International Alliance of Protected Areas

Operation Guide Series

(For Protected Area Managers)

Friendly Development Operation Guide for Protected Areas and their Surroundings

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International Alliance of Protected Areas (IAPA) was proposed by Changbai Mountain National Nature Reserve of China in 2013. With strong support of Jilin Provincial Forestry Department and Changbai Mountain Conservation and Development Management Committee, IAPA was officially established in 2014 and affiliated to the International Society of Zoological Sciences (ISZS). It unites protected areas (PA) in the world to promote coordination, collaboration and cooperation among PAs at national, regional and international levels; promote species surveys and monitoring, trans-regional conservation, and mitigating the impact of global climate change on biodiversity; strengthen conservation publicity and education, explore friendly development strategies in PAs and surroundings, and promote combating environmental crime at site. It becomes a platform for improving management effectiveness of PAs to achieve the goal of harmonious development between man and nature. The first five IAPA annual meetings were held in Changbai Mountain, Shennongjia and Tangjiahe national nature reserves of China. By September 2018, there are 99 PA members (31 from outside of China).

IAPA Operation Guide Series are especially designed for PA managers, and kept short, practical and linked to the best and most recent guidelines in the world. It will be reviewed and updated constantly along with practices. Revisions are welcome and suggestions please send to: cbm_iapa@126.com

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The Global Protected Area Friendly System (GPAFS) was initiated in 2013 by the task force of Institute of Zoology, Chinese Academy of Sciences and encouraged by the 6th World Conservation Congress, to bring together scientists, entrepreneurs, civil organizations, and the public to support, promote and participate in new production models that are beneficial to nature conservation in and around PAs, to stop the decline in global biodiversity, and to ease the biodiversity loss crisis that threatens humanity's safe operating space. More information found in www.gpafs.net.
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IAPA
International Alliance of Protected Areas

GPAFS
保护地友好体系
Global Protected Area Friendly System

The PARADISE 桃花源
The Paradise International Foundation
桃花源生态保护基金会

Friendly Development Operation Guide for Protected Areas and their Surroundings

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The intersection between protected areas (PAs) and the development goals guiding government priorities presents some of the greatest challenges, as well as opportunities, to PA policy makers, planners, managers, and researchers. In the end, most challenges to PA are part of the larger challenges to national development, calling for wide cooperation to create the friendly conditions that will enable PAs and their surrounding lands to prosper.

1 The significance of PA to economic and social development

PA provide essential ecosystem services to society, supporting the health, safety, and economy of people in and around PA. Working on PA conservation work provides increasing employment opportunities and career development for the locals. Ecological compensation work is often around PA, which directly benefits the local community. PA also make many contributions to the development of the surrounding area, as discussed in further detail below.

1.1 PA are a critical part of the water cycle

Water purification is one of the most important ecological functions of PA. Forests, surface vegetation, litter, burrowing animals, subterranean fauna, a variety of bacteria and other microorganisms, as well as hydroids, mollusks, worms and other filter-feeding organisms and fishes in the wetland ecosystem help to purify water. Watershed protection and the provision of freshwater may well be one of the most valuable ecosystem services provided by PA, providing irrigation, drinking water, and hydroelectricity to the farmlands, villages, and cities. Areas around PA typically have much higher rainfall than the lowlands because many are located in the hilly or mountainous areas that capture clouds. The watersheds of many reservoirs are conserved by PA, helping to reduce erosion and thereby extending their effective life. Wetlands can also help to purify toxic bacteria, farmland pollution, domestic sewage and waste, industrial pollution, and so on.

1.2 PA can reduce disasters and conflicts

By keeping land in mature vegetation, PAs can help prevent the effects of heavy rainfall, windstorms, and earthquakes (and accompanying landslides). They can help prevent disasters from extreme natural events and mitigate their effects on people. Wetlands are adapted to flooding, which is a natural process that helps to provide nutrients to agricultural lands far downstream and enable fish to migrate and breed.

The PA along international borders help to avoid or at least cushion land disputes and contribute to the maintenance of national security and the well-being of local people.

1.3 PA can increase agricultural income

Agriculture is the main economic activity of many communities around rural PA. The rural people depend on food crops, herbs, condiments, forest products, livestock, fish, bamboo, silkworm silk, and other products. . PA provide better ecological conditions for the development of agriculture in their surrounding lands, and can increase agricultural income by maintaining healthy water resources, providing sustainable non-timber forest products, reduce disasters and increasing production through pollination services.

The healthy ecosystems of PA create conditions for diversified natural medicinal plants and animals in the surrounding area, and for their cultivating and breeding. This in turn brings benefits to the locals through direct medicinal use or cash income. Many medicinal plants are found in PA, and some of them may find their best habitats within PA or even be confined to them. Numerous species of plants contain bioactive organic compounds potentially useful for pharmaceutical applications, and many of these are harvested for local use as well as both domestic and international markets.

PA conserve genetic diversity of species of economic importance, including wild relatives of domestic plants and animals that can improve domestic crops. Wild fruit trees and wild animals such as forest chickens, pigs, mountain sheep and goats help support adaptive farming systems.

PA provides harbors for pollinators, which can improve pollination rate to increase agricultural productivity. PA provide natural enemies of crop pests, such bats and birds that prey on insects that feed on crops or spread diseases. Snakes, owls and many other small carnivores prey on rodents that can devastate stored grains as well as carry diseases.

Many farmers harvest wild freshwater fish whose supply ultimately depends at least partly on PA. Many of these fish are migratory species, being born upstream in the streams of PA and then migrating downstream as juveniles to grow into adults (and be captured to feed people or to be raised in aquaculture ponds) before returning upstream to again reproduce. These upstream PAs are an essential part of the life cycle of many species of harvested freshwater fish.

1.4 PA create conditions for ecotourism

PA create conditions for the development of tourism. PA can enhance the happiness of visitors, and provide children with opportunities to interact with nature, contributing to their personal growth. When people are close to water, they are happier, so waterfalls, streams, lakes, and seashores are very attractive to tourists. Tourism supports services such as catering, accommodation, culture, entertainment and leisure, demonstrating the economic value of PA and providing employment opportunities for local residents. With the economic benefits, local communities are more willing to

maintain and improve the ecotourism destination and the ecological environment of community through its own actions.

In addition to economic and environmental benefits, PA help conserve the cultural heritage of the local community. The local customs and cultures are closely related to unique landscapes, ecosystems, and flora and fauna. Many wild animals are of important iconic, cultural and spiritual value. Wild animals, often large carnivores or venomous snakes, have deep influences on arts and cultures, appearing in operas, movies, poems, artworks, calligraphy, paintings, handicrafts, and home ornaments as totems. Familiar examples include the strong and mighty tigers and eagles, song birds, graceful cranes, and long-lived turtles. Participating in ecotourism activities can stimulate local community pride in their natural resources and culture, which in turn encourages continuing conservation of wildlife and cultural heritage.

2 The impact on PA of development in their surrounding lands

While PA provide their sounding lands, including buffer zones, with multiples benefits such as those described above, some developments around PA may threaten them. These developments include but are not limited to spread of urban areas, construction of dams, illegal harvesting of timber or wildlife, road traffic, mineral extraction, introduction of invasive alien species, and unregulated tourism. Air, water, and soil pollution caused by agricultural runoff, industrial, and large fires, can degrade soils and harm wildlife thus changing the original ecological balance. Unregulated deforestation, excessive agroforestry, and overgrazing will destroy vegetation. Poaching or targeted killing of animals can cause drastic change in the population of certain species, disrupt food chains, and affect entire ecosystems. Removing large predators, for example, can lead to increased populations of wild pigs that can devastate crops. Soil pollution and excessive human disturbance disrupt the function of decomposers that contribute to soil fertility.

These problems can pose a threat to PA. Since the vast majority of PAs are for the long-term interests of the locals and the global population, the contradiction between these harmful activities and conservation cannot be solved only at the local level, but requires a wider range of national and even global support policies to help reduce the contradiction between development and conservation.

3 Overall planning for the development of PA

Handling the relationship between PA conservation and local community development is the most effective way to achieve conservation management objectives. While the focus of managers of PA will inevitably be on their sites, they must also address the needs of surrounding lands and waters, including farms, forest plantations, forest reserves, fish farms, mines, and all other land and water uses, as part of comprehensive land and water management that affects their PA. This relationship will affect the interaction between the various land uses, requiring planning as a dynamic process that goes through stages affected by feedback among the various interest groups.

