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SOIL CHEMICAL PROPERTIES AND PHYTODIVERSITY OF RIPARIAN FOREST LAND NEAR NANWAN LAKE

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The riparian zone of reservoir is a spatially fluctuating ecotone (between terrestrial and aquatic ecosystems) and is an important area for nutrients' circulation and materials' flow. Riparian forest plays an important role in the stability of riparian habitat. As yet, the relationship between soil chemical properties and biodiversity of riparian forest near reservoir has not been thoroughly elaborated. In this study, we analyzed the soil chemical properties (total nitrogen and carbon, available phosphorous and kalium) and community structure characteristics of trees (diameter at breast height, tree height, canopy width), shrubs and herbaceous (Shannon diversity index, Simpson dominance index, species richness index, Pielou uniformity index) in the riparian forest land at the tail section that is a part of Nanwan lake reservoir in China. Results showed that the structure of riparian forest near reservoir of Nanwan lake represents a stable community. There was no significant difference in soil chemical properties and vegetation biodiversity between the type of centre's island and the type of peninsula. The range of the nutrients' content in forest land (near Nanwan lake reservoir), respectively, is: total carbon (TC) – 7,8–19,5 g/kg, total nitrogen (TN) – 0,72–1,49 g/kg, available phosphorous (AP) – 1,89–3,83 mg/kg, available kalium (AK) – 48,0–100,5 mg/kg. The soil pH value of the riparian forest land near Nanwan Lake reservoir is low due to strong acid reaction, so the toxic effects of aluminum should be considered. In the RDA analysis, the first axis is explained 73,16% of the biodiversity factors of trees, shrubs and herbaceous, and the second axis – 6,48%. The reflection of the presence of shrub-herbaceous layer in the values of the chemical properties of soil is significant: this layer is an important source of soil organic matter in the coastal zone and has a positive effect on soil quality. Therefore, attention should be paid to maintaining the stability of community structure in understory shrub-herbaceous layer.

Key words: *Nanwan Lake reservoir, riparian habitat, community structure, Redundancy analysis (RDA).*

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Introduction. Riparian zone is a spatially fluctuating ecotone (between terrestrial and aquatic ecosystems), which has important ecological functions due to specific geographical conditions and seasonal environmental changes. Reservoir, as an important part of riparian ecosystem, provides important service functions for regional climate stability and ecological benefits, and is also an important place to aquatic tourism (Liu et al., 2018).

As an indispensable part of riparian microenvironment, riparian forest can affect the distribution of light, the input of sediment to the river, the temperature and water quality, and maintain a stable ecological environment (Ring et al., 2018). The periodic impoundment of the reservoir changes the original habitat of the riparian zone, erodes the soil and poses a great threat to the stability of the riparian habitat (Nakamura et al., 1997).

Hydrological environment is the key controlling factor for the formation of riparian habitats. The frequency and intensity of hydraulic erosion have important effects on the configuration of riparian vegetation community structure (Acker et al., 2003). Meanwhile, the fluctuation of water level will affect the structure characteristics of soil aggregates, and ultimately affect the soil nutritional status. E.g. the fluctuation of water level during the flood season will increase the accumulation of soil nutrients, while during the water season will increase the loss of soil nutrients (Fournier et al., 2013).

The coupling relationship between climate-vegetation-soil in different ecosystems has always been the focus of ecological research. Nevertheless, the relationship between forest vegetation structure and soil chemical properties is very complex (Li et al., 2013; Sarah & Rodeh, 2004).

Soil properties and vegetation community structure are interdependent and mutually antagonistic (Gao et al., 2004). At present, it is generally believed that the interaction between vegetation and soil is realized through metabolites such as roots and litters, the dominant species in a floristic composition often determines the development direction of the whole community and the influence of the community on the environmental quality (Cybill et al., 2020).

Vegetation provides soil with organic matter and other nutrient elements through the decomposition of litters, the stoichiometric characteristics and physical properties of soil nutrient elements, such as C/N ratio in turn regulate the decomposition rate and quality of litters (Jiao et al., 2014).

