Sustainability, climate change, and carbon sequestration in Panama

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Executive Summary

The goal of this thesis was to assess the potential for forestry projects in Panama. Three main issues were identified and elaborated in more detail with respect to sustainability and potentials for carbon sequestration: (1) water, energy and their links with climate change; (2) climate vulnerability and human security; and (3) forestry, finance, and culture. These three aspects are briefly summarized below, followed by the main conclusions of this thesis.

1) Water, Energy, and Climate Change

Panama has a high demand for water, the Canal using 200 million liters of water from the Panama Canal Watershed (PCW) per ship passage.[1] The PCW provides the Canal with fresh water while also supporting hydropower, ecosystems, agriculture, ranching, forestry, and suburban life.[2] Any significant change in land use in the PCW requires close attention since its water budget is tight with increasing demand from expanding agriculture, urbanization, populations, and the $5.25 billion expansion project. Expanding the Canal will require more water, yet current planning does not adequately address climate change nor sustainability in the management of PCW forests. $880 million was allocated to the ACP's own water supply and security[3] but nothing has been allocated to address upstream water security, the PCW and its forests. Of further concern are Panama's recorded economic growth rates of 11.2% in 2007, and 8.6% in 2008,[4] and the Canal expansion project which has fuelled them.[5] Inflation hit a 28-year high in Panama in 2008, due to an inability to assimilate high economic growth.[6]

Water security is a critical concern. Panama's dry season ranges from 100 to 130 days.[7] During this period, Panama has experienced water shortages, famines, water contamination, and forest fires, which are a major factor inhibiting reforestation while also causing deforestation. There is insufficient sewage treatment and trash collection in the PCW, and large centers are heavily polluted.[8] The ACP currently consumes 2 trillion liters of water annually[9] with revenues in 2008 of $2 billion or 10% of GDP, suggesting fresh water in Panama has a market value of at most one tenth of a cent. Panama uses hydropower to generate half of its electricity and imports over 70% of its energy requirements via oil, fueling both economic growth and Panama's high public debt which remains around half of GDP.

Changing precipitation patterns may severely affect Panama's ecosystems[10] and hydroelectric generation capacity. Electricity shortages constrain business investments in Panama and reliance on hydropower and oil which has seen a recent peak along with increasing extraction costs and decreasing reserves indicates significant vulnerabilities. In addition, uncertainties exist for Panama's future weather and climate regimes, and demand at the Canal. Global warming is heating up the Arctic twice as quickly as the rest of the planet, and has already partially opened the Northwest Passage in 2007[11], which is in direct competition with the Canal,[12] and may open to commercial shipping before the expansion project is completed.

2) Climate Vulnerability and Human Security

Panama's climate issues are deeply rooted in core development issues such as restrictions in capital, investments, technology, productivity, institutional structure and capacity, human security and socioeconomic equity. As the economy and population grow, and energy and water demand and uncertainties increase, Panama's forests and poor majority face increasing pressures. Panama's rural areas are of particular concern, having been largely ignored by governmental subsidies and laws, resulting in high levels of poverty and land degradation, and unsustainable methods of subsistence and agriculture. Changes in weather are coupled to changes in climate, and thus addressing these issues via weather-sensitive and long-term investments that are able to enhance Panama's adaptive capacity could result in additional developmental benefits.[13]

The ACP may face future turmoil as Canal inflow is only predictable up to a few months in advance,[14] and changing climatic conditions may shift both the frequency and intensity of ENSO,[15] which directly affects the human welfare of more than one third of the Earth's population.[16] ENSO's reaction to climate change is unclear, as are the mechanisms which control it. Models still struggle to accurately predict ENSO, especially beyond one year.[17] Latest research indicates that a change in the wind system in the Antarctic promotes the beginning of the El Nino cycle,[18] which correlates to adverse weather in Panama.

The occurrence of climate-related disasters in Latin America has already increased by a factor of 2.4 since 1970,[21] and in 1999 famine hit Panama due to El Nino related water shortages.[22] Water and energy supplies are inadequate and demand is increasing with urbanization, modernization, population and economic growth.[23] Rural Panamanians remain fearful of their future food security[24] and under-developed and poor rural regions where subsistence is at stake are highly vulnerable to both existing ENSO and climate variability and future changes.[25] Moreover, ENSO may generate large-scale forest fires, even in undisturbed dense forests,[26] and the largest impact from climate change in Panama may be on reforestation efforts.[27]

3) Forestry, Finance, and Culture

Panama requires significant levels of funding and assistance to foster sustainable forestry projects, yet carbon markets might be neither sufficient in size nor secure enough.[28] Panama has no Central Bank, creating a market driven money supply, and Panama's economy is 80% services based with markets dominated by the ACP and timber revenues predominately from teak.[29] Questionable spending, poor governance, and significant inequity have been politically driven since colonial times, and transnational corporations and Panama's minute elite class have profited immensely,[30] while soils and the environment erode, releasing carbon and reducing human wellbeing. Private investments currently overwhelmingly exceed conservation funding[31] however Panama has a poor image[32] and continues to report highly significant levels of socioeconomic inequity, poverty, and public debt.[33] Panama is the "black sheep" of both Central and Latin America; it has a Canal and the country is rich and highly developed, yet people are unhappy and uneducated.[35] Regarding environmental footprint and human wellbeing, Latin American countries occupy nine of the top ten spots.[36] Panama however came in at 18 while its neighbor, Costa Rica, topped the list. Panama lags Costa Rica in many critical indicators.[37] The HDI indicates that Panama is 10 places behind Costa Rica, yet the HDI does not encompass income equality. Panama has the highest level of income inequality in Central America and the 2nd highest in Latin America.[39] Moreover, public spending on education in Panama is the lowest on record for all of Central America,[40] and in 2006, Panama had an unusually low internet penetration rate of 6.7%.[41]

Panama's policies are subjugated by the heavy hand of its central government[42] and the even heavier hand of corporate interests and their short-term drive for profit. Land use decisions are largely driven by the central Panamanian government and foreign actors who are powerful enough to influence the state. Reducing native deforestation in Panama is crucial.[44] Levels of deforestation and degradation are severe and may be effectively costing Panama tens of billions of dollars annually.[45] However, as long as a trade off exists between the environment and short-term profit, then the environment will likely lose. Deforestation and environmental discounting are not sustainable and livestock's long shadow is not being reflected in Panama's policies.[46] Organic and sustainable methods may generate large benefits for the economy, rural poor, and environment, while also enabling participation in carbon and ES markets.[47] Carbon sequestration (CS) in Panama is potentially attractive owing to high rates of tree growth and carbon uptake, significant amounts of abandoned land, and other potentially large areas of land available for reforestation.[48] Teak is a major cash-crop and relatively adaptable to changing precipitation patterns. However, native species in Panama are not only more sustainable than teak, but can also outperform it in timber volume and carbon storage, while also enabling access to ES markets.

For the longer term political viability of CS projects in Panama, rural communities, poverty, smallholders, the inequality gap and social justice concerns should be addressed. Knowledge bases need developing, particularly regarding forestry and climate variability and change, and policies for reforestation should be reformulated to include the poor by expanding and coupling land titling programs with improved access to capital and equitable benefit sharing.[51] There are numerous benefits of cattle-ranching in Panama, including cultural acceptance and land title via Law 37 of 1962. Agriculture is a relatively small sector which is in need of drastic change.[52] Sustainable methods of farming have significant advantages over intensive and subsistence methods for soil and water, the environment, and human security.[53] However, knowledge, funding, and incentives lack.[54]

4) Conclusions

Panama has a high vulnerability to existing climate variability and future global and climate change, with a low capacity to adapt.[55] As a critical global transport route and biodiversity hotspot, Panama must ensure it can react and respond successfully. With or without global warming, adaptive and institutional capacities should be enhanced, particularly in rural regions and areas of conservation priority, as subsistence and poverty are driving deforestation and land degradation.

Panama's national government must mitigate its poor image and high levels of economic growth and public debt, and is in the best position to vanguard required reforms, attract vital foreign investments, and create sustainable economic alternatives. However, promoting sustainable development and implementing and maintaining market based policies under current conditions in Panama are substantial challenges under current conditions. Significant public funds may be generated from taxes on Panama's minute elite class, large land holders, the ACP, and mining-, timber-, and hydro-companies. Taxes are politically feasible in Panama and may offer a conduit for fostering the necessary conditions to successfully avoid deforestation, and given the uncertainties, a promising and flexible tool for initially funding sustainable development, forestry and agroforestry, and for addressing Panama's poor image and financial, political and socioeconomic inequities. Panama would further benefit from reforming the agricultural sector, from improving the management and coordination of its finances and bodies to enhance stability and transparency, from reducing its heavy reliance on hydropower for electricity and oil and wood for energy, from increasing levels of expenditure on local and rural governments and infrastructure, and from enhancing knowledge bases, technology, and the monitoring and enforcement of laws and rights.

1 The fresh water consumed by the Panama Canal Authority (ACP) is lost to the ocean

2 Graham et al. (2006); Ibanez et al. (2002); Palka (2005)

3 Needed since the water budget is already tight and more water and energy will be required per transit

4 CIA (2009)

5 CIA (2009); World Bank (2006); World Bank SDN (2007)

6 Wholesale inflation hit 17% in 2008 (Cato, 2009; Economist, 2008a)

7 For smallholders and rural centers, the government may subsidize the installation of rainwater storage tanks, particularly in drier regions, to minimize the risks of famine and irrigation dependent agriculture, and to reduce water stress.

8 Ibanez et al. (2002)

9 Graham et al. (2006)

10 Engelbrecht et al. (2007)

11 The Northwest Passage cuts over 6500 km off the journey from Northeast Asia to the USA's east coast (Cressey, 2007; ESA, 2007; Gautier, 2008; Global Envision, 2008; NSIDC, 2007). In September 2009, the Northeast Passage opened for the first time without the assistance of ice-breakers, allowing two commercial German freighters through (Kramer & Revkin, 2009)
Ex-president Jorge Illueca and the former sub-administrator of the Panama Canal Commission, Fernando Manfredo, state that the expansion is not necessary. They claim that the construction of a mega-port on the Pacific side would be sufficient to meet probable future demand (COHA, 2006)

13 Such investments include but are not limited to land and water management infrastructure, forestry projects, and improving roads, railroads, and buildings. In addition, less concrete investments into development plans (e.g. forestry, agricultural R&D), and improving laws, regulations, and knowledge bases (Fankhauser et al., 1999)

14 Graham et al. (2006)

15 See 3.1 Panama's climatic uncertainties, page 40 (Guilyardi, 2006; Müller & Roeckner, 2008)

16 Paeth et al. (2008)

17 Verdon and Franks (2006) indicate that the state of ENSO is strongly coupled with a much larger Pacific Decadal Oscillation (PDO) covering the entire Pacific Ocean. The phase of the PDO can not only change the probability but also the intensity of ENSO. Current models still struggle with ENSO and PDO, and have a long way to go (Joseph and Nigam, 2006)

18 Vovk & Egorova (2009). El Nino is ENSO's warm phase

21 Between 2000 and 2005 less than one fifth of these events were quantified with losses amounting to $20 billion (Magrin et al., 2007)

22 Moreno (2006)

23 Licthenfels et al. (2007); World Bank (2007b)

24 Tschakert et al. (2007)

25 In 2002, 68% of the people near Chagres National Park were subsistence farmers, and in smaller communities, employment was scarce and irregular. Consumption of crops is mostly at the household level. Even the smallest rural settlements were surrounded by pastureland, with few forests and limited crops. Moreover, most land was pasture and owned by non-locals, therefore the incentive to avoid degrading land is limited. In Santa Rosa, 75% of the land area was pasture owned by non-locals (Ibanez et al., 2002; Wallander et al. 2007)

26 Magrin et al. (2007)

27 Harmon et al. (2003)

28 Carbon markets alone are inadequate to address Panama's needs, operating under restrictive rules and imposing significant technical and monitoring issues (Lauterbach, 2007; Nordhaus, 2005; Potvin et al., 2008)

29 CIA (2009); Lichtenfels et al. (2007); Zanin (2005)

30 Wickstrom (2003)

31 World Bank SDN (2007)

32 See 6.2 Moving towards sustainability, page 78. Established perceptions of market risk and reward will dictate these investments (Louka, 2006; Miller, 2008). Panama today is unable to attract the required investments to develop sustainably, and this is partly due to its lax standards, which will need to change sooner or later as the global community seeks to abolish tax havens, improve transparency, and redress global laws and norms, particularly regarding tropical forests and intensive agriculture

33 See 2.2 Deforestation, degradation, and overexploitation, page 12. Poverty in Panama, particularly in rural regions, is a significant proximal driver for land degradation and deforestation. People living in conditions of poverty and subsistence will likely be more geared towards survival rather than sustainable resource management

35 Relatively speaking; Panama is a regional leader in terms of GDP and considered a developed and stable, business friendly democracy, yet poverty levels remain high, human capital is lacking, and Panama's labor force is considered a major impediment to sustainable development (Lichtenfels et al., 2007; World Bank SDN, 2007)

36 Abdallah et al. (2009), measured human wellbeing in relation to resource consumption

37 See 1.1 Panama's Indicators, page 3. A comparison of Costa Rica to Panama is particularly relevant since they share similar resources and populations, and also sharing a similar climate, topography, culture, environment, and susceptibility to extreme events (Magrin et al., 2007; Palka 2005; UNDP HDI, 2008; Yale, 2005; Zanin, 2005). Both countries contain mountainous forested bridges between the Caribbean Sea and the Pacific Ocean, containing high levels of biodiversity. Some significant differences however are that Costa Rica has no military (CIA, 2008), and that Panama is a vital global transport route with large revenues (11% of GDP) from its Canal (ACP, 2008)

[39] UNDP HDI (2008). The CIA (2009), reports that the top 10% of Panama's population consumes half the income or resources

[40] UNDP HDI (2008)

[41] Not only lagging well behind Costa Rica (27.6%), but also below the Latin American average of 18.4%. In 2006, only 5 Latin American countries were behind Panama for internet penetration; Bolivia (6.2%), Honduras (4.8%), Cuba (2.1%), Paraguay (4.3%), and Nicaragua (2.8%). All of these countries have significantly lower incomes per capita; less than half in the best case In 2006, Panama's local governments controlled less than 2% of total public sector expenditures. Law 24 of 1992 is also of concern being primarily geared towards corporate interests and does not provide incentives to small farmers with few resources. In 2001, the total cost to the state from Law 24 claims was over $40 million (Lichtenfeld, 2007 Lichtenfels et al., 2007). Panama's environmental authority, ANAM, is essentially voiceless and powerless with a severely limited budget ($27 million in 2005 or 0.3% of the country's budget) (Potvin et al., 2008). It has no formal say in cabinet meetings or governmental decisions (Lichtenfels et al., 2007), a severely limited capacity to implement and enforce laws (Lichtenfels et al., 2007; Wickstrom, 2003), and unable to control pervasive agricultural activity, even within Chagres national park (Lichtenfels et al., 2007)

[44] Protecting the PCW is a global priority. Market based environmental policy instruments (EPIs) potentially offer an effective method to this end. However, there is substantial evidence indicating that EPIs would find great difficulties in Panama today (Engel et al., 2008; Pagiola et al., 2002)

[45] Result taken from thesis and Sukhdev (2008). See 2.1.2 Natural resources, page 11Restoring old growth forest to its original condition takes 1'000 to 10'000 years (Koellner & Scholz, 2007). Panama this century may therefore be irreversibly incurring an opportunity cost of between $7- $11 billion from lost forest capital annually, and this figure does not consider Panama's incredible biodiversity

[46] For e.g., Law 25 has caused the deforestation and degradation of over 2 million ha by providing heavy subsidies to the cattle ranching industry (Lichtenfeld, 2007)

[47] See 5.2 Environmental policy instruments, page 65. ES are Environmental or Ecosystem Services

[48] According to the UNDP HDI (2008), Panama has approximately three times the carbon pools of Costa Rica. The end result indicates that Panama's forests store significantly more carbon; approximately 137 tC/ha compared to Costa Rica's 81 tC/ha Success ultimately hinges on ensuring permanence and minimizing leakage (Ebeling & Yasue, 2008; Wallander et al., 2007; Myers 2007; Oestreicher et al., 2009; Potvin et al., 2008)

[52] Approximatly 7% of GDP (Economist, 2008a; World Bank, 2006)

[53] See 5.4 Agroforestry, organic farming, and certification, page 69

[54] For e.g. Law 21 of 1997 aimed to replace farming with large scale forestry projects. Degraded lands and soils inhibit forestry projects, as do poor management methods which are typical for smallholders (Zanin, 2005). Panama's smallholders may have been given the view that global warming is advantageous, as more CO_2 indicates faster rates of tree growth, giving incentive to deforest and make way for teak and its large rewards via Law 21 and Law 24 of 1992.
See Chapter 3 Climate change adaptation in Panama, page 36 (Economist, 2008a; Halsnaes et al., 2007; Halsnaes & Verhagen, 2007; Lahsen & Nobre, 2007; Magrin et al., 2007; Metz & Kok, 2008)

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Abbreviations and Acronyms

ABM	Attribute Base Method
ACP	Panama Canal Authority
ADB	African or Asian Development Bank
ANAM	Panama's National Environmental Authority
A/R	Afforestation and Reforestation
BAU	Business as Usual
CAC	Command and Control
C	Carbon
CBA	Cost-Benefit-Analysis
CBD	Convention on Biological Diversity
CCI	Climate Change Index
CDM	Clean Development Mechanism
CEASPA	Provides information and promotes exchanges among smallholders in Panama
CIA	US Central Intelligence Agency
CO2	Carbon Dioxide
CO2e	Carbon Dioxide equivalence
COHA	Council on Hemispheric Affairs
CPI	Corruption Perceptions Index
CS	Carbon Sequestration
CVM	Contingent Valuation Method
EC	European Council
ENSO	El Niño Southern Oscillation
EPCW	Eastern PCW
EPI	Environmental Policy Instrument
EPI	Environmental Performance Index
EPR	European Pressurized Reactor
ES	Ecosystem/Environmental Services (ES)
ESI	Environmental Sustainability Index
EU	European Union
EU ETS	EU Emission Trading Scheme
FAO	UN Food and Agricultural Organization

FCPF	World Bank's Forest Carbon Partnership Facility
FTA	Free Trade Agreement
GACCC	German Advisory Council on Climate Change
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GOP	Government of Panama
GST/VAT	Goods and Services Tax
GNI	Gross National Income
HDI	Human Development Index
ICDP	Integrated Conservation and Development
IPAT	Panama's Tourism Ministry
IPCC	UN Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
IMF	International Monetary Fund
KP	Kyoto Protocol
km^2	Square Kilometers
MDB	Multilateral development banks
MM	Market Mechanism
NASA	US National Space Agency
OECD	Organization for Economic Co-operation and Development
OS	OECD Sustainability
OST	OECD Sustainability Tax
PCW	Panama Canal Watershed
PDO	Pacific Decadal Oscillation
PES	Payments for Ecosystem/Environmental Services
PP	Precautionary Principle
PPP	Purchasing Power Parity (a complicated measure of GDP, particularly difficult to assess for developing countries)
PA	Protected Areas
REDD	Reducing Emissions from Deforestation in Developing countries
RSF	Reporters Without Borders Index
STMP	Sustainable Tourism Master Plan
STRI	Smithsonian Tropical Research Institute

TI	Transparency International
US DOS	US Department of State
UN	United Nations
UNEP	UN Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change WDI
	World Bank's World Development Indicators
WHO	World Health Organization
WTO	World Trade Organization

Preface

I extend sincere gratitude to all those who assisted in the development of this thesis, and my health and education; to the supervisors and NCCR Climate, for their expertise, continuing support and super-vision; to my father, mother and her brother, for their perpetual support and understanding; and to all that sustains us, and which reminds me that diversity is the spice and essence of life.

Given the scope and complexity of this thesis, the conclusions may be read first to gain an overview and an understanding of why many figures and findings are consistently repeated throughout this paper. 11 years after telling my first and only careers councilor that I never wanted to write a paper again for the rest of my life!, my first thesis is produced, and I am reminded that the real sensitivity lies within mathematics and its comprehension, and within understanding how we work. My sincere thanks to Nina for her innate ability to know what to focus on and how to motivate people, and to Werner for his simultaneous attention to detail and the bigger picture which crystallized this thesis. Some truly astronomical figures have persistently perplexed me.[1] What proceeds now, is a general outline of my motivation and perpetual drive for truth and a clearer understanding of our Earth and climate system, and the economics behind what I may best describe as the short-sighted neglect of our environment and happiness.

Our international laws are a global public good and as such a difficult problem to address. The literature suggests a shift to energy efficiency, sustainable development, and adaptation. Economic growth in terms of GDP is not sustainable, and as long as a trade off between short-term profits and the environment exists, then it's the money that talks. Markets are increasingly being turned to in an attempt to redirect the wealth. They are thought to be more efficient, yet they are susceptible to being dominated by market actors. Democracy already performs questionably in the USA, as is manifest with their water, energy, and financial policies. In 2001, Dick Cheney acting as the chair of President Bush's Energy Task Force met with environmentalists once, renewable energy representatives once, then with oil and gas groups over 40 times before forming the USA's energy policy. Donald Rumsfeld (USA Secretary of Defense) announced the day before September 11 (2001) that trillions of dollars went missing from the Pentagon, and the USA's

[1] See for example Appendix 2: Environmental politics and market mechanisms, page A4 and A2.1: Climate change and policy, page A5

Federal Reserve continues to remain unconstitutional and secretive in its processes, even to congress. Democracy in resource rich developing countries tends to function sub-normally, and corruption is facilitated primarily through construction and resource and extraction companies, and, further down the chain, by bankers primarily in London, Singapore, and New York. Most conduct is guided by norms rather than laws which are more effective due to the pressure of conforming. Corporate activity is dictating global norms and as a result, sociopathic leaders and businessmen are being created. Central Banks and the UN Security Council need to act and get rid of pimping bankers who launder money from corrupt politicians and developers in developing countries. Changing our norms and laws is a global public good, and a precursor to addressing other global public goods, in particular, the global climate system and the stability and efficiency of the global financial system. The short sighted UN Security Council, which is responsible for human security, needs more scientific guidance to achieve its task. Not only has he forgotten his spectacles, but he has also forgotten his calculator and way too busy with oil games. Many developing countries face the peculiar situation of being rich in natural resources yet poor in human resources, public infrastructure, and environmental quality. They are facing explosive levels environmental degradation and increasing human security threats. Climate change, for the poor in particular, will make matters worse, particularly if populations remain uneducated and no technological or methodological breakthroughs break through the politics. Technological advancement is a function of our spending, investments, and laws. Living in the stone age of carbon, energy, and emissions intensive methods and technologies is harming millions upon millions of "others" (people), who can not really do much except chop down the forests or get oppressed for attempting to protect their land (our Earth and its resources). The information and knowledge exists, but it takes political will and the will of the greater population, which are however in the shadow of corporate profits. Corruption is a cultural phenomenon cultivated by corporate interests, and there is still no protection for those who would act to assist the state, society, and environment by blowing the whistle on illicit flight and dirty money. Corruption and profit are at odds with the environment and human wellbeing beyond the small group of individuals who gain from such activities. Once our global laws and norms are redressed and financial transparency and stability achieved, we can then move on to addressing the other "white elephant" global public goods; climate, property and land rights, health and happiness, knowledge, peace, and security.

1 Introducing Panama

Panama is a critical global trade link and a conservation priority with incredible levels of biodiversity resulting from its tropical location on the Central American land bridge (Ibanez et al., 2002; Palka, 2005; Graham et al., 2006; Figure 1.1, page 2). Panama's tropical forests attract leading research institutions, bioprospectors, and considerable levels of tourism which is centered primarily about the Panama Canal Watershed (PCW). The PCW delivers approximately 2'000'000 million liters of fresh water annually to the Panama Canal Authority (ACP) (Graham et al., 2006; Kursar et al., 2007; Palka, 2005; Schloegel, 2007), which is by far the most important economic entity in Panama (Lichtenfels et al., 2007).

Panama's service-based economy accounting for 80% of gross domestic product (GDP) makes the country a regional leader in terms of GDP per capita. In spite of this, Panama continues to report highly significant socioeconomic inequity, poverty, and levels of public debt (around half of GDP; CIA, 2008) which indicates fiscal unsustainability (Moreno-Villalaz, 2005). Services in Panama include banking, insurance, container ports, flagship registry, tourism, and operating the Panama Canal (ACP, 2008; CIA, 2008). The ACP's income ($2 billion or ~11% of GDP in 2008; ACP, 2008) derives primarily from the passage of ships; each ship transit results in 200 million liters of fresh water being dumped into the ocean (Dale et al., 2003; Graham et al., 2006; Palka, 2005). In 2006, Panama approved a $5.25 billion project to expand its canal, which will require more water. The project is expected for completion by 2015 (ACP, 2007).

Urbanization, modernization, population and economic growth are increasingly impacting already stressed energy and water supplies (CIA, 2008; Ibanez et al., 2002; PRB, 2009a). Panama recorded economic growth rates of 11.2% in 2007, and 8.6% in 2008 (CIA, 2009), and the Canal expansion project is expected to push economic growth even further (World Bank, 2007a). However, Panama's high levels of economic growth and inability to handle inflation need to be questioned (Cato, 2009; Economist, 2008a). Panama's poor majority and indigenous communities have severely limited capacities to handle increased pricing and adapt to change. 17% wholesale inflation in 2008 represented a 28-year high and was due to Panama's limited capacity to absorb increasing economic stimulus (Economist, 2008a; Wickstrom, 2003).

Water security is a critical concern for Panama, with insufficient sewage treatment and trash collection in the PCW, making streams near large centers heavily polluted (Ibanez et al., 2002). In 1999, water shortages and contamination led to famine (Moreno, 2006). Over 70% of Panamanians now live in urban areas and around a third of the population still lives in poverty (World Bank, 2006; UNDP HDI, 2008).

Panama's rural areas have been largely ignored by the government, resulting in inequity and poverty. Rural Panama consists primarily of pasture land intermingled with small fragments of forest (Ibanez et al., 2002; Zanin, 2005). Degradation, contamination, and deforestation are major concerns that will spread under business as usual (BAU) (Ibanez et al., 2002; Palka, 2005), and as the amount of available agricultural land declines and populations increase, these issues will become more pronounced (Fischer & Vasseur, 2000). Future turmoil is expected for Panama's agricultural sector due to heavy protection (Economist, 2008a; World Bank 2006). The sector faces substantial challenges and accounts for approximately 7% of Panama's GDP (WDI, 2008; World Bank, 2006).

Figure 1.1: A map of Central America (Panama on bottom right)

Source: Magellan (1997)

1.1 Panama's Indicators

By analyzing a range of indicators, Panama's resource use may be partially extracted by a relative comparison with other countries in the region. Of particular relevance, is a comparison with Costa Rica, which is Panama's neighbor and possesses similar resources and populations, and also sharing a similar climate, topography, culture, environment, and susceptibility to extreme events (Magrin et al., 2007; Palka 2005; UNDP HDI, 2008; Yale, 2005; Zanin, 2005). Both countries contain mountainous forested bridges between the Caribbean Sea and the Pacific Ocean, containing high levels of biodiversity. Some significant differences however are that Costa Rica has no military (CIA, 2008), and that Panama is a vital global transport route with large revenues (11% of GDP) from its Canal (ACP, 2008).

Table 1.1: A short summary for some of Panama's indicators

Indicators	Panama	Costa Rica	Winner
Environmental Sustainablity Index (ESI) (Yale, 2005)	Rank 28 (57.7)	Rank 18 (59.6)	Costa Rica
Environmental Performance Index (EPI) (CU, 2008)	32 from 149	5 from 149	Costa Rica
Human Development Index (HDI) (UNDP HDI, 2008)	62 from 177	48 from 177	Costa Rica
HDI % living below poverty line	37.3	22	Costa Rica
HDI % Urban population	70.8	61.7	
HDI % Public expenditure on Education	8.9	18.5	Costa Rica
HDI Gini Index	56.1	49.8	Costa Rica
HDI Forest Area (% total land)	57.7	46.8	Panama
HDI Carbon Stocks in Forests (MtC)	620	192.8	Panama
HDI Population (millions in 2005)	3.2	4.3	
HDI % Internet users (2006) (also at WDI, 2008)	6.7	27.6	Costa Rica
Press Freedom (RSF, 2009)	Rank 54	Rank 21	Costa Rica
Corruption Perceptions Index (TI, 2009)	**Rank 85**	Rank 47	Costa Rica
Ease of Doing Business (World Bank, 2008b)	Rank 81	Rank 117	Panama
Starting a Business (World Bank, 2008b)	**Rank 32**	Rank 123	Panama
Employing Workers (World Bank, 2008b)	**Rank 172**	Rank 77	Costa Rica

N.B. Sources are indicated in first column of table

On comparison with Costa Rica, Panama has many indicators lagging, which points to significant relative inefficiencies in resource uses. Panama may have a great deal to gain from emulating Costa Rica's strategies. These indicators and more are referred to when relevant. Generally, with more natural forests and resources, a strong financial and services sector, and significant and unique revenues from its Canal, Panama has some catching up to do with its neighbor (Tables 1.1 & 1.2).

Table 1.2: 2008 Human development indicators from the United Nations' Development Program

Indicators		Costa Rica	Panama
Human development index (trends)	1975	0.746	0.718
	1980	0.772	0.737
	1985	0.774	0.751
	1990	0.794	0.752
	1995	0.814	0.775
	2000	0.830	0.797
	2005	0.846	0.812
Human poverty index (HPI-1) rank		5	15
Population living below the national poverty line (%)	1990-2004a	22.0	37.3
Population, urban (% of total population)	1975b	41.3	49.0
	2005b	61.7	70.8
	2015b	66.9	77.9
Public expenditure on education (% of total government expenditure)	1991	21.8	18.9
	2002-05c	18.5	8.9
Internet users (per 1,000 people)	1990	0	0
	2005	254	64
GDP per capita (US$)	2005	4,627	4,786
GDP per capita, PPP (2005 international $)	2005d	10,180	7,605
Inequality measures, ratio of richest 10% to poorest 10%	e	37.8	57.5
Gini index	f	49.8	56.1
Imports of goods and services (% of GDP)	1990	36	79
	2005	54	72
Exports of goods and services (% of GDP)	1990	30	87
	2005	48	69
Forest area (% total land)	2005	46.8	57.7
Forest area, average annual change (%)	1990-2005	- 0.4	- 0.1
Carbon stocks in forests (living biomass) (Mt C)	2005g	192.8	620.0

Source: (UNDP HDI, 2008)

2 Panama and its resources

In Panama, all resource bases are well below their potential and this is primarily a function of ineffective and inefficient management and governance. In my analysis, natural resources represent Panama's strongest resource base, since it is a biodiversity hotspot and a conservation priority, with half the country still covered by forest (World Bank, 2006). Capital resources follow next, since Panama is considered a stable democracy with a strong services sector (CIA, 2008; Wallander et al., 2007). Capital resources include all tools used in production, such as infrastructure, computers, machinery, and technology. These however are focused primarily in non-rural areas in Panama (Wickstrom, 2003; Zanin, 2005). Human resources come in at a distant last, as many Panamanians are poor and uneducated, and Panama's labor force is considered a major impediment to sustainable development (Lichtenfels et al., 2007; World Bank, 2007b). Human resources refer to not only how many people are available to work, but also the skills and knowledge that they bring with them.

Figure 2.1a: A qualitative analysis of Panama's resources, their potentials and interactions. While Panama has immense natural resources, all resource bases are significantly below their potentials.

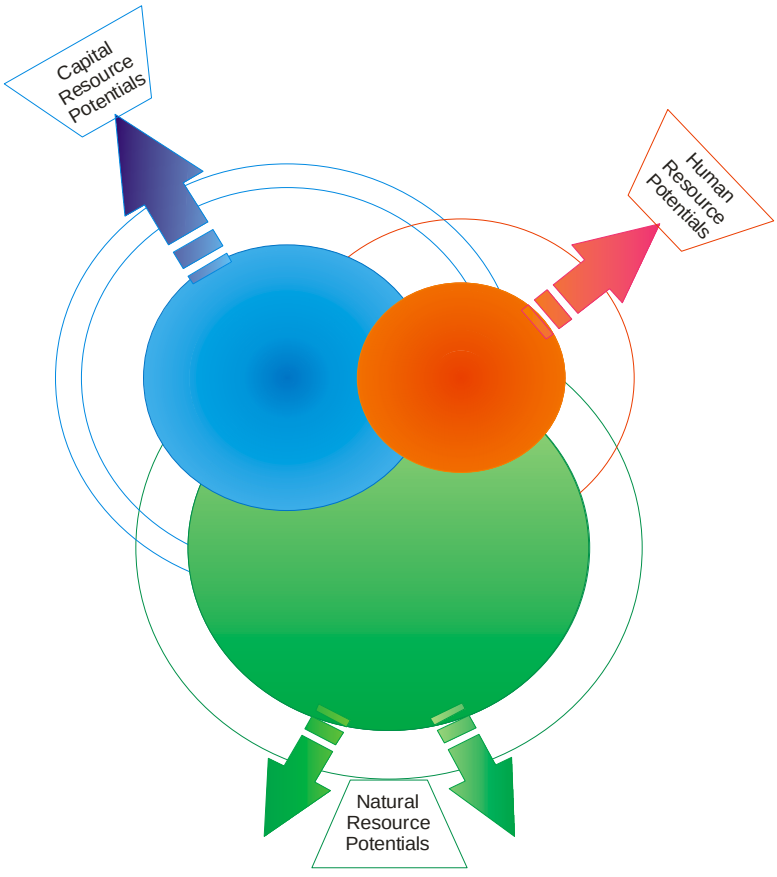
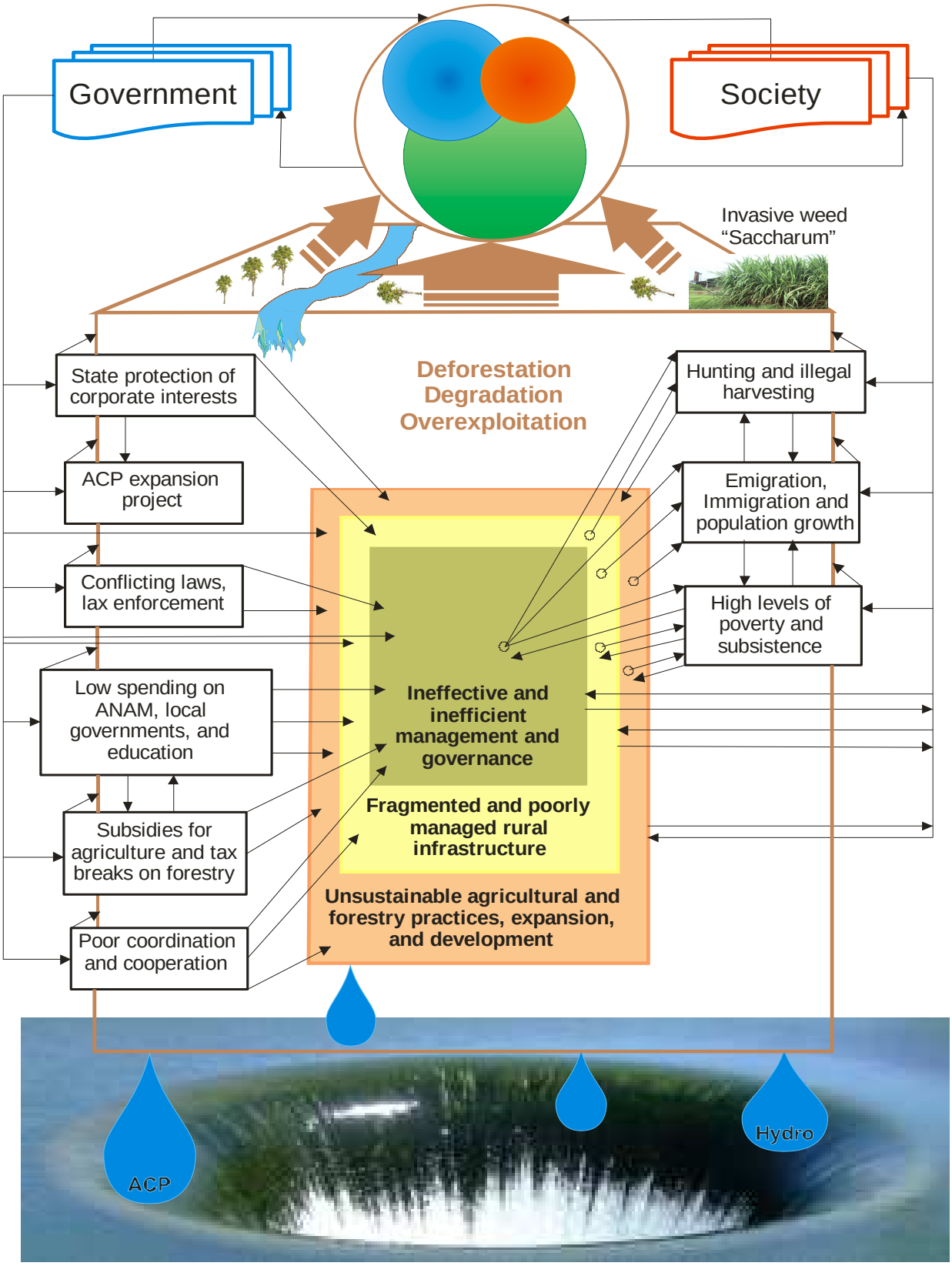


Figure 2.1b: An overview of this chapter and Panama's resource losses
(This graph is used as a discussion framework throughout this thesis)



2.1 Resources

Panama has a history of natural and human resource overexploitation. Poor governance and the significant inequity between the rich and the poor are reflected in many statistics and reports. Since 1904, every Panamanian constitution has dictated the government's right to govern and exploit indigenous lands, resulting in significant levels of degradation and inequality (Wickstrom, 2003).[1] In fact, despite Panama's economic position as a regional leader in gross domestic product (GDP) per capita (World Bank, 2006), its strong natural resource bases (UNDP HDI, 2008; Yale; 2005), and unique income of $2 billion from its canal in 2008 (ACP, 2008), it has the highest level of socioeconomic asymmetry of all Central American countries (UNDP HDI, 2008), and the 2nd highest in Latin America (CIA, 2008). The Gini index[2] (56.1) reveals that Panama has the 14th most inequitable income distribution in the world (UNDP HDI, 2008), while the CIA (2009) reports that the top 10% of Panamanian income earners consume almost half of the country's income or resources. According to Wickstrom (2003), this asymmetry has been politically driven since colonial times. Transnational corporations and Panama's minute elite class have profited immensely from the uneven distribution of resources.

According to the World Bank (2007a), reducing poverty and improving income distribution was one of the five pillars of the Government of Panama's (GOP) vision for 2005-2009.[3] They aimed to achieve this by developing human capital, increasing the use of market-based economic policies, and fostering productivity especially in agriculture (World Bank, 2007a). However there is little evidence to suggest that these goals have been achieved, particularly considering levels of spending on education remain significantly low (UNDP HDI, 2008) and that the Economist (2008) as mentioned earlier reported 17% inflation (a 28 year high) in 2008. Almost the entire (98.4%) indigenous population lives in poverty (World Bank, 2007a), and in 2006, 37% of Panamanians lived in poverty compared to Costa Rica's 22% (UNDP HDI, 2008). The CIA (2009), in its new and updated country profile for Panama (which fails to indicate high levels of corruption, as was clearly outlined in 2008)[4] indicates that poverty has dropped to 29%, however there are a number of issues with this figure that will be explored later on in this chapter.

[1] See Appendix 5: A5.3: Panama's historical context, page A42
[2] Based on the Lorenz curve. 0 is perfect equality and 100 indicates that one person owns all income
[3] See Appendix 5: The Government of Panama (GOP), page A35
[4] See Appendix 5: A5.4, page A55

2.1.1 Human and capital resources

Panama's human resources are severely lacking, representing a major impediment to sustainable development and foreign investments. According to my analysis, this situation is primarily due to Panama's inequitable distribution of capital resources. The Human Development Index (HDI) provides an insight into how Panama performs in terms of its human development and consequently its human resources. However, this index is not a comprehensive measure of human development since it does not encompass important indicators such as gender or income equality and more difficult to measure indicators including but not limited to respect for human rights and political freedoms. The HDI is simply a composite measure of three dimensions of human development; life expectancy, education levels, and standard of living (UNDP HDI, 2008). In terms of the HDI, Panama is ranked 15th while Costa Rica is ranked 5th. However, Panama also has the highest level of income inequality in Central America (UNDP HDI, 2008; Table 2.1), and the 2nd highest in Latin America (CIA, 2008). Panama is therefore far from achieving its human resource potential.

Table 2.1: 2008 Human Development Index (HDI) Report for Central America

Central American Countries

HDI rank	Population living below the national poverty line (%) 1990-2004 a	Population, annual growth rate (%) 1975-2005	2005-15 b	Public expenditure on education (% of total government expenditure) 1991	2002-05 c	Internet users (per 1,000 people) 1990	2005	GDP per capita (US$) 2005	Gini index d	Oil (% of total primary energy supply) 1990 e	2005
High Human Development											
48 Costa Rica	22.0	2.5	1.4	21.8	18.5	0	254	4,627	49.8	48.3	51.4
62 Panama	37.3	2.1	1.6	18.9	8.9f	0	64	4,786	56.1	57.1	71.7
Medium Human Development											
80 Belize	..	2.4	2.0	18.5	18.1	0	130	3,786	..	..	..
103 El Salvador	37.2	1.6	1.3	15.2	20.0	0	93	2,467	52.4	32.0	44.4
110 Nicaragua	47.9	2.2	1.4	12.1	15.0	0	27	954	43.1	29.2	41.4
115 Honduras	50.7	2.6	1.9	..	..	0	36	1,151	53.8	31.1	51.0
118 Guatemala	56.2	2.4	2.4	13.0	..	0	79	2,517	55.1	28.8	40.5

Source: (UNDP HDI, 2008)

Panama has severely lacking knowledge bases and human capital (Lichtenfels et al., 2007). Nevertheless, public investment in education has decreased from 18.9% of government expenditure in 1990 to 8.9% in 2005, and generally government expenditures are low while public debt remains high (UNDP HDI, 2008). In 2004, Panama spent 3.8% of GDP on education (CIA, 2009), and in 2006, Panama had an unusually low proportion of internet users (6.7%), not only lagging well behind Costa Rica (27.6%), but also below the Latin American average of 18.4% (WDI, 2008; UNDP HDI, 2008). This indicates a lack of capital resource investment and likely further inequity between the rich and poor. One might theorize that only Panama's tiny elite class had internet access in 2006. Considering Panama's high percentage in urban areas (71%) and relatively high GDP, a much higher number of internet users in Panama is expected. In fact, in 2006, only five Latin American countries were behind Panama for internet penetration; Bolivia (6.2%), Honduras (4.8%), Cuba (2.1%), Paraguay (4.3%), and Nicaragua (2.8%). All of these countries have significantly lower incomes per capita; less than half in the best case (Paraguay; $4040 PPP) and less than fifth in the worst case (Nicaragua; $930 GNI). Panama's GDP in terms of PPP in 2006 was $9204 and its GNI was $4890 (UNDP HDI, 2008).[1]

The Reporters Without Borders index reflects the degree of freedom that journalists and news organizations enjoy. Panama (ranked 54) significantly lags behind Costa Rica (ranked 21) (RSF, 2008). A significant issue for Panama is that bloggers (internet reporters) are now threatened as much as journalists in traditional media (RSF, 2009).[2] One might then calculate that if Panama had an average internet penetration rate of about 20% instead of 6.7% in 2006, then bloggers would be hassled accordingly, and the ranking for Panama may be significantly worse. Furthermore, with more internet reporters, Panama's image may be damaged; this may be a motive behind keeping internet penetration rates low, particularly in rural and indigenous regions. March 2009 figures reveal that Panama has significantly increased its internet penetration rate to 22.5%, yet it still lags well behind Costa Rica (35.7%) and also is below Latin American and world average rates (IWS, 2009). Therefore it may be deduced that Panama has recently increased its capital resources directly and human resources indirectly. Panama however may have simply benefited from the technology boom without significantly increasing spending, since such technology often has a substantial filter down effect with people upgrading their computers every few years.

[1] See page T8 for acronyms; PPP, GNI, GDP… etc…
[2] See Appendix 4.1: Media coverage in Panama, page A24

2.1.2 Natural resources

The Environmental Performance Index (EPI) is self explanatory and indicates that Panama is not using its natural resources as effectively as Costa Rica. It is gauged using 25 indicators covering 6 well-established policy categories. Costa Rica (ranked 5), is outperforming Panama (ranked 32) environmentally (CU, 2008). Panamanians need resources, instruments, and methods to more efficiently use the available land. According to Panama's environmental protection agency (ANAM), natural resource losses are primarily due to an irresponsible society and its style of development, poor waste management, and deforestation (FCPF, 2008). However, in Panama, particularly in rural regions, there is a scarcity of people who can capably manage and support natural resources and develop sustainable land use programs (Lichtenfels et al., 2007; World Bank, 2007a).

The lack of human resources and capacity to develop sustainably in Panama is of primary concern for Panama's government. Panamanians generally lack the necessary skills and knowledge to behave in a sustainable manner which is a significant developmental issue (Lichtenfels et al., 2007). One of Panama's five pillars in its five-year vision was to develop human capital by increasing the competitiveness of Panama's labor force while making health and education services an engine for reducing inequality (World Bank, 2007a).[1] However, this fails to effectively address the sustainability issue by not explicitly addressing a prime concern; knowledge regarding forestry is severely limited in Panama, with no forestry schools (Fischer & Vasseur, 2000; Wallander et al., 2007). The GOP's 2005-2009 Agricultural Strategic Plan "Let's Get to Work"[2] does not appear to effectively address Panama's primary environmental concerns either. Instead in outlines Panama's need to improve yields and reduce unit production costs and rural poverty, thereby improving sustainability and ensuring the profitability and competitiveness of production (World Bank, 2007a). This appears to be expanding intensive crops and livestock further, and more geared for trade, economic growth, and industrialized methods rather than agricultural sustainability.

To address evaluating natural resource losses[3] the European Council (EC) commissioned Pavan Sukhdev, the Managing Director of Deutsche Bank's Global Markets business in India, to head a study on quantifying forest capital loss. Sukhdev (2008) calculated that on an annual basis, $2-4.5 trillion is unaccounted for due to losses taking

[1] See Appendix 5: The Government of Panama (GOP), page A35
[2] See Appendix 5: A5.3, page A36
[3] See Figure 2.1, page 5

place as a result of deforestation and land degradation. They estimated the loss in human welfare as a capital item. This loss is still not accounted for in current markets and represents a significant equity issue, particularly for the many forest dwellers, and those whose lands have been degraded and polluted while receiving little to nothing in return and being unable to adequately represent themselves.[1] Assuming a total global deforestation rate of 14.6 million ha/year (FAO, 2006), this figure at minimum equates to: $2 trillion/14.6 million hectares (ha) = $137'000/ha. It is given that not all forest capital loss is from deforestation however, since deforestation often removes the most significant amount of forest services resulting in the most severe levels of land degradation and ecosystem failure (Koellner & Scholz; 2007), I assume this figure is close enough to work with and well within an order of magnitude.