This approach, commonly known as "adaptive management," requires long-term monitoring. First, the monitoring plan needs to be carefully designed, selecting appropriate indicators according to the needs. Select target species based on the resources available, local socio-economic and ecological conditions, and the management objectives of the management to ensure the implementation, relevance and utility of the monitoring plan. For more details on monitoring, please refer to the *IAPA Operation Guide Series - Monitoring Planning Operation Guide for Protected Areas* (Xie et al. 2018).

3.1 Establish support policies for friendly development around PA

The economic development around PA should adopt a different development model from other places. The PA objectives and the needs of biodiversity conservation must be given first priority. However, establishing and maintaining a friendly development approach cannot rely solely on local community initiatives. Locally friendly development methods must be supported by PA management agencies, governments and society. The lands surrounding a PA should be treated as a special economic belt, requiring relevant policies and support, corresponding management measures and incentive mechanisms, and a support system for PA. The core of such special economic belt management is to control the development that may lead to serious damage and to support and encourage the development of natural PA friendliness such as providing relevant ideas, technologies, capacity building and market and capital support for community friendly development. Implementing the following proposed policies will promote the formation of friendly economic development around PA:

1) To reduce the threat to conservation, the PA management should take it as an essential responsibility to help the communities develop environmentally friendly development, and actively help the community to improve related capabilities, and provide information and channels;
2) Design and support policies that strongly support friendly development around PA, including government procurement, ecological compensation, payment for ecosystem services, green finance, and ecological poverty alleviation;
3) Help the local community to establish community-based organizations, cooperatives, and enterprises to address the problem of community livelihoods, and fundamentally alleviate the contradiction between conservation and development;
4) Support social enterprises to jointly carry out various forms of conservation work directly or in conjunction with local communities and become the new participant of PA conservation;
5) Through the government and enterprises, purchase services of civil organizations that can become the major provider of conservation, supervision, education and ecological technology and other technical services in the special economic belt;
6) Through publicity and brand building, cultivate the economic market of friendly products around PA, so that the value of ecosystem services can be effectively transformed, value-added and realized, supporting eco-friendly development; and

7) The public far removed from PA has become a powerful social force of the ecological conservation by purchasing and experiencing friendly products and services, and supporting and participating in conservation.

The following operation guide can help the PA management body to promote the surrounding economic and friendly development as part of their work, in order to reduce the local development threat to PA, and improve their enthusiasm and participation in supporting conservation by improving local people's economic income, and mobilizing more extensive social support.

3.2 Overall planning of surrounding development areas

Each PA has its own conservation management objectives, which are different for different major conservation targets and the different types of activities that need to be implemented, such as management of forests, water, wetlands, birds, mammals, biodiversity, etc. The need to achieve the conservation goals, and therefore the development of friendly development methods and requirements will vary. Some may focus on water system conservation, some provide suitable habitat for flagship species, and some focus on the overall conservation of representative ecosystems (tropical rainforests, grasslands or wetlands). The shape or range delineated by the special economic zone around a PA will be planned according to its objectives. For example, the area that provides water for a PA lake plays an important role in the ecological conservation of the lake. Therefore, this special economic belt can be more concentrated in these water sources to ensure clean water flows into the lake. The planning and management of the surrounding development should focus on the specific management objectives of PA, determine the threats (including potential threats) that threaten the realization of these goals by surrounding development, plan at the landscape scale, design a series of measures and plans, and implement them effectively.

Achieving friendly development requires ecological assessment work based on the management objectives of PA, and an overall development plan for the surrounding region that will conserve biodiversity. The ecological assessment work needs to communicate with various local stakeholders (governments, operating companies, local communities, research institutions, non-profit organizations, etc.). The ecological assessment involves the following aspects:

1) Clarify the management objectives of PAs. Identify the overall situation of biodiversity, value of biodiversity, important rare species (key species, flagship species, umbrella species and indicator species etc.), natural and healthy vegetation, and distribution area of vegetation of the site;
2) Map terrain, landform, soil, drainage, river system, geographical advantage, peculiarity and vulnerability of each site;
3) Identify human activity type and situation on site, and analyze human activities affecting biodiversity;
4) For each site, establish zones in accordance with ecological characteristics, importance and development activities that should be limited, and implement a zoning management system according to the needs of ecological conservation and

restoration. For example, intertidal zones, coastal areas, rivers, and lakes are often ecologically fragile. The local zoning management should be particularly beneficial to the conservation needs of such systems. Since ecological health produces more biomass and biodiversity, it is also the most attractive place for tourists;

5) Put forward key ecological protection measures; ecological restoration areas; suggestions on agricultural development; suggestions on ecotourism development; and analysis of development capacity;
6) On the basis of the ecological protection report, formulate the development plan, including roads, buildings, other infrastructure, and agriculture. This is to ensure that, from the beginning, all projects include ecological conservation as an important element of the development plan, and develop the landscape to achieve ecological conservation.

3.3 Planning and management around water ecology

Water is a critical part of development-friendly PA management. Ideally, water management should be at the scale of a watershed, basically a drainage basin that typically will have many water users who all have legitimate demands on the water: local farmers, downstream farmers, hydropower installations, domestic users, fishermen, and industrial users, among others. Watersheds can be relatively small, like those found in the upper reaches of many forested PA. Some are internal to a country or may include several countries. The watershed or river basin scale helps resource managers consider the full range of ecosystem services and functions that the rivers are providing. Adding economic considerations can help ensure that the values of these various ecosystem services are well represented in negotiations over how the river and its PA ecosystems are to be best managed. Questions that need to be answered include:

1) When should the forests around a reservoir be managed as a PA that reduces sedimentation rates?
2) How much water should be allocated to the environmental flows that will enable the river to continue providing its full range of ecosystem services, including to PAs?
3) What are the ecosystem implications of alternative uses of the available water?
4) How should the reservoir system be managed in times of extraordinary rainfall, or in times of drought?

All of these issues will benefit from dialogue that will be more effective if the scale is sufficiently large to incorporate the full watershed of the river. PAs will typically have more responsibility for the upper watersheds, giving them an important role in answering these broader questions that have wide social and economic implications.

3.4 Planning for community participation

The main implementation party of friendly development around a PAs is the local community. The benefits generated from conservation should be generously shared with local communities, to ensure that the development rights of the community residents who may have paid a price for conservation, and to obtain the corresponding revenue from conservation results. Only when the local community can benefit from conservation can it be expected to stop destructive behaviors such as poaching, deforestation, and over-exploitation of resources, and support and help effective management of PA. A cultural resource of considerable, but often underappreciated, value is traditional ecological knowledge (TEK) that has been gained through many years (sometimes extending over many generations) of living in ecosystems now contained within the PA system. Development planning around PAs requires planning for community participation.

1) Recognize the value of traditional governance and local contributions to conservation, and seek ways to incorporate such TEK into modern management (and tourism development, as tourists often are interested in the peoples living in and around PAs, including ethnic minorities).
2) Build a participatory approach to PA management that recognizes such concepts as Free Prior and Informed Consent (FPIC) and clear channels of communication with PA management authorities, including at the planning stage. Such involvement can also help in reducing poaching pressure, and become part of Smart Patrolling.
3) Ensure that innovative forms of finance, such as payment for ecosystem services, are designed to provide material benefits to communities in and around PAs. This may require some development and training on the part of both PA management and the local communities.
4) Promote more conservation-friendly production practices, such as agroforests, for those communities living in and around PAs, thereby providing benefits to the local people while enhancing traditional conservation as an essential part of the improved practices.
5) Include TEK and other forms of ancient wisdom linked to the PA site within communications materials for both tourists and school visitors to the site. Such TEK can be applied to modern problems such as adapting to climate change, extreme natural events, and human health (for example, medicinal plants from within the forest).

4 Reduce ecological damage

The surrounding areas of PA often involve the infrastructure of roads, canals, pylons, transmission lines, mines, railways, and houses, as well as the construction and management of villages and towns. PA and surrounding areas may need other

infrastructure to help meet the management objectives of the site. Tourists and residents need clean water, reliable provision of energy (solar, micro-hydro, wind, and other clean energy sources are preferred), sanitation facilities, communications, and others. All such infrastructure should be designed and constructed using the best available technology applied to relations with the PA resources. Some of the PA infrastructure may also benefit nearby villages and towns, especially in remote areas. But improper planning, construction and use can pose a threat to the objectives of PA, and good management of infrastructure construction and operations can minimize negative impacts. Ways to reduce damage during construction and development are discussed below.

