The Experience of Natural capital in CGE Models

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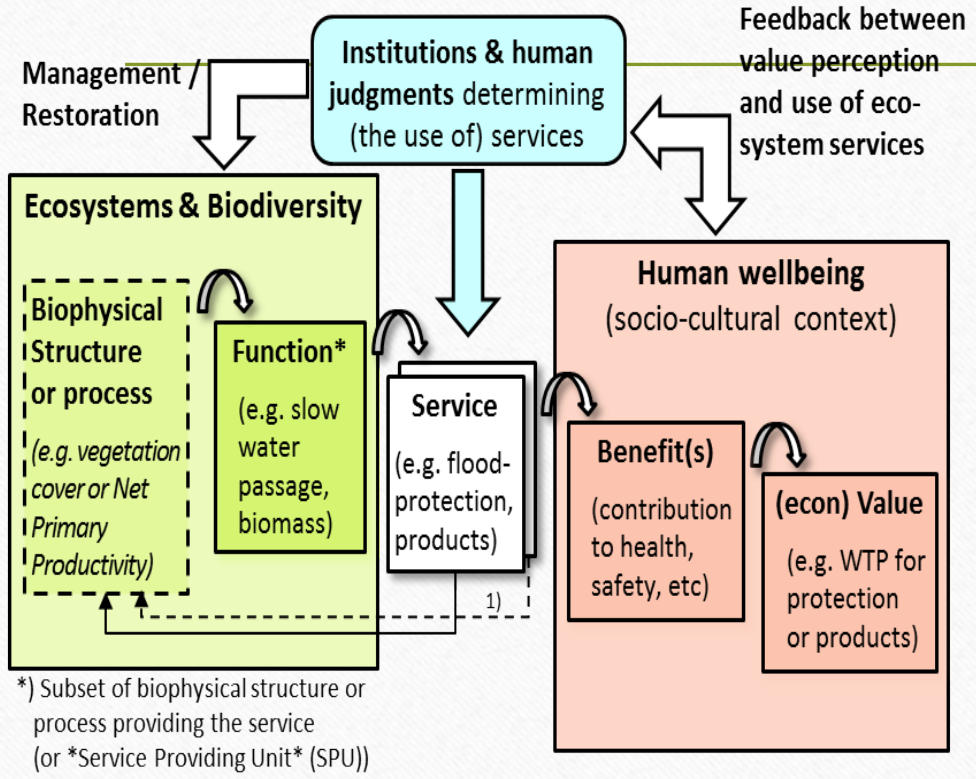
Natural Capital in CGE Models

- There is growing consensus that Natural Capital Accounts are needed, but they tell us little without quantitative tools that illuminate the benefits and costs of conserving/ better managing natural capital.
- A new generation of Computable General Equilibrium (CGE) Models based on extended social accounting matrices (SAM) can be such a tool.
- The new CGE models are integrated representations of national or regional economies. They can be used to simulate the economic and environmental effects of exogenous events (such as climate change) and policies to address them.

Capital in National Accounts

- GDP measures only account for expenditure in capital goods, which is recorded as «fixed capital formation» or «investment».
- Thus, GDP and national accounts record capital expenditure «as if» it were entirely converted into an increase in capital stock. They do not account for depreciation and do not record capital «destruction» .
- Physical capital is typically estimated using the permanent inventory method from accumulated capital expenditure.

