

# Study on the interests of nature reserves and their surrounding residents

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**Abstract.** In order to strike a balance between protecting wild animals and other natural resources and safeguarding the interests of people in the surrounding areas, we developed a dynamic game model that considers both factors. We used the number of wild animals and per capita GDP as observation targets, with the goal of optimizing the income of the surrounding residents while also maximizing the number of wild animals. The objective is to achieve a harmonious state where both benefits are balanced. While punishing residents for destructive behavior can be effective, it is important to protect their economic and living interests. This can be accomplished through increased awareness and education on the importance of preserving wild nature reserves, as well as by improving the employment and income opportunities of the residents. Developing local scenic spots can also help to increase the income of the surrounding communities and improve their overall living conditions. By taking these measures, we can create a sustainable and harmonious environment where both wild animals and people can thrive.

**Keywords:** People and Nature, Wild animal, Environmental benefits, dynamic game.

## 1. Introduction

During our research, we discovered that the Masai Mara National Park in Kenya is divided into two distinct areas: the peripheral area and the core area of Masai Mara. In order to investigate the complex relationship between wildlife and people in this region, we selected key cities as reference targets and studied the core part of the natural environmental reserve in Nairobi as well as the peripheral area in Vecouru. We carefully considered the relevant policies of local governments and regional management measures in our analysis.[1-2]

As we delved deeper into the topic, we recognized the inherent conflict between nature reserve protection and the interests of people in the surrounding cities. Through our research, we identified a dynamic game between the two, where both factors must be considered in order to find a sustainable balance. We therefore engaged in extensive discussion and exploration of this issue, exploring potential solutions that would promote the protection of the park's natural resources while also safeguarding the interests of the local communities.

By taking a comprehensive approach that considers the needs of both wildlife and people, we can create a more harmonious and sustainable relationship between the two. Our research and exploration of this complex issue have shed light on the challenges that must be addressed in order to achieve this goal.[3-4]

## 2. related work

Through searching the literature, we find the multi-purpose ecosystem service assessment model and the social-ecosystem model to study this kind of problem.[5-8]The Model I use is a dynamic game model, I will be the three models of the following analysis and comparison.

The two models have different goals. While both aim to achieve a balance of interests between humans and nature through assessment, prediction, and decision-making, they differ in focus. The dynamic game model emphasizes how people make decisions and how their choices impact the decisions and outcomes of others.

Additionally, the models use different methods. The first model utilizes economics, ecology, sociology, statistics, systems science, and other approaches. The dynamic game model, on the other hand, primarily relies on mathematical game theory and optimization theory.

Finally, the research subjects of the models differ. Both models study the interaction and dependence between humans and nature and aim to achieve sustainability and adaptability. However, the dynamic game model places more emphasis on people's behavior and strategy in various decision-making environments.

The two models can be used in different fields, including natural resource management, ecological protection, urban planning, climate change adaptation, environmental policy and so on. The dynamic game model is more widely used in the economic, financial, management, political and other fields.

Model complexity is different: the complexity of the above two models varies with the research problem, some models are simple, some are more complex. Dynamic game models are usually more complex than these two models and require more mathematical and computer support.

From the above comparison, I use the dynamic game model for two reasons.

Considering dynamic change: the dynamic game model emphasizes the dynamic change in the decision-making process, including the decision-maker's choice of strategies and other factors. This method can help decision makers better understand the dynamic trends of decision results and how to adjust their strategies according to different decision results.

2. The research scope is wide: dynamic game model can be applied in many fields, such as finance, management, politics, environment, resources, etc. It can help researchers better understand the decision-making process in different fields, analyze the interaction and dependence among different decision-makers, and make more accurate and feasible decision-making.

## 3. The Analysis of the dynamic game model

Game theory is a decision-making framework that explores the interdependence and interaction of strategies among actors. It finds extensive application in political, diplomatic, military, economic, and other research fields. While its most successful application is in microeconomics, game theory's research methods and characteristics extend beyond traditional economics. Game theory is closely integrated with economics, emphasizing individual rationality and the pursuit of utility maximization under given constraints. However, it also focuses on the maximization of utility as behavior changes for each agent, going beyond decision-making under impersonal price parameters. In addition to international trade, finance, and auction fields, game theory has proved useful in enterprise theory, particularly in the research methods of oligopolistic competition.

