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Research on risk assessment and early warning mechanism of agricultural non-point source pollution in *Bai-gui Lake* watershed by GIS

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Abstract
Weight value of disturbance and *Simpson Index* of indigenous plant species diversity along agro-disturbance of *Bai-gui Lake* watershed in *Ping-ding-shan City*. We concluded that there is a significantly negative correlation between *Simpson Index* of indigenous plant species and weight value of disturbance (P<0.01). Disturbance is the dominant environment driver of indigenous plant species diversity decreased on risk assessment and early warning mechanism of agricultural non-point source pollution. Thus, understanding dynamic links between indigenous plant species diversity and weight value of disturbance can be not just applied to preserve of plant species diversity, but also applied to risk assessment and early warning mechanism of agricultural non-point source pollution along different disturbance gradient.

Keywords: weight value of disturbance, indigenous plant species diversity, early warning mechanism, agricultural non-point source pollution, risk assessment, negative correlation

Introduction

The links between plant diversity and disturbance include dynamics of indigenous woody plant species diversity along disturbance [1], dynamics of biodiversity along environmental disturbance gradient [2], dynamics of biodiversity habitat along disturbance gradient [3], dynamics of biodiversity by agricultural disturbance [4], dynamics of forests along partial disturbance gradient [5], dynamics of young plants diversity along pollution disturbance gradient [6], dynamics of plant weed diversity vine disturbance [7] in the disturbance ecosystems. However, there are the links between indigenous plant species diversity and disturbance gradient in *Bai-gui* Lake of *Ping-ding-shan City* of China. By the way, indigenous plant species diversity are vital pharmaceutical materials in *Bai-gui* Lake.

Unfortunately, the indigenous plant species diversity is used as a framework for investigating the linkages between biodiversity and disturbance [8]. In many experiments or models have assessed the relationship between biodiversity and disturbance along disturbance gradient [1, 9]. In other words, it is the different dynamic links between natural ecosystem and disturbance ecosystem. It is a vital correction between plant functional groups and elevation along elevation gradient [10, 16]. For example, Liao *et al*. (2011a; 2014a) asked that the importance values of community's composition were significantly correlated with elevation along elevation on the northern and southern slope of the *Fu-Niu Mountain* [10, 11]. Liao *et al*. (2011b) proposed that biomass were significantly correlated with elevation along wetland elevation gradient in *Yi-Luo* River watershed[12]. However, It is a correction between biodiversity and disturbance along disturbance gradient [1, 9]. For instance, Liao *et al*. (2014b) found that biodiversity were significantly negatively correlated with disturbance [9].

Therefore, the objective of this research was to define the links between indigenous plant diversity and disturbance gradient at STES levels in *Bai-gui Lake* of *Ping-ding-shan City* in 2018.

The Physical Geographic Conditions and Study Methods

Bai-gui Lake is a key lake in *Ping-ding-shan City* of *He-nan Province in China*.The agricultural ecosystem is results of the historical natural and anthropogenic activities about *Bai-gui Lake*. It is a vital agricultural ecosystem mostly in the height of more than 80m (Figures1-4;Table 1-2).Three fields of community diversity of investigations were conducted in 2018, investigating the indigenous plant species diversity in *Bai-gui Lake*, which is ideal for studying distribution of plant functional groups and plant species diversity along agricultural disturbance(Figures1-4;Table 1-2).

Fig 1: GIS maps of geographical regional location of *Henan Province* in China

Fig 2: Geography Location of *Bai-gui Lake* watershed in *Henan Province* by GIS

Red, Location of *Bai-gui Lake watershed*; Green, Vegetation Landscape in *Henan Province*

Fig 3: Wetland and water zone landscape in *Bai-gui Lake* watershed in December of 2018.

Bottle Green, water zone landscape, Light Green, water Zone landscape in *Bai-gui Lake by* GIS; Brown, the ecotone between urbanization and agricultural landscape in *Bai-gui Lake* in 2018.

A field investigation was conducted, to study dynamics of indigenous plant species diversity along disturbance in agricultural ecosystem. The indigenous plant species diversity is a dominated biodiversity in agricultural ecosystem with farm landscape from 90 m to 170 m. Possessing steep different disturbance gradients, this area is idea for studying the links between indigenous plant species diversity and disturbance along elevation in *Bai-gui Lake* in 2018 (Figures 1-4; Table 1-2).

