Jiufeng Protected Area Biodiversity Threats Assessment

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Abstract

Located in the East of Wuhan City, Jiufeng Protected area is endowed with a rich biodiversity in diversity landscape (Metasequoia forests, forest ponds, pine forest, Wetland pine, fir, cedar forest, Liquidambar forests, oak forests massoniana and lobular, Lin and mushroom). The objectives of this study were to assess and understand the biodiversity threats, evaluate activities, help prioritize and anticipate what threats might become more severe in the future. Threat assessment was based on a review of peer articles and secondary data sources such as key informant interviews. Interviews with local and provincial authorities and visits in the field were held to gather information on Jiufeng protected area resources and biodiversity threats. This research was carried out on June 2009. The Interviews, the literature review and field report showed that the biodiversity is threatened by a variety of human activities and natural factors such as climate change and invasive alien species. These threats can cause the biodiversity loss. In Jiufeng Protected Area, human activities such as land use and land cover change, industrialization and pollution, tourism and recreation constitute threats for biodiversity.

Keywords: Biodiversity, Threats, Humanactivities, Climate change, Invasive species

1. Introduction

Biological diversity or biodiversity concept was firstly used in 1988 [Edward O.Wilson, 1988] and widely applied after the ratification of the Convention on Biodiversity (1992).

Biodiversity is the variety of living organisms considered at all levels of organization, from genetics through species, to higher taxonomic levels, including the variety of habitats and ecosystems, as well as the processes occurring therein. Biodiversity is not the same as the number of different kinds of species in a place: Biodiversity is in fact more complex than species richness, although species richness is certainly one component of Biodiversity.

There are in fact four levels of Biodiversity: genetic diversity, species richness, ecosystem diversity and landscape diversity. Biodiversity also depends on and encompasses processes, as well as entities. These

processes include, but are not limited to, biogeochemical cycles; biotic and abiotic disturbances; predator-prey, mutualistic, or parasitic relationships; migrations; competitive effects, and so on [Sala, O.E.; Chapin, F.S., III; Armesto, J.J. *et al*. 2000.]. Thus, Biodiversity includes all the entities of the living world at various levels of biological organization plus the various things that those entities do.

Biodiversity is important in all ecosystems, not only in those that are "natural" such as national parks or natural preserves, but also in those that are managed by humans, such as farms and plantations, and even urban parks. Biodiversity is the basis of the multiple benefits provided by ecosystems to humans. Ecosystem services are the benefits obtained by people from ecosystems. These include:

• Provision of services such as food, clean water, timber, fiber, medicines, building materials and genetic resources;

• Regulating services such as the regulation of climate, floods, disease, water quality, and pollination;

• Cultural services such as recreational, aesthetic, and spiritual benefits;

• Supporting services such as natural processes and the earth's life support systems, e.g., carbon sequestration, soil formation, purification of water and nutrient cycling.

Biodiversity plays an important role in the way ecosystems function and in the services they provide. Species composition matters as much or more than species richness when it comes to ecosystem services, since the functioning of an ecosystem, and thus its ability to provide services to humans, is strongly influenced by the ecological characteristics of the most abundant species, not by the number of species.

Climatic conditions and human activities are an important factor in determining species distributions, life cycle, habitat, abundance, genetic diversity…

Climate change poses a significant threat to biological diversity [Parmesan, C.; Yohe, G. 2003]. Before climate change became a credible threat, biological diversity was considered at risk at regional to global scales in response to many human stressors, land use in particular. Losses of biological diversity over the past 100 years are historically unprecedented, thus climate change represents an additional source of stress on an already at-risk pillar of ecosystem sustainability. Temperature and precipitation are predicted to change, and many questions exist about the challenges that these climate changes may pose to biological diversity. Some research suggests that climate change poses an even greater threat to biological diversity than land use [Sala, O.E.; Chapin, F.S., III; Armesto, J.J. *et al*. 2000.] [Thomas, C.D.; Cameron, A.; Green, R.E. *et al*. 2004.]. From the viewpoint of monitoring systems three different levels can be defined: genetic, species, and landscape diversity [Whittaker RH, 1972]. All levels are interacting with the environment, thus indirect (*e.g.*, climatic change, deposition) or direct human influences (deforestation, fragmentation) affect all these levels. This latter situation would indicate a need for significant maintenance and replacement funding to maintain the Biodiversity. It is necessary to assess biodiversity threats to take measures for the Biodiversity preservation. It is also necessary, for the assessment of biodiversity, to focus on all levels and if possible to integrate between different spatial scales. A two-level combination of remote sensing and field studies is used to derive information on the diversity and distribution of large numbers of species in Jiufeng protected area [Cheng Shenggao, 2005].

The aim of this threat analysis is to assess the biodiversity threats in Jiufeng protected area and evaluate the current activities, to see if they help address priority threats and determine if there is a need to change the activities. This will help us understand the major direct threats to biodiversity as well as the context and root causes of the threats. The assessment will also help prioritize and anticipate what threat might become more severe in the future. This information is critical in designing effective interventions, communicating the rational behind the program design, and creating adaptive management systems.

This paper presents first the biological diversity in Jiufeng protected area, second its threats and finally gives some recommendations about the highlight actions needed to conserve and protect the biodiversity in Jiufeng protected area.