Game theory has been a prominent topic in Western economics textbooks since the 1980s and is considered the latest frontier in economic research. Industrial organization theory textbooks, in particular, almost exclusively rely on game theory. The inclusion of game theory in economics reflects the trend toward more individualized and microscopic research objects. It highlights the increasing importance of studying interpersonal relations and interactions and the tendency to reconcile interpersonal interests and conflicts through optimal institutional arrangements. Moreover, game theory reflects the growing emphasis in economics on information. In individual choices and institutional arrangements, relevant information is often incomplete, and game theory provides a

framework to study its impact. The widespread application of game theory in economics has significantly improved the discipline's ability to explain real-world phenomena.[9]

While game theory has found wide application in microeconomics, there are still many practical challenges to its use. It cannot provide a single solution for fully exploring the interdependence between personal development and social development. Although the existing structure of game theory can strongly support the proposition that "cooperation is better than non-cooperation," it cannot fully explain the complex relationship between conflict and cooperation in reality. The assumption that groups of individuals will act cooperatively to achieve their common interests is not always true. Rational individuals seeking to maximize their personal interests may not act in the common interest, especially in larger groups. Even when they can benefit from taking cooperative action to achieve the common good, they may not voluntarily do so. This is because in many situations, individuals may not have sufficient incentives to cooperate or may face barriers that prevent them from doing so. Therefore, the practical use of game theory in understanding human behavior and decision-making remains an ongoing challenge.[10-14]

## 4. Results

### 4.1. Model building for dynamic game theory

In view of the protection of nature reserves and the interests of the people around the city of contradictory considerations, found that there is a game between the two phenomena. Therefore, through the analysis of the problem, Based on the distribution of the peripheral and core areas of the Masai Mara, we build a dynamic game model to consider the protection of the natural environment and the interests of the people in the surrounding cities. For example, figures 1 and figures 2.

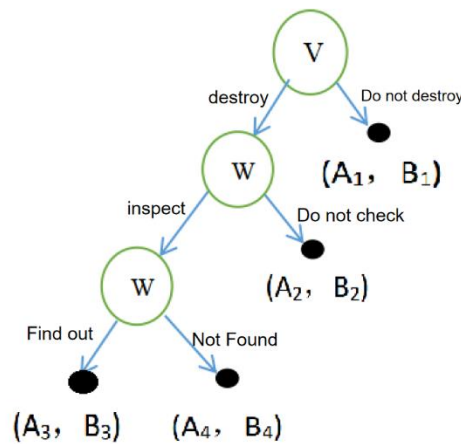


Figure 1. Dynamic game model of core area

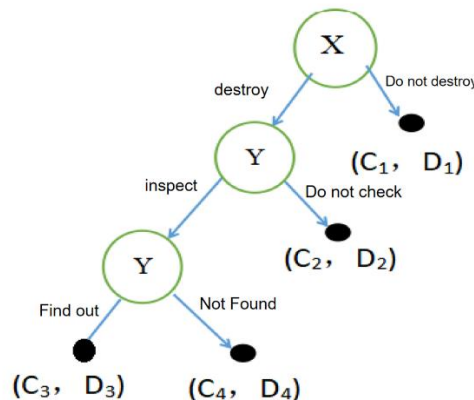


Figure 2. dynamic game model of peripheral area

In Figure 1, W is for the management of the nature reserve and V is for the surrounding residents. A represents the income of the management of the nature reserve, and B represents the income of the surrounding residents.

In Figure 2, Y is for the management of the nature reserve and X is for the surrounding residents. C represents the income of the management of the nature reserve, and D represents the income of the surrounding residents.

