Ecosystem services and human well-being:
A Case Study in Jambi Province, Sumatra, Indonesia

Seth Binder, Amy Rosenthal, Daniela Miteva, Subhrendu Pattanayak, Justin Johnson, Rebecca Traldi, Michael Anderson, Derric Pennington, Nirmal Bhagabati

Key question: What are the consequences of alternative spatial planning approaches for human well-being, especially for the poor?

Key message: The analyses conducted by the Natural Capital Project in Jambi Province, Sumatra helped discern whether and how integrating the value of nature into spatial planning and associated infrastructure development decisions affects local well-being. These analyses highlight that impacts on ecosystems affect people in multiple ways, and that spatial planning and development can have unintended consequences that are especially significant for the poor. Preliminary results suggest that if ecosystem-based spatial planning does not explicitly account for local well-being from the outset, specific targeting may be required to provide more equitable outcomes to communities.

Introduction - challenges and opportunities for sustainable spatial planning in Sumatra

Sumatra has experienced rapid land use change over the past decade, largely due to conversion of natural forest and peat land to plantations for timber, oil palm, and rubber production. This is a serious threat to the island's unique biodiversity and ecosystem services that benefit local communities. To prevent the loss of these benefits, the Government of Indonesia (GoI) has made a commitment to environmentally sustainable development and spatial planning. In October 2008, the ten governors of Sumatra and the Indonesian Ministers of Interior, Forestry, Environment and Public Works pledged to "save and conserve the ecosystem […] in order to balance ecological functions and economic development for the people of Sumatra" (cited in Bhagabati et al. 2012). The GoI recently signed a compact with the United States that includes a $332 million Green Prosperity Project with the Millennium Challenge Corporation (MCC), focused on the development of renewable energy and sustainable land management, especially in Jambi province in central Sumatra. In addition, the government has developed an ambitious long-term economic development plans that envision extraordinary investments in infrastructure throughout the country by 2050, and on Sumatra in particular.

Economic growth oriented around these investments may or may not be compatible with sustainable local development. Sumatra is at a critical juncture, and its future may be determined by the shape of provincial and district spatial plans. WWF, together with GoI and other civil society groups, has already developed an ecosystem vision for Sumatra as an alternative to existing plans and mapped ecosystem service changes in landscapes associated with planning alternatives (Bhagabati et al. 2012). These plans, described in Table 1, provide context for exploring the human well-being impacts of planned infrastructure investment and concomitant economic development, through its unintended effects on the provision of ecosystem services.

Such information can play an important role in decision-making around infrastructure investments and spatial planning.

Table 1. Alternative Spatial Plans

The Green Vision plan	The Government Plan
This is an ecosystem-based spatial plan for sustainable land use, developed by national government agencies and ForTRUST. It prioritizes habitat restoration and high value conservation areas, but also includes economic development and oil palm plantation expansion. For the purposes of this document, this plan will be referred to as the "Green Vision."	This landscape represented the existing spatial plans proposed by provincial and district governments in central Sumatra. These plans do not prioritize conservation and would likely lead to increased deforestation. For the purposes of this document, these plans will be referred to as the "Government Plan."

Our approach

We assessed how the difference in provision of ecosystem services to villages in Jambi[1] under the Green Vision relative to the Government Plan affects human well-being, and how these impacts vary with village-level poverty. The analysis focuses on ecosystem services that can be modeled by the InVEST (Integrated Valuation of Environmental Services and Tradeoffs) suite of software tools, and which were determined to have potential, calculable benefits to local communities. These include carbon storage, fuel wood supply in natural forests, and water regulation (in particular, baseflow). Carbon storage was included because local landholders have the potential to benefit from emerging national and international programs aimed at reducing carbon emissions from deforestation and degradation (REDD+) through a compensation mechanism. Access to fuel wood is a necessity for the 75% of villages in Jambi that still rely on it for cooking. Regulation of water yield and baseflow improve the quantity and reliability water available for agricultural and domestic use and reduces the prevalence of water-borne diseases.