2. Methods

2.1 Study area

Jiufeng protected area, located in the East of Wuhan City, covers an area of 30.02 km2,bounded by the planning area circles city road to East, the Yu lake median line to West, the East Lake water surface and railway to north, the Lao Wu Huanglu (i.e. 316 federal highways) and male Chu avenue production to south. Wuhan is the capital of Hubei Province, which is located in the middle of the Yangzi River delta, latitude 29°58′ −31°22′ north and longitude 113°41′ −115°05′ east. Its population is approximately 7.5 million people, of whom approximately 4.5

million reside in nine urban core districts within an area of 201 km^2. Wuhan has a subtropical, humid, monsoon climate with a distinct pattern of four seasons. Its average daily temperature in July is 37.2°C, and the maximum daily temperature often exceeds 40°C. The major industries in Wuhan include ferrous smelters, chemical plants, power plants, and machinery plants. The major sources of air pollution in the city are motor vehicles and the burning of coal for domestic cooking, heating, and industrial processes.

<Insert Map 1>

2.2 Data collection

The threats assessment is based on a review of peer articles and secondary data sources (see list of references) such as key informant interviews. Some interviews with local and provincial authorities and visits in the field were held to gather information on Jiufeng protected area resources, biodiversity threats and priorities.

A two-level combination of remote sensing and field studies is used to derive information on the diversity and distribution of large numbers of species diversity and distribution of large numbers of species in Jiufeng protected area [Cheng Shenggao, 2005].

Information gathered included:

• Vegetation assessment, kind of plant species and type of vegetation

• Fauna observed

• Existing habitat

• Existing or possible links to other areas

• Vegetation health

• Management infrastructure (fences, signs, barbeques, seating)

• Social value (observed or known from previous visits)

• Surrounding land uses and their possible impact on the site

• Weeds

• Disturbing factors and threatening processes

• Recommendations for management

3. Results and discussion

3.1 Flora

3.1.1 Flora diversity

In Jiufeng protected area, there are two groups of plant: Angiosperms and Gymnosperms.

Jiufeng protected areas has a total of 832 species, 368 genera and 121 families including 54 species under the hierarchy, sub-species (ssp.) four, and variants (var.) 44, and cultivars (cv.) six. In 832 seed plants, there are 717 kinds of wild species (86.18%) and 115 kinds of cultivated species (13.82%).

3.1.2 Landscape diversity and Plant Associations

According to "China vegetation classification system", after a preliminary investigation, Jiufeng protected areas are classified in three types of vegetation groups: coniferous forest, foliage forest and swamp, and aquatic vegetation. The vegetation types in Jiufeng Protected Area are Metasequoia forests, forest ponds, pine forest, Wetland pine, fir, cedar forest, Liquidambar forests, oak forests massoniana and lobular, Lin and mushroom. With the exception of pine forest, oak forests *pinus massoniana* and lobular and mushroom formations, the others are all artificial vegetation formations.

<Insert Map2>

<Insert Table1>

3.2 Fauna

3.2.1 Amphibians

There are height species of amphibians that belong to one order (Anura) and four families (Bufonidae, Hylidae, Microhylidae, Ranidae)**.** The dominant species are *Rana nigromaculata, Rana plancyi and Rana tigrina. Rana nigromaculata* population constitutes the largest number.

3.2.2 Reptiles

In Jiufeng protected areas, 19 species of reptiles belong to two orders (Testudines and Squamata), two suborders (Lacertilia and Serpentes) and eight (8) families are inventoried. *Gekko japonicus, Elaphe taeniura, Eumeces chinensis* and *Zaocys dhumnades* are dominant species. But *Elaphe taeniura* and *Zaocys dhumnades* population are more important.

3.2.3 Birds

Sixteen orders, 36 families and 109 species of birds are recorded in Jiufeng protected area. Forty two species of birds are Resident birds (47.7%), 32 species are summer resident birds (29.3%) and 25 species are winter resident birds (22.9%) and breeding birds (including resident birds and birds Jaap) 84 species, 77.1 percent of the total. The dominant species are mainly *Tachybaptus ruficollis poggei, Phalacrocorax carbo sinensis, Nycticorax n. nycticorax, Phasianus colchicus torquatus, Larus ridibundus, S. c. chinensis, C. m. icropterus, H. daurica japonica, Pycnonotus s. sinensis, Cettia fortipes davidiana, G. c. canurus, Dicrurus macrocercus cathoecus, Cyanopica cyana swinhoei, Acridotheres c. cristatellus, Sturnus sericeus, Eophono personata magnirostris* and *E. m. migratoria.*

3.2.4 Mammals

There are six orders, 11 families and 21 species of mammals. The dominant species are *Apodenus agraris ningpoersis, Rattus f. flavipectus, R. orvegicus socer, Mus musculus homourus and Microtus fortis.*

3.3 Economic and cultural Significance

China's natural living resources are ranked as third in the world and first in the northern hemisphere [China Environmental Science Press, 1998].These resources provide an enormous range of products but also immense valuable ecological services that are essential for the healthy development of the Chinese economy, agricultural systems hydrology, and atmospheric stability. In total these services are valued much higher than the direct products and it is felt that planning mistakes, where natural ecosystems are destroyed to make way for inferior production systems, is due to a widespread lack of appreciation of the ecological service values. The total estimated value of products and services was estimated to be between 257 and 421 $US billion per year. We stated that these were conservative figures and some figures would rise with further development. The table of service value estimates presented in 1995 is reproduced below. Interestingly, in quite separate studies for the production of the national Biodiversity Report for UNEP, a group of Chinese biologists and economists have also calculated that the total annual value of biodiversity products and services in China is in excess of $US 450 billion [CBPF,2007].