The dry-wet alternate water environment is the main external driving force affecting the characteristics of vegetation community structure and soil properties in riparian zone (Lite et al., 2005). Dramatic changes in the water environment have resulted in a mosaic riparian ecosystem. Vegetation community structure and soil chemical properties show strong heterogeneity, which is also one of the main factors of uncertainty in the study of riparian ecosystem (Liu et al., 2018; Zhang et al., 2021).

At the same time, the structure of riparian forest, the age of forest, the coverage of understory and the succession stage all affect the soil chemical properties, the migration and distribution of nutrient elements (de Souza et al., 2013). Studies have shown that the soil structure of riparian mixed forest has a stronger ability to resist heavy rainfall and runoff (Zhang et al., 2019). The understory vegetation community structure is also a key factor affecting soil organic matter in riparian forest and promoting the stability of forest ecosystem.

Researchers (Nilsson & Wardle, 2005) proposed that boreal forests in Sweden showed that undergrowth is the main driving force of the ecosystem, which affects the composition of forest species in the short term, and the main driving factor of soil fertility in the long term, affecting nutrient availability and plant growth.

Soil factors had a greater influence on understory vegetation distribution than climate in European beech forests (Weigel et al., 2019). With the development of modern sequencing methods, the individual effects of phytodiversity on soil factors can be quantitatively studied (Ran et al., 2020). However, soil factors that restrict biodiversity may be different in diverse regions. Therefore, revealing the relationship between soil drivers and vegetation biodiversity in riparian forests at a regional scale is of great significance for understanding the structure and function of riparian zone ecosystems.

Nanwan Lake reservoir is a national 4A scenic spot in China. After years of protection and restoration, the riparian zone in this region has formed a stable ecosystem structure. Large-scale afforestation movement in this area was mainly concentrated in the 1960's and 1970's, and the main afforestation species were *Pinus massoniana* Lamb. After a long period of regeneration and succession, the local suitable species of *Quercus dentata* Thunb. and *Quercus acutissima* Carruth. have gradually replaced the dominant position of *P. massoniana*. The upper layer of forest was formed with the main dominant tree species – *Q. dentata* and *P. massoniana*, accompanied by the potential replacement tree species such as *Q. acutissima* and *Pistacia chinensis* Bunge. The understory vegetation was mainly dominated by *Vitex negundo* Linn., *P. chinensis*, *Lindera glauca* (Sieb.et Zucc.) and *Carex breviculmis* R. Br.

With the development of ecological civilization project in China, the riparian forest land of Nanwan Lake reservoir is in the critical period of renewal and succession after many years of enclosure. *P. massoniana* gradually tends to be inferior in the competition, and appears the phenomenon of poor growth and even death. The coupling relationship between biodiversity indices driven by vegetation succession and soil properties dominated by riparian habitats is an important factor that determines the future ecological stability in this region.

The main object of this study was to: 1) Biodiversity characteristics of arbor and shrub-herbaceous community structure and basic state of soil chemical properties in riparian forest land of Nanwan Lake reservoir; 2) Coupling relationship between arbor, shrub-herbaceous biodiversity index and soil chemical properties? Which is the key vegetation factors driving soil properties of riparian zone?

These problems can provide theoretical basis for the stable and scientific management and decision-making of the riparian ecosystem of Nanwan Lake reservoir.

Materials and methods. *1 Site description.* The study site was located in the vicinity of Nanwan Lake Reservoir (E 114°08', N 32°13') in Xinyang City, in the southern part of Henan Province, China. Xinyang is a transitional region from subtropical zone to warm temperate zone, located at the boundary line of Qinling and Huai River.

The topography is higher in the south than north, with an altitude of 75–300 m. Xinyang has sufficient sunshine, with an average annual sunshine duration of 1900–2100 hours. The annual average temperature is 15,3–15,8°C, and the annual average precipitation ranges from 993 to 1 294 mm.

The relative humidity is 74–78% annually. There are many rivers in this region, belonging to the Yangtze River and the Huai

River, of which the area of the Huai River basin accounts for 98,2% of the city's total area. Xinyang is located on the upper reaches of the Huai River, which traverses the whole territory from west to east.

