Scholar Publishing Group
Nature Environmental Protection
https://doi.org/10.38007/NEP.2020.010303
ISSN 2790-2684 Vol. 1, Issue 3: 19-27

# *Highway Construction and Natural Ecological Environment Protection*

**Muhammad Zeeshan Khan***

*Texas A&M AgriLife Research-Blackland Research & Extension Center, Temple, TX 76502, USA*

**corresponding author*

***Keywords:*** Road Construction, Natural Ecology, Environmental Protection, Dynamic Comprehensive Evaluation

***Abstract:*** More and more environmental problems have been exposed in highway construction, which must be fully concerned and studied in order to avoid the ecological disaster caused thereby. In order to solve the shortcomings of the existing research on highway construction and natural ecological environment protection, based on the discussion of highway construction and natural ecological environment protection and R cluster model, this paper investigates and discusses the selected construction scale of Chengdu Shimen Mianyang Expressway Project and the land use status in the affected area. The data analysis on the impact of highway construction and natural ecological environment is carried out through R cluster model and dynamic comprehensive evaluation. Through statistical data, it is found that the vegetation recovery rate in Section 1 and Section 4 has reached 95% and 96%. Finally, according to the environmental impact data obtained from the evaluation method, corresponding suggestions and improvement measures are proposed for highway construction in natural ecological environment protection.

## 1. Introduction

While the expressway construction has made brilliant achievements, the expressway construction and operation have formed different degrees of negative impacts on the environment. Therefore, in the context of the rapid development of highway construction, strengthening environmental protection and minimizing the adverse impacts of expressway construction projects on the regional environment along the way are also key measures to achieve the healthy and harmonious development of regional expressway construction and the environment.

Nowadays, more and more scholars have done a lot of research in highway construction and natural ecological environment protection through various technologies and system tools, and have also made certain research achievements through practical research. Elias A, based on the current situation that the highway ecological restoration project lacks the ecological function evaluation

system method, focuses on the ecological restoration function of artificially constructed plant communities, highlights the key position of the highway ecosystem service function level in the highway ecological effect evaluation, and constructs a more scientific and comprehensive highway ecological restoration effect evaluation system. The ecological restoration effect was evaluated through specific projects [1]. Luis believes that convenient and unblocked roads have brought many conveniences to people's lives, and high-quality roads are the carrier of all-round traffic. In the process of highway construction, it not only takes up a lot of land resources, but also consumes other building materials. Therefore, on the basis of project cost and quality margin, using modern energy-saving and environmental protection construction technology to complete corresponding construction tasks can effectively reduce resource consumption. In addition, in the process of highway construction, it will inevitably have a certain impact on the environment, so it is necessary to use energy-saving and environmental protection construction technology as far as possible to reduce environmental pollution and promote the balance of the ecological environment in the construction process. On this basis, the application of energy-saving and environmental protection technology in highway construction is analyzed [2]. Irwin discussed the impact of highway construction and operation on environmental damage. Construction preparation, construction progress and construction stage are the main factors causing environmental impact and interference. Therefore, environmental construction of highway engineering should start from these aspects. On this basis, combined with years of practical experience, starting from the impact of highway construction on environmental damage, this paper expounds the specific factors of environmental damage, and puts forward preventive measures to improve the highway environment, so as to achieve the goal of sustainable development of highway construction [3]. Although the existing research on highway construction and natural ecological environment protection is very rich, there are still some limitations in its practical application.

This paper studies the impact of highway construction projects on the ecological environment and the evaluation system. Combined with the actual situation of highway construction projects, it scientifically understands the impact of the three stages of highway construction on the natural ecological environment, and puts forward a dynamic comprehensive evaluation method of the impact on the ecological environment. It discusses the comprehensive impact of highway construction projects on the ecological environment through the scale of project construction and the current situation of land use in the affected areas. Based on the model of Chengdu Shimen Mianyang Expressway, a lot of detailed observation and sampling were carried out along the Chengdu Shimen Mianyang Expressway, key special research was carried out on the ecological environment of Chengdu Shimen Mianyang Expressway, and impact assessment was carried out in four aspects: animals and plants, agricultural soil, water environment and vegetation.

