Linking Land Tenure and Use for Shared Prosperity
ANNUAL WORLD BANK CONFERENCE ON LAND AND POVERTY
WASHINGTON DC, MARCH 23-27, 2015

LAND USE CHANGE INDUCED BY LARGE SCALE LAND ACQUISITIONS

D'ODORICO, PAOLO (1,3); RULLI, MARIA CRISTINA (2); CASIRATI, STEFANO (2); DAVIS, KYLE (1); DELL'ANGELO, JAMPEL (3)

1: University of Virginia, United States of America; 2: Politecnico di Milano, Italy; 3: SESYNC, University of Maryland, USA
paolo@virginia.edu

Paper prepared for presentation at the
"2015 WORLD BANK CONFERENCE ON LAND AND POVERTY"
The World Bank - Washington DC, March 23-27, 2015

Copyright 2015 by author(s). All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Abstract

The increasing demand for food, fibers and biofuels, the consequently escalating prices of agricultural products, and the uncertainty of international food markets have recently drawn the attention of governments and corporations toward investments in productive agricultural land, mostly in developing countries. The targeted regions are often located in areas where crop yields are relatively low because of lack of modern technology. It is often suggested that in the long run large-scale investments in agriculture will bring the technology required to close the existing crop yield gaps. Recently, a number of studies and reports have documented the process of foreign land acquisition and the associated appropriation of land based resources (e.g., water and crops). The amount of food this land can produce and the number of people it could feed are a good measure of the potential impact of large scale land acquisitions on food security and rural livelihoods. The environmental impacts of these investments in agriculture have remained poorly investigated and need to be assessed. Here we analyze some recent quantitative assessments of the rates of water and crop appropriation potentially associated with large-scale land acquisitions, and evaluate some of the main societal and environmental implications.

Key Words:

Large scale land acquisitions, water appropriation, deforestation, logging, food security

LAND USE CHANGE INDUCED BY LARGE-SCALE LAND ACQUISITIONS

D'ODORICO, PAOLO (1,3); RULLI, MARIA CRISTINA (2); CASIRATI, STEFANO (2); DAVIS, KYLE (1); DELL'ANGELO, JAMPEL (3)

1: University of Virginia, United States of America; 2: Politecnico di Milano, Italy; 3: SESYNC, University of Maryland, USA
paolo@virginia.edu

Abstract

The increasing demand for food, fibers and biofuels, the consequently escalating prices of agricultural products, and the uncertainty of international food markets have recently drawn the attention of governments and corporations toward investments in productive agricultural land, mostly in developing countries. The targeted regions are often located in areas where crop yields are relatively low because of lack of modern technology. It is often suggested that in the long run large-scale investments in agriculture will bring the technology required to close the existing crop yield gaps. Recently, a number of studies and reports have documented the process of foreign land acquisition and the associated appropriation of land based resources (e.g., water and crops). The amount of food this land can produce and the number of people it could feed are a good measure of the potential impact of large scale land acquisitions on food security and rural livelihoods. The environmental impacts of these investments in agriculture have remained poorly investigated and need to be assessed. Here we analyze some recent quantitative assessments of the rates of water and crop appropriation potentially associated with large-scale land acquisitions, and evaluate some of the main societal and environmental implications.

Introduction

In recent years foreign land acquisitions (LSLAs) have dramatically increased in many regions of the world, particularly in Asia and Africa (Cotula et al., 2009). Large tracts of land around the world are acquired and converted from subsistence farming to large scale commercial farming (Anseuuw et al, 2012). The land is transferred from local communities to agribusiness corporations, investment funds, governments or government owned companies (Robertson and Pinstrup-Anderson, 2010; Cotula, 2013). Both foreign and domestic investors, as well as mixed domestic-foreign ventures are involved. These investments do not occur only in the direction from the “North” to the “South” of the world but also within the global South (Kugelman, 2013).

The recent land rush appears to coincide with *the escalating global demand for food and biofuels, and with years in which some of the major agricultural areas of the world (USA, Ukraine, and Russia) have been affected by adverse climate events (IMF, 2008). Thus both an increase in food demand and a decrease in supply have drawn the attention of investors and governments toward potentially productive agricultural land. This land rush is further contributed by the rising demand for timber, raw materials and carbon sequestration services. Overall,* the increased demand for land and land based resources has made the control of land resources more profitable.