Due to the influence of special geographical location and climate, the spatial and temporal distribution of rainfall is uneven, and the precipitation varies greatly within and between years. The precipitation mainly concentrates in June to August of the main flood season, and the difference between rich and dry years can be up to 2–3 times.

The region's main forest species community is *P. massoniana*, *Cunninghamia lanceolata* (Lamb.) Hook., *Q. acutissima*, *Q. dentata*, *P. chinensis*, etc., formed a pure forest or mosaic distribution of these species.

2. Experiment design:

2.1. Vegetation investigation. The experiment was conducted in August 2020, when the canopy leaves of each plant in riparian forest land were fully expanded. In the tail section of Nanwan Lake reservoir, 9 sample plots of arbor forest land near the water area were randomly selected. GPS was used to record the location of the sample plots, and the area of the sample plots was set at 20 m × 15 m. Tree species, DBH (diameter at breast height, > 5cm), tree height, canopy width and other factors were mainly recorded by measuring all trees in the sample plots. Shrub quadrates (5 m ×5 m) were set in the four corners and the center of the plots to record the shrub species name, number of vegetation, shrub high and coverage degree in the quadrate. Herbaceous quadrates (1 m × 1 m) set in the four corners and the center of the plots to record the species name, number of vegetation, average height and coverage in the quadrates. In order to facilitate the analysis, the calculated biodiversity index of shrub quadrates was combined with herbage quadrates.

2.2. Soil sampling. Removed the surface covering of the soil in the four corners and center of the arbor sample plots, used a soil sampler to take the soil samples at a depth of 10 cm, mix the 5 points thoroughly, put them into a self-sealing bag, and take them back to the laboratory for natural air drying in a cool place. After being air-dried, the roots, stones and animal and plant residues were removed, crushed with wooden sticks, and then screened by a 0,25 mm sieve for the determination of soil properties.

Field site on Nanwan Lake reservoir is presented on fig. 1.

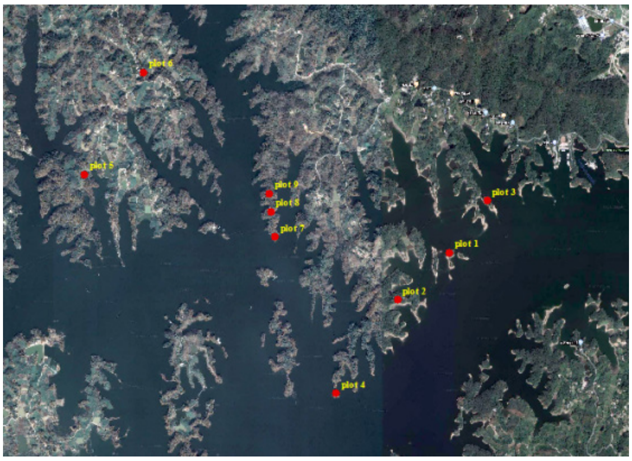

Fig. 1. Field site on Nanwan Lake reservoir

3. Analysis methods:

3.1. Biodiversity index. Biodiversity indicators are mainly reflected by the following indices (Alatalo, 1981; Magurran, 1988):

Simpson dominance index (Simpson): $Simpson = -\sum_{j=1}^{s} P_i \ln(P_i)$.

Shannon size diversity index (Shannon): $Shannon = 1 - \sum_{j=1}^{s} P_i^2$.

Species richness index: *S* = Number of species in sample / Sample area

Pielou uniformity index: *J = Simpson / ln S.*

Pi = *Ni*/*N*, where *Ni* is the number of individuals of the *i*-th species in the sample, and *N* is the total number of individuals in the sample.

3.2. Determination of soil chemical properties. The main soil chemical indexes were pH value, total nitrogen (TN), total carbon (TC), available phosphorus (AP) and total kalium (TK). PH value using pH acidity meter method; Soil total carbon (TC) was determined by potassium dichromate oxidation and external heating method. Total nitrogen (TN) was determined by Semi-trace Kjeldahl method. The available phosphorus (AP) was extracted by $NaHCO_3$ – Mo – Sb anti-colorimetric method. Total kalium (TK) was measured using a flame photometer.

