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Interactions of the Yangtze river flow and hydrologic processes of the Poyang Lake, China

Qi Hu [a,*,1], Song Feng [a], Hua Guo [b], Guiya Chen [c], Tong Jiang [b]

[a] School of Natural Resources and Department of Geosciences, University of Nebraska–Lincoln, Lincoln, 707 Hardin Hall, NE 68583-0987, United States
[b] Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008, China
[c] Hydrological Bureau, Yangtze River Water Resources Commission, Wuhan 430000, China

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Summary Recently available hydrological data from Hukou station at the junction of the Poyang Lake with the Yangtze River along with other data from stations in the Poyang Lake basin have allowed further examination and understanding of the basin effect (basin discharge generated by rainfall) and the Yangtze River blocking effect on variations of the Poyang Lake level and floods at annual to decadal scales. Major results show that the basin effect has played a primary role influencing the level of Poyang Lake and development of severe floods, while the Yangtze River played a complementary role of blocking outflows from the lake. In most cases, only when the basin effect weakened did the river effect become large, a relationship indicating that the river's blocking effect diminishes when the lake level is high from receiving large amount of basin discharge, albeit a few exceptions to this relationship occurred when river flow also was elevated from receiving large rainfall discharges in upstream areas. Moreover, the basin effect has become stronger in the period 1960–2003 in accordance with the increase of warm season rainfall in the Poyang Lake basin. In particular, large increases of the basin's rainfall in the 1990s corresponded to the most severe floods (in 1998, 1995, and 1992) of the last 4 decades. The strong increase of warm season rainfall in the Poyang Lake basin in the 1990s is consistent with the recent southward shift of major warm season rain bands in eastern China. Results of this study provide a utility for improving predictions of the Poyang Lake level and floods, which affect a population of about 10 million.

Introduction

Poyang Lake is the largest freshwater lake in China. Located in south-central China, the lake is a tributary of the Yangtze

* Corresponding author. Tel.: +1 402 472 6642; fax: +1 402 472 2946.
E-mail address: qhu2@unl.edu (Q. Hu).
[1] Adjunct Professor, Nanjing Institute of Geography and Limnology, Nanjing, China.

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River (Fig. 1) and directly exchanges and interacts with it. The lake—river interactions are complicated by surface discharges into the Poyang Lake from 5 sub-tributaries in the Poyang Lake basin, and by climate variations in the region. Outcomes of these interactions determine the lake level and its annual and interannual variations, expansion and contraction of the lake area (which influences the agricultural lands and economic production plans around the lake), and droughts and floods in the lake basin (~162 000 km^2), which has a population about 10 million.

Although the river and lake interactions have long been recognized as crucial to understanding the lake level variation and flood development in both Poyang Lake and downstream areas of the Yangtze River (e.g., Jin et al., 2002; Xu et al., 2001), little has been known of the specifics of these interactions, e.g., how do such interactions take place and what are the major dynamic processes that involved in the interactions. This situation may be partly attributed to the previous lack of available data, particularly from the station at the junction between the Yangtze River and the Poyang Lake (the Hukou station, see Figs. 1 and 2).

Such data have recently been made available by the Hydrological Bureau of the Yangtze River Water Resources Commission. These data can be used to examine the river—lake interactions (including effects of basin discharge) and their effects on lake level variations at annual to decadal scales. This study examines hydrological processes influencing the lake level variations using the Hukou station data along with hydrological and meteorological data from stations in the Poyang Lake basin and stations at the middle and lower reaches of the Yangtze River. The hydrological processes associated with river—lake interactions are further applied to understanding development of the major floods in the Poyang Lake basin from 1960 to 2003. In addition,

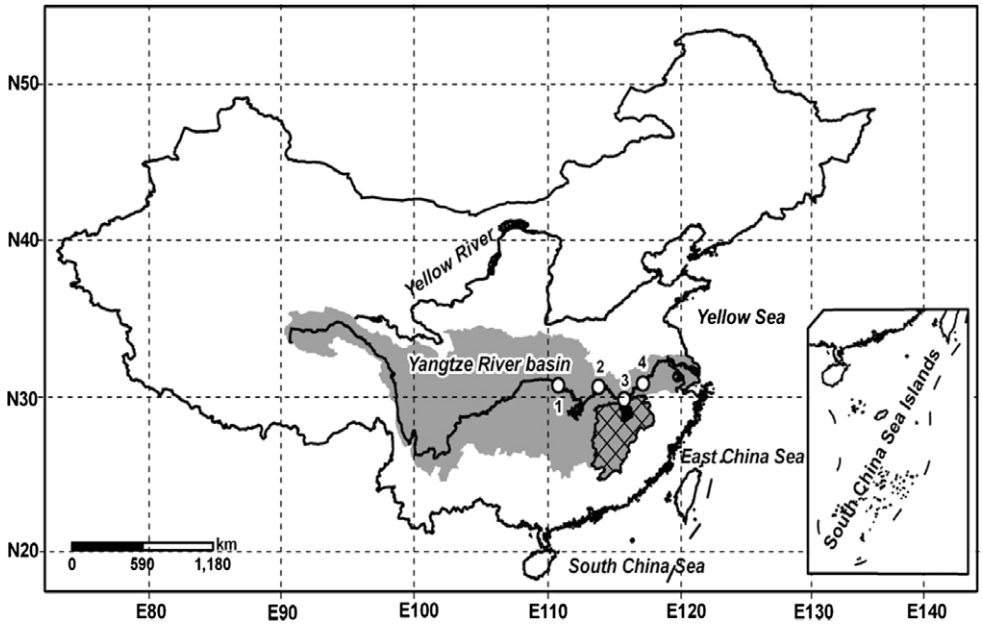

Figure 1 The Yangtze River basin (shaded) and the Poyang Lake basin (crosshatched area). The Poyang Lake is the dark shaded area in the Poyang Lake basin. The Arabic numbers 1—4 mark the hydrological stations Yichang, Hankou, Hukou, and Datong, respectively. (The lake between Yichang and Hankou is the Dongting Lake.)

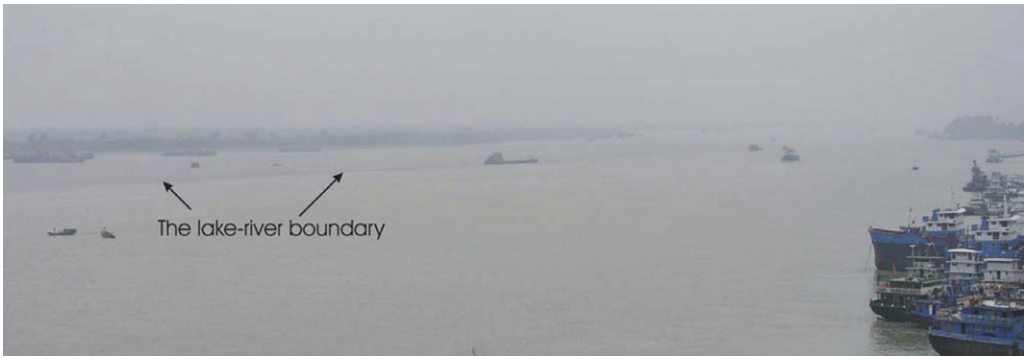

Figure 2 A picture taken at the Hukou hydrological station looking northward at the Yangtze River which flows from the left to the right of the picture. The arrow points to the color discontinuity between the nearby Poyang Lake and the more turbid Yangtze River in far distance.