Jiufeng protected area has a rich biological diversity. Nine hundred and eighty nine species are inventoried, belonging to one hundred and eighty families and nine classes. The species diversity can play a very important economic and cultural role for local population, provincial administration and national government. For example in China, there are more than 30, 000 species of higher plants [Kuipers S, 1996] and 6, 347 species of vertebrates, 1, 000 species of economic trees and more than 11, 000 species of medicinal plants.

Biodiversity is essential for our existence because the earth's biological systems and processes provide us many economic and cultural services such as food, biological pest control, climate regulation, storm buffering, medication, Industry, building material, handicraft, Recreational harvesting, Tourism and recreation.

3.4 Threats to Biodiversity

One of the main threats to the biodiversity in Jiufeng protected area is the uncontrolled development currently taking place in Wuhan. The urbanization trend is adding to this problem, as cities are continuously expanding into previously undeveloped lands. Tourism, recreation and residential developments have largely taken place without controls, proper planning, consideration of carrying capacity and infrastructure needs, and local community input.

The threats to biodiversity in Jiufeng protected area are essentially Human activities, climate change and invasive species.

3.4.1 Human activities

The adverse effects of human impacts on biodiversity are increasing dramatically and threatening the very foundation of sustainable development. These effects are altering the environment. The extent of those alterations, and their consequences for the distribution and abundance of species, ecological systems, and genetic variability are unprecedented in human history, and pose substantial threats to sustainable economic development and the quality of life. Loss of biological resources and their diversity threaten our food supplies, sources of wood, medicines and energy, opportunities for recreation and tourism. It also interferes with essential

ecological functions such as the regulation of water runoff, the control of soil erosion, the assimilation of wastes and purification of water, and the cycling of carbon and nutrients. Human activities such as land use change, overexploitation, building, industrialization and pollution, tourism, recreation and forest fire are a veritable threat to biodiversity. A lot of inappropriate development behaviors are noted in Jiufeng protected area. For example, some residential areas have been built after the Jiufeng Protected Area establishment; some mines which should be banned are still running; some residents which should be relocated are still living in the core area of Jiufeng Area.

❖ Land use and land cover change

Urbanization is perhaps one of the most widespread environmental challenges of the 21st century with enormous impact at local, regional and global scales. The conversion of agricultural or natural areas to urban use is now the greatest source of landscape and forest fragmentation on earth [Munroe, D.K., C. Croissant and A.M. York, 2005] [Alig, R.J., J.D. Kline and M. Lichtenstein, 2004] [Seto, K.C. and R.K. Kaufmann, 2003]. Although, urbanization in the form of land-cover (either built-up or impervious surfaces) occupies only about 0.3% of the earth's surface [Angel, S., S.C. Sheppard, D.L. Civeo,R. Buckley, A. Chabaeva, L. Gitlin, A. Kraley, J. Parent and M. Perlin,2005], there is plentiful evidence that human disturbance due to urbanization has significantly altered the natural landscape. Urbanization changes the characteristics of the vegetation and soils on the territories of the cities, which in turn leads to the change of parameters of the carbon cycle [Svirejeva-Hopkins, A., H.J. Schelln Huber and V.L. Pomaz, 2004].

Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) images in 1987 and 2005 were used to quantify the land use and land cover changes (LUCC) in Wuhan area using supervised classification method with a new vegetation index based on universal pattern decomposition method (VIUPD). Land use dynamic index was also used to analyze the temporal character and internal rule of number and construction of land use/land cover change. The land use/cover dynamics are shown in table 1.urban area increased by 7,270.92ha (11.02%) between 1987 and 1994, from 10,174.82 ha (15.42%) 17,445.74 ha (26.44%) respectively. It increased by 13,764.07ha (20.86%) between 1994 and 2005, from 17,445.74 ha (26.44%) to 31,209.81 ha (47.31%). The annual increase rate of urban area during the 1994-2005 period about (2.0%) over 11 years was somewhat slower compared to that for the 1987-1994 period over 7 years. Urban expansion was still at the expense of mostly non-forest area (most of which is agricultural land), water and forest area. Non-forest area declined by -5,338.03 ha (-8.09%) over 1987-1994 period and -11,669.12 ha (-17.69%) during 1994-2005 period. Water saw a relatively large decline of -3, 649, 71 (-5.53%) over 1994-2005 compared to -1,209.49 ha (-1.83%) over the 1987-1994 period. Forest loss -2,523.03 ha (-3.82%) during 1987-1994 period which was almost completely reversed by its increase of 2,454.58 ha (3.72%) during the 1994-2005 period [Douty Chibamba and Jiangfeng Li,2008].These indices show how land use and cover change can affect the biodiversity. Human land use furthers habitat loss, degradation and fragmentation. Habitat loss, degradation, and fragmentation are important causes of known extinctions. In Jiufeng protected area, building and road construction are noted. These activities involve cutting trees before the construction. It is a factor which can cause fragmentation, the loss and degradation of biodiversity habitat.

