Tourist attractions capping visitor numbers

MISG 2023

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January 20, 2023

Outline

Introduction

As part of revitalisation of tourist attractions, determining the number of visitors that should be welcomed per day (capping visitor numbers) is one of the key mergers to put in place.

The assumption is that once the attraction revitalisation process is complete, through marketing the attraction could attract more tourist due to its unique offerings.

This success will be financially improved when the site manager's are able to directly and correctly charge visitors.

Objectives of the project

Develop and solve a tourism mathematical model that will:

- determine the social carrying capacity of a tourist attraction.
- track the flow of the activities at a specific time

What are the tourism attractions capping visitor numbers?

- The carrying capacity of tourism is defined as the highest tourism presence at a destination that does not interrupt ordinary activities of residents and does not preclude tourists from appreciating the destination
- The carrying capacity application has the greatest potential in protected areas, in frequently visited cultural and natural attractions, and in relation to sustaining of the lifestyle of the local community and tourism destination potential in general.

Model formulation: Tourism attractions capping visitor numbers models

PARAMETERS	
PARAMETERS	**DESCRIPTION**
$\alpha_1 ... \alpha_4$	Rate of change of population
$\gamma_1 ... \gamma_{12}$	Rate of change between activities
$\beta_1 ... \beta_4$	Rate of change between activities
Λ	Recruitment rate
μ	Removal rate

VARIABLES

VARIABLES	
VARIABLES	**DESCRIPTION**
P	Population
W	Wild life
S	Swimming pool
R	Restaurant
G	Guided walk

