

Ecological Studies, Vol. 221

Analysis and Synthesis

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Ecosystem Services, Biodiversity and Environmental Change in a Tropical Mountain Ecosystem of South Ecuador

 Springer

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ISSN 0070-8356

ISBN 978-3-642-38136-2

ISBN 978-3-642-38137-9 (eBook)

DOI 10.1007/978-3-642-38137-9

Springer Heidelberg New York Dordrecht London

Library of Congress Control Number: 2013943580

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Printed on acid-free paper

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Preface

Threat to biodiversity and ecosystem services by global change is meanwhile undisputed. Climate change, expansion of land use, atmospheric fertilization, and invasion by alien species have been identified as the main current and future drivers of ecosystem deterioration (Sala et al. 2000; Pereira et al. 2010). The Millennium Ecosystem Assessment (MEA 2005) connected for the first time the interdependence of ecosystem functioning and human interference with nature in a well-arranged, comprehensive manner by defining specific categories of services which the earth's ecosystems provide for their own stability and in particular for the benefits of their human inhabitants. While acknowledging those services as a major precondition for human well-being, the aim of the report was to assess the consequences of (predominantly) man's impact on ecosystems for human well-being and to provide the scientific basis for a responsible, sustainable use of ecosystems, including conservation. Notwithstanding the appreciation of the impressive conceptual work condensed in that report, its focus on the global dimension of ecosystem services inevitably generates scarcity of regional and local assessments. Thus, e.g. for the biodiversity hotspot of Ecuador information on the current or the predicted states is completely lacking (Fig. 6.1 in MEA 2005). At the same time, the report deplores insufficient knowledge, among others, on (1) long time series of local environmental data, (2) quantitative relationships between biodiversity and ecosystem services, particularly regarding regulative, cultural, and supporting services of specific ecosystems, which would allow predictions, and (3) the incapability to derive regional and local projections of the future development of ecosystem services (MEA 2005).

This book will contribute to fill such local gaps for one of the "hottest" biodiversity hotspots of the world, the south-eastern Andes of Ecuador. Assessment of the current and future state of biodiversity and ecosystem services in the valley of the Rio San Francisco is based on 15 years of comprehensive interdisciplinary ecosystem research, producing a wealth of data, and profound as well as far-reaching information on ecosystem structure and functioning, covering the biotic, abiotic, and socioeconomic spheres. A basis to this endeavor is the predecessor volume ("Gradients in a Tropical Mountain Ecosystem of Ecuador" in the

same Series, Vol. 198, edited by Beck et al. 2008), which has been published five years ago. A special advantage of the selected study area is the direct spatial vicinity of the protected mountain rain forest as the natural ecosystem of the region on the one side of the valley and an anthropogenic agricultural replacement system on the opposite side. While the natural forest appears to be fairly resilient to climate changes, the agricultural systems, mostly pastures, turned out to be non-sustainable. The unique opportunity to conduct comparative field surveys and ecological experiments in both manifestations of the ecosystem allowed the authors to gather quantitative information on current ecosystem services which are subjected to the impacts of an ongoing climate and land-use change. With regard to ecosystem services, the book is based on an approach adapting the MEA (2005) service categories, as described in detail in Sect. 4.2.

Part II presents the current state of the different service categories. Naturally this part cannot claim to be exhaustive regarding the immense complexity of the tropical ecosystems. Thus, the authors have focused on services which are of major importance for the country, e.g., biodiversity as the main preserving but also cultural service, the regulation of climate, the water, carbon, and nutrient cycles, considering abiotic and biotic elements, the provision of water, the deposition of airborne nutrients, and various options of agricultural provisioning services (forestry and pasture management). The latter have been analyzed in a holistic way, ranging from ecological aspects to socioeconomic issues, in particular the sustainability of indigenous land-use systems.

Regarding prospective approaches, ecological intervention experiments on the one hand and numerical models calibrated and parameterized by a multitude of measured data on the other provide the basis for scenarios for the future development of the investigated ecosystems and ecosystem services. This is the concern of Part III. Special attention is given to derive a sustainable land-use portfolio from an ecologically adapted combination of suitable agricultural strategies and managements.