4.1 Avoid surface vegetation and ecosystem damage

Building houses and developing agroforestry on steep slopes must be restricted to avoid turning steep slopes into bare areas. Where it is necessary to construct on steep slopes, consider investing in strengthening measures to reduce erosion. It is better to building at the bottom of the steep slope.

Avoid building homes in areas prone to flooding. Such areas should be zoned as open areas, recreational areas, wildlife sanctuaries or farmland.

Avoid building houses on the top of mountains, where they are exposed to the wind and storms, and destroy natural landscapes. Buildings below the top of the mountain can get more shelter, and from a distance are discrete, helping maintain the natural environment and enhancing ecotourism potential.

Sandy coasts are very fragile and can be easily exposed to storms and seawater if they lose their natural vegetation. Development should be carried out on a solid surface away from the coast.

The original vegetation should be preserved as much as possible in the construction project; once the original vegetation is removed, it will be difficult to recover. Surface remodeling should be minimized to maintain a natural ground curve to minimize adverse effects on the environment. During the construction process, damage to natural vegetation should be minimized, and after the construction, natural vegetation should be restored as soon as possible to prevent landslides and soil erosion. Revegetation should always be with native species.

Highways should be built along natural contours to avoid direct access across mountainous terrain and reduce soil erosion. Road construction usually leads to soil erosion. During the construction of the road, the mountain on the high side is often destroyed. When gravel is dumped on the slope on the lower side, the high side can become a source of water erosion for a long time, and the vegetation on the lower side of the slope may take decades to recover.

Excessive grazing from domestic goats and sheep can destroy the quality and productivity of biodiversity and pastures, spreading toxic and unpalatable weeds. Different herbivores feed on different plants, and having several different species grazing on the grassland will be less damaging than grazing of a single species. The combination of different grazing patterns will result in higher plant diversity and better grassland quality.

The development of crop rotation agriculture on steep slopes will destroy biodiversity and cause a lot of soil erosion. Perennial cover crops or working forest that do not require tillage should be used on steep slopes. Rich and diverse surface coverage instead of monoculture should be encouraged to reduce soil erosion.

Methods to reduce soil erosion on farms include: construct terraces; construct physical or living (e.g. bamboo lines) bunds to reduce rate of water flow downhill; building check dams in erosion-prone gullies; cover land scars with vegetation as quickly as possible; increase water penetration of soils by introducing trees (agro-forestry); encourage vigorous green manure cover in fallow periods; plant wind breaks.

Coral reefs are highly productive ecosystems with a wealth of ecosystem services such as fish nurseries, tourist resorts, carbon sequestration, coastal conservation, and many more. These places must be managed for conservation, prohibiting coral reef mining, fishing, fish poisoning, illegal vessel mooring, sand mining or pollution discharge.

4.2 Development and management of roads in and around PA

While road transport is essential to the national economy, and some roads through PA may be required to meet the need for fast and convenient transportation, such transport routes also pose significant threats to PA. Roads tend to fragment habitats (thereby disrupting migration and other movements of plants and animals), lead to accidents that are dangerous to both wildlife and travelers, and open up the PA to poachers or even settlers. Roads have been shown to have a major influence on deforestation by providing easy access to valuable timber, even within PAs. Each official road in any forest tends to lead to additional illegal roads that branch like a tree into the PA, thereby providing access to the forest resources. Roads also help facilitate the invasion of native forest ecosystems by non-native species that may be harmful to the ecosystems the PA is designed to conserve.

Any roads built within and around a PA can avoid disrupting water flows, soil erosion, and pollution through comprehensive planning and subsequent monitoring of the effectiveness of road design features. Any areas cleared during construction of the road will be replanted with species of plants native to the PA.

Many national or provincial highways may pre-date the establishment of the PA through which they travel, or cut through the new PA complexes that are now becoming a major design principle for the PA system. It is seldom realistic to close such roads, especially when they are major transport routes. For these roads, seek to minimize their negative impacts on the PA and find ways to build corridors that enable wildlife to migrate over or under the highways.

Regional highways that pass through PA should post clear signs that indicate when they are entering the PA and when they are leaving it. Signs should also warn drivers when they are approaching areas where wildlife often crosses the highways. Such major

highways should provide an engineering solution to the problem of collisions between wildlife and vehicles. These can take the form of constructed wildlife corridors, including such elements as overpasses or tunnels that are designed to be attractive to species such as deer, takin, and tigers. In suitable habitats, overpasses should include trees of sufficient stature to enable arboreal species to cross the highway.

When highways enter National Parks or Wildlife Sanctuaries, vehicles should be expected to follow strict speed limits (for example, 60 km per hour), enforced through signs, radar, camera traps, and speed bumps.

All roads, even major ones, that go through PA or are adjacent to them, shall be subject to check points where automobiles and trucks can be inspected to ensure that they are not exporting any illegal products from the PA, or carrying plants or animals that may become invasive. These checkpoints can be made less intrusive by providing facilities such as fueling stations, restaurants, information booths, shops, restrooms, and waste disposal facilities.

Roads internal to the PA are typically connected to at least provincial roads, but are independent once they serve primarily the management purposes of the PA. Many roads in PA are also used by pedestrians, because they can provide good viewing opportunities for those on foot, but this may lead to some traffic congestion problems during popular periods and has generated conflicts with PA staff in some cases.

For popular PA, provide incentives to encourage visitors to use transport provided by the PA rather than private automobiles. Economic incentives could be inexpensive parking lots outside the PAs matched with frequent and inexpensive transport to key sites or attractions within the PA. This could be matched by a financial disincentive, such as a charge for an automobile to enter the park and parking fees at the popular sites where parking facilities are provided. This could also help generate new funding for the PA.

Design roads that are intended to support the management of the PA specifically to meet the management objectives for which it is constructed, typically either to highlight scenic attractions or to reach campgrounds, waterfalls, historic sites, or concession centers. Avoid disrupting natural vegetation, and blend any engineering structures into the natural setting wherever possible. Roads to support tourism should be well integrated into the landscape, include appropriate viewpoints, avoid coming too close to salt licks or watering points for wildlife, encourage a leisurely speed, and be as safe as possible for both wildlife and drivers. Such roads should enhance the positive attractions of the PA and add value to the experience of visiting the PA. They should minimize environmental impacts, and may be designed for low-speed traffic following one-way roads to provide a scenic loop (thereby reducing traffic congestion).

A major design objective for a PA road is to make it memorable to the visitors, so that the road itself becomes a destination, an opportunity for photographs, and with

multiple attractions along the route. When modifying existing roads or building new ones, advice should be sought from landscape architects, ecologists, and artists as well as engineers. Giving colorful names to some roads may also be appropriate, based on their major attractions (waterfalls, caves, wildlife observation). Provide roadside parking lots at popular spots along the road.

Design roads designed to facilitate patrolling against illegal activities so they are accessible only to vehicles of the PA staff, though such roads inevitably will become trails for tourists as well. Access roads to staff housing, maintenance facilities, sewage plants, and research facilities typically will also be closed to the public.

With the growing popularity of bicycles, special paths or roads for them may need to be considered. On the other hand, motorcycles may become a management problem when they are too noisy or encourage inappropriate off-road activity.

4.3 Promote green building construction

Some PA have no permanent housing, while others include housing for staff and hotels for tourists. More commonly, the lodges for visitors, and even high-quality hotels when the PA offers major attractions, are built in the PA buffer zone or in nearby towns. National PA agencies should provide the policy basis for such housing, while provincial or regional PA agencies may provide design standards with an emphasis on green building that helps to communicate the conservation message of the PA. Construction materials should come from outside the PAs, with an emphasis on sustainable production.

"Green buildings" are built and operated in harmony with nature throughout their entire life cycles, are suitable for using in a healthy way, and are operated with high efficiency. They use the minimum of resources such as energy, land, water, and materials, as well as protect the environment and reduce pollution. "Green buildings" improve the environment, upgrade living quality, conserve energy, reduce emissions, and contribute to protecting the environment.

