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Why financial incentives can destroy economically valuable biodiversity in Ethiopia

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Abstract

Ethiopian montane rainforests are economically valuable repositories of biodiversity, especially of wild *Coffea arabica* populations, and they are vanishing at accelerating rates. Our research results confirm theory which explains biodiversity loss by diverging private and social net benefits from land conversion. Poor farmers basically live from hand-to-mouth and manage resources with very short term planning horizons. In such circumstances they cannot afford to carry the cost burden of conservation from which the broader national and global society benefits. Society, on the other hand, highly values the biodiversity of Ethiopia's montane rainforests, but has not managed to put mechanisms in place which enable to pay for the conservation of these values and conservation policies are in place but are not implemented. While it is economically rational for the farmer to convert forests into agricultural land and thereby improve his income (the financial incentive we refer to here), it is economically irrational for national and global society not to pay for conservation. The core reasons for such divergence is that institutions for conservation and sustainable use are not in place. We identify the most important ones and recommend changes for the Ethiopian case.

1 Introduction

Ethiopian montane forests belong to the Eastern Afromontane Biodiversity Hotspot, which is one of recognized 34 biodiversity hotspot areas in the world. In addition to having high species diversity with a large number of endemic species, the forests are of global importance because they contain the world's only wild population of wild *Coffea arabica* (Gole 2003). Around 75% of the world's coffee production is from *Coffea arabica*, and genetic information contained in Ethiopian highlands is important as a reservoir of genetic diversity, crucial for coffee breeding.

The Afromontane rainforests of south-western Ethiopia represent a major proportion of Ethiopia's total forests and offer suitable climatic and ecological conditions for agriculture and human settlement. Therefore, it is a favourable region for immigrants from the North and a considerable proportion of the total population and livestock are concentrated there. Based on estimates of climatic climax vegetation, the natural forests of Ethiopia might have covered up to 40% of Ethiopia's total land area (Reusing 1998).

However, since several decades, there has been progressive degradation of forest resources in Ethiopia. Between 1990 and 2000, 141,000 ha of forest were lost every year, which equals an average annual deforestation rate of 0.93%. Then, between 2000 and 2005, the rate of deforestation increased by 10.4% to 1.03% per year, which totals to 14% (or around 2,114,000 hectares) of forest cover loss in the 15 years between 1990 and 2005 (FAO 2007). Recent estimates by the Center for Development Research (Lieth, unpublished data) show that the area of closed forest cover has declined to about 3-4% of the country. In the Southern Region of Ethiopia, a recent study on deforestation and its drivers (Wakjira 2007) concludes that an area of originally 281,000 ha forest in 1973 has decreased to 191,000 ha in 2005, representing a 32% loss of forest cover in 32 years, leaving merely 13,000 ha or about 11.9 % of Ethiopia's land area which is covered with forests (closed forest plus woodlands).

Deforestation has important local, national, and global implications. At all levels, forests are repositories of biodiversity and biodiversity is not only an assemblage of different genes, plants and ecosystems but also a provider of various ecosystem goods and services (functions). Deforestation results in a loss of several other ecological functions like soil erosion, land degradation, water and air pollution which in turn affect the livelihoods of rural people. This is even more important in counties like Ethiopia, where the majority of the people are dependent on natural resources. Over 85% of the population in Ethiopia live in rural areas and depend on agriculture as means of livelihood.

Some of the most important drivers of deforestation in south-western Ethiopia are the conversion into agricultural land, establishment of plantations and population growth, also from resettlement programs. Rising coffee prices are also identified as a reason for converting forests into more productive semi-forest coffee agro-forestry systems. Increasing coffee prices without rules and incentives for growing and harvesting coffee sustainably, are an incentive to produce coffee more intensively or to collect more wild coffee from the forests and clear undergrowth vegetation which is competing with coffee, thereby eventually converting forests into more intensive land use forms and reducing biodiversity (Schmitt 2006).

The broader socio-economic and political conditions in the forestry sector are similar to many developing countries which rely heavily on their natural resource base for economic development and repeats itself in Ethiopia: Poverty[1] and population growth[2], combined with market and institutional failure, like diverging *de jure* state ownership of land and *de facto* traditional private ownership or common property and therefore uncertain property rights, lead to a mutation of socio-ecological systems, in which actors behave in their own (and their families) immediate interest and treat forest resources as open access.