## 2. Highway Construction and Natural Ecological Environment Protection

### 2.1. Impact of Highway Construction on Ecological Environment

(1) Impact on land use: refers to the impact on land use caused by highway construction, mainly the impact on land caused by highway pavement occupation. The road and slope protection are permanently occupied farmland, which will cause a certain scale of loss of farmland, forest and agricultural land area. Others are temporarily occupied farmland [4].

(2) Impact on vegetation: During the construction period, some temporary land such as construction roads and raw material mixing sites arranged along the line are occupied and the area of bare ground in the area is expanded, which is likely to cause deterioration of the ecological environment. In the process of highway construction, a large amount of soil is borrowed and discarded, resulting in changes in the nature of the original surface coverage [5]. In addition, the

excavation of earth and stone will also directly damage the surface vegetation and soil layer surface, making it difficult to restore the vegetation in situ [6].

(3) Impact on water environment: the impact of highway construction on water environment mainly includes the impact on underground water, surface water and water quality [7].

1) Impact on groundwater. If the highway excavation section is located below the groundwater level, it will lead to water seepage at the edge of the subgrade and the excavated hillside, which will eventually lead to the decline of the groundwater level [8].

2) Impact on surface water. The blocking effect of roads will change the inherent situation of surface runoff, change its flow, velocity, catchment area, etc., and thus aggravate soil erosion. After the completion of forest roads, the water permeability of the pavement is lower than that of the original soil, which increases the surface runoff in this area, and will also cause some of the above environmental problems [9].

Impact on water quality. Forest roads are often located in the upper reaches of rivers and are the source of some rivers. The water quality of the area where the forest roads are located directly affects the water quality of the lower reaches and even the whole basin [10]. During the construction of the highway, the eroded soil at the subgrade and its edge enters the downstream water body with the surface runoff under the scouring effect of rainwater, reducing the downstream water quality. During the operation period, due to the entry of a large number of motor vehicles, fuel combustion emissions, engine oil, road building material particles, as well as tire and road wear materials, etc. enter the water body under the action of rain wash, affecting the water quality [11].

## 2.2. R Clustering Model

(1) R-cluster model

In this paper, Ward (deviation adjustment method) of R cluster analysis method is selected to cluster the research objects. The principle of Ward comes from variance analysis. If the indicators are clustered accurately, the Ward of the same meaning will be smaller, while the Ward of different categories will be larger [12]. The idea of Ward clustering method is to constantly seek the optimal solution in a category until the indicators are classified into one category, and Ward will gradually increase in this process [13]. After the evaluation indicators are standardized, set the number of indicators as $m$, the number of categories as $x$, $u$ as category $u$, $u=1,2,...,x$, $m_u$ as category $u$, and the calculation formula is as follows:

$$R_u = \sum_{v=1}^{m_u} (G_v^u - \overline{G}_v)(G_u^v - \overline{G}_u) \tag{1}$$

$$R = \sum_{u=1}^{w} \sum_{v=1}^{m_u} (G_v^u - \overline{G}_u)(G_u^v - \overline{G}_u) \tag{2}$$

In the formula, $R_u$ represents the square sum of type $u$ deviation, $R$ represents the total square sum of deviation, and $G_u^{(v)}$ represents the sample value vector $(v=1,2,...,m)$ of the $v$ index in type $u$; $\overline{G}_u$ refers to the average value vector of type $u$ index samples.

(2) Kruskal Wallis test

The essence of Kruskal Wallis is to judge the significant difference of different population data distribution by using multiple independent samples [14]. Assuming that all evaluation indicators are the same population, the original hypothesis proposition $T_0$ is that there is no significant difference in the data distribution characteristics of each indicator. The calculation formula of K.W test

statistics is as follows:

$$T = \frac{12}{M(M+1)} \sum_{u=1}^{w} \frac{F_u^2}{m_u} - 3(M+1) \tag{3}$$

Where, $T$ is the statistical variable, $M$ is the sum of sample sizes of all indicators, $k$ is the number of indicators, $m_u$ is the sample size of the $u$-th indicator, and $F_u$ is the sum of the sample values of the $u$-th indicator [15]. If $T_0$ hypothesis is true, $T$ follows the chi square distribution with $w-1$ degrees of freedom [16].