<Insert Table 2>

<Insert Picture 1>

<Insert Picture 2>

❖ Industrialization and pollution

The major industries in Wuhan are ferrous smelters, chemical plants, power plants, and machinery plants. The major sources of pollution in the city are motor vehicles and the burning of coal for domestic cooking, heating, industrial processes, municipal and domestic wastes. Pollution (air pollution, water pollution and solid wastes) presents one of the major challenges of rapid urban expansion in Wuhan city. For example, a recent study has revealed that heavy metal pollution in urban lakes of Wuhan city has increased due to rapid urbanization and industrialization over the last 2 decades [Liu, H., L. Li, C. Yin and B. Shan, 2008]. Pollution from chemical contaminants certainly poses a further threat to species and ecosystems. There are some landfills in Jiufeng area; they constitute a very important threat to biodiversity. Waste (industrial waste in particular) represents a health hazard, due to its content in toxic substances such as heavy metals (lead, cadmium), pesticides, solvents, and used oils. In biodiversity terms, any waste landfill means a subsequent elimination of a number of species on each hectare of the area intended to host a landfill. Moreover, changes are likely to occur in biocoenoses nearby the landfill, such as:

- Some species that are specific to polluted areas would become dominant in the vegetal assemblies;
- Some mammals, birds, insects would desert the area, in favor of beings that feed on refuse (rats, crows).

Insert picture 3

- Tourism and recreation

During the tourism and recreation activities in this area, people drop often biodegradable and non-biodegradable matters (plastics for example).

<Insert Picture 4>

3.4.2 Climate Change

Biological diversity is essential to maintaining ecosystem processes and services. If climatic factors such as temperature and precipitation change in a region beyond the tolerance of a species phenotypic plasticity, then distribution changes of the species may be inevitable [Lynch, M. & Lande R., 1993]. There is already strong evidence that plant species are shifting their ranges in altitude and latitude as a response to changing regional climates [Parmesan, C.; Yohe, G. 2003] [Walther, G. R. *et al*., 2002]. Climate change is a great deal of concern in Wuhan. Certain tree and animal species are particularly sensitive to temperature and precipitation changes.

- Temperature

In Hubei province, the temperature has increased during the last ten years. The temperature is a very important factor for the behavior, the survival and the evolution of biodiversity. An increase in temperature can affect the biodiversity. Increases in temperature raise the rate of many physiological processes such as photosynthesis in plants, to an upper limit. Extreme temperatures can be harmful when beyond the physiological limits of a plant.

<Insert graph1>

- Precipitation

From the period 1999-2007, the precipitation has slightly decreased in Wuhan. As water supply is critical for plant and animal growth, it plays a key role in determining the distribution and behavior of plants and animals.

<Insert Graph2>

- Extreme events: Drought and Flood

During the period of 1999 to 2007, there were extreme events such as drought and Flood in Hubei province. Heavy droughts were noted in 2000 (spring), 2001 (spring and summer) and 2007 (autumn) and light droughts in 2001 (autumn), 2002 (autumn), 2004 (spring and autumn) and 2006 (summer and autumn). There were heavy flood and light flood respectively in 2000 (autumn) and 2002 (spring) [Hubei meteorological station data from 1999 to 2007]. Hence, an increasing frequency of drought events may contribute to a destabilization of beech forests build up by less resilient populations [Kriebitzsch WU, Beck W, Schmitt U, Veste M.,2008].

3.4.3 Invasive and Alien Species (IAS)

Invasive species are non-indigenous species (e.g. plants or animals) that adversely affect the habitats they invade economically, environmentally or ecologically. An alien species, when invading a new environment without being monitored, is apt to proliferate and form a mono-dominant community, competing for living spaces previously enjoyed by local species. And their threats to ecological system are permanent, driving local species to extinction. China, a biodiversity 'hotspot', is under threat from over 400 invasive species, and its annual economic losses from alien insects and plants are estimated at US$14.5 billion. Invasive species are often imported and can be harmful to the environment. The China–US team says that invasive animal species increased from 1990 to 2003 by more than 30 per cent to 76 species, and invasive plant species tripled between 1995 and 2003. [Chen weixiao, 2008]The number of invasive alien species has almost doubled over the past five years in central China's Hubei Province, bringing about hundreds of millions of Yuan in economic losses a year. Agricultural scientists had discovered 73 harmful species alien to Hubei by the end of 2007, 35 more than that in 2003, according to an associate research fellow of the Hubei Provincial Academy of Agricultural Sciences [Xinhua, 2007]

<Insert Table3>

3.4.4 Biodiversity Threats Analysis

In Jiufeng Protected Area, Biodiversity is threatened by a variety of human activities and natural factors. The threats and their severity differ according the sources. Human activities such as land use (agriculture, housing,

roads and mining), industrialization and pollution, tourism and recreation are the largest and the most important threats to biodiversity in Jiufeng Protected area. They constitute perceived and direct threats to biodiversity.

Other parameters that cause threats to biodiversity include Invasive and Alien Species and Climate change.

Invasive and Alien species represent potential and persistent threats to biodiversity. They have both a direct negative impact on species and communities through losses and extinctions and an indirect impact on ecosystems and biodiversity through ecological changes brought by those losses and extinctions.

The threat of climate change include the direct impacts on habitat, ecosystem functioning and populations of higher concentrations of carbon dioxide; altered rainfall and temperature patterns and more frequent extreme storms, floods and droughts. Many species are highly sensitive to changes in climate and weather-related patterns and events. These can disrupt seasonal food supplies and other resources, life cycle events, development, mortality, breeding and fertility, such that entire reproductive strategies become less successful.