In order to protect biodiversity, the government of Ethiopia has established a protected area system including 12 national parks, three wildlife sanctuaries, 8 wildlife reserve areas, 18 controlled hunting areas, 3 coffee gene reserves and 58 national forest priority areas. In practice, however, the conservation capacity is low and the protected area system is little effective in arresting deforestation (Tadesse 2003).

In July 1997 the Rural Land Proclamation determined that all land is state owned, that farmers are entitled to lifelong use and have inheritable and transferable use rights to the land and trees planted on that land. Proclamation No. 94/1994 determines the conservation, development, protection and utilization of forest resources. Although the proclamation recognizes three types of ownership of forest land: state forests, regional forests and private forests, it is in the responsibility of the state and regional governments to designate, demarcate and register state, regional and protected forests and the lacking capacity to do so and lacking transparency in doing so leads to mistrust towards government authorities and uncertainty about property rights issues. In such a situation traditional property rights can be annulled at the disposal of local officials who may cooperate or not in conserving coffee forest resources.

[1] 45% of the total rural population (25.7 mio) is living under the poverty line. IFAD – the International Fund for Agricultural Development - mentions the following causes of rural poverty: wide fluctuations in agricultural production as a result of drought, an ineffective and inefficient agricultural marketing system, underdeveloped transport and communication networks, underdeveloped production technologies, limited access of rural households to support services, environmental degradation, lack of participation by rural poor people in decisions that affect their livelihoods (http://www.ruralpovertyportal.org/english/regions/africa/eth/index.htm).

[2] In 2005 Ethiopia's population was estimated at 77.4 million and estimates for the year 2030 project 129 million at growth rates of 2.43% (Report on the Ethiopian Economy 2004/05. Ethiopian Economic Association 2005).

Uncertainty over property rights is also created due to lacking legislation and implementation thereof. For example, the country's forestry policy has been drafted and re-drafted over many years without ever being passed. The latest draft received considerable input from forestry experts after a conference organised by the Institute of Biodiversity Conservation (IBC) and the Ethiopian Coffee Forest Forum (ECFF) in March 2006. Further, from all the factors identified to negatively influence the system 'conservation of coffee forests', an expert workshop carried out by ECFF identified "governance" as the most active variable steering the dynamics of the entire system (Gatzweiler and Volkmann 2006). In the absence of effective government steering, local level forest management decisions are based on private costs and benefits of different land use options. A major issue in forest management is that these private costs and benefits are not congruent with social costs and benefits of land use options at the level of the national or global society.

This paper explains the divergence of private and social costs and benefits as the underlying reason for forest land conversion and degradation in south-western Ethiopia. In order to do that we will first present a brief methodological background, and subsequently present the results of:

1. An estimation of the economic value of *Coffea arabica* genetic resources, which grow in the afromontane rainforests of Ethiopia,
2. An economic analysis of competing land use systems in the same area, and
3. An income analysis at farm level.

The results of 1. and 2. demonstrate the economic values of *Coffea arabica* genetic resources and coffee forest land use systems, while 3. represents the values of individual farmers in the coffee forest region whose priority is to sustain their livelihoods. The results of 1. are taken from Hein and Gatzweiler (2006), the results from 2. and 3. are taken from Rojahn (2006). We will conclude with providing suggestions for closing the divergence between private and social values by transposing high values and well meant policies into actual incomes. An important element here is customizing an incentive package which would make it worthwhile for individual farmers to invest into sustainable forest management and conservation.

2 Comparing private and social net benefits from land conversion

Conventional economic theory suggests a general decision rule according to which either society or the individual will decide in favour of land use alternatives where either social or private costs are lower than the benefits attributed to a respective activity (e.g. either converting or conserving forests). Once agricultural land becomes unproductive or scarce (e.g. because of drought or population pressure) the farmer's private costs of land management increase to a degree at which it is cheaper for him to convert forest into agricultural land instead of investing into maintaining the productivity of his current land (maybe because of lacking knowledge on sustainable land management practices or expensive inputs required to do so). In doing so he reduces forest ecosystem functions to a few production functions that are necessary for keeping the farmer's family alive. Many other functions of the original forest ecosystem (such as habitat and information functions of the forest) are deleted and the costs (of not being able to enjoy these goods or services or the costs of downstream effects, such as erosion and pollution) are being externalised. These costs are passed on to society (Figure 1). Figure 1 further illustrates why additional land conversion is economically rational from a private and social perspective, depending on the position of the marginal social cost (MSC) curve.

