



Analysis

A dynamic bio-economic model for community management of goat and oak forests in Zagros, Iran



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ARTICLE INFO

Article history:

Received 20 July 2013

Received in revised form 18 June 2014

Accepted 31 July 2014

Available online 24 August 2014

Keywords:

Dry land

Forest policy

Matrix model

Model scenarios

Traditional management

ABSTRACT

A deterministic, non-linear dynamic bio-economic model is developed to analyze interactions between goats and forests under different management regimes at a village level in Zagros, Iran. Data for the study were mainly obtained through participatory rural appraisal, village level survey, forest inventory and secondary sources. The model was run under six alternative management regimes represented by model scenarios: (1) BAU: the business as usual, (2) NSIR: no state intervention with traditional rules, (3) NRFG: no state and traditional rules, (4) NRF: no state and traditional rules without goat husbandry, (5) NFH: no forest harvesting, and (6) NGH: no goat husbandry. The results of BAU, NSIR and NRFG scenarios brought out that state control, traditional rules as well as biological feed-back mechanisms keep the goat population within carrying capacity. Comparing forest density in NSIR and NRFG model scenarios showed that even without state control, villagers managed to preserve forest resources through traditional institutional arrangements. The population of goats would decline if forest harvesting was banned due to reduction in coppicing and fodder availability. The highest NPV was observed under the NRFG model scenario resulting in lowest sustainability of resource use.

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1. Introduction

Low density forests (woodlands or rangelands) in dry parts of the world are often used for a multitude of purposes; such as wood production, grazing, hunting, and collection of non-wood forest products. Rural people use such lands not only to meet their subsistence needs but also to enhance their livelihoods through sale of forest products. Large parts of these lands, both in Asia and Africa, are owned, *de jure*, by the state (Thomas, 2008) and managed by some public agency. Such agencies often view poor people as a threat to forests (Larson and Ribot, 2007) and believe that centralized state management is the only option to avoid overexploitation. However many local communities in Asia and Africa still use traditional management practices for managing common forests and rangelands (e.g. Berkes et al., 2000). Similar conditions are observed in Zagros region of Iran to which this study relates.

Zagros region is located in the western part of Iran where the forests cover about five million hectares, constituting 40% of the Iran's forests wealth (Sagheb-Talebi et al., 2004). Forests in this region are dominated by oak and have a long history of settlement and utilization of natural resources (Djamali et al., 2009; Wright et al., 1967). High reproduction capacity of oak trees through coppicing after felling trees and natural damage has been the main factor that helped these forests to survive until today (Fattahi et al., 2000). These forests have been nationalized

after 1963 (Yachkaschi et al., 2010) resulting in a centralized state management. Forest resources have been managed and protected on the basis of regulations and plans approved by the Forest, Range and Watershed Management Organization (FRWO) of Iran. To protect the natural ecosystem, wood harvesting, charcoal making, and tree lopping have been banned. The number of goats and sheep are also restricted by law. While the authorities have restricted resource use *de jure*, the situation is not fully controlled *de facto*. However, forests and grazing are not open access resources. Local communities have their own traditional arrangements (community-based management) for controlling use of natural resources (Yachkaschi et al., 2010), particularly those required for goat husbandry (Soltani and Eid, 2013). The main challenge regarding forest management in Zagros is the conflict related to forest ownership, access and use. Traditional and customary rights to forest resources were reflected poorly in Iranian Forest Nationalization Law of 1963 and local people's access to the natural resources has been severely restricted legally. The enforcement of state ownership has been weak and ineffective due to limited resources allocated to FRWO. It is not clear whether this is the result of political considerations concerning access to natural resources for rural people, or just a low priority accorded to forest and rangeland in budget discussions.

Zagros was the cradle of goat domestication 10,000 years ago (Zeder and Hesse, 2000), and goats still remain central elements in rural livelihoods of these mountainous areas. Small ruminants in large numbers have exploited the vegetation and influenced its structure (Hoekstra and Shachak, 1999) and particularly goat has been viewed as a threat to forest resources in Zagros (Jazirei and Rastaghi, 2003; Sagheb-Talebi

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et al., 2004). Besides serving as a source of feed for the goats, forests have been the main source of biomass energy in Zagros for a long time. In spite of an increasing consumption of fossil fuel in many rural villages, firewood still continues to be an important source of energy. There is, thus, a need to view the problem of sustainable management of resources in the region in its entirety, i.e., by not incorporating forests and livestock interactions only, but also the role of traditional institutions of local communities. The bio-economic model developed by us helps analyzing these complexities.