In order to compare the impact of alternative spatial plans on local well-being, we evaluate the changes in ecosystem service benefits realized by villages throughout the study area as a result of projected land use changes. To do this, we apply three common economic valuation techniques. *Unit value transfer* directly uses estimates from existing studies in similar contexts to value changes in a given ecosystem service. We use this approach to value carbon storage, and baseflow in terms of avoided costs of diarrhea incidence (Pattanayak and Wendland 2007) and reduced costs of domestic water collection (Pattanayak 2004). *Function transfer* takes from an

[1] For more info on village as unit of analysis, see manuscript

existing study the estimated parameters of a model linking services to the value of benefits but where possible replaces the data for variables used in the original study with data from the new target study site. We apply this approach for the valuation of changes in baseflow in terms of agricultural benefits (Pattanayak and Kramer 2001). A third method draws on observable prices and other measurable parameters from the study site and applies these to a model of human behavior to simulate the value of changes in the environment. We apply this approach to value changes in access to natural forest for fuel wood collection, using a new InVEST model for non-timber forest product (NTFP) harvesting.

Results

We summarize our results here in map and tabular form, demonstrating the distribution of ecosystem service "winners" and "losers" spatially and by village poverty rate. Over all, more villages saw increases in benefits from ecosystem services under the Green Vision than under the Government Plan; however, these benefits were less pronounced, and the results more mixed, for the poorest villages in Jambi (Figure 2).