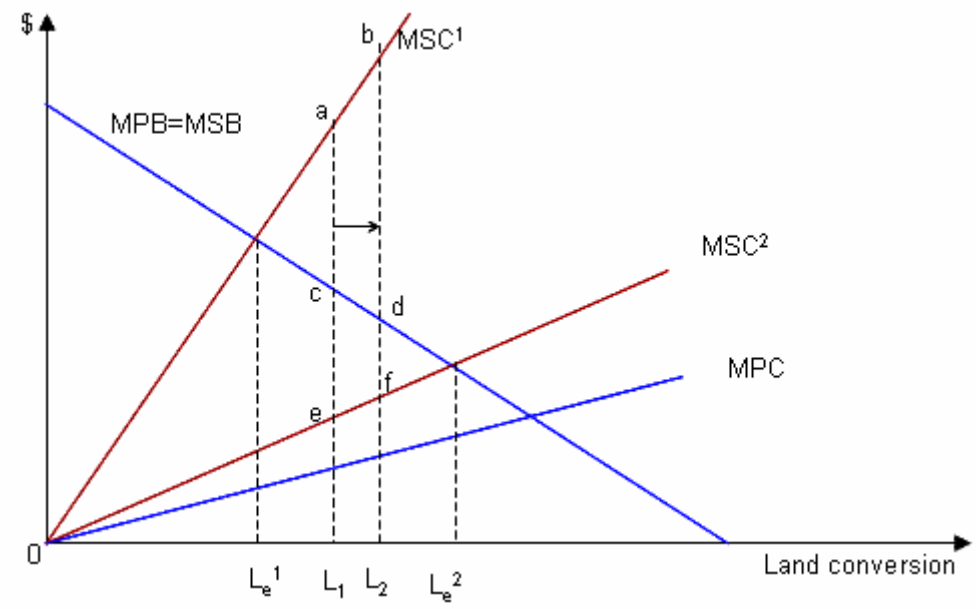
Holden et al. (1998) have shown that Ethiopian (forest coffee) farmers have a very short-term planning horizon (high discount rates up to 53%) when it comes to accounting for future benefits from agricultural and forestry resources. This can be explained by the fact that they have to meet immediate subsistence and food security needs and can not afford to invest in long-term and capital intensive activities, such as nature conservation, which do not provide short-term returns and immediate food security. Hence, the farmers cannot be expected to carry the entire costs of conservation and thereby provide benefits to the rest of society. In contrast to the private financial perspective, from an economic perspective the sustainable management of forests has a value which exceeds that of agricultural use of the forest land. The conversion of forest land into crop land and the respective loss of biological diversity in general and wild Coffea arabica genetic resource in particular is therefore an ongoing social loss for Ethiopia.

Figure 1 depicts the diverging private and social costs of conservation. MPB / MSB are the Marginal Private / Social Benefits, the additional private / social benefits that arise if an additional unit of forest land is converted. MPC / MSC are the Marginal Private / Social Costs, i.e. the additional private/social costs that arise if an additional unit of forest land is converted. L_1 shows the actual area of converted land and L_2 the increase in area of converted land (option). If MSC1 (=marginal private costs plus marginal external costs) reflects the true social costs of land conversion, the efficient amounts of converted land would be L_e1. An increase in land conversion (from L1 to L2) is inefficient because social costs would exceed social benefits. If MSC2 reflects the true social costs of conversion, an increase of land conversion from L1 to L2

and even further until L_e2 would be an economically justifiable decision. However, the farmer faces the Marginal Private Cost curve (MPC). Irrespective of the location of MSC, he will be inclined to pursue further land conversion, up to the point where MPC crosses MPB. It becomes clear that the true social costs are crucial in determining the efficiency of land conversion. Valuing the external costs of land conversion is therefore fundamental.

In order to solve that problem it is necessary to provide incentives for resource users and other stakeholders, to invest in the conservation of coffee forest areas and identify and avoid disincentives which prevent forest users from using the forests sustainably.

