Siegrist, D., Clivaz, C., Hunziker, M. & Iten, S. (eds.) (2006). Exploring the Nature of Management.
Proceedings of the Third International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas.
University of Applied Sciences Rapperswil, Switzerland, 13-17 September 2006. Rapperswil.

A Prediction of a Human Action on Seashell-Digging at a Seaside Park Based on a Multi-Agent Simulation Model

Motohiko Murai, Takashi Hirobayashi, Ryoichi Yamanaka & Yoshiyuki Inoue

Yokohama National University, Japan

m-murai@ynu.ac.jp
hiroba@ocean.jks.ynu.ac.jp
yamanaka@ynu.ac.jp
y-inoue@ynu.ac.jp

Keywords: Seashell-digging, seaside-park, multi-agent-model, human action. human impact.

Introduction

"Uminokouen" is one of the major seaside parks in Tokyo-bay. Over 20,000 people visit it for seashell-digging (shell-gathering) in a holiday. The human impact on spatial and annual distributions of bivalves in the park is quite large.

In this paper, we propose a computational model which predicts the human action for seashell-digging at this park through a multi-agent-algorithm. When comparing the simulation results with the actual data, there is good agreement of the visitor's staying time. Then, we investigate the spatial distributions of the amount of the caught bivalves, and show that the distribution is significantly affected by human impact rather than the initial spatial distributions of the bivalves.

Since the 1960's, we have lost 90 percent or more of the tidal flat area of Tokyo-bay by land reclamation. "Uminokouen" is an artificial seashore park developed in 1988 at the southeast of Yokohama and is well known as a relaxation place for the citizens.

Seashell-digging is one of the major purposes of visiting the park. In Japan, a major season of the seashell-digging is from April to May. More than 20,000 citizens visit the park on a holiday of the season as shown in figure 1. The most part of living bivalves which grew up after the last summer or autumn disappears during the season. Thus, estimating the relation between the seashell-digging impacts and the amount of bivalves is important for the management of the park.

Figure 1: Seashell-digging visitors at "Uminokouen" in spring.

Simulation model

The shell-digging action is dependant on each person and the surrounding situations; digging ability, tidal height, visitor density and so on. So, we try to use a multi-agent-algorithm for the simulation of the shell-digging action of all the visitors. The multi-agent-algorithm is a numerical simulation technique in which every agent autonomously and individually acts on a certain judgment standard.

To prepare the simulation we created the geographic data of the park by combining the general map and topography of the tidal flat zone measured by us as shown in figure 2. Since our investigation of the amount of bivalves shows that the spatial distribution of bivalves strongly relates to the topography of the seabed in this park, we assumed that the initial spatial distribution of the bivalves depends on the topography. The admission timings of visitors are decided by the actual data.

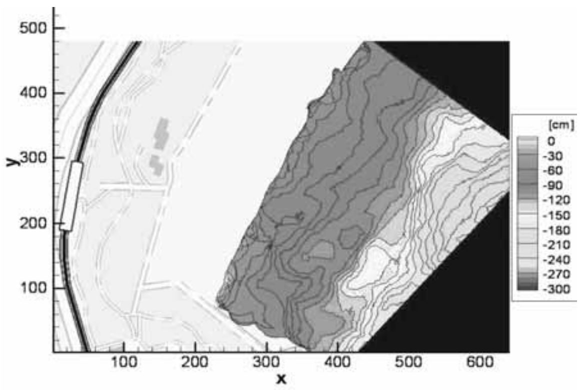


Figure 2: The standard depth of the sea in the seaside park.

The action of the visitors is categorized into movement-phase and seashell-digging-phase in this simulation. In the movement-phase, each virtual visitor starts with his/her conditions which consist of the tolerance range of the sea-depth and visitor's density, which are based on the result of our questionnaire and the video analysis. They make a survey of the situation around them and decide the direction of the movement. When they arrived at the position which fulfills the conditions, their modes change to the seashell-digging-phase.

