On the basis of the discussion paper, we made the following modifications:

1、For consistency, we changed "Q" to "R" in the full paper.

2、In 3.3, line 238-241, we removed the description of Budyko hypothesis, and add explanation of RH in detail.

3、In 4.3, line 362-369, we discussed the two assumptions that is the water balance equation and the Budyko curve, and in line 370-378,we added the discussion of extreme precipitation figure to further prove that human activities have had the main influence on the decreasing runoff. Besides, in line 411-418, we added discussion of the significance about improved climate elasticity method.

4、In 2.1, line 135-136, and in 2.2, line 150-155, we did some cut which were not significant.

Response to the reviews：

Review 1：

(1) Line 240-246, in the improved method, please explain the hypothesis that the Budyko curve can precisely estimate the annual evaporation. In my mind, it is a very strong hypothesis, and in the annual scale, the departure from the curve could not be considered as the contribution by human activities.

Response:

Agree. In fact in Tables 2 and 3, for example, we use the long term mean annual water balance instead of the annual water balance. So in our revision we replace the annual evaporation or annual runoff into the mean annual evaporation or mean annual runoff to avoid any confusion.

(2) Table 2 and Table 3 show that the precipitation elasticity in the original method is smaller than that in the improved method, and the potential evapotranspiration elasticity in the original method is larger. Figure 2 shows that precipitation decreased, while potential evapotranspiration increased slightly. In the elasticity method, the contribution of climate change can be calculated as follows. Therefore, the contribution of climate change calculated by the improved method should be larger in my opinion. But, the result of this study is opposite. Please clarify it.

Response:

Agree. In fact in the original method, R in the formula $\frac{\Delta R_C}{R} = \varepsilon_P \frac{\Delta P}{P} + \varepsilon_{E_0} \frac{\Delta E_0}{E_0}$ represents average observed runoff which is regarded as natural runoff. In the improved method, the corresponding formula is $\frac{\Delta R_C}{R'} = \varepsilon_P' \frac{\Delta P}{P} + \varepsilon_{E_0}' \frac{\Delta E_0}{E_0}$, in this formula ε_P and ε_{E_0} have changed differently, and R also changes accordingly, and it is the observed runoff formally, but not natural runoff substantially. The runoff caused by human activities, ΔR_H, should be deducted from natural runoff R, so the contribution of climate change caused by ε_P' and ε_{E_0}' is not always larger or smaller . In this study, the formula $\Delta R_C = \Delta R - \Delta R_H$ is used to calculate ΔR_C, and ΔR_H is easy to calculate by ε_H formula. The details about the improved climate elasticity method can be seen in Equations (12-16), and the method improvement just is the main innovation of the manuscript.

Review 2：

My main concern of the paper relates to the improved climate elasticity method. The authors assumed that over a long period of time, change in catchment storage can be neglected so that the water balance equation can be expressed as P=E+R. They further assumed that the Budyko curve can precisely estimate mean annual evaporation. However, we know that the Budyko curve can be used to estimate mean annual evaporation, but not precisely. The third assumption made here is that any departure from the Budyko curve would be caused by human activities. The fact is that any departure from the Budyko curve could be caused by change in climatic variables, i.e. P and E0 not necessarily by human activities. For example, studies have shown that changes in rainfall distribution can affect estimates of evaporation from the Budyko curve. The authors defined RH as the water consumption by human activities and what does it present exactly? Does it include evapotranspiration from crops and reservoirs? What are the effects of these assumptions on the results presented in the paper? I am not convinced that the method described here is an improvement over the climate elasticity method reported in the literature.

Response:

