A STUDY OF THE LONG-RUN BEHAVIOUR OF THE VISITORS OF MT. OLYMPUS: A MARKOV CHAIN ANALYSIS APPROACH

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ABSTRACT

In this paper the long-run variations in the behaviour of visitors to a natural area of Greece are examined. Specifically the area chosen to be studied is the national park of Mountain Olympus, which is the first one established by law in Greece, in 1938, and which attracts many thousands of visitors Greeks and foreigners every year. The 1986 and 1995 visitors surveys revealed interesting characteristics concerning the population visitors such as, age, nationality, duration of visit, reasons of visit, etc. This paper classifies the population of visitors of the Mt. Olympus as *new* (first time visitors) and *old* (more than once visitors) and employs transitional probability matrices of a Markov chain to examine the long-run behaviour of the visitors. The results of this study seem to be important towards an optimal allocation of available resources to the protection, conservation, and more generally to the planning and development of Mt. Olympus.

RÉSUMÉ

A travers cet article, nous examinons à long terme, les variations du comportement des visiteurs dans une région de la Grèce. Spécifiquement la région choisie pour notre étude est le Parc National du Mont Olympe, qui, en 1938, fut le premier parc en Grece, établi et protégé par la loi. Chaque année, ce parc reçoit des milliers de visiteurs, grecs et étrangers. Des enquêtes réalisées sur les visiteurs, en 1986 et 1995, nous ont revelé des caractéristiques de population intéressantes, au sujet de l'âge, de la nationalité, de la durée et des raisons de visite, etc. Cet article classifie la population des visiteurs du Mt Olympe en nouveaux *(première visite) et* anciens *(plus d'une fois); et utilise les matrices de transition d'une chaîne de Markov pour examiner à long terme le comportement des visiteurs. Les resultats de cette étude sont considerés très importants pour une gestion et une utilisation optimales des ressources disponibles, pour la protection et enfin, pour une planification du développement du Mt. Olympe.*

1. INTRODUCTION

Mount Olympus, the cradle of liberal Greek religion, philosophy and education, has become the symbol of the modern European civilisation. However, its natural environment with vegetation alternations, that is characterised by a rare variety of forms and structures, as well as the incorporated local wild life, is combined with extended samples of a historical-anthropogenous environment of a unique value.

There is also an increasing international interest for Mt. Olympus. Specifically in the year 1981, UNESCO declared the mountain part of the international network of Biosphere Reserves and it has included it in the program "Man and Biosphere", whose aim is the protection and conservation of nature in the most important ecosystems in the world. Hence, with the E.C. (directory 79/409, art. 4), Mount Olympus is included in the Special Protection Areas. During the years 1986 and 1995, two stratified sample taking surveys, (Kyritsis & Farmakis, 1987) on the population of visitors to Mt. Olympus, were carried out. The total population was subdivided into homogenous and non-overlapping strata. The total number of visitors of the mountain during each survey, is considered as the "population". This paper employs Markov chain analysis to study the long-run behavior of the visitors of the Mt. Olympus, classified as new (first time visitors and old (more than once visitors). The results of this study (which to the best of our knowledge is the first of this kind) play a significant role as, (Witt, 1992) refers, to the efficient protection, exploitation and more general planning and development of the area of Mt. Olympus. The remaining parts of the paper are organized as follows. In section 2 the population structure described by a transition matrix is introduced. In section 3 the long-run behaviour of the population of visitors is studied. Finally in section 4 the conclusions are discussed.

2. THE STRUCTURE OF THE POPULATION OF VISITORS

The classification into new visitors and old visitors has been chosen for the following two reasons. The presence of a new visitor indicates an interest to become aquatinted with the national landscape, and moreover, this interest is a result of being adequately informed.