Principles of accounting for natural capital In SAM-CGE models



- Productive sectors utilize natural resources as inputs in production processes.
- Because of lack of property rights and of proper markets, natural resources uses are generally not priced efficiently to reflect their opportunity costs.
- Net rents arise from the differences between the values of their productive contribution and users' costs (extraction, maintenance and servicing).
- Over-use and/or under-investment in natural resources tends to cause damages to natural capital ranging from deterioration to depletion.
- These damages can be quantified as forms of depreciation and/or through increasing shadow prices

Structure of an Environmental Social Accounting Matrix (SAM)

SAMEA	National economy	Rest of the world economy	National environment	Rest of the world environment
National economy Rest of the world economy	SAM: flows of product, distribution of income, final consumption and capital formation		Residuals by resident Residuals by non-resident	Residuals by resident to ROW
National environment Rest of the world environment	Natural resources inputs Natural resources from ROW	Natural resources exports		
National residuals	Residuals reabsorbed			Cross boundary residual outflows
Rest of the world residuals	Residuals reabsorbed		Cross boundary residual inflows	

Source: Morilla (2004).

CGE key abilities in NC treatment

- The ability to define shadow prices that better estimate the true (social) value of natural capital.
- The ability to develop full value added accounts including natural resources (NPP in contrast to GDP).
- The ability to illuminate the net benefits (in terms of NPP or other policy variable of interest) of alternative policy decisions on the use of natural capital, relative to a counterfactual.
- The ability to model the economy-wide effects of sudden shocks (e.g. climate disasters) that destroy natural and produced capital.

Dynamic CGE accounts are based on Net National Product (NNP) as Economic Potential

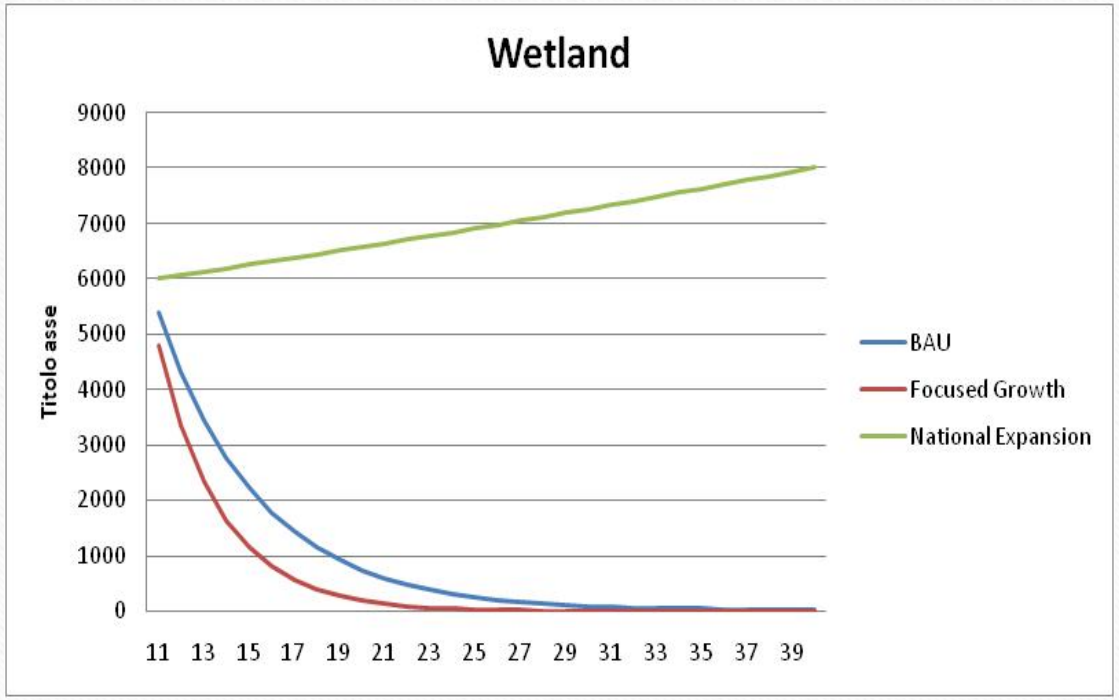
NNP= Net National Product= Economy's potential at shadow prices = consumption + net physical capital formation+ value of natural capital formation (or destruction)