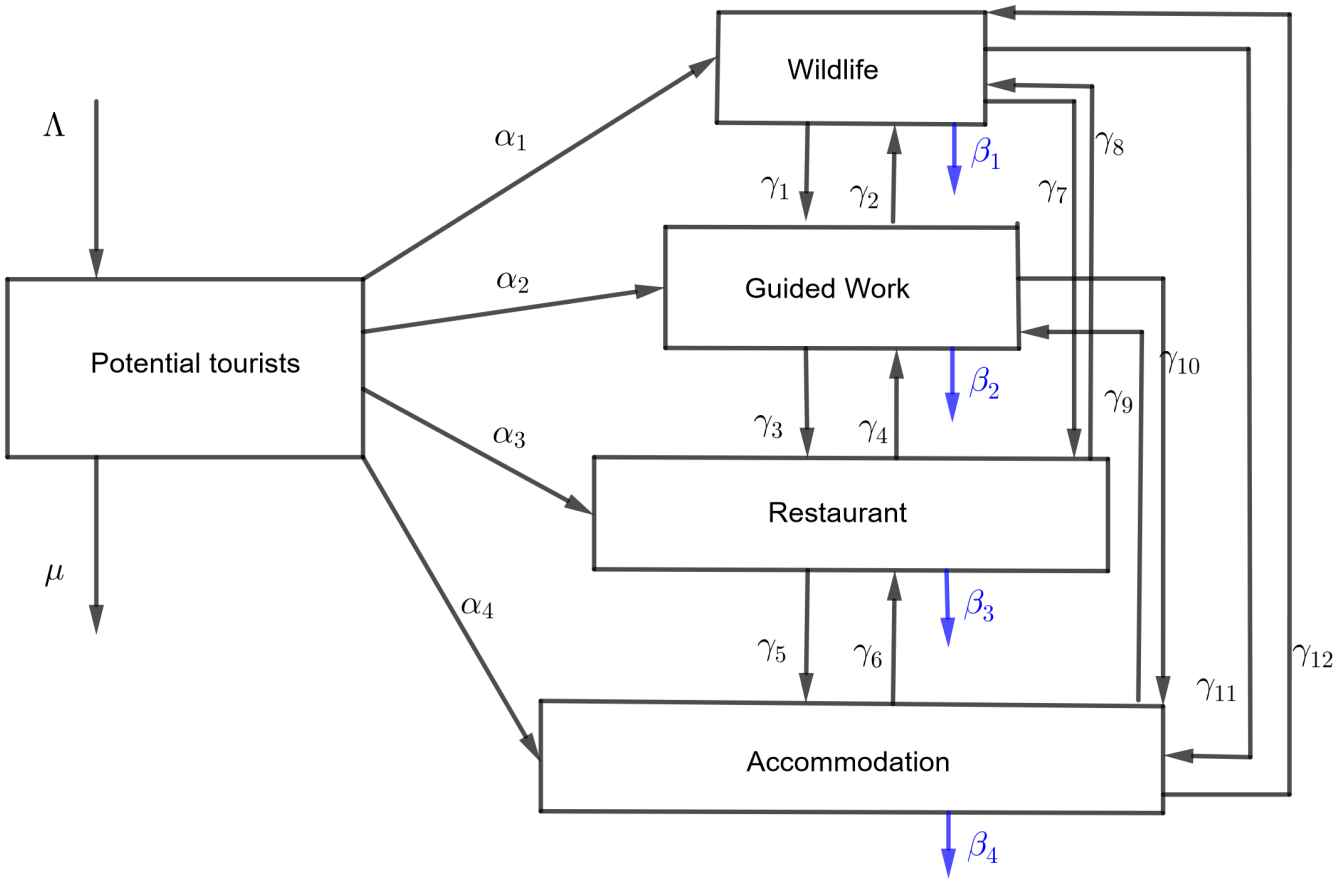

FIGURE 1: Activity model

Model I: Compartmental model

$$
\begin{aligned}
\frac{dP}{dt} &= -P\left(\alpha_1 W + \alpha_2 S + \alpha_3 R + \alpha_4 G + \mu\right) + \Lambda \\
\frac{dW}{dt} &= W\left(\alpha_1 P + \gamma_2 S + \gamma_8 R + \gamma_{10} G - \gamma_1 S - \gamma_9 G - \gamma_7 R - \beta_1\right) \\
\frac{dS}{dt} &= S\left(\alpha_2 P + \gamma_1 W + \gamma_{11} G + \gamma_4 R - \gamma_3 R - \gamma_2 W - \gamma_{10} G - \beta_2\right) \\
\frac{dR}{dt} &= R\left(\alpha_3 P + \gamma_3 S + \gamma_4 W + \gamma_6 G - \gamma_4 S - \gamma_5 G - \gamma_8 W - \beta_3\right) \\
\frac{dG}{dt} &= G\left(\alpha_4 P + \gamma_5 R + \gamma_9 W + \gamma_{12} S - \gamma_6 R - \gamma_{11} S - \gamma_{10} W - \beta_4\right)
\end{aligned}
\tag{1}
$$

Carrying capacity

Using the general formula for the carrying capacity, we can determine the capping number for the nature reserve