3.3. Data analysis. Cluster analysis was conducted on the data of 9 sample plots (Fig. 2). The clustering results classified sample plots 5, 6, 7 and 9 into one category, and sample plots 1, 2, 3, 4 and 8 into one category. According to the location of the sample plots and the distance from the water area, the results can be classified into two types: central island (plot 1, 2, 3, 4, 8) and peninsula type (plot 5, 6, 7, 9).

In this study, these two categories are used as the basis of data analysis. All data were did Shapiro-Wilk normal distribution test and the logarithmic transformation was used if the data did not meet the normal distribution; used Spearman rank sum test to analyze the correlation between soil chemical properties and vegetation biodiversity; used RDA redundancy analysis to analyze the effects of biodiversity factors on soil chemical properties. Before the RDA analysis, the data was first checked. The Axis length of the first Axis of RDA analysis was 0,2607, which was less than 3, indicating that the data was suitable for linear sorting RDA analysis.

Arbor factors (DBH, height, canopy) and shrub-herbaceous factors (Shannon index, Simpson index) were taken as environmental factors and analyzed the relationship between with soil chemical properties, to determine the explanatory degree of arbor and shrub-herbaceous layer to the soil. All data analysis and mapping were completed using R 4.0.3.

Biodiversity index and RDA analysis were completed using Vegan module in R package.

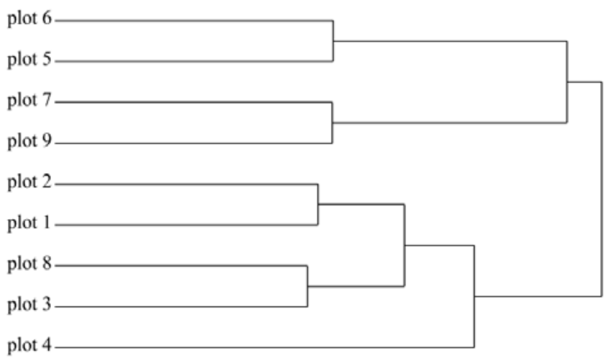

Fig. 2. Cluster analysis results of riparian forest land sample plots in Nanwan Lake reservoir

Results. There was no significant difference in soil chemical properties and phytodiversity (arbor and shrub-herbaceous layers) index between different types of riparian forest land in Nanwan Lake reservoir (Fig. 3, Table 1).

Abbreviations of soil parameters and vegetation biodiversity: RDA (Redundancy analysis), TN (total nitrogen), TC (total carbon), AP (available phosphorus), AK (available kalium), C/N (C/N ratio), DBH (diameter at breast height), Height (tree height), Canopy (crown width), Shannon (Shannon size diversity index), Simpson (Simpson dominance index) (tre1 – central island; tre2 – peninsula type).

Table 1

Soil chemical properties and phytodiversity (arbor and shrub-herbaceous layers) index of riparian forest land of Nanwan Lake reservoir

Indicator	Peninsula type	Central island
TN (g/kg)	0,862 ± 0,051	1,136 ± 0,143
TC (g/kg)	10,16 ± 1,08	14,79 ± 2,22
AP (mg/kg)	3,389 ± 0,368	2,776 ± 0,334
AK (mg/kg)	70,875 ± 8,464	72,900 ± 8,674
PH	3,985 ± 0,099	3,972 ± 0,098
C/N (%)	11,695 ± 0,611	12,839 ± 0,602
DBH (cm)	14,117 ± 2,071	14,174 ± 1,157
Height (m)	11,333 ± 0,638	10,982 ± 0,969
Canopy (m)	2,403 ± 0,411	2,214 ± 0,124
Shannon	2,289 ± 0,120	2,156 ± 0,222
Simpson	0,884 ± 0,014	0,860 ± 0,030
S	11,25 ± 1,315	10,60 ± 2,111
J	0,954 ± 0,005	0,959 ± 0,012

In terms of value, TN, AK and TC content of arbor forest land in the central island were higher than those in the peninsula type (1,14 g/kg, 72,90 mg/kg, and 14,79 g/kg, respectively), which were 1,31, 1,02, 1,46 and 1,46 times of those in the peninsula type.