Large scale land investments are often termed *land grabbing* when they occur without transparent contracts, in the absence of prior informed consent of land-users, and without accounting for the societal, economic and environmental impacts (ILC, 2011). Through these acquisitions some countries and agribusiness investors are enhancing their access to land and freshwater, thereby increasing their ability to produce food. At the same time these countries decrease their vulnerability to disturbance from droughts, pests (D'Odorico et al., 2010) and climate change (Vorosmarti et al., 2010) by increasing the diversity of the regions of the world they rely on.

Land investments are often driven by a need for freshwater resources that are crucial to farmland productivity. In fact, in some cases the investors do not have access to adequate freshwater resources for food production in their own country (Rulli at al., 2013). Recently, the appropriation of water associated with large scale land acquisitions has been quantified both in terms of water used in rainfed agriculture and of irrigation water under a variety of suitable scenarios (Rulli et al., 2013). The possible impact on water quality due to contaminant release by commercial farming developed in the acquired land has also been quantified in terms of "grey water" footprint, defined as the amount of water needed to maintain the concentration of pollutants below acceptable standards (Rulli and D'Odorico, 2013).

It is often argued that large scale land investments tend to target land that prior to the acquisition was for most part underutilized or even uncultivated, though conclusive evidence is still missing (e.g., Kugelman, 2013). In fact, information on the use of the land prior to the acquisition is seldom available, which prevents a quantitative assessment of the societal (e.g., eviction, displacement, livelihood loss) and environmental (e.g., land degradation, deforestation) effects of large-scale land acquisitions. Using satellite data in conjunction with land concession records, here we provide a regional analysis of land use change in the acquired land. We also analyze some recent studies on water and crop appropriations associated with large-scale land acquisitions and evaluate their impacts.

Water appropriated with large scale land acquisitions

Large-scale land acquisitions are often driven by the lack of freshwater resources. In arid regions agricultural development is often prevented by water limitations. Unlike fertilizers and technology, the water needed to sustain crop production cannot be transported (except in some rare cases); thus, if a region does not have suitable freshwater resources, no crop production can be established. Water is therefore a critical limiting factor for agricultural development. Through investments in agricultural land water limited countries can expand their agricultural production beyond their borders. Land acquisitions are a mechanism to appropriate water resources from other countries without having to actually transport them. Thus, many cases of large-scale land acquisitions are mainly freshwater appropriations (Anseeuw et al., 2012; Mehta et al., 2012; Rulli et al., 2013; Rulli and D'Odorico, 2013). On a global scale, it has been estimated that the 'acquired water' accounts for approximately 0.5×10^{12} m^3 y^{-1} (Figure 1), including both rainwater and irrigation water transpired (Rulli and D'Odorico, 2013). This is a substantial amount if compared with major forms of human appropriation of freshwater resources (D'Odorico and Rulli, 2013).

The volumes of water appropriated in each country can be explained by the extent of the grabbed land, type of crops, and climate. This phenomenon is mostly contributed by green water (401 billion of m^3 y^{-1}), while only a smaller amount of water is appropriated in the form of blue (i.e.. irrigation) water (≈ 66 billion of m^3 y^{-1}) and grey water (≈ 33 billion of m^3 y^{-1}). Africa has an overall greater area of acquired land than Asia-Oceania but exhibits a smaller rate of water appropriation (Rulli and D'Odorico, 2013). In the most targeted countries - Indonesia, Malaysia and Papua-New Guinea - investors tend to acquire large tracts of land and to focus on water demanding biofuel crops such oil palm. In these countries water appropriation is also contributed by non-negligible amounts of grey water, due to the cultivation of oil palm, which requires the use of fertilizers (Figure 1).

Food appropriation with large scale land acquistions

Large-scale land acquisitions could impact food availability and supply, both in target and in investor countries. Rulli and D'Odorico (2014) estimated the amount of food that could be produced in the acquired land by considering the current agricultural yield as well as 3 levels of yield gap closure taking in account potential technological improvements. Based on the more conservative estimates, which account for the fact that a share of palm oil and sugar cane is not used for food production, the acquired land has the potential to feed about 200 million people. This figure could substantially increase if agro-technological improvements are considered. The number of people potentially fed by the acquired lands overall account for 25-30% of the malnourished people globally. We stress that many of the targeted countries exhibit high rates of malnourishment and rely on food aid. Even though food availability is only one of the factors determining of food security (FAO, 2009), crop production in the acquired land could

substantially contribute to rural livelihoods. A common narrative is that the land targeted by large-scale acquisition is underutilized or not used at all and that modern technologies are simply expanding the frontiers of agricultural production. This argument however is debated as the concept of "empty" land does not reflect the multiplicity and importance of non-intensive local uses of land which can provide support to small holders and vulnerable people. Moreover considering land as "empty" neglects the importance of ecosystem services that can be generated in areas that are not exploited.

