Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 128 (2017) 350–357

Energy Procedia

www.elsevier.com/locate/procedia

International Scientific Conference "Environmental and Climate Technologies", CONECT 2017, 10–12 May 2017, Riga, Latvia

System dynamics model of research, innovation and education system for efficient use of bio-resources

Signe Allena-Ozolina, Gatis Bazbauers*

Institute of Energy Systems and Environment, Riga Technical University, Azenes iela 12/1, Riga, LV−1048, Latvia

Abstract

Due to a growing concern about climate change and sustainable development, it is necessary to develop and implement an effective policy for promoting of bio-economy. Latvia, as many other countries, lacks fossil energy resources; however, abundant bio-resources can be found on the land and in the water as well in residues and waste. More efficient promotion and rendering of bio-resources is one of the possibilities to promote sustainable development. It also helps to reduce an impact on the climate change and promotes adaptation to it, as well as reduces an import dependence on various resources and materials. Latvia faces a number of shortcomings, such as a lack of funding for education, research and development, insufficient cooperation between universities and industry, which drags the effective use of bio-resources. In order to develop an effective bio-economy sector, there is a need for coupling of human resources with relevant skills and knowledge with adequate institutional capacity, including infrastructure and financial resources. It is necessary to understand an interaction of the above mentioned elements as well as time required in order to develop an effective bio-economy policy, and an aim of the study was to create a model which helps to design such a policy. System dynamics modeling was chosen as a method in the study since it is well suited for analysis of complex and dynamic systems with nonlinearities, i.e. feedbacks, accumulation and delays.

Until now, most of system dynamics models have been developed separately for education and innovation issues, moreover innovation subjects have been discussed on the level of individual companies. In this study, the system dynamics model has been built up by combining science, innovation and education elements, and assessment of different funding scenarios has been carried out. The results show that, under assumptions made, the scenario with the highest share of funding for research infrastructure, as well as research and development projects, could be more efficient in terms of potential to generate high value added products than the scenario with the highest share of funding allocated to education.

Peer review statement - Peer-review under responsibility of the scientific committee of the International Scientific Conference "Environmental and Climate Technologies".

* Corresponding author. Tel.: +371-67089911.
E-mail address: gatis.bazbauers@rtu.lv

1876-6102
Peer review statement - Peer-review under responsibility of the scientific committee of the International Scientific Conference "Environmental and Climate Technologies".
10.1016/j.egypro.2017.09.051

Keywords: bio-resources; bio-economy; education; innovation; research and development; system dynamics

1. Introduction

System dynamics modeling experience increasing popularity in various problem-solving and decision-making issues [1, 2]. Several studies [3, 4] provide a brief analysis of importance of system dynamics in management of higher education, and since a university is a dynamic, complex, and non-linear system, it is considered that system dynamics modeling can be a useful tool in various decision-making cases. Similarly, a system dynamics method can be used in a variety of environment-related issues. For example, in Latvia a potential impact of agricultural development on the greenhouse gas emissions was studied using system dynamics [5]. System dynamics models were first used in studies of higher education systems in the 90-ies of the 20th century, and one of the pioneers was Galbraith, who developed several models of different management challenges in higher education institutions [6]. Another study of 90 years was who carried out studies in the USA, where system dynamics was used for planning of overall development of universities [7]. It was concluded that a system dynamics method is a useful tool for improving of higher education planning and development. Information that was obtained by the model was used to prepare universities for a future increase of higher education demand, as well as to assess an effectiveness of alternative strategies.

System dynamics method can be used in different ways, e.g. in Turkey researchers developed an interactive dynamic game as basis for university management's strategic decision-making [8]. Another interesting study was made for the long-term planning of a higher education system [9]. The main aim was to carry out a scenario analysis, with scenarios given by different system-related aspects, such as government policy, demand, study site, and a balance between number of students in public and private sectors. Whereas in another research [10] system dynamics model was developed to study the main factors that form basis for a decision-making system in order to balance supply and demand of an academic program, which directly refers to effective resource management.

System dynamics models have been used widely in the fields of science and innovation as well. One of the objectives of Oyo 2010 [11] study was to involve stakeholders in creation of a model, which takes into account customer desires. The developed model was also designed as a decision support tool in higher education management. In another study, a model was developed for a national innovation system in order to explore dynamic processes and interaction between flows of capital, human resources, knowledge, technology and products [12]. Researchers in Macedonia also have made national innovation system analysis [13] using a system dynamics method. The study analyzed an impact of innovation policy on the overall national innovation system, and the system dynamics method was used as an experimental method for evaluation of different alternatives.

Thus, researches have demonstrated the importance of system dynamics in different decision-making processes. With a system dynamic method it is possible to create a comprehensive system model that allows to explore flows, form clarity of feedback loops and provides an understanding of them. Studies have shown that the method is an important tool for a variety of issues related to higher education and scientific areas which allows to assess alternative policy strategies.

2. Methods

In order to enhance bio-resource utilization efficiency, it is necessary to develop new, innovative, high value added products derived from locally available bio-resources. These innovative products result from new innovative ideas which are successfully commercialized using an appropriate infrastructure for commercialization and subsequent introduction of these ideas to a market. In order to generate innovative ideas, an adequate human resources with appropriate skills are needed. And all these processes require time and funding.