In Panama, primary deforestation is occurring at a rate of 50'000 – 80'000 ha/year (Potvin et al., 2008). Koellner & Scholz (2007) indicate that it takes 1'000 to 10'000 years to restore and old growth forest to its original condition. Panama this century and in those to come may therefore be irreversibly incurring an opportunity cost of between $7- $11 billion from lost forest capital annually. This figure may not be precise however it indicates significant resource losses in Panama, and from an economic viewpoint, the benefits far outweigh the costs. Considering Panama's incredible biodiversity, and that natural forests play a larger role in regulating the global climate than previously thought and will likely become increasingly important (Le Quereet al., 2007; Stephens et al., 2007), this figure may likely be on the very low end. Moreover, agricultural expansion is a primary driver of deforestation in Panama yet it only accounts for approximately 7% of Panama's GDP (CIA, 2009). Theoretically, if Panama completely removes agriculture from its economy it would lose approximately $1.4 billion of GDP but may conserve tens of billions of dollars annually from protecting its forest capital. Panama may not directly notice this loss in capital in the short term, however, net agricultural expansion alone may be costing Panama's economy approximately $10 billion annually. Therefore, simply by halting all agricultural expansion and intensive developments, Panama would stand to lose at most $1.4 billion in GDP; the net effect would mean an annual gain for Panama of at minimum $5.6 billion. Removing agricultural subsidies and incorporating Panama's incredible levels of biodiversity would significantly add to this figure.

[1] See Appendix 4: A4.1: Media coverage in Panama, page A24

2.2 Deforestation, degradation, and overexploitation

Panama's severe levels of native deforestation, environmental degradation, poverty, and overexploitation represent major concerns for sustainability and the continuing operation of the Panama Canal. If Panama plans to sustainably develop, then its ecosystems and poor majority need further protection and significant levels of natural resource losses should be minimized. Specifically, government overexploitation, incentives, subsidies, laws, and protection of corporate interests drive natural resource losses and deforestation from the outside (distally) while poverty, subsistence, outdated methods, and population growth eat away at it from the inside (proximally) (FCPF, 2008; Wickstrom, 2003; World Bank, 2006; Zanin, 2005). Approximately one third of Panama's forests are currently in governmental protected areas (PA)[1]. Outside these areas however, rapid native deforestation (50'000-80'000 ha/year) is occurring. This is the crucial environmental issue to address (Dale et al, 2003; FCPF, 2008; Potvin et al, 2008; World Bank, 2006).

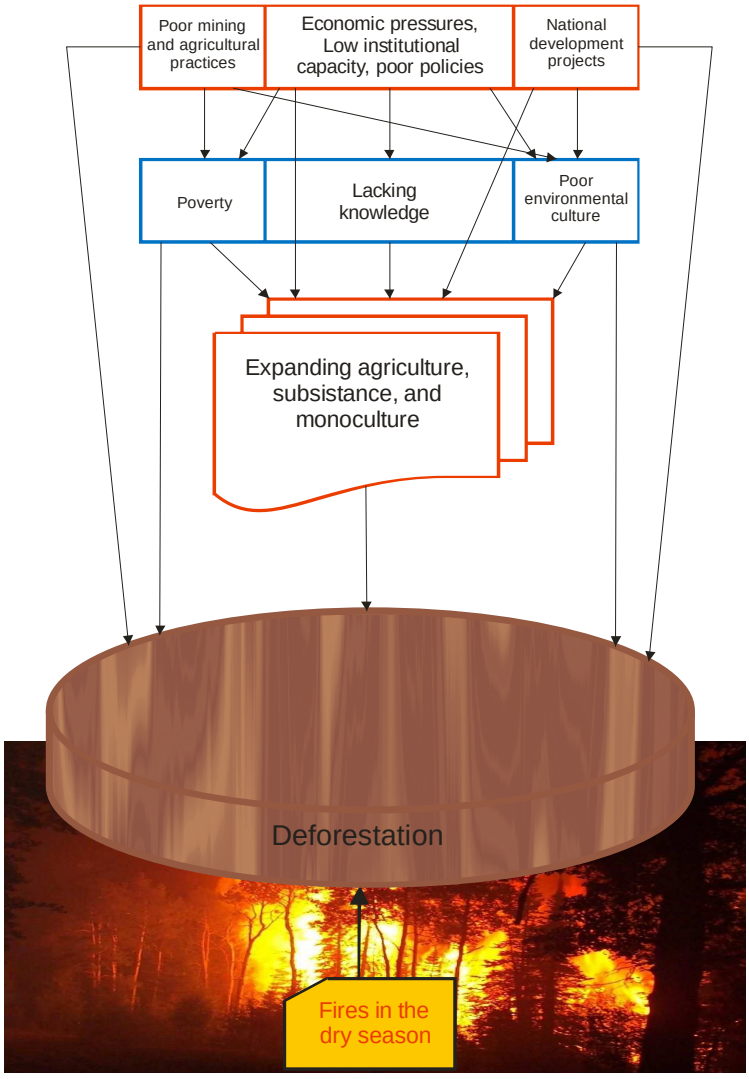
The Government of Panama (GOP) had a five-year vision (2005-2009) for the social and economic development of the country (World Bank, 2007a).[2] This strategy fails to explicitly address or mention any environmental concerns. It does however seek to transform the public sector into a vehicle that serves Panama's citizens (World Bank, 2007a), further indicating the GOP's poor governance record. This vision also aims to lower poverty to approximately 30% by 2009 through investments in human capital (modernizing education and training), the expansion of pre-school education, primary health care, and nutrition and basic infrastructure, particularly in poor and indigenous regions (World Bank, 2008a). However, it appears that poverty was primarily reduced by the short term burst in economic growth from Panama's expansion project.[3] Furthermore, the overall equity and human security gains from decreased poverty levels may effectively be negated by 28-year high inflation levels (Economist, 2008a).

Geist & Lambin (2002) analyzed 152 case studies on tropical deforestation, concluding that the primary causes of deforestation and degradation at the regional scale are economic pressures, institutions, and national policies combined with remote influences which all combine to drive local agricultural expansion and associated degradation. Major drivers of deforestation in Panama from other sources more specifically indicate economic

[1] See Figure 6.3, page 85
[2] See Appendix 5: A5.1, page A36
[3] See section 2.2.3, page 17

pressures and inequity, lacking institutional capacity, governance and knowledge bases, outdated methods of extraction and production, and poverty (FCPF, 2008; Fischer & Vasseur, 2000; Wallander et al., 2007; World Bank, 2007a; Wunder, 2005; Figure 2.2).

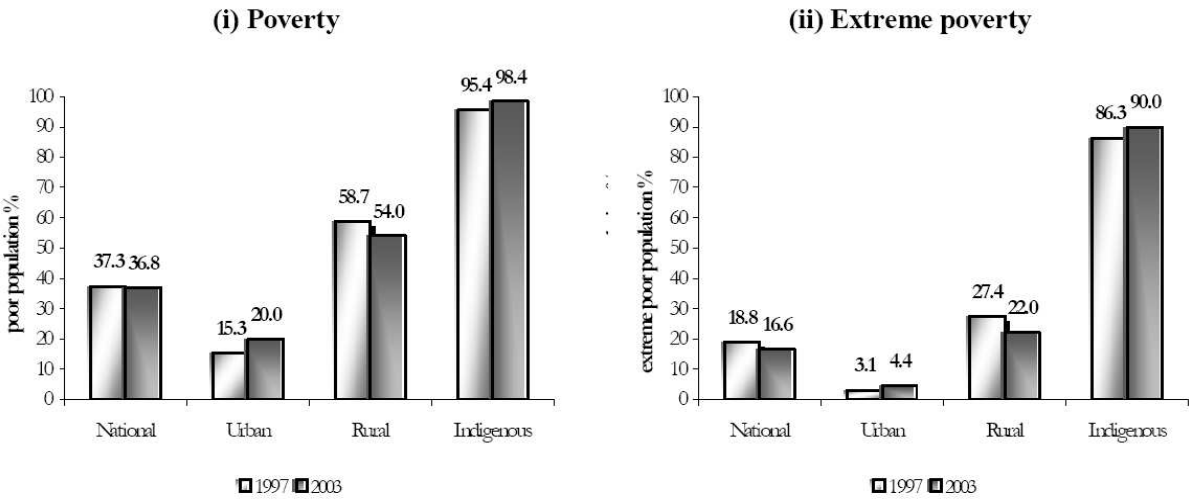
Figure 2.2: The complex drivers of deforestation in Panama



Sources: FCPF, (2008); Fischer & Vasseur, (2000); Wallander et al. (2007); World Bank, (2007a); Wunder, (2005)

Wickstrom (2003) also centers the argument on the GOP and further emphasizes the "devastating overexploitation" of Panama's indigenous peoples and lands, revealing that approximately three quarters of the mining concessions in Panama are on indigenous and forest lands while little is returned into their associated regions and communities. From 1997 to 2003, urban and indigenous poverty increased in Panama. In 2003, 98.4% of those living in indigenous areas lived in poverty, while 90% lived in extreme poverty (World Bank, 2006; Figure 2.3). Particular attention needs to be given to indigenes in Panama, since they are increasingly facing poverty and interacting with markets as economic pressures rise (World Bank, 2007a).

Figure 2.3: Poverty and extreme poverty in Panama



Source: World Bank (2007a)

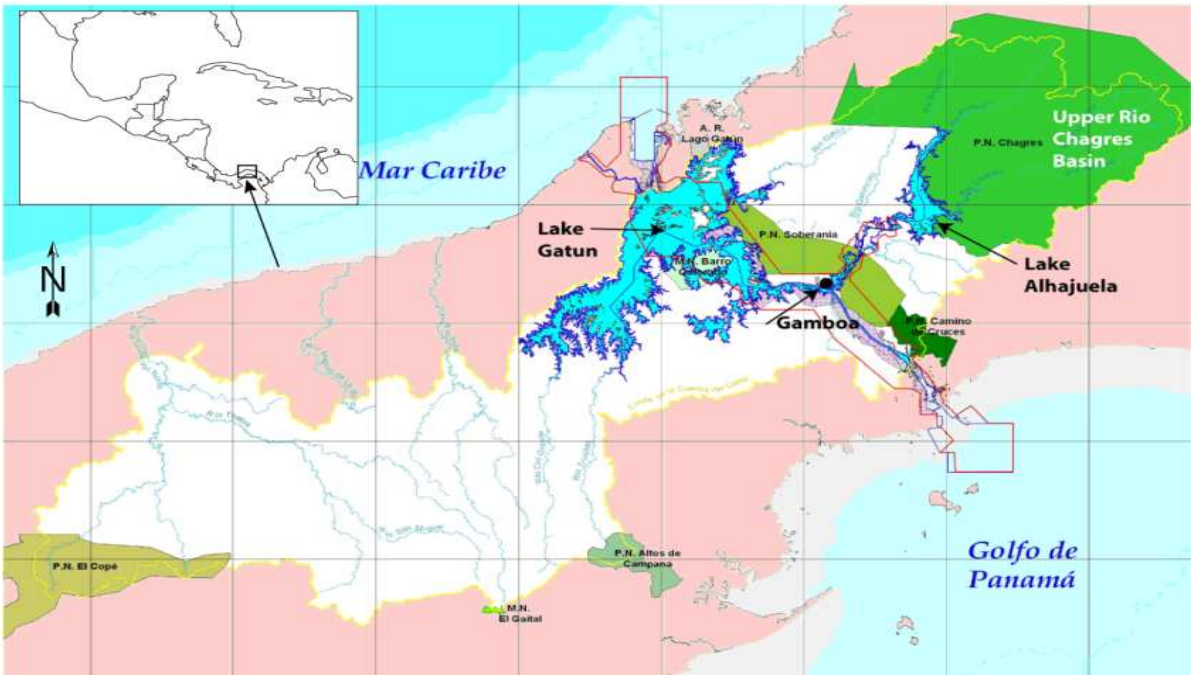
Poverty in Panama, particularly in rural regions, is a significant proximal driver for land degradation and deforestation. People living in conditions of poverty and subsistence will likely be more geared towards survival rather than sustainable resource management (Pagiola et al, 2003). Such behavior is evident in Panama's extremely degraded and contaminated large towns and rural centers (Ibanez et al., 2002). This will likely continue under BAU and the pressure on resources is likely to increase as the population and economy grows. Of particular concern is that the PCW's human population is increasing (Ibanez et al., 2002; World Bank, 2007b).

2.2.2 The Panama Canal watershed

The Panama Canal watershed (PCW) has an area of approximately 3300 square kilometers (km^2) and its boundaries are defined and protected by Panamanian law since the PCW and its dense tropical rainforest are vital natural resources for the country (Harmon et al., 2003; Palka, 2005), providing the Canal with fresh water while also supporting hydropower, ecosystems, agriculture, ranching, forestry, and suburban life (Graham et al., 2006; Ibanez et al., 2002; Palka, 2005).

Lake Gatun is used to regulate flow in the Panama Canal and is fed by a number of rivers and streams, the largest and most important of which is the pristine Rio Chagres (Palka, 2005; Harmon et al., 2003; Figure 2.4), which currently provides almost half of the fresh water necessary to operate the Canal while also providing the drinking water for residents of Panama City and Colón (nearly half of the country's population of 3.5 million) (Palka, 2005; Wang & Georgakakos, 2007).

Figure 2.4: A map of Panama showing the major basins and lakes of the Panama Canal Watershed (PCW)



Source: UOC (2008)

Of the water directly withdrawn from the entire PCW, 58% is used to operate the canal locks, 36% for hydro-electricity, and 6% for drinking water (Graham et al., 2006). Currently, the 80 km long Panama Canal[1] can pass one ship at a time and up to 40 ships per day. Each ship transit results in 200 million liters of fresh water being lost to the ocean (BBC, 2006; Dale et al., 2003; Graham et al., 2006; Figure 2.6, page 18). One month of full operations uses around one third of useful lake volume, which results in a strict dependence on precipitation, and is a major concern in the dry season (Condit; 1998; Graham et al., 2006; Wang & Georgakakos, 2007). The Panama Canal Authority (ACP), in response to the pressure of limited water resources, has considered the construction of another lake in the western portion of the PCW (Harmon et al., 2003; Vargas, 2003).

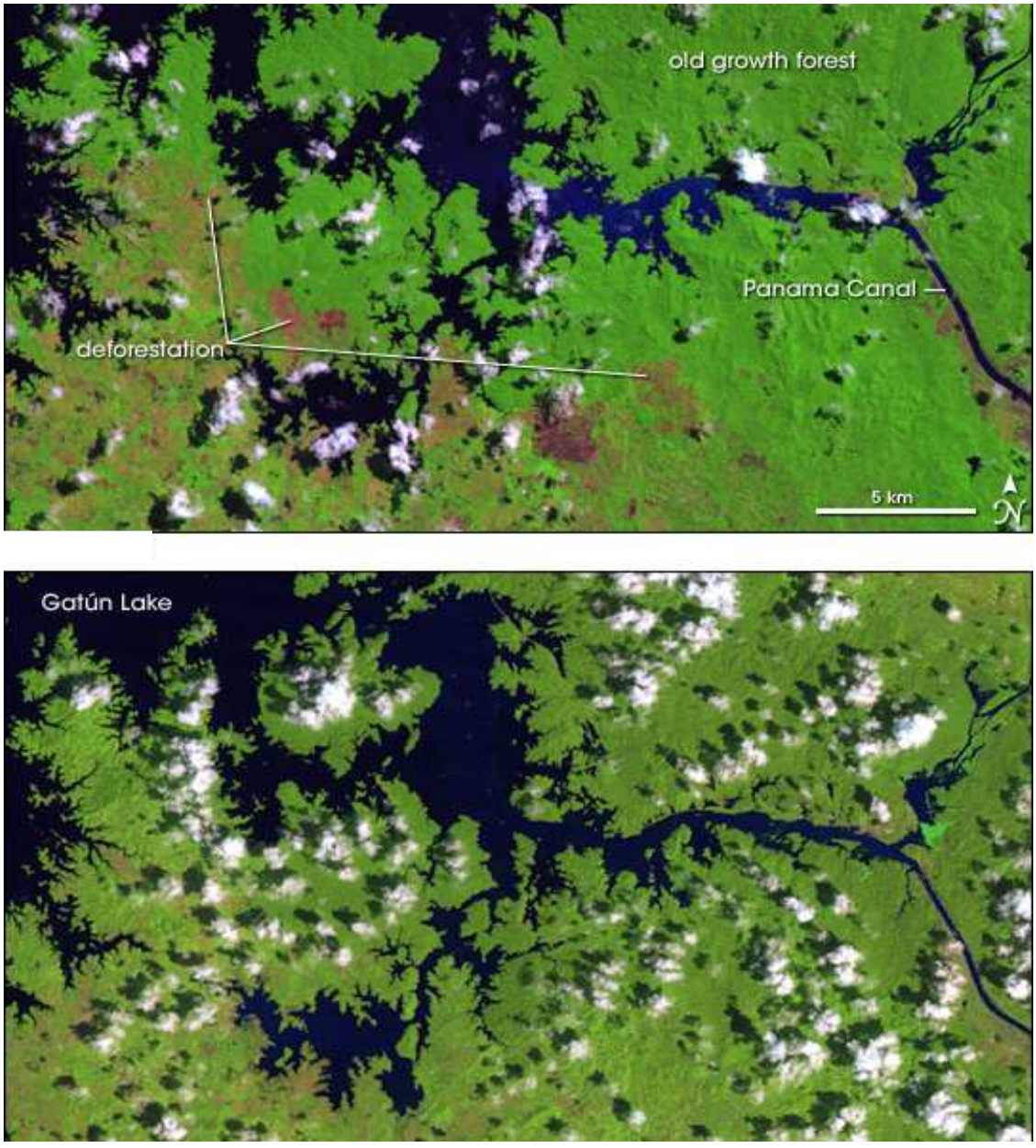
Any significant change in land use in the PCW requires close attention since its water budget is tight with increasing demand from expanding agriculture, urbanization, populations, and the expansion project (Lictenfels et al., 2007; Dale et al., 2003). Two exotic species to Panama are not only using up significant amounts of land, but are also responsible for substantial levels of land degradation and are increasing water stresses further; *Saccharum spontaneum* (SS) and teak. The exotic weed, SS, is invading abandoned sites in the PCW, attaining an average height of 2.5 m and growing in dense, impenetrable stands. It is adapted to drought, burns frequently, and does not yield to weeding, mulching, fire, or deep plowing. In addition, pasture grasses such as SS significantly decrease soil moisture due to their dense root mass (Hooper et al., 2002). The other concern is that virtually all commercial planting within the PCW has been with teak, which according to numerous studies has significant undesirable effects in Panama (Aylward 2002; Calder 2007; Zanin 2005). Calder (2007) indicates that the expected erosion, sedimentation, and water quality benefits from afforestation may not be realized since most of the plantations are teak, and evidence suggests that it also supports low levels of plant biodiversity and reduces annual flows, and if there is no significant effect on low flows then the capacity of the Canal may be reduced by up to 10%.

Law 21 of 1997 was introduced to reduce cattle farming in the Eastern PCW (EPCW) from 127,000 to 7,000 hectares by 2025 (Dale et al., 2003). Law 21 may be expanding the agricultural frontier and deforestation by effectively shifting cattle around Panama. Potvin et al. (2008) indicate that leakage in Panama may be significant since subsistence is at stake and limited alternatives. Law 21 may also offer incentive to deforest via the implication that teak is a plantation worthy of investment. One may possibly deforest natural habitats to

[1] See Figure 2.6, page 18. 80 km is in one direction from point A to point B

provide fertile ground for teak while reaping tax breaks from Law 24 of 1992 and selling native timber and claiming land title through Law 37 of 1962 (discussed later).

Figure 2.5: Deforestation around the Panama Canal; 1986 (below) and 2002 (top)

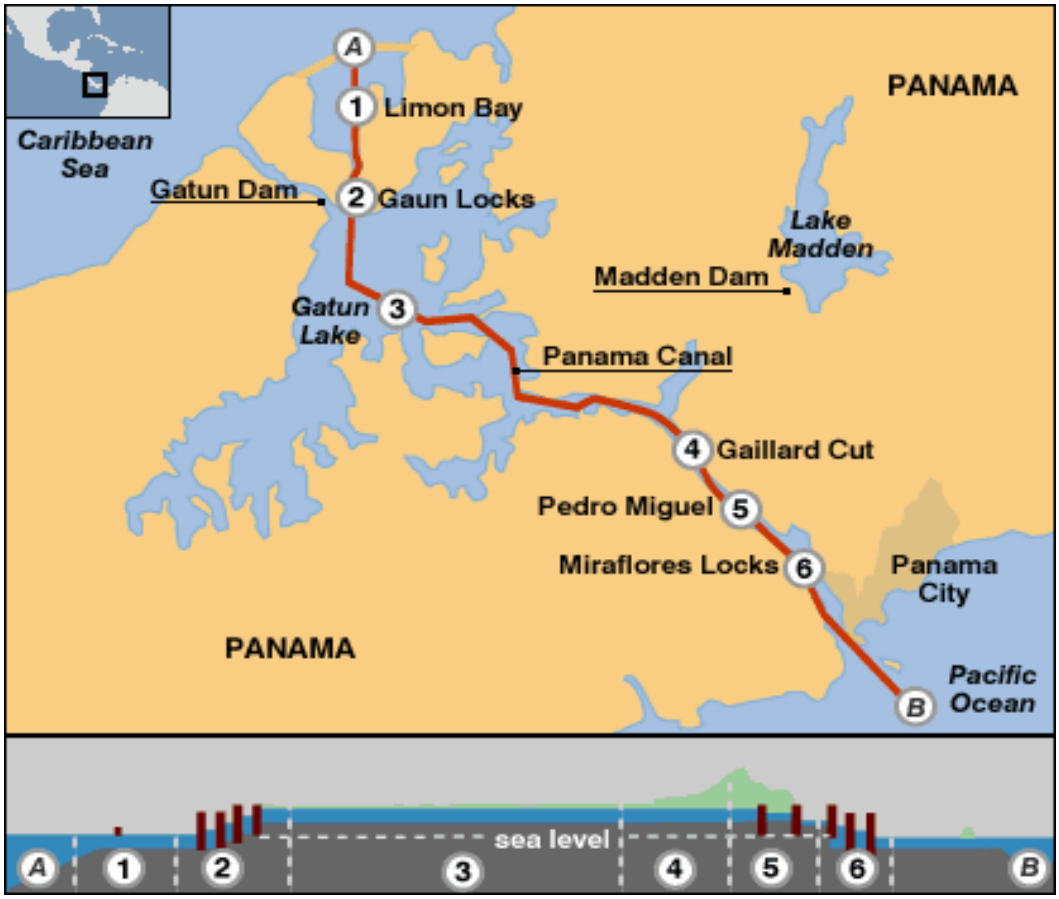


Source: NASA (2002)

2.2.3 The Panama Canal expansion project

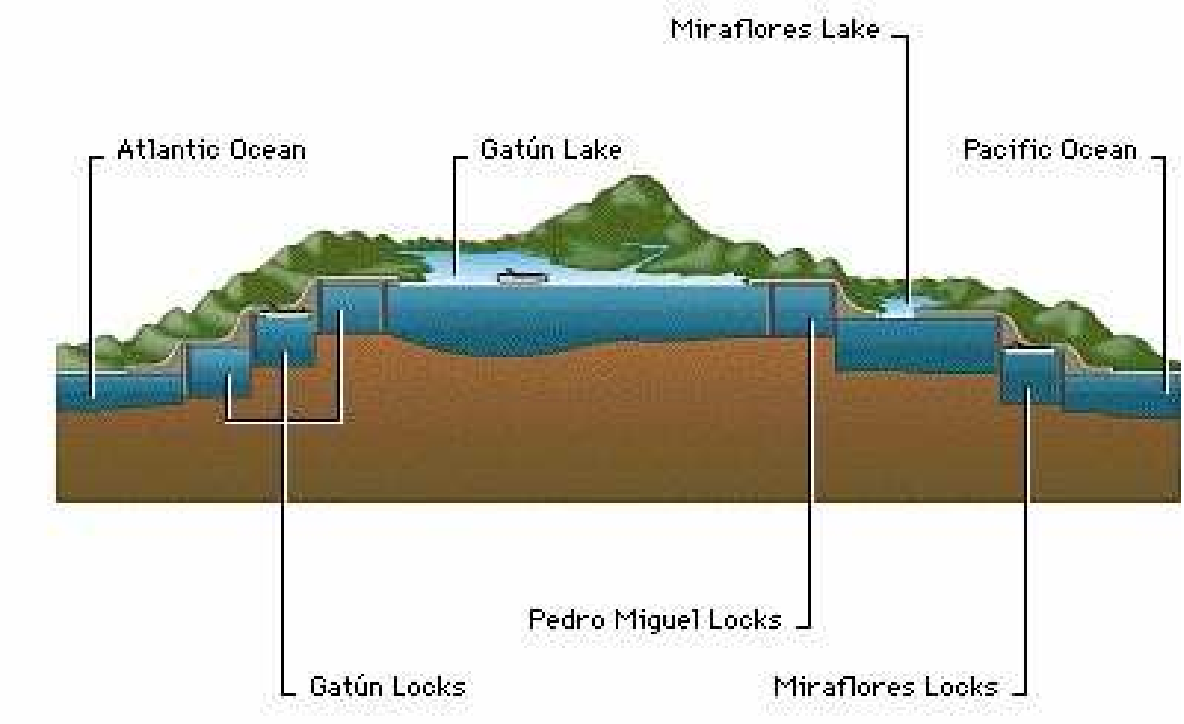
The Panama Canal is critical to Panama's economy and future, connecting the Pacific and Atlantic Oceans and handling an estimated 5% of total global trade (BBC, 2006; Graham et al., 2006; Ibanez et al., 2002; Palka, 2005). The Panama Canal and the health of the PCW and its rainforests are dependent upon a favorable climate and compatible human activities. Priority issues include landuse, water supply, population growth, deforestation, erosion, and reservoir sedimentation (Harmon et al., 2003; Ibanez et al., 2002; Palka, 2005). Failure to address these issues may result in substantial and immediate (and possibly long term) economic loss (Graham et al., 2006).

Figure 2.6: The Panama Canal route



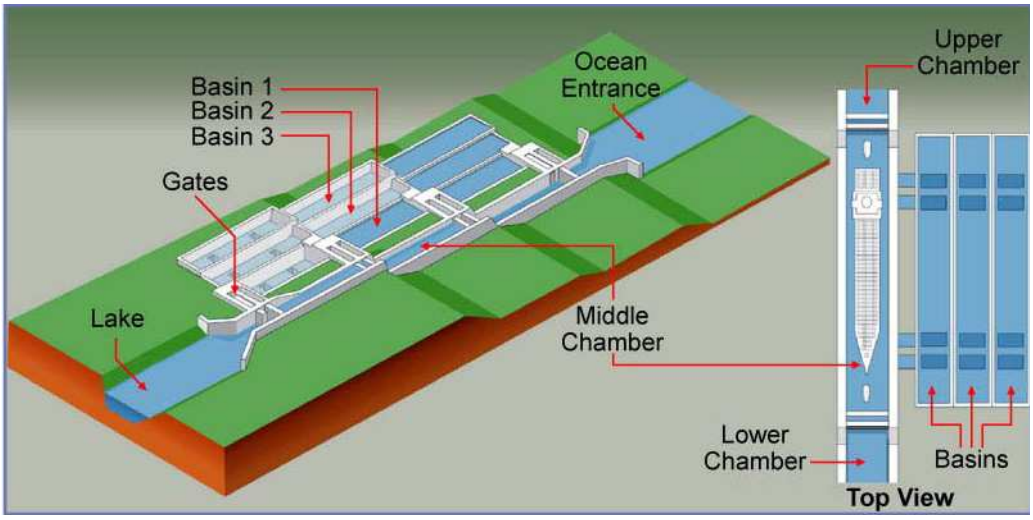
Source: BBC (2006)

Figure 2.7: A sectional view of the Panama Canal and its locks



Source: Panama Cruise (2008)

Figure 2.8: Isometric view of the new locks complex



Source: ACP (2006)

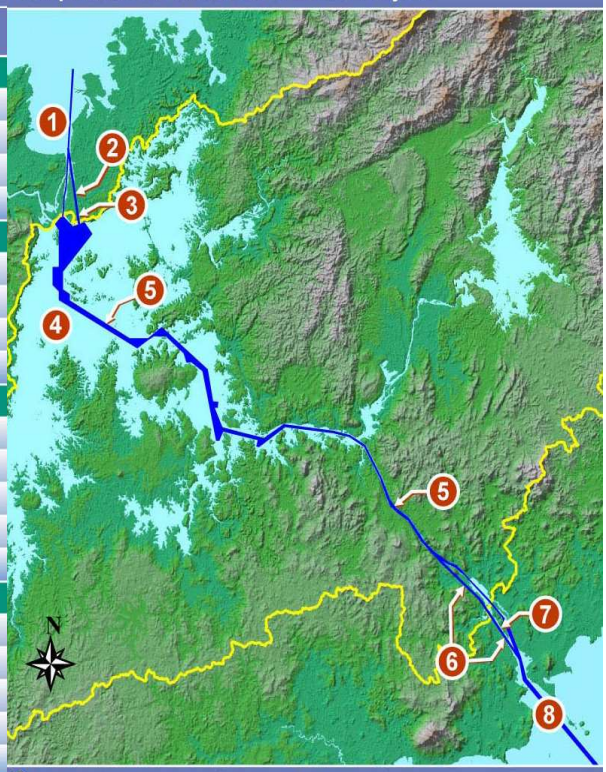
In October 2006, Panamanians approved a $5.25 billion project to expand their Canal "Third Set of Locks" (Figures 2.6 - 2.9). The ACP will reforest an area twice as large as the forest area that was cleared for the construction of the Project (ACP, 2007). Questions arise however as to where and with what they will reforest with, and the extent and nature of the clearing undertaken. Expanding the capacity of the canal under their current framework does not appear to adequately address climate change or the PCW and its forests.

Figure 2.9: The Third Set of Locks project

Cost Estimate for the Third Set of Locks Project

Project Components	Investment Estimate*
New Locks	
Atlantic Locks	1,110
Pacific Locks	1,030
Contingency for New Locks**	590
Total for New Locks	**2,730**
Water Saving Basins	
Atlantic Water Saving Basins	270
Pacific Water Saving Basins	210
Contingency for Water Saving Basins**	140
Total for Water Saving Basins	**620**
Access Channels for New Locks	
Atlantic Access Channels (Dredging)	70
Pacific Access Channels (Dry Excavation)	400
Pacific Access Channels (Dredging)	180
Contingency for Access Channels**	170
Total for New Locks Access Channels	**820**
Existing Navigational Channel Improvements	
Deepening and Widening of Atlantic Entrance	30
Widening of the Gatun Lake Channels	90
Deepening and Widening of Pacific Entrance	120
Contingency for Existing Channel Improvements**	50
Total for Navigational Channel Improvements	**290**
Water Supply Improvements	
Increase the Maximum Level of Gatun Lake to 27.1m (89') PLD	30
Deepening of the Navigational Channels to 9.1m (30') PLD	150
Contingency for Water Supply Improvements**	80
Total for Water Supply Improvements	**260**
Inflation During the Construction Period* **	**530**
Total Investment	**5,250 M***

Components of Third Set of Locks Project



1. Deepening and widening of the Atlantic entrance channel
2. New approach channel for the Atlantic Post-Panamax locks
3. Atlantic Post-Panamax locks with 3 water saving basins per lock chamber
4. Raise the maximum Gatun lake operating water level
5. Widening and deepening of the navigational channel of the Gatun lake and the Culebra Cut
6. New approach channel for the Pacific Post-Panamax locks
7. Pacific Post-Panamax locks with 3 water saving basins per lock chamber
8. Deepening and widening of the Pacific entrance channel

Source: ACP (2006)

From my analysis of the $5.25 billion ACP expansion project, there appears to be insufficient planning not only to address climate change and climate variability, but also for improving equity and water security. Halsnaes et al. (2008) indicates that despite the vulnerability of many development projects, most of them routinely overlook climate change.

Of the total projected cost of $5250 million, $260 million has been allocated for "Water Supply Improvements", while $620 million has been allocated for "Water Saving Basins". In total, it appears that $880 million (16.7% of project budget) has been allocated to its own water supply and security (needed since the water budget is already tight and more water and energy will be required per transit), but 0% of its budget on the PCW and its forests, and upstream water and soil quality and quantity (ACP, 2007; Figure 2.8). Panama already suffers energy and water stress and it is unclear how much additional water and energy will be used for each transit (Figure 2.9; Figure 6.5, page 89). Even if the ACP was not consuming additional water and energy, it has still been dumping 200 million liters of fresh water per ship transit into the ocean, with up to 40 ships passing per day (Graham et al., 2006), while poverty and energy and water stress remain as significant challenges to sustainability. This represents equity and security concerns as the ACP is in competition with the sectors of energy, agriculture, and forestry, while subsistence farmers and the population also require this water.

The expansion project began in 2007 and is expected to be completed around 2015. It could potentially double the Canal's capacity, significantly increase revenues and create jobs (ACP 2006/7; World Bank, 2007a). In addition, it may transfer technology and build capacity. However, of particular concern for Panama is its limited capacity to handle high levels of economic growth without agitating inflation (Economist, 2008a). The World Bank (2007a) reports that the expansion project will push economic growth further. In 2007, Panama recorded a growth rate of 11.7% (CIA, 2008). Speth (2008) argues that GDP growth is no longer the answer for addressing real socioeconomic growth, particularly in developing countries such as Panama. Economic growth must be redressed to incorporate the promotion of human wellbeing and nature. His results suggest that government is the principle means by which to address this problem. However, developing countries are all currently hooked on GDP growth (excepting Bhutan which has replaced GDP with Gross Domestic Happiness (GDH)).

One of Panama's five pillars in its five-year vision was to create employment through economic growth policy (World Bank, 2007a).[1] This was to be achieved by opening to international competition, developing export infrastructure, removing distortions and reducing transaction costs for investors, and improving urban transport (World Bank, 2007a). These however remain as significant concerns for Panama and will be explored later. It appears the GOP may have implemented the expansion project simply as a conduit for achieving one of its promises. In fact, the CIA (2009) notes in its new and updated website (which fails to mention high levels of corruption, as was clearly indicated in their 2008 version) that Panama, through economic growth from its expansion project, has managed to reduce poverty to 29%. Inflation however reached a 28-year high in 2008 (17.1%) due to the economy's limited capacity to handle economic growth (Economist, 2008a). This would likely have a significant impact on Panama's poor majority and the fact that poverty was reduced to 29% in light of this figure and Speth's (2008) results may be statistically irrelevant since equity was very likely further reduced while degradation continued.

Panama has a strong history of corruption and corporate protection while exploiting its largely uneducated and mostly poor population (CIA, 2008; US DOS, 2008; Wickstrom, 2003; World Bank, 2008a).[2] Two sectors stand out as requiring particular attention regarding corruption in Panama; resource and extraction, and construction companies. The problem is that these companies are predominately transnational companies (Collier, 2008) and the influence of the USA in Panama is strong due to the Panama Canal and Panama's strategic location. This may also be linked to the OECD (Organization for Economic Co-operation and Development) and the method in which economic development has been pursued up until very recently. In 1999, after a lot of pressure, the OECD managed to get an agreement among its member states to "make bribery of a public official in a foreign country an offense". However the private sector remains unaffected and there is still no protection for whistle blowers. Corruption remains since these laws are rarely enforced. Collier (2008) sarcastically comments "well at least bribes are no longer tax deductible!"

Collier (2008) also indicates that by the time natural resource incomes exceed 8% of GNI (Gross National Income), the net effect of democracy is adverse. Moreover, resource rich democracies not only under-invest, but invest badly, with too many "white elephant" projects. Panama's GNI was $18.4 billion in 2008 (World Bank, 2008b), with revenues of $2 billion from the canal (ACP, 2008), which represents approximately 11% of GNI. It may be

[1] See Appendix 5: A5.1, page A38
[2] See Appendix 4: Corruption, page A22 and Appendix 5: A5.3, page A42

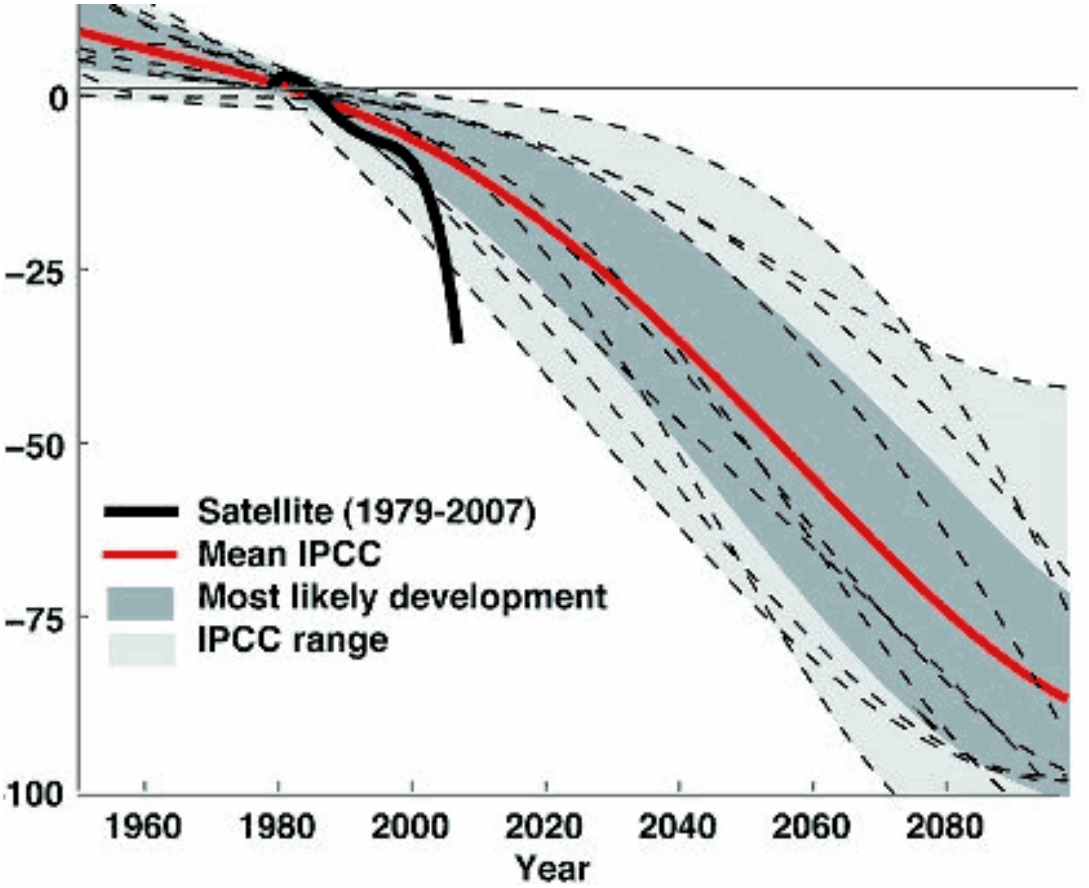
that Panama falls into the category of a resource rich malfunctioning democracy with a "white elephant" candidate; the ACP expansion project. In fact, ex-president Jorge Illueca and the former sub-administrator of the Panama Canal Commission, Fernando Manfredo, state that the expansion is not necessary. They claim that the construction of a mega-port on the Pacific side would be sufficient to meet probable future demand (COHA, 2006).

The precautionary principle appears to have been ignored by the expansion project. It implies that a lack of full scientific consensus should not be used as an excuse to ignore potential environmental issues and was reiterated in the 1992 Rio Declaration: (Principle 15) "In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation". Of concern is that the EU and the USA have taken opposite approaches thus far in their interpretation of this principle. The US has viewed the precautionary principle as if it were a protectionist principle, a new non-tariff barrier to trade. On the other hand, the EU has taken it as having so much weight that it has all but transformed it into a constitutional principle (Louka, 2006).

El-Nino Southern Oscillation (ENSO) is a major concern for Panama and the Panama Canal, and the effects of climate change on ENSO are still unknown as are the mechanisms behind ENSO itself (Paeth et al., 2007).[1] Climate variability is a major concern for Panama and changing rainfall patterns, sea level rise, and Arctic ice melt which may open the fabled "Northwest Passage" are all factors which imply a precautionary approach needs to be taken in developing the Panama Canal. However there are no precautionary measures evident in Panama's expansion project. Global warming is heating up the Arctic almost twice as quickly as the rest of the planet, and has already opened new tanker routes in 2007, "The Northwest Passage", cutting over 6500 km off the journey from Northeast Asia to the USA's east coast (Cressey, 2007; ESA, 2007; Gautier, 2008; Global Envision, 2008; NSIDC, 2007). Senior NASA climate scientist Jay Zwally reported that "the Arctic Ocean could be nearly ice-free at the end of summer by 2012" (NASA, 2008; Figure 2.10). Stroeve et al. (2007) claim an ice free Arctic by 2060. What is clear is uncertainty. In September 2009 the Northeast Passage opened for the first time without the assistance of ice-breakers, allowing two commercial German freighters through (Kramer & Revkin, 2009). The Northwest Passage was already opened in 2007, and the Arctic only needs partial ice loss not complete ice loss for a ship's passage. This is of significant concern for Panama as future demand at the Panama Canal may be significantly reduced (Economist, 2008a; Gautier, 2009).

[1] See Chapter 3, Section 3.1 Panama's climatic uncertainties, page 38

Figure 2.10: Arctic sea ice loss (%change from 1979-1990 mean)



Source (Cook, 2007)

Scientists have been unable to calculate the rate of Arctic sea ice loss (Rampal et al., 2009), and we appear to now be approximately thirty years ahead of schedule (Serreze, 2009). ENSO uncertainties also imply a precautionary approach. Models still struggle to accurately predict ENSO beyond one year (Paeth et al., 2007) and Canal inflow is only predictable up to a few months in advance (Graham et al., 2006). Latest research indicates that a change in the wind system in the Antarctic promotes the beginning of El Nino (Vovk & Egorova, 2009) and numerous other theories exist as to the mechanisms which control ENSO.[1]

[1] See Chapter 3, Section 3.1: Panama's climatic uncertainties, page 38

2.3 Unsustainable expansion and development

Panama should become more critical of corporate interests and their short term drive for profit-maximization and look to quantify unaccounted negative externalities if it hopes to develop in a sustainable manner, minimize unnecessary and costly resource losses, and maximize human and capital resources. However, the state's protection of corporate interests has a long history in Panama. One of Panama's five pillars for 2005-2009 was to reform and modernize the state by transforming the public sector into a facilitator of development that serves Panama's citizens (World Bank, 2007a). Wickstrom (2003) indicates that Panama's government has been heavily exploiting resources and protecting the more powerful political and economic actors on both domestic and international fronts since its first constitution in 1904, which has since then dictated the government's right to do so.

Panama's lack of public and private capacity to implement and enforce sustainable land use programs (World Bank, 2006; Wallander et al., 2007) is of particular importance regarding the states adherence to corporate will and expansion. According to Lichtenfels et al. (2007), landuse decisions in Panama are complex and driven by government policies and incentives, local political, economic, social, and natural factors, population growth and migration, international and local investments, and the canal expansion (Ibanez et al., 2002; Lichtenfels et al., 2007). Wickstrom (2003) however narrows this down and identifies that development in Panama usually means partnerships with foreign actors who will support the state in exchange for its cooperation. However, there is a lack of capacity to promote sustainability, and poverty and economic and population growth further stress already stressed natural resource bases (World Bank, 2006, Ibanez et al., 2002). Therefore, land use decisions are largely driven by the central Panamanian government and foreign actors who are powerful enough to manipulate the state, which suffers from low capacity to implement and enforce sustainable land use programs and develop in an independent fashion.

Cattle ranching and subsistence agriculture combined with significant levels of rural poverty are major drivers of deforestation, unsustainable landuse patterns, and significant resource losses. These are not uniquely a function of society, rather they are proximal causes of environmental destruction and are primarily due to poor government incentives, structures, levels of support, and the imposition of political-economic institutions and their

practices, projects and priorities (Wickstrom, 2003). Ibanez et al. (2002) found that 68% of the people near Chagres National Park were subsistence farmers, and in smaller communities, employment was scarce and irregular. They found that even the smallest rural settlements were surrounded by pastureland, with few forests and limited crops. Moreover, most land was pasture and owned by non-locals, therefore the incentive to avoid degrading land is limited. For example, in the community of Santa Rosa, 75% of the land area was pasture owned by non-locals.

The rural poor often deforest and degrade lands for subsistence and cattle ranching, their methods often being as poor as they are, depleting soil and water resources, leaving the land more prone to fire and erosion, then moving on to new plots with intact natural resources so the cycle repeats (Runk et al, 2007; Wallander et al., 2007; World Bank, 2006; Zanin, 2005). However, this is often the only option for the rural poor and subsistence farmers are increasingly being forced onto smaller and lower quality lands (Wickstrom, 2003). Indigenous production systems are also becoming increasingly unsustainable due to economic pressures, being replaced by monoculture farming systems without rotation, depleting soils and expanding the agricultural frontier further (World Bank, 2006). Cattle-ranching and forest clearing is however a part of Panama's culture and identity, and therefore inherently difficult to change, particularly in the absence of crisis (Wallander, 2007; Wickstrom, 2003; Runk et al, 2007).