The values of AP and pH of arbor forest land in the central island were lower than those of the peninsula type (2,78 mg/g and 3,98, respectively), which were 0,92 and 0,99 times of those in the peninsula type.

The DBH of the arbor forest land in the central island was larger than that of the peninsula type, and was 14,17 cm. The values of height and canopy of arbor forest land in the central island were lower than those of the peninsula type (10,98 m and 2,21 m, respectively), which were 0,96 and 0,92 times of those in the peninsula type. Shannon index, Simpson index and S index of arboreal forest in the central island were lower than those of peninsular type (2,156, 0,86 and 10,6, respectively), which were 0,94, 0,97 and 0,94 times of those in the peninsula type.

Simpson index was extremely significant positively correlate with Shannon index and S index (Fig. 4).

In the riparian zone of Nanwan lake Reservoir, soil TN was extremely significantly positively correlated with TC ($P < 0,01$), significantly positively correlated with C/N ratio ($P < 0,5$). Soil AK was significantly positively correlated with Height and DBH ($P < 0,5$). Soil pH was extremely significantly positively correlated with Height ($P < 0,01$), significantly positively correlated with Canopy and DBH ($P < 0,05$). DBH was extremely significantly positively correlated with Height ($P < 0,01$).

In the RDA analysis, the first axis explained 73,16 % of the biodiversity factors of arbor and shrub-herbaceous, and the second axis explained 6,48 % of the biodiversity factors of arbor and shrub-herbaceous. From the first axis, Canopy, Height and DBH all had strong negative correlation with soil chemical properties (not include AK). From the second axis, Shannon index, Simpson index has a strong negative correlation with Canopy and Height. Canopy, Height and DBH had a strong degree of explanation for the change of soil AK. Shannon index, Simpson index have a strong degree of explanation for the changes of soil AP, TC and TN.

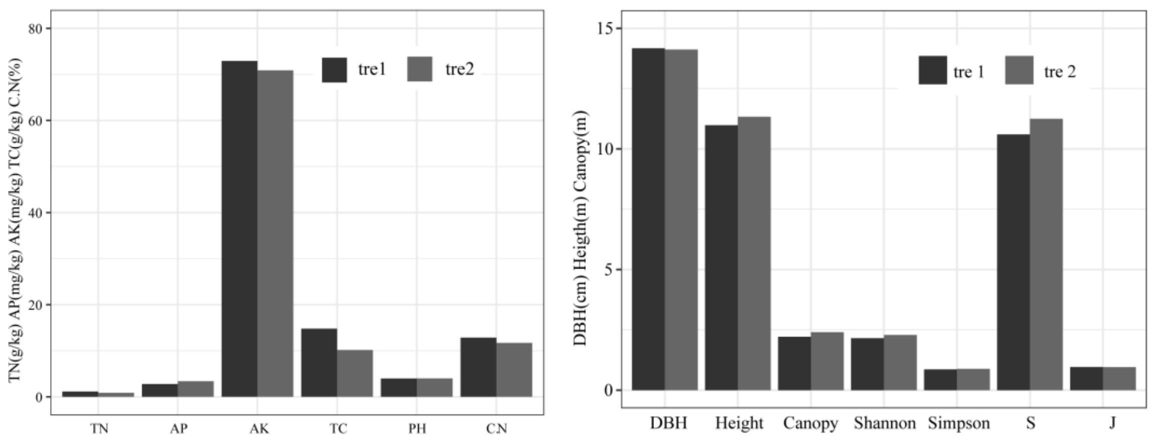

Fig. 3. Soil chemical properties and phytodiversity (arbor and shrub-herbaceous layers) index of riparian forest land of Nanwan Lake reservoir (tre1 – central island; tre2 – peninsula type)