Most of the food that can be produced in the acquired land is from crops grown inMalaysia, Indonesia, Papua New Guinea, and the former Sudan (Figure 2). Altogether these countries account for about 82% of the total food calories that can be produced by the large scale land acquisitions worldwide.

Large scale land acquisitions and deforestation

The environmental impacts of large-scale land acquisitions have not been fully addressed. Land-use changes associated with land-investments can have detrimental environmental outcomes. The exploitation and clearing of forested land can cause soil erosion, habitat destruction, biodiversity losses, and intensification of greenhouse gas emissions. Papua New Guinea, Malaysia, Cambodia and Congo, which encompass large tracts of wet tropical forests, have been a major target of agribusiness investors (Naylor, 2011). In the specific case of Brazil, it has been estimated that about 81% of the increase in soybean production that happened between 1995 and 2009 was contributed by agricultural expansion at the expenses of savannas and forested land (Naylor, 2011). Presently, deforestation rates in Brazil are declining (Nepstad et al., 2009), but new land policies aiming to the regularization of illegal occupations of unassigned public land in the Amazon (deOliveira, 2013) could favor land-based investments and trigger a new wave of deforestation in Brazil. In the case of Indonesia, in particular the Kalimantan, tropical rainforests are undergoing rapid deforestation to establish oil palm plantations for biodiesel production, mostly for the European market (Carlson, et al., 2012). Between 1990 and 2005, approximately 56% of the increase in oil palm production in Indonesia has taken place at the expenses of primary forests. The Indonesian government is giving land concessions to foreign investors in order to promote economic development, which (arguably) could benefit also smallholders (Naylor, 2011). These policies, however, have been criticized because they often lead to the violation of customary land rights, the eradication of indigenous practices, the loss of primary forest and enhancement of carbon emissions (Fargione, et al., 2008).

Changes in land use associated with large scale land acquisitions remain poorly investigated. Here we study to what extent this "land rush" is contributing to deforestation in the wet tropics. We focus in particular on land acquisitions for oil palm cultivation and logging in Indonesia and Liberia, respectively,

and evaluate the associated environmental impacts. Our detailed analysis of large-scale acquisitions and land use changes in these two target countries highlights the occurrence of extensive deforestation (Tables 1-2). In the in the case of Indonesia peatland forests are strongly affected by land use change and deforestation (Table 1). With high biodiversity and a large carbon storage capacity, peatland conversions to cropland or plantation are expected to have disastrous impacts on habitats, species richness, and carbon emissions. Indeed, these peatlands are becoming important greenhouse gas emitters if drained and converted to cultivable land. Moreover, in addition to land degradation, habitat loss and CO_2 emissions, deforestation and land use change associated with grabbing often entails the release of agricultural chemicals (mostly nitrogen fertilizers), whose impact on the environment is here analyzed in terms of the grey water footprint (Figure 1). Our analysis shows that fertilizer use in oil palm plantations is a substantial contributor to degraded water quality in the region.

To investigate the relationship between large-scale land acquisitions and deforestation for oil palm production and logging we analyze three dataset. By intersecting the three different datasets we estimate the size of deforested areas (for both logging and oil-palm) that have been affected by large-scale land acquisitions. Moreover we determine the post-deforestation increase in tree cover associated with oil palm growth.

Specifically, the datasets are:

(a) Forest cover maps developed by *Hansen et al.* (2013) using multispectral satellite (Landsat 7 with ETM + sensors) data. These maps (at 30×30 m^2 resolution) show annual variations in forest cover (i.e., both deforestation and reforestation) between 2000 and 2012.

(b) The registry of land concessions for oil palm provided by the Ministry of the Environment of the Indonesian Government as a "shapefile" database.

(c) The logging concessions data set available for Liberia (WRI, 2014). "Logging concession" are areas allocated by the government for logging in a public forest. Unlike wood fiber concessions which take place in plantation forests established to produce wood pulp and paper, logging concessions affect primary and secondary forests.

Compiled by *Global Witness* using government and contractual maps, this data set includes various types of concessions that give logging companies the right to harvest public forests for timber. This logging concession data set was developed for the report *Signing Their Lives Away: Liberia's Private Use Permits and the Destruction of Community Owned Rainforest* (Global Witness, 2012).