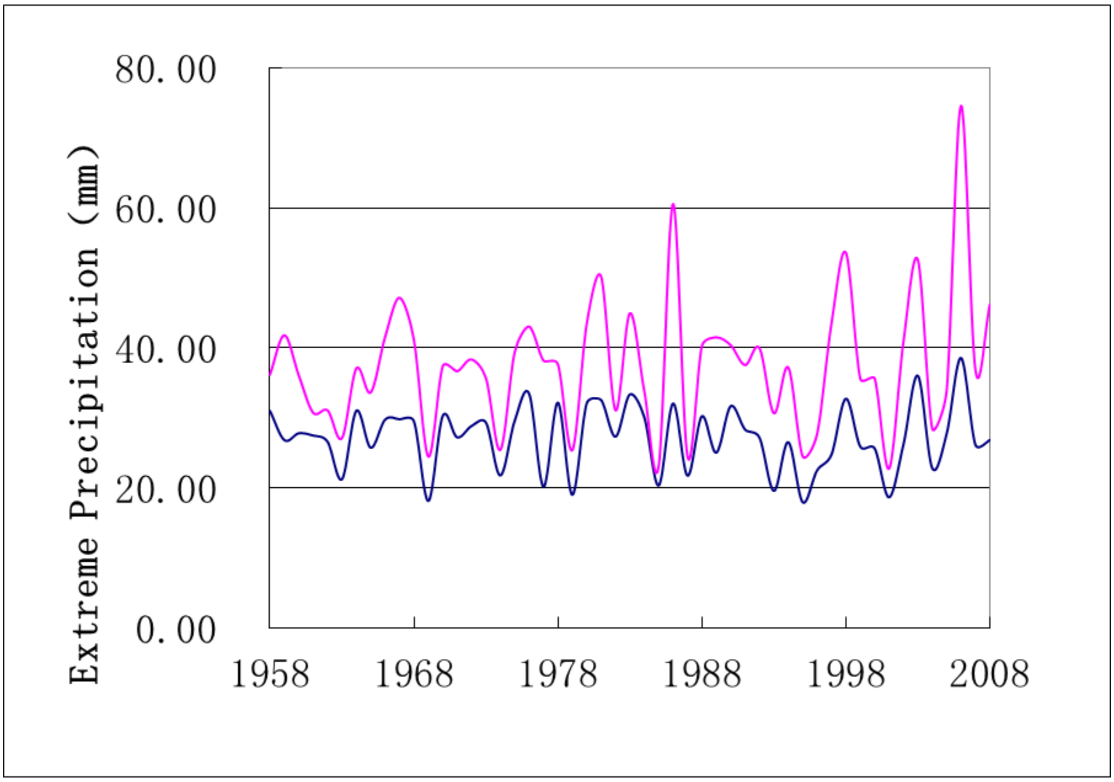
In fact the two assumptions are fundamental assumptions and commonly used in Budyko-type elasticity studies for long term average (For example P.2 in Gentine et al. 2012 GRL), while not perfect we agree. We would not think there is any approach that can estimate the mean annual evaporation “precisely” but if any, the Budyko curve would be comparable at least for long term mean.

Reference:

Gentine, P., P. D’Odorico, B. R. Lintner, G. Sivandran, and G. Salvucci (2012), Interdependence of climate, soil, and vegetation as constrained by the Budyko curve, Geophys. Res. Lett., 39, L19404, doi:10.1029/2012GL053492.

We agree there is potentially an influence from rainfall distribution. So we test the hypothesis by the Referee here. We estimated the maximum daily precipitation (purple) and also averaged the top five maximum daily precipitation (blue) for each year (Figure Below). The results are interesting. There is no steady decreasing trend in these two measures of extreme rainfall and distribution while the steady decrease in runoff investigated in this study would require a steady decrease in rainfall intensity if the change in distribution is the cause as referee suggested. Those results are consistent with our experience about this catchment.

We propose to add the figure in the main text in our revision.



Here RH refers to mainly water consumption or water intake by human activities which mainly include measures of water and soil conservation, river dam construction, water intake from rivers, water transfer and so on. Evapotranspiration from crops and reservoirs was not considered here.

We consider this because the water intake directly from rivers is significant amount in almost all rivers in China. However in the original Budyko-type elasticity from this part was not considered ($\Delta R_C = \varepsilon_P \frac{\mathrm{d}_\mathrm{p}}{P} + \varepsilon_{E_0} \frac{\mathrm{d}_{E_0}}{E_0}$, $\Delta R = \Delta R_C + \Delta R_H$). We extended that framework by including the direct influence from water intake to adapt to catchments with intense water consumption and intake $\Delta R = \varepsilon_P \frac{\mathrm{d}_\mathrm{p}}{P} + \varepsilon_{E_0} \frac{\mathrm{d}_{E_0}}{E_0} + \varepsilon_H \frac{\mathrm{d}_{R_H}}{R_H}$.

We believe this is a new contribution over the climate elasticity method reported in literatures.

Review 3:

Equation (12) is flawed: P =Robs +RH +E. For example, human activities such as water withdrawal from natural streamflow may used for irrigation which contribute to E. In equation (12), RH is counted twice. That's the reason why the human contribution (71%-78%) is overestimated compared with the elasticity method.

Response:

The division process of R does not change the relationship of water balance and Budyko hypothesis E=P*F(E0/P). As we all know, over a long period of time, the water balance equation for a closed catchment can be expressed as P=E+R if change in catchment storage can be neglected. Equation (12) is origined from the water balance equation P=E+R, and here R is divided into two parts, the field observed runoff Robs and the disturbed runoff RH.

We agree that water withdrawal from natural streamflow may be used for irrigation and contributes to E, however RH does not be counted twice. RH in the paper just is regarded as an imaginary separate component in order to calculate conveniently, and has participated in the whole processes of catchment water cycle. The part of water RH affects the local E and E0 at the same time, and the compositive effect is applicable for Budyko hypothesis and elasticity method.