	PH	TN	TC	AP	AK	C.N	DBH	Height	Conpy	Shannon	Simpson	S	J
PH		−0.51	−0.5	−0.44	0.61	−0.37	0.77 *	0.91 **	0.72 *	0.15	0.12	0.16	0.22
TN	−0.51		0.97 **	0.4	−0.21	0.69 *	−0.23	−0.55	−0.52	0.2	0.23	0.17	−0.56
TC	−0.5	0.97 **		0.38	−0.35	0.83 **	−0.27	−0.55	−0.55	0.27	0.28	0.28	−0.62
AP	−0.44	0.4	0.38		−0.36	0.31	−0.03	−0.34	−0.31	0.45	0.52	0.37	−0.46
AK	0.61	−0.21	−0.35	−0.36		−0.61	0.7 *	0.7 *	0.45	0.1	0.14	−0.01	0.33
CN	−0.37	0.69 *	0.83 **	0.31	−0.61		−0.29	−0.39	−0.59	0.42	0.36	0.51	−0.61
DBH	0.77 *	−0.23	−0.27	−0.03	0.7 *	−0.29		0.8 **	0.65	0.45	0.44	0.41	0.26
Height	0.91 **	−0.55	−0.55	−0.34	0.7 *	−0.39	0.8 **		0.51	0.31	0.29	0.3	0.28
Conpy	0.72 *	−0.52	−0.55	−0.31	0.45	−0.59	0.65	0.51		−0.1	−0.11	−0.12	0.37
Shannon	0.15	0.2	0.27	0.45	0.1	0.42	0.45	0.31	−0.1		0.99 **	0.98 **	−0.53
Simpson	0.12	0.23	0.28	0.52	0.14	0.36	0.44	0.29	−0.11	0.99 **		0.94 **	−0.56
S	0.16	0.17	0.28	0.37	−0.01	0.51	0.41	0.3	−0.12	0.98 **	0.94 **		−0.5
J	0.22	−0.56	−0.62	−0.46	0.33	−0.61	0.26	0.28	0.37	−0.53	−0.56	−0.5	

Fig. 4. Correlation between soil properties and arbor and shrub-herbaceous biodiversity index in Nanwan lake Reservoir

Discussion. *4.1. Soil chemical properties of the riparian forest*. Soil properties, as a key ecological factor controlling plant growth and development, are the basic properties and essential characteristics of soil and an important index determining soil fertility and soil quality (Hale et al., 2014; Soares et al., 2020). Soil organic matter (SOM) is the dynamic balance value of ecosystem under specific conditions, which mainly comes from plants, animals, microbial residues and their excretions and secretions, and is in the dynamic process of decomposition and synthesis (Jacobs & Gilliam, 1985).

There is a strong coupling relationship between carbon and nitrogen, and organic matter is the main energy source to drive nitrogen cycling microorganisms (Batlle-Aguilar et al., 2011; Gärdenäs et al., 2011). The C/N ratio of normal decomposition of organic matter by microorganisms is about 25:1, and the organic matter with high C/N ratio is difficult to decompose and mineralize or the speed is slow. In this study, total carbon (TC) content in riparian forest land of Nanwan Lake reservoir was higher than that of grassland and woodland in riparian zone of newly built reservoirs such as Three Gorges reservoir (de Sosa et al., 2018; Ye et al., 2019), this is mainly because the riparian forest land of Nanwan Lake reservoir is a stable ecosystem, and the root turnover and decomposition of surface vegetation and litter have accumulated for a long time, which has stored a large amount of organic matter for the riparian zone.

The content of organic matter in the central island is higher than that in the peninsula type, which may be mainly because the riparian arbor forest land in the central island is less affected by human activities and has accumulated more organic matter. The higher organic matter content can also explain the higher C/N ratio in the riparian arbor forest land of the central island, because the higher organic matter content can promote the activity of microorganisms and promote the mineralization of nitrogen.