These three datasets were georeferenced to determine the extent to which large scale land acquisitions are affecting concessions for oil palm and logging, and estimate their deforested fractions (between 2000-

2012). Additionally, the areas deforested for reasons different from oil palm and logging were also identified.

d) The Land Matrix (2013), a data set providing information on large scale land acquisitions, including, for each land deal, the acquired area, crop type, the implementation status (i.e., whether the deal is intended, concluded, and/or under production), and in some cases information on the investor.

By crosschecking datasets (b, c) and (d) the degree of consistency between large scale land acquisitions for oil palm and logging based on Land Matrix (2013) and land concession data sets was evaluated (Tables 1 and 2). Moreover, the analysis involved a detailed study of the agribusiness corporations and related financial groups reported by these two data sources.

Discussion and Conclusions

Results show that large scale land acquisitions for oil palm cultivation are a driver of deforestation in Indonesia so rising social and environmental concerns. Land use change for oil palm cultivation on deforested areas strongly increases CO_2 emissions especially when it affects peatlands. Moreover, the fertilizers typically used in Indonesia for oil palm production in commercial plantations contributes to pollution and water quality deterioration.

Large scale acquisitions for logging in Liberia cover the 30% of the total logging concessions in the country. Table 2, however, shows that in most of the acquired concessions forest cover has not changed. This fact suggests that to date the rate of timber extraction from these forests is still limited.

A further analysis has been carried out to investigate the forest biomes undergoing deforestation for oil palm and logging purposes by crosschecking the GLC2000 (Global Land Cover 2000) with the a;c,d maps (Figures 3,4,5). Results show that more than 80% of logging concessions are in closed evergreen and mosaic forests and that deforestation is occurring mainly in mosaic forest.

References

Anseeuw, W., et al. 2012. *Transnational land deals for agriculture in the global south*. The LandMatrix Partnership, CDE/CIRAD/GIGA, Bern/Montpellier/Hamburg.

Beddington, J. Food security: contributions from science to a new and greener revolution. *Philos Trans R Soc Lond B Biol Sci.* **12 365(1537)**, 61-71 (2010)

Carlson, K. M., et al. (2012). Expanding oil palm plantations in West Kalimantan, Indonesia: Impacts on land cover change and carbon emissions. *PNAS*, 109(19), 7559-7564.

Cotula, L., Vermeulen, S., Leonard, R. & Keeley, J. Land grab or development opportunity? Agricultural investment and international land transactions in Africa. *IIED, FAO & IFAD* London/Rome ISBN 978-1-84369-741-1 (2009).

D'Odorico, P., Laio, F. & Ridolfi, L. Does globalization of water reduce societal resilience to drought? *Geophys. Res. Lett.* **37**, L13403, doi:10.1029/2010GL043167 (2010)

deOliveira, G., Land regularization in Brazil and the global land grab, *Development and Change* 44(2): 261-283.

FAO 2009. *Declaration of the World Summit on Food Security, WSFS 2009/2*. Rome: Food and Agriculture Organization of the United Nations.

Fargione, J., J. Hill, D. Tilman, S. Polasky, and P. Hawthorne. 2008. Land clearing and the biofuel carbon debt. *Science* **319**:1235–1238.

Hansen, M.C., P.V. Potapov, R. Moore, M. Hancher, S.A. Turubanova, A. Tyukavina, D. Thau, S.V. Stehman, S.J. Goetz, T.R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C.O. Justice, J.R.G. Townshend. 2013. High-resolution global maps of 21st-century forest cover change. *Science*, 342 (6160), 850–853

ILC, 2011. *Report of the ILC International Conference and Assembly of Members*. International Land Coalition, Tirana.

International Monetary Fund, *Food and Fuel Prices, Recent Developments, Macroeconomic Impact, and Policy Responses.* (IMF 2008).

Kugelman, M. and S. Levenstein, eds. 2013. *Global farms race: Land grabs, agricultural investment, and the scramble for food security*. Washington, DC: Island Press.

Mehta, L., G. Jan Veldwisch, and J. Franco. 2012. Water grabbing? Focus on the (re)appropriation of finite water resources. *Special issue: Water Alternatives* 5.2: 193–207.

Nepstad, D., Soares-Filho, B. S., Merry, F., Lima, A., Moutinho, P., Carter, J., et al. (2009). The End of Deforestation in the Brazilian Amazon. Science, 326(5958), 1350–1351

Naylor, R. 2011. Expanding the boundaries of agricultural development, *Food Sec.*, 3: 233-251.

Robertson, B., and P. Pinstrup-Anderson. 2010. Global land acquisition: Neo-Colonialism or development opportunity? *Food Security* 2:271–283.

