Temporal changes in wetland plant communities with decades of cumulative water pollution in two plateau lakes in China’s Yunnan Province

Abstract: Wetland plant communities in the plateau lakes of Yunnan Province, China, have decreased significantly over the past decades. To better understand this degradation, we analyzed the processes and characteristics of changes in wetland plant communities in two of the largest lakes in Yunnan Province, Dianchi and Erhai lakes. We collected records of native and alien plant communities in the two lakes from literature published from the 1950s to current period. We calculated plant community types and their area in some historical periods when related data were reported, and analyzed the relationship between changes in plant communities and water pollution. In Dianchi Lake, 12 community types of native plant communities, covering over 80% of the surface in the 1950s and 1960s, were reduced to four types covering 2.4% by the late 2000s. Alien plant communities started to appear in the lake in the late 1970s, and have since come to cover 4.9% of the lake surface, thereby becoming dominant. In Erhai Lake, 16 community types of native plant communities, covering 47.1% of the lake surface in the late 1970s, declined to 10 community types, covering 9.3% of the surface, by the late 2000s. Alien plant communities appeared in the middle 1980s, and at present cover 0.7% of the surface area. It was indicated that changes in plant communities were significant related to water eutrophication. The area occupied by native and alien plant communities was, respectively, negatively and
positively related to the content of nutrients in water. This showed lacustrine pollution played an important role in native plant loss and alien plant invasion in the two plateau lakes.

**Keywords:** Dianchi Lake; Erhai Lake; Wetland plant community; Eutrophication; Alien plant

**Introduction**

Plateau lakes are water towers for downstream river basins, but they are ecologically very fragile and prone to human disturbances, for example, land reclamation and cumulative pollution, in terms of the lacustrine environment due to the geological formations and patterns of human habitation. Most of the lakes in Yunnan Province in Southwest China are sag ponds formed by land sinking along fault lines. In general the lakes are surrounded by mountains and forest, and have relatively steady water levels. These lakes are rich in plant communities and biodiversity (Yang et al. 2008). Around some of these large and fertile lakes, humans have been living for over 2000 years, and hence have been affecting the lacustrine environment. However, the effects of early human habitation, mostly resulting from traditional and small-scale agricultural activities, were minimal in comparison to the effects in recent decades, which are caused by industrial pollution and urban development. Lacustrine environments have experienced different magnitudes of change, and biodiversity has correspondingly degraded over the past decades (Yu et al. 2000; Li et al. 2011; Lu et al. 2012; Xiang et al. 2013; Wang et al. 2013). Previous studies on the two lakes focused mainly on the short-term (several years) changes of plant composition and community structure. It is unknown how the lacustrine environment affects changes in plant communities. In this paper, we summarize the distribution patterns of plant communities and the changing water conditions from 1950s to 2000s, and analyze the relationship of plant community change with regard to water pollution.

**1 Methods**

**1.1 Study sites**

The drainage basin of Dianchi Lake has a northern subtropical monsoon climate with an annual rainfall of about 1000 mm. More than 20 large and small rivers run into the lake, of which, Panlong River, the largest and longest, traverses through Kunming City, the capital of Yunnan Province. Similarly, Erhai Lake is located in the subtropical monsoon climate zone with an annual precipitation of 1060 mm and there are about 25 main rivulets injecting into the lake. The population has multiplied ten-fold in Dianchi Lake basin (Lian 2011), and three-fold in the Erhai Lake basin (Liao & Zhou 1993; Liao et al. 2003) in the last 60 years. Rapid population growth was accompanied by fast agricultural expansion and intensification, industrialization and urbanization, posing enormous pressure on the water quality in both lakes. Table 1 gives brief information about the two lakes (Wang et al. 2013; Fu et al. 2013).

**1.2 Data collection**

We collected records of native and alien plant communities from literature from the 1950s to the...