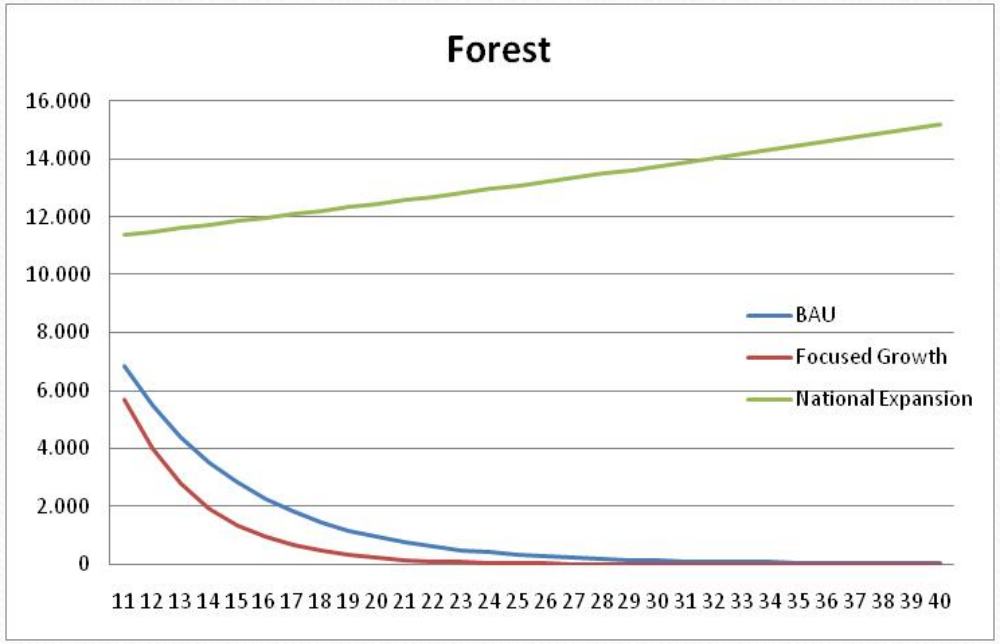
NNP is an estimate of the yearly equivalent of the NPV generated in a particular year.

