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# Hazards of Tourism-Generated Environmental Pollution and Measurement of Tourism Efficiency in Western China

**Renpeng Zhu**
The Major of Tourism Management, Institute of Foreign Language, Xijing University, Xi'an, Shaanxi, 710123, China

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## ABSTRACT

Western China is home to rich tourism resources. But environmental concerns have trodden on heels due to its lack of market competition mechanism, less investment, and outdated facilities. Apart from improper planning, unscientific management, and extensive development mode, low tourism efficiency creates another serious potential baffle. To give a further analysis of the hazards of environmental pollution in Western China, and measure the tourism efficiency, this study, by reference to articles of this field across the world, summed up the types of the hazards, and figured out by DEA-Malmquist Index the tourism efficiencies of 12 provinces in western China during the years 2010-2016. After that, this study put forth detailed measures for the environmental issues. As measurement and the results show, a pile of studies have pointed out that developing countries tend to face environmental pollution because of improper tourism planning, unscientific management, and extensive development mode. Such environmental defects of tourism can be found from air and water pollution, garbage, and destroyed biodiversity. During the seven years in question, all of the 12 provinces did not reach total factor productivity growth. While technical efficiency declined by 16% with pure technical efficiency down by 14%, they also saw an average of decrease in technical progress and scale efficiency by 2.1% and 2.5% respectively. To solve these problems, this study laid down steps of reinforced establishment of tourism environmental protection supervision, publicity and education mechanisms, as well as establishment of public involvement in environmental protection, environmental protection reward and punishment compensation, and scenic spot environmental early-warning mechanisms. In a word, the obtained conclusions have positive reference value to understand environmental pollution from tourism and realize a balance of tourism growth and environmental protection in Western China.

## INTRODUCTION

Tourism is regarded as a highly open integrated "smokeless industry". Like an "economic catalyser" for developing countries, it is feathered with loose investment need, good efficiency, and considerable profits. Hence, tourism drives associated sectors to create better development outcome and more jobs while promoting those of international economic exchanges. Despite rich sightseeing resources, whether natural or human landscape, tourism in Western China has long been growing slowly. The proportion of economic income in the province's GNP turns out to be small. Besides a shortage of market competitive mechanism, national fiscal reverses result in a long-term lack of government grants, further causing outdated tourism facilities. However, environmental issues brought by the region's tourism have become an unavoidably critical barrier against the development of tourism. Improper exploitation damages and even triggers environmental disasters to nature. Advancing tourism needs a considerable consumption of electricity and water, which gives a heavy burden on local resources. Without thorough planning, construction of hotels, roads and other infrastructure, easily destroy forests and green vegetation, and harass wildlife. Additionally, exhaust gas, sewage, garbage from tourism activities pollute local atmosphere, water, and soil.

As revealed by Fig.1, Western China has seen a rapid development of tourism over the recent years. Nonetheless, worsening ecological environment is yet a problem. Low efficiency of China's tourism well explains environmental pollution in one respect. Here, efficiency means the degree of effective allocation of tourism resources. By comparing tourism input and output, or cost and benefit, we can find tourism's utilization of each investment factor. In that way, development quality of tourism is observed. To meet increasing market demands for sightseeing, optimize internal structure of Western China's tourism, improve development quality of the industry, and create a more environmentally friendly sector, this paper will dissect hazards of environmental pollution caused by tourism in the 12 provinces in Western China, measure and compare their tourism efficiencies, and finally draw out measures and suggestions to develop tourism in harmony with the environment.

