Water Management through Forest Management

Trends of precipitation in Beijiang River Basin, Guangdong Province, China

Guoyi Zhou

South China Institute of Botany, Chinese Academy of Sciences, Guangzhou, 510650, China

November 12-16, 2007
Lots of evidence show that global change redistributes long-term precipitation patterns and result in increasing occurrences of droughts and floods.

1. Global land precipitation has increased significantly by about 2% since the beginning of last century, but not uniform spatially nor temporally (IPCC, 2001).

2. Precipitation in Canada has increased by an average of more than 10% over the 20th century (Mekis and Hogg, 1999).

3. Marked increase in precipitation was detected in the latter part of 20th century over northern Europe, with a general decrease southward to the Mediterranean (Schönwiese and Rapp, 1997).
4 For the former USSR, precipitation has increased since 1891 by about 5% in west of 90° E for both warm and cold seasons (Bogdanova, 1998; Groisman, 2001)

5 A large decrease in total precipitation and rain days occurred in southwestern Australia (Haylock, 2000)

6 In northeast Brazil and northern Amazonia, regional positive but non-significant trends have occurred in the rainfall of rainy season (Marengo et al., 1998)

7 An increasingly erratic monsoon rainfall has appeared for much of the period since the early 1940s in western Mexico (Douglas, 1998)
Several lines of related phenomena in China

1. An upward trend was observed in the west, southeast and northeast of China, while a downward trend was observed in other regions since 1950s (Qin et al., 2006; Wang et al., 2004; Ye et al., 2004; Ren et al., 2000; Zhai et al., 1999)

2. IPCC (2001) reported a 30 – 50% increase of precipitation in southern China in the winter months (Dec, Jan and Feb) from 1900-1999

3. Precipitations in the middle and lower reaches of the Yangtze River demonstrated a significant upward trend while that in the north and northeast of China showed a downward trend during summer (Jun, Jul and Augst) (Qin et al., 2006; Wang et al., 2004; Ye et al., 2004; Ren et al., 2000; Zhai et al., 1999)
OBJECTIVES

Beijiang River is one of the four largest rivers in Guangdong Province, and the region around its basin is one of the most developed areas of China. It is also one of main water sources for Pearl River Delta. Disasters such as floods and droughts happen in this region almost every year. On the background of global climate variation, the detailed analysis of precipitation trends and temporal and spatial distributions are important for the assessment of climate induced risks and pursue of countermeasures.

The study is to provide an more accurate results of regional precipitation patterns under global changes.
DATABASE

It belongs to Guangdong Provincial Hydrologic Bureau. The earliest record was from the beginning of last century.
Selected 63 precipitation stations are from 312 ones in this area.
All the 63 stations have 45 years (1959-2003) of precipitation records with less than 10% missing data. In addition, the consecutive missing months of the selected stations were less than 12 months. All the remaining missing values were estimated by linear regression based on precipitation at neighboring stations when correlation coefficient was larger than 0.85.
METHODOLOGY

17 time series:

- monthly totals 12
- annual total 1
- wet season total (Apr-Sept) 1
- dry season total (Oct-Mar) 1
- EFP total (early flood period, Apr-Jun) 1
- LFP total (late flood period, Jul-Sept) 1

7 Space series-7 sub-basins
Figure 2
7 Space series-7 sub-basins

Legend
- Station
- River
- Subarea

Scale: 1:3,000,000
Two different nonparametric methods (Mann-Kendall test and Sen’s T) were performed after processing with a serial correlation test to reduce errors in Mann-Kendall test

(please see Luo et al, Hydrological Processes, in press)
Figure 3  Sequential values of the statistics $u(t)$ and $u'(t)$ from the Mann-Kendall test for Baishui station in May

The point of intersection refers to the starting point of trend if any of the curves is beyond the reliability lines.
Figure 4
Spatial distribution of significant precipitation trends of all relative time series at the 5% level.
Downward trend is marked by ‘↓’ and upward trend by ‘↑’.
Table 1 Starting point of the detected trend in different time series

<table>
<thead>
<tr>
<th>Station</th>
<th>Time series</th>
<th>Direction of trend</th>
<th>Starting point of trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengkou</td>
<td>Jan</td>
<td>Upward</td>
<td>1967</td>
</tr>
<tr>
<td>Daqiao</td>
<td>Jan</td>
<td>Upward</td>
<td>1988</td>
</tr>
<tr>
<td>Lechang</td>
<td>Jan</td>
<td>Upward</td>
<td>1967</td>
</tr>
<tr>
<td>Nanxiong</td>
<td>Jan</td>
<td>Upward</td>
<td>1967</td>
</tr>
<tr>
<td>Renhua</td>
<td>Jan</td>
<td>Upward</td>
<td>2000</td>
</tr>
<tr>
<td>Tianxin</td>
<td>Jan</td>
<td>Upward</td>
<td>1969</td>
</tr>
<tr>
<td>Yunwu</td>
<td>Jan</td>
<td>Upward</td>
<td>1988</td>
</tr>
<tr>
<td>Wujing</td>
<td>Jan</td>
<td>Upward</td>
<td>1967</td>
</tr>
<tr>
<td>Hengjiang</td>
<td>Jan</td>
<td>Upward</td>
<td>1967</td>
</tr>
<tr>
<td>Qixialing</td>
<td>Jan</td>
<td>Upward</td>
<td>1967</td>
</tr>
<tr>
<td>Station</td>
<td>Annual rainfall (mm)</td>
<td>Months with trend</td>
<td>Rainfall in the month (mm)</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------</td>
<td>-------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Beishi</td>
<td>1698.5</td>
<td>May</td>
<td>271.0</td>
</tr>
<tr>
<td>Hengshi</td>
<td>2325.8</td>
<td>May</td>
<td>469.5</td>
</tr>
<tr>
<td>Hongqiao</td>
<td>1787.9</td>
<td>May</td>
<td>308.1</td>
</tr>
<tr>
<td>Maningshui</td>
<td>1883.0</td>
<td>Aril, May</td>
<td>595.3</td>
</tr>
<tr>
<td>Taipingwengyuan</td>
<td>1816.6</td>
<td>Mar, Jul, Sep</td>
<td>471.8</td>
</tr>
<tr>
<td>Zhongzhou</td>
<td>1829.8</td>
<td>Apr</td>
<td>275.1</td>
</tr>
</tbody>
</table>
Figure 5  Comparison of Sen’s T and Mann-Kendall test showing the station number of trend
Figure 6

Sen’s estimator of the slope of significant trend in station-based analysis
Figure 7 Sen’s estimator of the slope of significant downward trend in sub-basin-based analysis.
DISCUSSION

How did the trends of precipitation pattern happen

Precipitation in EFP mainly comes from frontal precipitation

Thus, Any weakening or strengthening of the air masses would result in reduction of precipitation on the interested spots. Many studies have shown that the cool and warm air mass has been weaken in this region due to global climatic changes.
While the precipitation in LFP mostly attributes to tropical cyclones

The upward trend of precipitation in LFP could be due to the positive anomaly of sea surface temperature (SST). The positive anomaly of SST in Northern Pacific Ocean would result in stronger summer monsoons, which may contribute more precipitation than usual during LFP in Guangdong, China.
Thanks!