



## The impact investigation and adaptation strategy analysis of climate change on nature reserve in China

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### ARTICLE INFO

#### Article history:

Received 18 July 2012

Revised 9 April 2013

Accepted 3 June 2013

#### Keywords:

Climate change

Biodiversity

Nature reserve

Adaptation strategy

Extreme climate event

### ABSTRACT

Nature reserve has been served as the important pathway for biodiversity conservation and carbon storage. Global climate change is an indisputable fact and impacted the biodiversity and nature reserve. How nature reserves adapt to climate change has drawn more and more concerns. This research conducted questionnaires of 68 national nature reserves from 24 provincial regions, and the questionnaires showed that all surveyed nature reserves experienced climate change, and 68.57%, 61.43% and 68.57% of nature reserves, respectively, considered warming temperature, precipitation change, and occurrence of extreme climate events as new threats to them. These new factors directly threat the distribution range and survival of endangered species, change of ecosystem function, enhance of pest and disease damages, and directed damage the infrastructures. However, most of the surveyed nature reserves did not consider the systematic monitoring the facts of climate change, and lack actions and strategies of initiative adaptation to climate change. At last, we proposed the strategies for nature reserves to adapt to climate change, including enhancing the monitoring on the impact of climate change, making scientific planning and designing for development of nature reserves, decreasing the pressure through sustainable development, and enhancing the scientific research and the investment to improve the ability of nature reserves to adapt to climate change.

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### 1. Introduction

Nature reserve, the important areas of biodiversity conservation, is the main body to protect our ecological security and the basis of maintaining economic and social sustainable development. As we all known, the nature reserve and biodiversity are the important contents in both the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. At the end of 2011, a total of 2640 nature reserves were set up in mainland of China, and 2012 nature reserves were managed by Forestry Administration Bureau. These nature reserves protected about 90% land ecosystems, 85% wildlife populations, 20% nature forest and 50% nature wetland in China [1].

Global climate change has become the fact and is already having significant effects on biodiversity, including shifts in species distri-

butions, changes in the timing of life-history events, reductions in population size, extinction or extirpation of range-restricted or isolated species and populations [2–4]. In China, the similar facts of climate change impact biodiversity were observed and the effects of climate change can operate at individual, population, species, community and ecosystem [5]. Under the background of global climate change, biodiversity loss not only affects the ecosystem structure, function and stability, but also will affect the functions of biodiversity for providing the living goods and services to human society and feedback regulation of climate change [6]. Therefore, these changes would significantly affect human society and ecosystem [7]. Climate change is not reversible. Nature reserves and biodiversity how to adapt the adverse effects of climate change has been increasingly strong concern of the international society and become one of the hot research fields in global environment. However, there are not the typical cases in China. In this study, we survey and analyze the effect of climate change on nature reserve and biodiversity by questionnaire in the first time, and provide some adapt strategies to improve the ability of nature reserves to adapt to climate change.

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## 2. Materials and methods

### 2.1. Questionnaire

Questionnaire of climate change impact on nature reserves was designed based on the other reference questionnaire and combined with the characteristics of climate changes and nature reserves. The questionnaire was revised and improved by inviting the relevant experts. The questionnaire has four parts, including the basic information on nature reserve, the observed fact of climate change in nature reserve, the effect of climate change on ecosystem, wildlife, surrounding communities and infrastructure, and the measure and technical requirements to adapt climate change in nature reserve. According to the institution building, professionals and facilities of nature reserve and the sensitivity for climate change, we surveyed the impacting of climate change by the questionnaire in about 200 national nature reserves. All the questionnaires were finish by email or meeting.

### 2.2. Data analysis

All the collected questionnaires were recorded to the Excel table and analyzed by the SPSS (version 19.0) and SigmaPlot (version 11.0) software.

## 3. Results

### 3.1. The questionnaire distribution

A total of 68 questionnaires were collected from 24 provinces in 68 national nature reserves which accounted for 27.53% of the national nature reserves managed by National Forestry Administration Bureau. According to the principle of national administrative divisions, all the questionnaires were classified as seven regions (Table 1). The collected questionnaires basically involved in the abundant biodiversity in China, including North China, Northeast China, East China, Central China, South China, Southwest China and Northwest China. Therefore, the collected questionnaires basically representative the real situation of nature reserves distribution and impacts of climate change.