Formula: Weight value of disturbance= (intensity +frequency +time in disturbance)/3×100%.

Table 1: The physical geographic conditions and vegetation in *Bai-gui Lake* watershed

Location and Elevation	Climatic/Area	Natural Vegetation Types (Plant Functional Groups)
Latitude (º): 33º45’18’’-33.46’24’’	Precipitation (mm):724	Trees: Ulmaceae/Cupressaceae/Moraceae/Moraceae /Platanaceae, *Sophora japonica, et al.*
Longitude (º): 113º7’36’’-113º11’15’’	Temperature(ºC) (Mean) :15.2	Shrubs:Rhamnaceae/Verbenaceae/Buxaceae/Oleaceae /Rosaceae/Vitaceae/Bignoniacea/Cornaceae, *et al.*
Elevation(m) † 90-170	Sunlight: 2230h	Herbs:Compositae/Leguminosae/Urticaceae/Gramineae/Convolvulaceae/Cyperaceae/Liliaceae/Umbellferae, *et al.*
	Area(km^2):6.73	

†Above sea level.

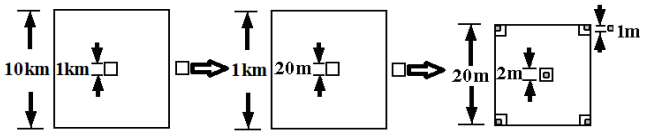

Fig 3: Quadrate settings

Applying plant community ecology techniques, GIS of techniques, a number of rasterizing of landscape maps, SPSS statistic analysis, we investigated all plant species (plant dominant and companion communities) along elevation gradients on the southern, southeastern, western, eastern, northern, southwestern, northeastern, and northwestern of *Bai-gui Lake* watershed in 2018 along Elevation and disturbance gradient (Figures 1-4; Table 1-2). There are 8 study plots establishing in per 20 m elevation by different azimuth and direction (East, West, South, Southeast, Southwest, North, Northeast, and Northwest) in 2018. A total of 27 plots were set in three times investigating. Each study plot (Figures 1-4), consisted of one 20 × 20 m tree layer quadrate, five (the center and four corners of the study plot) 2 × 2 m shrub layer quadrates and 1 × 1 m herb layer quadrates. Thus, there were 27 tree layer, 135 shrub layer, 135 herbaceous layer quadrates (Figures 1-3; Table 2-4). Moreover, different plant species identified during this investigation were assigned into three communities according to plant life form: 1) tree communities; 2) shrub communities; 3) herb communities [9, 13].

Table 2: Investigation index along the elevation and disturbance gradient variable

Investigation	Disturbance Types /Intensity/Frequency	Layer	Community	Species	Height	Crow	Diameter
Different plant community investigation	Differential Artificial disturbance /Natural disturbance	Trees /shrubs /herbs	Coverage/ community's age structure	Species/ individual number	Different Layer's Height	Crow Height /width	Different basal diameter

Results

The study showed three rules of the relationship between indigenous plant species diversity and weight value of disturbance.

Firstly, these shows there are 27 indigenous plant functional groups along disturbance gradient and elevation gradient between 90 and 200 m. This study show that indigenous plant species diversity decreased along disturbance gradient in *Bai-gui Lake watershed*.

Secondly, this study showed that there is a negative correlation between indigenous plant species diversity and weight value of disturbance (P<0.01).

Thirdly, the study analyzed the relationship between indigenous plant species diversity and weight value of disturbance. Regression equation is "y=-0.0028x + 0.3597, (R^2=0.9989)" (Figure5; Table 3).

Thus, the research explained that disturbance is the dominant environmental factors driven indigenous plant species diversity decreased along different disturbance gradient and elevation gradient from 90m to 170 m in *Bai-gui Lake* watershed in 2018.

