2016 International Symposium on Nonlinear Theory and Its Applications,
NOLTA2016, Yugawara, Japan, November 27th-30th, 2016

Spatial Dynamics of Acorn Masting and Tree Crops Alternate Bearing

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Abstract

In this paper, we investigat spatial synchronization of acorn masting and alternate bearing.Spatially extended resource budget models are used to demonstrate spatial dynamics of masting and alternate bearing. Pollination is considered as a coupling term of the model. Global coupling and local coupling are introduced by mean field and coupled map lattice, respectively. We also review the related researches in terms of field applications.

1. Introduction

Acorn masting is natural phenomenon by which plant populations occasionally produce a large number of seeds. It has been an attractive subject in wide areas [1],[2]. It is one of subjects to investigate in wild life management [3], as acorns are substantial food for wild animals. In sylviculture, to predict the tendency of masting in forest stands is a key technology for promoting natural regeneration approach. Acorn masting is recognized as a synchrony of collective dynamics consisting of coupled nonlinear oscillators and many types of coupling are investigated [4]-[8]. Alternate bearing of tree crops has been central subject in agriculture and pomology. Citrus (e.g. Orange, Lemon, Mandarin), Pistachio, Chestnut are the crops show pronounced alternate bearing[9]-[13].

2. Model

Isagi's resource budget model (RBM) can be used to explain the masting in whole forest stands and alternate bearing of each tree[4]. Combining RBM and coupled map lattice, the spatial dynamics of acorn masting was demonstrated e.g.[14]. The effect of weather conditions known as Moran's effect was investigated in terms of common noise induced synchrony [10][15][16]. Many attempts of modification of RBM for real world applications has been done e.g.[17][18].

3. Sensing

Sensing technologies of acorn and crop yield in forest stands and orchards are expected not only for field application but also validation of proposed masting models. Remote sensing techniques have been introduced in this purpose. Multi-spectral imaging and hyperspectral imaging were employed in airborne remote sensing [19][20] and ground truth[21].

4. Measures

Spatial autocorrelation is one of popular measures for quantifying the spatial synchronization. It was applied on acorn [14] and pistachio [11]. In terms of nonlinear dynamics, nonlinear time series analysis tools are also expected to evaluate the spatial dynamics. For example, Lyapunov exponents(LE), translation error(TE), deterministic nonlinear prediction(DNP) might be potential candidates to be modified for it.

5. Implementation

For field applications, GIS embedded models[15] is expected to demonstrate real world masting and alternate bearing. Both of canopy identification and calibration methods are the most important options to be developed

6. Conclusions

At the present stage, the skeleton such as models, sensing technologies and prediction(DNP) / control (OGY)[22] has been mostly prepared for field applications in masting and alternate bearing. It is necessary to set up collaborative works in inter-disciplinary / inter-sectional ways for realizing successful applications.

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