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Ecological and social consequences of the Forest Transition Theory as applied to the Argentinean Great Chaco

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ABSTRACT

Forest transition is the change from net deforestation to net reforestation. According to the Forest Transition Theory (FTT) in its original form, reforestation is triggered by the last stage of socio-economic development, when the rural population migrates to urban areas, and forest cover expands naturally on abandoned agricultural fields. The assumptions underlying the FTT have been changed to extrapolate it to the Argentinean Great Chaco (AGC). It is suggested that Indigenous people and low income peasants, who use land inefficiently, should migrate to the urban areas in search of a better life quality. Thus, the abandoned lands could be used for conservation, while the most suitable soils could be destined for food production. However, the subtropical forests in the AGC are highly vulnerable to desertification, as a consequence of rainfall irregularity and high summer evaporation rates. The probability exists that forest recovery does not occur in time scales relevant for conservation. Drawing on research data and bibliography, we tested the validity of the three main assumptions suggested for the Forest Transition Theory as applied to the AGC. Results show that original inhabitants have sustainable land use strategies; rural outmigration is driven by high-input agriculture, which pushes people toward the city skirts; and expansion of intensive agriculture is independent of soils production capacity. We discuss the social and environmental consequences of the proposed assumptions.

1. Introduction

Ever since Mather (1992) introduced the idea of forest transition for developed countries, much has been debated about its occurrence, processes and drivers (for example: Satake and Rudel, 2007; Barbier et al., 2010; Pfaff and Walker, 2010). Forest transition (FT) has been defined as a change from net deforestation to net reforestation in a given space, occurring as a gradual transition from loss to recover of native forest area (Redo et al., 2012). Reforestation is understood as spontaneous regeneration of forests on deforested lands. The Forest Transition Theory (FTT), introduced at a time of concern over forest loss in the northern hemisphere, was explained as a progressive adjustment of agriculture to land capability, resulting in less land area needed to obtain increasing amounts of agricultural products (Mather and Needle, 1998). Though initially the theory of forest transition was proposed for northern Europe it was later expanded to the tropical developing countries, where the driver was taken to be economic development (Rudel, 1998); that is, as industrialization and urbanization expands, rural to urban migration occurs, and native forest regenerates on abandoned lands (Walker, 1993; Rudel et al., 2005; Wright and Muller-Landau, 2006). For those of us who participated in the Hamburger Connection debate, it was hard to believe that development was the driver of outmigration (Matteucci, 1987; Edelman, 1995).

Recently, the Forest Transition Theory has been imported by local researchers into the seasonal dry forests of the Gran Chaco Region, in Argentina, Paraguay, Bolivia and Brazil (Aide and Grau, 2004; Grau and Aide, 2008). The process has been reformulated: it is assumed that reforestation occurs in lands that are abandoned by low-income farmers who make inefficient use of them; thus, rural–urban migration is driven by development (Grau and Aide, 2008), understood as expansion of agribusiness, urbanization, increase in food demand, foreign investment; in short, the set of interacting socioeconomic factors in a neoliberal and globalized economy. The authors state that food production should come from

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modern agriculture, practiced on the most productive soils (Grau et al., 2008). All these papers, that patronize land sparing by agricultural adjustment, do not consider other factors, such as effects of massive deforestation on long term forest ecosystem sustainability, in the climatic and edaphic conditions of the Chaco region. Neither do they take into account the rights of indigenous people to their lands, territories, culture and resources (UN, 2008). They never considered the possible consequences of deforestation on soil water loss, soil salinization and the two aquifers underlying the Chaco region. We think that the argument based on inefficient use of land is, at least, illegitimate, since it surreptitiously suggests that low-income peasants and indigenous communities should abandon the lands they have occupied for centuries, as well as their culture.

Some scientists state that the primary driver of industrial agricultural expansion is the international demand for food due to population growth and increased living standards in some countries (Grau et al., 2005, 2008; Gasparri and Grau, 2009). In Argentina, oilseeds are retained in plastic bins waiting for better international market prices. This would not happen if there were an increased food demand. As FAO (2012) reports, food production is sufficient to feed the world population. Food availability, which increased from 1850 kcal/person/day in the 1960s to 2790 kcal/person/day in 2006/08 in Latin America, helped reduce the percentage of chronically undernourished people from 34 percent in the mid-1970s to 5.1% in 2012/14 (FAO, 2014). Despite this progress, poverty and hunger still prevail in the World, while the damages caused by the advance of the agricultural frontier have continued (Pretty et al., 2006) up to date. Numbers given at international and national levels hide the situation in local communities. The problem is that food distribution is highly inequitable. Argentina plays an important role in global wheat, maize, and soybean markets, and has helped increasing the world supply of grains and oilseeds. However, the benefits of industrial production, led by major exporting companies, fail to reach small and medium farmers (Krapovickas and Longhi, 2013), while environmental setbacks (decrease in water availability and quality, loss of forest resources, lack of land for subsistence agriculture, reduction in wage labour; in short, worsening socioeconomic conditions and wellbeing) fall exclusively on them.