This study aimed at examining the biological relationship between forest trees and domestic animals in Zagros region, and to use this knowledge in further analyzing the economic relationship between the state and local communities. We chose a village in Zagros to illustrate as to how goat husbandry regimes may affect forest development under alternate management and *vice versa*. Besides, an attempt has also been made to quantify the economic effects of state policy to conserve forest environment. The study aims at answering the following specific questions:

1. Would it be profitable for the village as a whole to reduce the number of goats? This was based on empirical observations in many dry land situations (Le Houérou, 2006) suggesting that competition among village households leads to a larger herd of goats than what is economically optimal and environmentally sustainable for the village as a whole.
2. To what extent does the present goat stocking rate reduce forest recruitment and impair forest growth? How does the state of forest affect goat population? Previous studies have drawn somewhat conflicting conclusions on similar issues in various parts of the world (e.g. Crawley, 1983; Danell et al., 1997; Kolars, 1966; le Polain de Waroux and Lambin, 2012; McInnes et al., 1992; McPherson, 1993; Smale et al., 2008; Zamora et al., 2001).
3. How would villagers respond if the ban on felling live trees was lifted? Would they remove most trees as quickly as harvesting capacity allows? This is what textbook economic theory (Johansson and Löfgren, 1985) would predict for a case of private ownership and timber profit maximization when there are many mature trees in the forest. Is the present ban on felling live trees an effective measure to protect forests?

Answers to these questions will be useful to all people interested in sustainable management of forest and animal resources. The knowledge generated should be especially useful for rural people in Zagros, authorities in FRWO, and national policy makers in Iran. Besides, the findings of this study may also be of interest to researchers in the field of sustainable management of dry land resources in other parts of the world similar to those in Zagros.

In Section 2 we outline the model structure without going into the estimation of model parameters. Section 3 presents data and methods including a description of how model parameters were estimated from primary and secondary data. Results obtained by solving the model under different scenarios are given in Section 4 followed by discussion and conclusions in Sections 5 and 6.

2. Model structure

The conceptual framework of the model is shown in Fig. 1. While the forests contribute to carrying capacity for goats by providing plant material for fodder, goat husbandry affects the forest in two ways: (i) directly by eating seeds, seedlings and sprouts (browsing), and (ii) feeding in winter on cut (lopped) and stored branches of oak trees. When goats feed on seed (e.g., acorns) and coppices (sprouts growing from stumps left after harvested trees), it affects shape and growth of sprouts and seedlings. Goat browsing can even kill some seedlings and sprouts when the browsing pressure is too strong. Apparently, the effect of goat browsing is not limited to small trees. When people cut branches of trees to provide fodder for goats, larger trees are also affected (Bhat et al., 1995; Kishan Kumar and Tewari, 2000). Therefore regeneration and growth of trees will be hampered. These effects may be particularly severe in dry forests where growth is slow. During the summer season understory grass constitutes a small proportion of goat feed.

The justification for developing the model at a village level lies in the practice of sharing of the natural resources by the village community and a system of a common team of shepherds hired who take the animals of the entire village in a single herd for grazing into the forest.

The initial human population ($P(0)$), growth rate of human population (θ), immigration (IM) and emigration (EM) are treated exogenous

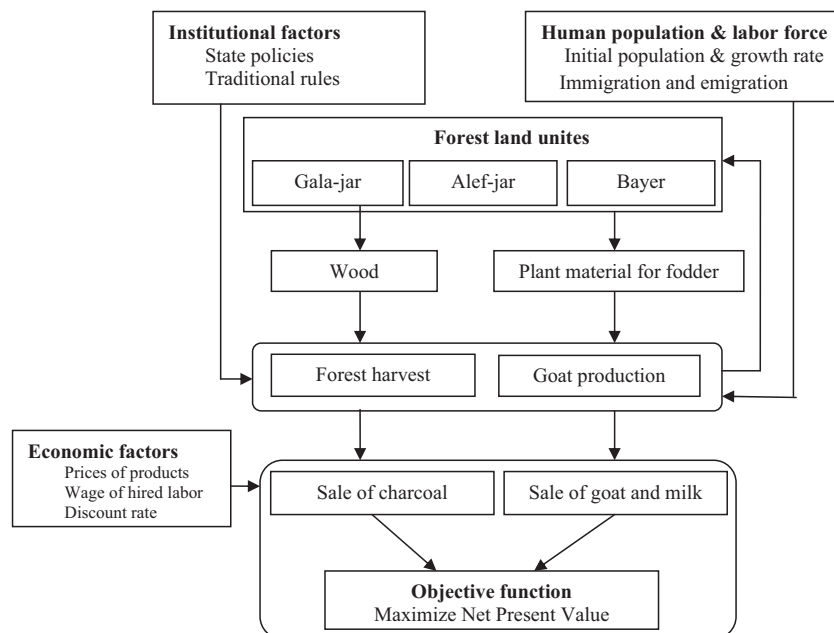


Fig. 1. Conceptual outline for the bio-economic model.

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