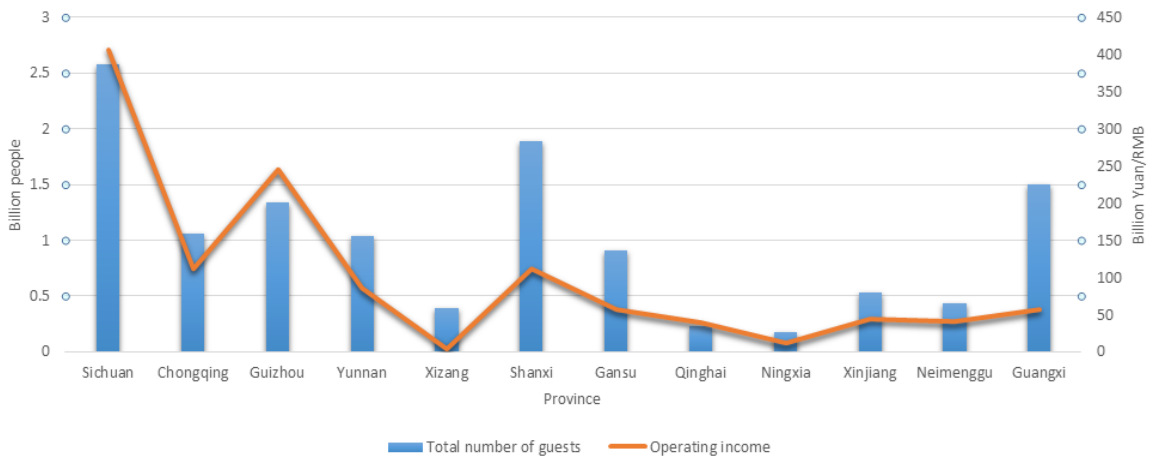


Fig. 1: Basic information of tourist trips and operation revenue in 12 provinces of western China in 2016.

## EARLIER STUDIES

Well conserved ecological environment provides an important premise for tourism growth. Up to now, environmental concerns brought by tourism have been listed as a significant exploration project of either sociologists or tourism researchers. Study examples of environmental pollution and tourism efficiency mainly include: Kocasoy (1989) analysed sea pollution from coastal tourism in a case study of Turkey. Kousis (2000) believed tourism had a serious impact on local animals and plants after dissecting from perspective of social movement the relationship between tourism and environmental pollution. Mbaiwa (2003) considered tourism of Okavango Delta had started an adverse influence on local area, causing noise, unreasonable waste management, and destruction of the ecology. Baoying & Yuanqing (2007) investigated water pollution of Lijiang Ancient Town, Yunnan, China by tourism. Giannoni (2009) studied the relationship between tourism and pollution's impact on residents' benefits based on establishment of a standard model of exogenous populations optimum growth. Subramani (2012) had an insight into air pollution brought by exhausts of vehicles into and out of tourism centres. Katircioglu (2014) made a research on the long-term balance relationship between international tourism, energy consumption and environmental pollution in the case of Turkey. Sajjad et al. (2014) thought advancement of tourism exacerbated air problem, picking up climate changes in light of a long-term consequence survey of air pollution and tourism development. Saenz-de-Miera & Rosselló (2014) deliberated how tourism of Mallorca Region affected local atmosphere with the output showing daily volume of tourists was a significant prediction indicator of air pollution concentration, 1% increase in the number of tourists leading to 0.45% increase of pm 10's concentration. Zhang et al. (2016) discussed with spatial panel data analysis method what was the impact of international tourism on China's energy consumption and environmental pollution. With regard to tourism efficiency, Morey & Dittman (1995) scored the efficiency of hotel managers with linear planning model. Anderson (1999) probed into and discussed efficiency measurement of tourism administration departments. Barros (2006) applied Stochastic Frontier Analysis (SFA) approach to study the operation efficiency of top 25 large travel agencies in Portugal. Fuentes (2011) used DEA model to appraise efficiencies of travel agencies in Alicante, Spain. Luo (2017) adopted SBM model to measure the tourism efficiencies of 30 provinces and autonomous regions in China, and proposed measures of developing tourism. According to existing literature studied, it can be noted tourism in most countries, especially developing economies, is deemed as a leading industry that should be developed in advance moderately. But due to improper planning, unscientific management, and extensive development mode, tourism faces a series of environmental pollution problems. Besides, no high tourism efficiency creates another serious potential baffle. Thus, in the case of the 12 provinces in Western China, this paper analyses impact of tourism on environmental pollution, and measure overall efficiency of the sector. Then the document sets forth reference comments on the balance of tourism development and environmental protection.