Green building design includes two main points. First, the building itself must have efficient resource utilization and use environment-friendly building materials. The second considers building surroundings, adapting the building to the local climate and geographical conditions.

Green building designs require compact and rational placement with high efficiency; reasonable indoor design layout with comfort, ease, health and safety; and an environment suitable for living. In terms of decoration materials, they minimize the use of polluting items so as to ensure indoor air quality; fully use sunshine and natural winds in main rooms; focus on heat insulation; and keep appropriate indoor temperatures in both summer and winter to save energy and create ecological comfort for residents. Green buildings are aimed at an integrated development of people, buildings, and natural environment. They seek to create a sound and healthy living environment through natural conditions and, where necessary, artificial means. Meanwhile, they reduce impacts on the natural environment as much as possible,

demonstrating a balance between people and the rest of nature.

The height of the building should be limited around the PA. High-rise buildings dominate the natural landscape, and the lower buildings are better integrated with the local landscape. The color should also be in harmony with nature, and generally choose the most common color in the local natural setting, such as land and vegetation.

5 Methods of controlling pollution

The construction and development of the PA should demonstrate management that minimizes water pollution, air pollution, sound pollution and light pollution, explicitly adopting practices that enhance the natural value and beauty of the area.

Limiting pollution also contributes to PA objectives. For example, the massive discharge of discarded chemicals in rivers, lakes, coastal areas and other waters, can lead to the outbreak of toxic algae, which release neurotoxins that kill fish and molluscs, and even threaten human health. Dealing with the pollution source and curbing the spread of pollution is a key contribution of PA to sustainable development. The following are steps that can be promoted by PA managers to achieve friendly development.

5.1 Reduce the use of pesticides and fertilizers

Excessive use of pesticides and herbicides in agriculture can destroy biodiversity, kill pollinators and natural predators of pests, and contaminate livestock and human food chains and water sources. Excessive use of chemical fertilizers can also lead to problems such as eutrophication, soil compaction, and pollution of water sources. Instead, use development-friendly technologies such as organic fertilizers, artificial weeding, biodegradable chemicals, targeted drugs, avoiding the use of chemicals near rivers or during the rainy season, using biological control techniques, setting pest control thresholds, etc. These measures actively promote ecological planting around PA, comprehensively use various measures to reduce the use of pesticides and fertilizers, improve biodiversity, and produce healthier food. The following are other friendly development practices that can be followed in the surrounding lands.

1) Reasonable intercropping and relay-cropping. Diversity cropping can avoid diseases and the kinds of pest explosion that have been induced by large-scale planting of monocrops. A greater diversity of crops will attract more living beings to develop a self-balanced system of mutual promotion and restraint. For example, shallot, ginger and garlic relay-cropping with crops of the same season can expel pests; and planting target crops (crops particularly attracting certain pests) can attract pests to take food from the target crop and mitigate loss of dominant crops; marigold and most types of vanilla can expel pests.

2) Straw mulching. For eco-agriculture, straw can be a real treasure for mulching, from both crops and wayside weeds, meeting multiple objectives: to protect soil

microorganism and insects, as the rotten straw can be food of microorganisms and some insects; to restrain weeds; to restrain evaporation and maintain soil moisture; to adjust soil temperature as natural air conditioner and keep soil warm in winter and cooler in summer; to increase nutrients by using the rotten straw as organic fertilizer; to improve soil by using the straw to attract soil microorganism and insects; and to retain water and soil, with soil sheltered from sunlight exposure and storm erosion to avoid water and soil loss.

3) Comprehensive utilization of methane slurry. Farmers are especially concerned about diseases and pests, which is why many of them use so much pesticides. But eco-agriculture offers a viable alternative. If farmers avoid violating the principle of biodiversity (such as the harmful practices of large-scale monoculture or applying chemical pesticides and fertilizers), the crops will be stronger and naturally resistant, so diseases and pests will decrease. Even if diseases and pests develop, a non-pesticide option is available: application of methane slurry. Methane slurry producing gas after more than two months normally contains various hydrolases, vitamin B group, amino acids, plant hormones, antibiotics, ammonia and ammonium salts, humectant and multitude of mineral elements. It can be applied as an excellent manure, and function to prevent diseases and pests. It can control the vast majority of diseases and pests of the vast majority of crops, including rice, wheat, corn, fruit trees, and vegetables. The method of application is simple: seed dressing, irrigating, root adding manure, and spraying every 15 days for 2-3 times. The back of the leaf should be focused on, as most of the leaf stomas are dispersed over this side of the blade. Note that the methane slurry should be diluted 50% before leaves turning green, and straight methane slurry can be used only after leaves have matured. In addition, avoid application at high temperature for fear of burning leaves.

4) Reasonable management of weeds. We seek to rehabilitate weeds, because they are the gifts of nature with many benefits:

- **Maintain balance**: the diversity of grass is favorable for ecosystem stability and balance;
- **Soil guard**: the weeds cover the soil to defend it from wind blowing, sunshine, raining, and keep the water and soil;
- **Fertilize soil:** the weeds can fix and make nutrients through photosynthetic activity;
- **Keep constant moisture and temperature**: the weeds can control soil climate, keep constant moisture, prevent water logging, and act as a natural air conditioner;
- **Improve soil**: the seasoned and dead roots can be satisfactory food for micro-organism, which can help in improving soil, and some species also fix nitrogen and thereby improve productivity;
- **Home of insects**: to provide food and living environment for insects that prey on pest species; beneficial insects also help crop growth; and
- **Mitigate pest damage**: to adsorb excess nitrogenous fertilizer, keep nutrient balance of crops, and reduce the loss from diseases and pests.

5) Science-based soil conservation. Although about 95% of soil is minerals, the other 5% comprises organic substances and microorganisms that determine soil quality. These determinants of soil fertility cannot be seen without a microscope but give life to the soil and convert non-absorbable nutrients or crops into absorbable ones. The key to soil protection is the protection of soil microorganisms, of which soils support numerous types and quantities, including as many as 500 million tiny animals, 500 million microphytes, 1 billion mycetes and 10 billion actinomycetes in one kilogram of fertile soil. Different microorganisms have different functions, some to reduce noxious materials in the soil; some to retain the soil moisture; some to fix the nitrogen in air into the soil and make nitrogenous nutrients absorbable for crops; some to synthetize humics; some to secrete antibiotics, restrain multiplication of pathogenic germs and mitigate the hazard of soil-passing pathogenic germs to crops; and some to promote soil development and shape soil aggregates.

Soil damage by pesticides is well known, but fertilizers and agricultural films can also damage soil microorganisms. Tillage is another disruption for microorganisms, making violent upheavals for them, whether through mechanical, animal power or human power, the microorganism families are scattered and broken up. No-tillage can protect the soil structure and microorganisms. Under no-tillage mode, the microorganisms, insects and temperature fluctuation of the seasons can keep soil loose naturally. No-tillage soil also avoids water and soil erosion, which is favorable for soil restoration and can save labor. Expert studies show that no-tillage fields have 1.1 times more rapidly-available phosphorus than a ploughed field, and 34.3% more rapidly available kalium than the ploughed field. In addition to the aforesaid practices, other methods include stockpile manuring, green manuring in slack winter season, and application of cake fertilizers to improve and fertilize the soil and provide soil nutrients.

5.2 Control other types of pollution

The emission of harmful gases should be strictly controlled around PA. The smoke caused by burning wood affects the air quality and reduces the value of eco-tourism. Instead, develop electricity and biogas than can reduce the demand for local firewood and improve the quality of the environment.

Burning agricultural waste can also reduce soil carbon content and fertility, kill beneficial soil microbes, and destroy biodiversity. Control combustion to promote the use of fertilizer decomposition methods that return organic matter to the soil.

The pollution discharge of surrounding buildings should be strictly controlled, and forbid direct discharge of any pollutants into the water system. For sanitation, cesspools should be established, and a special wetland for purifying water should be established downstream of the cesspool before the water is discharged into rivers and lakes.

Where dust, smoke and noise are generated in towns, the PA green buffer zone should be fully utilized for mitigation because green plants can absorb noise, absorb dust, improve the climate, beautify the environment, and attract birds and other wild animals. Local species that do not require extensive watering should be planted, and endemic plant species can also highlight local ecological characteristics and increase

biodiversity value.