4. Conclusion and Recommendations

This threat assessment has showed that the Jiufeng Protected area is endowed with a rich biodiversity in diversity landscape (Metasequoia forests, forest ponds, pine forest, Wetland pine, fir, cedar forest, Liquidambar forests, oak forests massoniana and lobular, Lin and mushroom). The Interviews, the literature review and field report showed that the biodiversity is threatened by a variety of human activities and natural factors such as climate change and invasive species. These threats can cause the biodiversity loss. Biodiversity loss has negative effects on several aspects of human well-being, such as food security, vulnerability to natural disasters, energy security, and access to clean water and raw materials. It also affects human health, social relations, and freedom of choice. That is why it's very important to preserve and protect the biodiversity. The conservation and sustainable uses of biological diversity are closely related to different aspects of social development. The loss of biodiversity is irreversible; once species or natural habitats such as tropical forest are lost it is impossible to recover them. Thus, biodiversity conservation is the most urgent issue of environmental conservation in the world. It is essential to have a well designed strategy and action plan in order to effectively carry out biodiversity conservation. The following are some recommendations according to the threats:

- Human activities:
  - Avoid any kind of human activity throughout the Jiufeng protected area
  - Long-term plan of rational and sustainable use of wildlife based on status survey of wildlife resource should be determined in order to monitor and regulate the uncontrolled and unsustainable use of wildlife resources still existing in China. Similar plan should also be worked out at the local or regional level.
  - To develop an integrated approach and more effective way of conservation and sustainable use of biological diversity; correct handling of relationship between the conservation and sustainable use of biodiversity
  - Better understanding and evaluation of the significance and value of biological diversity.
  - In long term view it is necessary to work out a general strategy and an action plan for conservation of biodiversity at national, regional or local level
- Climate change

There are no specific recommendations about climate change.

- Invasive species:
  - Prevention and early intervention are the most successful and cost-effective way of tackling invasive species. Once an invasive species has become established, its control and particularly its eradication through the use of chemicals or through the introduction of bio-control agents may not necessarily be effective and are extremely difficult and costly.
  - Use the biological and mechanical fight to eradicate invasive species
  - Avoid importing species from abroad.

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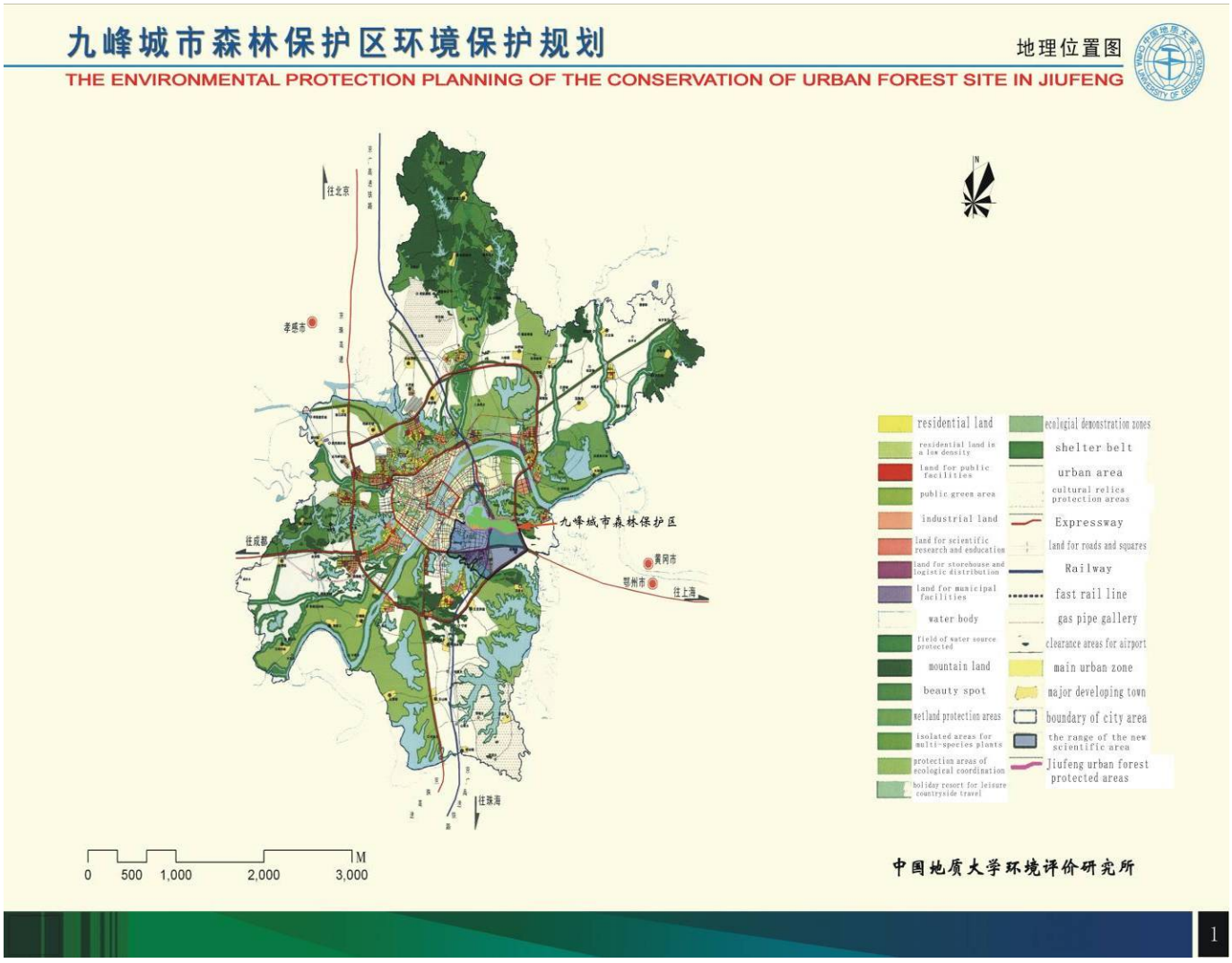
Map 1. Location map of Jiufeng protected area