## HAZARDS OF TOURISM-GENERATED ENVIRONMENTAL POLLUTION IN WESTERN CHINA

### Atmospheric Pollution

With the implementation of China's Western Development

strategy, more and more tourists are stepping into Western China's natural reserves. Particularly, increase of self-driving tours accompanies a growing amount of toxic vehicle exhaust, flying dust and carbon dioxide that visitors exhale, as well as waste gases from hotels and restaurants within scenic spots for domestic purpose or for boilers' function. All of these contaminate the air of natural reserves. Apart from that, some scenic spots use diesel to generate power, which will produce local contamination. There are some more backward areas gaining energy to heat or cook by using sulphurous fuel or bituminous coal. This will lead to even severer local air pollution.

### Water Pollution

Tourism activities have a broad and rigor influence on water environment. In Western China, water sports of tourists have an erosion effect on the beach and coastline. The eddy caused will additionally affect the marine ecology, such as the plankton and fish in the coral reefs. Oil leakage will also pollute the water body, and even spread chemicals, threatening the health of aquatic life. Water is especially sensitive to human activities. Since there is little nutrition in original background environment, when a mass of nutrient content floods into a water body, the recipient will be overburdened to self-purify, leading to eutrophication. In addition to such contamination of nutritive salt, waterway will come to face with massive bacterial growth.

### Garbage

Most scenic spots in Western China are derived from original ecological areas, which attracting hordes of tourists to encamp. But garbage produced remains in locality. If no appropriate treatment is conducted, it will undoubtedly have an austere impact on local environment health, thus influencing local people's well-being and normal life. Solid waste is the most difficult issue to be solved because of lots of derivative problems. For instance, if garbage cannot be treated in a well-arranged manner, a range of negative impacts will be brought onto water, soil, plants, wildlife, air, residents' health, beauty of landscape, etc.

### Destruction of Biodiversity

Western China is endowed with vast natural reserves. But for that, a great impact of tourism activities has had on the biodiversity. With more areas exploited, linear artificial landscapes like roads are constructed, and passages occupy much bigger space than roads themselves need. The weaving road network has divided a number of natural biological communities and populations in protection zones, reduced connectivity, but intensified fragmentation of natural landscapes, and damaged habitat of species in biomes. Some activities, such as hunting, cutting down plants to set up tourism facilities, and collecting wood, have grievous even fatal influence on either animals or plants within the ecological system of natural reserves.

## MEASUREMENT OF TOURISM EFFICIENCY IN WESTERN CHINA

### DEA-Malmquist Index

Malmquist Index based on DEA is mainly applicable to measure total factor productivity (TFP) and its analysis factors. Under variable return to scale, output-oriented Malmquist Index with times t and t+1 being technical parameters can be defined as below:

$$M_{t,t+1} = \frac{D^v_{t+1}(x_{t+1}, y_{t+1})}{D^v_t(x_t, y_t)} \times \left[ \frac{D^v_t(x_t, y_t)}{D^c_t(x_t, y_t)} \div \frac{D^v_{t+1}(x_{t+1}, y_{t+1})}{D^c_{t+1}(x_{t+1}, y_{t+1})} \right] \times \left[ \frac{D^c_t(x_t, y_t)}{D^c_{t+1}(x_t, y_t)} \times \frac{D^c_t(x_{t+1}, y_{t+1})}{D^c_{t+1}(x_{t+1}, y_{t+1})} \right]^{\frac{1}{2}} \quad ...(1)$$