## 3. Investigation and Research on Highway Construction and Natural Ecological Environment Protection

### 3.1. Overview of Highway Construction Project

(1) Project construction scale

This paper selects the full length of Chengdu Shimen Mianyang Expressway, design speed, subgrade width, and two-way four lane expressway standards. The number of major bridges, medium bridges, total length of bridges, number of culverts, number of highway interchanges, highway separated interchanges and railway separated interchanges are set up along the whole line, and the data statistics of permanent land occupation and temporary land occupation for construction are shown in Table 1 [17].

*Table 1. Specific data of project construction scale*

| Project | Numerical value |
|---|---|
| Route length | 87.30km |
| Design speed | 100km/h |
| Roadbed width | 24.5m |
| Big Bridge | 12578m/32sets |
| Medium bridge | 3192m/45 sets |
| Bridge length | Total length: 15.77km |
| Culvert | 8130m/261sets |
| Highway interchange | 10 interchanges |
| Highway separation type | 11interchanges |
| Passageway and overpass | 154 |
| Permanent land occupation | 643.87hm2 |
| Temporary land occupation | 252.41hm2 |

(2) Land use status in the affected area

According to the existing data, plants can become the main elements by using the landscape method. According to the combination study of soil quality, terrain and other elements, the region is divided into five categories, including the form of land use pattern. See Table 2 for specific statistics.

*Table 2. Land use status in the affected area*

| Block type | Number (block) | Area (hm2) | Percentage (%) |
|---|---|---|---|
| Woodland | 1254 | 258.91 | 4.73 |
| Bringing to | 321 | 49.25 | 0.90 |
| Arable land | 87 | 4927.34 | 90.00 |
| Waters | 124 | 177.27 | 3.24 |
| Buildings, beaches | 412 | 62.23 | 1.14 |

### 3.2. Dynamic Comprehensive Evaluation Method of Highway Construction and Natural Ecological Environment Impact

It is a linear planning method to analyze the information of evaluation indicators at different times and evaluate the status of different stages of highway construction through weight. In this paper, the dynamic comprehensive evaluation method is used to evaluate the environmental protection of highway green construction, and the specific evaluation steps are shown in Figure 1.