Rulli, M. C., and P. D'Odorico. 2014. Food appropriation through large scale land acquisitions. *Environmental Research Letters*

Rulli, M. C., A. Saviori, and P. D'Odorico, 2013. Global land and water grabbing. *Proceedings of the National Academy of Science, USA*, PNAS, 110(3), 892-897.

Rulli, M. C., and P. D'Odorico, 2013. The water footprint of land grabbing. *Geophysical Research. Letters* 40:1–6.

The LandMatrix (2014), The Land Matrix Database, available at landmatrix.org.

Vörösmarty, C.J., Green, P., Salisbury, J., & Lammers R.B. Global water resources: Vulnerability from climate change and population growth. *Science* **289**, 284–288 (2000).

World Resources Institute (WRI), "Logging". Accessed through Global Forest Watch on [2014]. www.globalforestwatch.org.

World Resources Institute (WRI), "Oil Palm". Accessed through Global Forest Watch on [2014]. www.globalforestwatch.org.

Tables

	Area (10^5 ha)	% of LSLA for Oil Palm
Total LSLA	66.0	-
LSLA for Oil Palm	18.9	-
Deforested LSLA for Oil Palm	4.8	25.6
Reforested LSLA for Oil Palm	2.8	14.6
Deforested and then reforested LSLA for Oil Palm	1.2	6.1
LSLA for Oil palm in peat forests	2.9	15.3

Table 1. Deforestation for oil palm and large scale land acquisition in Indonesia.

	Area (10^5 ha)	% of LSLA for Logging
LSLA for Logging	10.0	-
Total deforestation	4.3	-
Total Logging concessions	33.4	30
Deforestation for Logging	0.7	-
Deforestation in LSLA for Logging	0.2	4

Table 2. Deforestation for Logging and large scale land acquisition in Liberia.

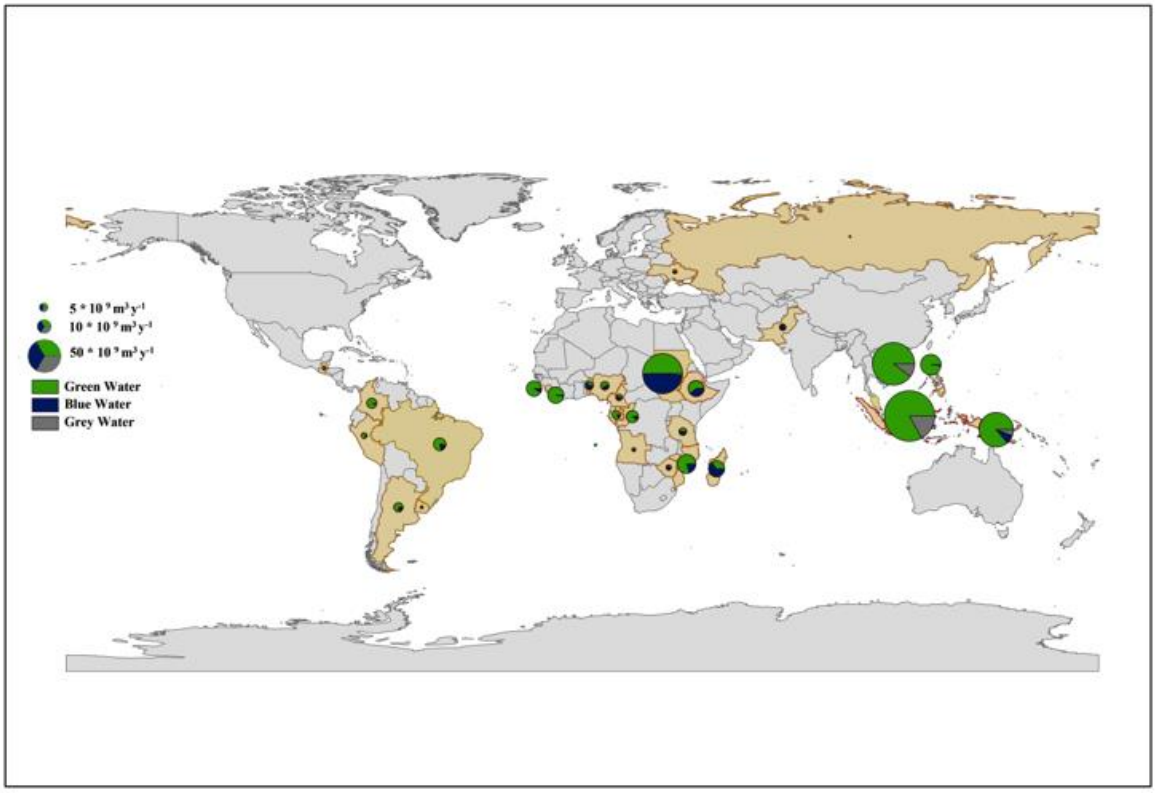

Figure 1. Water associated with large scale land acquisitions.

