Available online at www.sciencedirect.com
ScienceDirect
Land Use Policy 24 (2007) 584–599
Land Use Policy
www.elsevier.com/locate/landusepol

Comparison of a deductive and an inductive approach to specify land suitability in a spatially explicit land use model

Koen P. Overmars[a,b,*], Peter H. Verburg[b], Tom (A.) Veldkamp[b]

[a]Institute of Environmental Sciences (CML), Leiden University, PO Box 9518, 2300RA, Leiden, The Netherlands
[b]Environmental Sciences Department, Wageningen University, PO Box 37, 6700AA, Wageningen, The Netherlands

Received 22 March 2005; received in revised form 9 September 2005; accepted 23 September 2005

Abstract

In this paper, two research approaches to specify the relation between land use types and their explanatory factors are applied to the same modelling framework. The two approaches are used to construct land suitability maps, which are used as inputs in two model applications. The first is an inductive approach that uses regression analysis. The second applies a theoretical, actor decision framework to derive relations deductively using detailed field data. Broadly speaking, this classification coincides with the distinction between empirical and theoretical models and the distinction between deriving process from pattern and pattern from process. The two modelling approaches are illustrated by a scenario analysis for a case study in a municipality in the Philippines. Goodness-of-fit of the deductive approach in predicting current land use is slightly lower compared to the inductive approach. Resulting land use projections from the modelling exercise for the two approaches differ in 15 percent of the cells, which is caused by differences in the specification of the suitability maps. The paper discusses the assumptions underlying the two approaches as well as the implications for the applicability of the models in policy-oriented research. The deductive approach describes processes explicitly and can therefore better handle discontinuities in land use processes. This approach allows the user to evaluate a wide range of scenarios, which can also include new land use types. The inductive approach is easily reproducible by others but cannot guarantee causality. Therefore, the inductive approach is less suitable to handle discontinuities or additional land use types, but is well able to rapidly identify hotspots of land use change. It is concluded that both approaches have their advantages and drawbacks for different purposes. Generally speaking, the inductive approach is applicable in situations with relatively small land use changes, without introduction of new land use types, whereas the deductive approach is more flexible. The choice of modelling approach should therefore be based on the research and policy questions for which it is used.

Keywords: Land use change; Modelling; Deductive; Inductive; Actor decision model; Philippines

Introduction

Within land use and land cover change (LUCC) research much attention has been paid to the development of models (Briassoulis, 2000; Veldkamp and Lambin, 2001; Parker et al., 2003). Land use models are used as a tool to combine different aspects of the complex land use system and, therefore, enable researchers to study the dynamics of this system. Furthermore, land use change models are applied to evaluate scenarios to inform policy makers (Brown et al., 2004; Solecki and Oliveri, 2004).

In reviewing land use models many criteria have been used to classify models: for example, whether a model is economic or non-economic, spatially explicit or not or whether the model is statistical/empirical, mathematical or rule-based (Briassoulis, 2000; Brown et al., 2004; Verburg et al., 2004c). Most of the current land use models have in common that they all try to combine human and natural processes, which implies the involvement of various disciplines (Couclelis, 2001). In this paper we will use the broad distinction between deductive and inductive

*Corresponding author. Institute of Environmental Sciences (CML), Leiden University, P.O. Box 9518, 2300RA, Leiden, The Netherlands. Tel: +31 71 527 1495.
E-mail address: Koen.Overmars@wur.nl (K.P. Overmars).

0264-8377/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.landusepol.2005.09.008

approaches of modelling (e.g. Laney, 2004; Overmars et al., 2006). Broadly speaking, this classification coincides with the distinction between theoretical and empirical models and the distinction between deriving pattern from process and process from pattern.

Overmars et al. (2006) identify six types of modelling, which vary from completely deductive to completely inductive. In this study two of these types will be used to specify the relation between land use and its explanatory factors, which will be implemented in two applications of a spatially explicit land use model in the same region. The first approach can be classified as 'unstructured factors induction'. In this approach a conceptual framework is used to define the dependent variable and the independent variables but then leave it to the procedures of statistical inference to find correlations between these variables. Theories are used to construct hypotheses about the relation between land use and its explanatory factors, but the structure of these theories is not used or tested (e.g. Serneels and Lambin, 2001; Nelson et al., 2004). The second, more deductive approach used in this paper is called 'imposed theory'. In this approach a land use theory is specified for a real world case in terms of both structure and parameters, without any fitting to empirical data, and used to predict land use.