Some Recent SAM- CGE World Bank Studies Modeling Natural Capital

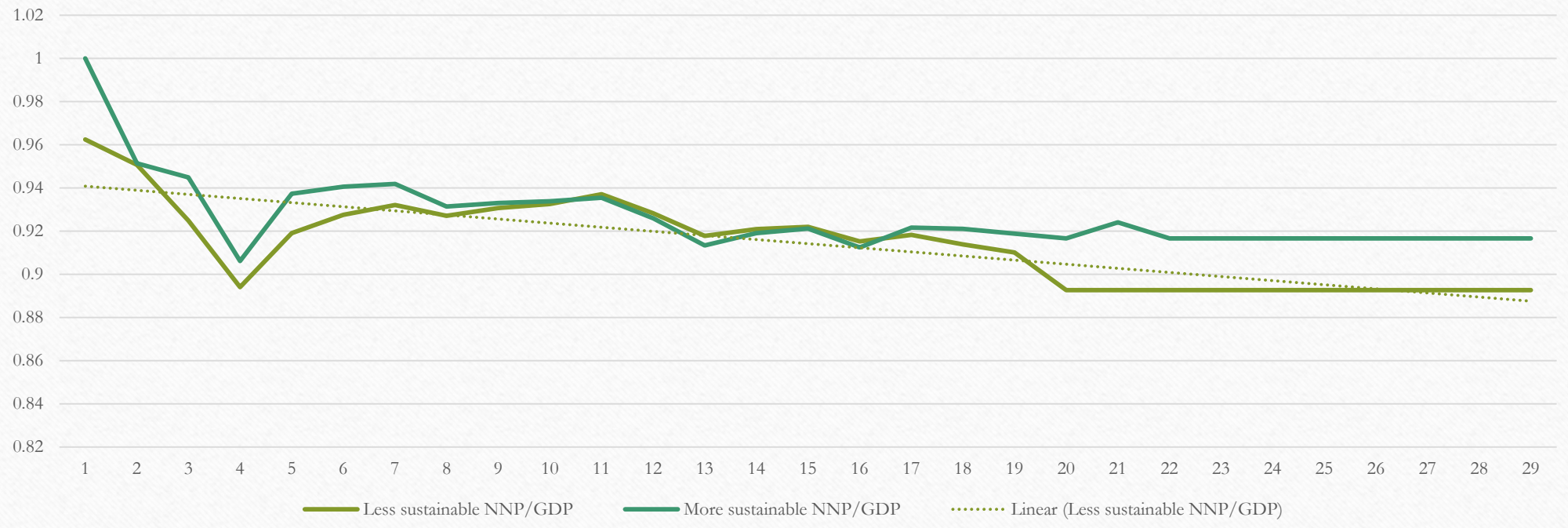
- Mexico (2013). A study of the policy options for public investment in the Yucatan Peninsula, with special attention to climate change (sea level rise and extreme events).
- Mexico (2015). Impact study of the carbon tax and green policies.
- Brazil (2014). Impact study of a WB development policy loan to the state of Piaui.
- Peru (2014). A study of policy options for the state of Apurimac assessed policy options to govern mining development, including income distribution and environmental effects.
- Tanzania (2014). Study of the impact of alternative investment policies on tourism and infrastructure policies, with special focus on the Serengetti and the other national parks.
- Tanzania (2015). A SAM based dynamic CGE model was used to assess the impact on growth, income distribution and the environment of the energy master plan.
- Kenya (2015-2016). The study uses a dynamic CGE to investigate alternative policies of investment in tourism, agriculture and infrastructure and their impact on poverty, income distribution, employment and natural resources (especially water).
- Mauritius (2016-2017). The study uses a dynamic CGE model to investigate the economic and ecological implications of investing in the development of the Ocean Economy, with special attention to the effects on different types of water, biodiversity and climate change.
- Kenya (2016-2018). This second round of the previous (2015-2016) study develops a regional dynamic CGE model to study the impact on biodiversity of road infrastructure and other policy measures

Quintana Roo: Biodiversity loss can be reversed with more balanced policies for tourism and coastal management