At a regional scale, nitrogen deposition has become the main driver of soil acidification. Despite the strong

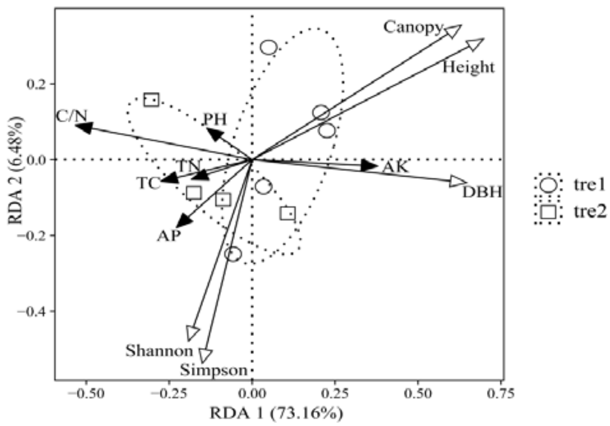

Fig. 5. RDA biplot representing the relationship between phytodiversity (in the riparian arbor forest land near of Nanwan Lake reservoir) and soil chemical properties

buffering capacity of soil, long-term soil acidification will have irreversible effects on the ecosystem. Studies have shown that when the soil pH is lower than 4, a large amount of Al^{+} will be released to cause aluminum toxicity (Lu et al., 2014; Lu et al., 2015). In this study, the pH values of riparian forest land of Nanwan Lake reservoir is lower than that of other types of riparian zone (Fan et al., 2014; Tripathi & Singh, 2009), and it is strongly acidic soil.

On the one hand, the local background soil is acidic red brown soil. It is mainly due to long-term NO^{3-} leaching in riparian arbor forest land, NO^{3-} will enter water body along with the surface runoff, resulting in serious acidification of soil. This is also in line with the soil characteristics of long-term stable riparian forest land (Bicalho et al., 2010).

Meanwhile, the long-term nitrogen deposition has also brought serious effects on the local forest soil, and the contribution of this aspect remains to be further studied. It is worth noting that the riparian forest soil acidification of Nanwan Lake is very serious, the occurrence of aluminum toxicity should be vigilant.

Phosphorus is one of the essential nutrient elements for plant growth and development, and available phosphorus refers to the phosphorus that can be absorbed and utilized by vegetation in the current season. However, a large amount of phosphorus fertilizer will not only lead to the waste of phosphorus fertilizer resources, but also increase the concentration of phosphorus in farmland runoff, and eventually lead to the eutrophication of water bodies (Young & Ross, 2016).

In this study, the available phosphorus (AP) content of peninsula type is higher than that of the central island, which may be mainly because the peninsula type riparian arbor forest land is more affected by human production and livelihood. In the process of phosphorus input from land to water, the peninsula type riparian forest land acted as an effective barrier and absorbed a large amount of phosphorus.

4.2. Structural characteristics of vegetation in riparian zone. Understory vegetation composition is a basic characteristic of the community, and vegetation diversity is an important characteristic of wetland ecosystem, high biodiversity can support a relatively stable ecosystem (Liu et al., 2011; Tripathi & Singh, 2009).

The configuration of forest community structure is the main mechanism driving biodiversity and forest primary productivity in subtropical forest [40] (Zheng et al., 2019). The role of arbor layer in ecological restoration and stability has been widely concerned, and is considered as a restoration approach to maintain the role of riparian ecosystem.

However, the importance of understory shrub-herbaceous vegetation has been widely emphasized in recent years (McClain et al., 2011). Studies have shown that the nutrient elements in herbaceous vegetation are significantly higher than those in woody plants.

Herbaceous layer provides available nitrogen pool for arbor layer, which can effectively compensate for the loss of nitrogen in forest system (Borisade, 2020; Gilliam, 2007). In this study, different types of riparian arbor forest land have no obvious differences in the community structure of arbor layer and shrub-herbaceous layer, which indicates that the riparian zones of Nanwan Lake reservoir are in a relatively stable ecological structure.

4.3. Relationship between soil chemical properties and vegetation biodiversity in riparian forest land. Soil factors are closely related to plant vegetation. Through the decomposition and release of litter, vegetation can improve the content of soil organic matter, activate the soil, and promote the circulation and absorption of nutrient elements. Meanwhile, soil nutrient elements also determine the succession, and growth of suitable vegetation on the site (Mikkelsen & Vesho, 2000). For example, riparian vegetation influences soil denitrification through both physical and biochemical pathways.