In the seashell-digging-phase, the visitor catches bivalves by a certain probability. If the amount of the bivalves caught by one digging action has become less than a certain value, the visitor's mode is changed to the movement-phase for finding a new position of the seashell-digging. When the total quantity of bivalves gathered has reached a certain value or the sun sets, they stop seashell-digging and exit the park from their entrance point.

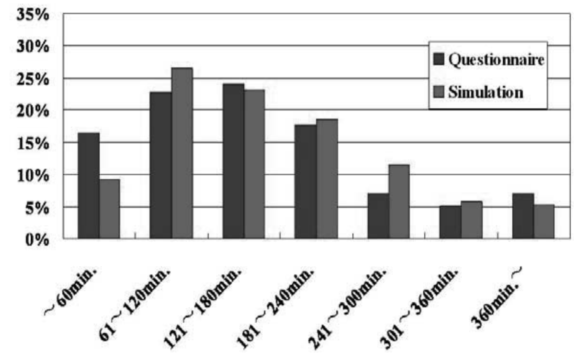


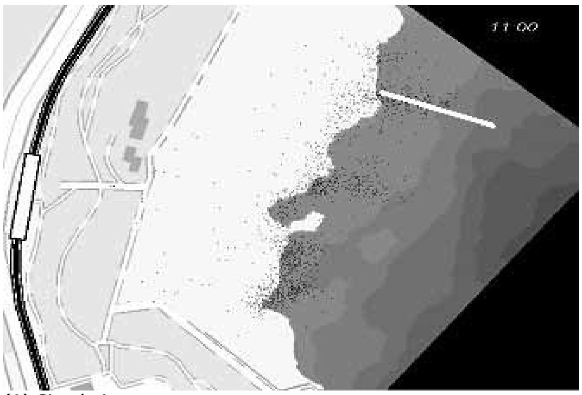
Figure 3: The distribution of staying time of the visitors.

Results

Comparison of the distribution of visitors' staying time between the simulation result and the actual observed data is shown in figure 3. The figure shows that both results agree well. The snapshots of the spatial distributions of the seashell-digging visitors are shown in figure 4. We can recognize in both snapshots that the seashell-digging visitors vertically queue to the coastal line. These results indicate that the computer code of the multi-agent-algorithm can simulate the human action in the seashore park quite well.

The spatial distribution of the amount of bivalves caught by the virtual visitors is shown in figure 5. Figure 5 indicates that the distribution is affected more by the spatial distributions of the visitors rather than by the initial spatial distributions of the bivalves.

In studies conducted in the near future, we should extend this code to predict the human impact on the whole of the seashell-digging season and examine how to manage the park to sustain its role as being a relaxation place for citizens.



(A) Simulation

(B) Photograph

Figure 4: The snapshots of the spatial distributions of the seashell-digging visitors.

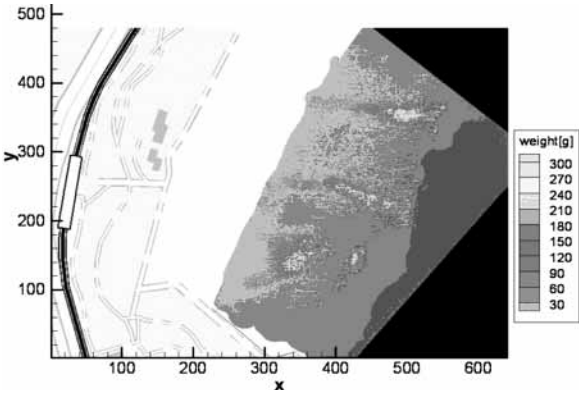


Figure 5: The spatial distributions of the amount bivalves which were caught by the virtual visitors.

References

Gilbert N. & Troitzsch, K.G. (1999). "Simulation for the Social Scientist" Open University Press.