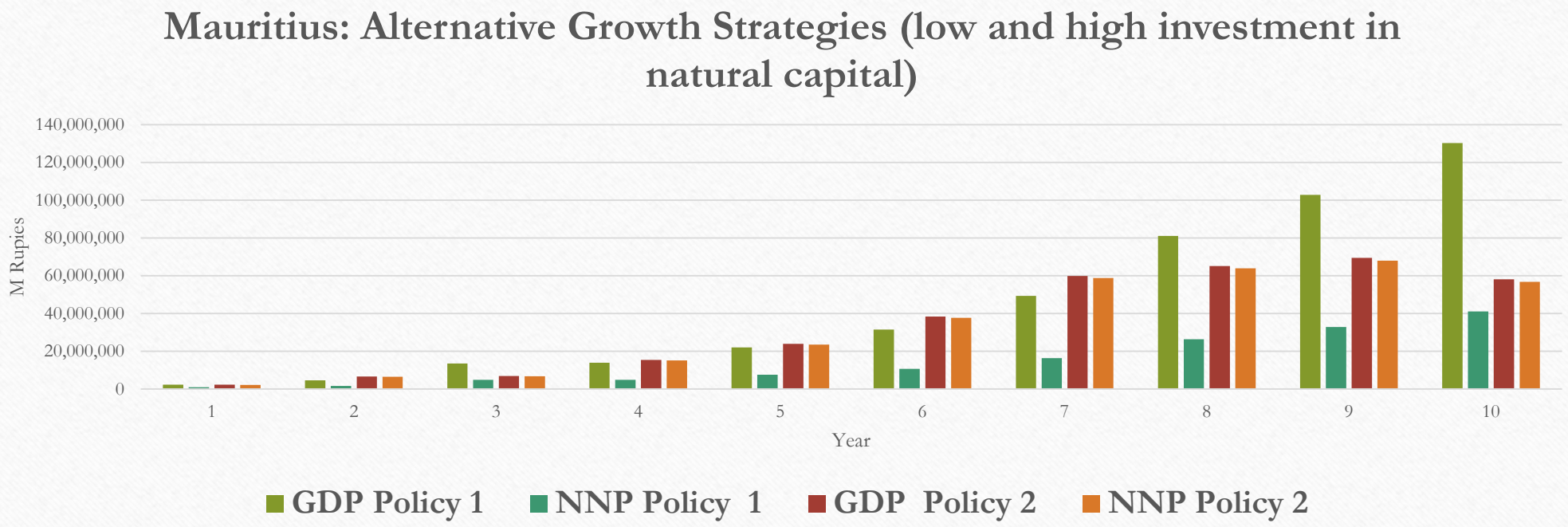




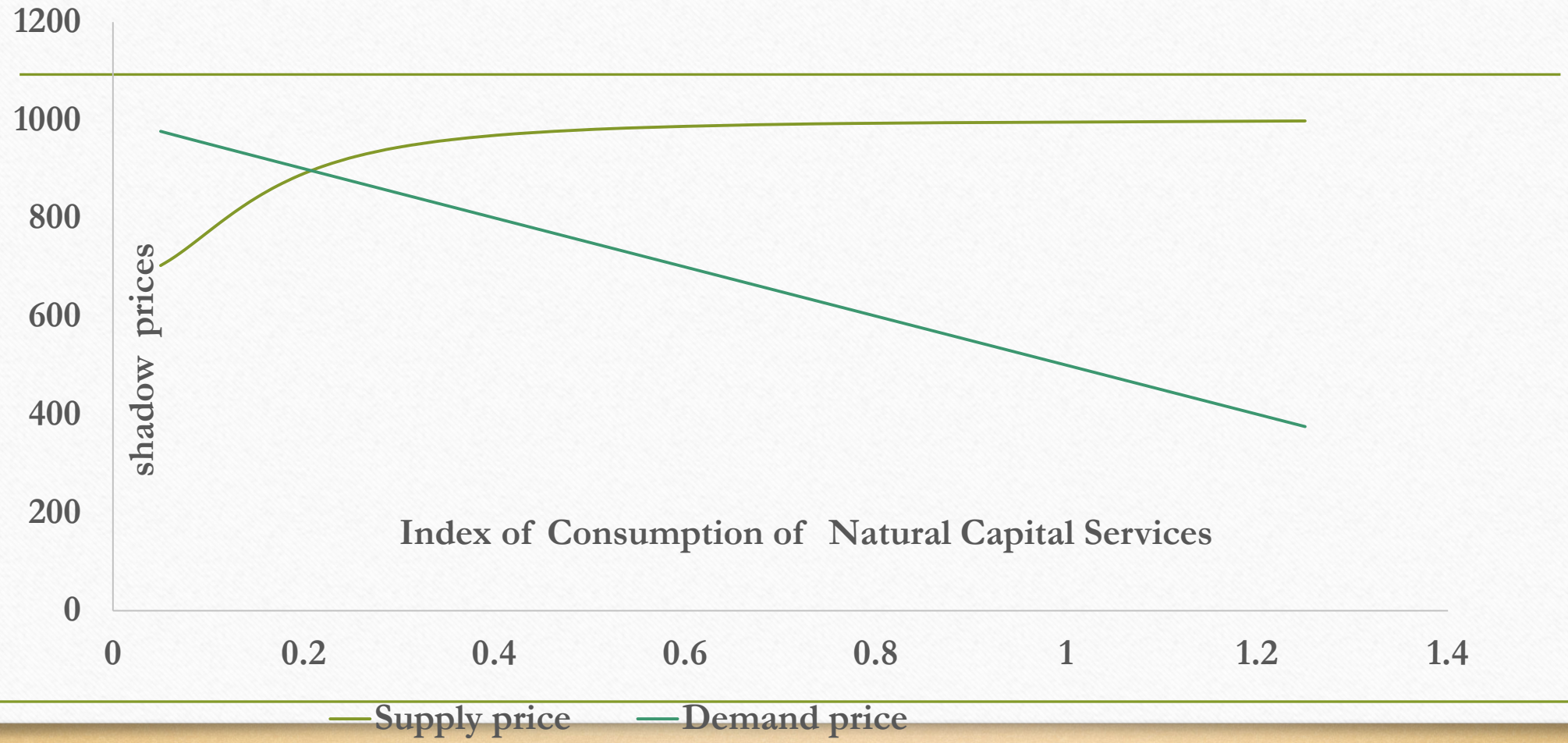
Tanzania Energy Master Plan: Ratio of NNP/GDP for two alternative energy investment plans