A number of laws and policies are of significant concern to Panama's sustainability. Law 21 was mentioned previously in regards to the Panama Canal Watershed. Law 37 of 1962 (Farm Code) continues to be of concern, offering squatter's rights or legal land title in exchange for the removal of forest (FCPF, 2008; Fischer & Vasseur, 2000) causing deforestation and land degradation, in contradiction with current forestry legislation focused on conservation and restoration (FCPF, 2009). Law 24 of 1992 is also of concern and was passed primarily to foster large scale reforestation via financial incentives and tax breaks. However, it has primarily benefited large landholders, and has been significantly revised and even reversed in parts due to abuse from large plantations, high costs from lost taxes, and deforestation via economic subsidies for reforestation (Lichtenfeld, 2007; Lichtenfels et al., 2007). Law 24 is primarily geared towards corporate interests and does not provide incentives to small farmers with few resources. In 1996, an amendment to assist smallholders to reforest did not pass (Fischer & Vasseur, 2000). Current incentives still however include waived import taxes on machinery, equipment, and value added products along with waived income tax on land costs. In 2001, the total cost to the state from Law 24 claims was over $40 million (Lichtenfels et al., 2007; Figure 2.11). Furthermore, Zanin

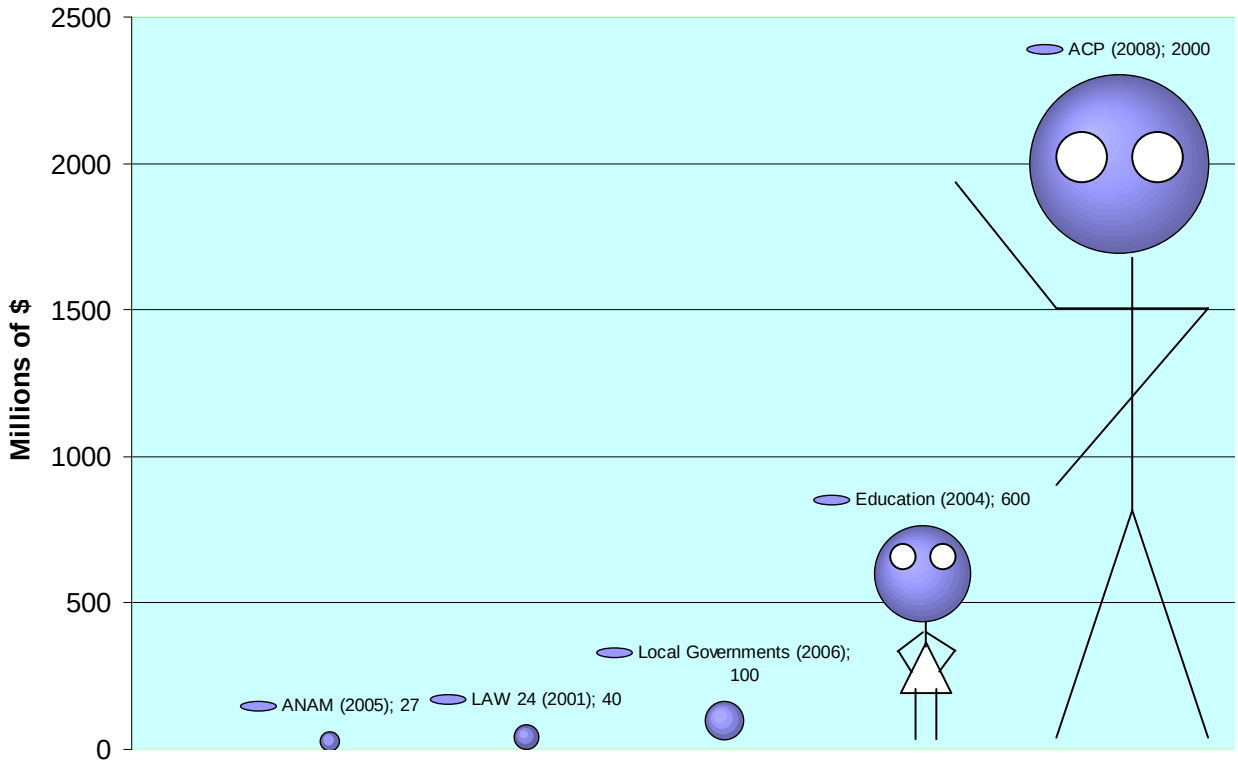
(2005) indicates that due to Law 24, 35,000 ha of teak have been planted. Unmanaged teak plantations result in significant resource losses, particularly for smallholders who are generally not organized or aware of the stakes involved and are often exploited. In the end, exploited smallholders frequently feel victimized and angered, and resolve to destroy their plantations. Consequently, health, community, and land deteriorate (Zanin, 2005). Law 25 is also in question, and has caused the deforestation and degradation of over 2 million ha by providing heavy subsidies to the cattle ranching industry (Lichtenfeld, 2007).

Perverse developmental incentives and the unregulated growth in tourism are an additional considerable concern (World Bank, 2006; World Bank 2008a). Panama's Tourism Ministry's (IPAT) Law 8 contains problematic development incentives which ignore the elementary principles governing sustainable development (Schloegel, 2007). Specifically, Law 8 appears to endorse the destruction of ecologically sensitive or unique areas, promoting development of golf courses and theme parks regardless of ecological sensitivity (Schloegel, 2007). According to the World Bank (2008a), IPAT in coordination with Panama's environmental protection agency (ANAM), plans to employ a $30 million loan from the World Bank to develop a Sustainable Tourism Master Plan (STMP) focused on 2020. The STMP aims to establish clear standards for sustainable tourism, mitigate social and local environmental impacts, generate relevant information on the distribution of tourism benefits to the poor, and enhance local government capacity to safeguard cultural and environmental preservation. This $30 million loan is nevertheless trivial compared to the necessary investments that the tourism sector requires (World Bank, 2008a).

2.4 Fragmented and poorly managed rural infrastructure

If Panama hopes to improve rural livelihoods, infrastructure, and environmental quality then it has some difficult facts to address. Capitalist development has failed to protect the environment and address Panama's poor majority (Wickstrom, 2003; Figure 2.11). In 2006, Panama's local governments controlled less than 2% of total public sector expenditures, restricting their opportunity to develop capacity. As a result, their ability for planning, budgeting, providing services, and maintaining infrastructure was also affected, representing significant hindrances for building institutional capacity (Lichtenfels et al., 2007; World Bank, 2006).

Figure 2.11: Panama's actors and their relative size (in monetary terms). Law 24 claims totaled $40 million in 2001 while ANAM received $27 million in 2005 and local governments received $100 million in 2006 in funding



Sources: CIA (2009), Lichtenfels et al. (2007); Potvin et al. (2008); Zanin (2005)

The General Environmental Law (Law 41) of July 1998 created Panama's environmental protection agency (ANAM) aiming to give more protection and support to the environment and indigenous communities. However, the enforcement of policies that protect the indigenous and their lands has been lax or absent, while private property rights and economic development projects within their lands have had full state protection (Wickstrom, 2003), thereby moving resources away from public and rural infrastructure and development. According to Wickstrom (2003), deals are still made in exchange for secure access to lands and resource bases which are then degraded or destroyed, and promised benefits often fail to appear. Environmental services (ES) provided by Panama's forests, such as water and soil quality and biodiversity are crucial to Panama's sustainable economy however, markets for ES in Panama and in particular in the Panama Canal Watershed (PCW) are undeveloped (Lichtenfels et al., 2007).[1] This may be due to the fact that markets in Panama are dominated by the Panama Canal Authority (ACP) and timber revenues (Lichtenfels et al., 2007), which both primarily focus on the short-term financial benefits found in economic growth. Panama's local and federal governments have attempted to correct market failures but often fail to adequately enforce or promote the required developments, representing both market and policy failures (Lichtenfels et al., 2007; Johnson et al., 2002; Landell-Mills & Porras, 2002).

Human resources in Panama are limited and rural poverty is forcing migration to relatively intact areas with high levels of globally significant biodiversity (World Bank, 2006). Poor peasants are migrating to the untouched parts of the Atlantic side since on the Pacific side, soil and water resources have been severely depleted due to traditional agricultural practices and inadequate conservation measures (World Bank, 2006). Fisheries also need more monitoring and management, while hunting in national parks near large towns, and restaurants using poached meat also need further attention (Ibanez et al., 2002). These situations would become less of an issue if Panama had well organized and managed rural infrastructure to monitor conditions and assist rural farmers and conservation and protection efforts.

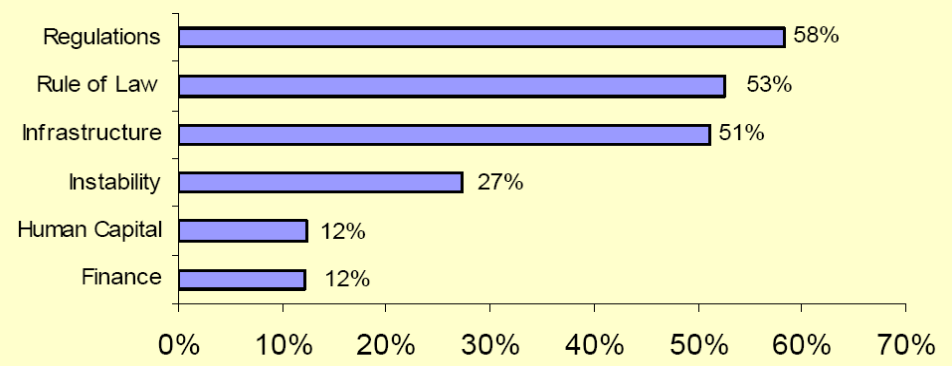
[1] See Chapter 5.2, page 65 and Appendix 2: Environmental policies and market mechanisms, page A4, and A2.3: Payments for environmental services, page A15

2.5 Ineffective and inefficient management and governance

Panama's local governance and financial autonomy lag far behind others in the region despite its position as a regional leader in terms of GDP (World Bank, 2006). Panama's state institutions including their leaders and managers lack effective cooperation and change with each administration, representing significant impediments for improving institutional capacity (Lichtenfels et al., 2007). Halsnaes & Verhagen (2007) identify that weak institutions may result in an economy being significantly below its potential since they manifest inefficient and ineffective energy and consumption patterns. Panama not only lacks institutional capacity, but capacity in general, with limited knowledge bases, personnel, and financial resources (Wallander et al., 2007; World Bank, 2006). As a result, legislation is poorly formulated and the enforcement of laws and contracts is weak, while the judicial system is subject to political manipulation and inundated with cases (Fischer & Vasseur, 2000; Wickstrom, 2003; World Bank, 2006).

The issue of corruption in Panama is a major concern. Corruption results in lost investments and money being directed into private hands and away from its intended destination (Figure 2.12).[1] This affects all resource bases since funds for improving the environment, society, and government and infrastructure are lost.

Figure 2.12: Investment constraints (by % of firms) in Panama. Regulations, rule of law, and infrastructure are constraining investments into Panama



Source: World Bank (2007b)

[1] See Appendix 4: Corruption, page A22

Transaction costs are a major impediment to attracting investments and market participation and formation (Pagiola et al., 2002; TI, 2008; Wickstrom, 2003; US DOS, 2008). Panama's weak institutions, mismanagement, and image of corruption affect investments and the country's economic and environmental performance (Halsnaes & Verhagen, 2007; Lichtenfels et al., 2007; Figure 2.12).

Human wellbeing depends on the services provided by the environment (Kursar et al., 2007). However, business, money and investments have been centered on the Canal area while elsewhere forests and rural lands have been practically ignored (Zanin, 2005; Wickstrom, 2003). Panama has recently shown signs of improvement by convincing private banks to halt financial support for the clearing of forest within the PCW (Wallander, 2007), and over 20% of Protected Areas (PAs) are now co-managed by ANAM with local non governmental organizations (NGOs) and others. These efforts have been adequate, but often suffer from low funding and high staff turnover (Lichtenfels et al., 2007) while national banks still finance the construction of new roads in remote areas, opening up more regions to logging, exploitation, and more migration (World Bank, 2006).

ANAM may be an example of Panama's problems with corruption and lacking regulations and governance. ANAM is essentially voiceless and powerless with a severely limited budget ($27 million in 2005 or 0.3% of the country's budget) (Potvin et al., 2008). It has no formal say in cabinet meetings or governmental decisions (Lichtenfels et al., 2007), a severely limited capacity to implement and enforce laws (Lichtenfels et al., 2007; Wickstrom, 2003), and unable to control pervasive agricultural activity, even within Chagres national park (Lichtenfels et al., 2007). Panama's "Strategy of Conservation for Sustainable Development" (2004 – 2009) aims to fortify the capacity of ANAM, enhance its coordination with all actors, and prioritize human welfare, natural resources, and job creation (FCPF, 2008). The World Bank (2008a) claims that ANAM has improved its environmental record and capacity, significantly progressing in implementing policy measures to protect natural resources, coordinate among other entities, and make information accessible. Nevertheless, in the same report it is evident that ANAM's capacity is still severely lacking. ANAM's submission to the FCPF (Table 2.2) is difficult to understand. Moreover, a total of $2 million is requested with blank spaces and no indication of exactly how this money might be used. This raises the concern that ANAM may have little understanding of how to address these particular issues and minimal capacity to act on them.

Table 2.2: Assistance requested by Panama's environmental protection agency (ANAM) from the World Bank's Forest Carbon Partnership Facility (FCPF)

Description	Observations	$ Million
Creation and strengthening of capacities to include technical personnel and professional in the rows of REDD (from the overseeing and control, to the evaluation and monitoring of results)	It will be needed to hire new personnel, as well as prepare the existing personnel in the ANAM to supervise, oversee and to carry a control of the forest zones of the country. Likewise, it is necessary to carry out the monitoring and evaluation of results set against the goal	1.5
Updating of information for the integrated management of hydrographic basins	There is existing information in some basins exists, but not all, for which there should be an investment in the updating and lifting of prominent information for REDD	1
Design and implementation of methodologies for the lifting of the historic forest national base line, as well as for the monitoring of the compliance of REDD commitments		0.5
Teams and tools to create the system of generation, administration and analysis of data, specifically for REDD decision making		1.5
Strengthening of the indigenous towns and other forest inhabitants that are found in critical areas of deforestation, through pilot projects of common investment	The focus of action is sustained by the narrow relation of the native populations and other forest inhabitants as important agents of the forest resource	0.5

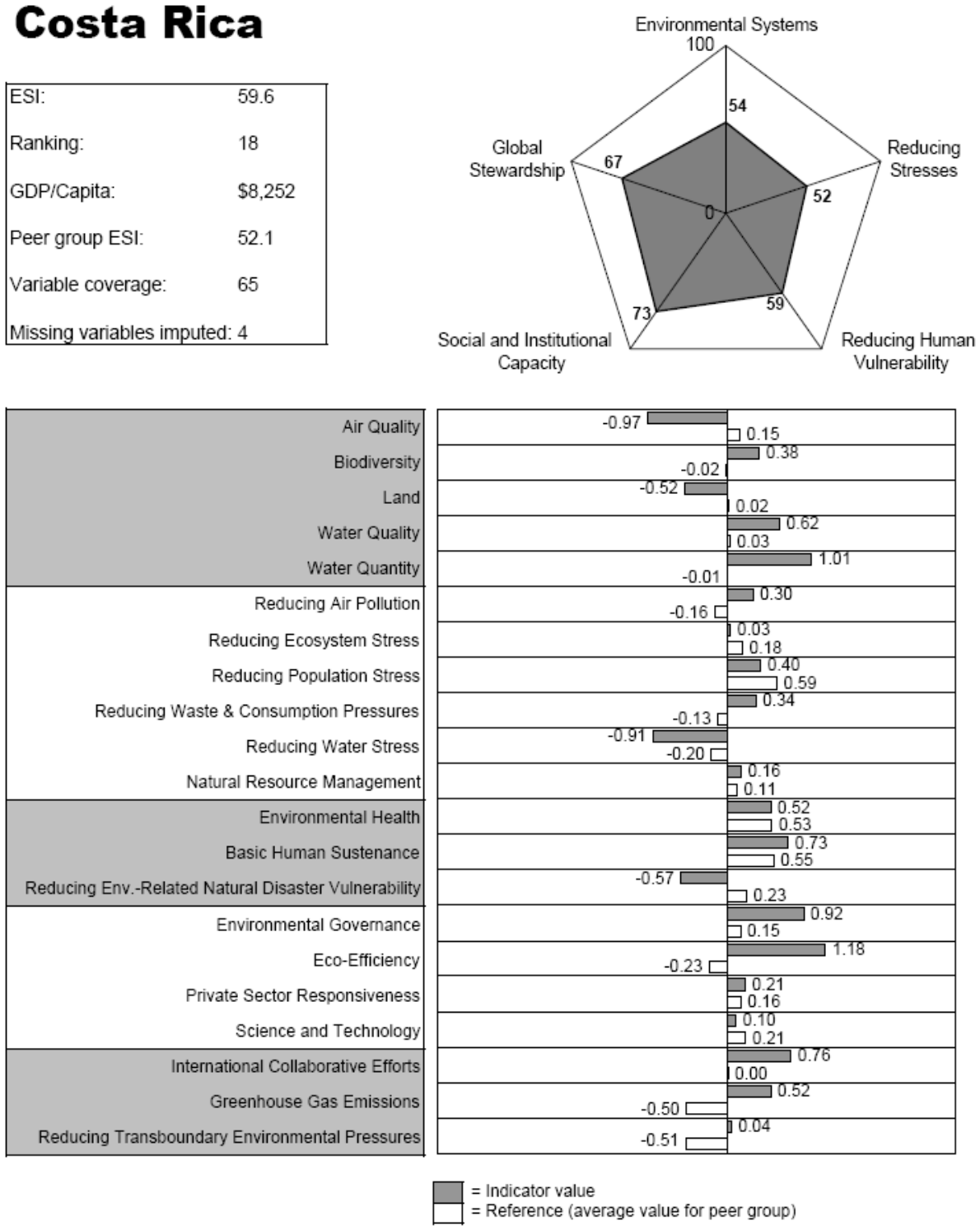
Source: FCPF (2008)

Environmental sustainability is of prime concern for Panama. Panama's severe lack of capacity to assess its own resource bases and integrate the latest scientific findings into its policies to maximize economic profitability is not however necessarily a significant impediment to addressing these issues. The Environmental Sustainability Index (ESI) provides a powerful environmental decision making tool for facilitating comparative policy analysis. It measures overall progress towards environmental sustainability for 142 countries. Panama's "Environmental Systems" return a higher figure than Costa Rica's; however Panama's "Global Stewardship" is significantly behind. Panama therefore has more natural resources to offer than Costa Rica but is doing less to protect them. Panama's "Social and Institutional Capacity" (47%) is of significant concern, being well behind Costa Rica's (73%). Its sub-indicators reveal that Panama's "Eco-Efficiency" and "Private Sector Responsiveness" are not only significantly below Costa Rica's but also below par for its peer group. Looking into other sub-indicators, Panama would also greatly benefit from adopting similar policies to Costa Rica regarding "Reducing Ecosystem Stress" and "Reducing Waste and Consumption Pressures" in addition to addressing "Basic Human Sustenance" (Figures 2.14 and 2.15).

Human sustenance is of particular concern for Panama and is related to human security, which may be defined as the capacity and freedom to choose among available options to deal with a threat; environmental, social, cultural or economic. Broadening the range of these available options relates to human development (Bohle & O'Brien, 2006).[1] These ideas are closely tied to human wellbeing, which is often regarded as the cornerstone of human security with human development as its foundation (Bohle & O'Brien, 2006). Abdallah et al. (2009), measured human wellbeing in relation to resource consumption; Costa Rica is currently the happiest country in the world with 85% of its residents saying they are happy and satisfied with their lives. Latin America, according to their report, is doing relatively well to secure its environment, with human wellbeing and happiness occupying nine of the top ten spots on its list. However, Panama came in at number 18, indicating that Panama is lagging well behind its neighbors with regards to human wellbeing and its environmental footprint.

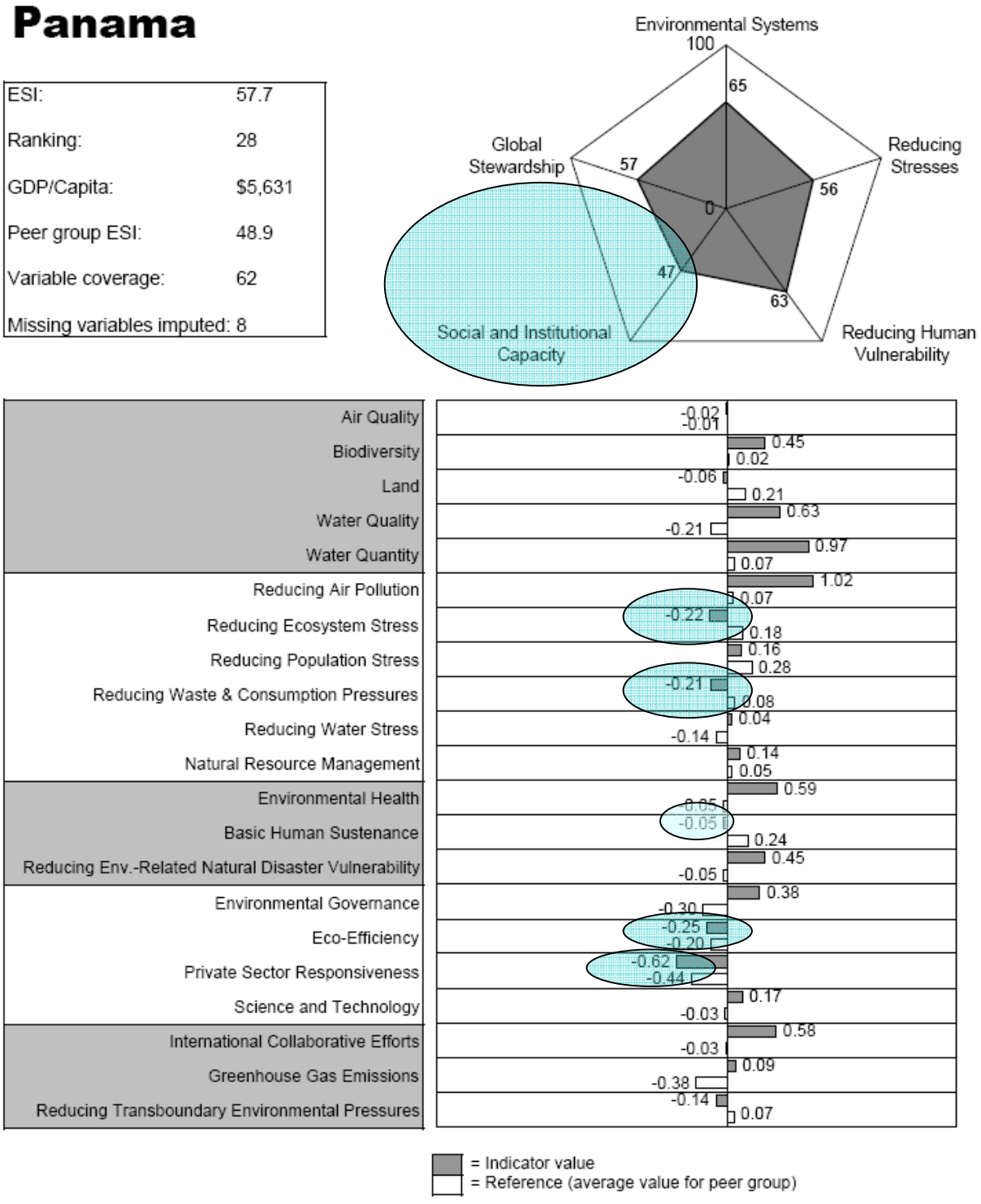
[1] See Table 3.2, page 48 and Table 3.3, page 50

Figure 2.14: Costa Rica's Environmental Sustainability Index (ESI)



Source: Yale (2005)

Figure 2.15: Panama's Environmental Sustainability Index (ESI)



Source: Yale (2005)

3 Climate change adaptation in Panama

Adaptation to climate change refers to ecological, social, or economic adjustments in response to the stimuli, effects or impacts from a changing climate. It requires reducing the exposure of communities, regions, and activities to climatic changes. Processes, practices, or structures may be altered to moderate or compensate likely damages, or to benefit from opportunities coupled with a changing climate (McCarthy et al., 2001). It is critical to note that most existing development policies in developing countries insufficiently address climate change, and studies in this field are not yet ample, representing only the beginning in identifying potential areas for integration (Halsnaes et al., 2008). Nevertheless, critical weather-sensitive and long-term investments are crucial since changes in weather are likely to occur first. Such investments include but are not limited to land and water management infrastructure, forestry projects, and improving roads, railroads, and buildings. In addition, less concrete investments into development plans (e.g. forestry, agricultural R&D), and improving laws, regulations, and knowledge bases will be required to offset likely changes in climate and weather (Fankhauser et al., 1999).

Panama's immediate development needs may significantly constrain action on climate change policy and adaptation. Panama's climate issues are however deeply rooted in core development issues such limitations in capital, investments, technology, capital resources and productivity, institutional structure and capacity, human security, wellbeing and socioeconomic equity. Addressing these issues often results in additional benefits going beyond simply addressing climate change (Halsnaes et al., 2007), and should arise from national planning processes, which may however be particularly difficult since resources for such programs are limited in Panama, which requires significant external assistance (Halsnaes & Verhagen, 2007; Murphy et al., 2008). In addition, the science-policy interface is weak and hampered by many factors, the most significant being resource scarcity and weak institutions (Lahsen & Nobre, 2007). Of particular concern is that the USA often overwhelmingly dominates the scientific rhetoric behind international environmental negotiations, which hinders Panama's environmental and climate policy development (Nobre et al., 2008). Moreover, Panama and the USA have a strong history and relationship tied into the Panama Canal and global trade. This represents many potential issues since large stakes are involved, and as outlined earlier, the state has a history of protecting corporate interests and exploiting its largely poor and uneducated population.

This may be a factor behind Panama's expansion project, which is consuming significant resources and fuelling record levels of inflation and economic growth. These resources may be put to more sustainable and constructive use elsewhere, in particular for building adaptive capacity and improving public policy. The fourth assessment report of the IPCC (2007) states that public policy plays a critical role in facilitating adaptation to climate change, which aims at reducing the vulnerability of individuals and infrastructure, offering information on investment risks and protecting property (Parry et al., 2007).

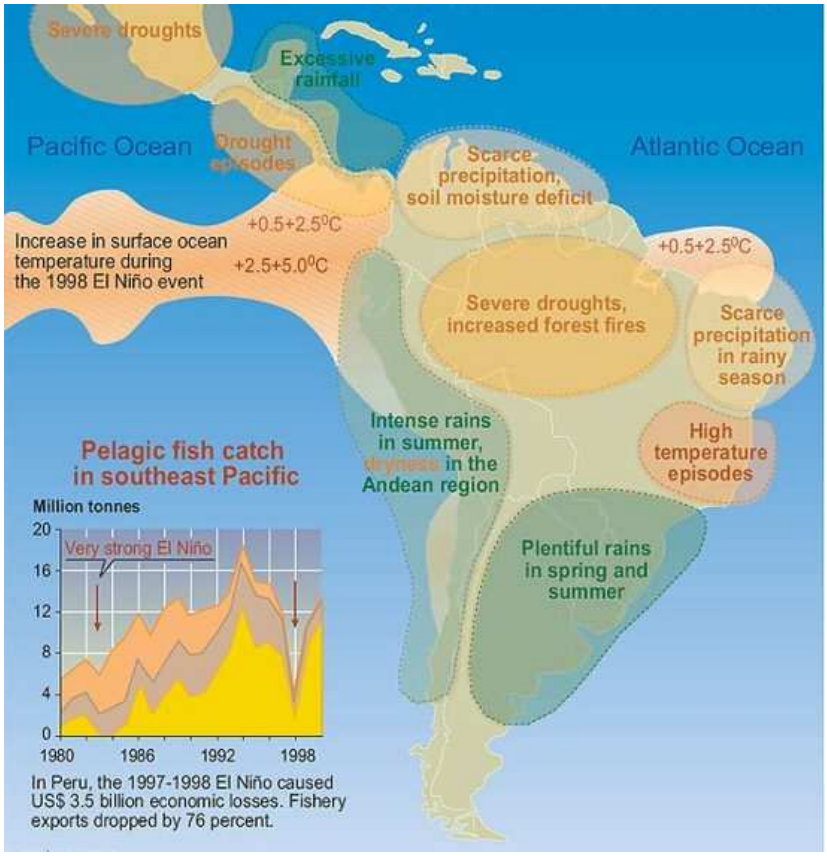
Effective adaptation strategies rely on the existence of adaptive capacity. Some aspects of adaptive capacity are generic, while others are specific to particular climate change effects such as sea level rise (Parry et al., 2007). Adaptive capacity in developing countries has not yet been employed in case studies so no empirical conclusions can be made to date (Halsnaes & Verhagen, 2007). Nevertheless, adaptive capacity depends on the characteristics of a system and is generally a social construct primarily shaped by politics, culture, and religion in addition to economic wealth, technology, information, infrastructure, institutions, and equity (ADB et al., 2003; McCarthy et al., 2001; Rayner, 2001; WHO, 2003). Adaptive capacity is therefore the potential of a system to react or respond to climate variability and change successfully (Parry et al., 2007). Of critical importance is to further distinguish spatial scale (local, regional, national), the sector considered (water, agriculture, tourism, health, energy, etc), the type of action (physical, technological, investment, regulatory, market), the actor (national or local government, international donors, private sector, NGOs, local communities and individuals), and their climatic zone (drylands, floodplains, mountains, tropics) (Parry et al., 2007).

To enhance adaptive capacity and effectively adapt to climate change, Panama should integrate climate change into sustainable development policies which would allow Panama to achieve its development goals while addressing climate change. To ensure success of such adaptation strategies in Panama requires a societal understanding and response, guided by policies informed by sound scientific advice which encompasses the environment, communities, and social and economic development in unison (WHO, 2003). Panama should act to increase its levels of wealth, education and awareness, improve its legal frameworks and institutional capacity, and foster an environment that enables people to take well-informed, long-term, sustainable decisions (Metz & Kok, 2008; WHO, 2003; IPCC, 2001).

3.1 Panama's climatic uncertainties

Significant variable factors affecting climate in Panama include vegetation and land use, pressure variability and El Niño-Southern Oscillation (ENSO) phases (Palka, 2005).[1] The water cycle in Panama is strongly modulated by ENSO, which is the most significant source of inter-annual/decadal climate variability in Panama and responsible for major economic and social problems in the region, resulting in occasional famines (Graham et al., 2006; Müller & Roeckner, 2008). In 1999, such a famine occurred in Panama; water supplies were contaminated when rivers and streams stopped flowing (Moreno, 2006).

Figure 3.1: ENSO impacts for in Southern America. Higher Sea surface temperatures effectively shift rainfall patterns, resulting in drought for Panama

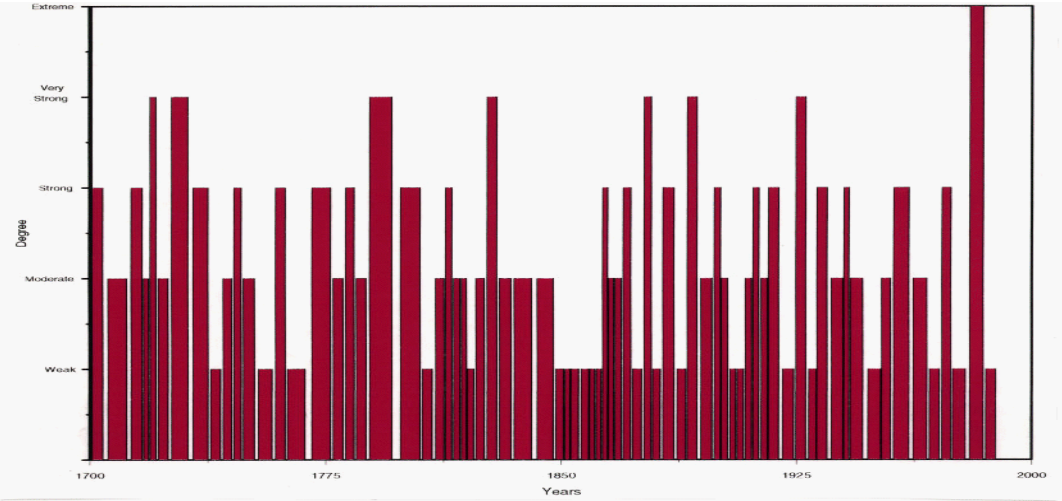


Source: UNEP (2003)

[1] See Appendix 1 for fixed factors

ENSO directly affects the human welfare of more than one third of the Earth's population (Paeth et al., 2008) and its reaction to climate change is unclear (Yeh & Kirtman, 2007). Paeth et al. (2008) researched 79 coupled ocean–atmosphere simulations from 12 different climate models under 6 different IPCC scenarios. The results indicate that ENSO may be highly sensitive to enhanced greenhouse conditions and that long-term trends predominately suggest an increased number of ENSO anomalies in the Pacific sector after 2050. In addition, the mean state of all models predicts a warming of over 5°C in the tropical eastern Pacific by 2100. This heating signal stands out from the background of natural variability and the systematic differences between various climate models.

Figure 3.2: ENSO severity over the last 300 years

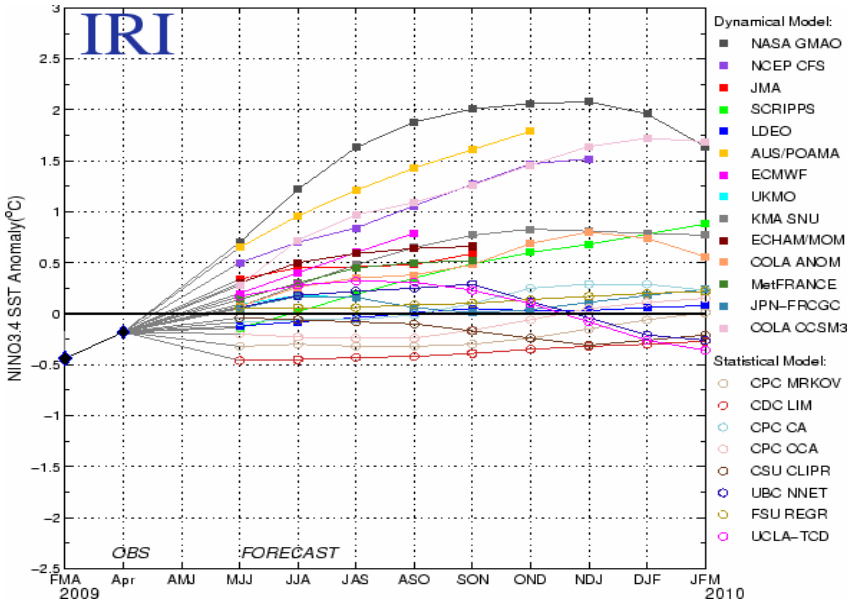


Source: AGC (2009)

ENSO is of major concern for Panama and has the potential to generate large-scale forest fires, even in undisturbed dense forests (Magrin et al., 2007). Furthermore, in the years following ENSO, there is a clear decrease in Panama's hydropower generation (Campos, 1996), which is their primary source of electricity. In addition, Canal inflow is only predictable at lead times of months (Graham et al., 2006).

ENSO anomalies can be exploited to make climate forecasts on a seasonal to annual time scale (Sterl et al., 2007). However, current models still struggle with the accurate prediction of ENSO events, especially beyond one year (Joseph and Nigam 2006) and it is unclear whether the present-day indicators such as the Southern Oscillation index (SOI) or the Nino3 index (NI3) will properly represent ENSO in a warmer climate (Paeth et al., 2008). Routine ENSO predictions are made with a variety of statistical and dynamic models, yet all are limited by observational data, and the quality of the data rapidly deteriorates prior to 1970 (Paeth et al., 2008). For other fields such as thermocline depth or ocean currents, the situation is worse, limiting the number of retrospective forecasts and the ability to accurately initialize forecasts (Madl, 2000). Furthermore, changes in ENSO frequency are not yet consistently quantified (Guilyardi 2006) and ENSO's reaction to climate change is still unclear (Müller & Roeckner, 2008) while the mechanisms behind ENSO lead to a handful of theories which are still being investigated. For example, Verdon and Franks (2006) indicate that the state of ENSO is strongly coupled with a much larger Pacific Decadal Oscillation (PDO) covering the entire Pacific Ocean. The phase of the PDO can not only change the probability but also the intensity of ENSO. Current models still struggle with ENSO and PDO, and have a long way to go (Joseph and Nigam, 2006).

Figure 3.3: ENSO model forecasts from May 2009

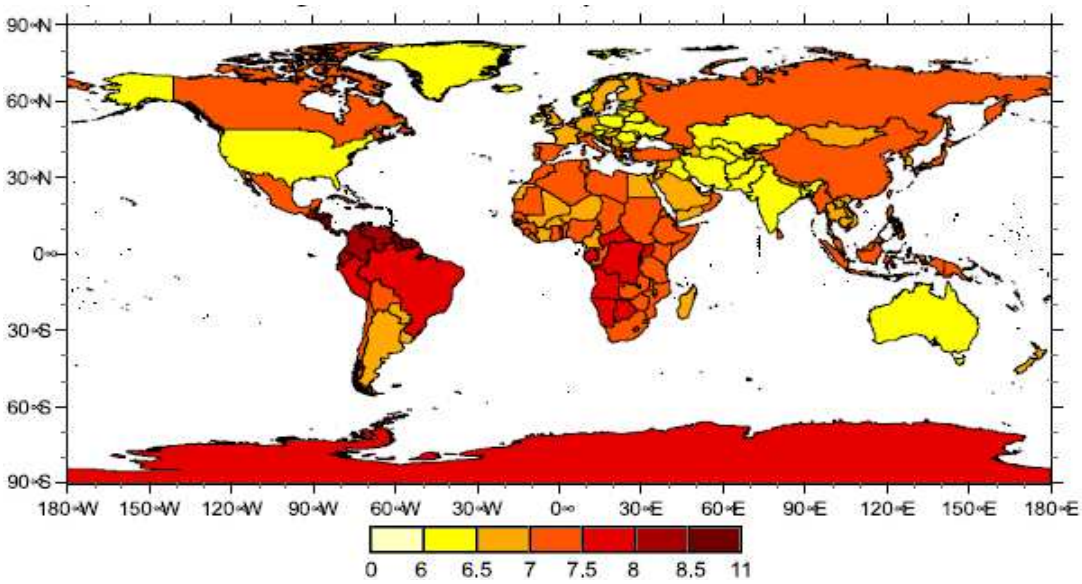


Source: Columbia University (2009)

3.2 Climate change impacts in Panama

The recorded increase of extreme events in Latin America and the quantified economic impact of just some of these events indicate significant vulnerabilities to changes in weather and climate. The occurrence of climate-related disasters in Latin America has already increased by a factor of about 2.4 since 1970. Between 2000 and 2005 less than one fifth of these events were quantified with losses amounting to approximately $20 billion (Magrin et al, 2007). Latin America is vulnerable to large-scale and consistent ENSO related rainfall anomalies and is likely to experience an increase in the frequency of weather and climate extremes with devastating impacts (Magrin et al, 2007). This is reflected in the Climate Change Index (CCI) developed by Baettig et al. (2007), which measures the strength of future climate change relative to today's natural variability and is composed of annual and seasonal indicators for temperature and precipitation. The CCI indicates that the strongest climate changes by the end of this century, relative to today's natural variability, will occur in Panama (the tropics) and in the upper northern hemisphere (Figure 3.4).

Figure 3.4: Climate Change Index (CCI) on a country basis

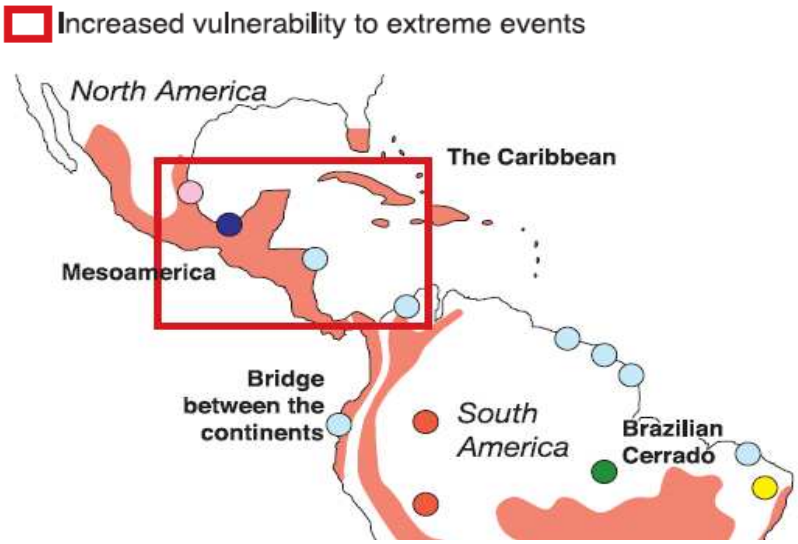


Source: Beattig et al. (2007)

Panama and its surrounding countries are expected to experience highly significant climate related susceptibilities (Figures 3.4, 3.5, 3.6 and Table 3.1) and should account for climate change directly in their policies since changes in weather extremes may occur much earlier than changes in climate, and many adaptation strategies have ancillary benefits and aid in human development and sustainability (Fankhauser et al., 1999; Metz & Kok, 2008).

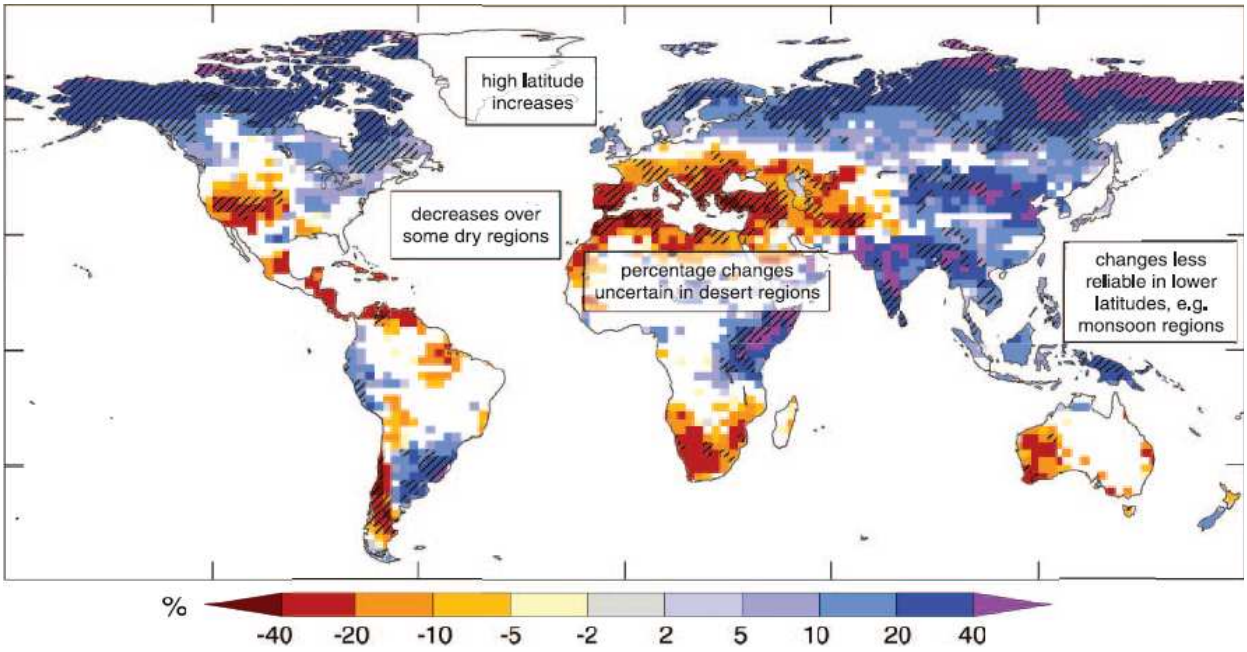
The most significant concern in Panama from a changing climate would be reductions in or increased variability of its water resources, which would affect its canal and ecosystems (Palka, 2005; Harmon et al., 2003). Shifting rainfall patterns, increased periods of drought and more flooding and erosion have been identified as likely for Panama (Engelbrecht et al., 2007; IPCC 2007). Hydro-generation, Panama's primary source of electrical energy (Lichtenfels et al., 2007) would be affected. However, this may not be the most significant challenge since according to Harmon et al. (2003) the most important climate change impact in Panama may be on reforestation efforts. Tropical forests in Panama show clear patterns of spatial organization in relation to precipitation. For example, Pacific dry forests are quite distinct from the wetter forests of the Caribbean coast (Harmon et al., 2003) and many plants and ecosystems are not expected to survive the predicted extended dry periods (Condit, 1998; Graham et al., 2006; Engelbrecht et al., 2007; Figure 3.7).

Figure 3.5: Panama's increased vulnerability to extreme events. Areas shaded in red are where significant levels of biodiversity losses are expected



Source: Magrin et al. (2007)

Figure 3.6: Projections for runoff by 2100



Source: IPCC (2007)

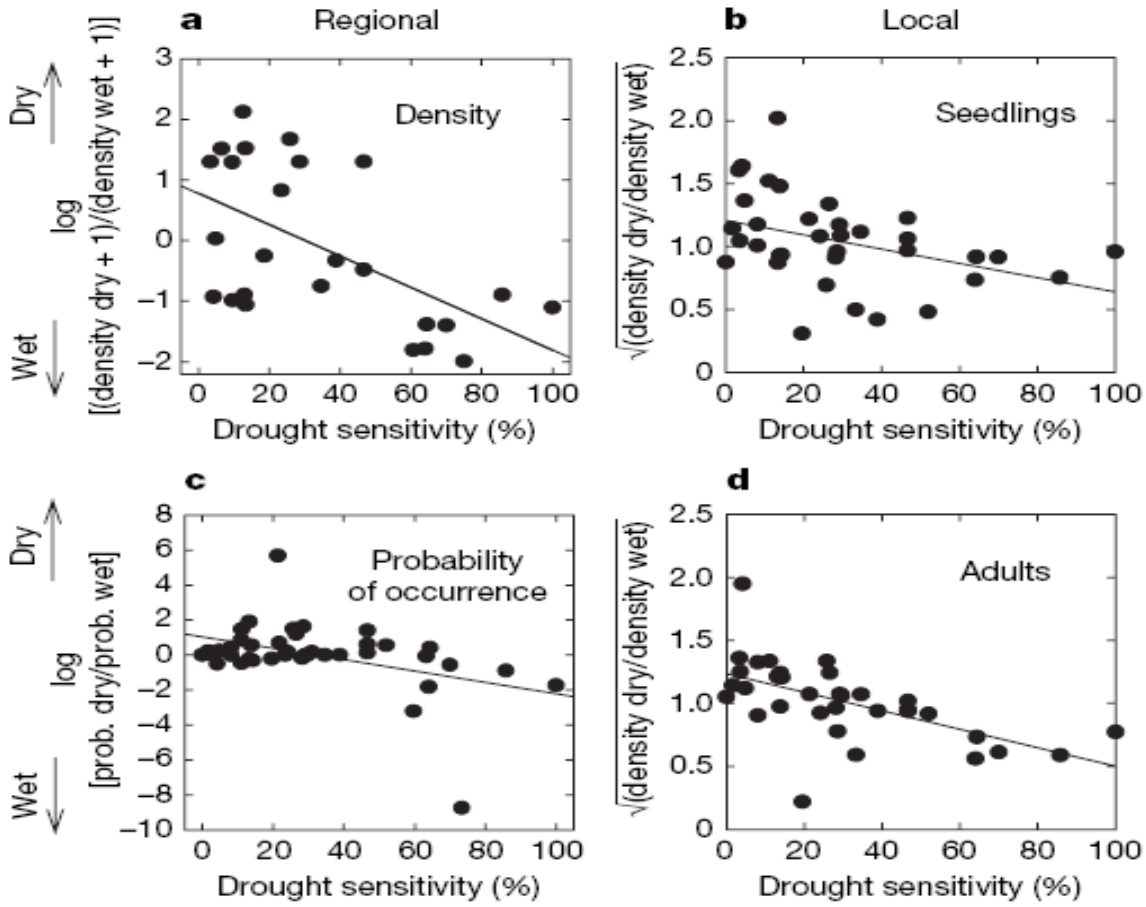
Table 3.1: Projected temperature (°C) and precipitation (%) changes for broad sub-regions of Central and South America for 2020, 2050, and 2080

		2020	2050	2080
Changes in temperature (°C)				
Central America	Dry season	+0.4 to +1.1	+1.0 to +3.0	+1.0 to +5.0
	Wet season	+0.5 to +1.7	+1.0 to +4.0	+1.3 to +6.6
Amazonia	Dry season	+0.7 to +1.8	+1.0 to +4.0	+1.8 to +7.5
	Wet season	+0.5 to +1.5	+1.0 to +4.0	+1.6 to +6.0
Southern South America	Winter (JJA)	+0.6 to +1.1	+1.0 to +2.9	+1.8 to +4.5
	Summer (DJF)	+0.8 to +1.2	+1.0 to +3.0	+1.8 to +4.5
Change in precipitation (%)				
Central America	Dry season	−7 to +7	−12 to +5	−20 to +8
	Wet season	−10 to +4	−15 to +3	−30 to +5
Amazonia	Dry season	−10 to +4	−20 to +10	−40 to +10
	Wet season	−3 to +6	−5 to +10	−10 to +10
Southern South America	Winter (JJA)	−5 to +3	−12 to +10	−12 to +12
	Summer (DJF)	−3 to +5	−5 to +10	−10 to +10

DJF= December/January/February, JJA= June/July/August.