### 3.2. The observed climate change fact

Compared with 10 years ago, the results found that all the surveyed nature reserves obviously felt the climate change. Warm winters and extreme climate change events are two typical climate change phenomenon observed in surveyed nature reserves. 61.64% of the surveyed nature reserves thought the main performance of climate change is the increasing of warm winter, and 49.23% of surveyed nature reserves thought the increasing of extreme climate change events. The extreme climate change events in nature reserves including the snowstorm, drought and floods. However,

**Table 1**  
The distribution information of questionnaire.

Regions	Including provinces and areas	Collected questionnaires
North China	Beijing, Hebei, Shanxi, Inn Meglolia	7
Northeast China	Heilongjiang	6
East China	Shandong, Jiangsu, Anhui, Zhejiang	5
Central China	Hubei, Hunan, Henan	7
South China	Guangdong, Guangxi, Hainan	10
Southwest China	Sichuan, Yunnan, Guizhou, Tibet	12
Northwest China	Shannxi, Gansu, Ningxia, Qinghai, Xinjiang	21

the fact of climate change has difference in different regions, for example, the warm winter increasing is significant in the regions in North China, Northeast China, East China and Northwest China, the extreme climate change events increasing are significant in the Central China, South China and Southwest China (Fig. 1).

According to the surveyed results, 57.14% of the surveyed nature reserves thought that forest maybe one of the most sensitive ecosystems to climate change and the fragile forest types are coniferous and deciduous broad-leaved forest. In Baimaxueshan national nature reserve of Yunnan, they observed the distribution line of warm coniferous forest is increased along the elevational gradients. 35.38% of the surveyed nature reserves thought that the climate change influenced the plant phenology, for example, the flower time of *Primula malacoides* and *Rhododendron* are become earlier. 87.69% of the surveyed nature reserves found that out of its hole for the hibernating animal is ahead of time and the migration for migration animal time in winter is pushed back.

### 3.3. The threats of climate change on nature reserve and biodiversity

In order to protect the fragile ecological environment and biodiversity, nature reserve was set up and has some degree of certain vulnerability itself. The impacts of climate change are over its self-adaptability of the nature reserve, the ecosystem function and protected objects in nature reserve will be degraded and disappeared [6]. 68.57%, 61.43% and 68.57% of the surveyed nature reserves thought that temperature increasing, precipitation changing and extreme climate change events formed new threats to nature reserve. The threat of climate change on nature reserve and biodiversity in different regions are variables, almost of all the surveyed nature reserves thought that the increased extreme climate change events is the most serious threat to nature reserve and biodiversity, except for the region of Southeast China. In addition, precipitation changing is the secondary serious threat to nature reserve in most of the region, except for the region of East China and North China (Fig. 2).

The cases of climate change impacted nature reserves and biodiversity were observed in the surveyed nature reserves and including influence endangered species distribution, survival, ecosystem function, and pests and diseases disaster. For example, the Fanjingshan fir (*Abies fanjingshanensis*), national class I protected plant, narrowed it distribution ranges in Fanjingshan nature reserve in Guizhou province. More and more *Rhododendron* were death in the high mountain in Fanjingshan nature reserve. In Tangjiahe nature reserve in Sichuan province, the increasing of precipitation reduced the fruit number of the tree which direct threats the food of some protected animal species, such as snub-nosed monkey and *Muntiacus reevesi*. The increasing of extreme climate change events lead to the directly death of a large number of rare resources, desertification and soil erosion. In 2010, persistent drought caused the directed death of a lot of *Cycas panzhihuaensis* in Yunnan Yaoshan national nature reserve, 237 *Chinese yew* and about 3000 *Davidia involucreta* Baill death Yunan Baimaxueshan national nature reserve. Some wildlife is very sensitive to temperature, precipitation and wet degree of environment. Warming can increase pathogen growth and survival rates, disease infectious and host susceptibility to infection. These factors combined threat the biodiversity. The survey found 39.1% and 37.0% of the surveyed nature reserves increased the frequency and areas of forest pests and diseases in recent 10 years, respectively.

### 3.4. The directly threat of extreme climate change events on nature reserve's infrastructure and surrounding community

The frequent occurrence of extreme climate change events caused devastating harm to the infrastructure of nature reserve

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