PA are rich in wildlife, and excessively strong artificial lighting in the evening can interfere with their living habits. Light attracts certain animals and can cause a large number of deaths of these species if they are trapped by predators. Therefore, peripheral areas of PAs should avoid the use of strong, overnight lights to reduce interference with wildlife. The reduction of lighting adds the light from stars and the moon to the natural beauty of the night scene, which is one of the attractions of nature for tourists.

Noise from construction, cars, music, and loud speeches will scare away wild animals, destroy natural tranquility, and drown out the natural sounds of animal calls, bird songs, streams, and wind and rain in the natural environment, greatly reducing the attraction from these areas as an ecotourism destination. Prohibiting sound-amplifying equipment and encouraging quiet behaviour will improve the leisure and tourism value of PA.

6 Maintain and restore the natural environment

Biodiversity originates from the great variety of geographical environments. Each place has undergone long-term interactions between biological and geographical factors, including human impacts over thousands of years, and this has formed the different ecological environment and biodiversity composition of each PA. The surrounding environment is deeply affected by the PA. And the surrounding land use methods should also follow the local natural, geographical, hydrological, humanistic, historical conditions and laws to preserve and restore the living conditions of wild animals and plants, and maintain the unique local conditions. Maintaining the distinctiveness of each PA surrounding landscape contributes to\ the long-term economic value of these places. If the ecological setting is destroyed and the uniqueness is lost, its long-term economic value will inevitably decline.

Maintaining the advantages of a healthy local environment requires taking appropriate conservation measures around the PA to maintain maximum ecosystem connectivity, stop or control hunting and collection of wild species, maximize habitat diversity, minimize the introduction of alien species, strictly control invasive species and take measures to conserve sensitive areas.

6.1 Controlling alien species

If non-native invasive species are introduced in the peripheral areas of a PA, they will expand into the PA. So do not introduce exotic ornamental plants, grass or trees, or introduce exotic animals or plant trees in natural grasslands. If the species becomes a problem in the future, it must be removed, and the sooner it is removed, the better.

Replacing local crops and vegetable varieties with new “high-yield” varieties has seriously damaged agricultural biodiversity and germplasm resources. Many new varieties deplete the fertility of the soil and require a large investment in expensive fertilizers and pesticides. Compensation, labeling, and other policies should be used to encourage farmers to continue to cultivate traditional varieties that are more

sustainable and require less fertilizer and pesticides. The variety of seeds needs to be conserved to be used in traditional cross-breeding methods in the future.

The non-native species that are phylogenetically or functionally close to the native species are most likely to become invasive. If the local species have the same function, never use alien species. When non-native species have to be used, a strict risk of intrusion assessment and long-term monitoring are required. Releasing species of unknown origin from non-local sources to PA surrounding areas should be strictly forbidden because they pose a threat to the natural ecosystem. Any release of an animals should be scientifically assessed to ensure that it is from a local source (for example, a rescued individual) and that its health condition is suitable before it can be released.

The risks of ecological safety for genetically modified products and technologies are still difficult to assess, and the use of genetically modified products and technologies should be eliminated around PAs.

Since almost all waterways are severely disturbed by humans, their natural flow has changed greatly and the interconnections often have been destroyed, and many alien species have become established so fish communities in lakes and other wetlands are likely to deviate from the natural balance, sometimes severely. Humans may need to intervene to reduce non-native and unpopular predatory fish. Artificial introduction of fish can increase the leisure and commercial value of wetlands. Artificially-bred fry can be purchased for wetlands, which can increase the number of recreational species that are commercially valuable or popular with tourists. This approach can be used to reintroduce native or naturally occurring species that are rare or threatened with extinction. This is essential if the natural passage of adult fish to upstream breeding sites is artificially blocked by downstream dams or other facilities. Avoid introducing species that may be harmful to the local ecosystem, instead selecting from the list of native species the appropriate species that need to be bred and introduced. Avoid making certain species dominant, as this can lead to excessive consumption of certain food types, and upsetting the natural interactions can lead to the destruction of ecological balance and ultimately to ecological damage.

6.2 Maintain ecological connectivity

PA are safe harbors for wildlife where birds, fish and other animals can rest, eat or reproduce, but some of them visit nearby farmlands, grasslands, wetlands, and even cities for food. Many species require seasonal migration between different habitat types. Frogs come out of the surrounding forest and mate in a pond; many fish species mate and lay eggs upstream of the main river, where the temperature is lower and the oxygen content in the water is higher, but the adult fish live downstream or in the sea. Therefore, they need to migrate along the river for breeding.

Some site managers see a need to put a fence around each PA to keep people and domestic animals out and keep wildlife in. This might be necessary in a few cases but generally wild animals need to move beyond the limits of PA.

Roads, farmlands, towns, dams, cofferdams and other obstacles around PA may become barriers to wildlife migration, leading to habitat fragmentation and isolation of

some species. Water flow and connectivity are essential for the health of the natural areas so great care must ensure these are not blocked by construction of roads or paths. Adequate tunnels or bridges need to be constructed to allow natural flows to continue based on needs of PA.

Construction of dams, wires and other structures can make such routes impossible, requiring construction of separate gentle passage ways that fish can negotiate. These structures are called fish ladders and they can be a very effective way of maintaining connectivity along rivers. Many designs can be reviewed on the internet and can be incorporated into the structural plans and designs of all new and existing artificial barriers.

Bridges and boardwalks should be established for visitors to wet and tidal zones, and bridges are much more effective than tunnels. Such artificial pathways through swamps and tidal areas can play important roles in conserving natural habitats and biodiversity, and be much less destructive than the filling construction mode. For boating, if the water level is relatively constant, a simple levee fixed to the support pole will be sufficient for management purposes. If the water level rises and falls substantially, a floating buoy with a hanging springboard may be more suitable. Piling is better than filling, and sediments and wildlife can move under the pile. If a mooring device is to be used by tourists, it is important to attach a safety railing.

The nomadic model is a good way to use the grassland seasonally, ensuring that the pasture is used evenly, efficiently and sustainably. Fences make the use of grassland uneven, and excessive grazing areas will degenerate and reduce the quality of the grassland. Fences also destroy the natural migratory patterns of wild herbivores, and this problem is exacerbated around PA.

Retaining local vegetation belts or patches in agricultural areas is conducive to the survival of pollinators and natural enemies of pests, as well as improving hydrology, providing shade and wind protection conservation, conserving biodiversity and retaining landscape value for crops.

6.3 Restoring degraded habitat

A good natural environment is the core attraction of ecotourism. However, the human activity area inevitably will have problems of ecological degradation. In areas with degraded vegetation, restoration of natural vegetation, control (or removal) of invasive species, and improvement of wildlife habitats can continue to provide important attractions for ecotourism. Rivers, lakes and waterfalls surrounded by vegetation are more attractive to tourists and contribute to water quality, biodiversity and ecological health.

However, in the process of restoring ecosystems, ignoring natural rules will often lead to a simplified biodiversity of the planted forest, which is unattractive to both visitors and wild animals, less efficient in providing ecosystem services, and more prone to fires, pests and diseases. Instead, study appropriate ecosystems in the local environment to find trees, shrubs and grasses naturally grown in local ecosystem, and naturally recover the most degenerated environment using natural succession of native vegetation. The focus of any artificial facilitation of this process can include providing

water to dry environments, providing saplings and seeds suitable for local ecosystem for places lacking natural seed sources, preventing fire, controlling overgrazing, stopping gathering plants and plant litter and so on. Diligently removing alien species leaves space and nutrition for self-recovery of local species, and do not plant trees of the same age by rows, because forests growing in this way won't form natural competition among trees, so cannot become scattered and full of rich canopy layers. The same height of crown canopy can easily block most of the sunlight, which prevents the growth of other healthy plants under the forest canopy; do not remove plant litter in the forest, but find ways to speed up their decomposition as they are a vital part of nutrient cycle in the soil.

