



Review

State of knowledge about energy development impacts on North American rangelands: An integrative approach



Urs P. Kreuter ^{a, *}, Alan D. Iwaasa ^b, Gene L. Theodori ^c, R. James Ansley ^d,
Robert B. Jackson ^e, Lauchlan H. Fraser ^f, M. Anne Naeth ^g, Susan McGillivray ^h,
Edmundo Garcia Moya ⁱ

^a Dept. of Ecosystem Science and Management, Texas A&M University, College Station, TX, USA

^b Semiarid Prairie Agric. Research Centre, Agric. and Agri-Food Canada, Swift Current, Saskatchewan, Canada

^c Dept. of Sociology, Sam Houston State University, Huntsville, TX, USA

^d Dept. of Ecosystem Science and Management, Texas A&M AgriLife Research, Vernon, TX, USA

^e Dept. of Earth System Science, Woods Institute for the Environment and Precourt Institute for Energy, Stanford University, Stanford, CA, USA

^f Biological Sciences, Thompson Rivers University, Kamloops, British Columbia, Canada

^g Dept. of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada

^h Alberta Environment and Sustainable Resource Development, Edmonton, Alberta, Canada

ⁱ Colegio de Postgraduados-Botánica, Campus Montecillo, 56230, Texcoco, Estado de México, Mexico

ARTICLE INFO

Article history:

Received 12 February 2016

Received in revised form

3 May 2016

Accepted 4 May 2016

Keywords:

Biofuels

Hydraulic fracturing

Land use change

Oil and gas

Rangeland restoration

Wind energy

ABSTRACT

To reduce dependence on foreign oil reserves, there has been a push in North America to develop alternative domestic energy resources. Relatively undeveloped renewable energy resources include biofuels and wind and solar energy, many of which occur predominantly on rangelands. Rangelands are also key areas for natural gas development from shales and tight sand formations. Accordingly, policies aimed at greater energy independence are likely to affect the delivery of crucial ecosystem services provided by rangelands. Assessing and dealing with the biophysical and socio-economic effects of energy development on rangeland ecosystems require an integrative and systematic approach that is predicated on a broad understanding of diverse issues related to energy development. In this article, we present a road map for developing an integrative assessment of energy development on rangelands in North America. We summarize current knowledge of socio-economic and biophysical aspects of rangeland based energy development, and we identify knowledge gaps and monitoring indicators to fill these knowledge gaps.

© 2016 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	2
2. Application of the ISEEC framework for energy development on rangelands	2
3. Aspects of the socio-economic subsystems of energy development	4
3.1. Public attitudes and behaviors relating to energy development and ecosystems	4
4. Aspects of the biophysical subsystems of energy development	4
4.1. Implications of biofuels production on rangeland resources	4
4.2. Wind energy development effects on wildlife conservation	4
4.3. Oil and gas production and water interactions in rangelands	5
5. Energy development implications of for rangelands in Canada and Mexico	5
5.1. Energy development effects on British Columbia grasslands	5
5.2. Restoration of rangelands disturbed by energy development in Alberta	6
5.3. Impacts of oil and gas developments in the rangelands of Northern Mexico	6

* Corresponding author.

E-mail address: urs@tamu.edu (U.P. Kreuter).

6.	Knowledge gaps and future research needs	6
7.	Conclusion	8
	References	8

1. Introduction

Energy security is essential for sustainable development because it provides the means for resolving many of the challenges facing humanity, including water and food shortages and poverty. Twentieth century agriculture was characterized by abundant, low cost energy derived from fossil fuels. To reduce dependence on foreign fossil fuel reserves, there has been a focus on developing more diverse sources of energy. In the United States of America this led to the Energy Policy Act of 2005 directing the Department of Energy to develop an Unconventional Strategic Fuels Program (RFF, 2005).

In North America, many untapped energy resources, including renewable sources (biofuels, wind and solar) and natural gas resources are associated with rangelands (Fig. 1), which cover much of the continent west of the 95th meridian (Havstad et al., 2007). Developing such energy resources will inevitably impact rangelands and the ecosystem services they provide. Comprehensively evaluating such effects is hindered by the complex interactions among biophysical and socio-economic factors that affect the functionality of ecosystems and the inconsistent use of concepts and terms by diverse scientific disciplines to describe complex social-ecological systems (Ostrom, 2009).

The Sustainable Rangeland Roundtable (SRR) developed the Integrated Social, Economic and Ecological Conceptual (ISEEC) framework to disentangle the complexity of interactions affecting the delivery and use of rangeland based ecosystem services (Fox et al., 2009). This framework provided a useful tool for systematically identifying interactions that influence the integrity of rangelands used for biofuels production and the indicators used to compare the effects of developing renewable energy and natural gas resources on rangelands (Kreuter et al., 2012).

This article consists of five parts. In the first section we describe the ISEEC framework in the context of energy development on rangelands. In the second and third sections we discuss key aspects of the socio-economic and biophysical subsystems of the ISEEC framework, respectively, with the latter section focusing on biofuels, wind energy and natural gas. Solar energy is not addressed because it is being developed almost exclusively in the arid southwest where rangeland vegetation productivity is low. In the fourth section, we discuss aspects of energy development on rangelands in Canada and Mexico. In the last section, we identify knowledge gaps that provide guidance for future research and indicators to comprehensively assess the effects of energy development on ecosystem services provided by North American rangelands.

2. Application of the ISEEC framework for energy development on rangelands

The ISEEC framework is a tool for systematically exploring complex interactions among biophysical and socio-economic elements of rangeland ecosystems. The state of the system is categorized by its biophysical condition and natural capital and its socio-economic capital and human condition, while biophysical processes determine the ability of rangelands to deliver ecosystem services and socio-economic processes create the context in which ecosystem services are used (Fig. 2). These processes act on the biophysical and socio-economic states at time t_0 to produce different states at a time t_1 . Interactions occur through delivery and utilization of extractable goods, in situ delivery and use of services, and external effects of human activities.

Expanding detail within the framework enables us to focus on key linkages pertaining to development of alternative energy



Fig. 1. Three energy options derived from rangelands near Abilene, Texas (Photo provided by R. James Ansley).

Download English Version:

<https://daneshyari.com/en/article/7479935>

Download Persian Version:

<https://daneshyari.com/article/7479935>

[Daneshyari.com](https://daneshyari.com)