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Analysis

Forest Loss and Economic Inequality in the Solomon Islands: Using Small-Area Estimation to Link Environmental Change to Welfare Outcomes

John Gibson

Department of Economics, University of Waikato, New Zealand

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ABSTRACT

To study welfare effects of environmental change, data from household surveys may be linked to remote sensing data. Using spatial aggregation to link risks ecological fallacy, since surveys are usually representative for areas larger than the spatial scale of decision-making units. This paper uses survey-to-census imputation to estimate welfare indicators for small areas to study the effect of deforestation on subsequent inequality in the rural Solomon Islands. This country depends on logging for almost half of foreign exchange and one-sixth of government revenue, and most forested land remains under customary ownership. A sharp increase in log exports, to seven times the sustainable yield, and a major shift in export destinations as other countries withdrew from the tropical log trade represents an exogenous shock that helps to identify effects of deforestation on inequality rather than the reverse relationship. A standard deviation increase in the rate of forest loss over 2000 to 2012 raises the Gini index of inequality in 2013 by one-third of a standard deviation. Mean incomes and poverty rates are also higher, implying that deforestation makes some households richer while others become poorer. These precisely estimated effects would be obscured using more spatially aggregated data.

1. Introduction

The human causes of deforestation are widely studied but the consequences for humans rather less so.[1] Instead, human causes and environmental consequences are the two most widely researched themes. One reason for this asymmetry may be that deforestation can affect people in different times and places from where it occurs, given the role of forests in the global carbon cycle. At this temporal and spatial scale, linking environmental change to a narrow indicator of human welfare for a defined group can be difficult. Yet, absent such evidence, policy makers may see immediate economic benefits, like export revenues and royalties from logging, but not have enough information on immediate welfare costs to balance them, especially if costs to the environment are downplayed as something for future policy makers to deal with.

This paper gives evidence on a particular welfare cost of forest loss, that it is associated with higher local economic inequality. This effect has at least two pathways. First, windfalls from natural resource exploitation can exacerbate rent-seeking conflict, creating winners and losers. This may be especially with customary ownership; without clearly delineated property rights there can be conflict over who gets what. Most evidence on how resource exploitation affects conflict is from cross-country studies but within-country evidence for this channel is also emerging (Aragón et al., 2015). Moreover, while poverty is sometimes thought to drive forest clearing, a household-level analysis for 24 developing countries shows it is wealthier and more market-orientated households who are more likely to clear forest (Babigumira et al., 2014). The same data show that forest resources have less of a buffering, safety-net role, than is often assumed (Wunder et al., 2014a, 2014b), undermining notions of seasonal or short-term poverty as contributing to deforestation. Instead, it seems that richer households are more likely to engage in, and benefit from, forest clearing, which will tend to increase inequality.

The second pathway is that the poor rely more on forests for food, fodder and fuel than do the non-poor, and so forests (and other sources of environmental income) should have an equalizing effect on the local income distribution (Vedeld et al., 2007; López-Feldman, 2014). For example, a comprehensive study of rural livelihoods that gave each of ca. 8000 households in 24 developing countries four quarterly recall

E-mail address: jkgibson@waikato.ac.nz.

[1] A small literature considers effects of deforestation on human health. There is evidence that forest loss increases the local incidence of malaria in Indonesia (Garg, 2016) and in Nigeria (Berazneva and Byker, 2017).

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surveys for various income sources found over one-fifth of total income came from natural forests, with a 2:1 ratio of fiber to food (Angelsen et al., 2014). The pro-poor nature of this environmental income is shown by the Gini coefficient being almost five points higher when the environmental income is ignored.[2] Thus, if forest-based livelihoods are disrupted, it will tend to exacerbate local inequality.

While the pathways from forest loss to inequality are intuitively plausible, they remain largely unstudied, perhaps because of the well-known problem of linking people to pixels (Geoghegan et al., 1998). Data on inequality and welfare are mostly from household surveys while environmental change is typically measured by remote sensing. If these two types of data are matched by using spatial aggregation there is risk of an ecological fallacy; most surveys are only representative for large areas, such as a province, that does not match the land-owning unit making decisions about forests. Moreover, aggregating to a larger area to get enough observations for calculating inequality statistics runs the risk of smoothing a lot of intra-unit spatial variability and may introduce spatial autocorrelation (Anselin, 2001).[3] The other alternative, of relying solely on the surveys, is also unlikely to be successful because most population-representative household surveys do a poor job of measuring environment income (Wunder et al., 2014a, 2014b) and are even less suited to measuring environmental change.

A technique that has proved useful in development economics, but is rarely applied in environmental economics, is small-area estimation with survey-to-census imputation.[4] Survey data are used to estimate a model of consumption, with explanatory variables restricted to those with overlapping distributions available from a recent census. Coefficients from this model are combined with variables from the census, to predict consumption for each census household. The models are designed to reduce common location terms in residuals so that predictions are more precise, and simulations draw from idiosyncratic and correlated components of the errors (Elbers et al., 2003). The repeated simulations are then used to calculate welfare indicators with a high degree of precision for small areas. Most applications of the method focus on poverty but it can also measure inequality for smaller areas than is possible with a survey. For example, Demombynes and Özler (2005) created inequality statistics for police precincts in South Africa ($n = 1064$) to match to crime rate data available at the same spatially disaggregated level.