Nurseries should be established for areas needing restoration. Site managers may identify a place on a farm or in the corner of a village where a nursery can be established. It should be partly shady to protect the establishing plants from direct heat of the sun. Identify plants that are native in the area, and select ones to be propagated in the nursery. Some plants can be transplanted directly from source to a landscape bed. Propagate only the plants that are regularly needed for replacement on landscape beds so the nursery is not filled with overgrown plants. When transferring seedlings or small trees from a nursery to the open landscape, great care should be taken in preparing the ground so the seedlings will prosper. A few hints to increase survival rates when planting:

1) Prepare individual holes for each tree or seedling, add suitable soil mix and water well after planting.
2) Plant out at times of the year when plants face lowest stress from desiccation (heat and wind) or cold. In temperate regions the winter period is a good time to plant when leaves have fallen.
3) Protect young trees from deer, pigs or other animals that may eat or disturb them.
4) Minimize root disturbance during transfer by suing planting bags or cutting root system out together with adhering soil.
5) Water vigorously for the first few weeks after planting until new roots get established, and shape the soil around plant base to be a cup shape to catch and hold water.

6.4 Restore and create wetlands and ponds

Restoring and creating wetlands and ponds can improve the ecological environment and play an important role in agriculture and tourism. Many abandoned quarries and mines can be converted into valuable lakes or ponds. In many places, simply allow the dry wetlands to be flooded. The use of sandbags to build dams in ditches is often sufficient to restore small wetlands, allowing many valuable wetland biota and ecosystem functions to be restored. Small lakes created in the form of barrage dams can reduce the erosion of the channel by the sediment and become part of the local soil conservation work.

Alternatively, plug the hole with a clay or plastic liner and fill the surface with water to create a new wetland or pond. By creating multiple water depths and underlying substrates (mud, gravel, reef), many different living environments can be created for more species. These can be done in a single farmland, or they can be done

together by a community to form a communal pond.

Ponds can have multiple functions, can be used as reservoirs, for crop irrigation, livestock drinking, and for raising fish; they can improve the local climate; and they can breed various insect-feeding species such as frogs, toads and birds.

River and wetland management can cover many management practices, such as the following:

1) Ensure good natural or artificial filtration, avoid contamination, and maintain good water flow to ensure oxygen content in the water. The higher the number of living organisms in the aquatic environment, the stronger the stability of the system, and the less opportunities of sudden disappearance of species, water bloom, water and grass blocking the river channel, etc.;
2) There should be a combination of different depths. Shallow water areas are conducive to fish and amphibians, reed growth areas can be used for rails and songbirds, and deeper areas will attract some species of fish.
3) Small islands in the pond will attract birds seeking refuge from carnivores.
4) Recognizing when more or less water is needed on a certain area of the wetland requires deep understanding of the local ecology and a clear plan of the desired outcomes. The timing will depend on when migratory birds visit the site and which species the manager wishes to encourage. Waders and shorebirds may require muddy and sandy banks and water depths of 5-10 cm, while ducks and geese may prefer water depths of 20-50 cm. The Royal Society for Protection of Birds (RSPB) in the U.K. has published technical guidelines for their application (https://www.rspb.org.uk/Images/Water_management_structures_tcm9-214636.pdf).

6.5 Fire prevention and fire suppression

Fire can destroy an ecosystem very quickly and many wild fires are caused by accidental or deliberate human activity. Lightning is usually accompanied by rain that makes it unlikely that a wild fire will occur, but sometimes the rain is formed high in the sky and evaporates before it reaches the ground. Under such storm conditions “dry” lighting can trigger a burst of wild fires.

Hot, dry and windy weather are the most dangerous time for wild fires, but almost all regions of China are susceptible to fire and sometimes these may get out of control of the fire fighters and burn great areas of forest, brush, and farm land, and even destroy houses and cause loss of life. Most forested regions of China have already established networks of fire breaks, watch towers and procedures to follow in the event of fire

All rural citizens around PA are expected to be careful not to cause fire, to be vigilant in spotting wild fires early, and to assist professional services in fighting fires should they occur. At dry times extra vigilance is needed, especially smokers who often are careless in the way they toss away their cigarette butts.

7 Biodiversity Conservation

7.1 Sustainable use of resources

Many farmers benefit from naturally grown resources, such as non-timber products under the forest, fish and grassland grazing. When they are seeking direct access to natural resources, attention should be paid to the natural regeneration of natural resources, controlling the timing, location and availability of acquisitions to ensure a balance between the natural regeneration and utilization rates.

The collection and utilization of natural plant resources such as medicines, wild vegetables, wild fruits, and bamboos should follow an appropriate collection location, time, and collection volume; avoid overuse leading to resource depletion; and avoid competition with wild animals that use these resources.

Overfishing reduces fish production, destroys fish diversity, reduces the average size of fish and spreads unpopular fish. The PA is also home to many wildlife species that also depend on fish for food, so the surrounding development should strictly control the catch of fish so that this food resource remains available for birds and other wild animals. This will also support development of ecotourism.

The density and type of herbivores determine the height and density of the herb layer, which and should be maintained at the optimum natural level as much as possible. Excessive herbivores can degrade grasslands, and managers need to find ways to reduce the pressure of grazing. If the natural herbivore density is too low due to hunting, the grass is often encroached by shrubs and trees. In this case, the manager can increase the number of herbivores by allowing free-ranging of some livestock until the grasslands recover their natural productivity.

7.2 Conserving wild plants and animals

Supporting the natural species composition is the most important foundation for self-renewal, supporting many wild animal pollinated plants along with pest control, litter decomposition, nutrient return to the soil. These ecological processes are the foundation for maintaining ecological system. Some 75% of the world's major crops and 80% of flowering plants are dependent on animal pollination, among which 15% are domestic bees, and 80% are other wild bees or other animals. The world supports 25,000 species of bees and over 40,000 species of pollinators. Excluding bees, the annual value that local pollinators contribute to agriculture globally can reach $54 billion.

All vegetation types need a variety of different mechanisms to disperse their seeds, colonize new available habitats and ensure ecosystem richness. Some plants, including several mangrove species, drop their seeds in the sea and the tidal action will move them around the intertidal zone. Other trees, such as willows (*Salix, Populus*), produce wind-dispersed seeds. Many other plants have hooked seeds that attach to the fur of passing mammals or human clothing and are transported by unwitting agents. Trees that produce edible nuts, like oaks (*Quercus, Lithocarpus*) or chestnuts (*Castanea*), take

advantage of squirrels or jays that disperse their fruit, bury, store or drop some fruits and thus help distribute the species. Trees and bushes with sweet fruits attract the attention of fruit-eating birds or mammals to either transport the fruits to feeding perches or to eat the fruits and pass the seeds out in their feces. This mutual cooperation between fruit trees and fruit eating animals is part of natural reforestation and gap filling but also supports diversity through bringing in a larger array of plant species and fruit-eating animals. Fig trees (*Ficus*), haws (*Crataegus*), *Sorbus*, persimmons (*Diospyros*), wild plums (*Prunus*), and many colonizer shrubs – *Rubus*, *Sambuccus, Lantana* etc. are maintained in this way but would quickly disappear if the fruit-eating doves, starlings, barbets, mynahs, flocks of little white-eyes (*Zosterops*) and various squirrels are not available to disperse their seeds and pollen. The colourful little flowerpeckers of genus *Dicaeum* feed on the sticky fruits of parasitic mistletoes (*Loranthus*). Some seeds get stuck on their beaks and their habit of wiping off sticky seeds from their bill to a tree branch transfers the seeds to new rooting places. The flowers of the mistletoes also attract the beautiful little sunbirds that brighten anyone's mood who cares to watch them flitting actively about.

Since bats are mostly active at night, their role in maintaining floral diversity is often overlooked but they are important in pollinating many of the feathery flowers of mangroves, *Barringtonia* and other trees. Large fruit-eating bats pluck large fruits, carry them off to a convenient perch and then slowly eat them and drop their seeds to the forest floor. Mangos, *Terminalia*, some large figs, and papayas are almost entirely distributed by bats. Plants that depend heavily on bats tend to have pendulous hanging fruits that can be more easily accessed by these animals that feed upside-down.

Despite the prevalent view of them as pests, small rodents, pikas, and marmots are essential parts of a healthy grassland, because they increase the permeability of soil and benefit water conservation. Their burrows are often habitats for cave breeding birds. These mammals are also food for carnivorous animas, such as foxes, weasels, and eagles. The mass poisoning grassland burrowing species leads to grassland degradation, loss of biodiversity, and decreased water conservation functions of the grassland.

The conservation of these species creates a more natural environment, improves agricultural output (variety, quantity and quality), improves the living environment, and helps increase the tourist attraction of the PA and the surrounding landscape.

