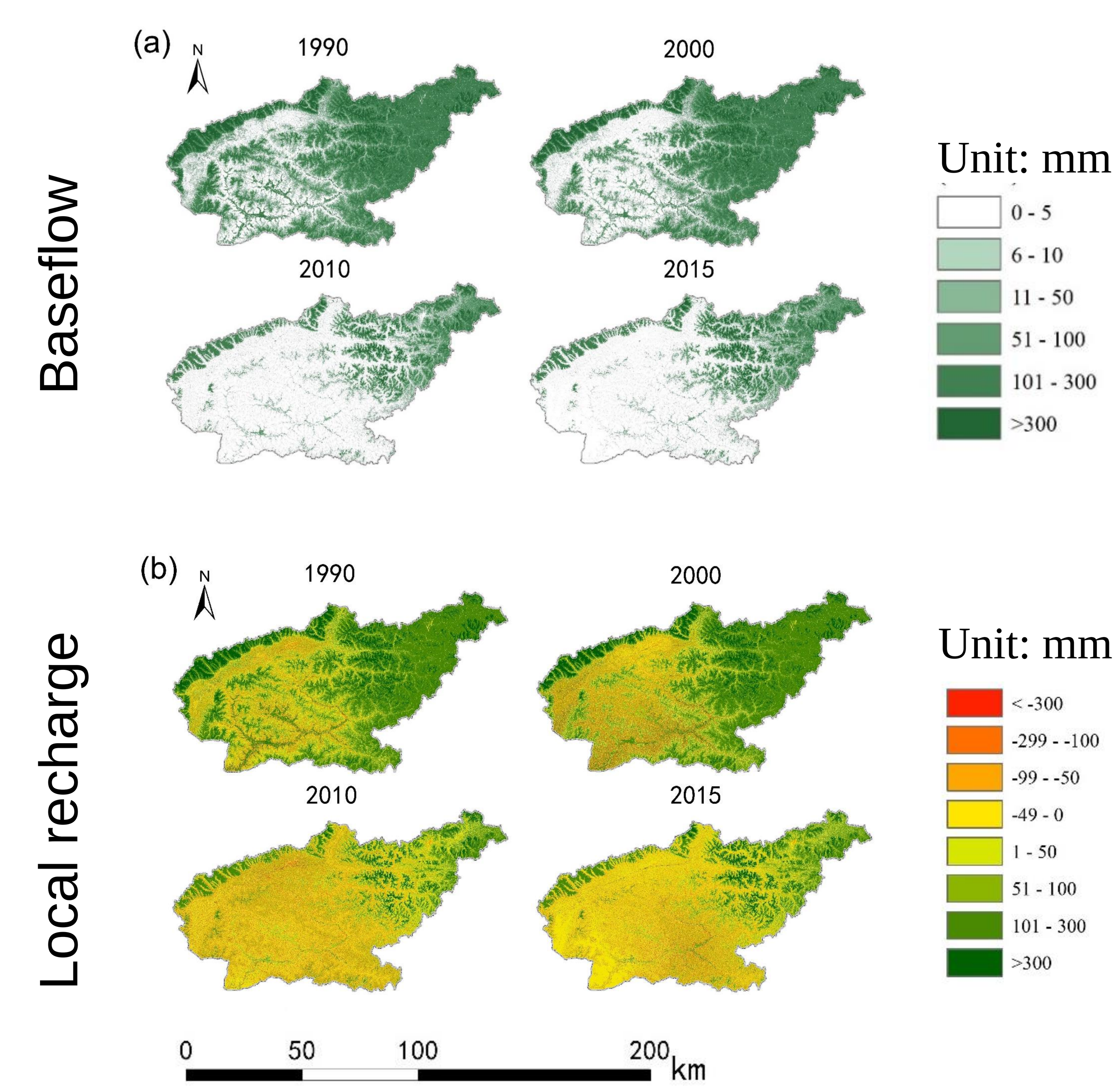


Fig 1. Comparison between the WHAT-separated and InVEST-simulated annual baseflow at three hydrological stations: Pangduo (PD), Tangjia (TJ), Lhasa (LS).