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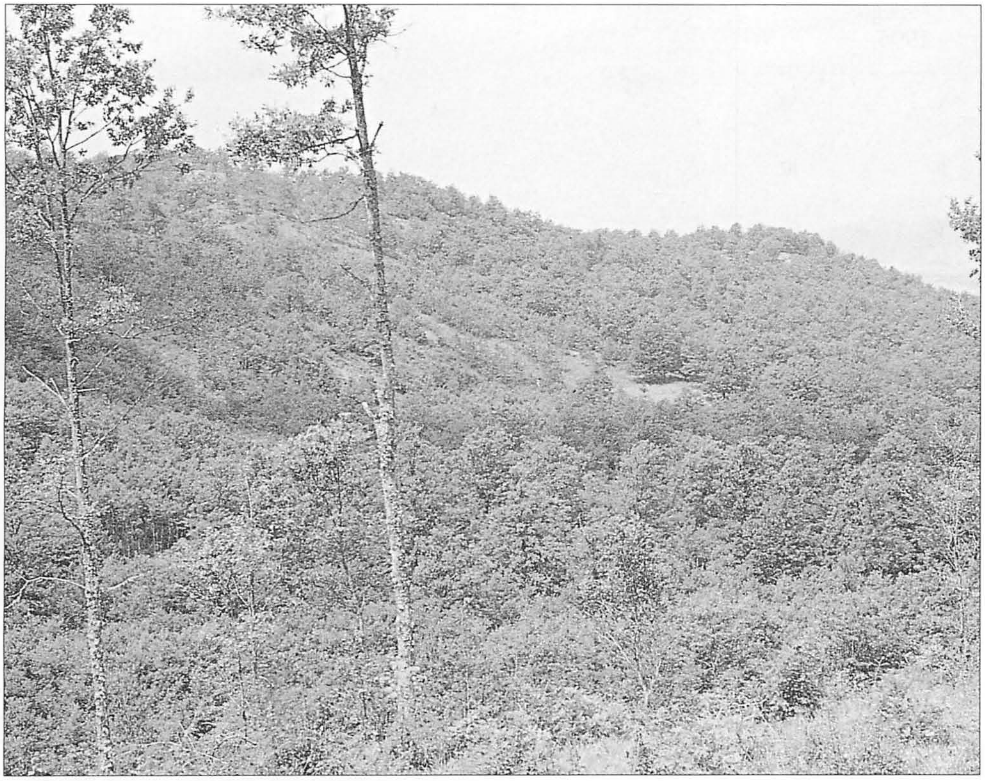

On the other hand, the presence of an old visitor indicates a high level of satisfaction during her or his past visits or at least an indication of comparative advantage over other areas, an interest for possible further study of that specific area etc. Hence, the compilation of the total number of visitors, as well as the duration of their visit (Oliveira et al. 1983), are factors that should be taken into consideration when the infrastructure for the area is organised and planned. The main purpose of this study is to create a time path between the structure of the elements of the initial vector and those of the final vector. This time path will form the basis to predict the population structure consisting of new and old visitors in the future. The 1986 research sample of n_1=439 visitors consists of 314 new visitors and 125 old. Thus the initial vector expressing the population structures is A_1=[314, 125]. We also have a second sample of n_2=439 visitors expressing the population structure a decade later, that is the year 1995, which consists of 286 new visitors and 153 old ones. That is second vector was A_2=[286, 153]. To obtain this we must find a transition probability matrix P that links the two vectors of the population structure at the beginning and at the end of the 1986-1995 decade.

A matrix P that links the two vectors has the form

$$A_2 = P \,.\, A_1$$

or

$$\begin{bmatrix} b_0 \\ b_1 \end{bmatrix} = \begin{bmatrix} p_{00} & p_{00} \\ p_{10} & p_{11} \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \end{bmatrix}$$

or

$$\begin{aligned} b_0 &= a_0 p_{00} + a_1 p_{10} \\ b_1 &= a_0 p_{01} + a_1 p_{10} \end{aligned} \qquad (1)$$

The probabilities:

p_{00}= probability in state 0 to be replaced by a visitor of state 0.
That is the probability of a new visitor to be replaced by a new visitor.

p_{01}= probability in state 0 to be replaced by a visitor of state 1.
That is the probability of a new visitor to be replaced by an old visitor.

p_{10}= probability in state 1 to be replaced by a visitor of state 0.
That is the probability of an old visitor to be replaced by a new visitor.

p_{11}= probability in state 1 to be replaced by a visitor of state 1.
That is the probability of an old visitor to be replaced by an old visitor.

of the transition matrix P are calculated as follows:

Every visitor can be in one of the two states. Specifically state 0 for the new visitor and state 1 for the old visitor.

Thus the number of the visitors X who change states is a random variable which can be described by a binomial distribution X~B(n, p) where p is the probability of changing states and n is the number of receptions. It is well known that $E(X) = np$.

It is also assumed that the expected number of visitors in state i at some period of time is the sum of the expected number of visitors who in previous period were either in state i and remained there or were instate j and jumped into state i. Matrix P is a stochastic matrix, that is a non-negative matrix having the sum of each row equal to one. Specifically it is a binary chain that describes the transition from state 0 to state 1, and vice versa. Furthermore it is assumed that the probabilities of such transitions are independent of each other. These phenomena are known as binary Markov-chains (Balmer, 1980; Revuz, 1975).