Map 2. Vegetation type in Jiufeng protected area

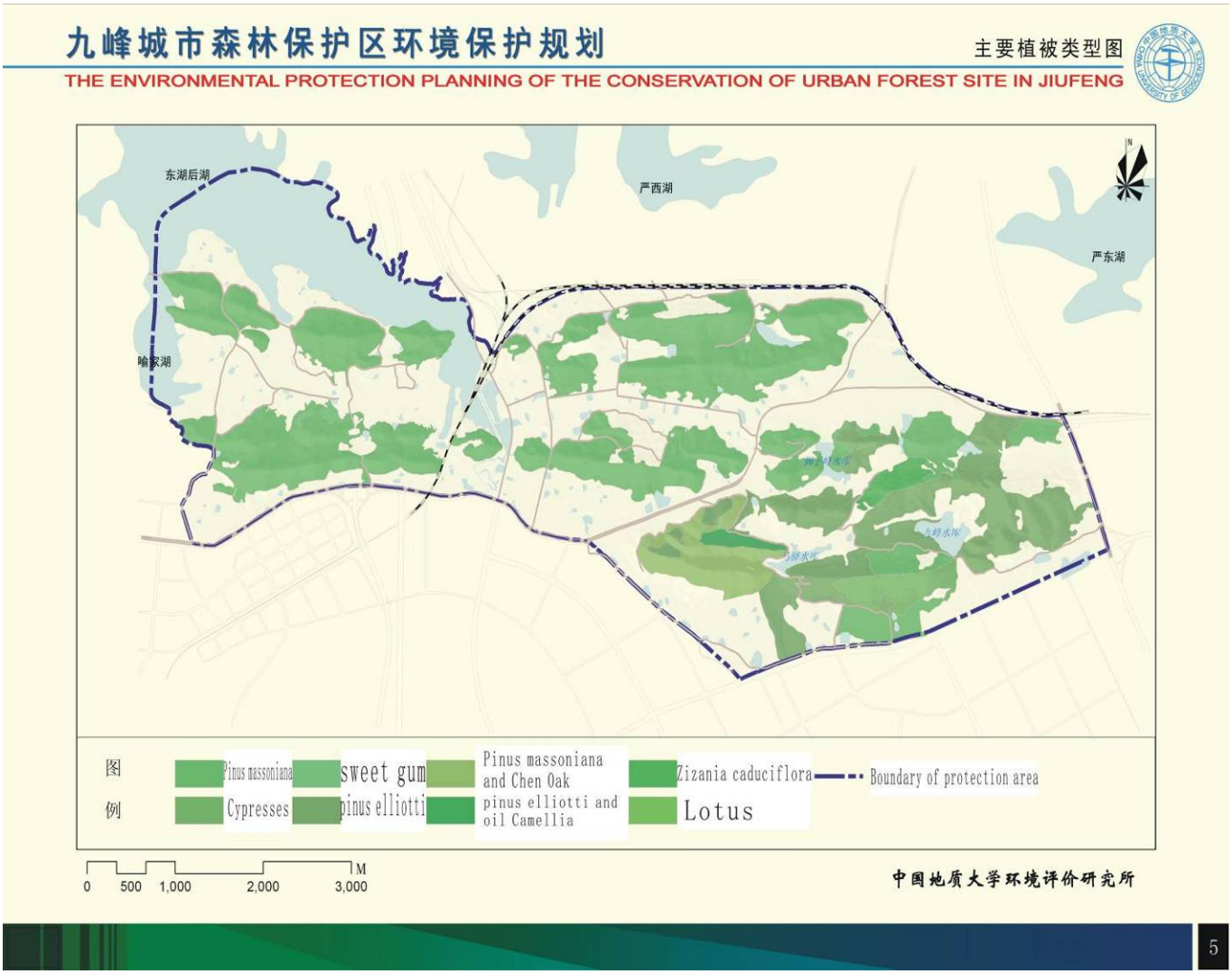


Table 1. Vegetation Types in Jiufeng Protected Area

Vegetation types	Plant association type	Plant composition and canopy cover
Pine forest (Form.*Pinus massoniana*	*Massoniana-Quercus serrata+hupeana-Ptilagrostis carex grass+ (*Ass.*Pinus massoniana-quercus serrata+Dalbergia hupeana-Capillipedium parviflorum+Carex sp).*	Tree layer cover is about 45%. *Pinus massoniana* dominates the composition of single-edge community. The average tree height is 8m; the average chest circumference is 37cm. Its associated species is only the artificial planting of Chinese fir (*Cuninghamia lanceolata*). Shrub layer cover is 40%. *Quercus serrata, Dalbergia hupeana* are dominant and associated with wild species of *Diospyros kaki var.sylvestris, Symplocos sumuntia, Vitex negundo, Glochidion puberum, Zanthoxylu armatum, Serissa japonica, Albizia kalkora, Loropetalum Chinese, Daphne genkwa.* Herb vegetation cover layer is about 15%; the types of mainly grass are *Capillipedium parviflorum, Carex sp*. There is also Rosa outer layer composed by *Rosa laevigata, Rosa multiflora and Salix sp.*
Massoniana + lobular oak forests (Form. *Pinus massoniana and Quercus chenii)*	*1-Massoniana + lobular oak – Wong Jing – light bamboo leaves (Ass. Pinus massoniana + Quercus chenii – Vitex negundo – Lophatherum gracile);* *2-Massoniana + lobular oak – Camelia + tip – Dryopteris carex + (Ass.Pinus massoniana + Quercus chenii – Camelia oleifera + Camelia cuspidata – dryopteris sp. + carex sp.).*	Tree cover is from 80 to 90%. The average height is 13m,the average chest circumference is 63cm for lobular oak; the average height is 12m and the average chest circumference is 58cm for Liquidambar. Massoniana and lobular dominant *Quercus, Liqidambar* in the artificial planting. Shrub layer is 30%. *Vitex* mainly are associated with *Rhus foam plug, mountain pepper, Broussonetia papyrifera, Pittosporum, Dalbergia,Tian foam plug.* Herb layer cover is less than 15%. They are mainly three-fold pulse Aster, *Erigeron, Clethroides, Lygodium japonicum* and *Smilax Scobinicaulis.*