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) \tag{2}$$

where

r maximum population growth rate

N population size

K population carrying capacity

$\frac{dN}{dt}$ rate of population change

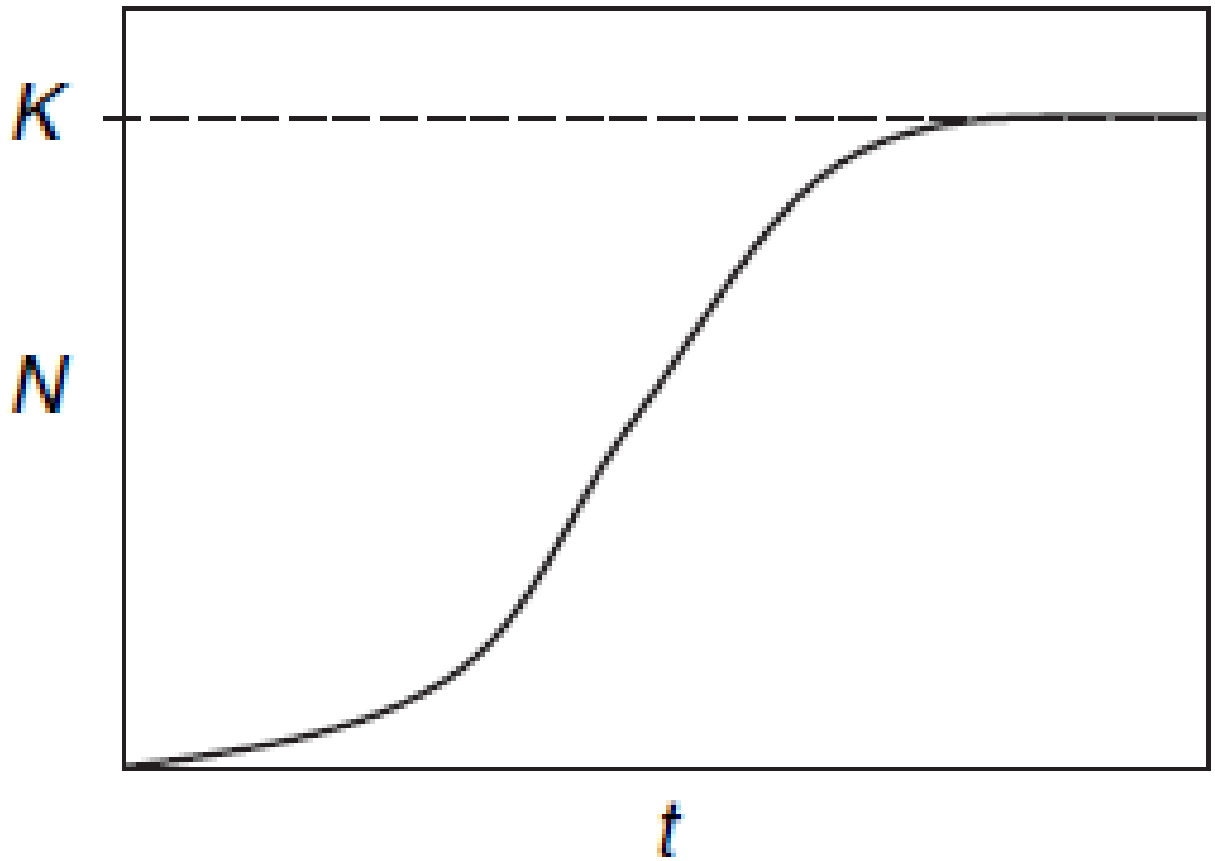

FIGURE 2: Carrying capacity [1]

Model I cont..

From the system of equations (1) we know that

$$\frac{dP}{dt} + \frac{dW}{dt} + \frac{dS}{dt} + \frac{dR}{dt} + \frac{dG}{dt} = \frac{dN}{dt} \tag{3}$$

(4)

Therefore, from Logistic equation we can establish that

$$\frac{dN}{dt} = \Lambda - (W\beta_1 + S\beta_2 + R\beta_3 + G\beta_4 + \mu P) \tag{5}$$