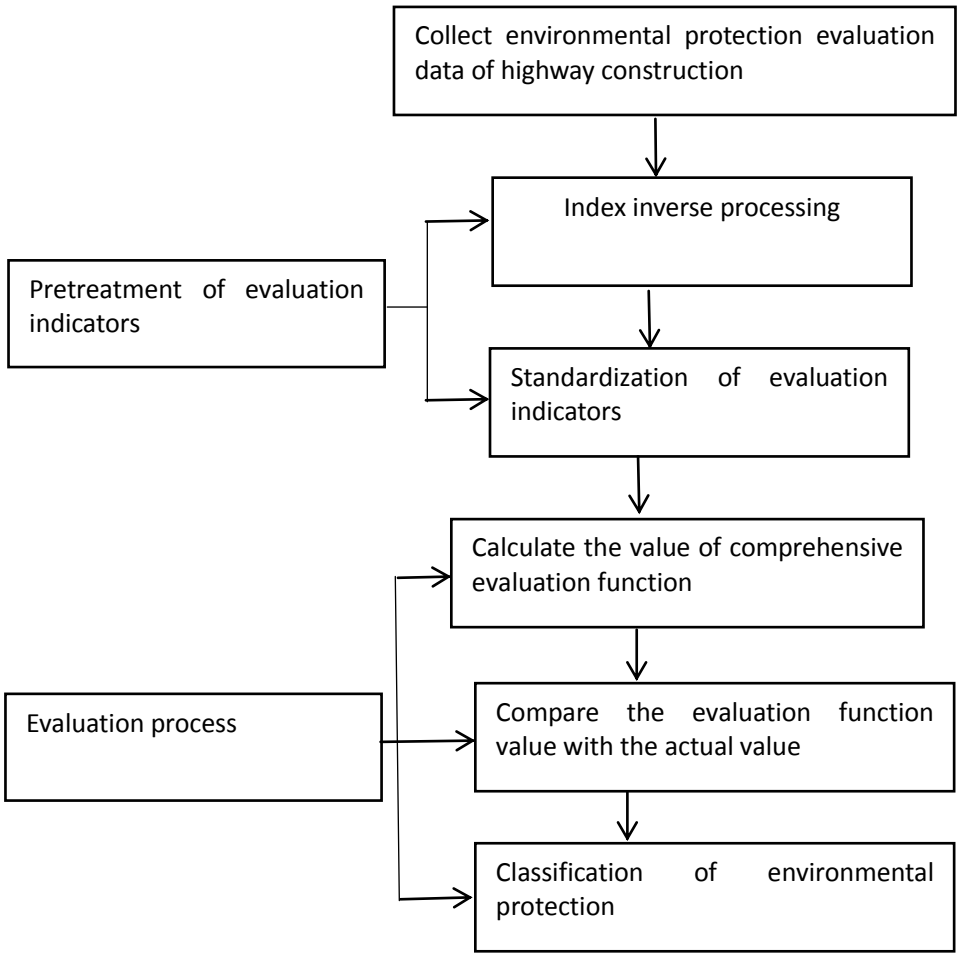


*Figure 1. Environmental protection assessment process of highway construction*

## 4. Application Research on Highway Construction and Natural Ecological Environment Protection

### 4.1. Statistics of Environmental Protection Assessment Data for Ecological Construction of Highway Construction

According to the field survey, the environmental protection assessment conditions for green construction of Chengdu Shimen Mianyang Expressway. There are 10 bid sections in the project, and four bid sections are selected for environmental protection assessment of ecological construction of highway construction. It is marked as Lot 1, Lot 2, Lot 3 and Lot 4, of which Lot 1 and Lot 2 are plain sections, and Lot 3 and Lot 4 are desert sections. The average value of the data is obtained by monitoring the quantitative indicators of the four road sections once a week for a month. The data of the original data will be inversely processed by indicators, and all the evaluation indicator data will become extremely large, and then standardized. Some data results are shown in Table 3.

*Table 3. Evaluation data of ecological construction environmental protection of highway construction*

| Index layer | Block1 | Block2 | Block3 | Block4 |
|---|---|---|---|---|
| Material storage and recovery(%) | 0.76 | 0.82 | 0.64 | 0.72 |
| Green space coverage(%) | 0.67 | 0.60 | 0.54 | 0.62 |
| Sewage reuse rate(%) | 0.65 | 0.67 | 0.24 | 0.50 |
| Vegetation destruction rate(%) | 0.45 | 0.01 | 0.28 | 0.47 |
| Vegetation recovery rate(%) | 0.95 | 0.78 | 0.70 | 0.96 |
| Rate of species change(%) | 0.35 | 0.22 | 0.35 | 0.52 |

