Hydrological Change of the Malian River

Shen Bing, Yan Jun-ping

Xi'an University of Technology, Water Resources Institute,

Xi'an China, 710048

The Loess Plateau is one of the most severe regions with the soil and water loss of $43\times10^4km^2$, e.g. every year the soil loss quantity reach to 40×10^8t. In the Loess Plateau Region, the climate is arid but in summer there are intensive rainfalls with short duration. Because there the terrain is fragment with loosen surface soils and dens population up to 73persons/km^2, the soil erosion is serious. The Loess Plateau locates at the edge of East Asia monsoon zone, the climate here is arid and unstable, with the trend of warm and dry. And the district is the key area of ecological construction region; the reasonable ecological construction strategy is needed urgently.

1 General Situation of the Basin

The Malian River is a tributary of the Jinghe River, as well as the tributary of the Yellow River. The control area at Yuluoping Gauging station is 19019km^2. The basin is one of the serious soil erosion regions on the Loess Plateau, with the annual runoff of $4.673\times10^8m^3$, the annual sediment exported of 1.317×10^8t, the erosion modulus of 9625t/(km^2·a)。

2 Hydrological Change of the Malian River

Table 1 lists the annual precipitation, annual runoff, annual sedimentation and the erosion modulus for the 5 rivers on the Loess Plateau. In average, the erosion modulus of the 5 rivers is 5058 t/(km^2·a), the annual sediment exported is 4.67×10^8t, which accounts to 58.4% of the sediment flow into the Yellow River, which is 8×10^8t.

Tab.1 The hydrological characteristics of the 5 rivers on the Loess Plateau

river	gauge	area (km^2)	annual runoff (10^8m^3)	annual sediment (10^8t)	erosion modulus ($10^4t/km^2$·a)	record period
Wuding	Chuankou	30217	12.0	1.22	4038	1957-1999
Yanhe	Yan'an	3820	1.35	0.35	9222	1965-1999
North Luo	zhuangtou	25154	8.24	1.00	3980	1939-1999
Malian	Yuluoping	19019	4.67	1.32	6825	1955-1999
Jinghe	Yangjiaping	14124	7.31	0.787	5571	1956-1999

Since 1950's, the hydrological regime of the 5 rivers have been changed a lot. In table 2, the comparison is made between 1960's and 1990's for precipitation, runoff and sediment. From Tab.2 and Fig.1, it can be seen that the decrease of precipitation for the 5 basins is not evident, the decrease of runoff is evident, the sediment exported in first 30 years decrease continuously, but in 1990's it increase significantly.

Tab.2 Hydrological change of the 5 rivers on the Loess Plateau

period	1960-1969	1970-1979	1980-1989	1990-1999	60's/90's
precipitation(mm)	538.8	474.3	491.3	433.7	0.805
runoff(10^8m^3)	43.48	43.38	30.64	26.48	0.609
sediment(10^8t)	6.14	4.32	3.02	4.99	0.733

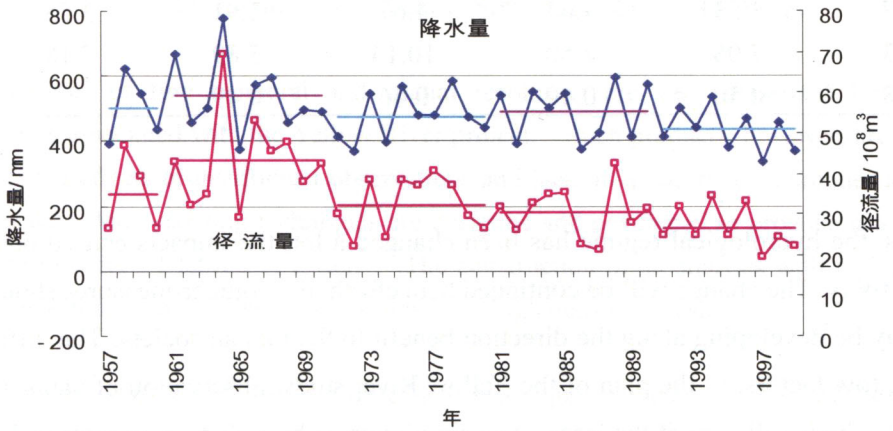

Fig.1 Change of precipitation, runoff and sediment of the 5 rivers

The precipitation, runoff and sediment are listed in table 3. From tab.3, it can be seen that the annual average precipitation has a trend of decreasing, the annual runoff fluctuation has a trend of increasing, but the sediment reach maximum in 1990's. And there exist some significant correlations between annual precipitation and annual runoff with the coefficient of 0.69, between annual precipitation and annual sediment with the coefficient of 0.48, and between annual runoff and annual sediment with the coefficient of 0.87. All the correlations reach the t-test with significance of 0.001. It is shown that the three correlations are positive correlations and have the synchronized feature. In Malian River Basin, the impacts of human activity exceed the effect of climate change, which bring about negative impact on the ecological construction. Such that, the reason should be find out, and then counter-measures should be established.

Tab.3 Comparison of sediment for different period in Malian River Basin

Item	1960-1969	1970-1979	1980-1989	1990-1999	Average	Ratio 60/90
precipitation (mm)	601.2	514.3	543.3	481.6	535.5	0.895
runoff (10^8m^3)	4.82	4.36	4.84	4.75	4.67	1.040
Sediment (10^8t)	1.37	1.20	1.04	1.63	1.32	1.144

If taken the runoff which may carry 10^8t of sediment as the index of sediment production, then the sediment production of the Malian River and the other four rivers are compared in Table. 4.

Tab.4 Sediment production of Malian River and other four rivers

river	1955-1959	1960-1969	1970-1979	1980-1989	1990-1999	平均
Malian	3.17	3.53	3.64	4.67	2.91	3.55
Other four	5.43	7.08	7.50	10.14	5.89	7.18
Ratio	0.58	0.50	0.49	0.46	0.49	

3 Conclude

Since the 1950's, the hydrological regime has been changed a lot, the impacts caused both by climate change and human activity. The change will be continued henceforth, the counter-measures should be studied, so that the change may be developing along the direction benefit to the human society. The difficult problem lies in distinguish the tow factors. In the plan of the Yellow River study, observation of vapor flux is one of the items in the study, which will benefit the large scale simulation of hydrological processes. It is suggested that the simulation should be forward step by step, which means that the simulation begin from the Malian River Basin, and then to the Weihe River, finally to the middle reaches of the Yellow River. On these bases, the factors which cause the impacts can be distinguished, the counter-measures proposed can be reasonable.