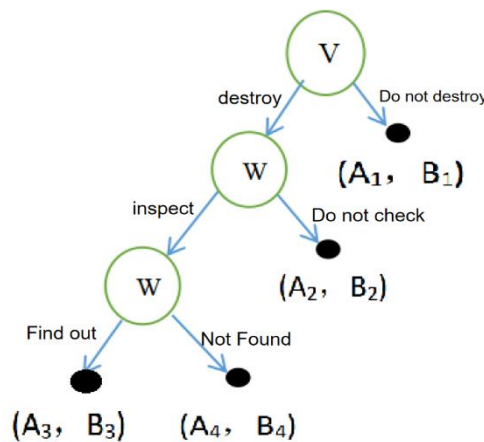
#### 4.2. Determination of the layer number of the dynamic game models

The dynamic game model is a sequence-based approach that involves multiple players at different stages of an event, leading to different outcomes. In this problem, the model aims to establish a close equilibrium between two interests. However, certain factors can affect the development of events, resulting in both positive and negative consequences. To optimize the results of the model, this approach is employed to identify the best way forward.

#### 4.3. The establishment of simulation model

The dynamic game model takes into account the actions and strategies of the local governments in protecting the nature reserve and addressing the interests of the people living in the surrounding cities. It also considers the impact of human behavior on the natural environment and the need for necessary actions to ensure the sustainable development of the area. By analyzing and balancing the interests of different stakeholders, the model can help identify optimal strategies and outcomes that benefit both the natural environment and the local communities.

#### 4.4. Analysis of experimental results



**Figure 3.** Core area dynamic game model

Figure 3 is the analysis of the dynamic game model of the core region.  $(A_1, B_1)$ ; If the surrounding community resident reserves carry out destructive behavior, and the management departments do not stop and inspect such behavior, then their respective benefits are  $(A_2, B_2)$ ; When the management department of the reserve finds out or later finds out the destructive behavior of the residents of the surrounding communities through evidence and punishes them, the two benefits are  $(A_3, B_3)$ ; If the destructive behavior of the surrounding community residents is not detected, the benefits are  $(A_4, B_4)$ .

We need  $H_1$  And  $H_2$  to express the benefits given to the management department and the surrounding residents, with  $I_1$  And  $I_2$  to show the economic input of the management department to the protection area and the input of the incentive policies for the surrounding residents, use  $J_1$  and  $J_2$  to show the compensation of the management department for the protection of animals and the loss caused by wild animals to the surrounding residents. A is used to indicate the benefits caused by surrounding residents when performing destructive behaviors, and b is used to indicate the economic punishment of administrative departments for destructive behaviors of surrounding residents. Use c

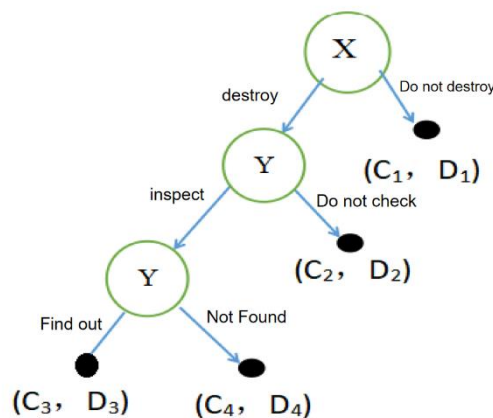
to indicate the management expenditure on the conservation management of the protected areas. Use  $d$  to indicate the cost of the administration to inspect evidence of destructive behavior of residents.

$$\begin{aligned}
 A_1 &= H_1 + I_1 - c, \\
 B_1 &= H_2 + I_2 + J_1 - J_2, \\
 A_2 &= H_1 + I_1 - c, \\
 B_2 &= H_2 + I_2 + J_1 - J_2 + a, \\
 A_3 &= H_1 + I_1 - c - d + b, \\
 B_3 &= H_2 + I_2 + J_1 - J_2 - b, \\
 A_4 &= H_1 + I_1 - c - d, \\
 B_4 &= H_2 + I_2 + J_1 - J_2 + a.
 \end{aligned}$$

The inspection requires the management department to spend high additional expenses  $c$ , and the probability that the management department can find out is  $P$ . Available reserve management to take inspection strategy and the surrounding community residents for the respective benefits of  $(M_1, N_1)$

$$\begin{aligned}
 M_1 &= P(H_1 + I_1 - c - d + b) + (1 - P)(H_1 + I_1 - c - d) \\
 &= H_1 + I_1 - cd + Pb \\
 N_2 &= P(H_2 + I_2 + I_1 - I_2 - b) + (1 - P)(H_2 + I_2 + J_1 - J_2 + a) \\
 &= H_2 + I_2 + J_1 - J_2 + (1 - P)a - Pb
 \end{aligned}$$

If,  $Pb > c$ , it means that the management department of the management area adopts the patrol strategy. Contrast, if  $Pb < c$ , then the management of the protected area did not adopt the patrol strategy. At this time, the efforts of the management department will be proportional to the income of the residents, and the management department reduces the economic investment, which will increase the destructive behavior of the residents, and increase the income of the residents, but the protection of natural resources will be reduced to the minimum. This model perfectly solves the economic balance between the residents in the core area and the natural environment protection.