Occurrences of pests and pathogens can often be attributed to the long-term use of chemical fertilizers and monocultures that lead to low biodiversity; the use of herbicides decreases natural weed diversity and the use of pesticides kills the natural predators of insects at the same as the target species. Reasonable adjustment of sowing time, early or late sowing, and avoiding the seasonal diseases of large areas, can reduce the occurrence of seasonal plant diseases; using local varieties and avoiding hybrid crops can enhance crop resistance and adaptability, as well as reduce plant diseases and insect pests. Here are some practical ways to increase natural enemies to control pests:

1) Leave natural cover and set up nest boxes for key raptor species;
2) Protect bat roosts in caves and house roofs;
3) Welcome swallows and swifts to nest in barns and house roofs;
4) Accept snakes as agricultural friends not enemies (most are not poisonous and none

attack unless provoked);
5) Protect wetland habitat for dragonflies, frogs etc.;
6) Place convenient perches for shrikes, raptors, starlings, drongos, etc.;
7) Limit use of insecticides on the farmlands.

The widespread use of insecticides in agriculture is the main reason for worldwide decreases in many pollinators, calling for a much more thoughtful use of such chemicals. Destruction of caves and improved standards of roof construction on houses has contributed to significant declines of bat populations.

In some regions, pollinators are too scarce to fully pollinate vegetable and fruit crops and are be becoming similarly scarce in wild. Agriculture is cutting back in some parts of the world, at least partly because of loss of pollinator biodiversity. Methods to increase population of pollinators include:
1) Encouraging bee hives in rural areas;
2) Planting especially-favoured nectar flowing bushes to boost wild populations;
3) Reaching agreements with local farmers to reduce dependence on insecticides;
4) Planting additional food-plants for specific butterflies and moths;
5) Leaving hollow trees, caves etc. for bats to roost, and putting up bat boxes to encourage local populations.

High-voltage energy transmission wire are very dangerous for some large birds that fly at night. The use of colored plastic balls can increase visibility. Should energy transmission be necessary around buildings in and around PA, the wires should be sealed in a pipeline buried underground, in order to avoid electric shock to primates, bats and birds.

As indicated earlier, wild ancestors of domestic plants continue to evolve in PA, enabling plant breeders to draw on the genetic diversity of these species to help breed crops that can adapt to changing conditions. Maintaining a broad genetic base among crops and their wild relatives is widely considered essential to productive agriculture.

7.3 Attracting wildlife

Increasing the visibility of various birds is very important for attracting the tourists and increasing the touristic value. Birds can be attracted by:
1) Providing suitable habitat, planting trees that provide fruit, flowers, perches, shelter, nest sites etc.:
2) Birds respond to protection, so simply keeping an area free of hunting, netting or loud disturbance will attract birds to use the area more often; in wetlands with lakes, birds recognise the added security of islands and tend to use small islands as resting areas and nesting areas;
3) Nest boxes can help increase number of birds. It is important that the inside of the box maintains a moderate temperature and that the box is durable. Nest boxes should be designed to be easy to check and clean. Holes with different sizes are suitable for different species (25mm or larger for Blue, Coal and Marsh Tit; 28mm or larger for Great Tit and Tree Sparrow; 32mm for House Sparrow). Some very

large birds can be encouraged by providing platforms on which to nest. Examples from China include the platforms for rodent-eating raptors across the high plateau grasslands and the use of wooden platforms for breeding of White Storks in Northeast China:

4) Providing birds and some mammals additional food in the lean seasons or water during the dry seasons may help them get through the bad times and will certainly make them more visible to visitors or researchers for observation. It is often advisable to place feeders near to visitor centres, cafeterias, etc. Different species need different types of food and a wide variety of feeder designs can be employed, constructed, viewed over the internet or ordered from specialist suppliers. It is generally best to present food and water well off the ground where visiting birds would be very vulnerable to predation by cats or natural predators. If squirrels frequently raid feeders designed for birds, the feeders may need placing inside squirrel proof cages.

Butterflies are beneficial to farmlands and PAs. They are good pollinators for fruits and beans and add to the beauty and peaceful atmosphere of a healthy countryside. The long-term health of butterflies is an indicator of the health of the ecosystem. Their absence is a sign that too much insecticide is being used on the land. Butterflies lay eggs on many wild plants in wetlands and open country and they can be encouraged by ensuring that suitable food plants are available for rare or charismatic species. Adults can also be attracted to feed at particularly attractive flowers. Rearing butterflies is a matter of growing the correct food plants for the species to be encouraged. Most species are rather specific on where they lay their eggs, but such information is generally well known. Details can be downloaded from the internet following a search for butterfly host plants. In tropical areas, *Citrus* attracts several swallowtail butterflies; *Aristolochia* vines attract many birdswing butterflies (*Troides* and *Atrophaneura* spp.); *Cassia* attracts Passiflora; Palms attracts many hesperids; Oleander family attracts several hawk moths. In temperate areas, *Urtica* attracts many nymphalids; Thistles attract some nymphalids; Wild Carrots attract Common Swallowtail; Willows attract *Apatura* spp.; Vetches attract many lycaenids; *Prunus* attract many species; Privet and, lime bedstraw attracts hawk moths.

In addition to attracting and encouraging butterflies by planting their larval food plants, adult butterflies can be attracted to flowers and other baits. Certain flowers are more attractive than others to attract showy butterflies to areas where people spend most time. Examples of very attractive plants are *Buddleia davidi* for temperate regions and *Hibiscus* and *Lantana* for tropical regions. *Lantana* must be well controlled as it can become an invasive alien weed. Purple emperors *Apatura* and *Charaxes* butterflies are attracted to animal (civet) dung or decaying carrion. Other *Charaxes*, nymphalids and swallowtails are attracted to animal urine or decaying fruits (bananas). Many tropical butterflies can be attracted to puddles or ground saturated with mineral-rich water. Carpets of pierids, swordtail and *Graphium* swallowtails and even the spectacular Birdswing butterflies *Troides* regularly visit such sites.

In addition to the butterflies, fireflies and dragonflies also undergo rapid recovery

after restoration of their habitats.

Keeping post-harvest fields dry greatly reduces the ability of the land to support local biodiversity during the fallow period, reducing the total productivity and soil fertility. The fallow period should be full of vitality as well. For example, keeping the irrigated rice fields wet after the rice harvest can provide important foraging site for wildlife in the winter and important stopovers for migratory waterfowls such as geese and cranes.

7.4 Reduce disturbance to wildlife

Consumption of wildlife means killing of the target species. From the body parts that are traditionally believed to be nourishing or health-promoting, to the fur used to decorate clothing, to the novel tourist souvenirs, and the trend of exotic pets, wildlife trade is driven by a variety of consumer demands that drive the hunting and gathering of wildlife. This is a serious threat to the biodiversity of our country and the world. Many measures can help reduce the destruction of wildlife resources and make the site a tourism destination with richer wildlife:

1) Restaurants and shops around PAs should not provide any wildlife products, and tourists should be discouraged from buying wildlife as souvenirs;
2) In the case of infraction, citizens should report to the relevant departments, usually the local forestry sector and the administration for industry and commerce, in a timely manner. Follow-up measures should be taken to remove the factors that threaten wildlife (e.g. removing snares for tigers);
3) Rescue the injured wild animals in the concentrated areas of wild animals, and release the rescued wild animals to the wild as soon as possible, and so on;
4) Use social media to make the consumption of wildlife products unfashionable, especially for the higher-priced items.

Breeding of wild animals should be strictly restricted in the peripheral areas of a PA, because the concentrated condition is easy to cause diseases that can be transmitted into the wild species; and such activity could potentially cause the invasion of non-native animals. In addition, a market for captive-bred animals may drive wild animal consumption. Wild animal breeding around PA must be subject to strict examination and approval procedures, and should be under long-term monitoring and supervision with a goal of ultimately removing any such facilities from the PA landscape.

Excess feeding of wild animals may cause over-concentration of the wild animals and damage the vegetation, vulnerability to predatory carnivorous animals, and diseases, all of which are contrary to the PA goals of conserving a natural habitat for the wildlife. Therefore, long-term, big-scale feeding of wild animals is discouraged. When feeding is deemed essential for the purposes of disaster and small-population recovery, scientific assessments and monitoring should guide the implementation and adjustment of the feed.