In formula (1), $D^c(x, y)$ is distance function under constant return to scale, while $D^v(x, y)$ is distance function under variable return to scale. $\frac{D^v_{t+1}(x_{t+1}, y_{t+1})}{D^v_t(x_t, y_t)}$ shows pure technical efficiency change (PECH), $\frac{D^v_t(x_t, y_t)}{D^c_t(x_t, y_t)} \div \frac{D^v_{t+1}(x_{t+1}, y_{t+1})}{D^c_{t+1}(x_{t+1}, y_{t+1})}$ provides the result of scale efficiency (SE) change, $\left[ \frac{D^c_t(x_t, y_t)}{D^c_{t+1}(x_t, y_t)} \times \frac{D^c_t(x_{t+1}, y_{t+1})}{D^c_{t+1}(x_{t+1}, y_{t+1})} \right]^{\frac{1}{2}}$ refers to technical progress (TECH), and $\frac{D^v_{t+1}(x_{t+1}, y_{t+1})}{D^v_t(x_t, y_t)} \times \left[ \frac{D^v_t(x_t, y_t)}{D^c_t(x_t, y_t)} \div \frac{D^v_{t+1}(x_{t+1}, y_{t+1})}{D^c_{t+1}(x_{t+1}, y_{t+1})} \right]$, which is derived from the product of the foregoing items, is technical efficiency (TE) change.

When $M_{t,t+1} > 1$, TFP is improved; when <1, TFP falls; when =1, TFP remains the same. Value of technical efficiency (TE) changes, pure technical efficiency changes (PECH), scale efficiency (SE) change or technical level change greater than 1 means it stimulates TFP to rise. Otherwise, it makes TFP decline. As for study on tourism efficiency, total factor productivity (TFP) is the weighted average portion of total output to all factors in production activities of the sector; technical progress (TECH) means that production efficiency is raised as tourism introduces scientific researches, inventions, technical improvements, and promotion of high technology; technical efficiency (TE) is determined by scale efficiency (SE) and pure technical efficiency change (PECH); SE refers to the degree to which the

whole tourism industry deviates from the optimal scale in the production process; PECH's growth mainly comes from reform of tourism systems, upgrade of administration mode, and full use of equipment, management, professionals and other resources in scenic spots.

### Selection of Variables and Data Source

To have an all-dimensional reflect and analysis of tourism efficiencies of the 12 provinces in Western China for years 2010-2016, this paper, in the principles of science, suitability and operability, took as capital-based factor input indexes the investment in fixed assets of accommodation and catering industries, and the number of starred hotels. Besides, this paper considered the population of employees in tourism as workforce input index, and income of this field as output index. With the above indexes, this paper established the tourism efficiency input-output system based on DEA-Malmquist Index model. Data in this paper were sourced from China Economic and Social Development Statistical Database (http://tongji.cnki.net).

### Measurement of Tourism Efficiency

This paper, from the perspective of output, adopted the panel data concerning the 12 provinces in Western China for years 2010-2016 to figure out the annual change of TFP with software Deap2.1. Measurement results are shown as Table 1.

As revealed by Table 1, during 2010-2016, all of the 12 provinces in Western China haven not reached total factor productivity growth. In other word, the provinces in question realized no increase of production efficiency. According to the trend of changes, TFP of tourism for the above area has descended year by year. Considering TFP with technical efficiency change and technical progress, it is easily noted the said provinces get an average decrease of 16% in technical efficiency and of 2.1% in technical progress. Since drop of the former is far more than that of the latter, the two items' decreases result in less TFP. Therefore, the 12 provinces in Western China should improve tourism technical efficiency to gain higher and higher productivity in future. To sum up, the reason why the aforesaid area's tourism cannot realize full growth of technical efficiency and technical progress is that local sector has not formed management mode of modern service industry. When further analysing technical efficiency change, we find PECH and SE have average falls of 14% and 2.5% respectively. More decrease of PECH than that of SE cause less TE for the investigated term. SE decrease means existing construction scale of the 12 provinces is still less satisfactory than the best one. That also indicates the very area is required to invest more heavily in building tourism infrastructure, and to adjust tourism structure. As PECH fall reflects, the area has a lack of tourism technology and modern technical processes, and hence should add even more technology to upgrade local tourism.