Researchers found that in the study of soil denitrification potential of different vegetation types in Danjiangkou reservoir that planting vegetation with high biomass could effectively improve soil organic matter and denitrification rate (Liu et al., 2011). It is not vegetation biodiversity but vegetation species that determines the change of soil chemical properties (Bouchard et al., 2007). Inhibition of soil biological nitrification also shows distinct promoting and inhibiting performances in different tree species (Laffite et al., 2020).

In this study, shrub-herbaceous layer explained most of the variation of soil chemical properties, and this explanation was mainly contributed by soil organic matter. This indicated that the shrub-herbaceous layer was the main driving force for soil organic matter storage, which may be mainly due to the higher rate of litter decomposition and root turnover in shrub-herbaceous layer, which provided most of the organic matter for soil. The arbor layer mainly contributed more to available kalium (AK).

Conclusions. The vegetation community structure and soil chemical properties in the riparian forest land of Nanwan Lake reservoir are relatively uniform, which is a stable riparian system. There was no significant difference in soil properties and vegetation biodiversity between the central island and peninsula type. It should be noted that the soil pH value in the riparian arbor forest land is generally low, so be alert to the occurrence of aluminum toxicity, which will affect the growth and development of the community in the riparian zone. The contribution of understory shrub-herbaceous layer to soil chemical properties is greater. The shrub-herbaceous layer is an important source of soil organic matter and drives the virtuous cycle of soil system in riparian zone. Therefore, attention should be paid to maintaining the stability of community structure in understory shrub-herbaceous layer.

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Хімічні властивості ґрунту та фіторізноманіття на прибережній лісовій території озера Наньван

Прибережна зона водойми є екотоном, який змінюється у просторі (між наземною та водною екосистемами) і є важливою зоною для циркуляції елементів живлення і потоку матеріалів. Прибережний ліс відіграє важливу роль у стабільності прибережного середовища існування. Поки що зв'язок між хімічними властивостями ґрунту та біорізноманіттям прибережного лісу поблизу водойми не є досить вивченим. У цьому дослідженні ми проаналізували хімічні властивості ґрунту (загальний азот та вуглець, доступний фосфор та калій) і особливості структури угруповань деревних (діаметр на висоті грудей, висота дерева, ширина крони), чагарникових та трав'янистих рослин (індекс різноманіття Шеннона, індекс домінування Сімпсона, індекс видового багатства, індекс однорідності Піелу) у прибережній лісовій землі на хвостовій частині водосховища, що є частиною озера Наньван у Китаї. Результати показали, що структура прибережного лісу поблизу водосховища озера Наньван являє собою стабільне угруповання. Не було зазначено суттєвої різниці в хімічних властивостях ґрунту та біорізноманітті рослинності між типом центру острова та типом півострова. Діапазон вмісту елементів живлення в лісовому ґрунті (поблизу водосховища озера Наньван) такий: загального вуглецю (TC) – 7,8–19,5 г/кг, загального азоту (TN) – 0,72–1,49 г/кг, доступного фосфору (AP) – 1,89–3,83 мг/кг, діапазон доступного калію у ґрунті (AK) становить 48,0–100,5 мг/кг. Значення pH ґрунту прибережної лісової землі поблизу водосховища озера Наньван є низьким внаслідок сильної кислої реакції, тому варто враховувати наслідки щодо токсичної дії алюмінію. У RDA-аналізі перша вісь пояснювала 73,16% факторів біорозмаїття дерев, чагарників та трав'яних рослин, а друга вісь – 6,48%. Відображення наявності чагарничково-трав'янистого ярусу у величинах хімічних властивостей ґрунту є значним: цей ярус є важливим джерелом органічної речовини ґрунту у прибережній зоні та позитивно впливає на якість ґрунту. Тому варто звернути увагу на збереження стійкості структури угруповання в підлісковому чагарничково-трав'янистому ярусі.

***Ключові слова:** водосховище озера Наньва,; прибережне середовище проживання, структура угруповання, аналіз RDA.*

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