Ecological Engineering 96 (2016) 1–7

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Editorial

Function, restoration, and ecosystem services of riverine wetlands in the temperate zone

ARTICLE INFO

Keywords:
Riverine wetlands
Temperate zone
Special issue

ABSTRACT

In this special issue, a number of the latest and meaningful research related to riverine wetlands from a variety of fields were presented and discussed, covering investigation and analysis of many studying sites, development of ecosystem service evaluation approaches, propose of ecosystems modeling methods, advancement of wetland restoration and protection techniques and strategies, as well as the applications of these methods and models in several typical wetlands and the associated river systems. In this special issue, 24 papers were selected for a thorough peer review process with at least two rounds of reviews. According to the journal's guideline and requirement, the 24 papers were reviewed by at least two authoritative experts in this field. All papers were related to the topic of "Function, Restoration, and Ecosystem Services of Riverine Wetlands in the Temperate Zone," offering a good view of relevant issues and research status, techniques, and applications for restoration. The 24 papers can be categorized into four groups: (a) investigation and evaluation of ecosystem services and functions, (b) dynamic modeling and optimal management of ecosystem services, (c) policies and technologies for ecosystem restoration, and (d) practices and application of ecosystems modeling and restoration approaches.

Introduction

Along with the construction of water conservancy project, creating and protecting riverine wetlands are of significant concerns, since they are habitats to a wide variety of aquatic organisms and plants, and provide many valuable ecosystem services to human society, including carbon storage, biodiversity maintenance, water quality improvement, and flood abatement (Brander et al., 2013; Cui et al., 2015). In the last and early 21st centuries, an unprecedented capacity has been accumulated by human being in manipulating and adjusting riverine wetland ecosystems to secure reliable sources of ecosystem goods and services. While humans have altered ecosystems for millennia, it has only been in the past few decades that concepts such as ecosystems goods and services have been proposed as one way to collectively describe many ways in which humanity and nature benefit from ecosystems (Daily, 1997; Cai et al., 2009, 2010). A recent global assessment has found that many ecosystem services are declining (Gunderson et al., 2016), pointing to riverine wetlands that have been severely altered or have completely disappeared. For example, a report showed that habitat alteration and the construction of multistage dams have resulted in a rapid decline of the *Schizothorax prenanti* (*S. prenanti*) population in Min river of China (Qin et al., 2016). A series of measures have been undertaken to protect the riverine wetlands thanks to the understanding of the great value of wetland ecosystem. Wetlands are now being created and restored with great frequency around the world both as "mitigation" wetlands meant to replace or compensate for wetland habitat loss and as wetland treatment systems for improving water quality (Mitsch et al., 2005). Particularly, research upon functions and restoration of riverine wetlands in the temperate zone is extremely significant. There are many regions and distinct seasons that benefit organisms in the temperate zone. Moreover, the climate in the temperate zone is complex and a number of system processes and/or factors are greatly affected by climate change to an uncertain degree, further amplifying the complexities (Cai et al., 2011; Tan et al., 2011). To respond to this problem, a summary about the function, restoration, and ecosystem services of riverine wetlands in the temperate zone is urgently desired.

Thus, main purpose of this special issue is to present a number of the latest and meaningful research related to riverine wetlands from a variety of fields, covering investigation and analysis of many studying sites, development of ecosystem service evaluation approaches, propose of ecosystems modeling methods, advancement of wetland restoration and protection techniques and strategies, as well as the applications of these methods and models in several typical wetlands and the associated river systems. Such studies can thus provide solid scientific support for protection and management of Riverine Wetlands in the Temperate Zone.

Special issue papers

After the initial invitation, 24 papers were selected for a thorough peer review process with at least two rounds of reviews.

http://dx.doi.org/10.1016/j.ecoleng.2016.10.001
0925-8574/

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Investigation and evaluation of ecosystem services and functions

There were seven papers on this topic. Han and Cui (2016) analyzed the performance of macrophyte indicators that were considered as reliable eutrophication pressure for ponds. In this study, the spatial distribution of total phosphorus (TP) and the ratio between transparency and water depth (i.e., Z_{SD}/Z_M) used to represent eutrophication pressure were characterized for Lake Baiyangdian in north China. For each of the 38 ponds in the studying area, richness of different species, diversity evenness, biomass, and relative abundance for submerged/emergent (i.e., $RA_{sub/eme}$) and sensitive/tolerant of submerged species (i.e., $RA_{sen/tol}$) were measured as macrophyte indicators. Results showed that except for richness of emergent and floating-leaved species, other macrophyte indicators were significantly correlated with concentration of TP and the value of ZSD/ZM. To evaluate the status of each pond, a scoring system was created through combining TP and evenness, biomass, $RA_{sub/eme}$ and $RA_{sen/tol}$ due to the close relationship among the four indicators and TP. The authors suggested that control of external and internal pollution sources, especially surface runoff from cropland reclamation, and intensive use of fish feed from aquaculture would be the most effective methods for local managers. Then, based on the obtained responses of submerged species abundance to light availability, the value of Z_{SD}/Z_M should be no less than 0.52 to restore submerged species in eutrophic ponds.