In this paper we will rely on partial results of projects carried out by our research team in the Argentinean Gran Chaco (AGC) to test the three assumptions relating to the FTT as applied to this region: (1) low income peasants use land inefficiently; (2) development drives rural–urban migration of low income peasants in search of a better life quality; (3) expansion of intensive agriculture occurs in the most productive lands.

2. Study area

The South American Chaco is the biggest continuous dry forest in the world; it is the second largest forest ecosystem in South America after the Amazon. It is the only subtropical dry forest on the planet; in similar latitudes (around 28° south) deserts are found in both hemispheres.

The Argentinean Great Chaco (AGC), with 608,598 sq.km, has very singular characteristics. A forest biome in this dry weather is explained by the presence of three large rivers flowing from the Andes (Pilcomayo, Bermejo and Dulce) that run from North–West to South–East on an extremely plain terrain. In geological time these rivers drifted southwards forming numerous minor streams, meanders, oxbow lakes and subsoil water deposits (Adámoli et al., 1990). Water stored in the soil has been protected by a relatively dense tree canopy with some peculiarities. (1) The three endemic quebracho tree species: chacoan red quebracho (*Schinopsis balansae* Engl.), santiaguenian red quebracho (*Schinopsis lorentzii* (Griseb.) Engl. and white quebracho (*Aspidosperma quebracho blanco* Schltdl.), are large trees, around 24 m high and 1 m in trunk diameter. Trees as large as these are unusual in a semiarid to arid climate. (2) White quebracho has persistent foliage, and red quebracho has semi persistent foliage, with a particular phenology because it sheds the leaves in late spring; i.e., it keeps the foliage throughout the winter, which is the rainless season, and protects the soils from desiccation (Ledesma, 1992). The winter deciduous trees mitigate the harsh environment of dry summers (Cáceres et al., 2004, 2007). These features play a key role in the conservation of relatively humid conditions under the canopy, favouring the persistence of the undergrowth, which protects the soil from drying out. (3) Under the canopy the microclimate is less warm and less dry than that of non-forested areas (Ledesma, 1992). One wonders if deforestation of large tracks of land would not lead to desertification, especially after harvesting. Other characteristics of the AGC are the high species and culture biodiversity, and the large spatial heterogeneity, with ecosystems interacting horizontally.

The AGC is divided in two ecoregions: the Dry Chaco to the West and the Humid Chaco to the East. There are some differences in climate, vegetation formations and land use between the two ecoregions, though they share general characteristics, such as high biodiversity, the main tree species, fauna, and cultural diversity.

The climate is subtropical, with average summer temperatures ranging from 28 °C to 22 °C from North to South. Due to the continental nature of climate, there are large temperature variations between summer and winter; maxima of 47 °C can be reached when the sun is high while frosts can occur in winter. Mean winter temperatures vary between 17 and 10 °C latitudinally, from North to South. Mean rainfall decreases from 800 to 500 mm from East to West in the Dry Chaco ecoregion, though it increases again up to 800 mm in the vicinity of the Andes, to the West. In the Humid Chaco, mean rainfall increases from 800 to 1200 mm from West to East. Rainfall concentrates in summer, but it is irregular and occasional dry periods may occur. The water balance has negative values for 10–12 months in the year.

The Dry Chaco Ecoregion is covered by xerophyte open forests, in which quebracho species, mistol (*Ziziphus mistol*) and *Prosopis* spp. are the most frequent tree species. In the driest central fringe, distinctive patches of burned vegetation stretching in a south–north direction interrupt both physiognomies. These patches originate by natural and human fires and follow prevailing wind direction. In the Humid Chaco Ecoregion, the vegetation forms a tangled mosaic of palm savannah, and dense forest patches, spotted with marshes, lagoons, flooded riverside forests, forested levees, and back swamp forests. In the parkland formation, patches of quebracho forest alternate with open grasslands. Areas dominated by palm trees (*Copernicia alba*) occupy swampy soils with salt accumulation. Low riparian forests skirt watercourses, and aquatic plants cover flooded areas. It is characterized by an alternating flood and drought regime, and many species are adapted to the natural rhythm of alternating wet and dry periods. Indigenous people plan their crops according to this alternating humid-dry conditions which they can predict in advance.

The history of land use change in the Dry Chaco is longstanding, and has been described within the framework of a historical periodization (Morello et al., 2007), though there is ample superposition between periods. The periods are: (1) local ethnic groups, (2) military activity, (3) ranching outposts, (4) railroad ties and poles, (5) tannin industry, (6) farming colonies, (7) oil exploration, (8) industrial agriculture, and (9) soybean agribusiness expansion.

Before the colonization (stage 1), indigenous people used mainly the grasslands and obtained few resources from the forest. At the beginning of colonial times (stages 1 and 2), the grasslands were again the main source of ecosystem services; cattle and horses were introduced, the former in small herds, while horses were brought in for use in rural tasks. A new social group appeared in scene, the