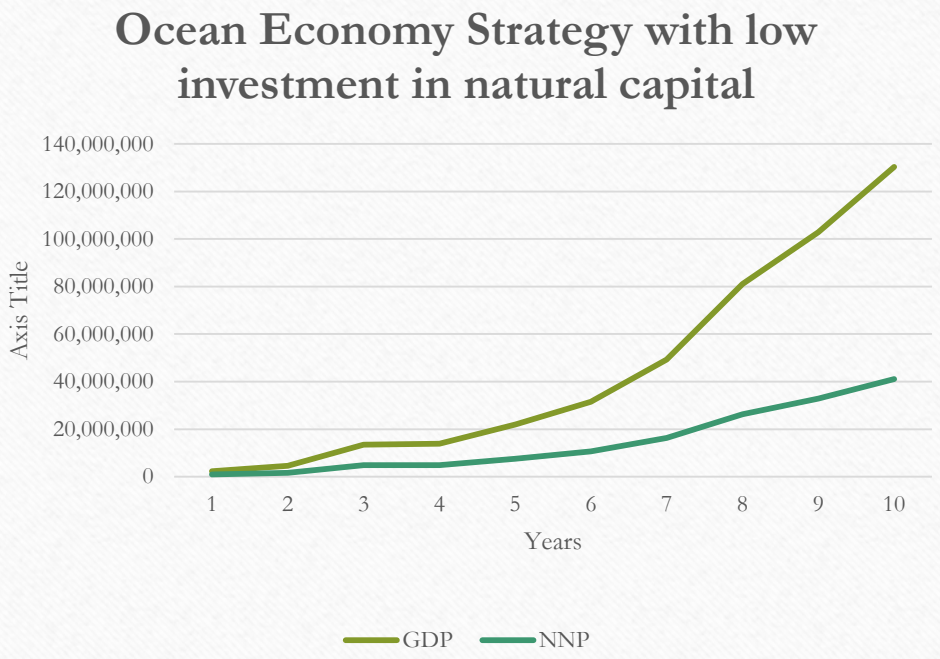
Mauritius: GDP-NNP trade offs under alternative growth strategies