Source: Magrin et al. (2007)

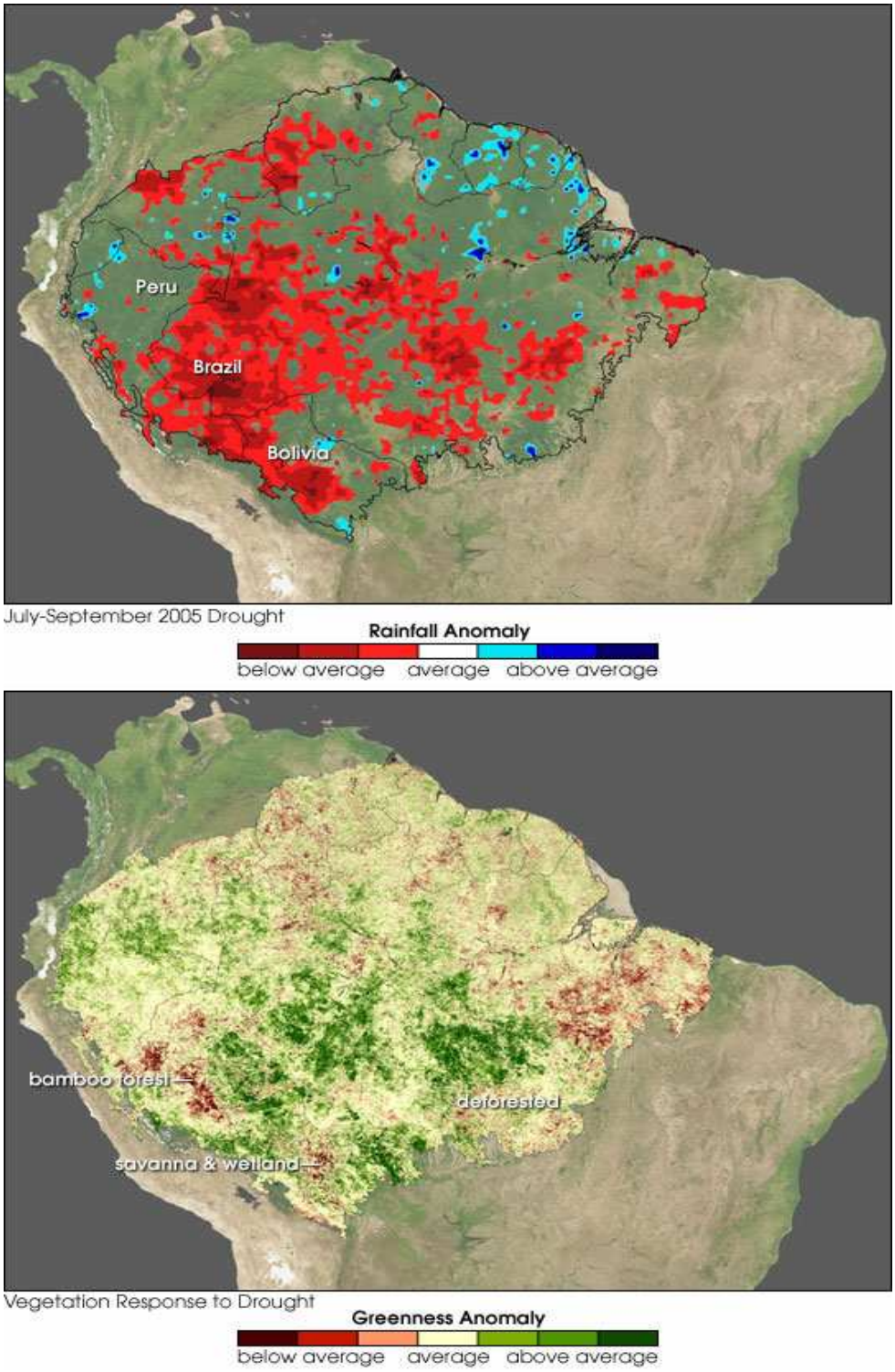
Figure 3.7: Significant drought sensitivity of seedlings in Panama



Source: Engelbrecht et al. (2007)

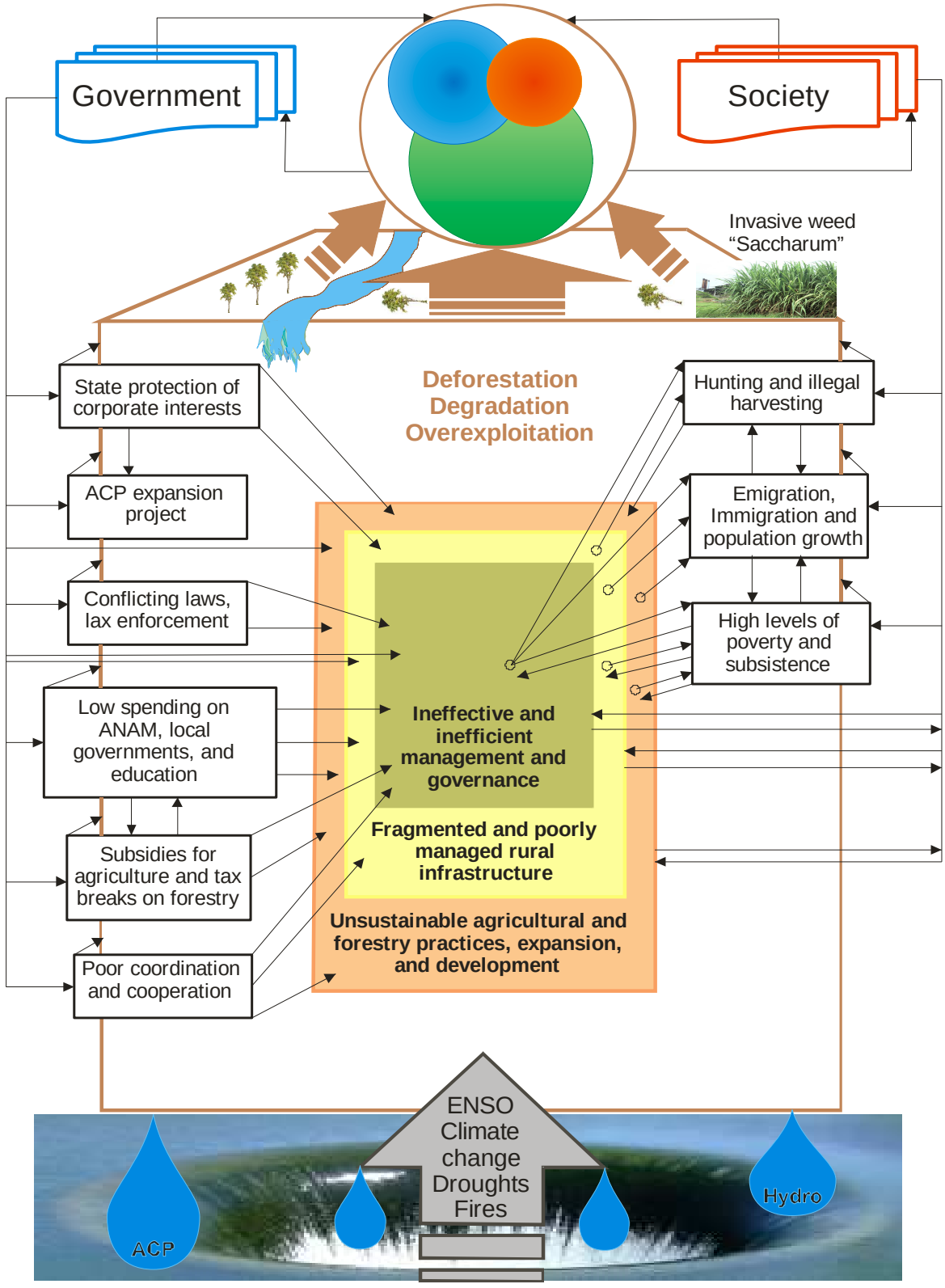
Panama's economy, biodiversity, natural ecosystems and water supply are at high risk. Magrin et al. (2007) report that the ranges occupied by many species will become unsuitable for them as the climate changes and it is probable that forests will be replaced by ecosystems with higher resistance to multiple stresses caused by temperature increase, droughts and fires, such as tropical savannas (Figure 3.8). They also indicate that tropical forests in mountainous regions will be threatened if temperatures increase by 1°C to 2°C during the next 50 years, significantly affecting diversity. In the cloud forest of Monteverde Costa Rica, these changes are already happening (Magrin et al., 2007).

Figure 3.8: Rainfall anomaly and vegetation response to 2005 drought in Brazil



Source: NASA (2007)

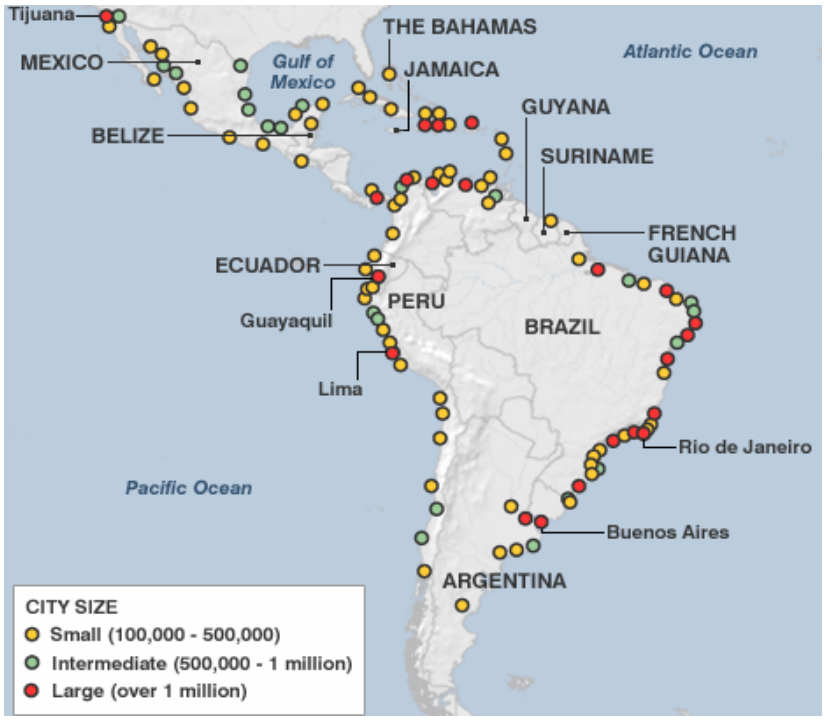
Figure 3.9: Climate change and ENSO increase pressure on Panama and its resource bases, primarily by affecting water supplies and security



3.2.1 Coastal impacts

Panama's coastline, coastal areas and cities (Panama City and Colon) are facing significant threats from climate change, being highly exposed to climate variability and extreme events such as rain and windstorms, cyclones and their associated storm surges (Magrin et al., 2007). The impact and frequency of floods has already increased and rising sea levels will very likely further affect Panama's coasts and coral reefs, which have already been severely bleached where local sea surface temperatures have risen (Magrin et al., 2007; Muller, 2008; Palka, 2005; Figure 3.10). Panama's coastline is about 3,000 km long. Its Caribbean coastline extends for about 815 km including several good natural harbors and extensive coral reefs with 350 or so islands that are arrayed along the coastline for more than 170 km. Along the Pacific coast are more than 1,000 islands (Palka 2005). Tourism, excessive afforestation with teak, and the decrease of fluvial discharge from rivers will add to the impacts on Panama's coastal environments (Magrin et al., 2007; Calder, 2007).

Figure 3.10: Latin American cities which are under threat from sea-level rise by 2050



Source: UNHO (2008)

3.3 Food and human security

Traditional approaches on climate change have primarily focused on energy and land use issues, with detailed economic and technological analysis (Halsnaes et al., 2007; Metz & Kok, 2008). These approaches often fail to critically assess climatic impacts on human security, focusing instead on environmental problems (Bohle & O'Brien, 2006). Climate impacts are largely shaped by inequity and injustice. More specifically, by combinations of inequitable political, social, economic and environmental conditions which threaten human security (O'Brien & Leichenko, 2006). Climate change may offer the opportunity to address these concerns since a range of development and climate policies exist that can be both economically and environmentally attractive (Halsnaes et al., 2007; Metz & Kok, 2008).

The adaptive capacity of human systems in Panama is low and vulnerability is high, particularly to extreme climate events (Magrin et al., 2007). Population growth and socioeconomic expansion are imposing enormous costs on Panama's environment and affecting already stressed coping capacities. Climate change is currently exacerbating this situation and Panama's poor people are particularly vulnerable to both existing climate variability and future climate change (ADB et al., 2003; Gautier, 2008; Halsnaes et al., 2007; Table 3.2).

Table 3.2: Pathways by which decreased rainfall can affect human security

Event	Type	Description	Potential health impact
Drought	Meteorological	Evaporation exceeds water absorption, soil moisture decreases	Changes in vector abundance if vector breeds in dried-up river beds
Drought	Agricultural	Drier than normal conditions leading to reduced crop yield	Depends on socio-economic factors, i.e., other sources of food available, including the means to acquire them
Drought	Social	Reduction in food supply or income, reduction in water supply and quality	Food shortage, illness, malnutrition (increased infection risk); increased risk of diseases associated with lack of water for hygiene
Drought	Food shortage/ famine/drought disaster	Food shortage leading to death, >10 killed, and/or 200 affected and/or government call for external assistance	Deaths (starvation); malnutrition (increased infection risk); health impact associated with population displacement

Source: Moreno (2006)

Climate change will drastically affect global food production, and the inequity in food supply is expected to increase (Niggli & Schmid, 2007). However, critical issues such as food security have not been sufficiently investigated, focusing instead on industrial agriculture while ignoring the many who rely on forests, subsistence, and fishing for survival (Easterling et al., 2007). These people will disproportionately suffer from changes in climate and weather since low incomes and poverty exacerbate climate change vulnerability (Barnett et al., 2006; Halsnaes et al., 2008). Magrin et al. (2007) reports that by the 2050s, half of agricultural lands in Latin America are very likely to be subjected to desertification and salinisation in some areas, while cattle and dairy productivity is expected to decline in response to increasing temperatures with great uncertainties in yield projections.

Cattle-ranching is part of Panama's cultural identity and inherently difficult to address. Many rural and indigenous Panamanians live in poverty and subsistence farmers mostly consume their crops at the household level (Ibanez et al., 2002; Wallander et al. 2007). Food security appeared in the top three most widespread sources of risk perceived by smallholders in Eastern Panama, together with risks from health and living conditions (Tschakert et al., 2007). An increase in heat stress and more dry soils may reduce yields to one-third where crops are already near their maximum heat tolerance. In addition, productivity of pastures would be affected, with loss of carbon and organic matter in organic soils (Magrin et al., 2007).[1]

Cost Benefit Analysis (CBA) is a popular decision tool, offering policy makers insightful information for climate policies. CBA in this regard aims to find the most attractive landuse options for individuals, firms, and societies. However, factors such as health, environment, culture and other quasi-tangible quantities are ignored. CBA with respect to climate change are sensitive to inherent value judgments and critical assumptions which are highly disputed, such as the degree of intergenerational equity (WHO, 2003). CBA focus on the efficient use of scarce resources, but do not deal with equity or non-market environmental concerns.

The Contingent Valuation Method (CVM) and the Attribute Base Method (ABM) have been widely employed to account for non-market ecosystem values. CVMs attempt to holistically evaluate ecosystem quality, health and extent, which can be viewed as an economic good and henceforth may be included in a CBA (Kramer et al., 2003). ABMs on the other hand focus on management or policy relevance by scientifically compiling social data on ecosystem attributes such as biodiversity and watershed protection measures. These may therefore also be employed in a CBA of protection and management alternatives (Holmes &

[1] See Chapter 4 Carbon sequestration, page 53

Adamowicz, 2003). To improve further on where a CBA fails in terms of equity and climate policy, development based studies which analyze human wellbeing indicators may be employed, however, they are often overlooked, being implicitly difficult to assess (Halsnaes & Verhagen, 2007). Including the social data to assess human wellbeing implies focused efforts to assess how policies that impact climate change adaptation and development patterns influence cost effectiveness, employment, equity, energy, food, human, and water security, and health (Barnett et al., 2006; Halsnaes et al., 2007; Table 3.3).

Table 3.3: Assessing human wellbeing

	Themes	Sector and project level indicators
Energy, food and water supply and consumption	Supply and demand including structure, efficiency, and costs	Energy balance
		Efficiency of conversion and end use
		Food products
		Essential nutrients
		Water balance
		Profit
		Costs
		Employment
Environmental impacts	Climate change	Climate change vulnerability
	Air pollution	GHG emissions
	Water	Air pollution
	Waste	Water pollution
	Biodiversity	Toxic compounds and organisms
		Soil degradation
		Flora and fauna
Accessibility	Supply to business and households	Energy balance
	Transmission	Transmission systems
	Other infrastructure	Supply structure, coverage, efficiency including income segment structure and gender issues
	Markets	Traditional fuels
Affordability	Costs	Cost measures
	Investments	Capital requirements and costs
	Income distribution	Energy expenditures relative to total production costs
		Energy expenditures relative to household expenditures for different income segments
		Food expenditures relative to total production costs
		Food expenditures relative to household expenditures for different income segments
		Time spent on energy and food provision
Health	Life expectancy	Life expectancy
	Nutrition	Infant mortality
	Energy for health services	Indoor air quality
		Nutrition
		Energy supply

Source: Halsnaes et al. (2007)

3.4 Conclusions

Weak institutional and adaptive capacities, ENSO, poverty and lacking human resources, food, energy, human and water security, population and economic growth, deforestation, excessive teak afforestation, forest fires, and dependence on hydro-power are the key issues to be considered for adapting to climate change in Panama (Condit, 1998; Harmon et al., 2003; Palka, 2005, Graham et al., 2006; Magrin et al., 2007). Yohe and Tol (2002) define mitigative capacity as the mirror image of adaptive capacity but on the emissions side. Building mitigative capacity would enhance Panama's ability to sequester carbon.

By an analysis of Barnett et al. (2006), Halseanes et al. (2008), Halsnaes & Verhagen (2007), Goklany (2005), IPCC (2001), Murphy, (2008), Rayner (2001), UNEP, (2004), and WHO (2003), Yohe & Tol (2002), to enhance adaptive capacity[1], Panama should focus on:

- Sustainable economic development by reducing GDP growth and inflation

- Its image, so as to attract financial resources

- Collaboration of public and private sectors and communities

- Infrastructure specifically designed to reduce exposure to climate variability and boost sustainable development (flood controls, less development in low lying coastal areas, rain-tanks in rural areas, sanitation and wastewater treatment)

- Technology and monitoring and surveillance systems

- The structure of critical institutions, the allocation of decision-making authority, and the decision criteria*

- The ability of its decision-makers to manage information, and the credibility of the decision-makers*

- Risk spreading processes and research to reduce key policy-relevant uncertainties*

- Levels of equity and the availability and distribution of resources, education, human capital and security across the population*

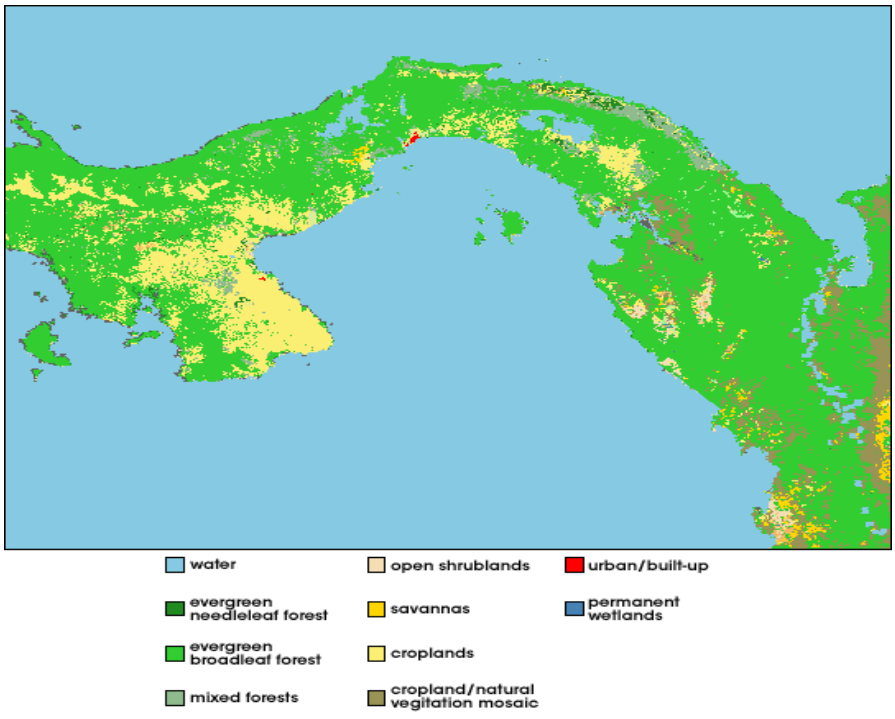
- Property rights*

[1] *Indicates that the option also directly enhances mitigative capacity, which is the same as adaptive capacity but on the emissions side (Yohe & Tol, 2002), and therefore may aid carbon sequestration (CS) projects.

4 Carbon sequestration in Panama

Panama may have a large potential for carbon sequestration (CS) owing to high rates of tree growth and carbon uptake (Anisfeld, 2007) combined with significant amounts of abandoned land which remains covered in grass and other potentially large areas of land available for reforestation (Anisfeld, 2007; Condit, 1998; Lauterbach, 2007; Figures 4.1 & 4.2). According to the UNDP HDI (2008), Panama has 620 Mega tonnes of Carbon (MtC) stored in its forests, compared to Costa Rica's 193 MtC. Although these figures may not be exact, they do indicate that Panama has approximately three times the carbon pools of Costa Rica. Panama however is larger in terms of land area and has a higher percentage of forested lands.[1] The end result indicates that Panama's forests store significantly more carbon; approximately 137 tC/ha compared to Costa Rica's 81 tC/ha (UNDP HDI, 2008).

Figure 4.1: A map of Panama showing land cover type

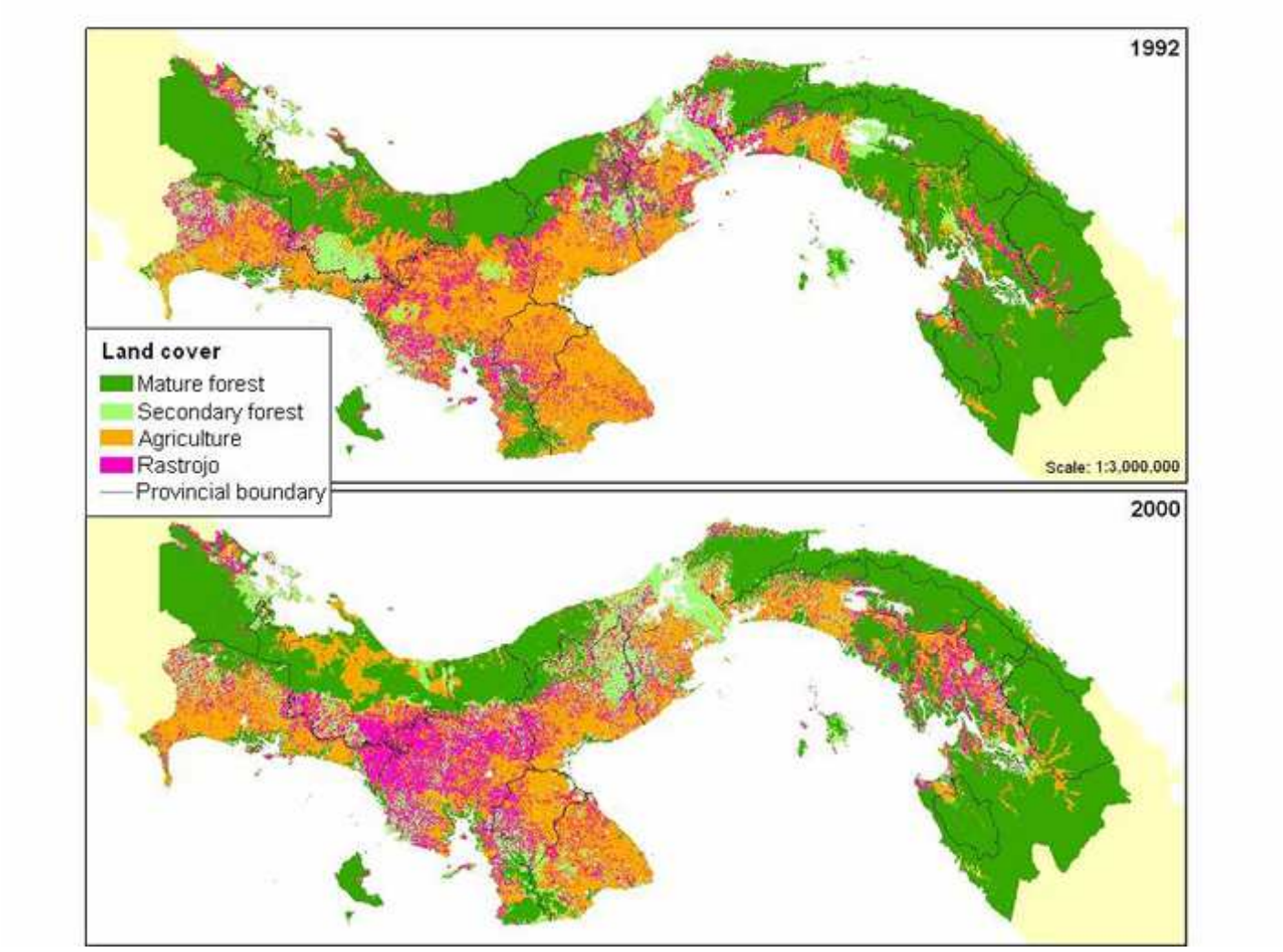


Source: NASA (2003)

[1] Panama's land area is approximately 78,000 km^2 with 57.7% covered in forest, compared to Costa Rica's 50,700 km^2 with 46.8% covered in forest (UNDP HDI, 2008)

To successfully preserve and maximize its carbon pools, Panama needs to address some critical issues and a few important considerations should be assimilated into future policy. Firstly, reforestation in the Eastern Panama Canal watershed (PCW), even after 20 years, would not compensate for the carbon loss from the current rates of deforestation (Heckadon-Moreno, 2005). Second, many tree species are not designed to handle the expected extended dry periods forecast, and Panama's natural ecosystems are at high risk (Engelbrecht et al., 2007; See Chapter 3).

Figure 4.2: Land-cover maps for 1992 (top panel) and 2000 (bottom panel) for Panama. Land cover was determined from LandSat image analyses conducted by ANAM
(N.B: Rastrojo or "Stubble" is likely referring to degraded grassland)



Source: (ANAM, 2003)

Finally, Panama is a biodiversity hotspot and a global conservation priority with forests reaching from the Atlantic to the Pacific Ocean (Ibanez et al., 2002; Palka, 2005). Biodiversity is critical to the stability of ecosystems, and the sustainability of this biodiversity depends on the preservation of native forest cover (Clawson, 2000). Land rapidly becomes degraded and infertile in Panama once natural forest cover has been lost (Wishnie et al., 2007). Over the last 50 years, Panama lost more than 30% of its forest cover, primarily due to the conversion of forested land to pasture and agriculture (Wishnie et al., 2007; Figure 4.2). Using land for conventional agriculture is one of the greatest threats to the sustainability of economies, ecosystems, and biodiversity (Hole et al., 2005).

Landuse generates substantial benefits for humans yet intensive agriculture, mining, forestry and urbanization have had a severely negative impact. Climate change enhances the dynamics, and the need for adaptation in the management of landuse is critical (Koellner & Scholz, 2007). The choice of landuse is largely based on soil characteristics, which play a central role in the effectiveness of the landuse system employed. The organic and carbon content of soils varies drastically with landuse, and often significantly decreases under intensive crop cultivation (Amezquita et al., 2008; Ellis & Mellor, 1995). This may be a significant concern for conserving and restoring carbon pools since within one year of organic decomposition, approximately 60-80% of soil organic matter is oxidized to CO2 and released into the atmosphere (Ellis & Mellor, 1995). Kirby & Potvin (2007), report that in pasture and agroforestry systems, over 80% of total carbon is not found in timber but found in the soil in relatively stable pools and therefore remains in the ecosystem.

Soil carbon is relatively consistent across forest, agroforest, and pasture systems; however crops often return a significantly lower figure, while forests store large amounts of carbon above ground (Amezquita et al., 2008; Kirby & Potvin, 2007). Newly established pastures and restoring natural forest on average sequesters 6 tC/ha annually in soil carbon alone over 3.4 years, while regeneration of degraded pasture stores 2 to 9 tC/ha annually in soil carbon, and when combined with afforestation or reforestation (A/R) also stores significant amounts of carbon above ground (Amezquita et al., 2008). Kirby & Potvin (2007) indicate that agroforestry systems store approximately 82 tC/ha above ground while pasture systems store only 4.2 tC/ha above ground. Moreover, late-secondary and primary forests in Eastern Panama and in the PCW store approximately 250 tC/ha above ground while harvest age teak (20 years old) in Panama stores less than half of this (120 tC/ha) in above ground carbon (Table 4.1, page 55).

Table 4.1: Carbon storage (tC/ha) for different land uses in Itepi-Embara (Eastern Panama)

Carbon			
Forest	Agroforest	Pasture	
			Above-ground pools
218.2 ± 27.6	71.9 ± 6.6	2.2 ± 1.2	Trees + palms (≥10 cm DBH)
6.2 ± 0.6	3.1 ± 0.8	0.3 ± 0.1	Saplings (1–10 cm DBH)
4.1 ± 1.0	0.19 ± 0.09	0 ± 0	Lianas (≥1 cm DBH)
0.15 ± 0.02	0.14 ± 0.02	0.16 ± 0.04	Seedlings
0.10 ± 0.03	0.14 ± 0.03	1.1 ± 0.2	Herbs
2.4 ± 0.2	2.6 ± 0.3	0.23 ± 0.04	Litter
4.0 ± 1.0	3.5 ± 0.8	0.20 ± 0.15	Woody debris
235.1 ± 27.5	81.6 ± 6.6	4.2 ± 1.3	Total above-ground C (Mg ha^{-1})
			Roots
52.4 ± 6.6	17.2 ± 1.6	0.5 ± 0.3	Trees + palms (≥10 cm DBH)[c]
1.5 ± 0.1	0.7 ± 0.2	0.7 ± 0.2	Saplings (1–10 cm DBH)[c]
1.0 ± 0.2	0.04 ± 0.02	0 ± 0	Lianas (≥1 cm DBH)[c]
54.8 ± 6.6	18.0 ± 1.6	0.6 ± 0.3	Total C in roots (Mg ha^{-1})
			Soil
15.3 ± 1.1	15.1 ± 0.8	14.6 ± 0.8	SOC 0–10 cm
7.2 ± 0.6	7.4 ± 0.6	5.8 ± 0.4	SOC 30–40 cm
22.5 ± 0.9	22.5 ± 0.7	20.5 ± 0.6	SOC 10–30 cm[d]
45.1 ± 2.4	45.0 ± 2.3	41.0 ± 1.8	Total C in soil (0–40 cm depth) (Mg ha^{-1})
335.1 ± 34.6	144.7 ± 2.3	45.7 ± 2.6	Total estimated C by land use (Mg ha^{-1})

Source: Kirby & Potvin (2003)

Panama is incredibly diverse including forested mountains, hills, lowlands, savannas, coastal mangrove swamps, and tidal flats. Dense tropical forests include multistory canopies that extend some 20-50 m above the ground in parts of the eastern and northwestern regions of the country (Palka, 2005; Lichtenfeld, 2007). Stephens et al. (2007) indicate that natural forests play a larger role than thought in regulating the global climate, and will likely become increasingly important as alternative sinks become saturated (Gullison et al., 2007; Le Quereet al., 2007). Protecting Panama's primary and late-secondary forests along with land use changes such as conversion of pasture to agroforestry and reforestation with native species should secure significant carbon pools while also combating degradation and attracting investments by protecting biodiversity and securing environmental services (ES).[1]

[1] See Chapter 5 on Carbon markets, page 63

4.1 Teak

Teak does not represent a sustainable nor permanent or long-term CS solution for Panama, although it appears to perform well in terms of timber yields under most conditions in Panama when properly managed, and is valuable in terms of timber value (Coomes et al., 2008; Lauterbach, 2007; Wishnie et al., 2007; Zanin, 2005). Teak is the major cash-crop in Panama (Zanin, 2005), and has been a popular choice for large scale stakeholders, comprising 76% of the plantations established between 1992 and 2000 (ANAM, 2003; Potvin et al., 2008). Teak is however not native to Panama and if unmanaged may result in tragedy (Zanin, 2005).[1] Teak is relatively water-intensive, may increase erosion, and reduce biodiversity and soil and water quality and quantity (Calder, 2007; Wallander et al., 2007). It is not a sustainable option, being particularly unrealistic for rural Panamanian communities and asset poor stakeholders (Calder 2007; Coomes et al., 2008; Wallander et al., 2007), owing more to economic barriers than financial, such as high labor demands, sunk costs and illiquidity, and production and price risk (Coomes et al., 2008; Wassenaar et al., 2007).

Harvest age teak (20 - 25 years old) according to Coomes et al. (2008) stores approximately 125 tC/ha above ground in Ipetı-Embera. It appears that in the same region, native forests store almost twice this figure while agroforestry stores approximately 82 tC/ha (Kirby & Potvin, 2003; Table 4.1). Furthermore, Wishnie et al. (2007), indicate that native species in Panama are not only more sustainable than teak, but also outperform it in volume index (VI) of timber and carbon storage, while also being a better choice for agroforestry systems. However, some uncertainty exists for native species' internal growth rates and for the state of their international timber markets (Wallander et al., 2007).

In spite of these issues, using native species for reforestation, agroforestry, and CS is a highly viable land use alternative particularly to regenerate degraded lands, offering many possible advantages and positive externalities such as improved soil and water chemistry, biodiversity, and ecosystem stability, the creation of fruiting sources and productive environments for human and food security, a diversified stream of revenue for landowners, and a public image of being socially responsible (Engelbrecht et al., 2007; Wallander et al., 2007; Wishnie et al., 2007).

[1] See Chapter 2, top of page 27

4.2 Carbon sequestration potential

Wishnie et al. (2007) analyzed the initial growth of 22 native and 2 exotic tree species (Teak & Acacia; Table 4.2) planted at three sites across a precipitation gradient (1100–2200 mm/year) in Panama and found sustainable solutions for timber production and agroforestry. Native species in Panama were found to outperform teak in volume index (VI) of timber and carbon storage after just 2 years of growth, developing as large or larger VI than the two commonly planted exotic timber species (teak and acacia), which characteristically have high initial growth rates which slow over time (Wishnie et al., 2007; Table 4.3).

Table 4.2: 24 species for carbon sequestration and timber production in Panama

Scientific name	Family	Common name	Species code	Wood density	Uses
Acacia mangium	Fabaceae	Acacia	AM	0.57	Exotic: restoration, timber
Albizia adinocephala	Fabaceae	Frijolillo	AD	0.66	Restoration
Albizia guachapele	Fabaceae	Guachapalí	AG	0.62	Fodder, timber
Astronium graveolens	Anacardiaceae	Zorro	AGr	0.80	High value timber
Calycophyllum candidissimum	Rubiaceae	Madroño, Lluvia de plata	CC	0.82	Restoration
Cedrela odorata	Meliaceae	Spanish cedar	CO	0.44	High value timber
Colubrina glandulosa	Rhamnaceae	Carbonero	CG	0.99	Timber, fuel wood
Copaifera aromatica	Fabaceae	Cabimo	CA		Timber
Cordia alliodora	Boraginaceae	Laurel	CAl	0.46	Timber
Diphysa robinioides	Fabaceae	Macano	DR		Fencing, fuel wood
Dipteryx oleifera	Fabaceae	Almendro de montaña	DP	0.80	Timber
Enterolobium cyclocarpum	Fabaceae	Corotú	EC	0.44	Timber, fodder
Erythrina fusca	Fabaceae	Palo bobo, Palo santo	EF	0.28	Restoration
Gliricidia sepium	Fabaceae	Balo	GS	0.74	Live fencing, fodder
Guazuma ulmifolia	Sterculiaceae	Guácimo	GU	0.55	Fodder, fuel wood
Inga punctata	Fabaceae	Guabita cansaboca	IP	0.58	Fruit, restoration
Luehea seemannii	Tiliaceae	Guacimo Colorado	LS	0.50	Restoration
Ochroma pyramidale	Bombacaceae	Balsa	OP	0.15	Restoration
Pachira quinata	Bombacaceae	Cedro espino	PQ	0.46	Timber
Samanea saman	Fabaceae	Guachapalí	SS	0.57	Fodder, timber
Spondias mombin	Anacardiaceae	Jobo	SM	0.43	Live fencing, fruit, restoration
Tabebuia rosea	Bignoniaceae	Roble	TR	0.84	Timber
Tectona grandis	Verbenaceae	Teak	TG	0.54	Exotic: high value timber
Terminalia amazonia	Combretaceae	Amarillo	TA	0.68	High value timber

Source: Wishnie et al. (2007)

After just 2 years at all sites, *Acacia mangium, Diphysa robinoides, Gliricidia sepium, Guazuma ulmifolia* and *Ochroma pyramidale* rapidly developed large, dense crowns and attained canopy closure. These species might be used in restoration efforts to rapidly stabilize soils and establish crown cover. As nitrogen-fixing legumes, *Diphysa robinoides* and *Gliricidia sepium* may also increase soil fertility (Wishnie et al., 2007).

Several species valued for their timber attained high VIs at all sites. These species included *Tectona grandis* (teak), *Pachira quinata* and *Tabebuia rosea*. At each site, the native tree *Pachira quinata*, which is valued for its timber quality was in the top eight in terms of VI, and is the only native species planted in significant numbers in plantations in Panama (4.6% of plantations established between 1992 and 2004) (Wishnie et al., 2007). *Pachira quinata* performed particularly well at the two drier sites where it attained mean VI significantly greater than that of teak (Wishnie et al., 2007).

A number of other species valued for their high wood quality also performed well; *Tabebuia rosea* was present in the upper half of species at all sites, and at the driest site (Rio Hato) *Albizia guachapele* and *Samenia saman* both ranked highly. These same two species have previously been reported to perform well at a number of very dry (<900 mm rainfall/year) sites in Central American (Wishnie et al., 2007).

Table 4.3: Mean basal diameter, height and volume index (VI) of timber production in Panama across three sites (S = Soberania, L = Los Santos, R = Rio Hato). No indication for the values a, b, and c are given in the original paper.

Species	Height (m)			Basal diameter (cm)			VI (m^3 ha)		
	S	L	R	S	L	R	S	L	R
*Acacia mangium**	7.62 a	6.42 b	4.74 c	14.41 a	11.98 b	9.68 c	49.92 a	28.93 b	14.20 c
Albizia adinocephala	3.00 a	2.61 b	2.48 b	3.78 a	3.20 b	2.79 c	1.96 a	1.16 b	0.78 b
Albizia guachapele	2.81 a	3.56 b	3.43 b	5.78 a	7.30 b	6.13 c	3.25 a	6.21 b	4.14 c
Astronium graveolens	1.59 a	2.18 b	1.27 c	3.39 a	4.47 b	3.10 a	0.68 a	1.58 b	0.68 a
Calycophyllum candidissimum	2.55 a	2.52 a	0.86 b	4.67 a	4.59 a	2.08 b	2.05 a	1.93 a	0.17 b
Cedrela odorata	2.44 a	2.88 b	1.33 c	7.63 a	9.34 b	5.64 c	4.47 a	7.66 b	1.78 c
Colubrina glandulosa	4.19 a	3.65 b	2.13 c	8.08 a	7.07 b	3.76 c	9.05 a	6.25 b	1.54 c
Copaifera aromatica	0.79 a	0.74 a	0.49 a	2.12 a	1.96 a	1.31 b	0.14 a	0.12 a	0.05 b
Cordia alliodora	2.07 a	3.20 b	0.86 c	4.74 a	6.52 b	2.17 c	2.63 a	6.16 b	0.50 c
Diphysa robinoides	3.28 a	3.39 a	2.05 b	11.07 a	7.85 b	4.88 c	14.14 a	7.71 b	1.98 c
Dipteryx panamensis	1.85 a	1.75 a	0.76 b	3.12 a	2.95 a	1.63 b	0.74 a	0.60 a	0.08 b
Enterolobium cyclocarpum	3.04 a	2.91 a	1.90 b	7.46 a	7.23 a	5.81 b	5.69 a	5.45 a	3.31 b
Erythrina fusca	3.08 a	2.74 b	1.76 c	10.77 a	11.56 b	7.21 c	12.32 a	17.27 b	2.93 c
Gliricidia sepium	6.01 a	5.99 a	2.73 b	12.05 a	12.28 a	5.92 b	27.31 a	29.29 a	3.52 b
Guazuma ulmifolia	4.86 a	4.23 b	2.41 c	10.23 a	9.08 b	5.55 c	16.09 a	10.92 b	2.80 c
Inga punctata	2.60 a	1.51 b	0.98 c	7.72 a	5.44 b	3.64 c	5.83 a	2.23 b	0.88 c
Luehea seemannii	2.92 a	3.15 b	2.04 c	8.31 a	8.89 a	5.45 b	6.62 a	8.18 b	3.40 c
Ochroma pyramidale	7.02 a	5.98 b	3.55 c	14.91 a	13.46 a	7.76 b	51.02 a	37.69 b	8.94 c
Pachira quinata	2.97 a	3.63 b	2.14 c	11.55 a	13.31 b	8.23 c	13.12 a	21.73 b	5.20 c
Samanea saman	3.16 a	3.64 b	2.70 c	6.03 a	7.55 b	5.25 c	4.03 a	6.69 b	2.51 c
Spondius mombin	4.24 a	4.30 a	1.78 b	10.42 a	10.64 a	5.16 b	15.22 a	17.00 a	1.96 b
Tabebuia rosea	3.78 a	3.55 a	2.37 b	8.31 a	8.35 a	5.54 b	8.41 a	7.77 a	2.48 b
*Tectona grandis**	6.23 a	5.04 b	3.36 c	10.84 a	9.12 b	6.72 c	22.31 a	13.49 b	6.63 c
Terminalia amazonia	3.83 a	2.55 b	1.17 c	5.72 a	4.29 b	2.55 c	4.30 a	1.85 b	0.35 c

Source: Wishnie et al. (2007)

4.3 Reforestation of degraded grasslands

Hooper et al. (2002) investigated 20 native tree species in Panama (Table 4.4) and found an economical solution for reverting abandoned and degraded grasslands dominated by the exotic invasive weed *Saccharum spontaneum* (SS). The successful reforestation strategy includes shading the site and using large-seeded and shade-tolerant native species. Most species had much higher performance where the SS was shaded, as a result of higher germination, survival, and growth compared to the control. Shading treatments essentially eliminated the SS. However, natural tree regeneration will not proceed unassisted, as SS is a difficult barrier to small seeded species that have the highest probability of being dispersed.

Ormosia macrocalyx had the highest integrated performance in the SS control, coupling high growth with moderate survival and germination. The large-seeded *Virola surinamensis, Carapa guianmensis*, and *Dipteryx panamensis* ranked next, with modest germination and growth, and high survival. *Sterculia apetala* had relatively high performance in the SS control, despite low germination, because of its high growth rate. *Calopyyllum longifolium* followed these with high germination, but low survival and growth. All other species had relatively poor performance in the SS control.

Table 4.4: Twenty species of native trees indigenous to Panama

Species	Family	Species code	Seed mass (g)	Index of light dependence†	Dispersal agent‡	Date collected (mm/dd/yr)	Date planted (mm/dd/yr)
Annona spraguei	Annonaceae	Annosp	0.04	0.831	animal	09/20/96	09/26/96
Antirrhoea trichantha	Rubiaceae	Antitr	0.02		bird	08/02/96	08/18/96
Byrsonima crassifolia	Malpighiaceae	Byrscr	2.08	0.998	animal	07/15/96	08/07/96
Calophyllum longifolium	Guttiferae	Calolo	13.70	−0.934	bat	08/27/96	09/01/96
Carapa guianensis	Meliaceae	Caragu	50.36	−0.991	animal	10/25/96	10/29/96
Ceiba pentandra	Bombacaceae	Ceibpe	0.52		wind	01/10/97	01/15/97
Dipteryx panamensis	Fabaceae	Diptpa	16.66	−0.379	animal	01/12/97	01/13/97
Genipa americana	Rubiaceae	Geniam	0.14	−0.783	animal	02/08/97	02/11/97
Hampea appendiculata	Malvaceae	Hampap	0.21	0.146	animal	01/15/97	01/19/97
Heisteria concinna	Olacaceae	Heisco	0.30	−0.966	animal	03/06/97	03/08/97
Jacaranda copaia	Bignoniaceae	Jac1co	0.01	0.044	wind	09/10/96	09/26/97
Lindackeria laurina	Flacourtiaceae	Lindla	0.09		animal	08/01/96	08/07/96
Ormosia macrocalyx	Fabaceae	Ormoma	0.48	0.619	animal	08/15/96	09/06/96
Posoqueria latifolia	Rubiaceae	Posola	0.62	−0.992	animal	01/08/97	01/13/97
Spondias mombin	Anacardiaceae	Sponmo	2.18	0.999	animal	08/15/96	08/21/96
Sterculia apetala	Sterculiaceae	Sterap	1.28	0.215	animal	01/27/97	01/31/97
Trattinickia aspera	Burseraceae	Tratas	0.19		animal	10/28/96	11/23/96
Trema micrantha	Ulmaceae	Tremmi	0.01	−0.111	bird	08/02/96	09/04/96
Virola surinamensis	Myristicaceae	Virosu	2.89	−0.964	animal	07/02/96	07/09/96
Vochysia ferruginea	Vochysiaceae	Vocyfe	0.02	0.913	wind	10/10/96	10/14/96

Source: Hooper et al. (2002)

Hooper et al. (2002) do not recommend mowing as a site treatment or planting small seedlings directly into the SS. SS growth was undiminished with mowing. Mowing the SS three times exposed tree seedlings to high irradiance, increasing temperatures by 5–9 °C, decreasing humidity by 10–15%, and lowering volumetric soil moisture by 10%. They found tree seedling germination, growth, and survival was lowest under these conditions (~50% lower values than those recorded in the shaded treatments). They do recommend producing a shade cover as quickly as possible and planting large-seeded shade tolerant tree species with the establishment of firebreaks. Shade greatly enhances the performance of most tree species and effectively kills SS. The shade tolerant species have immediate and high germination in comparison to the more light-demanding species which have higher growth. Once a shade cover is produced, they suggest planting seeds of the small-seeded, shade-tolerant species (*Posoqueria latifolia, Genipa americana,* and *Heisteria concinna*) to increase diversity.

