Collaboration for Environmental Evidence

Systematic Review No. 84

WORKING TITLE:

The relation between biodiversity and land use in the tropics.

Review Protocol

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Cover Sheet

Title	**The relation between biodiversity and land use in the tropics: a meta-analysis.**
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1. Background

The current loss of biodiversity at rates significantly exceeding those in the fossil record is a source of concern to many people, conservation organizations and governments (UNEP, 2002a). Recent assessments on global biodiversity show that biodiversity at levels of ecosystems, species and genes decreases rapidly due to several driving forces, including climate change, habitat fragmentation and land use change (MEA, 2005;CBD, 2006). At the species level the process of biodiversity loss is generally characterised by a decrease in the abundance of many species, resulting in an increase in the number of threatened species and in the extinction of others (Pullin, 2002).

Land use and land cover change results in considerable areas of natural habitats being converted into cropland, pasture, urban areas, or are otherwise impacted by human uses such as forestry and hunting. This causes biodiversity loss at a local, regional and global level (Hannah et al., 1994;Chapin et al., 2000;Sala et al., 2000;Sanderson et al., 2002;UNEP, 2002b). Even though it is clear that changes in land use and land cover will cause changes in species composition, the loss of biodiversity due to land use change is not well quantified. In some studies it is either explicitly or implicitly assumed that habitat loss due to conversion of land cover implies extirpation of all species from that habitat (e.g. MEA, 2005). This assumption does not hold for every land use change as shown by Majer and Beeston (1996) and Scholes and Biggs (2005). These studies show that the degree of biodiversity loss depends on the completeness of the conversion and on the intensity of land use after conversion.

Tropical forests that are relatively undisturbed harbor many floral and faunal species (Singh and Sharma, 2009 and references therein). Due to the conversion or degradation of this primary forest to other types of land use however, many species decline in numbers or disappear from the area (Castelletta et al., 2000;Barthlott et al., 2001;Raman, 2001;Robertson and van Schaik, 2001) which largely influences global biodiversity. In the proposed review we intend to assess the effect on biodiversity of different taxa when relatively undisturbed tropical forest is converted or degraded to other types of land use.

The data collected during the review will be used to feed the Global Biodiversity Model (GLOBIO3) developed by the Netherlands Environmental Assessment Agency (PBL). The GLOBIO3 model has been developed to assess human-induced changes in biodiversity, in the past, present, and future at regional and global scales. The model is built on simple cause–effect relationships between environmental drivers and biodiversity impacts, based on state-of-the-art knowledge and is used to study the worldwide biodiversity effects of environmental drivers (CBD, 2006; Alkemade et al., 2009).

The proposed review will be executed on behalf of the Netherlands Environmental Assessment Agency (PBL). PBL is the national institute for strategic policy analysis in the field of environment, nature and spatial planning. Among others, it performs assessments on biodiversity to evaluate policy and to explore policy options. For these assessments PBL develops indicators and models to determine the past, current and future state of biodiversity and its causes. The proposed systematic review deals with a topic relevant for an important component of one of PBL's models and will support PBL's efforts to develop policy scenario models of biodiversity responses to human interference.

2. Objective of the Review

2.1 Primary question

What is the effect on biodiversity when relatively undisturbed tropical forest is converted or degraded to other types of land use?

2.2 Secondary questions

Do different taxonomic groups show different responses when relatively undisturbed tropical forest is converted or degraded to other types of land use?

How does biodiversity differ between different types of land use?

3. Methods

3.1 Search strategy

The search aims to capture a representative sample of the literature published in peer-reviewed journals as well as other sources (grey literature), relevant to the research questions. Different sources of information will be searched in order to maximise coverage, among which will be ISI Web of Knowledge (Web of Science), Scopus and Google Scholar. The following search strings will be used: species AND tropic* AND primary forest OR mature forest OR intact forest OR old growth forest OR virgin forest OR pristine forest AND conversion OR degradation OR land use OR habitat type OR agro-forestry OR secondary forest OR plantation OR cropland OR urban area AND diversity OR biodiversity OR richness OR abundance. All returned hits from the academic databases will be checked for relevance. For returns from web search engines, only the first 100 hits will be checked. Variation in spelling of search terms will be checked.

The World Agroforestry Centre (ICRAF), and in particular Meine van Noordwijk (Global Science Advisor), as well as Douglas Sheil (Center for International Forestry Research) and Francis Putz (University of Florida) will be contacted for advice and provision of any unpublished data that might be relevant to our review study.

Prior to the review proposed in this protocol, the Netherlands Environmental Assessment Agency (PBL) collected data for a global study on biodiversity related to land use. Those data are recorded in a database and part of it will be used here. Data from the tropics will be selected and supplemented with data from 2007 until 2009 under the scope of the review proposed here. Similar search strings were used for the dataset from 2007 as we propose to use here. However, we will check if the existing database contains the studies that come up if we perform our search on literature from before 2007.