Figure 1: Land conversion from a private and social perspective (Source: Marggraf 2005:10)



3 The global economic value of Ethiopian wild Coffea arabica genetic resources

Most commercial *Coffea arabica* varieties have been derived from a limited number of accessions from Ethiopian forests, and have therefore limited genetic variety to respond to potential future pests and diseases (Oerke et al., 1994). The large majority of genetic information of *Coffea arabica* is therefore found in the understories of Ethiopian montane rainforests, which are however disappearing fast. Hein and Gatzweiler (2006) attempted an estimation of the economic value of these genetic resources. The valuation was based on an assessment of the

potential net benefits derived from the application of genetic information in breeding programs. A capital investment analysis was conducted which involved the comparison of the discounted potential benefits and costs of breeding programs aimed at producing improved coffee cultivars. Hein and Gatzweiler (ibid) examine the potential benefits of breeding 1) resistance for three major coffee pests and diseases; 2) a low caffeine coffee cultivar; and 3) high yielding coffee varieties. The pests and diseases considered were: coffee berry disease (CBD), Meloidogyne spp. and coffee rust. Pest and disease resistant cultivars yield economic benefits because they reduce yield losses and pesticide costs of coffee growers world-wide. With respect to the breeding of low caffeine coffee, the considered economic benefits relate to the avoided costs of decaffeinating. It is assumed that the required genetic information to breed these enhanced varieties is contained in the wild Coffea arabica populations which grow in the Ethiopian rainforests. In the value estimation the authors also assume that in-situ conservation is crucial for the maintenance of the Coffea arabica genepool. The reason is that coffee seeds are difficult to conserve ex-site because they maintain their germination potential only for two months and it is difficult to apply cryo-preservation. To compare present and future costs and benefits, a simple discounting procedure was used with a 30 years discounting period and two discount rates (5% and 10%). During the first 15 years, the breeding programs will be implemented, which will result in economic benefits stemming from increased coffee yields at lower prices in the second period of 15 years. Further assumptions and details of the methodology are described in Hein and Gatzweiler (2006).

Table 1: Economic value of Ethiopian coffee genetic resources

	NPV (US$ million), at discount rate:	
	5%	10%
Disease resistance	617	169
- CBD	60	11
- *Meloidogyne spp*	231	65
- Coffee rust	323	94
Decaffeinated coffee	576	175
Yield increases	266	75
Total value	**1458**	**420**

The results of the value estimation (Table 1) present a minimum value because the coffee genetic material of the wild populations contains more information and is therefore potentially useful for other breeding purposes, for example yet unknown diseases or demanded cup qualities of coffee. Several assumptions had to be made for this valuation, for example that the breeding program would provide for the benefits after 15 years, the replacement rate of enhanced coffee varieties and the costs of the breeding program. Also the outcomes of the valuation do not provide information on how much forests need to be preserved to maintain the Coffea arabica gene pool, because the relationship between forest area and extent of coffee genetic diversity is unknown.

Nevertheless, the study confirms the institutional failure of conservation. Whereas at a global level these genetic resources have high values, for example for coffee breeders and growers, but also for conservationists, this value is not an incentive for the local population to manage the forest resources sustainably.

4 Society's perspective: Economic analysis of competing land use systems in Ethiopia

Reichhuber and Requate (2007) compare three competing land use systems for the Ethiopian montane rainforest: 1) Forest conversion and maize production, 2) strict forest conservation and 3) sustainable semi-forest management. Here we merely refer to the traditional practice of felling trees from a forest plot, selling them once and planting maize without fertilizer and pesticide input or the use of improved planting material. Strict forest conservation refers to the laws which apply with the establishment of the National Forest Priority Areas (NFPA). No encroachment into NFPA or felling of trees is tolerated by law and sometimes even punished by prison sentences. In practice monitoring and rule enforcement is difficult. Sustainable semi-forest management involves the growing of coffee and collecting of other non-timber forest products, like spices, medicinal plants or honey.

For the valuation of economic costs and benefits associated with each land use option the concept of total economic value (TEV) was applied, which consists of direct, indirect, option and non-use values. Non-use values were, however, excluded from the analysis. Direct use values included the benefits from timber and fuel wood, as well as maize production. Direct costs include damage from wild animals on agricultural fields and the costs associated with the implementation of strict conservation measures (e.g. infrastructure development and personnel). Values derived from indirect use come from watershed services of the forest, carbon storage services and biodiversity provision services. Biodiversity is valued at a national level for potential pharmaceutical and agricultural use.