Given that firebreaks must be established, Hooper et al. (2002) recommend that species of local value be planted as seedlings in the firebreaks. They also recommend direct seeding of the colonizing species *Byrsonima crassifolia* and *Spondias mombin* in the firebreaks, where they could benefit from the mowing treatments undertaken for fire prevention. Planting these species in the cleared areas would be simple and cost-effective. Once established, these species could act as a green-firebreak and attract frugivores[1], increasing seed dispersal to the regeneration area, as has been found for windbreaks in Costa Rica. These breaks however must be large for effective fire protection because the flame height of SS wildfires can reach 15 m. Seedlings of large-seeded species (*Carapa guianesis, Dipteryx panamensis, Virola surinamensis, Ormosia macrocalyx,* and *Calophyllum longifolium*) could resprout following fire (Hooper et al., 2002).

[1] A frugivore is a fruit eater

4.4 Agroforestry

Agroforestry generally sequesters less carbon than other conversion options in Panama but may provide benefits such as improved crop yields, diversification of crops and economies, enhancement of water and soil quality and habitat, and reduction of chemical usage, soil erosion, and flooding (Wallander et al., 2007). According to Grossman (2007), agroforestry would sequester less than half of the carbon of native species plantations. CS estimates for agroforestry in Panama vary, however they are often significantly above the global median estimate of 95 tC/ha of total carbon stored (Kirby & Potvin, 2007). Kirby & Potvin (2007) indicate that agroforestry in areas currently used for pasture in Panama sequester approximately 144 tC/ha in total carbon over 23 years of which 89.2 tC/ha are above ground in biomass.

Griscom et al. (2005) tested three economically valuable native tree species with herbicide application and cattle removal in pastures within a deforested, dry region of Panama. They found to accelerate forest succession, herbicide should be initially applied and cattle removed before planting. However, herbicide application alone was not sufficient. They also found that cattle trampling was the most common cause of seed mortality, followed by being eaten by cattle, then canopy grass loading and insects. Death by common rodents was unique to *Enterolobium cyclocarpum*. Overall, *Cedrela odorata* had the highest survival rate at 42%, followed by *Enterolobium cyclocarpum* (35%), then *Capaifera aromatica* (12%). *Cedrela odorata* had greater growth with herbicide application and *Enterolobium cyclocarpum* had the greatest growth with cattle removal. However, these species store relatively little above ground carbon (Table 4.3, page 58).

Wishnie et al. (2007) indicate that the most promising species for use in agroforestry systems varied among sites in Panama. *Albizia guachapele, Gliricidia sepium, Samanea saman* and *Guazuma ulmifolia* were the top performers at the driest site (Rio Hato), while *Guazuma ulmifolia*, *Gliricidia sepium* and *Spondius mombin* were the best performers at the wetter sites (Soberania and Los Santos). *Glircidia sepium* and *Guazuma ulmifolia* performed well in terms of VI at all sites and therefore appear to be the best options. All species except *Guazuma ulmifolia* are nitrogen-fixing legumes, and if used in agroforestry systems may provide fodder and fencing while also improving soil and pasture quality. *Glircidia sepium* is the best option for combining agroforestry with CS. Additional revenues from timber may be secured by planting *Pachira quinata*, which is native and outperforms teak in terms of VI at drier sites (Wishnie et al., 2007; Table 4.3, page 58).

4.5 Conclusions

Panama has great potential for CS owing to vast amounts of abandoned and degraded lands and natural forests, and high rates of tree growth. Protecting natural resources, biodiversity and ecosystems, by avoiding deforestation, ecologically responsible cattle-ranching and agroforestry, and replanting native species are the best options for Panama, since even in the event of changing precipitation patterns or in the absence of external investments and markets, substantial benefits could be realized. Significant amounts of natural capital may be conserved and human development and security fostered.

For the longer term political viability of CS projects in Panama's rural communities, poverty, inequality, and social justice concerns should be addressed by Panama's government and smallholders should be included (Tschakert et al., 2007; Wallander et al., 2007). Improving pastoral and agroforestry systems significantly enhances carbon pools, particularly in terms of soil carbon, while offering an attractive economic alternative to farmers (Gobbi et al., 2008), and given Panama's cultural cattle-ranching identity, it may be among the best options. Furthermore, agroforestry in Panama stores significant amounts of carbon relative to the global mean, and substantially more compared to pasture lands which store only 4.2 tC/ha above ground (Kirby & Potvin, 2007). Therefore a shift from pasture to agroforestry would secure more carbon, while still providing the economic benefits found by cattle-ranching. For these methods to be adopted and successful, substantial changes in policies and governance are implied.

Sukhdev (2008) indicates Panama's drastic economic need to stabilize and support its incredibly diverse ecosystems, which would also protect the Panama Canal. Given the difficulties and uncertainties surrounding teak, it does not appear to be a good choice for smallholders, agroforestry, or CS projects. The environmental degradation and inequality from teak in Panama negates the short term financial and above-ground carbon and monetary gains from its timber. The pertinent analysis is how much economically and environmentally is this worth? Soil properties are a significant oversight; soil carbon and quality, water yields, quality and quantity, and the biomass which it supports are all coupled. Teak significantly impacts these in favor of above ground carbon, with only financial returns from timber in 20 - 25 years. Native species may be planted instead, which not only outperform teak in terms of timber production, but which also support ecosystems, agroforestry, ES markets, and human development.

5 Carbon markets

With both unsustainable levels of global emissions and environmental degradation, the international community is seeking to adopt new tactics for addressing global change.[1] These programs and developments may assist Panama to stimulate a shift in current land use and management patterns while improving possibilities for environmental service (ES) and CS market development and expansion (Wallander et al., 2007), however substantial investments are required (Corbera et al., 2007; Miller, 2008; Zhang & Maruyama, 2001). Securing sustainable investments may prove difficult for Panama since its image and environmental record are poor, and often failing to properly employ funding for environmental protection (Schloegel, 2007) due to various reasons outlined earlier such as high transaction costs and protection of corporate interests. As a result, even the PCW is under threat (Lichtenfels et al., 2007).

CS projects are rapidly increasing, being the most tangible of ES while also aiding in stabilizing the global climate and improving environmental and social welfare. CS projects must be carefully designed, and have not been utilized to its expected potential (GEF Council, 1999; IPCC, 2007b; Smith & Scherr, 2003; Pagiola et al., 2002). It is critical to be aware of the package effect of CS, as such projects can also protect biodiversity and soil and water resources, particularly in the case of CS through avoided deforestation of primary forests. Conservation of primary forests protects biodiversity and maintains ecosystem structure and function, and is therefore of critical importance for Panama's adaptation strategies (UNEP, 2007). Such projects not only bring significant environmental, economic and social benefits (Ebeling & Yasue, 2008; IPCC, 2007Ab), but they also tend to be a larger and more reliable stock of carbon than that stored in commercial forests and plantations, while also supporting more species and ES than any other land use options, and therefore more likely to attract stakeholder support for CS (Lauterbach, 2007; Kirby & Potvin, 2007). Even in developed countries however, CS schemes have proven particularly challenging due to difficulties such as leakage, non-permanence, establishing baselines, verification, and monitoring (UNEP, 2007). Much closer attention should be given by Panama's policy makers to accept forest conservation as a basis for carbon trading, since it promises many substantial benefits (Wassenaar et al., 2007).

[1] See Appendix 2: Environmental politics and market mechanisms, page A4

5.1 The Kyoto Protocol and forests

The Kyoto Protocol (KP)[1] contains the world's largest regulated carbon trading market and is a substantial source of funding for CS and forestry projects, and is projected to increase (Ebeling & Yasue, 2008). Funds for carbon trading have already far outweighed historical international forestry funding, which totaled approximately $1 billion annually during the last decade (Tomaselli, 2006). In comparison, the KP's international carbon markets transacted $14.1 billion in 2005 and $33.3 billion in 2006 (Ebeling & Yasue, 2008).

Due to political and methodological concerns the KP's clean development mechanism's (CDM) Land Use, Land Use Change and Forestry projects (LULUCF), only accepts carbon from afforestation and reforestation (A/R) (Lauterbach, 2007; Wallander et al., 2007; Strassburg et al., 2009). 14 distinct baseline and monitoring methodologies have been approved for A/R (UNFCCC, 2008), however such projects only generate temporary credits and have played an insignificant role in the carbon market so far, accounting for less than 1% of all CDM projects (Rocha, 2008; UNEP 2008). The CDM is still being developed with complex legal and technical issues requiring further debate (Rocha, 2008). No mechanism aimed at avoided deforestation of natural forests (RED) exists in spite of the overwhelming scientific evidence of its potential and clear benefits (Lauterbach, 2007; UNEP, 2007). In particular, for assisting in stabilizing ecosystems and the global climate, and addressing the tremendous inequalities which exist in many developing countries, especially in forest areas (Chomitz, 2006; Corbera et al., 2007; World Bank, 2006).

The framework for implementing the KP is most solidly institutionalized in the European Union Emission Trading Scheme (EU ETS), which covers almost half of Europe's CO2 emissions (PEW, 2007).[2] The EU ETS has not accepted A/R projects under its carbon trading scheme due to non-permanence, high costs for monitoring and enforcement, and leakage and other uncertainties (Rocha, 2008). The EU ETS is already highly complex and may not stand to gain anything from attempting to integrate A/R, which may then result in no properly functioning carbon market at all. Rocha (2008) argues that overcoming these issues may only be achieved through enough political will, which appears to be non-existent.

[1] See Appendix 2.1.1: The Kyoto Protocol, page A9
[2] See Appendix 2.1.2: The EU ETS, page A10

5.2 Environmental policy instruments

There is clear evidence that deforestation in the tropics is not only significantly impacting the global climate, but also the increasingly vulnerable welfare of developing nations. As economic pressures increase, the need for the development of environmental/ecosystem (ES) service markets and national and global policy reforms to address these issues is crucial (Corbera et al., 2007; IPCC, 2007b; Lichtenfels et al., 2007; UNEP, 2004). Environmental policy instruments (EPIs) are often employed by countries to address environmental concerns and ES market failures. EPIs however are a subset of environmental policy which is a subset of policy which is a subset of government, governance, and politics. As a result, ES markets usually fail to emerge in developing countries, the primary reason being that ES have historically been free of charge, and stakeholders often resist paying for that which was once free (Pagiola et al., 2002), particularly those who are powerful enough to dominate the state. ES are generally severely undervalued due to market distortions and the myriad of issues surrounding their evaluation. However, undervaluing ES may push landuse in directions that decreases economic welfare, therefore a comprehensive assessment of their value is essential and adequate data needs to be collected. Furthermore, significant external investments and assistance are required for Panama to successfully implement and maintain ES markets, however investments are being constrained by low levels of cooperation and transparency, and lack of regulatory and institutional frameworks, which can be exceptionally expensive to update and slow in taking effect (Pagiola et al., 2002/2004b).

EPIs such as sustainable forest management and certification, monetary and trade policies, payments for ES (PES), and the labeling of protected areas (PAs) have been engaged to counter environmental threats and redress undervalued ES markets (Wunder, 2005). Commonly debated EPIs include but are not limited to PES, subsidies, taxes, and command and control (CAC) approaches (Engel et al., 2008). In most countries, CAC approaches (non-market/direct regulation) dominate environmental policy. However, this situation is changing and market based EPIs/market mechanisms (MMs) are increasingly being turned to, as they operate on a decentralized level through their impact on market signals (Pagiola et al., 2002; UNEP, 2004). Nevertheless, CAC approaches will continue to be an integral part of environmental policy making. Panama should seek to find the optimal combination of MMs to implement alongside CACs. This varies as governments,

infrastructure, environments, and culture vary. A functioning MM in one country may fail in another due to these differences (Engel et al., 2008). Even under optimal conditions MMs may be difficult to implement and particularly slow in taking effect. Pagiola et al. (2002) reveal that designing and implementing the required reforms and infrastructure necessary to make MMs function in Panama discouraging.

MMs are relatively new in addressing environmental problems (Louka, 2006; UNEP, 2004). The development of MMs for ES such as CS, biodiversity, and watershed protection have been among the most ambitious and controversial EPIs to date (Landell-Mills & Porras, 2002). Nevertheless their potentials are promising. Studies in the USA indicate that MMs are on average 6 times more efficient than CAC approaches (UNEP, 2004). MMs aim to either drive up the costs of environmentally harmful activities or increase returns from sustainable approaches, thereby providing incentives to behave in a more responsible and sustainable manner (Louka, 2006; UNEP, 2004). A MM's effectiveness may be measured by assessing how many actors are attracted, to what extent their behavior is influenced, and the extent and nature of the services conserved (Pagiola et al., 2002).

If Panama hopes to implement these instruments to foster sustainability and its ability to develop ES markets and adapt to change, then it has some challenging facts to face up to and some significant issues to address. MMs are basically constrained by transaction costs and factors that undermine supply or demand (Landell-Mills & Porras, 2002). MMs therefore face significant barriers in Panama due to its low capacity, levels of technology and knowledge bases, lack of infrastructure, monitoring and enforcement, lack of accountability and transparency, high levels of corruption, poverty, and cultural resistance, ineffective and inefficient governance, an environmental agency (ANAM) which is essentially voiceless and totally unequipped to manage the task at hand, and indeterminate land titles and laws and inconsistent enforcement (Dudek et al., 1998; Engel et al., 2008; Landell-Mills & Porras, 2002; Pagiola et al., 2002/2004a/5; See Chapter 2, page 30).

To minimize the dependence on such constraints and initially address these market barriers, and build strong and stable ES markets, Panama's government may need to create ES market demand. As outlined above, these services have historically been provided for free and stakeholders may resist paying for them (Pagiola et al., 2002), particularly in Panama, where the state has traditionally been heavily protectionist of corporate interests, and largely disinterested in environmental sustainability, particularly in rural regions.

5.2.1 Taxes

Introducing new taxes is considered politically challenging, however taxes are ubiquitous and often an ideal solution for addressing emerging market failures, inequity, and environmental issues. A Goods and Services Tax (GST/VAT) is already set in OECD (Organization for Economic Cooperation and Development) countries, often at around 10%, and inflation is effectively a tax on money. Sweden and Norway in the early 1990s already implemented a carbon tax. Now, more countries have energy based taxes while others are currently seriously discussing proposals (Green et al., 2007). For Panama, introducing green taxes may be timely and necessary considering the fast response time and flexibility that taxes offer, and the current levels of inequity and the current state of the environment, particularly in the PCW. In fact, Panama has recently turned to increasing and implementing new taxes (Lichtenfels et al., 2007). Environmental taxes are considered superior to subsidies and are regarded as the best policy tool for promoting economic efficiency (Engel et al., 2008; Stephan et al., 1997). Taxes are often simple policy instruments to implement and enforce, particularly when the taxes are on only the major polluters (Milken, 2007; Nordhaus, 2005). A tax on emissions or pollution would be economically efficient and also an ideal instrument for addressing climate change, particularly considering the uncertainties and the flexibility and quick response time taxes offer (Milken, 2007; Open Europe, 2006).

Panama could artificially create demand for ES markets by implementing a green or equity tax on large land-holders, Panama's extremely rich minority, the ACP, hydro companies, and timber and mining operators. These operators could be charged a flat fee per ha of land deforested or a portion of the value of raw logs or minerals exported (Lichtenfels et al., 2007). Alternatively, the ACP may be in the best position to initiate such activities since local institutions and ANAM are severely underfunded, while Panama's government in general lacks the necessary tools for the job. In such a scenario, ANAM should be more involved with and funded by the ACP via a tax, which should be aimed at conserving biodiversity and protecting the canal's watershed. ACP's ability to dictate land use in the PCW directly (Lichtenfels et al., 2007) should be assimilated with institutions which have incentive and the capacity to make long term sustainable decisions.

Another promising EPI which could work together with taxes is PES, which are market-based EPIs that translate ES into financial incentives for landowners to protect their environment (Pagiola et al., 2008). More research is required before implementing PES in Panama.[1]

[1] See Appendix 2.3: Payments for environmental/ecosystem services, page A15

5.3 Afforestation and reforestation

Reforestation with native tree species would provide a strong base to access ES markets, sequester significant quantities of carbon, and enable trade in Certified Emission Reductions (CERs) under the CDM. However, economic costs and risks are prohibitive, and finances are lacking (Coomes et al., 2008; Wallander et al., 2007). Set up costs are of prime concern, with almost half of the costs of reforestation incurred during the first years of establishment (technical studies, land preparation, seedling planting, weeding, and substantial cost and fees for marketing CERs) (Lauterbach, 2007). Other issues include the threat of fire, disease and pests, premature cutting, gaps in research on growth and site-specific suitability, individual species' responses to environmental variables, and the continuous need to monitor and enforce (Coomes et al., 2008; Lauterbach, 2007; Wallander et al., 2007).

Carbon markets alone are inadequate to address Panama's needs, operating under restrictive rules and imposing significant technical and monitoring issues (Lauterbach, 2007; Nordhaus, 2005; Potvin et al., 2008). Panama faces significant barriers to participating in both regulated and unregulated carbon markets for afforestation and reforestation (A/R) projects, primarily due to its limited institutional capacity (Murphy et al., 2008). In regulated markets, failure to meet additionality and high transaction costs for project design and approval constrain development, while in unregulated markets, identifying potential consumers in a highly fragmented landscape is the primary challenge (Lauterbach, 2007). Regulated markets are unlikely to be an option for many Panamanians. A plot size of 40 ha in Panama incurs transaction costs for entering the regulated carbon market of approximately $40,000-$90,000 for the initial investment and around $5,000-$9,000 in ongoing monitoring. The non-regulated market is significantly less expensive, costing $9,000-$15,000 for the initial investment and $4,000-$6,000 for monitoring (Lauterbach, 2007). To address these costs, law 24 of 1992 which promotes large scale teak plantations while ignoring smallholders should be scrapped to increase funding for ANAM, local governments, and smallholders, to redress land titles and forestry laws and enforcement, and to bundle smallholders together to enable feasible access to markets and economies of scale (Wallander et al., 2007). In 2001, law 24 cost the state $40 million while in 2005 ANAM was severely underfunded with only $27 million in revenue.[1]

[1] See Figure 2.11, page 28

5.4 Agroforestry, organic farming, and certification

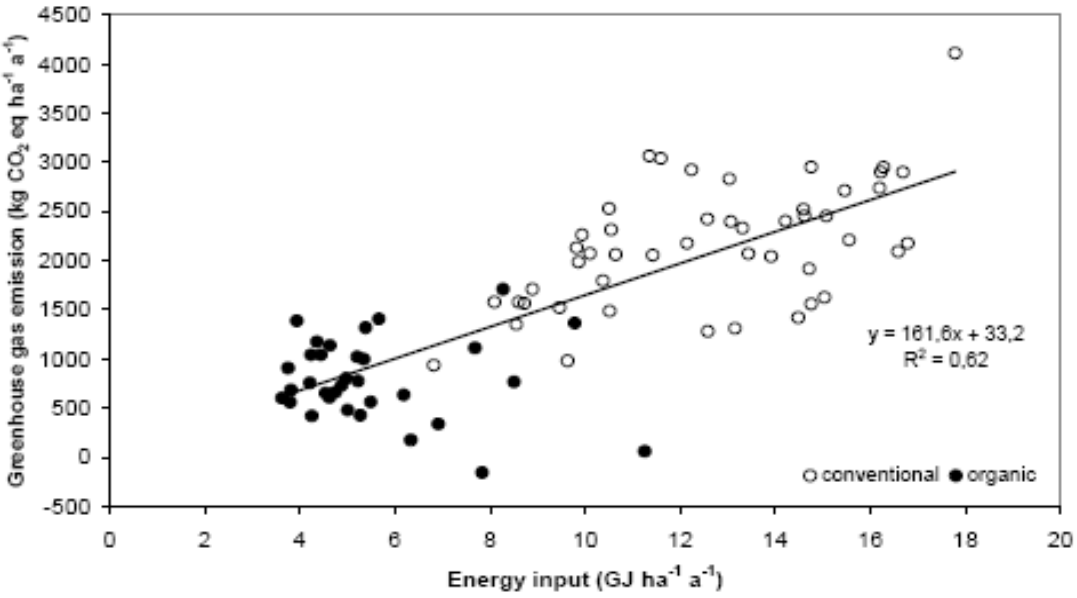
Agroforestry projects can simultaneously provide many market benefits including CS in regulated and voluntary carbon markets, ES, and biodiversity friendly products (Wallander et al., 2007). In Costa Rica, conservation and CS through the adoption of agroforestry has been highly successful in increasing landscape connectivity and reducing land degradation at a cost of approximately $40 per ha (Pagiola et al., 2004a). In bundling carbon with agroforestry, the main challenge is whether CS revenue can offset costs associated with carbon measuring and auditing, since these projects will need to prove additionality, permanence, and lack of leakage (Wallander et al., 2007). In Panama, agroforestry projects have had mixed success and there are significant barriers to successfully implementing it on a wide scale, such as economic feasibility and poor infrastructure (Fischer, 2002; Wallander et al., 2007). Further research is required to determine how well different types of agroforestry systems may sequester carbon, as well as how they impact ecosystems and crop yields (Grossman, 2007). Nevertheless, agroforestry may be marginally profitable in Panama for smallholders who could sell carbon credits, produce biodiversity friendly products for personal consumption and sale at local markets, and potentially receive payments for watershed services (Wallander et al., 2007). This is however currently an unattractive option for smallholders due to high risks and the lack of financial resources and incentives, functioning markets, and marketing (Fischer & Vasseur, 2000; Wallander et al., 2007). To make agroforestry possible, particularly for smallholders, more research is required into climate change impacts on soils and pastures, PES, geographic access to markets, optimum rotations, interactions between tree and agricultural species, and other information on planting dynamics to ensure high tree survival and growth rates and productivity (Magrin et al., 2007; Wallander et al., 2007; Wishnie et al., 2007).

Conventional agriculture can become more sustainable and environmentally friendly by adopting traditional organic techniques.[1] Therefore, another landuse option may be the inclusion of cattle, since cattle ranching is a part of Panama's cultural identity and creates livelihoods for the rural poor. Subsidies or ES payments combined with land title and a few cows for eco-grazing and subsistence is a promising alternative option for the many stakeholders facing poverty and limited options. Payments for carbon sequestration, conservation or regeneration, and watershed services may come from green taxes.

[1] See Appendix 6: Organic farming, page A56

Degraded lands near native forests could be partially regenerated and enforcement would come from the security of farming and the many economic benefits it provides. Compliance would be maximized by granting land title and a percentage of the harvest age timber to the farmer after 15 years of eco-methods and management, which could be up-to-date on the internet, and provided for them as an incentive and to aid in monitoring, enforcement, and compliance. Organic agricultural methods have a 6000 year history of sustainable soil, water, energy, and biological resource consumption patterns. On conventional farms, mineral fertilizer and pesticide application cause markedly higher energy inputs. Organic methods increase soil organic matter and nitrogen, lower fossil energy inputs, yield similarly to conventional systems, and conserve soil moisture and water resources. Soils treated with farmyard manure have 2 to 2.5 times as many worms as untreated soils, making the soil more fertile and water stable, draining water 4 to 10 times faster and making the water holding capacity 20% higher, representing a better option for the sustainability of the Panama Canal than teak (Küstermann et al., 2008; Pimmentel et al., 2005; Shiva; 2000; Figure 5.1)

Figure 5.1: Organic farms produce significantly less greenhouse gas emissions and energy than conventional methods



Source: Küsterman et al. (2008)

Even when not considering CS, the conversion from conventional to organic farming may result in a net decrease in greenhouse gas emissions (Niggli & Schmid, 2007). Each cow produces approximately 1.5 tC annually (Küstermann et al., 2007), therefore, to offset one cow's emissions would require for example regenerating only the soil carbon in 0.75 to 0.22 ha of degraded grasslands (Amezquita et al., 2008). This may also be combined with A/R, which stores substantial carbon above ground (Amezquita et al., 2008), and would reduce the cows per ha figure drastically.

Alternatively or in parallel with the above, since Panama has fast rates of tree growth and large portions of land available, it may simply promote sustainable forest management and the restoration of native vegetation by reverting croplands and exotic pastures to secure carbon payments, with additional economic incentives coming from sustainable tourism and/or the certification of biodiversity-friendly products (Schloegel, 2007; Wallander et al., 2007; Table 5.1). In the USA alone, the 2010 market forecast for eco-friendly timber is tens of billions of dollars (Butler & Lawrence, 2008). Barriers to supplying certified products in Panama include lack of awareness and cooperation, high initial certification costs, and an uncertainty surrounding price premiums (Miyata, 2007).

All abovementioned options would not only store and secure significant quantities of carbon, but may also bring substantial co-benefits for ecosystems and human development. While the crop yields and economics of organic systems appear to vary, the environmental benefits are consistently greater in organic systems compared to conventional systems (Pimmentel et al., 2005). Organic farming creates livelihoods in rural areas, while using less energy, sequestering carbon, and protecting our global climate, ecosystems, and soils (Niggli & Schmid, 2007), which is one of the most undervalued and abused of Panama's resources (Ellis & Mellor, 1995). Methane from cows and nitrous oxide emissions from soils contribute significantly to anthropogenic global warming, and there is a direct correlation between these emissions and conventional agriculture, which severely degrade soils.

The equity, smallholder, environmental, and market concerns that Panama faces are substantial. Panama may fund via taxes the ES of protecting biodiversity in combination with payments for CS or watershed services (Table 5.2). Native old growth forests store significant amounts of carbon and are relatively stable while offering a higher likelihood of access to ES markets. Moreover, Panama is a biodiversity hotspot and conservation stakeholders ideally prefer such land (Lauterbach 2007; Smith & Scherr, 2003).

Table 5.1: A recommended scenario for Panama to access environmental services (ES) markets while sequestering carbon

Scenario	Benefits	Challenges	Profitability
Native Species Plantation	• Native species confer positive externalities to environment and local communities. • Promotes existence of genetic diversity in native tree populations.	• Wood markets for native species are less developed than for exotic species. • Growth rates of native species are still being determined.	• Native species is not as profitable as exotic species given present state of knowledge. • Native species reforestation is less costly and potentially more profitable than agroforestry.
Carbon	• Provides a revenue stream throughout the life of a project. • Can provide revenue stream with no additional plantation costs. • Currently, the CDM EB is reviewing reforestation methodologies for carbon credit sales.	• High initial transaction costs to enter regulated and non-regulated markets. • Currently no CDM approved methodologies for reforestation. • Small landholders may have difficulty in addressing transaction costs of monitoring and approval. • Need to prove additionality, non-leakage and permanence.	• Regulated carbon markets have high transaction costs that would need to be offset. • Non-regulated markets have lower transaction costs, but these costs still may be an impediment to entering the market.
Sustainable Tourism	• Potentially large and unexplored cruise ship tourism market. • Small but significant revenue stream throughout the life of the project.	• Tourism is seasonal. • Willingness to pay for carbon offset tourism uncertain.	• Revenue is dependent upon the number of tourists who visit Panama.

Source: Wallander et al. (2007)

Table 5.2: Land use option acceptability for low-income households in Ipeti-Embera indicating negative net returns and impacts on ecosystems from cattle ranching but significant positive financial and environmental returns from A/R projects and avoided deforestation (Avoided deforestation is covered in section 5.5, page 73)

			Avoided
	CDM-AR	Cattle	Deforestation
Net returns	+ +	–	+
Financing	– –	–	na
Production risk	– –	–	–
Market risk	–	+ +	?
Labour demands	– –	+	+ +
Liquidity/sunk costs	– –	+	– –
Insurance value	–	+ +	+
Implementation modalities	– –	+ +	?
Perceived equity	– –	–	+ +
Ecological integrity	+	– –	+ +

Source: Coomes et al. (2008)

5.5 Reducing emissions from avoided deforestation and degradation

Linking reducing emissions from avoided deforestation and degradation (REDD) to international carbon markets could create a real opportunity to tackle the second largest source of greenhouse gas (GHG) emissions at comparably low costs while also curbing unsustainable levels of global degradation and providing substantial benefits for human security and equity (Stern, 2007; UNEP, 2008).[1] REDD is becoming more and more popular and in negotiations and has become more attractive than A/R (Rocha, 2008). REDD however faces several political and technical challenges, with similar issues to A/R projects and in particular the issues of non-permanence and leakage need to be addressed. Other issues include the economic competition from other forms of land use and over-flooding the carbon market with cheap credits, thus making emissions reductions too easy (Butler et al., 2009; Michaelowa & Dutschke, 2009; Rocha, 2008). Additionality and leakage have been highly controversial however market mechanisms associated with national baselines have been developed which prevent leakage while additionality may be completely scrapped in future negotiations (Brown et al., 2007; Engel & Palmer, 2009; Myers, 2007). A recent analysis unveils a successful REDD mechanism based on combined incentives and national baselines that prevent leakage which could mitigate over 90% of global deforestation at cost of $30 billion annually (Strassburg et al., 2009).

Carbon markets may be neither sufficient in size nor secure enough to stimulate REDD action.[2] Nevertheless, they may assist in overcoming funding constraints that have historically hampered forest conservation efforts (Ebeling & Yasue, 2008). In 2008, the World Bank under its newly formed Forest Carbon Partnership Facility (FCPF) selected Panama among 14 tropical countries to participate in conserving its forests under a carbon finance scheme. Panama intends to use this funding to build its capacity for REDD by establishing baselines, adopting strategies to reduce deforestation, and designing monitoring systems (FCPF, 2008). The World Bank's involvement is a troubling aspect given its history of dealing with forest peoples (Young, 2002). In Panama, defining property rights and fighting corruption should precede REDD which is still in its establishment phase, and may lead to more centralized governance of forests. Indigenous peoples are often the best custodians of their forests and REDD may infringe too heavily on their rights and the rural poor given the current conditions in Panama (Tauli-Corpz, 2008; Young, 2002).[3]

[1] See Appendix 2: Environmental politics and market mechanisms, page A4
[2] See Appendix A2.2: Securing external support, page A12
[3] See Chapter 2, page 8

Current instruments can not provide the necessary incentives and flexibility to stimulate REDD action, and uncertainties will fall on Panama's government, which may be unable to cover costs or honor contracts with private forest owners, which may spark further deforestation and social unrest (Potvin et al., 2008). Success ultimately hinges on ensuring permanence and minimizing leakage. Panama therefore must improve its governance, which means capacity-building, improved surveillance, and significant external investments coupled with community participation and equitable benefit sharing (Ebeling & Yasue, 2008; Myers 2007; Oestreicher et al., 2009; Potvin et al., 2008). Strategies to reduce deforestation must create alternative economic opportunities for stakeholders, since those who are asked to stop deforesting may simply relocate (leakage), which may become significant in Panama since subsistence is at stake and there is a lack of other available options (Potvin et al., 2008), with economic pressures increasing (World Bank, 2006; Economist, 2008a). In spite of the issues, REDD may not only generate low priced carbon credits and restore and protect Panama's ecosystems, but may also enhance equity and spur human development by providing jobs, security, and a sustainable alternative option for stakeholders (Ebeling & Yasue, 2008).

REDD costs that Panama would face include (Ebeling, & Yasue, 2008):

- The cost of developing alternative land-use strategies
- The cost of institutional reorganization (may be extremely expensive)
- An incentive element to ensure this is undertaken effectively
- Monitoring and enforcement (~$7/ha; Potvin et al., 2008)
- Administration (~$3/ha; Coomes et al., 2008)
- Opportunity cost (~$60/ha; Coomes et al., 2008)

Therefore, in Panama REDD would currently cost approximately $70/ha, which is approximately $2.68/tCO2e avoided annually in Panama for a 5000 ha plot and a 25 year contract period (Potvin et al., 2008). This figure only accounts for above ground carbon and assumes that misguided agricultural subsidies remain in place and that opportunity cost is gross income. These assumptions drive the cost of REDD up significantly and will be explored further on. The current market price for carbon credits is approximately $30/tCO2. Therefore, Panama would receive over $27/tCO2[1] if it could sell these credits on a carbon market. However it would have to establish national baselines, guarantee permanence and

[1] $30/tCO2 - $2.68/tCO2 (Panama's cost for providing carbon credits) = $27.32t/CO2

insignificant levels of leakage, and prove additionality. These represent significant challenges for Panama, although additionality may be excluded from this list (Wünscher et al., 2008) and may in fact even be scrapped from the CDM to enhance participation and ease compliance constraints (UNEP, 2008).[1]

Many rural Panamanians are living in poverty and are driven to deforestation for subsistence, land title, and the lack of any alternatives. A job as a monitoring and enforcement agent to protect forests would be an opportunity for these Panamanians, who could walk or drive or ride around and monitor 50 ha of forest. It is clear that covering 50 ha per day (or 0.5 square kilometers) may be out of reach for one person. However, over a week, a clear indication of the areas condition should be easily obtained, and if any concerns should arise, then governmental reinforcement via personnel or satellite monitoring may be employed. Their wage would be $458 annually (or $458/50ha = $9.16/ha; N.B. $7/ha; Potvin et al., 2008). This would effectively make them richer in income (and they don't have costs) than a 5 ha smallholder cattle rancher in the PCW (Coomes et al., 2008), and lift them out of poverty ($458/365 > $1.25/day).[2] Although the financial incentive may be low, the economic feasibility is high, and equity and natural resources should be enhanced.[3] Three incentives drive the supply side of this market. It offers the option for those many Panamanians without any other options and without land titles and living in poverty. It offers an income above that of a 5 ha cattle-rancher in the PCW. It offers the chance to be a part of protecting Panama's natural resources and enhancing human security. On a national scale, assuming a native deforestation rate of 50,000 ha, this would cost Panama's government $458,000 annually; it would lift 1000 people out of poverty, and may create an environmental culture of sustainability. If these people were indigenes, Panama's natural forests would be most secure.

The analysis of Potvin et al. (2008) suggests that REDD is not financially feasible and that none of the currently proposed mechanisms can provide the necessary incentives and flexibility to stimulate action. According to Potvin et al. (2008), the opportunity cost makes REDD prohibitive. However, the validity of their method is questionable, they misrepresented Tomaselli (2006), and used net present value (NPV) of benefits compounded over 25 years to calculate the annual opportunity cost, suggesting Panama needs substantial upfront funding.[4]

[1] See Appendix A2.1.1 The Kyoto Protocol, page A9
[2] World Bank's new inflation adjusted international poverty line is $1.25 per day
[3] This may occur both directly and indirectly, e.g. reducing pressures to overgraze pastures and compete in international markets
[4] See Appendix 3: Financial analysis of REDD in Panama, page A17

Transferring large sums of money upfront to Panama's highly centralized government is not advisable, since it lacks capacity and efficiency, and is unable to address market failures. Potvin et al. (2008) report Tomaselli (2006) an order of magnitude out ($1 billion annually, not $1 billion over last decade as reported by Potvin), and some incoherence exists as Coomes et al. (2008) note that based on NPV, cattle ranching is not profitable (NPV = minus $420/ha) and therefore not an investment option. Finally, attempting to keep adding 5000 ha under the same contract and then averaging out over 25 years is not conductive to transparency or market formation.

To further improve this analysis, at minimum a CBA should be performed. Net income should be taken since where costs are not negligible, it better reflects opportunity costs. Soil carbon and forest services conserved should be factored in, and agricultural subsidies factored out since they are typically unsustainable (Economist, 2008a, World Bank, 2006). If Panama scraps these subsidies, it would reduce the cost of REDD and also provide a stream of funding for REDD. In addition, costs are not fixed and would substantially vary under different conditions. Economies of scale and enhanced institutional capacity and efficiency would likely reduce costs significantly. Real opportunity cost depends on targeting, subsidies and taxes. Administration costs depend on project size and institutional and other capital factors. Monitoring and enforcement costs depend on technology, capacity, and levels corruption, and Panama's environmental culture and identity. The theoretical best case scenario for REDD in Panama would be targeted, subsidized, tax assisted, large scale, technologically advanced and transparent with high levels of capacity, all in a culture which promotes environmental protection and indigenous inclusion.

To address the added value of forest services, Sukhdev (2008) notes $2 - $4.5 trillion is lost annually from forest services. This figure broken down to 5000 ha and factored in makes REDD a highly attractive investment option. Using my results from chapter 2 (page 11), and Sukhdev (2008), each hectare of land in Panama is worth approximately $87'500 to $220'000 in terms of its forest capital, not including biodiversity which would likely significantly add to the value. According to Potvin et al. (2008) it currently costs approximately $70/ha to protect Panama's forests, but may cost significantly less (if for example indigenous areas were protected and indigenes were employed, effectively removing the need to pay for the opportunity cost of over $60/ha). If opportunity cost was removed, it would then currently cost approximately $11/ha annually to protect $87,500 to $220,000 worth of forest capital. This may be a substantial investment opportunity for bioprospectors, the financial sector and other key stakeholders, but Panama would likely have great difficulty selling such a product under current conditions.

6 Sustainability and carbon sequestration in Panama

6.1 Adapting to climate change

Effective adaptation to the already committed degree of climate change by reducing energy and environmental stresses and poverty can happen quickly with insignificant risks and uncertainties and would benefit Panama regardless of changing climatic conditions. In spite of this, Panama's government primarily acts in the interests of groups powerful enough to dominate it[1]. Panama's politicians are effectively being forced or coerced to heavily discount sustainable development and climate change policies.[2] However, climate change and ENSO are expected to have significant impacts in Panama, and water, energy, and human security and equity are of prime concern. To sustain a strong economy and the Panama Canal, and to mitigate the impacts of climate change, it is crucial to build adaptive and institutional capacities, protect natural ecosystems, and create sustainable economic alternatives for stakeholders. Ecosystems and many species of plants are not expected to survive the dry periods forecast, and this may significantly impact human security, and inhibit CS development and success.

Panama must recognize its need to adapt and acquire the ability to adapt. Access to proper information and the ability to process it is crucial, particularly for Panama's poor majority (Fankhauser et al., 1999). Panama may advance its adaptive and institutional capacities by integrating development and governance approaches while focusing on sustainability and current climate-sensitive vulnerabilities which may explode under future scenarios (Goklany, 2005; Halsnaes et al, 2007; Murphy, 2008). This can be accomplished by: 1. improving the enforcement of laws and contracts, property rights, income equity, and access to education; 2. by synthesizing economic resources and human capital; 3. by exploring innovative financing mechanisms; 4. by removing policy constraints, institutional weaknesses and strong opposing interest groups[3]; 5. by seeking assistance on how to choose the appropriate tools and integrate them effectively (Goklany, 2005; Halsnaes, 2007; Murphy, 2008; UNEP, 2004). Building adaptive capacity however requires more detailed information which may be extracted from micro-oriented or sector based approaches (Halsnaes et al., 2007).

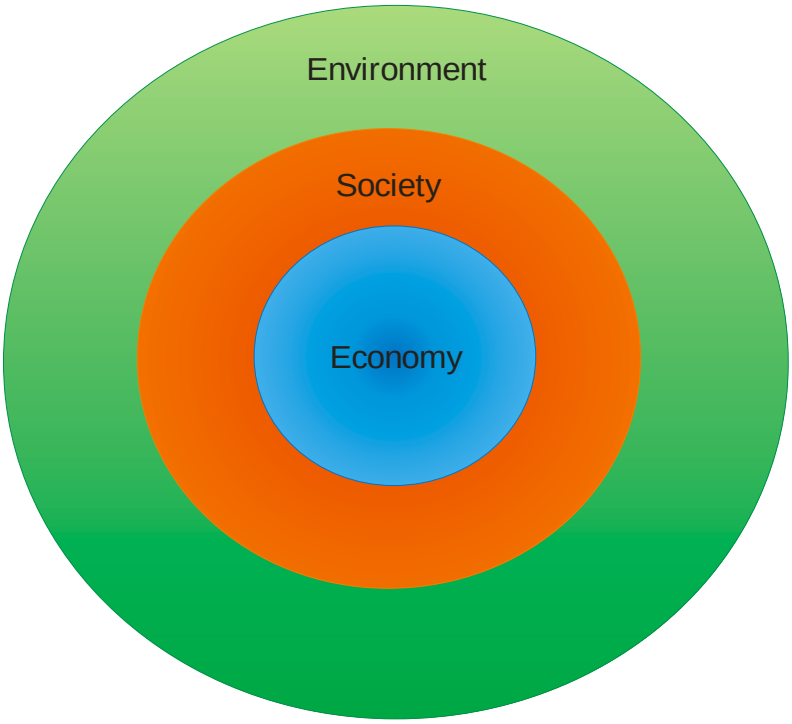
[1] See Appendix 4: Corruption, page A22; See Chapter 2, page 7
[2] See Appendix 2.1: Climate change and policy, page A5 (last paragraph)
[3] See Appendix 4: Corruption, page A22

6.2 Moving towards sustainability

Panama faces a host of inter-related governance, environmental and social issues which threaten development, investments, the capacity to build ES markets, adapt to climate change, and move towards sustainability (Ibanez et al., 2002; Lichtenfels at al., 2007; World Bank, 2006; World Bank, 2007a; World Bank, 2008a; Schloegel, 2007; Wickstrom, 2003). Panama's economy is not sustainable and climate change coupled with pressures from economic and population growth and unsustainable practices are expected to make matters worse. Economic analysis often favors converting native forests into land uses with only short-term financial benefits, such as unmanaged timber extraction and cash-crop agriculture, representing both market and policy failures (Johnson et al., 2002; Lichtenfels et al., 2007; Pagiola et al., 2002). Panama may gain from redefining its idea of economic growth, since its economy is embedded within its society, which operates within nature (Cato; 2009; Figure 6.1). Economic growth (measured as GDP) in Panama only includes what is gained in material wealth, which is not equitably shared, and the value of natural resources has traditionally been disregarded, and more recently undervalued due to market distortions and inadequate data. What is lost from degrading Panama's land and watersheds is largely ignored (Speth, 2008), and may be a significant oversight. Undervaluing ES may decrease economic welfare therefore a full assessment of value is essential. Poverty and unsustainable agricultural subsidies and methods also need more policy attention since they are major proximal drivers of deforestation and land degradation (FCPF, 2008; Ibanez et al., 2002; Wallander et al., 2007; World Bank, 2007a).

Panama's government has significant issues with management, coordination, capacity and corruption. As a result, adaptive capacity and sustainability are hampered, sustainable investments are prioritizing other markets, and the country's reputation and image are suffering along with its resource bases. Panama's government may not be the ideal tool for addressing these concerns, but it is by far the best tool available today. Direct government regulation needs to be accompanied by policy reforms and market based instruments. However, acting alone such instruments are insufficient (Engel et al., 2008; Lichtenfels et al., 2007; Pagiola et al., 2002; UNEP, 2004). Panama's government should play the role of "big brother" by creating alternative sustainable economic opportunities for stakeholders, by coordinating with the private and financial sectors, and by seeking new and innovative ways to finance ES (e.g. microcredit) (Drucker et al., 2002).

Figure 6.1: The environment and its relationship to society and the economy



Source: Cato (2009)

The primary concerns are a high dependency on secretive banking and particularly weak institutions with lacking human resources (Harris, 2003; World Bank, 2006), creating high transaction costs, and impeding market development, sustainable investments, and business (Halsnaes et al., 2007; Pagiola et al., 2002). Direct financial transactions to the relatively corrupt and centralized Panamanian government are unlikely to have the desired impact (Lichtenfels et al., 2007; Wallander et al., 2007). Panama still has much room for improvement with significant untapped potentials, and could be attracting considerably higher amounts of foreign investments as a stable and business-friendly democracy (Lichtenfels et al., 2007). These investments are primarily a function of governance and the management of information (Halsnaes & Verhagen, 2007) therefore Panama should look to befriend the international community, socially responsible actors, and the Organization for Economic Cooperation and Development (OECD).[1]

[1] See Appendix 4: Corruption, page A22

6.2.1 A good place to do business

The OECD states that its mission is to support sustainable economic growth, boost employment, raise living standards, maintain financial stability, assist other countries' economic development, and contribute to growth in world trade. Panama should look for the OECD's full support since it fits in unusually well with their agenda. The OECD may be a great source of sustainable growth, investment, and capacity building for Panama. However, Panama needs to move on and adhere to its 2002 OECD agreements. Moreover, Panama's government must recognize that private investments currently overwhelmingly exceed official development assistance (World Bank SDN, 2007), and that established perceptions of market risk and reward will dictate these investments (Louka, 2006; Miller, 2008).

Panama's historic economic success may be linked to its protection of corporate interests and Panama continues to act in a manner which protects its tax haven status and service based economy which accounts for 80% of GDP. Panama should recognize its need to adapt to international norms and act to improve its environmental record and public image, since banks and businesses would be more interested in projects in Panama if it could offer them stability and a good reputation and image (Drucker et al., 2002; Lichtenfels et al., 2007; Louka, 2006). Therefore, to attract sustainable investments, Panama's government must intervene to create long term and stable signals by improving transparency and efficiency, by reforming policies and legal frameworks, by mainstreaming ES into regular programs, by channeling resources in a more environmentally-friendly and safe direction, by avoiding projects and developments that harm ecosystems and those who depend on them, by developing standardized contracts, and by tax incentives and green funds to enable ongoing and sustainable payments (Drucker et al., 2002; Miller, 2008; Pagiola & Platais, 2002; Wallander et al., 2007; Wunder, 2005). Adhering to international norms and OECD commitments would prove a strong conduit for achieving these required reforms. Of particular concern is that Panama has no Central Bank (CIA, 2008), creating a completely market-driven money supply (Harris, 2003). Collier (2008) emphasizes that Central Banks play a critical role in ensuring the transparency of an economy. Reforms to reduce corruption in Panama have had little effect since it has off-shore havens, a favorable tax regime, lax regulations, and political elites that desire secrecy. In addition, while all "dollarized" economies are attractive for money laundering, Panama offers the added benefits of proximity to the US, a business friendly political and military regime, and high economic dependency on international banking and tight secrecy laws (Harris, 2003).

Panama's limited capacities are among the most daunting of concerns for market development and functioning. Panama needs more support for reducing its strong reliance on imports, for implementing and maintaining sustainable land use programs, for reducing deforestation, poverty, and corruption, for enhancing its severely restricted institutional and adaptive capacities, and human capital (Dale et al, 2003; Fischer & Vasseur, 2000; Lichtenfels et al., 2007; Myers et al., 2000; Wallander et al., 2007). EPIs and any strategy for expanding ES markets or environmental protection must reflect these realities in Panama today, while also accounting for possible changes in policies and markets (Gentry, 2007).

Panama's government should move to improve its tax and legal systems, coordination, and reputation and image, which are critical for ensuring continuous leverage and payments, long term success, and for counteracting the lack of financial resources and the inefficiency in the use of these resources (Drucker et al., 2002; Wunder, 2001; Zhang & Maruyama, 2000). Elevating ANAM's status within the government and giving it a formal voice in cabinet meetings and decisions may assist Panama in finding the additional public and private support that it requires (Lichtenfels et al., 2007). This however will likely be insufficient and Panama should also actively cooperate with key stakeholders, different social, political, and educational institutions at various levels, the financial and private sectors, and socially responsible actors (Drucker et al., 2002; Oestreicher et al., 2009; Wunder, 2001; Zhang & Maruyama, 2000).