Ecological relationships between PA and their peripheral areas may not always be compatible. Land use in surrounding areas may bring management problems to the PA, including fire, invasive weeds, pollution, livestock disturbance, poaching, illegal

logging and other risks. The local community may complain about wild animals coming out of PA and destroy their crops and property. In such cases, planting trees that wild animals avoid can help reduce conflict. In cases of serious conflicts between the wild animals and the surrounding community, fences or trenches can be built.

8 Eco-tourism

For PAs, tourism is a double-edged sword. On one side, it draws international and national attention to the country, for its beaches, its cuisine, its culture, its nature, and, not least, its economy. It also makes visitors, and especially young people, feel happy and builds their respect and appreciation for nature. This attention helps make the attractions of PA valuable and worth both protection and effective management. On the other side, the flood of visitors can affect the very values that brought them to the PAs and can even change some aspects of the culture. The growing interest in nature from urban residents is likely to increase the number of domestic tourists visiting PA, and this is a very welcome trend.

Tourism to PAs becomes "ecotourism" when it is designed and implemented to make a positive contribution to the effective management of the PA and the conservation of the biodiversity found there. The International Ecotourism Society gives a more specific definition: "Responsible travel to natural areas that conserves the environment and improves the well-being of local people." Ecotourism includes six elements:

1) Protect ecological resources and the environment, and maintain biodiversity;
2) Use ecotourism funds to support conservation and research of ecological resources;
3) Increase the involvement of local communities and ensure that they benefit from it;
4) Do not exceed the natural environment's capacity of tourism;
5) Enhance the awareness of ecological protection by local communities and tourists;
6) Achieve the sustainable development of environment, social culture and economy.

IUCN's Best Practice Guidelines: Tourism and Visitor Management in Protected Areas (Leung et al. 2018), which includes very detailed content for further reference.

8.1 The advantages and characteristics of ecotourism in PAs

The environment in PA is conducive to children's interactions with nature. Through systematic approaches, a strong and effective bond between children and nature can be fostered, thereby promoting the children's physical wellness and mental development. PA activities should be specifically adapted to children of different ages, integrating various fields such as art, music, culture, mathematics, etc. In well-designed activities such as identifying plants, bird watching, insect observing, stargazing, and night safari, participants explore the interconnectedness of biotic factors and abiotic factors under the guidance of experts. Participants will also be guided to contemplate the relationship between humans and the rest of nature, form environmental awareness and identity, and ultimately adopt sustainable practices in daily life. Regarding

conducting environmental education in PAs, please refer to the *IAPA Operation Guide Series: Environmental Education Operation Guide in Protected Areas* (Zhou et al. 2018).

PAs are valuable natural resources with profound ecological wealth, and the design of ecotourism should fully tap into the uniqueness of each PA. Ecotourism should provide a holistic experience and serve as a driving force for public education and dissemination of conservation ideology. Although each PA has its own identity, some general patterns can guide systematic design of PA tourism:

1) **Best trails**: 1-3 tour trails carefully designed at each site, guided tours on local species (animal and plant), enjoy the prime, original natural scenery;
2) **Conservation participation**: identify typical ecological threats in each place, and lead the visitors to reduce these threats; and identify beneficial conservation activities that can benefit from public support;
3) **Scientific practice**: guide the tourists to participate in scientific investigation in detail, such as the collecting leaf or flower specimens where this is consistent with PA management, casting plaster models of footprints, infrared camera and quadrat study etc.;
4) **Ecological science**: based on the natural features of the site, provide specific and targeted training of scientific knowledge, such as ecosystem characteristics, geographical hydrology and climate, biodiversity, species identification, conservation status, etc.;
5) **Nature photography**: prepare 2-3 related nature video documentaries for each site, to provoke interest from visitors;
6) **Social media**: almost all visitors will have a cellphone that enables them to connect to various forms of social media, giving them an intimate opportunity to fully enjoy the site; so use this technology as the most effective way to reach modern tourists, especially among the young;
7) **Nature games**: with the unique natural environment, organize simple, interesting and interactive games, and enhance the perception of the nature and experience during the games;
8) **Folk Culture**: select 2-3 cultural characteristics for display and in-depth experience. These cultural characteristics could include the delicacy, customs, folk art, handicrafts, and so on, enabling the tourists to experience the fresh, unique and authentic culture of local community.

8.2 Improve the capacity of local residents and institutions

Ecotourism is an important way to demonstrate PA value and bring benefit to the local community. But some of the community may lack sufficient knowledge, guidance, training, management and supervision in the actual implementation of friendly development, and therefore capacity building may be an urgent needs. The cultivation of community capacity should include the following aspects:

1) **Development of knowledge and professional competence related to conservation**, including the overall recognition of local ecology and biodiversity, monitoring methods, species identification, interpretation, eco-friendly production

and life style, environment preservation in the process of tourism, etc.;

2) **Tourism-related knowledge and skills development**, including tour guide capabilities (ecological conservation knowledge, folk culture, historical legends, interpretation skills, photography, visitor organization and management, on-site interaction, etc.), catering service capabilities (such as setting up tables, welcoming guests, ordering, meals and drinks, cleaning, hygiene standards implementation, cooking skills, beverage production, etc.); accommodation service capabilities (bedding, cleaning, welcoming and other room skills and accommodation-related product design, processing, packaging, marketing);
3) **The knowledge about local culture**, including the local community culture and the native customs of the local people; show the real details of life, including production, performance, service, etc., and actively guide the tourists to participate and interact with each other. Explore and promote local cultural products such as local products, arts, and handicrafts, etc.

8.3 Identify and develop cultural specialty

Cultural products refer to all the intellectual products that human beings provide to society. The geographical environment, ecosystems, climate, customs, and social economy of each PA are different, and its cultural traditions and cultural products are also diverse. This diversity distinguishes PA and is also a profound cultural imprint. Friendly development requires awareness and cherishment of the diversity of this culture and its products, and PA managers should help communities recognize and value the local natural environment that fosters this unique culture, including respect for traditional culture in folk customs, legends, ancient monuments, celebrity biographies, village regulations, family genealogy, traditional techniques, ancient and famous trees.

The development of eco-friendly cultural products is an important way to reduce disruptive production activities and increase community income. Culture products include traditional handicrafts (paper-cutting, embroidery, clay sculpture, straw-woven crafts, bamboo and wood crafts, etc.), local dramas, songs and dances, folktales, etc. These representatives and cultural products that embody the traditional wisdom and cultural essence of "Nature-Friendly" have market competitiveness, cultural value, and the far-reaching social value.

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10 References

Leung YF, Spenceley A, Hvenegaard GT, Buckley RC. 2018. Tourism and visitor management in protected areas: guidelines for sustainability. IUCN Gland,

Switzerland. Available from http://papaco.org/wp-content/uploads/2018/04/PAG-027-En.pdf (Accessed in Sept. 2018)

Paul EFJ, Margaret BE & Teresa Chang-Hung T. 2001. *Guidelines for Tourism in Parks and PAs of East Asia*. IUCN, Gland, Switzerland and Cambridge, UK. x + 99 pp.

Paul EFJ, Stephen MF & Christopher HDA. 2002. *Sustainable Tourism in PAs: Guidelines for Planning and Management*. IUCN Gland, Switzerland and Cambridge, UK. xv + 183pp.

Liu Y, Xie Y, Lan H (eds). 2017. *On the Way – Luneng's Road of Ecological Priority – Green Development*. Science Press, Beijing. Pp 1- 286 (English) 1-246 (Chinese).

MacKinnon J & Xie Y (eds.). 2001. *Guidebook of Biodiversity Principles for Planners and Developers*. China's Forestry Press.

Xie Y. 2002. *Restoring China's Nature Vegetation*. China Forestry Publishing House.

Xie Y (eds.). 2008. *Bio-invasion and China's Bio-security*. Hebei Science and Technology Publishing House. Hebei: Shijiazhuang.

Xie Y, MacKinnon J, Gan XJ, Yang WH, Leempoel K (eds.). Issued in 2018 and updated in Sept. 2018. Monitoring Planning Operation Guide for Protected Areas. IAPA, Beijing, China. Available from http://www.iapa.pub (Accessed in October, 2018).

Zhou TT, Xie Y, MacKinnon J, Miao RL (eds.). Issued in 2018 and updated in Sept. 2018. Operation Guide for Environmental Education in Protected Areas. IAPA, Beijing, China. Available from http://www.iapa.pub (Accessed in October, 2018).