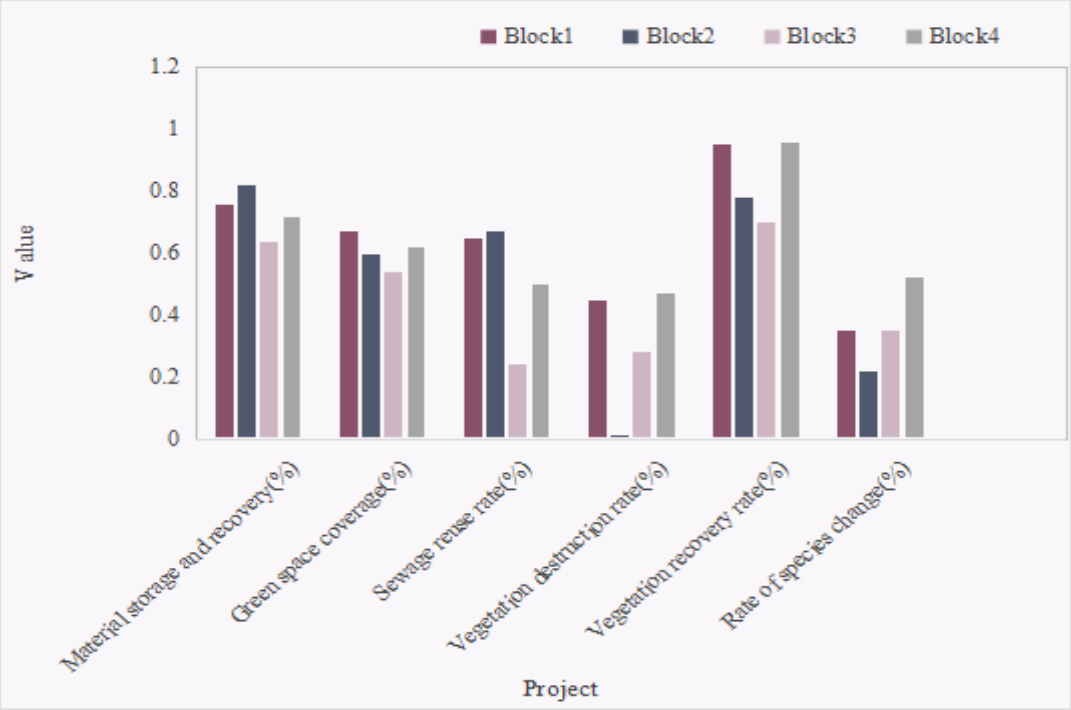


*Figure 2. Evaluation results of environmental protection for ecological construction of highway construction*

It can be seen from the data in Figure 2 that after the ecological construction of highway construction, the sewage reuse rate in three of the four bid sections has reached more than 50%. The storage and recovery rate of materials in the four bid sections has reached more than 60%, of which the bid section 2 has even reached 82%. Among the four sections, the green space coverage rate is more than 60% except for Section 3. The vegetation damage rate of the four bid sections is less than 50%, and the damage rate of bid section 2 is only 1%. The vegetation recovery rate of the four bid sections reached 75%, and the recovery rates of bid sections 1 and 4 even reached 95% and 96%. Among the four bid sections with species change rate, bid section 4 has reached 52%, and the other three bid sections are all below 40%.

### 4.2. Highway Construction and Natural Ecological Environment Protection Strategy

(1) Vegetation protection and restoration measures

It is inevitable to destroy the original vegetation during the construction of highway construction projects, which is easy to lead to water and soil loss and invasion of foreign harmful species. First, before commencement, strictly review the planning of facilities within the construction scope, establish a waste disposal area and a comprehensive mixing plant according to the EIA comments, and prohibit large temporary facilities from occupying forest land and farmland; On the other hand, through the establishment of crushed stone and screening machinery, the stripped rock can be fully utilized by means of screening and crushing. Restrict the expansion of land use for large-scale temporary facilities and reduce the damage to forest land and cultivated land.

(2) Protection of water resources

First of all, reservoirs, bathing ponds, shrimp ponds, etc. for irrigation and aquatic products breeding should also be carefully avoided. If they must be used, the route should be arranged below the soil and water area, and greening and isolation protection measures should be taken to protect the environment from damage. When designing the water system along the route, attention shall be paid to the water flow direction. The road water and side ditch water shall be discharged into certain waters to avoid polluting the surrounding water and soil resources.

(3) Control measures for disposal and utilization of solid waste

The green recycling treatment mode of solid waste is a recycling system that combines material saving with environmental protection. First, the quality and quantity of materials should be strictly controlled during the material selection and purchase stage; Secondly, the surplus materials and solid wastes used shall be classified in detail, the recyclable materials shall be recycled and stored, and the rest shall be treated. The energy generated after treatment can continue to be recycled.

## 5. Conclusion

Under the background of ecological civilization construction and sustainable development, this paper studies the evaluation index and application of highway ecological construction environmental protection. This paper classifies the evaluation index according to the characteristics of highway construction's impact on the ecological environment. The dynamic comprehensive evaluation model of highway ecological construction environmental protection is constructed by using the dynamic comprehensive evaluation method, and the dynamic evaluation index threshold is obtained and the environmental protection in the green construction stage of highway is dynamically evaluated. The evaluation data statistics of the environmental protection effect of highway ecological construction are carried out through specific implementation cases, and corresponding protection measures are proposed according to the evaluation results, providing a feasible evaluation tool for highway construction in the ecological environmental protection self-assessment link.