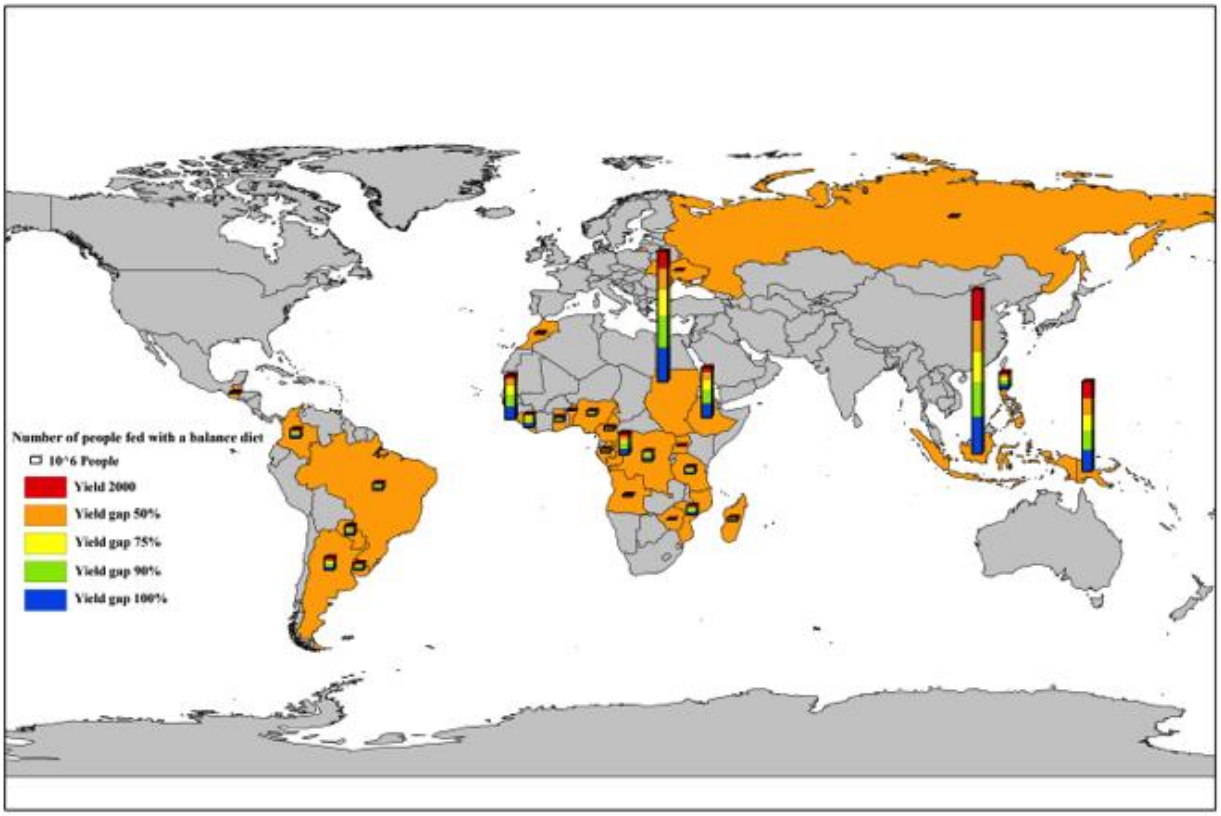

Figure 2. Number of people that could be fed by crops produced in the acquired lands with respect to 4 levels of yield gap closure (Modified after *Rulli and D'Odorico*, 2014).