Panama's government, as a sign of political will and out of inevitability, should initiate ES market formation and development by addressing the initial demand side of ES markets. After ES markets are established and functioning, Panama's government may then transfer parts of the costs to user financed payments via PES where conservation is a priority (e.g. PCW) and where opportunity cost is minimal (e.g. indigenous areas) (Oestreicher et al., 2009; Wunder, 2005). This may be most efficiently achieved via funds from implementing green taxes on activities where severe environmental degradation is taking place, from removing both beef and cash-crop subsidies, and from taxes on mining and timber companies (Cato, 2009; Economist, 2008a; Landell-Mills & Porras, 2002; Moreno-Villalaz, 2005; Oestreicher et al., 2009; Wunder, 2005). Taxes are politically feasible in Panama (Lichtenfels et al., 2007), and green taxes may minimize transaction costs and inequity, and enhance economic efficiency and environmental sustainability, while discouraging pollution and waste, and monopolies and oligopolies (Cato, 2009). However, such reforms must emphasize Panama's commitments to improving its environmental record and public image, and clearly indicate Panama's political and cultural move towards the principles behind sustainable development. After clear and long term signals have been sent, private

investments may be more readily available to support and extend successful programs, since they are increasingly seeking to improve their image and brand reputation (Economist, 2008b; Drucker et al., 2002; Figure 6.2).

Figure 6.2: Corporate social responsibility and perceived business benefits (%)

Source: (Economist, 2008b)

Another method to attract ES demand investments is proposed by Licthefels et al. (2007), who recommend developing an ES marketing plan, raising the international visibility of ES markets, educating Panamanian citizens about ES, and attracting NGO investments. According to Lichtenfels et al. (2007), the feasibility of this policy is high and the cost, although significant, is small in relation to the potential benefits. I argue that land titles, corruption and capacity should precede significant monetary investments in these fields, although such developments may arise from non-monetary investments such as knowledge sharing and international coordination efforts such as adherence to 2002 OECD commitments. Raising the visibility of Panama's current ES markets may have the opposite effect and deter financial investments, particularly from socially responsible actors.

6.3 Land

If Panama aims to attract investments into ES, carbon sequestration (CS) and sustainable land management, it must assign and negotiate clear, transparent, and state-enforced land titles and rights, since carbon and other ES can not be legally bought or sold without clear and recognized ownership (Halsnaes & Verhagen, 2007; Pagiola et al., 2002). However, 33% of rural agricultural lands are still untitled, effectively decreasing the amount of land available for CS and other sustainable landuse investments (Wallander, 2007). Wallander et al. (2007) indicate that there are considerable available funds to purchase and protect lands. However, there is an insignificant supply of land available for conservation in Panama.

To address Panama's severe need to assign land titles and rights, the World Bank (2006) financed a 15-year $50 million loan to vanguard the modernization of Panama's land registration and administration system. However, on my investigation into Panama's 2005-2009 policies[1], there appears to be no direct or indirect clause which aims to directly address this issue, which according to Pagiola et al. (2002), is among the most critical for ES market formation and success. Panama should therefore explicitly address this issue in its national policies and further expand and accelerate its land titling program (Lichtenfels et al., 2007).

Land degradation, deforestation and the associated effects are critical issues for adapting to projected climate impacts and variability, and for sustainability in general. Landuse management planning should be integrated with other sectors such as agriculture, and within broader development planning frameworks (Dale & Polasky, 2007; Muller, 2008; Murphy, 2008), and a number of perverse governmental incentives should be reconsidered. The clearing of forest to establish land claims (Law 37 of 1962) should be abolished (Engel et al., 2008; FCPF, 2008), Law 24 of 1992 and Law 21 of 1997 need particular attention regarding smallholders and teak, and Panama's tourism ministry (IPAT) needs to reformulate Law 8, which ignores fundamental principles behind sustainable development. IPAT also needs to identify infrastructure investments and regulate growth in tourism (Schloegel, 2007; World Bank, 2006; World Bank, 2008a).

[1] See Appendix 5: The Government of Panama, page A35

Panama should include smallholders, promote a sustainable environmental culture and native forest extension, and improve its environmental image, forest law enforcement, and governance which may be achieved by (FCPF, 2008; Ibanez et al., 2002; Lichtenfeld, 2007; Lichtenfels et al., 2007):

- Formulating a national plan for forest development and explicitly incorporating the provision of at minimum one ecosystem service

- Consolidating information on forest resources, complemented with an improvement on its system for registration and monitoring

- Improving registration and monitoring systems and forest information administration while standardizing processes at the national level

- Demonstrating that sustainable forestry is viable by utilizing native species from already developed lists

- Providing for riparian buffer zones, increasing buffers around areas of high conservation value, and further protecting sensitive areas, particularly those with low human populations that connect patches of native forest (e.g. a corridor between Soberanía and Chagres National Park should be protected and reforested)

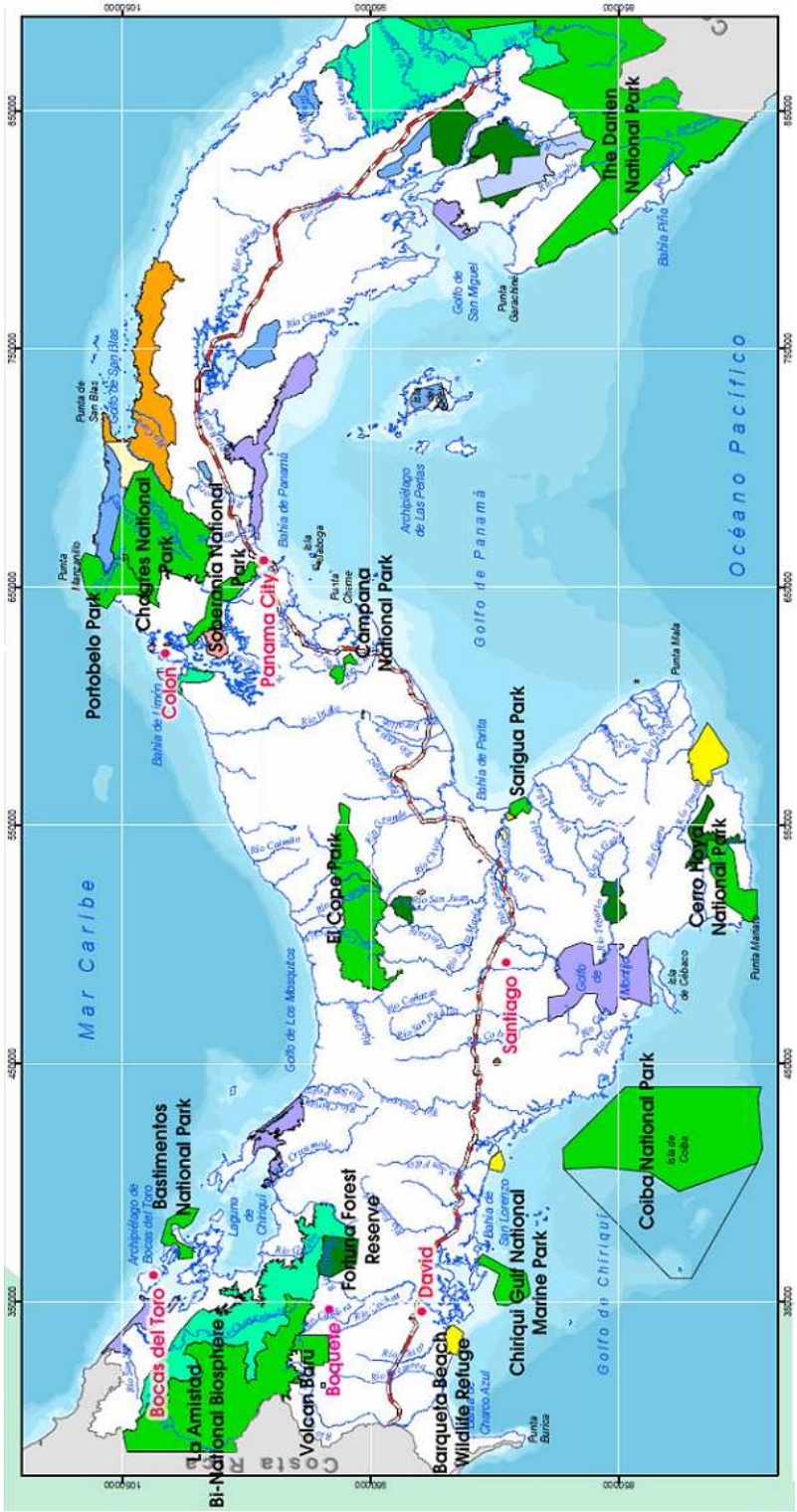
- Adding forests near Panama City, in the driest part of the watershed, to the national park system

- Limiting uncontrolled burning, and enforce the protection of sensitive areas

- Curtailing deforestation within parks and near streams outside parks by enhancing supervision and the presence of the government in several forest zones

Within Panama, agriculture is unsustainable at current levels and with current methods (Cochran & Bonnell, 2005; Shiva, 2000). However, the costs associated with supplying CS, such as measurement and verification, have been significant enough to deter many Panamanians from forestry projects, particularly those with small land holdings and limited access to capital (Lichtenfels et al., 2007). Policies for reforestation must be reformulated to include smallholders while avoiding perverse incentives, excessive state costs, and abuse by favored classes of landowners (Lichtenfels et al., 2007). Besides improving land titles and laws and other command and control policies, market based policy instruments may be employed to address market failures by providing landowners with incentive to change land usage. Landuse conversions should directly benefit the landholder and create ecological benefits while increasing the resilience of landscapes to the impacts of climate change (Cochran & Bonnell, 2005; Lichtenfels et al., 2007; McAlpine et al., 2009).

Figure 6.3: A map of Panama's national protected areas (NPA)



Source: Guardia (2008)

Government and industry organizations can play an important role in pooling reforestation projects together to make them more attractive. Pooling projects of all sizes can raise their collective value to buyers of ES while minimizing risks (Landell-Mills and Porras, 2002; Lichtenfels et al., 2007). To increase productivity while minimizing environmental degradation, smallholders may seek assistance from CEASPA (Centro de Estudios y Acción Social Panameño), which assists in relocating smallholders away from sensitive areas within Chagres National Park (Figure 6.3), and also supports the creation of highly diverse organic farms on lands that were previously a monoculture or invasive grass (Wallander et al., 2007). An expansion of such services may remove some incentives for smallholders to clear additional forest (Lichtenfels et al., 2007).

Panama should also reduce its protection of agriculture and limit the production of onions, raw sugar, potatoes, and milk (Economist, 2008a; Moreno-Villalaz, 2005; World Bank, 2007a). Intensive livestock agriculture is costly in terms of the resources it requires, although it provides short-term economic gains such as low time-demand, price risk and management costs. Nevertheless, the real environmental cost of production (extensive grazing and feedlots) is unaccounted for in today's market prices and Panama explicitly promotes increased production. Future policies however will need to introduce market pricing of beef that reflects its full environmental costs (FAO, 2006; McAlpine et al., 2009; UNEP IISD, 2009).[1]

Sustainable landuse options in Panama include the development of diverse ecological grazing systems, the sustainable management of agriculture and cattle, a shift from agriculture (particularly cash-crops and intensive livestock) to organic farming or agroforestry through partial reforestation and soil conservation, native forest plantations, non-native monoculture forest plantation (primarily teak) conversion to a native/non-native species mix, and natural forest preservation (Cochran & Bonnell, 2005; Dale & Polasky, 2007; FAO; 2006; Lichtenfels et al., 2007; McAlpine et al., 2009). A distinct landuse strategy would be to aid smallholders or indigenes in protecting the tropical forest in return for CS payments or watershed services (Coomes et al., 2008). However, they require additional expertise to fulfill ES contracts and such a system may generate perverse incentives to move to the forest frontier (Lichtenfels et al., 2007; Wunder, 2005). Nevertheless, landuse management and CS would become more attractive (Coomes et al., 2008), and many of Panama's environmental and developmental problems would be solved while enhancing the ability to adapt to climate change and attract investments.

[1] See Appendix 2: Environmental politics and market mechanisms, page A4

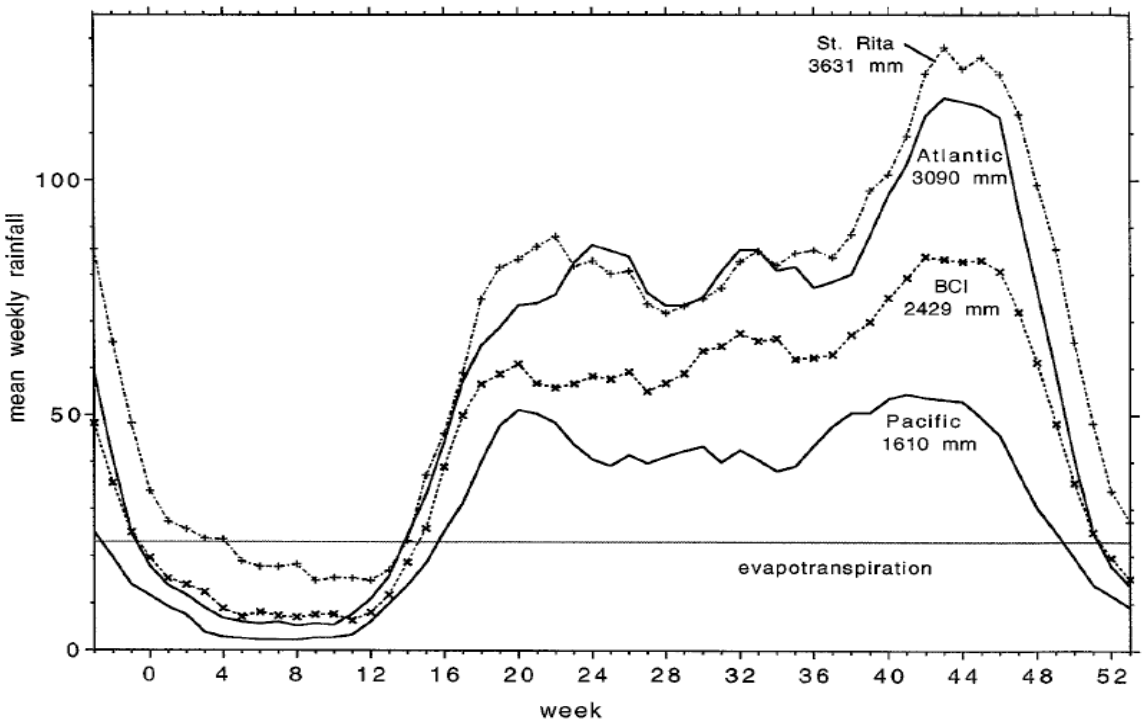
6.4 Water and energy

If Panama is aiming for continued economic success and growth then it must ensure its water and energy security. Panama depends on water and oil for development and economic success and already faces water and energy stresses, with growing demand. The ACP's expansion project appears to be focused on short term profit while ignoring the precautionary principle, and the water supply, energy, and institutional, developmental, and capacity issues which Panama would greatly benefit from addressing with or without global warming. This is especially concerning when considering the alternatives available, the opportunity costs, and the possible impacts that Panama may face in the wake of climate change and variability, and changing rainfall patterns.

The protection of the PCW is a global priority (Ibanez et al., 2002) and water used for agriculture and forestry is not available for hydroelectricity, lockage, or drinking, while water from the Rio Chagres used for hydroelectricity generation is also not available for lockage (Graham et al., 2006). Furthermore, there is insufficient sewage treatment in the PCW and streams near large towns are heavily polluted (Ibanez et al., 2002). Panama's population, particularly in the PCW, is increasing (UNDP HDI, 2008, Ibanez et al., 2002), economic growth is surging and expected to increase (World Bank, 2007b), demand for water is rapidly rising (Lichtenfels et al., 2007) and current total runoff across the watershed is inadequate (Condit et al., 2001).

Reducing deforestation and protecting the soil and water resources of the PCW has important implications for dry season flow, the sustainable operation of the Panama Canal, and Panama's economic sustainability (Graham et al., 2006; Ibanez et al., 2002; Palka, 2005). Panama's dry season flow is a significant concern, being an order of magnitude less than that of wet season flow. The mean dry season is 129 days near Panama City and 102 days on the Atlantic coast (Condit, 1998; Figure 6.4). Forest cover in the PCW can potentially improve water quality, quantity, and dry season flow (Anderson, 2007), while Ibanez et al. (2002) indicate that native deforestation reduces dry season flow in Panama, therefore reducing the water available to the Panama Canal. Panama should combat agricultural expansion and move to implement rain-fed and sustainable agro-development (Gautier, 2008).

Figure 6.4: Mean weekly rainfall (mm) from 27 years of data at four sites in central Panama, representing 3 regions (Atlantic site near Colon, Pacific site near Panama City, Barro Colorado Island (BCI) site near southern end of Lake Gatun)



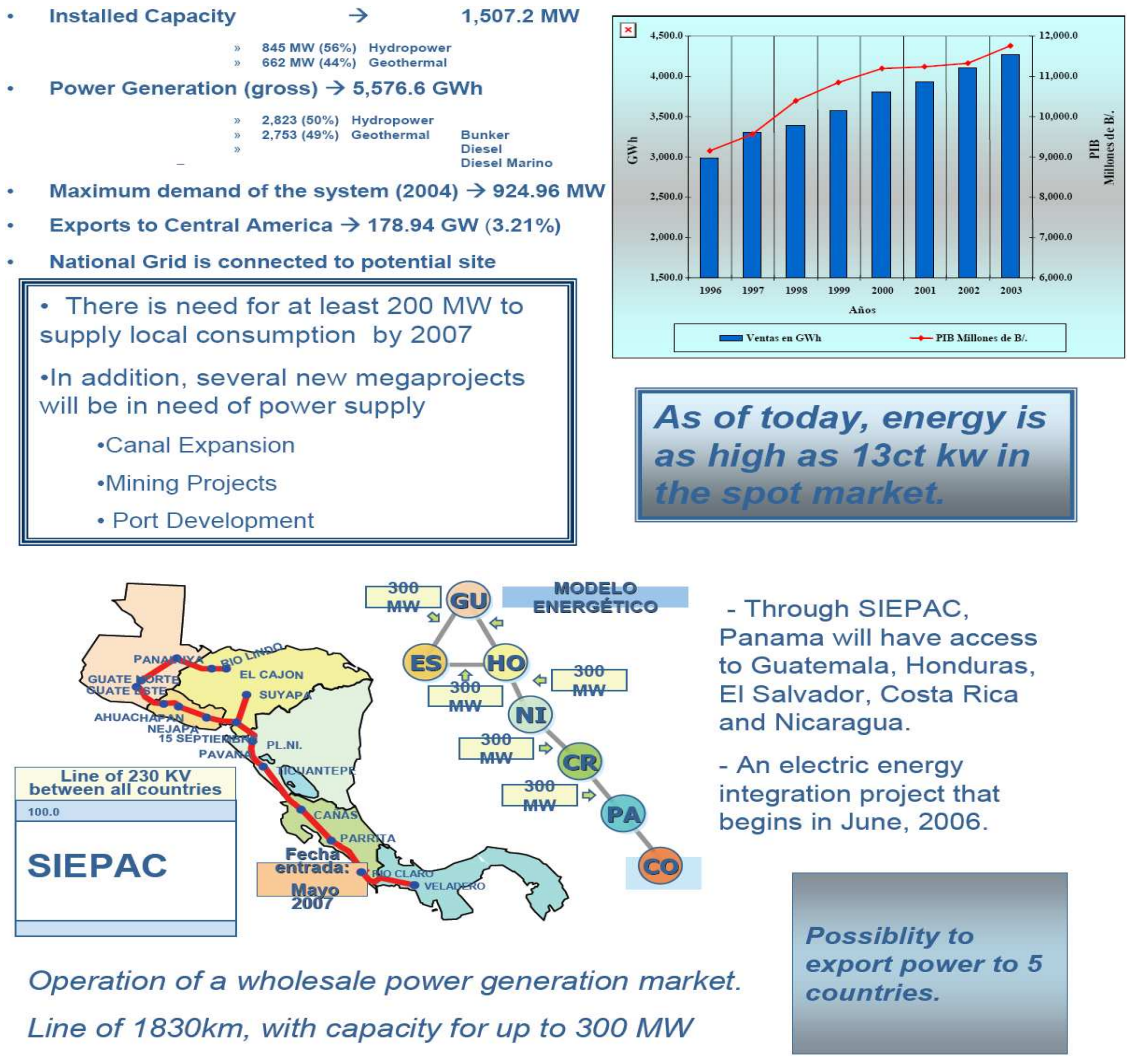
Source: Condit (1998)

Hydropower dams provide the majority of electricity in Panama (Lichtenfels et al., 2007) however they are highly vulnerable to changing rainfall patterns (Magrin et al., 2007). Furthermore, hydropower in Panama is in competition with lockage, agriculture, the environment, and the population for water. Hydroelectric power companies rely on the watershed for their income from the free flow of water. A tax reflecting the imputed value of watershed services might be introduced. For example, Colombian hydropower companies are required to give 2% of their income to either the national environmental authority or to reforestation projects (Lichtenfels et al., 2007).

The Panama Canal is precipitation fed and has been losing almost 2 hundred million liters of fresh water to the ocean each time a ship passes (Palka, 2005; Graham et al., 2006). Total revenue from the Canal in 2008 was $2 billion, owing to increased tolls (ACP, 2008). The ACP's $5.25 billion expansion project has allocated nothing to address upstream water supply or quality, representing significant security and equity concerns since water used for the canal is not available for other activities and the many Panamanians who still

live in poverty. The ACP should address upstream issues and seek to make the water from hydro-generation available to the locks and/or vise-versa (a hydro generator above or at the locks to power the locks) since energy supply is currently insufficient and the expansion project along with other developments will require more energy (Embassy of Panama, 2005; Figure 6.5). It may eventuate that the project was, in fact, as Collier (2008) indicates, a "white-elephant", masking a corruption scheme involving construction companies, Panama's government and tiny elite class, and the CIA.

Figures 6.5: Panama's electrical energy situation

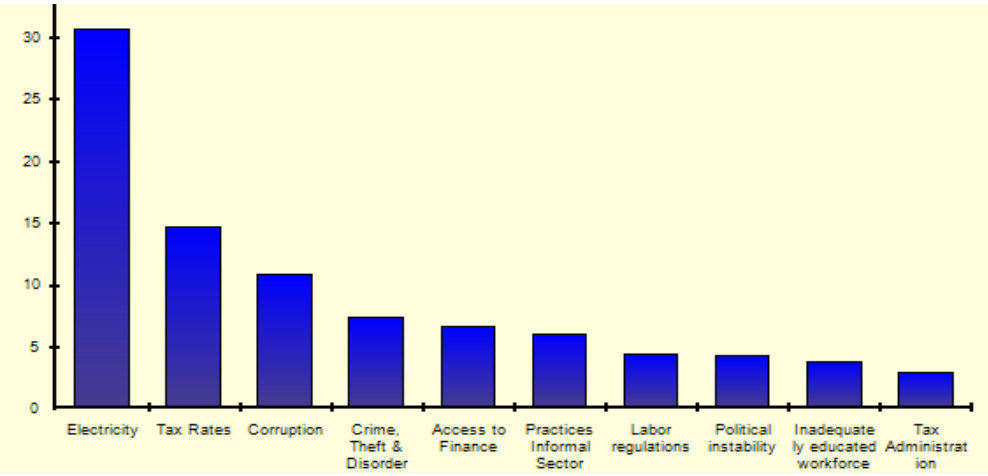


Source: Embassy of Panama (2005)

The recent peak in oil prices, increasing extraction costs, and dwindling reserves (Gautier, 2008) raise several important sustainability questions for Panama, which is importing almost 100'000 barrels of oil per day (CIA, 2009), representing over 70% of total energy supply (UNDP HDI, 2008). Panama primarily relies on importing oil for economic development and human wellbeing (Gautier, 2008), however Panama critically needs to address its fiscal sustainability and relatively high and consistent public debt levels, which have been around half of GDP (CIA, 2008; Moreno-Villalaz, 2005). Energy is a resource which is not only in short supply in Panama (Embassy of Panama, 2005; World Bank, 2008b; Figure 6.5), but also highly vulnerable to future uncertainties. Continuing to import oil on such a scale and being dependent on hydropower harms Panama's economy. This is particularly concerning as oil prices and water stresses are likely to increase (Koh & Ghazoul, 2008; Gautier, 2008).

Electricity shortages constrain investments in Panama (Figure 6.6). However, natural gas and coal are not consumed in Panama, and fuel-wood is a primary energy source for rural residential areas, which has a strong environmental impact (Aguilar & Condit, 2001; CIA, 2008; Energy Recipes, 2009; Gautier, 2008). This may mean further deforestation to supply rural energy needs. Converting cow manure into biogas would reduce greenhouse gas emissions, foreign energy dependence, and deforestation, while improving environmental quality (Cuellar & Webber, 2008).

Figure 6.6: Constraints to business investments in Panama (% of firms identifying problem as their greatest obstacle)

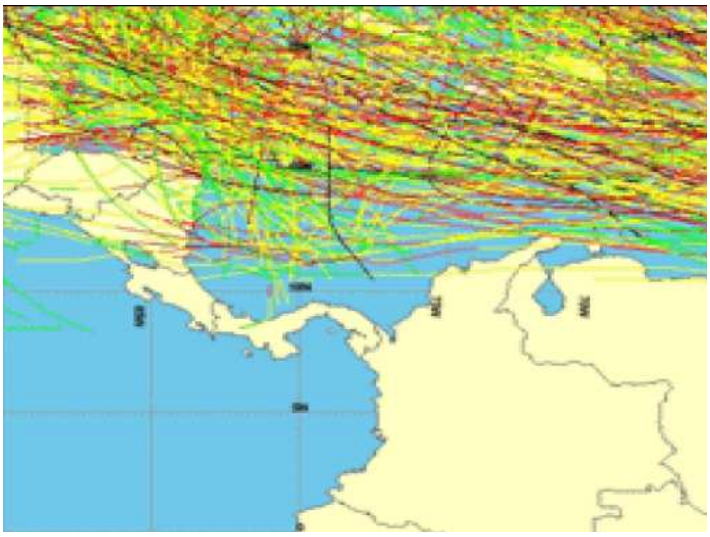


Source: World Bank (2008b)

Panama may reduce deforestation by importing natural gas, burning biomass, installing wind-farms (Figure 6.7), and reducing its dependence on fuel-wood for energy. A policy scenario for Panama may also include biofuels. The development and climate case study from Halsnaes and Garg (2006) concludes that Brazil's biofuel programs between 1975 and 2000 offset 550 million barrels of imported oil, saved $11.5 billion in foreign exchange, and avoided the emission of 400 million tCO2. Panama's government is currently seeking to spend $200 million on biofuels, which may reduce Panama's heavy reliance on oil imports (PRB, 2009b). However, biofuels may further stress water supplies and degrade lands (Berndes, 2002).

Panama must address global change through green, smart, and profitable economic developments. Green taxes and investment in cleaner energies would not only achieve this objective, but also move Panama to a more secure energy and water situation by reducing its heavy reliance on oil and hydropower energy. Hydropower is the main source of electricity in Panama and currently at 50.1% (Graham et al., 2006), down from 73% in 1995 (Campos et al., 1996). The difference may be partially attributed to increasing oil imports. If Panama moves to become more energy efficient and independent, it could free up its stressed freshwater resources, and possibly even export fresh water from the Rio Charges. Water quality and supply, once secured and stabilized should significantly enhance investments, and Panama's image and economic sustainability.

Figure 6.7: Panama is free from hurricanes and wind may be a source of energy



Source: Embassy of Panama (2005)

7 Conclusions

Panama faces a host of inter-related environmental and socioeconomic issues which threaten sustainability, investments, the development of carbon sequestration (CS) projects, and its capacity to adapt to climate and global change. With increasing populations and demand for water and electricity, low capacity, high levels of corruption, high levels of public debt and poverty, inefficient and under-funded institutions, high rates of deforestation and environmental degradation, and severely lacking land titles, human resources, and environmental services (ES) markets, Panama faces some sobering realities. Panama's success rests in addressing these issues, with or without global warming. Climate change coupled with global change, and unsustainable levels of economic and population growth threaten to make matters worse.

7.1 Economic redevelopment

Record economic growth and Panama's inability to handle high levels of stimulus likely means more inequity, demand for resources, and increasing unsustainable pressures on water, food, and ecosystems, and thus is at odds with human security and sustainability. Panama is one of the wealthiest countries in the region yet it has severe governance, equity, and image issues. Panama today is unable to attract the required investments to develop sustainably, and this is partly due to its lax standards, which will need to change sooner or later as the global community seeks to abolish tax havens, improve transparency, and redress global laws and norms, particularly regarding tropical forests and intensive agriculture. Panama's historic economic success may be linked to its protection of corporate interests and Panama's past relationships with dominant actors such as the US and OECD represents a prisoner's dilemma. The US refuses to install a free trade agreement, and the OECD hesitates to invest enough political will to aid in Panama's sustainable development. Panama in turn stalls in fulfilling its commitments, in part to protect its tax haven status and service based economy which accounts for 80% of GDP, and in part to avoid further domination from institutions which have historically played Panama as their pawn. It was not until 1999 that the OECD managed to sign an agreement amongst its member states to make bribery of a public official in a developing country illegal, and the US continues to be a dominant actor in the OECD and in international negotiations in the region, particularly regarding energy and development.

7.2 Climate variability and sustainability

As long as a trade off exists between the environment and short-term profit, then the environment will likely lose. Panama's reliance on hydropower for electricity and oil and wood for energy drives the country into social, environmental, and financial debt. For financial and business sustainability, Panama must reduce its high economic growth and public debt levels and secure energy supply and independence. Production of energy efficient buildings, technologies, recycling, and use of biomass may vault Panama towards energy independence, while reducing public debt, emissions, and levels of land degradation. Many countries in the region need energy and are in fact already linked with Panama's electrical grid. Such projects would not only reduce deforestation, poverty, water stress, debt and energy reliance, but would also enhance adaptive and institutional capacities, technology transfer, human wellbeing, and economic sustainability.

ENSO is still a major concern for water security, the ACP, human wellbeing, and the energy sector, and economic and population growth will increasingly stress already stressed water supplies in Panama. Climatic forecasts are predicting changing rainfall patterns and uncertainty for the region with significant impacts on the forestry sector and water shortages in the future. The ACP and hydro power companies demand a significant amount of water and water security. Moreover, they are in competition with the population, agriculture, and forestry for water. Water resources are already inadequate with rising demand, and dry season flow is an order of magnitude less than that of the wet season. Therefore the government may subsidize plantations of drought resistant native species, and the installation of rainwater storage tanks, particularly in drier regions to minimize irrigation dependent agriculture, the risk of another famine event, and to reduce water stress.

The main sustainability and environmental policy issue for Panama is to reduce native deforestation, which may be effectively costing tens of billions of dollars annually. Panama's government should become more critical of capitalistic development, and thus intervene by installing flexible incentive structures to foster a change in behavior and build human resources which are seriously lacking and a major driver behind Panama's socioeconomic and environmental problems. Subsistence and poverty are driving deforestation and environmental degradation from one side while corporate and agricultural expansion is muscling in from the other. Neither of these groups have incentive to conserve the environment nor act in an environmentally sustainable manner. Subsistence farmers and those in poverty are often more concerned with meeting their immediate needs, while capitalistic development inherently fails to account for the value of ES.

7.3 Protecting the Panama Canal Watershed

Panama must protect the PCW, which is a global priority. Market based environmental policy instruments (EPIs) potentially offer an effective method to this end. However, there is substantial evidence indicating that EPIs would find great difficulties in Panama, which has an environmental agency which is essentially voiceless and totally unequipped to manage the scope of the tasks at hand. To ensure the success of an EPI, it must operate within a sound policy framework and within an effective, transparent, and efficient governance structure and environmental and political culture. Reforming policies and institutions is therefore a precursor to implementing these instruments.

Panama requires significant levels of funding and assistance, and carbon markets might be neither sufficient in size nor secure enough. The financial sector and key stakeholders are critical to counteracting the lack of financial resources and the inefficiency in their use, but they will under-invest since Panama is not sending long term, stable, and transparent signals which indicate its intentions to act sustainably and in a manner that would ensure continued payments for long term success and leverage, and improved equity and human security. Therefore it is critical for Panama's government to address its adaptive and institutional capacities, particularly in rural regions and areas which are conservation priorities. This may be achieved by increasing levels of expenditure on local governments and infrastructure, by improving the management and coordination of its finances and bodies to enhance stability and transparency, and by enhancing knowledge bases, technology, and the monitoring and enforcement of laws and rights.

Panama initially should invest minimal resources into attempting to find market demand for CS and ES since its image is poor and has other more urgent issues to deal with, such as building capacity and improving water, energy, and human security. Panama's government should take the leading role in creating demand for ES markets as a sign of political commitment to the principles behind sustainable development, since it is in the best position to integrate environmental management with other sectors such as agriculture and finance, and within broader development plans. Funding and market demand may initially be found from diverted agricultural subsidies, the restructuring of law 24 of 1992, and taxation. Taxes are politically feasible in Panama, and given the uncertainties, an ideal tool due to flexibility and fast response time. A tax on Panama's minute elite class, large land holders, the ACP, and mining, timber, and hydro companies would not only generate significant public funds, but also better reflect the financial, political and socioeconomic realities in Panama today.

7.4 The long and winding road forward

The ACP is among the most powerful and stable institutions in Panama and has the legal authority to regulate landuse in the PCW directly. The impetus for the ACP should be building capacity and ensuring security by addressing upstream water supply and developing infrastructure which is robust, flexible, and accounts for climate change and variability. This would help to secure water supply for the canal, economy, ecosystems, and peoples. ES markets may be initiated by the ACP to address these failures since the ACP has the legal right to regulate landuse within the PCW. The ACP may slightly increase tolls or tax their own revenues or levels of water usage. ANAM and local institutions are severely under-funded, significant inequity exists, landuse patterns are unsustainable, and pressures are rising. The ACP's ability to directly dictate land use in the PCW could be coordinated with organizations which would enable it to make long term sustainable decisions, such as the socially responsible financials and the Smithsonian Tropical Research Institute. In addition, ANAM could be more involved with and funded by the ACP via an equity, green, water, or security tax, which should be aimed at vulnerable areas, conserving biodiversity and soil, and protecting the Canal's watershed and upstream water supply.

People in Panama are turning to deforestation not to prosper but to survive, as corporate globalization and outdated production methods have depleted resources and destroyed and degraded watersheds and large portions of land. For the longer term political viability of CS projects in Panama, rural communities, poverty, smallholders, the inequality gap, and social justice concerns should be addressed by Panama's government. Substantial amounts of degraded and untitled lands remain along with significant levels of inequity and poverty. Panama must send signals that it intends to adequately protect its environment and has the capacity to ensure continued leverage over land owners. RED and A/R projects need to become more attractive to investors before their significant potential for mitigating climate change can be realized, while teak, although not a sustainable option for long-term CS or ES markets, may be a part of the solution if properly managed and if smallholders are included, since it is a major cash-crop. For crop switching, CS, and sustainability, knowledge bases need developing and policies for reforestation should be reformulated to include the poor by expanding and coupling the land titling program with improved access to capital, and equitable benefit sharing.

In Panama, the knowledge required to act responsibly is severely lacking. The poverty and subsistence cycles repeat, becoming increasingly unsustainable as population, consumption, and competition increase. Knowledge regarding forestry is especially limited

while markets for ES are almost non-existent, and smallholders lack incentive to do anything apart from deforest. If Panama reduced levels of poverty and inequity, then subsistence and leakage would likely substantially decrease. Panama, in these regards, would benefit from increased spending on education and technology, reducing its heavy protection of agriculture, modernizing the energy and tax and legal systems, creating alternative sustainable economic opportunities for stakeholders, reformulating policies to include smallholders and the indigenous with reforms to avoid perverse incentives, excessive costs, and abuse by favored classes of landowners, and seeking new and innovative ways to co-ordinate finance for ES. Panama could begin by adhering to its OECD commitments and seeking their assistance in developing sound policies which address land titles, upstream water supply, poverty, and inequity. This should filter through to addressing the drivers of deforestation in Panama and foster an environment conductive for market mechanisms to work, which would also reduce implementation problems. Leakage in Panama is of concern due to high levels of poverty and subsistence, but may be reduced if urban and rural centers and institutions expand and increase capacity and efficiency. Removing incentives to deforest to gain land title is critical, as is increased coordination with key stakeholders and communities.

Protecting the PCW is a global priority, and the best option for achieving this is by avoiding deforestation with indigenes as the forest custodians. Market based EPIs would likely be ineffective in the short to medium terms, and the costs associated with their development and implementation are substantial. Redressing the agricultural industry may spear Panama towards improving its image and addressing many of its most critical concerns. Levels of deforestation and degradation are severe, and agriculture is a relatively small sector in need of drastic change. If Panama moves towards organic agriculture and agroforestry, it may generate many benefits for the economy, rural poor, and environment, while also enabling participation in carbon markets, ES markets, and markets for biodiversity friendly products. Panama may benefit from establishing national baselines and reforming agricultural production by focusing on sustainable subsidies, carbon sequestration, organic methods and certification, the protection of its biodiversity, soil and water resources, and improving environmental culture, while removing incentives to behave in an unsustainable manner. Significant investments are required yet substantial benefits would be realized in terms of rural development and equity, the regeneration of degraded lands, and addressing the severe losses in investments, forest capital, and in the PCW.

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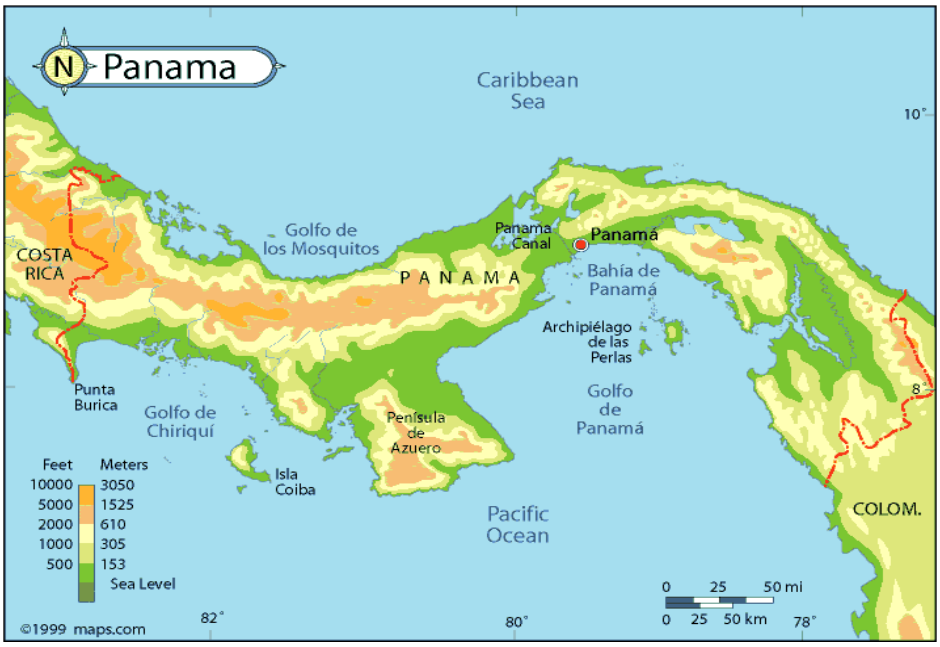
Appendix 1: Panama's tropical climate (Palka, 2005)

Panama is only slightly north of the equator, resulting in a tropical climate. The result is year-round high temperatures and minimal seasonal and daily variation at sea level. Local temperature and precipitation variations are based primarily on elevation, orientation, and proximity to the coast.

Altitude and maritime location significantly affect temperature regimes, while pressure systems and topographic barriers influence precipitation patterns. Fixed factors determining climate include mountainous terrain (altitude, pressure, and topographic barriers), equatorial proximity (high insolation), position between the Pacific Ocean and the Caribbean Sea (currents), and location near the inter-tropical convergence zone (ITCZ), which brings abundant precipitation caused by convection. As a result, Panama has significant diversity over small distances

The dominant inland terrain feature is a discontinuous spine of mountains running through the middle of southern Central America. Most sources generally use the term 'Cordillera Central' to refer to the range from the border with Costa Rica to the Panama Canal. The highest elevation is in the vicinity of Mount Barú (3,475 m) the lowest is sea level (0 m) (Figure A1.1).

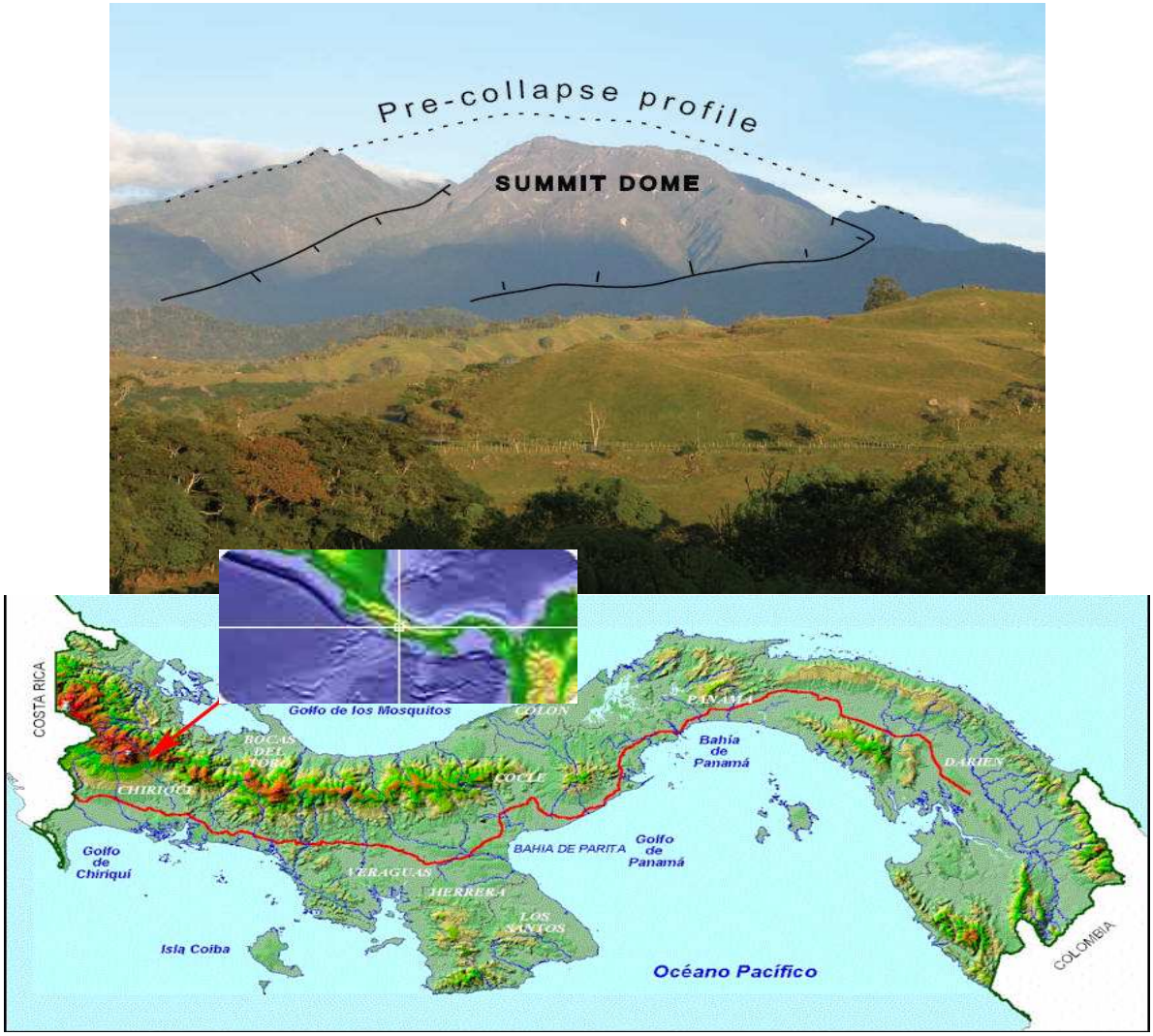
Figure A1.1: Topographic map of Panama



Source: http://panama-maps.com/qr-panama-map-elevations.htm

Topographic barriers have a dramatic effect on precipitation regimes throughout the country. Orographic precipitation on the windward side of mountain ranges is common as moist air is forced upwards and cooled adiabatically. By contrast, air on the leeward side of mountain ranges descends and warms adiabatically resulting in a rain shadow effect where the air is warmer and much drier.

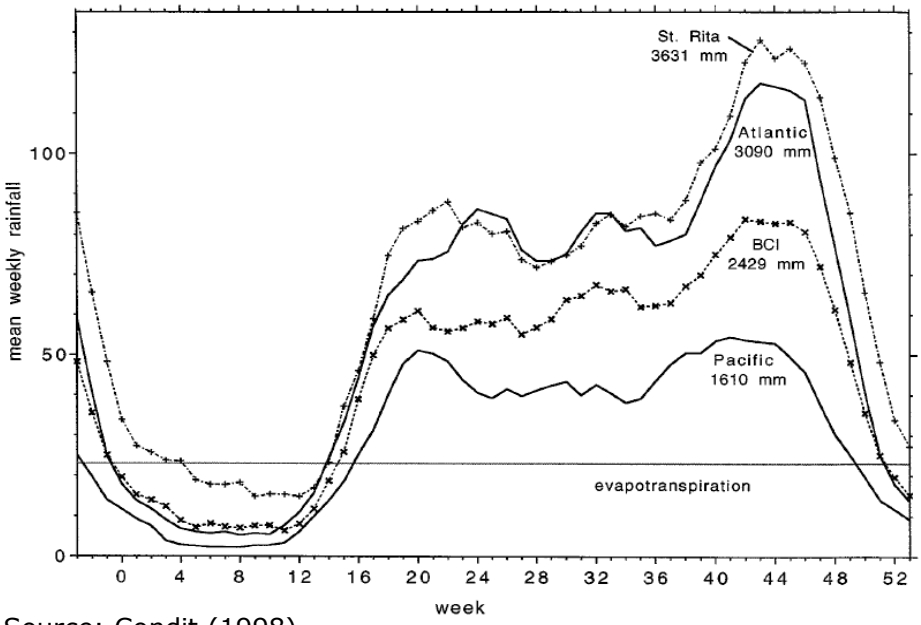
Figures A1.2: Mt Baru (3475m). Panama's highest point



http://richarddetrich.files.wordpress.com/2008/02/volcan-baru.jpg (top)
www.traveljournals.net/maps/384/3843255-volcan-baru-panama-map-zoom-x20.jpg (middle)
http://boqueteoutdooradventures.com/wp-content/uploads/2008/03/panama-relief-map.gif (bottom)

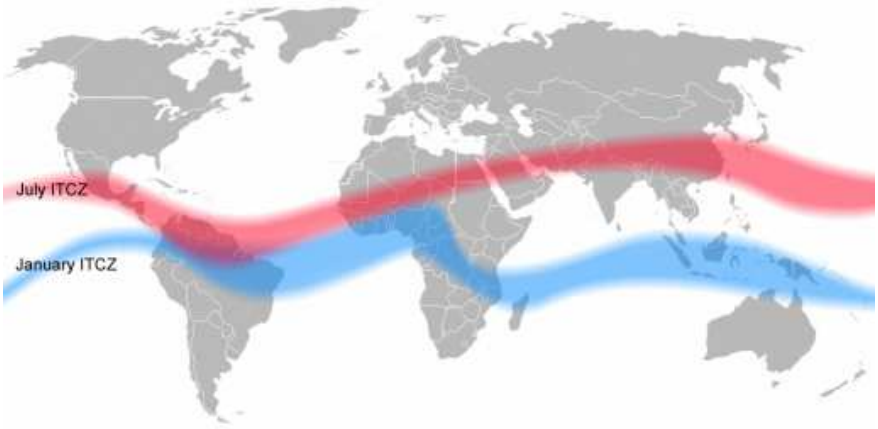
The Inter-Tropical Convergence Zone (ITCZ) significantly impacts Panama's climate as the low-pressure system migrates seasonally across the country. Parts of the country receive increased rainfall based on the presence of the ITCZ from May to December (in red), and significantly less rain from January to April (in blue) as the ITCZ migrates south (Figures A1.3 & A1.4).