Table 2 shows that none of the 12 provinces in Western China has realized TFP growth. In detail, TFP of Guizhou is the highest while that of Qinghai reaches the lowest. TECH of the area remains low. But Sichuan, Guizhou, Yunnan and Shaanxi have got higher TEs, which says tourism of these four provinces has gained higher degree of marketization in modern tourism sector. As to PECH, all provinces have not grown. That suggests Western China has an ill-reformed tourism system, lagging modern tourism management mode, failure of tourism equipment to meet visitors' requirement for better modern services, and shortage of better skilled tourism management personnel. SEs of most provinces in question are less than 1. That implies the scale of investment in the area's tourism is yet smaller than the best scale. Remarkably, SEs of Ningxia and Qinghai are minimal, which signifies the two provinces get not good economic gross, leading to ungenerous investment in tourism infrastructure. Therefore, both provinces should intensify overall investment in tourism.

## MEASURES TO MITIGATE TOURISM-GENERATED ENVIRONMENTAL POLLUTION

### Reinforced Establishment of Tourism Environmental Protection Supervision Mechanism

Local government should carry out unified planning for tourism in area under jurisdiction, define environmental protection goals, and conduct appraisal and monitoring necessary for key zones, reaching a standardized and scientific environmental management. Besides, tourism operator admission and withdrawal system is required to be established. Evaluation needs to be done about the impact on the environment of scenic spots. A rigid project review should be implemented. Any place of interest, if having a severe influence on environment, will be brought to bear the most stringent withdrawal punishment. In addition, environmental protection goal management responsibility regime should be practiced. A system of part-time and compulsory environmental protection supervisors need be introduced. Moreover, to warn operators who cause pollution, but is unable to erase negative effect, and improve scenic spots' ability of waste disposal, besides the systems framing operators' responsibilities in heath and garbage daily removal, it is necessary to bring in the environmental protection guarantee deposit and refund mechanism that advocates "Protection earns benefits while pollution charges payment". This mechanism is implemented according to the degree of damage. Any violator would not be refunded and even be fined.

Table 1: Change of tourism efficiency index of 12 provinces in western China for years 2010-2016 (time-based).

| Year | Technical Efficiency (TE) | Technical Progress (TECH) | Pure Technical Efficiency Change (PECH) | Scale Efficiency (SE) | Total Factor Productivity (TFP) |
|---|---|---|---|---|---|
| 2010-2011 | 1.204 | 1.006 | 1.045 | 1.152 | 1.211 |
| 2011-2012 | 1.017 | 0.884 | 1.032 | 0.985 | 0.899 |
| 2012-2013 | 0.893 | 1.004 | 0.945 | 0.945 | 0.897 |
| 2013-2014 | 0.882 | 1.003 | 1.041 | 0.847 | 0.884 |
| 2014-2015 | 0.901 | 0.991 | 1.007 | 0.895 | 0.893 |
| 2015-2016 | 0.097 | 0.984 | 0.095 | 1.024 | 0.096 |
| Mean | 0.839 | 0.979 | 0.861 | 0.975 | 0.821 |

Table 2: Change of tourism efficiency index of 12 provinces in western China for years 2010-2016 (province-based).

| Province | Technical Efficiency (TE) | Technical Progress (TECH) | Pure Technical Efficiency Change | Scale Efficiency (SE) | Total Factor Productivity (TFP) |
|---|---|---|---|---|---|
| Sichuan | 0.823 | 1.054 | 0.864 | 1.005 | 0.867 |
| Chongqing | 0.874 | 0.912 | 0.844 | 1.066 | 0.797 |
| Guizhou | 0.851 | 1.067 | 0.877 | 1.062 | 0.908 |
| Yunnan | 0.854 | 1.053 | 0.994 | 1.064 | 0.899 |
| Xizang | 0.810 | 0.996 | 0.845 | 0.959 | 0.807 |
| Shaanxi | 0.837 | 1.048 | 0.971 | 0.862 | 0.877 |
| Gansu | 0.856 | 0.921 | 0.874 | 0.979 | 0.788 |
| Xinjiang | 0.847 | 0.905 | 0.811 | 0.995 | 0.767 |
| Ningxia | 0.845 | 0.998 | 0.849 | 0.884 | 0.843 |
| Qinghai | 0.754 | 0.878 | 0.760 | 0.842 | 0.662 |
| Inner Mongolia | 0.845 | 0.946 | 0.778 | 0.987 | 0.799 |
| Guangxi | 0.874 | 0.967 | 0.867 | 0.998 | 0.845 |
| Mean | 0.839 | 0.979 | 0.861 | 0.975 | 0.821 |