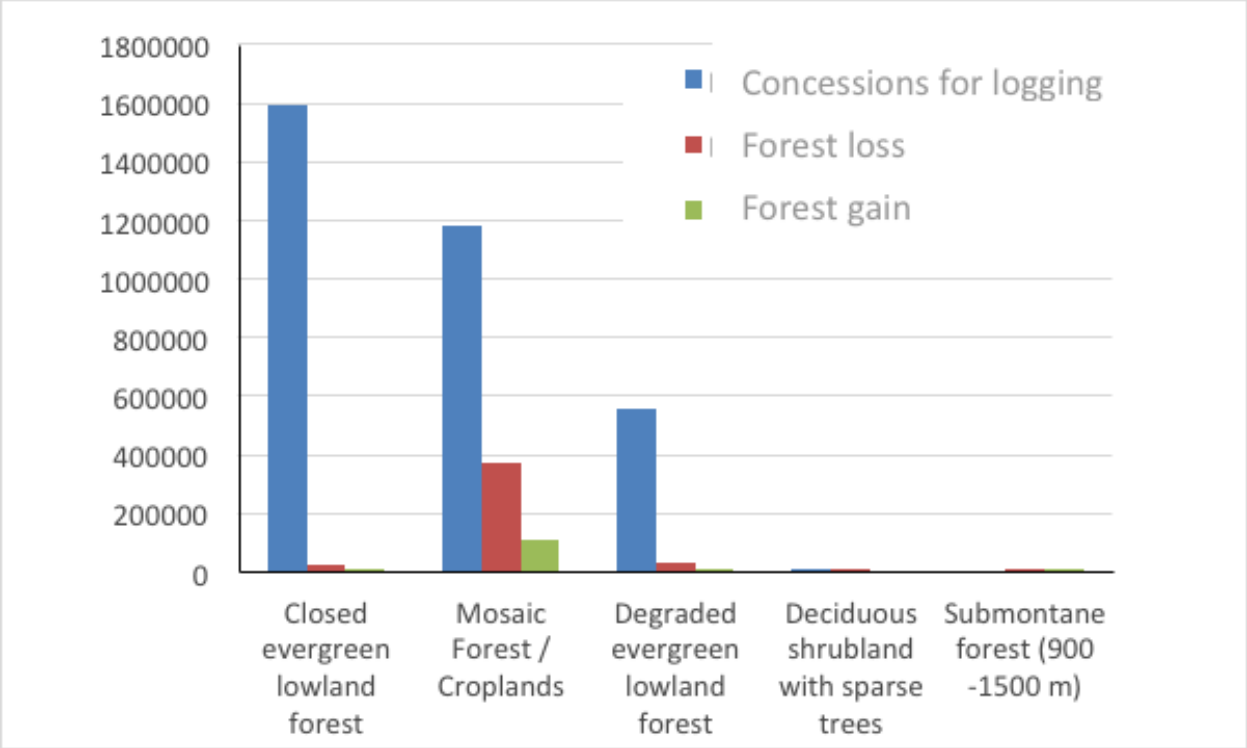

Figure 3. Major Forest biome loss and gain areas (ha) with respect to the extent of total concessions for logging in Liberia.