Figure 1: Spatial Distribution of Annual Impacts

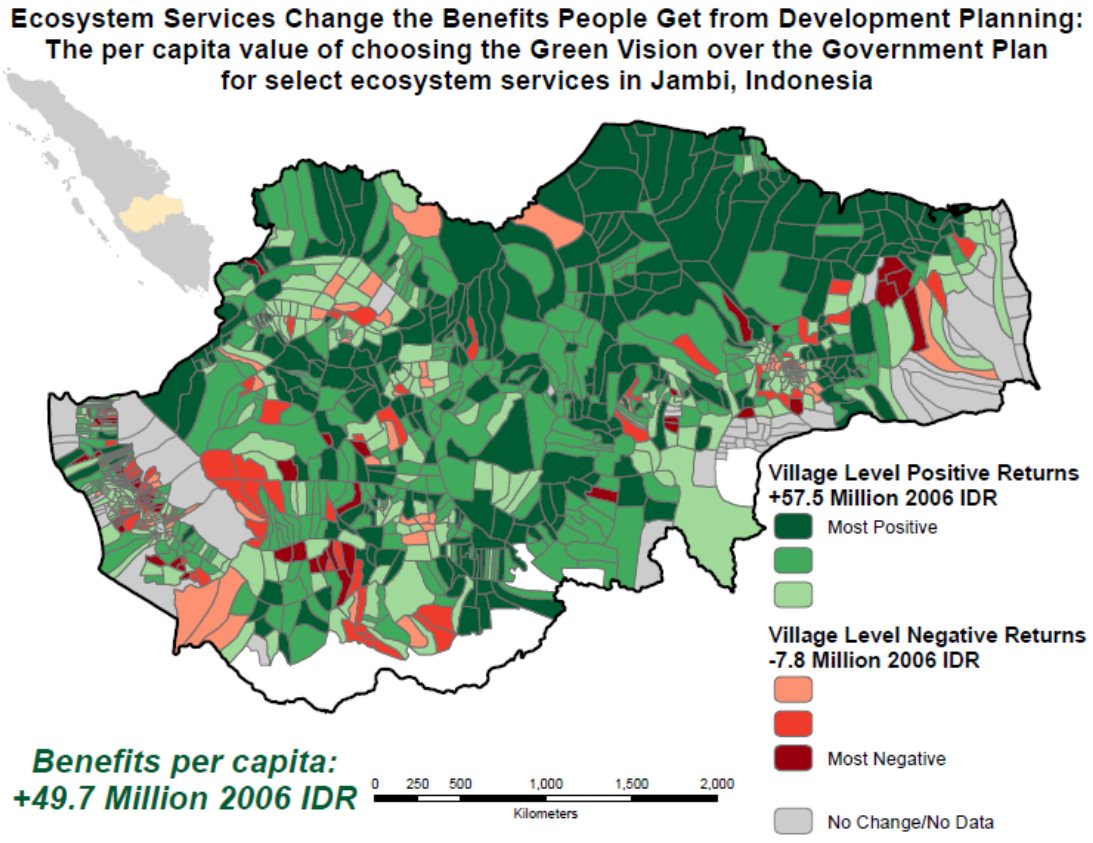
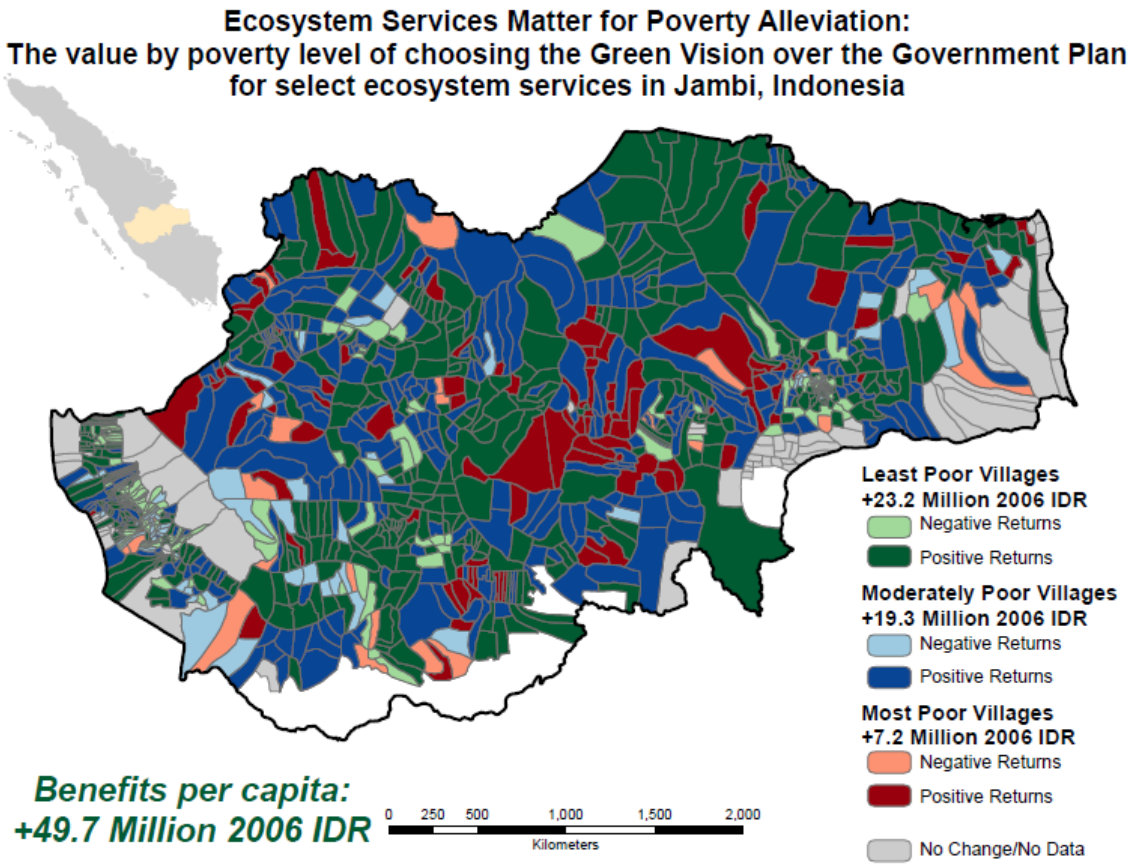


Figure 2: Distribution of Annual Impacts by Poverty Level



The impacts of ecosystem change on the lives of the poor can be substantial. Our results indicate that the annual value of changes in ecosystem services may represent as much as 4 percent of the annual poverty line (approximately 1.6 million 2006 IDR in 2013). Large fractions of the populations of many villages fall below this line (Figure 3). Although we observe substantial spatial variation in the distribution of impacts of ecosystem change associated with the Green Vision relative to the Government Plan (Figure 1), we do not see a strong relationship between village-level poverty and net impacts on human well-being (Table 1). However, we do see fairly strong correlations between village-level poverty and the value of changes in particular services. For instance, we observe a moderately high correlation between poverty rate and the magnitude of relative increases in water collection costs. We observe a similar correlation between poverty rate and the value of fuel wood access. Both of these correlations are to be expected, since more impoverished villages are more likely to rely on surface water versus piped water for domestic use and fuel wood versus kerosene for cooking.