Specifically, in the population of visitors to Mt. Olympus that has been examined, the data of the two periods, as they result from the correspondence of the two vectors we mentioned before, are the following:

1986			1995		
number	1	→	1	=	38
»	1	→	0	=	87
»	0	→	1	=	115
»	0	→	0	=	199
					439

For example the first row of the above mapping is explained as follows: the number of visitors who remained in the state old between 1986 and 1995 were 38 and so on.
From the above mapping the probability p_{ij} $i,j = 0,1$ are calculated as follows:

$$p_{00} = \frac{number(0 \to 0)}{number(0 \to 0) + number(0 \to 1)} = \frac{199}{199+115} = 0,634$$

$$p_{01} = \frac{number(0 \to 1)}{number(0 \to 0) + number(0 \to 1)} = \frac{115}{199+115} = 0,366$$

$$p_{10} = \frac{number(1 \to 0)}{number(1 \to 0) + number(1 \to 1)} = \frac{87}{87+38} = 0,696$$

$$p_{11} = \frac{number(1 \to 1)}{number(1 \to 0) + number(1 \to 1)} = \frac{38}{87+38} = 0,304$$

and therefore:

$$p = \begin{bmatrix} 0,634 & 0,366 \\ 0,696 & 0,304 \end{bmatrix} \quad (2)$$

The elements of the probability matrix P are explained as follows:
The probability of a new visitor to be replaced by a new visitor is p_{00}=0.634
The probability of a new visitor to be replaced by an old visitor is p_{01}=0.366
The probability of an old visitor to be replaced by a new visitor is p_{10}=0.696
The probability of an old visitor to be replaced by an old visitor is p_{11}=0.304

3. Long-run Behaviour

Assuming that the transition matrix P which transforms the vector A_1=[314, 125] of 1986 to the vector A_2=[286,

153] of 1995 remains the same for the coming years we have the follow sequence of transition matrices

$$A_2 = P \,.\, A_1, \quad A_3 = P \,.\, A_2 = P \,.\, P \,.\, A_1 = p^2 \,.\, A_1$$

and more generally

$$A_{n+1} = P^n \,.\, A_1$$

In order to find the long run tendency we need to find the matrix

$$\lim_{n \to \infty} P^n$$

It can be proved (Isaacson & Mansen, 1976) that

$$p^n = \frac{1}{p_{01}+p_{10}} \begin{bmatrix} p_{10} & p_{01} \\ p_{10} & p_{01} \end{bmatrix} + \frac{(p_{11}+p_{01})^n}{p_{01}+p_{10}} \begin{bmatrix} p_{01} & -p_{01} \\ -p_{10} & p_{10} \end{bmatrix} \quad (3)$$

From the fact that $[p_{11} - p_{01}] < 1$, it is obtained

$$\lim_{n\to\infty} P^n = \frac{1}{p_{01}+p_{10}} \begin{matrix} p_{10} & p_{01} \\ p_{10} & p_{01} \end{matrix} \quad (4)$$

The application of (4) to the data of the visitors to the Mt. Olympus gives

$$\lim_{n\to\infty} P^n = \begin{bmatrix} 0{,}655 & 0{,}345 \\ 0{,}655 & 0{,}345 \end{bmatrix} \quad (5)$$

Starting with the initial transition matrix

$$P = \begin{bmatrix} 0{,}634 & 0{,}366 \\ 0{,}696 & 0{,}304 \end{bmatrix}$$

We realize that:

$$P^2 = \begin{bmatrix} 0{,}657 & 0{,}343 \\ 0{,}653 & 0{,}347 \end{bmatrix} \text{ and } P^3 = \begin{bmatrix} 0{,}655 & 0{,}345 \\ 0{,}655 & 0{,}345 \end{bmatrix} \quad (6)$$

Which almost the same as

$$\lim_{n\to\infty} P^n$$

This asymptotic attitude of the rapid convergence is known as steady state property and is a result of the independence of the probability concerned. This property where the long-run behaviour of the system is independent of the initial distribution is referred as ergodic property.

Equation (6) has the following meaning. The probability of a new visitor to appear in the future is independent of his present state and is equal to $p_{00} = p_{10} = 0.655$. Similarly the probability of and old visitor to appear in the future is independent of his present state and is equal to $p_{01} = p_{11} = 0.345$.

This is translated as follow. In the future the population of visitors to the Mt Olympus will consist of 65.5% new visitors and 34.5% old visitors.

4. Conclusion

In this paper a Markov chain analysis was employed to study the dynamic structure of the population of visitors of the national part of mountain Olympus. It was found that in the long-run the population of visitors will consist of 65% new (first time) visitors and of 35% old (more than once) visitors. This is a valuable information which can be used to allocate the available resources and funds in more efficient and possibly optimal way. Specifically the tourist agents of the greater region of the national part of Mt Olympus would try to lengthen the visitors stay by providing better and less expensive facilities.

For the national park authorities this information can be used in a number of ways to increase the number of visitors and lengthen their stay while protecting, preserving and maintaining the physical beauties and attractions of the mountain. ●

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