**Reinforced Establishment of Tourism Environmental Protection Publicity and Education Mechanism**

Offering publicity and education on environmental protection is the core to understanding of the public for environment-related knowledge, enhancement of their awareness in this aspect, and conduct right environmental behaviours. Therefore, government must often provide education of tourism environmental protection. Apart from that, relevant bodies should make general education planning of environmental protection, establish and request managers, developers, and operators of scenic spots to practice regular learning rules. Furthermore, they are required to set out mechanism of tourist pre-visit education about environmental protection, and regime of environmental pollution warning. For the latter, caution signs of environmental protection should be placed along tourists' paths, which will alert visitors of would-be environmentally unfriendly behaviours.

**Establishment of Public Involvement in Environmental Protection Mechanism**

Government should establish a mechanism that allows the public to involve in environmental protection decision-making. All decisions regarding scenic spots need round tables which are formed by owners, operators, managers, and representatives of local residents, travel firms and tourists to seek for opinions. Additionally, the course of decision making should be included in associated decision makings in accordance with environment-oriented information disclose regulations. Moreover, an overall appraisal on scenic spots' environmental status shall be made in the light of field test data, and be released to the public. A mechanism should also be set up to treat and respond to claims of the public.

**Establishment of Environmental Protection Reward Mechanism**

Government should encourage tourism operators of scenic spots to promote green business, and local farmers to use effective, low-toxic and less-persistent bio-pesticides as well as pollution-free green organic fertilizers with high function in the course of agricultural production. Operator or farmer, if passing a series of inspection and acceptance procedures, will be rewarded. Local environmental protection organs and tourism administration departments should ap-

ply for allowance to reward those operators or farmers who invest in construction of environmental facilities. Operators, farmers or tourists that cause pollution should be warned, fined, or even pursued for criminal liabilities according to the degree of consequence.

### Establishment of Scenic Spot Environmental Early-Warning Mechanism

Government should establish tourists control mechanism. To this end, tourists accessible to a scenic spot should be limited after defining the target place's maximum capacity, thus avoiding overloaded reception and operation. Any operators who refuse to implement the provisions will be punished by fine, grant of an order to make corrections within specified term, or even cancellation of operation qualification. Besides, a refined emergency mechanism should be set up. For this, relevant administration bodies and environmental protection organs should draw out emergency plans, and organize personnel of all departments and operators to participate in drills, improving emergency treatment ability. In addition, environmental protection organs, government, operators and local resident representatives should gather to form a coordinated system for environmental incidents.

## CONCLUSIONS

Western China is faced with pollution of ecological environment due to its lack of well-established facilities besides low service level and unscientific planning. Apart from these, ineffective arrangement of tourism resources creates another serious potential baffle. This paper, by reference to articles regarding tourism, summed up types of the environmental pollution hazards from this field, and figured out by DEA-Malmquist Index the tourism efficiencies of 12 provinces in the region during years 2010-2016. After that, this paper put forth detailed measures to the environmental issues. As measurement and study results show, environmental defects of tourism can be found from air and water pollution, garbage, and destroyed biodiversity. During the seven years in question, all of the 12 provinces didn't reach total factor productivity growth. While technical efficiency declined by 16% with pure technical efficiency down by 14%, they also saw an average of decrease in technical progress and scale efficiency by 2.1% and 2.5% respectively. To solve those problems, this paper laid down steps of reinforced establishment of tourism environmental protection supervision, publicity and education mechanisms, as well as establishment of public involvement in environmental protection, environmental protection reward and compensation, and scenic spot environmental early-warning mechanisms. It is suggested to have an ongoing in-depth study around inherent mechanism of tourism vs environmental pollution, spatial measurement and economic analysis of tourism vs environmental pollution in different provinces, cause and effect between tourism and specific environmental pollution (e.g. water pollution, air pollution), etc.

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