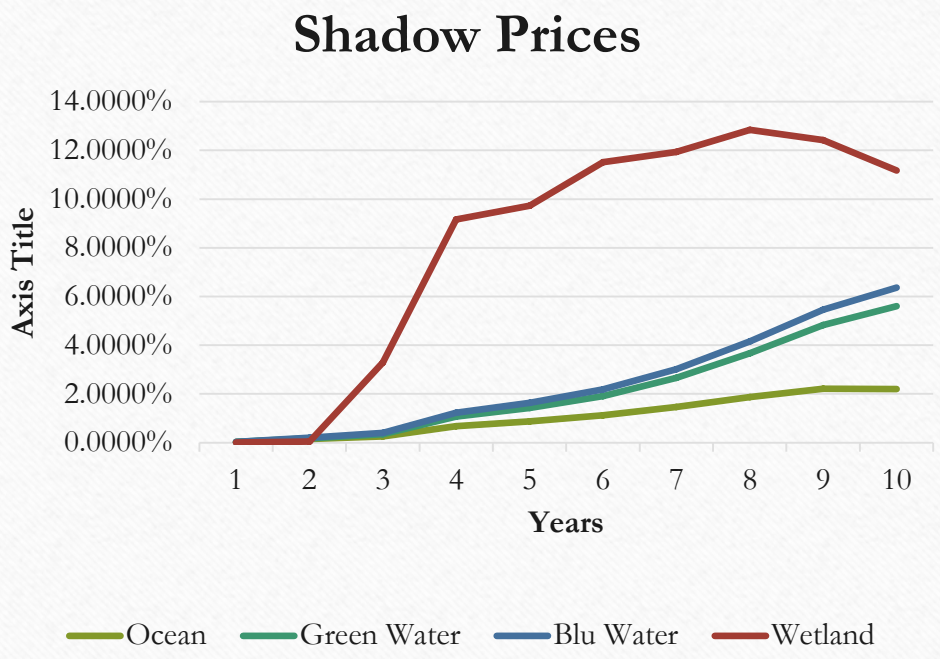


GDP- NNP tradeoffs are due to NC Market (demand prices) and shadow (supply) prices diverging as ecosystem services uses expand beyond sustainable levels