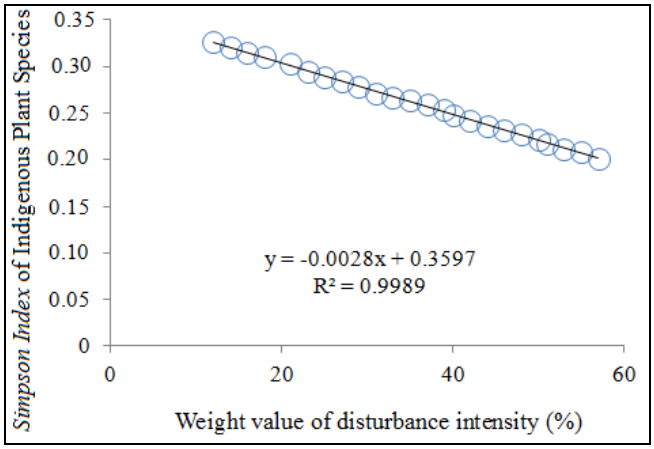

Fig 5: Dynamics of indigenous plant species diversity along disturbance in *Bai-gui Lake*.

Table 3: Correlating to tree individual number of functional groups and elevation.

Tree Function Groups along Elevation Gradient	Relationship between of indigenous plant species diversity and weight value of disturbance.
Indigenous plant species diversity	-0.999**

Note: *, P<0.05; **, P<0.01.

Discussion

This study showed that three key areas will substantially further effects to gain a rigorous understanding of three rules in *Bai-gui Lake* watershed in 2018:

1. There are 27 indigenous plant functional groups along differential disturbance gradient and elevation gradient between 90 m and 170 m. This study show that indigenous plant species diversity decreased along agricultural disturbance gradient in *Bai-gui Lake watershed*. Regression equation is "y=-0.0028x + 0.3597, (R^2=0.9989)".
2. This study showed that agro-disturbance was the dominant factors driven indigenous plant species diversity decreased along disturbance gradient and elevation gradient in *Bai-gui Lake*.
3. This study showed that there is a significantly negative correlation between indigenous plant species diversity and weight value of agro-disturbance (P<0.01) in *Bai-gui Lake watershed*.

Therefore, this study supported the experiments or models that disturbance gradient is the most key environmental factor affecting plant diversity distribution along disturbance gradient [1, 9], dynamics of plant functional groups [10, 12], indigenous plant functional groups [13, 16], biodiversity [17, 25] along different disturbance gradient at spatial-temporal-environmental scales (STES).

Conclusion

The results indicate that agricultural disturbance was the dominant environment driven indigenous plant species diversity decreased along disturbance gradient in this study. This research explained that there is a significantly negative correlation between indigenous plant species diversity and weight value of agricultural disturbance along disturbance gradient and elevation gradient from 90 m to 170 m (P<0.01). Thus, the study explained that disturbance is the dominant environment driven indigenous plant species diversity decreased at STES in *Bai-gui Lake* in 2018.

Discussion

The non-point source pollution of water caused by agricultural activities has become a major environmental problem in *Bai-gui Lake watershed*. The spatial distribution difference of agricultural non-point source pollution load is affected by the spatial structure of soil elements, hydrological pattern, land use type and planting structure, which is the quantitative links between different elements in the process of disturbance between human and nature.

In this project, *Bai-gui Lake watershed*is taken as the research area. Through data collection, soil monitoring, water quality monitoring, numerical simulation and other methods, the current situation of agricultural non-point source pollution and the impact of agricultural non-point source pollution on river water quality in the research area are analyzed, and the current situation of agricultural non-point source pollution based on GIS is formed. The migration and transformation model of main agricultural non-point source pollutants is established. The types of land use and The main influence mechanism of soil texture and other factors on agricultural non-point source pollution is to build a dynamic assessment system of agricultural non-point

source pollution risk based on GIS, to carry out dynamic analysis and trend research of agricultural non-point source pollution risk early warning, to identify the key areas of agricultural non-point source pollution risk in *Bai-gui Lake watershed* of *Henan Province*, to establish ecological risk early warning model of agricultural non-point source pollution, as well as to establish environmental friendly agricultural planting.

In short, in order to provide technical support for the establishment of a virtuous cycle of regional farmland ecosystem, we should establish a structural ecological model, formulate the corresponding technical scheme for the prevention and control of agricultural non-point source pollution, put forward a reasonable farmland irrigation mode and relevant incentive policies of the government in the future.

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