Figure 3: Distribution of Poverty in Jambi Province

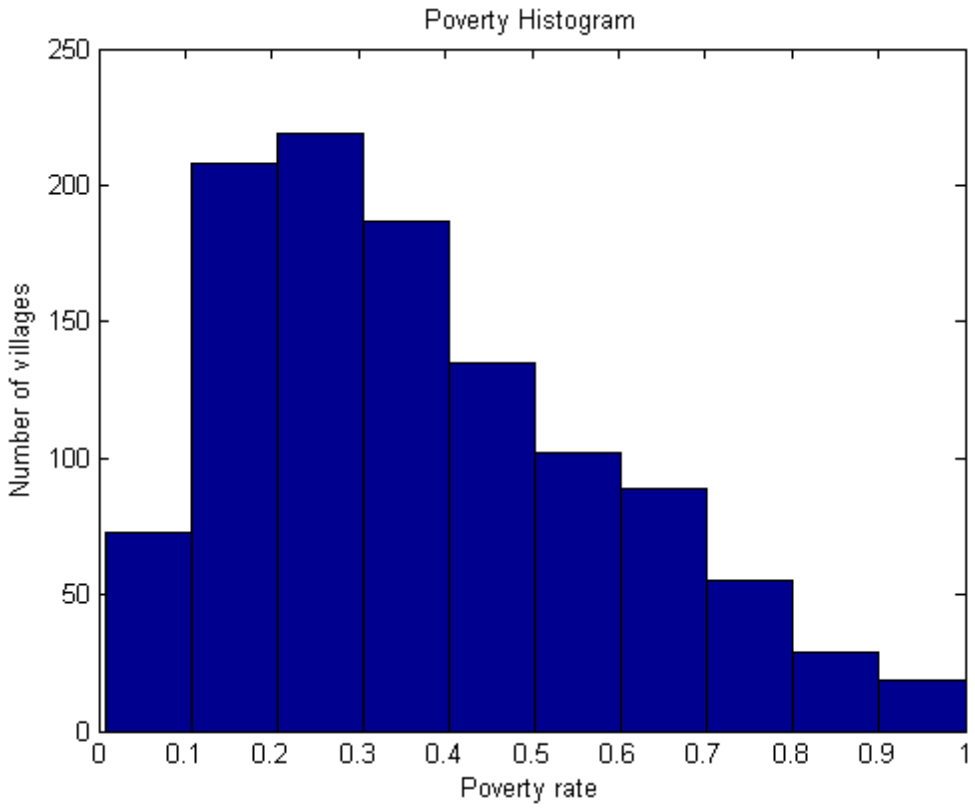


Table 1: Value of ecosystem service changes by poverty decile

Per capita village-level net benefits of Green Vision Plan by poverty decile						
	Avoided water collection costs	Agricultural profits	Avoided diarrhea treatment costs	Carbon compensation	Fuel wood access benefits	Net benefits
Bottom decile	-0.02	-2190.89	-14862.38	11195.73	46354.00	40496.43
2nd decile	-0.03	-2218.74	-21318.21	23144.06	43657.54	43264.63
3rd decile	-0.02	-2103.94	-17861.90	5872.85	48790.89	34697.88
4th decile	-0.02	-2185.09	-19281.79	14730.76	46231.93	39495.80
5th decile	-0.02	-1477.22	-14722.42	13211.84	57994.15	55006.33
6th decile	-0.05	-2462.86	-26942.67	13690.67	54361.02	38646.11
7th decile	-0.03	-1961.02	-25350.30	15743.87	56305.26	44737.78
8th decile	-0.05	-1988.52	-25007.59	16394.86	52630.49	42029.18
9th decile	-0.03	-1576.06	-22894.16	21314.35	53780.16	50624.28
Top decile	-0.05	-1593.32	-21884.23	26147.48	53806.79	56476.67