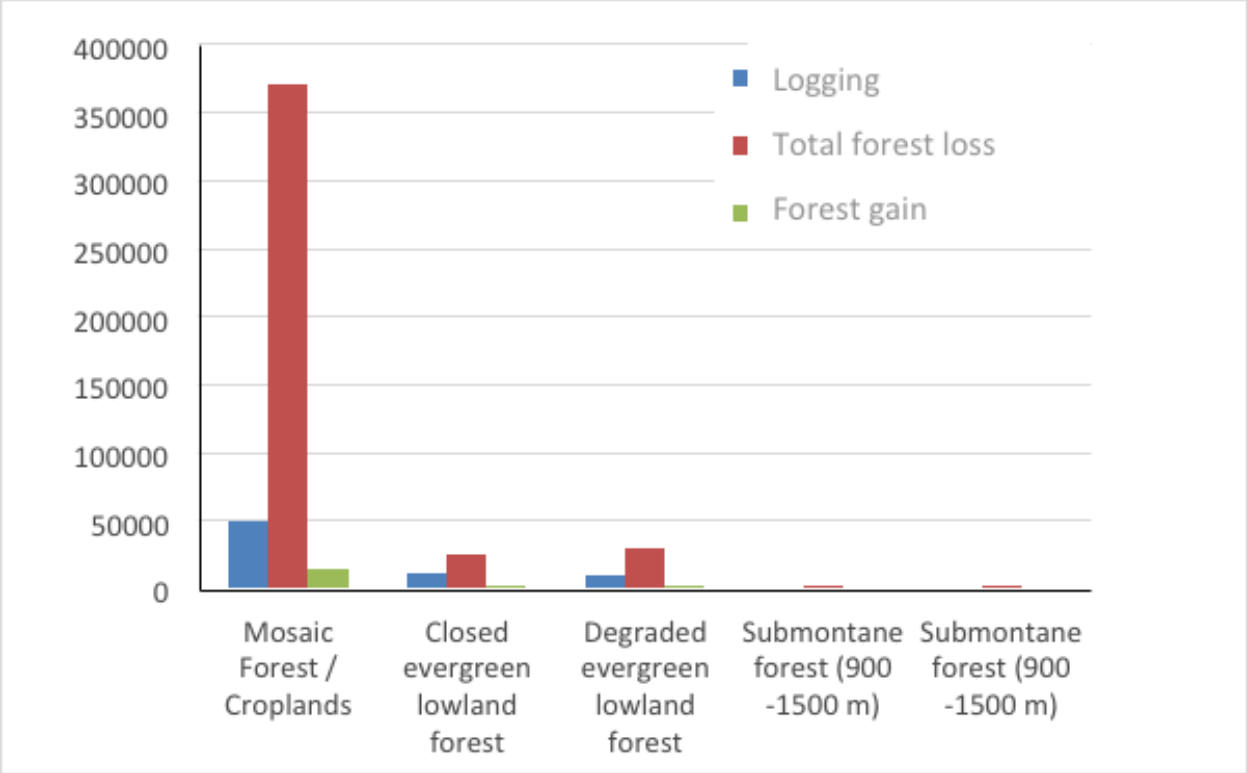

Figure 4. Logging with respect to total deforestation and gain for the 5 major biomes in Liberia

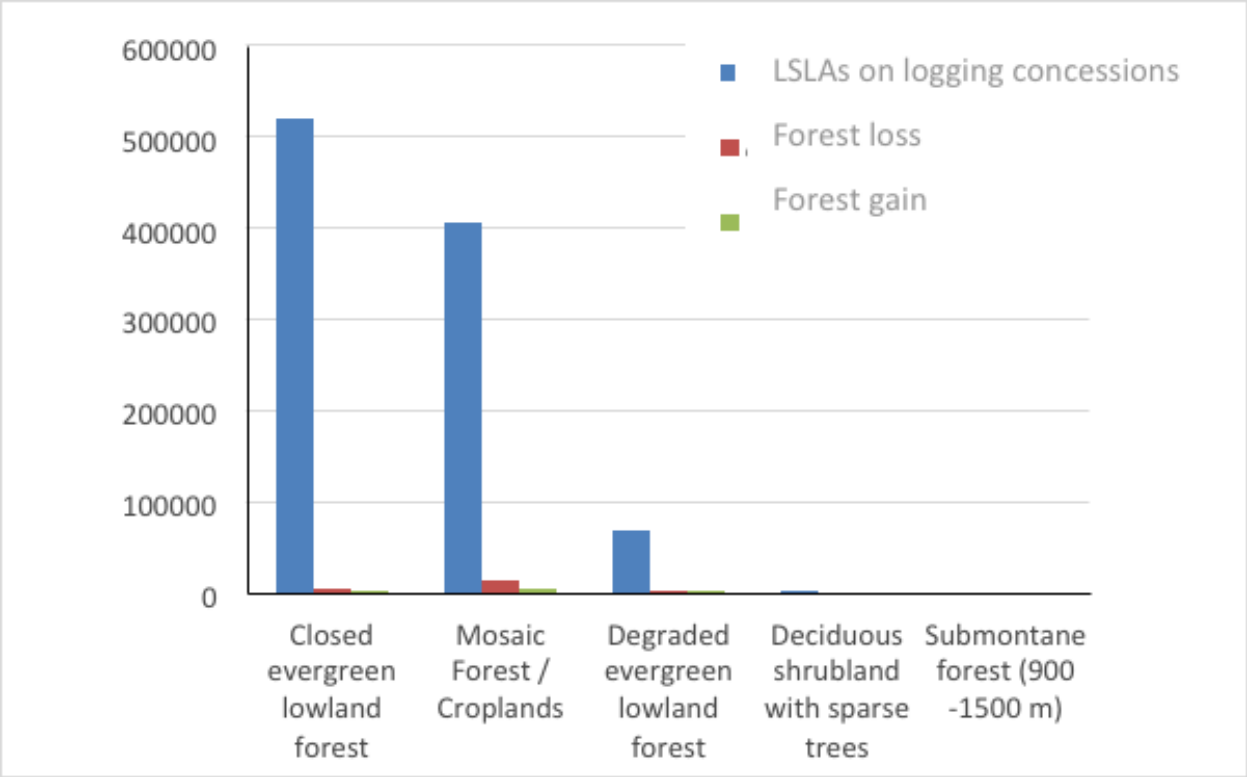

Figure 5. LSLAs in logging concession areas and areas undergoing forest loss and gain in 5 major forest biomes.