Kashiwagi Lin or cypress wood forest (Form.*cupressus funebris)*	*Kashiwagi – Quercus serrata – Carex + Chrysanthemum(Ass. Cupressus funebris – Quercus serrata – Carex sp. + Dendranthema indicum).*	Tree cover is 35%, composed of a single gifted by cedar species. The average height is 9m and the chest circumference is 15.8cm for the artificial cultivation of tree, aged about 12 years. Shrub layer cover is about 70%. *Quercus serrata* dominate by its cover about 50% and is associated with a large leaf *Lespedeza, Dalbergia, Camellia, Vaccinium bracteatum, mountain leucocephala.* As a result of poor site conditions, herb layer cover is less than 10%. Carex sp. And Koraiense are dominant and they are associated by *Ptilagrostis grass, Aster ageratoides three-fold* and *Rosa* outer layer plants.
Wetland Pine (Form.*Pinus elliottii*)	*Pinus elliottii – Quercus serrata + vitex negundo – Imperata cylindrical var.major.*	Tree cover is 20%, composed by single slash pine species distinctions. The average height is 5m and the average chest circumference is 12cm. Shrub layer cover is about 85%. There are more types of species such as *Quercus serrata* and a dominant *Vitex*. They are associated with tea,*Dalbergia, Acacia, Fordii, Symplocos* and wild hawthorn. Few herbs cover is less than 10%. There is only one kind of *Imperata*. Outer layer is composed by *Smilax* plants, wild rose and *Lygodium* stone.
Chinese sweet gum forest (Form. Liquidambar formosana)	*1-Liquidambar formosama –Quercus aliena + Dalbergia hupeana – Lophatherum gracile.* *2-Dryopteris sp.,Aster ageratoides three fold*	Because of the destruction of shrub layer, its cover is less than 10%. Quercus aliena and Dalbergia mainly are associated with *Eurya muricata* and wild Hawthorn. Herb layer cover is 30% mainly in light bamboo leaves. Outer layer hanging plants *Anoectochilus* turtle (*Stephania cepharantha),Rosa multiflora, Paederia* play fields such as foam
Fir (Form. Cuninghamia lanceolata)	-	Fir tree layer composed of a single dominant species in communities, the total canopy cover is about 40%, distribution of trees, trunks straight pass. There are obvious. The average height is 3 ~ 4m, the average diameter at breast height is 20cm, understory seedlings more updates good. Shrub layer cover is 30%. The common types are *Broussonetia papyrifera, Loropetalum chinense, Glochidion, Mallotus japonicus var.floccosus, Robinia pseudoacacia, Rhus chinensis* etc. Herb layer cover is 30%. The common species are *Carex sp., Pteridium revolutum*. The composition of understory is *Deyeuxia hupehensis, Lysimachia Clethroides, Arthroxon hispidus, Prunella vulgaris* and other plants.

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Table 2. Land use/cover dynamics for all the districts in Wuhan, 1987-2005

