SPATIAL ASPECTS OF ECOSYSTEM RESEARCH IN A BIODIVERSITY HOT SPOT OF SOUTHERN ECUADOR – AN INTRODUCTION

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With 1 figure
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The Andes of Ecuador are known as one of the "hottest" hotspots of biodiversity (Brummitt and Lughada 2003; Barthlott et al. 2007, Liede-Schumann and Breckle 2008). At the same time Ecuador suffers the highest annual rate (-21.5% between 1990 and 2005, FAO 2005) of deforestation in South America, belonging to the "Top Eleven" countries worldwide with regard to tropical forest destruction (Marshal 1999). In particular, the mountain forest is being chopped down legally as well as illegally at an alarming rate.

The major driver of deforestation results from poverty of the growing local population especially in the rural areas (Hall and Patrinos 2006). The motivation of the people for clearing the native forest is to improve their living standards by gaining pasture and/or arable land. Degradation of the natural ecosystem, mostly by slash and burn, impairs its ecosystem services, a term that encompasses the trade-offs from the resources and processes of the (original) ecosystem for human livelihood and well-being (see e.g. Daily 1997; MILLENIUM ECOSYSTEM ASSESSMENT 2005). While the so-called *provisioning services* (food, fuel, wood and fibre etc.) may increase, at least temporally, due to anthropogenic conversion of the ecosystem, the (ecosystem) *supporting and regulating services* such as the maintenance of an effective climate regulation function, balanced nutrient cycle and carbon sequestration are severely compromised, major factors which could locally mitigate the effects of global climate change. In particular ecosystem *preserving services* provided by its biodiversity are inevitably endangered by ecologically non-adjusted land use types. In the Andes of South Ecuador, pastoral land use can be considered the central *provisioning service* for the livelihood of the local population. Unfortunately, productiveness of the pastures suffers from an inappropriate use and method of maintenance by periodical burning. This holds also for the study area of a great ecological research project (Fig. 1), the DFG funded Research Unit 816 "*Biodiversity and Sustainable Management of a Megadiverse Mountain Ecosystem in South Ecuador*" which investigates the tropical ecosystems of the upper San Francisco valley in the Provinces of Loja and Zamora-Chinchipe.

In that valley about 48% of the natural mountain forest below 2200 m a.s.l., and even 6% above that line, have been cleared mainly for use as pastureland, but about 40% of the pastures are heavily infested by a terrible weed, the southern bracken, whose growth and encroachment is favoured by the above mentioned land use practices resulting in an abandonment of the pastures within a decade or less (Hartig and Beck 2003; Göttlicher et al. 2009). Today, 25 multidisciplinary projects are working together in the research unit to finally derive science-directed land use scenarios and to design a sustainable land use system which at the same time preserves biodiversity and its underlying ecosystem processes, rehabilitates attenuated diversity and lost ecosystem services and guarantees better livelihoods for the local population. Many projects are jointly examining ecosystem functioning and usability on common study plots in the natural forest and on the pastures. Major insights in the ecosystem that were extracted from investigations, which have partly gone on for more than 10 years, have recently been published (Beck et al. 2008). However, to derive options for a sustainable management, science-directed recommendations must be valid not only for single plots but for a whole region, a demand that requires research on the landscape scale. Particularly, knowledge on the effects of different management strategies on the various ecosystem services is needed. Thus, one overarching endeavour of the ongoing research programme is on models addressing ecosystem functioning and services on a wider spatial perimeter (Fig. 1).

This special issue of "Erdkunde" exemplarily presents several of our comprehensive study projects addressing models that are useful for an assessment of land use options.