The main synthesis (Part IV) summarizes the accumulated comprehensive knowledge, culminating in a science-directed recommendation of sustainable land-use system for the hotspot area, which was the overarching aim of the past 6 years of research. Although the book reports projects of basic research, there is one major point which must not be overlooked. In the spirit of the Access and Benefit Sharing (ABS) principle publicized by the CBD (Convention on Biological Diversity), research in a developing country should address the needs of the local communities and should be conducted together with the local people, scientists, and stakeholders for the sake of building capacity. After 15 years of joint German–Ecuadorian research, a multitude of benefits have been achieved and are communicated in Part IV. This holds in particular for the academic scene of southern Ecuador. Furthermore, the compiled results and developed technologies of several projects are now ready for transfer into application to serve the local society. Consequently, the potential of the research results for knowledge transfer has been assessed here, too.

At this point, it should be stressed that the results of this book not only hold for the ecosystem of the Rio San Francisco Valley but *mutatis mutandis* show transferability to other forested tropical mountain areas of the Andes (and beyond), if located in a comparable altitudinal range of approximately 1,000–3,500 m a.s.l. The environmental background conditions of the study area are comparable to many other sites at the tropical eastern Andean ranges. The altitudinal level of the study area is subjected to the influence of a belt of high cloudiness and precipitation, the so-called Andes-Occurring System (AOS), ranging from Columbia to Peru (Bendix et al. 2006). As in the study area, the population pressure in the biodiversity hotspot of the entire tropical Andes is one of the highest in the world. This causes ongoing land-use changes, i.e., clearing of the natural forest to increase livelihood by exploiting provisioning services as revenues from agriculture. However, the needed conversion of natural forest into arable land at the same time deteriorates ecosystem services at other levels. As in the study area, the removal of forest for pastures is the current land-use practice everywhere in the tropical Andes (Mulligan et al. 2009). This type of land-use change is generally suspected to threaten cultural, supporting, regulating and provision services, and also knowledge which is associated with functional biodiversity.

However, many uncertainties of ecological, economic, and social nature remain with respect to the bouquet of ecosystem services from the natural and the man-made ecosystems in the research areas and beyond. The book takes up all these uncertainties and attempts to provide exemplarily transferable comments on the state of current ecosystem services and their management.

Last but not least, the endeavor of compiling an interdisciplinary book of this extent is a major challenge. This had not been possible without the extraordinary commitment of the 103 authors who contributed their excellent knowledge, creativity, and enthusiasm during the compilation of the manuscript. Many thanks go also to our editors for moderating partly controversial but fruitful discussions in order to match the individual chapters and to the publisher for supporting the publication of our results in the Ecological Studies series. Our assistant editor, Dr. Esther Schwarz-Weig (Mistelgau), deserves a special praise for her outstanding perseverance and patience in collecting, editing, and commenting on the chapters. Without her help, this book would certainly never have been realized. The authors would also like to thank the German Research Foundation (Deutsche Forschungsgemeinschaft DFG) for generously funding the research and the external board of advisors/reviewers for their help to refine the research program. For the achievement of the knowledge compiled in this book, the excellent cooperation with Ecuadorian colleagues and local people was instrumental, who became good friends over the time. The foundation Nature and Culture International (NCI) provided the facilities, in particular the very well-equipped research station ECSF (Estación Científica San Francisco) together with the surrounding research area. The effective running of this station by NCI in cooperation with the German scientific coordinators Dr. Felix Matt and Dipl. Geoecologist Jörg Zeilinger must be considered a stroke of luck for the entire enterprise “Ecosystem Studies in South Ecuador.” The support of our counterparts from the Ecuadorian Universities, above

all from the Universidad Técnica Particular de Loja (UTPL), the Universidad Nacional de Loja (UNL), and the University of Cuenca, also deserves special acknowledgment. The authorship and coauthorship of many Ecuadorian collaborators in this book witness the excellent cooperation. Last but not least, we thank the Ecuadorian governmental administration for enabling this exciting research and, on behalf of others, the Ecuadorian Ministry of Environment (MAE) for issuing the research permissions. As the space of this preface is limited, it is not possible to thank all people by names who have contributed to the success of our research and in turn to the realization of this book. Nevertheless, we are very grateful to them and their support of our venture is well appreciated.

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