Figure A1.3: Weekly rainfall from 27 years of data at four sites in central Panama, representing 3 regions (Atlantic site near Colon, Pacific site near Panama City, Barro Colorado Island (BCI) site near southern end of Lake Gutan)



Source: Condit (1998)

Figure A1.4: The ITCZ



Source: kadarsah.wordpress.com/2007/08/30/itcz/

Appendix 2: Environmental politics and market mechanisms

If the world's population consumed at the level of the USA, it would take five to six planets, and around three planets for current European standards (Walter and Simms, 2006). We have severely impacted the environment through activities such as intensive agriculture, mining, forestry and urbanization. The Earth's capacity to provide resources and absorb waste has been exceeded and is unsustainable. The UN Millennium Declaration reports that "current unsustainable patterns of production and consumption must be changed". The need for the adaptation in land use towards sustainability is critical (Koellner, 2007; Sachs, 2009; UN, 2009).

If humans are to move towards sustainability then there are some significant problems to address. Population growth, corporate globalization, and conventional agriculture have severely depleted resource bases and degraded large portions of land. There is increasing competition for already scarce resources and the depreciation of natural assets is not accounted for (Sukhdev, 2008). Tropical deforestation is significantly impacting the global climate and the increasingly vulnerable welfare of developing countries (IPCC, 2007b). The main driver of deforestation has now shifted from predominately poverty driven to corporate driven (Butler et al., 2008), and the livestock sector is a major driver of deforestation, accounting for 80% of anthropogenic land use (Stehfast et al., 2009) while irrigated agriculture accounts for 70% of anthropogenic water use (FAO, 2009; Stiftung, 2009). Tropical forests need protection as they stabilize societies, ecosystems, soil and water resources, and contain high levels of biodiversity, and large pools of carbon. Transitioning to more sustainable land uses is both challenging and expensive, even under utopian conditions. Developing countries also contend with severe funding constraints, weak institutional capacity, and a dependence on resources for economic development (UNEP, 2004). To reduce vulnerability while increasing the resilience of those people most at risk, specific measures to cope with the adverse effects of climate change need to be implemented along with the development of capacity. This often requires significant external assistance, which should result from national planning processes in developing countries (Landell-Mills & Porras, 2002). Developing countries may seek financing from development and regional banks, bilateral aid as well as multinational agencies however private investments currently overwhelmingly exceed official assistance (World Bank SDN, 2007).

A2.1: Climate change and policy

Developing states require significant aid, capacity building and reform. The costs of adaptation to climate change in developing countries are currently calculated at between $50-100 billion annually (UN, 2008). To put this figure into perspective (and more perspective will follow), market-distorting subsidies for fossil fuels have approached $100 billion annually in non-OECD countries alone (Miller, 2008). The lack of funding available for adaptation is a large impediment to sustainable development (Murphy, 2008). Without sustained funding, adaptation may not be effectively addressed and be primarily targeted for reactive funding, such as short-term emergency relief. Ultimately, adaptation under the current scenario may prove to be extremely expensive (UN, 2008). The Stern Review concludes that the cost of inaction on climate change far outweighs the cost of strong and urgent action by at least five to one (Stern, 2006). Not everyone agrees on the details and ideology presented by Stern (2006) however there is consensus that the conclusions are correct (Weitzman, 2007; Yohe & Tol, 2008). Climate change has the potential for catastrophic outcomes and therefore must be addressed, regardless of whether it is caused by us or not. Urgent action is needed immediately. About one percent of global GDP is required annually to avoid the worst effects of climate change; failure to comply could reduce GDP by up to twenty percent (Stern, 2006).

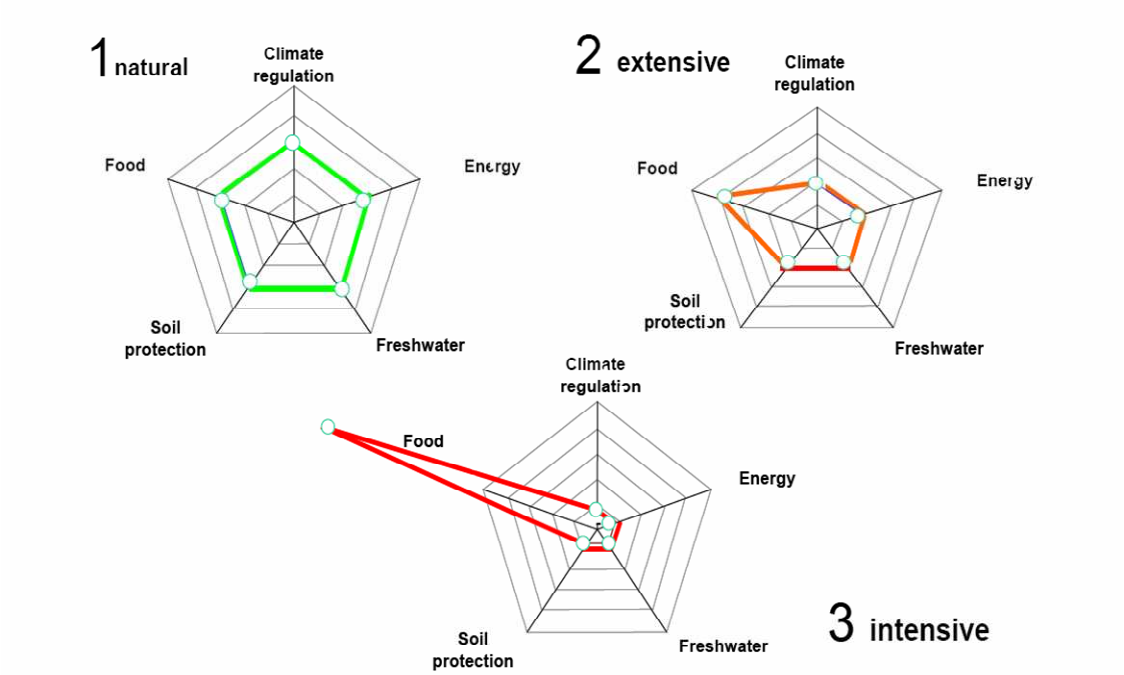
Climate change may come to represent the largest market failure to date (Stern, 2006) and may become a significantly larger problem than the financial instability of late, which to date has found over $12,800 billion in funding from the US government alone, which represents over $42,000 for every person in the US (Bloomberg, 2009). Central Banks need to act and get rid of "pimping" sociopath bankers who launder money from corrupt politicians and developers in developing countries (Collier, 2008) and the IPCC should seek cooperation with the IMF, UN Security Council, or WTO to bring greater effectiveness and coordination to international financing and climate change adaption. In fact, it has already been argued that the UN Security Council should take the leading role in addressing climate change, as it poses significant threats to human security (GACCC, 2007).

Policy-makers already handle multiple social objectives and pressures from stakeholders. They must now however also address the complex and ubiquitous challenges found within the uncertainties and threats posed by climate change. If we care about the long-term implications of our behavior, then the needs of future

generations should not be neglected, or "discounted" too heavily (Nordhaus, 2005; Stern, 2006). In reality however, long-term policies are heavily discounted and difficult to implement. Climate change policy currently belongs in this category and assumptions about change, particularly technological and political, are of great concern (Nordhaus, 2006).

Maybe the biggest barrier to making definitive policy decisions relates to the uncertainties regarding the magnitude, timing and effects of climate change. Politicians are however usually focused on short-term goals, such as re-election and keeping corporate stakeholders happy via short-term profit maximization. The result of this political paradigm is a higher probability that politicians will be forced or coerced to heavily discount (ignore) sustainable development and climate change policies. According to Hancock (2003), to move outside of this situation is difficult since the capitalist market imprisons the state by ruling out any significant actions that would hinder business profitability, which is itself an insidious form of corruption that breaches no law but is rather part of the system itself. Politics is the shadow cast on society by big business and the state is an instrument of power acting in the interests of groups powerful enough to dominate it (Hancock, 2003). Climate policies can be both economically attractive and environmentally friendly, offering attractive additional benefits for humans and ecosystems (Halsnaes, 2007) and in general, mitigation and adaptation are two policy options which should occur side by side to efficiently combat climate change. Mitigation however has a longer response time, and is complex and uncertain, while effective adaptation to the already committed degree of climate change can happen much faster, with insignificant risks and uncertainties (WHO, 2003). International cooperation towards efficient, effective, and equitable policies must be improved (Engel & Palmer, 2009). The fossil fuel age will surely end, and if we use our common sense it will end sooner rather than later. 80% of our energy comes from burning fossil fuels and the days of using the atmosphere as a free dumping ground are numbered (Gautier, 2008). On the global scale, the worlds 1000 largest corporations produce 80% of the world's output (Speth, 2008) and are therefore driving the global climate system into possible catastrophe, not to mention the severe and unaccounted for environmental degradation as a result of their profit drive and tendency to externalize costs. Developing countries should no longer be expected to pick up the bill for this lost capital and a global tax should be placed on these top 1000 corporations, with the proceeds going to adaptation in developing countries.

Figure A2.1: Land-uses and trade offs



Source: Ben ten Brink (MNP) presentation at the Workshop: *The Economics of the Global Loss of Biological Diversity 5-6 March 2008, Brussels, Belgium.*

Rising beef consumption is a major driver of regional and global change, and warrants greater policy attention (McAlpine et al., 2009). The livestock sector accounts for 80% of total anthropogenic land use and 18% of global emissions (Stehfast et al., 2009). By using an integrated assessment model, Stehfest et al., (2009) found that a global transition to a low meat-diet, as recommended for health reasons, would have dramatic effects, not only creating substantial benefits for human health and the environment, but also playing a critical role in future climate policies. Up to 2,700 million ha of pasture and 100 million ha of cropland could be abandoned, resulting in a large potential for carbon uptake while methane and nitrous oxide emissions would be substantially reduced. Moreover, this global transition would reduce the mitigation cost to achieve 450 ppm CO2-eq. stabilization by about 50% in 2050 compared to the reference case (Stehfast et al., 2008).

When cows are slaughtered and exported so too are the renewable energy, water, and fertilizer that they provide. Cows can provide energy from their waste, milk and meat, leather, and work from feeding and milking and collecting dung (Shiva, 2000). In addition, ecological "cow soil" (soil fed by biological cow dung) has a higher water holding capacity with 2 to 2.5 times as many worms as untreated

soils. Worms make the soil more fertile by maintaining structure, aeration, drainage and breaking down organic matter. Worm worked soil is more water stable, draining water 4 to 10 times faster and making the water holding capacity 20% higher (Shiva, 2000).

McAlpine et al. (2009) suggest four policy imperatives to mitigate the escalating environmental impacts of beef: 1. Stop subsidizing beef production and promoting beef consumption; 2. Control future expansion of soybeans and extensive grazing; 3. Protect and restore regrowth forests in grazing lands; 4. Allocate resources to less environmentally damaging alternative land uses.

Imperative 1: Stop subsidizing beef production and promoting beef consumption. Examples of hidden or unaccounted costs of beef production include introduction and spread of invasive grasses and deforestation, and degradation of ecological services such as clean water, soil health and biodiversity.

Imperative 2: Control future expansion of soybeans and extensive grazing. Tighter controls over the expansion of the beef industry and livestock fodder crops such as soybeans represents a priority global and regional strategy to halt tropical deforestation and is the global-change mitigation option with the largest and most immediate impact on global carbon stocks.

Imperative 3: Strategic protection and restoration of regrowth forests. Regrowth management helps to restore biodiversity and other ecological services in grazing landscapes and complements old forests and protected areas. There is considerable potential for both small and large landholders to financially benefit from a well designed carbon sequestration policy which includes regrowth forests.

Imperative 4: Allocate resources to ecologically sensitive alternative land uses. The development of diverse and sustainable grazing systems will increase the resilience of landscapes to the impacts of climate change. Benefits could be achieved via the integration of grazing systems with other income sources such as carbon credits, agro-forestry, bioprospecting, biodiversity credits and steward payments, and production of agricultural commodities for direct human consumption. Such schemes would allow beef producers to diversify their income sources, while maintaining some cattle.

A2.1.1: The Kyoto Protocol

The Kyoto Protocol (KP) has been a vanguard for addressing global warming, not only supporting the progressive development of international policies to achieve environmental objectives, but also setting out stringent and legally binding targets for the reduction of emissions which is unprecedented in an environmental agreement. It is also the first international agreement to include economic instruments and flexible mechanisms to assist meeting targets since climate change has been referred to as maybe the biggest market failure to date (Johnston, 2005; Stern, 2006). These mechanisms aim to promote sustainable development and address climate change and have great potential for channeling investment into developing countries via the Clean Development Mechanism (CDM) (Nordhaus, 2005).

The CDM under the KP intends to assist developing countries in achieving sustainable development and help industrialized countries in fulfilling their reduction targets under the KP. The CDM operates by allowing Annex I countries to finance emission reductions in developing countries (non-Annex I), when a GHG reduction project is implemented in these countries, that GHG Project will receive "Carbon Credit" which can be sold to Annex I buyers. Under the CDM, industrialized countries may use Certified Emission Reduction Units (CER) from greenhouse gas (GHG) emission reductions projects undertaken in developing countries to fulfill their reduction commitments (Nordhaus, 2005).

The Kyoto Protocol, while not the only option available, represents a large and relatively well-regulated market for carbon. However, it operates under restrictive rules and imposes significant technical and monitoring issues (Bloomfield et al., 2009; Rocha, 2008). UNEP (2008) criticizes the current state of the CDM, claiming that it is largely ignored that the CDM significantly relies on investors in developing countries financing projects (since they are already in the market) and thereby assisting developed countries to avoid such investments. This is neither the intention nor the expectation of the CDM and as a result, lower marginal abatement costs are not exploited, technology is not transferred, and investments are not flowing from developed to developing countries. UNEP (2008) suggests that market risk and regulation should be significantly reduced for the CDM to realign itself with its purpose. In fact, they argue that the additionality test may be completely abolished

with no risk of market flooding from developed countries, even though the integrity of the mechanism may then be reduced.

Nuclear power has become popular again due to energy insecurity and global climate change (Squassoni, 2009). Nuclear power was excluded from the CDM in 2001, after opposition from European and developing countries. However, the whole world may benefit from assisting developing countries to meet their rapidly increasing energy needs through low-carbon and less emissions intensive technologies. The latest figures indicate that due to decommissioning, the amount of nuclear electricity generated globally in 2008 was the lowest for five years. The World Nuclear Association (WNA) is expecting a "new wave of nuclear" after 2012 while carbon credits could cut the capital cost of building new nuclear stations by up to 40% (Edwards, 2009). Globally, 16% of electricity comes from nuclear, while the six reactors operating in Latin America supply 3.1% of the region's energy (Cevallos, 2006). In Latin America, plans for nuclear expansion are ambitious. Argentina and Brazil may seek to double or triple existing nuclear capacity, while Mexico may build as many as eight more reactors by 2025. Chile, Venezuela and Uruguay are also considering nuclear energy (Squassoni, 2009).

About 20 Fast Neutron Reactors (FNR) have already been operating, some since the 1950s. The economics of FNRs is the primary concern which still depends on the value of the plutonium fuel which is bred and used, relative to the cost of fresh uranium (WNO, 2009). FNRs are a technological step beyond conventional nuclear reactors. They offer vastly more efficient use of uranium and the ability to burn long-lived high-level nuclear wastes. Some 300 reactor-years experience has been gained in operating them. One scenario in France is for half of the present nuclear capacity to be replaced by FNRs by 2050, with the other half being replaced by 3rd-generation European Pressurized Reactors (EPRs) (WNO, 2009).

A2.1.2: The EU Emission Trading Scheme (EU ETS)

The framework for implementing the KP is most solidly institutionalized in the European Union Emission Trading Scheme (EU ETS), which covers almost half of Europe’s CO2 emissions (PEW, 2007). The EU ETS has been developed to achieve an effective and cost-efficient reduction of GHG emissions in the European Union and uses the KP’s "Flexible mechanisms" to supplement GHG mitigation by the joint

implementation (JI) of emission reduction projects between Annex I Parties or through the Clean Development Mechanism (CDM) (UNFCCC, 2008). However, projects from afforestation and reforestation (A/R) are not accepted by the current EU ETS, and according to the European Commission, the EU ETS does not envision changing its stance under the current rules of engagement (EC, 2008).

Tradable permits can be extremely complex instruments, and the more complex a system the harder it is to enforce. Enforcement always comes after monitoring and unless a vital state interest is at stake, states will generally allow treaty violation (Louka, 2006). The EU ETS is a cap-and-trade system and relies upon the accurate monitoring of emissions and only then the issue of enforcement comes into play. We live in a world where governments tend to vary in terms of honesty, transparency, and effectiveness (Nordhaus, 2005). These issues arise with particular force in international environmental policies, where countries may have little domestic incentive to comply, and weak governments may extend corrupt practices to international trading (Milken, 2007; Nordhaus, 2005).

The EU ETS legally and technically consists of 25 emission allowance trading schemes, all of which are linked (IELCN, 2005). The EU ETS is highly complex and subject to large amounts of unpredictability which undermines confidence in investing for the future, making it more likely that parties who have limited trading experience will poorly adapt. One of the main effects of the EU ETS will be to transfer emissions from firms operating within the scheme to firms in other countries to the extent that the overseas firms are less efficient. Hence the net effect of the EU ETS may be to increase global GHG emissions (Open Europe, 2006). The EU ETS nevertheless represents an unprecedented innovation in environmental policy, as it is a first application of the cap-and-trade system at a multi-state level and has the potential to serve as a building block for an international carbon market (Zapfel, 2003). By the end of 2005, emissions from the EU-15 were 1.5 percent below 1990 levels, while combined emissions from all 27 Member States were 7.9 percent lower (EC, 2008). Strict enforcement of the KP is more likely in those countries and industries covered by the EU ETS (Klepper, 2005). In reality however fewer than 20 countries are responsible for around 80 percent of the world’s emissions and in the early stages of emissions policy, the remaining 150 countries may only get in the way (Nature, 2007).

A2.2: Securing external support

Several regional and international organizations offer assistance related to combating climate change and promoting sustainable development such as capacity building, research and technical assistance activities. Being non-financial entities, the main activities of these organizations in the climate change arena are not, in principle, related to investment but information dissemination and capacity building, the budget and scope of which for this purpose vary from year to year (Zhang & Maruyama, 2001).

The World Bank and other global financials have developed many programs to assist developing countries, only to find problems related to regulatory frameworks, market awareness and affordability (Taylor et al., 2008). The barriers to a good investment climate, particularly those related to inadequate government policies (i.e. property rights and lengthy contract), lack of critical infrastructure, and project sponsors with weak credit ratings undermine otherwise attractive financing programs (Miller, 2008). The World Bank and other similar bodies reported that all MDBs (multilateral development banks) are prioritizing energy efficiency (ADB et al., 2007). MDBs may therefore be criticized for their continued support of fossil-fuel investments. Nevertheless, The World Bank is serving as one of the 3 implementing agencies of the global environmental facility (GEF) which was initially a unique source of financing for climate change mitigation projects however recently carbon trading and the establishment of Forest Carbon Partnership Facility (FCPF) has become a much larger resource (Miller, 2008).

A2.2.1: The Global Environment Facility (GEF)

The Convention on Biological Diversity (CBD) is a key document regarding sustainable development, offering guidance based on the precautionary principle. It is an international treaty adopted 1992 and has been ratified by 189 states. The three main goals of the CBD include the conservation of biodiversity, the sustainable use of its components (natural resources are not infinite), and the fair and equitable sharing of benefits arising from genetic resources (most notably those commercially used).

The GEF provides grants to developing countries for projects that benefit the global environment and promote sustainable livelihoods in local communities (Miller, 2008; Zhang & Maruyama, 2001). However, the GEF has been heavily criticized for its relative weakness compared to the scale of global environmental problems, for example, the World Bank's ongoing and much larger investments in logging, dams, fossil fuel extraction and other activities which exploit natural systems. It has in fact been tagged as a sideshow and a distraction for professional environmentalists, since their time may be better spent elsewhere (Young, 2002; Zhang & Maruyama, 2001).

Moving on to other more powerful legal frameworks reveals the limitations of the CBD and how it is linked to business. The 1648 Treaty of Westphalia outlines that obligations may be imposed on a sovereign state only with its consent. To account for this, international law relies on the multilateral compliance of states and may only be enforced by states; alternatively it may be governed through an agreed upon international institution, such as in the case of the EU (Louka, 2006).

In the end, business is in fact only answerable to the state, and may choose to ignore the CBD and the precautionary principle in those states which allow it to happen. In addition, customary international law requires that states shall fulfill in good faith their obligations under general principles and rules of international law, and not allow activities under national control to damage the territory of other states or areas beyond national jurisdiction, and that states shall use a precautionary approach (Louka, 2006).

It has been argued that custom is an authoritative source of international law; however difficulties arise as custom is hard to prove when considering bilateral and multilateral agreements among states (Louka, 2006). As a result, there is no legal mechanism by which countries may coerce disinterested countries or businesses to provide for global public goods. In other words, the Westphalian system is one that allows free-riding. Therefore, different approaches need to be adopted for global public goods compared with those taken for regional, national, or local public goods (Louka, 2006).

A2.2.2: Private investments

By bridging the information gap about other non Global Environmental Facility (GEF) sources of finance, the involvement of the finance sector in supporting the implementation of the CBD may be of significant importance. This potentially critical mechanism may be achieved via a social responsibility approach (convince them of the benefits of becoming more socially responsible, or by a join forces approach. Key stakeholders and those with expertise, knowledge and experience, should come together to make progress on the issues. Nevertheless, it has been recognized as a complex and long term process, which requires improved communication and transparency (Drucker et al., 2002).

In general, key stakeholders are willing to invest, if there are long term transparent and stable signals. These signals come about from policies and legal frameworks (Louka, 2006; Miller, 2008). Critical for success is the involvement of the financial sector and key stakeholders to counteract the lack of financial resources and the inefficiency in the use of these resources (Drucker et al., 2002; Zhang & Maruyama, 2001). One of the key stumbling blocks to effective co-operation between the supply side and demand side in the financial and ecosystem services sectors is the availability of suitable and bankable projects. To meet the banking criteria, it is important to have monetary valuation studies. The involved sectors also need practical guidance in appreciating the banking world's language and way of thinking (Drucker et al., 2002). The financial sector therefore should mainstream ES into regular banking programs so that the funds for these projects will be stable and sustainable. Banks wishing to mainstream such projects however often require practical guidance, especially at the operational level, to grasp related investment opportunities and to avoid investing in projects that harm ecosystems and those who depend on them (Drucker et al., 2002).

A2.3: Payments for environmental/ecosystem services

Payments for environmental services (PES) are market-based policy instruments that translate external, non-market ES into financial incentives for landowners to preserve the ecosystems that provide the services (Pagiola et al., 2008). PES payments need to be transparent and ongoing to ensure continued leverage over landowners, and may suffer from poor design. The same PES program would have different results in different countries due to varying ecological, socioeconomic, and institutional conditions and the need to accommodate political pressures (Pagiola & Platais, 2002; Wunder et al., 2008). Panama suffers from corruption and poor capacity and coordination and management, all of which increase transaction costs and severely affect markets, significantly slowing the development of ES markets in Panama (Lichtenfels et al., 2007; Wunder et al., 2008).

Costa Rica pioneered the use of the PES approach in developing countries by establishing a formal, nationwide program of payments (PSA). PSA is primarily financed by a fuel tax but has made substantial progress in charging water users. PSA thus remains largely a supply side PES Program and has significant room for improvement in charging biodiversity and CS users, and in the efficiency with which it generates ES (Pagiola et al., 2008) such as enhanced spatial differentiation in targeting which may increase efficiency (Wünscher et al., 2008). Wunder et al., (2008) indicates that significant differences exist between user- and government-financed PES. They found that user-financed programs are better targeted, more closely tailored to local conditions and needs, have better monitoring and a greater willingness to enforce conditionality, and far fewer confounding side objectives than government financed PES. Government-financed PES typically embrace multiple ES while user-financed programs tend to be focused on a single ES (Wunder et al., 2008). There is also a clear difference in scale between user and government-financed programs. Many user-financed programs are for hydrological protection at a small (500–5000 ha) watershed scale. Government financed PES (pilots excepted) are orders of magnitude larger, the smallest at 270,000 ha (Costa Rica). User-financed PES also tends to remain similar in size over time, while government financed PES often go through an initial pilot phase, followed by an expansion. Thereafter, size appears to depend on annual budget allocations, except when earmarking provides them a reasonably secure funding base (Wunder et al., 2008).

Overall, user-financed PES are more targeted in their effects compared to the larger, multiple-objective, government-financed programs that often have broader and ill-defined objectives (Wunder et al., 2008). PSA indicates the importance of being flexible to changing circumstances and is evolving by becoming more targeted and differentiated (Pagiola et al., 2008).

Wunder (2005) argues that the future of PES largely depends on its ability to demonstrate clear additionality, however additionally may be completely scrapped under the CDM (UNEP, 2008). Furthermore, preliminary evidence on PSA suggests that the program's additionality is low (Wünscher et al., 2008). However additionality is not a selection criterion of the PSA program; it would pay all plots that provide ES if financial resources were available, irrespective of additionality (Pagiola, 2008).

PES encourages more extensive reforestation and ensures that it provides more than just timber. PES has become increasingly popular due to its ability to secure finance for landowners (Wallander et al., 2007; Wünscher et al., 2008). Transaction costs however often severely affect PES, which must be ongoing to ensure continued leverage over land owners. As soon as payment ends, often so does the desired behavior (Pagiola & Platais, 2002; Wunder, 2005). Panama should first create ES markets via green taxes and then transfer parts of the costs to user financed payments via PES where conservation is a priority and where opportunity cost is minimal (Cato, 2009; Landell-Mills & Porras, 2002; Oestreicher et al., 2009; Wunder, 2005). To achieve this, Panama’s government should actively cooperate with key stakeholders, different social and political institutions at various levels, and the financial sector (Drucker et al., 2002; Oestreicher et al., 2009). Thereafter, financial assistance may move in to support and/or extend successful programs.

Appendix 3: Financial analysis of REDD in Panama

According to Potvin et al. (2008), if Panama hopes to participate in REDD then it would need to sell CRs for a yearly value of $3,678,594 ($735 x 5000 ha), in order to compensate for the opportunity cost. Their calculation suggests that it is unlikely that sufficient money could ever be found to offset the cost of REDD. They add that the country's total spending for protected areas in 2005 was $3.5 million.
The analysis of Potvin et al. (2008) suggests that REDD is not financially feasible and that none of the currently proposed mechanisms can provide the necessary incentives and flexibility to stimulate action. However, they misquote Tomaselli (2006), used NPV of benefits compounded over 25 years ($735) to calculate the annual opportunity cost, and misrepresented the emissions reductions (3,320,000 tCO2e annually for 5000 ha). Coomes et al. (2008) conclude that based on NPV, cattle ranching is not profitable (NPV = $-420/ha) and therefore not an investment option.

Potvin et al. (2008) report "…only a fund of US$5.9 billion would allow Panama to receive adequate compensation to offset the opportunity cost of deforestation. To put this figure in perspective, a recent UN study established that international funding for forestry has amounted to US$1.1 billion over the last decade (Tomaselli, 2006)". However, Tomaselli (2006) reports "For 2004, reported funding and investments in forest projects (as defined by each agency) by major ODA donors, including the OECD countries, and the World Bank, IADB, AfDB and GEF amounted to over US$ 1.1 billion". An order of magnitude out and pulling the result in the same direction, suggesting more funding is needed, which is of course the case.

Potvin et al. (2008) report "Administrative cost estimates from PES schemes in Costa Rica amount to 12–18% of the total contract size (Coomes et al., 2008; Grieg-Gran, 2006). Based on the Costa Rican estimate, this would amount to an administrative cost of $3/ha. In a study on the feasibility of PES for the Panama Canal Watershed, a similar figure of 10% was proposed (Coomes et al., 2008; Louis Berger Group, 2006).

The 3 costs for REDD include:

1. Monitoring and enforcement = $7.4/ha (Potvin et al., 2008; based on the assumption that protection requires three guards per 100 km2)
2. Administration = $3/ha (Potvin et al., 2008; Costa Rican case study)
3. Opportunity cost = $61/ha

The calculation of the total cost for 5000 ha is

$71.4/ha*5000 ha = $357’000/year

Potvin et al. (2008) add 5000 ha onto the contract every year.

Costs are $2.68/tCO2e annually
and storage is 26.6 tCO2e per ha per year
year 1 = 5000 ha x 26.6 tCO2 x $2.68/tCO2
year 2 = 10000 x 26.6 x 2.68
year 3 = 15000 x 26.6 x 2.68... etc...

cost for year n = n x 5000 x 2.68 x 26.6
sum n = 1 to n = 26 (25 years)
Therefore we have 2.68 x 5000 x 26.6 [(26 x 26/2) - (1/2)]
= 2.68 x 5000 x 26.6 [337.5]= cost of REDD in terms of tCO2e over 25 years with 5000 ha added each year

$115'843'000 is the total cost of 125'000 ha of supplying REDD carbon credits over 25 years (not including interest rates). But, it goes on ad-infinitum, as in the last year for example, you just finished your 1st year contract since its 25 years later, but you still have 120'000 ha of land under contract for the next 24 years... very complicated.

Just looking at the first 25 year contract

$115843000/25 = $4'633'720 annually.

=$4.63 million each year over 25 years

This is the average annual cost for REDD over a 25 year time frame, when starting with 5000 ha and adding 5000 ha to the contract each year.
So, just looking at the first 25 years, the carbon credits would cost Panama

$4.6 million annually for protecting an additional 5000 ha every year over 25 years
133'000 t CO2e per year for 5000 ha... so
$4.6 million /133'000 tCO2e = $34/tCO2 for year 1
$4.6 million/266'000 tCO2e = $17/tCO2e in year 2 (10'000 ha) etc etc

year 25... 4.6 million /25 x 133000 = $1.38 /tCO2e

Using this method makes it expensive upfront for developing countries and suggests they need significant initial funding. However, why give them all this money when they don't have the capacity to use it efficiently? Moreover, Why not put the 5000 ha plots into separate 25 year contracts and sell carbon credits accordingly with a cost to Panama of about $2 to $5/tCO2e, and significant other economic and non monetary benefits.

Just looking at one 25 year contract at a time covering 5000 ha would be significantly cheaper. This is the best option. Attempting to keep adding 5000 ha under the same contract and then averaging out over 25 years is not conductive to transparency or market formation or business involvement.

REDD costs $71.40 / ha annually, which is $71.4 x 5000 =$357'000
now $357'000 / 133'000 tCO2e
= $2.68/tCO2 in REDD benefits annually for Panama

or

$71.40 / ha is the cost, and 26.6 tCO2 is stored per ha
so $71.4/26.6 tCO2
= $2.68/tCO2

The end result is 133'000 t CO2e sequestered per year for 5000 ha of protected forest annually (25 years REDD contract). If we make a 100 year contract, then REDD would be 4 times cheaper for Panama.

So to protect and store 1tCO2 in forests costs $2.68 (ie $2.68/tCO2e) for Panama

Annual deforestation = 14.6 million ha
26 tCO2e/ ha annually for REDD over a 25 year contract
26 tCO2e/ha x $2.68/tCO2
= $70 to protect 1 ha for a year with carbon credits
$70/ha x 14.6 million ha
= $1 billion annually to avoid 14.6 million ha of deforestation (using Panama's figures, i.e. $70/ha)

Stern (2006) calculates that it would cost $10-$15 billion annually to reduce global deforestation by half. Considering these results, Panama's environmental issues and incredible biodiversity and the results from Sukhdev (2008), avoiding deforestation in Panama should be a global priority. REDD should decrease under future markets as technology improves and as agricultural subsidies will need to be rethought to better reflect market and environmental realities. However, investments into Panama are being constrained by significant transaction costs and corruption.

Potvin et al. (2008) indicate that "Using an above-ground C content measurement of 181.1 tC per hectare for mature forest in Panama (Kirby, 2005), the protection of 5,000 ha of forest land would correspond to a reduction in emissions of 3,320,000 tCO2e per year".

Their calculation went such
3.67 x 181.1 x 5000 = 3'321'250 tCO2e per year.

However, if a mature forest stores 181 tC/ ha, then it does not change by 181 tC/ha per year. In fact, it would (hopefully) remain rather stable over the 25 year period. Therefore, over 25 years, we could say
181tC/ha / 25 = 7.25 tC/ha per year (over 25 years of REDD),

This equates to

3.67 x 7.25 tC = 26.67 tCO2e /ha

Therefore, the protection of 5000 ha would correspond to a reduction in emissions of 130’000 tCO2e per year.

Appendix 4: Corruption

Most conduct is guided by societal norms rather than laws. Norms are effective because of peer pressure (Collier, 2008). Legal frameworks reveal the limitations of international norms and laws and how they are linked to business. The 1648 Treaty of Westphalia outlines that obligations may be imposed on a sovereign state only with its consent. In the end, business is in fact only answerable to the state, and may choose to ignore the international voice and the precautionary principle in those states which allow it to happen (Louka, 2006).

Corruption and a lack of information and transparency cause poverty and may keep people and institutions from being productive, and can threaten sustainability. Corruption is primarily for private gain and therefore the environment and society suffers. Corruption in Panama is noted by many sources as a significant challenge to be overcome (CIA, 2008; US DOS, 2009; Wickstrom, 2003; World Bank 2008). Transparency International (TI) defines corruption as the "abuse of entrusted power for private gain" limiting the argument to governing bodies in developing countries. According to Tax Research LLP, less than 5% of capital flight (dirty money) comes from this narrow category. A much larger portion (30%) derives from drug trafficking and money laundering while transfer mispricing constitutes 60% of “dirty money”. A large piece of the picture is therefore missing in TI’s analysis which ignores the “global shadow economy” (Sharife, 2009). Panama is one of only 13 countries and the only current or prospective Free Trade Agreement (FTA) partner that is listed on all of the major tax-haven watchdog lists but does not have US tax transparency treaties. Panama has not completed a single OECD agreement since committing itself in 2002. Panama is a magnet for tax evasion and corruption, and will find itself in an increasingly difficult situation as governments globally move to address these issues (FTA, 2009).

Panama is a critical global transport link and a major tax haven and financial conduit for Mexican and Colombian drug money (FTA, 2009). In addition, the Obama administration has recently put the Panama Free Trade Agreement (FTA) on hold while it develops a "new framework" for trade. Some of the largest recipients of US federal procurement contracts and money under the Troubled Asset Relief Program, including Citigroup and AIG, have many subsidiaries in Panama that would be empowered with expansive new rights if the FTA is implemented. These firms have

been among the top advocates for the Panama FTA (FTA, 2009). Panama has more than 350,000 foreign-registered companies, all of which face low to no taxes and regulation. This high rate of foreign incorporation (reportedly second only to Hong Kong) makes the country a magnet for tax evasion. The high volume of trade occurring through the Colon Free Zone (over 2,600 businesses are established in the Zone) presents many opportunities for trade-based money laundering to occur (US DOS, 2009).

The CIA (2009) reports that Panama's major political pressure groups and leaders include: Chamber of Commerce; National Civic Crusade; National Council of Organized Workers or CONATO; National Council of Private Enterprise or CONEP; National Union of Construction and Similar Workers (SUNTRACS); Panamanian Association of Business Executives or APEDE; Panamanian Industrialists Society or SIP; Workers Confederation of the Republic of Panama or CTRP. However, there appears to be no environmental pressure group on this list. Furthermore, the CIA (2009) reveals Panama's participation in over 50 international organizations however the OECD is absent from its list. The financial crisis will likely create new pressure on Panama simply because governments will need the tax revenues (Murphey, 2009).

A focus on national policies to increase investment is crucial since capital flows follow expected commercial returns. Therefore, unless national policy intervenes, established perceptions of market risk and reward will dictate investments since key stakeholders are usually only willing to invest if there are long term transparent and stable signals, which come about from policies and legal frameworks (Louka, 2006; Miller, 2008). The OECD may be a great source of sustainable growth and investment for Panama, if only it would adhere to its 2002 agreements. Panama has defiantly outlined its refusal to adopt key OECD reforms, promised in 2002 and has not completed a single agreement (FTA, 2009). According to the US DOS (2008),

The presence of tax havens, guaranteeing protection and discretion to corrupt political elites and economic criminals, directly undermines democracy and development, manipulating legal vacuums in unanticipated ways. Over 60% of global trade occurs in unobserved vacuums. In spite of this, the Organization for Economic Cooperation and Development (OECD) has marginalized structural exploitation, lax regulation, and the culture of secrecy, all of which underpin the larger OECD economies such as London (Sharife, 2009).

A4.1: Media coverage in Panama

Using a bottom up (de-centralized) approach, many issues stand out for Panama. It is interesting to note here that Panama has an unusually low proportion of internet users (6.7%) and that "Bloggers" are now threatened as much as journalists in traditional media (RSF, 2009; WDI, 2008). One might calculate that if Panama had an "average" internet penetration rate of about 20%, that more information on issues in Panama would be available. The following are summaries of the main points found in the news articles. More details can be found online.

N.B. Translations from Spanish to English are courtesy of Raul Mandarin, Neiva Galoro, and Google Translate.

15 Aug 2007
AES Corporation is planning to build three hydroelectric dams on the Changinola River in Panama. The NGO Rainforest Action Network requested a protest letter be sent by the public via the Center for Biological Diversity, claiming that biodiversity of a World Heritage site would be affected and rights and livelihood of the Naso and Ngobe tribes are at risk (Internationalrivers, 2007).

23 Aug 2007
Over 50 groups demanded that AES Corporation withdraw from three controversial hydroelectric projects that are threatening La Amistad International Park in Panama. Environmentalists claim that the dams threaten a World Heratige site and will displace local communities and wildlife (Mongabay, 2007).

08 April 2008
AES was granted concessions to build a series of dams by the government of Panama. AES and the government were accused of collusion after over one hundred police officers in riot gear leveled a Naso village. Over 200 people were left without any kind of shelter, and eight children were hospitalized. The police used tear gas and heavy equipment, demolished dozens of homes, a church, and the Naso cultural center. Police said they had orders to arrest indigenous leaders. The government said it would rebuild if they promise to move (Cultural Survival, 2008).

August 2008
Mr. James Anaya, a UN specialist on indigenous peoples, issued a declaration expressing concern about the Ngobe affected by the dam (Galvin, 2009)

01 Sep 2008
NGOs were concerned that the United Nation's Clean Development Mechanism may be used for AES's controversial Changuinola dam in Panama. The NGOs claimed that AES has tried to bribe, blackmail, repress and forcibly displace the local Ngobe tribe, and that ANAM approved the project without prior consent. The NGOs also said that the project would impact a UNESCO World Heritage Site and did not comply with the World Commission on Dams' guidelines (Carbontradewatch, 2008).

October 2008
The Inter American Commission on Human Rights held a public hearing on the legality of the displacement of the Ngobe tribe and the alleged failure of AES to obtain prior, informed consent (Galvin, 2009).

March 2009: The Ombudsman Office of Panama issued a special report on human-rights violations and the construction of the dam (Galvin, 2009).

04 Feb 2009
The Ganadera Bocas cattle company was using residential land for cattle grazing without consent or compensation. The Naso people claimed that the government has refused to protect their rights and that their livelihoods were severely affected. The company was accused of tearing down six houses belonging to the Naso people without consent and under the jurisdiction of the government (Laestrella, 2009).

25 March 2009
Indigenous Naso's and cattle farmers were in conflict after their housing was torn down by Ganadera de Bocas. The Naso were already combating the Bonyik Hydroelectric Dam proposed by Empresas Publicas de Medellín. AES has continued to search for funding despite the Inter-American Development Bank refusing to finance the project due to indigenous rights issues (Omal, 2009).

2008
Petaquilla mining denied activists access to the sites of Petaquilla Gold, Petaquilla Copper and Teck Cominco. Organizations claimed that the government is accomplice to mining interests, and that these mines cause irreversible environmental and community damage, that they exploit slave labor, violate national laws and engage in violent acts against communities (Panamaprofundo, 2008).

2009
The Alliance for Conservation and Development went before ANAM to condemn Cuprum Resources (a subsidiary of Bellahaven Copper & Gold) via their partner Dominion Minerals for exploratory mining without permission in protected areas of important biodiversity (Burica, 2009).

13 February 2008
193 people were arrested after police allegedly shot and killed a labor union leader (Beatty, 2008).

A4.2: Offshore services in Panama (Peter Macfarlane, 2009)

OFFSHORE SERVICES IN PANAMA: EIGHT IMPORTANT THINGS YOU SHOULD KNOW THAT YOUR PANAMA OFFSHORE LAWYER MIGHT NOT TELL YOU!
By Peter Macfarlane

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OFFSHORE SERVICES IN PANAMA: EIGHT IMPORTANT THINGS YOU SHOULD KNOW THAT YOUR PANAMA OFFSHORE LAWYER MIGHT NOT TELL YOU!

Before setting up a Panama IBC or bank account, offshore corporation or foundation, there are a few potential pitfalls you should really know about. But most Panamanian offshore service providers and lawyers will not warn you about these. Offshore banking and wealth management expert Peter Macfarlane will help you navigate through this maze so you can protect rather than risk your assets…
Panama can trace its history as an "offshore" business and banking nation back nearly a century. It deserves its hard-won reputation as a premier international financial center. Investors from all over the world, ranging from freedom and privacy minded individuals to multi-national corporations, benefit from Panama's tax-free and business friendly environment. They do so by setting up corporations, foundations, trusts and now LLCs under Panamanian law. It's also true that Panama has embraced the internet era by becoming a hub for international trade online, quite apart from the physical goods moving through the canal. E-commerce is buzz word in Panama City these days. But… in paradise not everything is quite what it seems. Some things are not black and white. Some of the ways of doing things – and not doing things – in Panama might surprise people, particularly those who are not used to doing business in Latin cultures and legal systems. Forewarned is forearmed, as they say. So here goes. Here are eight things you really should know about before you do business in Panama….

1. Panamanian lawyers will always recommend Panama

It may sound obvious. But you would be amazed how many people decide to come to Panama on a whim and do business here without comparing other options. It may also sound strange to say this in a report that is specifically about Panama… and believe me I consider Panama to be the home of my business… but the truth is there are a number of other pretty good tax havens around the world. Some of the best tax mitigation, asset protection and financial privacy strategies involve mixing and matching several different offshore banking havens. 99% of people who offer to sell you Panama corporations are in business to do just that. Whether it is the right thing for you in your circumstances does not really figure in their equation. What is important to them is making the sale. That's not necessarily bad, just something you should be aware of. Don't expect lawyers to give you impartial advice, especially if you are not asking for it. And remember that Panama lawyers are qualified only to talk about Panamanian laws. It is not their responsibility to know anything about the legal system in your home country. So if you want to be sure if a Panama corporation or bank account is right for you, at least ask your lawyer to explain things properly in language you understand… make sure you really drill down to the details of what you are getting into. Ask him or her to explain the exact purpose and nature of each document in the sheaf of papers being handed over, especially if you don't understand Spanish.

2. Understand Your Annual Obligations

You are the best one to look after your interests. So be sure to understand all your corporation's annual obligations and keep an eye open to make sure they are being complied with. For example, there is a fee of a few hundred dollars called the 'franchise tax' that each and every Panama corporation has to pay to the Panamanian government each year. Then there are the fees for registered agent, registered office, nominee directors and the like. Some providers are very efficient about billing each year, but others are not. Your provider might forget about you altogether… or he might even die. Or (unfortunately rather common) he might invoice you for the franchise tax but not hand it over to the government.
Any of these things will cause your Corporation to cease to be in Good Standing. You

probably won't notice immediately. But it could cause problems down the road when you need to make changes to the structure or obtain some official document. You will then be hit with a lot of fines and extra charges, and a big mess to sort out. If your corporation is not in good standing, your bank could freeze the account.
In short, make sure you understand all the obligations and annual costs? And always ask for written receipts, including a copy of the official government receipt confirming payment of the franchise tax.

3. Panamanian lawyers are not like American or British lawyers

There are some world class Panamanian law firms with excellent reputations, and there are some really good boutique law firms and individual lawyers. There is also a rather large contingent of bad Panamanian lawyers. Rules governing lawyers may be very different from what you are used to. For example, Panama lawyers may not be subject to the same guidelines on conflict of interest. You should be aware that it is not typical in Panama for lawyers to handle clients' funds or provide escrow services. Some law firms do so, but Panamanians would probably not expect it. It does not provide the same level of security you might expect back home. If the lawyer does not follow your instructions, you will have limited recourse. Panamanian lawyers are unlikely to carry and liability or professional negligence insurance. For real estate transactions, consider using a title insurance company. It is therefore really important to ask around for recommendations, which brings us to the next point…

4. Relationships and Culture Count

In Panamanian culture, business depends much more on personal relationships than what you might be used to back home. That is why, for example, it's very hard just to walk into a bank unknown and open an account. You need an introduction from a local professional. You then need to get to know your banker as a person and build up a good relationship with him or her. Your application for an account and the services you want won't be judged by a computer that's online to your credit score, as it might be back home. Bankers will judge the person sitting in front of them – including things like how they behave, talk and dress. They will also look at the

business plan/cash flow forecast - in other words, how much business you expect to be doing with the bank. It is better to overestimate your turnover than to underestimate it. They will probably ask you questions about it to see how serious your plans are, and whether you really know what you are talking about.
Bankers tend to think that they are doing the client a favor, not the other way round. If you want to bank in Panama you have to get used to this. It's also the reason why it's almost impossible to open bank accounts in Panama by mail. Some people say you can't open Panama accounts by mail at all. We know you can and we have seen it done. But we do NOT recommend it. If you want to open an account by mail for your Panama corporation, it's better to open an account in a different country.

5. Money Talks – Especially in Banks!

Another obvious one really… but I see too many people who get frustrated that a bank turned down their $1000 opening deposit. They think that "the customer is always right." As they are new clients, banks should be happy and welcome the business, even to the extent of bending rules for gringos to make the process easier. Other clients ask "which is the Panama bank with the lowest minimum opening deposit?" Most banks, as it happens, don't really have any fixed minimum. But they are also not interested in opening accounts with small deposits that are never going to see much activity. Too many dreamers open accounts with $1000 and never do anything with them. This is a waste of time for banks. Some people make the mistake of thinking that North Americans are the main users of Panama as an offshore banking center, and that everybody who looks Latino must be Panamanian. But that's not really the case. Panama is the financial hub of Latin America. Most of the "offshore" money in comes from other Latin Americans, like Colombians and Venezuelans. And the ones who are banking in Panama probably have a lot more money than you do. Yet their home governments are not the ones pressuring and threatening the Panamanian government and banks about transparency, information exchange and tax evasion. Of course if you are going to invest seven figures, banks will roll out the red carpet for you. Money talks. Money can even cause rules to be bent, as Panamanian bankers know very well. If you were the bank manager, would you rather take a $1000 deposit that could cause potential legal problems for the bank? Or $1,000,000 from a Venezuelan that is less likely to? Put that way, perhaps

you can understand why the banker thinks he is doing you a favor in opening a small account for you. It's therefore important to be respectful, businesslike and professional. Don't constantly complain or make annoying (to the banker) comparisons to your home country's banking system suggesting it is better. It isn't, or you wouldn't be considering doing business in Panama!