Figures reported in constant 2006 IDR (Indonesian Rupiah)

Implications for policy

Policymakers can utilize information regarding the type, magnitude and distribution of impacts of ecosystem change in order to better design plans and projects, mitigate anticipated effects, and compensate communities harmed by changes that cannot be avoided. Our analysis suggests that where impacts of the Green Vision plan are negative, they are driven by reductions in baseflow regulation that lead to increased costs of water collection and disease treatment and to lower agriculture profits. Accounting for potential changes in baseflow early in the planning process could have led to identification of low-cost opportunities to avoid or mitigate these effects.

Mapping village-level impacts allows policymakers to identify particular areas of focus for mitigation or compensation efforts. At the same time, it is important to keep in mind that villages that appear to benefit from a spatial plan on average may still have a number of households that are negatively affected. It is often possible to predict in advance which households are likely to be negatively affected based on particular socio-economic characteristics. For example, the poorest of the poor have claim to little or no land, and so are likely to be excluded from the potential benefits of compensation for carbon storage and from the agricultural benefits of augmenting baseflow and water yield. At the same time, the poorest households are likely to be most vulnerable to environmental diseases, such as diarrhea from contaminated water, and will bear a disproportionate share of the costs or benefits of changes in disease incidence due to ecosystem change.

In addition, our results highlight the importance of the broader policy context in determining the ultimate benefits of a given spatial plan. The positive human well-being impacts of the Green Vision plan derive primarily from carbon compensation and greater access to fuel wood. However, for villages to benefit from the increase in these ecosystem services there must be complementary-- and targeted--policies that ensure access to, or compensation for, those services. Such policies are not only critical to making the Green Vision pro-poor, but may be essential for providing the incentives to local resource users to abide by and achieve desired environmental outcomes. In short, the policies that underpin implementation of the proposed spatial plan will determine whether win-win outcomes will be achieved.

In general, these preliminary results strongly suggest that spatial planning focused on ecological outcomes of global importance (carbon storage, biodiversity conservation) does not necessarily deliver matching benefits to affected local populations. If policymakers aim to achieve win-win outcomes they must incorporate human well-being considerations in the early stages of decision-making regarding infrastructure, development and spatial land use plans. It is crucial to consider the net impacts of economic development and ecosystem change on human well-being from the outset, and the methods and analysis presented here demonstrate the potential to do just that.

Summary

- This study presents new methods for directly linking a population's well-being to ecosystems, highlighting methods for assessing differential impacts on populations.

- There is considerable variation in economic impact, by ecosystem service and across villages.

- The average per capita impact is low; however, the impact on the poor is substantial, given lower incomes and high dependence on natural resources. The values estimated here represent approximately 3.5% of the income of an individual at the poverty line.

- The magnitude of gains and losses in the value of ecosystem services is highly dependent on specific policy and market factors.

- Analysis shows that spatial planning to benefit the general welfare or global environmental benefits can still have negative impacts on particular communities.

- This analysis reveals opportunities to improve outcomes by considering net impacts of development and ecosystem change on human wellbeing in early stages of planning.

Bibliography

Bhagabati, N., et al. "A Green Vision for Sumatra: Using Ecosystem Services Information to Make Recommendations for Sustainable Land Use Planning at the Province and District Level." *Natural Capital Project, WWF-US and WWF-Indonesia, Washington DC* (2012).

Pattanayak, S.K. "Valuing watershed services: concepts and empirics from southeast Asia." *Agriculture, Ecosystems & Environment* 104 (2004): 171–184.

Pattanayak, S.K., Kramer, R.A., 2001. "Worth of watersheds: a producer surplus approach for valuing drought mitigation in Eastern Indonesia." *Environment and Development Economics* 6 (2001): 123–146.

Pattanayak, S.K., Wendland, K.J. "Nature's care: diarrhea, watershed protection, and biodiversity conservation in Flores, Indonesia." *Biodiversity and Conservation* 16 (2007) 2801–2819.