Forest Policy and Economics 28 (2013) 23–37

Contents lists available at SciVerse ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Uniform global deforestation patterns — An empirical analysis

Margret Köthke *, Bettina Leischner, Peter Elsasser

Thünen-Institute of Forest Economics, Leuschnerstr. 91, D-21031 Hamburg, Germany

ARTICLE INFO

Article history:
Received 16 May 2012
Received in revised form 3 January 2013
Accepted 7 January 2013
Available online 4 February 2013

Keywords:
Regression model
Cross-section analysis
Forest transition
Deforestation
REDD+
Baseline

ABSTRACT

The forest transition (FT) hypothesis implies that changes in a region's forest cover follow a determinable pattern of decline and later re-expansion over time, which is supposed to be similar across regions and countries. Such a uniform pattern – if empirically proven and quantified – might help in establishing REDD+ baselines (i.e., references against which reductions in the emissions from deforestation and forest degradation of developing countries could be measured, and subsequently be rewarded). REDD+ baselines are required to be based on a globally standardised method and also to consider country-specific circumstances. These requirements might be fulfilled by applying the concept of forest transition in a baseline setting.

With the objective of finding empirical evidence for a uniform global deforestation pattern, we specified a model of forest cover decline which is empirically testable at the global scale. Referring to the causal theory of the FT concept, we define variables which are globally testable with currently available data. By parameterisation of different model specifications, we first analyse deforestation patterns of developing countries, applying cross-section data from the most recent FAO Global Forest Resources Assessment 2010. Population density, cereal area yield, land suitability and the proportion of potential forest vegetation area are determined to significantly explain the variance of forest cover decline.

In a next step, we test the basic model by including modelled historical cross-section data of developed countries. The previously defined model was still found to be valid and no significant differences occurred between developing and developed countries.

Hence, a uniform pattern of forest cover decline could be detected on the national scale for 140 countries by an adjusted coefficient of determination of 0.788. The empirical evidence of a deforestation pattern provides the necessary justification for any further discussion of an inclusion in REDD+ baselines.

1. Introduction: REDD+ as the basic motivation for this study

Deforestation is a threat to biodiversity on Earth and a significant cause of anthropogenic greenhouse gas emissions. Reducing deforestation is a long-standing item on the political agenda of governments and non-governmental organisations. In the context of the United Nations' Framework Convention on Climate Change (UNFCCC), the development of incentives for Reducing Emissions from Deforestation and forest Degradation in developing countries, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (REDD+) currently have high priority (UNFCCC, 2008, 2009, 2010). For recent overviews, see, e.g., Miles and Kapos (2008), Skutsch and McCall (2010) or Streck (2010). One of the still unsolved problems with REDD+ is that of baseline determination, i.e., the development of a reference against which a country's reduction of emissions due to deforestation and forest degradation can be measured (cf. Griscom et al., 2009; Huettner et al., 2009; Leischner and Elsasser, 2010). Different basic possibilities exist for determining such a baseline: it could either refer to each country's previous ("historical") deforestation, or it could rely upon some general regularity of forest cover development (a third alternative would be avoided, i.e., negotiating reference emission levels individually for each country) (see Combes Motel et al., 2009). A mere reference to previous national deforestation rates might, however, hardly be acceptable for many countries, since this would privilege countries with previously high deforestation, and conversely inhibit development chances for other countries which have been canny with their forests so far. Moreover, a historical reference might be ambiguous and complicated to establish if previous deforestation was variable. Thus, several criteria have already been voiced in the international negotiations which are considered important for a REDD+ baseline: besides being reliable and applicable in any participating country, a baseline should go beyond mere "historical" deforestation rates and account for different national circumstances (e.g., UNFCCC, 2007).

The concept of forest transition (FT) might be a good starting point for developing a baseline method which meets such criteria. This concept suggests a general regularity of long-term changes in a country's forest cover, which is supposedly similar across regions and countries

* Corresponding author. Tel.: +49 40 739 62 308; fax: +49 40 739 62 399.
E-mail addresses: margret.koethke@ti.bund.de (M. Köthke), bettina.leischner@ti.bund.de (B. Leischner), peter.elsasser@ti.bund.de (P. Elsasser).

1389-9341/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.forpol.2013.01.001

(Mather, 1992). According to the FT concept, a country initially runs through a period of decline in forest cover, followed by a transition phase and eventually, some re-expansion during the course of development (Grainger, 1995; Mather and Needle, 1998; Walker, 1993, and others, see Section 2.1 for detailed literature review) (see Fig. 1). Indeed such a pattern has been observed in various countries and regions. However, two major problems are still associated with the FT concept: First, from an epistemic point of view, the empirical content of the concept (and vice versa, its refutability) is still low to this date. The original concept – although it has been elaborated further by several authors – neither specifies the duration and intensity of any of the aforementioned development phases, nor does it give much substantial guidance on how to measure and model these phases (with respect to relevant variables, and the functional relations between them). In Section 2.1, the theory behind the FT concept and its problems are described in more detail and a review of its application and further elaboration in recent studies, as well as on alternative approaches of forest cover modelling, is given. Second, the empirical application of the FT concept implies data requirements which are almost impossible to satisfy, since the concept includes statements about phenomena which were not recorded at the times of their occurrence (for example, the first centuries of deforestation in many now developed countries). The data problem is addressed in Section 2.2.