The results shown in Table 2 demonstrate that from the three land use options, only maize production and forest management have a positive net present value (NPV). Strict forest conservation with no use is not economically viable. This however depends upon the non-use value that society attributes to biodiversity conservation. The negative NPV could also be the result of missing data on the values for watershed services provided by the forest and incomes generated through tourism.

Table 2: Net present values of competing land use systems

NPV per ha at discount rates of	Conversion of forest into agricultural use (traditional maize production)	Semi-forest coffee management (sustainable forest management)	Strict forest protection
2%	17, 921	**28, 135**	-276
5%	17, 620	**21, 686**	-222
10%	**17,274**	15,614	-173

At a discount rate of 5% sustainable semi-forest management was found to be most profitable while at 10% discount rates maize production becomes more profitable. Sustainable forest management generates income from timber, non-timber products and coffee and is more profitable in the medium to long term, where discount rates of 5% apply. In the long run and at discount rates of 2% sustainable forest management would be the most viable land use option.

5 Financial incentives for the individual farmer: Income analysis of two competing land uses systems

From the three land use options Reichhuber and Requatte (2007) compared, "strict forest conservation" is not included in the income analysis, as it is assumed not to generate income. The remaining two are the conversion into farm land which yields returns from logging and maize production and sustainable use of the forests, which is characterized by a variety of income sources, like coffee, wood products and several non-timber forest products. Further a discount rate of 30 and 53% as lower and upper boundaries are assumed. As Holden et al. (1998) argue this is mainly because of high environmental risks, low life expectancy and health risks.

The calculations for the traditional maize production system incorporate a yearly 10% decline in productivity on deforested land, 1800kg yield per ha and year, and a farm gate price of 6-7 USD per 100kg. With labor costs for maize production of 48 US$/ha, cultivating one hectare of maize leads to net returns of US$ 60 in Sheko in the first year. Applying improved land management (improved planting material, fertilizer application and erosion control maize production generates a net annual income per hectare of US$ 80.5 in Sheko.

From the management of semi-forest coffee systems income can be generated from coffee, fuelwood and timber, as well as non timber forest products (NFTPs). These include honey, medicinal plants, and miscellaneous goods, such as Brown Cardamom (”Kororima”); ”Gesho”, a condiment for making a local drink; ”Desha”, used to clean the oven; ”Ensosela”, used for decorating the skin with color; mats and baskets made out of a liana and baskets made out of bamboo. Details of the calculation of costs and benefits from harvesting these goods are given in Reichhuber and Requatte (2007).

The results of the income analysis give an explanation for the deforestation in the area by showing that maize production is more profitable than semi-forest coffee management. Net incomes from traditional maize production (including the one-time sell of timber) were calculated at 6324 and 6274 USD/ha at 30% and 53% discount rates respectively. Whereas conventionally managed semi-forest coffee management systems generated 5103 and 3956 USD/ha at the above mentioned discount rates.

6 Conclusions and policy recommendations

The results of our economic evaluations have shown that the Ethiopian montane rainforests which harbour the last wild *Coffea arabica* populations have high economic values and that financial incentives (under current institutional and governance circumstances) destroy this worldwide unique and valuable resource (Table 3).

Table 3: Table 3: Financial incentive motivate farmers to convert forests into agricultural land despite its high economic value of biodiversity

NPV in US$, discount rates in brackets.	Conversion of forest into agricultural use	Semi-forest coffee management	Forest protection
Local-financial values (per ha)	6274 (53%) 6324 (30%)	3956 (53%) 5103 (30%)	Low to negligible value resulting from potential future income from tourism
National economic values (per ha)	17,274 (10%) 17,620 (5%)	15,614 (10%) 21,686 (5%)	Value dependent on watershed services and the non-use value attributed to biodiversity by the people of Ethiopia, with potential additional revenue from tourism
Global economic values	None	Some preservation of biodiversity and coffee genetic resources	- High non-use value related to Ethiopia’s unique biodiversity - Use value related to maintenance of genetic information: US$ 0.4 billion (10%); US$ 1,5 billion (5%)