6. Nominee Directors Can Take Over Control Your Company if You Don't Structure Things Right

It's customary in Panama, where corporations require three directors, to register secretaries of law firms as nominee directors of companies. The reason for this is that directors are registered in public, on the internet, at http://www.registropublico.gob.pa (As opposed to most other "offshore" jurisdictions where the names of the directors are not made public.) So using nominee directors achieves the privacy that most clients are seeking. Then, the directors typically issue a Power of Attorney to the client who will have signatory power over the bank account. Many lawyers will tell you that you are, therefore, protected because you are the only one with signatory power over the bank account. That is not however the whole truth. It's not a lie, because you are the only one authorized to give instructions on the bank account… for the moment. BUT consider this: If you open an account in Panama the nominees do have to sign the bank's application forms, not in their role as signatories but as directors. If the nominees wanted they could revoke your Power of Attorney and inform the bank. The bank would then have no legal alternative but to refuse you access to the company bank account, and let the directors appoint whatever signatory they want to give instructions in the future. (The bank could also choose to refuse the signatories and close the account, but they would be obliged to pay the balance to the company via its directors, not to you) The fact that directors are only nominees is not recognized by any law in Panama. Being a nominee director is not a regulated profession – you are generally dealing with low-skilled workers who are not always reliable or honest. Fortunately, there is a simple solution to this problem. Just don't tell the nominees, nor your law firm, nor the people who are selling you the company, at which bank you are opening an account. That way there is no risk that they can go and lay claim to it. Out of sight, out of mind. To do this, you will have to find a bank that will accept exclusively your full, unrestricted power

of attorney and allow you yourself to carry out the entire account opening procedure, without the people in Panama having anything to do with it. For practical purposes, no bank in Panama will accept this arrangement. Even if you have a Power of Attorney, in Panama the directors must always sign to open an account.
Therefore if you want to protect your privacy and security to the full, you should use nominee directors but you should keep any bank accounts holding significant assets out of Panama, and well hidden from anyone involved in the incorporation or management of your company. I must add that nominee directors stealing bank accounts is not a daily occurrence. The vast majority are honest and professional. We are talking about a theoretical risk here. For small bank accounts this risk is acceptable. But it is a risk, and you as the beneficial owner have a right to understand it.

7. Bearer Shares Can Cause Problems

Bearer shares, which have been regulated or outlawed in most offshore jurisdictions, are still common in Panama. Bearer shares appear on the surface to be an excellent privacy tool. In short, whoever holds the share certificate is the legal owner of the Corporation… something like cash. However, before deciding whether or not to issue bearer shares on your company, there are two pitfalls to be aware of: Banks and other financial institutions like brokerages are required by law to identify the beneficial owner of accounts. Needless to say, in the case of bearer shares it can be impossible for banks to keep track of who is the legitimate owner. For this reason, it may be very difficult to open a bank account if you opt for bearer shares. Though I do know a few banks who will still accept this form of ownership. Bearer shares are valuable documents and they need to be kept very safely. If they are lost, stolen, or accidentally destroyed, it can be a very complicated legal process to get everything back the way it should be.

8. Be Careful What You Say

Finally, I don't know if it's the humidity that makes people let down their guard, or maybe it's the heady combination of alcohol, cigars, casinos, and the attractive young ladies who hang out in them. But if I want entertainment in Panama, I can just head over to a few well known expat hangouts, order a beer and be sure of overhearing people's offshore business plans broadcast loudly in English. I can't think of a better way of improving your chances of ending up someplace you don't want to be (like engaged in a one-to-one conversation with a representative of the IRS, for example). Which Banks in Panama are Best for Expats? So, what's the bottom line about banking in Panama? There are hundreds of banks in Panama, most specializing in specific niche markets. If you can find a bank specialized in the specific niche where you are doing business, that is most likely the best bank for you. Otherwise, recommendations are always good. I would strongly recommend you to go for a bank where you can be introduced by a trusted friend who is an existing account holder. For general day-to-day banking requirements, HSBC is good. For confidentiality, however, I would give them a low rating. It would be easy for authorities from the USA or the UK to find out information about HSBC accounts. It might technically be illegal in Panama, but the authorities would likely turn a blind eye. Other banks we recommend are Multibank, Credicorp and Banvivienda. Credicorp have a big share of the expat market, but their policy Is that they no longer accept US citizens as signatories on accounts. Obviously if you are American that would be something of a problem. Multibank and Banvivienda do accept US citizens. Banco General is another good bank if you have residency in Panama, but they do not accept non-residents at all. If you would like to arrange for introduction to a Panama bank, it is also possible to pay lawyers and introduction services. My firm can arrange such services on request, and you can contact me via http://www.petermacfarlane.net

BONUS REPORT – BUYING GOLD BULLION IN PANAMA CITY

Gold bullion (I'm talking about gold coins, gold bars etc) is the ultimate in solid money, the best way to protect your assets from inflation. Can you buy it in Panama? Is it a good deal? Since I wrote The Gold Report (popularly known as How to Buy and Hide Gold Bullion Offshore) and since clients know I know a lot about Panama, I've received a flood of questions in recent months on the general topic of whether you can physically buy and/or store gold bullion in Panama. Many experts are now no longer recommending investment in gold certificates through ETFs and the like, with bank and underwriter collapses making electronic gold risky. And that's not even mentioning the criminal lawsuits in the USA against e-gold, and the burgeoning but risky "electronic money" business carried out by a number of firms here in Panama. The answer? Rather disappointing I'm afraid. Through the 1970s and 1980, Panama produced its own Gold Balboa bullion coins. You would think, therefore, that Panama would have something of a gold investinfg culture. But not really. My research shows that there is a huge pent up demand to buy gold bullion in Latin America's premier financial hub, but precious few sellers of the metal! Those few sellers there are, based on the demand, are demanding high premiums for purchasing physical gold coins.

As a tourist in Panama City you can buy gold coins in a number of casas de cambio. I always go to PanaCambios on Via España . They are located next to Plaza Concordia, behind the big Adams clothing store. They are conveniently situated just a short walk from business hotels like the Riande Continental, El Panama, the Veneto and the Marriott. They also speak good English. If you enter or leave Panama with more than $10,000 or equivalent you are obliged to fill out a customs declaration. This applies equally to gold coins. If you are interested in buying more serious quantities of gold bullion in Panama, contact me via the publishers for a referral to reputable and licensed gold dealers in other South American countries who can arrange secure shipment to Panama. For more information on investing in physical gold bullion (and on why you should buy physical gold rather than ETFs or electronic gold) go to The Q Wealth Report. (Note: if the above link does not work for any reason, go to http://www.qwealthreport.com/precious_metals_investments.php)

Source: Peter Macfarlane 2009

Appendix 5: The Government of Panama (GOP)

A5.1: Vision for Social and Economic Development

In June 2005, the Government of Panama (GOP) under the Martin Torrijos administration put forth its five-year vision for the social and economic development of the country. This strategy points to addressing climate change and sustainability by seeking to "transform the public sector" into a vehicle that serves Panama's citizens. The current GOP's vision focuses on fiscal discipline, transparency and greater efficiency, as well as accelerating export-led economic growth, and creating more jobs. The strategy also aims to lower poverty by one fifth by 2009 by prioritizing investments in human capital (including a big effort to modernize education and training) and introducing a targeted conditional cash transfer program coupled with the continued expansion of pre-school education, primary health care and nutrition and basic infrastructure, especially in poor and indigenous areas (World Bank, 2008).

The five pillars of this policy include (World Bank, 2007)

1. Reducing poverty and improving income distribution.
By spurring higher job-creating economic growth through market-based economic policies, developing human capital, and fostering productivity, especially in agriculture

2. Creating employment through economic growth policy.
By opening to international competition, developing export infrastructure, removing distortions and reducing transaction costs for investors, including through improved urban transport

3. Reforming public finance.
Via more accurate and transparent budget accounting, deficit reduction, and improved expenditure management

4. Developing human capital.
By increasing the competitiveness of Panama's labor force while making health and education services an engine for reducing inequality

5. Reforming and modernizing the state.
By transforming the public sector into a facilitator of development that serves Panama's citizens

A5.1.2: Agricultural Strategic Plan

Operating in parallel, the GOP's 2005-2009 Agricultural Strategic Plan "Let's Get to Work" (Manos a la Obra), seeks to improve producers' ability to compete through increasing yields, reducing unit production costs and energizing employment, thereby contributing to a reduction in rural poverty. Rural producers must adopt instruments and methods which more efficiently use available resources, thereby ensuring the profitability and competitiveness of their production (World Bank, 2007).

The strategy "Let's Get to Work" aims to:

1. Develop agricultural producers and their organizations

2. Increase production and improve competitiveness through increased yields and lower unit costs

3. Promote agricultural transformation oriented toward demand and linked to agro-exports, agro-industry and technological innovation

4. Meet the needs of the marginalized rural populace via socioeconomic programs that improve the quality of life for rural families, with emphasis on indigenous areas

5. Promote institutional strengthening for the development of the agricultural sector

A5.1.3: Strategy for Sustainable Development

Panama's submission to the World Bank's Forest Carbon Partnership Facility reports on its 2004 "Strategy of Conservation for Sustainable Development" (2004 – 2009) which includes among its main objectives (FCPF, 2008):

1. To fortify the capacity of ANAM to exercise its functions of rectory, regulation and control of environmental material, to contribute in the success of the transition of Panamanian society towards sustainable forms of organization of the development processes

2. To work more closely with the other agencies of the state, with local governments, with the private sector, with academics and with civil society

3. Prioritizing those components of the conservation strategy for sustainable development which have greater benefits for the welfare of the population, natural resources of the country and the creation of jobs

A5.2: Timeline Panama (BBC, 2009)

1502 - Spanish explorer Rodrigo de Bastidas visits Panama, which was home to Cuna, Choco, Guaymi and other indigenous peoples.

1519 - Old city founded. Panama becomes Spanish Vice-royalty of New Andalucia (later New Granada).

1821 - Panama becomes independent of Spain, but joins the confederacy of Gran Colombia, which also comprises Colombia, Venezuela, Ecuador, Peru and Bolivia.

1830 - Panama becomes part of Colombia following the collapse of Gran Colombia.

1846 - Panama signs treaty with US allowing it to build a railway across the isthmus.

1880s - France attempts to build a canal linking the Atlantic and Pacific oceans, but fails due to financial difficulties and the death of more than 20,000 workers from tropical diseases.

Independence, building the canal

1903 - Panama splits from Colombia and becomes fully independent. US buys rights to build Panama Canal and is given control of the Canal Zone in perpetuity.

US controlled the Panama Canal for almost a century
Length: 65 km (40 miles)
1 January 2000: Control passes to Panama by treaty from the USA

1914 - Panama Canal completed.

1915 - Official opening

1939 - Panama ceases to be a USA protectorate.

1968-81 - General Omar Torrijos Herrera, the National Guard chief, overthrows the elected president and imposes a dictatorship.

1977 - US agrees to transfer the canal to Panama as from 31 December 1999.

1981 - Torrijos dies in plane crash.

1983 - Former intelligence chief and one-time USA Central Intelligence Agency informant Manuel Noriega becomes head of the National Guard, builds up the size of the force, which he renames the Panama Defence Forces, and greatly increases its power over Panama's political and economic life.

1988 - USA charges Noriega with drug smuggling; Noriega declares state of emergency in the wake of a failed coup.

USA invades (See page A43)

1989 - Opposition wins parliamentary elections, but Noriega declares results invalid. Noriega declares "state of war" in the face of increased threats by Washington. The USA invades Panama, ousts Noriega and replaces him with Guillermo Endara.

1991 - Parliament approves constitutional reforms, including abolition of standing army; privatisation begins.

1992 - USA court finds Noriega guilty of drug offences and sentences him to 40 years imprisonment, to be served in a US prison.

1999 - Mireya Moscoso becomes Panama's first woman president.

1999 December - Panama takes full control of the Panama Canal, ending nearly a century of American jurisdiction over one of the world's most strategic waterways.

2000 - Moscoso announces creation of a panel to investigate crimes committed while military governments were in power between 1968 and 1989.

2002 January - President Moscoso sets up a commission to investigate corruption. The move follows large street protests against alleged graft in government circles.

2002 April - Panama removed from international list of uncooperative tax havens after promising to make its tax system more transparent.

2003 September - National strike over management of social security fund paralyses public services. More than 40 hurt in clashes.

2004 May - Martin Torrijos, son of former dictator Omar Torrijos, wins presidential elections.

2004 August-September - President Moscoso pardons four Cuban exiles Havana accuses of plotting to kill Cuban President Castro. Cuba severs ties. Newly-inaugurated President Martin Torrijos pledges to repair relations; both countries agree in November to restore ties.

2004 November - Panama Canal earns record revenues of $1 billion for the financial year.

2005 May-June - Plans to increase pension contributions and raise the retirement age spark weeks of protests and strikes. President Torrijos had promised to reform the cash-strapped social security system.

2006 - At least 50 people die after taking cough medicine tainted with an industrial solvent imported from China.

Canal upgrade

2006 October - Voters in a referendum back a $5.2bn plan to upgrade the Panama Canal. The scheme aims to double the capacity of the waterway.

2006 December - Panama and the US agree on a free trade deal.

2007 September - Work to widen Panama Canal begins.

2008 February - Fatal shooting of union leader triggers violent clashes between police and construction workers in Panama City.

2008 December - A Russian warship sails through the Panama Canal for the first time since World War II. The canal was shut to the Soviet Union during the Cold War.

2009 April - A US federal appeals court says Panama's ex-leader, Manuel Noriega, can be extradited to France. Noriega was released from a Florida prison in September 2008 after serving a 17-year sentence for drug trafficking.

2009 May - Ricardo Martinelli of the conservative opposition Alliance for Change coalition wins presidential election, defeating Balbina Herrera of the ruling centre-left Democratic Revolutionary Party.

Source: BBC (2009)

A5.3: Panama's historical context

Since 1904, every Panamanian constitution (including the current 1972 version) has dictated the government's right to govern and exploit indigenous lands; "reservas" or "comarcas". The General Environmental Law (Law 41) of July 1998 (Asamblea Legislativa, 1998) sought to address this. It gave explicit protection, guaranteeing rights to control and develop lands and resources, engage in autonomous development, and retain profits from development carried out by others within their "comarca". Other recent legislation has recognized indigenous authorities as part of the national system, acknowledging the need for consultation when development decisions affect them. However, the enforcement of policies that protect the poor indigenous and their lands has been lax or absent, while private property rights and economic development projects within comarcas have had full state protection (Wickstrom, 2003).

Capitalist development has failed to address Panama's poor majority (Wickstrom, 2003) with business, money and investment historically being centered on the Canal. Elsewhere, forests and rural lands have been practically ignored (Zanin, 2005). Panama's socioeconomic asymmetry since colonial times has been politically driven. Multinational corporations and Panama's tiny elite class have gained from the distribution of land, technical services, and capital, while subsistence farmers have been increasingly forced onto smaller and lower quality lands. Poverty and environmental destruction in rural Panama are primarily due to the imposition of political-economic institutions and their practices, projects and priorities. In response, subsistence farmers facing poverty in deforested and heavily eroded areas have migrated into forested areas with relatively intact natural resources and a high level of globally significant biodiversity. They leave the land more prone to fire and erosion, move on to new plots, and the cycle repeats (World Bank, 2006; Zanin, 2005). Government incentives have compounded the problem while national banks finance the construction of new roads in remote areas, opening up the forests to more logging, exploitation, and migration (Zanin, 2005). Agriculture is often the only option for the rural poor and cattle-ranching is a part of Panama's culture and identity. Culture and behavior are often difficult to change, particularly in the absence of crisis (Wallander, 2007; Runk et al, 2007).

The Panama Deception

Source: http://www.addictedtowar.com/docs/panama.htm

Elizabeth Montgomery, Narrator: "On December 19th 1989, while Panamanians were getting ready for the Christmas holidays, the United States was secretly mobilizing 26,000 troops for a midnight attack."

"The invasion was swift, intense and merciless."

"When it was over, thousands lay dead and wounded and the country was in shambles."

"Millions of U.S. tax dollars were swallowed up in three days of brutal violence."

"In many ways, the invasion served as a testing ground for the Persian Gulf War one year later. It is also an indication of the kinds of intervention the United States may undertake in the years to come. But still, big questions remain. What exactly happened during the invasion of Panama? And why?"

"As the invasion unfolded, Americans stayed glued to their TV's and newspapers for coverage. But how much of the real picture did the media give them?"

Michael Parenti, Author / Professor: "The performance of the mainstream news media in the coverage of Panama, has been just about total collaboration with the administration. Not a critical murmur, not a critical perspective, not a second thought."

Mark Hertsgaard, Author / Journalist: "The story that the White House was pushing, was getting this so-called Narco-terrorist in a net. And that was the thrust of all of the coverage. When are we going to get Noriega? Have they let Noriega get away?"

American news segments: "By late today, they had taken control of much of the country but their chief target, General Manuel Noriega, escaped."

"Manuel Noriega belongs to that special fraternity of international villains. Men like Qadaffi, Idi Amin, and the Ayatollah Khomeni, whom Americans just love to hate."

Valerie Van Isler, International journalist: "They focused on Noriega to the exclusion of what was happening to the Panamanian people, to the exclusion to the bodies in the street, to the exclusion of the number dead, to the exclusion of what happened to the women and children in that country, during this midnight invasion."

Narrator: "Noriega was head of Panama's military intelligence and had a long standing relationship with the United States. He had been on the CIA payroll since the 60's. When George Bush became Director of the CIA in 1976, under President Ford, he inherited Noriega as a contact. Despite evidence that Noriega was involved in drug trafficking, Bush kept Noriega on the payroll. In fact, he increased Noriega's salary to more than $100,000 a year and eliminated a requirement that intelligence reports on Panama include information on drug trafficking."

"With support from the CIA, Noriega was able to outmaneuver his rivals and in August of 1983, he became Commander of the Panamanian Military. As the Reagan administration expanded its covert war against the Sandinista government in Nicaragua, Noriega became increasingly helpful. Working with the CIA, and with Israeli arms dealers, Noriega helped coordinate an arms supply network to provide weapons to contra bases in northern Costa Rica."

Professor Peter Dale Scott, Author / Professor: "Noriega's involvement in the drug traffic really increased his importance as a source for the CIA and as someone who was able to conduct dirty tricks in the region for the CIA. So it's no accident that the CIA became the most prominent defenders of Noriega against the drug charges, because that's the sort of thing which CIA clients tend to do."

Narrator: "Despite Noriega's collaboration with many U.S. covert operations, he was becoming increasingly uncooperative with U.S. objectives in Central America. In 1984, he angered the Reagan administration by hosting Latin American leaders at the Contadora Peace Talks. The talks called for an end to U.S. intervention in Central American affairs."

American news segments: "But relations with Panama are under a new cloud tonight because of news reports alleging….."

"Senator Jesse Helms charged today that the military strongmen of Panama, Manuel Noriega, is the number one drug trafficker in the Americas."

Narrator: "The Reagan administration now openly called for his removal."

Former President Ronald Reagan: "We do want Noriega out of there and a return to a civilian democratic government."

Narrator: "The U.S. now undertook a systematic effort to overthrow Noriega. Economic sanctions were stepped up and additional troops were dispatched to Panama."

American news segment: "The United States tonight declared in effect that Panama's General Manuel Noriega is a threat to this country's national security."

Former President George Bush, Sr.: "Mr. Noriega, the drug indicted, drug-related, indicted dictator of Panama. We want to bring him to justice. We want to get him out and we want to restore democracy to Panama ...."

Narrator: "Sabina Virgo, a national labor organizer, was in Panama just weeks before the invasion.

Sabina Virgo, National Labor Organizer, USA: "Provocations against the Panamanian people by the United States military troops were very frequent in Panama and they had several results and in my opinion probably a couple of different intents. One, I think, was to create an international incident, was to have United States troops just hassle the Panamanian people until an incident resulted and from that incident the United States could then say that they were going into Panama for the protection of American life, which is in fact exactly what happened."

Narrator: "On December 20th, U.S. troops invaded Panama. The invasion was code-named *Operation Just Cause*. Shortly after midnight, U.S. troops simultaneously attacked 27 targets, many of which were in densely populated areas. One of the primary targets in Panama City was the headquarters of the Panamanian Defense Forces, located in the crowded neighborhood of El Chorillo. U.S. troops shelled the area for four hours before moving in and calling for surrender."

Voice of USA soldier: "We ask you to surrender..... If you do not, we are prepared to level each and every building….."

Narrator: "It soon became clear that the objectives were not limited only to military targets. According to witnesses, many of the surrounding residential neighborhoods were deliberately attacked and destroyed."

Unknown person describing what they saw: "They shot at everything that moved, without mercy and without thinking whether there were children or women or people fighting. Instead, everything that moved they shot."

Woman speaking in Spanish (Voice of translator): "The North Americans began burning down El Chorillo at about 6:30 in the morning. They would throw a small device into a house and would catch on fire. They would burn a house and then move to another and begin the process all over again. They burned from one street to the next. They coordinated the burning through walkie-talkies."

Narrator: "The Pentagon used Panama as a testing ground for newly developed high tech weapons such as the Stealth Fighter, the Apache Attack helicopter, and laser guided missiles."

Rear Admiral Eugene Carrol, *Center for Defense Information*: "President Bush wanted to make certain that this was going to be a success. This was going to be his vindication, denial of the wimp factor in spades. So they sent down a force that wasn't going to encounter any effective resistance but simply overwhelm the opposition and the fact that it would cause tremendous peripheral damage, damage to innocent civilians on a wide scale, was not of concern in the planning."

Mark Hertsgaard, Author / Journalist: "My God, we were sending in artillery and air strikes against a very heavily populated urban area. There was absolutely no question that there were going to be immense numbers of civilian casualties."

Narrator: "During the days and weeks following the invasion, the U.S. policy of applying overwhelming deadly force continued. There were many reports of indiscriminate killings and executions of unarmed civilians."

Gavrielle Gemma: *Independent Commission of Inquiry*: "We have eye witness accounts on the part of a number of Panamanians where soldiers took Panamanians who had been captured after the invasion and executed them on the street."

Narrator: "During the week of the invasion, more than 18,000 people who fled from the areas of attack were forced into temporary detention centers created by the U.S. forces."

Gavrielle Gemma: "They arrested close to 7,000 Panamanian individuals. They arrested almost every trade union leader, the leaders of the nationalist parties, of progressive parties, of Left parties in Panama. They arrested people who were cultural leaders. There are still hundreds of Panamanians who remain in jail, with no due process, with no formal charges against them."

Narrator: "As a result of the U.S. invasion, an estimated 20,000 Panamanians lost their homes. Hardest hit were residents in the poor neighborhoods of San Miguelito, Colon, Panama Veijo, and El Chorillo."

"How many people were killed in Panama? And who were they? These questions may never be answered because the United States military undertook elaborate efforts to conceal the number of dead, how they died, and the location of their bodies."

Robert Knight, journalist: "What happened in Panama is a hidden horror. Many of the bodies were bulldozed into piles and immolated in the slums where they were collected. Other bodies were left in the garbage shoots of the poor projects in which they died from the shooting, from the artillery, from the machine guns, from the airborne attacks. Others were said to have been pushed into the ocean."

Representative Charles Rangel (Democrat, New York)**:** "The truth of the matter is that we don't even know how many Panamanians we have killed. But we should have more information on what happened. How many civilians were killed?

Narrator: "The National Human Rights Commission of Panama interviewed hundreds of people in an effort to determine how many had died."

Olga Mejia, (***National Human Rights Commission)*****:** "What we have is different testimonies that help us to arrive to the conclusion that for sure, there were more than 4,000 people who died."

Jeff Cohen, Fairness and Accuracy in Reporting (www.fair.org): "The U.S. military said 250 civilians were killed. I mean, there isn't a credible source in Panama that believes that's true. Whether it's ambulance drivers, human rights monitors, doctors who worked in hospitals, neighbors of bombed out blocks. It's just clearly false. That story would be so easy to tell for any journalist worth his or her salt. But they're not telling it."

Michael Parenti: "When they interviewed people in Panama about what they thought of it, they invariably were interviewing white, middle class people, who could speak English. They didn't really go into the poor neighborhoods where people had been bombed. Did you see one media actually go into the bombed areas and talk to people who had lost a family or lost everything they had in the bombings? They focused totally on the invasion as a tactical event. Was it effective? Did it work well? Are we losing many American lives?"

American news segments: "While another unit moved in by helicopter"….. "15 American servicemen have died"……. "Gertrude Candy Haland, from Dixon, Illinois, is the twentieth American to die."

Parenti: "They focused with utter ethnocentrism only on American lives. The only life that was precious, the only life that one could report on, the only life that one could consider as a serious loss was an American life."

Narrator: "In the months following the invasion, Panamanians were shocked to discover the existence of mass graves where hundreds, perhaps thousands, of bodies were hastily dumped into pits and buried by U.S. troops."

Jose Morin *(Center for Constitutional Rights)***:** "To date, there have been 15 mass graves that have been identified throughout Panama. The United States military was directly responsible for the killings of the men, women and children that are in these mass graves and for their burial. These mass graves exist throughout Panama and some are believed to be on U.S.military bases which creates a difficulty in terms of access to these mass graves."

Voice of translator: "We found many young people, 15, 16, 18 years old. We found people in their '60s, and in their '70s. We found people killed by a shot to the back of their heads. Dead with their hands tied. Dead with casts on their legs or arms."

Narrator: "Although the U.S. media created a perception of support for the invasion within the United States, the invasion was overwhelmingly condemned in the international community."

Jeff Cohen: "If you look at any document in international law, any of numerous treaties, it's clear that this invasion was illegal. It's not debatable."

Joseph Morin, (*Center for Constitutional Rights)***:** "The Panama invasion violates the UN Charter and the OAS Charter which have specific prohibitions against invasions of sovereign country and invasions of the territorial integrity of other countries. These prohibitions are very strict and clear under international law. The United States actions, in violation of human rights, also violates the Geneva Convention which protects civilians from indiscriminate acts of violence as had occurred against civilian victims in Panama."

Mark Hertsgaard: "The four biggest most important papers in this country all endorsed the rightness of the Panama invasion. That's the Washington Post, the Los Angeles Times, strong endorsements, the New Times and the Wall Street Journal. Everyone of them. Now, a little body known as the United Nations had a vote about this. On December 29th they voted by an overwhelming majority to condemn the invasion as, in their words, "a flagrant violation of international law."

Michael Parenti: "The media was so cooperative with the government because the media are owned by the same interests that are being defended in Central America by that government policy. The media are not close to corporate America. They are not favorable to corporate America. They *are* corporate America. They are an integral part of corporate America."

Ramsey Clark: "We are a plutocracy. We ought to face it, a country in which wealth controls. May be true of all countries more or less but uniquely true of ours because of our materialism and the concentration of wealth here. Even our democratic processes are hardly that because money dominates politics and we know it. Through politics, it dominates government, and it dominates the media. We

really need desperately to find new ways to hear independent voices and points of view. It's the only way we are going to find the truth."

Former USA President George Bush Sr.: "The goals of the United States have been to safeguard the lives of Americans, to defend democracy in Panama ....."

Rear Admiral Eugene Carrol: "Then President Bush said we had to go to restore democracy in Panama. How in the world do you restore that which has never existed? Panama has never been a democracy since we created Panama for our own purposes in 1903. And all we did was go down to restore American control and dominance in Panama."

Narrator: "The new government installed by the invasion, was headed by the U.S.-backed candidates from the aborted national election, Endara, Calderon and Ford. Hours before the invasion, they were taken to a U.S. military base where they were sworn in as the President and Vice Presidents."

Esmeralda Brown, (*United Nations Methodist Office)***:** "Of course he is not going to say that Panama is occupied. In fact, he might not even call it an invasion. It wasn't his kind that were killed or massacred. He lives in the nicer area in the oligarchical area and you know his interest is protected. He is not running Panama, he is a puppet of the U.S. government. The U.S. government is running Panama. They are running all of the ministries in Panama. He's only abiding by what he's told to do."

Robert Knight, *(Investigative Journalist)***:** "The invasion sets the stage for the wars of the 21st century in South America. The 2,000-mile invasion from Washington to Panama City took place primarily with bases from the United States. The essential value of the Southern Command is to get another 2,000 miles of intervention capability which takes us right into the heart of the Andean cocoa producing region, where the wars of the next decade are entirely likely to take place."

Peter Kornbluh, *(National Security Archive)**:*** "Panama is another example of destroying a country to save it. And it's another case of how the United States has exercised a "might makes right" doctrine among smaller countries of the Third World. It has long been U.S. practice to invade these countries, get what we want, and leave the people that live there to kind of rot."

Angry woman, (Voice of translator)**:** "George Bush, may his children be spared what my daughter has been subjected to. My daughter, who doesn't want to live! May his generation be spared what our generation is living through! He should ask God for forgiveness for all the damage caused to many families down here!"

Former USA President George Bush, Sr.: "One year ago the people of Panama lived in fear under the thumb of a dictator. Today, democracy is restored. Panama is free."

Narrator: "In March 1991, President Guillermo Endara proposed a constitutional amendment that would forever abolish Panama's right to have an army. Later that year, a law was passed by the United States Congress to renegotiate the Panama Canal Treaties to ensure continued U.S. military presence in Panama, on the grounds that Panama was no longer capable of defending the canal."

Source: http://www.addictedtowar.com/docs/panama.htm

A5.4: The new California (Morais, 2008)

Monaco with Bananas

Richard C. Morais 04.17.08, 5:00 PM ET
Forbes Magazine dated May 05, 2008

Panama makes itself over as its lenient tax structure and strong economy attract investors and entrepreneurs

In 2005 Alexandre and Aude de Beaulieu, Parisians in commodities trading and public relations, picked up stakes and flew to the Republic of Panama. For $60,000 they bought, renovated and equipped a shop in Casco Viejo, a decrepit Panama City neighborhood that was filled with squatters but so architecturally unique it is a Unesco World Heritage site. Their business: gourmet ice cream, with flavors like cinnamon and basil.

"Everyone told us we were crazy," says Alexandre. By which they meant that the entrepreneurs should set up shop closer to home. But France's thicket of taxes, regulations and restrictions on hiring and firing workers scared them away. "Panama is like California 20 years ago. Everyone I know is building something--a newspaper, a development. It's very uplifting."

The De Beaulieus' ice cream parlor, called Granclément, furnished with family heirlooms and antique scoopers, has got glowing writeups in the *Financial Times* and numerous local papers. When FORBES visited the shop in February, a European film crew was shooting Granclément for a travelogue to be aired on KLM flights. Down the cobblestone lane construction workers were restoring a crumbling palace as a five-star hotel, while the latest James Bond flick was being filmed in a nearby square.

Granclément is busy enough to generate maybe $150,000 a year in revenue, a good take in a country where shop clerks earn $4,000 in salary and benefits. So these 36-year-old self-starters and their four young children are on their way to becoming wealthy. This year the De Beaulieus will add supermarket distribution and a shop

among the Miami-style high-rises and malls getting built in the modern banking quarter across the bay.

Panama granted the U.S. "sovereign rights" to a 500-square-mile zone down the center of the country at its independence in 1903; in 1914 the U.S. linked the Pacific and Atlantic oceans with a canal. Poverty festered and the Panamanian military periodically undermined the nation's democratic credentials, most famously in the 1980s when the drug-money-tainted dictator Manuel Noriega was overthrown by the U.S. It was only in 1999 that the U.S. completely relinquished rights to the canal.

America's recent exit was in some ways the real birth of Panama. This lively backwater--famous mostly for flying maritime flags of convenience and hosting dodgy finance--seems to have found its voice. Democratically elected governments have clamped down (somewhat) on corruption, signed several free trade agreements (the U.S. Congress has yet to ratify a 2007 deal with Panama) and instituted tax and social reforms.

Meantime, even as the U.S. pulled up its drawbridge to many foreigners after the Sept. 11 attacks, its dollar was the standard for Panama, which (until lately, at least) has found the currency bulwark an additional attraction for some of those same itinerants.

Result: Panama's GDP has been compounding at 7% these last five years. "Something's happened," says Joseph Harari, director of Panama's **Credicorp** (nyse: BAP - news - people) Bank and an executive board member at the Wharton School in Philadelphia. "We've always had very liberal tax laws. But we also use the U.S. dollar to run our economy. It all helped."

Panama's corporate tax rate is 30% and is levied on local income only. The U.S.' 35% federal corporate tax burden is, in contrast, the second highest in the world and is applied to global income. **Caterpillar** (nyse: CAT - news - people), **Procter & Gamble** (nyse: PG - news - people) and **Hewlett-Packard** (nyse: HPQ - news - people) have all recently announced significant investments in Panama. The personal income tax, capped at 27%, is also limited; the De Beaulieus, for example, don't pay Panamanian taxes on their French investments, which face high levies at home.

Between the glass towers of HSBC and BNP Paribas, South Beach-quality apartment complexes emerge from every weed-choked lot, turning Panama City's skyline into a porcupine of cranes. New developments are granted tax holidays for 10 to 20 years. On the seaside Avenue Balboa, famed interior designer Philippe Starck is filling a 56-floor tower; Panamanian and Colombian partners have teamed up with Donald Trump to build the 68-story Trump Ocean Club International Hotel & Tower, financed by a $220 million bond offering.

According to one report 35 towers of over 20 floors are under construction. Besides the danger of overbuilding, there are stress signs of too-rapid growth: brownouts from an overtaxed electricity grid, a Third World sewage system under the First World high-rises. Filth is still pumped into the bay. The government says it is working on sewerage improvements.

Of course, the newly arriving affluent also want high culture and good health care. Frank O. Gehry is designing Panama's museum of biodiversity; Hospital Punta Pacifica is the recently opened affiliate of Johns Hopkins Medicine International.

The old Howard U.S. Air Force Base is a 20-minute drive from downtown Panama City. Dotted with ugly barracks, this 3,500-acre property is still oddly elegant, with rolling lawns and hills, reminiscent of an African savanna, interspersed with flowering rain forest. Europe's London & Regional Properties, with partners, recently won the contract for Howard.

The plan, says Dan R. Marcus, an American developer who just arrived to run the project, is to build 12 million square feet of commercial space alongside 20,000 housing units, all woven together in a "holistic way." Houses will be integrated into the lush forest; on hand, everything from fire stations to chic restaurants. A free trade zone grants Howard-based firms generous vat to income tax breaks.

Backstopping all this glamour and hype are the canal and related ports. Some 14,000 ships a year make their way through the 50-mile link, paying a fee of up to $313,000. In 2006 Panamanians voted to build an additional set of locks, for $5.3 billion, that in 2014 will double capacity and finally allow modern and much larger container ships to pass through.

Canal revenue has jumped from $500 million to $1.8 billion since Panama took over eight years ago, and even a small cut of all the commerce with Asia coming through the expanded canal is likely to make a nation of 3.3 million quite prosperous over the coming years. "Everyone said that Panama would let the canal go to hell. In fact they've done a very good job maintaining it," says David Wilson, a semiretired California engineer consulting around the ports run by Hong Kong's **Hutchison Whampoa** (other-otc: HUWHY.PK - news - people).

Of course, below the surface of its newfound glitz, the seedy Panama of lore still flourishes. For $1,100, says Carlos Neuman, a 29-year-old immigration lawyer with slicked-back hair, he can, perfectly legally, set anybody up with a shell company. "If you don't want anyone to know about your money, no one will know," he assures us. The shell's three directors cost only $300 a year each. Panama lacks a tax treaty with the U.S. Its banking sector, while much cleaned up, is still laundering drug money, and, **says the CIA, "official corruption remains a major problem."**

Still, Panama has juice. At the dated but busy Veneto Casino, South American men line the bar, sipping beer and watching a soccer match. Gamblers pull the slots as hookers work the house. There's a lot of money sloshing around, and there will be more of it.

Source: Morais (2008)

Appendix 6: Organic farming (Hole et al., 2005)

Appendix A. Farming practices characteristic of organic systems and their likely impacts on biodiversity

Farming practice	Probable effects on biodiversity
Prohibition/reduced use of chemical pesticides	• Organic systems rely on a variety of practices (e.g. biological control; crop rotation; mechanical weed control) to manage plant and invertebrate pests (Lampkin, 2002) ⇒ avoids direct and indirect effects of pesticides on target and non-target organisms • *Direct effects*: herbicides ⇒ significant factor in the declines of many once common arable flowers in the UK (Cooke and Burn, 1995) and Europe (Andreasen et al., 1996), e.g. corn buttercup *Ranunculus arvensis*, night-flowering catchfly *Silene noctiflora* and prickly poppy *Papaver argemone* (Wilson and Sotherton, 1994); insecticides ⇒ major negative influence on invertebrate communities (Ewald and Aebischer, 1999), including anecic earthworms (Pfiffner and Mader, 1997), butterflies (Cilgi and Jepson, 1995; Feber et al., 1997) and epigaeic arthropods (Clausen, 1990; Kromp, 1989; Pfiffner and Niggli, 1996) • *Indirect effects*: removal of plant food resources and alteration of microclimate ⇒ negative impacts on invertebrate populations (Bell et al., 2002; Feber et al., 1998; Haughton et al., 1999; Kromp, 1989; Pfiffner and Niggli, 1996); reduction in both plant seed food resources and invertebrate abundance significant factor in the declines of a range of farmland bird species (Campbell et al., 1997; Donald et al., 2001b; Wilson et al., 1999); e.g. grey partridge Perdix perdix (Potts, 1986, 1997), yellowhammer *Emberiza citrinella* (Morris, 2002) and likely to have had a negative impact on mammals such as common shrew *Sorex araneus*, woodmouse *Apodemus sylvaticus* and badger *Meles meles* (Flowerdew, 1997)
Prohibition of mineral-based fertilisers	• Organic systems rely on a variety of practices (e.g. animal and green manuring; traditional crop rotations including a grass-clover ley or legume crop) to enhance soil fertility (Lampkin, 2002) ⇒ avoids detrimental impacts on biodiversity resulting from high levels of inorganic fertiliser application (Sotherton and Self, 2000) and consequent high stocking rates • *Effects predominantly indirect*: elevated crop growth rates ⇒ crop out-competes slower-growing arable weeds (Green, 1990); e.g. cornflower *Centaurea cyanus* (Stewart et al., 1994); increase in crop structural density ⇒ alters microclimate at soil level with potentially negative consequences for invertebrate fauna (Hokkanen and Holopainen, 1986; Kromp, 1989, 1990; Pfiffner and Niggli, 1996); limits foraging and nesting opportunities for bird species; e.g. lapwing *Vanellus vanellus*, skylark *Alauda arvensis* and yellow wagtail *Motacilla flava* (Galbraith, 1988; Nelson, 2001; O'Connor and Shrubb, 1986; Wilson et al., 1997)
Mechanical weeding	• Involves the dragging of tines or hoes across the soil surface to remove young weeds (Pullen and Cowell, 1997) • Often less efficient than using herbicides (Krooss and Schaefer, 1998) ⇒ contributes to a greater abundance of non-crop flora in arable fields, indirectly supporting higher densities of arthropods (Kromp, 1989, 1999) • Can be highly effective under certain conditions (Pullen and Cowell, 1997) ⇒ extensive use may lead to the decline of long-lived winter annuals and support of short-lived summer annuals, potentially leading to a more impoverished weed flora (van Elsen, 2000) • May cause high mortality amongst eggs and chicks of ground-nesting bird species (Hansen et al., 2001) unless carefully timed
Farmyard and green manuring	• Animal waste and green manures (i.e. the ploughing in of specific unharvested crops) ⇒ used to replace nitrogen and other elements and to build up soil organic matter content (Lampkin, 2002) • Generally supports a greater abundance of invertebrates that rely on un-degraded plant matter as a food source, e.g. earthworms (Gerhardt, 1997; Pfiffner and Mader, 1997), carabids (Kromp, 1999), and more diverse microbial communities (Fraser et al., 1988) • Can result in insufficient input of nitrogen into organic systems ⇒ leads to poor crop and weed growth, the development of an unfavourable microclimate and a depauperate invertebrate community (Brooks et al., 1995; Krooss and Schaefer, 1998)
Minimum tillage	• Involves the use of discs or tines to disturb the soil surface without physical turning of the soil (Lampkin, 2002) • Avoids detrimental effects of inversion ploughing (physical destruction, dessication, depletion of food and increased exposure to predators (Stoate et al., 2001)) on invertebrate populations; e.g. earthworms (Gerhardt, 1997; Higginbotham et al., 2000); spiders (Haskins and Shaddy, 1986); collembola (Alvarez et al., 2001) and other macrofauna (Krooss and Schaefer, 1998) • May negatively impact carabids ⇒ often found in greater abundance on ploughed fields (Baguette and Hance, 1997) • May modify floral community (McCloskey et al., 1996) ⇒ minimum tillage tends to favour annual weeds (Albrecht and Mattheis, 1998; Cousens and Moss, 1990) whilst perennial broad-leaved weeds are more common under ploughed regimes (Frick and Thomas, 1992; Higginbotham et al., 2000), as a result of variations in seed longevity and species-specific germination patterns • Effects on vertebrates are largely unknown ⇒ some evidence that minimum tillage may benefit bird communities (Lokemoen and Beiser, 1997; McLaughlin and Mineau, 1995)

Appendix A (*continued*)

Farming practice	Probable effects on biodiversity
Intercropping and undersowing	• Both can be used in a rotation to suppress weeds (Baumann et al., 2000) and increase crop yields (Fukai and Trenbath, 1993) • Undersowing increases vegetation structure and heterogeneity ⇒ enhances invertebrate populations; e.g. sawflies (Hymenoptera: Symphyta), carabids and spiders (Helenius et al., 1995; Potts, 1997; Sunderland and Samu, 2000); provides a greater abundance of invertebrate food resources for birds and mammals, e.g. grey partridge (Ewald and Aebischer, 1999; Potts, 1997) and corn bunting (Brickle et al., 2000) • Subsequent over-winter crop stubbles may provide only limited seed accessibility to granivorous birds as a result of a reduction in the area of exposed soil (Moorcroft et al., 2002) • Effects of intercropping on biodiversity are largely unknown ⇒ increase in heterogeneity may favour increased invertebrate diversity; e.g. polyphagous predators (Altieri and Letourneau, 1982; Sunderland and Samu, 2000)
Sensitive field margin/ hedgerow management/ creation of non-crop habitats	• Actively encouraged by organic standards to bolster natural predator populations (e.g. Soil Association, 1999) • Establishment of field margins and beetle banks ⇒ develops and supports larger, more diverse invertebrate communities (de Snoo, 1999; Haysom et al., 1999; Moreby et al., 1994; Thomas et al., 2002); e.g. predatory beetles (Lys and Nentwig, 1994); provides overwintering sites and refuges following harvest (Frieben and Kopke, 1995; Gluck and Ingrisch, 1990); supports a more diverse arable flora (Wilson and Aebischer, 1995); provides important nesting and feeding habitat for birds; e.g. yellowhammer (Bradbury et al., 2000; Morris et al., 2001), grey partridge (Rands, 1985, 1986), whitethroat *Sylvia communis* (Eaton et al., 2002) and a variety of small mammals (Smith et al., 1993) • Positive hedgerow management ⇒ reduced herbicide spray drift (prohibited in organic systems) prevents impoverishment of hedge bottom (Aude et al., 2003; Jobin et al., 1997; Kleijn and Snoeijing, 1997); results in greater floral diversity and increased invertebrate populations (Boatman et al., 1994); greater width and structural diversity is positively associated with abundance and species richness of breeding birds (Green et al., 1994; Hinsley and Bellamy, 2000; Parish et al., 1994, 1995); provides sheltering habitat for mammals; e.g. brown hare *Lepus europaeus* (Tapper and Barnes, 1986) • Hedgerows and other non-crop habitats provide dispersal corridors and islands in otherwise fragmented landscapes ⇒ facilitate dispersal of; e.g. many bird species (Hinsley and Bellamy, 2000), mammals (Fitzgibbon, 1997; Tew et al., 1994) and beetles (Holland and Fahrig, 2000) • Some bird species favour shorter hedgerows; e.g. whitethroat (Eaton et al., 2002) and linnet (Moorcroft, 2000); skylark and lapwing avoid tall boundary structures (O'Brien, 2002; Wilson et al., 1997)
Small field size	• Requirement for stock-proof boundaries in conventional mixed and organic systems is likely to result in smaller average field size than on specialist arable farms (e.g. Chamberlain and Wilson, 2000) • Evidence suggests small fields support greater biodiversity per unit area (principally as a result of a higher percentage of non-crop habitat separating individual fields) ⇒ abundance and diversity of carabids, spiders and arable flora decreases with distance from field margins (Frieben and Kopke, 1995; Hald, 1999; Jmhasly and Nentwig, 1995; Kay and Gregory, 1998, 1999; Kromp, 1999); large fields support less diverse spider communities (Basedow, 1998; Gluck and Ingrisch, 1990); density of brown hares is higher on farms with smaller fields (Tapper and Barnes, 1986)
Spring sown cereals	• Delayed development of spring-sown cereals (in comparison to autumn-sown) produces shorter, less dense crops in early and mid-season ⇒ preferred breeding and foraging habitat for a number of bird species; e.g. skylark (Donald et al., 2001b; Wilson et al., 1997), lapwing (Galbraith, 1988) and corn bunting (Brickle et al., 2000) • Spring sowing frequently results in stubble fields being left over part or all of the winter ⇒ allows spring-germinating annual weeds to set seed and germinate; e.g. cornflower, red hemp-nettle *Galeopsis angustifolia* (Stewart et al., 1994) and corn marigold *Chrysanthemum segetum* (Wilson and Sotherton, 1994); provides a crucial winter food source (i.e. weed seed and spilt grain) for seed-eating birds (Donald and Evans, 1994; Evans, 1997; Wilson et al., 1996); e.g. corn bunting (Brickle et al., 2000), cirl bunting (Evans and Smith, 1994)
Crop rotation	• Involves the planting of a sequence of crops, including a grass ley (often undersown into the previous crop) – used primarily to control weeds and other pests/diseases; also to enhance soil fertility via the inclusion of a legume (e.g. clover in the grass mix) (Lampkin, 2002; Liebman and Dyck, 1993; Stoate, 1996) • Presence of a grass-clover ley ⇒ significantly enhances populations of non-pest butterfly species (Feber et al., 1997); undersowing encourages invertebrate populations (see above) • Increased crop diversity ⇒ may benefit a variety of species that require a structurally diverse crop/habitat mosaic; e.g. skylark (in order to make multiple breeding attempts (Wilson et al., 1997)), lapwing (require adjacent cereal and pasture (Galbraith, 1988; Tucker et al., 1994)), brown hare (graze a variety of crops at different times of the year (Tapper and Barnes, 1986))
Mixed farming	• The occurrence of arable fields in close juxtaposition with pastoral elements is likely to have significant benefits for biodiversity across a range of taxa ⇒ increases habitat heterogeneity at multiple spatial and temporal scales (Robinson et al., 2001; Stoate et al., 2001; Vickery et al., 2001; and see Benton et al., 2003 for a review)

(*Note*: these practices are not exclusive to organic farming and may be utilised within some conventional systems).

Source: Hole et al. (2005)