3.2 Study inclusion criteria

- **Relevant subject(s):** floral and faunal species assemblages
- **Types of intervention:** conversion or degradation of relatively undisturbed tropical forest to other types of land use
- **Types of comparator:** relatively undisturbed tropical forest
- **Types of outcome:** change in species richness, species abundance and species diversity
- **Types of study:** all primary studies that report on the effect on species presence and abundance when undisturbed tropical forest is converted or degraded

We will include all taxa and all species (indigenous as well as exotic) that we encounter during the search. They will be categorized into 5 groups: plants, invertebrates, birds, mammals and herpetofauna (following Scholes and Biggs 2005 with the addition of invertebrates). Interventions can be selective logging, or (near) clear-cutting and possibly burning for a variety of reasons, such as pastures, agricultural activities, crop field or urbanization.

The term tropical forest includes any type of forest, whether wet or dry, mountain or lowland, as long as it is described as 'tropical' by the author. 'Relatively undisturbed forest' in our study is defined as primary forest which is either undisturbed for as long as it is known or which was subject to mild disturbance in the past. Mild disturbance could include small scale selective logging or subsistence hunting. Such disturbance should be clearly described in the study. Old growth secondary forests do not count as 'relatively undisturbed forest' unless they are more than 100 years old. The study needs to describe the 'primary', 'intact', 'mature' or 'old growth' forest which is studied, otherwise the study will not be included in the review.

3.3 Potential effect modifiers and reasons for heterogeneity:

The theme is very broad and so will the variation in data because we include a large variety of studies in our review. Reasons for this variability include the type and extension of forest conversion, time since forest conversion, the temporal and spatial scale of studies, variety in the biodiversity and the type of the reference forest, proximity to mature forest, location of the study and sampling schemes and techniques. Species or taxonomic groups respond differently to conversion. Depending on the data we will find, we will analyse the reasons for heterogeneity in a quantitative manner by assessing how much each factor contributes to variation in species richness and abundance.

Numerous factors other than land use change affect the abundance and spatial distribution of plants and animals, including climate change, background colonisation and extinction patterns, etc.

Despite the expected variation in data we believe a systematic review is appropriate since we will calculate a common effect size (relative Mean Species Abundance: MSA) and we will thoroughly analyse reasons for heterogeneity in the data. There is a strong need for a quantitative review on this topic based on sound scientific evidence,

because the MSA is one of the indicators being used to study the worldwide biodiversity effects of environmental drivers (CBD, 2006;Alkemade et al., 2009).

3.4 Study collection

A first reviewer will filter the outcome of the searches by screening all hits of each search result and selecting those studies with a relevant title and keywords. The abstracts of these articles will be read to further determine the suitability of the study. The studies remaining hereafter will be read in full to determine which ones are suitable for data extraction. A second reviewer will check the studies of which the suitability is unclear to the first reviewer.

At the start of the literature selection phase, both reviewers will assess suitability of several studies together to assure consistent use of inclusion criteria.

3.5 Study quality assessment

Ideally a study includes a undisturbed primary tropical forest as a reference, to which species abundance in other types of land use is compared. A table with individuals counts per species in the undisturbed reference and in other types of land use within the same area would be most suitable to calculate relative mean species abundance and relative species richness (of original species) (see below for a description of these biodiversity indicators). If such tables are absent, graphs and other figures will be studied to determine if they can provide information to calculate at least one of the biodiversity indicators.

Studies may differ in the number of species, or taxonomic groups studied and in the spatial and temporal scales that are covered. Sampling design and techniques may also seriously affect the quality of the studies. We will however incorporate all studies if they fulfil the inclusion criteria. We will report on the number of species and taxa studied, the location, the type of primary forest, the size and number of plots, the repetition of measurements and the sampling technique. Some of these study characteristics will be explored in our review as sources of heterogeneity in the data.

3.6 Data extraction strategy

Only quantitative data will be extracted from the articles. Two reviewers will assess the suitability of the data in order to proceed with calculations. The data that will be extracted are stored in a database that already exists (it contains data relevant to the topic of the review up to and including 2006). If present in the article or report, tables presenting individuals or species counts in different land use types will be copied to the excel database for further calculations.

3.7 Data synthesis and presentation

The extracted data will be used to calculate three indicators of biodiversity for each land use type covered in the study. Each study will have to include a reference biodiversity calculated for the undisturbed forest (the comparator). We will apply

meta-analytical techniques to combine the results of independent studies in a quantitative way (Arnqvist and Wooster, 1995).

The first biodiversity indicator is relative species richness (RSR) which is defined as the species richness found in a particular land use type, relative to that of the undisturbed forest. The second is the relative species richness of original species (RSR_{os}) which is the proportion of species in a particular land use type that were also recorded in the undisturbed forest. The third is the relative mean species abundance (MSA) and is a refinement of RSR_{os} as it not only accounts for the presence or absence of species but also the change in abundance of each species. We realize that these indices, like other biodiversity metrics, are a simplification of the over-arching concept of biodiversity. We will discuss uncertainties related to the use of these biodiversity indices.

Biodiversity indicators will be presented per land use type and for each taxonomic group separately. The land use types that will be distinguished are: undisturbed forest, lightly used forest, secondary forest, agro-forestry, wood plantation, perennial crops, low-input crops, high-input crops and urban areas.

4. Potential Conflicts of Interest and Sources of Support

Tropenbos International supports this review.

There are no known conflicts of interests.

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