The two approaches to quantify the relation between driving factors and land use, resulting in a land 'suitability' estimate, will be implemented in two applications of CLUE-S, which is a dynamic land use model, to simulate scenarios of LUCC in a study area in the municipality of San Mariano in the northern part of the Philippines. The remainder of the model setting will be kept the same for the two modelling approaches to be able purely to assess the effect of having different methods to specify land suitability.

The aim of this paper is to compare the differences between the two model applications, which have different specifications of land suitability as input. The difference in outcome of two model applications as well as the different assumptions underlying the two model specifications will be discussed. Furthermore, the paper describes the implications for the applicability of the approaches for different research and policy questions.

Study area and data collection

Study area

The study area is situated in Cagayan Valley in the northeastern part of the island Luzon, the Philippines (Fig. 1). The study area includes 16 *barangays* (villages) in the municipality of San Mariano, in the province of Isabela, and its size is approximately 25,000 ha. It is situated between the town of San Mariano in the west and the forested mountains of the Sierra Madre mountain range in the east. The area is inhabited by approximately 17,000 people (about 3150 households) of various ethnic groups, among whom the Ilocano, Ibanag and Ifugao, who are migrants or descendents of migrants that came to the area from the 1900s onwards, and the Kalinga and Agta,

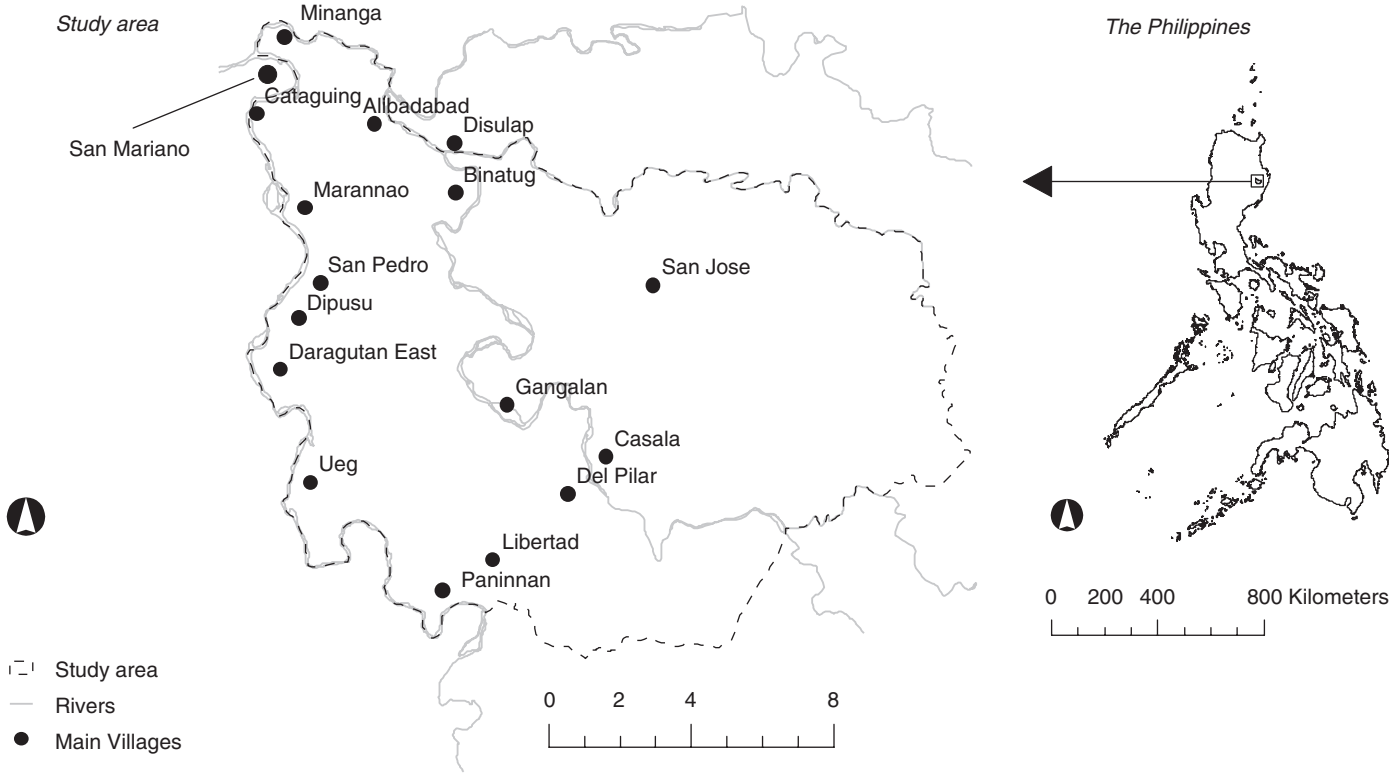

Fig. 1. Study area.