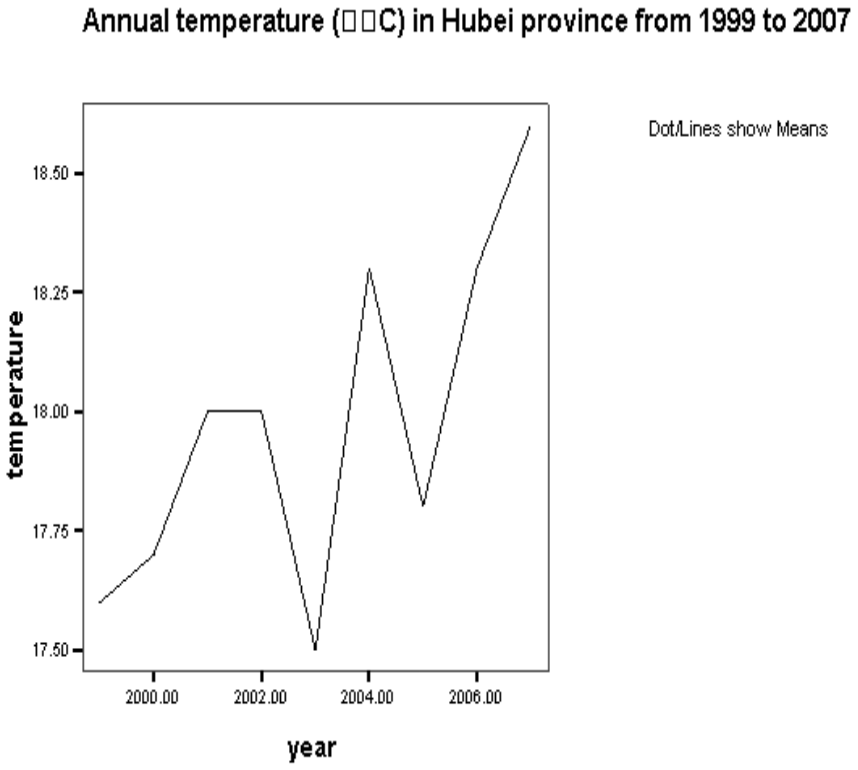
	1987		1994		2005		Change in 1987-1994		Change in 1994-2005	
Land use type	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
Urban	10174.82	15.42	17445.74	26.44	31209.81	47.31	7270.92	11.02	13764.07	20.86
water	15889.32	24.08	14679.83	22.25	11030.12	16.72	-1209.49	-1.83	-3649.71	-5.53
Non-forest	33677.91	51.05	28339.88	42.96	16670.76	25.27	-5338.03	-8.09	-11669.1	-17.69
Forest	7132.01	10.81	4608.98	6.99	7063.56	10.71	-2523.03	-3.82	2454.58	3.72

Sources: Douty Chibamba and Jiangfeng Li, 2008

Table 3. Summary of Biodiversity threats identified in Jiufeng Protected area

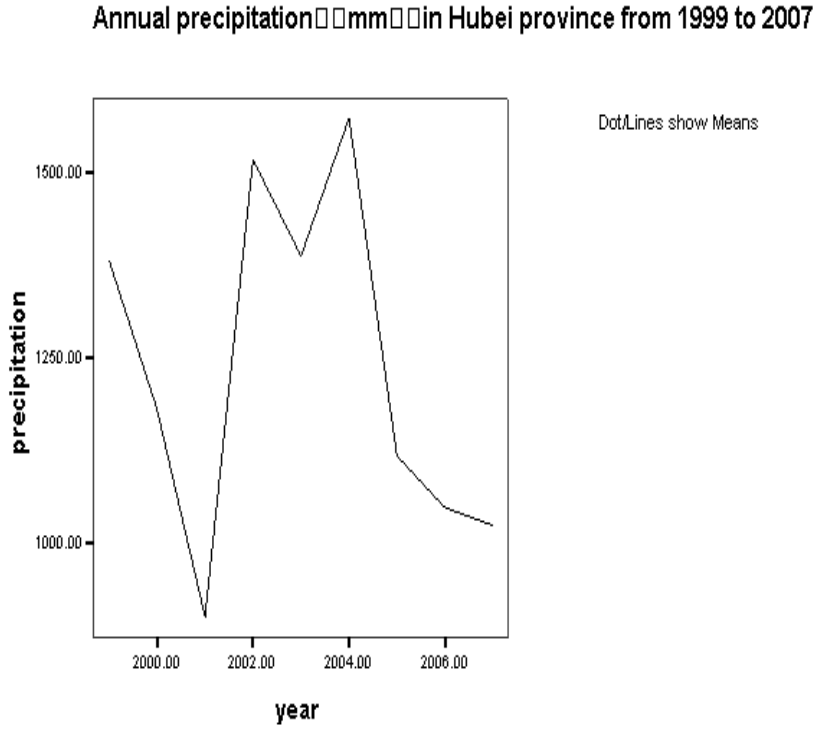
Threats type		Identification method			observations
		Literature review	interviews	Fieldwork	
Land use and land cover change	Agriculture		x	x	Habitat destruction and fragmentation, landscape degradation, reduced population sizes, isolation of populations, loss of species and diversity, depleted condition and functioning of ecosystems.
	housing		x	x	
	roads		x	x	
	Mining		x	x	
Industrialization and pollution		x	x	x	Waste and industrial waste in particular, represents a health hazard, due to its content in toxic substances such as heavy metals (lead, cadmium), pesticides, solvents, and used oils that have proven to be very damaging to the habitat and species. In biodiversity terms, any waste landfill means the subsequent elimination of a number of species
Tourism and recreation			x	x	During the tourism and recreation activities in this area, people drop often biodegradable and non-biodegradable matter such as plastic.
Climate change	Temperature	x	x		Altered rainfall and temperature patterns and more frequent extreme storms floods and drought.
	Precipitation	x	x		
	Extreme events	x	x		
Invasive and alien species		x	x	x	Predation and competition by Invasive and alien species have reduced the extent and abundance of native species

Graph 1. Annual temperature (°C) in Hubei Province 1999-2007



Sources: Hubei meteorological station data from 1999 to 2007

Graph 2. Annual precipitation (mm) in Hubei Province 1999-2007



Sources: Hubei meteorological station data from 1999 to 2007

Picture 1. Building construction in Jiufeng Protected area

Picture 2. Road construction in Jiufeng protectedarea

Picture 3. Landfill in Jiufeng area

Picture 4. Wastes from tourism and recreation activities