Results

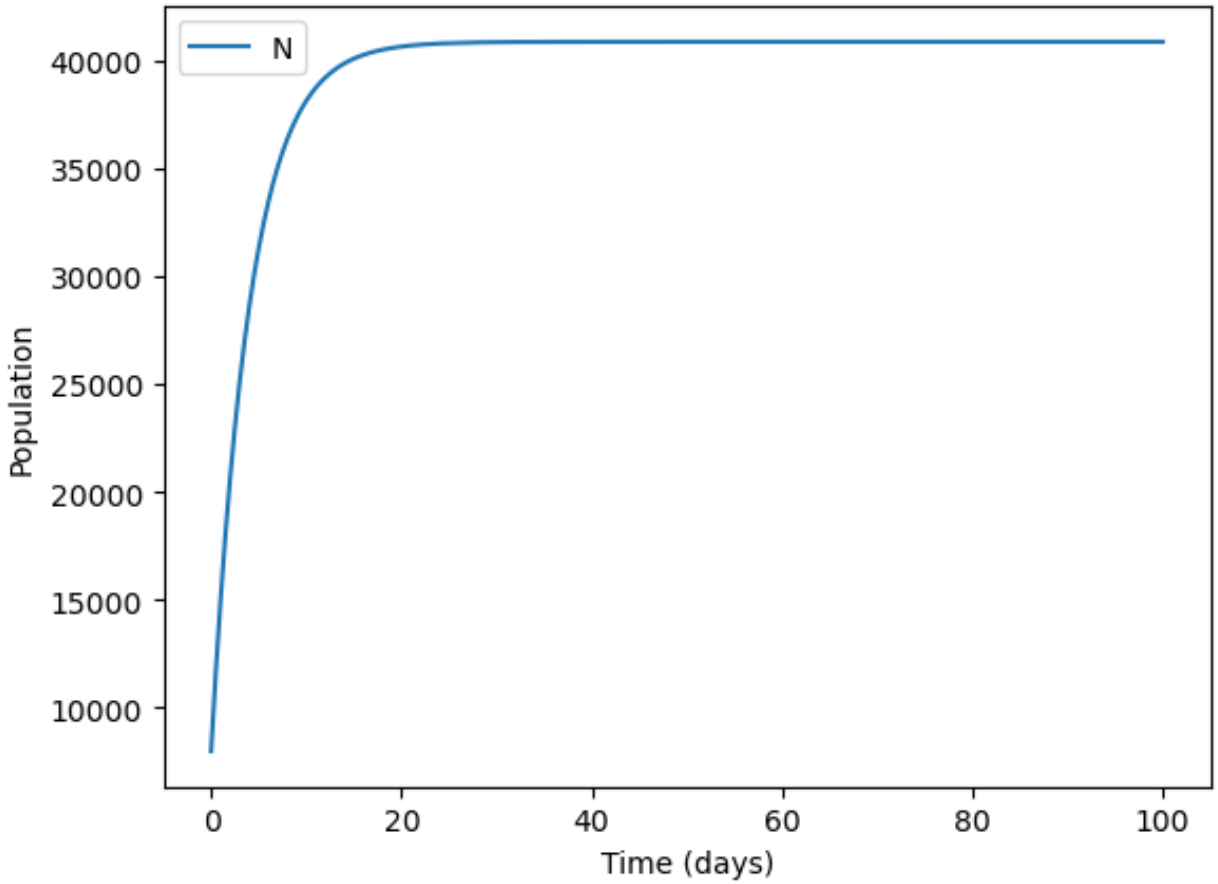

Figure 3: Nature reserve carrying capacity

- Due to lack of adequate data, we assumed the parameters values used to determine the carrying capacity.
- From Figure 3 the managers would be able to adjust the carrying capacity based on the algorithm.

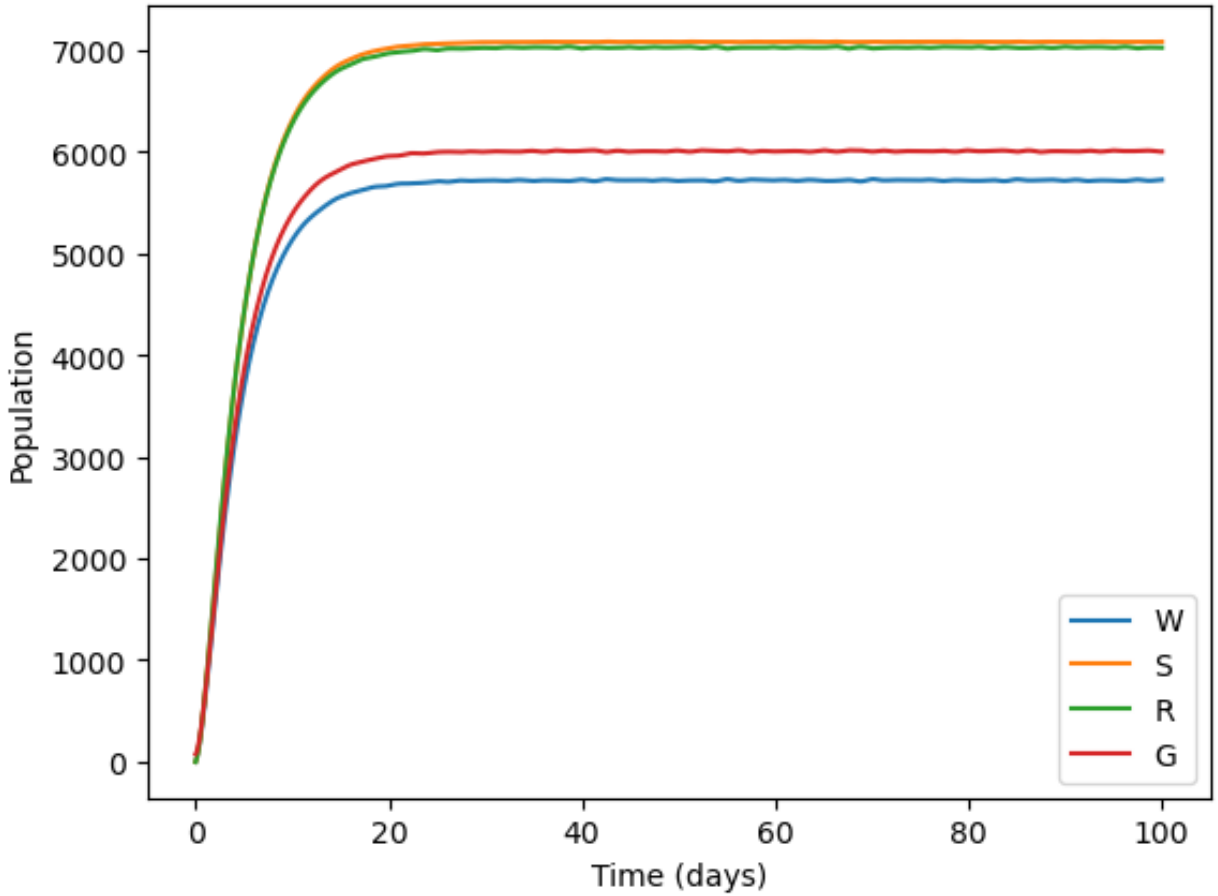

FIGURE 4: Dynamics of the model

Approach II

Physical Carrying Capacity (PCC):