In Jinchuan Wetland of the Changbai Mountain area, China, Wang et al. (2016b) investigated the soil nematode community to reflect wetland and farmland interactions. Their results suggested that the native wetland has great biodiversity abundance. The genus of nematodes initially increased upon recovery from farmland. Then, nematode densities decreased in the tillage and cropping wetlands. Also, *Wilsonem* and *Prismatolaimus* were sensitive to tillage. The bacterial-feeder nematodes increased after the first tillage treatment, while the nematode community maintained a relatively stable level after being changed back to wetlands after 30 years of agriculture. Plant parasite index (PPI) in paddy farmlands was 10 times lower than that in the original wetland. The values were positively associated with the change extent of recovery to reclamation of wetlands. This study showed that agricultural activities perturbed the diversity of soil nematodes in Jinchuan Wetland. Also, the effects of paddy cultivation on the wetland soil ecosystem can be acquired based on certain streams of genus and trophic diversity of the nematode community.

Wang et al. (2016b) conducted a germination experiment in a greenhouse to compare the seed banks of four natural sedge meadows and four adjacent farmed fields along the Nongjiang River under drained and flooded conditions in order to determine if key structural dominant wetland plant species were present as seeds in farmed sedge meadows in northeastern China. They then investigated the vegetation in four natural sedge meadows and found that sedges (i.e., *Carex* species) and the grass *Calamagrostis angustifolia* dominated the plant communities in the natural sedge meadows. Many important sedge meadow species (e.g., >30 species) survived the cultivation as seeds. Farmed fields converted from sedge meadows were nearly devoid of dominant *Carex* species, including two keystone tussock-forming species (i.e., *Carex appendiculata* and *Carex meyeriana*). Species of various life history types required either drawdown or flooding for successful germination. The structure of the seed bank was related to experimental water regime. Nonmetric Multidimensional Scaling (NMDS) was used to analyze the field environments, including the latitude, the number of farmed years, and the field water depth. This study indicated that although certain critical components of the vegetation were not retained in seed banks, making it difficult to replicate historic habitat via natural recolonization, the seed banks of farmed sedge meadows could still contribute to the restoration of wetland vegetation assemblages under suitable environmental conditions. Then, *Carex* reestablishment could rely upon artificial introduction if necessary.

Chen et al. (2016a) presented a comprehensive analysis of the ecological benefit and loss of Xiaolangdi Reservoir over the period of 2000–2012. Firstly, they proposed a three-step framework for the ecological benefit-loss evaluation of hydropower projects and established an index system of riverine wetland ecosystem services valuation. Then they made a quantitative valuation of the changes in riverine wetland ecosystem services caused by this project. Finally, the ecological benefits and losses of the project in the riverine wetland were evaluated in two aspects. The results showed that (a) the positive impacts of Xiaolangdi Reservoir could be summarized mainly in 9 categories of ecosystem services including flood control, ice prevention, sedimentation reduction, energy substitution, emission reduction benefit, water supply, afforestation, shipping, and recreation. The total ecological benefit of the project in the riverine wetland was 26.2058 billion CNY; (b) the negative impacts of Xiaolangdi reservoir mainly included 5 categories, including land submergence, heritage submergence, water and soil erosion, reservoir sedimentation, and immigration. The total ecological loss of the project in the riverine wetland was 24.2167 billion CNY; and (c) over the studying period, the net value of ecological benefit-loss for the project was 1.9891 billion CNY.

Cui et al. (2016) employed seed germination trials to assess the viability of seeds of all species in studying the relationships between standing vegetation and the soil seed bank of four vegetation cover types [i.e., fleabane lakeshore zone (Zone A), bush and grass lakeshore zone (Zone B), crop lakeshore zone (Zone C), and natural reed lakeshore zone (Zone D)] on the shoreline of Lake Taihu, China. Zones A to D had 4, 16, 8, and 6 species from the seed bank, respectively. Sorensen similarity coefficients resulting from a comparison between the species found in the seed bank and the species found in the standing vegetation in four habitats were 0.250, 0.333, 0.143, and 0.154, respectively. Low similarity levels between standing vegetation and the seed banks indicated that measures should be taken to protect and manage the wetland because of its low recovery potential. Seed density was significantly lower in Zone B than that of the rest of the studying zones. Also, the vertical distribution of seeds in the seed bank in the four zones showed a significant decreasing trend with increasing soil depth. The reserves of seeds in the topsoil seed bank accounted for 64.10%, 60.00%, 56.86%, and 68.89% of the entire seed bank in Zones A to D, respectively. This research is promising in its potential to instruct and inform management practices in wetland protection, management, restoration and reconstruction.

Chi et al. (2016) investigated vertical distribution of soil *Fe* in typical riparian subzones of the Sanjiang Plain in China, which is considered as a key source for *Fe* pollution in the Amur River and the Sea of Okhotsk. In this research, soil samples were taken from