This paper studies the effect of forest loss from 2000 to 2012 on the subsequent level of economic inequality, at ward level for the rural Solomon Islands. Wards are the sub-national unit below provinces, and the median rural ward has just 360 households, which is far smaller than the typical survey domains for which inequality is reported. The inequality estimates produced by the survey-to-census imputation allow an area-to-area matching of remote sensing and welfare data that is particularly suitable when resource management decisions are made by collective entities, such as tribes. In the Solomon Islands, 90% of the forested land is under customary (tribal) ownership. Landowners get royalties from logging companies (equivalent to about 15% of free-on-board log prices) and also may be compensated if roads have to be built on their land so as to access forest stands. In some cases, community leaders may be paid by the companies to facilitate negotiations over logging concession.

Although wards are political and statistical units, they match well with patterns of tribal control over land. It is the customary landowners (or some subset of them) who grant logging concessions so the pattern of deforestation also tends to have spatial patterns that vary by ward. Typically, tribal boundaries extend inland from the coast to the mountainous spine of each of the main islands. The lack of existing roads, and the easy access from the sea also mean that logging follows a similar spatial pattern. Indeed, the forests in the Solomon Islands are highly accessible, compared to other forested islands in Asia-Pacific, because islands are close to each other so a foreign logging company can quickly move from one site to another, and can service several sites with the same mother ships (Katovai et al., 2015).

The accessibility of forests and the limited scope of other economic activities make the Solomon Islands highly dependent on logging. Almost 50% of foreign exchange and 17% of government revenue come from logging (URS, 2014). There is little chance of logging being replaced with plantation forestry; plantations are just 1% of the area of indigenous forests (Pauku, 2009). Likewise, sawn timber exports – often from indigenous companies rather than multinationals – are only 5% of the value of log exports (URS, 2014). Thus, policy makers may see current economic benefits from logging while the environmental costs are discounted as falling more on future generations. This may be especially so in the Solomon Islands, which remains highly forested even though the value of the forest resource is being rapidly depleted. In such a setting, a more complete evaluation may be possible if some of the current welfare costs of logging – which may include higher inequality – are highlighted.

While the effect of forest loss on inequality is largely unstudied, there is literature on the reverse relationship, of inequality causing environmental degradation.[5] For example, Boyce (1994) claims that inequalities of power and wealth lead to more environmental degradation, since the extent to which an environmentally degrading activity is carried out depends on the balance of power between those who benefit from the activity and those who bear the cost of the degradation. Torras and Boyce (1998) found corroborating evidence in cross-country data, with greater income inequality associated with more pollution. A related study by Koop and Tole (2001) found that countries with high levels of inequality in either income or land ownership saw economic development associated with more deforestation, while in more equal countries there was less deforestation as the country grew richer.

While cross-country studies predominate in the literature on the effects of inequality on environmental damage,[6] if the same relationship were to hold at the micro level it may make it hard to untangle effects of deforestation on inequality from the reverse relationship. One favourable feature for a causal interpretation of how deforestation from 2000 to 2012 impacted inequality in 2013 is the dramatic shift in the volume and profile of log exports from the Solomon Islands. Since 2001, export volumes grew at an annual rate of 11.4% (s.e. 1.2%), with no significant time trend immediately prior to then. The driving force behind this growth has been exports to China, which have an annual growth rate of 23.3% (s.e. 4.2%). China has gone from being the destination for just 13% of Solomon Islands log exports in 2001 to now taking 95% of these exports. At the same time, the Solomon Islands has become the second largest source of tropical log imports for China. These shifts in export destinations for Solomon Islands logs and import sources for China are likely driven by other countries withdrawing from the trade in tropical logs, and so this represents an exogenous change

[2] In particular settings where environmental income also includes open access water resources, such as Cambodia, it has been found that environmental income lowers the Gini by up to seven points; from 0.53 to 0.46 (Nguyen et al., 2015). Since much of the logging in the Solomon Islands is sea-based, environmental disruption is not only to land-based ecosystems, with damage to reef and lagoon resources and inshore fisheries also important.

[3] If pixels are small, and if surveyed households (or clusters of them, such as a particular point in an enumeration area) are geo-referenced, then buffers can be created around each household or cluster and measurements of forest change made for all pixels within the buffer (e.g. this is used by Berazneva and Byker, 2017). However, the size of the buffer is often ad hoc and may not match with the scale of decision-making units.

[4] Sims (2010) studies the effect of protected areas in Thailand on local poverty, with the small-area estimation method used here.

[5] These are just a small component of the broader literature that considers how environmental degradation varies with economic development. For example, only 2.7% of regressions used to study the environmental Kuznets curve for deforestation include an inequality variable, in the meta-analysis by Choumert et al. (2013).

[6] Cushing et al. (2015) review almost 100 studies and find the only within-country ones are for the United States.