**Figure 4.** Dynamic game model in the peripheral area

Figure 4 shows the analysis of the dynamic game model of the peripheral area. If the residents of the surrounding cities do not adopt various destructive behaviors, then the benefits of the management and residents at this time are  $(C_1, D_1)$ ; If the protected area of the surrounding community commits destructive behavior, and the management does not stop and inspect such behavior, then the respective benefits are  $(C_2, D_2)$ ; When protected area management discovers or subsequently identifies through evidence the disruptive behaviour of residents of surrounding communities and punishes them, the benefits are  $(C_3, D_3)$ ; If the destructive behaviour of the inhabitants of the surrounding community is not detected, the benefits are  $(C_4, D_4)$ .

We need  $H_1$  And  $H_2$  To express the benefits given to the management department and the surrounding residents, with  $E_1$  And  $E_2$  .To show the economic investment of the management department in the protection area and the incentive policy investment for the surrounding residents, with  $F_1$  And  $F_2$  .To show the compensation of the management department for the protection of animals and the loss caused by wild animals to the surrounding residents. We use  $e$  to express the

benefits caused by the surrounding residents when performing destructive behavior, and we use  $f$  to indicate the economic punishment of the management department for performing destructive behavior. We use  $g$  to indicate the expenditure of the protected area. Use  $h$  to indicate the cost of the administration to inspect evidence of destructive behavior of residents.

$$\begin{aligned} C_1 &= H_1 + E_1 - g, \\ D_1 &= H_2 + E_2 + F_1 - F_2, \\ C_2 &= H_1 + E_1 - G, \\ D_2 &= H_2 + E_2 + F_1 - F_2 + e, \\ C_3 &= H_1 + E_1 - g - h + f, \\ D_3 &= H_2 + E_2 + F_1 - F_2 - f, \\ C_4 &= H_1 + E_1 - g - h, \\ D_4 &= H_2 + E_2 + F_1 - F_2 + e. \end{aligned}$$

Just like the core area, the inspection requires the management department, and the probability of the management department is  $Z$ . Available reserve management to take inspection strategy and the surrounding community residents for the respective benefits of  $(Q_1, W_1)$

$$\begin{aligned} Q_1 &= Z(H_1 + E_1 - g - h + f) + (1 - Z)(H_1 + E_1 - g - h) \\ &= H_1 + I_1 - gh + Zf \\ W_2 &= Z(H_2 + E_2 + F_1 - F_2 - f) + (1 - Z)(H_2 + E_2 + F_1 - F_2 + e) \\ &= H_2 + I_2 + J_1 - J_2 + (1 - Z)e - Zf \end{aligned}$$

If,  $Zf > g$ , he means that the management department of the management area adopts the inspection strategy. On the contrary, if  $Zf < g$ , then the management department of the management area did not adopt the patrol strategy. At this time, the efforts of the management department will be proportional to the income of the residents, and the management department reduces the economic investment, which will increase the destructive behavior of the residents, and increase the income of the residents, but the protection of natural resources will be reduced to the minimum. This model perfectly solves the economic balance between the residents in the peripheral area and the natural environment protection.[15]

## 5. Conclusions

Through the game model for the relevant areas and the establishment of the answer, the GDP analysis of the residents around the nature reserve, it was found that the per capita benefits of the core areas of the Nairobi-led nature reserve were better than those of the peripheral areas of the Wikuru-led nature reserve. And the Kenyan government's amendments to the relevant laws, so that the core and peripheral areas of human and natural interests are multiplied. However, by looking at the interests of Nairobi, found that the implementation of the Nairobi region policy is more suitable for the whole of Kenya to implement.[15-18]

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