Water yield change



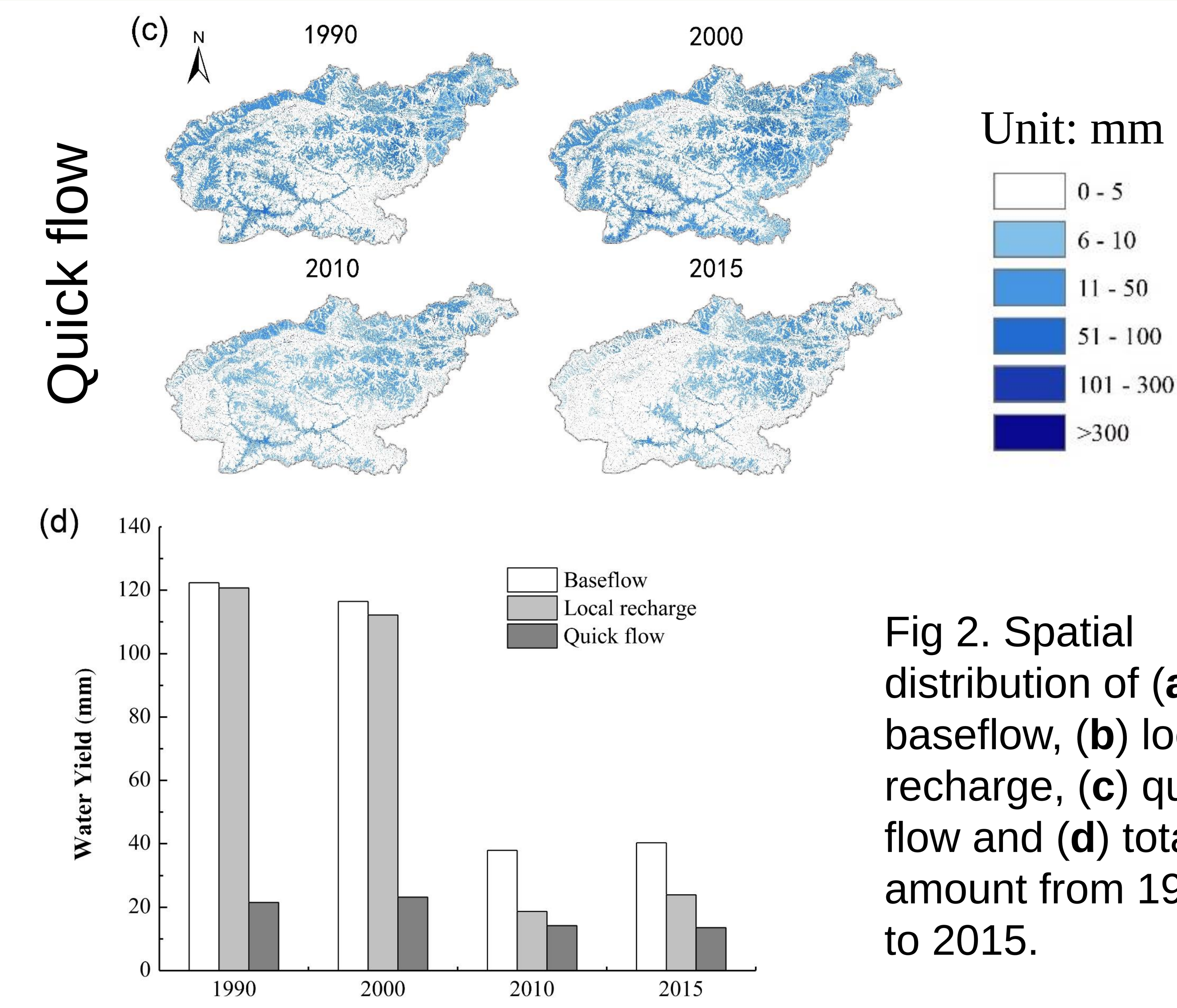


Fig 2. Spatial distribution of (**a**) baseflow, (**b**) local recharge, (**c**) quick flow and (**d**) total amount from 1990 to 2015.

Relative contributions of influencing factors

Table 1. The individual contributions of precipitation (ΔP), land cover (ΔL) and NDVI (ΔN) change on water yield changes (Unit: mm).

Time period	1990-2000			2000-2010			2010-2015		
Influencing factor	ΔP	ΔL	ΔN	ΔP	ΔL	ΔN	ΔP	ΔL	ΔN
Baseflow	22.80	-0.09	-25.78	-76.68	0.06	-3.46	1.77	-0.88	1.97
Local Recharge	22.81	-0.09	-28.91	-90.74	0.08	-3.96	4.21	2.71	-0.67
Quick flow	1.58	0.03	0.00	-8.93	0.01	0.00	-0.61	-0.03	0.00

Note: The negative sign (-) is used to represent a negative effect, i.e. a change resulting in a decrease in water yield.

Conclusion

Precipitation and NDVI change were the main factors affecting water yield, while land cover change began to exert greater influence after 2010. A combination of climate change and human activities had driven water yield change, especially through vegetation change.

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