## Funding

This article is not supported by any foundation.

## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

## References

*[1] Elias A. Aquariums and Human–Animal Relations at the Great Barrier Reef. Queensland Review (2020) 28(2): 98-113.*

*[2]Luis F, Miranda-Moreno. Weather or Not to Cycle: Temporal Trends and Impact of Weather on Cycling in an Urban Environment. Transportation Research Record (2018) 2247(1): 42-52. https://doi.org/10.3141/2247-06*

*[3]Irwin, Yeo, Alexandra. Spot Prices Rise in Asia, Europe as Buyers Build up Stocks. World Gas Intelligence (2018) 29(34): 9-10.*

*[4]Natural, gas, intelligence. Appalachian E&Ps Searching for More Connectivity, Lower Costs on Infrastructure Build-Out. Natural Gas Intelligence. (2018) 37(25): 9-9.*

*[5] Singh N, Sonone S, Dharaiya N. Sloth Bear Attacks on Humans in Central India: Implications for Species Conservation. Human-Wildlife Interactions. (2018) 12(3): 338-347.*

*[6]Yan, Ropert-Coudert. Conservation Insight. BBC Wildlife. (2018) 36(1): 59-59.*

*[7]Alec, G, Blair. Community Perception of the Real Impacts of Human-Wildlife Conflict in Laikipia, Kenya: Capturing the Relative Significance of High-Frequency, Low-Severity Events. Oryx: The International Journal of Conservation (2018) 52(3): 497-507. https://doi.org/10.1017/S0030605316001216*

*[8]Fernando, Trujillo. Conservation Insight Amazon River Dolphin. BBC Wildlife. (2018) 36(3): 58-58.*

*[9]Regina, Asmutis-Silvia. Conservation Insight North Atlantic Right Whale. BBC Wildlife (2018) 36(5): 60-60.*

*[10]Dhungana, Rajendra, Savini. Living with Tigers Panthera Tigris: Patterns, Correlates, and Contexts of Human-Tiger Conflict in Chitwan National Park, Nepal. Oryx: The International Journal of Conservation. (2018) 52(1): 55-65. https://doi.org/10.1017/S0030605316001587*

*[11]Abstract. Image-based Quantification of Patella Cartilage Using MRI - Evaluation of Novel Methods for Segmentation, Volume and Thickness Estimation. Aquatic Conservation Marine & Freshwater Ecosystems (2018) 16(6): 569-578.*

*[12]Iezzi, M, Eugenia. Conservation of the Largest Cervid of South America: Interactions between People and the Vulnerable Marsh Deer Blastocerus Dichotomus. Oryx: The International Journal of Conservation. (2018) 52(4): 654-660. https://doi.org/10.1017/S0030605317000837*

*[13]Mujtaba, Bashari, Erin. Hunting in Afghanistan: Variation in Motivations Across Species. Oryx: The International Journal of Conservation (2018) 52(3): 526-536. https://doi.org/10.1017/S0030605316001174*

*[14]Simi, Talukdar, Abhik. Attitudes towards forest and wildlife, and Conservation-Oriented Traditions, around Chakrashila Wildlife Sanctuary, Assam, India. Oryx: The International*

*Journal of Conservation. (2018) 52(3): 508-518. https://doi.org/10.1017/S0030605316001307*

*[15] Hossen M B, Auwul M R. Comparative Study of K-Means, Partitioning Around Medoids, Agglomerative Hierarchical, and DIANA Clustering Algorithms by Using Cancer Datasets. Biomedical Statistics and Informatics (2020) 5(1): 20-25. https://doi.org/10.11648/j.bsi.20200501.14*

*[16] Bhatnagar V, Majhi R, Jena P R. Comparative Performance Evaluation of Clustering Algorithms for Grouping Manufacturing Firms. Arabian Journal for Science & Engineering. (2018) 43(8): 4071-4083. https://doi.org/10.1007/s13369-017-2788-4*

*[17] Botre M K, In T. Modified Clustering Algorithms: Survey Paper. International Journal of Development Research (2018) 2(3): 34-39.*