The calculations of economic values are estimates and they are based on assumptions and scenarios for each calculation. The results confirm theoretical explanations on deforestation and biodiversity loss: private and social values of forests diverge and lead to deforestation. Although at a global and national level forest resources are valued highly, these values are not translated into incentives for local resource users which are in direct interaction with forest resources for their livelihoods. Not deforestation because of converting forest into agricultural land by local farmers is uneconomic, but the fact that national and global society lets this happen because of the failure to translate their willingness to pay for conservation into concrete incentive mechanisms for local resource users. In economic terms, that is a waste of forest resources, at least partly as a result of lacking capability and will to create new and implement existing "institutions of sustainability" (Hagedorn, 2003) – incentives which would allow local stakeholders to invest into conservation and sustainable forest and land management.

The waste of forest resources and the failure to change incentive structures could however also be due to high transaction costs which may occur, related to establishing local incentives for sustainable biodiversity management, and for monitoring compliance with restrictions on land conversion. Values and policies are often there but they need to be transposed into incomes and action. For such a case, Gatzweiler (2006) has proposed the organisation of a "public ecosystem service economy" by changing institutions in a manner that relieves local resources users from the cost burden of conservation which society values and demands.

Creating incentives for conservation would mean creating "institutions of sustainability" in which the farmer can live from his land without having to destroy the ecosystem functions which provide for the (self-sustaining) regeneration of ecological goods and services. We have identified high discount rates as an important variable in our value estimates. Therefore, part of these "institutions of sustainability" need to be incentives which stimulate long term investments into the forest or land, for example by securing property rights and reducing further population pressures by halting immigration or family planning. If farmers can not use their land (which is not "theirs") as collateral for receiving credits from banks they are condemned to live from hand to mouth. For that reason (and having in mind that, according to Nega et al. (2003), the legal framework on land issues since the socialist Derge regime show more similarities than differences to the current one) Ethiopia is urgently in needs to evaluate the effects of the land reform from 1975 and implement land policies which provide for better tenure security.

Other types of incentives are those which make local markets work better by rewarding farmers for the goods they can offer on the market. That could mean better prices for organically grown or produced goods, like forest coffee or honey. Currently many products harvested from the forest are regarded as being provided for free by nature and their price reflects little more than the costs for collecting and transporting them. Investing into the quality of products which are sustainably managed and adequately paid for, also means investing into people's capabilities by providing education and training. Although setting up a labelling or certification

infrastructure for goods harvested from the forest also involves high transaction costs, such investments will most probably pay-off in the future.

Changing the circumstances into those which allow local resource users to manage their forest and land resources sustainably does not only involve sharing the costs for conservation but also lowering the discount rates. Currently the importance of immediate food supply is so high, that we need to apply discount rates of up to 53%. The future and sustainable management practices are not worth much under such circumstances, where farmers are condemned to live from hand to mouth. Mechanisms are therefore needed that ease the dependence on immediate food supply and increase food security. This need refers back to the long-term investments farmers could make on their own land if it would be their own land.

In addition to incentives which allow local communities to manage resources more sustainably, mechanisms are needed at national and global level which translate these values into environmental policies which are actually implemented. A prominent example is the reportedly successful co-management arrangements for participatory forest management (not only) in Ethiopia, with strong support from the government and the international donor community. But also general environmental education schemes are an investment into people's unexploited capabilities and thereby indirectly transpose high economic values at national level to innovative income opportunities at local level. Environmental taxes or other levies could be another mechanism. Tax revenues generated would need to be re-invested into the conservation capacity of the country by strengthening conservation education, training and extension services.

We have shown that the global community has considerable benefits from the biodiversity of Ethiopia's montane rainforests. These especially refer to the high values of the wild Coffea arabica genetic resources in those forests. Despite the boom of the specialty coffee industry (Daviron and Ponte 2005) and the high profits made (OXFAM 2002) a negligible amount is re-invested into the conservation of Ethiopia's montane rainforests and its wild *Coffea arabica* genetic resources. That must be perceived as a great damage for the image and social corporate responsibility of the global coffee industry, especially roasters and retailers. Support of Ethiopian conservation NGOs, voluntary payments, a conservation tax or other types of levies collected at national level could be possible contributions.

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