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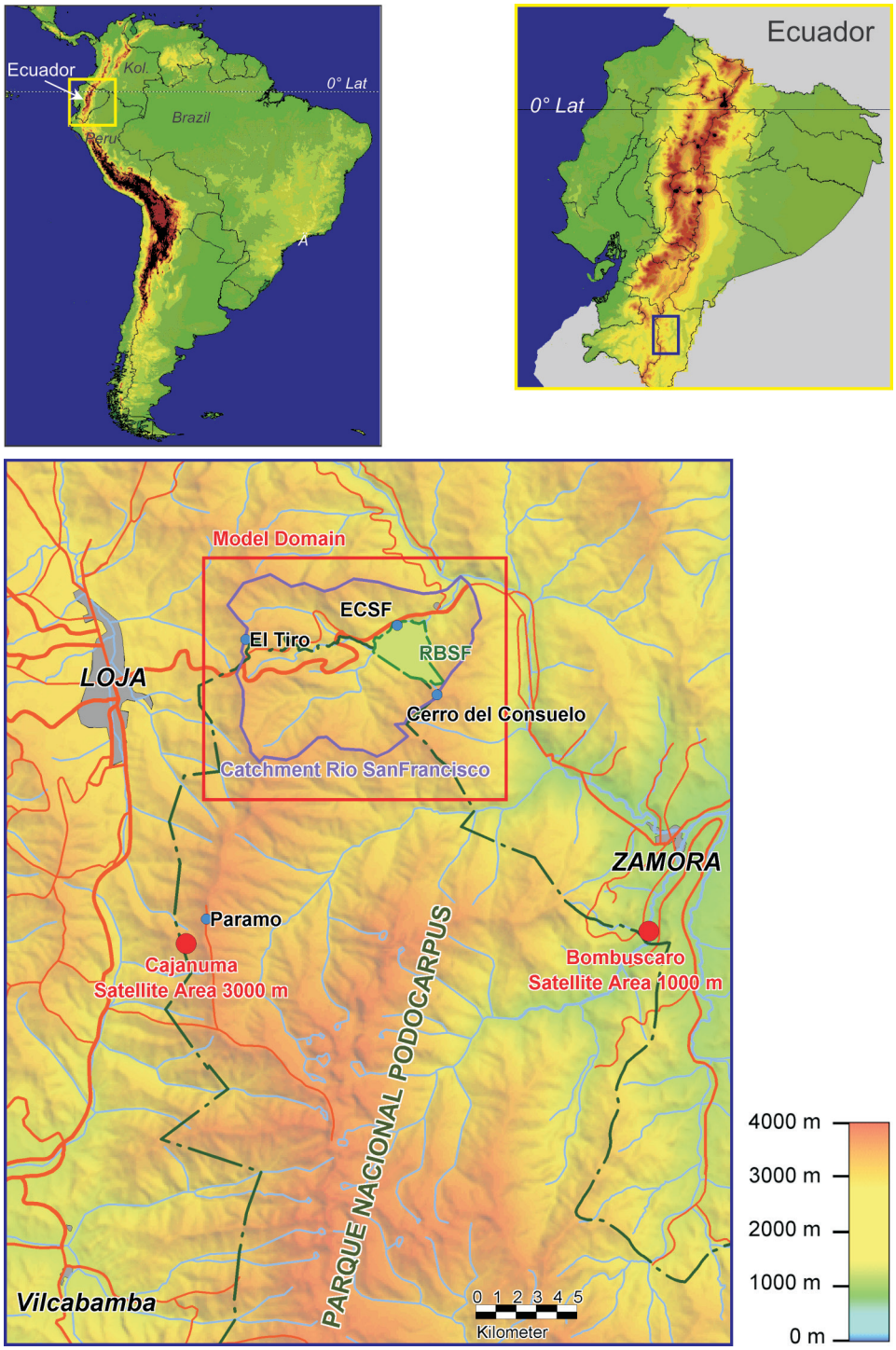

Fig. 1: Study area of the Research Unit in the eastern Andes of South Ecuador. Extensive research is conducted on common plots in a small area around the research station ECSF (Estación Científica de San Francisco, lat. 3°58'18" S, long. 79°4'45" W, alt. 1860 m a.s.l.). This RBSF (Reserva Biologica San Francisco) core area comprises an elevational gradient from 1800 to 3200 m a.s.l. in the natural forest, but also pasture land and abandoned pastures, mainly on the orographically left side of the lower parts of the valley. To complete the altitudinal gradient in the natural ecosystem particularly for plot-based ecological field experiments, two satellite areas (Bombuscaro, Cajanuma) were selected in the wider study area. The spatial approaches on the landscape scale in the framework of the overarching theme models presented in this special issue are working in the RBFS and on the opposite slopes, in the catchment area of the Rio San Francisco, and on the whole perimeter as displayed in the map.

A basic requirement for spatial approaches dealing with numerical models is the availability of spatial data sets for model initialization. Information on soil properties is of particular importance for most process models (e.g. SVAT models, hydrological models etc.). Extensive soil surveys have been conducted over the last years in the study area. Now, Liess et al. (2009) present a method for the regionalization of the soil type distribution which relies on a classification and regression tree (CART) approach using basic topographic information. Fries et al. (2009) produced high resolution maps of monthly averages of 2 m minimum, mean and maximum air temperature by combining a detrending technique and satellite-based land cover classification. With this work, they show how conversion of the forest into pastoral land can reduce the thermal regulation function (*regulating services*) of the ecosystem. Bräuning et al. (2009) examine growth (and thus carbon sequestration) of a deciduous broadleaved tree species, *Cedrela montana*. The first ring-width chronology from this tree covers the time until 1840. Correlation functions calculated with spatially available moderate-resolution NCEP/NCAR (*N*ational *C*enters for *E*nvironmental *P*rediction/*N*ational *C*enter of *A*tmospheric *R*esearch; refer to Kalnay et al. 1996) climatic data fields show the relationship of extension growth with temperatures during the leafy period of the tree. Also related to carbon sequestration in context with the dynamics of tree diversity (*preserving services*) is the paper of Dislich et al. (2009). They parameterized and validated the process-based, individual-oriented forest simulation model FORMIND and simulated the succession in the study area in terms of relative abundances of different species groups and stem size distribution in the tree community. Central aspects of a sustainable land use management (*provisioning services*) are addressed by Knoke et al. (2009). Based on a risk sensitive bio-economic land use model, a mixed portfolio concept for sustainable land use was identified, which avoids deforestation while in contrast aims at a stepwise reforestation of abandoned pasture land. This concept could rely on cheap credits financed by the carbon markets, carbon taxes or other financial sources. Thus, it directly addresses aspects of carbon sequestration from a socio-economic point of view. Altogether, the work presented in this special issue show that spatial approaches can help to disentangle selected ecosystem functions and services to support science-directed recommendations for a sustainable land use, even in such a complex megadiverse tropical ecosystem as the study area.

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