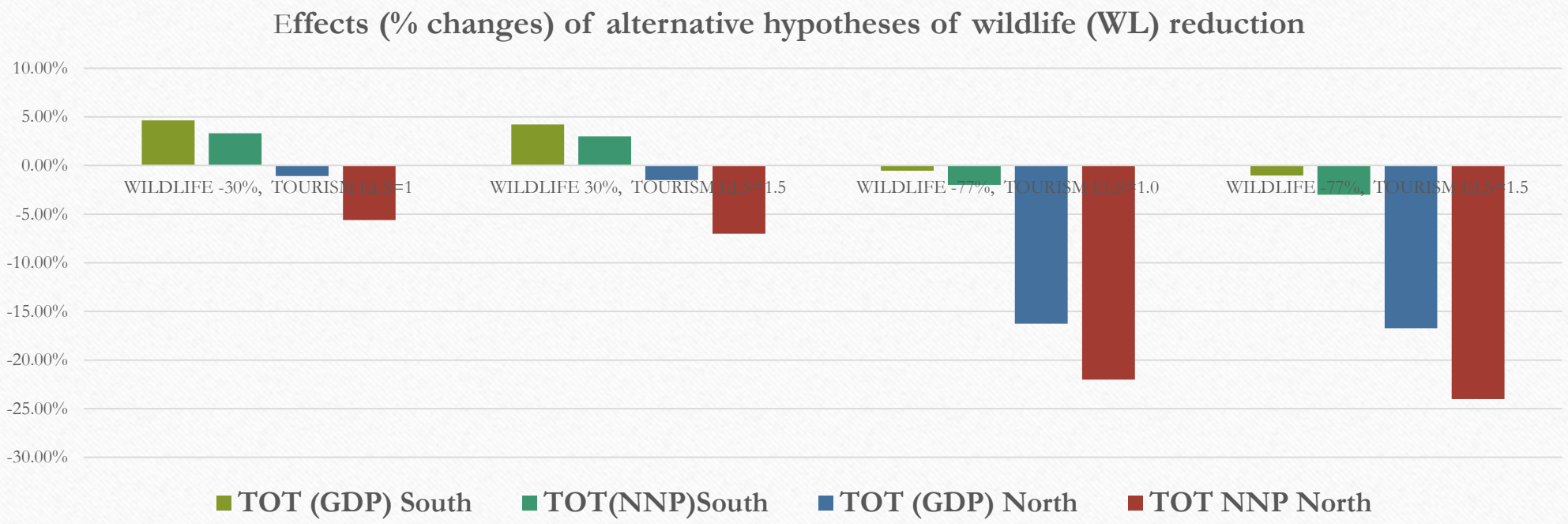


Mauritius: GDP , NNP and Shadow Prices of Natural Resources





Kenya: quantifying wildlife reduction negative effects on NNP



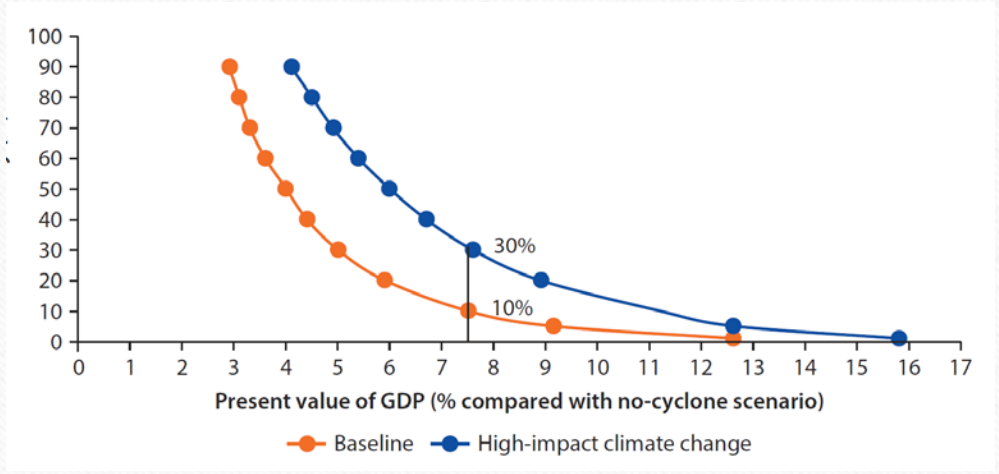
Kenya Policy Experiment: Investment in Wildlife Conservation

VALUE ADDED (Mln US$)	South		North		% hange	
	BASE CASE	Conservation	BASE CASE	Conservation	Region A	Region B
LABOR	19,324.90	20,884.90	1,764.40	2,503.30	8.1%	41.9%
CAPITAL	31,278.20	33,931.20	2,607.40	4,005.90	8.5%	53.6%
LAND	5,163.20	7,722.90	895.40	2,218.30	49.6%	147.7%
ECOSERVICES	1,214.00	2,374.70	700.30	1,964.00	95.6%	180.5%

INCOME (Mln US$)	South		North		% change	
	BASE CASE	Conservation	BASE CASE	Conservation	Region A	Region B
Enterprises	31,278.20	33,931.30	2,607.40	4,005.90	8.5%	53.6%
Rural Poor	7,996.50	9,615.10	1,683.90	2,772.90	20.2%	64.7%
Rural non Poor	13,069.50	15,642.00	2,607.00	4,261.90	19.7%	63.5%
Urban Poor	1,437.90	1,580.70	214.80	303.30	9.9%	41.2%
Urban non poor	36,365.70	40,401.30	6,480.90	8,903.90	11.1%	37.4%
Government	21,010.40		23,938.50		13.94%	
NATURAL CAPITAL FORMATION	5,573.90		7,987.80		43.31%	
Investment in Conservancies	**285.4**	**570.8**	**0.1**	**0.2**		
Investment in Wildlife	**1598.8**	**3197.5**	**529.7**	**1059.3**		

Simulating the Impact of Climate Change in Mauritius

Projected GDP losses from tropical cyclone



Impact of 100 year cyclone event over 3 scenarios