Therefore, the objective in this study is to apply the current FT concept to define a forest cover model which can be used to test the supposed structural similarity of forest cover development across time and between countries on the global scale (see Section 3 for model specification). According to the scope and practical motivation of our study, it is not our main interest to further refine the causal theory of the FT concept or to identify and explain individual drivers of deforestation processes in different regions, but rather to test whether any global similarities of forest cover decline can be empirically demonstrated (see Section 4 for regression results). Empirical evidence for such a global deforestation pattern is the starting point and justification for any further political and technical discussions on a possible application and for further specification of a deforestation model. Section 5 describes how predictions of future forest cover development, under consideration of country-specific circumstances, can be made by the model. A discussion on the possible contribution of the findings and on the still existing gaps in the process of defining REDD+ baselines is included here. The paper ends with a final discussion (Section 6) about the methodology and the reliability of data and on recommendations for model improvement and further investigation.

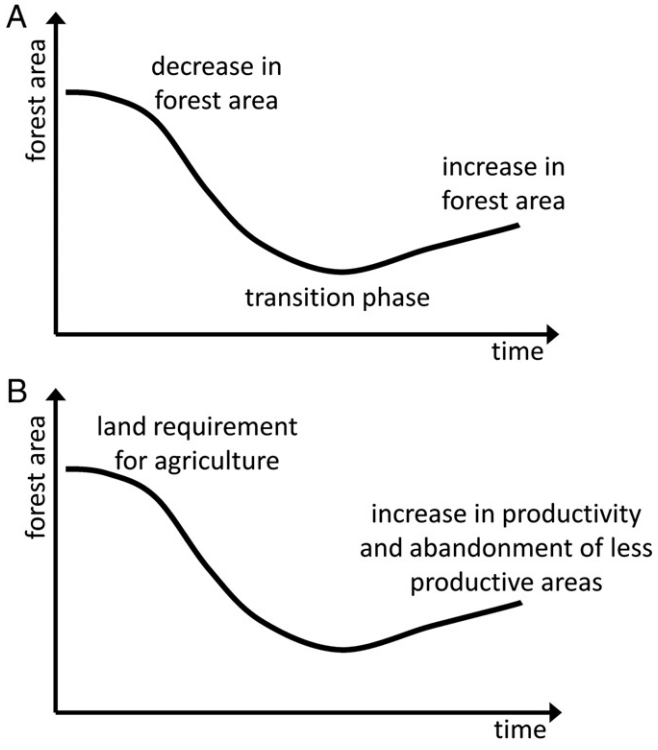

Fig. 1. The forest transition curve: shape [A] and rationale [B] (schematic diagrams, adapted from Grainger (1995) after Mather (1992).

2. Materials

2.1. The Forest Transition (FT) hypothesis as a theoretical background

The FT concept was initially a historical generalisation going back to the observation that a change from decreasing to expanding forest areas has taken place in many developed countries, a phenomenon which might similarly occur in developing countries in the future (Mather, 1992). Walker (1993) named the phenomenon "landscape turnaround". The original argumentation generally acknowledged that a combination of many factors affects forest area development as underlying causes, but it emphasised the progressive adjustment of land-use to agricultural needs and possibilities as a single fundamental driver (Mather and Needle, 1998). According to this rationale, forests are initially reduced due to a society's need for farmland. Progress in agricultural productivity and knowledge will later allow some of the farmland which turns out to be only marginally productive to be abandoned, so that forests can recover (see Fig. 1). Other factors may delay this adjustment (such as growing demand for food due to population growth), or they may accelerate it (such as increasing factor productivity due to technological progress).

Starting from this core explanation at the macro-level, several authors have modified the framework of the FT concept. Rather than interpreting forest cover development as the result of one single process, Grainger (1995) distinguished deforestation and forest cover increase as two distinct phenomena which might be influenced by different mechanisms. He called the two phases "national land-use transition" and "forest replenishment" and specifically acknowledged timber demand as a driver of the latter. This distinction explicitly allows for a delay between the deforestation and the forest replenishment phase, rather than interpreting this transition as a single turning point. This two-phase division has been taken up and further refined by other authors like Barbier et al. (2010) and Palo (2000).

Empirical studies have revealed exemplary evidence of forest transitions in several industrialised countries including Denmark (Mather et al., 1998), France (Walker, 1993; Mather et al., 1999), Switzerland (Mather and Fairbairn, 2000), the USA (Walker, 1993; Houghton and Hackler, 2000), Scotland (Mather, 2004), Austria (Krausmann, 2006), Greece, Portugal, Spain, Italy, United Kingdom, Norway, Japan and Canada (Walker, 1993), and in some developing countries (Puerto Rico: Walker (1993); Grau et al. (2003); Rudel et al. (2000); Dominican Republic: Aide and Grau (2004); El Salvador: Hecht et al. (2006); Vietnam: Mather (2007); Meyfroidt and Lambin (2007); China and India: Mather (2007)), generally by exploring the course of deforestation over time. Altogether these case studies go deeper into the details of forest transitions in the respective countries; however, explanations often remain context-specific for the analysed cases, and cannot be generalised. Cross-national evidence for the alleged structural similarity of forest cover development across time and space does not emerge from these studies.

Cross-national analyses on forest cover development have been conducted in the past with reference to different theoretical backgrounds, mostly focussing on deforestation rates in developing tropical