- This is the maximum number of visits that is possible to admit during a day
- Formula
  PCC = Area of region x $\frac{v}{a}$ x Rf where;
  $\frac{v}{a} = \frac{1}{4^2} = \frac{1}{16}$ (the amount of space every visitor needs to move freely), the assumption here is that under normal conditions 4 m^2 is allocated per individual.
  Rf = 1 (daily number of visits to a certain place)

Approach II Cont...

Real Carrying Capacity (RCC):

- Is the maximum number of visits that is possible after applying a series of correction factors to the PCC.
- Formula
  ECC = PCC× F_{cx} where;
  where F_{cx} is the correction factor.

Effective Carrying Capacity (ECC):

- Is the maximum number of visitors to a place that the existing management can handle in a sustainable manner.
- Formula
  ECC = RCC× management capacity.

Activities and PCC formula description

ACTIVITIES	PCC CALCULATIONS
Swimming pool	Average no of swimmers at a time $\times \frac{Total\ period\ open}{Average\ period\ per\ person}$
Wildlife	Number of available vehicles $\times$ Number of passengers per vehicle $\times$ number of trips per day
Guided Walk	Number of available guides $\times$ Number of people being guided $\times$ number of walks per day
Restaurant	Number of seats $\times \frac{total\ time\ the\ restaurant\ is\ opened}{average\ time\ a\ customer\ takes}$
Picnic Area	$\frac{Total\ picnic\ surface\ area}{average\ area\ per\ group} \times$ average number of people per group $\times \frac{Total\ open\ time}{average\ time\ a\ group\ takes}$

ACTIVITIES PCC DESCRIPTION

DESCRIPTIONS	
ACTIVITIES	PCC CALCULATIONS
Bird Hide	number of people at a time $\times \frac{Total\ time\ picnic\ area\ is\ opened}{average\ a\ person\ stays\ at\ the\ picnic\ area}$
Accommodation	$\sum$ Number of rooms per dormitory type $\times$ total number of people per room
Braai Area	Number of braiing facilities $\times$ average number of people per facility $\times \frac{total\ open\ period}{average\ period\ per\ group}$

ACTIVITIES AND THEIR PCC,RCC AND ECC CALCULATIONS

DESCRIPTIONS			
ACTIVITIES	PCC	RCC	ECC
Swimming pool	$14\times6+17\times6+14\times12+17\times2 = 588$	$588 \times \frac{4}{12} = 418$	$418\times1 = 418$
Wildlife	$2 \times 10 \times 2 = 40$	$40\times\frac{9}{12} = 30$	$30 \times 1 = 30$
Guided walk	$2 \times 20 \times 2 = 80$	$80\times\frac{9}{12} = 60$	$60 \times 1 = 60$
Restaurant	$100 \times \frac{14}{2} = 700$	$700 \times 1 = 700$	$700\times1 = 700$
Picnic	$2 \times 10 \times \frac{12}{4} = 60$	$60\times\frac{9}{12} = 45$	45

ACTIVITIES AND THEIR CALCULATIONS CONT...

DESCRIPTIONS			
ACTIVITIES	PCC	RCC	ECC
Bird Hide	$10 \times \frac{12}{4} = 30$	$30 \times \frac{9}{12} = 22$	22
Accomm.	$12 \times 29 + 16 \times 2 + 3 \times 4 + 15 \times 2 + 20 \times 6 = 542$	$542 \times 1 = 542$	542
Braai	$16 \times 4 \times \frac{12}{4} = 192$	$192 \frac{9}{12} = 144$	144

Carrying capacity

$$Total\ carrying\ capacity = \sum ECC\ of\ all\ activities = 1961$$

M A Hixon,Carrying Capacity, *Elsevier*, **2008**, Oregon State University, Corvallis, OR, USA

McCool, Stephen F and Lime, David W Tourism carrying capacity: tempting fantasy or useful reality?. *Journal of sustainable tourism Taylor & Francis***2001**, *9 (5)*, 372–388.

THANK YOU-:)